PUBLIC REQUEST TO ADDRESS
THE BOARD OF SUPERVISORS
COUNTY OF LOS ANGELES, CALIFORNIA

MEMBERS OF THE BOARD

HILDA L. SOLIS
HOLLY J. MITCHELL
LINDSEY P. HORVATH
JANICE HAHN
KATHRYN BARGER

Correspondence Received

			The following individuals submitted comments on agenda item:	
Agenda #	**Relate To**	**Position**	**Name**	**Comments**
8.		**Favor**	Victoria Yundt	In Favor of SAFER appeal
		Other	Chad Christensen	These comments were originally submitted to publichearing@bos.lacounty.gov, and ExecutiveOffice@bos.lacounty.gov on Monday, 3/16/26, before 5:00 PM as shown in the attached "2026-03-16 MRCA Comments regarding Northlake appeal" correspondence.
		Item Total	**2**	
Grand Total			**2**	

As of: 3/20/2026 11:00:11 AM

MOUNTAINS RECREATION & CONSERVATION AUTHORITY
King Gillette Ranch
26800 Mulholland Highway
Calabasas, California 91302
PHONE (818) 878-0886

March 16, 2026

Board of Supervisors
Hall of Administration
County of Los Angeles
500 West Temple Street
Los Angeles, California 90012

Northlake Project No. R2015-00408 - Justification for Support of Appeal
Omission of Wildlife Presence Evidence and Imperils Mountain Lion Population

Hon. Chairperson Solis and Supervisors:

The Mountains Recreation and Conservation Authority (MRCA) recommends the County of Los Angeles (County) Board of Supervisors uphold the appeal of the Regional Planning Commission's decision to approve the Partial Creek Avoidance Alternative (PCAA) of the Northlake Phase 1 Project No. R2015-00408, Vesting Tentative Tract Map No. 073336, Vesting Tentative Parcel Map No. 073335, and Conditional Use Permit No. RPPL2023004316 (Project). MRCA recommends that the Board of Supervisors deny the Project as-is due to the Applicant's serious misleading statements leading to the Regional Planning Commission (RPC) approval of the Project's PCAA on January 28, 2026.

To greatly lessen regionally significant biological impacts, it is imperative that the Board of Supervisors grant the appeal in part and permanently eliminate the Phase 2 portion of the PCAA from the project approvals by adding a new condition to deed restrict all of Phase 2 as permanent open space. As proposed, Phase 1 must be a feasible, standalone project. With almost 3,000 housing units, it provides ample housing, sport facilities, public amenities, and a strong economic return.

Applicant and County Staff Mislead Decision Makers with Key Data Omissions

At the January 28, 2026, RPC hearing, Commissioner Hastings (Supervisorial District 5) asked Applicant representative, Damon Mamalakis of Armbuster Goldsmith & Delvac, LLP, about the Project's impacts to local wildlife.

Hastings: Before you go, for all the acreage you guys are building on here [in Grasshopper Canyon], you said your cameras never picked up any wildlife movement? (Unofficial Transcript, RPC Hearing 1/28/2026, 13:09:55 – 13:10:05)[1]
Mamalakis: No wildlife movement. We put the cameras where all of the crossings are on the property. I think it was for three or four months. We did not pick up any [wildlife movement]. (Ibid, 13:10:05 – 13:10:18)
Hastings: You did not pick any? That's amazing. (Ibid, 13:10:18 – 13:10:22)

Mr. Mamalakis' unequivocal answer following a direct question from Commissioner Hastings about the Project's likely impacts to wildlife movement must be viewed as part of a pattern by the Applicant to mislead decision makers. In addition, at no time did County staff attempt to correct the record about Mr. Mamalakis' false statement. Subsequently, the RPC voted to approve the Project under the false impression that zero wildlife were observed in Grasshopper Canyon.

On February 12, 2026, MRCA filed a Public Records Act (PRA) request with the County to obtain wildlife movement-related materials including camera studies, movement data, and/or wildlife monitoring projects within the proposed Project and within 500 feet of the Project. When the County did not respond to the PRA after 10 days, MRCA followed up on February 25th to which County staff replied with a link to County Planning File No. 26-013 materials and indicated more time would be required to provide responsive materials. On March 4, 2026, County provided a link to a 3.5-gigabyte zip folder with included documents indexed by bates numbers (i.e., "AR" followed by a unique sequential number indicating a page reference within the comprehensive Administrative Record).

Within the administrative record, MRCA found a letter dated September 13, 2018, from Tony Bomkamp, Technical Director and Senior Biologist for Glenn Lukos Associates (GLA) to Applicant representative Damon Mamalakis (AR015999)[2] that summarizes the wildlife captured by 12 wildlife cameras deployed by GLA staff between July 12 and September 4, 2018. Of the 12 cameras deployed, nine (9) "picked up" wildlife movement including deer, coyote, red-tail hawk, Cooper's hawk, barn owl, skunk, raccoon, cow, and more. For the cameras that were deployed in the proposed Project Area within Grasshopper Canyon (Camera Stations 3, 4, 5, 6, and 7 per Exhibit 1; AR016046),[2] only Camera Station 5 failed to "pick up" wildlife movement; otherwise, four of five cameras did "pick up" wildlife movement in Grasshopper Canyon. The GLA wildlife study continues "Bobcat, gray fox, and coyote were also detected by tracks or other 'sign' (e.g., scat)" (AR016007).[2] This GLA wildlife study directly contradicts Mr. Mamalakis' testimony at the January 28, 2026, RPC hearing that no wildlife were detected.

The RPC Approval Package published on the County's Legistar webservice (File No. 26-013, RPC Hearing 1/28/2026, Attachment 2) is an incomplete record due to omitting the relevant information from the September 2018 GLA letter (AR015999)[2] documenting wildlife movement in Grasshopper Canyon. County staff's error of omission, combined with Applicant's erroneous statements made during the RPC hearing that zero wildlife were detected, renders County Finding No. 14 for California Environmental Quality Act (CEQA) Determination insufficient for impacts to existing wildlife using Grasshopper Canyon. Confirmed wildlife usage of Grasshopper Canyon, whether from GLA, MRCA, or another entity, appears to be new and significant information denied to decision makers and represents a substantial increase in the environmental impacts not previously analyzed by the EIR resulting in an inadequate public review process and conclusory findings not supported by the complete administrative record.

Cumulative Impacts Fragment a Regional Wildlife Corridor and Imperil "Threatened" Mountain Lions

Since 2020, MRCA has documented numerous wildlife using I-5 Undercrossing No. 2 including, but not limited to, mountain lion, deer, coyote, bobcat, roadrunner, and quail.[3]

In 2024, MRCA initiated the I-5 (Sierra Madre-Castaic) Wildlife Crossing Infrastructure Assessment and Implementation Plan (I-5 Wildlife Crossing Plan), funded in part by the Wildlife Conservation Board, The Nature Conservancy, and Wildlife Conservation Network, to improve wildlife connectivity across the 26-mile stretch of I-5 between State Route 138 and State Route 126. This segment of I-5 is designated as a critical wildlife barrier (Barrier W231)[4] by California Department of Fish and Wildlife (CDFW). CDFW's fact sheet for Barrier W231: "The Sierra Madre-Castaic linkage is vitally important for restoring gene flow to southern California mountain lion populations. This section of the I-5 is a roadkill hotspot with multiple mountain lions being hit and killed over the years. There are also some development projects in the works along this segment …" which, if completed, would further degrade wildlife connectivity to extensive protected lands on either side of I-5. The Northlake Project proposes to add approximately 11 miles of wildland-urban interface (perimeter of Phases 1 and 2) to the currently "vacant" Grasshopper Canyon and add approximately 2 linear-miles of development barrier to the western approach/dispersal route to/from Castaic Lake. While individual, high-mobility, more human tolerant wildlife might be able to occasionally navigate this newly fragmented environment, less human tolerant and low-mobility wildlife will encounter permanent barriers from both phases of the Project.

In support of MRCA's I-5 Wildlife Crossing Plan, MRCA contracted for extensive wildlife monitoring of culverts, bridges, and other I-5 crossing structures along CDFW Barrier W231. Between the Templin Highway interchange and the Violin/Marple Canyon concrete culvert identified in the Northlake Project as Undercrossing No. 1—the stretch of I-5 closest to the Northlake Project—MRCA contractors completed field deployment of wildlife cameras in November 2025 and have since captured numerous wildlife (e.g., mountain lion, bobcat, coyote, and grey fox) moving between Grasshopper Canyon and Marple Canyon.[3]

Combined, MRCA's efforts document that the Project area contributes to a regional wildlife corridor and undermine Tentative Tract Map Finding No. 43 that the Project is "… not likely to cause substantial environmental damage or substantially and avoidably injure fish or wildlife or their habitat." MRCA-controlled Undercrossing No. 2 represents one of the only wildlife-safe connection points between Grasshopper Canyon and Marple Canyon. Northlake's PCAA Phase 2 exhibits depict a major new access road that essentially cuts across and through the habitat leading to Undercrossing No. 2. Cumulative impacts of Northlake Phase 1 and Phase 2 would degrade wildlife connectivity across I-5 and CDFW Barrier W231, especially at Undercrossing No. 2, as additional Project-related Vehicle Miles Traveled (VMT) will result in more wildlife-vehicle

collisions, more road noise, light and microplastic tire pollution, and wider dispersal of litter that attracts nuisance wildlife.

The Northlake Project is adjacent to a particularly dangerous section of southbound I-5 near the end of the descent from Violin Summit. Downhill car, bus, and tractor-trailer speeds regularly exceed the posted speed limit. For every wildlife-vehicle collision, for every near-miss or high-speed swerve to avoid a wildlife collision, numerous people are at risk of serious injury and death. The proposed Project will degrade access to one of I-5's extremely rare safe-crossing structures (i.e., Undercrossing No. 2), add thousands of VMT to Ridge Route Road and I-5, and result in additional vehicle strikes to wildlife. A January 21, 2026, news article in the Los Angeles Times[5] described how "An injured mountain lion cub was captured by wildlife officials Wednesday after it was seen huddled in the middle of a roadway in the Castaic Area, probably after being struck by a car, officials said." This lion cub was found cowering in the intersection of Hillcrest Parkway and Olympic Street approximately 2.5 miles south of the Northlake Project site in a similar 1990s/2000s-era development that contributed to habitat fragmentation on the west side of I-5.

At the February 2026 meeting of the California Fish and Game Commission[6], the Central Coast and Southern California evolutionary significant unit of mountain lion was unanimously listed as a "threatened" species for protection by the California Endangered Species Act (CESA). According to CDFW, individual mountain lion territory can range up to 300-500 square miles. Preserving and enhancing functional habitat within and near the South Coast Missing Linkages Project's *Sierra Madre-Castaic Connection* (*Connection*) is critical to support the genetic heterogeneity of mountain lions in the Santa Monica Mountains, Simi Hills, and Santa Susana Mountains. Extensive research by National Park Service (NPS) and CDFW staff indicates Santa Monica Mountain lions are already suffering from deleterious inbreeding. The Northlake Project's impacts to Undercrossing No. 2 will degrade wildlife connectivity in the southern extent of the *Connection*, and the Board of Supervisors has a responsibility to act on new and significant information to require the Northlake Project avoid, or fully mitigate, cumulative impacts to one of the extremely few now-functional, wildlife-safe undercrossings of I-5 north of Santa Clarita.

In the County's "Findings of Fact and Statement of Overriding Conditions regarding the Northlake Specific Plan Project" (AR000230),[7] the County generally recognizes the importance of "north-south linkage between the mountainous open space of the National Forest and resource rich riparian zones along the Santa Clara River" and then erroneously asserts, "However, construction of Castaic Dam, Lake, Lagoon, [Castaic Lake State Recreation Area] SRA and its associated facilities along with residential development west of the Lagoon has essentially eliminated this linkage" (AR000273).[7] That might be true for Castaic Canyon/Creek and its connection five miles further south to the Santa Clara River, but Grasshopper Canyon is vacant and connects public lands adjacent to the Angeles National Forest with the SRA—an important north-south linkage between the ANF and perennial, accessible water in Castaic Lagoon.

Nonetheless, the key regionally significant biological impact is east-west wildlife movement between mountain ranges that are bisected by I-5, CDFW Barrier W231.

The County's "Findings of Fact …" (AR000230) then proceeds to make unsubstantiated assumptions about potential wildlife utilization of I-5 Undercrossing No. 2:

> However, use of this undercrossing is expected to be minimal for a variety of factors. The location of the crossing is not associated with any notable natural landscape feature, which typically would concentrate movement such as a ridge line, water feature, or drainage. The location is associated with an unimproved road but the road travels across a slope providing vehicular access to transmission towers but offering little to no cover for wildlife. In addition, the location is not associated with any corresponding crossing in the vicinity that allows wildlife to travel under the north bound lanes of the I-5. There are no ridge lines or drainages or similar features that typically convey concentrated movement to or from a crossing of the northbound lanes of I-5. In fact, the nearest under-crossings of the northbound lanes are located approximately one mile north and approximately two miles south of this crossing. (AR000273 – AR000274)[7]

The fact is: wildlife are regularly using I-5 Undercrossing No. 2 as documented by MRCA since 2020. The County has never incorporated into its Findings the September 13, 2018, GLA letter to Mr. Mamalakis (AR015999) that wildlife were documented using Grasshopper Canyon (via Camera Stations 3, 4, 5, 6 and 7) as a north-south linkage between Angeles National Forest and Castaic Lagoon. In the nearly eight (8) years since the Applicant's expert biologists *did* detect wildlife movement in Grasshopper Canyon, during which time mountain lions were nominated as "candidate species" for CESA listing to State-listed as "threatened," neither the Applicant nor the County have followed up with any additional wildlife movement surveys. When directly asked at the RPC hearing by Commissioner Hastings about wildlife movement through the Project site, Mr. Mamalakis claimed, "We did not pick up any," and County staff did not correct the facts or note the eight-year data gap for the record.

The above assertion that I-5 Undercrossing No. 2 has low regional ecological value both because it does not have the requisite natural landscape features and is by a road, underscores Undercrossing No. 2's importance because, as is, it is vital to maintain regional habitat connectivity despite its minor imperfections. Plus, there is an equivalent undercrossing to the west across Marple Canyon to facilitate wildlife movement under the northbound lanes of I-5. A complete I-5 undercrossing system across Marple Canyon is in place but depends on no development occurring in the Phase 2 portion of the PCAA. The MRCA invested in lands on both sides of Undercrossing No. 2 because of its regional and local significance. Today a high-quality intact system for wildlife movement across I-5 is fully in place with no additional public investment required. That is the baseline condition, the efficacy of which the data now in the public record clearly proves. The Phase 2 portion of the PCAA destroys the eastern pathway into that intact system. A

portion of this critical east-west linkage can only be retained if the entire Phase 2 portion of the PCAA is deed restricted as permanent open space as a tract map condition for Phase 1.

MRCA also questions the feasibility of the Applicant to secure sufficient, suitable lands for extensive off-site compensatory habitat preservation and/or establishment as summarized in the August 28, 2018, "Feasibility Analysis of NorthLake Biological Mitigation Requirements" Psomas Memorandum (AR015235).[8] This Memorandum identifies "properties with the appropriate biological resources and of sufficient acreage" to satisfy anticipated mitigation requirements. The largest property identified, Temescal Ranch (Castaic area) is now owned by MRCA and is not legally available for mitigation. Similarly, the lands identified as Tract 42537 are now largely owned by MRCA with complete acquisition anticipated by June 2026. As provided in MRCA's comment letter to the RPC on January 26, 2026, MRCA also owns the majority of land within Marple Canyon that was identified specifically for southwestern spiny rush mitigation, and it is not available for that purpose. The Applicant's options to find properties with the required acreages of specific habitat types are extremely limited and costly.

The MRCA points to the probable infeasibility of multiple required off-site mitigation land requirements that may be unobtainable because of a dearth of appropriate, now-privately-held habitat to work with. The current mitigation measures are further inadequate because there is no direction provided on either the Applicant's rights or the public's protection if the required quantity of habitat cannot be protected or restored. If the complete package of offsite mitigation cannot be provided because of a lack of suitable or obtainable offsite mitigation properties, then the Project must be commensurately downscaled to reduce impacts to specified impacted habitat types.

Climate Risks Will Stress Already Burdened County Resources

Since the Northlake Specific Plan was adopted in 1992, the Project site has been State-designated as Very High Fire Hazard Severity Zone, and there have been at least 111 recorded wildfires within seven (7) miles of the Project as shown on MRCA – Northlake Fire Recurrence Map. This wildfire count does not include small fire starts (generally an acre or less) along the I-5 Freeway that do not get archived. Despite the best intentions of structure hardening, fuel modification zones, pre-event evacuation routing for vehicles, and risk disclaimers to future residents, the Project adds approximately 11 miles of additional wildland-urban interface for County firefighters to protect. The 2025 Palisades and Eaton Fires showed some of the most well-resourced, quick-responding, and mutual aid-supported fire departments could be overmatched by wildfires supercharged by climate change conditions. In 2024, The Center for Climate Integrity released the "Los Angeles County Climate Cost Study"[9] that provides a list of the local governments facing the highest costs for climate adaptations through 2040 with the unincorporated Santa Clarita Valley costing County taxpayers an estimated $96,832,000. MRCA cautions the Board of Supervisors' approval of the Project given the current federal regime's antipathy towards matching funds for local climate change mitigation.

Partial Creek Avoidance Alternative Must be Reduced to Phase 1 Limits

If the Board of Supervisors acts to approve a version of the Northlake Project, that project should be limited to just the Phase 1 footprint in the PCAA. As proposed in the CEQA documentation, Phase 1 is a standalone project that does not need elements of Phase 2 to be feasible. The complete elimination of Phase 2's development footprint would retain minimum viable wildlife access to and from the critical I-5 Undercrossing No. 2. The elimination and deed restriction of all of Phase 2 is the only project footprint adjustment that can substantially reduce the biological impacts associated with the proposed development impeding wildlife access to and from I-5 Undercrossing No. 2. However, to ensure that wildlife access to the undercrossing is permanently protected, the County approval of Phase 1 must deed restrict development of the remainder of the property from immediately north of the Phase 1 boundary with recordation of that specific deed restriction being an irrevocable condition of map recordation. If the proposed water tank on County-owned land adjacent to Phase 2 is required for Phase 1, that relatively benign unlit, road-gated, unmanned landscape feature will still work for adequate wildlife movement through Undercrossing No. 2.

Please address any correspondence to me by email at chad.christensen@mrca.ca.gov, by phone at (310) 589-3230, ext. 121, or at the above letterhead address.

Sincerely,

Chad Christensen
Deputy Chief, Natural Resources and Planning

Attachments:
MRCA – References Cited Exhibit
MRCA – Northlake Fire Recurrence (1992-2025) Map
MRCA – Northlake Puma Observation Map

MRCA – References Cited Exhibit

1. Los Angeles County Regional Planning Commission Hearing 01/28/26. Unofficial Transcript. Excerpted Pages: 1, 6-7, and 55-56 of 61 PDF pages. Retrieved from: https://lacdrp.granicus.com/DocumentViewer.php?file=lacdrp_349fea00f6572ca8593b652587fb7bf6.pdf&view=1

2. Bomkamp, T. (2018, September 13). Indepenent Review of Biological Resources Assessment by BonTerra Psomas for the Northlake Final Supplemental EIR. Glenn Lukos Associates. Excerpted Pages: AR015999, AR016007, AR016046.

3. MRCA I-5 (Sierra Madre-Castaic) Wildlife Crossing Infrastructure Assessment & Implementation Plan – Prelim Data of Main Animal Categories: 2025-11-18 through 2026-01-01.

4. California Department of Fish & Wildlife. (n.d.) Region 5 Barrier ID: W321. I-5 *Sierra Madre to Castaic Ranges Barrier*. Retrieved from: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=229701

5. Toohey, G. (2026, January 21). *Baby mountain lion found with 'concerning' injuries in middle of L.A. County roadway*. Retrieved from Los Angeles Time: https://www.latimes.com/california/story/2026-01-21/injured-mountain-lion-cub-found-in-la-county-road

6. California Fish and Game Commission, February 20, 2026, News Release: California Fish and Game Commission Finds CESA Protections Warranted for Southern California and Central Coast Mountain Lion. Retrieved from: https://wildlife.ca.gov/News/Archive/california-fish-and-game-commissionfinds-cesa-protections-warranted-forsouthern-californiaandcentral-coastmountain-lion

7. County of Los Angeles, Department of Regional Planning. (2019, April 2). Findings of Fact and Statement of Overriding Conditions regarding the Northlake Specific Plan Project. *Findings and SOC.* Excerpted Pages: AR000230, AR000273, AR000274.

8. Blain, M. (2018, August 28). Feasibility Analysis of NorthLake Biological Mitigation Requirements. Psomas. Excerpted Pages: AR015235, AR015239.

9. The Center for Climate Integrity. (2024, April). Los Angeles County's Climate Cost Challenge: A $12.5 Billion Bill to Protect Communities Through 2040. *Los Angeles County Climate Cost Study.* Retrieved from: https://climateintegrity.org/projects/climate-costs-studies/los-angeles-county

11:47:33
>>
11:47:41
>>
11:48:02
>>
11:48:16
>> LA COUNTY REGIONAL PLANNING
11:48:31
>> JANUARY 28, 2026
11:48:37
>>
11:51:42
>>
11:58:32
>>IT IS JANUARY 28, WELCOME TO THE
12:00:38
REGIONAL PLANNING COMMISSION. WE WILL
12:00:38
START WITH THE LAND ACKNOWLEDGMENT. PAY
12:00:42
ATTENTION TO THE SCREEN ABOVE.
12:00:51
THE COUNTY OF LOS ANGELES RECOGNIZES
12:01:01
THAT WE OCCUPY LAND ORIGINALLY
12:01:03
INHABITED AND CARED FOR BY THE
12:01:05
TONGA, TATAVIAM, SERRANO, KIZH
12:01:7
AND CHUMASH PEOPLES. WE HONOR AND PAY
12:01:08
RESPECT TO THE OUR ELDERS AND
12:01:11
DEFENDANTS PAST PRESENT AND EMERGING AS
12:01:14
THEY CONTINUE THEIR STEWARDSHIP OF
12:01:18
THESE LANDS AND WATER WE ACKNOWLEDGE
12:01:22
THAT SETTLER COLONIZATION RESULTED IN
12:01:24
LAND SEIZURE DISEASE SUBJUGATION SLAVERY
12:01:31
 RELOCATION BROKEN PROMISE GENOCIDE AND
12:01:36
MULTIGENERATIONAL TRAUMA. THIS

12:06:25
CARRIES THANK YOU
12:06:25
>> WE WILL MOVE TO THE PUBLIC HEARING
12:06:25
SECRETARY PLEASE GIVE US A DECISION FOR
12:06:25
THE HEARING THIS MORNING
12:06:27
>> IF YOU ARE JOINING VIA ZOOM ON YOUR
12:06:30
COMPUTER OR MOBILE DEVICE AND WANT TO
12:06:34
PROVIDE COMMENT, STAFF WILL OBTAIN YOUR
12:06:34
INFORMATION THROUGH THE CHAT BOX
12:06:38
FEATURE. PLEASE PROVIDE STAFF WITH THE
12:06:40
AGENDA ITEM NUMBER YOUR FIRST NAME LAST
12:06:44
NAME AND EMAIL ADDRESS. IF YOU ARE
12:06:45
JOINING VIA TELEPHONE AND WANT TO
12:06:45
PROVIDE COMMENT ON THE ITEMS PLEASE
12:06:56
SEND AN EMAIL TO
12:06:56
COMMENT@PLANNING.LACOUNTY.GOV AND
12:06:56
PROVIDE THE AGENDA ITEM NUMBER YOUR
12:06:56
FIRST NAME LAST NAME EMAIL ADDRESS AND
12:07:00
PHONE NUMBER. ALL PARTICIPANT
12:07:01
MICROPHONES WILL BE MUTED UNLESS YOU
12:07:01
HAVE SIGNED UP TO PROVIDE COMMENT. IF
12:07:07
YOU HAVE SIGNED UP TO PROVIDE COMMENT
12:07:08
YOUR MICROPHONE WILL BE UNMUTED WHEN
12:07:08
IT'S TIME TO SPEAK AND I CALL YOUR NAME.
12:07:13
I WILL SWEAR IN THE MEMBERS OF THE

12:07:14
PUBLIC INCLUDING IN PERSON AND REMOTE
12:07:16
SPEAKERS REQUESTING TO [INDISCERNIBLE]
12:07:21
ON PUBLIC HEARING ITEMS. THOSE OF YOU
12:07:21
ADDRESSING PUBLIC HEARING ITEMS PLEASE
12:07:21
STAND AND RAISE YOUR RIGHT HAND. IN THE
12:07:33
TESTIMONY YOU MAY GIVE BEFORE THE
12:07:33
COMMISSION DO YOU SOLEMNLY SWEAR TO
12:07:33
TELL THE TRUTH THE WHOLE TRUTH AND
12:07:33
NOTHING BUT THE TRUTH SO HELP YOU GOD?
12:07:35
THANK YOU YOU MAY HAVE A SEAT
12:07:39
>> THANK YOU. WE WILL HEAR FROM STAFF
12:07:45
ON PROJECT 201500408 IN THE FIFTH
12:07:50
DISTRICT. STAFF YOU HAVE THE FLOOR
12:07:55
>> THANK YOU GOOD MORNING COMMISSIONERS
12:07:55
AND MR. CHAIR I AM JODY SENIOR PLANNER
12:07:58
WITH THE SUBDIVISION SECTION. TODAY'S
12:07:59
ITEM 7 IS NORTHLAKE PHASE I PROJECT.
12:08:07
THE ADOPTED NORTHLAKE SPECIFIC PLAN
12:08:10
AREA IS LOCATED EAST OF RIDGE ROOT ROAD
12:08:17
AND THE FREEWAY AND WEST OF
12:08:17
[INDISCERNIBLE] IN THE UNINCORPORATED
12:08:24
COMMUNITY OF [INDISCERNIBLE]. NORTHLAKE
12:08:25
PHASE I PROJECT ENTITLEMENT SHOWN IN
12:08:29
THIS MAP CONSISTS OF VESTING TENTATIVE

13:08:45
PATHWAYS THIS VERSION OF THE
13:08:45
ALTERNATIVE WOULD ALLOW FOR WILDLIFE
13:08:48
MOVEMENT. YOU CAN SEE IT CIRCLED IN
13:08:51
YELLOW, THAT IS THE CULVERT BOX CROSSING
13:08:59
MR. EDELMAN AND JOHN CHRISTIANSEN WERE
13:09:04
MENTIONING. YOU SEE IT IS OFF THE
13:09:04
PROPERTY YOU SEE THE DEVELOPMENT IS NO
13:09:07
WAY IMPEDING IT. AND THERE'S A 70 FOOT
13:09:11
GRADE DIFFERENCE. THIS SLIDE SHOWS THE
13:09:14
WILDLIFE MOVEMENT PATTERNS THAT WOULD
13:09:16
HAVE BEEN PROVIDED FOR WITH THE
13:09:21
PREVIOUSLY APPROVED PROJECT. AS YOU CAN
13:09:21
SEE THERE'S ONLY ONE CORRIDOR MOVEMENT
13:09:24
IN THE NORTH. VERSUS WITH A PARTIAL
13:09:29
CREEK AVOIDANCE ALTERNATIVE THERE ARE
13:09:34
NOW THREE PROVIDED FOR. I BELIEVE THAT
13:09:39
ADDRESSES ALL THE ISSUES.
13:09:39
>> THAT CONCLUDES YOUR? OKAY THANK YOU.
13:09:45
LET'S CLOSE THE PUBLIC COMMENT PERIOD.
13:09:52
THIS IS IN YOUR DISTRICT DISTRICT 5 I
13:09:52
WILL ASK YOU TO TAKE THE LEAD
13:09:55
>> BEFORE YOU GO, FOR ALL THE ACREAGE
13:09:57
YOU GUYS ARE BUILDING ON HERE, YOU SAID
13:10:00
YOUR CAMERAS NEVER PICKED UP ANY ANIMAL

13:10:05
MOVEMENT? NO WILDLIFE MOVEMENT. WE PUT
13:10:07
THE WILDLIFE CAMERAS WHERE ALL OF THE
13:10:10
CROSSINGS ARE ON THE PROPERTY. I THINK
13:10:14
IT WAS FOR THREE OR FOUR MONTHS, WE DID
13:10:18
NOT PICK UP ANY
13:10:18
>> YOU DID NOT PICK UP ANY, THAT'S
13:10:22
AMAZING
13:10:22
>> THE INTERESTING THING IS THE TWO
13:10:26
BOTTOM CROSSINGS THAT GO UNDER THE
13:10:30
FREEWAY, THEY DON'T FULLY GO UNDER THE
13:10:30
FREEWAY BECAUSE THAT'S WHERE FIVE
13:10:32
SPLITS. IF YOU GO UNDER IT THE ANIMALS
13:10:35
GET STUCK IN THE MIDDLE OF THE
13:10:42
FREEWAYS. THERE'S GOOD REASON FOR WHY
13:10:42
WE DID NOT CATCH ANYTHING THERE. THE
13:10:47
NORTHERN ONE....
13:10:52
>> THANK YOU. THE GAS LINE RUPTURE CAME
13:10:54
UP QUITE A BIT YET IT WAS ADDRESSED? I
13:10:59
HEAR IT WILL BE RELOCATED WITH THE NEW
13:10:59
GAS LINE WHICH WILL BE BUILT BETTER?
13:11:04
YOU WANT TO DO A QUICK RESPONSE TO THAT
13:11:04
PLEASE
13:11:07
>> I AM THE [INDISCERNIBLE] SECTION
13:11:10
HEAD. THERE WAS A GAS LEAK AFTER

GLENN LUKOS ASSOCIATES
Regulatory Services



September 13, 2018

Damon P. Mamalakis
Armbruster Goldsmith & Delvac LLP
12100 Wilshire Boulevard, Suite 1600
Los Angeles, California 90025

Subject: Independent Review of Biological Resources Assessment by BonTerra Psomas for the Northlake Final Supplemental EIR

I have conducted an independent peer review of the biological resources section for the Northlake Final Supplemental EIR (FSEIR) to determine whether the FSEIR accurately identifies significant impacts of the project on various biological resources and where impacts are determined to be significant, whether the proposed mitigation is sufficient to reduce identified significant impacts to less than significant.

In conducting the independent review, the following resources were evaluated in detail[1]:

- Draft Supplemental EIR (DSEIR) Project Description, Biological Resources Section, Supporting Biological Technical Report (DSEIR Appendix D), and related documents (e.g., appendices to Appendix D);

- FSEIR, including public comments from Blum Collins (Blum Collins), California Department of Fish and Wildlife (CDFW), California State Parks (CSP), Center for Biological Diversity (CBD), Santa Monica Mountains Conservancy (SMMC), and Shawn Smallwood (Smallwood) along with the associated responses to comments prepared by BonTerra Psomas (BonTerra); and

- Additional Biological Surveys conducted in support of the FSEIR including, Appendix B: Biological Resources Downstream Impacts Assessment; Appendix C: Mitigation Plans, Appendix D: Wildlife Crossing Assessment Memo;

[1] Additional documents were reviewed as well, including the First Errata to the NorthLake SEIR as well as BonTerra's responses to comments submitted to the Los Angeles County Regional Planning Commission.

29 Orchard ▪ Lake Forest ▪ California 92630-8300
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2018 by Mr. Ahrens and Ms. Stephanie Cashin, GLA Wildlife Biologist,with additional cameras deployed by Ms. Cashin on July 23, 2018. Data was collected on July 30 and September 4, 2018 with the cameras retrieved on September 4, 2018 for final data collection. Cameras were not installed at the paired undercrossings associated with Undercrossing 3 because it was determined that wildlife movement associated with this crossing would not be affected by the project as already noted above.

Results

Animals recorded by the camera stations, are summarized in Table 1. Large mammals detected include mule deer and coyote. Direct observations were also made of mule deer. Bobcats, gray fox, and coyote were also detected by tracks or other "sign" (e.g., scat). Mountain lions were not recorded at any of the Wildlife Camera Stations and were not otherwise detected (e.g., by sign). Other species as indicated in the last column of Table 1 include woodrat, screech owl, desert cottontail, raccoon, striped skunk, ground squirrel, red-tail hawk, barn owl, Virginia opossum, and Cooper's hawk. Humans and cows were also captured.

The results of the camera study, which did not detect mountain lions in Grasshopper Creek provide additional evidence that Grasshopper Creek is not an important north-south movement corridor for mountain lions as already reported by BonTerra in the SDEIR and in FSEIR Appendix D.

Table 1: Summary of Wildlife Detected at Camera Stations

Station	Mule Deer	Bobcat	Coyote	Mountain Lion	Other
1	--	--	X	--	X
2	--	--	--	--	--
3	X	--	X	--	X
4	--	--	X	--	X
5	--	--	--	--	--
6	X	--	X	--	X
7	X	--	X	--	X
8	--	--	--	--	--
9	--	--	X	--	X
10	--	--	X	--	X
11	--	--	--	--	X
12	--	--	X	--	X



Coordinate System: State Plane 5 NAD 83
Projection: Lambert Conformal Conic
Datum: NAD83

Map Prepared by: C. Lukos, GLA
Date Prepared: July 9, 2018

N

Parcel Boundary

Wildlife Camera Location

0 625 1,250 2,500
Feet

1 inch = 1,306 feet

NORTHLAKE SPECIFIC PLAN

Glenn Lukos Associates Wildlife Camera Access

GLENN LUKOS ASSOCIATES

Exhibit 1

AR016046

MRCA I-5 (Sierra Madre-Castaic) Wildlife Crossing Infrastructure Assessment & Implementation Plan Prelim Data of Main Animal Categories: 2025-11-18 through 2026-01-01													
Vicinity	**Camera Name**	**Bear**	**MtLion**	**Bobcat**	**Coyote**	**Grey Fox**	**Deer**	**Skunk**	**Raccoon**	**Opossum**	**Ground Squirrel**	**Road runner**	**Grand Total**
South of Project	1B			36	21	6							63
	1D				3				3				6
	1E				3								3
	2A			3					27			13	43
	2C								12				12
North Project Lake	3A								291				291
	3B				3								3
	3C			3					117				120
	3F			9	3				6				18
	4A			12	171								183
	4B			15	180						8		203
	5A			192	18								210
	5B			9	60				9				78
	5D				3				12				15
	5E			3	15				6				24
	6B								9	3			12
	7A		6		9			3	3				21
	7E		6			18		33					57
North of Project	8B					6							6
	8C		9	3	3	33		33	30				111
	8D			15	12				48				75
	8H		15			3		6	3		18		45
	11D							3			3		6
	12C	3			9								12
	12D	3		72	102	120		9	72				378
	13A					6	111						117
	13B				66	18			3				87
	13C					6							6
	15A												3
	11C			3		3		12					18
	12B			3		3			9				18
	15C			6	90				9				108
	H01					3		3	3				9
	Grand Total	**6**	**36**	**384**	**771**	**225**	**111**	**102**	**672**	**3**	**29**	**13**	**2361**

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News Releases, 2022-Present

California Fish and Game Commission Finds CESA Protections Warranted for Southern California and Central Coast Mountain Lion

February 20, 2026

In Other Regulatory Action, Commission Streamlines Charitable Donation of Sport-Caught Fish

The California Fish and Game Commission (Commission) at its Feb. 11-12 meeting voted to list mountain lion populations in parts of southern California and the central coast as a threatened species under the California Endangered Species Act (CESA).

In a unanimous vote, the Commission determined that listing a distinct population segment of mountain lions in southern California and the central coast is warranted due to threats such as habitat loss, habitat fragmentation and isolation of small populations as a result of expanding human infrastructure, among others. The Commission considered presentations from the California Department of Fish and Wildlife (CDFW) on its species status review and from the listing petitioner the Center for Biological Diversity, as well as public comment. The Commission will adopt its findings at a future meeting.

“This segment of the mountain lion population is clearly at risk from distinct threats,” said President Eric Sklar. “Habitat loss, habitat fragmentation by roads, freeways and housing, and mortality from vehicle strikes, rodenticides and risks of isolation and inbreeding would lead to the extinction of these mountain lions if we remained on the same trajectory.”

Following the 1974 ban on hunting mountain lions in California, in 1990 voters approved Proposition 117,

which designated mountain lion a specially protected mammal in the state and established some exemptions for lethal removal of mountain lions to preserve public safety and to protect private property and livestock. The Commission noted that those statutory provisions remain intact and that this listing is focused specifically on preventing the potential loss of the identified population segment through science-based management and conservation action.

Donation of Sport-Caught Fish

The Commission adopted regulatory amendments related to processing and donating sport-caught fish. Sport fishing license holders who exchange fish for processing will be able to donate their fish to charities directly through fish processors rather than having to deliver the fish themselves as presently allowed. The adopted amendments streamline the donation of sport-caught fish to nonprofit organizations, California Native American tribes, public schools within a California unified school district and California city or county government programs. The changes will provide sport fishing license holders the opportunity to support nonprofit, community, school and tribal initiatives addressing food insecurity, access and distribution.

Commission Elections, Committee Assignments and Meeting Participation

In its first meeting of 2026, Commissioner Eric Sklar was elected Commission president and Commissioner Darius Anderson vice president. The Commission moved to retain Marine Resources, Wildlife Resources and Tribal Committee co-

chair assignments — Sklar and Commissioner Samantha Murray will continue to serve on the Marine Resources
Committee, Anderson and Commissioner Erica Zavaleta on the Wildlife Resources Committee and Commissioner Jacque Hostler-Carmesin on the Tribal Committee.

Sklar, Zavaleta and Murray were in attendance for both days of the February Commission meeting held in Sacramento; Hostler-Carmesin and
Anderson were absent both meeting dates.

The complete agenda for the meeting, along with supporting information, is available on the Commission website. Archived video of past Commission meetings is available online. The next meeting of the Commission is scheduled for April 15-16, 2026, at the California Natural Resources Agency building in Sacramento. Participants are encouraged to attend in person, with options available for Zoom or phone; for more information visit the Commission website.

The Commission authorized public notice of upcoming potential regulation changes related to:

Central Valley and Klamath River Basin sport fishing regulations: A discussion hearing is scheduled for April 15-16 and an adoption hearing for May 6 on proposed amendments related to Central Valley and Klamath River Basin sport fishing regulations.

Media Contacts:
Krysten Kellum, CDFW Communications, (916) 825-7120
Jen Benedet, CDFW Communications, (916) 202-4465

Categories: FGC, Marine, Species, Wildlife

Tagged: mountain lion | sport-caught fish donation | California Fish and Game Commission | California Department of Fish and Wildlife

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Los Angeles Times

CALIFORNIA

Baby mountain lion found with ‘concerning’ injuries in middle of L.A. County roadway



A mountain lion cub was found injured on a roadway in the Castaic area early Wednesday. (RMG Media)



By Grace Toohey
Staff Writer | Follow

Jan. 21, 2026 **Updated** 10:47 PM PT

An injured mountain lion cub was captured by wildlife officials Wednesday after it was seen huddled in the middle of a roadway in the Castaic area, probably after being struck by a car, officials said.

The juvenile mountain lion was taken to a local veterinarian to be assessed, Cort Klopping, a spokesperson for the California Department of Fish and Wildlife, said Wednesday afternoon.

“You never want to see any animal, but especially a juvenile, injured,” Klopping said. “It’s certainly concerning … and we’re hoping for a good outcome on this.”

The cub was found sitting, motionless, in the middle of Hillcrest Parkway near Olympic Street in Castaic just before 1 a.m. Wednesday, according to April Elliott, a spokesperson for the California Highway Patrol, which first responded to the call about the animal.

The juvenile sat there for more than an hour as troopers waited for wildlife officials to arrive, with local broadcasters capturing gripping footage of the cub in the middle of the roadway.

The cub eventually got up and walked off on its own just after 2 a.m., Elliott said.

When wildlife officials arrived at the scene, they began searching for the injured cat, eventually finding it in some thick brush, Klopping said.

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The team was able to capture the cub to take it to be examined.

Tiffany Yap, urban wildlands science director at the nonprofit conservation organization the Center for Biological Diversity, called this incident the latest example of why the region's mountain lions deserve specific protections under the Endangered Species Act, something the state's Fish and Game Commission will consider next month.

"It's dangerous and frightening for mountain lions to navigate our roads and developments, especially for cubs like this one in Castaic," Yap wrote in a statement. "These wide-ranging animals need room to roam and they need their habitat connected. ... Mountain lions like this young kitten should get a proper chance to grow up and live healthy lives alongside us."

More to Read

Mountain lion sightings close Orange County park. Expert calls cat behavior 'super' unusual

Nov. 5, 2025



Two mountain lions that were found malnourished and alone as cubs are released back into the wild

Sept. 29, 2025



Mother of two mountain lion cubs struck and killed on State Route 74

Sept. 21, 2025



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Grace Toohey

Grace Toohey is a reporter at the Los Angeles Times covering breaking news for the Fast Break Desk. Before joining the newsroom in 2022, she covered criminal justice issues at the Orlando Sentinel and the Advocate in Baton Rouge. Toohey is a Maryland native and proud Terp.

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Region 5 Barrier ID: W231 (Barrier).

Barrier Name: I-5 Sierra Madre to Castaic Ranges.

Linear Infrastructure: I-5.

Geographic Area: Bisects the linkage of Sierra Madre to Castaic Ranges within Los Padres National Forest. Castaic Lake is to the east and Pyramid Lake is to the west. Runs from Santa Clarita to Caswell.

Length: 41.20 km (25.6 mi).

Target Species: Mountain lion (*Puma concolor*), deer (*Odocoileus hemionus*), black bear (*Ursus americanus*), striped skunk (*Mephitis mephitis*), spotted skunk (*Spilogale gracilis*), Virginia opossum (*Didelphis virginana*), raccoon (*Procyon lotor*), gray fox (*Urocyon cinereoargenteus*).

Connectivity Concerns: The I-5 through this segment is a major barrier to wildlife movement, and there are likely only two to four existing bridges (that also carry vehicles) in the entire study area that may be functioning, at some level, for wildlife movement. The Sierra Madre-Castaic linkage is vitally important for restoring gene flow to southern California mountain lion populations. This section of the I-5 is a roadkill hotspot with multiple mountain lions being hit and killed over the years. There are also some development projects in the works along this segment, so land acquisition is an important thing to consider.

Remediation Goals: Restore functional connectivity across I-5 between the Sierra Madre and Castaic Ranges to support: day-to-day movements of wildlife seeking food, shelter, or mates; juvenile dispersal; seasonal migration, healthy mixing of genes among populations, recolonizing unoccupied habitat after a local population goes extinct, and for species to shift their geographic range in response to global climate change. To accomplish this, we will need to find areas of highest usage/risk to wildlife. We aim to expand and enhance existing infrastructure such as culverts and creek bridges, add new under/over-crossings and wildlife exclusion fencing. Removing barriers to wildlife movement across I-5 would reconnect extensive protected lands and provide measurable benefits to a wide diversity of natural communities and numerous native species.



Figure: I-5 Sierra Madre to Castaic Ranges is a Region 5 wildlife connectivity barrier.

FINDINGS OF FACT and

STATEMENT of OVERRIDING CONSIDERATIONS

regarding the NORTHLAKE SPECIFIC PLAN PROJECT

PROJECT NUMBER: R2015-00408-(5)

VESTING TENTATIVE TRACT MAP: TR073336

CONDITIONAL USE PERMIT: CUP201500019

STATE CLEARINGHOUSE NUMBER: 2015031080

COUNTY OF LOS ANGELES DEPARTMENT OF REGIONAL PLANNING

320 WEST TEMPLE STREET

LOS ANGELES, CALIFORNIA 90012

Restoration Program be developed and approved by USACE, CDFW, and LACDRP prior to issuance of grading permits, and which will reduce impacts to a less than significant level.

Potential Impacts Regarding Wildlife Movement

The Project Site is utilized by resident and migratory wildlife for both movement and breeding of various degrees. On the Project Site, Grasshopper Canyon is undeveloped and is adjacent to open space in the Angeles National Forest and Castaic Lake SRA, both of which provide high-quality wildlife habitat. Historically, the Castaic Creek drainage adjacent to the Project Site may have been an important north-south linkage between the mountainous open space of the National Forest and resource rich riparian zones along the Santa Clara River. However, construction of Castaic Dam, Lake, Lagoon, SRA and its associated facilities along with residential development west of the Lagoon has essentially eliminated this linkage. Only local movement of species habituated to an urban landscape (e.g., coyote) are expected to navigate the extensive set of existing barriers. Regional movement along the east-west-aligned Transverse Range north of the site has also been restricted through the Project Site as a result of construction of I-5. As discussed in the Biological Technical Report appended to the Draft SEIR and the Independent Review of Biological Resources Assessment, results of regional landscape linkage studies identify the importance of this east-west connection. However, Castaic Lake and Lagoon to the east and I-5 to the west substantially reduce the Project Site's potential to provide significant east-west linkage value. Although Castaic Lake and Lagoon are sources of water, they are unpassable for nearly all but avian species and are difficult to access due to unvegetated and steep shorelines surrounding nearly all these water bodies other than the northern edge of Castaic Lake. West of the Project Site, a single underpass beneath I-5 could feasibly be utilized by a variety of wildlife as a safe crossing to and from either side of the highway. However, use of this undercrossing is expected to be minimal for a variety of factors. The location of the crossing is not associated with any notable natural landscape feature, which typically would concentrate movement such as a ridge line, water feature, or drainage. The location is associated with an unimproved road but the road travels across a slope providing vehicular access to transmission towers but offering little to no cover for

wildlife. In addition, the location is not associated with any corresponding crossing in the vicinity that allows wildlife to travel under the north bound lanes of the I-5. There are no ridge lines or drainages or similar features that typically convey concentrated movement to or from a crossing of the northbound lanes of I-5. In fact, the nearest under-crossings of the northbound lanes are located approximately one mile north and approximately two miles south of this crossing. As a result, potential undercrossing events of both the northbound lanes and the southbound lanes at this location are expected to be rare at best. A second crossing west of the southern tip of the Project includes both northbound and southbound lanes. However, the southbound crossing stretches over 700 feet within a narrow concrete-lined channel rendering it as low potential for use by most wildlife. Furthermore, the northern entrance extends upstream into the un-vegetated concrete lined-channel with adjacent developed land offering no cover for wildlife.

A third under-crossing of the southbound lanes is located immediately west of the northwestern portion of the site. Similar to the undercrossing to the south described above, this location is not associated with any notable natural landscape feature, which typically would concentrate movement such as a ridge line, water feature, or drainage. However, this location does have a corresponding undercrossing directly opposite under the northbound lanes, 1,600 feet to the west, which may render it more likely than others to be utilized on occasion. In addition, the east side of this crossing provides access to the northeast without significantly steep slopes rendering it more compatible to movement events.

Due to the constraints of the southern and eastern edges of the site, wildlife using these crossings are expected to move to and from the crossing and areas north of the Project Site to allow continued east-west movement. Under existing conditions, and as verified by a review of literature as well as recent wildlife surveys as described in the Draft SEIR and a recent camera study documented in the Independent Review of Biological Resources Assessment, these crossings do not represent an important component of the regional movement of the area. Therefore, Project implementation would result in adverse but less than significant impacts on regional wildlife movement.

Potential Impacts to Wildlife Nursery Sites

MEMORANDUM

August 28, 2018

To:
John Arvin
NorthLake

From:
Marc Blain

Subject: Feasibility Analysis of NorthLake Biological Mitigation Requirements

---

An analysis was conducted to confirm the feasibility of implementing NorthLake biological mitigation measures for the NorthLake Project. Specifically, requirements for preservation of existing vegetation or preservation with restoration of potentially suitable habitat for select wildlife species were reviewed and required amounts of mitigation by habitat type were calculated. Using a two-pronged approach, potential mitigation properties were identified and then evaluated using a GIS tool to rank potential mitigation parcels based on biological values relative to NorthLake mitigation needs. The results of this analysis, as discussed below, indicate that properties with the appropriate biological resources and of sufficient acreage are currently available or are in process towards becoming available within the region. Properties were considered to be "available" if they are currently listed for sale, if there are no recorded development plans for the sites, where information provided by sellers or brokers indicated that offers would be considered or potentially considered, where properties have other constraints to development such as USFWS designated Critical Habitat, and where the properties have not been used as mitigation for prior projects. As such, biological resources mitigation for the NorthLake Project is feasible.

The attached tables and maps include properties identified based on communication with sellers, brokers, mitigation bank managers, and/or other publicly available information, and the results of a preliminary analysis of on-site vegetation and soils. The purpose of the analysis was to identify available properties with native habitat that exhibit sufficient acreage to offset the potential loss of native habitats associated with Project development. Properties were identified by Psomas staff based on (1) staff's previous knowledge of properties; (2) inquiries with approved mitigation banks; (3) inquiries with entities such as the Trust for Public Lands, Mountains Recreation and Conservation Authority, and California Department of Fish and Wildlife; and (4) review of properties listed for sale (and thus assumed to be available). Potential properties were given priority based on size, proximity to the Project site, proximity to other preserved open space areas, and overall level of disturbance and quality of habitat. Aerial photos were reviewed for each site to determine the general type of habitat (e.g. scrub, riparian, grassland, etc.) as were soil maps to determine each site's suitability for establishment/translocation of special status plant species and seasonal pools for western spadefoot toad. In addition, estimated vegetation types and acreage was extracted from Cal Fire Regional Vegetation Maps.

Psomas' Ecologists and GIS Specialists then developed a searchable database, using existing ecological/geographic data (federal/State/local), to assess the suitability of identified properties as well as other potentially suitable parcels of undeveloped land in the Project region. For this purpose, undeveloped land was defined as parcels that were totally or nearly totally undeveloped.

TABLE 1
SUMMARY OF NORTHLAKE MITIGATION REQUIREMENTS and PARTIAL LIST OF MITIGATION OPPORTUNITIES

BIOLOGICAL RESOURCE	IMPACTS *	REQUIRED MITIGATION @ 2:1	APPROPRIATE HABITAT CURRENTLY OWNED BY NORTHLAKE: ON-SITE (WITHIN NORTHLAKE BOUNDARY) **	APPROPRIATE HABITAT CURRENTLY OWNED BY NORTHLAKE: OFF-SITE (OUTSIDE NORTHLAKE BOUNDARY) **	REQUIRED MITIGATION NOT CURRENTLY OWNED BY NORTHLAKE	PARTIAL LIST OF OFF-SITE MITIGATION PROPERTIES WITH APPROPRIATE HABITAT NOT OWNED BY NORTHLAKE: A	B	C	D	E	F	G	H	I	J	K	L	M	N	TOTAL OFF-SITE OPPORTUNITIES (A-N) (ACRES)	TOTAL OFF-SITE OPPORTUNITIES (A-N) (% of REQ'D)
VEGETATION TYPE (ACRES)																						
Sage Scrub	635	1269	330	189	751		324	1800	65	10	200	120	300	130	20	35				3004	400%
Native Grassland	24	48	1	3	45	250														250	560%
Annual Grassland	399	798	51	18	729	250	72	700		40	400									1462	201%
Riparian/Open Water Communities	13	27	1	1	24			500			10									510	2146%

PLANT SPECIES (INDIVIDUALS)	IMPACTS	REQUIRED MITIGATION @ 1:1																		TOTAL OFF-SITE OPPORTUNITIES (A-N) (INDIVIDUALS)	TOTAL OFF-SITE OPPORTUNITIES (A-N) (% OF REQ'D)
Round-leaved Filaree	39	39	100	170	0		1000	2000	300	200	1000	300	1000	300	100	100	100	100	100	No offsite property required	
Paniculate Tarplant	300	300	100	170	30		1000	2000	300	200	1000	300	1000	300	100	100	100	100	100	6600	22000%
Southwestern Spine Rush	300	300	100	170	30		1000	2000	300	200	1000	300	1000	300	100	100	100	100	100	6600	22000%
Slender & Club-haired Mariposa Lily	3000	3000	300	450	2250		3000	6000	1000	1000	3000	1000	3000	1000	300	300	300	300	300	20500	911%

JURISDICTIONAL WATER (ACRES)	IMPACTS *	REQUIRED MITIGATION @ 1:1					TOTAL OFF-SITE OPPORTUNITIES (A-N) (ACRES)	TOTAL OFF-SITE OPPORTUNITIES (A-N) (% OF REQ'D)
Waters of the United States	11	11	0	0	11	26	26	246%

WILDLIFE (INDIVIDUALS)	IMPACTS	REQUIRED MITIGATION				TOTAL OFF-SITE OPPORTUNITIES (A-N) (INDIVIDUALS)	TOTAL OFF-SITE OPPORTUNITIES (A-N) (% OF REQ'D)
Burrowing Owl ***	2	13	25	55	0	No offsite property required	
Coastal California Gnatcatcher	2	2	0	0	2	Will be part of Sage Scrub acreage listed above	
Western Spadefoot Toad	0.5	0.5	2	4	0	No offsite property required	

PARTIAL LIST OF OFF-SITE MITIGATION PROPERTIES WITH APPROPRIATE HABITAT NOT OWNED BY NORTHLAKE

A - Peterson Ranch Mitigation Bank
B - Gilmore Ranch Property Val Verde
C - Temescal Ranch Property, Castaic
D - Castaic APN 3247-010-011
E - Val Verde APN 3247-032-031
F - Santa Clarita San Martinez Grande Canyon Road
G - Acton APN 3217-005-018
H - Lannan Ranch Agua Dulce
I - Tract 42537
J - Castaic APN 3247-010-056
K - Castaic APNs 3247-039-007/3247-039-008
L - Templin Highway Undercrossing APN 3247-008-003
M - Templin Highway Undercrossing APN 3247-005-035
N - Templin Highway Undercrossing APN 3247-009-004

Note: The above properties are either: 1) currently part of an established mitigation bank, 2) currently for sale, or 3) have been known to be for sale on the open market.

Footnotes:

* Acreage numbers includes Permanent and Temporary Impact Areas.

** Acreage numbers includes Non-impacted and Temporary Impact Areas.

*** Burrowing Owl mitigation shown hereon is a conservative estimate. As stated in the SEIR, the actual mitigation amount will be determined by field surveys conducted prior to construction.



Los Angeles County's Climate Cost Challenge

A $12.5 Billion Bill to Protect Communities Through 2040

CENTER FOR CLIMATE INTEGRITY

The Center for Climate Integrity

April 2024

Los Angeles County's Climate Cost Challenge

A $12.5 Billion Bill to Protect Communities Through 2040

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resilient-analytics.com

This study and the data it produced are available at climateintegrity.org/la-county-costs.

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Cost to Mitigate Wildfires
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Cost to Protect Infrastructure from Sea Level Rise
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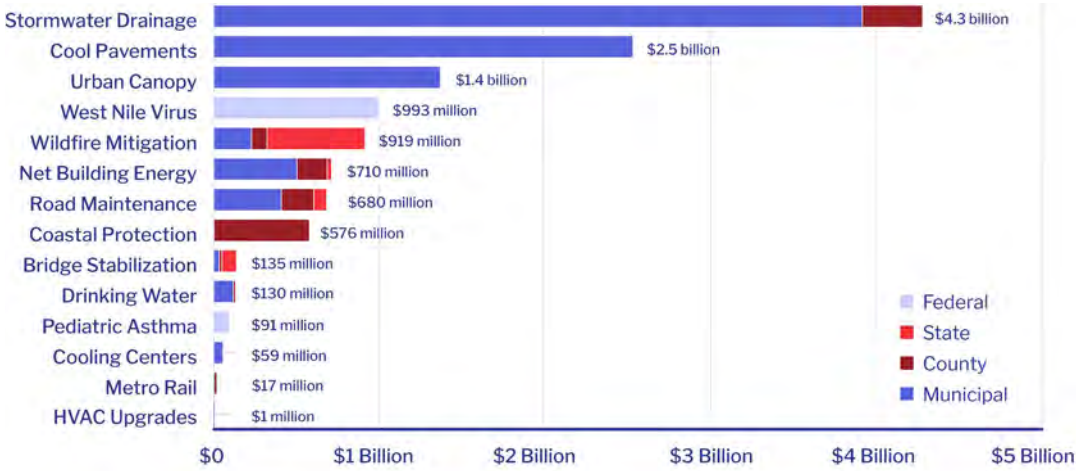
Executive Summary

Within the first two months of 2024, the City of Los Angeles had already exceeded its average annual rainfall, receiving nearly 15 inches of rain in back-to-back deluges.[1] The storms flooded roads, brought massive wind gusts, ripped down trees, and killed nine people.[2] The year prior was the hottest year ever recorded, including unseasonably hot weather into the fall months in Southern California. In October 2023, a wildfire ripped through rural lands southeast of the City of Los Angeles, destroying multiple buildings and forcing approximately 4,000 people to evacuate.[3]

With climate-driven disasters in Southern California growing more intense every year, it's more important than ever for communities to invest in a growing range of climate adaptation and resilience projects. This study is the first-ever attempt to calculate the costs of preparing for and adapting to 14 different climate impacts on municipal, county, state, and federal governments in Los Angeles County.

We estimate municipal, county, state, and federal governments will need to spend at least $12.5 billion through 2040, over $9 billion of which will be incurred by municipal governments. The total cost equates to approximately $780 million per year to protect communities in Los Angeles County from extreme heat, changing precipitation, wildfires, rising sea levels, and climate-induced public health threats.

Figure 1: Total cost for each adaptation strategy from 2024 through 2040.



1 Kathryn Prociv, "Soaked California Faces Another Day of Flood Watches as Los Angeles Already Hits Yearly Rainfall Average," *NBC News*, February 21, 2024, https://www.nbcnews.com/news/weather/soaked-california-faces-another-day-flood-watches-los-angeles-already-rcna139745.

2 Grace Toohey, "9 People Killed in California's Massive Storm: Here's How They Died," *Los Angeles Times*, February 8, 2024, sec. California, https://www.latimes.com/california/story/2024-02-07/californias-storm-claimed-nine-lives-heres-what-we-know.

3 Dani Anguiano, "California Wildfire Threatens 1,300 Homes South-East of Los Angeles," *The Guardian*, October 31, 2023, https://www.theguardian.com/us-news/2023/oct/31/california-wildfire-evacuation-santa-ana-winds.

We calculate taxpayers in Los Angeles County will face the following climate adaptation costs through 2040:

- **$4.3 billion** to improve stormwater management to mitigate flooding
- **$2.5 billion** to invest in cool pavements to combat heat
- **$1.4 billion** to plant and maintain trees to combat urban heat islands
- **$1.1 billion** to respond to an increase of childhood asthma and West Nile Virus cases
- **$919 million** to mitigate wildfire damage
- **$710 million** to heat and cool public buildings in response to changing temperatures
- **$680 million** to increasing road maintenance because of heavy rain and heat stress
- **$576 million** to build coastal defenses to protect infrastructure from rising seas
- **$135 million** to reinforce bridges against anticipated climate wear and tear
- **$130 million** to treat drinking water during increased droughts
- **$59 million** to expand and operate cooling centers
- **$17 million** to make metro rail tracks resilient to increasing temperatures
- **$1 million** to upgrade air conditioning in public buildings

Across the country, local governments are paying for the vast majority of climate adaptation and resilience measures. Taxpayers in Los Angeles are no exception, and as climate impacts grow more destructive, the need for these adaptive measures will only become more acute. While local leaders could seek additional financial support from the federal government, there is no source of federal funds for adaptation at this scale — and the funding that is available is still coming from taxpayers.

How to Interpret These Costs

Where possible, this report delegates the costs of climate adaptations to each local government type that would be responsible for paying for the costs depending on ownership of structures, land, and/or services. In cases where it is not clear how governments divide responsibility, costs have been assigned to the municipality where the adaptations are being made, or based on the entity that owns the infrastructure in question — for example stormwater infrastructure improvements are assigned to the municipality the infrastructure is in, while the state is assigned costs for a state-owned highway.

For a full explanation of how costs are assigned for each climate adaptation, see Table A2 in Appendix A.2.

Meanwhile, the major oil and gas companies that knew their products would lead to catastrophic climate change, and then deceived the public and policy-makers about it for decades, pay nothing.[4] A more just alternative would be to make the polluters most responsible for the climate crisis pay their fair share of the climate adaptation and resilience costs facing Los Angeles County communities. We are in a climate crisis because Big Oil companies lied about their products for decades; it's only right that they pay their share for the costs they have imposed on communities.

Dozens of states and communities, including the State of California and eight California municipalities, have filed lawsuits to recover the costs of climate damages from major oil companies, following the same legal framework as landmark tobacco and opioid lawsuits.[5] Each and every community in Los Angeles County should consider bringing similar legal actions to hold climate polluters accountable and ensure that taxpayers aren't left to pay the bill alone.

How We Calculated These Costs

These findings are based on a moderate climate scenario (Shared Socioeconomic Pathway 2 - 4.5 [SSP2-4.5]) and do not account for the costs of recovering from any climate-driven disasters that will almost certainly occur, creating additional damages. This study is confined to costs created by only 14 out of many climate impacts (see Appendix Table A3) that communities will ultimately face (Figure 1). The costs are calculated in 2023 dollars, use generally accepted standard engineering protocols, and assume that governments will make less expensive proactive adaptation repairs as opposed to potentially more expensive reactive repairs. This report uses publicly available data to determine which local governments will be responsible for paying for the evaluated climate costs. Local governments, in turn, will ultimately be responsible for deciding whether or not to implement the adaptations necessary to protect their constituents from worsening climate change. Failing to spend these dollars will almost certainly result in much larger costs in the future, both to recover from preventable climate damages, and to implement more costly adaptive measures down the road. Finally, these calculations are limited to the cost of adapting to these climate impacts, not reversing them.



Wildfire smoke obscures Los Angeles skyscrapers: September 12, 2020.

4 René Marsh, "Big Oil Has Engaged in a Long-Running Climate Disinformation Campaign While Raking in Record Profits, Lawmakers Find | CNN Politics," *CNN*, December 9, 2022, https://www.cnn.com/2022/12/09/politics/big-oil-disinformation-record-profits-climate/index.html.

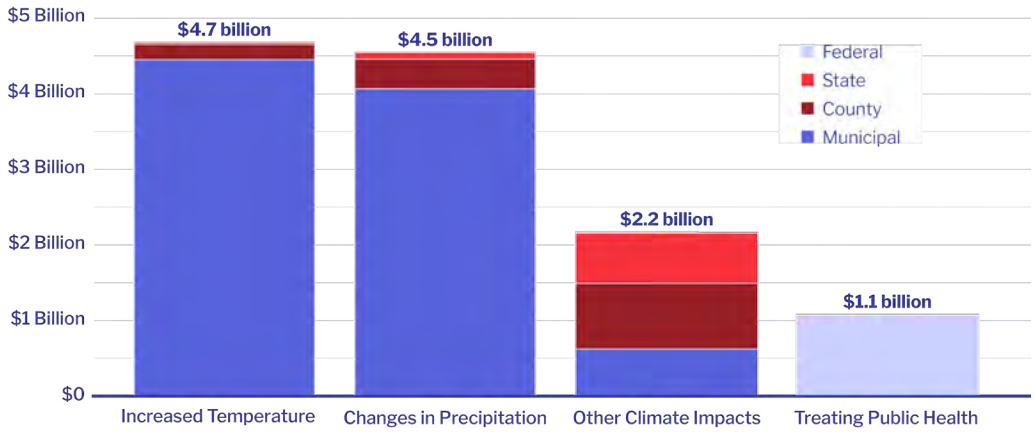
5 Center for Climate Integrity, Cases, accessed March 14, 2024, https://climateintegrity.org/cases.

Key Findings

Combating floods from increased precipitation and more severe storms is the most expensive climate cost we identified facing communities in Los Angeles County. Investing in stormwater drainage infrastructure such as porous pavement, bioswales, and bioinfiltration — the least expensive stormwater infrastructure — to manage increased precipitation will cost communities in Los Angeles County $4.3 billion from 2024 through 2040. That is equivalent to about $252 million per year, or approximately 14% of the county's Water Resources budget for Fiscal Year 2023 (Appendix G.2).[6]

The second most expensive climate adaptation measure identified is the cost to address urban heat islands — areas where heat is intensified because of the near total absence of trees or green space, allowing buildings and roads to absorb, intensify, and radiate the sun's heat, making these areas up to 20°F hotter than surrounding, less urbanized areas.[7] To help counteract rising temperatures, it will cost $2.5 billion to install cool pavements — pavement that doesn't absorb as much heat — in public parking lots and $1.4 billion to plant and maintain urban trees across the county from 2024 through 2040. The yearly average cost of installing cool pavements across the Los Angeles County area would be about $149 million, equivalent to 16% of the county's 2023 transportation budget (Appendix G.2).[8]

Figure 2: The total costs local governments in Los Angeles County face through 2040 to protect communities from the worsening impacts of climate change.[9]



6 LA County, "LA County Open Budget Appropriation (Auditor-Controller)," January 3, 2024, https://data.lacounty.gov/datasets/lacounty::la-county-open-budget-appropriation-auditor-controller/explore.

7 Anna Tzavali et al., "Urban Heat Island Intensity: A Literature Review," *Fresenius Environmental Bulletin* 24, no. 12b (2015): 4537–54, https://www.researchgate.net/publication/298083233_Urban_heat_island_intensity_A_literature_review.

8 LA County, "LA County Open Budget Appropriation (Auditor-Controller)."

9 The increased temperature adaptations are installing cool pavements, increasing urban canopy, net building energy usage, protecting residents during heatwaves, applying reflective coating to metro rail tracks, and upgrading HVAC capacity. The changes in precipitation adaptations are increasing stormwater drainage capacity, bridge stabilization, and increased drinking water treatment. The other climate impact adaptations are wildfire mitigation, proactive road maintenance, and protecting infrastructure from sea level rise. Treating public health includes pediatric asthma and West Nile Virus treatment.

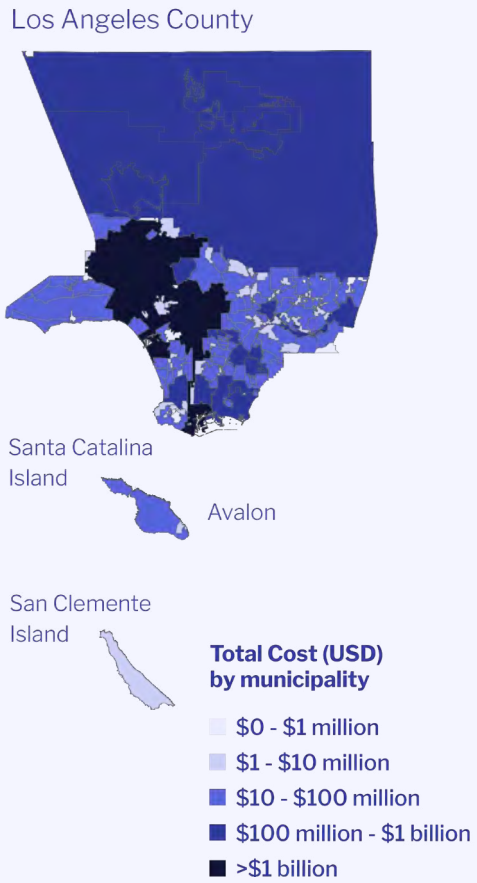
Table 1: Local governments facing the highest costs for 10 municipal climate adaptations from 2024 through 2040.

Rank	Municipality	Total Cost	Municipal Cost	County Cost	State Cost	Federal Cost
1	Los Angeles	$3,753,831,000	$3,656,890,000	$66,433,000	$30,482,000	$26,000
2	Antelope Valley	$538,925,000	N/A* *unincorporated	$226,995,000	$308,443,000	$3,487,000
3	Long Beach	$507,080,000	$505,544,000	$204,000	$1,332,000	N/A* *no wildfires
4	Santa Clarita	$340,237,000	$313,518,000	$2,700,000	$23,969,000	$50,000
5	Santa Clarita Valley	$271,629,000	N/A* *unincorporated	$96,832,000	$173,691,000	$1,106,000

Climate impacts present enormous and difficult choices for communities. With finite resources and growing budget demands, investing in climate resilience may mean not spending on other services such as firefighting, police, schools, senior centers, libraries, sanitation, and more. Faced with these trade offs, communities often delay or fail to implement climate adaptation initiatives until after a major disaster, if even then. This invariably costs taxpayers more in the end.[10]

As an example, we examined proactive road maintenance versus reactive repairs. We found that Los Angeles County communities are not only more likely to repair roads after they are damaged rather than upgrade them beforehand, but that this will cost at least $340 million more than proactive road repairs through 2040. In addition, climate adaptation projects in unincorporated areas of Los Angeles County — home to about one million residents — will fall on the responsibility of the county and stress the county budget, as the unincorporated areas do not have municipal governments.[11] The cost of climate adaptations in the unincorporated areas of the county is estimated at about $86 million per year, or about 60% of Los Angeles County's 2023 Municipal Services budget, which is the budget used for services in unincorporated areas of Los Angeles County.

Figure 3: The total cost of implementing 10 municipal climate adaptations through 2040. The costs are concentrated in high-population urban cities and large unincorporated areas.



10 The costs associated with protecting infrastructure from rising sea levels, applying reflective coating to metro rail tracks, treating pediatric asthma, and treating West Nile Virus are unable to be assigned to municipalities (Appendix A.2).

11 Public Works Los Angeles County, "Municipal Services," LA County Public Works, 2024, https://content.pw.lacounty.gov/core-service-areas/municipal-services/.

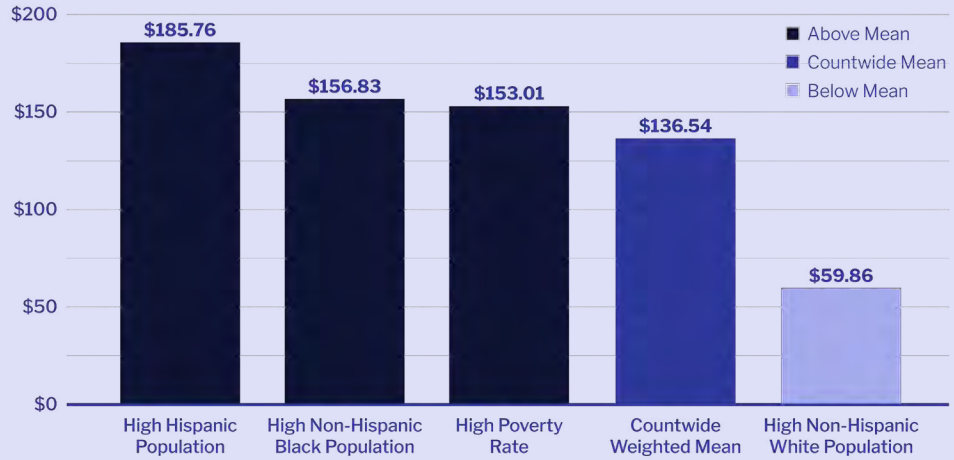
Finally, while there is no community that can escape the impacts of climate change, the burden of the climate crisis does not fall equally on Los Angeles municipalities. Of all 162 municipalities in this study, the City of Los Angeles faces the highest climate adaptation costs. The city is also very diverse and has significant wealth disparity[12] across various racial and ethnic groups, meaning the costs for climate adaptation will be felt differently throughout the city (see Appendix A.4 for more information).

The burden of life-threatening heat does not fall equally across Los Angeles County communities.

Lower income and higher diversity communities disproportionately lack green spaces that can cool urban environments, meaning these same populations will face the highest per capita costs to combat worsening heat islands. Our analysis confirmed that the costs of adapting to climate impacts, particularly heat, are greatest in communities of color and those with lower income. The per capita costs of heat adaptation and cooling measures in census tracts with high non-Hispanic Black and Hispanic populations is nearly three times higher than those with higher than average white populations.

Statistics of demographic characteristics in Los Angeles County come from the 2020 American Community Survey 5-Year Data (ACS-5) compiled by the U.S. Census Bureau (Appendix G.1). We use the demographic terminology reported in the ACS-5 throughout this report.

Figure 4: The cost to increase urban canopy is disproportionately higher in areas of the county with higher Hispanic (3.1 times higher compared to high white areas) and non-Hispanic Black (2.6 times higher compared to high white areas) populations, as well as communities with higher rates of poverty (2.6 times higher compared to high white areas).



12 "The Color of Wealth in Los Angeles," *The Samuel DuBois Cook Center on Social Equity at Duke University* (blog), March 16, 2016, https://socialequity.duke.edu/portfolio-item/the-color-of-wealth-in-los-angeles/.

Cost to Adapt to Hotter Temperatures $4.7 Billion

As the climate crisis continues to escalate, Los Angeles County's traditionally moderate climate will get much hotter. The region is expected to experience an average of 48.5 days above 90°F per year during the study period (2024 through 2040), or about 12.5 more hot days per year than communities experienced from 1994 to 2013. The increase in days above 90°F will vary significantly across the county, leaving some communities with many more extreme heat days than others.

To combat the dangers of this rising heat risk, communities in Los Angeles County can invest in installing cool pavements, expanding urban green space, painting metro rail tracks with reflective paint to keep them at an operable temperature, and upgrading cooling systems for public buildings like schools. (See Appendix A.3 for a more comprehensive list of adaptations).

Converting public parking lots to cool pavements that reflect instead of absorb sunlight, thus lowering the proximal temperature and reducing heat islands, is an effective and simple way to moderate the urban heat island effect. It is also the highest temperature-related cost facing communities in the county at $2.5 billion through 2040. Per year, cool pavements will cost an average of about $149 million to implement throughout the Los Angeles County region, or the equivalent of 16% of the county's 2023 transportation budget. In the City of Long Beach, the cost to install cool pavement is about $9 million annually, which is 55% of what the city budgeted annually for their 5-year Climate Adaptation and Action Plan ($16 million).[13]



City of Los Angeles during a record-breaking heatwave: September 7, 2022.

13 The City of Long Beach, "Innovation & Efficiency," 2023, https://longbeach.gov/globalassets/finance/media-library/documents/city-budget-and-finances/budget/budget-documents/fy-24-proposed-budget/fy-24-innovation-and-efficiency?_gl=1*10yobop*_ga*MTM2MjAxOTc0MS4xNzA5MTU1OTQ2*_ga_DH0765KYTY*MTcwOTE1NTk0Ni4xLjEuMTcwOTE1NjEyOC41My4wLjA.

Cool pavements are a complementary investment to tree planting — another proven way to reduce dangerous urban heat islands — which is the second largest temperature adaptation cost facing the Los Angeles County area. Notably, tree planting requires additional water usage for maintenance.

Figure 5: Percent of the total temperature cost for each of five[14] temperature-related adaptation strategies.

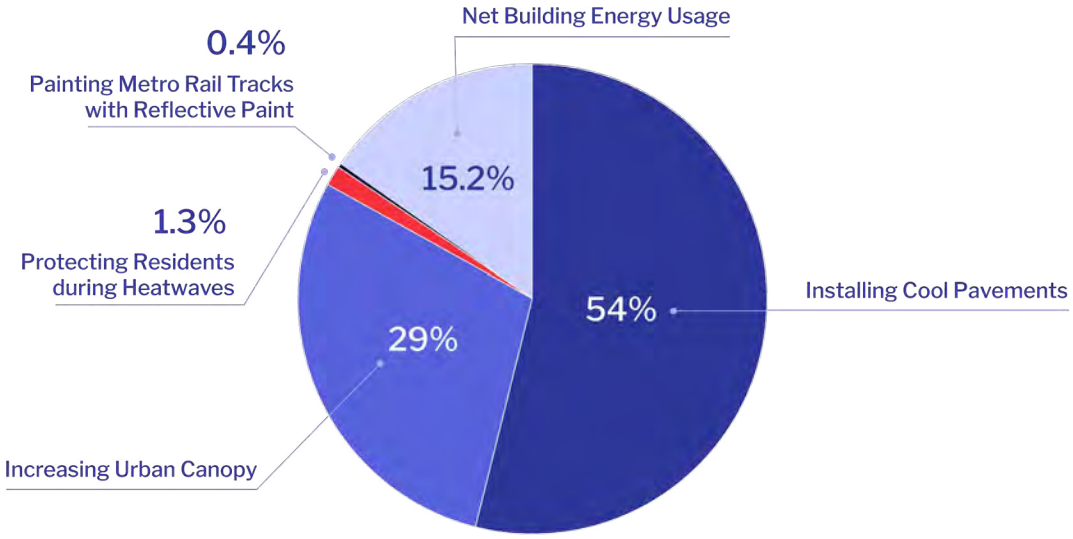


Table 2: Local governments facing highest costs from five temperature-related climate impacts[15] through 2040. County and state costs are incurred for net building energy costs and upgrading air conditioning capacity.

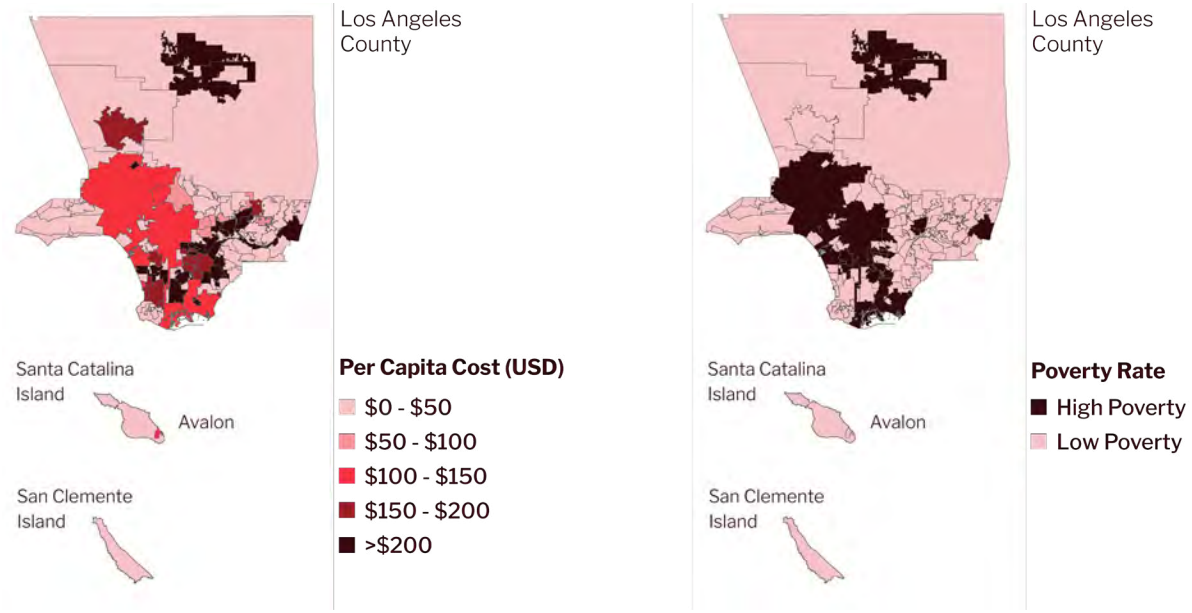
Rank	Municipality	Total Cost	Municipal Cost	County Cost	State Cost
1	Los Angeles	$1,469,324,000	$1,394,112,000	$66,433,000	$8,779,000
2	Long Beach	$242,676,000	$241,965,000	$204,000	$507,000
3	Lancaster	$197,197,000	$182,006,000	$7,804,000	$7,387,000
4	Carson	$149,278,000	$149,070,000	$19,000	$189,000
5	Palmdale	$135,301,000	$135,243,000	$58,000	N/A

14 Upgrading air conditioning capacity, the sixth temperature adaptation cost, will cost around $1 million, which is equivalent to 0% of the total cost. As such, it is not illustrated in the pie chart.

15 The county is responsible for making metro rail tracks more resilient to increased temperature through application of reflective paint. As such, this cost is not reflected in this table.

The inequitable impact of climate change is apparent when it comes to the costs of combating urban heat islands across Los Angeles County. Heat islands are typically more prevalent in low income areas with higher than average populations of non-Hispanic Black and Hispanic residents[16] that have historically received less investments in green space. Because of this deficit, these areas of the county will require greater investment costs to combat the rising risk of heat. While the average per capita tree planting cost for the county is $136.54, high Hispanic and high non-Hispanic Black areas of the county face $185.76 and $156.83 per capita planting costs, respectively. Areas of the county with a higher than average non-Hispanic white population[17] face $59.86 per capita to plant trees through 2040. It will cost the City of Los Angeles about $28 million per year to increase green space by planting and maintaining trees, which is equal to the city's entire Street Tree and Parkway Maintenance Appropriated Budget for 2024.[18]

Figure 6: Per capita costs to combat urban heat islands through planting and maintaining urban trees (increasing urban canopy) across Los Angeles County (left). Areas with high poverty rate (above 13.9%) across Los Angeles County correspond to areas with higher per capita urban canopy costs (right).



16 Municipalities that are high non-Hispanic Black have more than 7.9% non-Hispanic Black populations and municipalities that are high Hispanic have more than 48% Hispanic populations.

17 Municipalities that have above average non-Hispanic white populations have more than 32.5% non-Hispanic white populations.

18 City of Los Angeles, "LA City Open Budget: Bureau of Street Services," 2024, https://openbudget.lacity.org/#!/year/2024/operating/0/department_name/Bureau+of+Street+Services/0/program_name.

Cost to Adapt to Changes in Precipitation $4.5 Billion

Studies show that climate change will increase the number of severe storms and extreme wet years,[19] creating bouts of significant rainfall that will increase flood risk in Los Angeles County.[20] This shift can already be observed: a series of major storms hit Los Angeles County in the winter of 2023-24, flooding streets, creating life-threatening conditions, and revealing how the region's stormwater system is unprepared for the increasing threat of precipitation.[21] Expanding stormwater drainage capacity to manage this increase in rainfall is the most expensive climate adaptation cost analyzed by this report facing the Los Angeles County area. To mitigate the impacts of climate-driven rainfall, communities in Los Angeles County will face $4.3 billion to expand stormwater drainage infrastructure, like installing bioswales and porous pavement, through 2040. These 'green infrastructure' upgrades are the least expensive option to cope with increasing extreme rainfall events, and easier to implement in urban areas where increasing the size and scale of hard infrastructure like drain pipes is far more expensive and unwieldy. Investing in green infrastructure represents 94% of the total precipitation-related costs calculated by this report.

Water Treatment

While Los Angeles County can expect an increase in heavy rainfall, a changing climate will also contribute to an increase in drought conditions. Times of drought lead to an increase in sediment and nutrient concentration in drinking water, which causes additional drought-induced water treatment costs. Los Angeles County will experience an annual average of 1.4 more months of climate-induced drought from 2024 through 2040 compared to the baseline period of 1965 through 2014. If residents are restricted to 80 gallons of water per day per person, as they are encouraged to during times of drought,[21] it will cost Los Angeles County about $130 million more to treat residential water from 2024 through 2040. However, if Los Angeles County residents do not cut water use and continue to use their average of 120 gallons per person per day[22] during times of drought, it will cost the region $176 million more to treat the water over the next 17 years.

19 Lu Dong et al., "Contributions of Extreme and Non-Extreme Precipitation to California Precipitation Seasonality Changes Under Warming," *Geophysical Research Letters* 46, no. 22 (2019): 13470–78, https://doi.org/10.1029/2019GL084225.

20 Alex Hall et al., "California's Fourth Climate Change Assessment: Los Angeles Region Report," University of California, Los Angeles, 2019, https://www.energy.ca.gov/sites/default/files/2019-11/Statewide_Reports-SUM-CCCA4-2018-013_Statewide_Summary_Report_ADA.pdf.

21 Andrew Freedman, "Deadly Storm Pummeling California Dumps Historic Rains over LA," *Axios*, February 7, 2024, https://www.axios.com/2024/02/05/california-storm-floods-los-angeles.

22 Hayley Smith and Ian James, "To Survive Drought, Parts of SoCal Must Cut Water Use by 35%. The New Limit: 80 Gallons a Day," *Los Angeles Times*, April 30, 2022, sec. California, https://www.latimes.com/california/story/2022-04-30/can-you-get-by-on-just-80-gallons-of-water-a-day.

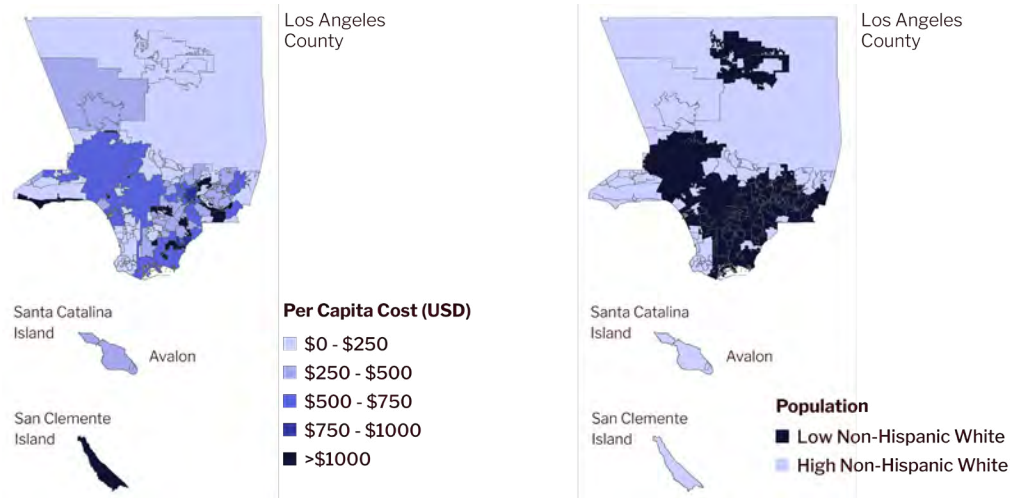
23 "Our County Water Briefing," 2018, https://ourcountyla.lacounty.gov/wp-content/uploads/2018/08/Our-County-Water-Briefing_For-Web.pdf.

Table 3: Local governments facing highest costs from three precipitation-related climate impacts through 2040.

Rank	Municipality	Total Cost	Municipal Cost	County Cost	State Cost
1	Los Angeles	$2,048,702,000	$2,048,702,000	N/A	N/A
2	Long Beach	$250,566,000	$250,566,000	N/A	N/A
3	Santa Clarita	$141,432,000	$122,268,000	$1,640,000	$17,524,000
4	El Monte	$91,147,000	$91,147,000	N/A	N/A
5	Lakewood	$84,280,000	$84,280,000	N/A	N/A

On average, mitigating the impact of increased rainfall by increasing stormwater drainage capacity will cost the region about $252 million per year from 2024 through 2040. Some municipalities could be especially hard hit. In Santa Clarita, it will cost about $6 million per year to mitigate the rising flood risk by increasing stormwater drainage capacity, equivalent to 121% of the city's Stormwater Utility budget for 2023-2024."[24] In the City of Los Angeles, the annual cost of about $118 million is nearly four times the city's Capital Improvements - Flood Control budget for 2024.[25] The per capita costs are also expected to be higher for communities that have greater non-white populations compared to areas of the county with predominantly white populations.[26]

Figure 7: The per capita cost for each municipality across Los Angeles County to increase stormwater drainage capacity from 2024 through 2040. The largest per capita costs will be incurred by residents in urban areas with large amounts of impervious surfaces (left). Areas with low non-Hispanic white populations (below 32.5%) across Los Angeles County correspond to areas with higher per capita costs to increase stormwater drainage capacity (right).



24 City of Santa Clarita, "Annual Operating Budget & Capital Improvement Program: FY2023-2024," 2023, https://filecenter.santa-clarita.com/cmo/FY%202023-24%20Budget%20-%20opt.pdf.

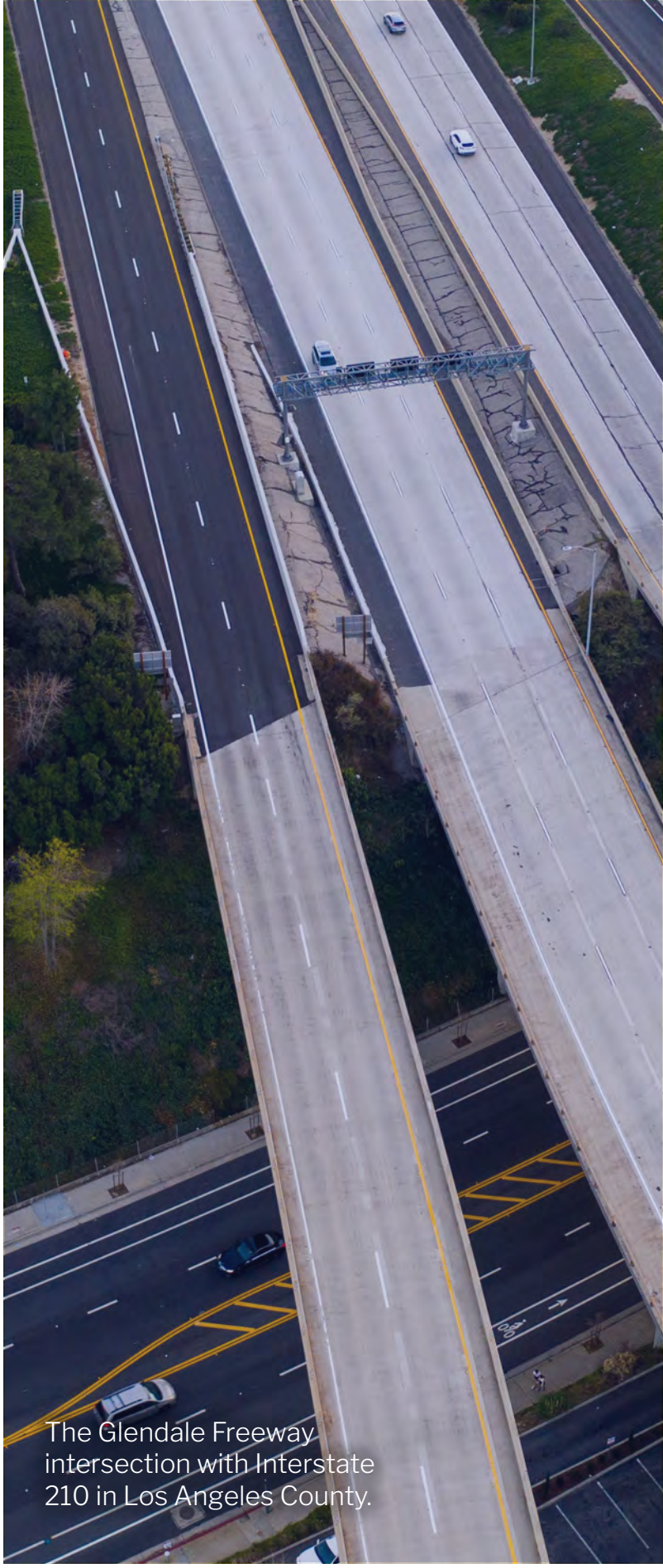
25 City of Los Angeles, "LA City Open Budget: Capital Improvements - Flood Control," 2024, https://openbudget.lacity.org/#!/year/2024/operating/0/program_name/Capital+Improvements+-+Flood+Control/0/department_name?vis=barChart.

26 Predominantly white areas are areas with ≥32.5% non-Hispanic white population (see Appendix G.1; Table G4).

Cost to Proactively Maintain Roads $680 Million

Climate change is brutal on roads. Higher temperatures soften road surfaces and increase degradation rates, making roadways cracked and rutted. Higher precipitation increases erosion, which weakens the road base and creates more maintenance demands in order to keep the infrastructure functioning as designed. Southern California will experience both from now through 2040. Even if regional governments take the less expensive, proactive approach to maintain the current service level of roads across the county, governments still face $680 million in climate-related adaptations for roads in the Los Angeles County area through 2040. Like the other analyses in this report, this cost only covers adapting to climate-impacts on roads and does not include costs that may be associated with additional unexpected climate disasters.

The City of Los Angeles faces the highest costs of proactive road investments at $164 million through 2040. It will cost the city $10 million per year to proactively maintain its municipal roads, which is comparable to 8.5% of the City of Los Angeles' 2024 $112 million budget for pavement preservation.[27]



The Glendale Freeway intersection with Interstate 210 in Los Angeles County.

27 City of Los Angeles, "LA City Open Budget: Pavement Preservation," 2024, https://openbudget.lacity.org/#!/year/2024/operating/0/department_name/Bureau+of+Street+Services/0/program_name/Pavement+Preservation/0/source_fund_name.

Table 4: Top five municipalities with the greatest difference in total reactive vs. proactive road maintenance costs from 2024 through 2040.

Municipality	Reactive Cost	Proactive Cost	Difference in Cost	Percent Increase
Los Angeles	$356,012,000	$185,842,000	$170,170,000	92%
Glendale	$33,329,000	$21,233,000	$12,096,000	57%
Santa Clarita	$44,632,000	$33,614,000	$11,018,000	33%
Downey	$13,428,000	$4,633,000	$8,795,000	190%
Torrance	$17,248,000	$9,713,000	$7,535,000	78%



Freeway overpasses in Los Angeles County.

Cost to Mitigate Wildfires $919 Million

Los Angeles County will face an average of 36 more high fire days[28] through 2040 and up to 58 more high fire days in certain areas like West Los Angeles under a moderate climate change scenario, as compared to a baseline of high fire days from 1994 to 2013. Wildfires regularly wreak havoc on the county. The Woolsey Fire in 2018 burned nearly 100,000 acres, destroyed more than 1,000 residential and commercial buildings, and killed three people, not to mention the additional health damages that result from wildfire smoke.[29] It's estimated the Woolsey Fire cost between $3 to $5 billion in insured losses alone.[30] In the past two years, two major insurance companies have stopped writing home and business insurance policies in California, citing increasing wildfire risk and the massive cost recovery associated with it.[31]

Wildfire mitigation through mechanical intervention, or clearing fuel from land around infrastructure in Los Angeles County will cost municipal, county, state, and federal governments $919 million from 2024 through 2040. Antelope Valley, an unincorporated community at the western tip of the Mojave Desert, will face the highest preventative costs at $356 million.



Wildfire scorches the Santa Clarita Valley: August 2016.

28 High fire days are defined by the KBDI index. See methods section for more information.

29 "Los Angeles County, California," Community Planning Assistance for Wildfire, accessed March 6, 2024, https://cpaw.headwaterseconomics.org/project/los-angeles-county-california/.

30 Ibid.

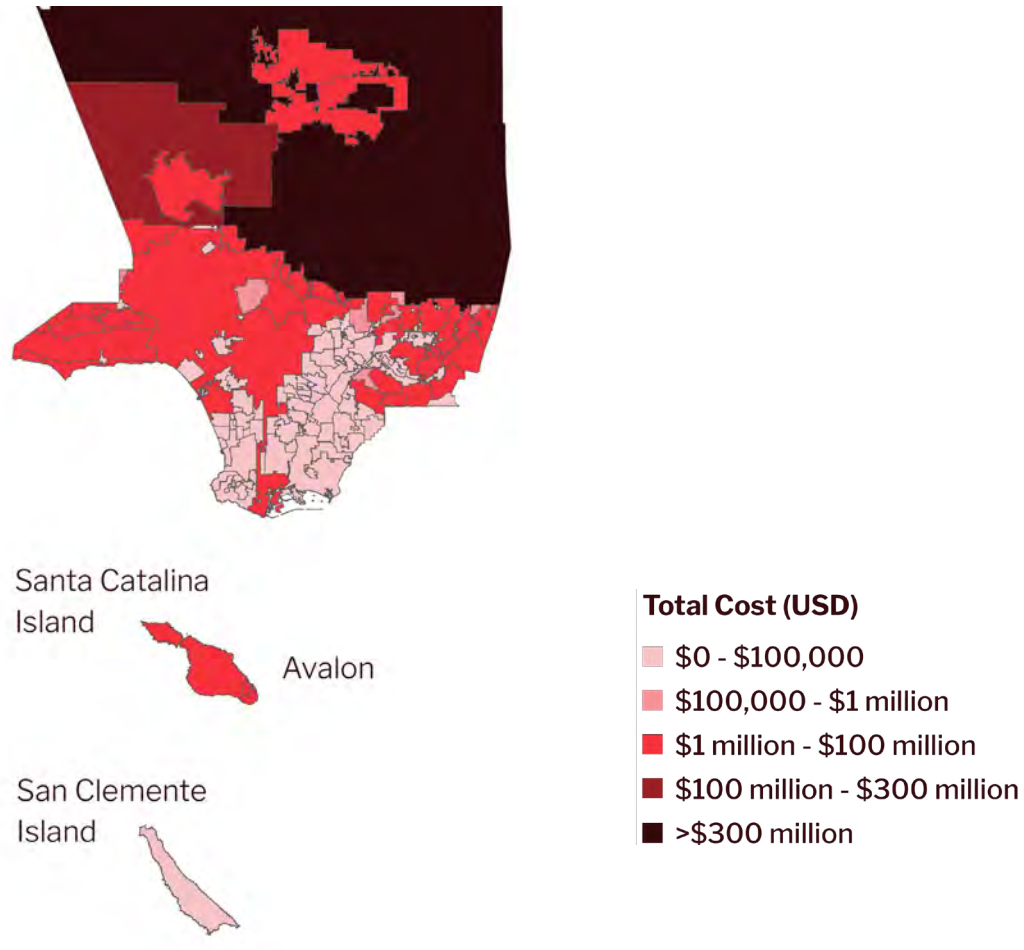
31 Michael R. Blood, "California Insurance Market Rattled by Withdrawal of Major Companies," *AP News*, June 5, 2023, https://apnews.com/article/california-wildfire-insurance-e31bef0ed7eeddcde096a5b8f2c1768f.

The costs to fight and recover from wildfires are dramatically higher than the costs to mitigate wildfire impacts presented here.

Table 5: Local governments facing highest costs to mitigate wildfires through 2040.

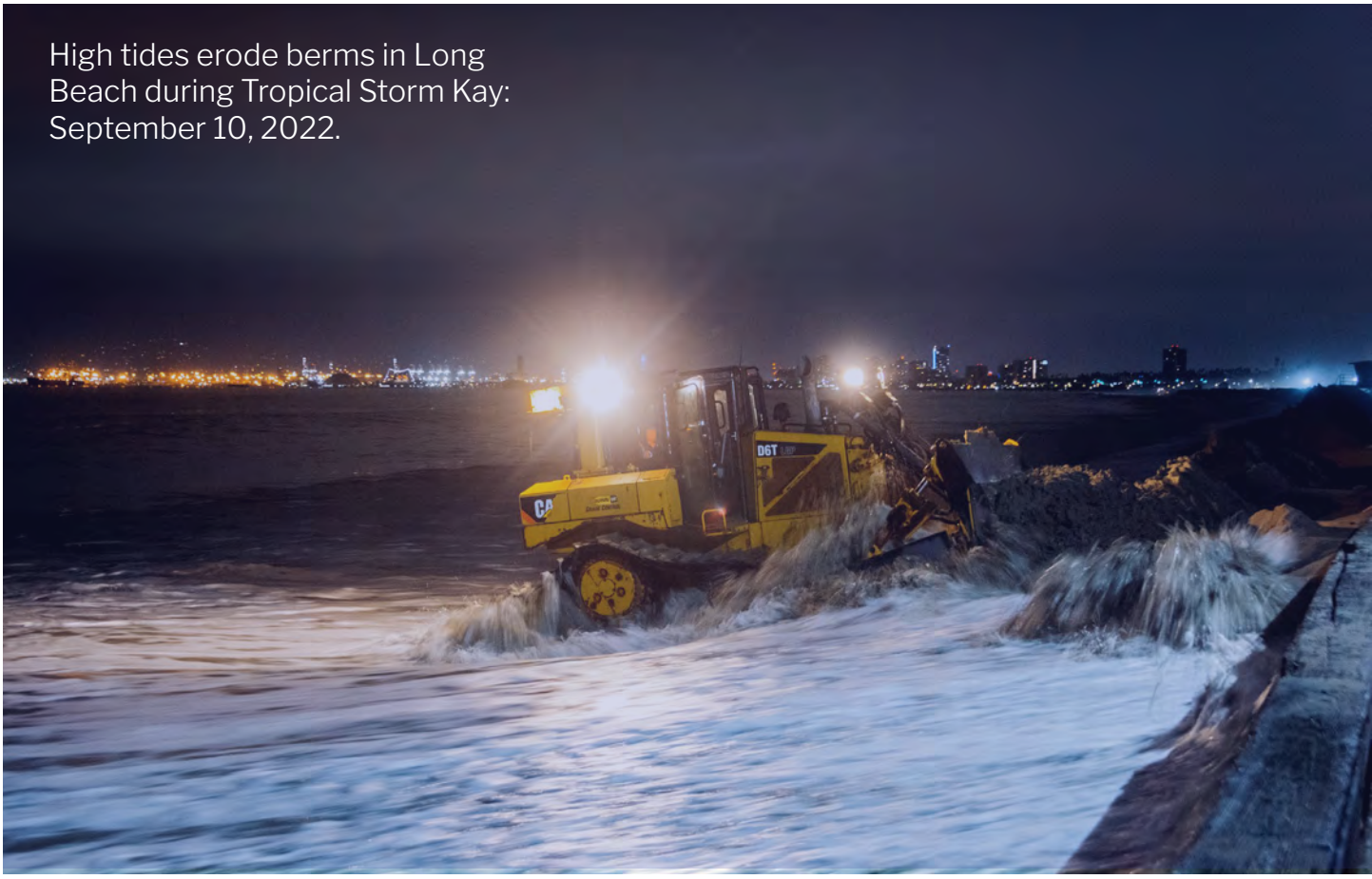
Rank	Municipality	Total Cost	Municipal Cost	County Cost	State Cost	Federal Cost
1	Antelope Valley	$355,828,000	N/A* *unincorporated	$91,409,000	$260,932,000	$3,487,000
2	Santa Clarita Valley	$146,952,000	N/A* *unincorporated	$777,000	$145,069,000	$1,106,000
3	Santa Monica Mountains Coastal Zone	$83,233,000	N/A* *unincorporated	$41,000	$82,128,000	$1,064,000
4	Los Angeles	$46,963,000	$49,748,000	N/A* *incorporated	$189,000	$26,000
5	Santa Clarita	$48,875,000	$48,709,000	N/A* *incorporated	$116,000	$50,000

Figure 8: The total cost by municipality for wildfire mitigation from 2024 through 2040. The costs are concentrated in areas near the wildland-urban interface and largely affect unincorporated areas.



Cost to Protect Infrastructure from Sea Level Rise $576 Million

By 2050, sea levels are expected to rise by about one foot along the Los Angeles County coast,[32] putting coastal communities at greater risk for flooding and other infrastructure damage. Investing in coastal protection to mitigate the risk of rising seas will cost the region approximately $576 million.[33] The costs could be broken down to an annual price of about $34 million, which is equivalent to 34% of Los Angeles County's FY2023 Beaches & Harbors budget.[34]



High tides erode berms in Long Beach during Tropical Storm Kay: September 10, 2022.

32 William V. Sweet et al., "Global and Regional Sea Level Rise Scenarios for the United States: Updated Mean Projections and Extreme Water Level Probabilities Along U.S. Coastlines" (National Ocean Service, Silver Spring, MD: National Atmospheric and Oceanic Administration, 2022), https://aambpublicoceanservice.blob.core.windows.net/oceanserviceprod/hazards/sealevelrise/noaa-nos-techrpt01-global-regional-SLR-scenarios-US.pdf.

33 Sverre LeRoy et al., "High Tide Tax: The Price to Protect Coastal Communities from Rising Seas" (Center for Climate Integrity and Resilient Analytics, 2019), https://climatecosts2040.org/files/ClimateCosts2040_Report.pdf.

34 LA County, "LA County Open Budget Appropriation (Auditor-Controller)."

Cost to Treat Climate-Induced Public Health Threats $1.1 Billion

As climate change alters temperatures, precipitation rates, and other weather patterns in the Los Angeles area, ecological conditions that contribute to various insect populations — and the corresponding diseases they carry — will also shift. Increasing populations of mosquitoes are expected to lead to about 500,000 new cases of West Nile Virus in Los Angeles County from 2024 through 2040, infecting about 5% of the population. This is equivalent to a 270% increase in West Nile Virus cases in Los Angeles County in 2040 as compared to 2024, which will cost an estimated $993 million to treat, or 92% of the total public health cost estimated in this study.

Climate change will also lead to an increase in pollen, leading to higher rates of pediatric asthma. **We estimate there will be about 160,000 new cases of pediatric asthma in Los Angeles County from 2024 through 2040, or about a 60% increase in cases in 2040 as compared to 2024.**

These findings only consider pediatric asthma triggered by increased allergen levels due to increased temperature. Wildfire- and other climate-induced pediatric asthma cases were not analyzed in this study, but they also pose a significant risk to children in the Los Angeles County area.

The yearly average treatment cost for both West Nile Virus and pediatric asthma cases in Los Angeles County is about $64 million from 2024 through 2040.



Comparison of Costs Across Governments

The majority of the climate adaptation costs analyzed in this report — about $9.2 billion — are expected to fall on municipal governments in Los Angeles County. Adaptation costs in the unincorporated areas of the county — areas that do not have a local municipal government — will fall on the county itself, ballooning Los Angeles County's climate adaptation costs through 2040 to about $1.5 billion, or to about $86 million annually, which is roughly 60% of the county's yearly municipal services budget.[35] The state will be responsible for $781 million and the federal government will face $1.1 billion in costs to adapt to the 14 climate impacts analyzed in this report.

Conclusion and Recommendations

This report identifies at least $12.5 billion in climate adaptation and resilience costs that governments in Los Angeles County face through 2040. These figures capture only a portion of the total bill that major climate polluters have racked up for local taxpayers. Without seeking other funding options, the burden of paying for these necessary measures will fall on the same residents who are suffering from intense flooding, deadly heat, and threatened infrastructure. In reality, local governments — and their taxpayers — will simply not be able to afford these costs to protect communities and infrastructure.

Los Angeles County communities that are suffering the most from the climate crisis did not create it — fossil fuel companies did. Just 100 companies are responsible for more than 70% of global carbon emissions since 1988, with ExxonMobil, Shell, Chevron, and BP ranking among the most egregious polluters.[36] It's only fair that major polluters that knowingly caused and profited from the climate crisis pay their share of the resulting costs.

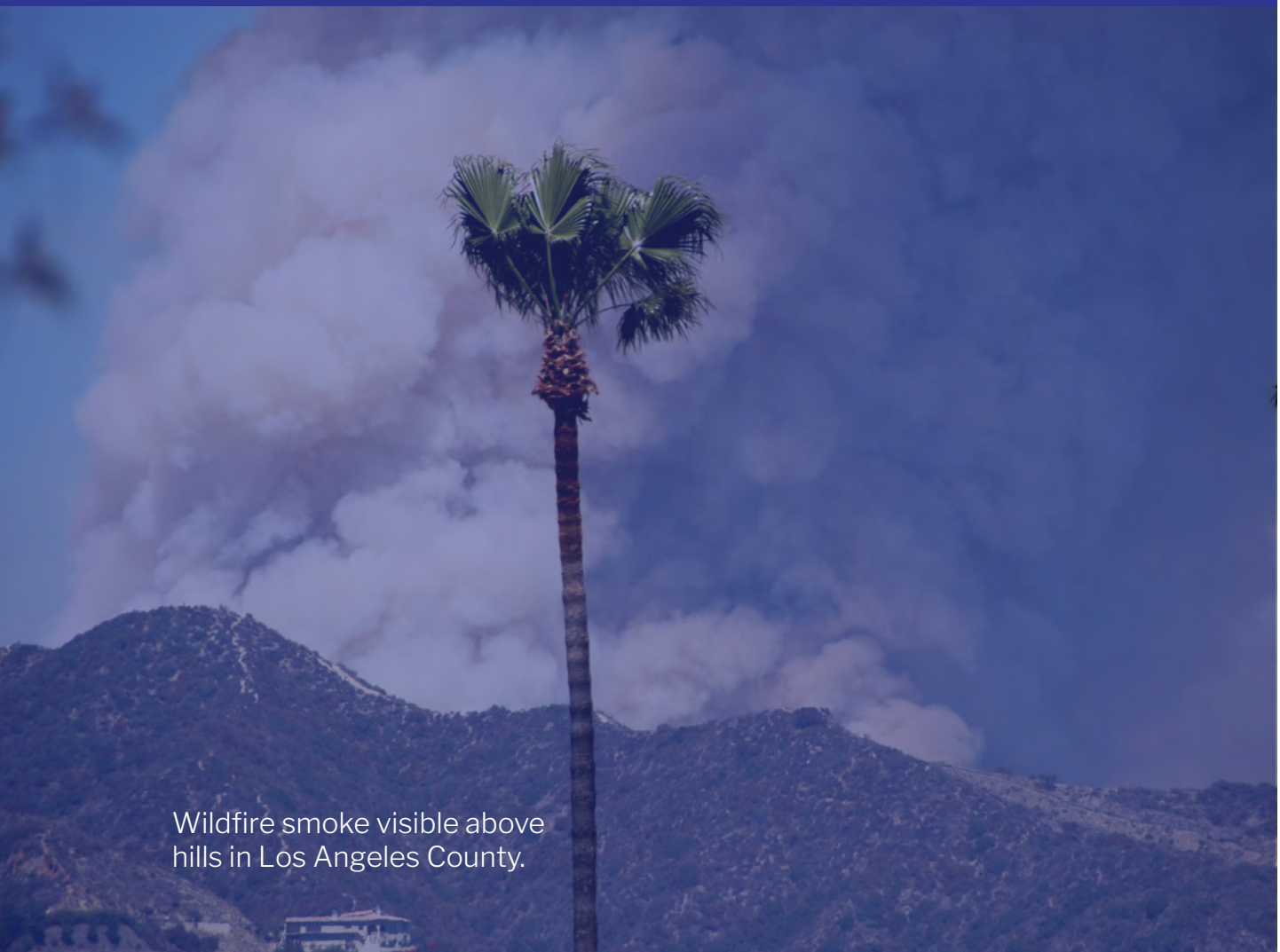
35 Ibid.

36 Paul Griffin, "New Report Shows Just 100 Companies Are Source of over 70% of Emissions," CDP, July 2017, https://www.cdp.net/en/articles/media/new-report-shows-just-100-companies-are-source-of-over-70-of-emissions.

When state and local governments have sought to hold corporations accountable and recover costs incurred by harmful products, they often turn to the courts. Successful legal actions to make tobacco companies, opioid manufacturers, and other deceitful actors pay for the damages they've caused provide a useful model.

In 2023, the State of California took legal action, suing BP, Chevron, ConocoPhillips, Exxon, Shell, and the American Petroleum Institute for climate damages and fraud. Previously in 2017 and 2018, eight California municipal governments — the counties of San Mateo, Santa Cruz, and Marin, as well as the cities of San Francisco, Oakland, Richmond, Santa Cruz, and Imperial Beach — filed suits to recover climate costs from many of the same defendants. Those cases are all advancing in varying stages in state court. Across the country, a growing number of state and local governments are taking legal action to hold oil majors accountable for the cost to protect communities from climate harms.

Los Angeles County municipal leaders have an opportunity to take bold action to protect their residents by holding fossil fuel companies accountable and demanding these polluters pay their fair share of the crisis they imposed on these communities.



Wildfire smoke visible above hills in Los Angeles County.

Appendix

Appendix A: Supplemental Information

Appendix A.1: Adaptation Definitions

Table A1: This report estimates the cost of 14 climate change adaptation strategies that Los Angeles County taxpayers will face, defined in the table below. Note that this report is not exhaustive and Los Angeles County taxpayers will likely incur further costs as a result of additional climate change adaptation strategies not assessed herein.

Climate Impact	Adaptation	Explanation	Taxpayer Costs	Analysis Method	Appendix
Increased temperature	Upgrading heating and cooling infrastructure.	Cost to upgrade HVAC system capacity in 100% of public buildings to cope with the need for increased usage due to climate change. Note we assume 100% of public buildings in Los Angeles County already have HVAC systems installed.	Municipal, county, state	One time cost	C.1
Increased temperature	Estimating the change in energy costs to heat and cool public buildings.	Changes in energy costs are estimated based on the number of days below (heating) or above (cooling) a certain threshold as compared to the climate baseline.	Municipal, county, state	Time series	C.1
Increased temperature	Expanding and operating cooling centers.	To help residents escape the increasing summer heat, cooling centers will need to be expanded and operated. The cost of opening and operating cooling centers due to increased days with temperatures above 80°F, as compared to the climate baseline are estimated.	Municipal (incorporated) and county (unincorporated)	Time series	C.2
Increased temperature	Planting and maintaining urban trees.	Planting trees can help decrease ambient air temperature by cooling the air through evapotranspiration. The adaptation is planting and maintaining trees in urban areas and accounts for both initial costs and yearly maintenance costs. The initial costs include labor and materials. The maintenance costs include water, fertilizer, pruning, and pest spraying.	Municipal	Time series	C.3
Increased temperature	Implementing cool pavements in public parking lots.	Converting existing areas of pavement to high-albedo cool pavement has been shown to decrease proximal ambient temperature and is a complementary approach to combat increased summer temperatures in urban areas. The cost to convert public parking lots to cool pavements is estimated.	Municipal	Time series	C.4

Climate Impact	Adaptation	Explanation	Taxpayer Costs	Analysis Method	Appendix
Increased temperature and precipitation	Proactively and reactively fixing roads.	When pavement temperature rises above its mixture threshold, increased degradation occurs. In the reactive scenario, this increased cracking requires more maintenance to avoid a decrease in the projected lifespan of the road. In the proactive scenario, adaptation includes installation of roads with pavement rated to projected future temperatures. Excess precipitation above what the road was designed to handle can also increase degradation. Road maintenance costs are informed by the percentage decrease in lifespan based on the level of projected damage as compared to the climate baseline. In the proactive road scenario, adaptation requires a strengthening the roadbase to resist the increased potential for erosion. In the reactive road scenario, adaptation is fixing roads after precipitation-induced damage.	Municipal, county, state	Time series	C.5
Increased high fire days	Implementing mechanical wildfire mitigation in intermix areas.	Mechanical intervention focuses on reducing fuel for a fire by manually cutting and removing undergrowth, as well as thinning the density of forested area. Due to an increase in the number of fire days (i.e., length of the fire season), controlled burns are not as feasible, as the available time for a controlled burn is being significantly reduced. Mechanical intervention costs $1,500 per acre.	Municipal, state, federal Unincorporated municipal costs assigned to the county.	Twice per decade	C.6
Increased temperature	Painting the metro rail tracks with high-albedo paint.	Los Angeles can avoid metro rail slow downs and shut downs by painting the tracks with a high-albedo (light reflecting) paint to keep the tracks cool. Australia, Italy, and Switzerland already implement this technique with success. For optimal results, we assume that Los Angeles should paint their rails every year.	County	Once per year	C.7

Climate Impact	Adaptation	Explanation	Taxpayer Costs	Analysis Method	Appendix
Increased precipitation	Installing drainage & stormwater infrastructure.	To combat increased inflow to the wastewater treatment plants, we estimate the cost to increase drainage area by implementing drainage & stormwater infrastructure. Drainage & stormwater infrastructure includes bio retention, porous pavement, bioinfiltration, and bioswale construction.	Municipal (incorporated) and county (unincorporated)	Time series	D.1
Increased precipitation	Proactively adapting bridges.	As rivers flow faster during extreme precipitation events, bridges will degrade faster due to enhanced scour. To combat enhanced damage to bridges, we estimate the cost to proactively rehabilitate bridges in order to prevent disruption. Rehabilitation consists of applying riprap to stabilize bridges and additional concrete to strengthen piers and abutments.	Municipal, county, state	One time cost	D.2
Increased drought	Increased drinking water treatment.	Drought increases sediment and nutrient concentration in drinking water. As such, municipalities incur drought-induced increased drinking water treatment costs. The cost has been estimated at $94.75 per million gallons more than water treatment during non-drought times. We estimate the excess cost to treat 80 gallons per capita for Los Angeles residents during the projected increase in drought conditions as compared to the climate baseline.	Municipal (incorporated) and county (unincorporated)	Time series	D.3
Sea Level Rise	Install coastal protection.	High tide flooding, storm surge, and coastal erosion from sea level rise threaten coastal infrastructure. We estimate the cost to protect critical infrastructure along Los Angeles County's coastline with seawalls.	County	One time cost	E
Public Health: Increased temperature	Increased costs from pediatric asthma hospital visits.	Increased temperatures correlates to increased pollen levels, which lead to more cases of pediatric asthma that require emergency room visits. We estimate the government-incurred cost of increased pediatric asthma visits as compared to the climate baseline.	Federal	Time series	F.1

Climate Impact	Adaptation	Explanation	Taxpayer Costs	Analysis Method	Appendix
Public Health: Increased temperature and increased precipitation	Initial and long-term costs to treat increased West Nile Virus manifestations.	Mosquitoes thrive in warm temperatures and near water, so increased temperatures and precipitation due to climate change will make West Nile Virus more prevalent. We estimate the increased government-incurred cost to treat both initial and long-term manifestations of West Nile Virus.	Federal	Time series	F.2

Appendix A.2: How to read this report.

In the report, we present municipal, county, state, federal, and total costs to adapt to climate change. We break down what each of these costs mean below:

Municipal Costs: Costs we assume will be incurred by the city/town government. When we cannot assign costs to specific government entities, we assume that municipalities are incurring the entirety of the cost. For example, the available data limit our ability to precisely assign the costs for increasing stormwater drainage capacity across multiple levels of government. As a result, we assume 100% of these costs will fall on the municipality, though we recognize that in some cases, the county, state, or federal government may incur some portion of this cost.

County Costs: Costs we can directly assign to Los Angeles County. We assume unincorporated municipalities cannot incur municipal costs and therefore assign those costs to the county.[1] Throughout the report, unincorporated municipalities will have $0 in municipal costs for all impacts analyzed. We also assign costs to the county when the data inventory allows us to assign ownership of structures and/or services to the county. In the case of metro rail, we assign all costs to the county because the county owns and operates this service.[2] Seawall costs are also aggregated county-wide, based on cost estimates from a previous study that calculated costs based on "census designated place."

State Costs: Costs we can assign directly to the State of California. We assign state costs when the data inventory allows us to assign ownership of land, structures, and/or services to the state.

Federal Costs: Costs we can assign directly to the Federal government. We assign federal costs when the data inventory allows us to assign ownership of land and health care costs to the federal government.

Total Costs: The aggregate of municipal, county, state, and federal costs for the 14 impacts included.

1 Public Works Los Angeles County, "Municipal Services," LA County Public Works, 2024, https://content.pw.lacounty.gov/core-service-areas/municipal-services/.

2 CALCOG, "Los Angeles County Metropolitan Transportation Authority (Metro)," California Association of Councils of Governments, July 17, 2020, https://calcog.org/los-angeles-county-metropolitan-transportation-authority-metro/.

Table A2: The 14 climate adaptations and the government entities we assign the costs to.

Climate Impact	Adaptation	Taxpayer Costs
Increased temperature	Upgrading heating and cooling infrastructure.	Municipal, county, state
	Estimating the change in energy costs to heat and cool public buildings.	Municipal, county, state
	Expanding and operating cooling centers.	Municipal (incorporated) and county (unincorporated)
	Planting and maintaining urban trees.	Municipal
	Implementing cool pavements in public parking lots.	Municipal
	Painting the metro rail tracks with high-albedo paint.	County
Changes in precipitation	Installing drainage & stormwater infrastructure.	Municipal (incorporated) and county (unincorporated)
	Proactively adapting bridges.	Municipal, county, state
	Increased drinking water treatment due to drought.	Municipal (incorporated) and county (unincorporated)
Increased temperature and increased precipitation	Proactively and reactively fixing roads.	Municipal, county, state
Increased high fire days	Implementing mechanical wildfire mitigation in intermix areas.	Municipal, state, federal Unincorporated municipal costs assigned to the county
Sea Level Rise	Install coastal protection.	County
Public Health: Increased temperature	Increased costs from pediatric asthma hospital visits.	Federal
Public Health: Increased temperature and increased precipitation	Initial and long-term costs to treat increased West Nile Virus manifestations.	Federal

Appendix A.3: Other costs Los Angeles County may incur due to climate change.

Table A3: Climate change impacts the Los Angeles County area faces and some of the potential costs associated with these impacts. **Items in bolded text were analyzed in this report.** This list is not exhaustive and other costs may be incurred as a result of additional climate change impacts.

Climate Impact	Category	Potential Costs Incurred by Communities in Los Angeles County
Increased Precipitation	Structure and Infrastructure Projects	Remove, relocate, acquire, or demolish structures to minimize future flood losses.
		Install, reroute, increase capacity, or implement a routine cleaning plan of the storm drainage system.
		Add extra culverts, increase dimensions of existing culverts, or implement routine cleaning and repairing.
		Install detention or retention basins, relief drains, spillways, drain widening/ dredging or rerouting, etc.
		Inspect and maintain drainage systems and flood control structures (dams, levees, etc.).
		Inspect bridges in order to identify and/or implement repairs or retrofits or clean under low bridges.
		Resurface roads with more permeable pavement and concrete.
		Elevate roads and bridges above the base flood elevation (BFE)[3] to maintain dry access.
		Elevate structures above the BFE, or relocate utilities, water heaters, etc. above BFE.
		Floodproof inside of municipal buildings, for example by installing check valves, sump pumps, or backflow prevention devices.
		Floodproof wastewater treatment facilities located in flood hazard areas.
		Floodproof water treatment facilities located in flood hazard areas.
		Protect emergency operations by requiring or moving all emergency operations centers, police stations, and fire department facilities outside of flood-prone areas.
		Protect critical and emergency facilities by requiring all critical facilities be built one foot above the 500-year flood elevation (to meet requirements of FEMA Executive Order 11988).[4]
		Protect critical and emergency facilities from floods using any other technique, for example, raising components above BFE, installing pumping systems or back-up generators for pumping, building dikes, or stabilizing banks.
		Construct floodwalls, small berms, revetments, bioengineered bank stabilization, or other small structural mitigants.
	Natural Flood Mitigation	Protect and enhance natural floodplain mitigation features (such as wetlands, dunes, and vegetative buffers) to help prevent flooding in other areas.

3 Base flood elevation (BFE), as defined by FEMA, is "the elevation of surface water resulting from a flood that has a 1% chance of equaling or exceeding that level in any given year."

4 Federal Emergency Management Agency, "Executive Order 11988: Floodplain Management," www.fema.gov/executive-order-11988-floodplain-management.

Climate Impact	Category	Potential Costs Incurred by Communities in Los Angeles County
	Local Planning and Regulation	Update flood risk maps and flood zones.[5]
		Develop a floodplain management plan.
		Adopt a stormwater management or drainage plan.
		Adopt, apply, and enforce building codes to ensure buildings can withstand flooding.
		Obtain easements to use privately-owned land for temporary water retention and drainage.
		Join or improve compliance with the National Flood Insurance Program (NFIP).[6]
		Apply for Floodplain Management, Protection, and Risk Awareness Grants through California Department of Water Resources.[7]
		Preserve floodplains as open space using any of several land use planning tools: develop a plan that targets hazard areas for acquisition, reuse, and preservation, a land banking program, use of transfer of development rights to keep floodplains vacant, easements to prevent development, or acquiring properties in the floodplain and turning them into open space.
	Education and Awareness Programs	Increase public outreach to encourage flood insurance purchase; educate residents in flood safety, flood mitigation, technical assistance availability, funding sources, and best practices.
		Locate new utilities and critical facilities outside of susceptible areas.
		Identify, map, or track erosion hazard areas.

5 Brett Sanders et al., "Large and Inequitable Flood Risks in Los Angeles, California," *Nature Sustainability* 6, no. 1 (2023): 47–57, https://doi.org/10.1038/s41893-022-00977-7.

6 U.S. Federal Emergency Management Agency (FEMA), The National Flood Insurance Program (NFIP), at www.fema.gov/national-flood-insurance-program Policy Information by State (https://nfipservices.floodsmart.gov//reports-flood-insurance-data), accessed August 10, 2023; Los Angeles County only has one active NFIP policy in place, which covers $212,000. For comparison, Kern County has over 1,755 active policies covering over $390 million.

7 California Department of Water Resources, "Floodplain Management, Protection, and Risk Awareness Grant Program," Accessed August 11, 2023, https://water.ca.gov/Work-With-Us/Grants-And-Loans/Flood-Management-Protection-Risk-Awareness-Program.

Climate Impact	Category	Potential Costs Incurred by Communities in Los Angeles County
Sea Level Rise	Structure and Infrastructure Projects	Stabilize susceptible coastal slopes and cliffs and shorelines using grading techniques, planting vegetation, riprap or geotextile fabric, or bioengineering.
		Refer to "Structure and infrastructure projects" from "Increased Precipitation," as they also apply here.
	Coastal Protection	Protect critical infrastructure using techniques like beach nourishment, jetties, and **seawalls**.
		Restore natural wetland areas.
	Local Planning and Regulation	Identify, map, and track coastal erosion and flood hazards.
		Develop and enforce a coastal zone management plan.
		Develop site and building standards.
		Other local planning and regulation as suggested by the Legislative Analyst's Office.[8]
	Education and Awareness Programs	Increase awareness by disclosing location of high-risk areas to current and future property owners; offer mitigation technique information.
		Locate new utilities and critical facilities outside of susceptible areas.
		Identify, map, or track erosion hazard areas.
		Other education and awareness programs as suggested by the Legislative Analyst's Office.[9]
Increased Temperature	Structure and Infrastructure Projects	Energy efficiency retrofits in public and private buildings and housing, including costs for the design and development of standards.
		Increased cooling costs for all public buildings, including green roofs or cool roofing systems on public buildings and new AC installation or upgrade costs for schools.
		Increased road damage due to more frequent extreme heat events.
		Plan for and increase capacity for increased energy demands due to both increased daytime and nighttime temperature.
		Increase high-albedo surfaces on buildings, roads, or where feasible.
	Public Health Projects	**Build and manage more cooling centers, including staffing and tracking of high-risk individuals.**
		Increased demand for publicly financed air conditioning targeted to low income families and public housing.
		Control the increase of vector borne illness – education and physical and chemical controls for ticks and mosquitoes.
		Treat victims of vector borne illness.
		Increase in asthma attacks requiring hospitalization (resulting from increased heat and ground level ozone, and the increase in airborne allergens).
		Reduce the urban heat island effect by planting trees.
		Protect drinking water supplies from hazardous algae blooms.

8 Gabriel Petek, "Preparing for Rising Seas: How the State Can Help Support Local Coastal Adaptation Efforts," Legislative Analyst's Office, 2019, https://lao.ca.gov/reports/2019/4121/coastal-adaptation-121019.pdf.

9 Ibid.

Climate Impact	Category	Potential Costs Incurred by Communities in Los Angeles County
Increased Drought	Water Management	Individual purchase of water during water scarce times.[10]
		Public health costs related to increased exposure to water-borne illnesses.[11]
		Replace old pipelines that have water leak issues.[12]
		Use climate science to update water treatment, wastewater treatment, and other energy infrastructure.[13]
		Reinforce roads, bridges, and buildings to withstand prolonged drought.
	Wildfires	Increase fire suppression, including staffing and aviation.
		Rebuild or relocate damaged properties and public infrastructure, such as homes and utility lines.
		Relocate public infrastructure where necessary.
		Update power lines to withstand dust from wildfires.
		Implement fire mitigation strategies for the future like burying utility lines underground.
		Plan for and disburse community aid after wildfires.
		Implement fire detection strategies, like solar-powered sensors.[14]
		Rehabilitate the landscape post-fire to reduce the risk of erosion and invasive species and mitigate future fire risk.
		Increased hospitalization costs for asthma attacks and other chronic health conditions (resulting from decreased air quality due to wildfire smoke).
	Local Planning and Regulation	Organize meetings to create water scarcity management plans.[15]
		Develop tools for monitoring ground and surface water resources for public use.[16]
	Education and Awareness Programs	Public education, outreach, and awareness campaigns about water conservation.[17]
		Increase public outreach to encourage wildfire risk management; educate residents in wildfire safety, technical assistance availability, funding sources, and best practices.
Other Extreme Weather	Structure and Infrastructure Projects	Increased costs of storm recovery and clean-up.
		Protect power lines through pruning trees.
		Bury overhead power lines or install systems that allow small sections of power lines to fail rather than the complete system.

10 Zoë Roller et al., "Closing the Water Access Gap in the United States: A National Action Plan," Dig Deep and US Water Alliance, 2022, https://static1.squarespace.com/static/5e80f1a64ed7dc3408525fb9/t/6092ddcc499e1b6a6a07ba3a/1620237782228/Dig-Deep_Closing-the-Water-Access-Gap-in-the-United-States_DIGITAL_compressed.pdf.

11 Ibid.

12 "Drought and Infrastructure - A Planning Guide" (Cybersecurity and Infrastructure Security Agency with the National Drought Resilience Partnership, 2021), https://www.cisa.gov/sites/default/files/publications/Drought_and_Infrastructure_A_Planning_Guide_508c.pdf.

13 Ibid.

14 Jennifer L, "Wildfires Cost Over $148B and 30% of Emissions," Carbon Credits, January 30, 2023, https://carboncredits.com/wildfires-cost-emissions/; Western Fire Chiefs Association, "What Is the Financial Cost of a Wildfire?," December 7, 2022, https://wfca.com/articles/cost-of-wildfires/.

15 CISA, "Drought and Infrastructure - A Planning Guide."

16 Ibid.

17 Ibid.

Climate Impact	Category	Potential Costs Incurred by Communities in Los Angeles County
Other Public Health Costs	Education and Awareness and Treatment	Increased allergen levels, food- and waterborne infections, and zoonotic diseases.[18]

Appendix A.4: City of Los Angeles.

We recognize that many cities across Los Angeles County have neighborhoods with vastly different demographic characteristics. To capture the disproportionate impacts on these demographics, we present a small case study of the City of Los Angeles that demonstrates some of the demographic differences within municipalities that should be accounted for when thinking about climate change and the costs associated with adaptation strategies (Table A4).

Table A4: Demographic characteristics for the City of Los Angeles. The minimum and maximum characteristic at the census tract level is presented along with the population-weighted mean characteristic, which was used in the equity analysis for this study.
The City of Los Angeles faces a per capita cost of $964.60 to adapt to the 14 climate impacts analyzed in this study. Demographic characteristics and social vulnerabilities vary widely across the city (Table A4; Figure A1). Therefore, it is likely that the per capita cost to adapt to climate change will be felt differently by residents within the city.

Demographic Characteristic	Minimum	Maximum	Weighted Mean
Median Household Income	$0	$250,001	$71,570
Poverty Rate	0%	100%	15%
Percent Non-Hispanic White	0%	94%	29%
Percent Non-Hispanic Black	0%	84%	8.5%
Percent Non-Hispanic Asian	0%	80%	12%
Percent Hispanic	0%	100%	47%
Percent without a High School Degree	0%	76%	21%
Percent with Limited Access to Internet	0%	100%	11%
Percent Disabled	0%	100%	10%
Percent Uninsured	0%	50%	11%
Percent Foreign Born	0%	82%	36%

18 Carmen Milanes et al., "Indicators of Climate Change in California," Office of Environmental Health Hazard Assessment, 2022, https://oehha.ca.gov/media/downloads/climate-change/report/2018caindicatorsreportmay2018.pdf.

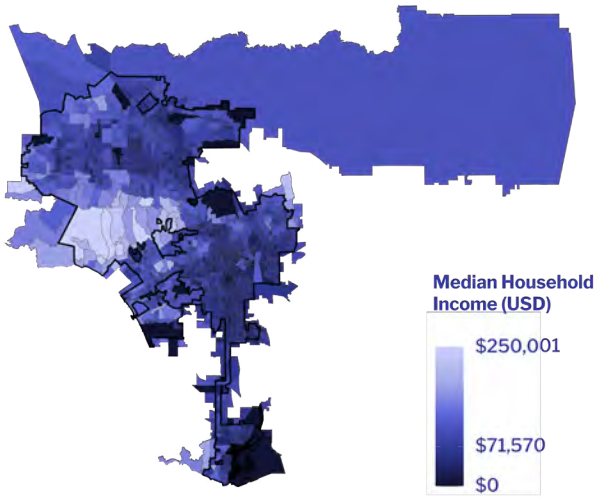


Figure A1: The black outline shows the Municipal boundary of the City of Los Angeles. Census tract bounds (gray) are colored by median household income. The map shows that in the City of Los Angeles, some census tracts have a median household income of $0, while others have a median household income of around $250,000. Dark blue areas highlight the census tracts in the City of Los Angeles that have lower household income than the citywide weighted average median household income ($71,570).

Appendix B: Climate Baselines

The climate projections in this report are derived from the Localized Constructed Analogs (LOCA) statistically downscaled Coupled Model Intercomparison Project Phase 6 (CMIP6) climate projections for North America. We selected different climate variables at 1/16th of a degree (approximately 3.7 mile^2) resolution[19] for 23 global climate models (GCMs) under a moderate greenhouse gas and aerosol emission scenario (Shared Socioeconomic Pathway 2-4.5 [SSP2-4.5]). In the report, the 50th percentile of the 23 model outputs is presented for each of the analyses. The projection time period used is a 17-year period that estimates total costs incurred through 2040 (2024-2040). We also make the data available for download. In the data download, the estimated cost through 2040 and through 2060 are presented. The projection time period for the 2060 cost is typically a 20-year period (2041-2060). The cost estimates for both time periods are also based on the 50th percentile of the 23 model outputs for SSP2-4.5 for each analysis. The climate baseline for temperature-related analyses in this study is derived from Livneh et al. (2015).[20] The climate baseline for precipitation-related analyses in this study is derived from Pierce et al. (2021).[21] We use at least a 20-year baseline time period for all analyses presented. A shapefile of Los Angeles County municipal boundaries is used throughout the study.[22]

We present a cumulative cost over the projection time period for all costs. The two main ways adaptation costs are estimated are either as a time series (Table A1) or assessed once in 2040 and then again in 2060 (one time costs; Table A1). Two adaptations, mechanical intervention for wildfires and painting metro rail tracks, are one time costs but are incurred twice per decade or once per year, respectively (Table A1).

We assume all municipal costs incurred in unincorporated municipalities are incurred instead by the county.

19 David W. Pierce, Daniel R. Cayan, and Bridget L. Thrasher, "Statistical Downscaling Using Localized Constructed Analogs (LOCA)," *Journal of Hydrometeorology* 15, no. 6 (December 1, 2014): 2558–85, https://doi.org/10.1175/JHM-D-14-0082.1; David W. Pierce et al., "Improved Bias Correction Techniques for Hydrological Simulations of Climate Change," *Journal of Hydrometeorology* 16, no. 6 (December 1, 2015): 2421–42, https://doi.org/10.1175/JHM-D-14-0236.1.

20 Ben Livneh et al., "A Spatially Comprehensive, Hydrometeorological Data Set for Mexico, the U.S., and Southern Canada 1950–2013," *Scientific Data* 2, no. 1 (August 18, 2015): 150042, https://doi.org/10.1038/sdata.2015.42.

21 David W. Pierce et al., "An Extreme-Preserving Long-Term Gridded Daily Precipitation Dataset for the Conterminous United States," *Journal of Hydrometeorology* 22, no. 7 (July 1, 2021): 1883–95, https://doi.org/10.1175/JHM-D-20-0212.1.

22 County of Los Angeles, "City and Unincorporated Community Boundary (Regional Planning)," 2023, https://data.lacounty.gov/datasets/lacounty::city-and-unincorporated-community-boundary-regional-planning/about.

Appendix C: Methodologies for estimating the cost to address temperature-related impacts

Appendix C.1: Installing and Upgrading Building Heating and Cooling Infrastructure and Estimating the Change in Energy Cost

Taxpayer costs were analyzed at the municipal, county, and state level.

Buildings Inventory

We create a buildings database that is based on public datasets to inform building location, area, owner, and use type. Building location and footprint are based on the USA Structures data published by the Federal Emergency Management Agency (FEMA).[23] Building height is assumed based on the classification as published within the United States Geological Survey (USGS) national dataset of average building height[24] using the United States Census (Census) block groups.[25] Each block group is sorted into one of four classifications based on the average number of stories per building. These classifications are sourced from a National Aeronautics and Space Administration (NASA) dataset of Census block group data, which is based on LiDAR data collected in 2000 and verified and published in 2016.[26] This data provides a conservative height estimate, as we assume that the building height classification in any given block group has either increased or remains unchanged since the dataset was verified. Total building floor area is calculated by multiplying a given building's footprint by the average number of stories in the block group where the building is located. Building owner is determined based on a text scrape algorithm of the Los Angeles County Assessor Publicly Owned Parcels database[27] for keywords in the building type related to each of the local governments of concern.[28] For example, buildings with "State" in their name are filtered into the state-owned category. Lastly, building type is based on the Homeland Security buildings database[29] and the Department of Housing and Urban Development public housing database.[30] Each building within the inventory is assigned a building type from the Department of Energy (DOE) energy models in order to inform the energy, install, and upgrade calculations. The costs associated with municipal buildings in unincorporated areas are assigned to the county. Please note that the buildings inventory may not be an exhaustive representation of all public buildings that exist.

Climate Metrics

The number of cooling degree days (CDD)[31] and heating degree days (HDD)[32] for the baseline and projection time periods for each building are computed to determine changes in energy costs. The 20-year average number of annual CDDs and HDDs are reported. A degree day base of 50°F[33] is utilized

23 FEMA, "USA Structures" (Federal Emergency Management Agency Geospatial Resource Center, 2022), https://gis-fema.hub.arcgis.com/pages/usa-structures.

24 James A. Falcone, "U.S. National Categorical Mapping of Building Heights by Block Group from Shuttle Radar Topography Mission Data" (U.S. Geological Survey, 2016), https://doi.org/10.5066/F7W09416.

25 United States Census Bureau, "Glossary," under "Block Group," (accessed September 27, 2023), https://www.census.gov/glossary/?term=Block+Group+%28BG%29.

26 Falcone, "U.S. National Categorical Mapping of Building Heights by Block Group from Shuttle Radar Topography Mission Data."

27 County of Los Angeles, "Assessor Publicly Owned Parcels (Current)," May 10, 2023, https://data.lacounty.gov/datasets/c42fd5850b5b40d88e79c7d4204b9371_0/about.

28 U.S. Department of Homeland Security, "Homeland Infrastructure Foundation-Level Data (HIFLD)" (Geospatial Management Office, 2021), https://hifld-geoplatform.opendata.arcgis.com/.

29 Ibid.

30 Department of Housing and Urban Development, "Public Housing Buildings" (HUD GIS Helpdesk: Office of Policy Development and Research (PD&R), 2023), https://hudgis-hud.opendata.arcgis.com/datasets/HUD::public-housing-developments/about.

31 Cooling degree days (CDD) is a daily measure of how much (in degrees) the average outside air temperature is above a specified temperature threshold.

32 Heating degree days (HDD) is a daily measure of how much (in degrees) the average outside air temperature is below a specified temperature threshold.

33 In this context, CDD and HDD with a base of 50°F are used as climate variables. The base temperature does not inform when any given building is in cooling or heating mode (which typically has a threshold of 65°F).

for each because it demonstrates a better relationship with building cooling capacity and energy usage than other temperature metrics, such as degree days with a base of 65°F.

Degree Day Relationships

The DOE Commercial Reference Building models define the characteristics of a representative building for each climate zone[34] based on nationwide survey data.[35] Models are available for buildings built pre-1980, post-1980, and new. We used only the post-1980 models for the purposes of this study. Cooling system type, heating system type, cooling system capacity, cooling system energy usage, heating system energy usage, and building square footage as defined by the DOE Reference Building Models were used to calculate cooling capacity intensity (ft^2/ton), cooling energy use intensity (kWh/ft^2) and heating energy use intensity (kWh/ft^2 for electricity or MJ/ft^2 for gas) for a representative building in each climate zone.

Each building type within the building inventory is matched with a building type from the DOE representative energy models as outlined in the table below (Table C1).

Table C1: Building types within the building inventory and their corresponding building type within the DOE reference building energy models.

Inventory Building Type	DOE Building Type
Court House	Office
EMS	Office
Fire Station	Office
Hospital	Hospital
Library	Office
Post Office	Office
Prison	Hotel
Public Health Department	Office
Public Housing	Midrise Apartment
Primary School	Primary School
Secondary School	Secondary School
Town Hall	Office

Cooling Days

A relationship was established between the annual CDDs with base 50°F (CDD50) reported in ASHRAE 90.1 2004[36] and both the cooling capacity intensity and the cooling energy use intensity for each representative building. This relationship was used to calculate cooling system capacity and energy usage for all buildings using inputs of baseline and projected CDD50, building area, and building type.

34 There are eight main climate zones that are subdivided into moist, dry, and marine subsets to make 16 total classifications. The zones are determined based on a location's historic weather characteristics, in this case as defined by Briggs et al., (2003), https://www.proquest.com/openview/d1c49b47cddf83d4cb8ffc7b2ec1b075/1?pq-origsite=gscholar&cbl=34619.

35 U.S. Department of Energy, "Commercial Reference Buildings" (Department of Energy: Office of Energy Efficiency & Renewable Energy, 2010), https://www.energy.gov/eere/buildings/existing-commercial-reference-buildings-constructed-or-after-1980.

36 ASHRAE, ANSI/ASHRAE/IESNA Standard 90.1-2004: Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings, distributed by ASHRAE, (2004).

Heating Days

A relationship was established between the annual HDD50 reported in ASHRAE 90.1 2004[37] and the heating energy use intensity for each representative building. This relationship was used to calculate heating system energy usage for all buildings using inputs of baseline and projected HDD50, building area, and building type.

Cost Estimates: Cooling System Capacity

Cost per ton of cooling is calculated for install and upgrade. System install and upgrade use the same $/ton costs based on RSMeans Assembly costs in the 2021 edition of the RSMeans Square Foot Cost Book.[38] System types in the DOE Commercial Reference Building documentation were matched with the most appropriate assembly type (Table C1) in the RSMeans construction cost estimating data.

Costs are in Q2-2023 dollars and include material, labor, sales tax (6%), general requirements (10%), general contractor overhead (5%) and profit (5%), and an average location factor for Los Angeles County based on the national average.[39] No architect fee or contingency was added. Percentages follow RSMeans methodology. Additional costs will vary on a case-by-case basis and are outside of the scope of this study.

Cooling system installation costs were calculated for each building in the database based on projected capacity needs. Cooling system upgrade costs were calculated for each building in the database based on the projected capacity increase from baseline. An upgrade was assumed to be necessary if the change in cooling system capacity in a given projection was more than 10% higher than the cooling system capacity for the baseline. Only the increased cost from the change in baseline capacity was estimated, rather than the full system capacity, so that only impacts on system size arising from anthropogenic climate change were captured. Costs are presented on a municipal, county, and state basis by summing upgrade and install costs for all buildings within the respective jurisdiction that are owned by the jurisdiction(s) of interest.

Since the prevalence of air conditioning within most building types is unknown, the upgrade and installation costs for these building types are presented in a series of bins according to the prevalence of air conditioning across the jurisdiction's building stock. As an example, the 25% bin implies that 25% of a jurisdiction's buildings have existing cooling, and so 25% of the upgrade costs are reported while 75% of the installation costs are reported. In Los Angeles County, we assume all buildings have air conditioning[40] and therefore only upgrade costs are reported (0% of buildings need air conditioning installed, 100% of buildings are subject to upgrade costs).

Cost Estimates: Cooling and Heating Energy

Cost per kWh of electricity and per MW of natural gas are based on statewide 2022 annual average values as reported by the United States Energy Information Administration (US EIA).[41] Costs presented are based on 2022 average utility costs rather than projected costs. Available energy cost projections include substantial uncertainty and only extend to 2050. Additionally, use of present-day dollar amounts maintains consistency with the other analyses, which do the same. Energy costs assume all buildings have cooling and heating, while the percent change in costs will apply to any prevalence of buildings with both cooling and heating.

37 ASHRAE, ANSI/ASHRAE/IESNA Standard 90.1-2004: Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings, distributed by ASHRAE, (2004).

38 RSMeans, Building Construction Cost Data, (2021), distributed by Gordian, https://www.rsmeans.com/.

39 Attilio Rivetti, "Turner Building Cost Index: 2023 Second Quarter Forecast" (Turner Construction Company, 2023), https://www.turnerconstruction.com/cost-index.

40 Matt Barnum, "Exclusive: Too Hot to Learn: Records Show Nearly a Dozen of the Biggest School Districts Lack Air Conditioning," June 14, 2017, https://www.the74million.org/article/exclusive-too-hot-to-learn-records-show-nearly-a-dozen-of-the-biggest-school-districts-lack-air-conditioning/.

41 U.S. Energy Information Administration, "Electricity Data Browser," 2022, https://www.eia.gov/electricity/data/browser/; U.S. Energy Information Administration, "Natural Gas Prices," 2022, https://www.eia.gov/dnav/ng/ng_pri_sum_a_EPG0_PCS_DMcf_a.htm.

Assumptions

System type is as reported in DOE Commercial Reference Building models. Only components[42] that are included in the RSMeans assemblies were included in our estimate. Other items that may incur costs but were not included in analysis include: required code improvements, structural improvements, asbestos abatement, redundant equipment, electrical upgrades, inflation, design fees, permitting, inspections, crane, constructability, demolition, waste and disposal. Costs are based on the average $/ton across all system capacities reported in RSMeans.

The cooling capacity intensity relationship with CDD50 was calculated without the equipment sizing factor of 1.2[43] used by the DOE Reference Building models.

Appendix C.2: Protecting Residents during Heatwaves

Taxpayer costs were analyzed at the municipal level. Costs for unincorporated municipalities are assigned to the county.

We quantified how much it will cost Los Angeles County to expand and operate cooling centers in order to protect residents from extreme heat in "vulnerable areas." We used 2019 U.S. Census block data and the Los Angeles County Municipal Bounds to identify the "vulnerable areas" within each municipality, defined as an area that has a median income at or below twice the poverty line for a family of four ($55,500).[44] We used ArcGIS to assess the vulnerable area (mile^2) within each municipality.

Using Census block groups[45] to identify vulnerable areas in rural communities results in large regions of undeveloped areas being considered vulnerable, and therefore overestimates the amount of cooling centers required. To remedy this, we only used areas classified as medium or high intensity developed areas by the National Land Cover Database (NLCD) developed areas. In ArcGIS, we layered the NLCD classifications over the previously created vulnerable block groups. We saved only the overlapping NLCD developed areas, which leaves developed areas that are within vulnerable areas. As such, we determined the quantity of vulnerable areas within each municipality.

We assume that a cooling center within a vulnerable area must be within a 0.5 mile radius walking distance, thus every cooling center covers 0.785 sq. mi. To determine the number of cooling centers required in a given municipality, we divided the vulnerable area of each municipality by 0.785. Based on a report from the Center for Disease Control,[46] we assume that 62% of cooling centers do not incur additional costs, 15% incur only additional HVAC costs, and 23% incur both additional HVAC and staffing costs when operating for 8-hours. Though 62% of cooling centers did not incur additional costs for the first 8-hours of operation, 54% of all cooling centers operate on a 12-hour schedule and will incur an additional 4-hours of HVAC and staffing costs.[47] For this reason, we separated costs into 8-hours and 4-hours (see example computation below; Table C2). We estimated operational costs by using a report

42 The RSMeans system costs include the parts typical to cooling systems like the air handling unit, piping, valves, insulation, etc. These costs are for a generalized system and any given installation would likely see variations to meet the specific needs of that system.

43 The DOE reference building models include a 20% safety factor when sizing a cooling system. We remove this safety factor to determine the minimum amount of cooling a building needs.

44 "What Is the Federal Poverty Level (FPL)?," healthinsurance.org, accessed December 13, 2023, https://www.healthinsurance.org/glossary/federal-poverty-level/.

45 United States Census Bureau, "Glossary," under "Block Group," accessed September 27, 2023, https://www.census.gov/glossary/?term=Block+Group+%28BG%29.

46 Stasia Widerynski et al., "The Use of Cooling Centers to Prevent Heat-Related Illness: Summary of Evidence and Strategies for Implementation Climate and Health Technical Report Series Climate and Health Program, Centers for Disease Control and Prevention," Climate and Health Technical Report Series (Climate and Health Program: Centers for Disease Control and Prevention, 2017), https://www.researchgate.net/publication/319112587_The_Use_of_Cooling_Centers_to_Prevent_Heat-Related_Illness_Summary_of_Evidence_and_Strategies_for_Implementation_Climate_and_Health_Technical_Report_Series_Climate_and_Health_Program_Centers_for_Disea.

47 Ibid.

from the City of Los Angeles that details the city's cooling center costs. They report that HVAC costs were $26.86 per hour (HC), and HVAC and staffing costs (HSC) were $292.79 per hour.[48]

Table C2: An example for how to calculate the cost to operate cooling centers in a Los Angeles County municipality.

Vulnerable Area (A)	# of Cooling Centers (CC)	Additional HVAC Costs (AHC)	Additional HVAC and Staffing Costs (AHSC)	8 Hour Costs (C8)	4 Additional Hours Costs (C4)	Total Daily Costs
	A/0.785, round up to nearest whole number	CC*0.15*HC*8	CC*0.23*HSC*8	AHC + AHSC	((CC*0.62)* 0.54)*HSC*4	C8 + C4

This method calculates the daily operation cost for cooling centers for each municipality in Los Angeles County. The next step is to multiply the daily costs by the number of days that each municipality experiences over 80°F. The resulting amount will be the rough estimation for each municipality's cooling center costs on a yearly basis.

Note that because some areas are vulnerable but will not require cooling centers (rural areas) there is an additional filter that if a municipality has a vulnerable area less than half of the area covered by a cooling center (0.785 sq. mi) then it is determined that area does not require a cooling center. Areas with this occurrence are most likely rural areas with low populations relative to other urban environments.

Appendix C.3: Combating Heat Islands – Urban Trees

Taxpayer costs were analyzed at the municipal level.

We quantified how much it will cost Los Angeles County municipalities to increase urban tree canopy in order to adapt to an urban heat island exacerbated by higher temperatures. An urban tree constitutes any tree located in a developed area of medium or high intensity according to the NLCD. We did not determine the cost of planting urban trees in municipalities with less than 500 pop/mi^2 or municipalities with less than 100 people as the total population as these are not "urban" areas and are excluded from the analysis.

Quantifying canopy coverage in Los Angeles County urban environments

We used NLCD 2021 Land Cover data and NLCD 2021 Canopy Coverage to quantify the current canopy coverage in municipalities across Los Angeles County.

Cost Data

We used RSMeans to collect cost data.[49] We broke the initial planting data into labor costs and material costs. Labor and material costs were estimated using an average across multiple planting sizes as well as a variety of representative sapling species. We calculated tree maintenance costs by combining water, fertilizer, pruning, and pest spraying. We adjusted the costs to 2023 values using an inflation rate of 13.84%, per the Turner Building Cost Index.[50] Additionally, we adjusted the national average to Los Angeles County specific city cost index data.

48 C.P. Parks, "Cooling Center Operations in Los Angeles City." (City of Los Angeles Emergency Management Department, 2022), https://clkrep.lacity.org/onlinedocs/2021/21-1277_rpt_07-29-22.pdf.

49 Derrick Hale, "Site Work & Landscape Costs with RSMeans Data" (The Gordian Group, 2021), https://www.rsmeans.com/media/wysiwyg/2021-SiteWork-TOCs.pdf.

50 Rivetti, "Turner Building Cost Index: 2023 Second Quarter Forecast."

Determining Ideal Canopy Numbers

We combined canopy cover from 16 metropolitan areas across the country to serve as representative models for different size municipalities in Los Angeles County including each city's canopy coverage goal percent, canopy goal year, current canopy coverage, the year the current canopy coverage was calculated, and the current population density. Regressing on these variables with goal canopy percent as the dependent variable resulted in an adjusted R squared value of 0.73.

The output regression formula is:

Canopy Cover Goal % = -5.4913424 + (-3.74075E-06 * (Pop Density))
+ (1.073584308 * (Initial Canopy Cover))
+ (0.003353585 * (Year Assessed))
+ (-0.000552275*(Target Year))

We used the formula to calculate goals for municipalities for each development level as shown below. We used a target year of 2033 based on a 10-year period for trees to reach their average canopy cover (Table C3).

Table C3: Los Angeles County urban canopy model. Note that each municipality has an average current and goal canopy cover. The percentages in this table represent the average of those current and goal canopy covers across all incorporated municipalities.

Incorporated Municipalities		
Population Density	6,411	
Year Assessed	2023	
Target Year	2033	
Developed Area	**Current Canopy Cover (%)**	**Goal Canopy Cover (%)**
Medium Intensity	5.60	6.16
High Intensity	0.85	1.05

Table C4: The urban tree canopy coverage increase needed to meet the goal canopy cover for Los Angeles County. The table also shows how much it will cost to increase canopy coverage and the approximate number of trees to do so.

Developed Area	**Needed Increase (sq. ft.)**	**Cost to Increase**	**~# of Trees**
Medium Intensity	219,087,480	$39,435,746	697,931
High Intensity	46,223,874	$8,320,297	147,252
Total	**265,311,353**	**$47,756,044**	**845,183**

Cost Estimates

Table C5: Cost model for urban canopy in Los Angeles County showing an initial planting cost and then the costs in Year 1 (Y1), Y2, and Y3.

Developed Area	Initial Planting Cost	Y1 (2023)	Y2 (2024)	Y3 (2025)
Medium & High Intensity	$330,764,632	$47,282,063	$47,282,063	$47,282,063
Tree Mortality Cost	–	–	$22,491,995	$22,491,995
Total	**$330,764,632**	**$47,282,063**	**$69,774,058**	**$69,774,058**

The cost model uses a variety of inputs to calculate a final cost value. Important inputs include:

- Average canopy cover per tree (sq. ft.)
  - Average canopy cover in Los Angeles was determined by referencing a document released by Tree People listing approved street trees for the City of Los Angeles.[51] This list was then cross referenced against the Southern Nevada Water Authority regional plant list[52] which provides canopy coverage in square feet. Together these documents provided a list of 27 recommended trees and their coverage to average.
- Average annual cost to maintain an urban tree ($)
  - Explained above
- Initial cost to plant a tree ($)
  - Explained above
- Cost per canopy ($/sq. ft.)
  - Calculated by dividing cost to maintain an urban tree by the average canopy cover per tree
- Tree mortality rate Years 1-5 and Year 6+[53]

Next, we priced out these costs into the future. Year one costs include both the initial maintenance cost as well as the initial cost to plant trees. After year one, the maintenance cost stays the same. However, there is a tree mortality cost: for years 1-5 there is an assumed 6.8% loss of trees per year, and there is an assumed 3.3% loss for year 6+.[54] Each year, this loss is translated into the cost to replace that amount of trees. The cost model can be extended for as many years as desired and inflation costs can be incorporated based on whatever rate is deemed appropriate. Note that the model does not specify where trees are planted within the municipalities.

51 TreePeople, "City of Los Angeles Approved Street Tree List," 2021, https://www.treepeople.org/wp-content/uploads/2021/02/TreePeoples-LA-City-Approved-Street-Tree-List.pdf.

52 Southern Nevada Water Authority and Southern Nevada Regional Planning Coalition, "Regional Plant List," 2021, https://www.snwa.com/assets/pdf/water-smart-plant-list.pdf.

53 Deborah R. Hilbert et al., "Urban Tree Mortality: What the Literature Shows Us," *Arborist News*. Oct: 22-26. Oct (2019): 22, https://www.fs.usda.gov/research/treesearch/59819.

54 Ibid.

Appendix C.4: Combating Heat Islands – Cool Pavements

Taxpayer costs were analyzed at the municipal level.

It is possible that future drought conditions will hinder Los Angeles County's ability to support a robust tree canopy. In such a scenario, other approaches to urban temperature reduction will be required to maintain a favorable temperature in the urban environment. Converting existing areas of pavement to high-albedo cool pavement has been shown to decrease proximal ambient temperature and is a complementary approach to urban tree canopy that was considered as part of this report, as the City of Los Angeles has enacted an ordinance to "reduce nonroof heat islands for 75% of pathways, patios, or other paved areas" by utilizing both urban trees and cool pavements, as well as other strategies not considered in this study.[55]

Quantifying parking lot area in Los Angeles County

Only parking lots were considered for cool pavement adaptations due to the large surface area that parking lots cover in Los Angeles County and to maintain a conservative cost estimate. Parking lots also offer a more consistent canvas for cool pavement conversion than the variation existing among driveways, sidewalks, and other impermeable surfaces. Los Angeles County's official GIS website hosts information on the boundary of all parking lots in the county and was used to determine the current square footage of parking lots in incorporated areas of Los Angeles County.[56]

Cost Estimates

RSMeans[57] and an Environmental Protection Agency (EPA) study on cool pavement costs[58] informed the cost estimates used herein. Labor and material costs were estimated using an average across several cool pavement methods, including white topping, micro surfacing, and chip seal. Costs from the EPA document were adjusted to 2023 dollars using the National Highway Construction Cost Index (NHCCI).[59] RSMeans nationwide average costs were adjusted by a city cost index of $109.85 from the national average based on cities within Los Angeles County and also adjusted to 2023 dollars.

To determine final unit costs, we used a conservative method utilizing the lower cost of the range presented by the EPA along with the longer estimated service life for each method. For example, the EPA lists ultra-thin white topping as costing $1.50-$6.50 per installed square foot with an estimated lifespan between 10-15 years. For this method we use $1.50 per square foot and a lifespan of 15 years to factor into an average across multiple methods. A mix of methods were used due to the variety of current surfaces and conditions parking lots may exist in. Thus, variations of white topping, micro surfacing, and chip seal were all averaged to result in a $0.06/ft^2 annual cost for a 20-year estimate (Table C6). We present the cumulative 17-year cost in this study.

55 Council of the City of Los Angeles, "Ordinance No. 187208" (2021), https://www.ladbs.org/docs/default-source/publications/ordinances/20-1139_ord_187208.pdf?sfvrsn=6acdc153_9.

56 County of Los Angeles, "Parking Lots (2014) from LARIAC," 2023, https://egis-lacounty.hub.arcgis.com/datasets/413ba9befacf41a68f7dcad55a08f9a8_0/explore?location=33.867487%2C-118.278003%2C15.90.

57 Hale, "Site Work & Landscape Costs with RSMeans Data."

58 U.S. Environmental Protection Agency, *Reducing Urban Heat Islands: Compendium of Strategies. Cool Pavements,* 2012, https://www.epa.gov/sites/default/files/2017-05/documents/reducing_urban_heat_islands_ch_5.pdf.

59 Federal Highway Administration, "National Highway Construction Cost Index (NHCCI)," 2023, https://data.bts.gov/Research-and-Statistics/National-Highway-Construction-Cost-Index-NHCCI-/wgzr-nyxc.

Table C6: The minimum cost per square foot, the minimum lifespan, and the total 20-year cost for the various cool pavement techniques used in this analysis.

Source	Technique	$/sq ft.	Lifespan (years)	20-Year Cost ($/sq ft.)
EPA	Ultra-thin whitetopping	2.63	15	3.51
EPA	Microsurfacing	0.61	10	1.23
EPA	Chip Seal with light aggregate	0.18	8	0.44
RSMEANS	Chip Seal, Medium Fine, Parking lot	0.38	8	0.95
RSMEANS	Chip Seal, Medium, Parking lot	0.43	8	1.08
RSMEANS	Microsurfacing, Type II-MSE, Parking Lot	0.37	10	0.73
RSMEANS	Microsurfacing, Type IIa-MSE, Parking Lot	0.53	10	1.06

Appendix C.5: Maintaining Roads

Taxpayer costs were analyzed at the municipal, county, and state level.

To determine the potential future damage to municipal, county, and state roads in Los Angeles County, we analyzed both the historic environment and projected future conditions to determine how climate change will affect the as-designed condition of road infrastructure. Increasing temperatures cause more surface degradation[60] and decreases road lifespan.[61] Increasing precipitation levels cause erosion, which weakens the roadbase, causing increases in cracking, potholes, and breakage.[62] We designed distinct stressor-response functions for paved (assumed to be asphalt), gravel, and unpaved roads. Furthermore, within each category we made refinements for primary, secondary, and tertiary roads.[63] We identified local roads using a database containing Los Angeles County roads that are owned by municipalities, counties, or states. Ownership is determined for each road segment based on classification from the Census.[64] The costs associated with municipal roads in unincorporated areas are assigned to the county.

Temperature

Pavement temperature determines the required pavement design or the ability for the pavement to withstand temperature-related degradation.[65] We find a relationship between pavement temperature and 7-day maximum ambient air temperature ($T\text{-}7_{max}$), so we use historic and projected $T\text{-}7_{max}$ to determine when a projected change in temperature will be significant enough to cause climate-based damage to road infrastructure.

60 Degradation is the projected increase in raveling and cracking that will occur due to pavement weakening.

61 Transportation Research Board, "Superpave: Performance by Design," 2005, https://www.trb.org/publications/sp/superpave.pdf.

62 James E. Neumann et al., "Climate Change Risks to US Infrastructure: Impacts on Roads, Bridges, Coastal Development, and Urban Drainage," *Climatic Change* 131, no. 1 (July 1, 2015): 97–109, https://doi.org/10.1007/s10584-013-1037-4.

63 Paul Chinowsky and Channing Arndt, "Climate Change and Roads: A Dynamic Stressor–Response Model," *Review of Development Economics* 16, no. 3 (2012): 448–62, https://doi.org/10.1111/j.1467-9361.2012.00673.x.

64 U.S. Census Bureau, "TIGER/Line Shapefiles," 2022, https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.html.

65 Patrick Lavin, *Asphalt Pavements: A Practical Guide to Design, Production and Maintenance for Engineers and Architects* (London: CRC Press, 2003), https://doi.org/10.1201/9781482267716.

We used guidance from Superpave increments of pavement temperature to determine the exceedance parameters.[66] When pavement temperature rose above the mixture threshold, we calculated the increased degradation based on published material studies.[67] In the reactive scenario, this increased cracking requires more maintenance to avoid a decrease in the projected lifespan of the road.[68] In the proactive scenario, adaptation includes installation of roads with pavement rated to projected future temperatures.

Precipitation

We used historic and projected maximum monthly precipitation amounts to determine if excessive erosion will increase damage to the roadbase. We compared the historic maximum monthly precipitation to the projected change in maximum monthly precipitation rates at the time-slice of interest. We used a threshold based on the type of road surface to determine whether increased damage will occur to the road. If a threshold is exceeded, then a percentage decrease in lifespan is calculated based on the level of projected damage. In the proactive road scenario, adaptation for this scenario requires a strengthening of the roadbase to resist the increased potential for erosion. In the reactive road scenario, adaptation is fixing roads after precipitation-induced damage.

Cost Estimates

We conducted this analysis with the goal of retaining the original design life and service level of the roadways. We present costs for both a proactive and reactive adaptation approach.

Proactive: The proactive scenario includes the additional costs required to adapt design and construction to defend against projected changes in climate expected to occur over the asset's lifespan. We estimated total costs based on the cost associated with enhancing the materials selected or alternate design requirements. First, we generated stressor-response values for infrastructure elements. Next, we designed infrastructure to a level that protects against the future changes in climate conditions and the accompanying changes in material or design requirements. Last, we subjected any new or rehabilitated structures to material changes when it was anticipated that a significant climate change stressor would occur during the lifespan.

Reactive: Reactive adaptation costs were calculated to understand the cost-benefit of proactive adaptation. Reactive adaptation involves fixing roads as problems arise and is usually more expensive than a proactive approach. Damage threshold exceedance data from each grid within the climate model data is used to determine the level of additional maintenance and repair required for any given segment of road on an annual basis. This is then fed into the cost module where a per-mile maintenance cost is applied to each mile of road segment within each affected grid. Lastly, road maintenance costs are aggregated from a grid-level to a municipality-level using an area-based weighted average approach.

66 Transportation Research Board, "Superpave: Performance by Design."

67 M Miradi, "Artificial Neural Network (ANN) Models for Prediction and Analysis of Ravelling Severity and Material Composition Properties," ed. M. Mohammadian, *CIMCA* 2004, 2004, 892–903, https://research.tudelft.nl/en/publications/artificial-neural-network-ann-models-for-prediction-and-analysis-.

68 Ibid.

Appendix C.6: Wildfires

Taxpayer costs were analyzed at the municipal, state, and federal level. Costs for unincorporated municipalities were then assigned to the county.

Wildfire mitigation typically consists of two different strategies: controlled burns and mechanical intervention. Controlled burns focus on reducing fuel areas by intentionally lighting a fire in a small area of forest to eliminate fuel while reducing potential burn area in a larger blaze. Mechanical intervention focuses on reducing fuel for a fire by manually cutting and removing undergrowth, as well as thinning the density of forested area. Due to an increase in the number of fire days (i.e., length of the fire season),[69] controlled burns are not as feasible, as the available time for a controlled burn is being significantly reduced.[70] Thus, we estimate the cost of mechanical intervention for vulnerable areas in Los Angeles County. This approach requires more effort and cost, but it has the advantage of potentially generating revenue with harvested timber. Additionally, mechanical intervention can take place at any time of the year (i.e., it is not limited to low fire days).

Determining At-Risk Areas

We first identify the extent of the at-risk areas by determining the amount of area that falls within local fire responsibility areas and wildland urban interface[71]/intermix that has increased fire risk, as quantified through the Keetch-Byram Drought Index (KBDI). We focus on the wildland urban interface (WUI) that is under the responsibility of municipal or county firefighters. These areas include both forested areas and scrub brush areas known as chaparral as determined by the NLCD.[72] We use data from Cal Fire to find the amount of area that falls within each of the firefighting responsibility bounds.[73]

Data

- Wildland Urban Interface[74]
- Firefighting Responsibility Bounds[75]
- Los Angeles County Boundary
- Los Angeles County Municipalities
- NLCD 2021 Landforms[76]
- Keetch-Byram Drought Index (KBDI)[77]

69 A.L. Westerling et al., "Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity," *Science* 313 (2006): 940–43, https://doi.org/10.1126/science.1128834.

70 Bruce R. Hartsough et al., "The Economics of Alternative Fuel Reduction Treatments in Western United States Dry Forests: Financial and Policy Implications from the National Fire and Fire Surrogate Study," *Forest Policy and Economics* 10, no. 6 (August 2008): 344–54, https://doi.org/10.1016/j.forpol.2008.02.001.

71 Emilio Chuvieco et al., "Towards an Integrated Approach to Wildfire Risk Assessment: When, Where, What and How May the Landscapes Burn," *Fire* 6, no. 5 (May 2023): 215, https://doi.org/10.3390/fire6050215.

72 Multi-Resolution Land Characteristics Consortium, "National Land Cover Database Class Legend and Description," accessed December 4, 2023, https://www.mrlc.gov/data/legends/national-land-cover-database-class-legend-and-description.

73 Cal Fire, "GIS Mapping and Data Analytics," 2023, https://www.fire.ca.gov/what-we-do/fire-resource-assessment-program/gis-mapping-and-data-analytics.

74 Franz Schug et al., "The Global Wildland–Urban Interface," *Nature* 621, no. 7977 (September 7, 2023): 94–99, https://doi.org/10.1038/s41586-023-06320-0; Spatial Analysis For Conservation and Sustainability Lab, "The Global Wildland-Urban Interface (WUI) – 2020," 2023, https://silvis.forest.wisc.edu/globalwui/.

75 Cal Fire, "GIS Mapping and Data Analytics."

76 "Multi-Resolution Land Characteristics (MRLC) Consortium," 2023, https://www.mrlc.gov/.

77 U.S. Forest Service, "Keetch-Byram Drought Index (KBDI)," accessed November 28, 2023, https://www.drought.gov/data-maps-tools/keetch-byram-drought-index.

Estimating Costs

We use a cost of $1,500 per acre for mechanical intervention.[78] Given the area of potential mitigation responsibility and the cost per acre of treatment, the final element in the calculation is to determine what areas will require additional treatment. Historically, the fire season in Southern California runs from approximately July-October, or 120 days of mixed fire-risk days from low to extreme. The season generally ends with autumn rains and lower temperatures that arrive in November. However, climate change has caused temperatures to increase on both sides of the traditional fire season.[79] With this trend continuing, we utilize a threshold of 100 high or extreme fire days (as determined by KBDI measurements) as the indicator of whether mechanical treatments should be employed. This threshold reflects both an increase in the number of severe days during the traditional season as well as an increase in the number of days that are occurring outside the traditional season. Where the threshold is exceeded, the cost per acre is applied to the WUI area impacted by the increased number of fire days.

Appendix C.7: Los Angeles Metro Rail Improvements

Taxpayer costs were analyzed at the county level.

The Los Angeles metro rail system, and other light rail systems, are susceptible to damage from increasing temperatures similar to commercial Class 1 rail. Specifically, rails will deform as temperatures increase above a neutral temperature. This can cause separation between the rails as well as the potential for significant deformation if trains are allowed to continue to run on the rails in the hot temperatures.[80]

Adaptation Strategies

The traditional approach to minimizing this impact is to put slow-down orders in place which require operations to be slowed or stopped for a period of time until the temperatures return to normal operating levels. The adaptation to this impact is to either enhance the detection of heated rails to target slow-down orders, or to implement an approach to reduce the heating of the rails themselves. Currently, Los Angeles Metro (LA Metro), the operator of the Los Angeles County metro rail system, implements a combination of slow-down orders and heat sensors to reduce temperature-induced delays.[81] Slow-down orders are put in place when temperatures exceed 90°F. Concurrently, heat sensors have been installed to enable the system to put slowdown orders in on specific lines rather than over the entire system.[82]

The next step in adaptation is to focus on reducing the temperature of the rails during heat events. The approach adopted for this study is to coat the rails with reflective paint. This is an approach currently adopted in Europe and Australia and has been shown to have positive effects for reducing the temperature of rails.[83] While this is a new approach, initial studies have demonstrated the potential to reduce temperatures by 10°C or more.[84]

78 Ibid.

79 Chunyu Dong et al., "The Season for Large Fires in Southern California Is Projected to Lengthen in a Changing Climate," *Communications Earth & Environment* 3, no. 1 (2022): 22, https://doi.org/10.1038/s43247-022-00344-6.

80 Paul Chinowsky et al., "Impacts of Climate Change on Operation of the US Rail Network," *Transport Policy* 75 (March 1, 2019): 183–91, https://doi.org/10.1016/j.tranpol.2017.05.007.

81 Ryan Fonseca, "Will LA Metro Be Ready To Take The Heat Of Climate Change? It's 'Complicated,'" *LAist*, September 20, 2019, sec. News, https://laist.com/news/la-metro-climate-change-extreme-heat.

82 Karen Gorman, "Office of Inspector General 'Is LA Metro Ready for Climate Change?,'" https://www.documentcloud.org/documents/6422665-la-metro-climate-change-presentation.html.

83 Federal Railroad Administration, "Quantification of the Effectiveness of Low Solar Absorptivity Coatings for Reducing Rail Temperature," 2015, https://railroads.dot.gov/sites/fra.dot.gov/files/fra_net/15600/Effectiveness_of_Solar_Coatings_final.pdf; Federal Railroad Administration, "Low Solar Absorption Coating for Reducing Rail Temperature and Preventing Buckling," 2018, https://railroads.dot.gov/sites/fra.dot.gov/files/fra_net/18062/Low%20Solar%20Absorption%20Coating%20for%20Reducing%20Rail%20Temperature%20and%20Preventin..._.pdf; Julian Turner, "Cool Runnings: Is White Paint the Perfect Solution to Overheated Rail Tracks?," *Railway Technology* (blog), December 4, 2019, https://www.railway-technology.com/features/solution-to-overheated-rail-tracks/.

84 Hao Wang, Milad Salemi, and P. N. Balaguru, "Multifunctional Coating System for Rail Track Applications" (2017 Joint Rail Conference, American Society of Mechanical Engineers Digital Collection, 2017), https://doi.org/10.1115/JRC2017-2323.

The cost estimate of the coatings approach is based on the need for a crew to apply the coating across the LA Metro system. The LA Metro system consists of 109 miles of track. The track requires one coat of primer plus two coats of topcoat. It is estimated based on product information that 10 buckets of primer and 20 buckets of topcoat are required per mile. This is equivalent to $7,500 per mile in materials. Over the entire system, this would equate to $817,500.

The labor cost is based on a method developed in Australia that utilizes a mechanized approach with a vehicle and spray application.[85] Using a crew of four painters and a laborer applying coating at 5 km/hr, it is estimated that it will take about one week to do each coat, or three weeks to complete the application over the entire system. Labor cost is anticipated to be less than $100,000 in total.

The result of this would be an estimated $1 million per required application of coating. We present the cost of painting rail every year, as the Los Angeles County climate is similar to Rome, Italy, where rails have been painted annually for several decades. The summer temperatures between the two locations are similar with average temperatures within 5°F of each other and max temperatures within 10°F. Winter temperatures and rain amounts are also similar, making Rome and Los Angeles good comparisons. Given this relationship, it is assumed that an annual application is needed. This equates to a cumulative cost of $17 million from 2024 through 2040.

Appendix D: Methodologies for estimating the cost to address precipitation-related impacts

Appendix D.1: Drainage & Stormwater Infrastructure: Mitigating Urban Flooding and Inflow to Water Treatment Plants

Taxpayer costs were analyzed at the municipal level. Costs for unincorporated municipalities were assigned to the county.

We assessed the impact of increases in extreme wet weather events to wastewater conveyance systems and wastewater treatment plants and processes. The most significant impact of increased rainfall on wastewater conveyance systems are increased overflows, blockages, and breakages. Increased rainfall intensity and extreme weather events are likely to lead to increased occurrence of inflow and infiltration (I&I) into wastewater networks. This occurs when stormwater directly enters combined networks or infiltrates the sewer network through cracks, direct connections, and corroded manholes.[86]

The most significant impacts likely to affect treatment plants and processes are increased inflows and power outages. Increased rainfall will result in larger volumes and peak inflows into wastewater treatment plants as a result of flow from combined systems and I&I. While the volume or 'flow' of the wastewater increases during increased stormwater infiltration, the total suspended solids (TSS) of the wastewater remains the same, resulting in a dilution of the influent to the wastewater treatment plant, which can affect biological treatment processes.[87] During extreme weather events, system bypasses can be activated, diverting flows past part or all of the treatment process. This causes partially treated or untreated wastewater to directly enter the receiving environment.[88]

85 Pacific Edge Pty Ltd, "Rail Painting Process," 2005, https://www.solacoat.com.au/wp-content/uploads/2020/07/6-Solacoat-Railway-Painting-Process-Report.pdf.

86 James Hughes et al., "Impacts and Implications of Climate Change on Wastewater Systems: A New Zealand Perspective," *Climate Risk Management* 31 (January 1, 2021): 100262, https://doi.org/10.1016/j.crm.2020.100262.

87 Benedek Gy Plósz, Helge Liltved, and Harsha Ratnaweera, "Climate Change Impacts on Activated Sludge Wastewater Treatment: A Case Study from Norway," *Water Science and Technology: A Journal of the International Association on Water Pollution Research* 60, no. 2 (2009): 533–41, https://doi.org/10.2166/wst.2009.386.

88 J. G. Langeveld, R. P. S. Schilperoort, and S. R. Weijers, "Climate Change and Urban Wastewater Infrastructure: There Is More to Explore," *Journal of Hydrology* 476 (January 7, 2013): 112–19, https://doi.org/10.1016/j.jhydrol.2012.10.021.

To combat increased inflow to wastewater treatment plants, we estimate how much it will cost to install drainage and stormwater infrastructure (referred to as green infrastructure in the engineering literature).[89] Drainage and stormwater infrastructure includes bio retention, porous pavement, bioinfiltration, and bioswale construction. By increasing pervious surfaces with drainage and stormwater infrastructure, flooding during wet weather events decreases, offsetting what would have been increased inflows to wastewater treatment plants from climate change. We choose this adaptation, as opposed to expanding or adding culverts and storm drains, as it is generally low-impact and less expensive. The California State Water Resources Control Board has a report on green (drainage and stormwater) infrastructure for Los Angeles.[90]

Change in wet weather events

We look at the change in magnitude of the 98% precipitation event and the 99.6% precipitation event. The 98% precipitation event represents the threshold for a "high-precipitation event," which occurs approximately seven times a year and could cause moderate increases of inflow into the wastewater treatment plants. The 99.6% precipitation event represents the extreme wet weather event that could cause large increases of inflow into the wastewater treatment plants and occurs approximately once per year.

We calculate the percent change in these events from the change in rainfall depth (inches) for a certain percentile between the two distributions (baseline distribution and the projected distribution). For example, if the 99.6% baseline wet weather event is 3 inches and the projected 99.6% wet weather event is 3.3 inches, then we would say the extreme wet weather event increased by 10%. We use the maximum of the high (98%) and extreme (99.6%) change for the next step.

Given a change in wet weather events, we assume that the municipality must invest to offset additional runoff (thus infiltration and inflow) into the wastewater treatment plant. We assume the offset is proportional to the change in wet weather events. For example, if the wet weather events are increasing by 10%, then 10% of the developed impervious area needs to be offset by drainage and stormwater infrastructure.

We calculate the developed impervious area using the NLCD.[91]

We derived the per-unit cost for drainage and stormwater infrastructure from the following equation:[92]

- Cost = A * ΔWWE * DSI
- Where:
  - A is area of developed impervious surfaces (acres)
  - ΔWWE is the change in wet weather events (%)
  - DSI is the unit cost of drainage and stormwater (green) infrastructure ($ per impervious acre controlled)

89 S.E Gill et al., "Adapting Cities for Climate Change: The Role of the Green Infrastructure," *Built Environment* 33, no. 1 (March 13, 2007): 115–33, https://doi.org/10.2148/benv.33.1.115.

90 California State Water Resources Control Board, "Green Infrastructure for Los Angeles: Addressing Urban Runoff and Water Supply Through Low Impact Development," 2009.

91 Earth Resources Observation and Science (EROS) Center, "National Land Cover Database" (U.S. Geological Survey, 2021), https://www.usgs.gov/centers/eros/science/national-land-cover-database.

92 Allegheny County Sanitary Authority, "Staring at the Source: How Our Region Can Work Together for Clean Water - Appendix E-3: GIS Cost Literature Review," 2015, https://www.alcosan.org/docs/default-source/clean-water-plan-documents/cwp-appendixe/cwp-appendix-e-3_gsi-cost-literature-review.pdf?sfvrsn=6d863977_2.

GSI unit costs are sourced from a green (drainage and stormwater) infrastructure report.[93] The unit costs are adjusted to Los Angeles County using an RSMeans location multiplier. Finally, the costs are adjusted to 2023 dollars.

Appendix D.2: Bridge Stabilization

Taxpayer costs were analyzed at the municipal, county, and state level.

Climate-driven changes in precipitation will increase the flow rates of waterways, thereby increasing the rate of wear and tear on the bridges that span them. To approximate bridge-related costs associated with the projected increase in precipitation, we developed a method that translates increases in 24-hour precipitation rates to changes in flow rates in waterways where bridges are present. From there, we calculated the potential increase in damage to bridges resulting from increases in scour around the base of the piers. While there are multiple climate-related costs associated with bridges, we chose to quantify the cost to proactively rehabilitate bridges in order to prevent disruption. We classify bridges into municipal, county, and state owned using the National Bridge Inventory ownership identifiers. The costs associated with municipal bridges in unincorporated areas are assigned to the county.

Methods based on the United States Department of Agriculture's Natural Resources Conservation Service (NRCS) TR-20 model were used to translate 24-hour rainfall "design-storm" depths to peak discharge.[94] This model is based on empirical runoff relationships referred to as the Soil Conservation Service Curve Number Method.[95] The bridge data is from the National Bridge Inventory,[96] from which we selected only inland bridges that spanned bodies of water. Changes in runoff were determined based on a study of the watersheds feeding the waterways. The location and details of the rivers were derived from the USGS Hydrologic Unit Code 8 (HUC 8) database for Los Angeles County.[97] We determine the increase in peak discharge based on a study of the watersheds at the HUC8 level feeding the local waterways. We utilize daily runoff data, which covers Los Angeles County. The LOCA Global Climate Model (GCM) projections provide daily precipitation outputs from the Coupled Model Intercomparison Project Phase 6 (CMIP6) as inputs.

Cost Estimates

We quantified the cost to proactively rehabilitate bridges to prevent disruptions by applying riprap to stabilize bridges and additional concrete to strengthen piers and abutments. We rehabilitate bridges only if they are known to be threatened by a near-term river flow level that crosses one of the thresholds. We stabilize bridges only if projected runoff increases by 20% compared to the baseline. We strengthen piers and abutments only when runoff increases by 60% compared to the baseline for bridges on non-sandy soils and by 100% compared to the baseline for bridges on sandy soils. The percent increase in runoff for the different soil types are based on federal guidelines and were also utilized in Wright et al. (2012).[98] This method may underestimate potential damages because proactive costs are likely far lower than repairing or rebuilding a failed bridge.[99] Notably, our analysis does not estimate damages associated with delays/disruptions from the bridge being closed.

93 Ibid.

94 Len Wright et al., "Estimated Effects of Climate Change on Flood Vulnerability of U.S. Bridges," *Mitigation and Adaptation Strategies for Global Change* 17, no. 8 (December 1, 2012): 939–55, https://doi.org/10.1007/s11027-011-9354-2.

95 Surendra Kumar Mishra and Vijay P. Singh, Soil Conservation Service Curve Number (SCS-CN) Methodology, vol. 42, *Water Science and Technology Library* (Dordrecht: Springer Netherlands, 2003), https://doi.org/10.1007/978-94-017-0147-1.

96 Federal Highway Administration, "National Bridge Inventory," 2023, https://www.fhwa.dot.gov/bridge/nbi/ascii.cfm.

97 "Hydrologic Unit Maps," United States Geological Survey, accessed December 13, 2023, https://water.usgs.gov/GIS/huc.html.

98 Wright et al., "Estimated Effects of Climate Change on Flood Vulnerability of U.S. Bridges."

99 Neumann et al., "Climate Change Risks to US Infrastructure."

Appendix D.3: Drought Impact on Drinking Water

Taxpayer costs were analyzed at the municipal level for incorporated municipalities and at the county level for unincorporated municipalities.

The impact of drought is broad, extending from agriculture to ground subsidence, and drinking water quality. In California, drought has been shown to impact water-related ecosystem services[100] and degrade drinking water quality[101] (both groundwater[102] and surface water). In this analysis, we focus on the additional cost of treating drinking water due to drought.[103]

Drinking water treatment costs are higher during drought events because increased sediment and nutrient concentration occur as drought conditions emerge. The Cadmus Group describes this effect as follows, "Because source water quality can be affected by drought conditions (i.e., sedimentation can increase and runoff is likely to have elevated concentrations of pollutants), drinking water utilities will likely face increased costs related to water treatment during drought."[104]

The cost of this impact is based on a study by Dearmont et al. (1998) that is still referenced as the basis for drought-based costs for water treatment.[105] Further from the study, "[the authors] determined that the cost of water treatment would increase by $94.75 per million gallons when elevated concentrations of chemical contaminants are present in source water." Adjusting this cost to 2023 dollars, the additional cost to treat drinking water during drought events is $223 per million gallons.

We use both the previous drought-related restriction of residential water use to 80 gallons per capita per day mandated by the Metropolitan Water District of Southern California[106] as a low-end estimate and the average consumptive demand for Los Angeles County of 120 gallons per capita per day as a high-end estimate of water use.[107] With a 2020 Census population of around 10 million,[108] the total residential water use for Los Angeles County is estimated at 801 million gallons per day during drought and 1.2 billion gallons per day on average. This means that it will cost Los Angeles County an additional $179,000 per day to treat water during drought events, depending on whether or not water restrictions are implemented and whether or not residents follow those restrictions. This equates to a monthly cost of around $5.4 million per additional month of projected drought.

We estimate the increase in drought days for the municipalities in Los Angeles County, which allows us to estimate an increase in water treatment costs due to climate change induced drought. This cost is divided among the municipalities in the county based on population as the individual municipalities contract with Los Angeles County for drinking water.

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100 Heejun Chang and Matthew Ryan Bonnette, "Climate Change and Water-Related Ecosystem Services: Impacts of Drought in California, USA," *Ecosystem Health and Sustainability* 2, no. 12 (2016): e01254, https://doi.org/10.1002/ehs2.1254.

101 Benjamen Wright et al., "Managing Water Quality Impacts from Drought on Drinking Water Supplies," *Journal of Water Supply: Research and Technology-Aqua* 63, no. 3 (November 7, 2013): 179–88, https://doi.org/10.2166/aqua.2013.123.

102 Zeno F. Levy et al., "Critical Aquifer Overdraft Accelerates Degradation of Groundwater Quality in California's Central Valley During Drought," *Geophysical Research Letters* 48, no. 17 (2021): e2021GL094398, https://doi.org/10.1029/2021GL094398.

103 "Water Utilities," 2023, Drought.gov, accessed December 13, 2023, https://www.drought.gov/sectors/water-utilities.

104 Julie Blue et al., "Drought Management in a Changing Climate: Using Cost-Benefit Analyses to Assist Drinking Water Utilities" (Water Research Foundation and NOAA, 2015), https://cadmusgroup.com/wp-content/uploads/2015/08/WaterRF_Drought-Management.pdf.

105 David Dearmont, Bruce A. McCarl, and Deborah A. Tolman, "Costs of Water Treatment Due to Diminished Water Quality: A Case Study in Texas," *Water Resources Research* 34, no. 4 (1998): 849–53, https://doi.org/10.1029/98WR00213.

106 Hayley Smith and Ian James, "To Survive Drought, Parts of SoCal Must Cut Water Use by 35%. The New Limit: 80 Gallons a Day," *Los Angeles Times*, April 30, 2022, sec. California, https://www.latimes.com/california/story/2022-04-30/can-you-get-by-on-just-80-gallons-of-water-a-day.

107 "Our County Water Briefing," 2018, https://ourcountyla.lacounty.gov/wp-content/uploads/2018/08/Our-County-Water-Briefing_For-Web.pdf.

108 U.S. Census Bureau, "U.S. Census Bureau QuickFacts: Los Angeles County, California," 2022, https://www.census.gov/quickfacts/fact/table/losangelescountycalifornia/PST045222.

Note that we assume that drought-related water use restrictions will be implemented and residents will follow those restrictions. As such, we present the increased cost to treat an average of 80 gallons of water use per capita per day in the total cost to taxpayers in Los Angeles County in the report. The associated data download presents the increased cost to Los Angeles municipalities to treat 80 gallons of water use per capita per day.

Appendix E: Protecting Infrastructure from Sea Level Rise

Taxpayer costs were analyzed at the county level.

The methods used to estimate the cost of protecting infrastructure from sea level rise in Los Angeles County are from a previous study that estimated the price to protect coastal communities from sea level rise by constructing seawalls.[109] Note that this previous study used the Relative Concentration Pathway 4.5 (RCP4.5) instead of the SSP2-4.5, which is used in all other analyses in this report.

Appendix F: Methodologies for estimating the cost to treat climate-induced illnesses

In all public health analyses, a baseline year of 2010 was used to determine increased costs of hospitalizations due to climate change.

Appendix F.1: Treating Pediatric Asthma

Taxpayer costs for pediatric asthma were analyzed at the federal level.

Pediatric asthma-related emergency room visits are directly correlated to pollen levels, and therefore to climatic conditions that are projected to change in the coming decades. We quantify the cost of treatment for climate-induced respiratory illness for both the baseline and projected time periods. We define the asthma baseline as the average number of hospital visits for asthma in Los Angeles County per year from 2002 to 2019, which are documented in the National Environmental Public Health Tracking Network.[110] The baseline does not use data from 2020 onward because COVID-19 significantly reduced the number of pediatric asthma emergency department visits.[111] We use a distribution curve relating the number of asthma cases to pollen levels[112] to determine weekly asthma cases, since the National Environmental Public Health Tracking Network only reports asthma cases annually and ages are not included in the data. We use the documented pollen counts for trees, weeds, and grasses (pollen types) from 2018-2021 to set an average weekly level.[113] Average pollen load is determined by adding all pollen counts together and then dividing by the time period to smooth peaks that occur in some of the years.

The annual minimum temperature is used to calculate pollen counts for the asthma baseline and projection time periods to see a general trend in case counts.

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109 Sverre LeRoy et al., "High Tide Tax: The Price to Protect Coastal Communities from Rising Seas" (Center for Climate Integrity and Resilient Analytics, 2019), https://climatecosts2040.org/files/ClimateCosts2040_Report.pdf.

110 Centers for Disease Control and Prevention, "National Environmental Public Health Tracking Network," n.d., https://ephtracking.cdc.gov/DataExplorer/.

111 Tregony Simoneau et al., "Impact of the COVID-19 Pandemic on Pediatric Emergency Department Use for Asthma," *Annals of the American Thoracic Society* 18, no. 4 (April 2021): 717–19, https://doi.org/10.1513/AnnalsATS.202007-765RL.

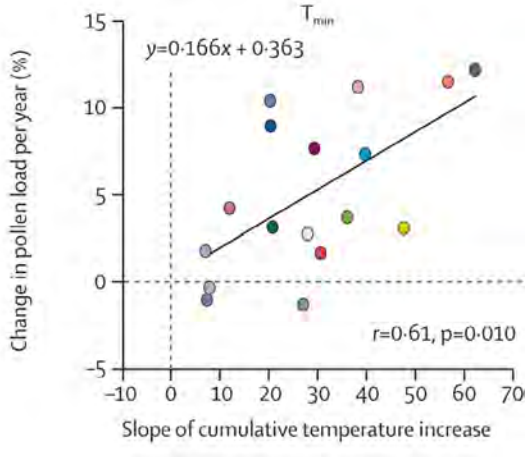
112 Paul J Villeneuve et al., "Outdoor Air Pollution and Emergency Department Visits for Asthma among Children and Adults: A Case-Crossover Study in Northern Alberta, Canada," *Environmental Health* 6 (December 24, 2007): 40, https://doi.org/10.1186/1476-069X-6-40.

113 Allergy, Asthma, & Sinus Center, S.C., "Pollen Explorer," 2023, https://myaasc.com/pollen-explorer.

Asthma Cases

We determine the impact of climate change on pollen loads by using the relationship between pollen load and annual cumulative minimum temperature.[114] The relationship used to determine pollen counts based on temperature comes from the slope of the best fit line in Figure F1. Using this relationship, we calculate the percent change in pollen load for each type of pollen (tree, grass, weed) through time compared to the baseline year (2010).

Figure F1: Slope of cumulative temperature increase (-) versus the change in pollen load per year (%) taken from Ziska et al. (2019).



Research has shown that pediatric emergency room visits increase in proportion to pollen loads.[115] Based on this research, we estimate the increase in cases from increase in pollen levels for each pollen type (Table F1).

Table F1: The 5-day average unit increase[116] for different pollen types and the corresponding increase in emergency room visits for pediatric asthma.

Pollen Type	5-day Average Pollen Concentration	5-day Average Pediatric Emergency Department Visits
Tree	664 unit increase	23% increase in visits
Grass	10 unit increase	2% increase in visits
Weed	10 unit increase	13% increase in visits

Cost Estimates

The yearly cost increase of the emergency room visits was established based on insurance type and what the individual scenarios cover.[117] The percent of patients with each insurance coverage and the corresponding cost per visit for that scenario (Table F2).

Table F2: The average breakdown of pediatric asthma visits in the United States.

Type of Insurance	Patient Count	Cost per Asthma Visit	Government Funded?
Uninsured	11.9%	$1,120	No
Medicaid	50.2%	$1,108	Yes – Federal
Medicare	0.5%	$414	Yes – Federal
Private	40.2%	$1,263	No

114 Lewis H. Ziska et al., "Temperature-Related Changes in Airborne Allergenic Pollen Abundance and Seasonality across the Northern Hemisphere: A Retrospective Data Analysis," *The Lancet. Planetary Health* 3, no. 3 (March 2019): e124–31, https://doi.org/10.1016/S2542-5196(19)30015-4.

115 Jessie A. Gleason, Leonard Bielory, and Jerald A. Fagliano, "Associations between Ozone, PM2.5, and Four Pollen Types on Emergency Department Pediatric Asthma Events during the Warm Season in New Jersey: A Case-Crossover Study," *Environmental Research* 132 (July 2014): 421–29, https://doi.org/10.1016/j.envres.2014.03.035.

116 1 unit increase is 1 grain per cubic meter. Since each source contains a different amount of pollen, unit increases are different for each source.

117 Tiffany Wang et al., "Emergency Department Charges for Asthma-Related Outpatient Visits by Insurance Status," *Journal of Health Care for the Poor and Underserved* 25, no. 1 (February 2014): 396–405, https://doi.org/10.1353/hpu.2014.0051.

Appendix F.2: Treating Increasing Incidence of West Nile Virus

Taxpayer costs were analyzed at the federal level.

West Nile Virus (WNV) is carried and transmitted by a genus of mosquitoes that thrive in warmer climates.[118] WNV was first detected in mosquitoes in Los Angeles in September 2003[119] and the first case in a human was reported the year after. Studies have shown that warmer temperatures are linked to accelerated mosquito breeding, bite rates, and the incubation of WNV within mosquitoes.[120] Increased rainfall can also contribute to expanding the suitable breeding grounds for mosquitoes.[121] While most people infected with WNV experience no symptoms, a small percentage develop life-threatening illness.[122]

We modeled the increasing number of cases of WNV in Los Angeles County and the associated health costs as a result of rising temperatures. We established a current WNV-infection rate for Los Angeles County using data provided by the CDC.[123] We used both mean weekly maximum temperature and daily maximum precipitation to model the future WNV incidence rate for Los Angeles County. We distribute cases by week by using the weekly incidence curve[124] since the county data is reported annually.

If the week's mean weekly maximum temperature is at least 5°C higher than the climate baseline (1991-2010), we assume the incidence increases by 40% that week and the following three weeks.[125] If the following three weeks also meet the same criteria, we do not increase the incidence by 40% again (i.e., the incidence will increase by 40% only once, even if all four weeks meet the temperature criteria).

If the week does not have increased incidences because of temperature, we then look at daily maximum precipitation per week.[126] If one or more days in a week have more than 50 mm of precipitation, then we assume the incidence increases by 33% that week and the following two weeks. If the following two weeks also meet that criteria, we *do not* increase the incidence by 33% again.

Because people cannot get WNV more than once, when the total case count reaches the county's population, we stop counting incidences.[127] Most of those infected with WNV experience no symptoms, while those that do get sick can have wide ranging symptoms. Using CDC data, we distributed the yearly incidences by manifestation (Table F3).[128]

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118 Pien Huang, "The U.S. Is Unprepared for the Growing Threat of Mosquito- and Tick-Borne Viruses," *NPR*, December 15, 2023, sec. Public Health, https://www.npr.org/sections/health-shots/2023/12/15/1219478835/arboviruses-mosquito-tick-borne-viruses-tropical-disease.

119 Jennifer L. Kwan et al., "West Nile Virus Emergence and Persistence in Los Angeles, California, 2003–2008," *The American Journal of Tropical Medicine and Hygiene* 83, no. 2 (August 5, 2010): 400–412, https://doi.org/10.4269/ajtmh.2010.10-0076.

120 David M. Hartley et al., "Effects of Temperature on Emergence and Seasonality of West Nile Virus in California," *The American Journal of Tropical Medicine and Hygiene* 86, no. 5 (May 1, 2012): 884–94, https://doi.org/10.4269/ajtmh.2012.11-0342; Shlomit Paz, "Climate Change Impacts on West Nile Virus Transmission in a Global Context," *Philosophical Transactions of the Royal Society B: Biological Sciences* 370, no. 1665 (April 5, 2015): 20130561, https://doi.org/10.1098/rstb.2013.0561; Nooshin Mojahed, Mohammad Ali Mohammadkhani, and Ashraf Mohamadkhani, "Climate Crises and Developing Vector-Borne Diseases: A Narrative Review," *Iranian Journal of Public Health* 51, no. 12 (December 2022): 2664–73, https://doi.org/10.18502/ijph.v51i12.11457.

121 C. B. Beard et al., "Ch. 5: Vectorborne Diseases," *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment* (U.S. Global Change Research Program, Washington, DC, April 4, 2016), https://health2016.globalchange.gov/vectorborne-diseases.

122 Centers for Disease Control and Prevention, "West Nile Virus," August 23, 2023, https://www.cdc.gov/westnile/index.html.

123 Centers for Disease Control and Prevention, "West Nile Virus Historic Data (1999-2022)," June 13, 2023, https://www.cdc.gov/westnile/statsmaps/historic-data.html.

124 Jonathan E. Soverow et al., "Infectious Disease in a Warming World: How Weather Influenced West Nile Virus in the United States (2001–2005)," *Environmental Health Perspective* 117, no. 7 (2009): 1049–52, https://doi.org/10.1289/ehp.0800487.

125 Ibid.

126 Ibid.

127 Centers for Disease Control and Prevention, "West Nile Virus."

128 Emily McDonald et al., "Surveillance for West Nile Virus Disease — United States, 2009–2018," *MMWR. Surveillance Summaries* 70 (2021), https://doi.org/10.15585/mmwr.ss7001a1.

Table F3: Initial and long-term cost to treat manifestations of West Nile Virus. Non-neuroinvasive manifestations only have an initial cost, and neuroinvasive manifestations have both an initial and long-term cost.

Manifestation Type	Initial Cost	Long-term Cost	Percent of Cases
Non-neuroinvasive	$5,873.07	$0	96.7%
Neuroinvasive			
Meningitis	$9,546.53	$181.44 per year	2.65%
Encephalitis	$19,900.34	$3,233,02 per year	0.35%
Acute Flaccid Paralysis	$27,313.00	$6,998.51 per year	0.15%

To account for death of a WNV patient due to the neuroinvasive WNV,[129] only 93.56% of the neuroinvasive cases are included in the long-term costs. This is because 6.44% of people with neuroinvasive WNV die within 90 days of symptom onset. To account for death for WNV patients that survive the first 90 days, 50% of the remaining 93.56% neuroinvasive WNV cases from 3 years prior starting in 2023 are removed. In other words, in 2023, 50% of the remaining 93.56% of neuroinvasive WNV cases are removed from 2020, in 2024, 50% of the remaining 93.56% of neuroinvasive WNV cases are removed from 2021, etc. This is because the median time between symptom onset and death is 3 years for people with neuroinvasive WNV if they did not die within the first 90 days. Thus, every year has an initial cost, a long-term cost, and a total yearly cost.[130]

Appendix G: Technical Documentation for Equity and Budget Analysis

Appendix G.1: Equity Analysis

All equity analysis was conducted in the R programming language.[131]

Data

The County of Los Angeles Enterprise GIS Hub[132] was used to determine census tract[133] and municipal[134] boundaries within Los Angeles County, as well as to obtain 11 demographic characteristics (Table G1) at the census tract level, which were collected by the Census Bureau as part of the 2020 American Community Survey 5-Year Data (ACS-5).[135]

129 David C.E. Philpott et al., "Acute and Delayed Deaths after West Nile Virus Infection, Texas, USA, 2002–2012," *Emerging Infectious Diseases* 25, no. 2 (February 2019): 256–64, https://doi.org/10.3201/eid2502.181250.

130 J. Erin Staples et al., "Initial and Long-Term Costs of Patients Hospitalized with West Nile Virus Disease," *The American Journal of Tropical Medicine and Hygiene* 90, no. 3 (March 5, 2014): 402–9, https://doi.org/10.4269/ajtmh.13-0206.

131 R Core Team (2023). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria, https://www.R-project.org/.

132 County of Los Angeles, "County Of Los Angeles Enterprise GIS," 2024, https://egis-lacounty.hub.arcgis.com/.

133 County of Los Angeles, "2020 Census Tracts," September 20, 2023, https://egis-lacounty.hub.arcgis.com/datasets/lacounty::2020-census-tracts-4/about.

134 County of Los Angeles, "City and Unincorporated Community Boundary (Regional Planning)."

135 United States Census Bureau, "American Community Survey 5-Year Data (2009-2022)," Census.gov, accessed January 29, 2024, https://www.census.gov/data/developers/data-sets/acs-5year.html.

Table G1: The 11 demographic characteristics from the ACS-5 analyzed in this study.

Equity Characteristic	County of Los Angeles Dataset Name136
Median Household Income	Census 2020 SRR and Demographic Characteristics[137]
Poverty Rate	
Percent Non-Hispanic White	
Percent Non-Hispanic Black	
Percent Non-Hispanic Asian	
Percent Hispanic	
Percent with Less Than a Highschool Education	
Percent without Internet	
Percent Disability	Disability Status (Census Tract)[138]
Percent Foreign Born Population	Foreign Born Population (Census Tract)[139]
Percent Uninsured	Health Insurance (Census Tract)[140]

Census tracts do not not align perfectly with municipal boundaries. A single census tract may intersect with more than one municipality and a municipality may contain multiple census tracts within its boundaries (Figure G1). Because the equity data is presented at the census tract level, it was first necessary to match each census tract to the municipality(s) that it intersects with and then determine the proportion of the census tract to be assigned to each intersecting municipality. First, we transform the coordinates for the municipal boundaries from World Geodetic System 84 (WGS84; decimal degrees) to North American Datum 83, Universal Transverse Mercator Zone 5 (NAD83, UTM Zone 5; US feet) to match the census tracts planar coordinate system. Then, we simply divide the area of a given municipality that intersects the given census tract by the total land area[141] of the given census tract. Assuming the population density in a given census tract is uniform, we estimate the population for each municipality by multiplying the fraction of the census tract that is in the municipality by the population of the census tract and round to the nearest whole number.[142] An example for census tract "400501" is shown below (Table G2).

136 The datasets for disability status, foreign born population, and health insurance contain information for one less census tract (990300) than the Census 2020 SRR and demographic characteristics dataset. Census tract 990300 has a population of 0, so this does not impact the equity analysis.

137 County of Los Angeles, "Census 2020 SRR and Demographic Characteristics," 2023, https://data.lacounty.gov/maps/e137518f57cf4dbc96ac7139a224631e/about.

138 County of Los Angeles, "Disability Status (Census Tract)," July 6, 2023, https://data.lacounty.gov/datasets/lacounty::disability-status-census-tract/about.

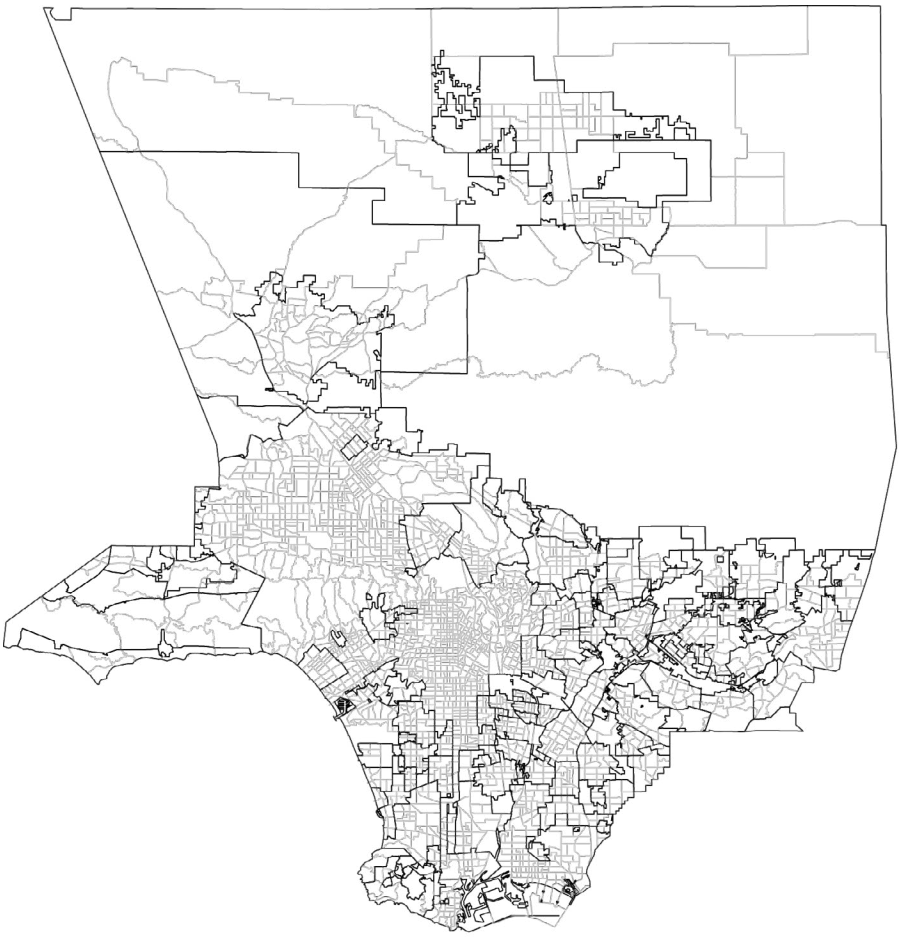
139 County of Los Angeles, "Foreign Born Population (Census Tract)," February 14, 2023, https://egis-lacounty.hub.arcgis.com/datasets/lacounty::foreign-born-population-census-tract/about.

140 County of Los Angeles, "Health Insurance (Census Tract)," https://egis-lacounty.hub.arcgis.com/datasets/lacounty::health-insurance-census-tract/about.

141 The municipal boundary shapefile contains "holes" in the data due to water (e.g. harbors). The census tracts do not contain these holes, so we use the land area of a census tract instead of total area, so that the area of the given census tract matches the area of all municipalities in the census tract. We do this by taking the sum of the area of all municipalities in the given census tract.

142 Due to rounding errors, we lose 25 residents or 0.00025% of the population of Los Angeles County.

Figure G1: Los Angeles County municipal boundaries (black outline) and census tract boundaries (gray outline).



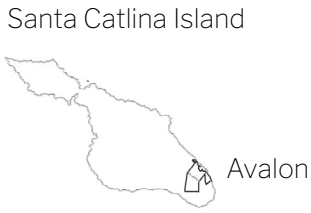




Table G2: An example of a population weighted estimate for census tract 400501, which exists within one incorporated municipality and three unincorporated areas.

Census Tract (CT20)	Municipality (CITY_COMM_)	Jurisdiction (JURISDICTI)	Area in CT20 (sq. ft.)	Proportion of CT20 in City	Area Weighted Population
400501	Antelope Valley	Unincorporated Area	22,032	0.0017	0
400501	Azusa	Incorporated City	1,806	0.000014	0
400501	East Azusa	Unincorporated Area	4,287,795	0.034	69
400501	Glendora	Incorporated City	118,637,700	0.94	1901
400501	Glendora Islands	Unincorporated Area	3,541,522	0.028	57
			Total Area	**Total Fraction**	**Total Population**
400501	–	–	126,490,830	1.00	2,027

We then take a population weighted average for each demographic dataset (Table G1) to determine an average characteristic for each municipality. The population (P) weighted average calculation for a given demographic characteristic in a given municipality is given by:

$$D_{muni} = \frac{(P_{CT1} * D_{CT1}) + (P_{CT2} * D_{CT2}) + (P_{CT3} * D_{CT3}) + \ldots + (P_{CTx} * D_{CTx})}{P_{Total}} \quad , \qquad \textit{(Eq. G1)}$$

where D_{muni} is the demographic characteristic in the city of interest, P_{CTx} is the area weighted population of the given census tract, D_{CTx} is the demographic characteristic in the given census tract, and P_{Total} is the total population in the given municipality. Table G3 outlines an example population (P) weighted average calculation (*Eq. G1*) for percent non-Hispanic white (NHW) residents in the City of Palos Verdes Estates following this logic.

Table G3: Non-Hispanic white population for each census tract (CT20) in Palos Verdes Estates and population weighted average non-Hispanic white population for the entire municipality.

City	CT20	Population (P)	Non-Hispanic White (D)
Palos Verdes Estates	651302	4	62.20%
Palos Verdes Estates	651304	1	63.25%
Palos Verdes Estates	670324	5117	74.59%
Palos Verdes Estates	670326	3706	63.73%
Palos Verdes Estates	670328	4500	55.76%
Palos Verdes Estates	670413	0[143]	39.55%
Palos Verdes Estates	670418	20	58.18%
Total: Palos Verdes Estates	**–**	**13,348**	**65.20%**

143 In some instances, a given census tract intersects such a small area of a municipality, that no population is assigned to the given municipality (see Table G3, census tract 670413). Note that the population of the census tract will be assigned proportionally to another municipality(s). We also note that the county has a "Split Tracts" dataset, which assigns census tracts to either incorporated municipalities or unincorporated Countywide Statistical Areas. Their method eliminates census tracts from a given municipality that intersect a negligible area of that given municipality (example census tracts 651302, 651304, 670413, 670418 in Palos Verdes Estates; Table G3).

We now have a dataset of all 11 population weighted demographic characteristics for all 162 municipalities in Los Angeles County. We use these data to assess how municipal per capita climate costs will impact residents across Los Angeles County. We define areas that are above or below, depending on the equity category, the Los Angeles County average statistic for that equity category (Table G4) as high priority equity areas.

Table G4: Los Angeles County mean demographic characteristics from the 2020 ACS-5 survey that are used to define the threshold for our equity categories.

Demographic Characteristic	Mean Characteristic for Los Angeles County[144]	Threshold	Number of Municipalities	Percentage of Municipalities
Median Household Income	$82,516	Low income if **below** $82,516	80	49%
Poverty Rate	13.9%	High poverty if **above** 13.9%	31	19%
Percent Non-Hispanic white	32.5%	Low white if **below** 32.5%	91	56%
Percent Non-Hispanic Black	7.9%	High Black if **above** 7.9%	32	20%
Percent Non-Hispanic Asian	15.0%	High Asian if **above** 15.0%	62	38%
Percent Hispanic	48.0%	High Hispanic if **above** 48.0%	66	41%
Percent Less Than High School Education	19.5%	Low education if **above** 19.5%	58	36%
Percent without Internet	7.4%	High if **above** 7.4%	94	58%
Percent Disabled	11.6%	High disability if **above** 11.6%	32	20%
Percent Uninsured	8.2%	High if **above** 8.2%	53	33%
Percent Foreign Born	33.1%	High foreign born if **above** 33.1%	63	39%

We note that municipalities can fall within multiple racial and ethnic demographic groups. For example, two municipalities fall within both the high white and high Hispanic groups,[145] 10 municipalities fall within both the high white and high non-Hispanic Black groups,[146] and 29 municipalities fall within the high white and high non-Hispanic Asian groups.[147]

144 U.S. Census Bureau, "Los Angeles County, California - Census Bureau Profile," Government, 2024, https://data.census.gov/profile/Los_Angeles_County,_California?g=050XX00US06037.

145 Avalon and Sylmar Island fall in both groups.

146 Altadena, Ballona Wetlands, Culver City, Lakewood, Marina del Ray, North Claremont, Northeast La Verne, Rolling Hills, West Fox Hills, and West Los Angeles fall in both groups.

147 Bradbury, Culver City, East Azusa, Gilmore Island, Kinneloa Mesa, La Canada Flintridge, La Crescenta - Montrose, La Habra Heights, La Habra Heights Islands, La Mirada, Lakewood, Lomita, North Claremont, Northeast La Verne, Oat Mountain, Palos Verdes Estates, Pasadena, Rancho Palos Verdes, Rolling Hills, Rolling Hills Estates, San Dimas, San Pasqual, Sierra Madre, South Pasadena, Torrance, Twin Lakes, West Fox Hills, West San Dimas, and Westfield fall in both groups.

Appendix G.2: Budget Analysis

As reported herein, communities in Los Angeles County face around $12.5 billion ($735 million per year) from 2024 through 2040 in adaptation costs to combat just 14 climate impacts. Using the adopted, appropriated budget for Los Angeles County for fiscal year 2023,[148] we examine how the 14 climate adaptation costs might stress the Los Angeles County departmental budgets (Table G5).

Table G5: Targeted county budget analysis for the Beaches & Harbors and Public Works (Water Resources, Transportation, Municipal Services) departments. Climate adaptations are assigned to each department of interest.

Fiscal Year	Department	Adopted Budget – Appropriated	Climate Adaptation
2023	Beaches & Harbors	$99,433,000	Coastal protection
	Public Works[149] – Water Resources	$1,836,914,000	Stormwater drainage and drinking water
	Public Works – Transportation	$882,475,000	Cool pavements, metro rail, road maintenance, bridge stabilization
	Public Works – Municipal Services[150]	$140,504,000	All services for unincorporated areas

We separate the adaptation strategies into the various departments based on publicly available information about which programs each department in Los Angeles County is responsible for. Since most of the adaptations are assigned to the Public Works Department, we separate the adaptations into different core service areas of the Public Works Department to better understand how implementing these climate change adaptations will stress the department.[151]

We also look at how the costs will stress municipal budgets within Los Angeles County. We use the publicly available budgets for the City of Los Angeles, the City of Long Beach, and the City of Santa Clarita, as those cities have some of the highest adaptation costs in the county (Table G6). Similar to our county budget analysis, we separate adaptation strategies into various departments based on publicly available information about which programs those departments are responsible for. We then compare the annual climate adaptation cost to the most recent annual budget for that department. We note that this can be done for any cost for any municipality estimated in this study.

148 LA County, "LA County Open Budget Appropriation (Auditor-Controller)," January 3, 2024, https://data.lacounty.gov/datasets/lacounty::la-county-open-budget-appropriation-auditor-controller/explore.

149 Public Works Los Angeles County, "FY2023-24 Core Services Areas Final Adopted Budget," https://content.pw.lacounty.gov/explore-public-works/budget/core-services-areas/.

150 Public Works Los Angeles County, "Municipal Services," LA County Public Works, 2024, https://content.pw.lacounty.gov/core-service-areas/municipal-services/.

151 Public Works Los Angeles County, "FY2023-24 Core Services Areas Final Adopted Budget."

Table G6: Targeted budget analysis for municipal climate adaptations are assigned to each department or budget line item of interest.

Fiscal Year	City	Department/Item	Budget	Climate Adaptation
2023	City of Long Beach	5-Year Climate Adaptation and Action Plan [152]	$16,350,000	Cool pavements
2024	City of Los Angeles	Street Tree and Parkway Maintenance[153]	$27,890,000	Urban canopy
2023	City of Santa Clarita	Stormwater Utility[154]	$4,802,000	Stormwater and drainage capacity
2024	City of Los Angeles	Capital Improvements - Flood Control[155]	$31,550,000	Stormwater and drainage capacity
2024	City of Los Angeles	Pavement Preservation[156]	$111,840,000	Proactive road maintenance

152 The City of Long Beach, "Innovation & Efficiency," 2023, https://longbeach.gov/globalassets/finance/media-library/documents/city-budget-and-finances/budget/budget-documents/fy-24-proposed-budget/fy-24-innovation-and-efficiency.

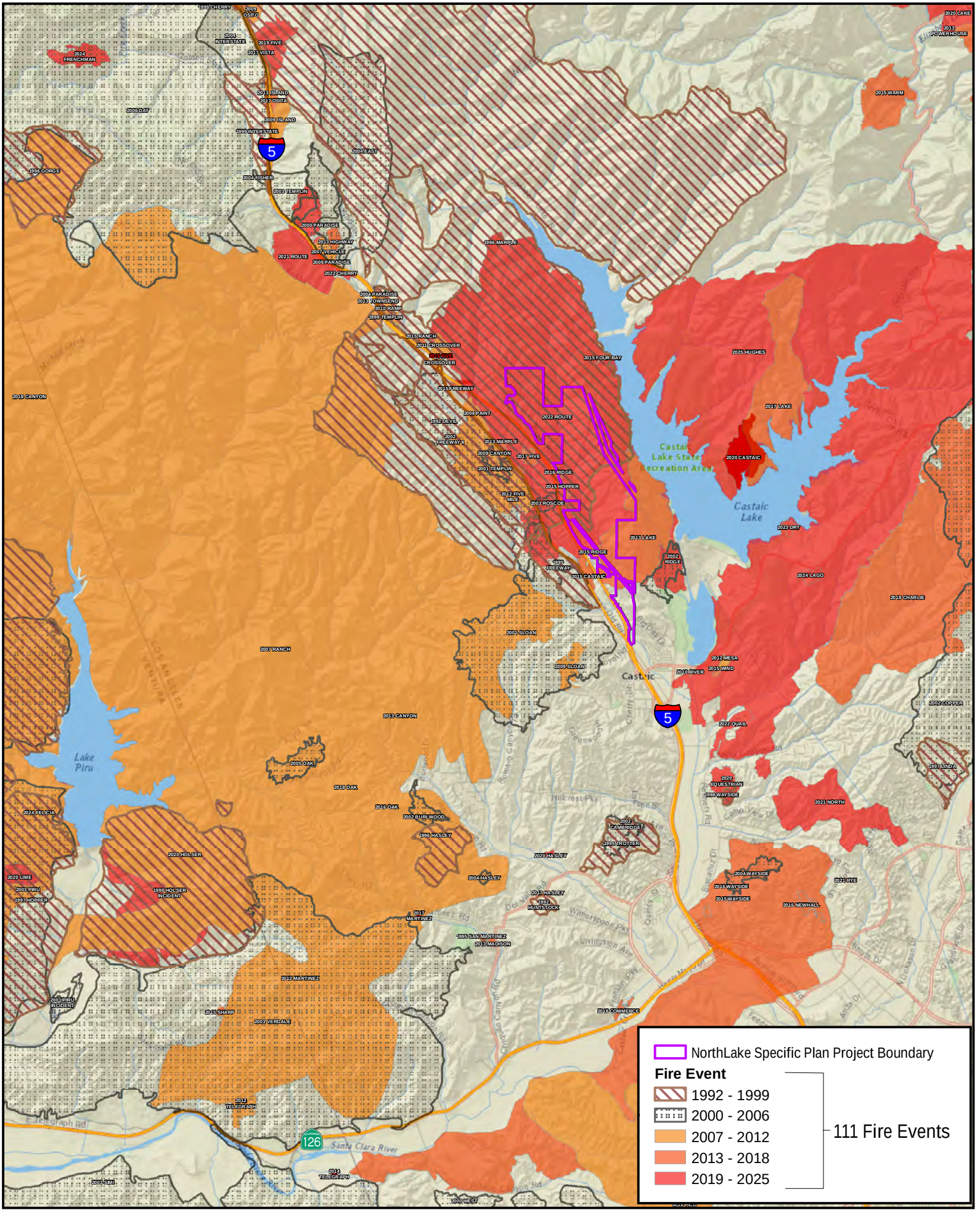
153 City of Los Angeles, "LA City Open Budget: Bureau of Street Services," 2024, https://openbudget.lacity.org/#!/year/2024/operating/0/department_name/Bureau+of+Street+Services/0/program_name.

154 City of Santa Clarita, "Annual Operating Budget & Capital Improvement Program: FY2023-2024," 2023, https://filecenter.santa-clarita.com/cmo/FY%202023-24%20Budget%20-%20opt.pdf.

155 City of Los Angeles, "LA City Open Budget: Capital Improvements - Flood Control," 2024, https://openbudget.lacity.org/#!/year/2024/operating/0/program_name/Capital+Improvements+-+Flood+Control/0/department_name.

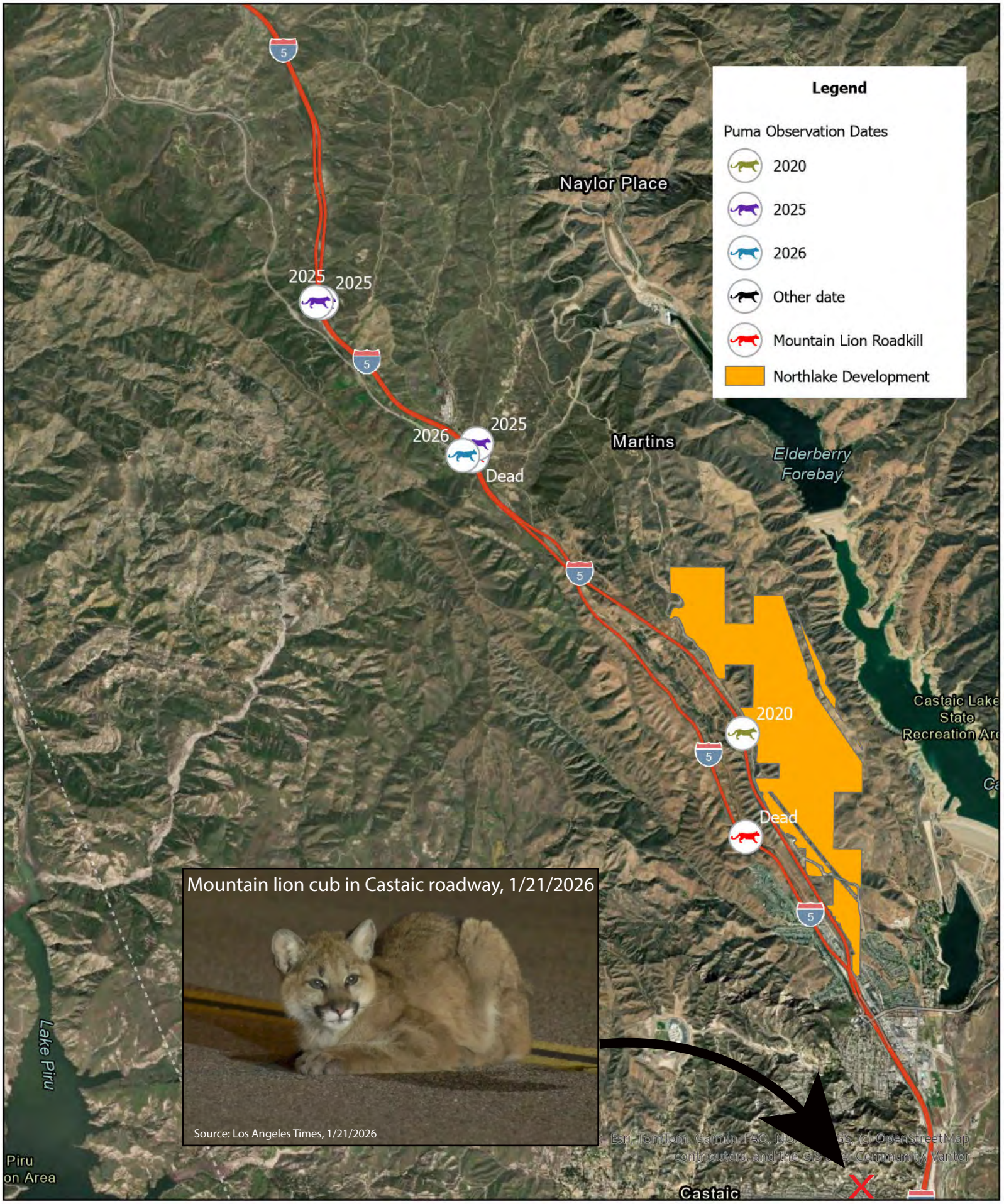
156 City of Los Angeles, "LA City Open Budget: Pavement Preservation," 2024, https://openbudget.lacity.org/#!/year/2024/operating/0/department_name/Bureau+of+Street+Services/0/program_name/Pavement+Preservation/0/source_fund_name.

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Northlake Project No. R2015-00408

Northlake Fire Recurrence Map (1992-2025 Fire Events Within Seven Miles)



Northlake Project No. R2015-00408

Northlake Puma Observation Map

Source:
UC Davis CA Roadkill Observation System &
wildlife camera data collected 2020,2025-2026

0 0.25 0.5 1 Miles

Chad Christensen

From: Chad Christensen
Sent: Monday, March 16, 2026 4:30 PM
To: ExecutiveOffice@bos.lacounty.gov; publichearing@bos.lacounty.gov
Subject: MRCA comments regarding Northlake appeal
Attachments: MRCA - Northlake Fire Recurrence (1992-2025) Map.pdf; MRCA - Northlake Puma Observation Map.pdf; MRCA - References Cited Exhibit.pdf; MRCA Comment Letter 2026-03-16 - Northlake Project Appeal.pdf

Good afternoon,

I received a delivery error on prior email due to size limit and wanted to follow up with smaller file sizes that comply with the email screening requirements.

Please find attached a letter from MRCA providing comments to the County Board of Supervisors regarding the appeal of the Northlake Project R2015-00408-(5), Vesting Tentative Tract Map No. 073336, Vesting Tentative Parcel Map No. 073335, Conditional Use Permit No. RPPL2023004316, Environmental Assessment NO. RPPL2023004887 (Project) in the Fifth Supervisorial District.

Attached are the following documents:

- MRCA Comment Letter 2026-03-16 – Northlake Project Appeal
- MRCA – References Cited Exhibit
- MRCA – Northlake Fire Recurrence (1992-2025) Map
- MRCA – Northlake Puma Observation Map

Please confirm receipt of this email and attachments for inclusion in the record for File ID 26-1204 and the Board of Supervisors meeting on March 24, 2026.

Thank you,
Chad

Chad Christensen
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March 17, 2026

VIA EMAIL &
ONLINE PUBLIC COMMENT PORTAL

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Re: Appellant SAFER's Comment on the Recirculated Partial Final Supplemental Environmental Impact Report for the NorthLake Specific Plan Project

Dear Chair Solis, Honorable Board of Supervisors, and Ms. Sackett:

This comment is submitted on behalf of Appellant Supporters Alliance for Environmental Responsibility ("SAFER") regarding the Recirculated Partial Final Supplemental Environmental Impact Report ("RPFSEIR") for the NorthLake Specific Plan Project (SCH No. 2015031080, Project No. R2015-00408-(5), Vesting Tentative Tract Map No. 07336, Tentative Parcel Map Np. 07335, Conditional Use Permit No. RPPL2023004316, Environmental Assessment No. RPPL2023004887), including all actions related or referring to the proposed development of 2,295 dwelling units, located east of Interstate (I) 5, west of Castaic Lake, and north of the community of Castaic, California in unincorporated Los Angeles County ("Project"). The Project is scheduled to be heard on appeal at the Los Angeles County Board of Supervisor's March 24, 2026 meeting.

As a result of *Center for Biological Diversity et al. v. County of Los Angeles et al.*, Case No. 19STCP01610, the Court ordered Los Angeles County ("County") to set aside its approval of the Project and decertify the 2018 Supplemental EIR ("2018 SEIR" or "SEIR"). The County is attempting to recirculate a legally compliant EIR by revising the vehicle miles traveled ("VMT")

analysis, among other sections in the 2018 SEIR. However, the VMT analysis is still inadequate, and must be updated to account for significant new information since the certification of the 2018 SEIR.

SAFER's review of the RPFSEIR was also assisted by transportation expert Norman Marshall of Smart Mobility, whose written comments and CV are attached as Exhibit A. As discussed below, based on Mr. Marshall's review of the RPFSEIR and Recirculated Partial Draft Supplemental Environmental Impact Report ("RPDSEIR"), he concluded that:

1. The residential component would result in a highly significant VMT impact.
2. The NorthLake Specific Plan VMT is almost entirely residential.
3. The residential component should be analyzed using home-based VMT per capita.
4. VMT per service population is an invalid metric.
5. Maximum possible VMT mitigation is required. (*See* Ex. A, pp. 1-10.)

Because there is substantial expert evidence that the Project will result in significant VMT impacts; the RPFSEIR lacks substantial evidence that the Project will not result in significant VMT impacts; and the RPFSEIR fails to adequately mitigate VMT impacts, the County must revise and recirculate a complete EIR that fully analyzes and mitigates the Project's significant VMT impacts.

LEGAL STANDARD

I. CEQA AND ENVIRONMENTAL IMPACT REPORT

CEQA has two primary purposes. First, CEQA is designed to inform decision makers and the public about the potential, significant environmental effects of a project. (14 CCR § 15002(a)(1).) "Its purpose is to inform the public and its responsible officials of the environmental consequences of their decisions before they are made. Thus, the EIR 'protects not only the environment but also informed self-government.'" (*Citizens of Goleta Valley v. Board of Supervisors* (1990) 52 Cal.3d 553, 564.) Second, CEQA requires public agencies to avoid or reduce environmental damage when "feasible" by requiring "environmentally superior" alternatives and all feasible mitigation measures. (14 CCR § 15002(a)(2) and (3); *see also Berkeley Jets Over the Bay Com. v. Board of Port Cmrs.* (2001) 91 Cal.App.4th 1349,1354; *Citizens of Goleta Valley v. Board of Supervisors* (1990) 52 Cal.3d 553, 564.)

CEQA requires that an agency analyze the potential environmental impacts of its proposed actions in an Environmental Impact Report (EIR) except in certain limited circumstances. (*See, e.g.*, Pub. Resources Code, § 21100.) The EIR is the very heart of CEQA. (*Dunn-Edwards v. BAAQMD* (1992) 9 Cal.App.4th 644, 652. The EIR is an "environmental 'alarm bell' whose purpose is to alert the public and its responsible officials to environmental changes before they have reached the ecological points of no return." (*Bakersfield Citizens for Local Control v. City of Bakersfield* (2004), 124 Cal.App.4th 1184, 1220.) The EIR also functions as a "document of accountability," intended to "demonstrate to an apprehensive citizenry that the

agency has, in fact, analyzed and considered the ecological implications of its action." (*Laurel Heights Improvements Assn. v. Regents of Univ. of Cal*. (1988) 47 Cal.3d 376, 392.)

While the courts review an EIR using an "abuse of discretion" standard, "the reviewing court is not to 'uncritically rely on every study or analysis presented by a project proponent in support of its position. A 'clearly inadequate or unsupported study is entitled to no judicial deference.'" (*Berkeley Jets*, 91 Cal.App.4th at 1355 (quoting, *Laurel Heights Improvement Assn. v. Regents of Univ. of Cal.* (1988) 47 Cal.3d 376, 391 409, fn. 12).) A prejudicial abuse of discretion occurs "if the failure to include relevant information precludes informed decisionmaking and informed public participation, thereby thwarting the statutory goals of the EIR process." (*San Joaquin Raptor/Wildlife Rescue Center v. County of Stanislaus* (1994) 27 Cal.App.4th 713, 722; *Galante Vineyards v. Monterey Peninsula Water Management Dist.* (1997) 60 Cal.App.4th 1109, 1117; *County of Amador v. El Dorado County Water Agency* (1999) 76 Cal.App.4th 931, 946.) As discussed below and in Mr. Marshall's attached expert comment letter, the RPFSEIR for this Project fails to adequately analyze and mitigate the Project's significant VMT impacts. Here, the RPFSEIR evaluates the NorthLake Specific Plan and revises and tiers from the 2018 SEIR, which tiers from the 1992 NorthLake Specific Plan EIR. (RPDSEIR, p. 1-3.) However, we found that the RPFSEIR prepared by the County here is inadequate for several reasons set forth below.

II. RECIRCULATION OF AN ENVIRONMENTAL IMPACT REPORT UNDER CEQA

Moreover, CEQA Guidelines Section 15088.5 sets forth the standard requiring recirculation prior to final project approval. Recirculation of an EIR is required when "significant new information is added to the EIR after public notice is given of the availability of the draft EIR for public review under Section 15087 but before certification [of the Final EIR]." (14 CCR § 15088.5(a).) New information added to an EIR is significant when "the EIR is changed in a way that deprives the public of a meaningful opportunity to comment upon a substantial adverse environmental effect of the project or a feasible way to mitigate or avoid such an effect (including a feasible project alternative) that the project's proponents have declined to implement." (*Id.*) The Guidelines require recirculation when:

(1) A new significant environmental impact would result from the project or from a new mitigation measure proposed to be implemented.
(2) A substantial increase in the severity of an environmental impact would result unless mitigation measures are adopted that reduce the impact to a level of insignificance.
(3) A feasible project alternative or mitigation measure considerably different from others previously analyzed would clearly lessen the environmental impacts of the project, but the project's proponents decline to adopt it.
(4) The draft EIR was so fundamentally and basically inadequate and conclusory in nature that meaningful public review and comment were precluded. (14 CCR § 15088.5(a); *Mountain Lion Coalition v. Fish and Game Com*. (1989) 214 Cal.App.3d 1043)

Based on Mr. Marshall's review, the Project would result in a substantial increase in the severity of VMT impacts than previously analyzed under the 2018 SEIR and feasible mitigation measures to reduce the severity of VMT impacts have not been properly evaluated and disclosed to the public. Therefore, in accordance with Section 15088.5 of the CEQA Guidelines, the County must revise and recirculate a complete EIR that fully analyzes and mitigates the Project's significant VMT impacts and provide the public with a meaningful opportunity to comment upon the substantial adverse VMT impacts of the Project.

DISCUSSION

I. THE RPFSEIR FAILS TO ADEQUATELY ANALYZE AND MITIGATE THE PROJECT'S SIGNIFICANT VMT IMPACTS.

Transportation expert Norm Marshall reviewed the County's analysis of the Project's VMT impacts. Mr. Marshall's comment letter and CV are attached as Exhibit A and his comments are briefly summarized here.

A. The Project would result in a substantial increase in the severity of VMT impacts than previously analyzed under the 2018 SEIR.

Mr. Marshall found that the RPFSEIR fails to disclose a very significant impact from the Project's residential component, requiring the County to revise its VMT analysis and recirculate a draft EIR. (*See* Ex. A, pp. 2-5.)

According to Mr. Marshall, the Transportation Analysis included in Appendix C-1 of the RPDSEIR includes outputs from the Los Angeles County VMT Tool demonstrating that the Project's residential component would result in a highly significant VMT impact. (Ex. A, p. 2.) Mr. Marshall's comment letter reproduces the VMT Tool outputs for the Project's Single-Family Housing, Multifamily Housing, and the entire Project at Figures 1, 2 and 3. (*Id.*, pp. 3-5.)

Mr. Marshall explains that "Los Angeles County has a higher VMT threshold for the northern portion of the county than for the more densely populated southern portion of the county." (Ex. A, p. 2.) The North County Residential VMT per capita Baseline is 20.7, with a significance threshold of 17.2 (16.8 percent below the baseline). (*Id.*) Based on the VMT Tool outputs, Mr. Marshall concluded that the Project's residential uses substantially exceed this threshold:

- Single-family 28.9 exceeds the threshold of 17.2 by 68%
- Multi-family 21.7 exceeds the threshold of 17.2 by 26%
- Combined uses 25.9 exceeds the threshold of 17.2 by 51%

(Ex. A, p. 2.) In addition, the VMT Tool relied upon in the RPDSEIR's Transportation Analysis also concludes that "project is not presumed to have a less than significant impact on VMT." (pp.

10-11, 13-15; Ex. A, pp. 3-5.) As such, Mr. Marshall concluded that the Project's residential component will result in substantially more severe VMT impacts than previously analyzed in the 2018 SEIR. (Ex. A, p. 2.) Because the RPDSEIR's Transportation Analysis and Mr. Marshall expert comments are substantial evidence of a significant VMT impact, the County must revise and recirculate a complete draft supplemental EIR that fully analyzes and mitigates the Project's significant VMT impacts.

B. The RPFSEIR's conclusion that the Project will not have a significant VMT impact is not supported by substantial evidence because it erroneously relies on an outdated VMT per service population metric.

Mr. Marshall explains that Los Angeles County requires VMT to be analyzed as follows:

> Residential projects are to be analyzed using the residential threshold. In mixed-use projects, each component is to be analyzed separately, i.e., the residential components are to be analyzed using the residential threshold. The residential component should be analyzed using home-based VMT per capita. (Ex. A, pp. 7-8.)

As discussed below, the RPFSEIR improperly relies on the invalid "VMT per service population" metric to evaluate VMT impacts under CEQA. (Ex. A, pp. 8-9.)

Mr. Marshall notes that the RPFSEIR's analysis of the Project's VMT impacts relies on a "VMT per service population" metric, which is defined as "[t]he total service population is the sum of the number residents and the number of employees." (Ex. A, p. 8.) However, Mr. Marshall explains that this approach is flawed because it obscures the Project's actual VMT impacts. (*id.*, pp. 8-9.) According to Mr. Marshall, combining the Project's residential and commercial employee VMT into a single service population "is a misguided attempt to reduce complex VMT issues to a single metric," especially given that the Project is "is more a residential project than a mixed use project." (*Id.*, p. 8.) He further explains that:

> Adding residents and employees together makes no sense because the VMT generated by an average employee is significantly larger than the VMT generated by an average resident . "Residents" include many nondrivers including children. Therefore, if there is a higher proportion of employees relative to the residents, calculated VMT per service population will be higher, and if there is a lower proportion of employees relative to residents, a lower VMT per service population will result. These differences do not represent real information about the VMT impacts of either the residential or employment components. (*Id.*)

Additionally, the VMT per service population metric is meaningless without knowing the percentages of residents and employees. (Ex. A, p. 8.) Here, 97 percent of the Project is residential. (*See id.*, p. 6 [Figure 4].) Nevertheless, the RPFSEIR relies on the combined VMT service population metric to assert that removing employment uses—including over 545,000

square feet of industrial uses and 99,000 square feet of commercial uses—reduces the Project's VMT impacts. (*Id.*, p. 9.) As Mr. Marshall explains:

> [T]his result is just a computational quirk that results from removing employees with higher VMT per employment and leaving mostly residents with lower VMT per resident. As documented above, the predominant residential VMT component in the NorthLake project is highly significant, and this VMT per service population calculation does not address this issue.
>
> In fact, the RPDSEIR uses the VMT per service population metric to support the opposite conclusion than what should be drawn. The reason for the highly-significant residential VMT is that the planned housing is far from job centers, and this necessitates long commutes and trips to services. Removing most of the jobs will not improve this situation and would likely aggravate it. (*Id.*)

Therefore, Mr. Marshall concludes that "[i]t is invalid to apply a VMT per service population rate that is inflated by the higher VMT per employee component embodied in the combined rate." (*Id.*, p. 8.) Instead, these Project components must be analyzed separately, with the residential component analyzed using home-based VMT per capita. (*Id.*, pp. 7-8.)

Moreover, even if the VMT per service population metric should be applied, the RPFSEIR still failed to adequately analyze VMT impacts because it applied an incorrect and outdated threshold of significance to measure impacts. The Department of Transportation's ("DOT") May 29, 2025 comment on the Draft SEIR states that the County applied an outdated threshold to measure VMT impacts. (RPFSEIR, p. A.2-3.) Specifically, the DOT explains that the County incorrectly applied the prior Northlake Specific Plan VMT per service population (27.03) as the significance threshold for determining an impact. However, the VMT per Service Population (27.03) is the baseline for comparison to the previously approved Project. The County was required to apply the VMT per Service Population (25.70) per the methodology required by the County Department of Public Works. As such, even if the incorrect VMT per service population metric is used, the Project's VMT impacts—using DOT's recommended lower VMT per service population threshold—would still exceed the significance threshold.

Thus, the RPFSEIR's less-than-significant conclusion for VMT impacts cannot be relied upon. A revised and complete draft supplemental EIR should be prepared and recirculated that includes an adequate analysis of the Project's VMT impacts using the proper threshold of significance.

C. The RPFSEIR fails to include feasible mitigation to reduce the Project's significant VMT impacts.

As discussed above, the Project's residential component will result in significant VMT impacts. (*See* Ex. A, p. 2.) However, the RPFSEIR requires no mitigation to reduce VMT impacts, even though the RPFSEIR includes a Caltrans comment letter dated May 29, 2025, stating:

> To further support VMT reduction and for the County's consideration, we recommend that the project incorporate a Transportation Demand Management (TDM) program. TDM strategies such as enhanced transit connectivity, subsidized transit passes, carpool/vanpool programs, employer-based trip reduction incentives, bicycle and pedestrian infrastructure, and telecommuting support can materially reduce project-level VMT. These measures should be quantified, monitored, and integrated into project conditions or mitigation measures to ensure accountability and effectiveness. (RPFSEIR, p. A.2-4.)

Rather than including mitigation measures to reduce VMT impacts as recommended by Caltrans, the RPFSEIR provided the following inadequate response to Caltrans' comment:

> While TDM programs are effective in reducing VMT, here, VMT impacts were determined to be less than significant, and therefore no mitigation is necessary or required. (RPFSEIR, p. 2-11.)

As Mr. Marshall concludes, "[t]his response is woefully inadequate." (Ex. A, p. 10.) Moreover, Caltrans recommended a comprehensive TDM program should be developed and: "These measures should be quantified, monitored, and integrated into project conditions or mitigation measures to ensure accountability and effectiveness." (RPFSEIR, p. A.2-4.) Therefore, the RPFSEIR fails to include feasible mitigation measures to reduce the severity of VMT impacts, which have not been properly evaluated and disclosed to the public. (14 CCR § 15088.5(a).) A revised and complete draft supplemental EIR should be prepared and recirculated that includes adequate mitigation measures to reduce the Project's significant VMT impacts

CONCLUSION

SAFER requests that the Board of Supervisors grant the appeal and deny approving this Project, and instead, direct staff to address these shortcomings in a revised and recirculated complete SEIR that fully analyzes and mitigates the Project's significant VMT impacts prior to considering approvals for the Project. SAFER reserves the right to supplement these comments during the administrative process. (*Galante Vineyards v. Monterey Peninsula Water Management Dist*. (1997) 60 Cal.App.4th 1109, 1121.)

Sincerely,

Victoria Yundt

Victoria Yundt
Lozeau Drury LLP

EXHIBIT A

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Norman Marshall, President
(802) 356-2969
nmarshall@smartmobility.com

March 4, 2026

Victoria Yundt
Lozeau | Drury LLP
1939 Harrison St., Suite 150
Oakland, CA 94612

Subject: NorthLake Specific Plan

Dear Ms. Yundt,

I have reviewed the vehicle miles traveled ("VMT") impacts of the NorthLake Specific Plan in Los Angeles County as described in the Recirculated Partial Final Supplemental Environmental Impact Report dated December 2025 ("RPFSEIR") and the Recirculated Partial Draft Supplemental Environmental Impact Report dated April 2025 ("RPDSEIR"). I make the following findings:

1) The residential component would result in a highly significant VMT impact.
2) The NorthLake Specific Plan VMT is almost entirely residential.
3) The residential component should be analyzed using home-based VMT per capita.
4) VMT per service population is an invalid metric.
5) Maximum possible VMT mitigation is required.

The Residential Component Would Result in a Highly-Significant VMT Impact

RPDSEIR Appendix C-1 includes outputs of the Los Angeles County VMT Tool that show that the residential components of the NorthLake Specific Plan would result in a highly-significant VMT impact. In the RPDSEIR, the current proposal is labeled "Previously Approved Project." The Tool outputs for the Previously Approved Project for Single-Family Housing, Multifamily Housing, and the entire project are reproduced below as Figures 1, 2 and 3.

The Los Angeles County has a higher VMT threshold for the northern portion of the county than for the more densely populated southern portion of the county. Figures 1, 2 and 3 show that the North County Residential VMT per capita Baseline is 20.7, and that the threshold for significance is 17.2 (16.8% less).

These thresholds are significantly exceeded in the NorthLake Specific Plan location:

- Single-family 28.9 exceeds the threshold of 17.2 by 68%
- Multi-family 21.7 exceeds the threshold of 17.2 by 26%
- Combined uses 25.9 exceeds the threshold of 17.2 by 51%

Each of the Tool outputs shown in Figures 1, 2 and 3 concludes:

"The project is not presumed to have a less than significant impact on VMT, therefore a CEQA VMT analysis may be required."

Figure 1: Los Angeles County VMT Tool – Previously Approved Project Single-Family Housing

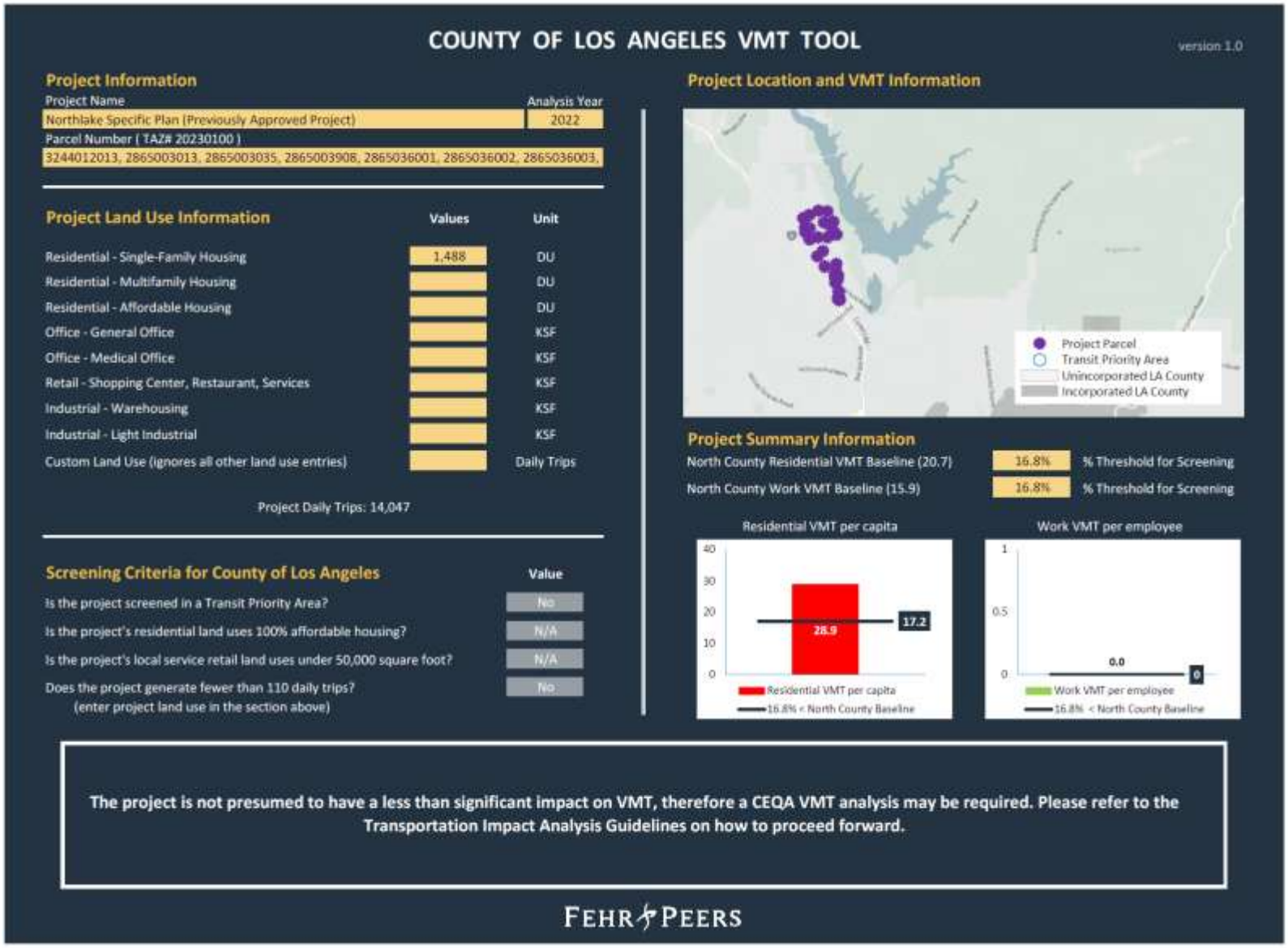


Figure 2: Los Angeles County VMT Tool – Previously Approved Project Multifamily Housing

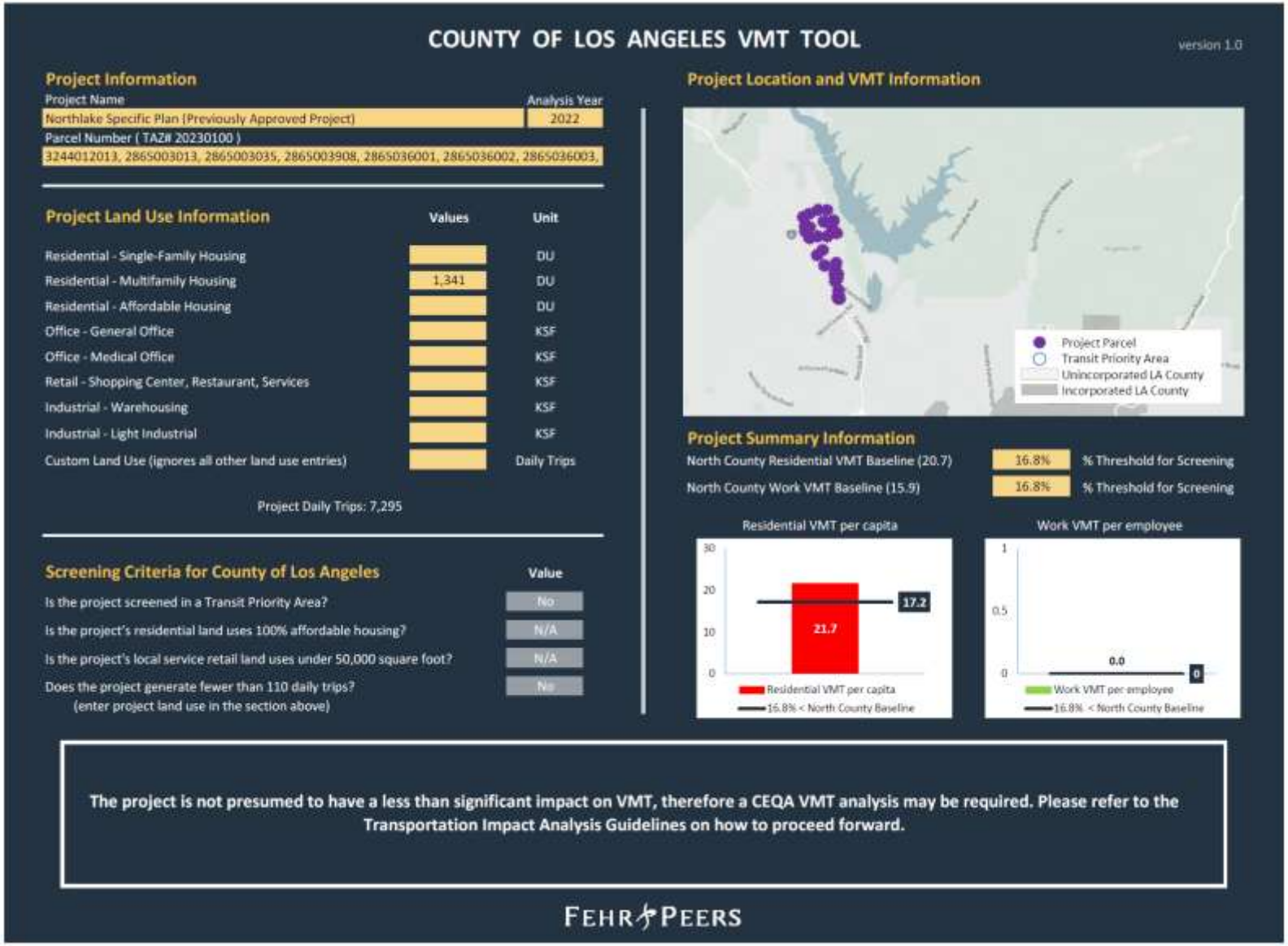
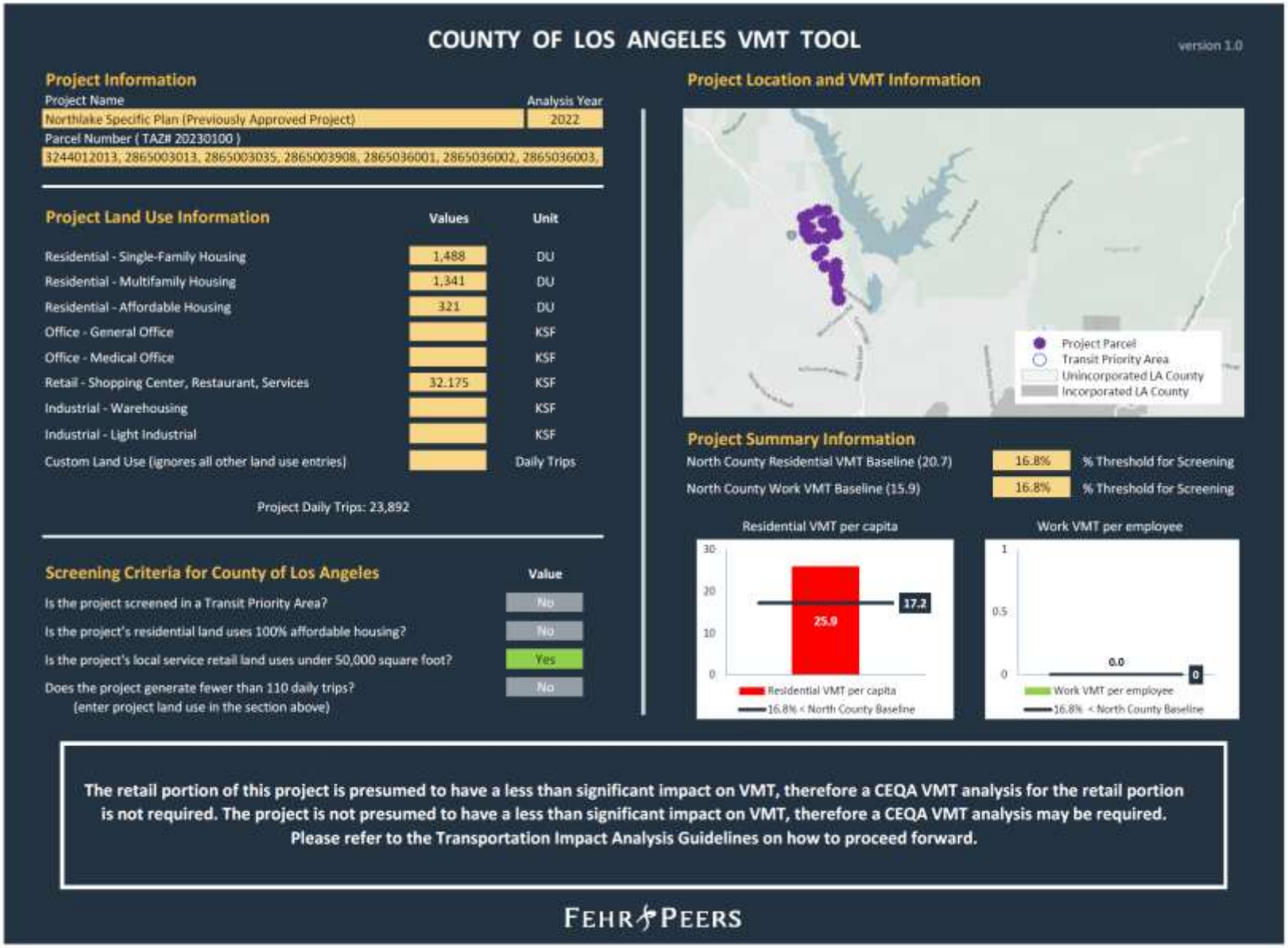


Figure 3: Los Angeles County VMT Tool – Previously Approved Project – Combined Uses



The NorthLake Specific Plan VMT is Almost Entirely Residential

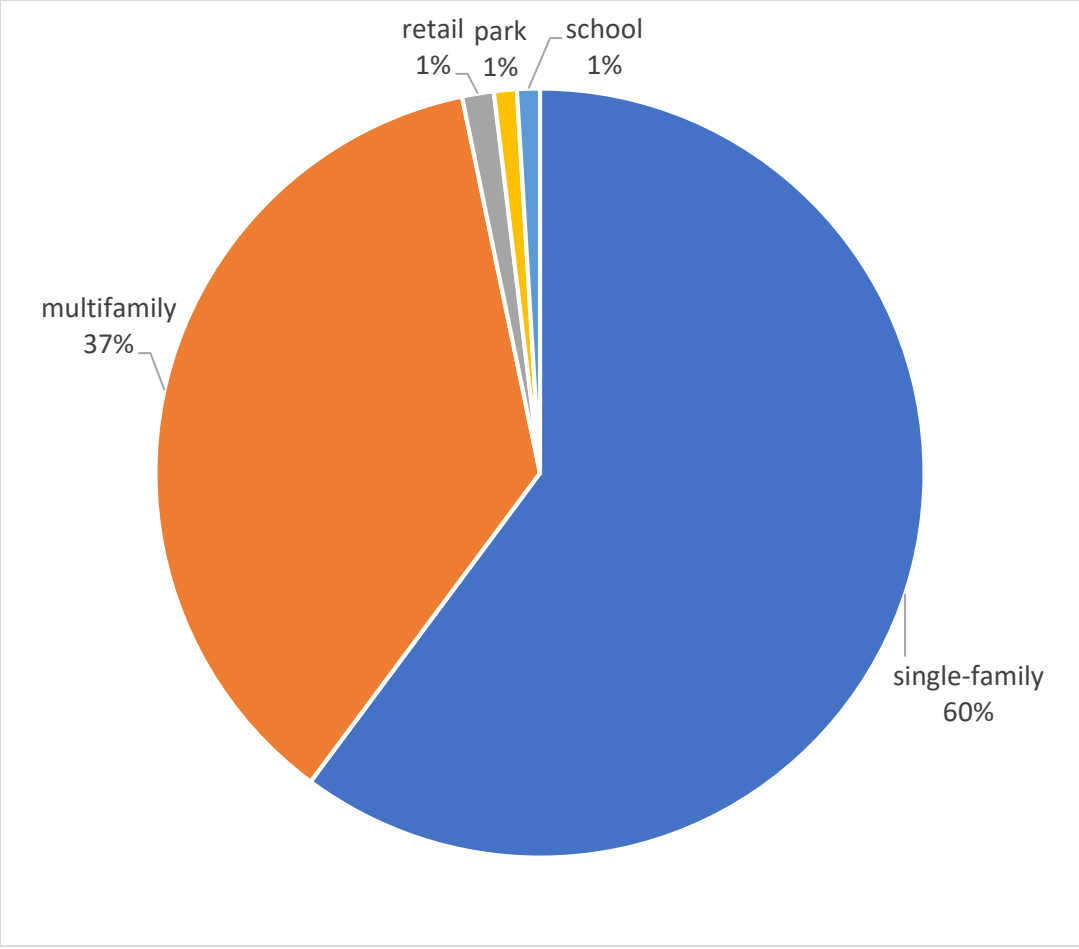
RPDSEIR Table 2-6 reproduced below summarizes estimated VMT by use.

TABLE 2-6
NLSP AND PREVIOUSLY APPROVED PROJECT VMT SUMMARY

Category	NLSP VMT	Previously Approved Project VMT
Single Family Residential	260,013	165,568
Multi-Family Residential	77,860	100,623
Commercial Retail	8,765	3,670
Light Industrial	13,869	--
Recreation/Park	1,320	2,640
School	2,640	2,640
Project VMT	**364,467**	**275,141**
Service Population	**13,485**	**10,705**
VMT per Service Population	**27.0**	**25.7**
See Appendix C-1 for the VMT and Service Population Worksheets.		

As shown in Figure 4, 97% of the estimated VMT for the Previously Approved Project is Residential

Figure 4: Previously Approved Project VMT by Land Use Category



The Residential Component Should be Analyzed Using Home-Based VMT Per Capita

The table reproduced below shows Los Angeles County VMT Thresholds[1]

TABLE 6: LOS ANGELES COUNTY VMT THRESHOLDS

Project Type	Threshold for Determination of Significant VMT Impact
Residential Project	Project exceeds 16.8% below the North or South County Baseline VMT for home-based VMT per capita
Employment (Commercial or Industrial) Project	Project exceeds 16.8% below the North or South County Baseline VMT for home-based work VMT per employee
Regional Retail Project	Project results in a net increase in total VMT per service population in comparison to the North or South County Baseline VMT
Mixed-Use Projects	Evaluate each project land use component separately using the criteria above
Land Use Plans (Community Plan, Specific Plan)	Total VMT per service population generated by the Plan exceeds 16.8% below the North or South County Baseline VMT
Other land use types	Project exceeds 16.8% below the North or South County Baseline VMT. For land use types not listed above, the County can determine the appropriate VMT metric depending on the project characteristics. For projects that are generally producing job-related travel, the employment generating VMT (home-based work VMT per employee) can be compared to the applicable County baseline. For other projects, the total VMT per service population can be compared to the County baseline, or the net change in VMT can be compared within the study area.
Transportation Projects or Plans	Project results in an increase in VMT in comparison to the baseline VMT in the study area

[1] Fehr and Peers. Los Angeles County Senate Bill (SB) 743 Implementation and CEQA Updates Report, Prepared for Los Angeles County, June 2020.

Residential projects are to be analyzed using the residential threshold. In mixed-use projects, each component is to be analyzed separately, i.e., the residential components are to be analyzed using the residential threshold. The residential component should be analyzed using home-based VMT per capita.

"VMT per Service Population" is an Invalid Metric

The table reproduced above has a line for land use plans, including Specific Plans, giving a threshold of "total VMT per service population generated by the Plan exceeds 16.8% below the North or South County Baseline VMT."

The definition of service population is:

> The total service population is the sum of the number residents and the number of employees.

The service population concept was introduced in a misguided attempt to reduce complex VMT issues to a single metric. At best, this has muddied the waters. At worst, it has allowed false assertions as has been done in this case. The NorthLake project is more a residential project than a mixed use project, and it is a stretch to call it a "Specific Plan" at all.

Adding residents and employees together makes no sense because the VMT generated by an average employee is significantly larger than the VMT generated by an average resident . "Residents" include many nondrivers including children. Therefore, if there is a higher proportion of employees relative to the residents, calculated VMT per service population will be higher, and if there is a lower proportion of employees relative to residents, a lower VMT per service population will result. These differences do not represent real information about the VMT impacts of either the residential or employment components.

Here is an analogy drawn from high school math problems. Suppose there is a mix of nuts including peanuts and cashews. The peanuts separately cost $5 a pound and cashews separately cost $10 a pound. The mix is priced at $7.50 a pound, but the mix proportion is unknown. If it's almost all peanuts, it's overpriced. If it's almost all cashews, it is a bargain. The price alone tells us nothing about the value of the mix. We need to know the percentages in the mix.

Similarly, VMT per service population is meaningless without knowing the percentages in the mix. In this case, as documented above, 97% of the NorthLake Specific Plan VMT is residential. It is invalid to apply a VMT per service population rate that is inflated by the higher VMT per employee component embodied in the combined rate. The components should be analyzed separately.

RPDSEIR Table 2-5 compares the land uses in the previously approved project to the original NorthLake Specific Plan.[2]

TABLE 2-5
NORTHLAKE SPECIFIC PLAN PROJECT LAND USE SUMMARY

Category	NLSP			Previously Approved Project			Difference		
	(AC)	(DU)	(SQ. FT.)	(AC)	(DU)	(SQ. FT.)	(AC)	(DU)	(SQ. FT.)
Residential	600.3	3,623	--	362	3,150	--	-238.3	-794	--
Single Family	504.8	2,337	--	235	1,488	--	-269.8	-593	--
Multi-Family	95.5	1,286	--	107	1,341	--	11.5	-201	--
Affordable Mixed-Use Housing/Live-Work***	0	0	--	20	321*	--	10.8	321	--
General Commercial	9.2	--	100,188		--	38,700**		--	-61,488
Highway Commercial	4	--	69,696	2	--	32,175**	2	--	-37,521
Industrial	50.1	--	545,589	0	--	0	-50.1	--	-545,589
School	23.1	--	--	44	--	--	20.9	--	--
Recreation/Park	167	--	--	167	--	--	0	--	--

* For the purposes of the VMT analysis, the affordable mixed-use housing / market-rate live-work units are treated as multi-family units.

** Square footage per Northlake Design Guidebook

*** 315 affordable mixed-use units and 6 market-rate live-work units.

As shown in Table 2-6, the changes include removing most of the employment including 545,589 sq. ft. of industrial uses and 99,009 sq. ft. of commercial uses.

RPDSEIR Table 2-6 asserts that removing employment causes the VMT per Service Population for the previously approved project to be lower than for the original NorthLake Specific Plan. However, this result is just a computational quirk that results from removing employees with higher VMT per employment and leaving mostly residents with lower VMT per resident. As documented above, the predominant residential VMT component in the NorthLake project is highly significant, and this VMT per service population calculation does not address this issue.

In fact, the RPDSEIR uses the VMT per service population metric to support the opposite conclusion than what should be drawn. The reason for the highly-significant residential VMT is that the planned housing is far from job centers, and this necessitates long commutes and trips to services. Removing most of the jobs will not improve this situation and would likely aggravate it.

[2] There are multiple arithmetic errors in Table 2-5:

- Residential: 3,623 - 3,150 = 473 (not 794)
- Single Family: 2,337 - 1,488 = 849 (not 593)
- Multi-Family 1,286 - 1,341 = increase of 55 (not decrease of 201)

Maximum Possible VMT Mitigation is Required

As documented above, the Los Angeles County VMT Tool outputs included in the RPDSEIR show the residential VMT threshold is significantly exceeded in the NorthLake Specific Plan location:

- Single-family 28.9 exceeds the threshold of 17.2 by 68%
- Multi-family 21.7 exceeds the threshold of 17.2 by 26%
- Combined uses 25.9 exceeds the threshold of 17.2 by 51%

The RPFSEIR includes a Caltrans comment letter dated May 29, 2025 which states, in part:

> To further support VMT reduction and for the County's consideration, we recommend that the project incorporate a Transportation Demand Management (TDM) program. TDM strategies such as enhanced transit connectivity, subsidized transit passes, carpool/vanpool programs, employer-based trip reduction incentives, bicycle and pedestrian infrastructure, and telecommuting support can materially reduce project-level VMT. These measures should be quantified, monitored, and integrated into project conditions or mitigation measures to ensure accountability and effectiveness.

The RPFSEIR response, in part:

> While TDM programs are effective in reducing VMT, here, VMT impacts were determined to be less than significant, and therefore no mitigation is necessary or required.

This response is woefully inadequate. As documented above, the project's VMT impacts are highly significant. As Caltrans recommends, a comprehensive TDM program should be developed and: "These measures should be quantified, monitored, and integrated into project conditions or mitigation measures to ensure accountability and effectiveness."

Sincerely,



Norman L. Marshall

Resume

NORMAN L. MARSHALL, PRESIDENT

nmarshall@smartmobility.com

EDUCATION:

Master of Science in Engineering Sciences, Dartmouth College, Hanover, NH, 1982
Bachelor of Science in Mathematics, Worcester Polytechnic Institute, Worcester, MA, 1977

PROFESSIONAL EXPERIENCE: (37 Years, 23 at Smart Mobility, Inc.)

Norm Marshall helped found Smart Mobility, Inc. in 2001. Prior to this, he was at RSG for 14 years where he developed a national practice in travel demand modeling. He specializes in analyzing the relationships between the built environment and travel behavior and doing planning that coordinates multi-modal transportation with land use and community needs.

Regional Land Use/Transportation Scenario Planning

Portland Area Comprehensive Transportation System (PACTS) – the Portland Maine Metropolitan Planning Organization. Updating regional travel demand model with new data (including AirSage), adding a truck model, and multiclass assignment including differentiation between cash toll and transponder payments.

Loudoun County Virginia Dynamic Traffic Assignment – Enhanced subarea travel demand model to include Dynamic Traffic Assignment (Cube). Model being used to better understand impacts of roadway expansion on induced travel.

Vermont Agency of Transportation-Enhanced statewide travel demand model to evaluate travel impacts of closures and delays resulting from severe storm events. Model uses innovate Monte Carlo simulations process to account for combinations of failures.

California Air Resources Board – Led team including the University of California in $250k project that reviewed the ability of the new generation of regional activity-based models and land use models to accurately account for greenhouse gas emissions from alternative scenarios including more compact walkable land use and roadway pricing. This work included hands-on testing of the most complex travel demand models in use in the U.S. today.

Climate Plan (California statewide) – Assisted large coalition of groups in reviewing and participating in the target setting process required by Senate Bill 375 and administered by the California Air Resources Board to reduce future greenhouse gas emissions through land use measures and other regional initiatives.

Chittenden County (2060 Land use and Transportation Vision Burlington Vermont region) – led extensive public visioning project as part of MPO's long-range transportation plan update.

Flagstaff Metropolitan Planning Organization – Implemented walk, transit and bike models within regional travel demand model. The bike model includes skimming bike networks including on-road and off-road bicycle facilities with a bike level of service established for each segment.

Chicago Metropolis Plan and Chicago Metropolis Freight Plan (6-county region)— developed alternative transportation scenarios, made enhancements in the regional travel demand model, and used the enhanced

model to evaluate alternative scenarios including development of alternative regional transit concepts. Developed multi-class assignment model and used it to analyze freight alternatives including congestion pricing and other peak shifting strategies.

Municipal Planning

City of Grand Rapids – Michigan Street Corridor – developed peak period subarea model including non-motorized trips based on urban form. Model is being used to develop traffic volumes for several alternatives that are being additional analyzed using the City's Synchro model

City of Omaha - Modified regional travel demand model to properly account for non-motorized trips, transit trips and shorter auto trips that would result from more compact mixed-use development. Scenarios with different roadway, transit, and land use alternatives were modeled.

City of Dublin (Columbus region) – Modified regional travel demand model to properly account for non-motorized trips and shorter auto trips that would result from more compact mixed-use development. The model was applied in analyses for a new downtown to be constructed in the Bridge Street corridor on both sides of an historic village center.

City of Portland, Maine – Implemented model improvements that better account for non-motorized trips and interactions between land use and transportation and applied the enhanced model to two subarea studies.

City of Honolulu – Kaka'ako Transit Oriented Development (TOD) – applied regional travel demand model in estimating impacts of proposed TOD including estimating internal trip capture.

City of Burlington (Vermont) Transportation Plan – Led team that developing Transportation Plan focused on supporting increased population and employment without increases in traffic by focusing investments and policies on transit, walking, biking and Transportation Demand Management.

Transit Planning

Regional Transportation Authority (Chicago) and Chicago Metropolis 2020 – evaluated alternative 2020 and 2030 system-wide transit scenarios including deterioration and enhance/expand under alternative land use and energy pricing assumptions in support of initiatives for increased public funding.

Capital Metropolitan Transportation Authority (Austin, TX) Transit Vision – analyzed the regional effects of implementing the transit vision in concert with an aggressive transit-oriented development plan developed by Calthorpe Associates. Transit vision includes commuter rail and BRT.

Bus Rapid Transit for Northern Virginia HOT Lanes (Breakthrough Technologies, Inc and Environmental Defense.) – analyzed alternative Bus Rapid Transit (BRT) strategies for proposed privately-developing High Occupancy Toll lanes on I-95 and I-495 (Capital Beltway) including different service alternatives (point-to-point services, trunk lines intersecting connecting routes at in-line stations, and hybrid).

Roadway Corridor Planning

I-30 Little Rock Arkansas – Developed enhanced version of regional travel demand model that integrates TransCAD with open source Dynamic Traffic Assignment (DTA) software, and used to model I-30 alternatives. Freeway bottlenecks are modeled much more accurately than in the base TransCAD model.

South Evacuation Lifeline (SELL) – In work for the South Carolina Coastal Conservation League, used Dynamic Travel Assignment (DTA) to estimate evaluation times with different transportation alternatives in coastal South Caroline including a new proposed freeway.

Hudson River Crossing Study (Capital District Transportation Committee and NYSDOT) – Analyzing long term capacity needs for Hudson River bridges which a special focus on the I-90 Patroon Island Bridge where a microsimulation VISSIM model was developed and applied.

PUBLICATIONS AND PRESENTATIONS (partial list)

DTA Love: Co-leader of workshop on Dynamic Traffic Assignment at the June 2019 Transportation Research Board Planning Applications Conference.

Forecasting the Impossible: The Status Quo of Estimating Traffic Flows with Static Traffic Assignment and the Future of Dynamic Traffic Assignment. *Research in Transportation Business and Management* 2018.

Assessing Freeway Expansion Projects with Regional Dynamic Traffic Assignment. Presented at the August 2018 Transportation Research Board Tools of the Trade Conference on Transportation Planning for Small and Medium Sized Communities.

Vermont Statewide Resilience Modeling. With Joseph Segale, James Sullivan and Roy Schiff. Presented at the May 2017 Transportation Research Board Planning Applications Conference.

Assessing Freeway Expansion Projects with Regional Dynamic Traffic Assignment. Presented at the May 2017 Transportation Research Board Planning Applications Conference.

Pre-Destination Choice Walk Mode Choice Modeling. Presented at the May 2017 Transportation Research Board Planning Applications Conference.

A Statistical Model of Regional Traffic Congestion in the United States, presented at the 2016 Annual Meeting of the Transportation Research Board.

MEMBERSHIPS/AFFILIATIONS

Associate Member, Transportation Research Board (TRB)

Member and Co-Leader Project for Transportation Modeling Reform, Congress for the New Urbanism (CNU)

From:	Jeff
To:	PublicHearing; ExecutiveOffice; jsackett@planning.lacounty.gov
Cc:	Torres-Socarras, Ariel; Jeff
Subject:	Support Northlake, Deny Appeal – March 24th BOS Meeting
Date:	Wednesday, March 18, 2026 11:06:03 AM

Members of the Board,

My name is Jeff Preach, and I am a long-time resident of Castaic. I am writing to express my strong support for the Northlake project and to share a perspective that many people in our community rarely get the chance to put on the record—the impact that decades of delay have had on local businesses.

For years, retail centers were built in Castaic and businesses chose to locate here with the expectation that the Northlake community would be developed as approved by Los Angeles County in the early 1990s. Those businesses made long-term investments based on that promise. Unfortunately, Northlake never moved forward, and many of those businesses have been waiting—literally for decades—for the customer base that was supposed to arrive.

As a result, Castaic's local retail and service businesses have struggled. We do not have the population density needed to support restaurants, neighborhood services, and small retailers. Some businesses have closed, others barely get by, and new businesses are hesitant to invest. This is not because of a lack of effort or quality—it is because there simply are not enough rooftops.

Castaic badly needs the economic activity that new homes bring. New residents mean customers who shop locally, eat locally, and support local services. That economic impact is critical if we want our community's retail centers to survive and thrive rather than remain underutilized.

Northlake represents a long-overdue opportunity to finally deliver on what was planned and promised. Allowing this project to move forward is not just about housing—it is about keeping local businesses alive and creating a complete, sustainable community.

I respectfully urge the Los Angeles County Board of Supervisors to deny the appeal and to uphold the unanimous approval by the Planning Commission of the Northlake project and allow Castaic to finally realize the economic benefits it has been waiting for.

Thank you for your time and consideration.

Respectfully,

Jeff Preach
(661)993-7999
jeff.preach@earthlink.net

From: ExecutiveOffice
To: PublicHearing
Subject: Fw: Board of Supervisors Appeal Question
Date: Thursday, March 5, 2026 11:11:16 AM
Importance: High

Good morning, The following correspondence is being forwarded to you for your review and handling.

Please confirm receipt and update the Executive Office on the status and/or resolution.
Thank you!

Executive Office of the Board of Supervisors
Phone: (213) 974-1411 | Email: ExecutiveOffice@bos.lacounty.gov
Find us on Facebook, Instagram, LinkedIn, Twitter @ Youtube @LACountyBOS

From: Evan Levy <ELevy@biologicaldiversity.org>
Sent: Thursday, March 5, 2026 8:53 AM
To: ExecutiveOffice <ExecutiveOffice@bos.lacounty.gov>
Subject: Board of Supervisors Appeal Question

Good morning,

I have appealed the decision of the Planning Commission's approval of the Northlake project, no. R2015-00408(5). I emailed Jodie Sackett, the planner for the project, and he directed me to this email.

I was wondering if you could share details about the hearing format for the appeal in front of the Board of Supervisors. I have looked through the Board Rules and the County Code and haven't found rules that prescribe specific procedures for how appeals are supposed to be conducted at Board hearings.

For example, do you know how much time appellants will have to present to the Board? Will both appellants be given separate opportunities to present? Will there be an opportunity for the Board to ask us questions? Any information you could provide would be helpful for us to prepare.

I appreciate all you're doing to make sure this process moves along smoothly.

Thank you.

Best,

Evan

On the side of life

Evan Levy (he/him)
Associate Attorney
Urban Wildlands Program
Center *for* Biological Diversity
510-844-7156
elevy@biologicaldiversity.org



From:	ExecutiveOffice
To:	PublicComments
Subject:	Fw: Appeal Comments – Northlake Specific Plan Project (SCH No. 2015031080)
Date:	Wednesday, March 18, 2026 3:54:21 PM
Attachments:	2026-03-17 Northlake Board of Supervisors Comments.pdf

Good afternoon.
The following correspondence is being forwarded for your attention and review.
Thank you!

Executive Office of the Board of Supervisors
Phone: (213) 974-1411 | Email: ExecutiveOffice@bos.lacounty.gov
Find us on Facebook, Instagram, LinkedIn, Twitter @ Youtube @LACountyBOS

From: Evan Levy <ELevy@biologicaldiversity.org>
Sent: Tuesday, March 17, 2026 4:16 PM
To: ExecutiveOffice <ExecutiveOffice@bos.lacounty.gov>
Cc: First District <firstdistrict@bos.lacounty.gov>; Holly J. Mitchell <HollyJMitchell@bos.lacounty.gov>; Third District <ThirdDistrict@bos.lacounty.gov>; Supervisor Janice Hahn (Fourth District) <fourthdistrict@bos.lacounty.gov>; Barger, Kathryn <Kathryn@bos.lacounty.gov>; Tiffany Yap <TYap@biologicaldiversity.org>
Subject: Appeal Comments – Northlake Specific Plan Project (SCH No. 2015031080)

Dear Members of the Los Angeles County Board of Supervisors:

Please find attached the Center for Biological Diversity's comment letter regarding the appeal of the Planning Commission's approval of the Northlake Specific Plan Project and certification of the Recirculated Partial Final Supplemental Environmental Impact Report (SCH No. 2015031080).

These comments are submitted in advance of the finalization of the agenda packet for the Board of Supervisors meeting on March 24th. Please include these comments in the agenda packet.

The references cited in the comment can be downloaded here.

Please confirm receipt of this comment letter and that you are able to download the references. The Center will be sending a hard copy with a USB drive with references via FedEx.

If you have any questions or need additional information, feel free to contact us.

Best,

Evan

On the side of life

Evan Levy (he/him)
Associate Attorney
Urban Wildlands Program
Center *for* Biological Diversity
510-844-7156
elevy@biologicaldiversity.org





March 17, 2026

Sent via email and FedEx, with reference via FTP

Los Angeles County Board of Supervisors
Kenneth Hahn Hall of Administration
500 West Temple Street
Room 383
Los Angeles, CA 90012
executiveoffice@bos.lacounty.gov

Re: Appeal of the Planning Commission's Approval of the Northlake Specific Plan Project (SCH No. 2015031080)

Dear Members of the Board of Supervisors:

These comments are submitted on behalf of the Center for Biological Diversity (the "Center") regarding the proposed Northlake Development ("Project"). On February 9, 2026, the Center appealed the Planning Commission's approval of the Project and certification of the Recirculated Partial Final Supplemental Environmental Impact Report ("RPFSEIR") based on violations of the California Environmental Quality Act ("CEQA") and the State Planning and Zoning Law ("SPZL"). This comment letter summarizes key deficiencies that the Center has identified throughout the public process, including failure to adequately analyze and mitigate the project's impacts to biological resources, wildfire risk, transportation, and greenhouse gas emissions; failure to properly evaluate alternatives under CEQA; and inconsistency with the County's General Plan in violation of the SPZL. In addition to this summary, this comment provides further evidence and analysis regarding the deficiencies of the EIR for the Project's impacts to Grasshopper Creek, western spadefoot toad, mountain lions, wildlife connectivity, California condors, and vehicle miles traveled.

The Board of Supervisors should not certify the RPFSEIR or approve the Project. Doing so would green-light the worst kind of housing sprawl—housing that would install a new community in immediate and direct risk of wildfire and force thousands of people to live car-dependent lifestyles. Such a problematic development is made worse because it would require the condemnation and impoundment of an ecologically unique blue-line stream and the severance of one of the County's most important wildlife corridors.

The Center is a non-profit, public interest environmental organization dedicated to the protection of native species and their habitats through science, policy, and environmental law. The Center has members and online activists throughout California and the United States. The Center has worked for many years to protect mountain lions, imperiled plants and wildlife, open space, air and water quality, and overall quality of life for people in Los Angeles County.

I. The Center Has Long Opposed the Northlake Development

The Center successfully challenged the County's approval of the prior Northlake project in Los Angeles County Superior Court. Judge Fruin found the 2018 Supplemental Environmental Impact Report violated CEQA in multiple respects in its ruling *Center For Biological Diversity and Endangered Habitats League v. County Of Los Angeles, et al, and Real Parties in Interest, Northlake Associate*s, et al, Case No. 19STCPO1610, dated January 11, 2021.

Judge Fruin found that the County had failed to consider a reasonable range of alternatives because none of the alternatives presented in the SEIR considered protecting Grasshopper Creek. The County's decision to forgo an alternative that protected this "regionally significant wildlife habitat" rendered the analysis "fatally flawed." (Judgment at 11-12.) The Court also held that the County did not support its baseline of western spadefoot toad ("WST") populations with substantial evidence because that baseline likely underestimated the population because all surveys had been conducted during drought years rather than normal and wet years. The Court also held that the County's mitigation for impacts to the WST was improperly deferred because the County planned to create new off-site habitat for toads without having located where that habitat would be, nor demonstrated that the toads would use the habitat once monitoring ceased. Additionally, the Court held that mitigation measures for rare plants were improperly deferred because off-site mitigation lands to receive rare plant transplants had not been identified, and the efficacy of the transplantation plan had not been proven.

Due to these glaring deficiencies in the SEIR, the Court ordered the County to set aside their approvals of the Northlake Specific Plan, associated parcel maps, and the project's conditional use permit. The Court also ordered the County to set aside their certification of the SEIR and the County's findings, statement of overriding considerations, and mitigation monitoring and reporting program prepared under CEQA. The Court ordered all physical work on the project to cease.

Northlake's new project fares no better than this previous project. As described in this comment and other comments, this project contains the same deficiencies identified by Judge Fruin as the prior project, as well as containing new deficiencies and failing to account for significant new information.

The Center submitted extensive comments on the Partial Recirculated Draft SEIR on May 29, 2025, which it incorporates and includes here as Exhibit A. This letter addressed, but was not limited to, the following concerns:

- CEQA does not allow the County to limit public comment only to the deficiencies identified by the Court;

- Significant new information on the severity of climate change required recirculation of the EIR to more aggressively mitigate the project's greenhouse gas ("GHG") impacts;

- This significant new information regarding climate change rendered the 2018 GHG analysis outdated;

- Significant new information demonstrating that climate change will decrease California's water supply required the County to recirculate the EIR to account for projected future water supply;

- Significant new information regarding mountain lions required recirculation of the EIR because, among other things, the EIR failed to consider the 2019 candidacy status of the Central Coast/Southern California Distinct Population Segment under the California Endangered Species Act ("CESA"); new scientific studies since the 2018 EIR demonstrate that mountain lions in the area are more threatened than previously thought; and that, due to findings from these studies and recordings of mountain lions near the project area from wildlife cameras, that the project will have more severe impacts to mountain lions than previously thought;

- Significant new information regarding the 2024 candidacy status of burrowing owls and evidence of their continued population decline required recirculation of the EIR;

- Significant new information has emerged regarding wildlife connectivity and the importance of the project site for connectivity in the broader region,

- Developing the project site would lead to more severe impacts to wildlife connectivity than previously thought;

- The EIR's wildfire risk analysis remained deficient because, among other things, it failed to adequately describe ignition risk caused by the Project, especially in light of the nearby Eaton, Palisades, and Hughes fires; implement all feasible measures to mitigate the Project's significant wildfire impacts; acknowledge and incorporate Traditional Ecological Knowledge on fire ecology; analyze the air quality impacts caused by potential wildfires caused by the Project; account for the increased burden on public fire-fighting services; reckon with the environmental justice impacts of wildfire;

- The EIR's analysis of WST remained deficient because, among other things, it continued to fail to provide an adequate baseline and failed to implement all feasible mitigation measures;

- The EIR's analysis of the number of Vehicle Miles Traveled ("VMT") caused by the Project was deficient because it used a baseline that was not supported by substantial evidence; failed to implement all feasible mitigation measures; and did not comply with the County's General Plan's policy to reduce VMT; and

- The EIR's alternatives analysis remained deficient because it incorrectly asserted that the Creek Avoidance Alternative would fail to meet the Project's objectives.

The Center submitted another comment letter on January 26, 2026 on the Recirculated Partial Final SEIR. The comment was submitted and received ahead of the January 28 Planning Commission meeting. The Center responded to the County's response to comments in the RPFSEIR, expanded on the deficiencies identified in its prior letter, and continued to identify additional deficiencies. The Center incorporates and includes these comments as Exhibit B. The issues raised it this letter included, but were not limited to:

- The County's arguments that issues beyond the deficiencies identified by the Court on the 2018 EIR were barred by collateral estoppel were flawed because the additional issues raised by the Center were due to significant new information, which CEQA explicitly anticipates and allows;

- The EIR failed to address the significant new information regarding mountain lions in the project area because the California Department of Fish and Wildlife ("CDFW") recommended the listing of the mountain lions in the project area as threatened under CESA in December 2025; a mountain lion was documented traveling through Grasshopper Creek; and new scientific information has emerged further verifying the importance of the project site for mountain lion movement;

- The Final SEIR continued to fail to sufficiently mitigate impacts to the WST; support the baseline for WST with substantial evidence; and adequately characterize the importance of the habitat on the Project site for WST;

- The Final SEIR continued to dismiss the wildfire impacts of the Project by failing to address the burden the Project would place on public wildfire services and failing to have an effective evacuation plan; concluding, without support from substantial evidence, that wildfire risks would not be significant; failing to respond to the Center's comments regarding the air quality impacts of wildfire smoke; ignoring the evidence that wildfires in the wildland-urban interface pose heightened risks to wildfire and low-income, minority communities; and failing to consider mitigation for wildfire insurance that may be difficult to procure for houses on the Project site;

- The Final SEIR's transportation impacts analysis remains deficient because it failed to implement all feasible mitigation measures, failed to support its VMT analysis with substantial evidence, and used an improper threshold of significance for VMT.

The Center also provided oral testimony regarding the Project's CEQA deficiencies at the January 28, 2026 Planning Commission meeting. The Center incorporates and includes these comments as Exhibit C.

Contrary to the County's responses to comments in its RPFSEIR, the doctrine of res judicata does not apply to this EIR. (See RPFSEIR at Response B.4-1.) Because this project is an entirely different project than the one that was approved in 2018, appellants can bring new claims against this Project, and is not limited to the deficiencies identified by Judge Fruin.

For example, the new project installs a massive "debris basin" upstream of the housing proposed for Phase 2. (RPDSEIR at Ex. 3.) This debris basin would create many new threats to Grasshopper Creek that were not part of the previous project, as well as threaten the communities below with rapid flooding should be debris basin fail. Additionally, the new project changes the number of units and types of zoning in both Phase 1 and Phase 2 compared to the previous project. (Compare RPFSEIR at Table 2-11 with Final SEIR at Table 4-3.) The new Project also changes the land use types at the southern end of the Project site, nearly eliminating all employment opportunities from the Project. This further intensifies the impacts associated with exurban sprawl compared to the previous projects because it would require residents to commute longer distances compared to the previous project. These are just some of the ways that the currently proposed project is an entirely different project from the previous project.

And even if the 2026 project is the same project as the 2018 project, there are many deficiencies under CEQA requiring recirculation of the EIR. All deficiencies identified by Judge Fruin are entirely challengeable, which means impacts to and mitigation for WST and rare plants, as well as the alternatives analysis.

II. The Project's Environmental Review Has Continuously Downplayed the Importance of the Project Site for Western Spadefoot

As described in the Center's previous comment letters, the proposed Project will destroy a large area of highly valuable western spadefoot habitat, much of which has been ignored in the Project's environmental review. (Exhibits A & B).

The Project site is extremely important for the southern population of western spadefoot. Western spadefoot in Southern California (south of the Transverse Ranges) are genetically distinct from western spadefoots in central and northern California (Neal et al., 2018). As detailed in a recent Center petition to list western spadefoot as threatened or endangered under CESA, the southern population has experienced more severe declines than the northern population (Prado-Irwin, 2025). The population present at the Project site lies at the northernmost extent of the southern western spadefoot population. If the western spadefoot population currently present at the Project site is lost, the range of the southern population will shrink, furthering the pattern of regional decline.

Many of the populations in and around the Project site, including populations in the Santa Clarita Valley, are highly fragmented and surrounded by roads and development. This urbanization and development reduces regional and local connectivity across the landscape, isolating these remaining populations. When isolated populations experience years with low reproductive success or become locally

extirpated, recovery is difficult to impossible because they no longer have adjacent subpopulations to boost the population or facilitate re-establishment. Therefore, urban development that destroys remaining habitat and continues to fragment dwindling spadefoot populations leads to higher risks of local and regional extinction (Neal et al., 2020).

Importantly, very little suitable habitat remains in Los Angeles County or surrounding counties (Rose et al., 2022), so fully protecting the habitat that remains—especially occupied habitat like that which occurs at the Project site—is essential. A habitat suitability model developed by Rose et al. 2022 shows the remaining suitable habitat for western spadefoot in Southern California, including Los Angeles County. As shown in Figure 1 (below), only scattered and small patches of potentially suitable habitat remain in western Los Angeles County in and around Santa Clarita, including the Project site (Rose et al., 2022).

A query of the California Natural Diversity Database shows current known occurrences of western spadefoot in LA County (Figure 2, below).[1] In the southern portion of the county, including the San Fernando Valley, all occurrences are surrounded by or directly adjacent to urban development. Of the 25 observations in this region of the county, one is extirpated and 16 are possibly extirpated, leaving only eight potentially extant occurrences in the entire region. In the northwestern portion of the county, including the Project site, nearly all western spadefoot occurrences are also surrounded by urban and suburban sprawl development around the city of Santa Clarita, and/or fragmented by roads or off-roading trails. The only occurrences that are present on undisturbed, unfragmented, and undeveloped land are those on the Project site. Additionally, of the 44 observations in this region, only eight are listed as having "excellent" or "good" condition, including the two observations on the Project site.

It is thus clear that the Project site represents the last large, core habitat for western spadefoot in the entire County. The intact habitat present at the Project site, the lack of suitable habitat in the rest of the County, and the site's position at the northern edge of the southern population's range make the Project site extremely important for local and regional persistence of western spadefoot.

Despite this, the Project's environmental review documents have consistently downplayed the importance of the Project site for western spadefoot. The analyses included in the environmental review focused only on vernal pools, a specific type of temporary pool. But western spadefoots can also breed in many other types of temporary water bodies, including ditches, erosion cuts, road ruts, and ephemeral streams (Baumberger et al., 2019; Stebbins, n.d.). Yet the Project's environmental review never included any systematic surveys for western spadefoot toads or for breeding pools outside of those that were previously identified in surveys for fairy shrimp habitat, which excludes any ephemeral water bodies that fairy shrimp cannot occupy but western spadefoot can. Suitable western spadefoot breeding pools could

[1] CNDDB Rarefind tool query for western spadefoot (*Spea hammondi*) in Los Angeles County conducted on 5 March 2026. Additional information about Rarefind can be found at: https://wildlife.ca.gov/Data/CNDDB/Maps-and-Data (Accessed 5 March 2026).

form in many geologic features throughout the Project site, including along small canyons or areas with sandstone erosion, along defunct access roads, and especially in the upstream areas of the ephemeral Grasshopper Creek that experience low and intermittent flows. Given the fact that western spadefoot occupy upland habitat up to 600 meters away from breeding pools (Halstead et al., 2021), if ponding features are present across more of the Project site than presented in the environmental review documents—which is likely given the landscape and the modeling presented in Rose at al. 2022—much of the Project site, potentially the *entire* Project site, would also present suitable upland habitat and could be occupied by western spadefoot.

The project's environmental review documents do not even consider this possibility. Further, the RPFSEIR failed to provide any detail on how much of the Project site was surveyed, in what seasons the surveys occurred, or what the climatic conditions of the site were during these surveys. It is therefore impossible to know the extent of the western spadefoot population on the Project site. It is entirely possible, even likely, that western spadefoot are much more common throughout the Project site than the RPFSEIR claims, in which case the impacts to this sensitive species from Project construction and operation will be catastrophic.

Western spadefoots have been extirpated from 80% of their range in Southern California (Stebbins & McGinnis, 2012; US Fish and Wildlife Service, 2005). In Southern California, western spadefoot populations have become extremely fragmented, and persistence of remaining subpopulations of is fragile (Halstead et al., 2021; Neal, 2019; Neal et al., 2020). Additionally, it is more important than ever to prioritize climate resiliency as both drought and extreme storms become more common in California (Diffenbaugh et al., 2015; Swain et al., 2018).

If the Project moves forward as planned, the County will lose its last remaining unfragmented and high-quality western spadefoot habitat, pushing local populations closer to extirpation and reducing the species' climate resilience. We urge the County not to approve this Project.

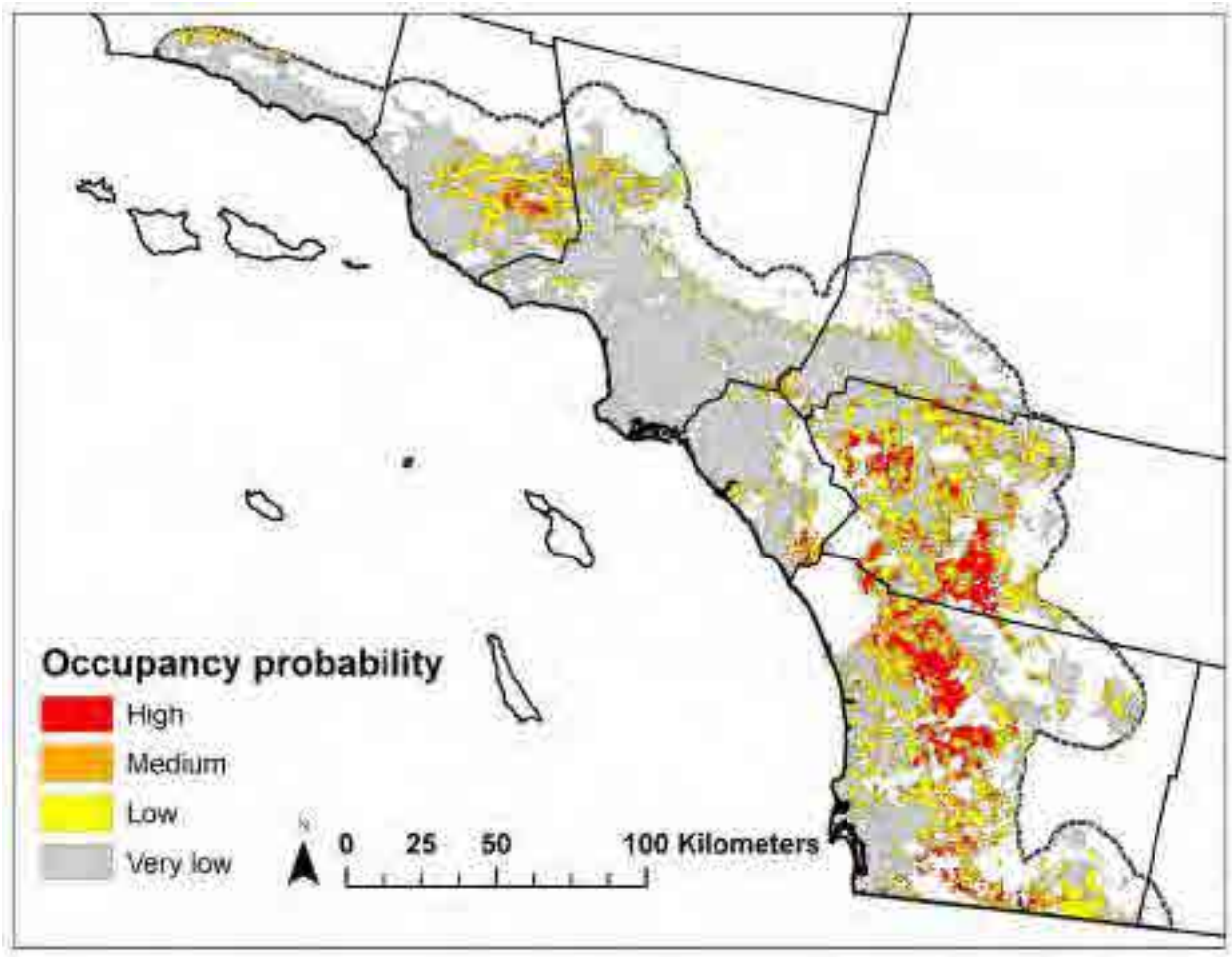


Figure 1. Suitable spadefoot habitat (represented as "occupancy probability") in southern California, including Los Angeles County. [Reproduction of Fig A6 from Rose et al. 2022: "Classification of spadefoot occupancy probability for areas in the southern range of the western spadefoot (Spea hammondii) that are currently unprotected by local, state, or federal government or non-governmental organizations. A very low occupancy classification corresponds to a predicted probability of spadefoot occurrence between 0 and 0.1; a low classification corresponds to a probability of spadefoot occurrence between 0.1 and 0.3; a medium classification corresponds to a probability of spadefoot occurrence between 0.3 and 0.5; a high classification corresponds to a probability of spadefoot occurrence ≥ 0.5."]


Lancaster
Palmdale
Santa Clarita
LOS ANGELES
Angeles National Forest
Simi Valley
Thousand Oaks
Rancho Cucamonga
El Monte
Los Angeles
Pomona
Santa Monica
Corona
Anaheim
Long Beach
Santa Ana
Huntington Beach
ORANGE
Mission Viejo



Figure 2. CNDDB occurrences of western spadefoot in Los Angeles County. Approximate Project site is marked with a red oval. A) Top photo includes the entire county. All occurrences in the southern portion of the county are surrounded by or adjacent to urban development. B) Bottom photo includes the Santa Clarita/Castaic Lake Area. Western spadefoot populations in this area are highly fragmented by urban development, suburban sprawl, roads, and off-road trails, except those on the Project site.

III. The Partial Creek Avoidance Alternative Fails to Adequately Analyze and Mitigate Devastating Impacts to Grasshopper Creek.

Ephemeral streams are critical components of many ecosystems, especially in the Mediterranean climate of California. Hydrological variability across space and time is the defining characteristic of ephemeral and intermittent streams (Godsey & Kirchner, 2014). They support aquatic ecosystems and riparian zones and play significant roles in numerous biogeochemical cycles. They also support unique biota that are not found in perennial waters—species that reside in ephemeral streams have adapted to intermittent flows, and the biological and ecological dynamics of ephemeral streams lead to different patterns of biodiversity compared to permanent rivers.

The biogeochemical cycles of these streams are also more variable than permanent rivers and streams. They serve as conduits for water, energy, material, and even species even when surface water is not present. They also move nutrients back and forth between the stream channel and the surrounding upland and floodplain areas.

They provide terrestrial and aquatic connectivity at the regional scale. Such connectivity is essential to drought resilience, especially in arid climates (Acuña et al., 2017).

Even when dry, ephemeral stream channels support diverse semi-aquatic and terrestrial communities, especially invertebrates. Dry channels also provide refuge for desiccation-resistant plant and animal (especially invertebrate) propagules, supporting biodiversity even as organisms remain dormant (Steward et al., 2012). Dry channels also provide habitat for many terrestrial vertebrates (Datry et al., 2018; Sánchez-Montoya et al., 2023; Steward et al., 2012).

The proposed Project will destroy a large portion of the primary ephemeral stream on the Project site, Grasshopper Creek. In response to the 2021 court order by Judge Fruin, the RPFSEIR included a revised alternatives analysis with a Creek Avoidance Alternative ("CAA") and a Partial Creek Avoidance Alternative ("PCAA"). However, the PCAA, which was approved by the Los Angeles County Regional Planning Commission on January 28, 2026, will have extremely significant impacts to Grasshopper Creek ("the creek") that have not been mitigated, despite the RPFSEIR's claims.

a. The PCAA Will Result in Complete Destruction of Grasshopper Creek.

While the PCAA claims to preserve the stretch of Grasshopper Creek in the Phase 2 area of the Project, this claim is completely false. As shown in Exhibit 3 of the RPDSEIR, and explained in CDFW's May 28, 2025 comment letter, the Project will transform Grasshopper Creek and its tributaries in the Phase 2 area into a debris basin and additional in-line water quality features. This amounts to destruction of the creek, not avoidance. As explained by CDFW, "The addition of urban runoff into ephemeral streams type converts them from ephemeral systems to intermittent or perennial systems. This changes the vegetation communities and hydrology, which allows invasive species such as Argentine ants, bullfrogs, crawfish, and invasive aquatic weeds to proliferate and damage the overall value of the surrounding habitat." (p. A.1-9).

The response to comments in the RPFSEIR does not dispute this fact. Instead, it simply states that "no further analysis is required" because "variations of an analyzed alternative do not need to be analyzed" and that there is "no rule or regulation that requires" debris basins and other in-line water quality features to be located outside of the stream, as CDFW recommends (RPFSEIR p. 2-9). However, even if no further *analysis* is required, it is extremely clear that additional *mitigation* is required, but the RPFSEIR fails to provide this.

Converting an ephemeral stream to a debris basin completely destroys that stream and represents an extremely large significant impact. The RPFSEIR fails to acknowledge this, and fails to require mitigation for this significant impact, in violation of CEQA. The RPDSEIR calls the alternative "the Partial Creek Avoidance Alternative" but this is a duplicitous misnomer – rather than avoiding the creek, the PCAA will destroy it. This minimization and misrepresentation of the true impacts of the Project

on Grasshopper Creek is egregious, irresponsible, inexcusable, and a clear violation of CEQA.

We concur with the recommendations made by CDFW that all water quality features must be located away from streams with a minimum 300-foot buffer, and any basins that may be continuously filled from urban runoff must be located a minimum 500 feet from any stream (A.1-8,9). The PCAA will not truly avoid impacts, even partially, unless these measures *at a minimum* are implemented. Additional mitigation for impacts to the remainder of the creek present in the Phase 1 area are also necessary, as described below, to reduce the Project's impacts to less than significant.

Buffer zones around aquatic habitats are essential to protect the high diversity of plants, fish, aquatic invertebrates, birds, amphibians, and reptiles that they support. Many species that rely on these aquatic habitats also rely on the adjacent upland habitats (*e.g.*, grassland habitat adjacent to wetlands). In fact, 60% of amphibian species, 16% of reptiles, 34% of birds and 12% of mammals in the Pacific Coast ecoregion depend on riparian-stream systems for survival (Kelsey & West, 1998). Many other species use riparian areas and natural ridgelines as migration corridors or foraging habitat (Dickson et al., 2005; Hilty & Merenlender, 2004; Jennings & Lewison, 2013; Jennings & Zeller, 2017). Larger buffer zones along streams and wetlands would provide more stream bank stabilization, water quality protection, groundwater recharge, and flood control both locally and throughout the watershed (Lovell & Sullivan, 2006; Nieswand et al., 1990; Norris, 1993; Sabater et al., 2000; Whipple Jr., 1993). Thus, to preserve the biodiversity in these habitats, it is important to develop and implement effective buffer widths. The 300-foot buffer proposed by CDFW in their May 28, 2025 comment letter should be the bare minimum; larger buffers should be implemented where possible. A literature review found that recommended buffers for wildlife often far exceeded 325 feet, well beyond the largest buffers implemented in practice (Fischer & Lindenmayer, 2000; Robins, 2002). The RPFSEIR not only fails to include effective buffers, it fails to avoid the stream itself, in gross contrast to the best available science.

b. The PCAA Fails to Adequately Mitigate Impacts to Grasshopper Creek.

As described above, implementation of the PCAA will result in the functional destruction of Grasshopper Creek throughout the entire Project footprint. In the Phase 1 area of the Project, the creek will be completely filled in. In the Phase 2 area of the Project, the creek will be fundamentally altered and effectively destroyed by the construction of a debris basin and other in-line water quality features within the creek itself.

While the PCAA fails to address the significant impacts to the creek in the Phase 2 area (as described above), the PCAA does acknowledge the significant impacts to the remainder of the creek present in the Phase 1 Project footprint. However, the RPFSEIR fails to fully mitigate these impacts.

As noted in CDFW's May 28, 2025 comment letter, "The proposed environmentally superior alternative, PCAA, would have similar impacts to the

previously approved Project. Therefore, the RPDSEIR does not entirely satisfy the avoidance of Grasshopper Creek and its potential associated species impacts." (p. A.1-7). In fact, the PCAA only prevents infill of the Creek in the smaller Phase 2 section of the Project and only reduces impacts to the stream by 20% compared to the initial Project, which included grading and filling of the entire Grasshopper Creek through the Project area (RPDSEIR, Appendix F1, p. 3). Significant impacts to the remaining length of the creek in the Phase 1 footprint will still occur, including the destruction via infill of the vast majority of Grasshopper Creek (RPDSEIR Exhibit 3; p. 2-89).

The RPDSEIR claims that this impact will be "reduced to less than significant levels with implementation of mitigation measures identified (and revised) above and in Draft SEIR Section 5.2, as applicable." (p. 2-89). However, the RPDSEIR does not actually include any mitigation measures for stream impacts "above," or anywhere else in the document. The only other mitigation measure in the RPDSEIR that is potentially relevant to Grasshopper Creek is the mitigation for southwestern spiny rush, a special status plant that is present throughout the creek (RPDSEIR p. 2-8, 2-36). This mitigation measure includes preservation of streambed habitat in Marple Canyon that contains southwestern spiny rush and the planting of new spiny rush on a different mitigation site. However, the RPDSEIR provides no detail on where Marple Canyon is (or even whether it is within the same watershed as the Project site), the type and condition of the stream present in Marple Canyon, how much of the stream would be preserved, or any other details. As such, this mitigation measure cannot be considered relevant for mitigating the impacts of stream destruction.

The mitigation measures included in Section 5.2 of the 2017 Draft SEIR ("2017 DSEIR") to which the RPDSEIR refers are also woefully insufficient to ensure less than significant impacts to Grasshopper Creek. First, the 2017 DSEIR fails to provide an environmental baseline regarding Grasshopper Creek. It fails to include any information on the length, acreage, or condition of the creek that will be destroyed as a result of the proposed Project, making it impossible to determine the extent of mitigation necessary or the sufficiency of the proposed mitigation. The 2017 DSEIR thus fails to establish a reliable baseline regarding Grasshopper Creek.

Under CEQA, an environmental review document must evaluate the potential environmental impacts of the project as compared to the existing environmental conditions (the "baseline"), so that the Project's impacts can be meaningfully analyzed and compared to alternatives. (CEQA Guidelines § 15125(a); see *County of Amador v. El Dorado County Water Agency* (1999) 76 Cal.App.4th 931, 952; *Neighbors for Smart Rail v. LA County Metropolitan Transit Authority* (2013) 57 Cal.4th 310, 315.) By failing to include information regarding the length, area, or condition of Grasshopper Creek throughout the Project footprint, the 2017 DSEIR has failed to accomplish this. Subsequent environmental documents (RPDSEIR, RPFSEIR) have not rectified this deficiency.

Second, the 2017 DSEIR also fails to provide adequate mitigation for impacts to Grasshopper Creek. The only mitigation measures in the 2017 DSEIR that may account for creek impacts are those that pertain to riparian areas (MM5.2-2, 5.2-3, and 5.2-11). However, it is unclear whether the 2017 DSEIR considers Grasshopper Creek to be

riparian. The creek is ephemeral, and the habitat in and around the creek bed may not be considered riparian; the 2017 DSEIR is not clear on this point. Based on Exhibit 5.2-1 and Table 5.2-1 (p. 5.2-5), it appears that the creek is not included in the defined riparian areas. If this is the case, and the creek is *not* considered riparian habitat, then the 2017 DSEIR essentially provides no mitigation for destruction of the creek, an egregious omission.

Allowing for the benefit of the doubt, even if Grasshopper Creek is considered riparian habitat, the mitigation measures provided in the 2017 DSEIR for impacts to riparian habitat are still insufficient. These mitigation measures include: MM5.2-2, which requires land acquisition to compensate for impacts to sensitive habitats including riparian areas (although no specific requirements regarding mitigation ratios are provided) (2017 DSEIR p. 5.2-42); MM 5.2-3, which lists several generic options for mitigating impacts to riparian habitat including on-site avoidance, habitat creation, or enhancement, or offsite habitat creation (2017 DSEIR p. 5.2-42); and MM5.2-11, which requires preservation, restoration, or enhancement of on- or off-site riparian vegetation at a minimum 2:1 ratio (2017 DSEIR p. 5.2-53). None of these mitigation measures provide any details on how they will be implemented, making it impossible to determine whether they can adequately address the significant impacts to Grasshopper Creek. The 2017 DSEIR fails to include the information necessary to understand the efficacy of these measures, including where compensatory mitigation land will be located, how many acres will be included, or how it will be protected. Instead, the 2017 DSEIR includes only generic requirements and various options, with no actual information on the environmental baseline, feasibility of mitigation, availability of mitigation lands, or important management considerations and success criteria. The 2017 DSEIR provides no justification for this lack of detail. Without any substantial information, concrete plans, or specific requirements, it is impossible to determine whether this plan will successfully mitigate impacts to lost creek habitat. The plan thus amounts to improperly deferred mitigation, which violates CEQA.

This improperly deferred mitigation for impacts to desert plants violates CEQA. (see *San Joaquin Raptor Rescue Center v. County of Merced* (2007) 149 Cal.App.4th 645, 670 [EIR inadequate where the success or failure of mitigation efforts "may largely depend upon management plans that have not yet been formulated, and have not been subject to analysis and review within the EIR"]). As courts have pointed out "[f]undamentally, the development of mitigation measures, as envisioned by CEQA, is not meant to be a bilateral negotiation between a project proponent and the lead agency after project approval, but rather, an open process that also involves other interested agencies and the public." (*Communities for a Better Environment v. City of Richmond*, 184 Cal. App. 4th 70, 93.) In the limited circumstances in which deferred mitigation is appropriate, the agency must meet all of the following elements: (1) practical considerations prevented the formulation of mitigation measures during the planning process; (2) the agency committed itself to developing mitigation measures in the future; (3) the agency adopted specific performance criteria prior to project approval; and (4) the EIR lists the mitigation measures to be considered, analyzed, and possibly incorporated into the mitigation plan. (See *POET, LLC v. State Air Resources Bd.* (2013) 218 Cal.App.4th 681, 736-37 [review denied].) Here, the DEIR fails to meet these

criteria and instead presents vague requirements with no guarantee of success, without justification—in violation of CEQA.

Additionally, the proposed mitigation in MM 5.2-11 requires only a 2:1 ratio for preservation, restoration, or enhancement of on- or off-site riparian vegetation. This low ratio is insufficient. Multiple scientific studies show the need for higher mitigation ratios (along with long-term monitoring, identified and measurable success criteria, and adaptive management strategies) to improve chances of adequately mitigating impacts to habitats and species (Matthews & Endress, 2008; Mitsch & Wilson, 1996; Moilanen et al., 2009; Stein et al., 2018; Sudol & Ambrose, 2002; Windmiller & Calhoun, 2007; Zedler & Callaway, 1999). Moilanen et al. (2009) found that "very high offset ratios may be needed to guarantee a robustly fair exchange" and that "considerations of uncertainty, correlated success/failure, and time discounting should be included in the determination of the offset ratio to avoid a significant risk that the exchange is unfavorable for conservation in the long run." This is especially true for created habitats.

If compensatory mitigation includes enhanced, restored, or created habitats, higher mitigation ratios coupled with extended years of effective monitoring and adaptive management strategies are needed to improve chances of establishing equivalent ecological function as the lost habitat (Ambrose et al., 2006; Bronner et al., 2013; Matthews & Endress, 2008; Moilanen et al., 2009; Stein et al., 2018; Sudol & Ambrose, 2002; Windmiller & Calhoun, 2007). Mitigation for aquatic resources like ephemeral streams should be at least 3:1 with in-kind preservation, 5:1 with restoration/enhancement, and 10:1 with created habitat. All mitigation (preservation, restoration/enhancement, creation of vernal pools and associated upland habitat for western spadefoots) should be protected in perpetuity, and the mitigation on these lands should include funded long-term monitoring, specified measurable success criteria, and adaptive management strategies. The preservation of high-quality ephemeral stream habitat in and near the Project area should be prioritized, and mitigation should be planned in a way that is protective from edge effects and fragmentation to improve the probability of ecologically functional mitigation. The proposed mitigation does not meet any of these standards and is therefore completely inadequate to mitigate for the destruction of Grasshopper Creek.

In summary, the proposed Project will completely destroy the entire length of Grasshopper Creek within the Project area, contrary to the stated purpose of the PCAA. The RPFSEIR fails to properly analyze or mitigate this highly significant impact, instead obfuscating the fact that the proposed Project will eliminate this important aquatic resource. The proposed Project violates CEQA and must be rejected and redesigned.

IV. The EIR Fails to Adequately Assess and Mitigate the Project's Impacts to Mountain Lions and Wildlife Connectivity.

As mentioned in the Center's January 26, 2026, letter, new information regarding the conservation status of local mountain lions has emerged since the Project was initially approved in 2018. In June 2019, the Center and the Mountain Lion Foundation submitted a petition to list Southern California and Central Coast mountain lions, which includes mountain lions in and near the Project area, under the California

Endangered Species Act (CESA) (Yap et al., 2019), and in April 2020 Southern California and Central Coast mountain lions were granted candidacy status. A CESA candidate species is afforded CESA protections while the California Department of Fish and Wildlife (CDFW) conducts a status review, which made local mountain lions provisionally listed in 2020. In December 2025, CDFW released their status review and recommended the Central Coast and Southern California distinct population segment (DPS) of mountain lions be listed as threatened under CESA (CDFW, 2025). And in the February 12, 2026 planning commission hearing, the California Fish and Game Commission voted unanimously to formalized the listing, determining that "listing the DPS is warranted due to threats such as habitat loss, habitat fragmentation and isolation of small populations as a result of expanding human infrastructure, among others" (CDFW, 2026).

These protections acknowledge the mounting scientific evidence that mountain lions in and near the Project area are at risk of spiraling towards extinction. According to former Acting Director, Valerie Termini, these mountain lions are "clearly at risk from distinct threats, habitat loss, fragmentation, roads, freeways, housing, mortality from vehicle strikes and rodenticides, and risks of isolation and inbreeding if left unmitigated" (CA Fish and Game Commission, 2026). These protections also acknowledge that we have the tools, knowledge, and the opportunity to prevent the DPS from becoming endangered or extinct. In discussing listing the DPS as threatened, Commissioner Murray poignantly pointed out that "CESA wasn't created just to protect species that are on the verge of blinking out with extinction. It's to give species a chance to bounce back before it's an absolute crisis, before it gets to that level of endangered" (CA Fish and Game Commission, 2026). Numerous scientific studies point to the need to protect existing connectivity and make existing barriers more permeable to improve gene flow and recover the DPS (e.g., Benson et al., 2019; Gustafson et al., 2022). Studies and surveys have repeatedly shown that wildlife crossings on roads can improve permeability for wildlife while reducing wildlife vehicle strikes (Kintsch et al., 2021). And as Commissioner Erika Zavaleta mentioned, "measures to stabilize puma populations, to address limited connectivity among them, to reduce the pace of habitat fragmentation and loss, and to improve habitat quality are all things that will also benefit other native wildlife and ecosystems" (CA Fish and Game Commission, 2026).

The Project area is located in the Sierra Pelona Mountains within the Sierra Madre-Castaic linkage, which CDFW has stated is "vitally important for restoring gene flow to southern California mountain lion populations" (CDFW, 2024). The Project is also located along a portion of the I-5 that CDFW has identified as Barrier W231: I-5 Sierra Madre to Castaic Ranges (CDFW, 2024). According to CDFW, this section of the I-5 is a roadkill hotspot and the department "aim[s] to expand and enhance existing infrastructure such as culverts and creek bridges, add new under/over-crossings and wildlife exclusion fencing. Removing barriers to wildlife movement across I-5 would reconnect extensive protected lands and provide measurable benefits to a wide diversity of natural communities and numerous native species" (CDFW, 2024). CDFW has also stated that mitigating the I-5 barrier in this area and conserving suitable habitat in the Sierra Pelona "should be considered high priorities" (CDFW, 2025). The proposed

Project will hamper and undermine CDFW's efforts to improve wildlife connectivity in the area.

At the January 28, 2026 Los Angeles County Planning Commission hearing, the Applicant stated that they "did a multi-month wildlife camera survey which indicated no wildlife movement on the property" and therefore they are "in no way impacting wildlife movement" (County of Los Angeles, 2026). When questioned further, the Applicant stated their wildlife cameras "didn't pick up anything," arguing that two culverts near the Project area are located where the I-5 splits and stating that "if [animals] go under [they] will get stuck between two freeways. So there was good reason we didn't find anything there" (County of Los Angeles, 2026). However, the Applicant fails to provide any evidence to support such claims. Indeed, these claims are contradicted by a 2018 memo provided by the County in a Public Records Act Request by the Mountains Recreation and Conservation Authority (MRCA) in which the County consultant clearly states that mule deer, coyote, bobcat, and gray fox were detected in the Project area (Glenn Lukos Associates, 2018). In addition, the County admits that no wildlife movement studies have occurred since the 2018 EIR. In response to MRCA's Public Records Act request, the County responded "No wildlife studies have occurred since the litigation was filed and none were done with the RPDSEIR. Therefore, any/all responsive information will be in the admin record." (See Exhibit D).

Ongoing mountain lion and wildlife connectivity studies demonstrate that mountain lions and other wildlife are moving in and around the Project area, contrary to the Applicant's assertions. The UC Davis California Carnivore Program began attempting mountain lion captures in the Sierra Madre-Castaic linkage south of SR 138 in January 2026 as part of their ongoing study: *Understanding ecological and human-related factors affecting felid movement in a critical wildlife linkage.* Researchers have collared three individuals so far, and they have documented mountain lion movement near the Project area on the west side of I-5 (Figure 3). Although researchers have yet to collar mountain lions on the east side of I-5, a habitat suitability model derived from previously collared mountain lions in the region indicates that there is high habitat suitability for mountain lions in and around the Project area (Figure 4).

These data indicate the presence of important live-in and move-through habitat for mountain lions in and near the Project area, and they highlight how critical the culverts and crossings near the Project area are for the persistence of the Central Coast and Southern California mountain lion DPS.

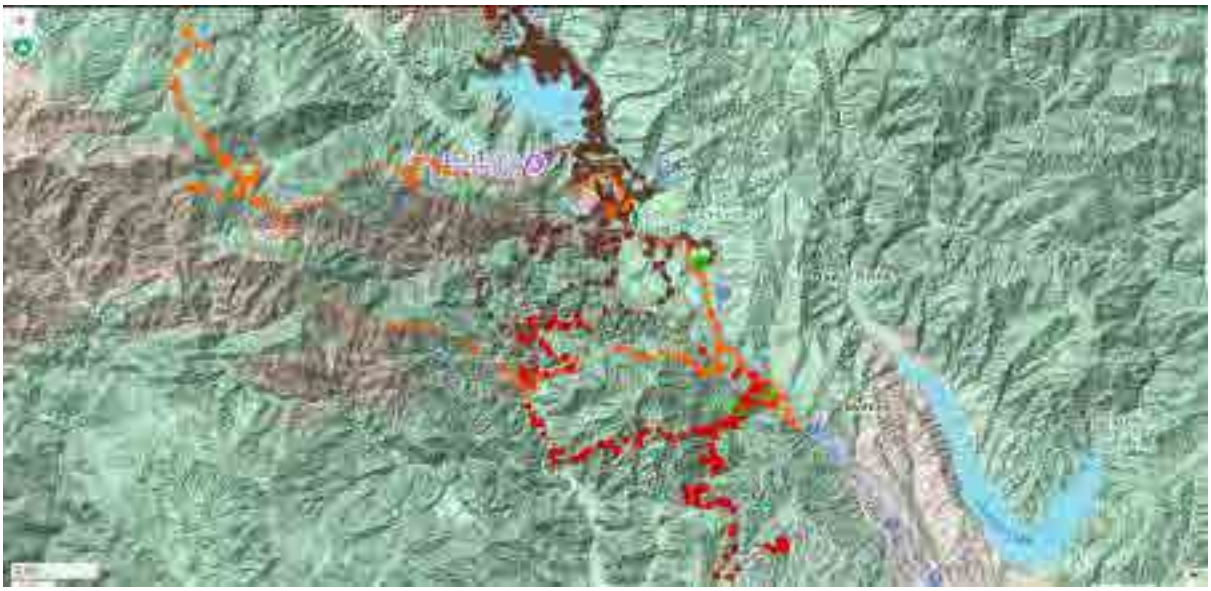


Figure 3. GPS collar data from the last four weeks of three mountain lions that have been collared by the UC Davis California Carnivore Program.



Figure 4. Mountain lion habitat suitability in the region. Darker green indicates high suitability. The model was created by the UC Davis California Carnivore Program researchers and is derived from habitat use and movement data for mountain lions they previously collared in the region.

Furthermore, between April 3, 2020 and November 30, 2025, the Mountains Recreation and Conservation Authority (MRCA) documented a wide variety of wildlife (including a mountain lion) using one of the culverts referenced by the Applicant at the January 28, 2026 Los Angeles County Planning Commission hearing (Christensen, 2026). These data were collected as part of a larger, state-funded effort to improve connectivity in the area. As mentioned in MRCA's January 26, 2026 letter, the Wildlife Conservation Board (WCB) funded MRCA's Marple Canyon I-5 Wildlife Crossing Enhancement Project. In addition to the wildlife camera surveys, this project included the removal of invasive plants and the establishment of native plants that "will provide shade, cover, and forage for wildlife attempting to cross I-5 between Marple and Grasshopper Canyons" (Christensen, 2026).

MRCA is leading an ongoing, WCB-funded, multi-agency effort to assess wildlife connectivity along 26 miles of the I-5 between SR 138 and SR 126 called the *Interstate 5 (Sierra Madre-Castaic) Wildlife Crossing Infrastructure Assessment and Implementation Plan*. The project is being conducted in coordination with the California Department of Transportation (Caltrans), CDFW, and the U.S. Geological Survey, as well as other partner organizations. Since their wildlife cameras were set up along I-5 in December 2025, the project team has documented numerous species using the culverts and crossings and moving through the area, including at least one mountain lion, a bear, coyotes, bobcats, and deer (see the Center's January 26, 2026 letter; Christensen, 2026; Penrod, 2026).

These data from previous and ongoing studies in the region highlight the importance of the Project area and the nearby culverts on I-5 as live-in and move-through habitat for mountain lions and other wildlife. Numerous state agencies have acknowledged the area's importance for mountain lions and wildlife connectivity, including CDFW and Caltrans. And state funding has been dedicated to enhancing connectivity in the region. Placing a large development like the proposed Project in this critical wildlife connectivity area adjacent to a culvert that is known to support wildlife movement across an existing barrier could have significant negative impacts to Central Coast and Southern California mountain lions and other wildlife. The proposed Project would also undermine previous and ongoing efforts by the state, UC Davis, and MRCA and their partner organizations to improve wildlife connectivity along I-5, and ultimately, the Sierra Madre-Castaic linkage.

This new and significant information regarding the conservation status of local mountain lions and the increasing threats they face, the movement of at least one mountain lion adjacent to the Project area, and the importance of the existing wildlife connectivity in and near the Project area has become available since the EIR was certified in 2018. As mentioned in the Center's January 26, 2026 letter, the California Environmental Quality Act ("CEQA") states that a subsequent or supplemental EIR may be required when either (1) substantial changes occur with respect to the circumstances under which the project is being undertaken which will require major revisions in the environmental impact report or (2) new information, which was not known and could not have been known at the time the environmental impact report was certified as complete, becomes available. (Pub. Res. Code § 21166.) There is clear evidence

regarding mountain lions and wildlife connectivity that falls into both categories. In disregarding new analyses of the Project's impacts to mountain lions and wildlife connectivity, the EIR fails to comply with CEQA.

V. The EIR Should Thoroughly Analyze and Mitigate Potential Impacts to Federally Endangered California Condor.

Recent documentation of the federally endangered California condor just north of the Project Area indicates that the species is likely using the Project area as foraging habitat. For example, from January through August 2025, wildlife photographer Shannon Sommer documented 27 individuals on Old Ridge Route, south of Templin Highway and just north of the Project area (Figure 5). In addition, numerous sightings in the same location have been documented on eBird since at least 2018.[2] Given that California condor sanctuaries and core habitat are located nearby at Sespe Condor Sanctuary, Hopper Mountain National Wildlife Refuge, and Bitter Creek National Wildlife Refuge, it is critical the EIR thoroughly analyze and mitigate the Project's impacts to this federally endangered species.



Figure 5. Heat map of California condor sightings by wildlife photographer, Shannon Sommer. These data include 119 sightings of 27 individuals from January to August, 2025 immediately north of the Project Area.

California condors barely escaped extinction with as few as 22 individuals in 1982. Fortunately, management and recovery efforts have been improving their

[2] eBird checklists from the following years (all accessed March 17, 2026):
2018: https://ebird.org/checklist/S45830914
2020: https://ebird.org/checklist/S71368370, https://ebird.org/checklist/S71406351
2024: https://ebird.org/checklist/S184816846
2026: https://ebird.org/hotspot/L43716330/bird-list

outlook, with captive breeding and wild release programs bringing wild California condor numbers up throughout the state. In 2022, the National Park Service reported 347 condors in the wild, with 89 in the local Southern California flock. (National Park Service, 2023). Importantly, although management and reintroduction have been successful and the species has been rebounding, California condors have not returned to their expansive historical ranges or numbers. For the species to recover, it is critical that they can continue to expand their range and grow their flocks. Therefore, condors need ample habitat for foraging and nesting.

Although the 2017 EIR acknowledges that the Project area has potentially suitable foraging habitat for California condors, the 2017 EIR also states that foraging is "not expected to occur" in the Project area without providing substantial evidence to support such claims. (2017 EIR at 5.2-37). Given that California condors have been repeatedly documented landing just north of the Project area in recent years, the EIR fails to thoroughly discuss or analyze the Project's direct and indirect impacts to these endangered species.

California condors still face numerous threats to their recovery and survival. Loss of potential foraging habitat and indirect impacts through increased human infrastructure and activities in and near the Project area could have a significant impact on this species. The proposed Project would place more roads and powerlines on the landscape, which could lead to increases in vehicle strikes (as condors could be attracted to additional roadkill) and electrocution from power lines. Other threats include lead poisoning and consumption of litter and microtrash. Shannon Sommer's photographs demonstrate that condors will forage through garbage left on the side of Ridge Road nearby. Introducing over 3,000 people—along with all their trash—into the project site has the potential to similarly threaten condors by attracting them to unnatural and dangerous food sources. The EIR should more thoroughly analyze and mitigate the Project's impacts to this iconic species.

VI. The Project is Inconsistent with the State Planning and Zoning Law

The Northlake Project also violates the State Planning and Zoning Law because it is inconsistent with the County's General Plan in many respects. As explained in the Center's May 29, 2025 letter, the Project does not decrease vehicle miles traveled, in conflict with the mandatory Policy LU 5.3. That letter also details how the RPDSEIR fails to adequately explain the Project's consistency with other General Plan policies. (Exhibit A at 17.) The Project also impermissibly relies on the outdated 1992 Northlake Specific Plan and the 1980 General Plan. (Exhibit A at 16.)

The RPFSEIR fails to discuss inconsistencies with the updated General Plan elements, such as the 2022 Guiding Principles and 2025 Land Use Element; and South Coast Association of Government's 2024 Regional Transportation Plan. (Los Angeles County, 2022, 2025; South Coast Association of Governments, 2024)CEQA requires projects to discuss any inconsistencies with plans such as these. The State Planning and Zoning Law also requires consistency with mandatory General Plan policies.

VII. Northlake's Sprawling Development is Against California's Public Policy

This Project would go against California's public policy of decreasing exurban sprawl and increasing urban infill. Sprawl has long-term negative impacts compared to infill, such as increasing living costs, public services costs, vehicles miles traveled, time spent commuting, and air pollution.

The California Air Resources Board's ("CARB") 2022 Scoping Plan, which lays the path for California's goal of carbon neutrality, identified VMT reduction as one of three key GHG reduction strategies for local jurisdictions. (2022 Scoping Plan - Appendix D: Local Actions, 2022). CARB recognized that a central way to decrease VMT is building dense housing in infill locations. (CARB, 2022b; Scoping Plan Appendix E - Sustainable and Equitable Communities, 2022). Building in infill locations brings the state closer to net zero because it greatly reduces residents' reliance on carbon-intensive passenger vehicles. (Boarnet, 2025). Building "transit-oriented development," or housing within a half mile of high-quality mass transit, can reduce VMT by 40% and reduce the number of people relying on cars by up to 90%. (Barbour, 2025; Jamey Volker, 2025).

Though densification is crucial, CARB has lamented that "[w]hile some progress on VMT reduction has been observed in [regions like LA], it has not been enough." (CARB, 2022a, p. iii). This meager progress means that the LA region is failing to reduce its GHG per capita fast enough to hit the targets identified by SB375, the Sustainable Communities Program. (CARB, 2022a). This Project would set the LA region even further back from VMT and GHG reduction goals by building housing far away from any existing services.

Sprawl is not only bad for the climate: it is expensive. Sprawl developments burden regional taxpayers with increased public infrastructure cost, increasing public costs by up to $500 per resident per year. (Litman, 2015). Over the entire project, this would amount to a public subsidy of $1.5 million per year for the project. In contrast, infill development can reduce overall transportation and infrastructure costs by half, amounting to $10,000 per year per resident. (Litman, 2015, p. 42). Infill development in California can also save people over an hour in commute times every day, leaving more time for working people to spend with their families. (Elkind et al., 2017). For more examples and evidence of the perils of sprawl, please refer to the Center's 2024 report, The True Cost of Sprawl. (Reid-Wainscoat et al., 2024).

The sprawl that would be created by this Project is reflective of the early 1990s when it was first proposed. Since then, California has disavowed such development for its serious climate risks and increased infrastructure costs. The County should follow the state's lead and deny this outdated project.

Sincerely,



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References

Acuña, V., Hunter, M., & Ruhí, A. (2017). Managing temporary streams and rivers as unique rather than second-class ecosystems. *Biological Conservation, 211*, 12–19. https://doi.org/10.1016/j.biocon.2016.12.025

Ambrose, R. F., Callaway, J. C., & Lee, S. F. (2006). *An Evaluation of Compensatory Mitigation Projects Permitted Under Clean Water Act Section 401 by the California State Water Quality Control Board, 1991-2002*.

Baumberger, K. L., Eitzel, M. V., Kirby, M. E., & Horn, M. H. (2019). Movement and habitat selection of the western spadefoot (Spea hammondii) in southern California. *PLoS ONE, 14*(10), 1–16.

Benson, J. F., Mahoney, P. J., Vickers, T. W., Sikich, J. A., Beier, P., Riley, S. P. D., Ernest, H. B., & Boyce, W. M. (2019). Extinction vortex dynamics of top predators isolated by urbanization. *Ecological Applications, 29*(3), e01868–e01868.

Bronner, C. E., Bartlett, A. M., Whiteway, S. L., Lambert, D. C., Bennett, S. J., & Rabideau, A. J. (2013). An Assessment of U.S. Stream Compensatory Mitigation Policy: Necessary Changes to Protect Ecosystem Functions and Services. *Journal of the American Water Resources Association, 49*(2), 449–462.

CA Fish and Game Commission. (2026). *California Fish and Game Commission February 12, 2026 hearing transcript*. CA Fish and Game Commission.

CDFW. (2024). *CDFW Region 5 Barrier ID W231: I-5 Sierra Madre to Castaic Ranges*. California Department of Fish and Wildlife.

CDFW. (2025). *A Status Review of the Petitioned Southern California/Central Coast Evolutionarily Significant Unit (ESU) of Mountain Lion (Puma concolor cougar) in California*. California Department of Fish and Wildlife.

CDFW. (2026, February 20). California Fish and Game Commission Finds CESA Protections Warranted for Southern California and Central Coast Mountain Lion. *CDFW News*.

Christensen, C. (2026). *Recirculated Partial Final Supplemental Environmental Impact Report for the Northlake Phase 1 Project No. R2015-00408, etc., Not in Compliance with CEQA*. Mountains and Recreation Authority.

Datry, T., Boulton, A. J., Bonada, N., Fritz, K., Leigh, C., Sauquet, E., Tockner, K., Hugueny, B., & Dahm, C. N. (2018). Flow intermittence and ecosystem services in rivers of the Anthropocene. *Journal of Applied Ecology*, *55*(1), 353–364.

Dickson, B. G., Jennes, J. S., & Beier, P. (2005). Influence of Vegetation, Topography, and Roads on Cougar Movement in Southern California. *Journal of Wildlife Management*, *69*(1), 264–276.

Diffenbaugh, N. S., Swain, D. L., & Touma, D. (2015). Anthropogenic warming has increased drought risk in California. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(13), 3931–3936.

Elkind, E. N., Carol Galante, Karen Chapple, Amy Martin, Marilee Hanson, & Nathaniel. (2017). *Right Type Right Place*. Terner Center.

Fischer, J., & Lindenmayer, D. B. (2000). An assessment of the published results of animal relocations. *Biological Conservation*, *96*(1), 1–11. https://doi.org/10.1016/S0006-3207(00)00048-3

Godsey, S. E., & Kirchner, J. W. (2014). Dynamic, discontinuous stream networks: Hydrologically driven variations in active drainage density, flowing channels and stream order. *Hydrological Processes*, *28*(23), 5791–5803.

Gustafson, K. D., Gagne, R. B., Buchalski, M. R., Vickers, T. W., Riley, S. P. D., Sikich, J. A., Rudd, J. L., Dellinger, J. A., LaCava, M. E. F., & Ernest, H. B. (2022). Multi-population puma connectivity could restore genomic diversity to at-risk coastal populations in California. *Evolutionary Applications*, *15*(2), 286–299. https://doi.org/10.1111/eva.13341

Halstead, B. J., Baumberger, K. L., Backlin, A. R., Kleeman, P. M., Wong, M. N., Gallegos, E. A., Rose, J. P., & Fisher, R. N. (2021). Conservation implications of spatiotemporal variation in the terrestrial ecology of western spadefoots. *Journal of Wildlife Management*, *85*(7), 1377–1393.

Hilty, J. A., & Merenlender, A. M. (2004). Use of Riparian Corridors and Vineyards by Mammalian Predators in Northern California. *Conservation Biology*, *18*(1), 126–135.

Jennings, M., & Lewison, R. (2013). *Planning for Connectivity Under Climate Change: Using Bobcat Movement To Assess Landscape Connectivity Across San Diego County's Open Space*.

Jennings, M., & Zeller, K. (2017). *Comprehensive Multi-species Connectivity Assessment and Planning for the Highway 67 Region of San Diego County, California*.

Kelsey, K. A., & West, S. D. (1998). Chapter 10: Riparian Wildlife. In *River Ecology and Management: Lessons from the Pacific Coastal Ecoregion*. Springer Science & Business Media.

Kintsch, J., Cramer, P., Singer, P., & Cowardin, M. (2021). *State Highway 9 Wildlife Crossings Mitigation Monitoring* (Issue March). https://www.codot.gov/programs/research/pdfs/2021-research-reports/state-highway-9-wildlife-mitigation-monitoring/cdot-2021-01.pdf

Los Angeles County. (2022). *Guiding Principles*.

Los Angeles County. (2025). *Land Use Element*.

Lovell, S. T., & Sullivan, W. C. (2006). Environmental benefits of conservation buffers in the United States: Evidence, promise, and open questions. *Agriculture, Ecosystems and Environment*, *112*(4), 249–260.

Matthews, J. W., & Endress, A. G. (2008). Performance criteria, compliance success, and vegetation development in compensatory mitigation wetlands. *Environmental Management*, *41*(1), 130–141.

Mitsch, W. J., & Wilson, R. F. (1996). Improving the success of wetland creation and restoration with know-how, time, and self-design. *Ecological Applications*, *6*(1), 16–17.

Moilanen, A., Van Teeffelen, A. J. A., Ben-Haim, Y., & Ferrier, S. (2009). How much compensation is enough? A framework for incorporating uncertainty and time discounting when calculating offset ratios for impacted habitat. *Restoration Ecology*, *17*(4), 470–478.

National Park Service. (2023). *Understanding and Managing Condors*. https://www.nps.gov/subjects/condors/understandingcondors.htm

Neal, K. M. (2019). *An Integrative Population and Landscape Genomic Approach to Conservation of a Threatened California Amphibian at Multiple Spatial Scales*. University of California Los Angeles.

Neal, K. M., Fisher, R. N., Mitrovich, M. J., & Shaffer, H. B. (2020). Conservation Genomics of the Threatened Western Spadefoot, *Spea hammondii*, in Urbanized Southern California. *Journal of Heredity*, *111*(7), 613–627.

Neal, K. M., Johnson, B. B., & Shaffer, H. B. (2018). Genetic structure and environmental niche modeling confirm two evolutionary and conservation units within the western spadefoot (Spea hammondii). *Conservation Genetics*.

Nieswand, G. H., Hordon, R. M., Shelton, T. B., Chavooshian, B. B., & Blarr, S. (1990). Buffer strips to protect water supply reservoirs: A model and recommendations. *Journal of the American Water Resources Association*, *26*(6), 959–966.

Norris, V. (1993). Review Article: The use of buffer zones to protect water quality: A review. *Water Resources Management*, *7*(4), 257–272.

Penrod, K. (2026). *Comments Northlake Recirculated Partial Final Supplemental EIR*. SC Wildlands.

Prado-Irwin, S. (2025). *Petition to list the northern and southern populations of western spadefoot (Spea hammondii) as threatened and endangered, respectively, under the California Endangered Species Act*. Center for Biological Diversity.

Robins, J. D. (2002, October 18). *Stream setback technical memo.* Jones & Stokes.

Rose, J. P., Halstead, B. J., Packard, R. H., & Fisher, R. N. (2022). Projecting the remaining habitat for the western spadefoot (Spea hammondii) in heavily urbanized southern California. *Global Ecology and Conservation*, *33*, e01944.

Sabater, F., Butturini, A., Marti, E., Munoz, I., Romani, A., Wray, J., & Sabater, S. (2000). Effects of riparian vegetation removal on nutrient retention in a Mediterranean stream. *Journal of the North American Benthological Society*, *19*(4), 609–620.

Sánchez-Montoya, M. M., Datry, T., Ruhi, A., Carlson, S. M., Corti, R., & Tockner, K. (2023). Intermittent rivers and ephemeral streams are pivotal corridors for aquatic and terrestrial animals. *BioScience*, *73*(4), 291–301. https://doi.org/10.1093/biosci/biad004

South Coast Association of Governments. (2024). *Regional Transportation Plan*.

Stebbins, R. C. (n.d.). *Western Reptiles and Amphibians* (3rd edition). Houghton Mifflin Company.

Stebbins, R. C., & McGinnis, S. M. (2012). Western spadefoot (Spea hammondii). In *Field Guide to Amphibians and Reptiles of California* (Revised edition, pp. 156–158). University of California Press.

Stein, B. A., Edelson, N., Anderson, L., Kanter, J. J., & Stemler, J. (2018). *Reversing America's Wildlife Crisis* (Issue March).

Steward, A. L., Von Schiller, D., Tockner, K., Marshall, J. C., & Bunn, S. E. (2012). When the river runs dry: Human and ecological values of dry riverbeds. *Frontiers in Ecology and the Environment*, *10*(4), 202–209. https://doi.org/10.1890/110136

Sudol, M. F., & Ambrose, R. F. (2002). The US Clean Water Act and habitat replacement: Evaluation of mitigation sites in Orange County, California, USA. *Environmental Management*, *30*(5), 727–734.

Swain, D. L., Langenbrunner, B., Neelin, J. D., & Hall, A. (2018). Increasing precipitation volatility in twenty-first-century California. *Nature Climate Change*, *8*(5), 427–433. https://doi.org/10.1038/s41558-018-0140-y

US Fish and Wildlife Service. (2005). *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon*.

Whipple Jr., W. (1993). Buffer zones around water-supply reservoirs. *Journal of Water Resources Planning and Management*, *119*(4), 495–499.

Windmiller, B., & Calhoun, A. (2007). Conserving Vernal Pool Wildlife in Urbanizing Landscapes. In *Science and Conservation of Vernal Pools in Northeastern North America* (pp. 233–251).

Yap, T. A., Rose, J. P., & Cummings, B. (2019). *A Petition to List the Southern California/Central Coast Evolutionarily Significant Unit (ESU) of Mountain Lions as Threatened under the California Endangered Species Act (CESA)*.

Zedler, J. B., & Callaway, J. C. (1999). Tracking wetland restoration: Do mitigation sites follow desired trajectories? *Restoration Ecology*, *7*(1), 69–73.

Exhibit A

May 29, 2025

Sent via email

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Re: Comments on the Partial Recirculated Draft Supplemental Environmental Impact Report NorthLake Specific Plan (State Clearinghouse No. 2015031080)

Dear Jodie Sackett:

This letter is submitted on behalf of the Center for Biological Diversity ("Center") regarding the Partial Recirculated Draft Supplemental Environmental Impact Report ("PRDSEIR") for the NorthLake Specific Plan ("Project") (State Clearinghouse No. 2015031080.) As you are aware, the Center successfully challenged this Project in 2019. As a result of that lawsuit, the Court ordered Los Angeles County ("County") to set aside its approval of the Project and decertify the 2018 Supplemental EIR ("2018 EIR" or "SEIR"). This PRDSEIR revises parts of the biological resources analysis, the VMT analysis, and the alternatives analysis in the County's next attempt to circulate a legally compliant EIR. But the revised EIR sections are still not adequate, and the sections that the County did not revise are seven years old and now must be updated to account for significant new information. The County must revise and recirculate a complete EIR that fully analyzes and mitigates the Project's impacts.

The Center is a non-profit, public interest environmental organization dedicated to the protection of native species and their habitats through science, policy, and environmental law. The Center has over 1.7 million members and online activists throughout California and the United States. The Center has worked for many years to protect imperiled plants and wildlife, open space, air and water quality, and overall quality of life for people throughout Los Angeles County.

I. THE COUNTY CANNOT LIMIT PUBLIC COMMENT TO THE REVISED PORTIONS OF THE EIR.

As a preliminary matter, the County cannot limit public comment to only the Recirculated Portions of the Draft EIR. Where an agency's actions violate CEQA, "it must do the environmental review process over if it wants to approve the project." (*Woodward Park Homeowners Assn., Inc. v. City of Fresno* (2007) 150 Cal.App.4th 683, 690.) Because the *entire* EIR was decertified in 2021, the County will need to again certify the completion of the revised EIR *as a whole*, not only the PRDSEIR's revised sections. (Guidelines § 21100.) If the County plans to recertify the entire EIR, it must follow the legal procedures to do so. Accordingly, before approving the Project, the County must prepare and circulate for public review a revised EIR that complies with CEQA. (*See, e.g., King & Gardiner Farms, LLC v. County of Kern* (2020) 45 Cal.App.5th 814, 901 [where EIR inadequate, County must revise EIR, circulate it for public review and comment, and prepare responses to the comments before reapproving same or modified project].). Any revised draft EIR must comply with CEQA's mandatory requirements for public review, including completing and filing with the State Clearinghouse, providing a 45-day comment period, and consulting with public agencies. (Guidelines §§ 15082-88, 15105.) The County must also consider and respond in detail to the public's comments. (*See* § 21091(d) [requiring agency responses to comments on draft EIRs]; Guidelines § 15088(c) [requiring "good faith, reasoned analysis" in responses]); (*Ukiah Citizens for Safety First v. City of Ukiah* (2016) 248 Cal.App.4th 256, 266-67 ["recirculation and consideration of public comments" necessary before revised project approval].)

Moreover, as a matter of policy, nothing limits the County to correcting only the flaws the court identified. All modified projects such as this require revised environmental analysis, and any CEQA document must reflect the County's "independent judgment." (Guidelines §§ 21082.1 & 15090.) The County should take this opportunity to hear from the public on all project aspects and ensure that the Project complies with its policies and intentions for its citizens now, in 2025. And the County should ensure that environmental review contains the analysis needed to allow the public and decisionmakers to understand environmental consequences of the Project and fully comply with CEQA. Restricting the public's ability to comment on the 2018 EIR circumvents CEQA's core purposes to allow for public input on projects. (Pub. Res. Code § 21061.) Accordingly, the Center incorporates here via reference its June 15, 2017, April 16, 2018, April 1, 2019, and December 22, 2020 letters on the previously circulated SEIR. (Exhibits A, B, C, and D).

II. SIGNIFICANT NEW INFORMATION REQUIRES THE COUNTY TO REVISE AND RECIRCULATE NUMEROUS OTHER SECTIONS OF THE 2018 EIR.

CEQA makes plain that significant new information on a project prior to EIR certification requires revision and recirculation for public review. (Pub. Res. Code § 21092.1; CEQA Guidelines § 15088.5(a).) CEQA specifically provides that a supplemental EIR is required when "[n]ew information, which was not known and could not have been known at the time the environmental impact report was certified as complete, becomes available." (Pub. Res. Code § 21166(c).) CEQA defines significant new information as information showing: (1) "[a] new significant environmental impact would result from the project . . ."; or (2) "[a] substantial increase in the severity of an environmental impact would result unless mitigation measures are adopted that reduce the impact to a level of insignificance." (CEQA Guidelines § 15088.5(a).) Additionally, CEQA requires a revised EIR when "substantial changes occur with respect to the circumstances under which the project is being undertaken which will require major revisions in the environmental impact report." (Pub. Res. Code § 21166(b).)

In this instance, the original EIR was certified in 2018 and entirely decertified in 2021. In the seven years since, significant new information has emerged regarding the Project's wildfire risk, climate change impacts, and uncertain water supply. Not only have multiple devastating wildfire seasons changed our understanding of wildfire risk, but groundbreaking climate change research has emerged, California has committed to new ambitious climate targets, and the state's water regime has dramatically shifted towards both extreme drought and flooding. The County must take into account significant new information on all Project impacts and revise and recirculate the EIR before certification. (CEQA Guidelines § 15088.5(a).)

A. The County Must Revise the EIR to Consider New Scientific Knowledge and State Policy on Climate Change.

Substantial new information on the severity of the Project's contributions to climate change has become available in the past seven years. Not only has California set new GHG reduction targets, but groundbreaking climate change research sheds light on the critical need to reduce GHG emissions further than the EIR proposes. The County must take this significant information into account and require further mitigation measures aligned with statewide goals.

i. Substantial New Information on Climate Change Impacts Requires Revision.

First, since the County certified the original 2018 EIR, the Intergovernmental Panel on Climate Change (IPCC), the leading international scientific body for the assessment of climate change, concluded in its 2023 Sixth Assessment Report that: "[u]nsustainable and unequal energy and land use as well as more than a century of burning fossil fuels have unequivocally caused global warming, with global surface temperature reaching 1.1°C above 1850-1900 in 2011-2020." (IPCC, 2023) The increase in global surface temperature has resulted in sea level

rise, more frequent extreme weather events, and "irreversible losses" at the species and ecosystem levels. (IPCC, 2023.) The United States' own 2023 Fifth National Climate Assessment, prepared by scientific experts and reviewed by the National Academy of Sciences and multiple federal agencies, echoed these findings. The 2023 Assessment concluded that "[t]he global warming observed over the industrial era is unequivocally caused by greenhouse gas emissions from human activities–primarily burning fossil fuels," and long-term responses include "sea level rise, ice sheet losses, and associated disruptions to human health, social systems, and ecosystems." (Climate Action Tracker, 2023)

This significant new information requires immediate and aggressive greenhouse gas emissions reductions to keep warming well below 2°C above pre-industrial levels. The IPCC Sixth Assessment Report and other expert assessments have established global carbon budgets, or the total amount of carbon that can be burned while maintaining some probability of staying below a given temperature target. According to the IPCC, "[t]he best estimates of the remaining carbon budgets from the beginning of 2020 are 500 GtCO2 for a 50% likelihood of limiting global warming to 1.5°C and 1150 GtCO2 for a 67% likelihood of limiting warming to 2°C." (IPCC 2023 at 19.) Additionally, "[i]f the annual CO2 emissions between 2020-2030 stayed, on average, at the same level as 2019, the resulting cumulative emissions would almost exhaust the remaining carbon budget for 1.5°C (50%), and deplete more than a third of the remaining carbon budget for 2°C (67%)." (IPCC 2023). As of 2023, climate policies by countries across the world would lead to an estimated 2.7°C of warming, and possibly up to 3.4°C of warming, well above the level needed to avoid the worst dangers of climate change. (Climate Action Tracker, 2023)

ii. The 2018 EIR's GHG Analysis Is Outdated.

The significant new information described *supra* leaves no doubt that climate change will transform California, resulting in increased temperature and frequency of wildfires, and a reduction in snowpack, precipitation levels, and water availability. (Turco et al., 2023) But the 2018 EIR does not take this into account, instead relying on an outdated GHG emissions calculation model, CalEEMod Version 2016.3.1. (SEIR at 5.7-1.) The significant new information regarding climate change impacts should be assessed under the new version of CalEEMod, which became available in 2020, and again in 2022, intended to incorporate the latest science on GHG emissions. (California Air Pollution Control Officers Association, 2021, 2022) Specifically, the newer models take into account critical sources of GHG emissions prior models did not, such as CARB's EMFAC2017 N2O emissions, and they incorporate the 2019 update to Title 24 (building efficiency percentage reduction). (CAPCOA 2021.) The County offers no justification for using a version two cycles and six years out of date that overlooks several aspects of GHG emissions. The analysis is therefore inadequate and must be revised and recirculated.

Further, the 2018 EIR fails to analyze the GHG emissions against a legally adequate threshold of significance. Any revised EIR must show how a project will conform to *current* statewide GHG reduction targets and adopt enforceable mitigation to achieve these goals. (*Center for Biological Diversity v. Department of Fish & Wildlife* (2015) 62 Cal.4th 204, 225-26; *League to Save Lake Tahoe v. County of Placer* (2022) 75 Cal.App.5th 63, 121-22.)

Since 2018, the State has released new GHG reduction targets. In 2022 California enacted AB 1279, the California Climate Crisis Act, requiring the state to achieve net zero GHG emissions by no later than 2045 and maintain net negative GHG emissions thereafter. (AB 1279 2022.) To achieve that goal, CARB released a new Scoping Plan in November 2022 that requires "aggressive reduction of fossil fuels" and "rapidly moving to zero emission transportation," and identifies "a technologically feasible and cost-effective path to achieve carbon neutrality by 2045." (2022 Scoping Plan for Achieving Carbon Neutrality, 2022) Newsom has continued to issue climate-related executive orders, such as a 2020 order requiring that, by 2035, all passenger vehicles will be zero-emission, in addition to other motor vehicle emission goals. (Executive Order N-79-20 (2020).). Enforcement of and compliance with these steps are essential to stabilize the climate and avoid catastrophic impacts to our environment.

The 2018 EIR purports to evaluate the significance of GHG emissions based on consistency with regulatory programs adopted for the purpose of reducing GHG emissions. (SDEIR at 5.7-22.) But, because it was written in 2018, it does not analyze consistency with relevant regulatory programs. Using 2018 regulatory programs as the basis for a threshold of significance in 2025 is not supported by substantial evidence. The GHG significance determination is therefore inadequate and must be revised and recirculated with an updated threshold of significance.

Once the County has revised the GHG analysis, it must consider current best practices in GHG mitigation and adopt all feasible mitigation. Appendix D of CARB's 2022 Scoping Plan includes on-site GHG-reducing design features and mitigation measures, as well as offsite measures the County should consider to conform to these new targets. Other feasible measures can be found in the California Air Pollution Control Officers Association 2022 Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity. (California Air Pollution Control Officers Association, 2024) The Center urges the County to take all feasible steps to reduce GHG emissions in light of the recent climate change research outlined *supra*.

B. The County Must Revise the EIR to Consider Significant New Information Regarding California's Water Supply.

Since the 2018 EIR's preparation and certification, significant new information reveals that California's water supply has become more uncertain. Indeed, climate change and

population growth pose unprecedented challenges to California's efforts to allocate and conserve limited water resources. New studies predict that in the next 35 to 60 years, if GHG emissions continue unchecked, the American West's snowpack will continuously shrink, disappearing for a decade or more at a time. (Siirila-Woodburn et al., 2021) In 2022, the IPCC specifically identified the American West as vulnerable, warning that with projected warming in the western mountains, accumulated snowpack is "virtually certain to decline." (IPCC, 2022) This warning informed a recent Executive Order from Governor Newsom, declaring that California must "redouble near-, medium-, and long-term efforts to adapt its water management to a changing climate, shifting precipitation patterns, and water scarcity." (Executive Order N-7-22 (2022).)

Climate change has caused increased water extremes—a boom and bust cycle between flooding and drought—that scientists predict will only get worse. (Polade et al., 2017; Swain et al., 2018) During wet years, California has experienced increased run-off as more water falls than can recharge groundwater. (Becker, 2024) In this context, the 2018 EIR's assumption that precipitation averages will be consistent with pre-2018 averages and its reliance on safe groundwater yields established in 2015 ignores reality. (See SDEIR at 5.12-4.) The significant new information is relevant to understanding whether a water supply shortfall is likely and must be considered.

C. The County Must Revise the EIR to Consider Significant New Information Regarding Mountain Lions.

i. CEQA and CESA Require Analysis and Mitigation for Impacts to Mountain Lions.

Relevant authorities require preparation of a subsequent EIR in these circumstances. The California Environmental Quality Act ("CEQA") states that a subsequent or supplemental EIR may be required when either (1) substantial changes occur with respect to the circumstances under which the project is being undertaken which will require major revisions in the environmental impact report or (2) new information, which was not known and could not have been known at the time the environmental impact report was certified as complete, becomes available. (Pub. Res. Code § 21166.)

New information since the EIR was approved in 2018 that mountain lions in the Project area are facing an extinction vortex fits within both of these categories. Mountain lions in the Project area are part of the Central Coast South (CCS) population, which were granted "candidacy status" in April 2020 under CESA, such that they are afforded the same protections as other CESA-listed species. CEQA requires a "mandatory finding of significance" when a project has the potential to impact a CESA-listed species. (CEQA Guidelines § 15065(a)(1); *Endangered Habitats League, Inc. v. County of Orange* (2005) 131 Cal.App.4th 777, 792 fn. 12.) And such a finding triggers a duty to consider and adopt all feasible alternatives or mitigation

measures to reduce such impacts. (Pub. Res. Code § 21002.) Moreover, under CESA, the County may not approve projects that could jeopardize the continued existence of these populations or result in destruction of essential habitat (Fish & Game Code § 2053(a)) and agencies must require that appropriate mitigation measures be implemented for projects that could destroy mountain lion habitat or impair connectivity (Fish & Game Code § 2054). Neither the 2018 EIR nor the 2025 PRDSEIR address these issues. Given that at least one mountain lion has been documented using a box culvert under the I-5 adjacent to the Project area (Exhibit E) moving from Grasshopper Canyon westerly into Marple Canyon, and there is other evidence of mountain lion presence in the vicinity,[1] adequate analyses and mitigation regarding the Project's impacts to mountain lions should be provided in a recirculated EIR.

ii. Numerous Scientific Studies Reveal That Mountain Lions in the Project Area are Threatened and the Project will Impact Their Long-term Survival

By way of background, continued habitat loss and fragmentation has led to 10 genetically isolated populations within California (Gustafson et al., 2018, 2021). There are six identified mountain lion populations in the Southern California and Central Coast Evolutionarily Significant Unit ("ESU"), and several are facing an extinction vortex due to high levels of inbreeding, low genetic diversity, high human-caused mortality rates from car strikes on roads, depredation kills, rodenticide poisoning, poaching, disease, and increased human-caused wildfires (Benson et al., 2016, 2019; Ernest et al., 2003, 2014; Gustafson et al., 2018; Riley et al., 2014; Vickers et al., 2015). This is detailed in the Center's petition to the California Fish and Game Commission to protect Southern California and Central Coast mountain lions under the California Endangered Species Act (Yap et al., 2019).

The effective population sizes (N_e) of the six populations within the ESU range from 2.3 to 26.9 (Gustafson et al., 2021). An effective population size of 50 is assumed to be sufficient to prevent inbreeding depression over five generations, while an effective population size of 500 is considered sufficient to retain evolutionary potential in perpetuity (Frankham et al., 2014; Traill et al., 2010). All six populations are well below that minimum threshold of 50 and none have an effective population size anywhere near 500, which indicates that these populations are at serious risk of becoming extirpated. Local mountain lions are located at the boundary of two ESU populations, the Central Coast South (CCS) and San Gabriel/San Bernardino (SGSB) populations. These southern California mountain lion populations are severely struggling. Low genetic diversity and high human-caused mortalities are driving mountain lions in the CCS and Santa Ana Mountains towards an extinction vortex (Benson et al., 2019). Scientists predict that the CCS populations is likely to become extinct within 50 years if gene flow with other mountain lion populations is not improved (Benson et al., 2019; Gustafson et al., 2021). Researchers have found that, of the California mountain lion subpopulations, the SGSB population has the smallest

[1] https://www.inaturalist.org/observations/70048855

effective population size and the smallest area of available habitat (Dellinger et al., 2020; Gustafson et al., 2021). Scientists suggest that the SGSB population "may be approaching levels of genetic drift and inbreeding similar to the well-monitored and genetically depauperate Santa Ana and Central Coast South populations" (Gustafson et al., 2021). Alarmingly, scientists have documented physical and reproductive signs of inbreeding depression in local mountain lions due to being boxed in by roads and development (Huffmeyer et al., 2021). If inbreeding depression sets in, the CCS population is predicted to have a 99% chance of becoming locally extinct within 50 years (Benson et al., 2019).

The Project area is located in the Sierra Pelona Mountains, an area that researchers have identified as one of the last remaining linkages for statewide genetic connectivity that is critical for the overall genetic health of Southern California and Central Coast mountain lions (Gustafson et al., 2021). It is in a sensitive and highly constrained area where the CCS, SGSB, and Western Sierra Nevada mountain lion populations converge (Yap et al., 2019). And, as mentioned, above, mountain lions have been recorded in the vicinity of the Project area and likely move through the area, as evidenced by the use of a nearby underpass to cross the I-5 going east to west (Exhibit E). One study found a single migrant improved the genetics of a small, isolated and inbred puma population in California (Gustafson et al., 2017), therefore any movement in and near the Project area, especially through adjacent crossings, is critical for gene flow and the long-term survival of local mountain lions. This emphasizes the importance of the Project area for maintaining and enhancing connectivity among and between the subpopulations and preserving habitat in the region. The SEIR fails to disclose this information and therefore fails to comply with CEQA.

Numerous studies highlight the impacts of human activities on mountain lions. Human-caused mortalities—including vehicle strikes, rodenticide poisoning, depredation kills, poaching, and wildfire—are the leading cause of death for mountain lions across California, exceeding natural mortality rates (Benson et al., 2020, 2023; Nisi et al., 2023; Vickers et al., 2015). In addition, human activities also alter these large carnivores' behavior in ways that likely further impede important movement and gene flow. For example, researchers found that mountain lions are so fearful of humans and noise generated by humans that they will abandon the carcass of a deer and forgo the feeding opportunity just to avoid humans (J. A. Smith et al., 2017). The authors concluded that even "non-consumptive forms of human disturbance may alter the ecological role of large carnivores by affecting the link between these top predators and their prey" (J. A. Smith et al., 2017). In addition, mountain lions have been found to respond fearfully upon hearing human vocalizations, avoiding the area and moving more cautiously when hearing humans (J. A. Smith et al., 2017; Suraci et al., 2019).

Other studies have demonstrated other shifts in behavior and movement patterns of pumas in response to human activities, like increased avoidance behavior in areas with more

roads and higher development densities and increased nocturnal activity as human presence increases (Bolas et al., 2025; Dougherty et al., 2025; Lucas, 2020; Nickel et al., 2020, 2021; Nisi et al., 2022, 2023; J. A. Smith et al., 2015, 2019; Y. Wang et al., 2017; Wilmers et al., 2013, 2021; Yovovich et al., 2020). Pumas have also been found to generally avoid areas with nearby night lighting (Barrientos et al., 2023). Thus, the increased human presence due to the Project's new roads and development could have significant negative impacts on puma survival and behavior, which could reduce the genetic health of the local population and ultimately diminish the long-term survival of the CCC population as well as the neighboring CCN and CCS populations. CEQA requires a recirculated EIR that adequately analyzes these potential impacts.

Another study further documented the impacts of human activities on mountain lions specifically on communication and reproductive behaviors important for their survival (Yovovich et al., 2020). Males use scrapes to delineate territories as well as attract potential mates (Allen et al., 2015, 2016), and the males in the study preferred to use relatively flat areas away from human influence as scrape habitat (Yovovich et al., 2020). Similarly, when nursing females (with kittens less than 8 weeks old) shrank their home ranges to an average of 9 km^2 while their young were most vulnerable, they also selected undeveloped lands away from human disturbance, opting for habitat with protective cover and sufficient water and prey availability (Yovovich et al., 2020). The loss of adequate undisturbed communication and nursery habitat could disrupt important communication and reproductive behaviors that facilitate social structure and overall survival. The authors predicted that future development within the Santa Cruz Mountains could reduce nursery and communication habitat by 20% and 50%, respectively, while further fragmenting the landscape. Such patterns likely extend to other regions within the proposed Southern California/Central Coast ESU.

Other studies document nuanced sensitivities of California mountain lions to human presence, activities, and infrastructure while also providing glimpses of how humans and mountain lions can safely coexist. Pumas in the Santa Cruz Mountains were found to less likely occur in areas with higher development densities (*i.e.*, areas with greater road and/or building densities) (Nickel et al., 2020). This aligns with other studies that have demonstrated that mountain lion avoidance behavior increases with greater development densities (J. A. Smith et al., 2015, 2019; Y. Wang et al., 2017; Wilmers et al., 2013). In addition, researchers found that in open space areas where recreational activities are allowed (*e.g.*, hiking, biking), mountain lions generally avoided human presence and became more nocturnal as human presence increased (Nickel et al., 2020). Similar shifts in puma behavior in response to human activities have been documented in other studies (Lucas, 2020; Suraci et al., 2019; Y. Wang et al., 2015, 2017). There is often a cost of these behavioral shifts, such as increased energy expenditure that could potentially reduce fitness. Studies have found that pumas expend more energy by increasing their kill rates in high housing density areas (J. A. Smith et al., 2017) and having higher nighttime activity in developed areas (Y. Wang et al., 2017). This is further supported by

a study that found mountain lions increased movement efficiency during the Covid-19 shutdown, which suggests that they incur energetic costs by increasing movement and space-use when avoiding human activity (Benson et al., 2021).

Although pumas have been found to have some flexibility to navigate urbanized landscapes, they spent more than 95% of their time away from developed areas and actively avoided open areas like golf courses, cemeteries, and other altered landscaped spaces (Riley et al., 2021). Mountain lions prefer larger habitat patches that are closer together and further away from buildings (Suraci et al., 2020), and they consistently select native vegetation types with dense cover, like chaparral, riparian woodland, and coastal sage scrub, with shrublands being their preferred habitat (Riley et al., 2021). This highlights the importance of intact and connected natural heterogeneous landscapes to the long-term health and persistence of constrained mountain lion populations. The authors state, "An important requirement for the effective conservation of at-risk mountain lion populations in southern California is preserving and enhancing connectivity between larger natural areas." (Riley et al., 2021). In addition, especially in areas where pumas are severely isolated and wildlife connectivity is already constrained, like in and near the Project area, it is important to note that even a single migrant from a different population can help enhance genetic diversity in inbred puma populations (Gustafson et al., 2017). This suggests that any area with important connectivity is critical for the long-term survival of local pumas. The proposed Project could drive local puma populations towards extinction while harming other wildlife.

There are many scientific studies that provide insights on the profound impacts human activities and infrastructure have on mountain lion survival, and they emphasize the need to adequately assess and mitigate impacts to these CESA candidate species in the Project area. These studies add to the accumulating evidence that mountain lions require a habitat mosaic that provides sufficient room to roam away from human-disturbed areas and connected to expansive, intact, heterogeneous habitats (Beier et al., 1995; Dickson et al., 2005; Dickson & Beier, 2002; Kertson et al., 2011; Zeller et al., 2017). Continued construction of roads and development in mountain lion habitat with little regard for their movement and behavioral needs, especially in an area where mountain lions have been detected and movement is already constrained, has significant direct and indirect lethal and sublethal impacts that threaten the persistence of Southern California and Central Coast puma populations. The SEIR fails to adequately assess and mitigate the Project's impacts to local mountain lions.

Mountain lions are a key indicator species of wildlife connectivity and healthy ecosystems. As the last remaining wide-ranging top predator in the region, the ability to move through large swaths of interconnected habitat is vital for genetic connectivity and their long-term survival. In addition, impacts to mountain lions in the region could have severe ecological consequences; loss of the ecosystem engineer could have ripple effects on other plant and animal

species, potentially leading to a decrease in biodiversity and diminished overall ecosystem function. Many scavengers, including California condors, kit foxes, raptors, and numerous insects, would lose a reliable food source (Barry et al., 2019; Ruth & Elbroch, 2014). Fish, birds, amphibians, reptiles, rare native plants, and butterflies would potentially diminish if this apex predator were lost (Ripple et al., 2014; Ripple & Beschta, 2006, 2008). In fact, a recent literature review found that mountain lions are important ecosystem engineers and have been documented to have ecological interactions with at least 485 plant and animal species (Labarge et al., 2022). Adequate assessment and mitigation of the Project's impacts to mountain lions is necessary to ensure their long-term survival as well as the long-term health of the area's biodiversity and ecosystems. The SEIR fails to adequately analyze and mitigate the Project's impacts to pumas.

Wildlife connectivity in this region is paramount for the survival of the Southern California mountain lions. Any project that does not adequately assess and address impacts to mountain lions and wildlife connectivity could lead to the extirpation of local mountain lions and severe loss of biodiversity and ecosystem function in the region. Further destruction of wildlife connectivity in the area will push local mountain lions closer towards extinction. See further discussion below regarding the SEIR's requirement to adequately describe, assess, and mitigate impacts to wildlife movement and connectivity.

D. The County Must Revise the EIR to Consider Significant New Information Regarding Burrowing Owls.

i. CEQA and CESA Require Analysis and Mitigation for Impacts to Burrowing Owls.

The previous EIR for the Project noted numerous burrowing owls have been documented in the Project area. Therefore, relevant authorities require preparation of a subsequent EIR in these circumstances to ensure potential impacts to burrowing owls are fully analyzed and, if needed, mitigated. The California Environmental Quality Act ("CEQA") states that a subsequent or supplemental EIR may be required when either (1) substantial changes occur with respect to the circumstances under which the project is being undertaken which will require major revisions in the environmental impact report or (2) new information, which was not known and could not have been known at the time the environmental impact report was certified as complete, becomes available. (Pub. Res. Code § 21166.)

New information since the EIR was approved in 2018 shows that western burrowing owls continuing to decline in California. On October 10, 2024, the California Department of Fish and Wildlife (CDFW) accepted a petition to list the Western Burrowing Owl as endangered under the California Endangered Species Act (CESA), determining the listing "may be warranted" and

advancing the species to the candidacy stage of the CESA listing process.[2] As a candidate species, the western burrowing owl now has full protection of a threatened species under CESA. (See Cal. Fish & Game Code §§ 2074.4, 2085; Cal. Code Regs. tit. 14 § 783.1(b).) "Take" of any endangered, threatened, or candidate species that results from a project is prohibited, except as authorized by State law (Fish & G. Code, §§ 86, 2062, 2067, 2068, 2080, 2085; Cal. Code Regs., tit. 14, § 786.9.) Take of individual burrowing owls and their nests is defined as "hunt, pursue, catch, capture or kill, or attempt to hunt, pursue, catch, capture or kill," and is prohibited by sections 3503, 3503.5 and 3513.

CESA's purpose is "to conserve, protect, restore, and enhance any endangered species or any threatened species and its habitat." (Fish & Game Code § 2052.) As such, CESA protects not only species facing imminent risk of extinction, but also those on a trajectory towards eventual extinction. An "endangered" species is one that is "in serious danger of becoming extinct throughout all, or a significant portion, of its range." (*Id*. § 2062.) In contrast, a "threatened" species is one that, "although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of . . . special protection and management efforts." (*Id*. § 2067.) And "candidate" species are those noticed for review for future listing or proposed to be added as endangered or threatened species, (Cal. Fish & Game Code §§ 2068, 2074.4), while also receiving protection under CESA. (Cal. Fish & Game Code §§ 2074.4, 2085; *see also* Cal. Code Regs. tit. 14 § 783.1(b).)

CESA requires development of "reasonable and prudent alternatives" that will not jeopardize the existence of a listed species but will maintain the project purpose to the greatest extent feasible. (Cal. Fish & Game Code § 2053(b).) In the event that such alternatives are infeasible, agencies may still approve individual projects if appropriate mitigation measures are implemented. (Cal. Fish & Game Code § 2054.)

CESA envisions these mandates will be incorporated into the CEQA process. (Cal. Fish & Game Code §§ 2064-2065; Cal. Code Regs., tit. 14, §§ 783.3 & 783.5.) CEQA requires a "mandatory finding of significance" if substantial evidence indicates that a Project may cause a "wildlife population to drop below self-sustaining levels; threaten to eliminate a plant or animal community; substantially reduce the number or restrict the range of an endangered, rare or threatened species[.]" (CEQA Guidelines § 15065(a)(1).) This means that projects that reduce a listed species' habitat or reduce the number or range of a listed species are deemed to have significant impacts on the environment as a matter of law. (See *Endangered Habitats League, Inc. v. County of Orange* (2005) 131 Cal.App.4th 777, 792 fn. 12 [citing *Defend the Bay v. City of Irvine* (2004) 119 Cal.App.4th 1261, 1273–1274].)

[2] https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=227089&inline

CEQA requires a "mandatory finding of significance" when a project has the potential to impact a CESA-listed species. (CEQA Guidelines § 15065(a)(1); *Endangered Habitats League, Inc. v. County of Orange* (2005) 131 Cal.App.4th 777, 792 fn. 12.) And such a finding triggers a duty to consider and adopt all feasible alternatives or mitigation measures to reduce such impacts. (Pub. Res. Code § 21002.) Moreover, under CESA, the County may not approve projects that could jeopardize the continued existence of these populations or result in destruction of essential habitat (Fish & Game Code § 2053(a)) and agencies must require that appropriate mitigation measures be implemented for projects that could destroy mountain lion habitat or impair connectivity (Fish & Game Code § 2054). Neither the 2018 EIR nor the 2025 SEIR address these issues. Given that numerous burrowing owls have been documented in the Project area (2018 EIR Exhibit 5), adequate analyses and mitigation regarding the Project's impacts to burrowing should be provided in a recirculated EIR.

E. The County Must Revise the EIR to Consider Significant New Information Regarding Habitat Connectivity.

The California Environmental Quality Act (CEQA) requires an EIR to provide decision-making bodies and the public with detailed information about the effect a proposed project is likely to have on the environment, to list ways in which the significant effects of a project might be minimized, and to indicate alternatives to the project. (Pub. Res. Code § 21061.) CEQA further requires a lead agency to mitigate to the extent feasible significant impacts. (CEQA Guidelines § 15064.4.) The SEIR fails to provide sufficient analyses and mitigation for the Project's potential impacts to wildlife connectivity and special-status species that rely on connected habitats in and near the Project area, including mountain lions, and therefore fails to comply with CEQA. A recirculated EIR that complies with CEQA must be prepared.

New information since the EIR was approved in 2018 that mountain lions in the Project area are facing an extinction vortex and have been documented in the vicinity of the Project area, including an individual using an underpass adjacent to the Project area moving from Grasshopper Canyon westerly into Marple Canyon (Exhibit E), qualifies as (1) a substantial change with respect to the circumstances under which the project is being undertaken which will require major revisions in the environmental impact report and (2) new information, which was not known and could not have been known at the time the environmental impact report was certified as complete, becomes available. (Pub. Res. Code § 21166.). Given that mountain lions in the Project area are part of the Southern California and Central Coast proposed ESU that was granted "candidacy status" in April 2020 under CESA and mountain lions require ample amounts of intact, heterogeneous habitats to move freely and find the resources they need to survive, CEQA requires a supplemental EIR that adequately assesses and mitigates the Project's impacts to wildlife connectivity and special-status species.

ii. The SEIR Fails to Adequately Assess and Mitigate the Project's Impacts to Regional Wildlife Connectivity.

The 2018 EIR fails to consider the critical importance of regional wildlife connectivity for the long-term survival of mountain lions and many other species in the area. The 2018 EIR also fails to adequately disclose, assess, and mitigate the Project's impacts to wildlife connectivity. As mentioned above, the Project area is located in the Sierra Pelona Mountains, a mountain range within the Transverse Ranges that scientists have highlighted as "a critical conservation priority in order to maintain gene flow between the Southern Coast [mountain lion] populations and the Sierra Nevada or Central Coast groups" (Gustafson et al., 2021). The Project would remove mountain lion habitat and extend and fortify a movement barrier (i.e., the I-5) in an area where connectivity is already tenuous, as shown by numerous mountain lion genetics studies (e.g., Benson et al., 2019; Ernest et al., 2003; Gustafson et al., 2018, 2021). New roads and development and increased human activities in the area will further degrade any future connectivity restoration work at this barrier. The Project will significantly impact the area's rich biodiversity and could push the local mountain lions, particular the CCS and SGSB populations, further toward local extinction.

ii. The SEIR Fails to Adequately Assess and Mitigate the Project's Impacts to Wildlife Connectivity in and Adjacent to the Project Area.

The County relies on the inadequate and outdated 2018 EIR, which dismisses and diminishes the importance of the Project area for wildlife movement because of the presence of a dam, lagoon, and some development west of the lagoon, stating that "[o]nly local movement of species habituated to an urban landscape (e.g., coyote) are expected to navigate the extensive set of existing barriers. However, the SEIR fails to provide substantial evidence to support such claims. The 2018 EIR reports almost 900 acres of sage scrub communities, more than 450 acres of grasslands (which includes a significant amount of native grasslands), and almost 15 acres of riparian and open water communities (2018 EIR Table 5.2-1), and numerous sensitive and special-status species are known to occur in the Project area, including but not limited to western spadefoots, western toads, gopher snakes, common kingsnakes, coastal California gnatcatchers, burrowing owls, golden eagles, white-tailed kites, badgers, and mountain lions. And the Project area is surrounded by public lands and other undeveloped wildlands. Clearly numerous wildlife species are using and moving through the Project area. Yet no wildlife movement studies or adequate analyses were conducted. The SEIR fails to adequately disclose, assess, and mitigate the Project's impacts to wildlife connectivity.

The 2018 EIR fails to adequately assess and mitigate the Project's impacts to wildlife movement that is reliant on more than three miles of blue-line stream, ephemeral waters, and

almost 15 acres of riparian and open water habitat in the Project area. In fact, the 2018 EIR and the current EIR fail to mention Grasshopper Creek and its tributaries in its wildlife movement discussion at all, merely referring to Castaic Creek and Castaic Dam. This is a serious misrepresentation of the Project area's importance for wildlife connectivity.

Permanent and ephemeral streams and wetlands provide important live-in and move-through habitat for a wide variety of species. For example, riparian habitats associated with streams provide important connectivity for a wide variety of species, including numerous resident and migratory birds, monarch butterflies (which have been documented nearby[3]), wide-ranging animals like bobcats and mountain lions.

Intermittent and ephemeral rivers and streams are often underestimated habitats despite their importance as live-in and move-through habitat. Recent scientific literature states that "[i]n many intermittent streams, remnant pools persist after flow ceases and provide refuge for aquatic organisms"(Bogan et al., 2019). The researchers state:

> Remnant pools in intermittent streams should be a focus of conservation efforts in regions with a Mediterranean climate, especially during extreme droughts. Native fauna adapted to harsh intermittent flow regimes can thrive in these habitats, whereas non-native taxa may fare poorly. Furthermore, remnant pools supported by deep groundwater sources, such as those along geological faults, may provide both ecological refuge and evolutionary refugia for freshwater biota. (Bogan et al., 2019)

Hydroperiod diversity is important for native amphibian population stability. Intermittent and ephemeral habitats are important refugia from invasive fish and American bullfrogs that outcompete and prey upon native amphibians in permanent waterbodies. They may also be important refuge and recovery sites for native amphibian species after extreme drought. Many native amphibian species, like western spadefoot and western toads that have been documented in the Project area, are adapted to successfully reproduce in seasonally-drying wetlands, including intermittent streams and vernal pools. But during dry years some species may go to permanent waterbodies to breed while species with long-lived adult forms may be able to recover quickly from a skipped breeding season. Although amphibian population declines due to drought have been observed, these adaptations make them more resilient than invasive species to rebound and recover (Moss et al., 2021). In fact, researchers have found that invasive fish and bullfrogs were extirpated from several permanent ponds that had completely dried out during extreme drought, which, once refilled with water, opened up new sites for native species to re-colonize

[3] https://www.inaturalist.org/observations?subview=map&taxon_id=48662

(Moss et al., 2021). This indicates that conserving intermittent and ephemeral waterways is vital for native amphibians to persist, particularly in areas where invasive species may occur or have the potential to occur. As climate change intensifies, preservation of connected habitats with diverse hydroperiods is vital for the persistence and metapopulation dynamics of native amphibians.

Around 90% to 95% of historic riparian habitat in the state has been lost. Continued destruction and degradation of what little is left will have severe, harmful impacts on overall biodiversity, ecosystem function and climate change resilience. Yet the SEIR ignores and fails to adequately assess and mitigate the Project's impacts to permanent and ephemeral streams and wetlands that both facilitate wildlife movement and need connectivity to upland habitat.

The SEIR's inadequate description of the baseline environmental conditions on the Project site and vicinity undermine its effectiveness as an informational document. It is critical for the SEIR to clearly disclose and adequately assess the importance and function of the habitats that occur in the Project area and the special-status species that are known or have the potential to occur or historically occurred in these habitats so that the public can determine whether the EIR adequately assesses and mitigates the Project's impacts. The SEIR effectively dismisses and downplays the Project area's importance supporting high levels of biodiversity and wildlife connectivity and ultimately fails to adequately describe and assess existing conditions while contradicting the best available science. The SEIR fails to mitigate impacts to wildlife connectivity, mountain lions, and other sensitive species to less than significant and fails to comply with CEQA.

As detailed in a 2021 Center Report (Yap, Rose, Anderson, et al., 2021), roads and development create barriers that lead to habitat loss and fragmentation, which harms native wildlife, plants, and people. As barriers to wildlife movement, poorly-planned development and roads can affect an animal's behavior, movement patterns, reproductive success, and physiological state, which can lead to significant impacts on individual wildlife, populations, communities, landscapes, and ecosystem function (Brehme et al., 2013; Ceia-Hasse et al., 2018; Haddad et al., 2015; Marsh & Jaeger, 2015; Mitsch & Wilson, 1996; Trombulak & Frissell, 2000; van der Ree et al., 2011). For example, habitat fragmentation from roads and development has been shown to cause mortalities and harmful genetic isolation in mountain lions in Southern California and along the Central Coast (Ernest et al., 2014; Gustafson et al., 2021; Riley et al., 2014; Vickers et al., 2015), increase local extinction risk in amphibians and reptiles (Brehme et al., 2018; Cushman, 2006)., cause high levels of avoidance behavior and mortality in birds and insects (Benítez-López et al., 2010; Kantola et al., 2019; Loss et al., 2014), and alter pollinator behavior and degrade habitats (Aguilar et al., 2008; Goverde et al., 2002; Trombulak & Frissell, 2000).

Habitat loss and fragmentation also severely impacts plant communities. An 18-year study found that reconnected landscapes had nearly 14% more plant species compared to fragmented habitats, and that number is likely to continue to rise as time passes (Damschen et al., 2019). The authors conclude that efforts to preserve and enhance connectivity will pay off over the long-term (Damschen et al., 2019). In addition, connectivity is important to allow for range shifts and species migrations as climate changes (Cushman et al., 2013; Heller & Zavaleta, 2009; Krosby et al., 2018). Loss of wildlife connectivity decreases biodiversity and degrades ecosystems. It also prevents the reestablishment of native species, like bald eagles, vernal pool fairy shrimp, and valley elderberry longhorn beetles that may occur in or near the Project area.

Edge effects like traffic, noise, and light from Project construction and operation will have impacts on wildlife and wildlife movement in an area that is already constrained. This is important to consider when open space and connectivity enhancement projects (i.e., a wildlife crossing project in the CDFW priority barrier at El Casco Creek) are nearby, as numerous wildlife have been found to be sensitive to edge effects. For example, field observations and controlled laboratory experiments have shown that traffic noise can significantly degrade habitat value for migrating songbirds (Ware et al., 2015). Subjects exposed to 55 and 61 dBA (simulated traffic noise) exhibited decreased feeding behavior and duration, as well as increased vigilance behavior (Ware et al. 2015). Such behavioral shifts increase the risk of starvation, thus decreasing survival rates. Another study found a 28% decrease in bird abundance in areas when traffic noise was present compared to when there was no traffic noise (McClure et al., 2013). Negative edge effects of roads and development have been documented in wide-ranging predators, such as mountain lions and bobcats (Crooks, 2002; Delaney et al., 2010, 2021; Lee et al., 2012; Riley et al., 2006; J. A. Smith et al., 2015), as well as smaller species with poor dispersal abilities, such as song birds, small mammals, and herpetofauna (Benítez-López et al., 2010; Cushman, 2006; Kociolek et al., 2011; Slabbekoorn & Ripmeester, 2008).

It is widely recognized that the continuing fragmentation of habitat by humans threatens biodiversity and diminishes our (humans, plants, and animals) ability to adapt to climate change. In a report for the International Union for Conservation of Nature (IUCN), world-renown scientists from around the world stated that "[s]cience overwhelmingly shows that interconnected protected areas and other areas for biological diversity conservation are much more effective than disconnected areas in human-dominated systems, especially in the face of climate change" and "[i]t is imperative that the world moves toward a coherent global approach for ecological connectivity conservation, and begins to measure and monitor the effectiveness of efforts to protect connectivity and thereby achieve functional ecological networks" (Hilty et al., 2020). New roads and development and increased human activities in the Project area will significantly impact wildlife connectivity and the rich biodiversity in the region. The SEIR fails to adequately disclose, assess, and mitigate the Project's impacts to wildlife connectivity.

III. THE PRDSEIR'S NEW ANALYSIS OF WILDFIRE RISK REMAINS INADEQUATE.

Wildfires are a natural and necessary process in many of California's ecosystems, and many areas need beneficial fire to restore ecosystem health and cultural connection to the land. However, the last decade of unprecedented wildfires in the wildland urban interface (WUI)—where homes extend into the natural landscape—has been devastating for people and wildlife. Poor land-use planning plays a primary role in destructive wildfire.

Since 2015, California wildfires have killed more than 230 people and destroyed more than 75,000 structures in the wildland urban interface (WUI), where homes extend into the natural landscape. Hundreds of thousands of people have had to evacuate their homes and endure power outages, and millions have been exposed to unhealthy levels of smoke and toxic air, soil, and water pollution. Meanwhile costs for fire suppression, loss of life, medical expenses, property damage, and indirect economic losses are in the hundreds of billions of dollars.

On January 7, 2025, the world watched Los Angeles go up in flames. In a matter of just three days, fires killed at least 29 people, destroyed more than 16,000 structures, and burned more than 34,000 acres of shrublands and oak woodlands. Post-fire rains caused flooding, mudslides, and debris flows, which threatened communities and polluted nearby waters. Toxic debris plagues the landscape, with dangerously high levels of lead, arsenic, and other metals in soils within and near the fire footprint.

Costs of wildfires are skyrocketing. Researchers found that the 2018 California wildfires, which included the Camp Fire that burned through Paradise and the Woolsey Fire that burned through Ventura and Santa Barbara, resulted in $148.5 billion in in capital losses, health costs related to air pollution exposure, and indirect losses due to broader economic disruption cascading along regional and national supply chains (D. Wang et al., 2021).

Experts estimate the costs of the 2025 Los Angeles fires could be as high as $432 billion when considering property and capital losses, wages lost by local businesses and employees, and a decline in county-level GDP (Li & Yu, 2025). These estimates do not include the costs of health impacts; costs could continue to rise as we learn more about the extent of the damage and the long-term impacts of exposure to toxic air pollutants, soil pollutants, contaminated water, and the trauma of fleeing wildfires and/or losing homes, schools, and communities.

The science is irrefutable. Almost all destructive wildfires are accidentally ignited by humans or human infrastructure near roads and development (Balch et al., 2024; Chen & Jin, 2022; Syphard, Rustigian-Romsos, et al., 2019). Development in fire-prone landscapes increases ignition risk while climate change is amplifying fire conditions. Meanwhile, developers make

money by selling risky homes, leaving the burden of recovery on homeowners and taxpayers. Yet the SEIR fails to adequately assess and mitigate the Project's impacts to wildfire risk and instead downplays the Project area's existing conditions and creates a false sense of security with minimal and inadequate mitigation.

CEQA requires an EIR to identify and analyze a project's significant environmental impacts, including those impacts caused or exacerbated "by bringing development and people into the area affected." (Pub. Resources Code, §§ 21002, 21002.1, subd. (a); CEQA Guidelines, § 15126.2, subd. (a).) The impacts of development in areas prone to wildfire specifically require consideration: "the EIR should evaluate any potentially significant direct, indirect, or cumulative environmental impacts of locating development in areas susceptible to hazardous conditions (e.g., floodplains, coastlines, *wildfire risk areas*), including both short-term and long-term conditions, as identified in authoritative hazard maps, risk assessments or in land use plans addressing such hazard areas." (CEQA Guidelines, § 15126.2, subd. (a), emphasis added.)

In 2018, the State officially recognized that introduction of development in the WUI increases ignition risk. (OPR 2018 Final Statement of Reasons – Update to CEQA Guidelines Checklist]; see also *Clews Land & Livestock, LLC v. City of San Diego* (2017) 19 Cal.App.5th 161, 193 [recognizing potential for significant environment effects when project brings new development to a wildfire prone area].) Moreover, as discussed in a 2021 Center Report, "*Built to Burn: California's Wildlands Developments are Playing with Fire*," policymakers must reckon with California's wildfire history and acknowledge that reckless land-use policies are increasing wildfire risk and putting more people in harm's way (Yap, Rose, Broderick, et al., 2021).

A. The PRDSEIR Fails to Adequately Describe and Assess the Project's Wildfire Ignition Risk.

A California Court of Appeal recently blocked development over wildfire concerns because the county failed to assess wildfire ignition risk. (See *People ex rel. Bonta v. County of Lake* (2024) 105 Cal.App.5th 1222, 1235 [finding that EIR must sufficiently discuss the project's potential adverse effect of human-cause ignitions and analyze in some detail how the project's design or mitigation measures alleviates such risks, and lead agency failed to utilize industry standard modeling tools or appropriate methodologies for its conclusory findings]). The PRDSEIR fails to do this.

The PRDSEIR falsely and erroneously states that "[n]either construction nor operation of the Project would exacerbate wildfire risks, thereby exposing occupants to pollutant concentrations from a wildfire or uncontrolled spread of a wildfire" (PRDSEIR at 2-67) without providing substantial evidence to support such a claim. The PRDSEIR further dismisses wildfire

risk, stating that the "level of risk is no greater than similar communities in the area and generally better than projects constructed prior to the current regulatory standards" (PRDSEIR at 2-66), without adequately disclosing or assessing the area's baseline conditions. The wildfire risk of existing communities in fire-prone areas is exceptionally high, as is evidenced by the numerous accidental ignitions in the WUI that have caused unprecedented levels of destruction and death in the last decade, and the risk of these existing communities is irrelevant to the Project's needed wildfire risk assessment. The science clearly shows that placing any new human presence in high fire-prone areas inevitably increases ignition risk. The Project would bring more roads and development and increased human activity into fire-prone areas, thereby increasing ignition risk and endangering the lives of new residents and existing communities.

According to a report from Governor Gavin Newsom's Office, construction of more homes in the wildland-urban interface is one of the main factors that "magnify the wildfire threat and place substantially more people and property at risk than ever before" (Governor Newsom's Strike Force, 2019). Another 2019 study found that housing and human infrastructure in fire-prone wildlands are the main drivers of fire ignitions and structure loss (Syphard et al., 2019). Sprawl developments extending into habitats that are prone to fire have led to more frequent wildfires caused by human ignitions, like power lines, arson, improperly disposed cigarette butts, debris burning, fireworks, campfires, or sparks from cars or equipment (Alexandre, Stewart, Keuler, et al., 2016; Alexandre, Stewart, Mockrin, et al., 2016; Balch et al., 2017; Bistinas et al., 2013; Keeley et al., 1999; Keeley & Fotheringham, 2003; Keeley & Syphard, 2018; Radeloff et al., 2018; Syphard et al., 2007, 2012; Syphard, Rustigian-Romsos, et al., 2019).

Reckless land-use planning that extends the WUI further into California's fire-prone landscape is causing fires to be more destructive. Almost all destructive wildfires are accidentally ignited by humans or human infrastructure near roads and development (Balch et al., 2024; Chen & Jin, 2022; Syphard, Rustigian-Romsos, et al., 2019). For example, the 2018 Camp and Woolsey fires and 2017 Tubbs and Thomas fires were sparked by powerlines or electrical equipment and the 2017 Carr fire was caused by car sparks. Exhibit 3.2-6 in the EIR shows the increased ignitions along roads. And although still under investigation, embers from a previous fire ignited by fireworks is suspected to have caused the Palisades Fire and a spark from a southern California Edison powerline likely caused the Eaton Fire. Placing more homes and people in high fire-prone areas would only increase the potential likelihood of these ignition sources, as has been documented in multiple scientific studies (Balch et al., 2017; Bistinas et al., 2013; Keeley et al., 1999; Keeley & Fotheringham, 2003; Keeley & Syphard, 2018; Radeloff et al., 2018; Syphard et al., 2007, 2012; Syphard, Rustigian-Romsos, et al., 2019).

The PRDSEIR also fails to adequately discuss the role of climate as it pertains to wildfire risk in the Project area. California's climate facilitates wildfire. With typically cool wet winters and hot dry summers, vegetation will grow and then dry out over the course of the year. Strong

seasonal winds, known as the Santa Ana winds in the Project area, occur in the fall and winter. If there is little or no precipitation prior to a strong wind event and a fire has been ignited, the winds can spread the fire dangerously fast (Cayan et al., 2022; Keeley et al., 2024).

Winds drive the fastest, deadliest, and most destructive wildfires in the U.S. (Balch et al., 2024). And researchers have found that fires are spreading faster. Between 2001 and 2020 the maximum daily growth rate of wildfires in the U.S. more than doubled, and California fires grew almost 400% faster (Balch et al., 2024). Experts suggest that this trend could be due to warming temperatures, habitat conversion to more flammable vegetation (i.e., nonnative grasses), and/or the co-occurrence of high winds with increasing human-related ignitions (Balch et al., 2024). Although the winds do not ignite the fires, ignitions in the WUI often coincide with strong wind events (Abatzoglou et al., 2018; Hantson et al., 2022; Mietkiewicz et al., 2020). Almost always ignited by humans and human infrastructure in dry shrublands and grasslands, these wildfires spread quickly and are difficult to contain during windy conditions, which amplifies their negative impacts to people and ecosystems (Hantson et al., 2022).

The three most destructive wildfires in California were driven by wind. Earlier this year, the Eaton Fire burned more than 10,000 acres within just 16 hours of ignition, damaging more than 9,000 structures and killing at least 18 people. The Palisades Fire burned more than 17,000 acres in the first 36 hours of ignition and resulted in almost 7,000 structures burning and at least 12 people dying. And in 2018 the Camp Fire burned more than 50,000 acres in its first day, eventually becoming California's deadliest and most destructive wildfire, killing 85 people and destroying almost 19,000 structures.

The Hughes Fire, which ignited on January 22, 2025 just east of the Project area, burned through more than 10,000 acres of land in less than 11 hours.[4] Although no one was injured, 31,000 people were under mandatory evacuations and more than 14,000 structures were at risk of burning. Yet the SEIR fails to mention this nearby fair and fails to adequately disclose and assess the prevailing winds in the Project area that influence and exacerbate the Project's wildfire ignition risk. The SEIR fails to comply with CEQA.

The PRDSEIR also fails to adequately assess the impacts climate change on wildfire risk. Climate change is exacerbating extreme weather conditions and wildfire impacts (Williams et al., 2019). The number of days with extreme fire weather conditions in California has doubled since 1980, and further climate change will amplify that trend (Goss et al., 2020). Hotter and drier conditions combined with later and shorter rainy seasons are making the landscape more conducive to wildfire ignitions and spread while lengthening the fire season (Dong et al., 2022; Goss et al., 2020; Luković et al., 2021; Ma et al., 2021; Swain, 2021). Wildfire risk is now year-

[4] CalFire (2025). Hughes Fire Status Update Reports. Available at: https://www.fire.ca.gov/incidents/2025/1/22/hughes-fire/updates.

round. Continued climate change and increasing fire conditions will lead to more intense and more destructive wildfires (MacDonald et al., 2023). The SEIR fails to adequately assess the Project's wildfire risk.

B. The PRDSEIR Fails to Adequately Mitigate the Project's Wildfire Risk.

The PRDSEIR fails to adequately mitigate wildfire ignition risk in the Project area while attempting to instill a false sense of security. The PRDSEIR erroneously concludes that the Project would have a "less than significant impact" before mitigation and "no mitigation is necessary" (PRDSEIR at 2-69) despite the best available science and numerous fire science experts demonstrating study after study that any increase extension of development into fire-prone areas increases ignition risk. Instead, the PRDSEIR relies on "project design features" for wildfire prevention and protection (PRDSEIR at 2-67); however, these measures are inadequate. As courts have repeatedly held, project design features cannot be used to avoid thorough analysis of a project's environmental impacts and adoption of adequate mitigation. (*Lotus v. Department of Transportation* (2014) 223 Cal.App.4th 645.) In particular, the efficacy of project design features cannot be assessed against an undefined wildfire impact and lack the enforceability of mitigation measures. Therefore, the Project's wildlife analysis is inadequate and violates CEQA.

The science clearly shows that placing any new human presence in high fire-prone areas inevitably increases ignition risk, yet the PRDSEIR simply relies on "project design features" that include compliance with Chapter 7A of the California Building Code, internal sprinklers, fuel breaks and fuel modification zones, a new fire station location (not an actual fire station with funded equipment and personnel) (PRDSEIR at 2-67). These measures do not guarantee safety when (not if) a fire burns through the area. While fire-resistant measures can reduce wildfire risk, they cannot make structures or communities fireproof. In an analysis that included more than 40,000 structures exposed to wildfire between 2013 and 2018 in California, many structures deemed "firesafe" were destroyed. And while an analysis conducted in the aftermath of the 2018 Camp Fire showed that new building codes improved home survival, with 38.5% of homes built to code undamaged compared to 11.5% of homes built prior to 2008, 61.5% of the homes built to fire-safety codes were still destroyed (Knapp et al., 2021).

In addition, even if the Project includes "a new fire station location" (PRDSEIR at 2-67), there is no guarantee that a fire station would actually be built. And even if it were to be built, it is unclear if human and monetary capital will be sufficient to sustain and maintain a new fire station. There is no requirement that the developer pay for the county's costs of building or operating a station, nor is there any guarantee that sufficient firefighting personnel and equipment will be available. During the LA wildfires in January 2025, firefighters lacked enough personnel and fire engines to keep all communities safe (Fuller et al., 2025; Toohey & Fry, 2025). The personnel cost over the life of the Project (essentially forever) will likely be hundreds

of millions of dollars. Funding is already lacking for the increasing costs of fire suppression and property damage from wildfires in California, and the developer is not required to reimburse the California Department of Forestry and Fire Protection (CalFire) for the many millions (or billions) of dollars CalFire will likely expense when (not if) Centennial needs to be defended from wildfire. The cost of fire suppression in areas managed by CalFire has skyrocketed from $114 million in the 2000-2001 fiscal year to close to $3 billion for the 2020-2021 and 2021-2022 fiscal years combined (CalFire 2022). The Legislative Analyst's Office (LAO) reported that CalFire used an estimated $3.3 billion for wildfire protection and suppression in the 2022-2023 fiscal year (LAO 2023). And as mentioned previously, climate change is amplifying extreme weather conditions and wildfire risk (Goss et al., 2020; Swain, 2021; Swain et al., 2018, 2025), which is making it more challenging to protect communities from wildfire. Such information must be analyzed when assessing wildfire risk. The PRDSEIR fails to adequately assess and mitigate the Project's impacts to wildfire risk to less than significant.

Development in and near fire-prone areas should be avoided. If unavoidable, mitigation measures should require structures to have ember-resistant vents, fire-resistant roofs, fire-resistant siding, double-paned windows, and irrigated defensible space immediately adjacent to structures and around communities. External sprinklers (not internal sprinklers, which are proposed in the SEIR) with an independent water source could reduce structures' flammability. Rooftop solar and clean energy microgrids could reduce fire risk from utilities' infrastructure during extreme weather. In addition, mitigation measures should include equitably retrofitting existing communities near the Project area with similar fire-resilient measures, providing wildfire personal protective equipment (e.g., N95 masks, air purifiers), and shelter-in-place facilities. Education and awareness for workers, new residents, and nearby communities should be provided and include how to reduce ignition risk. Maintenance and enforcement of ignition reduction measures should be funded and implemented in perpetuity. In addition, developers should be responsible for the insurability of homes and structures as well as recovery and remediation costs when (not if) a fire occurs in or near the Project area.

C. The EIR Must Incorporate Traditional Ecological Knowledge and Indigenous Science into Its Wildfire Analysis.

The PRDSEIR fails to mention or discuss the area's historical fire regimes and the role Indigenous communities likely played in shaping the fire ecology of habitats in and adjacent to the Project area. Indigenous communities should be included in discourse over climate change and wildfire. They are disproportionately impacted by wildfire. Native Americans were found to be six times more likely than other groups to live in high fire-prone areas, and high vulnerability due to socioeconomic barriers makes it more difficult for these communities to recover after a large wildfire (Davies et al., 2018). In addition, farmworkers, who are majority people of color

and often include migrant workers that come from Indigenous communities, often have less access to healthcare due to immigration or economic status. They are more vulnerable to the health impacts of poor air quality due to increased exposure to air pollution as they work. Yet farmworkers often have to continue working while fires burn, and smoke fills the air, or risk not getting paid (Herrera, 2018; Kardas-Nelson et al., 2020; Parshley, 2018).

Ramos (2022) states, "Indigenous communities have often been marginalized in the sciences through research approaches that are not inclusive of their cultures and histories." Traditional ecological knowledge ("TEK") is often excluded from analyses or distilled to conform to Western science (Ramos, 2022). EIRs, like this one, often fail to acknowledge that Indigenous communities and cultural burning played a role in California's historical fire activity and often only mention previous wildfires in the area in CalFire records. This perpetuates the exclusion and marginalization of Indigenous communities and TEK. Consultation with local Native Tribes and incorporation of Indigenous science, including but not limited to oral histories, ethnographies (that may include burn scars and charcoal records), and archeological data should be incorporated in fire history analysis. As a society, we need to work towards integrative research that "transcends disciplinary boundaries" and employs a range of methodological options to get a deeper understanding of the relationship between people and ecosystems (Ramos, 2022). Doing so will help inform fire management strategies and mitigation measures that work towards reducing harms of wildfire to people while facilitating beneficial fire for the appropriate ecosystems.

D. Increased Development in Fire Zones Disrupts Natural Fire Regimes and Harms California's Ecosystems and Wildlife.

Wildlife and the habitats they rely on have also suffered from the last decade of unprecedented fires in the WUI. Fragmented populations of sensitive species, like mountain lions, California condors, and San Joaquin kit foxes, are vulnerable to further habitat loss and fragmentation as well as the fires themselves, smoke inhalation and air pollution, post-fire landslides, and toxic runoff. The Project could amplify harms by increasing unintentional human-driven wildfires that disrupt natural fire regimes, further degrade ecosystems, and threaten California's wildlife.

E. Unintentional Wildfires Caused by Poorly Sited Development Cause Poor Air Quality and Harm People.

As discussed in the Center for Biological Diversity's report, *The True Cost of Sprawl: Bad Planning Harms People, Wildlife and the Climate* (Reid-Wainscoat et al., 2024), unintentional wildfires due to human activity and ill-placed developments lead to increased occurrences of poor outdoor and indoor air quality from $PM_{2.5}$ from smoke (*e.g.*, Phuleria et al.,

2005), which can have both acute and long-term health effects that disproportionately affect vulnerable populations, like children, the elderly, those with underlying chronic disease, low-income communities, and communities of color. Hospital visits for respiratory symptoms (*e.g.*, asthma, acute bronchitis, pneumonia, or chronic obstructive pulmonary disease) and cardiovascular symptoms (*e.g.*, congestive heart failure, ischemic heart disease, and myocardial infarction) have been shown to increase during and/or after fire events (Delfino et al., 2009; Künzli et al., 2006; Liu et al., 2015; Rappold et al., 2012; Reid, Brauer, et al., 2016; Viswanathan et al., 2006). In addition, epidemiologists have found that increased exposure to wildfire smoke may also be linked to higher rates of dementia (B. Zhang et al., 2023; Z. Zhang et al., 2023). Researchers estimated that between 2008 and 2018 more than 50,000 premature deaths were caused by California wildfire smoke (Connolly et al., 2024). And wildland firefighters are suffering disproportionately high rates of cancer and other serious diseases, likely due to extreme smoke exposure (Hwang et al., 2023; Johnson & Lam, 2023), as well as mental health issues due to extended fire seasons and working extended shifts away from their families (Ashton et al., 2018; Bransford et al., 2018; Del Real & Kang, 2018; Greene, 2018; Gutierrez, 2018; Simon, 2018).

Increases in wildfire also result in higher frequency and toxicity of smoke exposure to communities in the path of and downwind of the fires. This has become evident especially with the 2025 LA wildfires, where toxic air pollution and runoff from burned buildings and urban infrastructure are a growing concern. This can lead to harmful public health impacts due to increased air pollution not only from burned vegetation, but also from burned homes, commercial buildings, cars, etc. Buildings and structures often contain plastic materials, metals, and various stored chemicals that release toxic chemicals when burned, such as pesticides, solvents, paints, and cleaning solutions (Weinhold, 2011). During the 2018 Camp Fire that burned 19,000 structures, the smoke caused dangerously high levels of air pollution in the Sacramento Valley and Bay Area and the California Air Resources Board found that high levels of heavy metals like lead and zinc traveled more than 150 miles (CARB, 2021). And unsafe levels of lead, arsenic, and other dangerous metals have been documented in and downwind of the Eaton and Palisades fire footprints (Champlin, 2025; H. Smith & Briscoe, 2025).

F. More Unintentional Ignitions Due to Development in Fire Zones Increases Firefighting Costs and Strain on Firefighters.

More development in fire-prone areas will necessitate significant firefighting costs from both state and local authorities. CalFire is primarily responsible for addressing wildfires when they occur, and its costs have continued to increase as wildfires in the wildland-urban interface have grown more destructive. As mentioned above, the cost of fire suppression in areas managed by CalFire has skyrocketed from $114 million in the 2000-2001 fiscal year to close to $3 billion for the 2020-2021 and 2021-2022 fiscal years combined (CalFire 2022). The Legislative

Analyst's Office (LAO) reported that CalFire used an estimated $3.3 billion for wildfire protection and suppression in the 2022-2023 fiscal year (LAO 2023). This does not include the cost of lives lost, property damages, or clean up. As noted above, the vast majority of wildfires in California are unintentionally ignited by people in poorly-planned development in high fire prone areas (Balch et al., 2017; Keeley & Syphard, 2018). More development in high fire hazard areas will increase unintentional ignitions and associated fire suppression costs.

Climate change is increasing extreme weather and fire conditions, which, in combination with poorly planned development, has led to more ignitions and longer fire seasons that are increasing strain on over-burdened firefighters and first responders. According to Captain Michael Feyh of the Sacramento Fire Department, California no longer has a fire season (Simon, 2018); wildfires in California are now year-round because of increased human ignitions in fire-prone areas. Emergency calls to fire departments have tripled since the 1980s (Gutierrez & Cassidy, 2018), and firefighters (and equipment) are being spread thin throughout the state. Firefighters often work 24- to 36-hour shifts for extended periods of time (often weeks at a time), and are being kept away from their homes and families for more and more days out of the year (Ashton et al., 2018; Bransford et al., 2018; Del Real & Kang, 2018; Greene, 2018; Gutierrez, 2018; Simon, 2018). In addition, the firefighting force often must rely on volunteers to battle fires year-round. At its peak, more than 16,000 firefighters from the U.S., Canada, and Mexico, including from prison systems, were combatting the 2025 LA wildfires.

The extended fire season is taking a toll on the physical, mental, and emotional health of firefighters, as well as the emotional health of their families (Ashton et al., 2018; Del Real & Kang, 2018; Simon, 2018). As mentioned above, wildland firefighters are suffering disproportionately high rates of cancer and other serious diseases, likely due to extreme smoke exposure (Hwang et al., 2023; Johnson & Lam, 2023). For those fighting urban conflagrations, exposure to hazardous pollutants are even higher. In a preliminary study conducted on firefighters who fought the LA wildfires, lead and mercury blood levels were five and three times higher compared to firefighters who fought vegetation wildfires (Hernandez, 2025). In addition, the physical and mental fatigue of endlessly fighting fires and experiencing trauma can lead to exhaustion, which can cause mistakes in life-or-death situations while on duty, and the constant worry and aftermath that family members endure when their loved ones are away working in life-threatening conditions can be harrowing (Ashton et al., 2018). According to psychologist Dr. Nancy Bohl-Penrod, the strain of fighting fires without having sufficient breaks can impact firefighters' interactions with their families, their emotions, and their personalities (Bransford et al., 2018). There have also been reports that suicide rates and substance abuse have increased among firefighters (Cart, 2022; Greene, 2018; Simon, 2018).

G. Wildfire Disproportionately Affects Low-Income and Minority Communities.

Wildfire impacts disproportionately affect low-income and minority communities. As discussed in the Center's 2021 Built to Burn report (Yap, Rose, Broderick, et al., 2021):

> Past environmental hazards have shown that those in at-risk populations (*e.g.,* low-income, elderly, disabled, non-English-speaking, homeless) often have limited resources for disaster planning and preparedness (Richards, 2019). Vulnerable groups also have fewer resources to have cars to evacuate, buy fire insurance, implement defensible space around their homes, or rebuild, and they have less access to disaster relief during recovery (Davis, 2018; Fothergill & Peak, 2004; Harnett, 2018; Morris, 2019; Richards, 2019).
>
> In addition, emergency services often miss at-risk individuals when disasters happen because of limited capacity or language constraints (Richards, 2019). For example, evacuation warnings are often not conveyed to disadvantaged communities (Davies et al., 2018). In the aftermath of wildfires and other environmental disasters, news stories have repeatedly documented the lack of multilingual evacuation warnings leaving non-English speakers in danger. (Axelrod, 2017; Banse, 2018; Gerety, 2015; Richards, 2019). Survivors are left without resources to cope with the death of loved ones, physical injuries and emotional trauma from the chaos that wildfires have inflicted on their communities.
>
> Health impacts from wildfires, particularly increased air pollution from fine particulates ($PM_{2.5}$) in smoke, also disproportionately affect vulnerable populations, including low-income communities, people of color, children, the elderly and people with pre-existing medical conditions (Delfino et al., 2009; Hutchinson et al., 2018; Jones et al., 2020; Künzli et al., 2006; Reid, Jerrett, et al., 2016).
>
> Increased $PM_{2.5}$ levels during wildfire events have been associated with increased respiratory and cardiovascular emergency room visits and hospitalizations, which were disproportionately higher for low socioeconomic status communities and people of color (Hutchinson et al., 2018; Jones et al., 2020; Liu et al., 2017; Reid, Jerrett, et al., 2016). Similarly, asthma admissions were found to have increased by 34% due to smoke exposure from the 2003 wildfires in Southern California, with elderly and child age groups being the most affected (Künzli et al., 2006).
>
> Farmworkers, who are majority people of color, often have less access to healthcare due to immigration or economic status. They are more vulnerable to the health impacts of poor air quality due to increased exposure to air pollution as

they work. Yet farmworkers often have to continue working while fires burn, and smoke fills the air, or risk not getting paid (Herrera, 2018; Kardas-Nelson et al., 2020; Parshley, 2018).

When wildfires burn through communities, they threaten homes, livelihoods, lives, and health. In addition to the immediate impacts of lives and homes lost, evacuations and displacement, impacts from air pollution, soil contamination, lost jobs, and the trauma of escape and recovery extend well beyond the fire footprint and last long after the fire is extinguished. The SEIR fails to adequately assess and mitigate the Project's impacts to wildfire risk and the aftermath of a wildfire when it burns through communities in and near the Project area.

IV. THE PRDSEIR'S REVISED SECTIONS REGARDING IMPACTS TO WESTERN SPADEFOOT REMAIN INADEQUATE.

Due to their dependence on ephemeral aquatic breeding sites connected to suitable upland habitat, western spadefoots are particularly sensitive to habitat disruption. Increasingly fragmented habitats can create isolated subpopulations that have higher risks of local extinction (Neal et al., 2020). In southern California, western spadefoot populations have become extremely fragmented, and persistence of remaining subpopulations of is fragile (Halstead et al., 2021; Neal, 2019; Neal et al., 2020).

Additionally, western spadefoots are demographically unstable, meaning their population recruitment varies from year to year depending on environmental conditions, especially rainfall (Fisher & Shaffer, 1996). The species therefore experiences large annual fluctuations in population sizes, as breeding and recruitment can boom during exceptionally wet years and be impossible in dry/drought years. This high demographic instability makes them particularly sensitive to habitat alterations that may interfere with recolonization and reestablishment after unsuccessful recruitment years (Fisher & Shaffer, 1996).

Western spadefoot populations are often able to persist in the face of environmental variability due to metapopulation connectivity; when one population experiences declines, migrants from surrounding populations can bolster the population and prevent local extirpation. As climate change impacts become more severe and extreme weather events continue to occur, shifts in hydroperiod and increased temperatures expected to become more extreme (Montrone et al., 2019; Pyke, 2004; Thomson et al., 2016), and such population dynamics are likely to be increasingly important for species persistence. Due to reduced connectivity between suitable habitats, populations that are unable to successfully breed may decline and disappear and will be unable to be re-established by neighboring populations, leading to further permanent species decline. It is therefore highly important to consider habitat connectivity between upland and aquatic habitat as well as between different pools and pool complexes.

The PRDSEIR's analysis fails to take these important factors into account and therefore fails to provide sufficient mitigation that would ensure the local population persists into the future.

A. The PRDSEIR does not provide an adequate baseline regarding western spadefoot presence.

We appreciate that the PRDSEIR clarifies the pond descriptions and pond names in the various previous surveys and environmental review documents. However, the PRDSEIR still provides conflicting evidence regarding VP6/Pond 3. First, the PRDSEIR states that the initial fairy shrimp surveys in 2004/2005 showed that VP6 "did not support WST at the same time they were observed in SP 1 and VP 1 but did support western toad larvae leading to the conclusion that the habitat is at least potentially suitable during such above-average years." (Draft Western Spadefoot Toad (*Spea hammondii*) Impact Assessment and Habitat Mitigation and Monitoring Plan, or "WST Plan," p.8). Later, the SEIR states that "the feature designated VP 6 by BonTerra exhibited suitable ponding but WST were not detected." (WST Plan, p.10). It is not clear why the presence of tadpoles is not considered to be a detection of WST, or why the EIR would conclude that the habitat is "potentially suitable" and not "occupied." Despite claims that the pond does not support western spadefoot, the SEIR does acknowledge that it provides suitable habitat, and the proposed mitigation does include VP6/Pond 3 in its calculation of pond acreage that must be mitigated (WST Plan, p.13). Nonetheless, the characterization of VP 6/Pond 3 as unoccupied is unfounded, and downplays the importance of the existing pools to the spadefoot population present on the Project site.

The PRDSEIR also minimizes the importance of the western spadefoot population present at the Project site. The PRDSEIR states that the Court Ruling "suggests that WST are very rare within the Castaic area and the surrounding areas of northern Los Angeles County." (WST Plan, p.7). However, the Court Ruling merely echoes the comment letter submitted by CDFW,[5] which itself cites the Applicant's own previous environmental review document, specifically the SEIR. As quoted in the letter, the PRDSEIR states: "the Grasshopper Canyon population is one of few known populations in the region."

The PRDSEIR provides CNDDB records to show that numerous observations (35+) of western spadefoot occur in the region near the Project site and therefore claims that "WST populations are not rare in the nearby areas." (WST Plan, p.7). However, it is important to note that CNDDB observations do not necessarily represent whole populations, merely element occurrences. In fact, many western spadefoot CNDDB observations in the region are clustered and likely represent the same population. To better understand the occurrences discussed in the

[5] Courtney, Betty J. June 15, 2017. Northlake Specific Plan Project (PROJECT), DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT REPORT (DSEIR), SCH# 2015031080.

PRDSEIR, we conducted a query of CNDDB western spadefoot occurrences on May 21, 2025 including the Mint Canyon, Newhall, Val Verde, and Whitaker Peak, and San Fernando 7.5 Minute Quadrangles ("quads") (note that we included additional quads that were further from the Project site than those displayed in the PRDSEIR to capture the entire Santa Clarita Valley). Our search resulted in 44 total observations, including those at the Project site in the Whitaker Peak quad. Of these observations, only 10 had occurrence ranks (a ranking of the quality of the habitat and the condition of the population at that location) of "Good" or "Excellent;" 10 others were "Fair," 10 were "Poor," 14 were "Unknown" and one was "Possibly extirpated." The CNDDB results therefore do not necessarily indicate a healthy, widespread population—rather, they show that western spadefoot do occur in the area, but while numerous populations appear healthy, numerous others are likely struggling. We do not dispute the fact that western spadefoot occur south and west of the project, but this does not mean they are common, and it certainly does not mean they are free from risk of regional decline.

Additionally, the population at the Project site lies in an important location in the species' range, considering western spadefoot biogeography. Western spadefoot in southern California (south of the Transverse Ranges) are genetically distinct from western spadefoots in central and northern California (Neal et al., 2018). The western spadefoot present in the Project area belong to the southern population, which has experienced more severe declines than the northern population (although both populations have been heavily impacted by habitat loss and continue to decline). It is of course important to protect all existing western spadefoot populations, but the population present at the Project site lies at the northernmost extent of the southern western spadefoot population. If the westerns spadefoot currently present at the Project site are lost, the range of the southern population will shrink, furthering the pattern of regional decline. Thus, while the SEIR is correct in observing that other populations occur in and around the Santa Clarita Valley (Exhibit 3), it is important to recognize that this does not diminish the importance of the population at the Project site, especially considering its place at the northern edge of the southern population's range.

B. The proposed mitigation for impacts to western spadefoot is insufficient.

The mitigation for impacts to western spadefoot in the form of mitigation ponds is improved from previous environmental review documents but is still not sufficient to ensure long-term population persistence.

First, the PRDSEIR's analysis of previous studies misrepresents the efficacy of artificial pools as mitigation for impacts to existing aquatic habitat. The PRDSEIR cites Baumberger (2020) as evidence that artificial ponds can successfully provide habitat to western spadefoot, which we do not dispute. However, the SEIR misrepresents the results of this study, claiming that the mitigation was more successful than it was.

Baumberger (2020) investigated the success of artificial breeding pools that were created in 2006 as mitigation for impacts to ten breeding pools at a site in East Orange. The mitigation for this project included the creation of 21 pools to mitigate for the 10 affected pools, providing a total mitigation ratio of 2.1:1. Fifteen of these pools (which became 14 when two pools merged together) were in Irvine Mesa, and six were in Shoestring Canyon.

The PRDSEIR focuses only on the results related to Irvine Mesa, ignoring the results from pools at Shoestring Canyon. In Shoestring Canyon, all six mitigation pools failed to hold water and breeding western spadefoot were completely absent from the pools and the nearby creek bed during the 2016 survey period (Baumberger et al., 2020). The PRDSEIR omits this information, focusing only on the pools in Irvine Mesa, which had higher rates of success, thereby misrepresenting the success of the mitigation and making it appear to be more successful than it was.

Further, the results of Irvine Mesa are also misstated. The PRDSEIR quotes the following excerpt of the study itself, claiming that this excerpt shows WST breeding in 12 of the 14 pools on Irvine Mesa (WST Plan, p.31):

> Twelve of the 14 mitigation pools at Irvine Mesa held water for >30 d. During our 2016 surveys, two of the mitigation pools built by Glenn Lukos Associates, Inc. merged (Pools 5 and 9) and we considered them as one pool (Pool 9). We detected *S. hammondii* tadpoles in eight of the Irvine Mesa mitigation pools but documented successful breeding through metamorphosis at only seven of these pools in April 2016 due to desiccation and/or water quality.

However, this excerpt only says that 12 of the 14 pools held water for >30 days. It does not say that western spadefoot were breeding in those pools. In fact, the sentence following this excerpt states "*Spea hammondii* did not breed in all the pools with hydroperiods >30 d (Table 3)." (Baumberger et al., 2020). The excerpt itself states that tadpoles were only detected in eight of the pools, and breeding through metamorphosis was only observed at seven of the pools. It is difficult to understand therefore why the PRDSEIR claims that western spadefoot were breeding in 12 of the 14 pools in 2016, when the very excerpt they cite to support this statement says WST only bred in seven of these pools.

This misrepresentation makes it appear that the artificial mitigation pools were more successful during the drought year of 2016 than the reality. In fact, only ½ of the pools in Irvine Mesa showed successful breeding in 2016, and 0/6 of the pools in Shoestring Canyon showed successful breeding, leading to an overall success rate of just 33%. Thus the mitigation ratio of 2.1:1 did not even successfully mitigate for the full impacts to the ten original pools.

The EIR notes that the 2016 study occurred during a drought year, and that monitoring of the following 2016/2017 season showed tadpoles in 12 of the pools and "extensive breeding was present" (WST Plan p.31). The reference cited to support this claim is not published and is not publicly available (as far as we can ascertain), so it is impossible to determine whether the "12 pools" refers to pools in Irvine Mesa only or in Irvine Mesa and Shoestring Canyon, and therefore it is impossible to determine the overall efficacy of the mitigation during this "ideal" wet year. It appears likely that the study refers only to Irvine Mesa, in which case the population did show a notable increase in pool occupation, but the exclusion of Shoestring Canyon remains unexplained.

The PRDSEIR goes on to conclude that this observed change in number of pools occupied (from seven in the drought year to 12 the following wet year) shows that given adequate pool quality, "WST will increase in such ponds until a level of equilibrium is achieved (i.e., self-sustaining population), and the pools arrive at their carrying capacity" (p.31). This conclusion is unfounded and has no bearing on the adequacy of mitigation. Even if the study is limited to Irvine Mesa, it is unclear why occupancy of just 12 of the 14 pools would indicate that carrying capacity was reached. The PRDSEIR provides no explanation for this cutoff.

Further, occupancy of pools (which is what the PRDSEIR relies on in making this claim) is not enough to determine carrying capacity. Carrying capacity is the maximum population size that an area can support and sustain. Carrying capacity is therefore a demographic measure, and depends on many population factors including the number, age, and behavior of individuals, among others. Whether a pond is occupied or not does not provide this information. It is possible for ponds to be occupied by many individuals or few, and without actual demographic data it is impossible to say whether a population has reached carrying capacity. It is encouraging to see that the WST Plan includes some demographic monitoring, including counts of egg masses, larvae, and metamorphs (WST Plan, p.27). Such data collected over the ten-year monitoring period would no doubt be informative and aid in our understanding of western spadefoot ecology and demography. But without such data, claims about carrying capacity lack evidence.
Rather, what the data on increased pool occupancy during the 2016/2017 rainy season show is that the western spadefoot population size and pool occupancy varies depending on climatic conditions, as is well known. Changes in abundance between drought years and breeding years are common for western spadefoot (Fisher & Shaffer, 1996). Importantly, mitigation measures must be sufficient to support populations during drought years, not only during average or rainy years. If mitigation ratios and/or mitigation measures are designed with average or wet years in mind, they are likely to underperform during drought years and therefore leave western spadefoots vulnerable to extirpation. Given the variable conditions experienced by vernal pools including drought—which can last for years in California and is expected to become more common in the future (Diffenbaugh et al., 2015)—reliance on a simple 1:1 replacement is not sufficient to mitigate for impacts to breeding habitat by creating artificial pools.

However, this is essentially what the EIR does. The EIR proposes to create 1.07 acres of artificial ponds to mitigate for 0.95 acres of impacted ponds, which amounts to a mitigation ratio of just 1.1:1 (WST Plan, p.13, p.18). Given the success rate of the very study that is cited in the EIR (Baumberger et al., 2020), this mitigation ratio is unlikely to successfully replace the breeding habitat currently present on the property, and leaves the population at risk of decline or extirpation during extended droughts.

Further, the proposed mitigation ponds are very clustered, unlike the current pond arrangement. Currently, the stock pond is approximately 4,000ft away from the seasonal ponds, which are all within approximately 100-400ft of one another (including VP-6/Pond 3) (WST Plan, Exhibit 4). However, the proposed mitigation ponds are all clustered very close together on the west side of the property, within 50ft of one another (WST Plan, Exhibit 5). The EIR claims that "total acreage as opposed to number of ponds is all that is relevant" (WST Plan, p.18). However, this claim does not consider the importance of landscape connectivity and potential metapopulation dynamics. As discussed above, the natural history of western spadefoots makes them vulnerable to climate and habitat disturbances. Given the variation in geology, hydrology, climate, and habitat across a landscape, if one population declines or becomes extirpated, it is possible that others nearby can survive and re-colonize. If the ponds are all clustered, any extreme climatic events or random disturbances are likely to impact all of them in similar ways. On the contrary, if ponds are more spread out across the landscape, the local population is more resilient to random disturbance and potential climatic, hydrological, and ecological changes as well.

The proposed mitigation is therefore insufficient because a) the mitigation ratio is too low, and does not provide sufficient replacement habitat in the form of artificial pools and b) the ponds are too close together, increasing the risk of extirpation compared to more dispersed aquatic habitat. The EIR must remedy these deficiencies by a) increasing the mitigation ratio to at least 3:1, thereby providing increased acreage of artificial breeding ponds and b) placing additional mitigation ponds further from the three currently proposed ponds to provide landscape-level population resilience.

The WST Plan notes in its discussion of contingency mitigation that there are "nearby sites which can be utilized as replacement site(as) (*sic*) such that the mitigation criteria are fulfilled," including locations at the north end of the Project site and in nearby Marple Canyon (WST Plan p.30). A revised EIR should include these sites not as contingency sites, but as enforceable mitigation sites for additional artificial pools.

V. THE PROJECT DOES NOT ADEQUATELY DEFINE AFFORDABILITY, NOR DOES IT GUARANTEE THE LONGEVITY OF THE DESIGNATED AFFORDABLE UNITS.

California is experiencing an affordable housing crisis (Kimberlin, 2019). In October 2021, about half of Americans (49%) said housing affordability was a major problem where they live, up 10 percentage points from early 2018. In the same 2021 survey, 70% of Americans said young adults today have a harder time buying a home than their parents' generation did.[6]

These perceptions are backed by data. The national median sale price for a single-family home jumped 25% from $327,100 in the fourth quarter of 2019 (the last full quarter unaffected by the COVID-19 recession) to $408,100 in the fourth quarter of 2021.[6] These impacts also extend to those that are renting their homes. In 2020, 30% of all households had "unaffordable" rent or mortgage payments, defined as exceeding 30% of monthly household income. This is up 1.5 percentage points from 2019. More than 1 in 7 households paid over half of their income on housing.[7]

A variety of factors have set the stage for the financial challenges American homeowners and renters have been facing in the housing market. These include incomes that haven't kept up with inflation, a surge in investor owned properties, rising interests rates, and short term rentals. [7]

To change these trends, it is critical that the County invest in building units that are permanently designated as affordable. While this project does include affordable units at the request of the County, the PRDSEIR does not define affordability, nor does it guarantee these units will remain affordable in perpetuity.

Currently 10% of the units in the NLSP are designated as affordable (PRDSEIR, page 2-56). We encourage the County to set specific targets of either 15% of all units, designated for those that make 50% of the average median income or 20% of all units, designated for those that make 60% of average median income. Additionally, these units should never term out. They can be adjusted if the AMI changes, but they should be affordable in perpetuity.

VI. THE PRDSEIR'S TRANSPORTATION SECTION FAILS TO SUFFICIENTLY ANALYZE THE PROJECT'S VMTS AND MITIGATE IMPACTS.

Increasing a region's VMTs isn't just bad planning, it also undermines community health. Increased VMT increases emissions of air pollutants such as nitrogen oxides (NO_x), volatile organic compounds (VOCs), carbon monoxide, heavy metals, carbon dioxide and respirable particulate matter ($PM_{2.5}$). Increased VMT also leads to more ozone (O_3) production through the photochemical reactions of NO_x and VOCs emitted by vehicles (Lurmann et al., 2015). Short- and long-term exposure to several of these pollutants has been linked to premature mortality,

[6] https://www.pewresearch.org/fact-tank/2022/03/23/key-facts-about-housing-affordability-in-the-u-s/
[7] https://www.habitat.org/costofhome/2022-state-nations-housing-report-lack-affordable-housing

compromised birth outcomes, heart disease and a host of respiratory illnesses (Mujtaba & Shahzad, 2021).

Another serious direct impact of increasing the number of cars on roads is automobile crashes, which are the leading cause of death among young people (15 to 19 years old) in the United States.[8] An estimated 42,915 people in the U.S. died in car crashes in 2021 alone and 3.4 million people are injured each year, which costs an estimated $473.2 billion annually as measured by wage and productivity losses, medical expenses, motor-vehicle damage, and employers' uninsured costs (Frumkin et al., 2004; U.S. Department of Transportation, 2022).[9]

Beyond the direct impacts, increased VMT has long term impacts on commuters. In 2019, the duration of the average daily commute in the United States increased to a new high of 55.2 minutes, and a record 9.8 percent of commuters reported daily commutes of at least 2 hours (Burd et al., 2021). These long commutes reduce time available to spend with family, friends, and community, and reduce opportunities for healthy recreation. The increase in inactivity and isolation can also lead to long-term health complications such as pre-diabetes, diabetes, obesity, asthma, isolation, stress and depression (Ewing et al., 2003; Leyden, 2003).

iii. The PRDSEIR's Unsupported Baseline Invalidates the Traffic Analysis.

The PRDSEIR incorrectly concludes that there will be no significant transportation impacts associated with the project. The PRDSEIR's revised traffic analysis is invalid because of its reliance on an inaccurate baseline that does not reflect current environmental conditions. The EIR's resulting conclusion that this development—a sprawl development surrounded by vacant land on two sides, five miles from the nearest town—will have insignificant VMT impacts is incorrect. (SEIR at 3-1.)

CEQA requires that an EIR identify the environmental baseline against which project impacts will be assessed. (Guidelines § 15125(a) [agency must describe "baseline physical conditions by which a lead agency determines whether an impact is significant"].) "Establishing a baseline at the beginning of the CEQA process is a fundamental requirement so that changes brought about by a project can be seen in context and significant effects can be accurately identified." (*Communities for a Better Environment v. City of Richmond* (2010) 184 Cal.App.4th 70, 89 [emphasis added].) An accurate environmental baseline is critical to the CEQA process because it forms the foundation for the entire EIR, serving as the point of comparison for

[8] Center for Disease Control and Prevention. "Underlying Cause of Death, 2018-2021." https://wonder.cdc.gov

[9] NSC Injury Facts. "Costs of Motor-Vehicle Injuries." 2021. https://injuryfacts.nsc.org/all-injuries/costs/guide-to-calculating-costs/data-details/

evaluating the significance of impacts. (*County of Amador v. El Dorado County Water Agency* (1999) 76 Cal.App.4th 931, 953-54.) Accordingly, an EIR does not comply with CEQA where the environmental baseline is "inaccurate, incomplete, or misleading." (*Clover Valley Foundation v. City of Rocklin* (2011) 197 Cal.App.4th 200, 219 (citation omitted).)

An EIR must evaluate the significance of an environmental impact and the effectiveness of mitigation against a baseline of existing conditions, not against hypothetical conditions that might be allowed but have never actually occurred. (14 Cal Code Regs §15125(a)(3). See *Woodward Park Homeowners Ass'n v City of Fresno* (2007) 150 CA4th 683, 707 (EIR for planning and zoning changes for new commercial development rejected because EIR compared proposed development only to hypothetical office park that could be developed under preexisting plan but did not compare proposed development with existing physical conditions on site); *Environmental Planning & Info. Council v County of El Dorado* (1982) 131 CA3d 350 (EIR on proposed new general plan must address existing level of physical development as baseline for impact analysis, not existing plan, even though new plan would allow less growth than existing plan).)

The project site is currently undeveloped (SEIR at 2-81; 2-88; 2-92). But the PRDSEIR evaluates traffic impacts of the project not against the site's current environmental condition, as required by law, but against the hypothetical full buildout of a specific plan that was adopted in 1992 but never actually built. (PRDSEIR at 2-53, 55.) That specific plan authorized 2,337 single family units, 1,286 multi-family units, commercial and industrial space, and an 18-hole golf course. (*Id.* at 2-53.) The PRDSEIR estimates that the plan being considered here will have lower VMT than the 1992 plan. (*Id*. at 2-56.) But what might have been approved in 1992 is not the current environmental condition of the site, is not the correct baseline, and is not relevant to whether this Project has significant impacts. (14 Cal Code Regs §15125(a)(3). See *Woodward Park Homeowners Ass'n v City of Fresno* (2007) 150 CA4th 683, 707.) The traffic analysis must be revised and recirculated.

iv. The SEIR Fails to Mitigate for VMT Impacts.

The County must impose mitigation measures to reduce impacts associated with increasing the County's vehicle miles travelled. CEQA requires that mitigation must include concrete, specific, and enforceable actions. (*California Clean Energy Committee v. City of Woodland* (2014) 225 Cal.App.4th 173 [City's urban decay mitigation measures were inadequate under CEQA to address the impact from the development of a 234-acre regional shopping center on undeveloped agricultural land because the measures did not ensure the city would take concrete, measurable actions].) The County may not defer mitigation measures to a later date unless the EIR provides specific reasons why they cannot be developed now and provides specific performance measures to evaluate their success. (*Preserve Wild Santee v. City of Santee*

(2012) 210 CA 4th 260, 281 [mitigation measures that are so undefined that their effectiveness is impossible to determine are legally inadequate].)

There are many mitigation measures that can and should be incorporated. Specifically, investment in public transit should be a priority of the project. Providing alternatives to single occupancy vehicle travel is essential to building an efficient, sustainable and equitable transportation system. Unfortunately, we have a long way to go if we are going to achieve this vision in the U.S. In 2013, it was reported that of all the U.S. daily commutes to work, 76.4% are of people driving alone (McKenzie, 2015). According to the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2015, our collective daily transportation in the U.S. constitutes about 27% of the total greenhouse gasses released (U.S. Environmental Protection Agency, 2017) California's annual average emissions associated with passenger vehicles between 2000 and 2020 was approximately 110 million metric tons of CO2e.

To change these trends, government agencies need to invest in alternative modes of transportation to not only make them cheaper to use, but more efficient than driving. **Best practices for transportation options should include providing free public transit services for future residents and workers; implementing bus only lanes; optimizing bus routes to minimize overlap and ensuring coverage across the city in line with demand; and providing high-frequency, reliable services with regular bus stops for easy access.**

Studies indicate that free public transit services typically result in ridership increase from 20% to 60% in a matter of just a few months (Studenmund and Connor, 1982). Similarly, bus lanes that reduce total transit door-to-door travel times by 5%-15% will increase urban peak ridership 2%-9% (UCLA Institute of Transportation Studies, 2019). Lastly, ensuring accessibility and convenience is essential to increasing ridership. Providing more bus stops decreases the distance residents have to travel to access such services.

It should be a priority of all governments to reduce VMTs with every new project, but instead this proposed sprawl development would steer the region in the opposite direction, eroding community and environmental health to build more sprawl development that relies on single-occupancy vehicle infrastructure. It is the "policy of the state that public agencies should not approve projects as proposed if there are feasible alternatives or feasible mitigation measures which will avoid or substantially lessen the significant environmental effects of such projects." (Pub. Res. Code § 21002.)

An accurate analysis of the Project's VMT impacts is needed and adoption of feasible mitigation measures that lower the Project's overall transportation impacts and its associated contribution to climate change, bad air quality and overall decreases community health are necessary.

v. The Project Does Not Comply with the General Plan's Goal to Reduce Vehicle Miles Travelled.

Los Angeles County's General Plan states that the county should "support land uses that promote bicycling and walking, and reduce VMTs (Policy LU 5.3, Land-Use Element, Page 75). The Los Angeles County Sustainability Plan states that "reducing vehicle miles traveled by prioritizing alternatives to single occupancy vehicles" is a key strategy (Strategy 8A, page 118). Additionally, the Southern California Association of Government's Regional Transportation plan states that a "more compact and sustainable land use pattern, combined with the transportation network improvements and strategies identified in Connect SoCal, will result in an improved pedestrian and bicycle environment, access to more community amenities, shorter average trip lengths, reduced VMT and better regional air quality" (Connect SoCal, page 144). The RPSDEIR concludes that "the Project does not conflict with the General Plan, any program plan, ordinance, or policy addressing the circulation system" (PRDSEIR, page 2-57).

However, this again relies on the false assumption that the VMT calculation does not need to rely on the County baseline. Research shows that suburban and exurban sprawl increases a region's VMTs (Rubiera-Morollón & Garrido-Yserte, 2020; Mujtaba & Shahzad, 2021). The NLSP represents sprawl and thus it will clearly increase the regions VMTs. This makes it in conflict with the County's General Plan, Sustainability Plan and Regional Transportation Plan.

The County should divest from such poor planning practices and instead focus on development of infill areas that already have critical community infrastructure.

VII. THE REVISED ALTERNATIVES ANALYSIS REMAINS INADEQUATE.

The PRDSEIR's alternatives analysis is conclusory and incorrectly asserts that the environmentally superior alternative would not meet Project objectives. CEQA mandates that significant environmental damage be avoided or substantially lessened where feasible. (Pub. Res. Code § 21002; Guidelines §§ 15002(a)(3), 15021(a)(2), 15126(d).) Moreover, although "an EIR need not consider every conceivable alternative to a project . . . it must consider a reasonable range of potentially feasible alternatives that will foster informed decision decision-making and public participation." (Guidelines § 15126.6(a).) Additionally, the "key to the selection of the range of alternatives is to identify alternatives that meet most of the project's objectives but have a reduced level of environmental impacts." (*Watsonville Pilots Assn. v. City of Watsonville* (2010) 183 Cal.App.4th 1059, 1089.) Accordingly, a rigorous analysis of reasonable alternatives to the Project must be provided to comply with this strict mandate. Unfortunately, the SEIR fails to meet this requirement because its analysis of the alternatives proposed is inadequate.

CEQA requires that before approving a project with significant environmental impacts, the agency must make findings identifying the specific considerations that make the environmentally superior alternative infeasible. (Pub. Res. Code § 21081; *Preservation Action Council v. City of San Jose* (2006) 141 Cal.App.4th 1336, 1351-52.) As the Center commented in 2020, the County improperly rejected Alternative C for not meeting "all the project objectives." (DEIR, Appendix D [FEIR at 5-15].) Specifically, it determined that Alternative C would not be financially and economically feasible. (*Ibid*. ["Alternative C would not provide enough resort amenities or large enough lots for a financially viable luxury resort."].) But under CEQA, determining that an alternative "may be more expensive or less profitable is not sufficient to show that the alternative is financially infeasible." (*Preservation Action Council, supra,* 141 Cal.App.4th at 1352.) Instead, the agency must present "evidence that the additional costs or lost profitability are sufficiently severe as to render it impractical to proceed with the [alternative]." (*Id.*) This evidence may include, for example: total estimated costs, total projected income, total expenses, and the change in the per unit cost of a project that results from a project alternative or mitigation measure. (*Citizens of Goleta Valley*, *supra*, 197 Cal.App.3d at 1180.) The findings of infeasibility must be supported by substantial evidence. (*Id*. at 1176-77.)

The PRDSEIR failed to conduct this analysis for the Creek Avoidance Alternative, instead simply stating that it would not be feasible, without elaboration. (PRDSEIR at 2-86.) For the Partial Creek Avoidance Alternative, the PRDSEIR concludes that it would not meet the project objective of improving opportunities for outdoor recreational experiences simply because it provides 37 fewer acres of open space than the Project. However, the PRDSEIR does not establish that providing 37 fewer acres is a significant impairment of the project objective, especially given that the changed footprint would protect the health of the creek and thereby preserve its use for recreation.

V. CONCLUSION

Thank you for the opportunity to submit comments on the PRDSEIR for the Partial Recirculated Draft Supplemental Environmental Impact Report NorthLake Specific Plan. We urge the County to prepare a new EIR for the Project that fully complies with CEQA and recirculate. Because significant new information has become available on many other impacts, the County must also reevaluate and incorporate new circumstances as well as new research and studies on those impacts that have become available in the last seven years.

Given the possibility that the Center will be required to pursue legal remedies in order to ensure that the County complies with its legal obligations including those arising under CEQA, we would like to remind the County of its statutory duty to maintain and preserve all documents and communications that may constitute part of the "administrative record" of this proceeding. (§ 21167.6(e); *Golden Door Properties, LLC v. Superior Court* (2020) 53 Cal.App.5th 733, 762.)

The administrative record encompasses any and all documents and communications that relate to any and all actions taken by the County with respect to the Project, and includes "pretty much everything that ever came near a proposed [project] or [] the agency's compliance with CEQA . . . ." (*County of Orange v. Superior Court* (2003) 113 Cal.App.4th 1, 8.) The administrative record further includes all correspondence, emails, and text messages sent to or received by the County's representatives or employees, that relate to the Project, including any correspondence, emails, and text messages sent between the County's representatives or employees and the Applicant's representatives or employees. Maintenance and preservation of the administrative record requires that, inter alia, the County (1) suspend all data destruction policies; and (2) preserve all relevant hardware unless an exact replica of each file is made.

Please add the Center to your notice list for all future updates to the Project and do not hesitate to contact the Center with any questions at the number or email listed below.

Sincerely,





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References

2022 Scoping Plan for Achieving Carbon Neutrality. (2022). California Air Resources Board. https://ww2.arb.ca.gov/sites/default/files/2022-12/2022-sp.pdf

Abatzoglou, J. T., Balch, J. K., Bradley, B. A., & Kolden, C. A. (2018). Human-related ignitions concurrent with high winds promote large wildfires across the USA. *International Journal of Wildland Fire*, *27*(6), 377. http://www.publish.csiro.au/?paper=WF17149

Aguilar, R., Quesada, M., Ashworth, L., Herrerias-Diego, Y., & Lobo, J. (2008). Genetic consequences of habitat fragmentation in plant populations: Susceptible signals in plant traits and methodological approaches. *Molecular Ecology*, *17*, 5177–5188.

Alexandre, P. M., Stewart, S. I., Keuler, N. S., Clayton, M. K., Mockrin, M. H., Bar-Massada, A., Syphard, A. D., & Radeloff, V. C. (2016). Factors related to building loss due to wildfires in the conterminous United States. *Ecological Applications*, *26*(7), 2323–2338.

Alexandre, P. M., Stewart, S. I., Mockrin, M. H., Keuler, N. S., Syphard, A. D., Bar-Massada, A., Clayton, M. K., & Radeloff, V. C. (2016). The relative impacts of vegetation, topography and spatial arrangement on building loss to wildfires in case studies of California and Colorado. *Landscape Ecology*, *31*(2), 415–430.

Allen, M. L., Wittmer, H. U., Houghtaling, P., Smith, J., Elbroch, L. M., & Wilmers, C. C. (2015). The role of scent marking in mate selection by female pumas (Puma concolor). *PLoS ONE*, *10*(10), e0139087.

Allen, M. L., Yovovich, V., & Wilmers, C. C. (2016). Evaluating the responses of a territorial solitary carnivore to potential mates and competitors. *Scientific Reports*, *6*.

Ashton, A., Lillis, R., & Ramirez, W. (2018, August). 249 nights away at California fires: Firefighter families cope with a 'new normal.' *The Sacramento Bee*.

Axelrod, J. (2017, December). California Wildfires Spark Issues of Bilingual Emergency Communications. *American City and County*.

Balch, J. K., Bradley, B. A., Abatzoglou, J. T., Nagy, R. C., Fusco, E. J., & Mahood, A. L. (2017). Human-started wildfires expand the fire niche across the United States. *Proceedings of the National Academy of Sciences*, *114*(11), 2946–2951.

Balch, J. K., Iglesias, V., Mahood, A. L., Cook, M. C., Amaral, C., DeCastro, A., Leyk, S., McIntosh, T. L., Nagy, R. C., St. Denis, L., Tuff, T., Verleye, E., Williams, A. P., & Kolden, C. A. (2024). The fastest-growing and most destructive fires in the US (2001 to 2020). *Science*, *386*(6720), 425–431.

Banse, T. (2018, April). How Do You Say 'Evacuate' in Tagalog? In a Disaster, English Isn't Always Enough. *Northwest Public Broadcasting*.

Barrientos, R., Vickers, W., Longcore, T., Abelson, E. S., Dellinger, J., Waetjen, D. P., Fandos, G., & Shilling, F. M. (2023). Nearby night lighting, rather than sky glow, is associated with habitat selection by a top predator in human-dominated landscapes. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *378*(1892), 20220370.

Barry, J. M., Elbroch, L. M., Aiello-lammens, M. E., Sarno, R. J., Seelye, L., Kusler, A., & Quigley, H. B. (2019). Pumas as ecosystem engineers: Ungulate carcasses support beetle assemblages in the Greater Yellowstone Ecosystem. *Oecologia*, *189*, 577–586.

Baumberger, K. L., Backlin, A. R., Gallegos, E. A., Hitchcock, C. J., & Fisher, R. N. (2020). Mitigation Ponds Offer Drought Resiliency for Western Spadefoot (Spea hammondii) Populations. *Bulletin, Southern California Academy of Sciences*, *119*(1), 1–12.

Becker, R. (2024, February 29). California's urban runoff flows down the drain. Can the drought-plagued state capture more of it? *Cal Matters*.

Beier, P., Choate, D., & Barrett, R. H. (1995). Movement patterns of mountain lions during different behaviors. *Journal of Mammalogy*, *76*(4), 1056–1070.

Benítez-López, A., Alkemade, R., & Verweij, P. A. (2010). The impacts of roads and other infrastructure on mammal and bird populations: A meta-analysis. *Biological Conservation*, *143*, 1307–1316.

Benson, J. F., Abernathy, H. N., Sikich, J. A., & Riley, S. P. D. (2021). Mountain lions reduce movement, increase efficiency during the Covid-19 shutdown. *Ecological Solutions and Evidence*, *2*(3), 1–14.

Benson, J. F., Dougherty, K. D., Beier, P., Boyce, W. M., Cristescu, B., Gammons, D. J., Garcelon, D. K., Higley, J. M., Martins, Q. E., Nisi, A. C., Riley, S. P. D., Sikich, J. A., Stephenson, T. R., Vickers, T. W., Wengert, G. M., Wilmers, C. C., Wittmer, H. U., & Dellinger, J. A. (2023). The ecology of human-caused mortality for a protected large carnivore. *Proceedings of the National Academy of Sciences*, *120*(13), e2220030120.

Benson, J. F., Mahoney, P. J., Sikich, J. A., Serieys, L. E. K., Pollinger, J. P., Ernest, H. B., & Riley, S. P. D. (2016). Interactions between demography, genetics, and landscape connectivity increase extinction probability for a small population of large carnivores in a major metropolitan area. *Proceedings of the Royal Society B: Biological Sciences*, *283*(1837), 20160957. https://doi.org/10.1098/rspb.2016.0957

Benson, J. F., Mahoney, P. J., Vickers, T. W., Sikich, J. A., Beier, P., Riley, S. P. D., Ernest, H. B., & Boyce, W. M. (2019). Extinction vortex dynamics of top predators isolated by urbanization. *Ecological Applications*, *0*(0), e01868. https://doi.org/10.1002/eap.1868

Benson, J. F., Sikich, J. A., & Riley, S. P. D. (2020). Survival and competing mortality risks of mountain lions in a major metropolitan area. *Biological Conservation*, *241*, 108294–108294.

Bistinas, I., Oom, D., Sá, A. C. L., Harrison, S. P., Prentice, I. C., & Pereira, J. M. C. (2013). Relationships between human population density and burned area at continental and global scales. *PLoS ONE*, *8*(12), 1–12.

Bogan, M. T., Leidy, R. A., Neuhaus, L., Hernandez, C. J., & Carlson, S. M. (2019). Biodiversity value of remnant pools in an intermittent stream during the great California drought. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *29*(6), 976–989.

Bolas, E. C., Pingatore, A. D., Mathur, M., Blumstein, D. T., Sikich, J. A., Smith, J. A., Benson, J. F., Riley, S. P. D., & Blakey, R. V. (2025). Human recreation influences activity of a large carnivore in an urban landscape. *Biological Conservation*, *301*, 110812.

Bransford, S., Medina, J., & Del Real, J. A. (2018, July). Firefighters Reflect on a Job Now 'Twice as Violent'. *The New York Times*.

Brehme, C. S., Hathaway, S. A., & Fisher, R. N. (2018). An objective road risk assessment method for multiple species: Ranking 166 reptiles and amphibians in California. *Landscape Ecology*, *33*, 911–935.

Brehme, C. S., Tracey, J. A., Clenaghan, L. R. M. C., & Fisher, R. N. (2013). Permeability of roads to movement of scrubland lizards and small mammals. *Conservation Biology*, *27*(4), 710–720.

Burd, C., Burrows, M., & McKenzie, B. (2021). *Travel Time to Work in the United States: 2019* (American Community Survey Reports). U.S. Department of Commerce, U.S. Census Bureau.

California Air Pollution Control Officers Association. (2021, June). *FAQs: What Updates Are Included in CALEEMod Version 2020.4.0?* https://www.aqmd.gov/caleemod/faqs#previous

California Air Pollution Control Officers Association. (2022, April). *Comparison to CalEEMod Version 2020.4.0*. https://www.caleemod.com/documents/user-guide/09_Appendix H.pdf

California Air Pollution Control Officers Association. (2024). *Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity*. https://caleemod.com/handbook/index.html

CARB. (2021). *Camp Fire Air Quality Data Analysis*.

Cart, J. (2022, June 13). Trial by fire: The trauma of fighting California's wildfires. *Cal Matters*. https://calmatters.org/series/california-firefighters-trauma-wildfires/

Cayan, D. R., DeHaan, L. L., Gershunov, A., Guzman-Morales, J., Keeley, J. E., Mumford, J., & Syphard, A. D. (2022). Autumn precipitation: The competition with Santa Ana winds in determining fire outcomes in southern California. *International Journal of Wildland Fire*, *31*(11), 1056–1067. https://www.publish.csiro.au/WF/WF22065

Ceia-Hasse, A., Navarro, L. M., Borda-de-Água, L., & Pereira, H. M. (2018). Population persistence in landscapes fragmented by roads: Disentangling isolation, mortality, and the effect of dispersal. *Ecological Modelling*, *375*, 45–53.

Champlin, C. (2025, April 11). The Eaton Fire hit Caltech scientists close to home. Now, they're studying the toxic aftermath. *KQED*. https://www.kqed.org/news/12035344/the-eaton-fire-hit-caltech-scientists-close-to-home-now-theyre-studying-the-toxic-aftermath

Chen, B., & Jin, Y. (2022). Spatial patterns and drivers for wildfire ignitions in California. *Environmental Research Letters*, *17*(5), 055004.

Climate Action Tracker. (2023). *Warming Projections Global Update*.

Connolly, R., Marlier, M. E., Garcia-Gonzales, D. A., Wilkins, J., Su, J., Bekker, C., Jung, J., Bonilla, E., Burnett, R. T., Zhu, Y., & Jerrett, M. (2024). Mortality attributable to PM 2.5 from wildland fires in California from 2008 to 2018. *Science Advances*, *10*(23), eadl1252. https://doi.org/10.1126/sciadv.adl1252

Crooks, K. R. (2002). Relative sensitivities of mammalian carnivores to habitat fragmentation. *Conservation Biology*, *16*(2), 488–502.

Cushman, S. A. (2006). Effects of habitat loss and fragmentation on amphibians: A review and prospectus. *Biological Conservation*, *128*, 231–240.

Cushman, S. A., McRae, B., Adriaensen, F., Beier, P., Shirley, M., & Zeller, K. (2013). Biological corridors and connectivity. In D. W. Macdonald & K. J. Willis (Eds.), *Key Topics in Conservation Biology 2* (First Edit, pp. 384–403). John Wiley & Sons, Ltd.

Damschen, E. I., Brudvig, L. A., Burt, M. A., Jr, R. J. F., Haddad, N. M., Levey, D. J., Orrock, J. L., Resasco, J., & Tewksbury, J. J. (2019). Ongoing accumulation of plant diversity through habitat connectivity in an 18-year experiment. *Science*, *365*(6460), 1478–1480.

Davies, I. P., Haugo, R. D., Robertson, J. C., & Levin, P. S. (2018). The unequal vulnerability of communities of color to wildfire. *PLoS ONE*, *13*(11), 1–15.

Davis, M. (2018, December). A tale of two wildfires: Devastation highlights California's stark divide. *The Guardian*.

Del Real, J. A., & Kang, I. (2018, July). California Today: The Increasing Strain on State Firefighters. *The New York Times*. https://www.nytimes.com/2018/07/30/us/california-today-firefighters.html

Delaney, K. S., Busteed, G., Fisher, R. N., & Riley, S. P. D. (2021). Reptile and Amphibian Diversity and Abundance in an Urban Landscape: Impacts of Fragmentation and the Conservation Value of Small Patches. *Ichthyology and Herpetology*, *109*(2), 424–435.

Delaney, K. S., Riley, S. P. D., & Fisher, R. N. (2010). A rapid, strong, and convergent genetic response to urban habitat fragmentation in four divergent and widespread vertebrates. *PLoS ONE*, *5*(9), e12767.

Delfino, R. J., Brummel, S., Wu, J., Stern, H., Ostro, B., Lipsett, M., Winer, A., Street, D. H., Zhang, L., Tjoa, T., & Gillen, D. L. (2009). The relationship of respiratory and cardiovascular hospital admissions to the southern California wildfires of 2003. *Occupational and Environmental Medicine*, *66*(3), 189–197.

Dellinger, J. A., Gustafson, K. D., Gammons, D. J., Ernest, H. B., & Torres, S. G. (2020). Minimum habitat thresholds required for conserving mountain lion genetic diversity. *Ecology and Evolution*, *10*, 10687–10696.

Dickson, B. G., & Beier, P. (2002). Home-range and habitat selection by adult cougars in Southern California. *The Journal of Wildlife Management*, *66*(4), 1235–1245.

Dickson, B. G., Jennes, J. S., & Beier, P. (2005). Influence of Vegetation, Topography, and Roads on Cougar Movement in Southern California. *Journal of Wildlife Management*, *69*(1), 264–276.

Diffenbaugh, N. S., Swain, D. L., & Touma, D. (2015). Anthropogenic warming has increased drought risk in California. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(13), 3931–3936.

Dong, C., Williams, A. P., Abatzoglou, J. T., Lin, K., Okin, G. S., Gillespie, T. W., Long, D., Lin, Y.-H., Hall, A., & MacDonald, G. M. (2022). The season for large fires in Southern

California is projected to lengthen in a changing climate. *Communications Earth & Environment*, *3*, 1–10.

Dougherty, K. D., Dellinger, J. A., Cristescu, B., Gammons, D. J., Garcelon, D. K., Higley, J. M., Martins, Q. E., Riley, S. P. D., Sikich, J. A., Stephenson, T. R., Vickers, T. W., Wengert, G. M., Wilmers, C. C., Wittmer, H. U., & Benson, J. F. (2025). A Functional Response in Resource Selection Links Multiscale Responses of a Large Carnivore to Human Mortality Risk. *Ecology Letters*, *28*(1), e70035.

Ernest, H. B., Boyce, W. M., Bleich, V. C., May, B., Stiver, S. J., & Torres, S. G. (2003). Genetic structure of mountain lion (Puma concolor) populations in California. *Conservation Genetics*, *4*, 353–366.

Ernest, H. B., Vickers, T. W., Morrison, S. A., Buchalski, M. R., & Boyce, W. M. (2014). Fractured genetic connectivity threatens a Southern California puma (Puma concolor) population. *PLoS ONE*, *9*(10). https://doi.org/10.1371/journal.pone.0107985

Ewing, R., Schmid, T., Killingsworth, R., Zlot, A., & Raudenbush, S. (2003). Relationship between urban sprawl and physical activity, obesity, and morbidity. *American Journal of Health Promotion*, *18*(1), 47–57. http://74.207.241.65/sites/default/files/AJHP_8_Ewing_0.pdf

Fisher, R. N., & Shaffer, H. B. (1996). The Decline of Amphibians in California's Great Central Valley. *Conservation Biology*, *10*(5), 1387–1397. https://doi.org/10.1046/j.1523-1739.1996.10051387.x

Fothergill, A., & Peak, L. A. (2004). Poverty and disasters in the United States: A review of recent sociological findings. *Natural Hazards*, *34*, 89–110.

Frankham, R., Bradshaw, C. J. A., & Brook, B. W. (2014). Genetics in conservation management: Revised recommendations for the 50/500 rules, Red List criteria and population viability analyses. *Biological Conservation*, *170*, 56–63.

Frumkin, H., Frank, L., & Jackson, R. J. (2004). *Urban sprawl and public health: Designing, planning, and building for healthy communities* (First Edition). Island Press.

Fuller, T., Berzon, A., Browning, K., & Hubler, S. (2025, January 11). Los Angeles geared up for fire risk, but fell short. *The New York Times*. https://www.nytimes.com/2025/01/11/us/los-angeles-calfire-firefighters.html

Gerety, R. M. (2015, September). Farm Workers in Wildfire Areas Aren't Always Aware of Evacuation Plans. *National Public Radio Morning Edition*.

Goss, M., Swain, D. L., Abatzoglou, J. T., Sarhadi, A., Kolden, C. A., Williams, A. P., & Diffenbaugh, N. S. (2020). Climate change is increasing the likelihood of extreme autumn wildfire conditions across California. *Environmental Research Letters*, *15*.

Goverde, M., Schweizer, K., Baur, B., & Erhardt, A. (2002). Small-scale habitat fragmentation effects on pollinator behaviour: Experimental evidence from the bumblebee Bombus veteranus on calcareous grasslands. *Biological Conservation*, *104*, 293–299.

Governor Newsom's Strike Force. (2019). *Wildfires and Climate Change: California's Energy Future*.

Greene, D. (2018, August). California Firefighters Battle Exhaustion. *National Public Radio*. https://www.npr.org/2018/08/08/636603563/california-firefighters-battle-exhaustion

Gustafson, K. D., Gagne, R. B., Buchalski, M. R., Vickers, T. W., Riley, S. P. D., Sikich, J. A., Rudd, J. L., Dellinger, J. A., LaCava, M. E. F., & Ernest, H. B. (2021). Multi-population

puma connectivity could restore genomic diversity to at-risk coastal populations in California. *Evolutionary Applications*.

Gustafson, K. D., Gagne, R. B., Vickers, T. W., Riley, S. P. D., Wilmers, C. C., Bleich, V. C., Pierce, B. M., Kenyon, M., Drazenovich, T. L., Sikich, J. A., Boyce, W. M., & Ernest, H. B. (2018). Genetic source–sink dynamics among naturally structured and anthropogenically fragmented puma populations. *Conservation Genetics*, *20*(2), 215–227.

Gustafson, K. D., Vickers, T. W., Boyce, W. M., & Ernest, H. B. (2017). A single migrant enhances the genetic diversity of an inbred puma population. *Royal Society Open Science*, *4*(5).

Gutierrez, M. (2018, July). California blazes tax budgets, firefighters: 'Fatigue is starting to set in'. *SFChronicle*. https://www.sfchronicle.com/california-wildfires/article/California-blazes-tax-budgets-firefighters-13121282.php

Gutierrez, M., & Cassidy, M. (2018, August 11). As California burns, volunteer firefighters become harder to find. *SFChronicle*.

Haddad, N. M., Brudvig, L. A., Clobert, J., Davies, K. F., Gonzalez, A., Holt, R. D., Lovejoy, T. E., Sexton, J. O., Austin, M. P., Collins, C. D., Cook, W. M., Damschen, E. I., Ewers, R. M., Foster, B. L., Jenkins, C. N., King, A. J., Laurance, W. F., Levey, D. J., Margules, C. R., … Townshend, J. R. (2015). Habitat fragmentation and its lasting impact on Earth's ecosystems. *Science Advances*, *1*(e1500052), 1–9.

Halstead, B. J., Baumberger, K. L., Backlin, A. R., Kleeman, P. M., Wong, M. N., Gallegos, E. A., Rose, J. P., & Fisher, R. N. (2021). Conservation implications of spatiotemporal variation in the terrestrial ecology of western spadefoots. *Journal of Wildlife Management*, *85*(7), 1377–1393.

Hantson, S., Andela, N., Goulden, M. L., & Randerson, J. T. (2022). Human-ignited fires result in more extreme fire behavior and ecosystem impacts. *Nature Communications*, *13*(1), 2717. https://www.nature.com/articles/s41467-022-30030-2

Harnett, S. (2018, September). Low-Income Communities Struggle to Recover After a Wildfire. *KQED*.

Heller, N. E., & Zavaleta, E. S. (2009). Biodiversity management in the face of climate change: A review of 22 years of recommendations. *Biological Conservation*, *142*, 14–32.

Hernandez, S. (2025, March 27). Palisades and Eaton firefighters had elevated levels of mercury, lead in their blood. *LA Times*.

Herrera, J. (2018, November 14). As Wildire Smoke Fills the Air, Farmworkers Continue to Labor in the Fields. *Pacific Standard*.

Hilty, J. A., Worboys, G., Keeley, A., Woodley, S., Lausche, B., Locke, H., Carr, M., Pulsford, I., Pittock, J., White, W., Theobald, D., Levine, J., Reuling, M., Watson, J., Ament, R., & Tabor, G. (2020). *Guidelines for conserving connectivity through ecological networks and corridors*. International Union for Conservation of Nature.

Huffmeyer, A. A., Sikich, J. A., Vickers, T. W., Riley, S. P. D., & Wayne, R. K. (2021). First reproductive signs of inbreeding depression in Southern California male mountain lions (Puma concolor). *Theriogenology*, *177*, 157–164.

Hutchinson, J. A., Vargo, J., Milet, M., French, N. H. F., Billmire, M., Johnson, J., & Hoshiko, S. (2018). The San Diego 2007 wildfires and Medi-Cal emergency department presentations, inpatient hospitalizations, and outpatient visits: An observational study of smoke exposure periods and a bidirectional case-crossover analysis. *PLoS Medicine*, *15*(7), e1002601.

Hwang, J., Chong, N.-S., Zhang, M., Agnew, R. J., Xu, C., Li, Z., & Xu, X. (2023). Face-to-face with scorching wildfire: Potential toxicant exposure and the health risks of smoke for wildland firefighters at the wildland-urban interface. *The Lancet Regional Health - Americas*, *21*, 100482. https://linkinghub.elsevier.com/retrieve/pii/S2667193X2300056X

IPCC. (2022). Summary for Policymakers. In *Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change,*.

IPCC. (2023). *Climate Change 2023: Synthesis Report*.

Johnson, J., & Lam. (2023, August 29). California's wildland firefighters are being poisoned by smoke. And we're doing little to protect them. *San Francisco Chronicle*. https://www.sfchronicle.com/projects/2023/firefighter-health/

Jones, C. G., Rappold, A. G., Vargo, J., Cascio, W. E., Kharrazi, M., McNally, B., & Hoshiko, S. (2020). Out-of-Hospital Cardiac Arrests and Wildfire-Related Particulate Matter During 2015-2017 California Wildfires. *Journal of the American Heart Association*, *9*(8), e014125.

Kantola, T., Tracy, J. L., Baum, K. A., Quinn, M. A., & Coulson, R. N. (2019). Spatial risk assessment of eastern monarch butterfly road mortality during autumn migration within the southern corridor. *Biological Conservation*, *231*, 150–160.

Kardas-Nelson, M., Alvarenga, J., & Tuirán, R. A. (2020, October 6). Farmworkers forced to put harvest over health during wildfires. *Investigate West*.

Keeley, J. E., Flannigan, M., Brown, T. J., Rolinski, T., Cayan, D., Syphard, A. D., Guzman-Morales, J., & Gershunov, A. (2024). Climate and weather drivers in southern California

Santa Ana Wind and non-Santa Wind fires. *International Journal of Wildland Fire*, *33*(8).

Keeley, J. E., & Fotheringham, C. J. (2003). Impact of Past Present and Future Fire Regimes on North American Mediterranean Shrublands. In *Fire and climatic change in temperate ecosystems of the Western Americas* (pp. 218–262).

Keeley, J. E., Fotheringham, C. J., & Morais, M. (1999). Reexamining fire suppression impacts on brushland fire regimes. *Science*, *284*(5421), 1829–1832.

Keeley, J. E., & Syphard, A. D. (2018). Historical patterns of wildfire ignition sources in California ecosystems. *International Journal of Wildland Fire*, *27*(12), 781.

Kertson, B. N., Spencer, R. D., Marzluff, J. M., Hepinstall-Cymerman, J., & Grue, C. E. (2011). Cougar space use and movements in the wildland—Urban landscape of western Washington. *Ecological Applications*, *21*(8), 2866–2881.

Kimberlin, S. (2019). *California's Housing Affordability Crisis Hits Renters and Households With the Lowest Incomes the Hardest*.

Knapp, E. E., Valachovic, Y. S., Quarles, S. L., & Johnson, N. G. (2021). Housing arrangement and vegetation factors associated with single-family home survival in the 2018 Camp Fire, California. *Fire Ecology*, *17*.

Kociolek, A. V., Clevenger, A. P., St. Clair, C. C., & Proppe, D. S. (2011). Effects of Road Networks on Bird Populations. *Conservation Biology*, *25*(2), 241–249.

Krosby, M., Theobald, D. M., Norheim, R., & Mcrae, B. H. (2018). Identifying riparian climate corridors to inform climate adaptation planning. *PLoS ONE*, *13*(11), e0205156.

Künzli, N., Avol, E., Wu, J., Gauderman, W. J., Rappaport, E., Millstein, J., Bennion, J., McConnell, R., Gilliland, F. D., Berhane, K., Lurmann, F., Winer, A., & Peters, J. M.

(2006). Health effects of the 2003 Southern California wildfires on children. *American Journal of Respiratory and Critical Care Medicine*, *174*, 1221–1228.

Labarge, L. R., Planck, M., Behavior, A., & Elbroch, L. M. (2022). Pumas Puma concolor as ecological brokers: A review of their biotic relationships. *Mammal Review*.

Lee, J. S., Ruell, E. W., Boydston, E. E., Lyren, L. M., Alonso, R. S., Troyer, J. L., Crooks, K. R., & Vandewoude, S. (2012). Gene flow and pathogen transmission among bobcats (Lynx rufus) in a fragmented urban landscape. *Molecular Ecology*, *21*(7), 1617–1631.

Leyden, K. M. (2003). Social Capital and the Built Environment—The Importance of Walkable Neighborhoods. *American Journal of Public Health*, *93*(9), 1546–1551.

Li, Z., & Yu, W. (2025). *Economic Impact of the Los Angeles Wildfires*. UCLA Anderson School of Management.

Liu, J. C., Pereira, G., Uhl, S. A., Bravo, M. A., & Bell, M. L. (2015). A systematic review of the physical health impacts from non- occupational exposure to wildfire smoke. *Environmental Research*, *136*, 120–132. https://doi.org/10.1016/j.envres.2014.10.015.A

Liu, J. C., Wilson, A., Mickley, L. J., Ebisu, K., Sulprizio, M. P., Wang, Y., Peng, R. D., Yue, X., Dominici, F., & Bell, M. L. (2017). Who among the elderly is most vulnerable to exposure to and health risks of fine particulate matter from wildfire smoke? *American Journal of Epidemiology*, *186*(6), 730–735.

Loss, S. R., Will, T., & Marra, P. P. (2014). Estimation of bird-vehicle collision mortality on U.S. roads. *Journal of Wildlife Management*, *78*, 763–771.

Lucas, E. (2020). Recreation-related disturbance to wildlife in California-better planning for and management of recreation are vital to conserve wildlife in protected areas where recreation occurs. *California Fish and Wildlife, Recreation Special Issue*, 29–51.

Luković, J., Chiang, J. C. H., Blagojević, D., & Sekulić, A. (2021). A Later Onset of the Rainy Season in California. *Geophysical Research Letters*, *48*(4), e2020GL090350. https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2020GL090350

Lurmann, F., Avol, E., & Gilliland, F. (2015). Emissions reduction policies and recent trends in Southern California's ambient air quality. *Journal of the Air & Waste Management Association*, *65*(3), 324–335. https://doi.org/10.1080/10962247.2014.991856

Ma, W., Zhai, L., Pivovaroff, A., Shuman, J., Buotte, P., Ding, J., Christoffersen, B., Knox, R., Moritz, M., Fisher, R. A., Koven, C. D., Kueppers, L., & Xu, C. (2021). Assessing climate change impacts on live fuel moisture and wildfire risk using a hydrodynamic vegetation model. *Biogeosciences*, *18*(13), 4005–4020.

MacDonald, G., Wall, T., Enquist, C. A. F., LeRoy, S. R., Bradford, J. B., Breshears, D. D., Brown, T., Cayan, D., Dong, C., Falk, D. A., Fleishman, E., Gershunov, A., Hunter, M., Loehman, R. A., Van Mantgem, P. J., Middleton, B. R., Safford, H. D., Schwartz, M. W., & Trouet, V. (2023). Drivers of California's changing wildfires: A state-of-the-knowledge synthesis. *International Journal of Wildland Fire*, *32*(7), 1039–1058.

Marsh, D. M., & Jaeger, J. A. G. (2015). Direct effects of roads on small animal populations. In *Roads and ecological infrastructure: Concepts and applications for small animals* (pp. 42–56).

McClure, C. J. W., Ware, H. E., Carlisle, J., Kaltenecker, G., & Barber, J. R. (2013). An experimental investigation into the effects of traffic noise on distributions of birds: Avoiding the phantom road. *Proceedings of the Royal Society B: Biological Sciences*, *280*.

McKenzie, B. (2015). *Who Drives to Work? Commuting by Automobile in the United States: 2013* (American Community Survey Reports). U.S. Department of Commerce, U.S. Census Bureau.

Mietkiewicz, N., Balch, J. K., Schoennagel, T., Leyk, S., St. Denis, L. A., & Bradley, B. A. (2020). In the Line of Fire: Consequences of Human-Ignited Wildfires to Homes in the U.S. (1992–2015). *Fire*, *3*(3), 50. https://doi.org/10.3390/fire3030050

Mitsch, W. J., & Wilson, R. F. (1996). Improving the success of wetland creation and restoration with know-how, time, and self-design. *Ecological Applications*, *6*(1), 16–17.

Montrone, A., Saito, L., Weisberg, P. J., Gosejohan, M., Merriam, K., & Mejia, J. F. (2019). Climate change impacts on vernal pool hydrology and vegetation in northern California. *Journal of Hydrology*, *574*, 1003–1013. https://doi.org/10.1016/j.jhydrol.2019.04.076

Morris, B. (2019, April). How the Ultra-Wealthy are Making Themselves Immune to Natural Disasters. *LA Magazine*.

Moss, W. E., McDevitt-Galles, T., Muths, E., Bobzien, S., Purificato, J., & Johnson, P. T. J. (2021). Resilience of native amphibian communities following catastrophic drought: Evidence from a decade of regional-scale monitoring. *Biological Conservation*, *263*, 109352.

Mujtaba, G., & Shahzad, S. J. H. (2021). Air pollutants, economic growth and public health: Implications for sustainable development in OECD countries. *Environmental Science and Pollution Research*, *28*(10), 12686–12698. https://doi.org/10.1007/s11356-020-11212-1

Neal, K. M. (2019). *An Integrative Population and Landscape Genomic Approach to Conservation of a Threatened California Amphibian at Multiple Spatial Scales*. University of California Los Angeles.

Neal, K. M., Fisher, R. N., Mitrovich, M. J., & Shaffer, H. B. (2020). Conservation Genomics of the Threatened Western Spadefoot, *Spea hammondii* , in Urbanized Southern California. *Journal of Heredity*, *111*(7), 613–627. https://doi.org/10.1093/jhered/esaa049

Neal, K. M., Johnson, B. B., & Shaffer, H. B. (2018). Genetic structure and environmental niche modeling confirm two evolutionary and conservation units within the western spadefoot (Spea hammondii). *Conservation Genetics*.

Nickel, B. A., Suraci, J. P., Allen, M. L., & Wilmers, C. C. (2020). Human presence and human footprint have non-equivalent effects on wildlife spatiotemporal habitat use. *Biological Conservation*, *241*, 108383.

Nickel, B. A., Suraci, J. P., Nisi, A. C., & Wilmers, C. C. (2021). Energetics and fear of humans constrain the spatial ecology of pumas. *Proceedings of the National Academy of Sciences of the United States of America*, *118*(5), 1–8.

Nisi, A. C., Benson, J. F., King, R., & Wilmers, C. C. (2023). Habitat fragmentation reduces survival and drives source–sink dynamics for a large carnivore. *Ecological Applications*, *33*(4), e2822. https://esajournals.onlinelibrary.wiley.com/doi/10.1002/eap.2822

Nisi, A. C., Benson, J. F., & Wilmers, C. C. (2022). Puma responses to unreliable human cues suggest an ecological trap in a fragmented landscape. *Oikos*, *2022*(5), e09051. https://onlinelibrary.wiley.com/doi/10.1111/oik.09051

Parshley, L. (2018, December 7). The Lingering Effects of Wildfires Will Disproportionately Hurt People of Color. *Vice*, 1–11.

Phuleria, H. C., Fine, P. M., Zhu, Y., & Sioutas, C. (2005). Air quality impacts of the October 2003 Southern California wildfires. *Journal of Geophysical Research*, *110*. https://doi.org/10.1029/2004JD004626

Polade, S. D., Gershunov, A., Cayan, D. R., Dettinger, M. D., & Pierce, D. W. (2017). Precipitation in a warming world: Assessing projected hydro-climate changes in California and other Mediterranean climate regions. *Scientific Reports*, *7*(1), 10783. https://doi.org/10.1038/s41598-017-11285-y

Pyke, C. R. (2004). Habitat Loss Confounds Climate Change Impacts. *Frontiers in Ecology and the Environment*, *2*(4), 178–182.

Radeloff, V. C., Helmers, D. P., Kramer, H. A., Mockrin, M. H., Alexandre, P. M., Bar-Massada, A., Butsic, V., Hawbaker, T. J., Martinuzzi, S., Syphard, A. D., & Stewart, S. I. (2018). Rapid growth of the US wildland-urban interface raises wildfire risk. *Proceedings of the National Academy of Sciences*, *115*(13), 3314–3319.

Ramos, S. C. (2022). Understanding Yurok traditional ecological knowledge and wildlife management. *The Journal of Wildlife Management*, 1–21.

Rappold, A. G., Cascio, W. E., Kilaru, V. J., Stone, S. L., Neas, L. M., Devlin, R. B., & Diaz-Sanchez, D. (2012). Cardio-respiratory outcomes associated with exposure to wildfire smoke are modified by measures of community health. *Environmental Health: A Global Access Science Source*, *11*(71). https://doi.org/10.1186/1476-069X-11-71

Reid, C. E., Brauer, M., Johnston, F. H., Jerrett, M., Balmes, J. R., & Elliott, C. T. (2016). Critical review of health impacts of wildfire smoke. *Environmental Health Perspectives*, *124*(9), 1334–1343.

Reid, C. E., Jerrett, M., Tager, I. B., Petersen, M. L., Mann, J. K., & Balmes, J. R. (2016). Differential respiratory health effects from the 2008 northern California wildfires: A spatiotemporal approach. *Environmental Research*, *150*, 227–235.

Reid-Wainscoat, E., Rose, J. P., Yap, Tiffany A., & Prabhala, A. (2024). *The True Cost of Sprawl: Bad Planning Harms People, Wildlife and the Climate*. Center for Biological Diversity.

Richards, R. (2019, July). After the Fire: Vulnerable Communities Respond and Rebuild. *Center for American Progress*.

Riley, S. P. D., Pollinger, J. P., Sauvajot, R. M., York, E. C., Bromley, C., Fuller, T. K., & Wayne, R. K. (2006). A southern California freeway is a physical and social barrier to gene flow in carnivores. *Molecular Ecology*, *15*, 1733–1741.

Riley, S. P. D., Serieys, L. E. K., Pollinger, J. P., Sikich, J. A., Dalbeck, L., Wayne, R. K., & Ernest, H. B. (2014). Individual behaviors dominate the dynamics of an urban mountain lion population isolated by roads. *Current Biology*, *24*(17), 1989–1994. https://doi.org/10.1016/j.cub.2014.07.029

Riley, S. P. D., Sikich, J. A., & Benson, J. F. (2021). Big Cats in the Big City: Spatial Ecology of Mountain Lions in Greater Los Angeles. *Journal of Wildlife Management*, *85*(8), 1527–1542.

Ripple, W. J., & Beschta, R. L. (2006). Linking a cougar decline , trophic cascade , and catastrophic regime shift in Zion National Park. *Biological Conservation*, *133*, 397–408.

Ripple, W. J., & Beschta, R. L. (2008). Trophic cascades involving cougar, mule deer, and black oaks in Yosemite National Park. *Biological Conservation*, *141*, 1249–1256.

Ripple, W. J., Estes, J. A., Beschta, R. L., Wilmers, C. C., Ritchie, E. G., Hebblewhite, M., Berger, J., Elmhagen, B., Letnic, M., Nelson, M. P., Schmitz, O. J., Smith, D. W., Wallach, A. D., & Wirsing, A. J. (2014). Status and ecological effects of the world ’s largest carnivores. *Science*, *343*(6167), 1241484.

Rubiera-Morollón, F., & Garrido-Yserte, R. (2020). Recent Literature about Urban Sprawl: A Renewed Relevance of the Phenomenon from the Perspective of Environmental Sustainability. *Sustainability*, *12*(16), 6551. https://doi.org/10.3390/su12166551

Ruth, T. K., & Elbroch, L. M. (2014). The carcass chronicles: Carnivory, nutrient flow, and biodiversity. *Wild Felid Monitor*, 14–19.

Siirila-Woodburn, E. R., Rhoades, A. M., Hatchett, B. J., Huning, L. S., Szinai, J., Tague, C., Nico, P. S., Feldman, D. R., Jones, A. D., Collins, W. D., & Kaatz, L. (2021). A low-to-no snow future and its impacts on water resources in the western United States. *Nature Reviews Earth & Environment*, *2*(11), 800–819. https://www.nature.com/articles/s43017-021-00219-y

Simon, S. (2018, August). Constant Wildfires Leave California Firefighters Strained. *National Public Radio*.

Slabbekoorn, H., & Ripmeester, E. A. P. (2008). Birdsong and anthropogenic noise: Implications and applications for conservation. *Molecular Ecology*, *17*, 72–83.

Smith, H., & Briscoe, T. (2025, April 11). LA County soil testing near Eaton, Palisades fires shows significant contamination. *LA Times*. https://www.latimes.com/environment/story/2025-04-11/soil-testing-eaton-palisades-fires-significant-contamination

Smith, J. A., Duane, T. P., & Wilmers, C. C. (2019). Moving through the matrix: Promoting permeability for large carnivores in a human-dominated landscape. *Landscape and Urban Planning*, *183*, 50–58.

Smith, J. A., Suraci, J. P., Clinchy, M., Crawford, A., Roberts, D., Zanette, L. Y., & Wilmers, C. C. (2017). Fear of the human 'super predator' reduces feeding time in large carnivores. *Proceedings of the Royal Society B: Biological Sciences*, *284*(1857), 20170433.

Smith, J. A., Wang, Y., & Wilmers, C. C. (2015). Top carnivores increase their kill rates on prey as a response to human-induced fear. *Proceedings of the Royal Society B: Biological Sciences*, *282*, 20142711.

Studenmund, A. H., & Connor, D. (1982). The free-fare transit experiments. *Transportation Research Part A: General*, *16.4*, 261–269.

Suraci, J. P., Clinchy, M., Zanette, L. Y., & Wilmers, C. C. (2019). Fear of humans as apex predators has landscape-scale impacts from mountain lions to mice. *Ecology Letters*, *22*(10), 1578–1586.

Suraci, J. P., Nickel, B. A., & Wilmers, C. C. (2020). Fine-scale movement decisions by a large carnivore inform conservation planning in human-dominated landscapes. *Landscape Ecology*, *35*(7), 1635–1649.

Swain, D. L. (2021). A Shorter, Sharper Rainy Season Amplifies California Wildfire Risk. *Geophysical Research Letters*, *48*(5), e2021GL092843.

Swain, D. L., Langenbrunner, B., Neelin, J. D., & Hall, A. (2018). Increasing precipitation volatility in twenty-first-century California. *Nature Climate Change*, *8*(5), 427–433. https://doi.org/10.1038/s41558-018-0140-y

Swain, D. L., Prein, A. F., Abatzoglou, J. T., Albano, C. M., Brunner, M., Diffenbaugh, N. S., Singh, D., Skinner, C. B., & Touma, D. (2025). Hydroclimate volatility on a warming Earth. *Nature Reviews Earth & Environment*, *6*(1), 35–50. https://doi.org/10.1038/s43017-024-00624-z

Syphard, A. D., Keeley, J. E., Massada, A. Bar., Brennan, T. J., & Radeloff, V. C. (2012). Housing arrangement and location determine the likelihood of housing loss due to wildfire. *PLoS ONE*, *7*(3), e33954.

Syphard, A. D., Radeloff, V. C., Keeley, J. E., Hawbaker, T. J., Clayton, M. K., Stewart, S. I., Hammer, R. B., Syphard, A. D., Radeloff, V. C., Keeley, J. E., Hawbaker, T. J., Stewart, S. I., & Hammer, R. B. (2007). Human influence on California fire regimes. *Ecological Society of America*, *17*(5), 1388–1402.

Syphard, A. D., Rustigian-Romsos, H., Mann, M., Conlisk, E., Moritz, M. A., & Ackerly, D. (2019). The relative influence of climate and housing development on current and projected future fire patterns and structure loss across three California landscapes. *Global Environmental Change*, *56*, 41–55.

Syphard, A. D., Rustigian-romsos, H., Mann, M., Conlisk, E., Moritz, M. A., & Ackerly, D. (2019). The relative influence of climate and housing development on current and projected future fire patterns and structure loss across three California landscapes. *Global Environmental Change*, *56*, 41–55.

Thomson, R. C., Wright, A. N., & Shaffer, H. B. (2016). *California amphibian and reptile species of special concern*. University of California Press.

Toohey, G., & Fry, H. (2025, January 8). LA officials admit firefighters were overwhelmed and outgunnded by deadly firestorms. *LA Times*.

Traill, L. W., Brook, B. W., Frankham, R. R., & Bradshaw, C. J. A. (2010). Pragmatic population viability targets in a rapidly changing world. *Biological Conservation*, *143*, 28–34.

Trombulak, S. C., & Frissell, C. A. (2000). Review of ecological effects of roads on terrestrial and aquatic communities. *Conservation Biology*, *14*(1), 18–30.

Turco, M., Abatzoglou, J. T., Herrera, S., Zhuang, Y., Jerez, S., Lucas, D. D., AghaKouchak, A., & Cvijanovic, I. (2023). Anthropogenic climate change impacts exacerbate summer forest fires in California. *Proceedings of the National Academy of Sciences*, *120*(25), e2213815120.

UCLA Institute of Transportation Studies. (2019). *Best Practices in Implementing Tactical Transit Lanes*. UCLA Institute of Transportation Studies.

U.S. Department of Transportation. (2022). *Early Estimates of Motor Vehicle Traffic Fatalities and Fatality Rate by Sub-Categories 2021*. U.S. Department of Transportation.

U.S. Environmental Protection Agency. (2017). *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2015*. U.S. Environmental Protection Agency.

van der Ree, R., Jaeger, J. A. G., van der Grift, E. A., & Clevenger, A. P. (2011). Effects of roads and traffic on wildlife populations and landscape function: Road ecology is moving toward larger scales. *Ecology and Society*, *16*(1), 48.

Vickers, T. W., Sanchez, J. N., Johnson, C. K., Morrison, S. A., Botta, R., Smith, T., Cohen, B. S., Huber, P. R., Ernest, H. B., & Boyce, W. M. (2015). Survival and mortality of pumas (Puma concolor) in a fragmented, urbanizing landscape. *PLoS ONE*, *10*(7), 1–18. https://doi.org/10.1371/journal.pone.0131490

Viswanathan, S., Eria, L., Diunugala, N., Johnson, J., & Mc Clean, C. (2006). An analysis of effects of San Diego wildfire on ambient air quality. *Journal of the Air and Waste Management Association*, *56*(1), 56–67. https://doi.org/10.1080/10473289.2006.10464439

Wang, D., Guan, D., Zhu, S., Kinnon, M. M., Geng, G., Zhang, Q., Zheng, H., Lei, T., Shao, S., Gong, P., & Davis, S. J. (2021). Economic footprint of California wildfires in 2018. *Nature Sustainability*, *4*, 252–260.

Wang, Y., Allen, M. L., & Wilmers, C. C. (2015). Mesopredator spatial and temporal responses to large predators and human development in the Santa Cruz Mountains of California. *Biological Conservation*, *190*, 23–33.

Wang, Y., Smith, J. A., & Wilmers, C. C. (2017). Residential development alters behavior, movement, and energetics in a top carnivore. *PlosOne*, *12*(10), e0184687.

Ware, H. E., Mcclure, C. J. W., Carlisle, J. D., & Barber, J. R. (2015). A phantom road experiment reveals traffic noise is an invisible source of habitat degradation. *Proceedings of the National Academy of Sciences*, *112*(39), 12105–12109.

Weinhold, B. (2011). Fields and forests in flames: Vegetation smoke and human health. *Environmental Health Perspectives*, *119*(9), A386–A393.

Williams, A. P., Abatzoglou, J. T., Gershunov, A., Guzman-Morales, J., Bishop, D. A., Balch, J. K., & Lettenmaier, D. P. (2019). Observed impacts of anthropogenic climate change on wildfire in California. *Earth's Future*, *7*, 892–910.

Wilmers, C. C., Nisi, A. C., & Ranc, N. (2021). COVID-19 suppression of human mobility releases mountain lions from a landscape of fear. *Current Biology*, *31*(17), 3952-3955.e3. https://doi.org/10.1016/j.cub.2021.06.050

Wilmers, C. C., Wang, Y., Nickel, B., Houghtaling, P., Shakeri, Y., Allen, M. L., Kermish-Wells, J., Yovovich, V., & Williams, T. (2013). Scale dependent behavioral responses to human development by a large predator, the puma. *PLoS ONE*, *8*(4).

Yap, T. A., Rose, J. P., Anderson, I., & Prabhala, A. (2021). *California Connections: How Wildlife Connectivity Can Fight Extinction and Protect Public Safety*.

Yap, T. A., Rose, J. P., Broderick, P., & Prabhala, A. (2021). *Built to Burn: California's Wildlands Developments Are Playing With Fire*.

Yap, T. A., Rose, J. P., & Cummings, B. (2019). *A Petition to List the Southern California/Central Coast Evolutionarily Significant Unit (ESU) of Mountain Lions as Threatened under the California Endangered Species Act (CESA)*.

Yovovich, V., Allen, M. L., Macaulay, L. T., & Wilmers, C. C. (2020). Using spatial characteristics of apex carnivore communication and reproductive behaviors to predict responses to future human development. *Biodiversity and Conservation*, *29*(8), 2589–2603.

Zeller, K. A., Vickers, T. W., Ernest, H. B., & Boyce, W. M. (2017). Multi-level, multi-scale resource selection functions and resistance surfaces for conservation planning: Pumas as a case study. *PLoS ONE*, *12*(6), 1–20.

Zhang, B., Weuve, J., Langa, K. M., D'Souza, J., Szpiro, A., Faul, J., Mendes De Leon, C., Gao, J., Kaufman, J. D., Sheppard, L., Lee, J., Kobayashi, L. C., Hirth, R., & Adar, S. D. (2023). Comparison of Particulate Air Pollution From Different Emission Sources and Incident Dementia in the US. *JAMA Internal Medicine*.

Zhang, Z., Chen, L., Wang, X., Wang, C., Yang, Y., Li, H., Cai, M., & Lin, H. (2023). Associations of Air Pollution and Genetic Risk With Incident Dementia: A Prospective Cohort Study. *American Journal of Epidemiology*, *192*(2), 182–194.

Exhibit B

January 26, 2026

Sent via email, with references via FTP and FedEx

Chair Michael R. Hastings and Members of the
Regional Planning Commission
Los Angeles County Department of Regional Planning
320 West Temple St.
Los Angeles, CA 90012
commission@planning.lacounty.gov
comment@planning.lacounty.gov

Re: January 28, 2026 Regional Planning Commission Meeting Agenda Item No. 7 – Northlake Development (Project No. R2015-00408-(5))

Dear Chair Hastings and Members of the Regional Planning Commission:

These comments are submitted on behalf of the Center for Biological Diversity (the "Center") regarding the proposed Northlake Development ("Project"). The Center has reviewed the Recirculated Partial Final Supplemental EIR ("EIR") closely and remains concerned that the EIR's analysis of, *inter alia*, biological resources, wildfire, and transportation impacts is inadequate. The Center urges the Regional Planning Commission ("Commission") not to approve the Project without first remedying these deficiencies.

The Center is a non-profit, public interest environmental organization dedicated to the protection of native species and their habitats through science, policy, and environmental law. The Center has members and online activists throughout California and the United States. The Center has worked for many years to protect imperiled plants and wildlife, open space, air and water quality, and overall quality of life for people in Los Angeles County.

I. The RPFSEIR Fails to Adequately Assess and Mitigate the Project's Impacts to Mountain Lions and Wildlife Connectivity.

The RPFSEIR fails to appropriately respond to the Center's comments regarding mountain lions and wildlife connectivity, stating "[w]ith respect to the portions of the SEIR that were not recirculated, the doctrines of res judicata and collateral estoppel preclude litigation and/or relitigation of those issues states" (RPFSEIR at 2-22) and that "[c]ollateral estoppel bars relitigation of the mountain/wildlife movement *[sic]* and connectivity issues" (RPFSEIR at 2-24). However, as discussed in the Center's May 29, 2025 comment letter, new and significant information regarding the conservation status of local mountain lions and the increasing threats they face, the movement of at least one mountain lion adjacent to the Project area, and the

importance of the existing wildlife connectivity in and near the Project area for their long-term survival has become available since the EIR was certified in 2018.

The California Environmental Quality Act ("CEQA") states that a subsequent or supplemental EIR may be required when either (1) substantial changes occur with respect to the circumstances under which the project is being undertaken which will require major revisions in the environmental impact report or (2) new information, which was not known and could not have been known at the time the environmental impact report was certified as complete, becomes available. (Pub. Res. Code § 21166.) Below we present clear evidence regarding mountain lions and wildlife connectivity that falls into both categories. Therefore, the RPFSEIR fails to comply with CEQA.

A. Since Project Approval, CDFW has Recommended Mountain Lions in the Project area to be Listed as Threatened under the California Endangered Species Act.

The Project area is located in the Sierra Pelona Mountains, which is within the geographic range of the Southern California and Central Coast mountain lion populations that were petitioned to be listed under the California Endangered Species Act ("CESA") in June 2019 (Yap et al., 2019). In April 2020 these populations were granted "candidacy status" under CESA, such that they are afforded the same protections as other CESA-listed species. And on December 10, 2025, the California Department of Fish and Wildlife ("CDFW") released their status review regarding the petition and recommended listing all of the petitioned mountain lion populations as a threatened Southern California and Central Coast mountain lion distinct population segment (DPS) under CESA (CDFW, 2025a).

CDFW's recommendation relies on numerous scientific studies published after the Northlake EIR was certified in April 2018 that illuminate the dire conditions of the DPS mountain lion populations' genetic health and viability, the myriad threats they face, and the importance of the Project area for their long-term survival (e.g., Benson et al., 2019, 2023; Gustafson et al., 2018, 2021); see the Center's May 29, 2025 comments, the CESA petition [Yap et al., 2019], and the CESA status review [CDFW 2025a] for more studies and details). In particular, CDFW identifies the Sierra Pelona Mountains as a high priority area that is critical to maintain and improve the genetic health of the populations within the DPS because of its proximity to the Tehachapi Mountains, an important area for genetic exchange between the DPS and relatively robust mountain lions in the Western Sierra Nevada (CDFW, 2025a). According to CDFW, "[m]itigating the barriers of Highway 58 and Interstate 5 to allow safer and easier dispersal across those roads should be considered high priorities, as well as the conservation of suitable habitat in the Sierra Pelona, Topatopa, and San Emigdio Mountains" (CDFW, 2025a). The previously certified EIR does not—and cannot—adequately analyze or mitigate impacts of the Project on mountain lions given this wealth of new information.

The Project would result in the destruction of high-priority mountain lion habitat and degradation of a critical connectivity area that is already constrained, which could drive the Southern California and Central Coast mountain lion DPS closer towards extinction. The Project is also located adjacent to a segment of the I-5 that, in 2024, CDFW identified as Barrier ID W231: I-5 Sierra Madre to Castaic Ranges, with mountain lion as a target species for recovery (CDFW, 2024). According to CDFW, "[t]he Sierra Madre-Castaic linkage is vitally important for restoring gene flow to southern California mountain lion populations" (CDFW, 2024).

CEQA requires a "mandatory finding of significance" when a project has the potential to impact a CESA-listed species. (CEQA Guidelines § 15065(a)(1); *Endangered Habitats League, Inc. v. County of Orange* (2005) 131 Cal.App.4th 777, 792 fn. 12.) And such a finding triggers a duty to consider and adopt all feasible alternatives or mitigation measures to reduce such impacts. (Pub. Res. Code § 21002.) Moreover, CESA provides that agencies should not approve projects that could jeopardize the continued existence of this DPS or result in destruction of essential habitat (Fish & Game Code, § 2053(a)) and agencies must require that appropriate mitigation measures be implemented for projects that could destroy mountain lion habitat or impair connectivity. (See Fish & Game Code, § 2054).

The CESA status of local mountain lions as a candidate species in 2020 and a recommended threatened DPS in 2025 and the numerous scientific studies published after the 2018 EIR certification qualify as both (1) substantial changes that require major revisions in the environmental impact report so that it includes adequate analyses and mitigation for the Project's impacts to mountain lions and wildlife connectivity and (2) new information, which was not known and could not have been known at the time the environmental impact report was certified as complete. (Pub. Res. Code § 21166.) The RPFSEIR lacks any analysis or mitigation for the Project's impacts to mountain lions and therefore fails to comply with CEQA.

B. Since Project Approval, at Least One Mountain Lion Traveled from Grasshopper Canyon to Marple Canyon Through an Adjacent Wildlife Crossing.

The Mountains Recreation and Conservation Authority ("MRCA") documented at least one mountain lion using a box culvert under the southbound I-5 that is adjacent to the Project area. Photos, authenticated by the attached declaration from Chad Christensen, the Deputy Chief of Natural Resources and Planning for MRCA, depict a mountain lion crossing from the east side of the southbound direction of the separated I-5 freeway from Grasshopper Canyon westerly into Marple Canyon on November 5, 2020 approximately between 2:49 a.m. and 2:59 a.m. (the "Mountain Lion Photos") (Exhibit A). The single-lane box culvert for the Marple Canyon access road that crosses under this southbound section of I-5 is identified as "Tunnel 2" and "Underpass 2" in Santa Monica Mountains Conservancy's April 17, 2018 letter on the Northlake Development (Exhibit B). Underpass 2 is one of two freeway crossing structures along a ten-mile section of I-5 between Templin Highway and Castaic Creek. The MRCA owns 245 acres of Marple Canyon west of Underpass 2 between the separated north-/southbound sections of I-5 and six acres east of Underpass 2 that connect with Grasshopper Canyon. The Mountain Lion Photos were taken by a camera placed on MRCA conservation lands by Mr. Christensen for the MRCA's Marple Canyon I-5 Wildlife Crossing Enhancement Project.

The use of this crossing by a mountain lion moving west, towards the severely imperiled Central Coast South population that is facing an "extinction vortex" (Benson et al., 2019) from the eastern side of I-5 indicates potential gene flow that is desperately needed. According to researchers, "a single migrant [per generation] can have immediate positive effects on the genetics of a small, isolated and inbred puma population" if the individual successfully breeds (Gustafson et al., 2017). This documented movement adjacent to the Project area highlights the critical value of the Project area as live-in and move-through habitat and for east-west mountain lion movement.

While the approved 2018 EIR for the Northlake Project does generally acknowledge that mountain lions may use the Project area (2018 Final EIR at 2-136), County counsel joined the project proponents (which include Northlake Associates, LLC, which is controlled by NLDP Associates, LLC, Castaic Development Partners, LLC, and Michael Rosenfeld of Woodridge Capital Partners, LLC) in representing in court proceedings that "mountain lions will not be impacted by the Project" and "mountain lions are not using Project site crossings as confirmed by expert studies, including a wildlife camera study . . . ." (Respondents' and Real Parties in Interest's Joint Opposition Trial Brief at pp. 8 & 16-17.) **The Mountain Lion Photos demonstrate that these claims (which were based on a developer-commissioned study) are incorrect.**[1]

The County's own staff biologist, Joseph Decruyenaere, urged the developer's EIR drafters not to minimize the connectivity value of the existing culverts under the I-5, which are far from perfect but are the only available means for mountain lions to cross the I-5 in the area. Mr. Decruyenaere wrote that the EIR language prepared by the developer's consultant:

> unduly minimizes the value of compromised movement opportunities. Nowhere else in biological conservation would you want to argue that because a resource is rare it's less than valuable. The fact that the use of a highly constrained opportunity for movement between natural areas might be made more difficult should always be considered a potentially significant impact unless there simply aren't any wildlife around to use the crossing. If a movement opportunity lacks a vegetated approach or some other feature that would seem to make it work better, that doesn't mean it doesn't pose an opportunity for movement. It just suggests that an animal might be less inclined to use it in the imaginary scenario that they have a better alternative. **However, in the real world, and in the highly fragmented, difficult to navigate landscapes that wildlife are consigned to, compromised movement opportunities may be the only opportunities available.** Revise the discussion to acknowledge the value of the crossings and instead of devaluing them, talk about how the project might change the potential for their use.[2]

Mr. Decruyenaere also wrote that the developer's consultant relies "chiefly on the idea that existing crossing features are not ideal but [they] neglect[] to provide conclusions as to how

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[1] On December 17, 2020, the Center for Biological Diversity and Endangered Habitats League requested judicial notice of the Mountain Lion Photos in Los Angeles County Superior Court case *Center for Biological Diversity et al. v. County of Los Angeles et al*., Case No. 19STCP01610, and the County and developer submitted a brief opposing the request for judicial notice. The request was denied, and the Mountain Lion Photos were not considered in the Court's decision.

[2] Mr. Decruyenaere's comments were attached to an email sent by County Planner Jodie Sackett on February 18, 2018 and are accessible in the administrative record ("AR") of the Los Angeles County Superior Court case *Center for Biological Diversity et al. v. County of Los Angeles et al*., Case No. 19STCP01610 at AR025874 (and Mr. Sackett's email is located at AR025825-26).

overall wildlife movement on the site and through the crossing features may actually change with buildout of the project."[3]

The Mountain Lion Photos confirm that mountain lions (and likely other wildlife) can and do use the culvert adjacent to the Project site even if the culvert could be enhanced to be more friendly for wildlife. If built as proposed, the Northlake Development would destroy high quality, intact mountain lion habitat; degrade surrounding habitat with edge effects including but not limited to new roads and increased traffic, lighting at night, noise, rat poisons, disease risk, domestic animals, and wildfire, which could have direct and indirect impacts to mountain lions (e.g., (Barrientos et al., 2023; Benson et al., 2023; Blakey et al., 2022; CDFW, 2025b); block this critical crossing; and further constrain the already-limited movement opportunities for mountain lions and other wildlife in the region.

The Mountain Lion Photos qualify as both (1) a substantial change that requires major revisions in the environmental impact report so that it includes adequate analyses and mitigation for the Project's impacts to mountain lions and wildlife connectivity and (2) new information, which was not known and could not have been known at the time the environmental impact report was certified as complete. (Pub. Res. Code § 21166.) The documented use of this crossing by a mountain lion, new scientific studies identifying the vulnerability of the region's mountain lions to extinction and the importance of the Project area for mountain lion habitat and connectivity (and therefore the genetic health of populations within the DPS), and CDFW's recommendation to list local mountain lions as threatened under CESA illuminate the major deficiencies in the previously certified EIR and precipitate the need of new analyses of the Project's impacts to mountain lions and wildlife connectivity in the RPFSEIR. (See *Moss v. County of Humboldt* (2008) 162 Cal.App.4th 1041 [finding supplemental environmental review was required when there was mere anecdotal evidence of a listed species newly occurring in the project area].)

C. New Data Indicate the Project Area is Important for Mountain Lions and Wildlife Movement.

The Project area is located in a focal area for recent and ongoing wildlife connectivity and mountain lion studies. As mentioned previously, CDFW has identified the I-5 as an important barrier to mitigate to improve gene flow in the Southern California/Central Coast mountain lion DPS, in part because of the area's importance for statewide gene flow and there is high quality suitable mountain lion habitat on both sides of the freeway. These studies aim to help decisionmakers understand how mountain lions are moving through the area and how conditions could be improved to support more movement. From 2022 to 2025, the UC Davis California Carnivores Program collected movement data from several individuals that were radio-collared west of I-5 and north of SR-138 as part of the first phase of their ongoing study, "Understanding ecological and human-related factors affecting felid movement in a critical wildlife linkage" (Figure 1). The study area was focused in the Tehachapi Mountains linkage, north of the Project area. In October 2025 the UC Davis California Carnivores Program began the second phase of their study, expanding southward to investigate mountain lion movement in

[3] Mr. Decruyenaere's comments are included in an email sent on February 12, 2018, and is available at AR025822-23.

the Castaic Study Area (Figure 2). January 2026 was their first month of attempting captures, and they have already collared two individuals west of I-5 (Figure 3).

In addition to the radio-collar data, a young injured mountain lion cub was found in Castaic, on Hillcrest Parkway near Olympic Street, on January 21, 2026. And witnesses observed a mom and sibling mountain lion nearby. The presence of these mountain lions in Castaic indicates suitable habitat in the vicinity, including in the Project area. And when the young mountain lions become old enough, they will need suitable habitat and connectivity to safely disperse and find their own territories.

The data indicate that mountain lions are present and moving through the landscape quite widely while also showing the I-5 is a formidable barrier to movement. This highlights the importance of every single time a mountain lion is able to successfully cross the I-5 through the limited culverts. Although mountain lions east of I-5 and south of SR-138 have not yet been collared, the UC Davis researchers are planning to collar mountain lions in the area as part of the study. Given the data of mountain lion movement west side of I-5 and the high quality habitat east of I-5, mountain lions are likely living in and moving through the Project area.

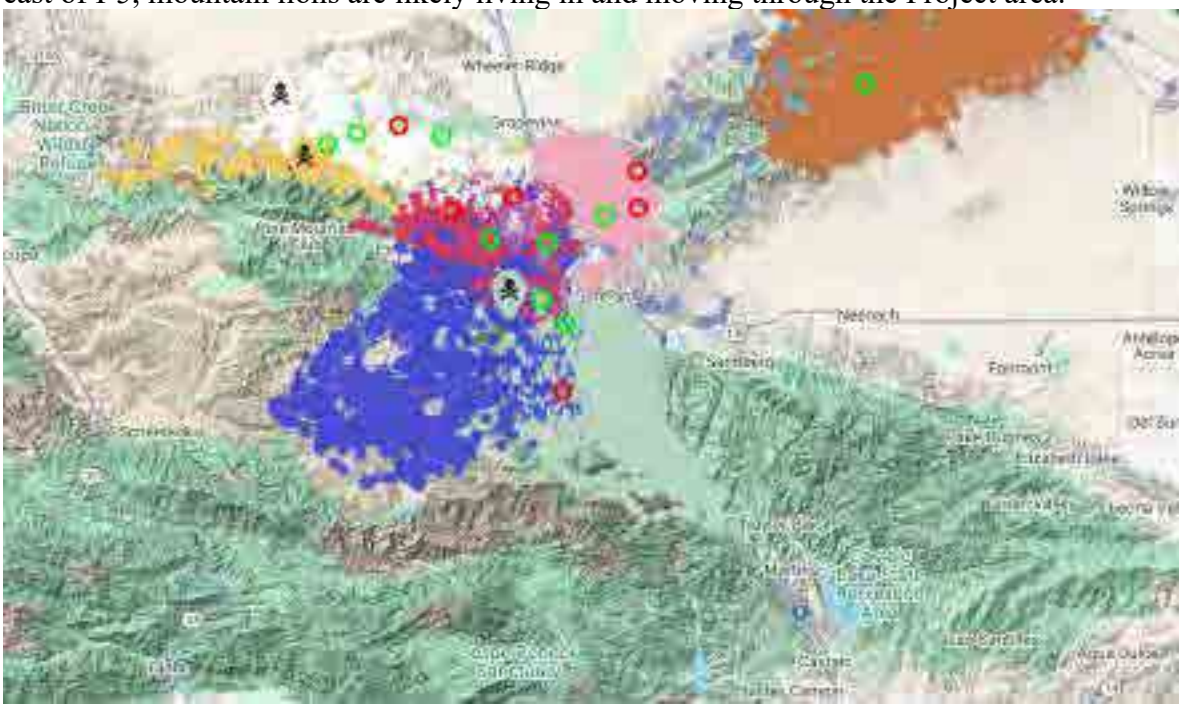


Figure 1: The last 18 months of radio-collar data from individuals captured in the first phase (2022-2025) of the UC Davis California Carnivores Program study.

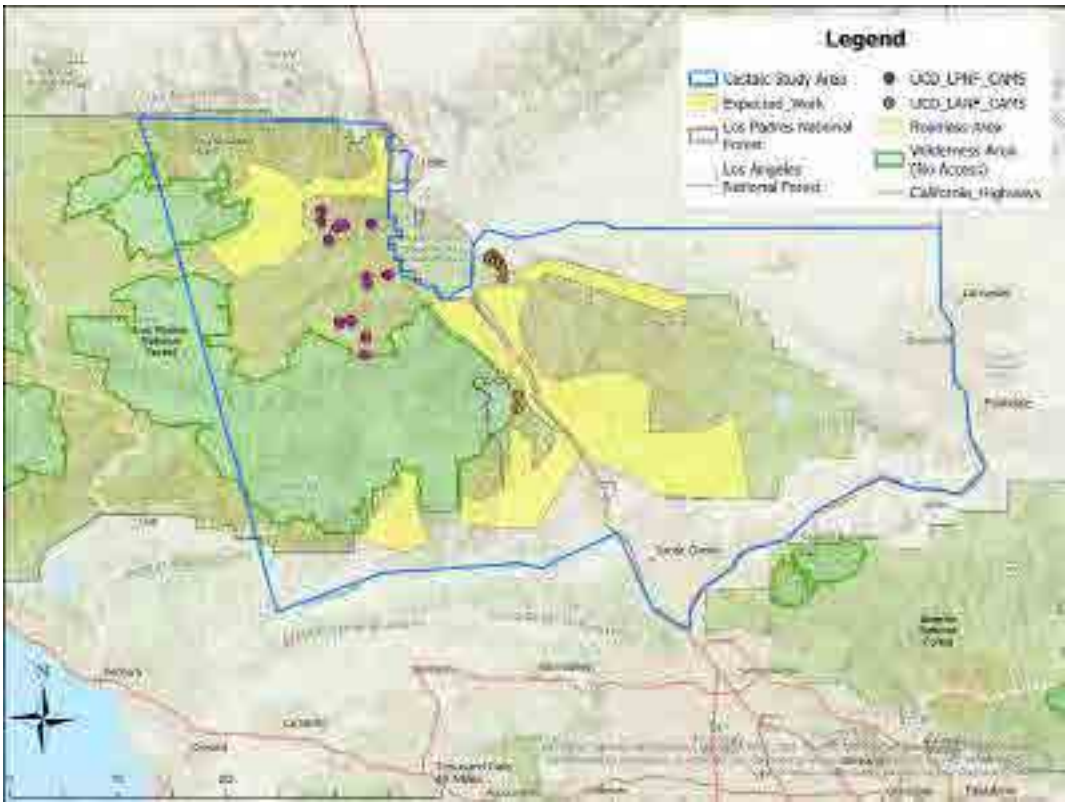


Figure 2: The UC Davis California Carnivores Program Castaic Study Area. This encompasses the second phase of the study, which began in October 2025.


Figure 3: GPS collar data from the first two mountain lions collared in the Castaic Study Area. These lions were captured and collared in January 2026.

Meanwhile, the Mountains Recreation and Conservation Authority ("MRCA") is leading a wildlife connectivity study in the area for their "Interstate 5 (Sierra Madre-Castaic) Wildlife Crossing Infrastructure Assessment and Implementation Plan," which began in December 2025. Their study includes roadkill surveys and wildlife cameras set up at culverts along I-5, including along the section of I-5 that is near the Project area. Importantly, in the first two months since they placed cameras at culverts along I-5, they have documented three instances of a mountain lion using culverts less than four miles from the northernmost portion of the Project area (Figure 4). Mountain lion home ranges can be large, depending on the sex and life stage (i.e., females tend to have smaller home ranges than males, females denning with kittens shrink their home ranges, and dispersing subadult mountain lions can travel long distances). For example, in the nearby Santa Monica Mountains, home ranges were found to be an average of 52 mi^2 for females and 144 mi^2 for males in the nearby (Riley et al., 2021). And dispersing mountain lions in Southern California have been documented traveling 50 to 93 miles (Vickers et al., 2015). Given their large home ranges and long-distance traveling behaviors, it is not inconceivable that the mountain lions documented in nearby culverts could move through the Project area and be impacted by new development there. In addition, other wildlife have been documented using the culverts (Figure 5), indicating these culverts provide important connectivity for other wildlife in the region.



Figure 4: I-5 Mountain lion observation data from MRCA's ongoing wildlife connectivity study.



Figure 4: I-5 Other wildlife observation data from MRCA's ongoing wildlife connectivity study.

II. The RPFSEIR Continues to Provide Insufficient Analysis and Mitigation for Impacts to Western Spadefoot.

The RPFSEIR did not substantially address concerns raised in the Center's May 29, 2025 comment letter regarding the PRDSEIR related to the importance of the western spadefoot (referred to as "WST" in the RPFSEIR) population present at the Project site, the interpretation of previous studies, the uncertainty of success for artificial pools providing adequate breeding habitat, or the importance of connectivity. Instead, the RPFSEIR's primary response is to explain that the Habitat Mitigation and Monitoring Plan ("HMMP") has been approved by CDFW (RPFSEIR 2-28, 29). The RPFSEIR further claims that our previous comment "provides no credible evidence of a potential significant impact not already addressed in the WST analysis or fully mitigated to CDFW's satisfaction."

On the contrary, the Center's May 29, 2025 comment letter explains the uncertainty around long-term success of artificial breeding pools, the importance of redundancy given recent history of drought in California, and the importance of landscape connectivity, as restated below. Regardless of CDFW's approval, the EIR fails to respond to the comment or address the concern, as detailed below.

A. The RPFSEIR Continues to Minimize the Importance of the Project Site for Western Spadefoot.

The RPFSEIR continues to minimize the importance of the western spadefoot population present at the Project site. The RPFSEIR includes no changes regarding western spadefoot analysis and impacts. As such, the RPFSEIR continues to claim that "WST populations are not rare in the nearby areas." (WST Plan, p.7). As described in our previous letter, this claim is contrary to the Applicant's own description in the 2017 Draft Supplemental Environmental Impact Report ("DSEIR"), which states that "the Grasshopper Canyon population is one of few known populations in the region" (DSEIR p. 5.2-36) (and which is quoted in a June 15, 2017 comment letter submitted by CDFW). The claim is also contrary to available evidence regarding the presence of western spadefoot in the region and the current status of western spadefoot populations.

As described in the May 29, 2025 comment letter, we conducted a query of the California Natural Diversity Database ("CNDDB") western spadefoot occurrences on May 21, 2025 including the Mint Canyon, Newhall, Val Verde, and Whitaker Peak, and San Fernando 7.5 Minute Quadrangles ("quads") (note that we included additional quads that were further from the Project site than those displayed in the PRDSEIR to capture the entire Santa Clarita Valley). Our search resulted in 44 total observations, including those at the Project site in the Whitaker Peak quad. Of these observations, only 10 had occurrence ranks (a ranking of the quality of the habitat and the condition of the population at that location) of "Good" or "Excellent;" 10 others were "Fair," 10 were "Poor," 14 were "Unknown" and one was "Possibly extirpated." The CNDDB results therefore do not necessarily indicate a healthy, widespread population—rather, they show that western spadefoot do occur in the area, but while numerous populations appear healthy, numerous others are likely struggling. Importantly, many of the populations in and around the Santa Clarita Valley are highly fragmented and surrounded by roads and development. Such urbanization and development reduce regional and local connectivity across the landscape, isolating these remaining populations. When isolated populations experience years with low reproductive success or become locally extirpated, recovery is difficult because they no longer

have adjacent subpopulations to supply individuals and boost the population or facilitate re-establishment. Therefore, urban development that destroys remaining habitat and continues to fragment dwindling spadefoot populations leads to higher risks of local and regional extinction (Neal et al., 2020). We do not dispute the fact that western spadefoot occur south and west of the project, but this does not mean they are common, and it certainly does not mean they are free from risk of regional decline.

Additionally, the population at the Project site lies in an important location in the species' range, considering western spadefoot biogeography. Western spadefoot in Southern California (south of the Transverse Ranges) are genetically distinct from western spadefoots in central and northern California (Neal et al., 2018). The western spadefoot present in the Project area belong to the southern population. As detailed in a recent Center petition to list western spadefoot as threatened or endangered under CESA, the southern population has experienced more severe declines than the northern population (although both populations have been heavily impacted by habitat loss and continue to decline) (Prado-Irwin, 2025). The population present at the Project site lies at the northernmost extent of the southern western spadefoot population. If the western spadefoot population currently present at the Project site is lost, the range of the southern population will shrink, furthering the pattern of regional decline.

Importantly, very little suitable habitat remains in Los Angeles County or surrounding counties (Rose et al., 2022), so fully protecting the habitat that remains—especially occupied habitat like that which occurs at the Project site–is essential. The Project site represents the last large, undeveloped, core habitat for western spadefoot in the entire County. Thus while the PRDEIR is correct in observing that other populations occur in and around the Santa Clarita Valley, it is important to recognize that this does not diminish the importance of the population at the Project site, especially considering the intact habitat present at the Project site, the lack of suitable habitat in the rest of the County, and the population's position at the northern edge of the southern population's range.

B. The RPFSEIR Still Fails to Provide an Adequate Baseline Regarding Western Spadefoot Presence.

In addition to the issues described above regarding the importance of the western spadefoot population at the Project site, the RPFSEIR also fails to provide sufficient information to establish a reliable environmental baseline at the Project site regarding potential western spadefoot habitat and western spadefoot presence.

The WST Plan states that "WST was observed on the NorthLake Project site during various general and focused amphibian surveys as well as during focused surveys for listed fairy shrimp within seasonal pools" and "While numerous ephemeral ponds and features have been observed on the Project site over time with respect to various surveys for different species, at no time have more than 3 features been observed to contain WST and one additional feature was observed to contain potential WST habitat, despite no WST being observed." (WST Plan, p. 7).

Importantly, the analysis of suitable habitat for western spadefoot was initially extrapolated from surveys for suitable habitat for fairy shrimp, as stated in the WST Plan: "A determination for the extent of suitable habitat for WST is possible from the data collected during wet-season fairy shrimp surveys in 2004/2005, which was one of the wettest rainfall years in the last 50 years" (WST Plan, p. 8). However, fairy shrimp and western spadefoots do not have the same habitat requirements. Fairy shrimp generally occupy clay-pan vernal pools.

Western spadefoots occupy these types of pools as well, but can also breed in many other temporary water bodies, including ditches, erosion cuts, road ruts, and ephemeral streams (Baumberger et al., 2019; Stebbins, 2003).

The WST Plan goes on to state that "In 2014, surveys for fairy shrimp and amphibians, were conducted" (WST Plan, p. 9) but fails to provide any details on survey methodology. It is unclear whether the 2014 surveys used the same methods as the 2004/2005 surveys, in which case non-vernal pool habitats would likely be overlooked, or used a different methodology. Further, the WST Plan provides no information regarding the geographic scope of either survey (2004/2005 or 2014). It is completely unclear whether the entire site was even surveyed for western spadefoot. If indeed the surveys were based on methodology intended to identify vernal pools, they would likely have excluded higher elevation areas or habitats like Grasshopper Creek and temporary pools along eroded areas or defunct roads.

If additional suitable breeding pools do exist at the Project site, based on the survey methodology, it is likely that they would not have been detected. Surveys focused on fairy shrimp in 2004/2005 would have likely excluded water bodies that contain suitable western spadefoot habitat but were not suitable for fairy shrimp. And surveys in 2014, which did target western spadefoot, would not necessarily have detected additional pools due to the "lower-than-average rainfall" that year (WST Plan, p.9). Aside from the lack of detail on the area surveyed, the survey methodology simply does not guarantee that all suitable western spadefoot habitat would have been detected.

Additional temporary waters could occur in many geologic features throughout the Project site, including along small canyons or areas with sandstone erosion, along defunct access roads, and especially in the upstream areas of the ephemeral Grasshopper Creek that experience low and intermittent flows. Given the fact that western spadefoot occupy upland habitat up to 600 meters away from breeding pools (Halstead et al., 2021), if ponding features are present across more of the Project site than presented in the WST Plan—which is likely given the landscape—much of the Project site would present suitable habitat and could be occupied by western spadefoot. However, because the RPFSEIR does provide any detail on how much of the Project site was surveyed, when it what seasons the surveys occurred, or what the climatic conditions of the site were during these surveys, it is impossible to know the extent of the western spadefoot population. It is entirely possible that western spadefoot are much more common throughout the Project site than the RPFSEIR claims, in which case the impacts to this sensitive species from Project construction and operation would be highly significant and potentially catastrophic.

Under CEQA, an environmental review document must evaluate the potential environmental impacts of the project as compared to the existing environmental conditions (the "baseline"), so that the Project's impacts can be meaningfully analyzed and compared to alternatives. (CEQA Guidelines § 15125(a); see County of Amador v. El Dorado County Water Agency (1999) 76 Cal.App.4th 931, 952; Neighbors for Smart Rail v. LA County Metropolitan Transit Authority (2013) 57 Cal.4th 310, 315.) The information provided in the RPFSEIR regarding the presence of suitable western spadefoot habitat does not meet this standard.

C. The Proposed Mitigation for Impacts to Western Spadefoot Remains Insufficient.

As we described in the May 29, 2025 comment letter, the mitigation for impacts to western spadefoot in the form of mitigation ponds is improved from previous environmental review documents, but is still not sufficient to ensure long-term population persistence.

The RPFSEIR claims that "it is speculation to assume that onsite pools will not be successful and thus additional ponds at different locations will be needed." (RPFSEIR at 2-29). However, we do not assume the onsite pools will not be successful without evidence. Rather, the evidence cited in the PRDEIR itself shows that success rates of artificial pools are not 100%. Based on the results of the study conducted by Baumberger et al (2020) and referenced in the PRDSEIR, it is entirely reasonable to expect that some pools may not be successful.

As we wrote in our previous comment letter, Baumberger (2020) investigated the success of artificial breeding pools that were created in 2006 as mitigation for impacts to ten breeding pools at a site in East Orange. The mitigation for this project included the creation of 21 pools to mitigate for the 10 affected pools, providing a total mitigation ratio of 2.1:1. Fifteen of these pools (which became 14 when two pools merged together) were in Irvine Mesa, and six were in Shoestring Canyon. In Shoestring Canyon, all six mitigation pools failed to hold water and breeding western spadefoot were completely absent from the pools and the nearby creek bed during the 2016 survey period (Baumberger et al., 2020). The PRDEIR omits this information, focusing only on the pools in Irvine Mesa, which had higher rates of success, thereby misrepresenting the success of the mitigation and making it appear to be more successful than it was.

Further, the PRDSEIR quotes the following excerpt of the study itself, claiming that this excerpt shows WST breeding in 12 of the 14 pools on Irvine Mesa (WST Plan, p.31):

> Twelve of the 14 mitigation pools at Irvine Mesa held water for >30 d. During our 2016 surveys, two of the mitigation pools built by Glenn Lukos Associates, Inc. merged (Pools 5 and 9) and we considered them as one pool (Pool 9). We detected *S. hammondii* tadpoles in eight of the Irvine Mesa mitigation pools but documented successful breeding through metamorphosis at only seven of these pools in April 2016 due to desiccation and/or water quality.

However, the PRDSEIR misrepresents the findings of this study. This excerpt only says that 12 of the 14 pools held water for >30 days, but merely holding water does not necessarily mean that western spadefoot were breeding in those pools. In fact, the sentence following this excerpt states "*Spea hammondii* did not breed in all the pools with hydroperiods >30 d (Table 3)." (Baumberger et al., 2020). The excerpt itself states that tadpoles were only detected in eight of the pools, and breeding through metamorphosis was only observed at seven of the pools. It is difficult to understand therefore why the PRDSEIR claims that western spadefoot were breeding in 12 of the 14 pools in 2016, when the very excerpt they cite to support this statement says WST only bred in seven of these pools.

The PRDSEIR is misleading and falsely claims that the study's artificial mitigation pools were more successful during the drought year of 2016 than the reality. In fact, only ½ (7/14) of the pools in Irvine Mesa showed successful breeding in 2016, and 0/6 of the pools in Shoestring Canyon showed successful breeding, leading to an overall success rate of just 35% (7/20). Thus the mitigation ratio of 2:1 implemented in the study did not even successfully mitigate for the full impacts to the ten original pools.

The PRDSEIR notes that the 2016 study occurred during a drought year, and that monitoring of the following 2016/2017 season showed tadpoles in 12 of the pools and "extensive breeding was present" (WST Plan p.31). The reference cited to support this claim is not published and is not publicly available (as far as we can ascertain), so it is impossible to determine whether the "12 pools" refers to pools in Irvine Mesa only or in Irvine Mesa and Shoestring Canyon, and therefore it is impossible to determine the overall efficacy of the mitigation during this "ideal" wet year. It appears likely that the study refers only to Irvine Mesa, in which case the population did show a notable increase in pool occupation, but the exclusion of Shoestring Canyon remains unexplained.

Given the variable conditions experienced by vernal pools including drought—which can last for years in California and is expected to become more common in the future (Diffenbaugh et al., 2015)—reliance on a simple 1:1 replacement, which is what the RPFSEIR does, is not sufficient to mitigate for impacts to breeding habitat by creating artificial pools.

The RPFSEIR should take into account the fact that, habitat loss and species displacement from construction of the proposed Project are immediate, while any gains from their mitigation are uncertain. Moilanen et al. (2009) found that "very high offset ratios may be needed to guarantee a robustly fair exchange" and that "considerations of uncertainty, correlated success/failure, and time discounting should be included in the determination of the offset ratio to avoid a significant risk that the exchange is unfavorable for conservation in the long run." Restoring complex ecosystems like ephemeral wetlands often results in reduced ecological function. In studies conducted in California on wetland mitigation sites permitted between 1979 and 2002, less than 20% of mitigated wetlands were performing optimally (Ambrose et al., 2006; Sudol & Ambrose, 2002).

Given the importance of vernal pools and associated upland (heterogeneous) habitat to western spadefoots and numerous other native, rare, and special-status animals and plants, connectivity, and overall biodiversity, the RPFSEIR should provide higher mitigation ratios. In addition, mitigation ratios need to take the types of mitigation to be implemented into consideration, as not all mitigation is created equal. Restoration, enhancement, and creation of habitats can have limited success due to the challenges of establishing the appropriate hydrology when compared to preservation of existing habitats (Matthews & Endress, 2008; Stein et al., 2018; Sudol & Ambrose, 2002; Windmiller & Calhoun, 2007). Scientific studies specifically speak to the need for higher mitigation ratios (along with long-term monitoring, identified and measurable success criteria, and adaptive management strategies) to improve chances of adequately mitigating impacts to habitats and species (Matthews & Endress, 2008; Mitsch & Wilson, 1996; Moilanen et al., 2009; Stein et al., 2018; Sudol & Ambrose, 2002; Windmiller & Calhoun, 2007; Zedler & Callaway, 1999). The western spadefoot's continued survival relies on created wetlands having the appropriate hydrological and biological conditions and adequate upland habitat.

Given that western spadefoots have been extirpated from 80% of their range in Southern California (Stebbins & McGinnis, 2012; US Fish and Wildlife Service, 2005) and amphibian populations in the U.S. are declining at an alarming rate of almost 4% per year (Grant et al., 2016), a higher mitigation ratio than the approximate 1:1 ratio employed by the RPFSEIR is necessary.

Further, the proposed mitigation ponds are very clustered, unlike the current pond arrangement. Currently, the stock pond is approximately 4,000ft away from the seasonal ponds, which are all within approximately 100-400ft of one another (including VP-6/Pond 3) (WST Plan, Exhibit 4). However, the proposed mitigation ponds are all clustered very close together on the west side of the property, within 50ft of one another (WST Plan, Exhibit 5). The PRDSEIR claims that "total acreage as opposed to number of ponds is all that is relevant" (WST Plan, p.18). However, this claim does not consider the importance of landscape connectivity and potential metapopulation dynamics.

The natural history of western spadefoots makes them vulnerable to climate and habitat disturbances. Given the variation in geology, hydrology, climate, and habitat across a landscape, if one population declines or becomes extirpated, it is possible that others nearby can survive and re-colonize. Importantly, high pool density per se is not a problem. We acknowledge that high density of a pool complex can be quite beneficial for connectivity between pools and vernal pool complex hydrology. However, in placing the planned vernal pools so close to one another, and only creating two vernal pools, the Project design has minimized the amount of upland habitat available around the vernal pools and decreased the likelihood of population resilience in the case of an extreme disturbance. If the ponds are clustered, any extreme climatic events or random disturbances are likely to impact all of them in similar ways. On the contrary, if ponds are more spread out across the landscape, the local population is more resilient to random disturbance and potential climatic, hydrological, and ecological changes as well. The RPFSEIR does not address this point at all, and continues to claim that creating two ponds clustered close to one another is sufficient to maintain the spadefoot population at this site. The RPFSEIR fails to consider the importance of redundancy and landscape connectivity to population resilience, especially for a demographically unstable species like western spadefoot. Their high demographic instability makes them particularly sensitive to habitat alterations that may interfere with recolonization and reestablishment after unsuccessful recruitment years (Fisher & Shaffer, 1996).

Western spadefoot populations are often able to persist in the face of environmental variability due to metapopulation connectivity; when one population experiences decline, migrants from surrounding populations can bolster the population and prevent local extirpation. As climate change impacts become more severe and extreme weather events continue to occur, shifts in hydroperiod and increased temperatures expected to become more extreme (Montrone et al., 2019; Pyke, 2004; Thomson et al., 2016), and such population dynamics are likely to be increasingly important for species persistence. Due to reduced connectivity between suitable habitats, populations that are unable to successfully breed may decline and disappear and will be unable to be re-established by neighboring populations, leading to further permanent species decline. It is therefore highly important to consider habitat connectivity between upland and aquatic habitat as well as between different pools and pool complexes.

In Southern California, western spadefoot populations have become extremely fragmented, and persistence of remaining subpopulations of is fragile (Halstead et al., 2021; Neal, 2019; Neal et al., 2020). Additionally, it is more important than ever to prioritize climate resiliency as both drought and extreme storms become more common in California (Diffenbaugh et al., 2015; Swain et al., 2018).

The proposed mitigation therefore remains insufficient because a) the mitigation ratio is too low, and does not provide sufficient replacement habitat in the form of artificial pools and b) the ponds are too close together, increasing the risk of extirpation compared to more dispersed

aquatic habitat. The RPFSEIR thus fails to adequately analyze or mitigate impacts to western spadefoot.

III. The RPFSEIR Dangerously Dismisses the Increased Ignition Risk and Harms to People, Communities, and Wildlife Due from the Project.

The RPFSEIR fails to adequately assess and mitigate the Project's impacts on wildfire risk, and the RPFSEIR's responses to the Center's comments regarding the Project's impacts to wildfire risk are insufficient. The responses mostly point to technical appendices D-1, D-2, and K, which lack adequate analyses and unsubstantiated conclusions. Neither the responses nor the appendices resolve the concerns raised in the Center's May 29, 2025 comment letter. Although Appendix D-1 acknowledges that "the expected fire behavior in the interface of the Northlake development indicates that the fire behavior could produce extreme fire behavior" (RPFSEIR Appendix D-1 at 5), the RPFSEIR somehow, and without providing substantial evidence or using the best available science, concludes that the Project's impacts to wildfire risk are less than significant.

A. The RPFSEIR Overly Relies on Over-burdened Wildfire Protection Services and Resources.

The Project will put more families and structures in harm's way without adequate safeguards for their health and well-being. For example, the RPFSEIR skirts responsibility for when (not if) a fire occurs, stating, "[w]here fires are initialized within the Project Site or near its boundary, the fire incident command and control will have to determine if the population will be moved or "sheltered in place"." (RPFSEIR Appendix D-1 at 5). The Project proponent essentially passes off responsibility for community safety to the County, which has repeatedly failed to keep residents safe from wildfire.

An after action review of the 2018 Woolsey Fire, which resulted in three deaths and more than 1,600 structures destroyed in Los Angeles and Ventura counties, identified that the responding agencies were "overwhelmed" by the fire's "speed and weight of impact" and lacked sufficient trained staff, clear policies and protocols, crisis communication, inter-agency and inter-jurisdictional collaboration, situational awareness, real-time data availability with coordinated response tools, emergency preparedness, and evacuation plans (Citygate Associates, 2019). These same issues have come up in other wildfire disasters throughout the state that occurred around the same time, including the 2017 Tubbs Fire (County of Sonoma, 2018) and 2018 Camp Fire (Constant Associates, 2020).

Despite these reports on lessons learned from fires that occurred seven years ago, the County of Los Angeles and likely many other counties have failed to make the necessary improvements. This is evident with the response to the Eaton and Palisades fires. The County was plagued with the same problems as previous fires, which led to fatal errors and destruction (Jarvie, 2025; McChrystal Group, 2025). Lack of funding, insufficient staffing, unclear and outdated evacuation protocols, limited firefighting resources, insufficient communications and alerts, and more resulted in the death of at least 31 people, the destruction of more than 17,000 structures, and the loss and upheaval of many communities that will be recovering for years to come.

The appendix provides "a simple decision tree for evacuation vs. protecting people in place" (RPFSEIR Appendix D-1 at 75). However, as detailed in the numerous incident reviews

cited above, such decisions while navigating these crises are anything but simple, particularly at a time when wildfires are moving faster and climate change is amplifying extreme weather conditions and wildfire risk (Goss et al., 2020; Swain, 2021; Swain et al., 2018, 2025). The after action review of the Woolsey Fire states, "the size and speed of the Woolsey Fire, at times, outpaced the early efforts of some of the largest and most experienced and capable agencies in the United States" (Citygate Associates, 2019). The review also highlights the need to manage the public's "unrealistic expectations" of agency abilities to protect communities from fire, stating, "[w]e cannot expect that all population growth in Very High or High Fire Hazard Severity areas can be protected simply by increasing resiliency [hardening buildings, fuels treatment, and vegetation management] to wildfire and by adding more fire engines" (Citygate Associates, 2019). The RPFSEIR cannot rely on "fire incident command and control" to keep people safe from wildfire while adding to the burden by placing more people and structures in high fire-prone areas.

In addition, relying on sheltering in place if evacuation becomes infeasible has no basis in U.S. fire safety standards and cannot protect thousands of residents in a fast-moving wildfire. While some measures can reduce fire risk, they do not make structures or communities fire*proof*. Experts found that 56% of homes built to Chapter 7A fire-safety codes burned in the 2018 Camp Fire (Knapp et al., 2021). And such measures do not prevent structure-to-structure fire spread during extreme wind events (Knapp et al., 2021; Zamanialaei et al., 2025). Without population-level standards or evidence that thousands of residents could survive while trapped inside their homes or "safety zones" or "areas of refuge" to be identified after a fire has already been ignited (RPFSEIR Appendix D-1 at 76), sheltering in place cannot be an option.

The RPFSEIR also relies on a new fire station that may not ever get built. According to the appendix, "[a] site will be provided for a new fire station within the development. In addition, the project will pay its proportionate fees for the construction of that station which will enhance the regional fire protection already in place" (RPFSEIR Appendix D-1 at 4). However, as mentioned in the Center's May 29, 2025 comment letter, there is no guarantee that a fire station would actually be built. And even if it were to be built, it is unclear if human and monetary capital will be sufficient to sustain and maintain a new fire station. There is no requirement that the developer pay for the county's costs of building or operating a station, nor is there any guarantee that sufficient firefighting personnel and equipment will be available. During the LA wildfires in January 2025, firefighters lacked enough personnel and fire engines to keep all communities safe (Fuller et al., 2025; Toohey & Fry, 2025). The personnel cost over the life of the Project (essentially forever) will likely be hundreds of millions of dollars. Funding is already lacking for the increasing costs of fire suppression and property damage from wildfires in California, and the developer is not required to reimburse the California Department of Forestry and Fire Protection (CalFire) for the many millions (or billions) of dollars CalFire will likely expense when (not if) Centennial needs to be defended from wildfire. The cost of fire suppression in areas managed by CalFire has skyrocketed from $114 million in the 2000-2001 fiscal year to close to $3 billion for the 2020-2021 and 2021-2022 fiscal years combined (CalFire 2022). The Legislative Analyst's Office (LAO) reported that CalFire used an estimated $3.3 billion for wildfire protection and suppression in the 2022-2023 fiscal year (LAO 2023). And as mentioned previously, climate change is amplifying extreme weather conditions and wildfire risk (Goss et al., 2020; Swain, 2021; Swain et al., 2018, 2025), which is making it more challenging to protect communities from wildfire. Such information must be analyzed when assessing wildfire risk.

This build now, deal with it later approach is no way to house Californians.

B. The Project's Impacts to Wildfire Risk are Significant and Unavoidable.

The RPFSEIR erroneously concludes that the Project's impacts to wildfire risk are less than significant. The RPFSEIR states that the Center's May 29, 2025 letter "provided no credible evidence of a significant wildfire impact" (RPFSEIR at 2-27), which is false. We provided ample scientific evidence that is specific to California ecosystems and land use practices that unequivocally highlights that placing new developments in fire-prone habitats increases ignition risk. As mentioned in the Center's May 29, 2025 comment letter, reckless land-use planning that extends the wildlife-urban interface ("WUI") further into California's fire-prone landscape is causing fires to be more destructive. Almost all destructive wildfires are accidentally ignited by humans or human infrastructure near roads and development (Balch et al., 2024; Chen & Jin, 2022; Keeley & Syphard, 2018; Syphard et al., 2019).

According to a report from Governor Gavin Newsom's Office, construction of more homes in the wildland-urban interface is one of the main factors that "magnify the wildfire threat and place substantially more people and property at risk than ever before" (Governor Newsom's Strike Force, 2019). Another 2019 study found that housing and human infrastructure in fire-prone wildlands are the main drivers of fire ignitions and structure loss (Syphard et al., 2019). Sprawl developments extending into habitats that are prone to fire have led to more frequent wildfires caused by human ignitions, like power lines, arson, improperly disposed cigarette butts, debris burning, fireworks, campfires, or sparks from cars or equipment (Alexandre, Stewart, Keuler, et al., 2016; Alexandre, Stewart, Mockrin, et al., 2016; Balch et al., 2017; Bistinas et al., 2013; Keeley et al., 1999; Keeley & Fotheringham, 2003; Keeley & Syphard, 2018; Radeloff et al., 2018; Syphard et al., 2007, 2012, 2019).

Yet the RPFSEIR dismisses this established science, simply stating "Appendix K (Wildland Fire Risk Report Northlake Project Addendum #1) specifically addresses risk from new human presence in high fire-prone areas and the wildlife-urban interface (WUI) and concluded that "the increased wildfire risk from human-ignited wildfire is less than significant"" (RPFSEIR at 2-27). However, upon inspection of Appendix K, the RPFSEIR fails to provide credible evidence that supports their conclusions. The appendix seemingly avoids recent California studies, opting instead to highlight one 2009 California study and a few studies conducted in central Texas and Canada to argue that "at a point of development density, wildland fuels are reduced/eliminated or fragmented to a point where fire suppression effort are more effective" (RPFSEIR Appendix K at 2). However, this rationale is false and dangerously misleading. Although previous studies have found that low to intermediate development density surrounded by vegetation had the greatest risk of burning in a wildfire (*i.e.*, Syphard et al., 2012), more recent analyses show that once structures ignite in high-density development, there is an increased risk of fire through structure-to-structure spread (Knapp et al., 2021; Mockrin et al., 2023; Zamanialaei et al., 2025). Wildfires in the WUI since 2017 demonstrate this falsehood. High density development was extremely vulnerable and many lives and homes were lost in Santa Rosa, Paradise, Palisades, and Altadena in the 2017 Tubbs Fire, the 2018 Camp Fire, the 2025 Palisades Fire, and the 2025 Eaton Fire, respectively. To dismiss these horrific tragedies is a complete failure to analyze relevant information that is necessary to keep communities safe. The RPFSEIR endangers families by ignoring glaring truths and excluding analyses of these recent California wildfires.

C. Wildfire in the Wildland Urban Interface Leads to Harmful Air Quality and Health Impacts

The RPFSEIR fails to adequately respond to the Center's comments regarding how wildfires in the WUI cause poor air quality and therefore harm people, stating the following:

> "[c]ommenter speculates that an unintentional wildfire in the Project Area would result in poor air quality; none of the commenter's citations are Project Site specific. CEQA does not require the analysis of speculative impacts. (CEQA Guidelines Section 15145.) Commenter provided no credible evidence of a significant wildfire impact" (RPFSEIR at 2-27).

This is false. Such impacts are not mere speculation. Providing evidence that is site-specific to Northlake is unnecessary. When unintentional wildfires occur, science and experience show (and common sense dictates) that burning vegetation and structures filled with toxic metals, plastics, and other hazardous chemicals release $PM_{2.5}$ and toxic smoke, and such air pollution harms people. Numerous scientific studies provided with the Center's May 29, 2025 comment letter support the fact that wildfires result in an increases fine particulate matter ($PM_{2.5}$) exposure, which has been found to have severe health effects, including respiratory and cardiovascular symptoms; higher rates of dementia, cancer and other serious disease; and premature death. Other studies have found that toxic smoke from building structures can travel more than 150 miles. For more details and citations see the Center's May 29, 2025 comment letter and Section D: Wildfires in the Wildland Urban Interface Harm People and Wildlife. The RFPSEIR fails to adequately assess the Project's impacts to wildfire risk and the impacts of ignition to air quality and human health.

D. Wildfires in the Wildland Urban Interface Harm People and Wildlife

The RPFSEIR must consider that when wildfires burn through communities, they threaten homes, livelihoods, lives, and health. In addition to the immediate impacts of lives and homes lost, evacuations and displacement, impacts from air pollution, soil contamination, lost jobs, and the trauma of escape and recovery extend well beyond the fire footprint and last long after the fire is extinguished. Impacts to wildlife are also potentially long-lasting. The RPFSEIR downplays and dismisses the serious and cascading consequences of more wildfire in the WUI and continues to lack adequate wildfire analyses and mitigation.

i. Wildfire Impacts Disproportionately Affect Low-income, Minority Communities

Impacts of wildfire disproportionately affect vulnerable communities with less adaptive capacity to respond to and recover from hazards like wildfire. Low-income and minority communities, especially Native American, Black, Latinx, and Southeast Asian communities, are the most marginalized groups when wildfires occur (Davies et al., 2018).

Those in at-risk populations (*e.g.,* low-income, elderly, disabled, non-English-speaking, unhoused) often have limited resources for disaster planning and preparedness (Richards, 2019). Vulnerable groups also have fewer resources to have cars to evacuate, buy fire insurance,

implement fire-resilient retrofits, maintain defensible space around their homes, or rebuild, and they have less access to disaster relief during recovery (Davis, 2018; Fothergill & Peak, 2004; Harnett, 2018; Morris, 2018; Ong, Pech, Frasure, et al., 2025; Richards, 2019; Vives & Castillo, 2025). And survivors are left without resources to cope with the death of loved ones, physical injuries and emotional trauma from the chaos that wildfires have inflicted on their communities.

Emergency services often miss at-risk individuals when disasters happen because of limited capacity or language constraints (Richards, 2019). This was the case for both the Palisades and Eaton fires. Many elderly and disabled community members unable to evacuate on their own were left stranded as the wildfires advanced, and the median age of those who died in the fires was 77 (Ellis, 2025; Jarvie et al., 2025). Meanwhile, delayed evacuation alerts and limited fire trucks in western Altadena, a predominantly Black and Latino neighborhood, resulted in 18 of the 19 deaths from the wildfire (Castleman, 2025; Ellis & Greene, 2025; Toohey & Jarvie, 2025).

In the aftermath of wildfires and other environmental disasters, news stories have repeatedly documented the lack of multilingual evacuation warnings leaving non-English speakers in danger (Axelrod, 2017; Banse, 2018; Gerety, 2015; Ong, Pech, Ong, et al., 2025; Richards, 2019). This was exemplified during the Eaton and Palisades fires; evacuation alerts were only sent in English and Spanish, leaving more than 12,000 Asian Americans with limited English proficiency in the evacuation zones without potentially life-saving information (Ong, Pech, Ong, et al., 2025).

Health impacts from wildfires can have both acute and long-term health effects that disproportionately affect vulnerable populations, like children, the elderly, pregnant women and fetuses, those with underlying chronic disease, low-income communities, and communities of color. A recent study found that wildfire smoke now accounts for up to 50% of ambient fine particle pollution ($PM_{2.5}$) in the western United States (Burke et al., 2021).

Increased exposure to fine particulates in wildfire smoke has been linked with increased hospital visits for respiratory symptoms (*e.g.*, asthma, acute bronchitis, pneumonia, or chronic obstructive pulmonary disease) and cardiovascular symptoms (*e.g.*, congestive heart failure, ischemic heart disease, and myocardial infarction) (Delfino et al., 2009; Künzli et al., 2006; Liu et al., 2015; Rappold et al., 2012; Reid et al., 2016; Viswanathan et al., 2006). It has also been linked to higher rates of dementia (B. Zhang et al., 2023; Z. Zhang et al., 2023). And experts have also found that greater exposure to wildfire smoke and excessive heat during the month before conception and the first trimester of pregnancy is linked with greater risk of both short- and long-term health problems (Evans et al., 2022; Khalili et al., 2025). Researchers estimated that between 2008 and 2018 more than 50,000 premature deaths were caused by California wildfire smoke (Connolly et al., 2024). As climate change intensifies, scientists predicted that wildfire smoke could cause approximately 700,000 excess deaths between 2025-2055 (Qiu et al., 2025).

Wildfires in the WUI can lead to other harmful public health impacts due to increased exposure to toxic contaminants from burned buildings, cars, electronics, and more. Buildings and infrastructure often contain plastic materials, heavy metals, benzene, and carcinogenic gases. These toxic chemicals pose a threat in the burn area and they can travel long distances.

During the 2018 Camp Fire that burned 19,000 structures, the smoke caused dangerously high levels of air pollution in the Sacramento Valley and Bay Area and the California Air Resources Board found that high levels of heavy metals like lead and zinc traveled more than 150 miles (CARB, 2021). And unsafe levels of lead, arsenic, and other dangerous metals have

been documented in and downwind of the Eaton and Palisades fire footprints (Champlin, 2025; Smith & Briscoe, 2025).

Families living or working in or near the burn area also risk increased exposure to hazardous chemicals. After the Eaton Fire, some families with no other options returned to live in homes deemed "uninhabitable" by insurance companies, surrounded by toxic debris (Vives & Castillo, 2025). Almost 50% of schools where students had returned to in the Pasadena Unified School District had elevated levels of lead and arsenic in their soils due to toxic ash, which can have damaging effects on the nervous system, cardiovascular system, and kidneys (Haggerty & Briscoe, 2025). And farmworkers often have to continue working while fires burn and pollutants fill the air, or risk not getting paid (Herrera, 2018; Kardas-Nelson et al., 2020; Parshley, 2018). Wildfire victims have also had to deal with lack of funding and support for cleanup as well as improper cleanup, "adding to the trauma" they have already endured (Briscoe, 2025; Briscoe et al., 2025).

Service workers also face increased risk. Firefighters are suffering disproportionately high rates of cancer and other serious diseases (Dreier, 2025; Hwang et al., 2023; Johnson & Lam, 2023) as well as mental health issues due to extended fire seasons and working extended shifts away from their families (Ashton et al., 2018; Bransford et al., 2018; Del Real & Kang, 2018; Greene, 2018; Gutierrez, 2018; Simon, 2018). And firefighters who fought blazes in the LA wildfires had high levels of lead and mercury in their blood, (Hernandez, 2025). Fire cleanup workers also risk increased exposure to harmful chemicals; they often do not use appropriate protective gear as they remove toxic debris from the burn area (Haggerty, 2025).

Scientists are continuing to uncover the devastating health impacts of wildfires in the WUI. In a study that included more than 1,100 participants that were affected by the 2023 wildfires in Maui, Hawai'i, researchers found that six to 14 months after the wildfires more than 20% of participants had reduced lung function and almost 50% had clinical symptoms of depression (Juarez et al., 2025). The majority of participants reported food insecurity, economic hardship, and displacement due to the wildfires (Juarez et al., 2025), and in the month of the wildfires, the suicide and overdose rate doubled (Purtle et al., 2025). Other experts attributed more than 400 additional deaths to the LA wildfires, likely due to poor air quality, delays in health care, and other factors (Paglino et al., 2025).

Science unequivocally shows that California wildfires in the WUI are increasing negative health impacts within and beyond their footprint. Proper analyses and mitigation of the Project's impacts on wildfire ignition, wildfire spread, and the negative health impacts associated with wildfire are needed. The RPFSEIR fails to accomplish this and is dangerously deficient.

ii. Wildfires in the WUI Threaten Vulnerable Wildlife

Wildfires are a natural and necessary process in many of California's ecosystems, and many areas need beneficial fire to restore ecosystem health and cultural connection to the land. However, the last decade of unprecedented wildfires in the wildland urban interface ("WUI") are pushing fragmented populations of sensitive species to the brink. Wildlife, including genetically isolated mountain lions, remnant populations of frogs and fish, resident and migratory birds, nearby marine life, and more are all vulnerable to direct and indirect impacts from wildfire. They can suffer burns, smoke-induced asphyxiation, heat stress, traumatic injuries, and death (Garcês & Pires, 2023).

For example, two mountain lion deaths in the Santa Monica Mountains were attributed to the 2018 Woolsey Fire. Although mountain lions are highly mobile and generally able to move away from wildfires, these lions were unable to escape to safety because they were boxed in by roads and development. In addition, researchers found that after a large wildfire in an urbanized region, mountain lions avoided burn areas and increased risky behavior that could lead to more conflict with people, increased mortality, and extinction risk (Blakey et al., 2022). Such deaths can further destabilize small mountain lion populations that are already facing numerous other threats, including low genetic diversity, vehicle strikes and rodenticide poisoning, and make them more vulnerable to local extinction (Benson et al., 2016, 2019).

Smoke inhalation from wildfires can lead to negative health effects, like carbon monoxide poisoning, damage to lung tissue, and weakened immune response, in both terrestrial and aquatic wildlife (Sanderfoot et al., 2021). Smoke exposure can also cause shifts in animal behavior and stress levels, which could influence short- and long-term health and survival (Sanderfoot et al., 2021). One study found that increased smoke exposure led to decreased body condition (i.e., lower body mass) of wild birds in California, which suggests that they expend more energy while coping with sub-lethal health effects of smoke exposure (Nihei et al., 2024).

Heavy rains after wildfire can trigger landslides and debris flows that threaten small populations of sensitive, less mobile species that have been diminished due to habitat loss and fragmentation from sprawl development, dams, disease, non-native predators, and other threats. After the 2020 Bobcat Fire, biologists were desperate to rescue remnant populations of yellow-legged frogs, Santa Ana suckers, unarmored threespine stickleback fish, speckled dace, arroyo chub and arroyo chub because they were concerned that post-fire debris flows due to winter rains would wipe out their populations in the fire zone (Sahagun, 2020). Biologists conducted similar rescue missions for the last-known populations of Southern California steelhead and northern tidewater gobies in the Santa Monica Mountains after the 2025 Palisades Fire (Seidman, 2025a, 2025b, 2025c).

Historically, these species would have been able to recolonize from neighboring populations after the loss of individuals or populations to fire impacts. Unfortunately, that ability is now limited by the species' currently small and fragmented population structure. Continued alteration of historical fire regimes due to sprawl development will further endanger remnant populations.

Devastation caused by wildfire in the WUI is far-reaching and long-lasting. We have yet to uncover the full extent of harm such wildfires due to wildlife and the habitats they rely on, but it is certain that careless land use planning and policy are causing death and destruction in the natural world. The RPFSEIR fails to adequately assess and mitigate the Project's impacts on wildfire risk and how increased ignitions will impact biological resources.

iii. The RPFSEIR fails to consider mitigation related to wildlife insurance for new residents and owners.

California is facing an insurance crisis. Many private insurers are leaving California or otherwise refusing to insure homes built in the wildland-urban interface (like the Proposed Project), and this has resulted in an addition of approximately one half of a *trillion* dollars of added assets being "covered" under California's FAIR Plan, which was designed to be a wildfire insurance of last resort for homeowners otherwise unable to obtain coverage (and is owned and managed by the State) (Saleh, 2025). In turn, this has caused a major uptick in premiums on the

State's FAIR Plan, which has led some homeowners to forego wildfire insurance altogether. (*Id*.) And many of the homeowners that have been able to retain private wildfire insurance have been unable to actually be reimbursed through their insurers' claims process (Overland, 2025 [discussing litigation filed by victims of the recent fires in Los Angeles against their insurer for failing to pay out valid claims resulting from those fires]).

The RPFSEIR should therefore analyze whether the residences contemplated will be insurable through private insurers or will require access to the California FAIR Plan and what each home's premium ought to be. (*Laurel Heights Improvement Assn.*, 47 Cal. 3d at 392.) In undertaking that analysis, the Project proponent must also take into account that many private insurers have a documented practice of underinsuring homes when contracting for wildfire insurance, and that this practice of underinsurance has resulted in many homeowners receiving far less than their home's worth from their insurer after their homes are destroyed by wildfire (Neilson, 2025). Moreover, the RPFSEIR should include a mitigation measure requiring the Project proponent to financially cover the wildfire insurance for the homes being sold or otherwise disclose accurate and helpful information regarding the availability of private or public wildfire insurance, the costs thereof, and the risks inherent in obtaining such insurance and, more importantly, in foregoing to do so when advertising and selling the residences contemplated under the Proposed Project and Specific Plan. (14 C.C.R. § 15021(a).) In fact, the State is working on preparing and publishing a tool that would help facilitate that process (Rahim, 2025).

IV. The County's Environmental Review of the Project's Significant Transportation Impacts Is Deficient.

This Project will increase regional vehicle miles traveled ("VMT'') by more than *one hundred million miles* each year, running against California's goals to reduce car-based lifestyles, vehicle accidents, greenhouse gas emissions, and air pollution. By building in the wildland urban interface far from existing services, this Project will entrench automobile dependence for the Project's residents for decades to come. The impacts from this enormous increase in car travel are significant and must be mitigated as such.

Providing alternatives to single occupancy vehicle travel is essential to building an efficient, sustainable and equitable transportation system. Unfortunately, the U.S. is far from achieving a multi-modal transit system, and projects like this move California even further from that target. In 2013, one study found that 76.4% of U.S. daily commutes were people driving alone (McKenzie, 2015). According to the EPA, the collective daily transportation in the U.S. constitutes about 27% of the total greenhouse gasses released (U.S. Environmental Protection Agency, 2017). California's annual average emissions associated with passenger vehicles between 2000 and 2020 was approximately 110 million metric tons of CO2 equivalent, or 25% of the state's total emissions. (CARB, 2022).

Increasing a region's VMTs isn't just bad planning, it also undermines community health. Increasing VMT increases emissions of air pollutants such as nitrogen oxides (NO_x), volatile organic compounds (VOCs), carbon monoxide, heavy metals, carbon dioxide and respirable particulate matter ($PM_{2.5}$). Increasing VMT also leads to more ozone (O_3) production through the photochemical reactions of NO_x and VOCs emitted by vehicles. (Fu et al., 2021). Short- and long-term exposure to several of these pollutants has been linked to premature mortality, compromised birth outcomes, heart disease and a host of respiratory illnesses (Mujtaba & Shahzad, 2021).

Another serious direct impact of increasing the number of cars on roads, like the Project would do, is automobile crashes, which have historically been the leading cause of death among adolescents in the United States. (Goldstick et al., 2022 [showing vehicle crash as the top cause of death from 1999 to 2019, when firearm deaths narrowly surpassed vehicle deaths]). An estimated 42,915 people in the U.S. died in car crashes in 2021 alone and 3.4 million people are injured each year, which costs an estimated $473.2 billion annually as measured by wage and productivity losses, medical expenses, motor-vehicle damage, and employers' uninsured costs (Frumkin et al., 2004; U.S. Department of Transportation, 2022). The rate of deaths due to traffic has been increasing since 2013. (National Safety Council, 2026)

Beyond the direct impacts, increased VMT has long term impacts on commuters. In 2019, the duration of the average daily commute in the United States increased to a new high of 55.2 minutes, and a record 9.8 percent of commuters reported daily commutes of at least 2 hours (Burd et al., 2021). These long commutes reduce the amount of time that workers are available to spend with family, friends, and community. The increase in inactivity and isolation can also lead to long-term health complications such as pre-diabetes, diabetes, obesity, asthma, isolation, stress and depression (Ewing et al., 2003; Leyden, 2003). In contrast, developments that facilitate commuting my mass transit, foot, or bicycle increase people's overall activity level and health. (Sahlqvist et al., 2012).

Given the myriad public health problems associated with increased car dependance, it should be a priority of the County to reduce VMT with every new project, especially for projects as large as this. The County needs to continue investing—and requiring project applicants to invest—in alternative modes of transportation to not only make multi-modal transit cheaper, quicker, and easier than passenger vehicle transit. Best practices for transportation options should include providing free public transit services for future residents and workers; implementing bus only lanes; optimizing bus routes to minimize overlap and ensure coverage across the city in line with demand; and providing high-frequency, reliable services with regular bus stops for easy access.

Studies indicate that free public transit services typically result in ridership increase from 20% to 60% in a matter of just a few months (Studenmund and Connor, 1982). Similarly, bus lanes that reduce total transit door-to-door travel times by 5%-15% will increase urban peak ridership 2%-9% (UCLA Institute of Transportation Studies, 2019). Lastly, ensuring accessibility and convenience is essential to increasing ridership. Providing more bus stops decreases the distance residents have to travel to access such services.

Instead of pursuing these common-sense solutions, this Project envisions continuing California's failed experiment of building car-centered infrastructure by creating a sprawling, low density, mass transit desert far from any existing services. This will result in the Project's residents being tethered to their cars for their every need for decades to come. The VMT analysis shows that the Project will induce over 100 million miles travelled per year. (RPFSEIR Appx. C-1 at 9.) This dramatic amount of automobile travel will result in an average of 1.38 of the Project's residents to die each year in vehicle accidents. (National Safety Council, 2026 [showing a death rate of 1.38 people per 100 million miles travelled].) Vehicle travel resulting from the Project will also emit 53,873 tons of CO_2 per year, 220 pounds of Nox per day, 657 pounds of carbon monoxide per day, and 237 pounds of particulate matter 10 per day. (Draft SEIR at 5.1-34, 5.7-26.) This Project will steer region in the opposite direction of local, county, and state policy, eroding community and environmental health to build yet more car-dependent infrastructure.

The RPFSEIR fails to adequately assess and mitigate the VMT, GHG, air pollution impacts from the massive increase in car travel that will be caused by this Project.

A. The RPFSEIR'S VMT Analysis is Unsupported and Deficient

The County argues that this Project, which will add one hundred million VMT to the area's roadways each year, does not have a significant traffic impact. The Project's enormous VMT impacts are significant when compared to the County-established threshold. Yet instead of using its established threshold, the County instead used an inapposite environmental baseline and threshold of significance to preclude a finding of significance. These findings are not supported by substantial evidence. The County must recirculate the EIR to explain how it will mitigate its significant impacts to VMT.

i. The County Was Required to Perform a VMT Analysis in the RPFSEIR

Senate Bill 743, passed in 2013, amended CEQA to require lead agencies to replace the outdated level of service traffic metric with VMT. (See Guidelines § 15064.3). The level of service analysis focused on how a project would impact road congestion, a metric that does not factor in GHG emissions or air pollution. The purpose of SB 743 was to amend CEQA to be more "able to promote the state's goals of reducing greenhouse gas emissions and traffic-related air pollution, [while] promoting the development of a multimodal transportation system, and providing clean, efficient access to destinations." (Steinberg, 2013). In other words, SB 743 aligns CEQA with California's climate goals by focusing the traffic analysis on how much a project will impact automobile use, rather than how a project will impact road congestion.

Though Senate Bill 743 was passed after the 1992 development was approved, CEQA requires the County to replace its outdated level of service analysis with a VMT analysis. CEQA Guidelines section 15007(b) states that "new requirements in amendments will apply to steps in the CEQA process not yet undertaken by the date when agencies must comply." This step in the CEQA process—the Revised Partial SEIR—could not have begun before the final judgment granting the Center's writ of mandate was filed by the Los Angeles County clerk. This filing occurred on February 1, 2021, well after the new VMT requirement took effect on July 1, 2020. (See Guideline § 15064.3.) As such, the VMT CEQA Guidelines apply to this RPFSEIR, and the County was required to redo its 1992 traffic analysis.

The County recognized this requirement and prepared a Transportation Analysis because the "level or service metric . . . is no longer the applicable metric for identifying significant impacts under CEQA." (RPFSEIR Appx C-1 at p. 1.) While the County appropriately decided to conduct this analysis, the analysis and its attendant findings were deficient.

ii. The Environmental Baseline Used in the VMT Analysis is Unsupported

The new traffic analysis found that VMT impacts were not significant. The County's conclusion is flawed for two reasons. First, the appropriate environmental baseline is the existing, undeveloped baseline. Instead, the Conty used the hypothetical baseline of the 1992 project at full buildout. Second, the threshold of significance chosen by the County is not supported by substantial evidence.

The County used the 1992 project and its 12,585 hypothetical residents as the environmental baseline, rather than the actual baseline, which is no residents. The County's

attempt to obfuscate the significance of the Project's VMT impacts by inflating the environmental baseline violates CEQA. As evidenced thoroughly in the Center's May 29 letter, a foundational aspect of CEQA is to treat the *existing* environment as the baseline. The County provided no rebuttal to the abundant evidence provided by the Center, failing to cite a single case, provision of the Public Resources Code, CEQA Guideline, or County policy. Instead, the County relies on unsupported assertions that the previous project, which was never built, was not hypothetical.

Though the development had been approved in 1992, that approval does not constitute an acceptable baseline. The CEQA Guidelines and Supreme Court speak directly to this set of facts, detailing that permitted conditions are not the same as a CEQA baseline. The Guidelines detail that "an existing conditions baseline shall not include hypothetical conditions, *such as those that might be allowed, but have never actually occurred*." (Guidelines § 15125(a)(3) [emphasis added].) The Supreme Court has held that "a long line of Court of Appeal decisions holds, in similar terms, that the impacts of a proposed project are ordinarily to be compared to the actual environmental conditions existing at the time of CEQA analysis, *rather than to allowable conditions defined by a plan* or regulatory framework." (*Communities for a Better Environment v. South Coast Air Quality Management Dist.*, 48 Cal. 4th 310, 320-321 [emphasis added].) Though the 34-year-old development approval set some "allowable conditions," those conditions never came to fruition. The "actual environmental conditions existing at the time of" this RPFSEIR are undeveloped land with no residences and minimal business activity. The environmental baseline must be set based on this reality, not the hypothetical project.

Using this appropriate, existing environmental baseline would undeniably lead to a finding of significance because the Project would add 275,141 VMT to the region each day compared to the negligible existing VMT associated with the Project area.

As described in the next subsection, even if the Project uses the generous Southern California Association of Governments environmental baseline of 22.3 VMT per capita, the Project will nonetheless result in significant VMT impacts.

iii. The VMT Significance Threshold Used by the County is Unsupported

The appropriate threshold of significance of 18.5 VMT per capita has already been established by the County, yet the County failed to use this threshold for the Project.

Los Angeles County prepared a SB 743 Implementation and CEQA Updates Report ("County Guidance") in 2020 to help guide agencies through Senate Bill 743 VMT analyses for the purposes of CEQA review. This County Guidance sets the baseline VMT for North Los Angeles County, where the Project is located, for a residential project at 22.3 VMT per capita. (Los Angeles County, 2020, pp. 16, 30). The County Guidance sets the VMT significance threshold at 16.8% below this baseline. (Los Angeles County, 2020, pp. 16, 29). In this case, a 16.8% reduction from the 22.3 VMT per capita equals 18.5 VMT per capita. (Los Angeles County Public Works, 2020, p. 11).

The significance threshold of 18.5 VMT per capita is dramatically lower than the Project's 25.7 VMT per capita. (RPFSEIR Appx. C-1 at 9.) Since the per capita VMT will greatly exceed the County-established significance threshold for residential projects, the VMT impacts from the Project are significant and must be analyzed and mitigated as such.

Instead of using the County's own guidance for residential projects, the County declares that any decrease in VMT per *service population* compared to the 1992 project automatically

results in insignificance. (RPFSEIR Appx. C-1 at p. 7.) As described in the County Guidance, VMT per service population is the correct metric only when a project is *not* a residential or office project. (SB 743 Implementation Report, 2020, p. 30). This is because VMT per service population is intended to include the VMT from both a development's residents and employees commuting to "service" the development's businesses. As such, the baseline for VMT per service population is higher than per capita because it includes these worker trips from outside the development.

Where, as here, a development has no businesses, this metric does not make sense. This Project is almost entirely residential, with only 22.9 acres of the 1329.7 acre Project zoned as commercial or industrial. (PRFSEIR at Ex. 1). Non-residential VMT makes up just 3.2% of the Project's overall VMT. (RPFSEIR Appx C-1 at 4 [showing commercial retail VMT at 3,670, recreation/park VMT at 2,640, and school VMT at 2,640].)

The County argues that the Project's impacts are not significant because VMT per service population decreased from 27 to 25.7 for the 1992 development compared to the 2018 Project. Yet the correct metric is VMT per capita, which is the exact same for both projects. The RPFSEIR must redo its analysis using this per capita metric rather than the unsupported per service population metric.

iv. The Traffic Analysis's VMT Per Capita is Flawed

Beyond using an unsupported environmental baseline and significance threshold, the entire VMT analysis understates the amount of driving that the Project will cause. As noted in footnote 2 of the VMT and Service Population Calculation Worksheet, the only trips used in the analysis include "2 trips per employee (26.4 VMT per employee/2 trips per employee =13.2 miles." (RPFSEIR Appx C-1 at 9.) This meager VMT accounting ignores that the Project will require residents to drive to fulfill all their daily needs, not just to get to work. Unaccounted for are trips to the grocery store, to drop kids off at school, to medical appointments, to restaurants, to cultural and social events, and more. And since this Project sprawls into undeveloped lands without existing services, residents would need to travel miles to existing urban centers to fulfill these needs. If these unaccounted for trips were included in the VMT analysis, the overall VMT would no doubt be substantially higher As such, the VMT analysis is not supported by substantial evidence.

v. The RPFSEIR Fails to Incorporate All Feasible Measures to Mitigate VMT Impacts

Since the Project's VMT impacts are significant, the County must implement all feasible mitigation measures. The RPFSEIR fails to do so, requiring no mitigation for VMT. Even if the County succeeded in implementing the Project's "features that tend to reduce VMT" (which are not enforceable mitigation measures), the Project would still greatly exceed the VMT significance threshold. These features include building bike infrastructure (VMT reduction of 0.08%), expanding the transit network (4.6%), affordable housing (2.4%)[4], and pedestrian network (6.4%). Together, this would decrease VMT per capita by 13.4%, or 22.3 VMT per capita. This is number is still 20% higher than the significance threshold of 18.5 VMT per capita.

[4] This reduction is based on a 28.6% decrease for the Project's 315 affordable units, assuming those units are multiple family residential units with an average of 2.79 inhabitants. (RPFSEIR Appx C-1 at 9.)

Since the VMT would remain far above the significance threshold under any circumstance contemplated by the RPFSEIR, the County must consider all feasible measures to mitigate the Project's VMT impacts. Some of the short-term measures identified by the County in its guidance document, but not included in the RPFSEIR, include implementing a commute trip reduction program, providing ride-sharing programs, implementing subsidized or discounted transit programs, encouraging telecommuting and alternative work schedules, unbundling parking costs from property costs, implementing market price public on-street parking, providing traffic calming measures, and implementing car-sharing programs. (Los Angeles County, 2020, p. 34). The County guidance also identified two long-term mitigation measures, neither of which were contemplated by the Project. These measures include a VMT mitigation exchange and a VMT mitigation bank. (Los Angeles County, 2020, p. 36). The County must adopt enough of these additional, feasible mitigation measures to reduce the VMT per capita below the threshold of significance.

A decades-old EIR that fails to even calculate VMT is not sufficient to satisfy CEQA's requirements; the appropriate inquiry is "whether a proposed project or plan adequately reduces total VMT." (Los Angeles County Public Works, 2020). This Project clearly does not.

V. Conclusion

The Center appreciates the Commission's consideration of these comments. Because the environmental review for the Project is inadequate for the foregoing reasons, the Center urges the Commission not to approve the Project unless and until these deficiencies are remedied.

Given the possibility that the Center will be required to pursue legal remedies in order to ensure that the County complies with its legal obligations including those arising under CEQA, we would like to remind the County of its statutory duty to maintain and preserve all documents and communications that may constitute part of the "administrative record" of this proceeding. (Pub. Res. Code § 21167.6(e); *Golden Door Properties, LLC v. Superior Court* (2020) 53 Cal.App.5th 733.) Please include this letter and the provided references in the County's file for this Project, and continue to include the Center on the notice list for this Project using the contact information below.

Sincerely,



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References

Alexandre, P. M., Stewart, S. I., Keuler, N. S., Clayton, M. K., Mockrin, M. H., Bar-Massada, A., Syphard, A. D., & Radeloff, V. C. (2016). Factors related to building loss due to wildfires in the conterminous United States. *Ecological Applications*, *26*(7), 2323–2338.

Alexandre, P. M., Stewart, S. I., Mockrin, M. H., Keuler, N. S., Syphard, A. D., Bar-Massada, A., Clayton, M. K., & Radeloff, V. C. (2016). The relative impacts of vegetation, topography and spatial arrangement on building loss to wildfires in case studies of California and Colorado. *Landscape Ecology*, *31*(2), 415–430.

Ambrose, R. F., Callaway, J. C., & Lee, S. F. (2006). *An Evaluation of Compensatory Mitigation Projects Permitted Under Clean Water Act Section 401 by the California State Water Quality Control Board, 1991-2002*.

Ashton, A., Lillis, R., & Ramirez, W. (2018, August). 249 nights away at California fires: Firefighter families cope with a 'new normal.' *The Sacramento Bee*.

Axelrod, J. (2017, December). California Wildfires Spark Issues of Bilingual Emergency Communications. *American City and County*.

Balch, J. K., Bradley, B. A., Abatzoglou, J. T., Nagy, R. C., Fusco, E. J., & Mahood, A. L. (2017). Human-started wildfires expand the fire niche across the United States. *Proceedings of the National Academy of Sciences*, *114*(11), 2946–2951.

Balch, J. K., Iglesias, V., Mahood, A. L., Cook, M. C., Amaral, C., DeCastro, A., Leyk, S., McIntosh, T. L., Nagy, R. C., St. Denis, L., Tuff, T., Verleye, E., Williams, A. P., & Kolden, C. A. (2024). The fastest-growing and most destructive fires in the US (2001 to 2020). *Science*, *386*(6720), 425–431.

Banse, T. (2018, April). How Do You Say 'Evacuate' in Tagalog? In a Disaster, English Isn't Always Enough. *Northwest Public Broadcasting*.

Barrientos, R., Vickers, W., Longcore, T., Abelson, E. S., Dellinger, J., Waetjen, D. P., Fandos, G., & Shilling, F. M. (2023). Nearby night lighting, rather than sky glow, is associated with habitat selection by a top predator in human-dominated landscapes. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *378*(1892), 20220370.

Baumberger, K. L., Backlin, A. R., Gallegos, E. A., Hitchcock, C. J., & Fisher, R. N. (2020). Mitigation Ponds Offer Drought Resiliency for Western Spadefoot (Spea hammondii) Populations. *Bulletin, Southern California Academy of Sciences*, *119*(1), 1–12.

Benson, J. F., Dougherty, K. D., Beier, P., Boyce, W. M., Cristescu, B., Gammons, D. J., Garcelon, D. K., Higley, J. M., Martins, Q. E., Nisi, A. C., Riley, S. P. D., Sikich, J. A., Stephenson, T. R., Vickers, T. W., Wengert, G. M., Wilmers, C. C., Wittmer, H. U., & Dellinger, J. A. (2023). The ecology of human-caused mortality for a protected large carnivore. *Proceedings of the National Academy of Sciences*, *120*(13), e2220030120.

Benson, J. F., Mahoney, P. J., Sikich, J. A., Serieys, L. E. K., Pollinger, J. P., Ernest, H. B., & Riley, S. P. D. (2016). Interactions between demography, genetics, and landscape connectivity increase extinction probability for a small population of large carnivores in a major metropolitan area. *Proceedings of the Royal Society B: Biological Sciences*, *283*(1837), 20160957–20160957.

Benson, J. F., Mahoney, P. J., Vickers, T. W., Sikich, J. A., Beier, P., Riley, S. P. D., Ernest, H. B., & Boyce, W. M. (2019). Extinction vortex dynamics of top predators isolated by urbanization. *Ecological Applications*, *29*(3), e01868–e01868.

Bistinas, I., Oom, D., Sá, A. C. L., Harrison, S. P., Prentice, I. C., & Pereira, J. M. C. (2013). Relationships between human population density and burned area at continental and global scales. *PLoS ONE*, *8*(12), 1–12.

Blakey, R. V., Sikich, J. A., Blumstein, D. T., & Riley, S. P. D. (2022). Mountain lions avoid burned areas and increase risky behavior after wildfire in a fragmented urban landscape. *Current Biology*, *32*(21), 4762-4768.e5.

Bransford, S., Medina, J., & Del Real, J. A. (2018, July). Firefighters Reflect on a Job Now 'Twice as Violent'. *The New York Times*.

Briscoe, T. (2025, August 7). Homeowners say Army Corps botched L.A. fire cleanups. *LA Times*.

Briscoe, T., Haggerty, N., & Smith, H. (2025, May 4). FEMA didn't test for toxic substances in the soil after Eaton, Palisades fires. *LA Times*.

Burd, C., Burrows, M., & McKenzie, B. (2021). *Travel Time to Work in the United States: 2019* (American Community Survey Reports). U.S. Department of Commerce, U.S. Census Bureau.

Burke, M., Driscoll, A., Heft-Neal, S., Xue, J., Burney, J., & Wara, M. (2021). The changing risk and burden of wildfire in the United States. *Proceedings of the National Academy of Sciences*, *118*(2), e2011048118.

CARB. (2021). *Camp Fire Air Quality Data Analysis*.

CARB. (2022). *California Greenhouse Gas Emissions for 2000 to 2020 Trends of Emissions and Other Indicators*. California Air Resources Board.

Castleman, T. (2025, July 22). Six months after LA's firestorms, the remains ofa 31st victim are found in Altadena. *LA Times*.

CDFW. (2024). *CDFW 2024—Wildlife Connectiviyt Barrier I-5 Sierra Madre to Castaic Ranges*. California Department of Fish and Wildlife.

CDFW. (2025a). *A Status Review of the Petitioned Southern California/Central Coast Evolutionarily Significant Unit (ESU) of Mountain Lion (Puma concolor cougar) in California*. California Department of Fish and Wildlife.

CDFW. (2025b). *Pesticide Exposures & Mortalities in Non-target Wildlife 2024 Annual Report*. California Department of Fish and Wildlife.

Champlin, C. (2025, April 11). The Eaton Fire hit Caltech scientists close to home. Now, they're studying the toxic aftermath. *KQED*. https://www.kqed.org/news/12035344/the-eaton-fire-hit-caltech-scientists-close-to-home-now-theyre-studying-the-toxic-aftermath

Chen, B., & Jin, Y. (2022). Spatial patterns and drivers for wildfire ignitions in California. *Environmental Research Letters*, *17*(5), 055004.

Citygate Associates. (2019). After Action Review of the Woolsey Fire. In *After Action Review of the Woolsey Fire*. County of Los Angeles.

Connolly, R., Marlier, M. E., Garcia-Gonzales, D. A., Wilkins, J., Su, J., Bekker, C., Jung, J., Bonilla, E., Burnett, R. T., Zhu, Y., & Jerrett, M. (2024). Mortality attributable to PM 2.5 from wildland fires in California from 2008 to 2018. *Science Advances*, *10*(23), eadl1252. https://doi.org/10.1126/sciadv.adl1252

Constant Associates. (2020). *Camp Fire Response County-wide After Action Report*. Butte County.

County of Sonoma. (2018). *October 2017 Complex Fires Emergency Operations Center After Action Report and Improvement Plan*. County of Sonoma.

Davies, I. P., Haugo, R. D., Robertson, J. C., & Levin, P. S. (2018). The unequal vulnerability of communities of color to wildfire. *PLoS ONE*, *13*(11), 1–15.
Davis, M. (2018, December). A tale of two wildfires: Devastation highlights California's stark divide. *The Guardian*.
Del Real, J. A., & Kang, I. (2018, July). California Today: The Increasing Strain on State Firefighters. *The New York Times*. https://www.nytimes.com/2018/07/30/us/california-today-firefighters.html
Delfino, R. J., Brummel, S., Wu, J., Stern, H., Ostro, B., Lipsett, M., Winer, A., Street, D. H., Zhang, L., Tjoa, T., & Gillen, D. L. (2009). The relationship of respiratory and cardiovascular hospital admissions to the southern California wildfires of 2003. *Occupational and Environmental Medicine*, *66*(3), 189–197.
Diffenbaugh, N. S., Swain, D. L., & Touma, D. (2015). Anthropogenic warming has increased drought risk in California. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(13), 3931–3936.
Dreier, H. (2025, August 17). Wildfire Fighters, Unmasked in Toxic Smoke, Are Getting Sick and Dying. *The New York Times*.
Ellis, R. (2025, January 22). Many residents with disabilities can't flee fires on their own. *LA Times*.
Ellis, R., & Greene, S. (2025, July 23). A Times Investigation: As west Altadena burned, LA county fire trucks stayed elsewhere. *LA Times*.
Evans, J., Bansal, A., Schoenaker, D. A. J. M., Cherbuin, N., Peek, M. J., & Davis, D. L. (2022). Birth Outcomes, Health, and Health Care Needs of Childbearing Women following Wildfire Disasters: An Integrative, State-of-the-Science Review. *Environmental Health Perspectives*, *130*(8). https://ehp.niehs.nih.gov/doi/10.1289/EHP10544
Ewing, R., Schmid, T., Killingsworth, R., Zlot, A., & Raudenbush, S. (2003). Relationship between urban sprawl and physical activity, obesity, and morbidity. *American Journal of Health Promotion*, *18*(1), 47–57.
Fisher, R. N., & Shaffer, H. B. (1996). The Decline of Amphibians in California's Great Central Valley. *Conservation Biology*, *10*(5), 1387–1397.
Fothergill, A., & Peak, L. A. (2004). Poverty and disasters in the United States: A review of recent sociological findings. *Natural Hazards*, *34*, 89–110.
Frumkin, H., Frank, L., & Jackson, R. J. (2004). *Urban sprawl and public health: Designing, planning, and building for healthy communities* (First Edition). Island Press.
Fu, F., Purvis-Roberts, K., & Williams, B. (2021). Study of the Effectiveness of VMT Reduction on Air Quality in California, US. *AGU Fall Meeting 2021 Abstracts*, A35D-1653.
Fuller, T., Berzon, A., Browning, K., & Hubler, S. (2025, January 11). Los Angeles geared up for fire risk, but fell short. *The New York Times*. https://www.nytimes.com/2025/01/11/us/los-angeles-calfire-firefighters.html
Garcês, A., & Pires, I. (2023). The Hell of Wildfires: The Impact on Wildlife and Its Conservation and the Role of the Veterinarian. *Conservation*, *3*(1), 96–108.
Gerety, R. M. (2015, September). Farm Workers in Wildfire Areas Aren't Always Aware of Evacuation Plans. *National Public Radio Morning Edition*.
Goldstick, J. E., Cunningham, R. M., & Carter, P. M. (2022). Current Causes of Death in Children and Adolescents in the United States. *New England Journal of Medicine*, *386*(20), 1955–1956.

Goss, M., Swain, D. L., Abatzoglou, J. T., Sarhadi, A., Kolden, C. A., Williams, A. P., & Diffenbaugh, N. S. (2020). Climate change is increasing the likelihood of extreme autumn wildfire conditions across California. *Environmental Research Letters*, *15*.

Governor Newsom's Strike Force. (2019). *Wildfires and Climate Change: California's Energy Future*.

Grant, E. H. C., Miller, D. A. W., Schmidt, B. R., Adams, M. J., Amburgey, S. M., Chambert, T., Cruickshank, S. S., Fisher, R. N., Green, D. M., Hossack, B. R., Johnson, P. T. J., Joseph, M. B., Rittenhouse, T. A. G., Ryan, M. E., Waddle, J. H., Walls, S. C., Bailey, L. L., Fellers, G. M., Gorman, T. A., … Muths, E. (2016). Quantitative evidence for the effects of multiple drivers on continental-scale amphibian declines. *Scientific Reports*, *6*(1), 25625–25625.

Greene, D. (2018, August). California Firefighters Battle Exhaustion. *National Public Radio*. https://www.npr.org/2018/08/08/636603563/california-firefighters-battle-exhaustion

Gustafson, K. D., Gagne, R. B., Buchalski, M. R., Vickers, T. W., Riley, S. P. D., Sikich, J. A., Rudd, J. L., Dellinger, J. A., LaCava, M. E. F., & Ernest, H. B. (2021). Multi-population puma connectivity could restore genomic diversity to at-risk coastal populations in California. *Evolutionary Applications*.

Gustafson, K. D., Gagne, R. B., Vickers, T. W., Riley, S. P. D., Wilmers, C. C., Bleich, V. C., Pierce, B. M., Kenyon, M., Drazenovich, T. L., Sikich, J. A., Boyce, W. M., & Ernest, H. B. (2018). Genetic source–sink dynamics among naturally structured and anthropogenically fragmented puma populations. *Conservation Genetics*, *20*(2), 215–227.

Gustafson, K. D., Vickers, T. W., Boyce, W. M., & Ernest, H. B. (2017). A single migrant enhances the genetic diversity of an inbred puma population. *Royal Society Open Science*, *4*(5).

Gutierrez, M. (2018, July). California blazes tax budgets, firefighters: 'Fatigue is starting to set in'. *SFChronicle*. https://www.sfchronicle.com/california-wildfires/article/California-blazes-tax-budgets-firefighters-13121282.php

Haggerty, N. (2025, May 22). Many fire cleanup workers are not protecting against toxic debris. *LA Times*.

Haggerty, N., & Briscoe, T. (2025, May 16). Nearly half of Pasadena Unified schools have contaminated soil, district finds. *LA Times*.

Halstead, B. J., Baumberger, K. L., Backlin, A. R., Kleeman, P. M., Wong, M. N., Gallegos, E. A., Rose, J. P., & Fisher, R. N. (2021). Conservation implications of spatiotemporal variation in the terrestrial ecology of western spadefoots. *Journal of Wildlife Management*, *85*(7), 1377–1393.

Harnett, S. (2018, September). Low-Income Communities Struggle to Recover After a Wildfire. *KQED*.

Hernandez, S. (2025, March 27). Palisades and Eaton firefighters had elevated levels of mercury, lead in their blood. *LA Times*.

Herrera, J. (2018, November). As Wildire Smoke Fills the Air, Farmworkers Continue to Labor in the Fields. *Pacific Standard*.

Hwang, J., Chong, N.-S., Zhang, M., Agnew, R. J., Xu, C., Li, Z., & Xu, X. (2023). Face-to-face with scorching wildfire: Potential toxicant exposure and the health risks of smoke for wildland firefighters at the wildland-urban interface. *The Lancet Regional Health - Americas*, *21*, 100482.

Jarvie, J. (2025, October 7). Fire after fire, L.A. County keeps promising to fix failures but doesn't deliver. *Los Angeles Times*.

Jarvie, J., Castleman, T., & Lin, S. (2025, March 29). Elderly, disabled were left stranded during LA fires as evacuation plans broke down. *LA Times*.

Johnson, J., & Lam. (2023, August 29). California's wildland firefighters are being poisoned by smoke. And we're doing little to protect them. *San Francisco Chronicle*. https://www.sfchronicle.com/projects/2023/firefighter-health/

Juarez, R., Phankitnirundorn, K., Ozorio Dutra, S. V., Bond-Smith, D., Lee, A. G., & Maunakea, A. K. (2025). Health and Social Support in the Aftermath of the Maui Wildfires. *JAMA Network Open*, *8*(8), e2525430.

Kardas-Nelson, M., Alvarenga, J., & Tuirán, R. A. (2020, October). Farmworkers forced to put harvest over health during wildfires. *Investigate West*.

Keeley, J. E., & Fotheringham, C. J. (2003). Impact of Past Present and Future Fire Regimes on North American Mediterranean Shrublands. In *Fire and climatic change in temperate ecosystems of the Western Americas* (pp. 218–262).

Keeley, J. E., Fotheringham, C. J., & Morais, M. (1999). Reexamining fire suppression impacts on brushland fire regimes. *Science*, *284*(5421), 1829–1832.

Keeley, J. E., & Syphard, A. D. (2018). Historical patterns of wildfire ignition sources in California ecosystems. *International Journal of Wildland Fire*, *27*(12), 781–781.

Khalili, R., Liu, Y., Xu, Y., O'Sharkey, K., Pavlovic, N., McClure, C., Lurmann, F., Yang, T., Chen, X., Vigil, M., Grubbs, B., Al Marayati, L., Lerner, D., Lurvey, N., Marsit, C. J., Johnston, J., Bastain, T. M., Breton, C. V., Farzan, S. F., & Habre, R. (2025). Adverse Birth Outcomes Associated with Heat Stress and Wildfire Smoke Exposure During Preconception and Pregnancy. *Environmental Science & Technology*, *59*(25), 12458–12471.

Knapp, E. E., Valachovic, Y. S., Quarles, S. L., & Johnson, N. G. (2021). Housing arrangement and vegetation factors associated with single-family home survival in the 2018 Camp Fire, California. *Fire Ecology*, *17*.

Künzli, N., Avol, E., Wu, J., Gauderman, W. J., Rappaport, E., Millstein, J., Bennion, J., McConnell, R., Gilliland, F. D., Berhane, K., Lurmann, F., Winer, A., & Peters, J. M. (2006). Health effects of the 2003 Southern California wildfires on children. *American Journal of Respiratory and Critical Care Medicine*, *174*, 1221–1228.

Leyden, K. M. (2003). Social Capital and the Built Environment—The Importance of Walkable Neighborhoods. *American Journal of Public Health*, *93*(9), 1546–1551.

Liu, J. C., Pereira, G., Uhl, S. A., Bravo, M. A., & Bell, M. L. (2015). A systematic review of the physical health impacts from non- occupational exposure to wildfire smoke. *Environmental Research*, *136*, 120–132. https://doi.org/10.1016/j.envres.2014.10.015.A

Los Angeles County. (2020). *SB 743 Implementation Report*. Los Angeles County.

Los Angeles County Public Works. (2020). *Transportation Impact Analysis Guidelines*. Los Angeles County Public Works.

Matthews, J. W., & Endress, A. G. (2008). Performance criteria, compliance success, and vegetation development in compensatory mitigation wetlands. *Environmental Management*, *41*(1), 130–141.

McChrystal Group. (2025). *After-Action Review of Alert Notification Systems and Evacuation Policies for the Eaton and Palisades Fires*. County of Los Angeles.

McKenzie, B. (2015). *Who Drives to Work? Commuting by Automobile in the United States: 2013* (American Community Survey Reports). U.S. Department of Commerce, U.S. Census Bureau.

Mitsch, W. J., & Wilson, R. F. (1996). Improving the success of wetland creation and restoration with know-how, time, and self-design. *Ecological Applications*, *6*(1), 16–17.

Mockrin, M. H., Locke, D. H., Syphard, A. D., & O'Neil-Dunne, J. (2023). Using high-resolution land cover data to assess structure loss in the 2018 Woolsey Fire in Southern California. *Journal of Environmental Management*, *347*, 118960.

Moilanen, A., Van Teeffelen, A. J. A., Ben-Haim, Y., & Ferrier, S. (2009). How much compensation is enough? A framework for incorporating uncertainty and time discounting when calculating offset ratios for impacted habitat. *Restoration Ecology*, *17*(4), 470–478.

Montrone, A., Saito, L., Weisberg, P. J., Gosejohan, M., Merriam, K., & Mejia, J. F. (2019). Climate change impacts on vernal pool hydrology and vegetation in northern California. *Journal of Hydrology*, *574*, 1003–1013.

Morris, B. (2018, April). *How the Ultra-Wealthy are Making Themselves Immune to Natural Disasters*.

Mujtaba, G., & Shahzad, S. J. H. (2021). Air pollutants, economic growth and public health: Implications for sustainable development in OECD countries. *Environmental Science and Pollution Research*, *28*(10), 12686–12698.

National Safety Council. (2026). *Motor Vehicle Injury Facts*. National Safety Council. https://injuryfacts.nsc.org/motor-vehicle/overview/introduction/

Neal, K. M. (2019). *An Integrative Population and Landscape Genomic Approach to Conservation of a Threatened California Amphibian at Multiple Spatial Scales*. University of California Los Angeles.

Neal, K. M., Fisher, R. N., Mitrovich, M. J., & Shaffer, H. B. (2020). Conservation Genomics of the Threatened Western Spadefoot, *Spea hammondii*, in Urbanized Southern California. *Journal of Heredity*, *111*(7), 613–627.

Neal, K. M., Johnson, B. B., & Shaffer, H. B. (2018). Genetic structure and environmental niche modeling confirm two evolutionary and conservation units within the western spadefoot (Spea hammondii). *Conservation Genetics*.

Neilson, S. (2025, April 2). A broken system is keeping California homes underinsured. Millions have no idea they're at risk. *San Francisco Chronicle*. https://www.sfchronicle.com/projects/2025/california-home-insurance-underinsured/

Nihei, A., Sanderfoot, O. V., LaBarbera, K., & Tingley, M. W. (2024). Wildfire smoke impacts the body condition and capture rates of birds in California. *Ornithology*, *141*(4), ukae023.

Ong, P., Pech, C., Frasure, L., Comandur, S., Lee, E., & González, S. R. (2025). *LA Wildfires: Impacts on Altadena's Black Community*. UCLA Ralph J. Bunche Center.

Ong, P., Pech, C., Ong, J., de La Cruz-Viesca, M., Gonzalez, S. R., & Enzo Morales, B. (2025). *Data Brief: Asian American Language Needs in LA Wildfires*. UCLA.

Overland, M. A. (2025, April 13). LA homeowners are suing insurance companies for not covering damages from the fires. *NPR*. https://www.npr.org/2025/04/13/nx-s1-5362537/la-homeowners-are-suing-insurance-companies-for-not-covering-damages-from-the-fires#:~:text=There%20are%20private%20insurers%20who,association%20of%20the%20private%20insurers.

Paglino, E., Raquib, R. V., & Stokes, A. C. (2025). Excess deaths attributable to the Los Angeles wildfires from Jan 5 to Feb 1, 2025. *JAMA*.

Parshley, L. (2018, December). The Lingering Effects of Wildfires Will Disproportionately Hurt People of Color. *Vice*, 1–11.

Prado-Irwin, S. (2025). *Petition to list the northern and southern populations of western spadefoot (Spea hammondii) as threatened and endangered, respectively, under the California Endangered Species Act*. Center for Biological Diversity.

Purtle, J., Machavariant, E., Rivera-Gonzalez, A. C., Mauri, A. I., Stimpson, J. P., Kaholokula, J. K., & Ortega, A. N. (2025). Increases in suicides and overdoses during the 2023 wildfires in Maui. *JAMA*.

Pyke, C. R. (2004). Habitat Loss Confounds Climate Change Impacts. *Frontiers in Ecology and the Environment*, *2*(4), 178–182.

Qiu, M., Li, J., Gould, C., Jing, R., Kelp, M., Childs, M., Wen, J., Xie, Y., Lin, M., Kiang, M., Heft-Neal, S., Diffenbaugh, N., & Burke, M. (2025). *Wildfire smoke exposure and mortality burden in the US under future climate change*. https://doi.org/10.31223/X5RQ5C

Radeloff, V. C., Helmers, D. P., Kramer, H. A., Mockrin, M. H., Alexandre, P. M., Bar-Massada, A., Butsic, V., Hawbaker, T. J., Martinuzzi, S., Syphard, A. D., & Stewart, S. I. (2018). Rapid growth of the US wildland-urban interface raises wildfire risk. *Proceedings of the National Academy of Sciences*, *115*(13), 3314–3319.

Rahim, S. (2025, September 15). California to create first public wildfire model for insurance. *E&E News*. https://subscriber.politicopro.com/article/eenews/2025/09/15/california-to-create-first-public-wildfire-model-for-insurance-00563170

Rappold, A. G., Cascio, W. E., Kilaru, V. J., Stone, S. L., Neas, L. M., Devlin, R. B., & Diaz-Sanchez, D. (2012). Cardio-respiratory outcomes associated with exposure to wildfire smoke are modified by measures of community health. *Environmental Health: A Global Access Science Source*, *11*(71). https://doi.org/10.1186/1476-069X-11-71

Reid, C. E., Brauer, M., Johnston, F. H., Jerrett, M., Balmes, J. R., & Elliott, C. T. (2016). Critical review of health impacts of wildfire smoke. *Environmental Health Perspectives*, *124*(9), 1334–1343.

Richards, R. (2019, July). After the Fire: Vulnerable Communities Respond and Rebuild. *Center for American Progress*.

Riley, S. P. D., Sikich, J. A., & Benson, J. F. (2021). Big Cats in the Big City: Spatial Ecology of Mountain Lions in Greater Los Angeles. *Journal of Wildlife Management*, *85*(8), 1527–1542.

Rose, J. P., Halstead, B. J., Packard, R. H., & Fisher, R. N. (2022). Projecting the remaining habitat for the western spadefoot (Spea hammondii) in heavily urbanized southern California. *Global Ecology and Conservation*, *33*, e01944.

Sahagun, L. (2020, November). Rescue operations underway in the San Gabriel Mountains for rare species marooned by wildfire. *Los Angeles Times*, *2020*.

Sahlqvist, S., Song, Y., & Ogilvie, D. (2012). Is active travel associated with greater physical activity? The contribution of commuting and non-commuting active travel to total physical activity in adults. *Preventive Medicine*, *55*(3), 206–211.

Saleh, F. (2025, January 27). Addressing the insurance gap and the hidden risks for California homeowners in wildfire-prone areas. *Moodys*.

https://www.moodys.com/web/en/us/insights/insurance/addressing-insurance-gap-and-hidden-risks-for-california-homeowners-in-wildfire-prone-areas.html
Sanderfoot, O. V., Bassing, S. B., Brusa, J. L., Emmet, R. L., Gillman, S. J., Swift, K., & Gardner, B. (2021). A review of the effects of wildfire smoke on the health and behavior of wildlife. *Environmental Research Letters*, *16*(12), 123003.
Seidman, L. (2025a, January 23). Hundreds of endangered fish rescued from Palisades burn area—In the nick of time. *LA Times*.
Seidman, L. (2025b, February 1). Nearly 300 trout rescued from Palisades Fire burn scar. *LA Times*.
Seidman, L. (2025c, June 18). Endangered fish saved from the Palisades fire were just returned to their Malibu home. *LA Times*.
Simon, S. (2018, August). Constant Wildfires Leave California Firefighters Strained. *National Public Radio*.
Smith, H., & Briscoe, T. (2025, April 11). LA County soil testing near Eaton, Palisades fires shows significant contamination. *LA Times*.
Stebbins, R. C., & McGinnis, S. M. (2012). Western spadefoot (Spea hammondii). In *Field Guide to Amphibians and Reptiles of California* (Revised edition, pp. 156–158). University of California Press.
Stein, B. A., Edelson, N., Anderson, L., Kanter, J. J., & Stemler, J. (2018). *Reversing America's Wildlife Crisis* (Issue March).
Steinberg. (2013). *Senate Bill 743*.
Studenmund, A. H., & Connor, D. (1982). The free-fare transit experiments. *Transportation Research Part A: General*, *16.4*, 261–269.
Sudol, M. F., & Ambrose, R. F. (2002). The US Clean Water Act and habitat replacement: Evaluation of mitigation sites in Orange County, California, USA. *Environmental Management*, *30*(5), 727–734.
Swain, D. L. (2021). A Shorter, Sharper Rainy Season Amplifies California Wildfire Risk. *Geophysical Research Letters*, *48*(5), e2021GL092843.
Swain, D. L., Langenbrunner, B., Neelin, J. D., & Hall, A. (2018). Increasing precipitation volatility in twenty-first-century California. *Nature Climate Change*, *8*(5), 427–433. https://doi.org/10.1038/s41558-018-0140-y
Swain, D. L., Prein, A. F., Abatzoglou, J. T., Albano, C. M., Brunner, M., Diffenbaugh, N. S., Singh, D., Skinner, C. B., & Touma, D. (2025). Hydroclimate volatility on a warming Earth. *Nature Reviews Earth & Environment*, *6*(1), 35–50.
Syphard, A. D., Keeley, J. E., Massada, A. Bar., Brennan, T. J., & Radeloff, V. C. (2012). Housing arrangement and location determine the likelihood of housing loss due to wildfire. *PLoS ONE*, *7*(3), e33954–e33954.
Syphard, A. D., Radeloff, V. C., Keeley, J. E., Hawbaker, T. J., Clayton, M. K., Stewart, S. I., Hammer, R. B., Syphard, A. D., Radeloff, V. C., Keeley, J. E., Hawbaker, T. J., Stewart, S. I., & Hammer, R. B. (2007). Human influence on California fire regimes. *Ecological Society of America*, *17*(5), 1388–1402.
Syphard, A. D., Rustigian-Romsos, H., Mann, M., Conlisk, E., Moritz, M. A., & Ackerly, D. (2019). The relative influence of climate and housing development on current and projected future fire patterns and structure loss across three California landscapes. *Global Environmental Change*, *56*, 41–55.

Thomson, R. C., Wright, A. N., & Shaffer, H. B. (2016). *California amphibian and reptile species of special concern*. University of California Press.
Toohey, G. (2026, January 21). Baby mountain lion found with 'concerning' injuries in middle of L.A. County roadway. LA Times.
Toohey, G., & Fry, H. (2025, January 8). LA officials admit firefighters were overwhelmed and outgunnded by deadly firestorms. *LA Times*.
Toohey, G., & Jarvie, J. (2025, May 21). Signs point to human error in Altadena evacuation failure—Los Angeles Times.pdf. *LA Times*.
UCLA Institute of Transportation Studies. (2019). *Best Practices in Implementing Tactical Transit Lanes*. UCLA Institute of Transportation Studies.
U.S. Department of Transportation. (2022). *Early Estimates of Motor Vehicle Traffic Fatalities and Fatality Rate by Sub-Categories 2021*. U.S. Department of Transportation.
U.S. Environmental Protection Agency. (2017). *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2015*. U.S. Environmental Protection Agency.
US Fish and Wildlife Service. (2005). *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon*.
Vickers, T. W., Sanchez, J. N., Johnson, C. K., Morrison, S. A., Botta, R., Smith, T., Cohen, B. S., Huber, P. R., Ernest, H. B., & Boyce, W. M. (2015). Survival and mortality of pumas (Puma concolor) in a fragmented, urbanizing landscape. *PLoS ONE*, *10*(7), 1–18.
Viswanathan, S., Eria, L., Diunugala, N., Johnson, J., & Mc Clean, C. (2006). An analysis of effects of San Diego wildfire on ambient air quality. *Journal of the Air and Waste Management Association*, *56*(1), 56–67.
Vives, R., & Castillo, A. (2025, March 20). Their homes survived Eaton fire. But living there has been hell, residents say. *LA Times*.
Windmiller, B., & Calhoun, A. (2007). Conserving Vernal Pool Wildlife in Urbanizing Landscapes. In *Science and Conservation of Vernal Pools in Northeastern North America* (pp. 233–251).
Yap, T. A., Rose, J. P., & Cummings, B. (2019). *A Petition to List the Southern California/Central Coast Evolutionarily Significant Unit (ESU) of Mountain Lions as Threatened under the California Endangered Species Act (CESA)*.
Zamanialaei, M., San Martin, D., Theodori, M., Purnomo, D. M. J., Tohidi, A., Lautenberger, C., Qin, Y., Trouvé, A., & Gollner, M. (2025). Fire risk to structures in California's Wildland-Urban Interface. *Nature Communications*, *16*(1), 8041.
Zedler, J. B., & Callaway, J. C. (1999). Tracking wetland restoration: Do mitigation sites follow desired trajectories? *Restoration Ecology*, *7*(1), 69–73.
Zhang, B., Weuve, J., Langa, K. M., D'Souza, J., Szpiro, A., Faul, J., Mendes De Leon, C., Gao, J., Kaufman, J. D., Sheppard, L., Lee, J., Kobayashi, L. C., Hirth, R., & Adar, S. D. (2023). Comparison of Particulate Air Pollution From Different Emission Sources and Incident Dementia in the US. *JAMA Internal Medicine*.
Zhang, Z., Chen, L., Wang, X., Wang, C., Yang, Y., Li, H., Cai, M., & Lin, H. (2023). Associations of Air Pollution and Genetic Risk With Incident Dementia: A Prospective Cohort Study. *American Journal of Epidemiology*, *192*(2), 182–194.

Exhibit C

January 28, 2026

Los Angeles County Regional Planning Commission

Public Hearing – Agenda Item No. 7: Northlake Development

Public Testimony

Good morning Commissioners,

My name is Peter Broderick; I am an attorney with the Center for Biological Diversity, a non-profit, public interest environmental organization dedicated to the protection of native species and their habitats. As you know, the Center has been engaged on this Project since 2018.

As we explained in our extensive written comments on the Partial Recirculated EIR, the County's revised environmental review contains numerous gaps and omissions that render it inadequate.

In particular, this project threatens to have disastrous effects on mountain lions. The 2018 EIR concluded, wrongly, that the site is not occupied by mountain lions. But since then, an abundance of scientific evidence, including photographs, motion camera, and location data have demonstrated conclusively that the Project site is used extensively by the species. The County cannot simply ignore this evidence; it is significant new information and requires an updated analysis.

The Project is also far from existing residential development—it is a textbook example of leapfrog "sprawl" that fragments habitat, drives up vehicle miles traveled, and pushes people into fire-prone areas. It is also inconsistent with the County's current General Plan policies including the County's July 2022 update to the General Plan Safety Element update to reducing risks from wildfire, flooding, and other hazards in unincorporated areas, which the Partial Recirculated EIR failed to disclose.

The Center urges the Commission not to approve this harmful sprawl development unless and until it addresses the issues we've raised in our comments in a recirculated EIR for the public's consideration.

Thank you,

Exhibit B

However, if anyone else can download this and share, that would be great, too.

Thanks,

Chad

From: Jodie Sackett <jsackett@planning.lacounty.gov>
Sent: Wednesday, March 4, 2026 10:20 AM
To: Chad Christensen <chad.christensen@mrca.ca.gov>; DRP PRA <pra@planning.lacounty.gov>; EDL-DRP BU-D Executive Office <executive@planning.lacounty.gov>
Cc: Elizabeth Kent <elizabeth.kent@mrca.ca.gov>
Subject: Re: PRA - Northlake wildlife movement information
Importance: High

Greetings Chad,

Please access the below link which contains the administrative record for the 2018 litigation. No wildlife studies have occurred since the litigation was filed and none were done with the RPDSEIR. Therefore, any/all responsive information will be in the admin record. Lastly, note that both the index and the documents have bates numbers. This completes our response to the PRA.

(Control+Click to follow link)

https://spaces.hightail.com/receive/VdE9uWhtLR

Regards,

JODIE SACKETT

SENIOR PLANNER

O: (213) 974-6433 | D: (213) 893-7409
general questions: subdivisions@planning.lacounty.gov

case inquiries: jsackett@planning.lacounty.gov

From: Chad Christensen <chad.christensen@mrca.ca.gov>
Sent: Tuesday, March 3, 2026 8:14 AM
To: Jodie Sackett <jsackett@planning.lacounty.gov>; DRP PRA <pra@planning.lacounty.gov>; EDL-DRP BU-D Executive Office <executive@planning.lacounty.gov>
Cc: Elizabeth Kent <elizabeth.kent@mrca.ca.gov>
Subject: RE: PRA - Northlake wildlife movement information

CAUTION: External Email. Proceed Responsibly.

Good morning, Jodie,

Follow up request for the "expert studies, including a wildlife camera study" used by applicant and County to determine the Project site is not used by mountain lions or other wildlife.

If necessary, please provide a definitive timeline of when County will be able to produce these wildlife movement-related materials.

Thank you,

Chad

From: Chad Christensen
Sent: Thursday, February 26, 2026 2:49 PM
To: Jodie Sackett <jsackett@planning.lacounty.gov>; DRP PRA <pra@planning.lacounty.gov>; EDL-DRP BU-D Executive Office <executive@planning.lacounty.gov>
Cc: Elizabeth Kent <elizabeth.kent@mrca.ca.gov>
Subject: RE: PRA - Northlake wildlife movement information

Hi Jodie,

I have reviewed the materials available online under File # 26-013 and File # 25-092 and cannot find wildlife movement-related materials cited as support for the County's determination that "mountain lions are not using Project site crossings as confirmed by expert studies, including a wildlife camera study" and repeated by applicant representative Damon Mamalakis during the Regional Planning Commission hearing on January 28, 2026.

This quoted sentence is from page 2 of the Center for Biological Diversity's letter dated 12/22/2020 that is an exhibit in several Project documents:

> While the EIR for the Northlake Project does generally acknowledge that mountain lions may use the Project Area (Final EIR at 2-136), County counsel joined the project proponents … in representing in court proceedings that "mountain lions will not be impacted by the Project" and "mountain lions are not using Project site crossings as confirmed by expert studies, including a wildlife camera study …." (Respondents' and Real Parties in Interest's Joint Opposition Trial Brief at pp. 8 & 16-17.)

Mr. Mamalakis stated at the 1/28/2026 RPC hearing: "we put the wildlife cameras where all of the crossings are on the property. I think it was for three or four months. We did not pick up any [wildlife]." This statement seemed to take Commission Hastings by surprise as he followed up, "You did not pick up any [wildlife]? That's amazing."

Please provide the referenced "expert studies, including a wildlife camera study" along with correspondence between the County and Applicant (or their representatives) regarding wildlife occurrences in, or within 500 feet of, any phase of the Project.

Thank you,

Chad

From: Jodie Sackett <jsackett@planning.lacounty.gov>
Sent: Wednesday, February 25, 2026 3:16 PM
To: Chad Christensen <chad.christensen@mrca.ca.gov>; DRP PRA <pra@planning.lacounty.gov>; EDL-DRP BU-D Executive Office <executive@planning.lacounty.gov>
Cc: Elizabeth Kent <elizabeth.kent@mrca.ca.gov>
Subject: Re: PRA - Northlake wildlife movement information

Greetings Chad,

I'm currently working to provide the responsive materials. Most of the recent wildlife movement-related materials will be in our hearing documents currently posted online; but I will need additional time to provide the older materials. Here's the hearing documents link for reference:

https://lacdrp.legistar.com/LegislationDetail.aspx?ID=7802416&GUID=E3BA41DF-ED14-4631-99E9-450C19F7B3E7&Options=ID|Text|&Search=26-013

I will be in contact with you. Please contact me for any questions or updates.

Best Regards,

JODIE SACKETT

SENIOR PLANNER

O: (213) 974-6433 | D: (213) 893-7409
general questions: subdivisions@planning.lacounty.gov

case inquiries: jsackett@planning.lacounty.gov

From: Chad Christensen <chad.christensen@mrca.ca.gov>
Sent: Wednesday, February 25, 2026 12:54 PM
To: DRP PRA <pra@planning.lacounty.gov>; Jodie Sackett <jsackett@planning.lacounty.gov>; EDL-DRP BU-D Executive Office <executive@planning.lacounty.gov>
Cc: Elizabeth Kent <elizabeth.kent@mrca.ca.gov>
Subject: RE: PRA - Northlake wildlife movement information

CAUTION: External Email. Proceed Responsibly.

Resending due to error in executive@planning.lacounty.gov email address.

From: Chad Christensen
Sent: Wednesday, February 25, 2026 12:52 PM
To: 'pra@planning.lacounty.gov' <pra@planning.lacounty.gov>; jsackett@planning.lacounty.gov; 'executive@plannin.lacounty.gov' <executive@plannin.lacounty.gov>
Cc: Elizabeth Kent <elizabeth.kent@mrca.ca.gov>
Subject: RE: PRA - Northlake wildlife movement information

Good afternoon,

I am following up regarding the PRA submitted on Thursday, February 12, 2026, for materials related to wildlife detection and movement within or near the proposed Northlake development project. While I did receive an immediate automated response to my PRA request, I have not received a response from LA County Planning regarding transmittal of requested information or a response about a production timeline.

Included on this email is MRCA staff counsel, Beth Kent, who is familiar with the PRA process and is available to assist MRCA's receipt of requested materials.

Thank you very much for your timely response.

Chad Christensen

Deputy Chief of Natural Resources and Planning

Mountains Recreation and Conservation Authority

26800 Mulholland Highway

Calabasas, California 91302

o: 310-589-3230, x.121

c: 213-392-0495

From: Chad Christensen
Sent: Thursday, February 12, 2026 12:48 PM

To: 'pra@planning.lacounty.gov' <pra@planning.lacounty.gov>
Cc: jsackett@planning.lacounty.gov
Subject: PRA - Northlake wildlife movement information

Good afternoon,

The Mountains Recreation and Conservation Authority (MRCA) requests any and all records, files, data, attachments, reports, documents, or "materials" associated with wildlife movement including camera traps, studies, or monitoring projects conducted by or on behalf of Northlake Associates LLC (the "Applicant" or any of its predecessors, subsidiaries, owners, representatives, contractors, etc.) or otherwise provided to the County following the 2007 withdrawal of the Applicant's request for additional entitlements associated with the 1992-adopted Northlake Specific Plan, Conditional Use Permit, Development Agreement, and Vesting Tentative Tract Map.

MRCA's request should be interpreted broadly to include wildlife movement materials submitted to the County in support of the Project Number R2015-00408, Vesting Tentative Tract Map No. 073336, Vesting Tentative Parcel Map No. 073335, Conditional Use Permit No. RPPL2023004316, Environmental Assessment No. 201500030 (RPPL2023004887).

MRCA's request is inclusive of all correspondence between Applicant and County from 2007 onwards regarding wildlife occurrences including camera traps, studies, movement data, and/or monitoring projects within the proposed Project footprint and within 500-feet of the Project.

Thank you,

Chad

Chad Christensen

Deputy Chief of Natural Resources and Planning

Mountains Recreation and Conservation Authority

26800 Mulholland Highway

Calabasas, California 91302

o: 310-589-3230, x.121

c: 213-392-0495

From:	ExecutiveOffice
To:	PublicComments
Subject:	Fw: Appeal of the Planning Commission's Approval of the Northlake Specific Plan Project, Hearing Date, March 24, 2026
Date:	Wednesday, March 18, 2026 3:55:05 PM
Attachments:	EHL-NorthLake-Board of Supervisors-Hearing 3.24.26.pdf

Good afternoon.
The following correspondence is being forwarded for your attention and review.
Thank you!

Executive Office of the Board of Supervisors
Phone: (213) 974-1411 | Email: ExecutiveOffice@bos.lacounty.gov
Find us on Facebook, Instagram, LinkedIn, Twitter @ Youtube @LACountyBOS

From: Dan Silver <dsilverla@me.com>
Sent: Tuesday, March 17, 2026 6:20 PM
To: ExecutiveOffice <ExecutiveOffice@bos.lacounty.gov>; First District <firstdistrict@bos.lacounty.gov>; Holly J. Mitchell <HollyJMitchell@bos.lacounty.gov>; Third District <ThirdDistrict@bos.lacounty.gov>; Supervisor Janice Hahn (Fourth District) <fourthdistrict@bos.lacounty.gov>; Barger, Kathryn <Kathryn@bos.lacounty.gov>
Cc: Amy J. Bodek <ABodek@planning.lacounty.gov>; Jodie Sackett <jsackett@planning.lacounty.gov>
Subject: Appeal of the Planning Commission's Approval of the Northlake Specific Plan Project, Hearing Date, March 24, 2026

Gentlepersons:

Please find comments on this forthcoming agenda item, submitted in advance of publication of the final agenda. Please include them in the agenda packet for distribution.

Acknowledgment of receipt is requested and appreciated.

Thank you

Sincerely,
Dan Silver

NOTE NEW MAILING ADDRESS

Dan Silver, Executive Director
Endangered Habitats League
505 S Flower St #71001
PO Box 71001
Los Angeles CA 90071

213-804-2750

dsilverla@me.com
https://ehleague.org

ENDANGERED HABITATS LEAGUE

DEDICATED TO ECOSYTEM PROTECTION AND SUSTAINABLE LAND USE

March 17, 2026

VIA ELECTRONIC MAIL

The Hon. Hilda Solis, Chair
Los Angeles County Board of Supervisors
Kenneth Hahn Hall of Administration
500 West Temple Street
Room 383
Los Angeles, CA 90012
executiveoffice@bos.lacounty.gov

RE: Appeal of the Planning Commission's Approval of the Northlake Specific Plan Project, Hearing Date, March 24, 2026

Dear Chair Solis and Members of the Board:

Endangered Habitats League (EHL) supports the appeal (by the Center for Biological Diversity) of the Planning Commission's approval and certification of this project. For the reasons outlined below, we respectfully urge that the project be denied. For your reference, EHL is a Southern California conservation group dedicated to ecosystem protection and land use that uses "smart growth" to accommodate housing for all income levels.

Unfortunately, this project is outdated sprawl from the early1990s. *Backward even for that era*, it is contrary to contemporary needs. According to the Santa Monica Mountains Conservancy, NorthLake is a "tragedy." *Your Board is under no obligation to make Overriding Findings on behalf of the applicant.* Rather, significant and unavoidable impacts are legal grounds for denial.

EHL hereby *incorporates by reference* the detailed comments submitted to your Board in a letter of March 17, 2026 from the Center for Biological Diversity, with which we concur. These comments describe significant new information concerning biological resources (mountain lion, spadefoot toad, California condor), fire hazard (Eaton and Palisades fires), and other impact areas. They document deferred and inadequate mitigation and defective analysis, e.g., for Vehicle Miles Traveled. Very disturbingly, the Partial Creek Avoidance Alternative is shown to be nothing of the sort, as a debris basin in the Phase 2 area will fundamentally damage the biological value and hydrology of Grasshopper Creek. These impacts are not disclosed.

No vested rights accrue from the 1992 Specific Plan, whose Development Agreement expired. Following denial, the project can be expeditious replanned to provide an economic use to the landowner consistent with the constraints of landslides, remote location, wildlife habitat and rare plants, and fire hazard.

Thank you for your consideration.

Yours truly,



Dan Silver
Executive Director

From:	ExecutiveOffice
To:	PublicComments
Subject:	Fw: Appellant SAFER's Comment on the Recirculated Partial Final Supplemental Environmental Impact Report for the NorthLake Specific Plan Project
Date:	Wednesday, March 18, 2026 3:52:20 PM
Attachments:	2026.03.17 Appellant SAFER NorthLake SP Project Comment - FINAL & Exhibit.pdf

Good afternoon.

The following correspondence is being forwarded for your attention and review.

Thank you!

Executive Office of the Board of Supervisors

Phone: (213) 974-1411 | Email: ExecutiveOffice@bos.lacounty.gov

Find us on Facebook, Instagram, LinkedIn, Twitter @ Youtube @LACountyBOS

From: Emy Lipkind <emily@lozeaudrury.com>
Sent: Tuesday, March 17, 2026 1:35 PM
To: First District <firstdistrict@bos.lacounty.gov>; Holly J. Mitchell <HollyJMitchell@bos.lacounty.gov>; Third District <ThirdDistrict@bos.lacounty.gov>; Supervisor Janice Hahn (Fourth District) <fourthdistrict@bos.lacounty.gov>; Barger, Kathryn <Kathryn@bos.lacounty.gov>; ExecutiveOffice <ExecutiveOffice@bos.lacounty.gov>
Cc: Chase Preciado <Chase@lozeaudrury.com>; Leslie Reider <leslie@lozeaudrury.com>; Victoria Yundt <victoria@lozeaudrury.com>; Richard Drury <richard@lozeaudrury.com>
Subject: Appellant SAFER's Comment on the Recirculated Partial Final Supplemental Environmental Impact Report for the NorthLake Specific Plan Project

Dear Chair Solis, Honorable Board of Supervisors, and Ms. Sackett:

I hope this email finds you well. On behalf of Supporters Alliance for Environmental Responsibility ("SAFER") please find attached Appellant comment on the Recirculated Partial Final Supplemental Environmental Impact Report for the NorthLake Specific Plan Project.

If you could please confirm receipt of this email and the attached comments that would be greatly appreciated.

Thank you kindly for your assistance,
Emy

--
Emy Lipkind (she/her)
Legal Assistant
Lozeau | Drury LLP
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March 17, 2026

VIA EMAIL &
ONLINE PUBLIC COMMENT PORTAL

Hilda L. Solis, Chair
Holly J. Mitchell, Chair Pro Tem
Janice Hahn, Supervisor
Lindsey P. Horvath, Supervisor
Kathryn Barger, Supervisor
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Jodie Sackett, Planner
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320 West Temple Street, 13th Floor
Los Angeles, CA 90012
jsackett@planning.lacounty.gov

Re: Appellant SAFER's Comment on the Recirculated Partial Final Supplemental Environmental Impact Report for the NorthLake Specific Plan Project

Dear Chair Solis, Honorable Board of Supervisors, and Ms. Sackett:

This comment is submitted on behalf of Appellant Supporters Alliance for Environmental Responsibility ("SAFER") regarding the Recirculated Partial Final Supplemental Environmental Impact Report ("RPFSEIR") for the NorthLake Specific Plan Project (SCH No. 2015031080, Project No. R2015-00408-(5), Vesting Tentative Tract Map No. 07336, Tentative Parcel Map Np. 07335, Conditional Use Permit No. RPPL2023004316, Environmental Assessment No. RPPL2023004887), including all actions related or referring to the proposed development of 2,295 dwelling units, located east of Interstate (I) 5, west of Castaic Lake, and north of the community of Castaic, California in unincorporated Los Angeles County ("Project"). The Project is scheduled to be heard on appeal at the Los Angeles County Board of Supervisor's March 24, 2026 meeting.

As a result of *Center for Biological Diversity et al. v. County of Los Angeles et al.*, Case No. 19STCP01610, the Court ordered Los Angeles County ("County") to set aside its approval of the Project and decertify the 2018 Supplemental EIR ("2018 SEIR" or "SEIR"). The County is attempting to recirculate a legally compliant EIR by revising the vehicle miles traveled ("VMT")

analysis, among other sections in the 2018 SEIR. However, the VMT analysis is still inadequate, and must be updated to account for significant new information since the certification of the 2018 SEIR.

SAFER's review of the RPFSEIR was also assisted by transportation expert Norman Marshall of Smart Mobility, whose written comments and CV are attached as Exhibit A. As discussed below, based on Mr. Marshall's review of the RPFSEIR and Recirculated Partial Draft Supplemental Environmental Impact Report ("RPDSEIR"), he concluded that:

1. The residential component would result in a highly significant VMT impact.
2. The NorthLake Specific Plan VMT is almost entirely residential.
3. The residential component should be analyzed using home-based VMT per capita.
4. VMT per service population is an invalid metric.
5. Maximum possible VMT mitigation is required. (*See* Ex. A, pp. 1-10.)

Because there is substantial expert evidence that the Project will result in significant VMT impacts; the RPFSEIR lacks substantial evidence that the Project will not result in significant VMT impacts; and the RPFSEIR fails to adequately mitigate VMT impacts, the County must revise and recirculate a complete EIR that fully analyzes and mitigates the Project's significant VMT impacts.

LEGAL STANDARD

I. CEQA AND ENVIRONMENTAL IMPACT REPORT

CEQA has two primary purposes. First, CEQA is designed to inform decision makers and the public about the potential, significant environmental effects of a project. (14 CCR § 15002(a)(1).) "Its purpose is to inform the public and its responsible officials of the environmental consequences of their decisions before they are made. Thus, the EIR 'protects not only the environment but also informed self-government.'" (*Citizens of Goleta Valley v. Board of Supervisors* (1990) 52 Cal.3d 553, 564.) Second, CEQA requires public agencies to avoid or reduce environmental damage when "feasible" by requiring "environmentally superior" alternatives and all feasible mitigation measures. (14 CCR § 15002(a)(2) and (3); *see also Berkeley Jets Over the Bay Com. v. Board of Port Cmrs.* (2001) 91 Cal.App.4th 1349,1354; *Citizens of Goleta Valley v. Board of Supervisors* (1990) 52 Cal.3d 553, 564.)

CEQA requires that an agency analyze the potential environmental impacts of its proposed actions in an Environmental Impact Report (EIR) except in certain limited circumstances. (*See, e.g.*, Pub. Resources Code, § 21100.) The EIR is the very heart of CEQA. (*Dunn-Edwards v. BAAQMD* (1992) 9 Cal.App.4th 644, 652. The EIR is an "environmental 'alarm bell' whose purpose is to alert the public and its responsible officials to environmental changes before they have reached the ecological points of no return." (*Bakersfield Citizens for Local Control v. City of Bakersfield* (2004), 124 Cal.App.4th 1184, 1220.) The EIR also functions as a "document of accountability," intended to "demonstrate to an apprehensive citizenry that the

agency has, in fact, analyzed and considered the ecological implications of its action." (*Laurel Heights Improvements Assn. v. Regents of Univ. of Cal*. (1988) 47 Cal.3d 376, 392.)

While the courts review an EIR using an "abuse of discretion" standard, "the reviewing court is not to 'uncritically rely on every study or analysis presented by a project proponent in support of its position. A 'clearly inadequate or unsupported study is entitled to no judicial deference.'" (*Berkeley Jets*, 91 Cal.App.4th at 1355 (quoting, *Laurel Heights Improvement Assn. v. Regents of Univ. of Cal.* (1988) 47 Cal.3d 376, 391 409, fn. 12).) A prejudicial abuse of discretion occurs "if the failure to include relevant information precludes informed decisionmaking and informed public participation, thereby thwarting the statutory goals of the EIR process." (*San Joaquin Raptor/Wildlife Rescue Center v. County of Stanislaus* (1994) 27 Cal.App.4th 713, 722; *Galante Vineyards v. Monterey Peninsula Water Management Dist.* (1997) 60 Cal.App.4th 1109, 1117; *County of Amador v. El Dorado County Water Agency* (1999) 76 Cal.App.4th 931, 946.) As discussed below and in Mr. Marshall's attached expert comment letter, the RPFSEIR for this Project fails to adequately analyze and mitigate the Project's significant VMT impacts. Here, the RPFSEIR evaluates the NorthLake Specific Plan and revises and tiers from the 2018 SEIR, which tiers from the 1992 NorthLake Specific Plan EIR. (RPDSEIR, p. 1-3.) However, we found that the RPFSEIR prepared by the County here is inadequate for several reasons set forth below.

II. RECIRCULATION OF AN ENVIRONMENTAL IMPACT REPORT UNDER CEQA

Moreover, CEQA Guidelines Section 15088.5 sets forth the standard requiring recirculation prior to final project approval. Recirculation of an EIR is required when "significant new information is added to the EIR after public notice is given of the availability of the draft EIR for public review under Section 15087 but before certification [of the Final EIR]." (14 CCR § 15088.5(a).) New information added to an EIR is significant when "the EIR is changed in a way that deprives the public of a meaningful opportunity to comment upon a substantial adverse environmental effect of the project or a feasible way to mitigate or avoid such an effect (including a feasible project alternative) that the project's proponents have declined to implement." (*Id.*) The Guidelines require recirculation when:

(1) A new significant environmental impact would result from the project or from a new mitigation measure proposed to be implemented.
(2) A substantial increase in the severity of an environmental impact would result unless mitigation measures are adopted that reduce the impact to a level of insignificance.
(3) A feasible project alternative or mitigation measure considerably different from others previously analyzed would clearly lessen the environmental impacts of the project, but the project's proponents decline to adopt it.
(4) The draft EIR was so fundamentally and basically inadequate and conclusory in nature that meaningful public review and comment were precluded. (14 CCR § 15088.5(a); *Mountain Lion Coalition v. Fish and Game Com*. (1989) 214 Cal.App.3d 1043)

Based on Mr. Marshall's review, the Project would result in a substantial increase in the severity of VMT impacts than previously analyzed under the 2018 SEIR and feasible mitigation measures to reduce the severity of VMT impacts have not been properly evaluated and disclosed to the public. Therefore, in accordance with Section 15088.5 of the CEQA Guidelines, the County must revise and recirculate a complete EIR that fully analyzes and mitigates the Project's significant VMT impacts and provide the public with a meaningful opportunity to comment upon the substantial adverse VMT impacts of the Project.

DISCUSSION

I. THE RPFSEIR FAILS TO ADEQUATELY ANALYZE AND MITIGATE THE PROJECT'S SIGNIFICANT VMT IMPACTS.

Transportation expert Norm Marshall reviewed the County's analysis of the Project's VMT impacts. Mr. Marshall's comment letter and CV are attached as Exhibit A and his comments are briefly summarized here.

A. The Project would result in a substantial increase in the severity of VMT impacts than previously analyzed under the 2018 SEIR.

Mr. Marshall found that the RPFSEIR fails to disclose a very significant impact from the Project's residential component, requiring the County to revise its VMT analysis and recirculate a draft EIR. (*See* Ex. A, pp. 2-5.)

According to Mr. Marshall, the Transportation Analysis included in Appendix C-1 of the RPDSEIR includes outputs from the Los Angeles County VMT Tool demonstrating that the Project's residential component would result in a highly significant VMT impact. (Ex. A, p. 2.) Mr. Marshall's comment letter reproduces the VMT Tool outputs for the Project's Single-Family Housing, Multifamily Housing, and the entire Project at Figures 1, 2 and 3. (*Id.*, pp. 3-5.)

Mr. Marshall explains that "Los Angeles County has a higher VMT threshold for the northern portion of the county than for the more densely populated southern portion of the county." (Ex. A, p. 2.) The North County Residential VMT per capita Baseline is 20.7, with a significance threshold of 17.2 (16.8 percent below the baseline). (*Id.*) Based on the VMT Tool outputs, Mr. Marshall concluded that the Project's residential uses substantially exceed this threshold:

- Single-family 28.9 exceeds the threshold of 17.2 by 68%
- Multi-family 21.7 exceeds the threshold of 17.2 by 26%
- Combined uses 25.9 exceeds the threshold of 17.2 by 51%

(Ex. A, p. 2.) In addition, the VMT Tool relied upon in the RPDSEIR's Transportation Analysis also concludes that "project is not presumed to have a less than significant impact on VMT." (pp.

10-11, 13-15; Ex. A, pp. 3-5.) As such, Mr. Marshall concluded that the Project's residential component will result in substantially more severe VMT impacts than previously analyzed in the 2018 SEIR. (Ex. A, p. 2.) Because the RPDSEIR's Transportation Analysis and Mr. Marshall expert comments are substantial evidence of a significant VMT impact, the County must revise and recirculate a complete draft supplemental EIR that fully analyzes and mitigates the Project's significant VMT impacts.

B. The RPFSEIR's conclusion that the Project will not have a significant VMT impact is not supported by substantial evidence because it erroneously relies on an outdated VMT per service population metric.

Mr. Marshall explains that Los Angeles County requires VMT to be analyzed as follows:

> Residential projects are to be analyzed using the residential threshold. In mixed-use projects, each component is to be analyzed separately, i.e., the residential components are to be analyzed using the residential threshold. The residential component should be analyzed using home-based VMT per capita. (Ex. A, pp. 7-8.)

As discussed below, the RPFSEIR improperly relies on the invalid "VMT per service population" metric to evaluate VMT impacts under CEQA. (Ex. A, pp. 8-9.)

Mr. Marshall notes that the RPFSEIR's analysis of the Project's VMT impacts relies on a "VMT per service population" metric, which is defined as "[t]he total service population is the sum of the number residents and the number of employees." (Ex. A, p. 8.) However, Mr. Marshall explains that this approach is flawed because it obscures the Project's actual VMT impacts. (*id.*, pp. 8-9.) According to Mr. Marshall, combining the Project's residential and commercial employee VMT into a single service population "is a misguided attempt to reduce complex VMT issues to a single metric," especially given that the Project is "is more a residential project than a mixed use project." (*Id.*, p. 8.) He further explains that:

> Adding residents and employees together makes no sense because the VMT generated by an average employee is significantly larger than the VMT generated by an average resident . "Residents" include many nondrivers including children. Therefore, if there is a higher proportion of employees relative to the residents, calculated VMT per service population will be higher, and if there is a lower proportion of employees relative to residents, a lower VMT per service population will result. These differences do not represent real information about the VMT impacts of either the residential or employment components. (*Id.*)

Additionally, the VMT per service population metric is meaningless without knowing the percentages of residents and employees. (Ex. A, p. 8.) Here, 97 percent of the Project is residential. (*See id.*, p. 6 [Figure 4].) Nevertheless, the RPFSEIR relies on the combined VMT service population metric to assert that removing employment uses—including over 545,000

square feet of industrial uses and 99,000 square feet of commercial uses—reduces the Project's VMT impacts. (*Id.*, p. 9.) As Mr. Marshall explains:

> [T]his result is just a computational quirk that results from removing employees with higher VMT per employment and leaving mostly residents with lower VMT per resident. As documented above, the predominant residential VMT component in the NorthLake project is highly significant, and this VMT per service population calculation does not address this issue.
>
> In fact, the RPDSEIR uses the VMT per service population metric to support the opposite conclusion than what should be drawn. The reason for the highly-significant residential VMT is that the planned housing is far from job centers, and this necessitates long commutes and trips to services. Removing most of the jobs will not improve this situation and would likely aggravate it. (*Id.*)

Therefore, Mr. Marshall concludes that "[i]t is invalid to apply a VMT per service population rate that is inflated by the higher VMT per employee component embodied in the combined rate." (*Id.*, p. 8.) Instead, these Project components must be analyzed separately, with the residential component analyzed using home-based VMT per capita. (*Id.*, pp. 7-8.)

Moreover, even if the VMT per service population metric should be applied, the RPFSEIR still failed to adequately analyze VMT impacts because it applied an incorrect and outdated threshold of significance to measure impacts. The Department of Transportation's ("DOT") May 29, 2025 comment on the Draft SEIR states that the County applied an outdated threshold to measure VMT impacts. (RPFSEIR, p. A.2-3.) Specifically, the DOT explains that the County incorrectly applied the prior Northlake Specific Plan VMT per service population (27.03) as the significance threshold for determining an impact. However, the VMT per Service Population (27.03) is the baseline for comparison to the previously approved Project. The County was required to apply the VMT per Service Population (25.70) per the methodology required by the County Department of Public Works. As such, even if the incorrect VMT per service population metric is used, the Project's VMT impacts—using DOT's recommended lower VMT per service population threshold—would still exceed the significance threshold.

Thus, the RPFSEIR's less-than-significant conclusion for VMT impacts cannot be relied upon. A revised and complete draft supplemental EIR should be prepared and recirculated that includes an adequate analysis of the Project's VMT impacts using the proper threshold of significance.

C. The RPFSEIR fails to include feasible mitigation to reduce the Project's significant VMT impacts.

As discussed above, the Project's residential component will result in significant VMT impacts. (*See* Ex. A, p. 2.) However, the RPFSEIR requires no mitigation to reduce VMT impacts, even though the RPFSEIR includes a Caltrans comment letter dated May 29, 2025, stating:

> To further support VMT reduction and for the County's consideration, we recommend that the project incorporate a Transportation Demand Management (TDM) program. TDM strategies such as enhanced transit connectivity, subsidized transit passes, carpool/vanpool programs, employer-based trip reduction incentives, bicycle and pedestrian infrastructure, and telecommuting support can materially reduce project-level VMT. These measures should be quantified, monitored, and integrated into project conditions or mitigation measures to ensure accountability and effectiveness. (RPFSEIR, p. A.2-4.)

Rather than including mitigation measures to reduce VMT impacts as recommended by Caltrans, the RPFSEIR provided the following inadequate response to Caltrans' comment:

> While TDM programs are effective in reducing VMT, here, VMT impacts were determined to be less than significant, and therefore no mitigation is necessary or required. (RPFSEIR, p. 2-11.)

As Mr. Marshall concludes, "[t]his response is woefully inadequate." (Ex. A, p. 10.) Moreover, Caltrans recommended a comprehensive TDM program should be developed and: "These measures should be quantified, monitored, and integrated into project conditions or mitigation measures to ensure accountability and effectiveness." (RPFSEIR, p. A.2-4.) Therefore, the RPFSEIR fails to include feasible mitigation measures to reduce the severity of VMT impacts, which have not been properly evaluated and disclosed to the public. (14 CCR § 15088.5(a).) A revised and complete draft supplemental EIR should be prepared and recirculated that includes adequate mitigation measures to reduce the Project's significant VMT impacts

CONCLUSION

SAFER requests that the Board of Supervisors grant the appeal and deny approving this Project, and instead, direct staff to address these shortcomings in a revised and recirculated complete SEIR that fully analyzes and mitigates the Project's significant VMT impacts prior to considering approvals for the Project. SAFER reserves the right to supplement these comments during the administrative process. (*Galante Vineyards v. Monterey Peninsula Water Management Dist*. (1997) 60 Cal.App.4th 1109, 1121.)

Sincerely,



Victoria Yundt
Lozeau Drury LLP

EXHIBIT A

1295 Hartford Avenue #8
White River Junction, VT 05001
Norman Marshall, President
(802) 356-2969
nmarshall@smartmobility.com

March 4, 2026

Victoria Yundt
Lozeau | Drury LLP
1939 Harrison St., Suite 150
Oakland, CA 94612

Subject: NorthLake Specific Plan

Dear Ms. Yundt,

I have reviewed the vehicle miles traveled ("VMT") impacts of the NorthLake Specific Plan in Los Angeles County as described in the Recirculated Partial Final Supplemental Environmental Impact Report dated December 2025 ("RPFSEIR") and the Recirculated Partial Draft Supplemental Environmental Impact Report dated April 2025 ("RPDSEIR"). I make the following findings:

1) The residential component would result in a highly significant VMT impact.
2) The NorthLake Specific Plan VMT is almost entirely residential.
3) The residential component should be analyzed using home-based VMT per capita.
4) VMT per service population is an invalid metric.
5) Maximum possible VMT mitigation is required.

The Residential Component Would Result in a Highly-Significant VMT Impact

RPDSEIR Appendix C-1 includes outputs of the Los Angeles County VMT Tool that show that the residential components of the NorthLake Specific Plan would result in a highly-significant VMT impact. In the RPDSEIR, the current proposal is labeled "Previously Approved Project." The Tool outputs for the Previously Approved Project for Single-Family Housing, Multifamily Housing, and the entire project are reproduced below as Figures 1, 2 and 3.

The Los Angeles County has a higher VMT threshold for the northern portion of the county than for the more densely populated southern portion of the county. Figures 1, 2 and 3 show that the North County Residential VMT per capita Baseline is 20.7, and that the threshold for significance is 17.2 (16.8% less).

These thresholds are significantly exceeded in the NorthLake Specific Plan location:

- Single-family 28.9 exceeds the threshold of 17.2 by 68%
- Multi-family 21.7 exceeds the threshold of 17.2 by 26%
- Combined uses 25.9 exceeds the threshold of 17.2 by 51%

Each of the Tool outputs shown in Figures 1, 2 and 3 concludes:

"The project is not presumed to have a less than significant impact on VMT, therefore a CEQA VMT analysis may be required."

Figure 1: Los Angeles County VMT Tool – Previously Approved Project Single-Family Housing

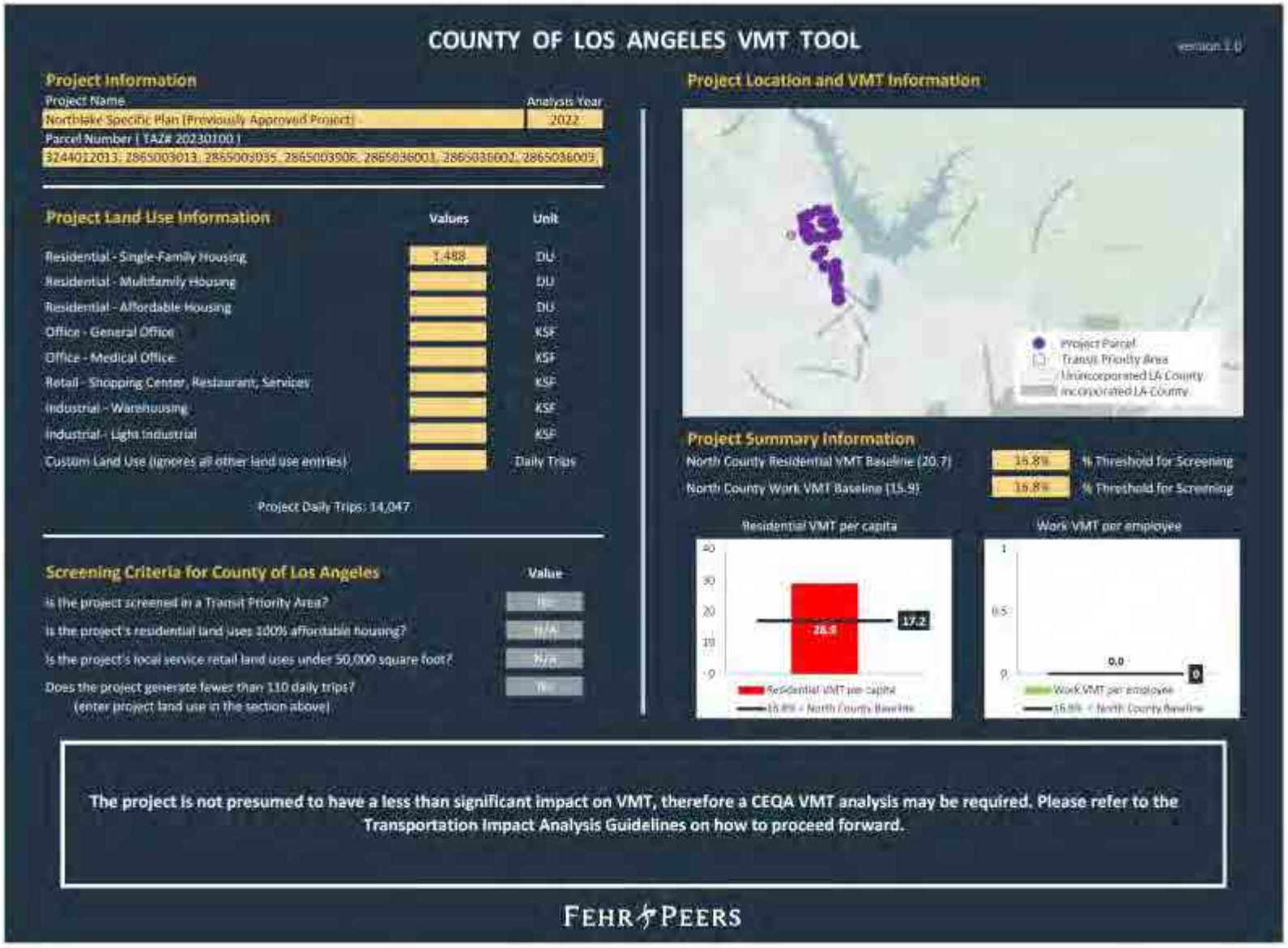


Figure 2: Los Angeles County VMT Tool – Previously Approved Project Multifamily Housing

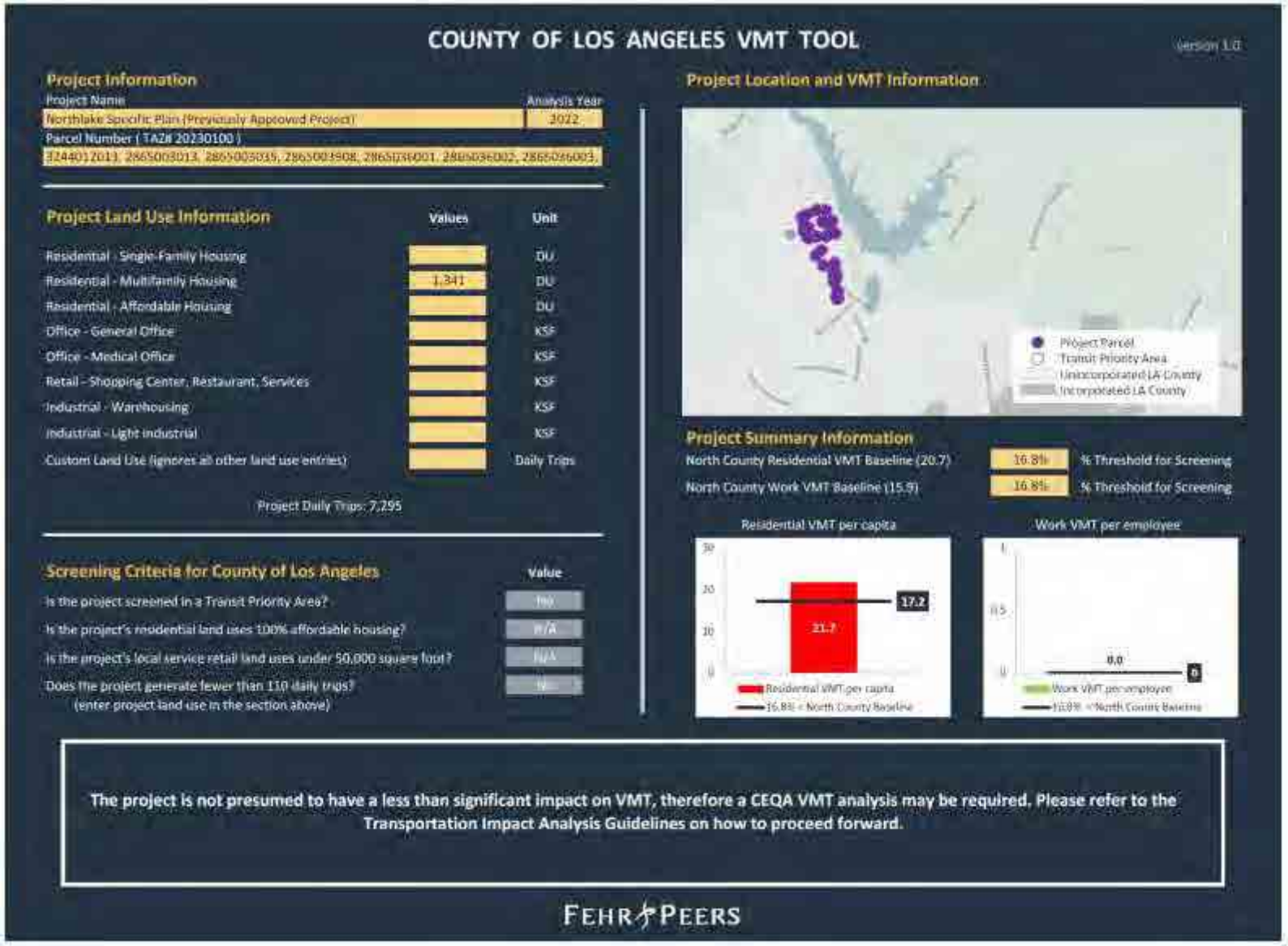
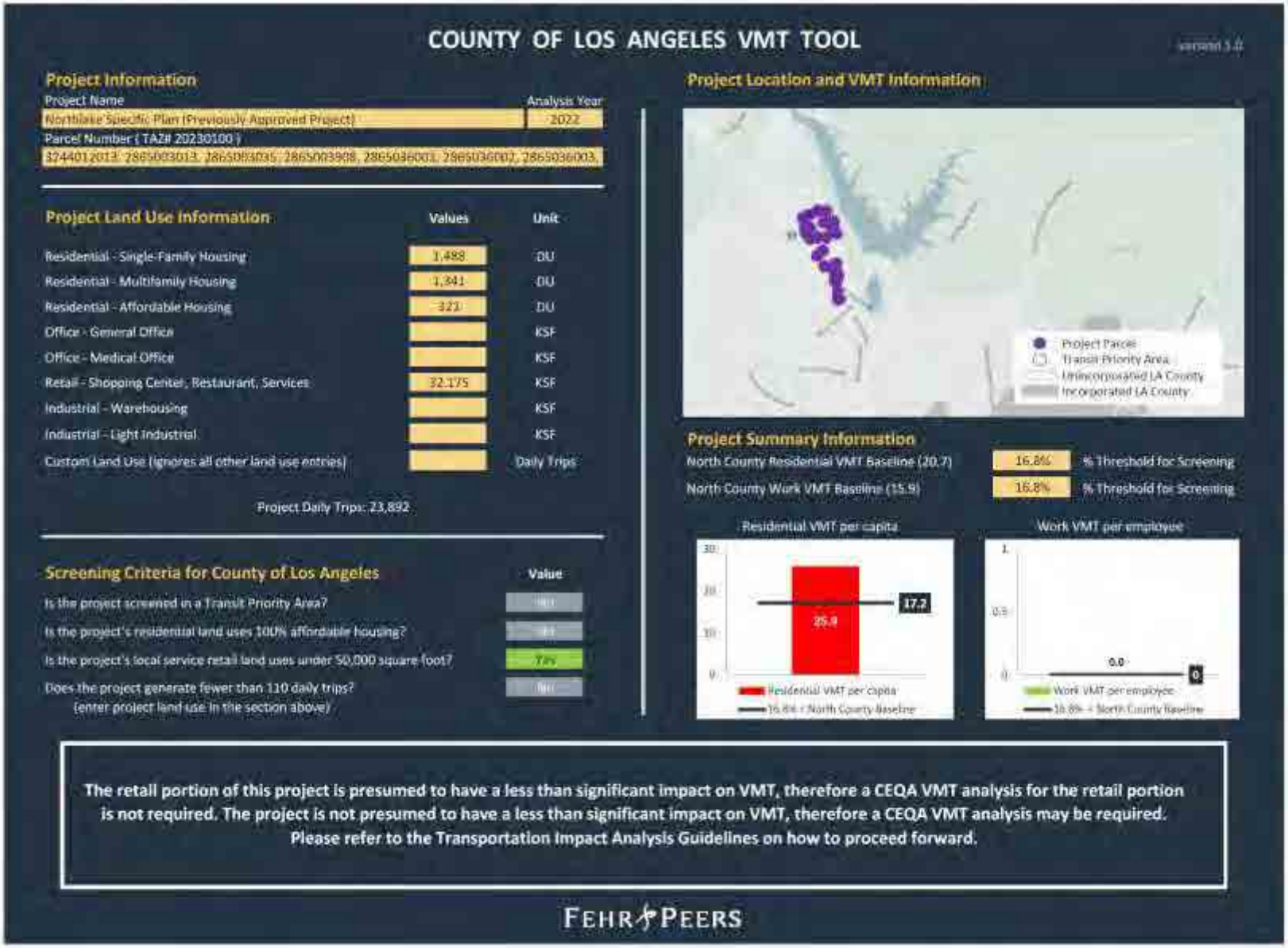


Figure 3: Los Angeles County VMT Tool – Previously Approved Project – Combined Uses



The NorthLake Specific Plan VMT is Almost Entirely Residential

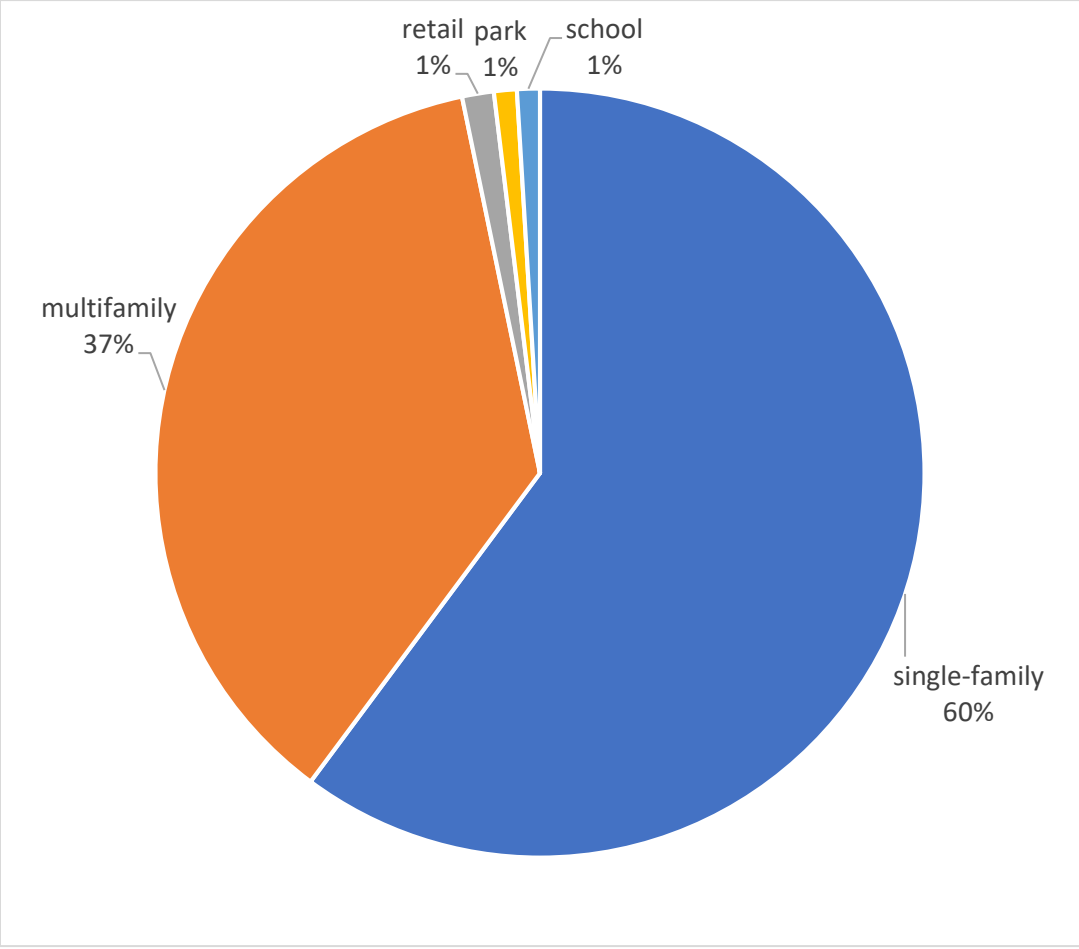
RPDSEIR Table 2-6 reproduced below summarizes estimated VMT by use.

TABLE 2-6
NLSP AND PREVIOUSLY APPROVED PROJECT VMT SUMMARY

Category	NLSP VMT	Previously Approved Project VMT
Single Family Residential	260,013	165,568
Multi-Family Residential	77,860	100,623
Commercial Retail	8,765	3,670
Light Industrial	13,869	--
Recreation/Park	1,320	2,640
School	2,640	2,640
Project VMT	**364,467**	**275,141**
Service Population	**13,485**	**10,705**
VMT per Service Population	**27.0**	**25.7**
See Appendix C-1 for the VMT and Service Population Worksheets.		

As shown in Figure 4, 97% of the estimated VMT for the Previously Approved Project is Residential

Figure 4: Previously Approved Project VMT by Land Use Category



The Residential Component Should be Analyzed Using Home-Based VMT Per Capita

The table reproduced below shows Los Angeles County VMT Thresholds[1]

TABLE 6: LOS ANGELES COUNTY VMT THRESHOLDS

Project Type	Threshold for Determination of Significant VMT Impact
Residential Project	Project exceeds 16.8% below the North or South County Baseline VMT for home-based VMT per capita
Employment (Commercial or Industrial) Project	Project exceeds 16.8% below the North or South County Baseline VMT for home-based work VMT per employee
Regional Retail Project	Project results in a net increase in total VMT per service population in comparison to the North or South County Baseline VMT
Mixed-Use Projects	Evaluate each project land use component separately using the criteria above
Land Use Plans (Community Plan, Specific Plan)	Total VMT per service population generated by the Plan exceeds 16.8% below the North or South County Baseline VMT
Other land use types	Project exceeds 16.8% below the North or South County Baseline VMT. For land use types not listed above, the County can determine the appropriate VMT metric depending on the project characteristics. For projects that are generally producing job-related travel, the employment generating VMT (home-based work VMT per employee) can be compared to the applicable County baseline. For other projects, the total VMT per service population can be compared to the County baseline, or the net change in VMT can be compared within the study area.
Transportation Projects or Plans	Project results in an increase in VMT in comparison to the baseline VMT in the study area

[1] Fehr and Peers. Los Angeles County Senate Bill (SB) 743 Implementation and CEQA Updates Report, Prepared for Los Angeles County, June 2020.

Residential projects are to be analyzed using the residential threshold. In mixed-use projects, each component is to be analyzed separately, i.e., the residential components are to be analyzed using the residential threshold. The residential component should be analyzed using home-based VMT per capita.

"VMT per Service Population" is an Invalid Metric

The table reproduced above has a line for land use plans, including Specific Plans, giving a threshold of "total VMT per service population generated by the Plan exceeds 16.8% below the North or South County Baseline VMT."

The definition of service population is:

> The total service population is the sum of the number residents and the number of employees.

The service population concept was introduced in a misguided attempt to reduce complex VMT issues to a single metric. At best, this has muddied the waters. At worst, it has allowed false assertions as has been done in this case. The NorthLake project is more a residential project than a mixed use project, and it is a stretch to call it a "Specific Plan" at all.

Adding residents and employees together makes no sense because the VMT generated by an average employee is significantly larger than the VMT generated by an average resident . "Residents" include many nondrivers including children. Therefore, if there is a higher proportion of employees relative to the residents, calculated VMT per service population will be higher, and if there is a lower proportion of employees relative to residents, a lower VMT per service population will result. These differences do not represent real information about the VMT impacts of either the residential or employment components.

Here is an analogy drawn from high school math problems. Suppose there is a mix of nuts including peanuts and cashews. The peanuts separately cost $5 a pound and cashews separately cost $10 a pound. The mix is priced at $7.50 a pound, but the mix proportion is unknown. If it's almost all peanuts, it's overpriced. If it's almost all cashews, it is a bargain. The price alone tells us nothing about the value of the mix. We need to know the percentages in the mix.

Similarly, VMT per service population is meaningless without knowing the percentages in the mix. In this case, as documented above, 97% of the NorthLake Specific Plan VMT is residential. It is invalid to apply a VMT per service population rate that is inflated by the higher VMT per employee component embodied in the combined rate. The components should be analyzed separately.

RPDSEIR Table 2-5 compares the land uses in the previously approved project to the original NorthLake Specific Plan.[2]

TABLE 2-5
NORTHLAKE SPECIFIC PLAN PROJECT LAND USE SUMMARY

Category	NLSP			Previously Approved Project			Difference		
	(AC)	(DU)	(SQ. FT.)	(AC)	(DU)	(SQ. FT.)	(AC)	(DU)	(SQ. FT.)
Residential	600.3	3,623	--	362	3,150	--	-238.3	-794	--
Single Family	504.8	2,337	--	235	1,488	--	-269.8	-593	--
Multi-Family	95.5	1,286	--	107	1,341	--	11.5	-201	--
Affordable Mixed-Use Housing/Live-Work***	0	0	--	20	321*	--	10.8	321	--
General Commercial	9.2	--	100,188		--	38,700**		--	-61,488
Highway Commercial	4	--	69,696	2	--	32,175**	2	--	-37,521
Industrial	50.1	--	545,589	0	--	0	-50.1	--	-545,589
School	23.1	--	--	44	--	--	20.9	--	--
Recreation/Park	167	--	--	167	--	--	0	--	--

* For the purposes of the VMT analysis, the affordable mixed-use housing / market-rate live-work units are treated as multi-family units.
** Square footage per Northlake Design Guidebook
*** 315 affordable mixed-use units and 6 market-rate live-work units.

As shown in Table 2-6, the changes include removing most of the employment including 545,589 sq. ft. of industrial uses and 99,009 sq. ft. of commercial uses.

RPDSEIR Table 2-6 asserts that removing employment causes the VMT per Service Population for the previously approved project to be lower than for the original NorthLake Specific Plan. However, this result is just a computational quirk that results from removing employees with higher VMT per employment and leaving mostly residents with lower VMT per resident. As documented above, the predominant residential VMT component in the NorthLake project is highly significant, and this VMT per service population calculation does not address this issue.

In fact, the RPDSEIR uses the VMT per service population metric to support the opposite conclusion than what should be drawn. The reason for the highly-significant residential VMT is that the planned housing is far from job centers, and this necessitates long commutes and trips to services. Removing most of the jobs will not improve this situation and would likely aggravate it.

[2] There are multiple arithmetic errors in Table 2-5:

- Residential: 3,623 - 3,150 = 473 (not 794)
- Single Family: 2,337 - 1,488 = 849 (not 593)
- Multi-Family 1,286 - 1,341 = increase of 55 (not decrease of 201)

Maximum Possible VMT Mitigation is Required

As documented above, the Los Angeles County VMT Tool outputs included in the RPDSEIR show the residential VMT threshold is significantly exceeded in the NorthLake Specific Plan location:

- Single-family 28.9 exceeds the threshold of 17.2 by 68%
- Multi-family 21.7 exceeds the threshold of 17.2 by 26%
- Combined uses 25.9 exceeds the threshold of 17.2 by 51%

The RPFSEIR includes a Caltrans comment letter dated May 29, 2025 which states, in part:

> To further support VMT reduction and for the County's consideration, we recommend that the project incorporate a Transportation Demand Management (TDM) program. TDM strategies such as enhanced transit connectivity, subsidized transit passes, carpool/vanpool programs, employer-based trip reduction incentives, bicycle and pedestrian infrastructure, and telecommuting support can materially reduce project-level VMT. These measures should be quantified, monitored, and integrated into project conditions or mitigation measures to ensure accountability and effectiveness.

The RPFSEIR response, in part:

> While TDM programs are effective in reducing VMT, here, VMT impacts were determined to be less than significant, and therefore no mitigation is necessary or required.

This response is woefully inadequate. As documented above, the project's VMT impacts are highly significant. As Caltrans recommends, a comprehensive TDM program should be developed and: "These measures should be quantified, monitored, and integrated into project conditions or mitigation measures to ensure accountability and effectiveness."

Sincerely,



Norman L. Marshall

Resume

NORMAN L. MARSHALL, PRESIDENT

nmarshall@smartmobility.com

EDUCATION:

Master of Science in Engineering Sciences, Dartmouth College, Hanover, NH, 1982
Bachelor of Science in Mathematics, Worcester Polytechnic Institute, Worcester, MA, 1977

PROFESSIONAL EXPERIENCE: (37 Years, 23 at Smart Mobility, Inc.)

Norm Marshall helped found Smart Mobility, Inc. in 2001. Prior to this, he was at RSG for 14 years where he developed a national practice in travel demand modeling. He specializes in analyzing the relationships between the built environment and travel behavior and doing planning that coordinates multi-modal transportation with land use and community needs.

Regional Land Use/Transportation Scenario Planning

Portland Area Comprehensive Transportation System (PACTS) – the Portland Maine Metropolitan Planning Organization. Updating regional travel demand model with new data (including AirSage), adding a truck model, and multiclass assignment including differentiation between cash toll and transponder payments.

Loudoun County Virginia Dynamic Traffic Assignment – Enhanced subarea travel demand model to include Dynamic Traffic Assignment (Cube). Model being used to better understand impacts of roadway expansion on induced travel.

Vermont Agency of Transportation-Enhanced statewide travel demand model to evaluate travel impacts of closures and delays resulting from severe storm events. Model uses innovate Monte Carlo simulations process to account for combinations of failures.

California Air Resources Board – Led team including the University of California in $250k project that reviewed the ability of the new generation of regional activity-based models and land use models to accurately account for greenhouse gas emissions from alternative scenarios including more compact walkable land use and roadway pricing. This work included hands-on testing of the most complex travel demand models in use in the U.S. today.

Climate Plan (California statewide) – Assisted large coalition of groups in reviewing and participating in the target setting process required by Senate Bill 375 and administered by the California Air Resources Board to reduce future greenhouse gas emissions through land use measures and other regional initiatives.

Chittenden County (2060 Land use and Transportation Vision Burlington Vermont region) – led extensive public visioning project as part of MPO's long-range transportation plan update.

Flagstaff Metropolitan Planning Organization – Implemented walk, transit and bike models within regional travel demand model. The bike model includes skimming bike networks including on-road and off-road bicycle facilities with a bike level of service established for each segment.

Chicago Metropolis Plan and Chicago Metropolis Freight Plan (6-county region)— developed alternative transportation scenarios, made enhancements in the regional travel demand model, and used the enhanced

model to evaluate alternative scenarios including development of alternative regional transit concepts. Developed multi-class assignment model and used it to analyze freight alternatives including congestion pricing and other peak shifting strategies.

Municipal Planning

City of Grand Rapids – Michigan Street Corridor – developed peak period subarea model including non-motorized trips based on urban form. Model is being used to develop traffic volumes for several alternatives that are being additional analyzed using the City's Synchro model

City of Omaha - Modified regional travel demand model to properly account for non-motorized trips, transit trips and shorter auto trips that would result from more compact mixed-use development. Scenarios with different roadway, transit, and land use alternatives were modeled.

City of Dublin (Columbus region) – Modified regional travel demand model to properly account for non-motorized trips and shorter auto trips that would result from more compact mixed-use development. The model was applied in analyses for a new downtown to be constructed in the Bridge Street corridor on both sides of an historic village center.

City of Portland, Maine – Implemented model improvements that better account for non-motorized trips and interactions between land use and transportation and applied the enhanced model to two subarea studies.

City of Honolulu – Kaka'ako Transit Oriented Development (TOD) – applied regional travel demand model in estimating impacts of proposed TOD including estimating internal trip capture.

City of Burlington (Vermont) Transportation Plan – Led team that developing Transportation Plan focused on supporting increased population and employment without increases in traffic by focusing investments and policies on transit, walking, biking and Transportation Demand Management.

Transit Planning

Regional Transportation Authority (Chicago) and Chicago Metropolis 2020 – evaluated alternative 2020 and 2030 system-wide transit scenarios including deterioration and enhance/expand under alternative land use and energy pricing assumptions in support of initiatives for increased public funding.

Capital Metropolitan Transportation Authority (Austin, TX) Transit Vision – analyzed the regional effects of implementing the transit vision in concert with an aggressive transit-oriented development plan developed by Calthorpe Associates. Transit vision includes commuter rail and BRT.

Bus Rapid Transit for Northern Virginia HOT Lanes (Breakthrough Technologies, Inc and Environmental Defense.) – analyzed alternative Bus Rapid Transit (BRT) strategies for proposed privately-developing High Occupancy Toll lanes on I-95 and I-495 (Capital Beltway) including different service alternatives (point-to-point services, trunk lines intersecting connecting routes at in-line stations, and hybrid).

Roadway Corridor Planning

I-30 Little Rock Arkansas – Developed enhanced version of regional travel demand model that integrates TransCAD with open source Dynamic Traffic Assignment (DTA) software, and used to model I-30 alternatives. Freeway bottlenecks are modeled much more accurately than in the base TransCAD model.

South Evacuation Lifeline (SELL) – In work for the South Carolina Coastal Conservation League, used Dynamic Travel Assignment (DTA) to estimate evaluation times with different transportation alternatives in coastal South Caroline including a new proposed freeway.

Hudson River Crossing Study (Capital District Transportation Committee and NYSDOT) – Analyzing long term capacity needs for Hudson River bridges which a special focus on the I-90 Patroon Island Bridge where a microsimulation VISSIM model was developed and applied.

PUBLICATIONS AND PRESENTATIONS (partial list)

DTA Love: Co-leader of workshop on Dynamic Traffic Assignment at the June 2019 Transportation Research Board Planning Applications Conference.

Forecasting the Impossible: The Status Quo of Estimating Traffic Flows with Static Traffic Assignment and the Future of Dynamic Traffic Assignment. *Research in Transportation Business and Management* 2018.

Assessing Freeway Expansion Projects with Regional Dynamic Traffic Assignment. Presented at the August 2018 Transportation Research Board Tools of the Trade Conference on Transportation Planning for Small and Medium Sized Communities.

Vermont Statewide Resilience Modeling. With Joseph Segale, James Sullivan and Roy Schiff. Presented at the May 2017 Transportation Research Board Planning Applications Conference.

Assessing Freeway Expansion Projects with Regional Dynamic Traffic Assignment. Presented at the May 2017 Transportation Research Board Planning Applications Conference.

Pre-Destination Choice Walk Mode Choice Modeling. Presented at the May 2017 Transportation Research Board Planning Applications Conference.

A Statistical Model of Regional Traffic Congestion in the United States, presented at the 2016 Annual Meeting of the Transportation Research Board.

MEMBERSHIPS/AFFILIATIONS

Associate Member, Transportation Research Board (TRB)

Member and Co-Leader Project for Transportation Modeling Reform, Congress for the New Urbanism (CNU)

From:	ExecutiveOffice
To:	PublicComments
Subject:	Fw: Northlake Specific Plan Project RPFSEIR Approval - CNPS Comments
Date:	Wednesday, March 18, 2026 3:59:39 PM
Attachments:	Outlook-n0lgnnhg.png Bellis 2024.pdf CDFW 2021.pdf Fiedler 1991.pdf Godefroid 2011.pdf Harrison 2023.pdf Nicholas Jensen CV 2025.pdf NorthLake Specific Plan - CNPS Comment.pdf

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Good afternoon.
The following correspondence is being forwarded for your attention and review.
Thank you!

Executive Office of the Board of Supervisors
Phone: (213) 974-1411 | Email: ExecutiveOffice@bos.lacounty.gov
Find us on Facebook, Instagram, LinkedIn, Twitter @ Youtube @LACountyBOS

From: Brendan Wilce <Bwilce@cnps.org>
Sent: Tuesday, March 17, 2026 5:53 PM
To: Local Govermental Services Commission <lgs@bos.lacounty.gov>; First District <firstdistrict@bos.lacounty.gov>; Holly J. Mitchell <HollyJMitchell@bos.lacounty.gov>; Third District <ThirdDistrict@bos.lacounty.gov>; Supervisor Janice Hahn (Fourth District) <fourthdistrict@bos.lacounty.gov>; Barger, Kathryn <Kathryn@bos.lacounty.gov>
Cc: Nicholas Jensen <njensen@cnps.org>
Subject: Northlake Specific Plan Project RPFSEIR Approval - CNPS Comments

Dear Chair Solis and Members of the Board,

Please see the attached comments on the LA County Planning Commission's approval of the RPFSEIR for the Northlake Specific Plan Project submitted on behalf of the California Native Plant Society. The materials cited in our comments are also attached. Thank you for your consideration of our comments and please reach out to us if you would like to discuss our comments.

Sincerely,
Brendan Wilce

Brendan Wilce (He/Him)
Conservation Program Coordinator
California Native Plant Society
2707 K Street, Suite 1
Sacramento, CA 95816


60
YEARS
1965-2025

CALIFORNIA
NATIVE PLANT SOCIETY
2707 K Street, Suite 1, Sacramento, CA 95816-5130 (916) 447-2677 www.cnps.org
Protecting California's native flora since 1965

March 17, 2026

LA County Board of Supervisors
Attn: Kenneth Hahn
Hall of Administration
500 West Temple Street
Los Angeles, CA 90012

Submitted via email to: lgs@bos.lacounty.gov, FirstDistrict@bos.lacounty.gov, HollyJMitchell@bos.lacounty.gov, ThirdDistrict@bos.lacounty.gov, FourthDistrict@bos.lacounty.gov, Kathryn@bos.lacounty.gov,

Re: California Native Plant Society Comments on the NorthLake Specific Plan Project

Dear Chair Solis and Members of the Board:

Thank you for the opportunity to comment on the LA County Planning Commission's decision to approve the NorthLake Specific Plan Project (project) Recirculated Partial Final Supplemental Environmental Impact Report (RPFSEIR). The following comments are submitted on behalf of the California Native Plant Society (CNPS), a non-profit environmental organization with over 13,000 members in 35 Chapters across California and Baja California, Mexico. CNPS's mission is to protect California's native plants and their natural habitats, today and into the future, through science, education, stewardship, gardening, and advocacy. We work closely with decision-makers, scientists, and local planners to advocate for well-informed policies, regulations, and land management practices.

The project site represents an important that is biogeographically significant, as it is located in the Western Transverse Ranges of Southern California. This area is a key linkage between the coastal areas of Ventura and Santa Barbara Counties and the interior, montane portions of Los Angeles County for plant and animal species. As a result, the area is home to a wide range of biota and habitats that are important to conserve, including grassland, sage scrub, and chaparral plant communities. This is evident in the 205 native species that have been recorded in the environmental documents associated with the project. Furthermore, a significant amount of habitat in this region has already been lost to development. Also, many habitats in the region have been affected by an increasing number of human-caused wildfires that have resulted in the type conversion of habitat. Consequently, it is important that the remaining habitat on the Northlake Project and its vicinity be conserved and managed for biodiversity.

The RPFSEIR does not contain sufficient information to show that the concerns of the California Department of Fish and Wildlife (CDFW or The Department) cited in the Court Ruling regarding impacts to offsite mitigation areas, or likelihood that mitigation of special-status species would be successful, were adequately addressed. Additionally, we are concerned that the RPFSEIR is flawed despite the County's changes to mitigation measures. Specifically, we contend that even if there is initial success with the mitigation efforts for special status plant species that these will fail once monitoring and maintenance ends even if populations are meeting performance standards, and that many of the methods proposed in the mitigation measures may not be justified by any scientific evidence.

Compliance with the Court Ruling

The Los Angeles Superior Court ruling on Issue Four—that the mitigation measures provided in the SEIR to protect the rare plants improperly deferred and not supported by substantial evidence—includes concerns raised by CDFW that were not addressed in the Special-status Plants Impact Assessment and Habitat Mitigation and Monitoring Plan (HMMP) or the RPFSEIR. The ruling states that "The Department has concerns when the DSEIR states it will transplant species off-site as this implies other areas will be subject to impact by this action. This additional impact would then need mitigation as this ecosystem is now being altered." AR 7398. None of the surveys in the 2015 Biological Technical Assessment Report were done in the areas proposed for offsite mitigation of special status plant species, specifically the offsite area labeled as "3" in the maps include in the HMMP where mitigation of special-status plant species is proposed to occur. The HMMP and RPFSEIR also did not include any information to indicate that the level of surveys and analysis needed to show that mitigation activities would not cause additional impacts, such as impacts to additional special-status species that may be present on the offsite mitigation areas. To comply with the court ruling, protocol level surveys, following the 2021 update to the 2018 CDFW Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Sensitive Natural Communities (CDFW 2021), should have occurred and impacts to any resources found during these surveys should have received a full analysis in the HMMP and RPFSEIR. The ruling for issue four also states that "CDFW was concerned that the mariposa lilies might not survive transplantation, saying it was unaware of any population created by seeding or translocation having been successful "at demonstrating long-term self-sustaining population."" The County fails to provide substantial evidence that the HMMP and the mitigation measures included in the RPFSEIR will reduce impacts to special status plants to a less than significant level because they fail to include any citations, scientific literature, or published reports to indicate the efficacy of the proposed measures. The failure to address these issues indicates that the RPFSEIR does not comply with the ruling. Decision makers are being asked to trust in unproven and unsupported mitigation measures. The reality is that the measures as planned will almost surely fail in the long term.

Mitigation Measures for Special Status Plant Species

Many of the proposed methods included in the mitigation measures are not based on any factual evidence that they will result in successful mitigation intended to reduce documented impacts to less than significant.

Mitigation Measure 5.2-4 incorporates by reference the HMMP, yet does not incude much of the

analysis to show that the HMMP would be successful. Given the importance of the HMMP in ensuring the success of this mitigation measure additional information should have been included in the

- The RPFSEIR does not include specific information regarding the salvage of bulbs or soil blocks included in the HMMP. The HMMP does not offer any evidence that a depth of 10-14" would be sufficient to salvage *Calochortus clavatus* var. *gracilis/clavatus* bulbs. Without any evidence to support a salvage depth of 10-14" there is a distinct possibility that bulbs may be deeper than this and that the salvage of soil block to this depth will not result in salvaged plant material. MM 5.2-4 needs to provide specific guidelines to ensure succesful salvage of plant material.
- Information regarding the deposition of topsoil on the recipient site from the HMMP is not included in the RPFSEIR. The application of salvaged soil to a depth of 18" is not explained or justified in the HMMP. Leaving this soil uncompacted would make any bulbs planted in it susceptible to predation, desiccation, and/or erosion. Un-compacted soil is easy for burrowing mammals to forage in, contains more air space that would allow for the drying of bulbs, and is more likely to be transported by runoff from precipitation. This would also impact and native vegetation present at the recipient site. We strongly discourage the deposition of large quantities of topsoil into any proposed mitigation areas without any specific and justifiable goal or analysis of impacts to existing vegetation. The RPFSEIR and HMMP also failed to analyze how adding 18 inches of soil may impact the existing plant communities at the transplantation sites, including any special status species that may occur there.
- The production of 500 *Calochortus* plants as nursery stock (.25 plants for each 1 plant impacted if no more than 2,000 *Calochortus* are identified during pre-construction surveys, dropping below .25 plants for each 1 pant discovered if more than 2,000 plants are identified) is not justified by any evidence that this would be a suitable number of plants needed to sustain the required performance standards. We would encourage that a minimum of four plants for each plant impacted be produced as nursery stock.

According to research commissioned by CDFW, most mitigation efforts for special status species fail, showing that just ~15% of transplantation, relocation, or reintroduction efforts reviewed in the study were considered successful (Fiedler, 1991). Additional research shows that despite moderate survival (52%) that flowering and fruiting rates were quite low, 19% and 16% respectively (Godefroid 2011). Even when initial establishment is successful long term survival is poor or uncertain without maintenance and monitoring (Bellis 2024).Given that the selected mitigation sites are known to have populations of invasive species, and the mitigation measures in the RPFSEIR anticipate the need to actively control weeds to meet performance standards, it is highly likely that mitigation efforts will fail once active management is ceased due to invasive species recolonizing mitigation areas if left unchecked, even if performance standards are being met at the conclusion of the monitoring period. For these mitigation measures, there should be ongoing monitoring throughout the life of the project (as long as the Northlake homes are occupied). Maintenance and monitoring should occur for 10 years after planting the last transplants (or after the container stock in the instance that additional plants are needed to meet performance standards) as described in the RPFSEIR. If performance standards are not met, the Project Botanist shall consult with CDFW to determine if steps can be taken to achieve performance standards or if alternative receptor sites will need to be evaluated, as described in the RPFSEIR. If performance standards are met after the 10-year maintenance and monitoring period monitoring should occur each year for 3 years to ensure that populations are continuing to

meet performance standards without maintenance. If monitoring shows populations are stable without maintenance then monitoring shall occur every other year throughout the life of the project. If at any point monitoring shows that performance standards are not met then active maintenance will occur for 5 years, if performance standards are met after 5 years, then monitoring shall occur every year for 3 years, returning to monitoring every other year if performance standards are without maintenance.

In addition to a nursery holding seed for contingency plantings the mitigation measures for special-status plant species should also include a requirement for long term seed banking to preserve the genetics of impacted populations and bulking of seed collected from the impact area. Relying on a limited quantity of seed held by a nursery may not be sufficient in quantity for future needs. Potential alternative seed sources needed for contingency mitigation should be identified and analyzed for potential impacts. Seed collection may induce impacts to donor populations, given that the seed would be coming from special-status plants these impacts could be significant. Additionally, alternative populations may not contain the same genetic diversity of the plants intended to be mitigated for. A portion of collected seed should be provided to a qualified entity (such as the California Botanic Garden) for long term seed banking. A portion of seed should also be provided to a suitable entity for bulking of seed to ensure that a suitable quantity of seed is available to produce additional nursery grown plants to meet performance standards and for future contingency mitigation efforts in the event that initial attempts are unsuccessful.

The mitigation measures in the RPFSEIR regarding seed mixes are improperly deferred. That mitigation does not clearly indicate whether seed mixes would be free of non-native species, what species mix would be used, or where the seed would be sourced from. A report from the National Academy of Sciences has recognized that "a limited supply of native seeds and other native plant materials is a widely acknowledged barrier to fulfilling our most critical restoration needs," (Harrison 2023). This is the sort of information that must be supplied within the CEQA analysis and not put off until after Project approval. Any seed mixes used for remediation, restoration, or revegetation must be locally sourced, genetically appropriate, and certified to be free of any non-native species. Preferably, seed mixes should be collected from impacted areas of the project site prior to disturbance. To ensure availability of sufficient seed for ongoing needs, a portion of collected seed should be bulked by a qualified entity (such as the California Botanic Garden) for future use.

To fully mitigate significant impacts to special status plants and the destruction of thousands of acres of native plant habitat, the County must identify an offsite parcel of land with suitable acreage and populations of impacted species and vegetation communities to be placed into a conservation easement to be held in perpetuity. This parcel must be identified before project approval, or else it would be deferred mitigation under CEQA. This method of off-site mitigation would provide durable protections for species and habitat types impacted by the project. If no such parcel of land exists, that would illustrate how important and irreplaceable the habitats on the project site are.

The PRFSEIR indicates that herbicides used could be used as part of the Site Preparation and Maintenance Program for sage scrub, annual grassland/wildflower fields, foothill needlegrass grasslands, and riparian vegetation. All mentions of herbicide use should explicitly state that any potential use of herbicides shall be approved by the Project Biologist to ensure that use would not impact mitigation sites for western spadefoot and should specify allowable wind speeds for

herbicide application to prevent drift and timing before and after precipitation to prevent runoff. The mitigation measures that mention herbicide use need to specify that all herbicide use will be consistent with the herbicide label. The monitoring and maintenance of southwestern spiny rush and round-leaf filaree must include measures to ensure that maintenance and monitoring efforts do not adversely affect western spadefoot mitigation sites.

In conclusion, we do not feel that the PRFSEIR has complied with the intent of the court ruling, and we feel that ongoing maintenance and monitoring will be needed for successful mitigation, and that amendments to guarantee the availability of genetically appropriate mitigation material and to address potential conflicts regarding sites with multiple mitigation targets are needed. Thank you for the opportunity to comment on this project and please contact me if you have any questions.

Sincerely,



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References

Bellis, J., Osazuwa-Peters, O., Maschinski, J., Keir, M.J., Parsons, E.W., Kaye, T.N., Kunz, M., Possley, J., Menges, E., Smith, S.A. and Roth, D., 2024. Identifying predictors of translocation success in rare plant species. Conservation Biology, 38(2), p.e14190. https://conbio.onlinelibrary.wiley.com/doi/pdf/10.1111%2Fcobi.14190

Fiedler, P.L., 1991. Mitigation-related Transplantation, Relocation and Reintroduction Projects Involving Endangered and Threatened, and Rare Plant Species in California, Final Report. California. Department of Fish & Game. Endangered Plant Program. https://cccal.info/docs/usa/ca/cc/_wide/GITEA/1991_Fiedler_MitigationRarePlants.pdf

Godefroid, S., Piazza, C., Rossi, G., Buord, S., Stevens, A.D., Aguraiuja, R., Cowell, C., Weekley, C.W., Vogg, G., Iriondo, J.M. and Johnson, I., 2011. How successful are plant species reintroductions?. Biological conservation, 144(2), pp.672-682. https://www.researchgate.net/profile/Magdalena-Vicens-Fornes/publication/229104055_How_successful_are_plant_species_reintroductions_Biol_Cons/links/5a003ea8458515a835b8c527/How-successful-are-plant-species-reintroductions-Biol-Cons.pdf

Harrison, S.P., Atcitty, D., Fiegener, R., Goodhue, R., Havens, K., House, C.C., Johnson, R.C., Leger, E., Lesser, V., Opsomer, J. and Shaw, N., 2023. An assessment of native seed needs and the capacity for their supply. Washington, DC: The National Academies Press. 221 p. https://www.fs.usda.gov/rm/pubs_journals/2023/rmrs_2023_harrison_s001.pdf

State of California Natural Resources Agency Department of Fish and Wildlife, 2021. Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Sensitive Natural Communities. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=18959&inline

Received: 8 June 2023 | Revised: 10 August 2023 | Accepted: 12 September 2023

DOI: 10.1111/cobi.14190

CONTRIBUTED PAPERS

Identifying predictors of translocation success in rare plant species

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Article impact statement: Maximizing founder population sizes and committing to adaptive management can improve the success of rare plant translocations.

Abstract

The fundamental goal of a rare plant translocation is to create self-sustaining populations with the evolutionary resilience to persist in the long term. Yet, most plant translocation syntheses focus on a few factors influencing short-term benchmarks of success (e.g., survival and reproduction). Short-term benchmarks can be misleading when trying to infer future growth and viability because the factors that promote establishment may differ from those required for long-term persistence. We assembled a large ($n = 275$) and broadly representative data set of well-documented and monitored (7.9 years on average) at-risk plant translocations to identify the most important site attributes, management techniques, and species' traits for six life-cycle benchmarks and population metrics of translocation success. We used the random forest algorithm to quantify the relative importance of 29 predictor variables for each metric of success. Drivers of translocation outcomes varied across time frames and success metrics. Management techniques had the greatest relative influence on the attainment of life-cycle benchmarks and short-term population trends, whereas site attributes and species' traits were more important for population persistence and long-term trends. Specifically, large founder sizes increased the potential for reproduction and recruitment into the next generation, whereas declining habitat quality and the outplanting of species with low seed production led to increased extinction risks and a reduction in potential reproductive output in the long-term, respectively. We also detected novel interactions between some of the most important drivers, such as an increased probability of next-generation recruitment in species with greater seed production rates, but only when coupled with large founder sizes. Because most significant barriers to plant translocation success can be overcome by improving techniques or resolving site-level issues through

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early intervention and management, we suggest that by combining long-term monitoring with adaptive management, translocation programs can enhance the prospects of achieving long-term success.

KEYWORDS
endangered species, population restoration, reintroduction, seedling recruitment, species recovery, threatened species

Identificación de pronosticadores del éxito de reubicación en especies raras de plantas

Resumen: El objetivo fundamental de la reubicación de plantas raras es la creación de poblaciones autosuficientes con resiliencia evolutiva que persistan a la larga. De todas maneras, la mayoría de las síntesis de estas reubicaciones se enfocan en unos cuantos factores que influyen sobre los parámetros a corto plazo del éxito (supervivencia y reproducción). Los parámetros a corto plazo pueden ser engañosos si se intenta inferir el crecimiento y la viabilidad en el futuro ya que los factores que promueven el establecimiento pueden diferir de aquellos requeridos para la persistencia a largo plazo. Ensamblamos un conjunto grande de datos representativos en general ($n = 275$) de las reubicaciones de plantas en riesgo bien documentadas y monitoreadas (7.9 años en promedio) para identificar los atributos de sitio más importantes, las técnicas de manejo y los rasgos de las especies para seis parámetros de ciclos de vida y medidas poblacionales del éxito de reubicación. Usamos el algoritmo de bosque aleatorio para cuantificar la importancia relativa de las 29 variables de pronosticadores para cada medida del éxito. Los factores en los resultados de las reubicaciones variaron con los marcos temporales y las medidas de éxito. Las técnicas de manejo tuvieron la mayor influencia relativa sobre la obtención de parámetros de ciclos de vida y tendencias poblacionales a corto plazo, mientras que los atributos de sitio y los rasgos de la especie fueron más importantes para la persistencia poblacional y las tendencias a largo plazo. En específico, las grandes cantidades de fundadores incrementaron el potencial de reproducción y reclutamiento de la siguiente generación, mientras que la declinación de la calidad del hábitat incrementó el riesgo de extinción y el trasplante de especies con baja producción de semillas redujo el rendimiento del potencial reproductivo a la larga. También detectamos interacciones novedosas entre algunos de los factores más importantes, como el aumento en la probabilidad del reclutamiento en la siguiente generación en especies con tasas mayores de producción de semillas, pero sólo cuando se emparejó con grandes cantidades de fundadores. Ya que las barreras más significativas para el éxito de la reubicación de plantas pueden superarse al mejorar las técnicas o resolver los temas a nivel de sitio por medio de un manejo y una intervención temprana, sugerimos que con la combinación del monitoreo a largo plazo con el manejo adaptativo los programas de reubicación pueden aumentar el prospecto de lograr el éxito a largo plazo.

PALABRAS CLAVE
especie amenazada, especie en peligro, reclutamiento de plántulas, recuperación de especie, reintroducción, restauración poblacional

确定珍惜植物迁地保护成功的预测因素

【摘要】珍稀植物迁地的基本目标是建立能够自我维持、具有演化恢复力、能够长期续存的种群。然而, 大多数对植物迁地计划的综述研究都侧重于影响短期成功基准(如存活和繁殖)的几个因素。这些短期基准可能会对推断未来的生长和生存力产生误导, 因为利于种群建立的因素可能与种群长期续存所需要的因素不同。本研究收集了大量($n = 275$)具有广泛代表性的数据集, 这些数据集包含了记录详实且受到监测(平均7.9年)的濒危植物迁地计划案例, 可用于确定指示迁地保护成功与否的6个生命周期基准及种群统计参数中最重要的位点属性、管理技术和物种特征。我们使用随机森林算法量化了29个预测变量对每个迁地保护成功指标的相对重要性, 发现不同时间段和不同成功指标的迁地保护结果驱动因素各不相同。管理技术对实现生命周期基准和短期种群趋势的影响最大, 而位点属

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性和物种特征对种群续存和长期趋势更为重要。具体来说, 奠基者数量多可以增加下一代繁殖和种群补充的潜力, 而栖息地质量下降和物种外植种子产量低则分别会导致灭绝风险增加和潜在的长期繁殖输出减少。我们还在一些最重要的驱动因素之间发现了新的相互作用, 例如种子产量高的物种下一代种群补充的概率会增加, 但只有在奠基者数量多的时候才存在这种关系。通过改进技术或通过早期干预及管理解决位点的问题, 可以克服植物迁地保护中主要的障碍, 因此我们建议将长期监测与适应性管理相结合, 以帮助迁地保护计划取得长期成效。【翻译:胡怡思;审校:聂永刚】

关键词: 重引入, 出苗, 物种恢复, 种群恢复, 受威胁物种, 濒危物种

INTRODUCTION

Reintroductions and other types of conservation translocations are an established method to reduce the extinction risk of rare plants when in situ conservation measures fail to adequately protect and recover a species (Maschinski & Haskins, 2012; Maunder, 1992). They involve the intentional and planned movement of plants or plant propagules from one place to another either to augment an existing population or to establish a new population (IUCN/SSC, 2013). The use of translocations as a conservation tool has increased significantly in recent decades (Armstrong et al., 2019), and as threats to biodiversity intensify due to rapid anthropogenic climate change, habitat degradation, and the spread of invasive species and diseases (Díaz et al., 2019), further increases are expected (Swan et al., 2018). Yet, despite their growing popularity, translocations can be risky (Novak et al., 2021) and expensive (Fenu et al., 2019) and are less certain of a beneficial outcome than in situ management actions (Zimmer et al., 2019).

Global syntheses of plant translocations indicate mixed success rates, with short-term survival, flowering, and fruiting rates generally being quite low (Dalrymple et al., 2012; Godefroid et al., 2011). Poor performance has prompted several investigations into the factors influencing translocation success (Albrecht & Maschinski, 2012; Godefroid et al., 2011; Liu et al., 2015; Menges, 2008; Silcock et al., 2019). However, many published studies base success on a few short-term performance measures of the founder population (Menges, 2008), which can be misleading when trying to infer future growth and viability because factors that promote establishment may differ from those required for long-term persistence (Iles et al., 2016). Additionally, slow-maturing and long-lived plants require a much longer term perspective on success because it may take decades for the outplanted individuals to become reproductive (e.g., Menges et al., 2016) and even longer to reach a second generation (Albrecht et al., 2019). Consequently, the success of a plant translocation depends on the adopted definition, the period within which the evaluation is applied, and the life history of the focal species (Drayton & Primack, 2012).

A diverse array of factors can influence translocation outcomes, and they can be broadly grouped into three categories: site attributes, management techniques, and species' traits (Kaye, 2009). Site attributes, such as soil type, species composition, and physical habitat structure, are often evaluated based on their apparent similarity with local natural populations (Holl & Hayes, 2006; Osborne & Seddon, 2012; Turner & McGraw, 2015). Because poor physical habitat quality and unsuitable environmental conditions rank as the most commonly reported causes of project failure (Godefroid et al., 2011; Silcock et al., 2019), relying on similarities to present conditions of a species occurrence may be insufficient for translocation planning. Management techniques, such as increasing the number of founders and the life stage of transplants, have led to increases in survival and attainment of reproduction and next-generation recruitment of seedlings (Liu et al., 2015; Silcock et al., 2019; Whitehead et al., 2023). Less attention has been given to the influence of life-history traits on translocation outcomes given the short time scales reported for many plant translocations (Albrecht et al., 2019). Ultimately, complex interactions between multiple factors likely drive translocation outcomes, but previous syntheses are limited to a small number of variables, often analyzed in isolation.

Because plants have different limiting factors at different life stages, the relative importance of site attributes, management techniques, and species' traits should vary depending on the success metric under consideration (Young et al., 2005). However, most preceding syntheses analyzed variable importance for attaining metrics associated with the reproductive niche of the founder individuals, such as the occurrence of flowering or fruiting (Dalrymple et al., 2012; Godefroid et al., 2011; Liu et al., 2015; Reiter et al., 2016; but see Silcock et al., 2019). Evaluations of these metrics have yielded valuable insight and have an advantage over intergenerational metrics (such as next-generation recruitment) in that sample sizes and analyses are less constrained by the short average monitoring length (3 years [Dalrymple et al., 2012]) of plant translocations. However, this bias toward metrics associated with the founder individuals, combined with the frequent decision to bypass early life stages by planting ex situ grown transplants (Albrecht & Maschinski, 2012), means relative understanding of the factors governing the recruitment niche and the development of the second generation, which have been shown to limit population growth (Clark et al., 2007), is poor.

We assembled a large data set of well-monitored and well-documented rare plant translocations in the United States to identify the most important site attributes, management techniques, and species' traits for six metrics of translocation success. These metrics, which represent key life-cycle

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benchmarks and indications of a population's health and reproductive potential (Maschinski & Albrecht, 2017), include population persistence, next-generation recruitment, next-generation maturity, overall population size, and the short- (≤6 years) and long-term (>6 years) reproductive population size. By considering both short- and long-term indicators of population performance across a broad range of species, sites, and ecosystems, we aimed to gain comprehensive insights into the most influential drivers of rare plant translocation success.

METHODS

Data collection

We assembled a data set on the translocations of rare plant species in the United States as part of an ongoing effort by the Center for Plant Conservation (CPC) to develop a standardized repository and continually expanding database of long-term rare plant translocations (https://saveplants.org/reintroduction-database/). Our data collation efforts included all categories of conservation-motivated translocations defined by the International Union for Conservation of Nature: reinforcements, reintroductions, and conservation introductions within and beyond a focal species' indigenous range (IUCN/SSC, 2013). Projects conducted for commercial purposes or with no clear conservation-related objective were excluded. We focused only on translocations of globally or regionally rare plant taxa according to the NatureServe conservation status system, which assigns conservation ranks on a 1–5 numerical scale (from most vulnerable to most secure, G/T1 to G/T5) to organisms distributed in North America.

The data we analyzed were collected directly from individuals involved in translocations rather than the scientific literature, which can be biased toward the most successful plant translocations (Godefroid et al., 2011). We used a three-step approach to assemble our data set (see Appendix S1). First, we disseminated an electronic survey (June 2016) via multiple listserves (e.g., Center for Plant Conservation and Plant Conservation Alliance) to identify participants willing to contribute data on rare plant translocations. Second, we circulated a survey via REDCap (research electronic data capture), a secure and freely available web-based application (https://www.project-redcap.org/), to individuals who agreed to participate in step 1. Finally, we supplemented our REDCap data set with projects that met our criteria described above from CPC's original Reintroduction Registry, which included data from published and unpublished translocation projects (Guerrant, 2012).

Our approach to data collection resulted in the contribution of projects from a variety of organizations, including federal, state, and local governments, botanical gardens, research institutes, nonprofit organization, indigenous groups, and private individuals. We use the term *practitioner* as an umbrella term to encompass the diverse range of groups and individuals involved in the practice of rare plant translocation.

Each data point in the REDCap data set represents a unique translocation project defined as the outplanting of plant propagules of a single species over a single or multiple years at the same site or in multiple locations (<1 km apart) within a single site (Appendix S1). In cases where a species was translocated to multiple locations or sites, contributors were asked to decide whether they qualified as a single or separate translocation project based on their familiarity and knowledge of the species and translocation sites. We provided two rules of thumb: a spatial proximity rule (adapted from NatureServe's 2004 Habitat-based Plant Element Occurrence Delimitation Guidelines) and an experimental treatments rule. With spatial proximity, distinct units that are <1 km apart are collapsed into a single translocation project; those that are 1–10 km apart are considered single or separate projects, depending on the species biology, project goals, and habitat; and those that are >10 km apart are considered separate translocation projects. With experimental treatments, all experimental treatments at a site are collapsed into a single translocation project unless they can be considered separate translocation projects based on the spatial proximity rule.

After cleaning and processing (Appendix S1), our final data set consisted of 275 translocation projects, involving 127 taxa from 21 distinct orders (see Appendix S2 for list of translocated taxa). A majority of translocations were of taxa that were imperiled or critically imperiled (83%) at the global level according to NatureServe conservation statuses and occurred within a taxon's indigenous range (98%). We did not conduct a comprehensive compilation of all rare plant translocations in the United States. Rather, we assembled a broadly representative data set of well-documented and monitored translocations spanning varied geography (23 states, including Hawaii), life forms (50% forbs, 41% woody plants, 5% cacti, 3% ferns, 1% graminoids), and ecosystems (41% forest, 21% savanna and shrub-steppe, 12% herbaceous wetlands, 11% upland grassland). Due to their low representation in the data set, translocations of ferns, graminoids, and cacti were combined with the two dominant life-form categories (ferns and graminoids with forbs to form perennial herbs and cacti with woody plants to form woody plants and cacti) (Table 1).

Metrics of translocation success

We initially evaluated translocation success across six metrics, one focused on population persistence, three focused on the attainment of life-cycle benchmarks (reproductive maturity, next-generation recruitment, and next-generation maturity), and two derived from population censuses (population size and reproductive population size) (Appendix S1). To evaluate population persistence, we grouped all extinct populations with populations containing <50 individuals and a decreasing population trend, based on the assumption that these populations have too few individuals surviving to result in a viable population without further augmentation (Silcock et al., 2019). The threshold of 50 is based on a minimum viable effective population size rule in which 50 individuals are assumed to represent the absolute minimum number of plants required to prevent inbreeding depression (Jamieson & Allendorf, 2012).

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TABLE 1 Predictor variables included in the random forest models to analyze benchmarks of success in rare plant translocations.

Variable	Type	Levels or observed ranges
Site attribute		
Habitat quality (preplanting)	Categorical	excellent, good, poor, or fair
Habitat quality change (between preplanting and most recent assessment)[a]	Categorical	positive, negative, no change
Ecosystem type	Categorical	forest, herbaceous wetland, savanna & shrub-steppe, sparsely vegetated, upland grassland, upland shrub land, woody wetlands or riparian
Number of obstacles[a]	Categorical	0, 1, >1
Number of threats (preplanting)[a]	Categorical	0, 1, 2 – 4, >4
Change in number of threats[a]	Categorical	increasing, decreasing, no change
Management technique		
ln(founder size)[b]	Continuous	0.693–10.389 (original range: 2–32,500)
Founder relatedness	Categorical	bulk collection, maternal lines separated
Management interventions (preplanting)[a]	Categorical	0, 1 – 3, >3
Management interventions (postplanting)[a]	Categorical	0, 1 – 3, >3
sqrt(monitoring length)	Continuous	0–6.782 (original range: 0 – 46)
Number of outplanting years	Categorical	single, 2 – 5, >5
Number of source populations	Binary	single, multiple
Number of subsites	Binary	single site, multiple subsites
Project type	Categorical	assisted colonization, introduction (to indigenous range), reinforcement, reintroduction
Propagule type	Categorical	seeds, seedlings, adults, mixed
Traits		
Clonal reproduction	Categorical	strongly clonal, clonal, weakly clonal, none
Dispersal mode	Categorical	animals: high mobility, low mobility; plants: wind or water, other mode, no obvious agent
Disturbance dependency	Categorical	frequent disturbances, infrequent disturbances, none
Life form	Binary	perennial herbs, woody plants & cacti
Life span	Categorical	2–10 years, 11–50 years
Light requirement for reproduction	Categorical	high, low, none
Mating system	Categorical	autogamously selfing, obligately outcrossing, mixed mating
Order[c]	Categorical	Apiales, Asparagales, Asterales, Brassicales, Caryophyllales, Ericales, Fabales, Gentianales, Lamiales, Liliales, Malpighiales, Malvales, Poales, Polypodiales, Ranunculales, Rosales, Sapindales, Solanales
Pollination mode	Binary	insect, other modes
Conservation status[c]	Categorical	G/T1, G/T2, G/T3, G/T4, G/T5
Reproductive frequency	Categorical	iteroparous, semelparous
Seed production rate (number of seeds per plant)	Binary	<100, ≥100
Seed size	Categorical	small (<1 mg), medium (1–500 mg), large (>500 mg)

[a]Derived from existing variables either by summing and categorizing multiple selection questions or by calculating a change between two related variables. See Appendix S1 for methodology behind each modified variable.
[b]Number of founder individuals.
[c]Obtained independently from NatureServe. Conservation status extracted at the taxonomic level at which the focal taxon was reported in the REDCap survey (i.e., G, ranks for full species; T, ranks for subspecies and varieties).

We also split the two population census metrics into projects with short- (≤6 years) and long-term (>6 years) monitoring lengths because the importance of certain factors in determining changes in population size may vary across different time frames (Bialic-Murphy et al., 2022).

When analyzing variable importance for each of the success metrics, we excluded reinforcements ($n = 72$) because it was unclear whether the observations of life-cycle benchmarks or the results of censuses were due to outplanted individuals or naturally occurring plants. We also excluded annuals ($n = 14$)

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and the longest lived species (>50 year life spans) ($n = 33$) due to highly imbalanced cases in the response variables and reduced model performance (see "Caveats" below).

Predictor Variables

We focused on 29 predictors of translocation success and classified all predictor variables into one of three categories: site attributes, management techniques, or species' traits (Table 1). Site attributes describe characteristics of the location where the species was translocated; management techniques describe characteristics specific to an individual translocation event and largely under the control of practitioners; and species' traits describe characteristics of the species translocated. Although we considered the relative effects of each predictor variable separately, we classified predictors into three categories to facilitate synthesis and aid in the identification of generalities that influence different metrics of translocation success. To prepare the data for analyses, we modified the levels of some predictors by collapsing levels with very low frequencies. We created new variables by summing and categorizing multiple selection questions or by calculating a change between two related variables (Table 1 ; Appendix S1). We also transformed the two continuous variables, founder size (natural log) and monitoring length (square root), to improve model performance (by reducing effects of skewed distributions on variable selection) and to enhance the visualization of model outputs (Zheng & Casari, 2018).

Analyses

To quantify the relative importance of predictor variables for each metric of translocation success, we used the random forest algorithm. When compared with classical parametric methods, such as logistic regression, random forests offer some advantages, such as their robustness to missing information, effectiveness at detecting patterns in high-dimensional data (i.e., when the ratio of the number of cases to number of predictors is low), ability to reveal complex interactions and nonlinear relationships, and capacity to handle multiclass classification problems (Strobl et al., 2009). Because our data set was characterized by a substantial amount of missing data, a large number of mostly categorical predictors, and multiple response variables with more than two classes (e.g., population size and reproductive population size), random forest offered a valuable approach for which comparable parametric methods would have been less appropriate (Strobl et al., 2007).

Because random forests constructed from individual classification trees are biased toward selecting variables with more categories over variables with only a few, we used unbiased conditional inference trees drawn without replacement (Hothorn et al., 2006), as recommended in Strobl et al. (2007). To identify the most influential predictor variables for each metric of translocation success, we generated variable importance values with the varimp function in the party package 1.3-10 (Hothorn et al., 2022) in R 4.2.0 (R Core Team, 2022), which calculates importance by comparing model prediction accuracy before and after permutation of each predictor (Strobl et al., 2008); large decreases in model accuracy after permutation indicate greater importance.

Random forests were run in two phases. In the first phase, random forest analysis was run as a filter to exclude unimportant variables that made little contribution to the model. These models were run with 10,000 trees and eight randomly chosen predictors tested at each node (mtry = 8); default values were retained for all other parameters of the cforest function. We applied Strobl et al.'s (2009) approach to variable exclusion. We removed all variables with importance values that were negative, zero, or had a small positive value that was within the same range of the negative values because these variables provide less information than random variables. In the second phase of random forest analysis, we ran models with only the selected variables from phase 1 and kept the default settings for function cforest but not for ntree (ntree = 10,000). Variable importance values of the most important predictors in each model were relativized for presentation.

We used the partial_dependence function in the edarf package 1.1.1 in R to estimate partial variable effects for the most important predictors (Jones & Linder, 2016). Partial dependence shows how the predicted outcome changes with respect to a single predictor variable, whereas all other predictors in the model are held constant. We produced partial dependence plots to visualize and interpret the relationship between each important predictor variable and the associated response variable. Determining which predictors were the most important from each of the phase 2 models was done by assessing the size of the steps in the variable importance plots (Holmes et al., 2015). Although strongly correlated predictors can affect the interpretation of variable importance through the unpredictable inflation or deflation of other closely associated predictors (Biau & Scornet, 2016), we did not find any significant pairwise correlations or associations between predictor variables that might affect final interpretation (Appendix S1).

To identify potential interactions between the most important predictors, we computed classification trees with the ctree function from the partykit package 1.2-16 (Hothorn & Zeileis, 2015). This function uses recursive partitioning to create a classification tree and identifies the predictor variable and split point (or variable levels) that maximize the statistical association between the predictor and the response at each node of the tree. Statistical significance ($\alpha = 0.05$) indicates that the null hypothesis of independence between the predictor and the response can be rejected. Interactions are represented by nodes in the tree where multiple predictors are involved in the split. This approach avoids overfitting and a selection bias toward covariates with many possible splits, which are common features in other recursive partitioning methods (Strobl et al., 2009).

We evaluated the classification performance of our random forest models with the area under the curve (AUC) of the receiver operating characteristic (ROC) and generalized for multiclass classifications when response variables consisted of more than two classes (Hand & Till, 2001). The value of AUC

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ranges from 0.50, for discrimination that is no better than random, to 1.00, for perfect discrimination (Hanley & McNeil, 1982). We considered models with an AUC of ≥0.70 to have at least acceptable levels of discrimination capacity (Hosmer et al., 2013). Random forest models for reproductive maturity and short-term population size (≤6 years) did not meet our AUC threshold and were consequently excluded from variable importance analyses (model AUC scores in Appendix S3).

RESULTS

Summary of the full data set

At the time of data collection, translocation projects had been monitored for an average of 7.9 years (median = 6, min–max = 1–46, n = 275) since outplanting. Reproductive maturity occurred in 80% of populations, whereas next-generation recruitment was recorded in 53% of populations that reached maturity (43% of total), and next-generation maturity occurred in 50% of populations that recruited (21% of total) (Appendix S1). At the most recent monitoring event, the majority of translocated populations remained extant with ≥50 individuals present and a stable or increasing population (71%). The size of extant populations tended to be medium (51–500, 55%) or small (1–50, 31%), rather than large (>500, 14%), at the most recent census. Most extant populations had a small number of reproductive individuals present (1–50, 41%), one-third had a medium-to-large number (>50, 32%), and the remainder had no reproductive individuals present (27%).

Predictors of translocation success

Predictors associated with management techniques had the largest influence on population persistence and the two life-cycle benchmarks (Figure 1a–c). Large founder population sizes reduced the probability of extinction (Figure 2a) and increased the probability of recruitment success (Figure 2d). Next-generation maturity was best detected when monitoring lasted longer (Figure 2e). The introduction of propagules from a single-source population rather than multiple populations and outplanting across multiple subsites rather than a single subsite also increased the probability of attaining next-generation maturity. Site attributes, such as the change in habitat quality and the habitat quality before outplanting, influenced population persistence. A poor or fair baseline habitat quality or a negative change in quality increased the probability of extinction (Figure 2b,c). However, classification tree analysis showed that extinction probabilities at sites with negative changes in habitat quality could be reduced to levels more comparable with stable or increasing habitat conditions when the founder size exceeded 112 (ln = 4.718) individuals (Figure 3a).

Founder size also ranked highly in models of census-derived metrics, such as population size and the number of reproductive individuals recorded within 6 years of outplanting (Figure 1d,e). Increasing the founder size increased the probability of establishing medium- and large-sized populations (Figure 4a) and increased the number of reproductive individuals in the short term (≤6 years) (Figure 4d). However, founder size was less influential for long-term metrics, such as next-generation maturity (Figure 1c), population size at >6 years (Appendix S3), and the number of reproductive individuals at >6 years (Figure 1f). In the two long-term census metrics, site-level variables, such as the number of threats at the time of outplanting and the change in habitat quality, were more important. A higher relative number of threats at outplanting (two or more) reduced reproductive population sizes, and negative changes in habitat quality reduced the overall population size (Figure 4e; Appendix S3).

Trait-related variables tended to influence census-derived metrics more than life-cycle benchmarks when considered independently (Figure 1). However, classification tree analysis revealed an interactive effect between seed production rate and founder size for next-generation recruitment, indicating that even with a substantial number of founders (>119, ln = 4.779), recruitment rates were three times lower in species with low seed production (Figure 3b). Population sizes were largest in taxa with 2- to 10-year life spans, and variation in population size was much greater for taxa with life spans of 11–50 years (Figure 4b; Appendix S3). In the short term (≤6 years), populations of woody plants and cacti were most likely to be represented by a medium- to large-sized number of reproductive individuals, whereas perennial herbs were most likely to have small reproductive populations (Figure 4c). Herb translocations often required very large founder sizes (>550, ln = 6.310) to establish a reproductive population within 6 years (Figure 3c). Over time frames of >6 years, translocations of taxa with comparatively higher seed production rates (≥100 per plant) resulted in larger reproductive populations than less fecund taxa (<100 seeds per plant) (Figure 4f).

DISCUSSION

We assembled a large data set on translocations of rare plant species in the United States that spanned multiple life forms (herbaceous to woody), biomes (tropical to temperate), and ecosystems (forest to grassland), and averaged much longer time frames than previous syntheses of plant translocations (nearly 8 years compared with 3–5 years in Dalrymple et al., 2012, Liu et al., 2015; Reiter et al., 2016; though see Silcock et al., 2019). Our results demonstrated how the relative importance of site, technique, and species' traits vary across different life-cycle benchmarks and population metrics in rare plant translocations. Additionally, we uncovered novel interactions among these factors that highlight the most important barriers to creating viable populations of translocated rare plant species.

Site attributes

Habitat quality is a fundamental driver of translocation success in plants globally (Godefroid et al., 2011). Consistent with this, low-quality habitat at the time of outplanting was one of

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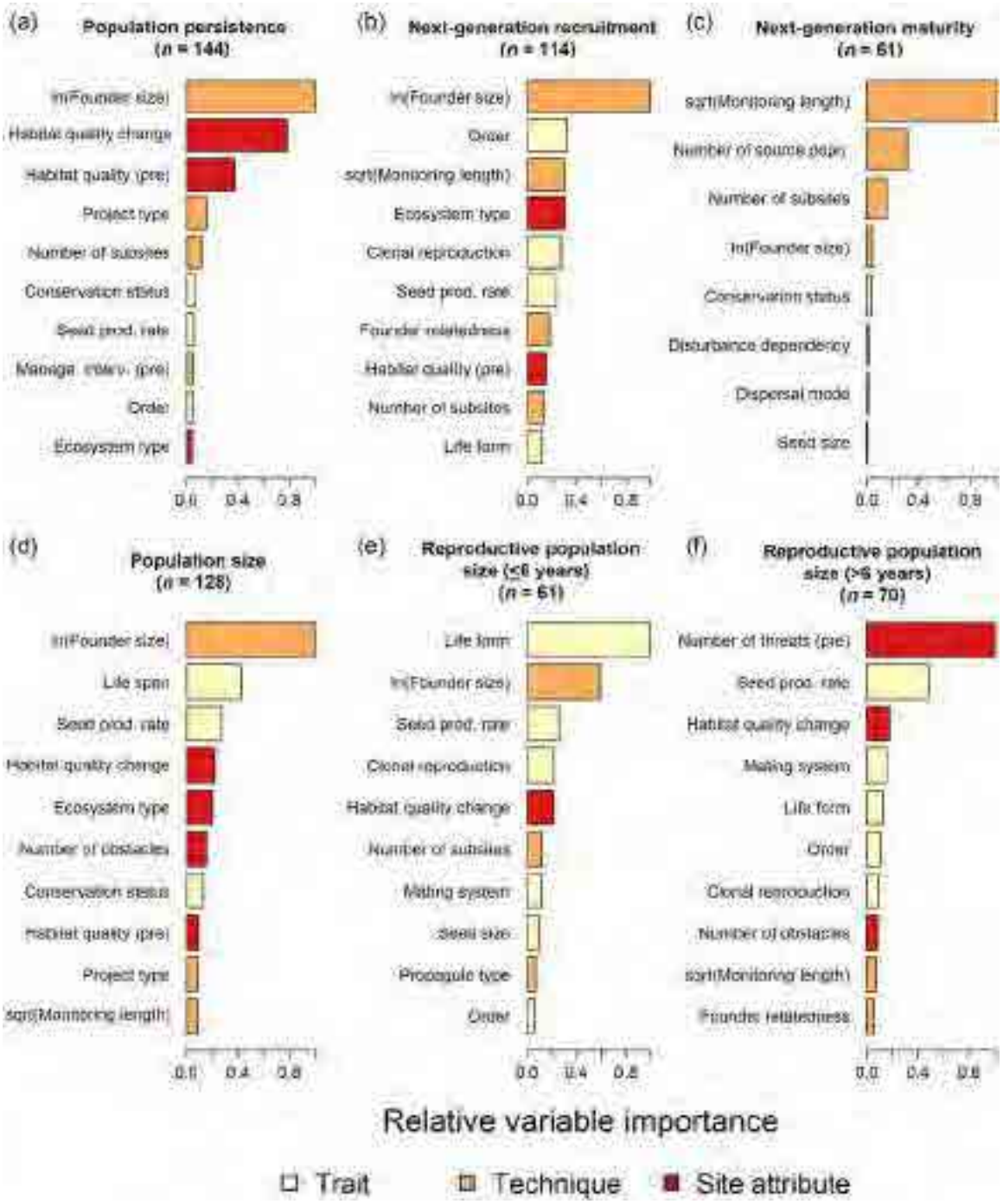


FIGURE 1 Relative variable importance of the 10 or 8 (next-generation maturity) most influential predictors for six metrics of plant translocation success identified using random forest models: (a) population persistence, (b) next-generation recruitment, (c) next-generation maturity, (d) population size, (e) reproductive population size (≤6 years), and (f) reproductive population size (>6 years). Models were fit with data on two life-span categories (2–10 years and 11–50 years). Importance was calculated by comparing model prediction accuracy before and after permutation of each predictor.

the strongest predictors of population extinction in U.S. plant translocations. The typically complex habitat requirements of rare species are sometimes underestimated in translocations. Recipient sites are selected based on subjective judgements of habitat quality (Osborne & Seddon, 2012) or the historical presence of the species, which disregards recent or potential future changes in environmental conditions (but see Rusconi et al., 2022). Low relative habitat quality prior to outplanting and diminished habitat quality after outplanting emerged as primary barriers to population persistence, supporting this contention. Although a recent review of recipient site selection indicated a shift toward more systematic approaches, such as habitat

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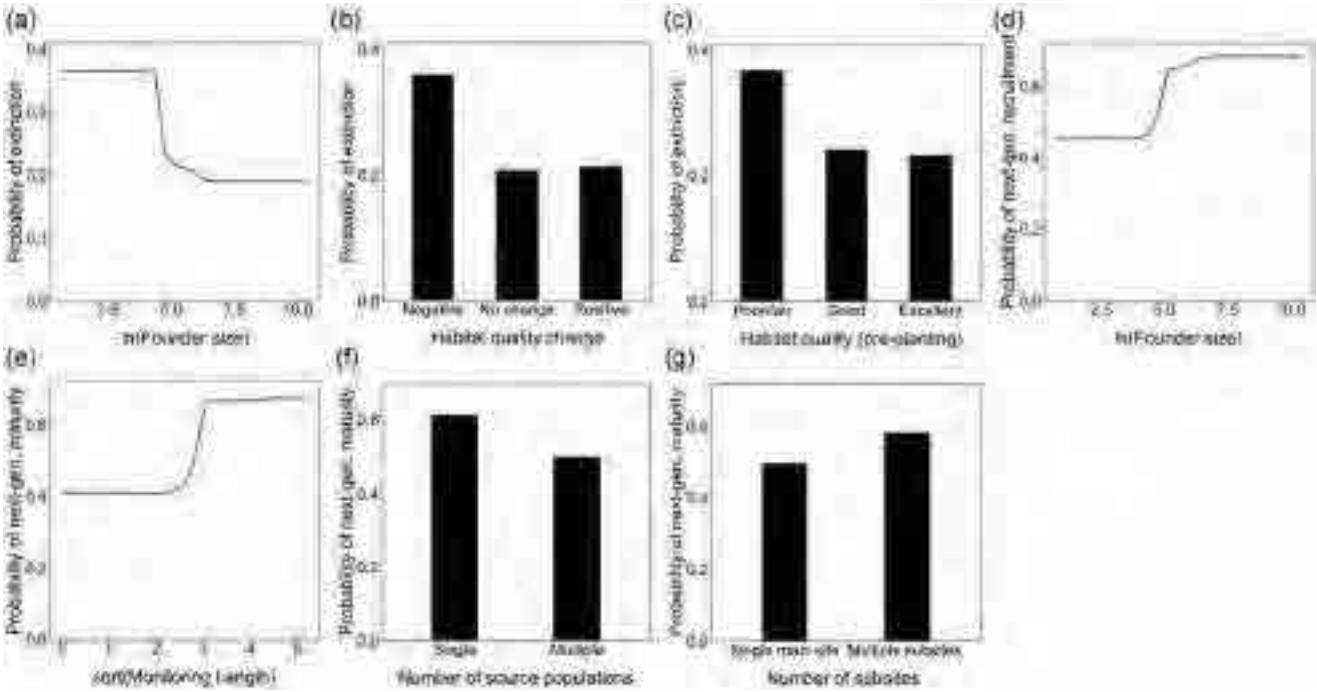


FIGURE 2 Partial dependence of the most influential variables for species with 2–10 and 11–50 year life spans in random forest models on (a–c) population persistence, (d) next-generation recruitment, and (e–g) next-generation maturity (lines or bars, predicted probability of the response class according to all values of a continuous variable or level of a categorical variable). Partial dependence indicates dependence of the dependent variable on the focal predictor variable while controlling for the effects of all the other predictors in the random forest model.

suitability modeling and experimental translocation trials (Stadtmann & Seddon, 2018), our findings suggest that more rigorous selection of high-quality sites and greater attention to changes in habitat quality after outplanting could help reduce the extinction risk of translocated plant populations.

Identifying and controlling threats prior to outplanting is a key step for successful translocation (Commander et al., 2018; IUCN/SSC, 2013; Maschinski & Albrecht, 2017). Practitioners in our study reported an average of three threats at the time of outplanting; translocations in Hawaii had almost double (4.1) the number of threats as those in the continental United States (2.3) due to intense anthropogenic pressure from agriculture, invasive species, harvesting, fire, and land conversion (Wilcove et al., 1998). However, the average number of management actions used to control threats was proportionally similar to the number of threats in both regions (Hawaii = 3.9, continental United States = 1.5), which may help explain why the number of threats did not have a significant influence on population persistence.

The number of threats at outplanting was the most influential predictor of the long-term (>6 years) size of the reproductive population. In rare plant translocations, achieving large reproductive population sizes is essential to overcoming reproductive barriers (such as Allee effects and mate limitation) and achieving next-generation seedling recruitment (Albrecht et al., 2019). When no threats or a single threat was observed at the time of outplanting, a medium to large population of reproductive individuals (>50) was the most probable outcome, whereas when ≥2 threats were present, there was roughly the same probability of having zero reproductive individuals. Consequently, practitioners would be well advised to conduct detailed threat assessments during the project planning stage, select recipient locations that have as few threats as possible, and be willing to control threats before and after outplanting (Maschinski & Albrecht, 2017). This may include constructing cages or fences to exclude herbivores (Albrecht & Long, 2019; Monks et al., 2023), protecting plants from recreational activities (Fenu et al., 2016), or changing disturbance regimes, such as fire frequency and intensity (Menges & Quintana-Ascencio, 2004).

Techniques

Best practice guidelines recommend the use of as many founding individuals as is feasible to bolster population growth (Maschinski & Albrecht, 2017). Concordant with this recommendation and results from previous syntheses (Albrecht & Maschinski, 2012; Godefroid et al., 2011; Silcock et al., 2019; Whitehead et al., 2023), founder population size emerged as an important predictor across multiple metrics of translocation success. Larger founder sizes increased the probability of population persistence, the occurrence of next-generation recruitment, the size of the reproductive population within ≤6 years, and the attainment of a large (>500 individuals) population size.

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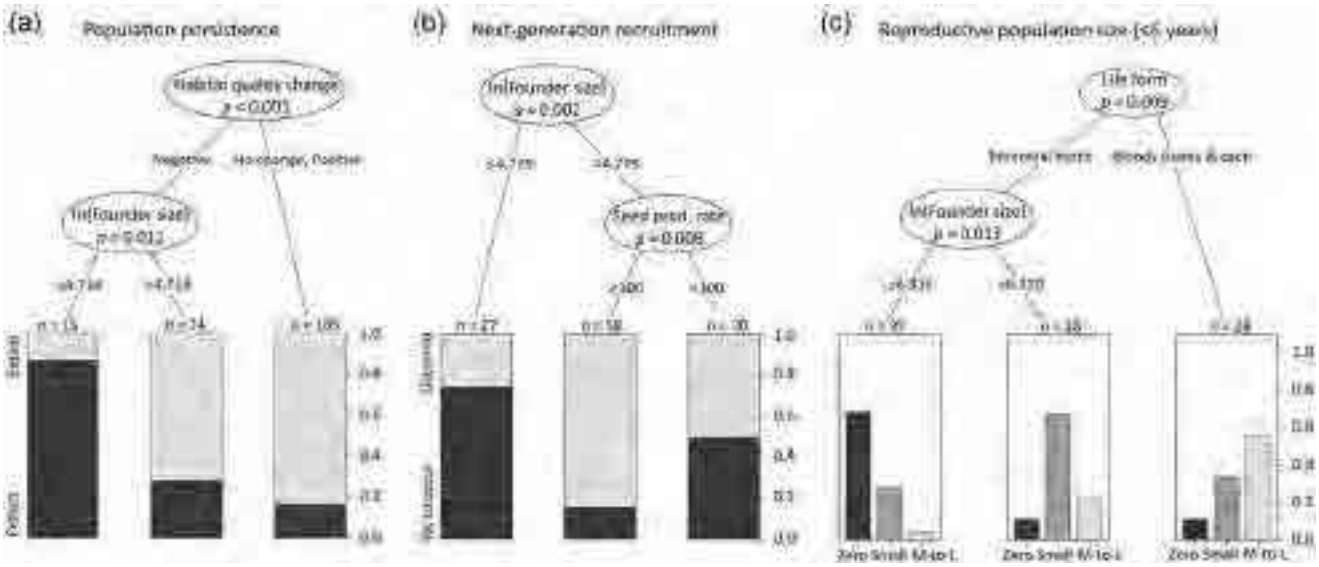


FIGURE 3 Interactive effect of important predictor variables for three metrics of translocation success: (a) population persistence, (b) next-generation recruitment, and (c) short-term reproductive population size (≤6 years) (ranges of short-term reproductive population size categories: zero, 0; small, 1–50; M-to-L, medium to large [>50]. Interactive effects are identified using classification tree analysis and are for species with life spans of 2–10 and 11–50 years. Classification tree partitions are based on the lowest statistically significant p value ($\alpha = 0.05$). Categories for each split are shown immediately below the oval displaying the name of the explanatory variable.

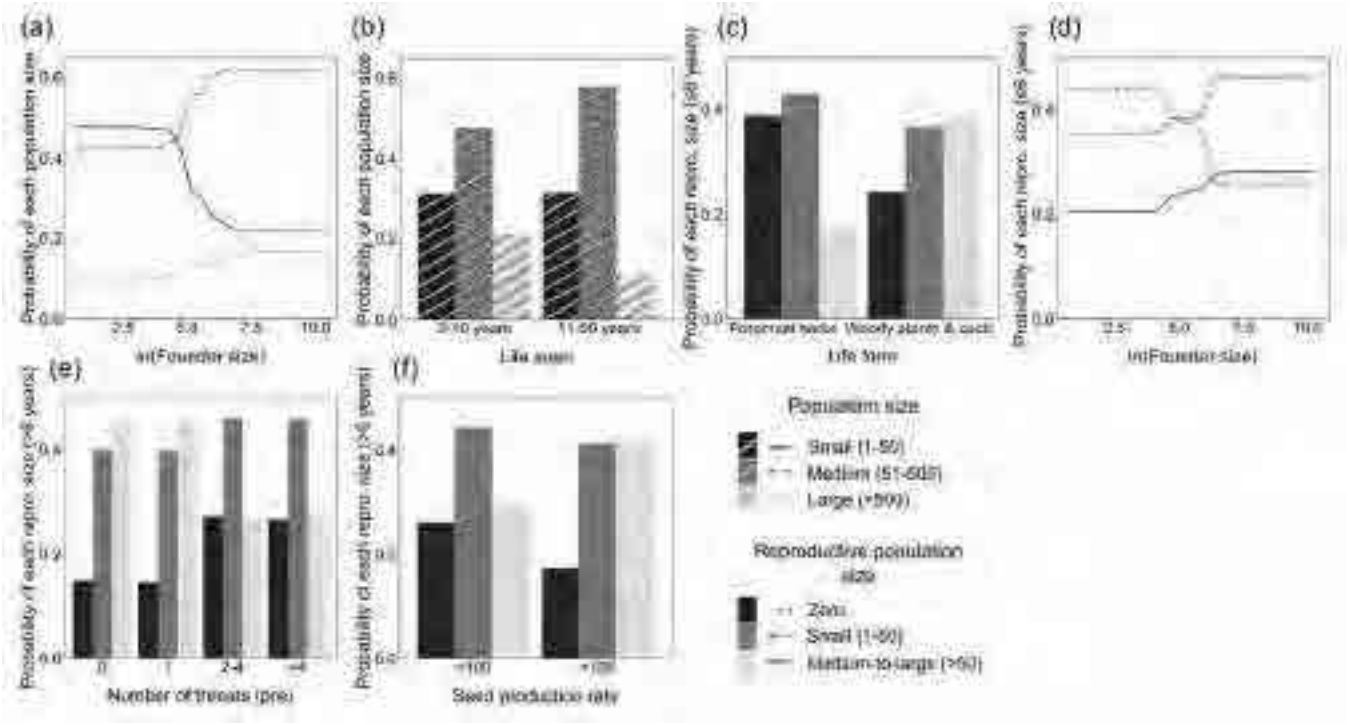


FIGURE 4 Partial dependence of the most influential variables for species with 2–10- and 11–50-year life spans in random forest models on (a, b) population size, (c, d) short-term (≤6 years) reproductive population size, and (e, f) long-term (>6 years) reproductive population size (lines or bars, predicted probability of response class according to all values of a continuous variable, or level of a categorical variable). Partial dependence indicates the dependence of the dependent variable on the focal predictor variable while controlling for the effects of all the other predictors in the random forest model.

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Maximizing the number of founder individuals can reduce the risk of loss due to demographic stochasticity (Lande, 1993). In contrast, the introduction of few individuals can limit total genetic diversity, creating a bottleneck and increasing the risk of inbreeding depression and further losses due to genetic drift (Keller et al., 2012), both factors that increase extinction risk (Frankham et al., 2017). We detected a significant interaction between founder size and habitat quality that supports this prediction: small founder sizes (≤112) markedly increased the extinction risk of translocated populations in deteriorating habitats, whereas large founder sizes (>112) resulted in populations that were more resistant to negative changes in habitat quality.

Techniques emerged as the most influential predictors of whether next-generation recruits attained reproductive maturity. Unsurprisingly, this life-cycle benchmark was more likely to be observed in projects with longer monitoring time frames because our data set consisted of perennial species with potentially delayed reproduction. These intergenerational benchmarks may take several decades for long-lived species to attain (Albrecht et al., 2019), highlighting the need for a commitment to long-term monitoring and sustained funding and stakeholder engagement. Although the use of multiple source populations was generally more effective in previous studies (Lesica & Allendorf, 1999; Maschinski et al., 2013; Van Rossum et al., 2020), we found that using a single-source population slightly improved the probability of attaining next-generation maturity. This could be because use of single- versus multiple-source populations is context-specific and depends on the species biology, genetic structure, and goals of the translocation project (Weeks et al., 2011).

Traits

The success of plant translocations is reported to vary widely across species (Dalrymple et al., 2012; Godefroid et al., 2011; Liu et al., 2015), but the role of species' traits in determining translocation outcomes remains unclear. In general, we found that species' traits were better predictors of the population size than life-cycle benchmarks and that taxonomic order was generally not a strong predictor of translocation success. The latter finding suggests that species with shared ancestry may have different translocation outcomes.

Life span and reproductive output, two independent axes of plant life-history strategies that predict demographic performance (Salguero-Gómez et al., 2016), were important predictors of translocation outcomes. Species with short life spans (2−10 years) were more likely to establish large populations compared with long-lived species (11−50 years). Similarly, species that were prolific seed producers were more likely to obtain next-generation recruitment and a large number of reproductive individuals over the long-term compared with species that produce few seeds. These findings are consistent with the prediction that species with short life spans and high reproductive rates have more rapid population growth rates than long-lived species with slow life histories and low reproductive rates (Salguero-Gómez, 2017; Salguero-Gómez et al., 2016). In our data set, most translocations were founded with seedlings or adult plants as opposed to seeds (>90%), which can further reduce extinction risk and amplify short-term population growth rates more in short- than long-lived species (Iles et al., 2016). Our results also illustrate how species' traits can interact with techniques to influence translocation outcomes. Species with high seed production were more likely to obtain next-generation recruitment compared with those with low seed production, but only when translocated with large founder sizes. By investing more in seed production, populations with high seed production increase the likelihood of seeds reaching safe sites (Westoby et al., 2002, but see Clark et al., 2007), resulting in higher seedling recruitment rates.

Woody plants and cacti achieved large reproductive population sizes in the short term (≤6 years) compared with perennial herbs. Although an interaction between founder size and life form highlighted the very large founder sizes (>550) required for herb translocations to establish any number of reproductive individuals in the short term, founder sizes in these herb translocations were much larger (median = 322) than in translocations involving woody species (median = 165). There was also little variation in the life spans or the stages of propagules outplanted between the two life forms. Instead, differences in reproductive population sizes may have been driven by life-history factors, such as higher levels of clonal growth in woody species, which may have slowed population declines. Alternatively, biogeographical factors may help explain this variation given that 83% of short-term woody translocations took place in tropical ecosystems of Hawaii, whereas the majority of herb translocations (77%) occurred in temperate habitats of the continental United States. With consistently high temperatures, less seasonality, and greater productivity, tropical environments may allow plants to reach reproductive maturity more rapidly and in greater numbers (Brown, 2014). Given the disproportionately high number of tropical woody species that are extinct or in decline globally (Humphreys et al., 2019), these results hold promise that translocations could promote their future recovery.

Caveats

Time frames that reflect the life history of species are important when evaluating translocation success (Monks et al., 2012). We used the life span of translocated taxa to determine their eligibility for inclusion in our variable importance analysis, retaining species with 2–10 and 11–50 year life spans and excluding annuals and long-lived (>50 years) species. We preserved life span as a binary predictor (2-10 years, 11–50 years) because our models revealed that shorter life spans were advantageous for establishing larger populations. We excluded annuals and long-lived (>50 years) species based on extreme imbalances in the ratios of most response classes. For example, despite average monitoring length being relatively long in our sample of translocations (nearly 8 years), just 6% ($n = 2$) of long-lived taxa produced next-generation recruits, whereas every project involving annuals ($n = 14$) attained this benchmark (compared with 62% for all other taxa, $n = 71$). When evaluating the effect of excluding life-span categories on model performance and our interpretations of variable importance, we found that models

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run with all life spans mostly had relatively poor discrimination capacity (Appendix S3) and led to the population persistence model falling below our AUC quality control threshold (≥0.7) (Hosmer et al., 2013). However, variable importance rankings for the remaining five metrics of success were broadly consistent between models run with (Appendix S4) and without (Figure 1) annuals and long-lived species, especially for the most influential predictor in each model, which changed only for short-term reproductive population size (life span exchanged with founder size). While the most important predictors of translocation success appeared to be consistent across life spans, the success of annual and long-lived species translocations may be less dependent on the predictors identified as important in our analyses. In the case of annuals, although habitat quality and founder size have also proved important for persistence (Holl & Hayes, 2006), field studies suggest that seed bank size and water availability before and after outplanting should also be considered by practitioners (Holl & Hayes, 2006; Pavlik & Espeland, 1998).

The percentage of population extinctions (9%, including annuals and long-lived species) in our data set cannot be directly compared with previous reviews on plant translocations (e.g., Dalrymple et al., 2012; Godefroid et al., 2011). Our survey method depended on responses from practitioners and did not attempt to comprehensively review translocation outcomes in the United States. An underrepresentation of negative results may indicate a reluctance by practitioners to share data on failures, perhaps because of the perceived risks to future funding or potential harm to their reputation or that of their organization. Alternatively, some unsuccessful projects may just be poorly designed and documented. Irrespective of the causes, a lack of data on failed translocations inhibits translocation science and practice by limiting the size and statistical power of future analyses and by preventing practitioners from using that information to devise their own experiments and management plans (Menges, 2008).

Synthesis and recommendations

Plant translocations are complex conservation actions that integrate horticultural, genetic, and ecological dimensions. Understanding the general drivers of translocation outcomes therefore requires the integration of data across many different variables and metrics of translocation success. Our large-scale study demonstrates that the drivers of translocation outcomes vary across different success metrics and change over time: techniques have a greater relative influence on the attainment of life-cycle benchmarks and population persistence, whereas site-level factors and species characteristics have a greater influence on population size and the number of reproductive adults. Although we concentrated on translocation projects in the United States, the diverse range of life forms, biomes, and ecosystems involved indicates the potential applicability of these findings to other regions.

Our study was made possible through the synthesis of translocations with well-designed monitoring programs conducted over long periods, which increased our ability to evaluate the response of translocated populations to changing habitat conditions and to detect barriers to success that might take years to express (e.g., inbreeding depression in perennial species). Given that most major barriers to plant translocation success involve techniques under practitioner control, site-level changes in habitat quality, or threats that could be mitigated through early intervention, we conclude that integrating a long-term monitoring plan with adaptive management through planned experimentation could increase success rates and reduce extinction risk.

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ACKNOWLEDGMENTS

Our research was supported by Botany in Action Fellowship through Phipps Conservatory; Environmental Securities Technology Certification Program (RC-201201); Florida Endangered Plant Advisory Council; Hawaii Department of Land and Natural Resources Division of Forestry and Wildlife, Napuu Conservation Project; National Fish and Wildlife Foundation; National Park Service; National Science Foundation (DEB-0613611 and DEB-1118702); North American Lily Society; Pacific Cooperative Studies Unit; U.S. Fish and Wildlife Service; and U.S. Geological Survey Ecosystems Mission Area. Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government. We thank the three anonymous reviewers and the handling editor, whose comments and suggestions contributed to the enhancement of the manuscript.

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REFERENCES

Albrecht, M., & Long, Q. (2019). Habitat suitability and herbivores determine reintroduction success of an endangered legume. *Plant Diversity*, *41*(2), 109–117.

Albrecht, M., & Maschinski, J. (2012). Influence of founder population size, propagule stages, and life history on the survival of reintroduced plant populations. In J. Maschinski & K. E. Haskins (Eds.), *Plant reintroduction in a changing climate* (pp. 171–188). Island Press.

Albrecht, M. A., Osazuwa-Peters, O. L., Maschinski, J., Bell, T. J., Bowles, M. L., Brumback, W. E., Duquesnel, J., Kunz, M., Lange, J., McCue, K., McEachern, A. K., Murray, S., Olwell, P., Pavlovic, N. B., Peterson, C. L., Possley, J., Randall, J. L., & Wright, S. J. (2019). Effects of life history and reproduction on recruitment time lags in reintroductions of rare plants. *Conservation Biology*, *33*(3), 601–611.

Armstrong, D. P., Seddon, P. J., & Moehrenschlager, A. (2019). Reintroduction. In B. D. Fath (Ed.), *Encyclopedia of ecology* (2nd ed., Vol. 1, pp. 458–466). Elsevier.

Bialic-Murphy, L., Knight, T. M., Kawelo, K., & Gaoue, O. G. (2022). The disconnect between short- and long-term population projections for plant reintroductions. *Frontiers in Conservation Science*, *2*(1), 1–10.

Biau, G., & Scornet, E. (2016). A random forest guided tour. *Tested*, *25*(2), 197–227.

Brown, J. H. (2014). Why are there so many species in the tropics? *Journal of Biogeography*, *41*(1), 8–22.

Clark, C. J., Poulsen, J. R., Levey, D. J., & Osenberg, C. W. (2007). Are plant populations seed limited? A critique and meta-analysis of seed addition experiments. *The American Naturalist*, *170*(1), 128–142.

Commander, L. E., Coates, D., Broadhurst, L., Offord, C. A., Makinson, R. O., & Matthes, M. (2018). *Guidelines for the translocation of threatened plants in Australia* (3rd ed.). Australian Network for Plant Conservation.

Dalrymple, S. E., Banks, E., Stewart, G. B., & Pullin, A. S. (2012). A meta-analysis of threatened plant reintroductions from across the globe. In J. Maschinski & K. E. Haskins (Eds.), *Plant reintroduction in a changing climate: Promises and perils* (pp. 31–52). Island Press.

Díaz, S. M., Settele, J., Brondízio, E., Ngo, H., Guèze, M., Agard, J., Arneth, A., Balvanera, P., Brauman, K., Butchart, S., & Chan, K. (2019). *The global assessment report on biodiversity and ecosystem services: Summary for policy makers*. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

Drayton, B., & Primack, R. B. (2012). Success rates for reintroductions of eight perennial plant species after 15 years. *Restoration Ecology*, *20*(3), 299–303.

Fenu, G., Bacchetta, G., Charalambos, S. C., Fournaraki, C., Giusso del Galdo, G. P., Gotsiou, P., Kyratzis, A., Piazza, C., Vicens, M., Pinna, M. S., & de Montmollin, B. (2019). An early evaluation of translocation actions for endangered plant species on Mediterranean islands. *Plant Diversity*, *41*(2), 94–104.

Fenu, G., Cogoni, D., & Bacchetta, G. (2016). The role of fencing in the success of threatened plant species translocation. *Plant Ecology*, *217*(2), 207–217.

Frankham, R., Ballou, J. D., Ralls, K., Eldridge, M., Dudash, M. R., Fenster, C. B., Lacy, R. C., & Sunnucks, P. (2017). *Genetic management of fragmented animal and plant populations*. Oxford University Press.

Godefroid, S., Piazza, C., Rossi, G., Buord, S., Stevens, A. D., Aguraiuja, R., Cowell, C., Weekley, C. W., Vogg, G., Iriondo, J. M., Johnson, I., Dixon, B., Gordon, D., Magnanon, S., Valentin, B., Bjureke, K., Koopman, R., Vicens, M., Virevaire, M., & Vanderborght, T. (2011). How successful are plant species reintroductions? *Biological Conservation*, *144*(2), 672–682.

Guerrant, E. O. (2012). Characterizing two decades of rare plant reintroductions. In J. Maschinski & K. E. Haskins (Eds.), *Plant reintroduction in a changing climate: Promises and perils* (pp. 9–29). Island Press.

Hand, D. J., & Till, R. J. (2001). A simple generalisation of the area under the roc curve for multiple class classification problems. *Machine Learning*, *45*(2), 171–186. https://doi.org/10.1023/A:1010920819831

Hanley, J. A., & McNeil, B. J. (1982). The meaning and use of the area under a receiver operating characteristic (ROC) curve. *Radiology*, *143*(1), 29–36.

Holl, K. D., & Hayes, G. F. (2006). Challenges to introducing and managing disturbance regimes for *Holocarpha macradenia*, an endangered annual grassland forb. *Conservation Biology*, *20*(4), 1121–1131.

Holmes, N. D., Griffiths, R., Pott, M., Alifano, A., Will, D., Wegmann, A. S., & Russell, J. C. (2015). Factors associated with rodent eradication failure. *Biological Conservation*, *185*(6), 8–16.

Hosmer, Jr, D. W., Lemeshow, S., & Sturdivant, R. X. (2013). *Applied logistic regression* (3rd ed.). John Wiley & Sons.

Hothorn, T., Hornik, K., Strobl, C., & Zeileis, A. (2022). *party: A laboratory for recursive partytioning*. R package version 1.3-10. http://party.R-forge.R-project.org

Hothorn, T., Hornik, K., & Zeileis, A. (2006). Unbiased recursive partitioning: A conditional inference framework. *Journal of Computational and Graphical Statistics*, *15*(3), 651–674.

Hothorn, T., & Zeileis, A. (2015). partykit: A modular toolkit for recursive partytioning in R. *The Journal of Machine Learning Research*, *16*(1), 3905–3909.

Humphreys, A. M., Govaerts, R., Ficinski, S. Z., Nic Lughadha, E., & Vorontsova, M. S. (2019). Global dataset shows geography and life form predict modern plant extinction and rediscovery. *Nature Ecology and Evolution*, *3*(7), 1043–1047.

Iles, D. T., Salguero-Gómez, R., Adler, P. B., & Koons, D. N. (2016). Linking transient dynamics and life history to biological invasion success. *Journal of Ecology*, *104*(2), 399–408.

IUCN/SSC. (2013). *Guidelines for reintroductions and other conservation translocations*. Version 1.0. IUCN Species Survival Commission.

Jamieson, I. G., & Allendorf, F. W. (2012). How does the 50/500 rule apply to MVPs? *Trends in Ecology and Evolution*, *27*(10), 578–584.

Jones, Z., & Linder, F. (2016). edarf: Exploratory data analysis using random forests. *The Journal of Open Source Software*, *1*(6), 92.

Kaye, T. N. (2009). Toward successful reintroductions: The combined importance of species traits, site quality, and restoration technique. In *Proceedings*

15231739, 2024, 2, Downloaded from https://conbio.onlinelibrary.wiley.com/doi/10.1111/cobi.14190, Wiley Online Library on [17/03/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

of the CNPS Conservation Conference (pp. 99–106). California Native Plant Society.

Keller, L. F., Biebach, I., Ewing, S. R. &, & Hoeck, P. E. A. (2012). The genetics of reintroductions: Inbreeding and genetic drift. In J. G. Ewen, D. P. Armstrong, K. A. Parker, & P. J. Seddon (Eds.), *Reintroduction biology: Integrating science and management* (pp. 362–396). John Wiley & Sons.

Lande, R. (1993). Risks of population extinction from demographic and environmental stochasticity and random catastrophes. *The American Naturalist*, *142*(6), 911–927.

Lesica, P., & Allendorf, F. W. (1999). Ecological genetics and the restoration of plant communities: Mix or match? *Restoration Ecology*, *7*(1), 42–50.

Liu, H., Ren, H., Liu, Q., Wen, X., Maunder, M., & Gao, J. (2015). Translocation of threatened plants as a conservation measure in China. *Conservation Biology*, *29*(6), 1537–1551.

Maschinski, J., & Albrecht, M. (2017). Center for plant conservation's best practice guidelines for the reintroduction of rare plants. *Plant Diversity*, *39*(6), 390–395.

Maschinski, J., & Haskins, K. E. (2012). *Plant reintroduction in a changing climate: Promises and perils*. Island Press.

Maschinski, J., Wright, S. J., Koptur, S., & Pinto-Torres, E. C. (2013). When is local the best paradigm? Breeding history influences conservation reintroduction survival and population trajectories in times of extreme climate events. *Biological Conservation*, *159*, 277–284.

Maunder, M. (1992). Plant reintroduction: An overview. *Biodiversity & Conservation*, *1*, 51–61.

Menges, E. S. (2008). Restoration demography and genetics of plants: When is a translocation successful? *Australian Journal of Botany*, *56*(3), 187–196.

Menges, E. S., & Quintana-Ascencio, P. F. (2004). Population viability with fire in *Eryngium cuneifolium*: Deciphering a decade of demographic data. *Ecological Monographs*, *74*(1), 79–99.

Menges, E. S., Smith, S. A., & Weekley, C. W. (2016). Adaptive introductions: How multiple experiments and comparisons to wild populations provide insights into requirements for long-term introduction success of an endangered shrub. *Plant Diversity*, *38*(5), 238–246.

Monks, L., Coates, D., Bell, T., & Bowles, M. L. (2012). Determining success criteria for reintroductions of threatened long-lived plants. In J. Maschinski & K. E. Haskins (Eds.), *Plant reintroduction in a changing climate: Promises and perils* (pp. 189–208). Island Press.

Monks, L., Yen, J., Dillon, R., Standish, R., Coates, D., Byrne, M., & Vesk, P. (2023). Herbivore exclusion and water availability improve success across 76 translocations of 50 threatened plant species in a biodiversity hotspot with a Mediterranean climate. *Plant Ecology*, *224*, 1–14.

Novak, B. J., Phelan, R., & Weber, M. (2021). U.S. conservation translocations: Over a century of intended consequences. *Conservation Science and Practice*, *3*(4), 1–19.

Osborne, P. E., & Seddon, P. J. (2012). Selecting suitable habitats for reintroductions: Variation, change and the role of species distribution modelling. In J. G. Ewen, D. P. Armstrong, K. A. Parker, & P. J. Seddon (Eds.), *Reintroduction biology: Integrating science and management* (pp. 73–105). John Wiley & Sons.

Pavlik, B. M., & Espeland, E. K. (1998). Demography of natural and reintroduced populations of *Acanthomintha duttonii* an endangered serpentinite annual in northern California. *Madroño*, *45*(1), 31–39.

R Core Team. (2022). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.R-project.org/

Reiter, N., Whitfield, J., Pollard, G., Bedggood, W., Argall, M., Dixon, K., Davis, B., & Swarts, N. (2016). Orchid re-introductions: An evaluation of success and ecological considerations using key comparative studies from Australia. *Plant Ecology*, *217*(1), 81–95.

Rusconi, O., Broennimann, O., Storrer, Y., Le Bayon, R. C., Guisan, A., & Rasmann, S. (2022). Detecting preservation and reintroduction sites for endangered plant species using a two-step modeling and field approach. *Conservation Science and Practice*, *4*, 1–14.

Salguero-Gómez, R. (2017). Applications of the fast–slow continuum and reproductive strategy framework of plant life histories. *New Phytologist*, *213*(4), 1618–1624.

Salguero-Gómez, R., Jones, O. R., Jongejans, E., Blomberg, S. P., Hodgson, D. J., Mbeau-Ache, C., Zuidema, P. A., De Kroon, H., & Buckley, Y. M. (2016). Fast-slow continuum and reproductive strategies structure plant life-history variation worldwide. *Proceedings of the National Academy of Sciences of the United States of America*, *113*(1), 230–235.

Silcock, J. L., Simmons, C. L., Monks, L., Dillon, R., Reiter, N., Jusaitis, M., Vesk, P. A., Byrne, M., & Coates, D. J. (2019). Threatened plant translocation in Australia: A review. *Biological Conservation*, *236*(4), 211–222.

Stadtmann, S., & Seddon, P. J. (2018). Release site selection: Reintroductions and the habitat concept. *Oryx*, *54*(5), 687–695.

Strobl, C., Boulesteix, A. L., Kneib, T., Augustin, T., & Zeileis, A. (2008). Conditional variable importance for random forests. *BMC Bioinformatics [Electronic Resource]*, *9*(1), 1–11.

Strobl, C., Boulesteix, A. L., Zeileis, A., & Hothorn, T. (2007). Bias in random forest variable importance measures: Illustrations, sources and a solution. *BMC Bioinformatics [Electronic Resource]*, *8*(25), 1–21.

Strobl, C., Malley, J., & Tutz, G. (2009). An introduction to recursive partitioning. *Psychological Methods*, *14*(4), 323–348.

Swan, K. D., Lloyd, N. A., & Moehrenschlager, A. (2018). Projecting further increases in conservation translocations: A Canadian case study. *Biological Conservation*, *228*(3), 175–182.

Turner, J. B., & McGraw, J. B. (2015). Can putative indicator species predict habitat quality for American ginseng? *Ecological Indicators*, *57*, 110–117.

Van Rossum, F., Hardy, O. J., Le Pajolec, S., & Raspé, O. (2020). Genetic monitoring of translocated plant populations in practice. *Molecular Ecology*, *29*(21), 4040–4058.

Weeks, A. R., Sgro, C. M., Young, A. G., Frankham, R., Mitchell, N. J., Miller, K. A., Byrne, M., Coates, D. J., Eldridge, M. D., Sunnucks, P., & Breed, M. F. (2011). Assessing the benefits and risks of translocations in changing environments: A genetic perspective. *Evolutionary Applications*, *4*(6), 709–725.

Westoby, M., Falster, D. S., Moles, A. T., Vesk, P. A., & Wright, I. J. (2002). Plant ecological strategies: Some leading dimensions of variation between species. *Annual Review of Ecology and Systematics*, *33*, 125–159.

Whitehead, M. R., Silcock, J. L., Simmons, C. L., Monks, L., Dillon, R., Reiter, N., Jusaitis, M., Coates, D. J., Byrne, M., & Vesk, P. A. (2023). Effects of common management practices on threatened plant translocations. *Biological Conservation*, *281*, 110023.

Wilcove, D. S., Rothstein, D., Dubow, J., Phillips, A., & Losos, E. (1998). Quantifying threats to imperiled species in the United States. *Bioscience*, *48*(8), 607–615.

Young, T. P., Petersen, D. A., & Clary, J. J. (2005). The ecology of restoration: Historical links, emerging issues and unexplored realms. *Ecology Letters*, *8*(6), 662–673.

Zheng, A., & Casari, A. (2018). *Feature engineering for machine learning: Principles and techniques for data scientists*. O'Reilly Media.

Zimmer, H. C., Auld, T. D., Cuneo, P., Offord, C. A., & Commander, L. E. (2019). Conservation translocation—An increasingly viable option for managing threatened plant species. *Australian Journal of Botany*, *67*(7), 501–509.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Bellis, J., Osazuwa-Peters, O., Maschinski, J., Keir, M. J., Parsons, E. W., Kaye, T. N., Kunz, M., Possley, J., Menges, E., Smith, S. A., Roth, D., Brewer, D., Brumback, W., Lange, J. J., Niederer, C., Turner-Skoff, J. B., Bontrager, M., Braham, R., Coppoletta, M., … Albrecht, M. A. (2024). Identifying predictors of translocation success in rare plant species. *Conservation Biology*, *38*, e14190. https://doi.org/10.1111/cobi.14190

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Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Sensitive Natural Communities

STATE OF CALIFORNIA
CALIFORNIA NATURAL RESOURCES AGENCY
DEPARTMENT OF FISH AND WILDLIFE

DATE: March 20, 2018*

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1. INTRODUCTION AND PURPOSE

The conservation of special status native plants and their habitats, as well as sensitive natural communities, is integral to maintaining biological diversity. The purpose of these protocols is to facilitate a consistent and systematic approach to botanical field surveys and assessments of special status plants and sensitive natural communities so that reliable information is produced and the potential for locating special status plants and sensitive natural communities is maximized. These protocols may also help those who prepare and review environmental documents determine when botanical field surveys are needed, how botanical field surveys may be conducted, what information to include in a botanical survey report, and what qualifications to consider for botanical field surveyors. These protocols are meant to help people meet California Environmental Quality Act (CEQA)[1] requirements for adequate disclosure of potential impacts to plants and sensitive natural communities. These protocols may be used in conjunction with protocols formulated by other agencies, for example, those developed by the U.S. Army Corps of Engineers to delineate jurisdictional wetlands[2] or by the U.S. Fish and Wildlife Service to survey for the presence of special status plants.[3]

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* Minor editorial revisions were made to this document on February 3, 2021

1 Available at: https://files.resources.ca.gov/ceqa/

2 Available at: https://www.usace.army.mil/Missions/Civil-Works/Regulatory-Program-and-Permits/techbio/

3 U.S. Fish and Wildlife Service Survey Guidelines: https://www.fws.gov/sacramento/es/Survey-Protocols-Guidelines/

Department of Fish and Wildlife Trustee and Responsible Agency Mission

The mission of the California Department of Fish and Wildlife (CDFW) is to manage California's diverse wildlife and native plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public. CDFW has jurisdiction over the conservation, protection, and management of wildlife, native plants, and habitat necessary to maintain biologically sustainable populations (Fish & G. Code, § 1802). CDFW, as trustee agency under CEQA Guidelines section 15386, provides expertise in reviewing and commenting on environmental documents and provides protocols regarding potential negative impacts to those resources held in trust for the people of California.

Certain species are in danger of extinction because their habitats have been severely reduced in acreage, are threatened with destruction or adverse modification, or because of a combination of these and other factors. The California Endangered Species Act (CESA) and Native Plant Protection Act (NPPA) provide additional protections for such species, including take prohibitions (Fish & G. Code, § 2050 *et seq.*; Fish & G. Code, § 1908). As a responsible agency, CDFW has the authority to issue permits for the take of species listed under CESA and NPPA if the take is incidental to an otherwise lawful activity; CDFW has determined that the impacts of the take have been minimized and fully mitigated; and the take would not jeopardize the continued existence of the species (Fish & G. Code, § 2081, subd. (b); Cal. Code Regs., tit. 14 § 786.9, subd. (b)). Botanical field surveys are one of the preliminary steps to detect special status plant species and sensitive natural communities that may be impacted by a project.

Definitions

Botanical field surveys provide information used to determine the potential environmental effects of proposed projects on special status plants and sensitive natural communities as required by law (e.g., CEQA, CESA, and federal Endangered Species Act (ESA)).

Special status plants, for the purposes of this document, include all plants that meet one or more of the following criteria:

- Listed or proposed for listing as threatened or endangered under the ESA or candidates for possible future listing as threatened or endangered under the ESA (50 C.F.R., § 17.12).
- Listed or candidates for listing by the State of California as threatened or endangered under CESA (Fish & G. Code, § 2050 et seq.).[4] In CESA, "endangered species" means a native species or subspecies of plant which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease (Fish & G. Code, § 2062). "Threatened species" means a native species or subspecies of plant that,

[4] Refer to current online published lists available at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=109390&inline

although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by CESA (Fish & G. Code, § 2067). "Candidate species" means a native species or subspecies of plant that the California Fish and Game Commission has formally noticed as being under review by CDFW for addition to either the list of endangered species or the list of threatened species, or a species for which the California Fish and Game Commission has published a notice of proposed regulation to add the species to either list (Fish & G. Code, § 2068).

- Listed as rare under the California Native Plant Protection Act (Fish & G. Code, § 1900 et seq.). A plant is rare when, although not presently threatened with extinction, the species, subspecies, or variety is found in such small numbers throughout its range that it may be endangered if its environment worsens (Fish & G. Code, § 1901).
- Meet the definition of endangered, rare, or threatened species under CEQA Guidelines section 15380, subdivisions (b) and (d), which may include:
    - Plants tracked by the California Natural Diversity Database (CNDDB) as California Rare Plant Rank (CRPR) 1 or 2;[5] and
    - Plants that may warrant consideration on the basis of declining trends, recent taxonomic information, or other factors. This includes plants tracked by the CNDDB as CRPR 3 or 4.[6]
- Considered locally significant plants, that is, plants that are not rare from a statewide perspective but are rare or uncommon in a local context such as within a county or region (CEQA Guidelines, § 15125, subd. (c)), or as designated in local or regional plans, policies, or ordinances (CEQA Guidelines, Appendix G). Examples include plants that are at the outer limits of their known geographic range or plants occurring on an atypical soil type.

Sensitive natural communities are communities that are of limited distribution statewide or within a county or region and are often vulnerable to environmental effects of projects. These communities may or may not contain special status plants or their habitat. CDFW's *List of California Terrestrial Natural Communities*[7] is based on the best available information, and indicates which natural communities are considered sensitive at the current stage of the California vegetation classification effort. See the Vegetation

[5] See CNDDB's Special Vascular Plants, Bryophytes, and Lichens List for plant taxa with a CRPR of 1 or 2: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=109383&inline

[6] CRPR 3 plants (plants about which more information is needed) and CRPR 4 plants (plants of limited distribution) may warrant consideration under CEQA Guidelines section 15380. Impacts to CRPR 3 plants may warrant consideration under CEQA if sufficient information is available to assess potential impacts to such plants. Impacts to CRPR 4 plants may warrant consideration under CEQA if cumulative impacts to such plants are significant enough to affect their overall rarity. Data on CRPR 3 and 4 plants should be submitted to CNDDB. Such data aids in determining and revising the CRPR of plants. See CNDDB's Special Vascular Plants, Bryophytes, and Lichens List for plant taxa with a CRPR of 3 or 4: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=109383&inline

[7] Available at: https://wildlife.ca.gov/Data/VegCAMP/Natural-Communities#natural communities lists

Classification and Mapping Program (VegCAMP) website for additional information on natural communities and vegetation classification.[8]

2. BOTANICAL FIELD SURVEYS

Evaluate the need for botanical field surveys prior to the commencement of any activities that may modify vegetation, such as clearing, mowing, or ground-breaking activities. It is appropriate to conduct a botanical field survey when:

- Natural (or naturalized) vegetation occurs in an area that may be directly or indirectly affected by a project (project area), and it is unknown whether or not special status plants or sensitive natural communities occur in the project area;
- Special status plants or sensitive natural communities have historically been identified in a project area; or
- Special status plants or sensitive natural communities occur in areas with similar physical and biological properties as a project area.

Survey Objectives

Conduct botanical field surveys in a manner which maximizes the likelihood of locating special status plants and sensitive natural communities that may be present. Botanical field surveys should be floristic in nature, meaning that every plant taxon that occurs in the project area is identified to the taxonomic level necessary to determine rarity and listing status. “Focused surveys” that are limited to habitats known to support special status plants or that are restricted to lists of likely potential special status plants are not considered floristic in nature and are not adequate to identify all plants in a project area to the level necessary to determine if they are special status plants.

For each botanical field survey conducted, include a list of all plants and natural communities detected in the project area. More than one field visit is usually necessary to adequately capture the floristic diversity of a project area. An indication of the prevalence (estimated total numbers, percent cover, density, etc.) of the special status plants and sensitive natural communities in the project area is also useful to assess the significance of a particular plant population or natural community.

Survey Preparation

Before botanical field surveys are conducted, the botanical field surveyors should compile relevant botanical information in the general project area to provide a regional context. Consult the CNDDB[9] and BIOS[10] for known occurrences of special status plants and sensitive natural communities in the project area prior to botanical field surveys. Generally, identify vegetation and habitat types potentially occurring in the project area based on biological and physical properties (e.g., soils) of the project area

[8] Available at: https://www.wildlife.ca.gov/Data/VegCAMP
[9] Available at: https://www.wildlife.ca.gov/Data/CNDDB
[10] Available at: https://www.wildlife.ca.gov/Data/BIOS

and surrounding ecoregion.[11] Then, develop a list of special status plants and sensitive natural communities with the potential to occur within the vegetation and habitat types identified. The list of special status plants with the potential to occur in the project area can be created with the help of the CNDDB QuickView Tool[12] which allows the user to generate lists of CNDDB-tracked elements that occur within a particular U.S. Geological Survey 7.5' topographic quad, surrounding quads, and counties within California. Resulting lists should only be used as a tool to facilitate the use of reference sites, with the understanding that special status plants and sensitive natural communities in a project area may not be limited to those on the list. Botanical field surveys and subsequent reporting should be comprehensive and floristic in nature and not restricted to or focused only on a list. Include in the botanical survey report the list of potential special status plants and sensitive natural communities that was created, and the list of references used to compile the background botanical information for the project area.

Survey Extent

Botanical field surveys should be comprehensive over the entire project area, including areas that will be directly or indirectly impacted by the project. Adjoining properties should also be surveyed where direct or indirect project effects could occur, such as those from fuel modification, herbicide application, invasive species, and altered hydrology. Surveys restricted to known locations of special status plants may not identify all special status plants and sensitive natural communities present, and therefore do not provide a sufficient level of information to determine potential impacts.

Field Survey Method

Conduct botanical field surveys using systematic field techniques in all habitats of the project area to ensure thorough coverage. The level of effort required per given area and habitat is dependent upon the vegetation and its overall diversity and structural complexity, which determines the distance at which plants can be identified. Conduct botanical field surveys by traversing the entire project area to ensure thorough coverage, documenting all plant taxa observed. Parallel survey transects may be necessary to ensure thorough survey coverage in some habitats. The level of effort should be sufficient to provide comprehensive reporting. Additional time should be allocated for plant identification in the field.

Timing and Number of Visits

Conduct botanical field surveys in the field at the times of year when plants will be both evident and identifiable. Usually this is during flowering or fruiting. Space botanical field survey visits throughout the growing season to accurately determine what plants exist in the project area. This usually involves multiple visits to the project area (e.g., in early, mid, and late-season) to capture the floristic diversity at a level necessary to determine

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11 Ecological Subregions of the United States, available at: http://www.fs.fed.us/land/pubs/ecoregions/toc.html

12 Available at: https://www.wildlife.ca.gov/Data/CNDDB/Maps-and-Data. When creating a list of special status plants with the potential to occur in a project area, special care should be taken to search all quads with similar geology, habitats, and vegetation to those found in the project area.

if special status plants are present.[13] The timing and number of visits necessary to determine if special status plants are present is determined by geographic location, the natural communities present, and the weather patterns of the year(s) in which botanical field surveys are conducted.

Reference Sites

When special status plants are known to occur in the type(s) of habitat present in a project area, observe reference sites (nearby accessible occurrences of the plants) to determine whether those special status plants are identifiable at the times of year the botanical field surveys take place and to obtain a visual image of the special status plants, associated habitat, and associated natural communities.

Use of Existing Surveys

For some project areas, floristic inventories or botanical survey reports may already exist. Additional botanical field surveys may be necessary for one or more of the following reasons:

- Botanical field surveys are not current;[14]
- Botanical field surveys were conducted in natural systems that commonly experience year to year fluctuations such as periods of drought or flooding (e.g., vernal pool habitats or riverine systems);
- Botanical field surveys did not cover the entire project area;
- Botanical field surveys did not occur at the appropriate times of year;
- Botanical field surveys were not conducted for a sufficient number of years to detect plants that are not evident and identifiable every year (e.g., geophytes, annuals, and some short-lived plants);
- Botanical field surveys did not identify all plants in the project area to the taxonomic level necessary to determine rarity and listing status;
- Fire history, land use, or the physical or climatic conditions of the project area have changed since the last botanical field survey was conducted;
- Changes in vegetation or plant distribution have occurred since the last botanical field surveys were conducted, such as those related to habitat alteration, fluctuations in abundance, invasive species, seed bank dynamics, or other factors; or

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13 U.S. Fish and Wildlife Service Guidelines for Conducting and Reporting Botanical Inventories for Federally Listed, Proposed and Candidate Plants available at: https://www.fws.gov/sacramento/es/Survey-Protocols-Guidelines/

14 Habitats, such as grasslands or desert plant communities that have annual and short-lived perennial plants as major floristic components, may require multiple annual surveys to fully capture baseline conditions. In habitats dominated by long-lived perennial plants, such as forests, surveys that were not conducted within the previous five years may not adequately represent the current baseline conditions and should be re-conducted.

- Recent taxonomic studies, status reviews or other scientific information has resulted in a revised understanding of the special status plants with potential to occur in the project area.

Negative Surveys

Adverse conditions from yearly weather patterns may prevent botanical field surveyors from determining the presence of, or accurately identifying, some special status plants in the project area. Disease, drought, predation, fire, herbivory, or other disturbance may also preclude the presence or identification of special status plants in any given year. Discuss all adverse conditions in the botanical survey report.[15]

The failure to locate a known special status plant occurrence during one field season does not constitute evidence that the plant occurrence no longer exists at a location, particularly if adverse conditions are present. For example, botanical field surveys over a number of years may be necessary if the special status plant is an annual or short-lived plant having a persistent, long-lived seed bank and populations of the plant are known to not germinate every year. Visiting the project area in more than one year increases the likelihood of detecting special status plants, particularly if conditions change. To further substantiate negative findings for a known occurrence, a visit to a nearby reference site may help ensure that the timing of botanical field surveys was appropriate.

3. REPORTING AND DATA COLLECTION

Adequate information about special status plants and sensitive natural communities present in a project area will enable reviewing agencies and the public to effectively assess potential impacts to special status plants and sensitive natural communities and will guide the development of avoidance, minimization, and mitigation measures. The information necessary to assess impacts to special status plants and sensitive natural communities is described below. For comprehensive, systematic botanical field surveys where no special status plants or sensitive natural communities were found, reporting and data collection responsibilities for botanical field surveyor remain as described below, excluding specific occurrence information.

Special Status Plant and Sensitive Natural Community Observations

Record the following information for locations of each special status plant and sensitive natural community detected during a botanical field survey of a project area.

- The specific geographic locations where the special status plants and sensitive natural communities were found. Preferably this will be done by use of global positioning system (GPS) and include the datum[16] in which the spatial data was

[15] U.S. Fish and Wildlife Service Guidelines for Conducting and Reporting Botanical Inventories for Federally Listed, Proposed and Candidate Plants available at: https://www.fws.gov/sacramento/es/Survey-Protocols-Guidelines/

[16] NAD83, NAD27 or WGS84

collected and any uncertainty or error associated with the data. If GPS is not available, a detailed map (1:24,000 or larger) showing locations and boundaries of each special status plant population and sensitive natural community in relation to the project area is acceptable. Mark occurrences and boundaries as accurately as possible;

- The site-specific characteristics of occurrences, such as associated species, habitat and microhabitat, structure of vegetation, topographic features, soil type, texture, and soil parent material. If a special status plant is associated with a wetland, provide a description of the direction of flow and integrity of surface or subsurface hydrology and adjacent off-site hydrological influences as appropriate;
- The number of individuals in each special status plant population as counted (if population is small) or estimated (if population is large);
- If applicable, information about the percentage of each special status plant in each life stage such as seedling, vegetative, flowering, and fruiting;
- The density of special status plants, identifying areas of relatively high, medium and low density of each special status plant in the project area; and
- Digital images of special status plants and sensitive natural communities in the project area, with diagnostic features.

Special Status Plant and Sensitive Natural Community Documentation

When a special status plant is located, data must be submitted to the CNDDB. Data may be submitted in a variety of formats depending on the amount and type of data that is collected.[17] The most common way to submit data is the Online CNDDB Field Survey Form,[18] or equivalent written report, accompanied by geographic locality information (GPS coordinates, GIS shapefiles, KML files, topographic map, etc.). Data submitted in digital form must include the datum[19] in which it was collected.

If a sensitive natural community is found in a project area, document it with a Combined Vegetation Rapid Assessment and Relevé Field Form[20] and submit the form to VegCAMP.[21]

Voucher Collection

Voucher specimens provide verifiable documentation of special status plant presence and identification and a scientific record. This information is vital to conservation efforts and valuable for scientific research. Collection of voucher specimens should be

---

17 See https://www.wildlife.ca.gov/Data/CNDDB/Submitting-Data for information on acceptable data submission formats.

18 Available at: https://www.wildlife.ca.gov/Data/CNDDB/Submitting-Data

19 NAD83, NAD27 or WGS84

20 Available at: https://www.wildlife.ca.gov/Data/VegCAMP/Natural-Communities/Submit

21 Combined Vegetation Rapid Assessment and Releve Field Forms can be emailed to VegCAMP staff. Contact information available at: https://www.wildlife.ca.gov/Data/VegCAMP

conducted in a manner that is consistent with conservation ethics, and in accordance with applicable state and federal permit requirements (e.g., scientific, educational, or management permits pursuant to Fish & G. Code, § 2081, subd. (a)). Voucher collections of special status plants (or possible special status plants) should only be made when such actions would not jeopardize the continued existence of the population. A plant voucher collecting permit[22] is required from CDFW prior to the take or possession of a state-listed plant for voucher collection purposes, and the permittee must comply with all permit conditions.

Voucher specimens should be deposited in herbaria that are members of the Consortium of California Herbaria[23] no later than 120 days after the collections have been made. Digital imagery can be used to supplement plant identification and document habitat. Record all relevant collector names and permit numbers on specimen labels (if applicable).

Botanical Survey Reports

Botanical survey reports provide an important record of botanical field survey results and project area conditions. Botanical survey reports containing the following information should be prepared whenever botanical field surveys take place, and should also be submitted with project environmental documents:

Project and location description

- A description of the proposed project;
- A detailed map of the project area that identifies topographic and landscape features and includes a north arrow and bar scale;
- A vegetation map of the project area using Survey of California Vegetation Classification and Mapping Standards[24] at a thematic and spatial scale that allows the display of all sensitive natural communities;
- A soil map of the project area; and
- A written description of the biological setting, including all natural communities; geological and hydrological characteristics; and land use or management history.

Detailed description of survey methodology and results

- Names and qualifications of botanical field surveyor(s);
- Dates of botanical field surveys (indicating the botanical field surveyor(s) that surveyed each area on each survey date), and total person-hours spent;
- A discussion of the survey preparation methodology;
- A list of special status plants and sensitive natural communities with potential to

[22] Applications available at: https://www.wildlife.ca.gov/Conservation/Plants/Permits

[23] A list of Consortium of California Herbaria participants is available at: http://ucjeps.berkeley.edu/consortium/participants.html

[24] Available at: https://www.wildlife.ca.gov/data/vegcamp/publications-and-protocols

occur in the region;

- Description(s) of reference site(s), if visited, and the phenological development of special status plant(s) at those reference sites;
- A description and map of the area surveyed relative to the project area;
- A list of all plant taxa occurring in the project area, with all taxa identified to the taxonomic level necessary to determine whether or not they are a special status plant;
- Detailed data and maps for all special status plants and sensitive natural communities detected. Information specified above under the headings "Special Status Plant and Sensitive Natural Community Observations," and "Special Status Plant and Sensitive Natural Community Documentation," should be provided for the locations of each special status plant and sensitive natural community detected. Copies of all California Native Species Field Survey Forms and Combined Vegetation Rapid Assessment and Relevé Field Forms should be sent to the CNDDB and VegCAMP, respectively, and included in the project environmental document as an Appendix;[25]
- A discussion of the potential for a false negative botanical field survey;
- A discussion of how climatic conditions may have affected the botanical field survey results;
- A discussion of how the timing of botanical field surveys may affect the comprehensiveness of botanical field surveys;
- Any use of existing botanical field surveys and a discussion of their applicability to the project;
- The deposition locations of voucher specimens, if collected; and
- A list of references used, including persons contacted and herbaria visited.

Assessment of potential project impacts

- A discussion of the significance of special status plant populations in the project area considering nearby populations and total range and distribution;
- A discussion of the significance of sensitive natural communities in the project area considering nearby occurrences and natural community distribution;
- A discussion of project related direct, indirect, and cumulative impacts to special status plants and sensitive natural communities;
- A discussion of the degree and immediacy of all threats to special status plants and sensitive natural communities, including those from invasive species;
- A discussion of the degree of impact, if any, of the project on unoccupied,

[25] It is not necessary to submit entire environmental documents to the CNDDB.

potential habitat for special status plants; and

- Recommended measures to avoid, minimize, or mitigate impacts to special status plants and sensitive natural communities.

4. BOTANICAL FIELD SURVEYOR QUALIFICATIONS

Botanical field surveyors should possess the following qualifications:

- Knowledge of plant taxonomy and natural community ecology;
- Familiarity with plants of the region, including special status plants;
- Familiarity with natural communities of the region, including sensitive natural communities;
- Experience with the CNDDB, BIOS, and Survey of California Vegetation Classification and Mapping Standards;
- Experience conducting floristic botanical field surveys as described in this document, or experience conducting such botanical field surveys under the direction of an experienced botanical field surveyor;
- Familiarity with federal, state, and local statutes and regulations related to plants and plant collecting; and
- Experience analyzing the impacts of projects on native plant species and sensitive natural communities.

5. SUGGESTED REFERENCES

Bonham, C.D. 1988. Measurements for terrestrial vegetation. John Wiley and Sons, Inc., New York, NY.

California Native Plant Society, Rare Plant Program. Most recent version. Inventory of rare and endangered plants (online edition). California Native Plant Society. Sacramento, CA. Available at: http://www.rareplants.cnps.org/.

California Native Plant Society. Most recent version. A manual of California vegetation. California Native Plant Society. Sacramento, CA. Available at: http://www.cnps.org/cnps/vegetation/manual.php.

California Department of Fish and Wildlife, California Natural Diversity Database. Most recent version. Special vascular plants, bryophytes and lichens list. Updated quarterly. Available at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=109383&inline.

Elzinga, C.L., D.W. Salzer, and J. Willoughby. 1998. Measuring and monitoring plant populations. BLM Technical Reference 1730-1. U.S. Dept. of the Interior, Bureau of Land Management. Denver, Colorado. Available at: https://www.ntc.blm.gov/krc/uploads/265/technical%20reference.pdf.

Jepson Flora Project (eds.) Most recent version. Jepson eFlora. Available at: http://ucjeps.berkeley.edu/eflora/.

Leppig, G. and J.W. White. 2006. Conservation of peripheral plant populations in California. Madroño. 53:264-274.

Mueller-Dombois, D. and H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley and Sons, Inc. New York, NY.

U.S. Fish and Wildlife Service. 1996. Guidelines for conducting and reporting botanical inventories for federally listed plants on the Santa Rosa Plain. Sacramento, CA.

U.S. Fish and Wildlife Service. 1996. Guidelines for conducting and reporting botanical inventories for federally listed, proposed and candidate plants. Sacramento, CA.

Van der Maarel, E. 2005. Vegetation Ecology. Blackwell Science Ltd. Malden, MA.

This document is available online at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=18959&inline

FINAL REPORT

MITIGATION-RELATED TRANSPLANTATION, RELOCATION AND REINTRODUCTION PROJECTS INVOLVING ENDANGERED AND THREATENED, AND RARE PLANT SPECIES IN CALIFORNIA

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June 14, 1991

Funded by:
California Endangered Species Tax Check-Off Fund
Contract No. FG-8611

FINAL REPORT: MITIGATION-RELATED TRANSPLANTATION, RELOCATION, AND REINTRODUCTION PROJECTS INVOLVING ENDANGERED, THREATENED, AND RARE PLANT SPECIES IN CALIFORNIA

I. EXECUTIVE SUMMARY

To investigate the efficacy and overall success of transplantation, relocation, and reintroduction of California State-listed endangered, threatened, and rare species, a questionnaire was mailed to 377 individuals, state and federal agencies, and public and private institutions that potentially have been involved in transplantation, relocation, and reintroduction projects. One hundred sixty-eight questionnaires (168) were returned. Of these, twenty-four (24) individuals and/or agencies indicate that they have been directly involved in mitigation-related projects for California plants; one hundred fourteen (114) individuals and/or agencies have not. At minimum, this represents a 45% return rate for the questionnaire.

Files of California Department of Fish and Game's Endangered Plant Program were also reviewed to complete the survey. An additional 13 projects involving eight (8) State-listed species were identified as of these types. Information obtained from the Endangered Plant Program files supplemented 13 responses to the questionnaire.

This report summarizes the results of the questionnaire for each species identified by the respondents and information obtained from the Endangered Plant Program's files. A total of forty-six (46) projects were reviewed, involving fifty-three (53) transplantation, relocation and reintroduction attempts with forty (40) special status species. Of the plant species examined in this review, 25 (63%) are listed by the State as endangered, 3 (8%) are listed as threatened, 6 (15%) are listed as rare, and 6 (15%) are not listed by the State, but have some other form of protection or special status.

In addition, the 40 plant species reviewed belong to 21 plant families. Asteraceae represented the highest number of species involved (9; 23%), followed by the Brassicaceae (4; 10%). Eight (8) additional plant families were represented by two taxa, while ten (10) families were represented in this study by one taxon. The genus *Erysimum* had the greatest number of taxa (3) involved, followed by the genera *Brodiaea, Hemizonia, Lupinus*, and *Oenothera* (2 each).

Results of the survey indicate that of the 46 projects reviewed, 38 (83%) are mitigation-related, while eight (8) projects (17%) are research-related. Of the 53 manipulation attempts, forty-one (41; 77%) involved translocation (including relocation) of species of concern, nine (9) projects (17%) involved reintroduction, and 2 projects (4%) involved restoration of a population of a State-listed species. One additional project reviewed is a research-related project that has yet to include a transplantation, relocation or restoration component.

Thirty-six (36) projects have been implemented, while ten (10) projects are still in the planning stages. Seventeen projects (27%) are developments for housing, business parks, or recreational facilities initiated by private companies and corporations. Eleven projects (24%) are the result of state service operations, such as those by the California Department of Transportation and Department of Water Resources. The remaining projects are either initiated by county services (9%), private and public energy utilities (11%), or are research related. Of the total 46 projects, only 15 projects (33%) had explicitly defined criteria for success of the mitigation project, while

the remaining 31 (67%) either had no criteria for success or the criteria were only vaguely defined.

Only 15% (8) of the 53 transplantation, relocation, or reintroduction attempts reviewed should be considered fully successful (13% of the 46 projects). Plant species for which the project was successful included *Amsinckia grandiflora, Dudleya cymosa* ssp. *marcescens, Holocarpha macradenia, Lasthenia burkei, Opuntia basilaris* var. *treleasei,* and *Sidalcea pedata.* However, of these eight (8) projects, only four (4) are mitigation-related. Therefore, the success rate of the mitigation-related transplantation, relocation, and reintroduction attempts is 8% (9% of the projects). An additional seven (7) transplantation projects (13%) (9 attempts [17%]) are considered partially successful, or of limited success. Twelve (12) projects (26%) are considered here to be unsuccessful, no information was found in the review of files for four (4) projects (9%), and the success of an additional sixteen (16) projects (35%) could not be evaluated because they are on-going or in the planning stages.

In a summary review of the successes and failures of transplantation, relocation and reintroduction of sensitive plant species in California, three broad recommendations can be made that are based on crucial aspects of the biology of imperiled plant species. These recommendations are:

> (1) Individuals should be removed with as little physical disturbance as possible to the individual, and at a phenologically appropriate time of year, as when the individual is dormant or photosynthetically inactive;
>
> (2) The receptor site should be of the same habitat quality, particularly with respect to soil type and its physical characteristics. Various other manipulation aspects of the receptor site may include weeding to decrease competition from native and exotic species, watering during times of drought, and fencing and/or other forms of site protection; and
>
> (3) Knowledge of the biology of the organism appears to aid greatly in the design of appropriate horticultural techniques for the preparation of cuttings, transplantation, seed germination, *etc.* This is problematic, however, because the biology of most State-listed species is poorly known. Although some species such as cacti and succulents may be amenable to standard horticultural techniques for propagation, most are not. Therefore, without sufficient knowledge of the biology of impacted species, success of the transplantation, relocation, or reintroduction will not be assured.

Finally, it is suggested that because of the lack of or limited success (21; 32% combined) of most of the transplantation, reintroduction, or restoration attempts documented, and the uncertainty of many of the on-going projects, the Endangered Plant Program of the California Department of Fish and Game's Natural Heritage Division should remain extremely cautious in any mitigation agreement that will allow any of these techniques to serve as mitigation for project impacts.

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II. INTRODUCTION AND PROJECT OBJECTIVES

The Endangered Plant Program (EPP) of the California Department of Fish and Game (CDFG) requested that mitigation-related transplantation, relocation, and reintroduction projects involving the State's endangered, threatened, and rare plant species be assessed for overall project efficacy and success. Thus the purpose of this research is to document the results of mitigation-related projects of this type involving the State's rare plant species of concern. The documentation may serve in the future as a position paper for the EPP's policy on transplantation, relocation, and reintroduction of State-listed species as mitigation.

The Department of Fish and Game currently requires an approved Mitigation Agreement (MA) for the manipulation of State-listed species (*cf.* Howald and Wickenheiser 1990). An MA is the legal document used by CDFG to approve mitigation projects for State-listed species that are required under the California Environmental Quality Act, Statutes, and Guidelines (CEQA). Mitigation is not explicitly defined in CEQA, but is listed as "including":

> (a) Avoiding the impact altogether by not taking a certain action or parts of an action.
>
> (b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation.
>
> (c) Rectifying the impact by repairing, rehabilitating, or restoring the impacted environment.
>
> (d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.
>
> (e) compensating for the impact by replacing or providing substitute resources or environments (CEQA §15370).

If these five forms of mitigation are interpreted as priority in order of listing, then the preferred form of mitigation under CEQA (1986) is project avoidance, followed by minimization of impacts, rectification of impacts, *etc.* It should be noted that compensation is the least preferable form of

mitigation under this interpretation.

III. METHODS

Questionnaire: To begin the assessment, a questionnaire was developed by the author and reviewed by members of the CDFG's Endangered Plant Program. Three hundred seventy-seven (377) individual questionnaires were sent in the summer of 1989, along with, at that time, a current list of State-listed endangered, threatened, and rare plant species (California Department of Fish and Game 1989), to a broad spectrum of public resource and land management agencies, consulting firms, nurseries, museums, academic institutions, and private individuals or conservation organizations (Table 1). The individuals selected for the survey were compiled from California Native Plant Society and California Department of Fish and Game files, and personal mailing lists. The questionnaire and cover letter are included as Appendix A. The mailing list is included as Appendix B.

Review of Internal Files: Project and species files held by the EPP were reviewed in the winter of 1990, to clarify materials received from the questionnaire and to gather additional information. These files were particularly helpful regarding the MOU and MA conditions of the mitigation-related projects. Most, but not all of the current (*i.e.*, on-going and/or currently negotiated) mitigation-related transplantation, relocation, and reintroduction projects were reviewed. However, several recently initiated and on-going projects that conform to newly instituted EPP mitigation standards are not reviewed in this document because assessment of their success is not possible at this time.

Mitigation Project Assessment: The questionnaires received and EPP files reviewed were examined for the following information:

(1) whether the project reported was mitigation- or research-related,

(2) mitigation project objective(s),

(3) responsible party's criteria for mitigation success,

(4) transplantation, relocation, or reintroduction methods,

(5) design and implementation of the mitigated population's monitoring plan,

(6) respondent's assessment of mitigation project success, and

(7) date of transplantation, reintroduction, or relocation project.

Once these data were compiled, the projects were tallied for their assessed success and efficacy. The results of this analysis are summarized in Section IV.

IV. RESULTS

A total of one hundred sixty-eight (168) questionnaires was returned for this survey. All those organizations and individuals who responded to the questionnaire, and their summary responses are listed in Appendix C.

The majority of respondents (114, 68%) have not been involved in any transplantation, relocation, or reintroduction project involving state- (or federally-) listed endangered, threatened, or rare plant species. Twenty-four (24) individuals have been involved, however, and they are reviewed in detail in Section IV.A and IV.B. Table 2 outlines the responses to questionnaire.

A significant number of respondents reported on transplantation, relocation, and reintroduction projects that were not mitigation-related, but rather, research-related. Mitigation-related projects are defined as those that required either an MA or formerly, a Memorandum of Understanding (MOU). Thus several of the projects described in the returned questionnaires were research activities that did not require a Mitigation Agreement (MA). These projects were included in the analysis, and are described in Section IV.B. However, the listing is not exhaustive for research-

TABLE 1. SUMMARY OF RECIPIENTS OF THE MITIGATION QUESTIONNAIRE

Organization or Individual	Number[1]
Consulting Firms	66
Resource Agencies	
Federal	9 (30)[2]
State	10 (43)[3]
County	10 (15)[4]
City	3[5]
Private Nature Preserves	7
Museums	7
Private Energy Companies	1
Public Utilities	4
Private Conservation Organizations	4
Botanic Gardens	6
Nurseries	4
Universities	20 (29)[6]

[1]The number of questionnaires will not sum to a total of 377 because in many cases several individuals within the same office were sent a questionnaire. Therefore, although the questionnaire may have been duplicated within any one office, the probability of receiving a response was increased.

[2]The first number in this column represent the total number of different federal agencies queried. These included the U.S. Fish and Wildlife Service, U.S. National Park Service, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, U.S. Bureau of Land Management, U.S. Soil Conservation Service, U.S. Air Force, U.S. Navy, and the U.S. Forest Service. The number in parentheses indicates the total number of federal agency offices contacted.

[3]The first number in this column represents the total number of different state resource agencies queried. These included the California Department of Fish and Game, Department of Forestry, Department of Transportation, Jackson State Forest, State Lands Commission, California Conservation Corps, California Department of Parks and Recreation, Department of Water Resources, Department of Food and Agriculture, and the Division of Mines and Geology.
The number in parentheses indicates the total number of state offices contacted.

[4]The first number represents the total number of county offices queried. These include planning and resource offices in the following ten counties: Chico, Placer, San Diego, San Luis Obispo, Sacramento, Santa Barbara, Solano, Sonoma, Tuolumne, and Yolo. The number in parentheses represents the total number of county offices contacted.

[5]Planning and resource agencies were contacted in the cities of Santa Rosa, Modesto, and San Diego.

[6]The first number in this column represents the total number of different colleges and universities queried, including American River College; Butte College; California Polytechnic Pomona; California State Universities at Bakersfield, Chico, Hayward, Humboldt, Sacramento, San Diego, San Francisco, San Jose, and San Luis Obispo; Mills College; Pacific Union College; Palomar College; Stanford University; University of California at Berkeley, Davis, Santa Barbara, and University of San Diego.

TABLE 2. SUMMARY OF RESPONSES TO MITIGATION QUESTIONNAIRE

Organization	Number of Questionnaires Sent	Responded Yes	Responded No[7]
Private Individuals/			
Citizen Groups	90	2	24
Consulting Firms	66	6	18
Resource Agencies			
State Agency Offices	10 (44)[8]	11	9
Federal Agency Offices	9 (30)	7	13
County Offices	10 (15)	4	9
City			
University Faculty	20 (29)	5	11
Museums	7	0	3
Private Nature Preserves	7	0	3
Botanic Gardens	6	1	2
Nurseries	4	1	1
Public Utilities	4	0	3
Private Conservation Organizations	4	0	1

[7]In all cases in this table, the total number of respondents will not total to 168 because multiple individuals were contacted within a single office or agency, and therefore multiple questionnaires were returned from a single office or agency.

[8]In all cases, first number in the column represents the total number of agencies queried, and the number in parentheses represents the total number of offices contacted.

related transplantation, relocation, and reintroduction projects, but it is considered nearly so for completed mitigation-related projects of these types.

A total of forty-six (46) projects were review, involving 53 transplantation, relocation, or reintroduction efforts. Forty (40) plant species were reviewed, 34 (85%) are listed by the State, federal government, or the California Native Plant Society as either endangered, threatened, or rare. Specifically, 25 (63%) are listed by the State as endangered, 3 (8%) are listed asthreatened, and 6 (15%) are listed as rare, and 6 (15%) are not listed by the State, but have some other form of protection or special status (California Department of Fish and Game 1990, Smith and Berg 1988).

In addition, the 40 plant species reviewed belonged to 21 plant families. Asteraceae represented the highest number of species involved (9; 23%) including species in the genera *Blennosperma*, *Cirsium*, *Eriophyllum*, *Hemizonia*, *Lasthenia*, and *Pentachaeta*. This was followed by the Brassicaceae (4; 10%), encompassing the genera *Arabis*, *Eryngium*, and *Erysimum*. Eight additional plant families were represented by two taxa, while ten families were represented in this study by one taxon. The genus *Erysimum* had the greatest number of taxa (3) involved in this study, followed by the genera *Brodiaea*, *Hemizonia*, *Lupinus*, and *Oenothera* (2 each).

Additional results of the survey indicate that of the 46 projects reviewed, 38 (83%) are mitigation-related, while eight (17%) are research-related. Of the 53 manipulation attempts, forty-one (41; 77%) involved translocation (including relocation) of species of concern, nine (9) projects (17%) involved reintroduction, and 2 projects (4%) involved restoration of a population of a State-listed species. One additional project reviewed is a research-related project that has yet to include a transplantation, relocation or restoration component.

Of the 46 projects reviewed, 40 projects have been implemented, while 4 projects are in the

planning stages. Of the total 46 projects, only 15 projects (33%) had explicitly defined criteria for success of the mitigation project, while the remaining 31 projects (67%) either had not criteria for success or the criteria were only vaguely defined.

Only 15% (8) of the 53 transplantation, relocation, or reintroduction attempts reviewed should be considered fully successful (13% of the 46 projects). I define "success" in this survey as either: (1) the respondent to the questionnaire felt that the project was successful; or, (2) greater than 75% of the mitigation propagules established a reproducing population over the life of the project as reported. "Unsuccessful" projects were determined to be so in this survey because either: (1) the respondent in the questionnaire reported that the project was unsuccessful; or, (2) less than 25% of the mitigation propagules established a population, and subsequently died. "Limited success" was assigned to those projects for which: (1) the respondent in the questionnaire reported as "limited" or "partially" successful; or, (2) the respondent reported a middle range of mitigation propagule establishment (>25% but <75%).

Plant species for which the transplantation, relocation, or reintroduction project was successful included *Amsinckia grandiflora*, *Dudley cymosa* ssp. *marcescens*, *Holocarpha macradenia*, *Lasthenia burkei* (3 projects), *Opuntia basilaris* var. *treleasei*, and *Sidalcea pedata*. However, of the eight projects involving these species, only four are mitigation-related; therefore the success rate of the mitigation-related attempts is 8%. An additional seven (7) transplantation attempts (13%) are considered partially successful, or of limited success. Twelve (12) of the 53 attempts (23%) are considered here to be unsuccessful, and the success of an additional four projects is unknown (*i.e.*, unreported or no information was found in EPP files). Sixteen projects (35%) could not be evaluated for their success because they are on-going or in the planning stages.

IV.A. Rare, Threatened and Endangered Plant Species Involved in Mitigation-Related Transplantation, Relocation and Reintroduction Projects

The following is a discussion of the state- (and federally-) listed species that have been the subject of mitigation-related transplantation, relocation and reintroduction projects, as outlined by the respondents of the questionnaire and a review of the EPP files. Table 3 lists the endangered, threatened and rare plant species involved in transplantation, relocation, and reintroduction projects. Information from the questionnaire and EPP files is summarized briefly by species. Questionnaires and personal notes are on file and available for review of additional information.

IV.A.1. *Acanthomintha ilicifolia* (San Diego Thornmint): State endangered; Federally Candidate Category 1, CNPS List 1B.

Respondent: None. Data obtained from EPP files.

Project Name and Description: "Westview Planned Residential Development." The Pardee Company agreed to mitigate for destruction of a population of *A. ilicifolia* by the construction of a road (Black Mountain Road) and a housing development by creating a 13.6 acre on-site open space preserve for the San Diego thorn-mint.

Mitigation-Related?: Yes.

Project Objectives: The goal of the mitigation plan was to create a viable population of *A. ilicifolia* in an on-site preserve through the importation of seed and soil.

Project Methods: The Pardee Company contracted with Environmental and Energy Services Company (ERC) to salvage all the *Acanthomintha ilicifolia* seeds in the population affected by the construction. Approximately 10.8 gm. of seed were collected in July 1988. Topsoil was then salvaged from the *Acanthomintha ilicifolia* population area to collect seed potentially stored in the soil. The soil was transported to the mitigation site.

TABLE 3. CALIFORNIA STATE ENDANGERED, THREATENED, AND RARE PLANT SPECIES INVOLVED IN MITIGATION-RELATED OR RESEARCH-RELATED TRANSPLANTATION, RELOCATION, OR REINTRODUCTION PROJECTS

SPECIES	FAMILY	PROTECTION STATUS[9]
Acanthomintha ilicifolia	Lamiaceae	Endangered
Amsinckia grandiflora	Boraginaceae	Endangered
Antennaria flagellaris	Caryophyllaceae	None
Arabis macdonaldiana	Brassicaceae	Endangered
Arctostaphylos hookeri var. *ravenii*	Ericaceae	Endangered
Bensoniella oregana	Saxifragaceae	Rare
Blennosperma bakeri	Asteraceae	Rare
Brodiaea filifolia	Amaryllidaceae	Endangered
Brodiaea insignis	Amaryllidaceae	Endangered
Calochortus greenei	Liliaceae	None (Fed C2)
Chorizanthe howellii	Polygonaceae	Threatened
Cirsium occidentale var. *compactum*	Asteraceae	None (Fed C2)
Cordylanthus palmatus	Scrophulariaceae	Endangered
Croton wigginsii	Euphorbiaceae	Rare
Dudley cymosa ssp. *marcescens*	Crassulaceae	Rare
Eriastrum densifolium ssp. *sanctorum*	Polemoniaceae	Endangered
Eriophyllum mohavense	Asteraceae	None (Fed C2)
Eryngium aristulatum var. *parishii*	Apiaceae	Endangered
Erysimum capitatum var. *angustatum*	Brassicaceae	Endangered
Erysimum menziesii	Brassicaceae	Endangered
Erysimum teretifolium	Brassicaceae	Endangered
Gilia tenuiflora ssp. *arenaria*	Polemoniaceae	Threatened
Hemizonia increscens ssp. *villosa*	Asteraceae	Endangered
Hemizonia minthornii	Asteraceae	Rare
Holocarpha macradenia	Asteraceae	Endangered
Lasthenia burkei	Asteraceae	Endangered
Lilaeopsis masonii	Apiaceae	Rare
Lupinus tidestromii var. *tidestromii*	Fabaceae	Endangered
Lupinus milo-bakeri	Fabaceae	Threatened
Mahonia nevinii	Berberidaceae	Endangered
Monardella linoides ssp. *viminea*	Lamiaceae	Endangered
Oenothera deltoides ssp. *howellii*	Onagraceae	Endangered
Oenothera wolfii	Onagraceae	None (Fed C2)
Opuntia basilaris var. *treleasei*	Cactaceae	Endangered
Orcuttia viscida	Poaceae	Endangered
Pentachaeta lyonii	Asteraceae	Endangered
Pogogyne abramsii	Scrophulariaceae	Endangered
Pseudobahia peirsonii	Asteraceae	Endangered
Sedum albomarginatum	Crassulaceae	None (Fed C1)
Sidalcea pedata	Malvaceae	Endangered

[9]State of California, Department of Fish and Game, Nongame-Heritage Program, Endangered Plant Project. Designated Endangered, Threatened or Rare Plants. 1990.

Twenty-five (25) 4 ft^2 experimental plots in the preserve were located and prepared by removing existing vegetation. Seeds sown in the test plots were observed in December, 1988, while the remaining seed was sent to the Rancho Santa Ana Botanic Garden (RSA) for germination tests.

Seedlings occurred in 12 of the 25 test plots in March 1989. At the time of the preparation of this report, no additional information is available. However, the MOU on file requires a monitoring program to be established in the mitigation plots that must continue for five (5) growing seasons.

Criteria for Success: As outlined by the MOU, performance criteria include: (1) erosion control [soil stabilized]; (2) weed invasion [no interference with *A. ilicifolia* establishment]; (3) herbivory ["minimal" damage to *A. ilicifolia* seedlings]; (4) vigor [5 cm minimum height per individual plant]; and, (5) reproductive success [to be determined on the basis of offsite monitoring].

Project Success: Project on-going.

Date Project Initiated: July 1988.

2) Respondent: None. Data obtained from EPP files.

Project Name and Description: "Shea Homes Palos Vista Development." Shea Homes designed a development of 979 acres within the city of Escondido that involved the construction of 730 homes and some open space. Shea Homes contracted initially (October 1988) with Royce B. Riggins and Associates (RBR), working in conjunction with Mr. Jim Dillane of the Lake Hodges Native Plant Club, to prepare the biological reports and initial mitigation design for the project. In May, 1989, ERC completed the work initiated by RBR. The mitigation site was selected as the San Diego Wild Animal Park.

Mitigation-Related?: Yes.

Project Objectives: The goal of the mitigation contract was to assure the preservation of

two small disjunct populations of *Acanthomintha ilicifolia* that were originally located within the boundaries of the Palos Vista residential development.

Project Methods: Plants were collected in June and July of 1988 and transplanted to the mitigation site. The site is a 40 x 30 ft parcel on which a 2 ft layer of subsoil was imported and laid down prior to transplantation.

Criteria for Success: As outlined by the MOU on file, performance criteria are based on reproductive success, as follows: (1) number of plants shall equal or exceed 30% of the mean density of plants in natural populations at the first end of the growing season; (2) number of plants shall equal or exceed 50% of the mean density of plants in natural populations at the end of the second growing season; (3) number of plants shall equal or exceed 70% of the mean density of plants in natural populations at the end of the third growing season; (4) number of plants shall equal or exceed 90% of the mean density of plants in natural populations at the end of the fourth growing season; and, (5) number of plants shall equal or exceed 100% of the mean density of plants in natural populations at the end of the fifth growing season.

Project Success: Project on-going.

Date Project Initiated: December 1988.

3) Respondent: None. Data obtained from EPP files.

Project Name and Description: "Reparation for the Sabre Springs Development." One of the largest known populations of *Acanthomintha ilicifolia* is located on property located within the City of San Diego Open Space System, previously owned by the Pardee Company. In the spring of 1989, the population was reduced by one-third due to an accidental road grading operation. In order to avoid prosecution by the State for these damages, Pardee Company was notified of several measures to rectify the damage. Pardee Company has or is complying with all seven conditions of the reparation plan, but with

varying degrees of success.

Mitigation-Related?: Yes.

Project Objectives: To rectify the accidental damage inflicted on a large population of *Acanthomintha ilicifolia*

Project Methods: The disturbed population was fenced and bermed, signed, weeded, and the adjacent roadbed hydroseeded. A second phase of the project will be to manage suitable *Acanthomintha ilicifolia* areas near existing populations to encourage their spread. Seed will be broadcast onto suitable clay soils adjacent to extant stands in January, 1992.

Criteria for Success: As stated in the reparation plan, the goal of the project is to increase the remaining *Acanthomintha ilicifolia* population to predisturbance size or greater.

Project Success: Project on-going.

Date Project Initiated: Spring-summer 1989.

4) Respondent: None. Data obtained from EPP files.

Project Name and Description: "Indian Hill," "McIntire" ("Las Brisas"), and "Spyglass" urban development projects. The three projects together required translocation of *Acanthomintha ilicifolia* to open space areas on the development sites. Mitigation projects were contracted to Pacific Southwest Biological Services (PSBS) of San Diego. PSBS was responsible for all relocation activities, including seed collection, and excavation and placement of clay soils associated with *Acanthomintha ilicifolia* (PSBS, Inc. 1988).

Mitigation-Related?: Yes.

Project Objectives: None stated. Presumably the project objectives were to establish viable populations of *Acanthomintha ilicifolia* from transplanted plant material at four translocation sites (open space areas onsite at the Las Brisas and Indian Hill sites; within a natural, dedicated open space area at the El Camino Condominium and Tennis Club; a project adjacent to the Spyglass project; and within the natural area of the Quail Botanical Garden

County Park.

Project Methods: Seeds were collected at Jetton Property (Las Brisas Mobile Home Park) during the summer of 1986 and sown by hand on the relocated clay lens. Soils were excavated and prepared for seeding within a 24-hour period. Seeds were collected as whole plant material, occupying approximately 1/2 yd^3 and weighing about 2 pounds.

Criteria for Success: None state specifically.

Project Success: The project was halted and the MOU terminated due to the difficulty the EPP had in dealing with PSBS. Success of the transplantation was limited as of May 1988. However, at the Las Brisas relocation site in May 1988, an estimate of between 700-1000 individuals (1100 "flowering heads") was reported. At the Quail Gardens relocation site, the population estimate was made during the seedling stage. As of 8 May 1988, "seed heads" numbered 70, while the population survey during the seedling stage resulted in 200-300 plants. PSBS reported that associated native plant species were abundant at the Las Brisas site, though more rare at Quail Gardens.

Date Project Initiated: Spring 1985

IV.A.2. *Blennosperma bakeri* (Sonoma Sunshine): Not state listed: Federal Candidate C2; CNPS List 1B.

1) Respondent: Mr. Charlie Patterson, Plant Ecologist. Private Consultant, El Cerrito.

Project Name and Description: "Montclair Park." Project involved the construction of a small housing development by Christopherson Homes in the city of Sonoma (lead agency for the permit), entitled "Montclair Park." The mitigation included the dedication (as compensation) of approximately 2.0 acres of undeveloped land, located on the edge of the development, within which up to 1.0 acres of actual vernal pool habitat would be created and seeded with *Blennosperma bakeri* and associated vernal pool species.

Mitigation-Related?: Yes.

Project Objectives: Objectives for the housing development were the replacement of 0.3 to 0.5 acres of wetlands and of the pre-existing 10,000 individuals of *Blennosperma bakeri* that were destroyed during the construction of the housing development.

Project Methods: The habitat was graded and shaped, creating approximately 10 new vernal pools in a soil that is underlain by the same claypan existing under the destroyed pools.

Blennosperma bakeri seeds were collected in late May 1989 by collecting the dry flower heads, vacuuming the surface for seeds, duff and dust, and scraping by hoe, 1-2 inches of the top soil of existing pools. Collected seed and duff was air-dried in shallow trays in a cool, dry environment. Seeds were transferred to the created pools by hand. The created pools were fenced (wood and wire) and a berm constructed for protection.

The project design also included several additional trial vernal pools within a storm runoff detention basin to investigate the feasibility of managing detention basins and vernal pools concurrently as a contaminant settling basin.

Monitoring of the pools includes: (1) habitat integrity and stability; (2) *Blennosperma bakeri* growth and reproduction; and, (3) overall vernal pool community development.

Criteria for Success: Essentially the replacement of a self-sustaining colony of *Blennosperma bakeri*. This includes: (1) at least 75% of the created vernal pool habitat should be documented as stable, with no measurable erosion or deposition, and with no significant channel formation; (2) at least 75% of the pools should have adequate [undefined] water-holding capacity; (3) local drainage patterns should be shown to be adequate [undefined] to fill the pools (75%) without input from street runoff or eucalyptus debris; (4) at least 10 colonies of *B. bakeri* should be established in the new pools, and be self-sustaining populations; (5) the total habitat area of at least 0.3 acres should be dominated by *Blennosperma bakeri* for at least 2 years without supplement seeding; (6) the

total population should number at least 10,000 individuals without supplemental seed over 2 years; (7) at least 75% of the total pool habitat should be dominated by typical (native?) vernal pool plants; (8) each pool should contain at least 4 (native?) vernal pool species; and, (9) encroachment by grasses and/or upland weeds should be documented as stable, with no significant advancement into the pools over the last 2 years of the monitoring program.

Project Success: Respondent felt that, after one dry year, the results are promising -- *i.e.*, several thousand individuals of *Blennosperma bakeri* are established. However, the pools need to be regraded and probably deepened.

Date Project Initiated: 1989.

2) Respondent: None. Data obtained from EPP files.

Project Name and Description: "Santa Rosa Rare Plants Mitigation Plan San Miguel Estates I." In 1989 Cobblestone Development Corporation proposed the development of San Miguel Rancho Subdivision (RSM) at 2001 Waltzer Road within the city of Santa Rosa, Sonoma County and San Miguel Estates No. 2 (SME) at 2192 Francisco Avenue, also within Santa Rosa. The SME project is an on-going housing construction and the RSM housing project was a 1989 development. The projects would destroy approximately 2.51 acres of vernal pool habitat. (see IV.A.19(3) for more details.)

Mitigation-Related?: Yes.

Project Objectives: According to the Mitigation Agreement between Cobblestone and CDFG, the mitigation should establish self-sustaining populations of plants in approximately 2.97 acres of newly created habitat on the mitigation site. Self-sustaining is defined as approximately 13,000 individuals of *Lasthenia burkei* and 137,000 individuals of *Blennosperma bakeri* for 2 consecutive years without supplemental seeding.

Project Methods: The mitigation plan was devised by R. Osterling, Inc. (1989). The plan proposed to transplant all existing plants and/or seeds to a 20-acre receptor site located

approximately 1.5 miles west of the San Miguel Estates property, with existing 3.49 acres of vernal pool resources. Approximately 2.5 acres of vernal pool habitat will be constructed at the receptor site with pool configuration and depth based on survey of existing pools. Grading will be done with small equipment under supervision of a qualified botanist (Charlie Patterson, private consultant). Plant material will be "transferred." Seed will be collected from donor pools and the top 1-2 inches of pool bottom duff will be excavated and spread in the excavated pools at the receptor site. Monitoring will continue through June 1991.

Criteria for Success: None explicitly stated.

Project Success: Unknown. No information found in EPP files.

Date Project Initiated: March 1989.

IV.A.3. *Brodiaea filifolia* (Thread-leaved Brodiaea): State endangered; Federal Candidate C1; CNPS List 1B.

Respondent: None. Data obtained from EPP files.

Project Name and Description: "College Area Specific Plan in San Marcos." The Baldwin Company proposed a development on 530 acres of undeveloped land in the City of San Marcos, on a ridge behind the college. The onsite population of *Brodiaea filifolia* is part of the county's most extensive, known population.

According to the monitoring plan (WESTEC 1988), the mitigation plan included: (1) all onsite mitigation activities; (2) a 12-acre preserve that is completely fenced (vinyl-clad chain-link), protected for the life of the project; (3) planting of (presumably) local plants; (4) creation of a stable, relatively weed free *Brodiaea filifolia* population, requiring low maintenance; (5) onsite salvage of each plant species included in the preserve; (6) transportation and laying of suitable soils (Huerhuero Series); (7) maintenance during the first several years; and, (8) monitoring by a qualified botanist.

Mitigation-Related?: Yes.

Project Objectives: Two objectives were identified: (1) to set aside a 12-acre preserve for existing native grassland habitat supporting *B. filifolia*; and, (2) to reintroduce *Stipa pulchra* (purple needle grass) to disturbed portions of the preserve (ERC Environmental and Energy Services Co. 1990c).

Project Methods: During 1988, clay soils and 8167 *B. filifolia* corms were collected from a 25 ft^2 area within the original population and brought to the preserve. Five plots were marked and rabbit exclosures were installed. The largest corms collected were planted in planting holes in the test plots and throughout the preserve. Smaller corms were shipped to a contract nursery (Tree of Life Nursery, San Juan Capistrano) to be grown for increased size. A portion of these corms (870) were outplanted in the fall of 1990. Seed of *Brodiaea filifolia* also was collected from the original population and seedlings were grown at the nursery for two seasons. These were planted in the preserve in 1990 (ERC Environmental and Energy Co. 1990c).

Monitoring includes: (1) overall success; (2) role of corm size in relation to survivorship and flowering; (3) field establishment of nursery corms under controlled conditions with and without fertilizer treatments; (4) efficacy of relocating *B. filifolia* populations by soil importation; (5) role of supplemental irrigation in the establishment of transplanted corms; and, (6) use of field-collected seed and nursery-generated seedling corms in restoration (ERC Environmental and Energy Services Co. 1990c).

Criteria for Success: Criteria for success includes: (1) 75% survival rate of *Brodiaea filifolia* corms in test plots and 80% in the grassland; (2) 80% survival rate of *Stipa pulchra* plugs (seeds were planted similarly and an 80% survival rate was considered for this activity); (3) weeds should not cover the test plots dense enough to interfere with *Brodiaea filifolia* establishment and noxious weed species [undefined] should be eliminated from the preserve. The same criteria were considered for the *S. pulchra* plantings; (4) herbivory

damage assessed as above-ground and below-ground growth for *B. filifolia*. Acceptable damage to vegetative material is 10% or less of all plantings. Gopher damage to corms cannot exceed 5% in any one plot or 20% overall; and, (5) acceptable herbivory losses for *S. pulchra* should not exceed 10%. No criteria were established for reproductive success, "offset" production of corms, or soil importation.

Project Success: Project is in-progress and will continue until December 1993. To date, preliminary results of the monitoring efforts indicate that the introduction of *Brodiaea filifolia* corms has been largely successful. Corm growth increased significantly between 1989 and 1990. Eighty-seven percent (87%) of the corms have remained viable and 19.9% have produced "offsets." Also, fertilizer treatments of corms grown in the nursery did not improve vegetative development. Irrigation showed initial signs of promise in improvement of establishment of corms, particularly with soil importation. At the time of the monitoring report, results were not available for assessing the success of the transplanted nursery-grown corms. Direct seeding was not successful, in either the irrigated or non-irrigated seed locations. Why it was not successful is not known, but it may be possible that the seeds were held in storage too long and lost viability.

The 1989 planting of *Stipa pulchra* plugs was not successful due to the late planting in conjunction with very warm weather and drought. A portion of the plugs was replaced in winter 1990, and an additional experimental plot was installed in 1990 to test the effects of supplemental irrigation on *S. pulchra* establishment. Significantly more plants survived than those grown from seed (94.8% *vs.* 61.6%).

Efforts to eliminate sweet fennel (*Foeniculum vulgare*) and cardoon (*Cynara cardunculus*) have largely been successful, although mustard (*Brassica* [*nigra?*]), wild radish (*Raphanus sativus*), and invasive annual grasses are not controlled.

Herbivory on *Brodiaea filifolia* by rabbits does not appear to be a problem, although there appears to be some disturbance by gophers within as well as outside the

exclosures (ERC Environmental and Energy Services Co. 1990c).

Date Project Initiated: May 1988.

IV.A.4. *Brodiaea insignis* (Kaweah Brodiaea): State endangered; Federal Candidate C1; CNPS List 1B.

Respondent: Mr. John Stebbins, Fresno.

Project Name and Description: "Kaweah Reservoir Dam Expansion" (Tulare County), initiated by the California Department of Water Resources. Project plans are being drafted at this time.

Mitigation-Related?: Yes.

Project Objectives: Project plans are being drafted at this time. Not yet available.

Project Methods: Project plans are being drafted at this time. Not yet available.

Criteria for Success: Project plans are being drafted at this time. Not yet available.

Project Success: Not yet available.

Date Project Initiated: 1989.

IV.A.5. *Calochortus greenei* (Greene's Mariposa Lily): Not state listed; Federal Candidate C2; CNPS List 1B.

Respondent: Mr. William Ferlatte, Siskiyou County Dept. Agriculture and Ms. Barbara Williams, U.S. Forest Service, Klamath National Forest.

Project Name and Description: None. *Calochortus greenei* is not a state-listed species, and both respondents answered briefly. Project involved a road widening/construction project that required two mitigation transplantation efforts.

Mitigation-Related?: Yes.

Project Objectives: None stated.

Project Methods: None stated, but presumably the bulbs were dug by hand and transported

to the mitigation sites and replanted there.

Criteria for Success: None stated.

Project Success: Approximately 65 plants/bulbs were transplanted on May 23, 1989. As of May 9, 1990 [sic] (June 1989?), approximately 10 individuals survived the transplantation onto U.S. Bureau of Land Management and private property. This resulted in a survivorship rate of approximately 15%.

Date Project Initiated: May 1989.

IV.A.6. *Chorizanthe howellii* (Howell's Spineflower): State threatened; Federal Candidate C2; CNPS List 1B.

Respondent: Ms. Frederica Bowcutt, State of California Deparument of Parks & Recreation, Sacramento.

Project Name and Description: None. Project involved the reintroduction of *Chorizanthe howellii* and *Erysimum menziesii* to archeological sites at MacKerricher State Park (Mendocino County) after an archeological dig. The site is a coastal dune ecosystem. University of California, Davis, initiated an archeological dig in 1989-90 at sites containing rare species. (see IV.A.13(1) for more details).

Mitigation-Related?: Yes.

Project Objectives: None stated.

Project Methods: Seed was collected in the summer of 1989 from the plants on site before the archeological dig was initiated. Plug plants were grown at the California Conservation Corps (CCC) Napa nursery and outplanted in February 1990 by the CCC. Plants were monitored by an undescribed photo monitoring technique. Outplanted plants also were counted and mapped. Initial costs for the project were: (1) salary $800.00; (2) travel $400.00; and, (3) plants $200.00, for a total of $1400.00.

Criteria for Success: None stated.

Project Success: Project on-going. Information not yet available.

Date Project Initiated: July 1989.

IV.A.7. *Cirsium occidentale* var. *compactum* (Compact Cobweb Thistle): Not State listed; Federal Candidate C2; CNPS List 1B.

Respondent: Mr. Gary Ruggerone, California Department of Transportation, San Luis Obispo.

Project Name and Description: California Department of Transportation is involved in two projects, "Little Pico Bridge Replacement" and "Piedras Blancas Shoulder Widening." The former is on-going, and the latter was conducted in 1986. Both projects are along Highway 1 in San Luis Obispo County on ocean bluffs. *Cirsium occidentale* var. *compactum* is found along the disturbed highway shoulders.

Mitigation-Related?: Yes. However, neither project included CEQA permit conditions regarding transplantation of *Cirsium occidentale* var. *compactum*, although California Department of Transportation consulted with the USFWS.

Project Objectives: Transplantation and reseeding of the disturbed areas with *Circium occidentale* var. *compactum* to maintain populations.

Project Methods: Plants of various ages were removed from the impact area and were transplanted to immediately adjacent areas in January and February (1987?). Seed was collected in July through October (1986?), scarified, and scattered in January and February (1987?).

Both sites are monitored several times per year until it can be determined whether a reproducing population has been established. Neither site has received long-term protection, although the areas are considered by Caltrans as "environmental sensitive areas." Costs of the projects have been absorbed in the overhead. No reports other than brief field notes of the transplantation were filed.

Criteria for Success: Success was defined as survival of transplants and germination of seed for reintroduction to establish a continued presence of *Cirsium occidentale* var. *compactum* in the area.

Project Success: For Piedras Blancas, there was only partial success. Transplanting was a total failure, but the respondent reported some success with reseeding. For Little Pico, the transplantation was a failure. Seeding has not yet been initiated.

Date Project Initiated: 1986.

IV.A.8. *Croton wigginsii* (Wiggin's Croton): State rare; Federal Candidate C3C; CNPS List 2.

Respondent: Mr. Gerald Hillier, U.S. Bureau of Land Management, Riverside.

Project Name and Description: None. Project involved the construction of a new campsite ("Gecko") at the Imperial Sand Dunes, immediately south of Highway 78 (Imperial County).

Mitigation-Related?: Yes.

Project Objectives: Objectives were to establish seedings of *Croton wigginsii* in an adjacent Wilderness Study Area (WSA).

Project Methods: Seedlings were dug with a shovel of sand, and then placed in a bucket of wet sand. The buckets were transported approximately 1 mile away to a WSA site on the north side of Highway 78. A slice with a shovel was made in the new substrate, and the seedlings were transplanted in approximately 5 per group. About 12 groups were established.

The seedlings were visited approximately every three days for two weeks to monitor the success of the transplantation. During that two-week period, all the seedlings died.

Criteria for Success: Not clearly stated. Respondent suggested that the criterion was

successful establishment of transplanted seedlings.

Project Success: Respondent considered that the project was successful because it established whether transplantation of *C. wigginsii* seedlings would be a viable option. However, as stated above, none of the seedlings survived and therefore, it should not be considered successful from a biological viewpoint.

Date Project Initiated: Unknown.

IV.A.9. *Eriastrum densifolium* ssp. *sanctorum* (Santa Ana River Woollystar): State endangered; Federal endangered; CNPS List 1B.

Respondent: Mr. Craig Martz, Associate Environmental Planner, California Department of Transportation, Sacramento, and data obtained from EPP files.

Project Name and Description: "Santa Ana River Woollystar Relocation Project." California Department of Transportation (Caltrans) attempted to change State Route 30 in San Bernadino County. The project included freeway construction along State Route 30, and a second phase of construction between Intersate 10 in Redlands and Fifth Street in the City of San Bernadino. Grading in the second phase would have resulted in the loss of approximately 1.24 acres of alluvial scrubland, habitat for 1039 individuals of *Eriastrum densifolium* ssp. *sanctorum*. However, the project was modified to affect only 733 individuals, with the remaining 308 individuals preserved in a designated environmental sensitive area avoided during the construction phase. The area is to be protected in perpetuity once construction is completed.

Mitigation-Related?: Yes.

Project Objectives: None stated specifically, but the overall objective appears to be the successful establishment of transplanted individuals of *Eriastrum densifolium* ssp. *sanctorum* from along State Route 30 in the Santa Ana River Wash to three transplant receptor areas within the right-of-way.

Project Methods: A contractor (Nativescapes) was hired to transplant 733 individuals of *E. densifolium* ssp. *sanctorum* from the west side of the Highway 30 project site to three locations on the east side of the highway; during January through March 1988. Plants were removed with a Vermeer TS-20 tree spade mounted on a Bobcat tractor. Plants were then fitted into burlap-lined mesh baskets that conformed to the rootballs for transport to the recipient areas. Individuals were planted in rows within each of the three transplant areas. Each row as initially marked with a wooden stake that was labeled with the number of individuals in the row. However, this labeling method was deemed inadequate in the second year of monitoring. Transplants were then marked individually with aluminum tags. Monitoring of the transplants is to be conducted for three years following the transplantation.

Criteria for Success: None stated explicitly.

Project Success: Respondent felt that the project had not achieved the level of success that was hoped for, in part because of the current drought conditions. After the first year of monitoring, Transplant Area 1 suffered a 39% mortality, Transplant Area 2 suffered a 56% mortality, and Transplant Area 3 suffered a 48% mortality of transplants. Most of the mortality in the first year was attributed to transplant shock, although natural mortality and competition may also be responsible in part (Martz 1990). The first year monitoring report suggests that the transplanation project was "highly successful thus far" because of relatively high survivability (61%, 44%, and 52% in Areas 1, 2, and 3, respectively), and good seedling production was observed.

Results of the May 1990 monitoring (Martz 1990) indicate a survival rate of 46.7% in Transplant Area 1, 38.9% in Transplant Area 2, and 40.5% in Transplant Area 3. The overall survival for the three areas was 332 individuals (44.2%). Approximately 85.5 percent of the surviving individuals were reproductive; however, 31 individuals (9.3%) were considered to be in obvious decline.

Seedling recruitment in the three Transplant Areas numbered 783, 80, and 339, respectively. Martz figured that seedling production in the three areas totalled 3.6 seedlings per Transplant Area 1, 3.3 seedlings per Transplant Area 2, and 5.7 seedlings per Transplant Area 3. However he also suggested that native *Eriastrum* plants already existing in Areas 2 and 3 may have contributed to these totals.

Date Project Initiated: January 1988.

IV.A.10. *Eriophyllum mohavense* (Barstow Woolly Sunflower): Not State listed; Federal Candidate C2; CNPS List 1B.

Respondent: Mr. James Brownell, California Energy Commission, Sacramento.

Project Name and Description: "Luz SEGS VII." The project involved the construction in 1988 of a solar power plant by the California Energy Commission, at Kramer Junction in San Bernardino County (Mojave Desert). Luz Engineering, the company that was contracted to construct the power plant, attempted to salvage the plant by collecting seed, topsoil, and additional subsoil material, and by depositing these on the receptor site.

The original occurrence of more than 1700 individuals of *Eriophyllum mohavense* on less than 2 acres represented the western-most location of the species, which is one of the main reasons for attempts to preserve this site. The site is also unusual because population densities are much higher here than in other regions where *Eriophyllum mohavense* is found. Also, a soil investigation was conducted by ERT (1988a; Fort Collins, Colorado) to determine whether the distribution of *Eriophyllum mohavense* (and the Mojave spineflower [*Chorizanthe spinosa*]) is controlled by edaphic factors. The report established that there are distinct differences between the soils on the low knolls that support *Eriophyllum mohavense* and adjacent areas that do not. The rare plants apparently grow on areas with a near surface layer (Btn natric horizon) and an underlying "pan" layer (the lower portion of the natric horizon, the Btkn horizon) that are both highly alkaline.

These layers apparently restrict rooting and establishment by spiny saltbush and other common shrubs of the area, but are not restrictive to *Eriophyllum mohavense* that roots above the pan (ERT 1988a). ERT also found very high levels of boron in the soil. This information was used in selection of the receptor site of *Eriophyllum mohavense*.

Mitigation-Related?: Yes.

Project Objectives: The state objective was to re-establish a population of *Eriophyllum mohavense* on a nearby artificially constructed hill. The original location of *Eriophyllum mohavense* was destroyed by the construction of the solar power plant.

Project Methods: According to the biological resources mitigation implementation plan (ERT 1988b), the consulting botanist worked with Mr. Mark Bagley of Bishop, California, to collect surface material (seed, litter, and the top 0.5 inch of topsoil) within a delineated area at the impacted site. This was done to be done with flat-bottomed shovels and other hand tools. The collected material was to be stored temporarily by spreading it on plastic sheets near the relocation site. About 25 percent of the seed source material was to be used to provide supplemental seed to areas of known habitat for *Eriophyllum mohavense*.

Soil was salvaged in three steps after seed collection. The base material was to be applied to the existing surface at the relocation site to increase the southerly aspect of the site to an approximately 4 percent slope. Following application of the base material, more soil was to be placed on the relocation site, spread, and contoured. In the last stage, the seed source was to be applied and raked smooth. The site was to be misted with water to moisten the seed material and help bind it to aid in erosion control. Finally, the relocation site was fenced by the Luz Engineering Corporation to prohibit future disturbance (ERT 1988b).

Criteria for Success: No specific success criteria were established. Respondent reported that the general criteria was to find the species on the relocation site.

Project Success: Respondents claims that at the present time, due to the unusually dry

years since this project has occurred, no systematic monitoring has been conducted and no plants have been found. However, they claim that the success is "uncertain" until the desert receives normal rainfall.

Date Project Initiated: 1988.

IV.A.11. *Eryngium aristulatum* var. *parishii* (San Diego Button Celery): State endangered; Federal Candidate C1; CNPS List 1B.

Respondent: Drs. C.H. Black and Paul Zedler, Dept. Biology, San Diego State University.

Project Name and Description: "Caltrans Del Mar Mesa Vernal Pools" and "U.S. Navy North Miramar Project Mitigation." As background, California Department of Transportation (Caltrans) had two major projects on Kearny Mesa that eliminated vernal pools. The first project was mitigated by the purchase of 26 acres of prime vernal pool habitat on Del Mar Mesa and a second acquisition of an additional 52 acres at Del Mar Mesa. This second acquisition was to be used in an experiment to create artificial pools capable of supporting *Eryngium aristulatum* var. *parishii* and *Pogogyne abramsii* (Zedler and Black 1988). Respondents did not explain the Miramar Project. (see IV.A.29 for additional information).

Mitigation-Related?: Yes.

Project Objectives: For both projects, the objective was to create vernal pool habitat for *Eryngium aristulatum* var. *parishii* and *Pogogyne abramsii*.

Project Methods: A set of 40 artificial basins was excavated in December 1986, and 387 were inoculated with material collected from the natural pools on Del Mar Mesa.

Criteria for Success: Respondents did not specifically designate criteria for success.

Project Success: Respondents feel that the projects are "not yet" successful because the rare species have not attained population densities found in the natural pools.

Date Project Initiated: December 1986.

IV.A.12. *Erysimum capitatum* var. *angustatum* (Contra Costa Wallflower): State endangered; Federally endangered; CNPS List 1B.

Respondent: Ms. Joy Albertson, U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge Complex.

Project Name and Description: "Vaca Dixon-Contra Costa 230-kV Reconductoring Project: Habitat Protection and Enhancement for Antioch Dunes." Pacific Gas and Electric Company (PG&E) reconductored the San Joaquin River crossing of the Vaca Dixon-Contra Costa 230 kV transmission line in the fall of 1988. The project took place specifically on the Sardis Unit of the Antioch Dunes National Wildlife Refuge (ADNWR), east of the town of Antioch. USFWS personnel conducted a Section 7 consultation with PG&E before granting access permit. (see IV.A.25 for more details.)

Mitigation Related?: Yes.

Project Objectives: Objectives were: (1) protection of habitat from future damage caused by construction/repair activities; (2) transplantation of sensitive species from the access corridor to allow vehicle access to the tower; (3) establishment of new subpopulations of *Erysimum capitatum* var. *angustatum* (and *Oenothera deltoides* ssp. *howellii*); (4) enhancement of existing populations; and, (5) determination of whether direct seeding or transplantation of nursery liners is preferable transplantation technique.

Project Methods: Eighteen wallflowers from the PG&E east parcel access corridor were transplanted either to other locations on the parcel or to the Sardis Pit area. A small circular area was first cleared of all vegetation, then an appropriate sized hole was dug. A plant was placed in the hole and dirt was packed firmly around it. Nursery grown plants were planted in a similar manner in pre-selected sites on the PG&E and Sardis Pit parcels

Three hundred seventy-seven (377) wallflower seedlings were planted in January

1990. A survey the following March provided a count of 364 surviving seedlings (96.6%) survival. Plants were monitored during the first spring and summer to determine whether additional water or weeding was needed so as to assure adequate survival. A final evaluation of survival will be made in the spring of the second year.

Cost of the nursery-grown seedlings was estimated at $0.30/seedling; 377 seedlings produced; therefore it cost $113.10.

Criteria for Success: The replacement of the plants that were destroyed by the construction, specifically 230 *E. capitatum* var. *angustatum* seedlings and 160 *O. deltoides* ssp. *howellii* seedlings was the criterion.

Project Success: Respondent felt that the project was partially successful. Transplantation of the wall flowers resulted in aa final 61.1% survival rate for 18 of the 22 plants, and 0.0% survival of the additional four (4) individuals. However, germination was high and survival of outplanted seedlings was 96.6% in the first year.

Date Project Initiated: April 5, 1989, for transplantation of *E. capitatum* var. *angustatum* individuals; January 1990 for seedling outplanting.

IV.A.13. *Erysimum menziesii* (Menzies' Wallflower): State endangered; Federal Candidate C1; CNPS List 1B.

1) Respondent: Ms. Frederica Bowcutt, State of California Department of Parks & Recreation, Sacramento.

Project Name and Description: None. Project involved the reintroduction of *Erysimum menziesii* and *Chorizanthe howellii* to archeological sites at MacKerricher State Park (Mendocino County) after an archeological dig. University of California, Davis, initiated an archeological dig in 1989-90 at sites containing rare species. (see IV.A.6 for more details.)

Mitigation-Related?: Yes.

Project Objectives: None stated.

Project Methods: Seed was collected in the summer of 1989 from the plants on site before the archeological dig was initiated. Plug plants were grown at the California Conservation Corps (CCC) Napa nursery and outplanted in February 1990 by the CCC. Plants were monitored by an undescribed photo monitoring technique. Outplanted plants also were counted and mapped. Initial costs for the project were: (1) salary $800.00; (2) travel $400.00; and, (3) plants $200.00, for a total of $1400.00.

Criteria for Success: None stated.

Project Success: Project on-going. Information not yet available.

Date Project Initiated: July 1989.

2) Respondent: Ms. Frederica Bowcutt, State of California Department of Parks & Recreation, Sacramento, and data obtained from EPP files.

Project Name and Description: "Spanish Bay." Project involved the reintroduction of *Erysimum menziesii*, *Lupinus tidestromii* var. *tidestromii*, and *Gilia tenuiflora* ssp. *arenaria* to the dunes surrounding the Links at Spanish Bay (Monterey County). (see IV.A.15 and IV.A.22 for more details.)

Mitigation-Related?: Yes.

Project Objectives: To increase the numbers of the three rare plant species and either enhance existing populations or create new stands.

Project Methods: Seed was collected from a population at Asilomar and propagated at Spanish Bay Nursery. Outplanting of seedlings was to occur during the winter rainy season. The populations were to be fenced and signed, and a boardwalk constructed to route foot traffic past the outplantings. Regular maintenance is to include weeding of invasive species.

Criteria for Success: Survivorship of 80% for the total outplanted seedlings in the first

year, and a total of 70% of the plants within each distinct outplanting site. Should survivorship fall below these standards, replanting would be required to occur during the next rainy season.

Project Success: Respondent reports that the project appears successful, although no information held in the EPP files confirmed this.

Date Project Initiated: 1987.

3) Respondent: Dr. John Sawyer, Department of Biology, Humbolt State University, Arcata.

Project Name and Description: None. Project involved a three-year research project to study the biology of *Erysimum menziesii* and mitigation techniques. The research was supported by a timber company to mitigate the impacts of their harvest operation.

Mitigation-Related?: Yes.

Project Objectives: Stated objectives were to determined a viable population size and ways of habitat restoration to achieve a viable population size.

Project Methods: The current research project has not included any transplantation, relocation or reintroduction at this date. However, 30 permanent plots in existing populations are monitored quarterly, and have been so for the last two and one-half years. Project costs were given at $650,000.00.

Criteria for Success: Criterion was stated somewhat vaguely as when the existing population exceeds in size that projected by computer modeling.

Project Success: Project was still in progress at the time of the questionnaire.

Date Project Initiated: 1988 is the date given for the beginning of the project, although seed collection commenced in April of 1989.

IV.A.14. *Erysimum teretifolium* (Santa Cruz Wallflower): State endangered; Federal Candidate C1; CNPS List 1B.

Respondent: None. Data obtained from EPP files.

Project Name and Description: "Revegetation of the Olympia Quarry." The revegetation is to be done in compliance with conditions stipulated in a mining permit administered by Santa Cruz County. The Olympia Quarry is operated by Lone Star Industries, Inc., and is located west of Scotts Valley. The quarry site is approximately 200 acres, the majority of which has been mined for coarse sand for construction.

The adjacent vegetation is considered biologically significant because it is a xeric environment of sand hills in the midst of more mesic vegetation. Some of the rare elements on the quarry site include rare disjuncts or unusual flower color morphs.

Mitigation-Related?: Yes.

Project Objectives: The goal of the revegetation is to establish the Santa Cruz wallflower on the mined slopes and benches of the Olympia Quarry. In addition, a revegetation plan will attempt to recreate the native plant associations on the previously mined areas.

Project Methods: Larry Seeman and Associates, Inc. (LSA 1989) proposes to collected 50% of all the seed produced by a group of 300 plants growing in the eastern section of the quarry. The planting areas are composed of 15-ft wide benches at 60-ft intervals along a 1.5:1 slope. The seeding regime is to replicate the density of the *Erysimum teretifolium* in undisturbed communities.

Criteria for Success: Criteria will be developed by quantitatively sampling the vegetation in areas with *Erysimum teretifolium*.

Project Success: Project is not yet implemented. Information not yet available.

Date Project Initiated: Revegetation Plan initially submitted by LSA Associates, Inc. in July 1987 (LSA 1987, 1989). The project has not yet begun, however.

IV.A.15. *Gilia tenuiflora* ssp. *arenaria* (Sand Gilia): State threatened; Federal Candidate C1; CNPS List 1B.

Respondent: Ms. Frederica Bowcutt, State of California Department of Parks & Recreation, Sacramento, and data obtained from EPP files.

Project Name and Description: "Spanish Bay." Project involved the reintroduction of *Erysimum menziesii*, *Lupinus tidestromii* var. *tidestromii*, and *Gilia tenuiflora* ssp. *arenaria* to the dunes surrounding the Links at Spanish Bay (Monterey County). (see IV.A.12(2) and IV.A.22 for more details.)

Mitigation-Related?: Yes.

Project Objectives: To increase the numbers of the three rare plant species and either enhance existing populations or create new stands.

Project Methods: Seed was collected from a population at Asilomar and propagated at Spanish Bay Nursery. Seeds of sand gilia need stratification and scarification with differing daylength and temperature regimes. Outplanting of seedlings was scheduled to occur during the winter rainy season. The populations were to be fenced and signed, and a boardwalk constructed to route foot traffic past the outplantings. Regular maintenance was to include weeding of invasive species.

Criteria for Success: Survivorship of 80% for the total outplanted seedlings in the first year, and a total of 70% of the plants within each distinct outplanting site. Survivorship was to be compared in outplanting sites with existing populations in an attempt to account for annual fluctuations that may be environmentally controlled. Should survivorship fall below these standards, replanting would be required to occur during the next rainy season.

Project Success: Respondent reports that the project appears successful, although no information in the EPP files confirmed this.

Date Project Initiated: 1987.

IV.A.16. *Hemizonia increscens* ssp. *villosa* (Gaviota Tarplant): State endangered; Federal Candidate C1; CNPS List 1B.

Respondent: Mr. John Storrer, Storrer & Semonsen Environmental Services, Santa Barbara.

Project Name and Description: "Gaviota Interim Marine Terminal, Santa Barbara County, California." Mitigation was required for the construction of a secondary access road to the marine terminal.

Mitigation-Related?: Yes.

Project Objectives: The stated objective was the establishment of 5,800 ft^2 of *Hemizonia increscens villosa* habitat.

Project Methods: The impacted site was surveyed for *Hemizonia increscens* ssp. *villosa* and it was determined that approximately 50 individuals lay within the access road alignment. There are considerably more individuals found adjacent to the area (approximately 400-600 individuals). Seed was obtained from plants collected from the tank farm area prior to construction. An additional 2-3 inches of topsoil was retrieved before grading. More topsoil (3 inches) also was removed from the access road alignment during grading. The receptor site is on California Department of Parks and Recreation property east of the Texaco Interim Marine Terminal. No further site preparation was attempted prior to broadcasting of seed. The receptor site was fenced with three strands of barbless wire to delineate boundaries, and the project was signed.

Additional (approximately) 50 tarplant seedlings were discovered during an inspection of the site in March 1989. Adjacent weedy vegetation was clipped within a 6 inch radius of many of the plants to decrease competition.

Criteria for Success: Performance criteria included: (1) no evidence of soil erosion; and, (2) presence of a viable *H. increscens* ssp. *villosa* population. The latter was determined by comparing the density of flowering plants during the peak growing period with that of

the surrounding populations.

Project Success: An intensive survey was conducted on May 24, 1989, that recorded 136 flowering tarplants, with an additional nine plants that had died or seeded. The first year densities of 1.2, 2.69 and 1.28 individuals per m^2 recorded were favorable in comparison with the Chevron restoration site. The project is on-going; however, the respondent felt that the first year's results were promising. More information is not yet available.

IV.A.17. *Hemizonia minthornii* (Santa Susana Tarplant): State rare; Federal Candidate C2; CNPS List 1B.

1) Respondent: None. Data obtained from EPP files.

Project Name and Description: "Santa Susana Tarplant (*Hemizonia minthornii*) Mitigation Program 2." Las Virgenes Municipal Water District built a new water reservoir adjacent to its existing reservoir in the Twin Lakes area near Chatsworth. Mitigation for this project involved the salvaging of *Hemizonia minthornii* plants, and transplanting the salvaged plants and some nursery plants grown from seed on the 250 m^2 cut slopes surrounding the new reservoir.

Mitigation-Related?: Yes.

Project Objectives: The overall project objective was to establish a new population of Santa Susana tarplants on the cut slopes surrounding the new water reservoir.

Project Methods: The project site boundaries were staked prior to the initiation of the construction. Seeds were collected in the summer of 1988 at a time considered by the consultants as not phenologically optimum for success -- *i.e.*, while the plants were in full bloom. Individual plants were located in either rock crevices or on thin soil in open areas. A pick mattock was used to break up the sandstone crevices to remove the top portion of the root, but the root was very deeply embedded in the substrate and could not be removed without breaking.

Potting mix was brought to the site and mixed with clean sand and soil from the site. Each transplanted plant was trimmed with clippers to compensate for the loss of the root system, and then potted. Each transplant was watered several times before transportation to Tree of Life Nursery. Cuttings were taken from the transplants and retained for their inflorescences and to attempt root cuttings. A total of 55 plants were potted, representing approximately 70% of the mature plants within the impacted area. Approximately 50% survived the initial transplantation operation; however, cutting survival and seed germination were poor (McClelland Consultants (West), Inc. 1988). None of the initial seed sown germinated (McClelland Consultants (West), Inc. 1988). A second collection of seed made in October 1988 was germinated at Tree of Life Nursery to compensate for the losses.

As of February 1989, however, only 8 of the 55 transplants have survived. During 1990, the site was visited and monitored only 4 times, as the plants appeared to show signs of naturalizing to the cut slope.

Criteria for Success: Performance criteria included the following: (1) 15 surviving mature plants from the transplants by May 1989; (2) 50 seedlings by May 1989; (3) 10 mature plants flowering by October 1989; (4) 30 mature plants by October 1990; (5) 100 seedlings by October 1990; (6) 50 mature plants by October 1991; (7) 70 mature plants with ground coverage of about 25 m^2 by October 1992 (McClelland Consultants (West) 1988).

Project Success: The project success has not been evaluated only because the project technically is still on-going. However, the survival of 8 of the 55 transplants, only 7 of which are doing well, is rather poor (McClelland Consultants (West) 19908). The project has been rather controversial (see article in the Los Angeles Times, February 3, 1989, p. 3, 14).

Date Project Initiated: July 1988 for the initial collection of seed and excavation of plants in the impacted area: January 1989 for the transplantation of salvaged plants.

2) Respondent: None. Data obtained from EPP files.

Project Name and Description: "Woolsey Canyon Development." Chateau Builders proposed in 1989 to construct an extensive residential community in Woolsey Canyon, western Los Angeles County. The project site is located in a sensitive ecological areas as designated by Los Angeles County. An environmental assessment performed by Michael Brandman & Associates (November 1988) identified that the proposed project would result in the direct loss of approximately 57 individuals of *Hemizonia minthornii*, in a population of approximately 147 individuals.

Mitigation-Related?: Yes.

Project Objectives: The primary objective of the mitigation plan will be: (1) to establish on the development site, a second population of *Hemizonia minthornii*, using propagules derived from individuals in the original population that is impacted by the development. The new population should be capable of natural regeneration over the long term; (2) offset of the loss of approximately 57 individuals of *Hemizonii minthornii* with the introduction of approximately 150 individuals as a founder group in a new population; and, (3) advance the state of knowledge of *Hemizonii minthornii* by carrying out appropriate research-related activities in conjunction with mitigation activities (Mistretta 1989).

Project Methods: The plants occur within a single population on a sandstone outcrop on the project site. The original development plan was designed to include 90 individuals in a reserve that would be bordered by the development. However, after consultation with CDFG, the reserve site was reconfigured to be continuous with an adjacent natural area on the southern boundary of the project, rather than being an island within the development (Mistretta 1989).

The Rancho Santa Ana Botanic Garden (RSABG) has been retained by the Chateau Group to advise on the horticultural and research-related aspects of the program. Data to be

gathered are: (1) number of individuals on site; (2) soil analyses; (3) population statistics; (4) reproductive capacity; (5) genetic composition; and, (6) floristic composition of the community.

The proposed revegetation program indicates that prior to the commencement of construction, the preserve site will be fenced and left undisturbed. The remaining Santa Susana tarplants will have the infructescences removed by hand at the appropriate season. Additional seed collection will be done if deemed necessary. Collected seed will be cleaned and dried prior to storage.

Half the collected seed will be sown in the preserve after the transplantation of salvaged individuals (see below). The remaining half will be propagated at RSABG for seedling transplantation.

In addition, the mature plants in the impacted area will be salvaged by digging with a shovel and pick mattock to a depth of 1 ft. Plants will be placed in planters for temporary off-site storage. Plants will be trimmed and watered 3 times during the first week and weekly thereafter until transplanted.

Transplant receptor sites within the preserve will be selected by a botanist/horticulturalist. Plants will be planted without mulch or fertilizers, and watered weekly for 4 weeks. The project site will be checked monthly by the botanist/horticulturalist for an undetermined period.

IV.A.18. *Holocarpha macradenia* (Santa Cruz Tarplant): State endangered; Federal Candidate C1; CNPS List 1B.

1) Respondent: None. Data obtained from EPP files.

Project Name and Description: "Hilltop Commons Development." The Nylen Company, Inc., developed an apartment complex in Pinole, Contra Costa County. Dr. Neil Havlik, then of the East Bay Regional Park District, agreed to perform a salvage of the mature

individuals of *Holocarpha macradenia* from the project site and transplant them to a nearby park within the East Bay Regional Park District.

Mitigation-Related?: Yes.

Project Objectives: None specifically stated, but the project was designed to salvage the mature plants of *Holocarpha macradenia* from a housing development site in Pinole, and subsequently establish a new population of *H. macradenia* at Wildcat Canyon Regional Park.

Project Methods: Pallets of soil, 4 ft^2 by 1 ft deep, containing *Holocarpha macradenia* plants were dug and seed was collected from these plants. Seed from the salvage was taken by Dr. Havlik and spread as an enlargement of several existing populations in Wildcat Canyon Park (Havlik's Stand Nos. 2, 11, 12, 13, 14, 15; [CNDDB Occ. Nos. 2, 29, 31 for the first three locations]). Seed also was spread at a site in Sather Canyon on the east side of San Pablo Reservoir.

Criteria for Success: None stated.

Project Success: Havlik monitored 21 populations, 7 of which were new populations, and reported an increase of 30% of the individuals from 1985 to 1986[10].

Date Project Initiated: September 13, 1986.

IV.A.19. *Lasthenia burkei* (Burke's Goldfields): State endangered; Federal Candidate C2; CNPS List 1B[11].

1) Respondent: Mr. Charlie Patterson, Plant Ecologist, private consultant, El Cerrito, and

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[10]See letter to Ms. Susan Cochrane, [formerly] Endangered Plant Coordinator, from Dr. N. Havlik, [formerly of the] East Bay Regional Park District, dated March 9, 1987.

[11]Mr. Ken Milam, Sonoma County Planning Director, returned a questionnaire for *Lasthenia burkei*, but the information provided was so vague as to be useless for this analysis. Therefore, the questionnaire is not included.

data obtained from EPP files.

Project Name and Description: " Airport Boulevard Business Park." A business park was constructed in 1984, located just northeast of the Sonoma County Airport.

Mitigation-Related?: Yes.

Project Objectives: The stated objective for the mitigation for the business park was the replacement of 0.3 acres of wetlands and pre-existing 5000 individuals of *Lasthenia burkei* with, at minimum, 10,000 individuals.

Project Methods: Seed was collected in 1984. Small pools were created by hand, clearing vegetation and topsoil in low swales within an 100 ft easement. These pools were seeded during the winter of 1985-1986. However, much of the easement was disturbed by the installation of a large storm drain before the seeding trials could be assessed. However, new larger pools were created later by a bulldozer-mounted blade during the fall of 1986, and seeded that year.

Criteria for Success: Essentially the replacement of a self-sustaining colony of *Lasthenia burkei* was the criterion for success.

Project Success: Respondent felt that the project was successful. The mitigated seeded population increased from no *Lasthenia burkei* to >6000 individuals in three years. However, due to additional complications, the pools were "re-worked" (*i.e.*, enlarged, re-contoured and re-seeded). The current year's results show in excess of 10,000 individuals.

2) Respondent: Mr. Charlie Patterson, Plant Ecologist, private consultant, El Cerrito, and data obtained from EPP files.

Project Name and Description: "Sonoma County Airport". This project involved the construction of a new, paved apron at the Sonoma County Airport in 1986.

Mitigation-Related?: Yes.

Project Objectives: Objectives stated by the respondent for the airport expansion project was the replacement of the colony of *Lasthenia burkei* lost during construction.

Project Methods: Eleven small artificial pools were created by shovel and hoe in a broad, nearly level portion of the infield between the north end of Runway 14 and Taxiway Y. Pools were made by selecting a low spot and then scraping 1 to 6 inches of the surface. The scraped soil was piled into small berms around the downslope edges of the pools. Pools were seeded the day of construction.

Seed was sown both as seed collected in 1985 and from other existing populations 0.5 miles away, and by spreading the scraped topsoil from nearby colonies. These were then left alone for most of the winter and spring. Pools were monitored, which involved checking them for water collection and holding capacity, *Lasthenia burkei* germination, phenology, and reproduction.

Criteria for Success: Essentially the replacement of a self-sustaining colony of *Lasthenia burkei* was the criterion for success.

Project Success: Respondent felt that the project was successful. Seeded areas of existing ditches now support several thousand individuals of *Lasthenia burkei*, and another several thousand are growing in the constructed pools.

3) Respondent: Carl Wilcox, California Department of Fish and Game, Yountville, and data obtained from EPP files.None. Data obtained from EPP files.

Project Name and Description: "Santa Rosa Rare Plants Mitigation Plan San Miguel Estates 1." In 1989 Cobblestone Development Corporation proposed the development of San Miguel Rancho Subdivision (RSM) at 2001 Waltzer Road within the city of Santa Rosa, Sonoma County and San Miguel Estates No. 2 (SME) at 2192 Francisco Avenue, also within Santa Rosa. The SME project is an on-going housing construction and the RSM housing project was a 1989 development. The projects would destroy approximately

2.51 acres of vernal pool habitat. (see IV.A.2(2) for more details.)

Mitigation-Related?: Yes.

Project Objectives: According to the Mitigation Agreement between Cobblestone and CDFG, the mitigation should establish self-sustaining populations of plants in approximately 2.97 acres of newly created habitat on the mitigation site. Self-sustaining is defined as approximately 13,000 individuals of *Lasthenia burkei* and 137,000 individuals of *Blennosperma bakeri* for 2 consecutive years without supplemental seeding.

Project Methods: The mitigation plan was devised by R. Osterling, Inc. (1989). The plan proposed to transplant all existing plants and/or seeds to a 20-acre receptor site located approximately 1.5 miles west of the San Miguel Estates property, with existing 3.49 acres of vernal pool resources. Approximately 2.5 acres of vernal pool habitat will be constructed at the receptor site with pool configuration and depth based on survey of existing pools. Grading will be done with small equipment under supervision of a qualified botanist (Charlie Patterson, private consultant). Plant material will be "transferred." Seed will be collected from donor pools and the top 1-2 inches of pool bottom duff will be excavated and spread in the excavated pools at the receptor site. Monitoring will continue through June 1991.

Criteria for Success: None explicitly stated.

Project Success: Respondent indicated that although it was too early to tell because the projects are only in their first year, "[e]arly indications are that they will be the most successful relocations yet achieved in the Santa Rosa Area."

Date Project Initiated: March 1989.

4) Respondent: WESCO, Novato.

Project Name and Description: "County of Sonoma Public Service Area 31 Waste Water Storage Pond." The project involved the creation of a wastewater storage pond in 1988 on

approximately 3.7 acres of northern vernal pool, seasonal marsh and intermittent stream habitat (and 10 acres of non-native grassland). *Lasthenia burkei* was transplanted to an area known as "The Wildflower Preserve" on the Sonoma County Airport. The receptor site is already protected as part of the Sonoma County Airport mitigation.

Mitigation-Related?: Yes.

Project Objectives: The project objective was to create 4.4 acres of seasonal wetland habitat and to provide a transplantation site for *Lasthenia burkei*.

Project Methods: Seed was collected from plants at the impacted site. Plants in bloom were salvaged, kept in containers until seeded and seed subsequently was collected to be sown at the mitigation site. Topsoil was salvaged from around the plants to spread at the new sites.

The number of individuals are to be counted for each of five years.

Criteria for Success: Criteria have not been established.

Project Success: "Although the criteria have not been established, we feel that, for at least the first year of monitoring, the transplantation was somewhat successful. . . . Of course, long term viability of the population is still questionable." Approximately 1000 individuals were observed at the mitigation site, while only 150 plants were found at the impacted site.

Date Project Initiated: 1988.

IV.A.20. *Lilaeopsis masonii* (Mason's Lilaeopsis): State rare; Federal Candidate C2; CNPS List 1B.

1) Respondent: Mr. Niall McCarten, Department of Integrative Biology, University of California, Berkeley, and Department of Water Resources (DWR), Sacramento (questionnaire unsigned).

Project Name and Description: "California Department of Water Resources (DWR) Barker Slough Bank Revetment." The project was initiated in 1989 by DWR for levee bank

protection on private property. Individuals of *Lilaeopsis masonii* were transplanted from the east side of the slough to the west side.

Mitigation-Related?: Yes.

Project Objectives: Project objectives were the removal of *Lilaeopsis masonii* from the proposed rip-rap site and the transplantation of individuals to suitable habitat.

Project Methods: Populations of *Lilaeopsis masonii* were removed with a shovel, placed in shallow water in plastic containers and then placed in a boat and transported to the potential habitat (receptor site). After placing the transplant into the new site, the surrounding substrate was pressed along the edges to homogenize the substrate.

Eighteen (18) 50 x 50 cm permanent plots were established, and marked with numbered, color-coded metal stakes (ECOS, Inc. 1988). Control populations were marked similarly. All plants were to be counted in each plot five times during the first two years following transplantation, and three times per year for the following three years.

The receptor site initially was not protected, but due to the biological values of the site, it was purchased by CDFG as a preserve in January 1990.

Criteria for Success: Specific criterion was the survival of 80% or better of the individuals transplanted over a 5-year monitoring period.

Project Success: Unknown, as the project is on-going. One year of raw data is available from Mr. David Brown, DWR. DWR respondent claims that it is too early to make a determination as to whether the project is successful.

Date Project Initiated: April 1989

2) Respondent: Ms. Frederica Bowcutt, State of California Department of Parks & Recreation, Sacramento.

Project Name and Description: None. Project is being considered; may involve the transplantation of *Lilaeopsis masonii* at Brannan Island State Recreational Area near Rio

Vista (Contra Costa County).

Mitigation-Related?: Yes.

Project Objectives: Project still being planned. None stated.

Project Methods: Project still being planned. None stated.

Criteria for Success: Project still being planned. None Stated.

Project Success: Project still being planned. Not applicable.

Date Project Initiated: Not yet initiated.

IV.A.21. *Lupinus milo-bakeri* (Milo Baker's Lupine): State threatened; Federal Candidate C2; CNPS List 1B.

Respondent: None. Data obtained from EPP files.

Project Name and Description: None. In 1985, California Department of Transportation (Caltrans) performed road maintenance along State Highway 162 (Mendocino Pass Road) near the city of Covelo (Mendocino County). The mitigation project was to offset the impacts of this activity.

Mitigation-Related?: Yes.

Project Objectives: None stated explicitly, but the project was to establish several new populations to offset the loss of *L. milo-bakeri* during highway maintenance.

Project Methods: Caltrans collected seed from the CNDDB occurrence #2 for *Lupinus milo-bakeri* from August through September 1985. Not more than 15% of the population's annual seed crop was collected. Prior to seeding, the collected seed was rinsed, and the seed beds prepared by adding topsoil from the parent population. In October 1985, Caltrans planted the seed in areas of suitable habitat along Highway 162 between post mile markers (PM) 31.50 and 31.61, and from PM 32.00 to 32.14, as well as planted seed in suitable habitat near the Caltrans equipment yard near Covelo.

Criteria for Success: None stated.

Project Success: In some of the plots, there was considerable competition from annual grasses. Caltrans annually sprays the highway edges with herbicide, and this added to the growth of *L. milo-bakeri* in the seeded areas.

Date Project Initiated: August 1985.

IV.A.22. *Lupinus tidestromii var. tidestromii* (Tidestrom's Lupine): State endangered; Federal Candidate 1; CNPS List 1B.

Respondent: Ms. Frederica Bowcutt, State of California Department of Parks & Recreation, Sacramento, and data obtained from EPP files.

Project Name and Description: "Spanish Bay." Project involved the reintroduction of *Lupinus tidestromii* var. *tidestromii, Erysimum menziesii*, and *Gilia tenuiflora* ssp. *arenaria* to the dunes surrounding the Links at Spanish Bay (Monterey County). (see IV.A.13(2) and IV.A.15 for additional details)

Mitigation-Related?: Yes.

Project Objectives: To increase the numbers of the three rare plant species and either enhance existing populations or create new stands.

Project Methods: Seed was collected from a population at Asilomar and propagated at Spanish Bay Nursery. Seeds of *Lupinus tidestromii* var. *tidestromii* need stratification and scarification with differing daylength and temperature regimes. Outplanting of seedlings was to occur during the winter rainy season. The populations were to be fenced and signed, and a boardwalk constructed to route foot traffic past the outplantings. Regular maintenance was to include weeding of invasive species. Monitoring will continue until 1993.

Criteria for Success: Survivorship of 80% for the total outplanted seedlings in the first year, and a total of 70% of the plants within each distinct outplanting site. Should survivorship fall below these standards, replanting would be required to occur during the

next rainy season.

Project Success: Respondent reports that the project appears successful, although no information in the EPP files confirmed this.

Date Project Initiated: 1987.

IV.A.23. *Mahonia nevinii* (Nevin's Barberry): State endangered; Federal Candidate C1; CNPS List 1B.

Respondent: None. Data obtained from EPP files.

Project Name and Description: None. The RANPAC Corporation proposed the construction of Vesting Tentative Tract No. 23267 that would impact a population of *Mahonia nevinii* on the Old Vail Ranch property. Although 12 plants are found on the property, the mitigation project involved the relocation of a single plant.

Mitigation-Related?: Yes.

Project Objectives: None stated explicitly.

Project Methods: The impacted plant would undergo crown division and root cuttings. These would be transplanted in the late fall (no more details were provided). The success of the transplantations would be monitored for three years following transplantation. Seed was to be collected in the summer of 1989 to be propagated in a nursery and maintained until the success of the transplantation efforts could be adequately assessed.

Criteria for Success: Success would be based on the number of (trans)plants that grow and reproduce.

Project Success: Unknown. No information available in EPP files.

Date Project Initiated: Fall 1988.

IV.A.23. *Monardella linoides ssp. viminea* (Willowy Monardella): State endangered; Federal Candidate C3; CNPS List 1B.

Respondent: None. Data obtained from EPP files.

Project Name and Description: None. Mitigation was required for the California Department of Transportation (Caltrans) construction in 1983 of an I-15 gap closure and the construction of State Route 52 from I-805 to Santo Road.

Mitigation-Related?: Yes.

Project Objectives: The project objective was simply to offset losses of this plant species caused by construction of the highway projects.

Project Methods: For the State Route 52 project, Caltrans collected a total of 55 individual *M. linoides* ssp. *viminea* plants within the impacted area, and collected green cuttings of this species for reintroduction into suitable habitat within the project area. For the two projects together, Caltrans collected no more than 50% of each year's seed from populations within the impacted area. Prior to broadcasting of seed, Caltrans reviewed existing sites to characterize the ecological parameters of the species.

Criteria for Success: None stated explicitly.

Project Success: Progress reports were submitted in November 1983, April 1984, June 1985, and May 1986. The 1986 report stated that from June 1985 to December 1985, approximately 389 (additional) seedlings died, from the earlier total of 509 plants. This was the result of overcrowding in the nursery.

Two of the original 16 containerized salvaged plants died by June 1985. By December 1985, an additional eight plants had died.

Findings in the 1986 report were: (1) salvaged *M. linoides* ssp. *viminea* plants required parent soil to survive; (2) plants in nursery conditions need to be aggressively pruned; (3) nursery containers must be widely spaced; (4) *M. linoides* ssp. *viminea* is easily propagated from seed and cuttings, and, (5) transplantation would be at a suitable site in Murphy Canyon.

Date Project Initiated: 1983.

IV.A.25. *Oenothera deltoides* ssp. *howellii* (Antioch Dunes Evening Primrose): State endangered; Federally endangered; CNPS List 1B.

Respondent: Ms. Joy Albertson, U.S. Fish and Wildlife Service, San Francisco Bay National Wildlife Refuge Complex.

Project Name and Description: "Vaca Dixon-Contra Costa 230-kV Reconductoring Project: Habitat Protection and Enhancement for Antioch Dunes." Pacific Gas and Electric Company (PG&E) reconductored the San Joaquin River crossing of the Vaca Dixon-Contra Costa 230 kV transmission line in the fall of 1988. The project took place specifically on the Sardis Unit of the Antioch Dunes National Wildlife Refuge (ADNWR), east of the town of Antioch. USFWS personnel conducted a Section 7 consultation with PG&E before granting access permit. (see IV.A.12 for more details.)

Mitigation Related?: Yes.

Project Objectives: Objectives were: (1) protection of habitat from future damage caused by construction/repair activities; (2) transplantation of listed species from access corridor to allow vehicle access to the tower; (3) establishment of new subpopulations of *Oenothera deltoides* ssp.*howellii* (and *Erysimum capitatum* var. *angustatum*); (4) enhancement of existing populations; and, (5) determination of whether direct seeding or transplantation of nursery liners is preferable.

Project Methods: Plants from the PG&E east parcel access corridor were transplanted either to other locations on the parcel or to the Sardis Pit area. A small circular area was first cleared of all vegetation, then an appropriately sized hole was dug. A plant was placed in the hole and soil was firmly packed around it. Nursery grown plants were planted in a similar manner in pre-selected sites on the PG&E and Sardis Pit Parcels.

Seed germination for *Oenothera deltoides* ssp. *howellii* was poor: only 10 seedlings survived to be planted. More seedlings were to be outplanted in December 1990. Cost of

the nursery-grown seedlings was estimated at $0.30/seedling; 377 seedlings produced; therefore it cost $113.10.

Criteria for Success: The replacement of the plants that were destroyed by the construction, specifically 160 *O. deltoides* ssp. *howellii* seedlings and 230 *E. capitatum* var. *angustatum* seedlings was the criterion.

Project Success: Respondent felt that the project was partially successful.

Date Project Initiated: April 5, 1989, for transplantation; January 1990 for seedling outplanting.

IV.A.26. *Opuntia basilaris ssp. treleasei* (Bakersfield Cactus): State endangered; Federal endangered; CNPS List 1B.

1) Respondent: James Brownell, California Energy Commission, Sacramento.

Project Name and Description: "Kern River Cogeneration Power Plant Project." Project involved the construction of a cogeneration power plant along the Kern River in 1983-85.

Mitigation-Related?: Yes.

Project Objectives: Objective of the mitigation project was to keep the cactus located at the edge of the road from being destroyed by truck traffic during construction.

Project Methods: Cactus pads were collected and allowed to callus. Approximately two weeks later, the pads were taken to the transplantation site. The receptor site is within the California Living Museum (CALM) property, a non-profit, privately-run educational program. CALM is located east of Bakersfield within the native range of *Opuntia basilaris* var. *treleasei*.

The receptor site had been weeded to remove non-native annual grasses, and soil had been loosened to allow the callus end of the pads to be placed in the soil. One hundred fifteen (115) cactus pads were positioned in nine (9) clumped in two (2) nearby areas. The receptor site was visited each year for three (3) years, and grasses were cleared at each

visit.

Criteria for Success: Success was achieved if the cactus flourished at the site.

Project Success: The project was considered successful, because the new plants were established wherever pads were planted.

Date Project Initiated: October 1983.

2) Respondent: Rick York, California Energy Commission, Sacramento, and data obtained from EPP files.

Project Name and Description: "Sycamore Cogeneration Project." Project involved the mitigation of operation activities of the Sycamore Cogeneration Company. A population of *Opuntia basilaris* var. *treleasei* became vulnerable to loss from erosion on a slope that was cut prior to construction of the project.

Mitigation-Related?: Yes.

Project Objectives: Sycamore Cogeneration Company, as part of the conditions of certification by the California Energy Commission, agreed to protect *Opuntia basilaris* var. *treleasei* in the main power plant area, pipeline right-of-ways, transmission line right-of-ways, access roads and the fuel oil storage area. If the Bakersfield cactus was disturbed, Sycamore agreed to transplant the affected stands to another area within the project vicinity in a manner similar to that described for the Kern River Cogeneration Project.

Project Methods: No details are provided in the Mitigation Agreement (MA). Information in EPP files indicates that Sycamore Cogeneration Company objected to the five-year monitoring stipulation in the MA.

Criteria for Success: No information was received.

Project Success: No information was received.

Date Project Initiated: 1989.

IV.A.27. *Orcuttia viscida* (Sacramento Orcutt Grass): State endangered; Federal Candidate C1; CNPS List 1B.

Respondent: Mr. Barry Hecht, Balance Hydrologics, Inc., Berkeley.

Project Name and Description: "Sunrise/Douglas Wetland Protection and Creation Program", Sacramento County. Project involved mitigation for two housing developments along Sunrise Boulevard, Sacramento County. Techniques for mitigation relocation/transplantation are "pending."

Mitigation-Related?: Yes.

Project Objectives: The objective for both projects was to re-establish species in vernal pools and freshwater seasonal wetlands within a 350-acre wetland preserve.

Project Methods: Methods are "pending."

Criteria for Success: Respondent reports two specific criteria: 1) Survival for 5 years in 90% of the pools and wetlands to which individuals of *Orcuttia viscida* are transplanted; and, 2) noticeable vigor and expansion of the range of *Orcuttia viscida* in 50% of the pools/wetlands into which individuals are transplanted.

Project Success: Decision of success is "pending."

Date Project Initiated: Project is "on-going;" presumably construction has not yet begun.

IV.A.28. *Pentachaeta lyonii* (Lyon's Pentachaeta): State endangered; Federal Candidate C1; CNPS List 1B.

Respondent: Mr. Carl B. Wishner, Envicom Corporation, Calabasas.

Project Name and Description: "Lake Sherwood Golf Course." The mitigation that was prepared by Envicom Corporation involved a salvage and restoration plan for *Pentachaeta lyonii* at the Lake Sherwood Golf Course site in Ventura County. The planning unit (Planning Unit No. 1) consisted of a 163-acre golf course, driving range, clubhouse, 146 single-family lots, and 4 estate lots, ranging from 0.3 to 12.7 acres.

Mitigation-Related?: Yes.

Project Objectives: Project objectives included: (1) maintenance of at least one site occurrence of *Pentachaeta lyonii* in perpetuity; (2) maintenance of at least one occurrence in an undisturbed state until the majority has flowered and seeded; (3) harvest of mature seed to establish a "germ plasm" collection at the Rancho Santa Ana Botanic Garden (RSABG), and to establish a living collection; (4) removal of top soil at impacted site for seed collection; (5) development of a five-year monitoring program; and, (6) conduction of a phytosociological study to determine habitat parameters.

Project Methods: Seed of *Pentachaeta lyonii* was collected by hand and by using a portable hand vacuum, yielding 7.75 grams. It was held cryogenically by the RSABG. Just before site grading, a target soil removal from areas of high plant density (70 flats of soil) was conducted, followed by overall surface scraping and stockpiling of about 2 yd^3 of soil.

Salvaged soil was redistributed of 0.1 acre *ex situ* just prior to the first major fall storm (November 1988). A small amount of seed and three (3) flats of salvaged soil were distributed onto the preserved *P. lyonii* location.

Prior to the extirpation of the *Pentachaeta lyonii* site, a grid system of 1 m squares was established using string and nails. Presence and ranked order estimates of density for each square meter were recorded. The identity of all species present within the areal extent of *P. lyonii* was recorded. A random sample of 60 quadrats was investigated for species presence. These data were subjected to an ordination analysis, along with similar data from other sites of occurrence. The *ex situ* site was similarly gridded in the spring of 1989. All species were recorded, and each quadrat checked for *Pentachaeta lyonii*.

Criteria for Success: Respondent indicated that the plan did not specifically designate criteria for success.

Project Success: Success in the stated context was not achieved. The respondent suggested that the plan for salvage was inadequate.

Date Project Initiated: May 1988.

IV.A.29. *Pogogyne abramsii* (San Diego Mesa Mint): State endangered; Federally endangered; CNPS List 1B.

Respondent: Drs. C.H. Black and Paul Zedler, Dept. Biology, San Diego State University.

Project Name and Description: "Caltrans Del Mar Mesa Vernal Pools" and "U.S. Navy North Miramar Project Mitigation." As background, California Department of Transportation (Caltrans) had two major projects on Kearny Mesa that eliminated vernal pools. The first project was mitigated by the purchase of 26 acres of prime vernal pool habitat on Del Mar Mesa and a second acquisition of an additional 52 acres at Del Mar Mesa. This second acquisition was to be used in an experiment to create artificial pools capable of supporting *Pogogyne abramsii* and *Eryngium aristulatum* var. *parishii* (Zedler and Black 1988). Respondents did not explain the Miramar Project. (see IV.A.11 for additional information).

Mitigation-Related?: Yes.

Project Objectives: For both projects, the objective was to create vernal pool habitat for *Eryngium aristulatum* var. *parishii* and *Pogogyne abramsii*.

Project Methods: A set of 40 artificial basins was excavated in December 1986, and 387 were inoculated with material collected from the natural pools on Del Mar Mesa.

Criteria for Success: Respondents did not specifically designate criteria for success.

Project Success: Respondents feel that the projects are "not yet" successful because the rare species have not attained population densities found in the natural pools.

Date Project Initiated: December 1986.

IV.A.30. ***Pseudobahia peirsonii*** (Tulare Pseudobahia): State endangered; Federal Candidate C1; CNPS List 1B.

Respondent: John Stebbins, California State University, Fresno.

Project Name and Description: "Round Mountain Flood Control Project," initiated by the Fresno County Metro Flood District. Project plans are being drafted at this time.

Mitigation-Related?: Yes.

Project Objectives: Project plans are being drafted at this time. Not yet available.

Project Methods: Project plans are being drafted at this time. Not yet available.

Criteria for Success: Project plans are being drafted at this time. Not yet available.

Project Success: Not yet available.

Date Project Initiated: Presumably the project has not yet begun.

IV.A.31. ***Sedum albomarginatum*** (Feather River Stonecrop): Not State listed; Federal Candidate C1; CNPS List 1B.

Respondent: Sharon Villa, California Department of Transportation (Caltrans), Redding.

Project Name and Description: "Feather River Canyon Storm Damage Repair." The project involved the repair of the February 1986 storm damage to State Route 70 in Plumas County. Work included widening at three (3) spot locations where the highway was reduced to a single lane. Initially, the existing rock slopes were cut back approximately 15 feet to restore two traffic lanes. The roadway was later realigned away from the East Branch North Fork Feather River.

Mitigation-Related?: Yes (for a federal candidate).

Project Objectives: The overall goal of the mitigation project was to reduce the severity of project impacts on *Sedum albomarginatum*. Specific project objectives were : (1) avoid unnecessary or inadvertent damage to the population by restricting habitat disturbance to those areas that are located within the slope lines; (2) salvage individual *S. albomarginatum*

plants from project impact areas prior to construction, and reintroduce these plants on suitable slopes within the immediate area following construction; (3) collect information on the distribution, density, and microhabitat preferences of *S. albomarginatum* within the project area to guide reintroduction efforts; and, (4) monitor the survival of re-established plants for a period of five years to evaluate the effectiveness of transplantation as a mitigation measure of *Sedum albomarginatum.*

Project Methods: An unspecified number of plants (up to 500 individuals) were salvaged from the impacted site, placed in a burlap bag and transferred to labeled flats. These were maintained in a lath house at the Butte College horticultural facility. The salvaged plants were returned to the area of origin and transplanted after the new highway slopes had been constructed. Two plantings were performed, one in Fall 1986 and the other in Spring 1987. Each plant was permanently marked with a numbered aluminum tag wired to a steel spike driven into the ground.

Criteria for Success: None were developed.

Project Success: One hundred fifty eight (158) plants were outplanted in Fall 1986 and an additional 158 were outplanted the following spring. Only 14 (8.8% survival rate) survived the fall transplant, and only three (3) individuals (1.9% survival rate) survived the spring transplant.

Date Project Initiated: June 1986.

IV.A.32. *Sidalcea pedata* (Bird-Footed Checkerbloom): State endangered; Federally endangered; CNPS List 1B.

Respondent: None. Data obtained from EPP files.

Project Name and Description: "*Sidalcea pedata* Transplantation Project." The project involved the construction of a store (Big Bear K-Mart) in the city of Big Bear Lake (San Bernadino County). The mitigation involved the transplantation of eleven (11) whole

plants.

Mitigation-Related?: Yes.

Project Methods: Terms of the Mitigation Agreement (MA) between CDFG and K-Mart Corporation stipulated that all four *Sidalcea pedata* plants on the impacted site were to be translocated to a protected site approximately 0.25 miles away, owned by The Nature Conservancy. However, by the time the MA was signed, several individuals of *S. pedata* were destroyed by equipment operations from an industrial contractor's yard adjacent to the K-Mart proposed site. The remaining twelve plants (10 mature and two seedlings) were transplanted by means of a Vermeer hydraulic spade during November 1988.

Site preparation included the removal of several tons of asphalt debris and light discing to reduce the compaction of the recipient area. The 0.9 acre parcel was fenced with a split rail around its entire perimeter.

Criteria for Success: None stated in the materials available for review.

Project Success: As of 16 May 1990, 10 of the 12 transplants survived to reproduce and one seedling transplant survived, despite two years of drought. This represents a 90% survival rate for the mature plants. T. Krantz, the contractor from Nativescapes responsible for the transplantation effort, suggests that the project was at least initially successful.

Date Project Initiated: November 1988.

IV.B. Endangered, Threatened, and Rare Plant Species Involved in Research-Related Transplantation, Relocation and Reintroduction Projects

IV.B.1. *Amsinckia grandiflora* (Large-Flowered Fiddleneck): State endangered; Federally endangered, CNPS List 1B.

Respondent: Mr. Kevin Shea, East Bay Regional Parks District (EBRPD), Oakland, and

data obtained from EPP files.

Project Name and Description: "*Amsinckia Grandiflora* Experimental Reintroduction." EPP contracted with Dr. Bruce Pavlik of Mills College, Oakland, to re-establish *Amsinckia grandiflora* at Black Diamond Mines Regional Reserve, a park within the East Bay Regional Park District (Pavlik 1990). The project included: (1) reintroduction of *Amsinckia grandiflora* to its historic location near Antioch, California ("Stewartville"), (2) monitoring the new population; and, (3) experimentally testing the effects of burning, clipping, and herbicide on survivorship and seed production of *Amsinckia grandiflora*. These results would be used to establish additional satellite populations of *Amsinckia grandiflora*.

Mitigation-Related?: No.

Project Objectives: Establishment of at least four new *Amsinckia* populations within its historic range in order to reduce the probability of extinction.

Project Methods: A 14 x 17 m plot was fenced with barbed wire to exclude livestock. Within the area, 20, 2 x 2 m plots of 4 treatments were selected by a stratified random design. Five plots served as controls, five plots were burned after sowing, five plots were hand-clipped, and five plots were sprayed with a dilute solution of a grass-specific herbicide (fluazifop-p-butyl, known as "Fusilade®", produced by the ICI Corporation).

Amsinckia grandiflora nutlets (3460 total), 1800 from a naturally occurring population (Site 300 source) and 1660 grown at the University of California at Davis were sown on October 19 and 20. Each plot was planted with 160 nutlets by pressing each into a shallow depression in the mineral soil. The nutlets were covered with approximately 20 cc of loose native soil to a depth of 1 cm. No supplements of water or nutrients were applied during the experiment.

Amsinckia grandiflora plots were monitored for the following parameters: (1) germination, (2) stress factors, (3) mortality, (4) phenology, (5) reproductive survivorship,

(6) pin-thrum ratio, and (7) nutlet output per plant and per plot.

Criteria for Success: Not explicitly stated, but the success of the reintroduction effort was based on the result that the maximum nutlet output in the experimental plots exceeded the predicted nutlet output (based on laboratory studies).

Project Success: Pavlik reported the project a success in its first year, based upon the production of approximately 35,000 seeds from 1140 individuals, representing a ten-fold increase over the number (3460) of individuals used in the experiment.

Date Project Initiated: October, 1989

IV.B.2. *Antennaria flagellaris* (Stoloniferous Pussytoes): Not state or federally listed, but meets CEQA criteria (§15380?) at the time of transplantation; CNPS List 4.

Respondent: Mr. Gary Schoolcraft, U.S. Bureau of Land Management, Susanville.

Project Name and Description: None. U.S. BLM initiated a transplantation project, moving a portion of a population consisting of approximately 10,000+ individuals, that at the time (1983), was considered the only known population in California. Transplantation was attempted as an experiment because it was believed that gold mining would return to the area, and the population was located at the edge of the previous mining activity.

Mitigation-Related?: No.

Project Objectives: Project was initiated to determine whether transplantation of *Antennaria flagellaris* could be used in the future as mitigation.

Project Methods: Plants were removed in groups from a large (>10,000+ individuals) by shovel. These were then transplanted immediately in flats to the relocation sites. Groups and soils were kept in tact, as much as possible. Some plants were watered with a vitamin B1 mixture, while others were not supplemented. No difference was observed in growth between these two groups.

Each summer following the transplantation, the total number of plants (both live

and dead) were counted. No transplanting report was prepared, but internal memoranda describing the transplantation and the concluding activities were prepared. Estimated cost of the transplantation was 1 work day per transplant.

Criteria for Success: Establishment and reproduction of the plants on site, to sufficient numbers to guarantee existence of the population.

Project Success: Not successful. Of the >400 plants transplanted into 4 different populations, only one newly established population exists. This consists of only 17 plants after 6 years. All other died. Schoolcraft suggested that because the plant is a short-lived perennial that reproduces vegetatively primarily by stolons, the receptor site may have had an inappropriate soil texture to allow adequate vegetative reproduction.

Date Project Initiated: October 1983.

IV.B.3. *Arabis macdonaldiana* (MacDonald's Rock Cress): State endangered; Federally endangered; CNPS List 1B.

Respondent: Purdee Bardwell, U.S. Bureau of Land Management (U.S. BLM) and Michael Baad, California State University, Sacramento.

Project Name and Description: "Geographic Distribution of Rare Plants on Public Lands Within the Red Mountain Study Area and A Study of the Population Dynamics and Reproductive Biology of McDonald's Rock-Cress [sic] (*Arabis macdonaldiana*)." The project was contracted by Dr. Baad with the U.S. BLM to determine the: (1) geographic distribution of rare plants on Red Mountain public lands; and, (2) population dynamics and reproductive biology of MacDonald's rockcress (Baad 1987).

Mitigation-Related?: No.

Project Objectives: The overall project objective of the contract was to determine why *Arabis macdonaldiana* is not more widely distributed within the rocky habitats of Red Mountain. The project was initiated in part in response to the 1984 Recovery Plan for

MacDonald's rock cress.

Project Methods: As part of this contract, in November 1985, Dr. Baad planted 30 1 m^2 plots with 100 *Arabis macdonaldiana* seeds each, over a wide range of habitats on Red Mountain. Several plots also received seedlings germinated from seed under greenhouse conditions. These were monitored during 1986.

Criteria for Success: None.

Project Success: The report notes that there was extremely poor germination success by *Arabis macdonaldiana* over the wide range of habitats into which they were outplanted. Dr. Baad concluded that this species has a relatively low rate of germination even in its preferred habitat. Also, the transplants did not do well, surviving in only 3 of the original plots. All but 5 of the original 25 transplants that remained were completely grazed and/or torn out of the ground by herbivores.

Date Project Initiated: Spring 1984.

IV.B.4. ***Arctostaphylos hookeri* var. *ravenii*** (Raven's Manzanita): State endangered; Federally endangered; CNPS List 1B.

Respondent: Ms. Terri Thomas, U.S. National Park Service, Golden Gate National Recreation Area, San Francisco.

Project Name and Description: "Raven's Manzanita Recovery Plan." The "relocation" project was initiated as part of the Raven's manzanita recovery plan.

Mitigation-Related?: No.

Project Objectives: To expand the number of individuals in the population, so that the single remaining individual could remain undisturbed.

Project Methods: Approximately 60 cuttings were taken and propagated by the Saratoga Horticultural Foundation and the University of California Botanic Garden. Later, 60 plants were outplanted in the Presidio in sites identified as similar to the original serpentine site of

the parent plant. Plants were watered periodically throughout the first season. An unreported number of seeds were collected, soaked in concentrated sulfuric acid for three hours, and then washed. They were then stratified in moist peat for three months at room temperature and then for three months in the refrigerator.

Criteria for Success: The criterion for success for the cuttings was simply survival. For the seeds, the criterion for success has not yet been determined, because they are still experimenting with collection times, germination techniques, *etc.* However, no mechanism for protection of the transplants has been initiated.

Project Success: Of the approximately 160 cuttings taken and grown at various local botanical gardens, 60 plants were eventually outplanted. It is not clear from the respondent whether any of these remaining 60 have died, but it appears that they have not.

Date Project Initiated: January 1987.

IV.B.5. ***Bensoniella oregana*** (Bensoniella): State rare; Federal Candidate C2; CNPS List 1B.

Respondent: Mr. Dave Imper, North Coast Chapter, California Native Plant Society, Eureka.

Project Name and Description: "*Bensoniella* Transplant Project." Project was initiated in 1979 by the Six Rivers National Forest because downcutting of stream channels appeared to threaten populations of *Bensoniella oregana*. Approximately 50 rosettes were removed from the Smokehouse Creek parcel and transplanted to Groves Prairie, east of Willow Creek, in similar habitat.

Mitigation-Related?: No.

Project Objectives. No specific objectives, although generally the Forest Service wanted to prevent the demise of the streamside populations of *Bensoniella oregana*.

Project Methods: Whole plants (rosettes) were removed from the Smokehouse Creek

Parcel (an outholding held by Six Rivers National Forest specifically for *Bensoniella oregana*), and transplanted to Groves Prairie, east of Willow Creek in a similar habitat of white fir (*Abies concolor*)/incense cedar (*Calocedrus decurrens*). Transplants were monitored from 1980-1985.

Criteria for Success: Not clearly defined, other than short-term survival. Respondent noted that a "rather inadequate" measure of vigor was included in the original monitoring plan.

Project Success: Success was not clearly defined, but some rosettes survived. During the first year, a large increase (>100%) in the number of rosettes and inflorescences was observed. However, there has been an apparent failure for these transplants to reproduce sexually. Respondent indicated that so little of the biology of this species is known that it is not clear whether *Bensoniella oregana* reproduces sexually anywhere or whether sexually reproduction is intermittent. Also, respondent indicates that the transplant population has declined significantly within the last year.

Date Project Initiated: 1978-79.

IV.B.6. *Cordylanthus palmatus* (Ferris' Bird's Beak): State endangered; Federal endangered; CNPS List 1B.

Respondent: Dr Larry Heckert, Jepson Herbarium, University of California, Berkeley.

Project Name and Description: None stated.

Mitigation-Related?: No.

Project Objectives: None stated. Presumably the objective of Dr. Heckert was to establish a self-sustaining population of *Cordylanthus palmatus* at the Mendota Wildlife Refuge.

Project Methods: An unspecified number of individuals was collected from somewhere outside the wildlife refuge and transplanted to the refuge. The population lasted for over 10 years, but eventually died out. At some time during this project, a naturally-occurring

population was discovered within the Mendota Wildlife Refuge.

Criteria for Success: None stated.

Project Success: Project was successful about a decade, but not for the long term.

Date Project Initiated: late 1970's.

IV.B.7. *Dudleya cymosa* ssp. *marcescens* (Santa Monica Mountains Dudleya): State rare; Federal Candidate C2; CNPS List 1B.

Respondent: Ms. D.A. Hoover, Woodland Hills, California.

Project Name and Description: "Soltice Canyon Native Plant Project." Volunteers from the California Native Plant Society (CNPS) proposed to eradicate invasive exotic species and replace them at Soltice Canyon Park with species native to the Santa Monica Mountains. This project included the reintroduction of *Hemizonia minthornii* and *Dudleya cymosa* ssp. *marcescens*. (see IV.B.8 for more details).

Mitigation-Related?: No.

Project Objectives: Objectives as stated were to expand the protected sites for the relatively rare native species and to learn practical methods for safe propagation without threatening native populations.

Project Methods: Individuals of *D. cymosa* var. *marcescens* were collected (salvaged) from along a road in Red Rock Canyon that was to be graded for fire-break maintenance. Approximately 7-8 individuals were lifted from the hard-packed roadside soil and transplanted to soil-filled pockets on a rocky berm on Humbolt Terrace at Soltice Canyon Park. Each plant was watered by hand for several months. The respondent suggested that the rocky setting protects the plants from gophers and also provides excellent drainage.

Plants were monitored by CNPS members through periodic inspections. Visits included weeding of competing exotics (*e.g.*, castor bean, tree tobacco, mustard, various thistles, *etc.*) and handwatering of additional native species. Total cost of the project was

$130.00 (gas @ $10.00 and paid assistance at $120.00).

Criteria for Success: None stated for *Dudleya cymosa* var. *marcescens*.

Project Success: For *Dudleya cymosa* var. *marcescens*, the respondent felt that the transplantation was successful because the transplanted plants established successfully. However, the respondent also noted that many more individuals of *D. cymosa* var. *marcescens* were lost due to road-scraping. The CNPS hopes to expand this reintroduced population through future off-site seed collection, germination, and transplantation.

Date Project Initiated: 1987; project on-going.

IV.B.8. *Hemizonia minthornii* (Santa Susana Tarplant): State rare; Federal Candidate C2; CNPS List 1B.

Respondent: Ms. D.A. Hoover, Woodland Hills, California.

Project Name and Description: "Soltice Canyon Native Plant Project." Volunteers from the California Native Plant Society (CNPS) proposed to eradicate invasive exotic species and replace them at Soltice Canyon Park with species native to the Santa Monica Mountains. This project included the reintroduction of *Hemizonia minthornii* and *Dudleya cymosa* ssp. *marcescens*. (see IV.B.7 for more details).

Mitigation-Related?: No.

Project Objectives: Objectives as stated were to expand the protected sites for the relatively rare native species and to learn practical methods for safe propagation without threatening native populations.

Project Methods: Seed was collected from two off-site populations in the Santa Monica Mountains (Calabasas Peak and Castro Peak), and stored for several weeks. These failed to germinate, but a second collection was made, and seeds were sown the same day of collection. These seeds germinated and subsequently were transplanted to a screen-covered seed bed in Soltice Canyon Park. The populations were subject to gopher predation and

overwatering, however.

Plants were monitored by CNPS members through periodic inspections. Visits included weeding of competing exotics (*e.g.*, castor bean, tree tobacco, mustard, various thistles, *etc.*) and handwatering of additional native species. Total cost of the project was $130.00 (gas @ $10.00 and paid assistance at $120.00).

Criteria for Success: None stated for *Hemizonia minthornii*.

Project Success: Respondent reported that virtually 100% of the seeds germinated, but the very young transplants died from drought. Approximately 10 individuals survived to flower. The Castro Peak seedlings will be transplanted to various locations in the park to test their ability to survive in each (different?) site.

Date Project Initiated: 1987; project on-going.

IV.B.9. *Oenothera wolfii* (Wolf's Evening Primrose): Not California State listed; Federal Candidate C2; CNPS List 1B.

Respondent: Mr. Dave Imper, North Coast Chapter, California Native Plant Society, Eureka.

Project Name and Description: None. Project involved the population expansion within the type locality of *Oenothera wolfii* at Luffenholtz Beach. In December, 1988, 3 individuals of *Oenothera wolfii* were transplanted from Luffenholtz parking area to adjacent habitat, along with two greenhouse seedlings and considerable amounts of seed.

Mitigation-Related?: No.

Project Objectives: The stated objective was to reduce the impacts of repaving, trampling, and vehicular use to populations of *Oenothera wolfii* at Luffenholtz Beach.

Project Methods: Seeds were collected and grown in respondent's greenhouse. Approximately 80 seedling rosettes ranging from 1 - 4 inches in diameter were outplanted on December 26, 1989, in four small areas east of Scenic Drive, south of the residence

driveway. In addition, a small amount of seed was planted directly.

Criteria for Success: None stated.

Project Success: Late summer mortality was high. Only 55 seedlings from 7000+ seeds currently survive. Five of the 7 onsite transplants survived, and one of the two greenhouse seedlings. However, the respondent suggests that both seeding and transplantation are potentially viable methods for mitigating impacts on this species, and for expanding small populations.

IV.C. Project Proponents

Of the 46 projects reviewed in this analysis, 17 (37%) were conducted by private businesses involved in housing construction, outdoor recreational facilities, and business offices (Table 4). However, state services such as the California Department of Transportation, California Department of Water Resources, California Department of Parks and Recreation, and the services of two counties (Sonoma and Fresno) together were involved in a total of 15 projects (33%). Finally, an additional 5 projects (11%) were conducted by energy companies (both private and public utilities) (Table 4). The remaining projects were research-related or mitigation-related projects conducted by various agencies of the federal government for a variety of reasons.

V. DISCUSSION OF FINDINGS

V.A. Mitigation Successes

Seven transplantation attempts were considered successful in this analysis. These attempts involved the plant species *Amsinckia grandiflora, Dudleya cymosa* ssp. *marcescens, Holocarpha macradenia, Lasthenia burkei, Opuntia basilaris* var. *treleasei*, and *Sidalcea pedata*. Of these species, the first two were not involved in mitigation-related transplantation efforts. However, the *Amsinckia* project appears to have been so successful because of the great detail and care taken in

TABLE 4. PLANT SPECIES INVOLVED IN TRANSPLANTATION, RELOCATION, OR REINTRODUCTION PROJECTS, PROJECT PROPONENTS, AND DEGREE OF MITIGATION SUCCESS.

SPECIES	PROJECT PROPONENT	PROJECT NAME	PROJECT SUCCESS
Acanthomintha ilicifolia	1) Pardee Company	Westview Planned Residential Development	On-going
	2) Shea Homes	Palos Vista Development	On-going
	3) Pardee Company	Reparation for Sabre Springs Development	On-going
	4) Unknown	Indian Hill, Las Brisas, & Spyglass	Limited success
Amsinckia grandiflora	N/A: Research-Related	*Amsinckia grandiflora* Experimental Reintroduction	Successful
Antennaria flagellaris	U.S. BLM	None	Not successful
Arabis macdonaldiana	N/A: Research-Related	Geographic Distribution of Rare Plants on Public Lands Within the Red Mountain Study Area,...	Not successful
Arctostaphylos hookeri var. *ravenii*	N/A: Research-Related	Raven's Manzanita Recovery Plan	On-going
Bensoniella oregana	N/A: Research-Related	*Bensoniella* Transplant Project	Limited success
Blennosperma bakeri	1) Christopherson Homes	Montclair Park	Limited success
	2) Cobblestone Development Corporation	San Miguel Estates	On-going
Brodiaea filifolia	Baldwin Company	College Area Specific Plan in San Marcos	On-going
Brodiaea insignis	Dept. Water Resources	Kaweah Reservoir Dam Expansion	Planning stage
Calochortus greenei	Siskiyou County	None	Not successful
Chorizanthe howellii	UC Davis	None	On-going
Cirsium occidentale var. *compactum*	Calif. Dept. Transportation	Little Pico Bridge Replacement & Piedras Blancas Shoulder widening	Partial success
Cordylanthus palmatus	N/A: Research-Related	None	Partial success
Croton wigginsii	U.S. BLM	None	Not successful
Dudley cymosa ssp. *marcescens*	N/A: Research-Related	None	Successful
Eriastrum densifolium ssp. *sanctorum*	Calif. Dept. Transportation	Santa Ana Woollystar Relocation Project	Not successful
Eriophyllum mohavense	Calif. Energy Commission	LUZ SEGS VII	Not successful
Eryngium aristulatum var. *parishii*	Calif. Dept. Transporation	Caltrans Del Mar Mesa Vernal Pools	Partial success
Erysimum capitatum var. *angustatum*	Pacific Gas & Electric Co.	Vaca Dixon-Contra Costa 230-kV Reconductoring Project....	Partial success
Erysimum menziesii	1) UC Davis	None	On-going
	2) Unknown	Spanish Bay	No information
	3) Unnamed timber company	None	On-going
Erysimum teretifolium	Lone Star Industries, Inc.	Revegetation of Olympia Quarry	Planning stage
Gilia tenuiflora ssp. *arenaria*	Unknown	Spanish Bay	No information
Hemizonia increscens ssp. *villosa*	Texaco	Gaviota Interim Marine Terminal	On-going
Hemizonia minthornii	1) N/A: Research-Related	None	Not successful
	2) Las Virgenes Municipal Water District	Santa Susana Tarplant Mitigation Progeam Twin Lakes Tank No. 2	Not successful
	3) Classeau Builders	Woolsey Canyon Development	Planning stage
Holocarpha macradenia	Nylen Company	Hilltop Commons Development	Successful
Lasthenia burkei	1) Unknown	Airport Blvd. Business Park	Successful
	2) Sonoma Co. Airport	Sonoma Co. Airport Expansion	Successful
	3) Cobblestone Development Corporation	San Miguel Estates	On-going
	4) Sonoma County	County of Sonoma Public Service Area 31 Waste Water Storage Pond	On-going
Lilaeopsis masonii	1) Dept. Water Resources	Baker Slough Bank Revetment	On-going
	2) Dept. Parks & Recreation	None	Planning stage
Lupinus tidestromii var. *tidestromii*	Unknown	Spanish Bay	No information
Lupinus milo-bakeri	Calif. Dept. Transportation	None	Unknown

TABLE 4. PLANT SPECIES INVOLVED IN TRANSPLANTATION, RELOCATION, OR REINTRODUCTION PROJECTS, PROJECT PROPONENTS, AND DEGREE OF MITIGATION SUCCESS (cont.).

SPECIES	PROJECT PROPONENT	PROJECT NAME	PROJECT SUCCESS
Mahonia nevinii	RANPAC Corporation	Vesting Tentative Tract No. 23267	Unknown
Monardella linoides ssp. *viminea*	Calif. Dept. Transportation	None	Not successful
Oenothera deltoides ssp. *howellii*	Pacific Gas & Electric Co.	Vaca Dixon-Contra Costa 230-kV Reconductoring Project....	Partial success
Oenothera wolfii	N/A: Research-Related	None	Not successful
Opuntia basilaris var. *treleasei*	1) Calif. Energy Commission	Kern River Cogeneration Power Plant Project	Successful
	2) Sycamore Cogeneration Company	Sycamore Cogeneration Project	Unknown
Orcuttia viscida	Unknown	Sunrise/Douglas Wetland & Creation Program	Ongoing
Pentachaeta lyonii	Unknown	Lake Sherwood Golf Course	Not successful
Pogogyne abramsii	Calif. Dept. Transportation	Caltrans Del Mar Mesa Vernal Pools	Partial success
Pseudobahia peirsonii	Fresno Co. Metro Flood Control District	Round Mountain Flood Control Project	Planning stage
Sedum albomarginatum	Calif. Dept. Transportation	Feather River Canyon Storm Damage Repair	Not successful
Sidalcea pedata	K-Man Corporation	*Sidalcea pedata* Transplantation Project	Successful

all phases of the research, and that is was peformed by a conscientious and skilled researcher, Dr. Bruce Pavlik. In this instance, the biology of the species was investigated in full, and various relevant (receptor) site treatments were included as an experimental component of the research. It appears crucial that the soil and habitat requirements of the species be understood completely before successful establishment can be assured.

As for the success of the nonmitigation-related transplantation of *Dudleya cymosa* ssp. *marcescens* and the mitigation-related *Opuntia basilaris* var. *treleasei*, these species are succulents which in general, have relatively easy horticulturaal requirements. Succulents by their biology are rather hardy and tolerant of drought and other forms of disturbance. Therefore, in the case of the Bakersfield cactus, using industry standards for cutting and callus formation may have insured its successful transplantation for the Kern River Cogeneration Power Plant Project. However, the receptor site was also carefully prepared to receive the cactus pads, and this again, appears to be important in assuring success of the transplantation.

The reasons for the success of the thwo *Lasthenia burkei* vernal pool projects (Sonoma County Airport Business Park, and the Sonoma County Airport Expansion are not clear. The issue of vernal pool creation, mitigation, and enhancement is exceptionally contentious among practicing biologists in the State, and there are many differing opinions about vernal pool mitigation "success" (see Ferren and Gevirtz 1990, for example). In a survey such as this, we must accept the accessment of success by the parties responsible for the mitigation, if the established criteria are met and it meets the criteria imposed by this review. In all three cases with *Lasthenia burkei*, populations were established with a greater number of individuals than there present originally (*i.e.*, no individuals). However, because these projects have been on-going for less than 10 years, the long-term viability of the populations is not yet known.

What is also interesting about the vernal pool projects in Sonoma County is that they also involved *Blennosperma bakeri*. Although these projects are technically on-going and were not evaluated as either successful or unsuccessful in this analysis, the early reported results indicate that this species will also successfully establish at created vernal pools. However, one respondent (N. Harrison, San Rosa Jr. College) suggested that despite the purported success of vernal pool creation in Sonoma County, this is an "unsuitable" method for mitigation. Preservation is the only viable mitigation method for vernal pool [plants]. She also reported that Sonoma State University [personnel] has tried for 12 years to vegetate an artificial vernal pool by seeding and transplantation from local sources, but without success. It is not clear from this review why there is such a clear discrepancy in the evaluation of mitigation success for Sonoma County's vernal pool plant species. It is likely that philosophic and ethic differences, rather than biology, drive this debate.

The successful mitigation efforts of the last two species, *Holocarpha macradenia* and *Sidalcea pedata*, are not known. For the Santa Cruz tarplant, the salvage of individual plants was accomplished with care, but preparation of the receptor site was not performed. It is possible that *H. macradenia* is a rather weedy species capable of taking advantage of small site disturbances to establish successfully. As for the bird-footed checkerbloom, the individuals were carefully removed from the construction site, the receptor site was prepared to receive the transplanted individuals, and the receptor site fenced for protection from disturbance. The assessment of success may be premature for this species because the project is only in the second year of monitoring, but the first year survival rate is significant (90%).

V.B. Mitigation Failures

Over one quarter (12 out of the 26 projects; 26%) of the transplantation, relocation, and reintroduction projects in this survey are considered failures. They will not be reviewed individually; however, several are notable, and will serve to illustrate the various reasons for a

project's lack of success. The Las Virgenes Municipal Water District's project involving the construction of a water and the consequent destruction of a population of *Hemizonia minthornii* is a controversial mitigation failure that received media attention (Los Angeles Times 1989). Several obvious reasons why this project failed are: (1) seed was collected from plants before it was fully mature (seasoned) and thus subsequent seed germination was poor; (2) plants were collected during the middle of the growing season when they may have been most vulnerable to disturbance; and, (3) because of the nature of the (rock) substrate, individuals were difficult to collect for transplantation. Although an attempt was made to extract individuals carefully, in many cases it appears that the roots had to be broken as individuals were torn from their rock substrate; consequently, few individuals survived.

The difficulties the California Department of Transportation had with the transplantation of *Monardella linoides* ssp. *viminea* again illustrates the problems of native substrate and soils. One of the findings made in the 1986 monitoring report was that this species required its parent material to survive in cultivation. This was discovered after a significant number of individuals had died. For *Antennaria flagellaris*, the respondent suggested that the reason this species did not thrive in its transplantation site was because the soils had an inappropriate soil texture to allow for stoloniferous growth. *Arabis macdonaldiana* is a serpentine endemic, and many such species are difficult to grow in cultivation. Dr. Baad's work demonstrated that this species has poor germination rates even on its native substrate, and did not fare well in any experimental manipulations in the field. Finally, despite serious efforts to control for the unusual edaphic factors that control the distribution of *Eriophyllum mohavense* (and *Chorizanthe spinosa*), transplantation of seeds of the Barstow woolly sunflower and its soil by the California Energy Commission did not succeed. Again, the respondent suggests that the current drought is responsible for the transplantation failure.

Another feature of the mitigation-related transplantation failures is illustrated, again by the California Department of Transportation, in its efforts to transplant *Sedum albomarginatum*. This species is a succulent, and unlike the other succulents in this survey, did not survive its transplantation. It is believed that the transplanted individuals did not survive in large part due to the present drought (Martz, personal communication).

The efforts of the U.S. Bureau of Land Management (BLM) illustrate the problems associated with the transplantation at different life stages. In this instance attempted to transplant seedlings of *Croton wigginsii*. The seedlings were reported as being transplanted with considerable care into an appropriate habitat, but all seedlings died. Because seedlings are a well known to be vulnerable life history stage, manipulations involving seedlings are not likely to succeed.

For other species, such as *Pentachaeta lyonii*, the reasons for failure are not clear. Despite considerable efforts on the part of the consultants to insure mitigation success, including cooperation with the Rancho Santa Ana Botanic Garden for horticultural expertise and sound field methods, the respondent reported that success of the project objectives was not achieved. The reason offered was that the salvage plan was "inadequate."

In summary of the successes and failures of transplantation, relocation and reintroduction of sensitive plant species in California, three broad recommendations can be made that are based on several aspects of the biology of imperiled plant species. These recommendations are:

(1) Individuals should be removed with as little disturbance as possible to the individual, and at a phenologically appropriate time of year when the individual is dormant or photosynthetically inactive;

(2) The receptor site should be of the same habitat quality, particularly with respect to soil

type and its physical characteristics. Various other aspects of the receptor site might include weeding to decrease competition from native and exotic species, watering during times of drought, and fencing and/or other forms of site protection; and

(3) Knowledge of the biology of the organism appears to aid greatly in the design of appropriate horticultural techniques for the preparation of cuttings, transplantation, seed germination, *etc*. This is problematic, however, because the biology of most State-listed species is poorly known. Although some species such as cacti and succulents may be amenable to standard horticultural techniques for propagation, most are not. Therefore, without sufficient knowledge of the biology of impacted species, success of the transplantation, relocation, or reintroduction will not be assured.

V.C. Overview and Summary

Mitigation of impacts to endangered, threatened, and rare plant species is an issue of considerable debate. On the one hand, the Canadian Botanical Association (Fahselt 1988), the American Society of Plant Taxonomists (ASPT 1989), and the Rare Plant Scientific Committee of the California Native Plant Society (CNPS 1990) do not favor mitigation and in point of fact, oppose transplantation as a means of plant preservation except in those instances for which there are no other means of protection. An otherwise doomed population of *Penstemon barrettiae* was transplanted under just such circumstances (Guerrant 1990). Mitigation guidelines propagated by the CNPS (1990) recommend impact avoidance as outlined in the California Environmental Quality Act (CEQA §15370) as the favored mitigation technique.

On the other hand, however, transplantation, relocation, and reintroduction of endangered, threatened, or rare species are routinely performed as mitigation for "unavoidable" project impacts, according to both state and federal environmental legislation. This is currently accomplished in

California for listed plant species through Mitigation Agreements. However, it is remarkable that such potentially harmful activities to State- and (federally-) listed species has, until very recently, been so poorly monitored by all parties (but see new guidelines by Howald and Wickenheiser 1990).

What is equally remarkable is the lack of performance criteria (*i.e.*, criteria for success) of the completed mitigation-related projects reviewed here. Only 15 of the 46 projects (33%) have explicitly defined criteria for success, and until quite recently, there was no consistency in these criteria. Without such "industry" standards, success of translocation, relocation, and reintroduction projects cannot be made objectively. When criteria are explicitly defined, for example the College Area Specific Plan in San Marcos for *Brodiaea filifolia*, mitigation successes can be assessed appropriately.

Such policy statements about transplantation, relocation, or reintroduction as mitigation as those promulgated by the Canadian Botanical Society and the American Society of Plant Taxonomists, combine an ethical viewpoint with a scientific evaluation of plant (and animal) transplantation efforts. For animals, Griffith *et al.* (1989) reported that success rates for the translocation of birds in the United States, Australia, Canada, and New Zealand range widely, from 10% to greater than 90%. The results depended upon the type of animal involved and the conditions of release. They concluded that without high quality habitat at the receptor site, translocations had a low chance of success, regardless of how many animals were released or the condition of the individuals. High quality receptor habitat may be even more critical for plant transplantations than for animals, because of the physical immobility of plants.

For plants, Hall (1986) recently reviewed transplantation for sensitive plants as mitigation for environmental impacts in California, and concluded that transplantation has not been a "panacea"

for botanical resource conservation. Hall also suggested that the lack of sufficient post-transplantation maintenance and monitoring has contributed to the unreliability of these mitigation techniques. Monitoring, however, is a labor-intensive commitment, and as such, may not be budgeted appropriately, particularly over the long term. In addition, monitoring of rare plant species can take many forms (see for example, Palmer 1987), and standards for monitoring should be established before mitigation successes can be compared. This is an enormous task.

The effective of many kinds mitigation-related projects is coming into question elsewhere, and it is a critical resource conservation issue for the regulatory community and the public alike. For example, the Florida Department of Environmental Regulation recently issued a report that summarized the success of wetland mitigation required for the issuance of dredge and fill permits under the state Henderson Wetlands Act of 1984 (FDER 1991). The success rate of mitigation was 27% (with some wetland types proving much less successfully mitigated than others). The report also finds that with the institution of simple remedial measures, mitigation success could have been increased to 40% overall. Interestingly, the report documented only 6% (4 out of 63) were found to be in full compliance with the mitigation requirements of the permit.

Some analogies may be relevant here. First, in both instances, success rates for mitigation projects is equal to or less than 25%. This statistic should be unacceptable to the regulating agency, and strongly indicates that the program is not working effectively. Second, some plants (as some wetland habitats) may be more easily manipulated (*i.e.*,, mitigated) than others. This is clearly reflected in the kinds of plants (*e.g.*, succulents and cacti) that were determined to be successfully mitigated in this review. Third, it is likely that with simple remedial measures (as discussed for the Florida wetlands), *e.g.*, hand-watering, weeding of competing exotics, fencing, *etc.*, mitigation success rates for the transplantation of State-listed species could be greatly enhanced. Finally, although not part of this study, it should be investigated whether the permittees are in full

compliance with the Mitigation Agreements.

There are some success stories, however. *Stephanomeria malheurensis* (Parenti and Guerrant 1990) and *Styrax texana* (Cox 1990) are two endangered plants that have been successfully reintroduced back into their native habitats in Oregon and Texas, respectively. In many instances, such as these two, success of relocation, reintroduction, or transplantation is achieved through Herculean means. Thus until we understand thoroughly the techniques of translocation, relocation, reintroduction, and restoration, it may be unwise to routinely agree to these forms of mitigation for endangered, threatened, or rare botanical resources.

In conclusion, it is recommended that because of the low success rate of the completed mitigation-related projects involving translocation, relocation, and reintroduction, and the reasonably high number of projects that are on-going and for which no conclusive information is currently available, the Endangered Plant Program should limit their Mitigation Agreements to those projects for which such techniques are the only known means of preservation of a population of an endangered, threatened, or rare species, or for impact avoidance is not possible, and for which there is no demonstrated practicable alternative.

VI. ACKNOWLEDGEMENTS

I gratefully acknowledge all those individuals and organizations who responded to my lengthy questionnaire. In addition, I wish to thank Ann Howald of the Endangered Plant Program for providing me with this opportunity, and for her considerable patience.

VII. LITERATURE CITED

American Society of Plant Taxonomists. 1989. Resolution adopted by the American Society of Plant Taxonomists at their annual meeting, August 7, 1989.

Baad, M. 1987. Geographic distribution of rare plants on public lands within the Red Mountain study area and a study of the population dynamics and reproductive biology of MacDonald's rock-cress, *Arabis macdonaldiana* Eastwood. Consultant's report for the U.S. Bureau of Land Management, Ukiah District Office.

California Department of Fish and Game. 1989. Designated endangered, threatened, or rare plants. Nongame-Heritage Division, Endangered Plant Project, January 1989.

California Department of Fish and Game. 1990. Designated endangered, threatened, or rare plants. Natural Heritage Program, Endangered Plant Project, March 1990.

California Native Plant Society, Rare Plant Scientific Advisory Committee. 1991. Mitigation guidelines regarding impacts to rare, threatened and endangered plants. Unpublished. 17 p.

Cox, P. 1990. Reintroduction of the Texas snowbell, (*Styrax texana*). Endangered Species UPDATE *8(1)*: 64-65.

ECOS, Inc. 1988. Experimental design for a transplant study of Mason's Lilaeopsis. Consultant's report prepared for the U.S. Bureau of Reclamation and the California Department of Water Resources, Central District.

ERC Environmental and Energy Services Co. 1990a. Status report, proposed maintenance/Monitoring plan, and performance criteria for the Palos Vista Thorn-mint mitigation program. Consultant's document, prepared February 1990, revised September 1990.

ERC Environmental and Energy Services Co. 1990b. San Diego Thorn-mint (*Acanthomintha ilicifolia*) biological reparation plan for the Pardee Company Sabre Springs Development, prepared June 1990, revised October 1990.

ERC Environmental and Energy Services Co. 1990c. Second annual report: *Brodiaea filifolia* mitigation program, San Marcos, California, prepared December 1990.

ERT, Inc. 1988a. Luz SEGS VII sensitive plant salvage soil survey technical report. Consultant's report prepared for Luz Engineering Corporation, Los Angeles, California, May 1988.

ERT, Inc. 1988b. Biological resource mitigation implementation plan for the Luz Solar Electric Generating Systems, Kramer Junction, California. Consultant's report submitted to the California Energy Commission, February 1988.

Fahselt, D. 1988. The dangers of transplantation as a conservation technique. Natural Areas Journal *8(4)*: 238-244. [The journal article included the policy statement transplantation as a method of preservation by the Canadian Botanical Association, adopted June 1987.]

Ferren, W.R., Jr. and E.H. Gevirtz. 1990. Restoration and creation of vernal pools: cookbook recipes or complex science? Pp. 147-178, in, D.H. Ikeda, R.A. Schlising (eds.), *Vernal Pool Plants, Their Habitat and Biology*. Studies from the Herbarium, California State University, Chico, No. 8; June 1990.

Florida Department of Environmental Regulation. 1991. Report on the effectiveness of permitted mitigation. Report submitted to Lawton Chiles, Governor; Gwen Margolis, President of the Senate; and T.K. Wetherell, Speaker of the House of Representatives. March 5, 1991.

Griffith, B., J.M. Scott, J.W. Carpenter, and C. Reed. 1989. Translocation as a species conservation tool: status and strategy. Science *245*: 477-480.

Hall, L.A. 1986. Transplantation of sensitive plants as mitigation for environmental impacts. Pp. 413-420, *In*, T.S. Elias and J. Nelson (eds) *Conservation and Management of Rare and Endangered Plants*. Proceedings of a California Conference on the Conservation and Management of Rare and Endangered Plants. California Native Plant Society, Berkeley.

Howald, A.M. and L.P. Wickenheiser. 1990. Mitigation plan annotated outline for endangered plants of California. California Department of Fish and Game, Natural Heritage Division, Endangered Plant Program. Unpublished document, August 1990. 33 p.

LSA Associates, Inc. 1987. Olympia Quarry revegetation plan. Consultant's report submitted to Lone Star Industries, July 1987.

LSA Associates, Inc. 1989. Draft plan to collect seed of Ben Lomand wallflower (*Erysimum teretifolium*) for the revegetation of the Olympia Quarry. Consultant's report submitted to the California Department of Fish and Game, September, 1989.

Los Angeles Times. 1989. Tough little plants don't survive term in nursery. Article by staff writer Bob Pool, February 3, 1989, p. 3, 14.

Martz, C. 1990. Annual monitoring report for Santa Ana Woollystar Relocation Project, 1990. California Department of Transportation Report.

McClelland Consultants (West), Inc. 1988. Santa Susana tarplant (*Hemizonia minthornii*) mitigation program Twin Lakes Tank No. 2. Initial progress report. Consultant's report submitted to Las Virgenes Municipal Water District and the California Department of Fish and Game, December 1988.

McClelland Consultants (West), Inc. 1990. Santa Susana tarplant (*Hemizonia minthornii*) mitigation program Twin Lakes Tank No. 2. Third annual progress report. Consultant's report submitted to Las Virgenes Municipal Water District and the California Department of Fish and Game, December 1990.

Misuetta, O. 1989. Amended mitigation and research plan for *Hemizonia minthornii* - Woolsey Canyon Development. Consultant's report [Rancho Santa Ana Botanic Garden], March 1989.

[Ralph] Osterling Consultants, Inc. 1989. Santa Rosa rare plants mitigation plan. San Miguel Estates 1. Consultant's report.

Palmer, M.E. 1987. A critical look at rare plant monitoring in the United States. Biological Conservation 39: 113-127.

Pavlik, B.M. 1990. Reintroduction of *Amsinckia grandiflora* to Stewartville. Consultant's report prepared for the Endangered Plant Program, California Department of Fish and Game,

Contract No. FG-7434.

PSBS, Inc. 1988. Monitoring report. *Acanthomintha ilicifolia*. Consultant's report, prepared 17 May 1988.

Smith, J.P., Jr. and K. Berg. 1988. *California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California*. California Native Plant Society Special Publication No. 1, 4th edition, Sacramento.

WESTEC Services, Inc. 1988. Biological mitigation plan for the College Area Specific Plan, San Marcos, San Diego County, California. Consultant's report, prepared April 29, 1988.

Zedler, P.H. and C. Black. 1988. Species preservation in artificially constructed habitats: preliminary evaluation based on a case study of vernal pools at Del Mar Mesa, San Diego County. Pp. 367-373, *In*, J.A. Kusler, S. Daly, and G. Brooks (eds.) *Urban Wetlands*. Proceedings of the National Wetland Symposium, June 26-29, 1988, Oakland, California.

APPENDIX A. EXAMPLE COVER LETTER AND QUESTIONNAIRE

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18 April 1990

Ms. Ann Howald, Program Ecologist
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Dear Ms. Howald:

As part of the California Department of Fish and Game's Endangered Plant Program review of mitigation for state-listed rare, threatened and endangered plant species, I am conducting a survey of mitigation, transplantation, replantation and reintroduction projects that have been implemented or planned in California. The purpose of this survey is to assess the success of mitigation-related transplantation, relocation and reintroduction projects of state-listed plant species.

The enclosed form details fifteen questions. Please answer each to the best of your knowledge. Should you need more room for your answers, please feel free to attach an additional sheet. Copies of any reports for projects of an unusual or special nature, or illustrative for any particular point, would be greatly appreciated.

If you are unable to complete this questionnaire, please contact me at your earliest convenience (415-338-6270). If you would prefer, this questionnaire can be completed by phone if you call me at a time convenient for both parties.

Thank you for your time. Your efforts are of considerable importance for a project that has significant ramifications for the future of the rare plant species of California.

Yours most sincerely,

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Joe McBride
Department of Forestry & Resource Management
University of California
Berkeley, CA 94720

Steve McCabe
U.C. Santa Cruz Arboretum
205 Morningside Dr.
Ben Lomand, CA 95005

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Elizabeth McClintock
1335 Union St.
San Francisco, CA 94109

Michael McElligott
Vandenberg Air Force Base
4016 Altair Place
Lompoc, CA 93436

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2122 Loomis St.
San Luis Obispo, CA 93401

Dale McNeal
Department of Biology
University of the Pacific
Stockton, CA

David Mayfield
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5201 Ruffin Road, Suite P
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909 12th Street
Sacramento, CA 95814

Tim Messick
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Sacramento, CA 95816

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Sonoma County Planning Director
575 Administration Drive, Room 105A
Santa Rosa, CA 95403

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Pacific Southwest Forest & Range Experiment Station
Box 245
Berkeley, CA 94701

Diane Mitchell
J & M Land Restoration
3826 Bryn Mawr Drive
Bakersfield, CA 9330

Maynard Moe
Dept. Biology
California State University
Bakersfield, CA 93111-1099

Sharon Moreland
U.S. Army Corps of Engineers
211 Main Street, Attn: Regulatory Branch
San Francisco, CA 94105

Sia Morhardt
EA Engineering Science & Technology
41A Lafayette Circle
Lafayette, CA 94549

Gilbert Muth
Biology Department
Pacific Union College
Angwin, CA 94508

Mona Myatt
Southern California Edison
P.O. Box 800, Rm. 427 GC1
Rosemead, CA 91770

Rodney Myatt
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San Jose State University
San Jose, CA 95192

Jim Nelson
State Energy Resources Conservation & Development Commission
1516 Ninth Street, MS 40, 4th Floor
Sacramento, CA 95814

Gail Newton
Division of Mines & Geology
650-B Bercut Drive
Sacramento, CA 95819

Larry Norris
USDA, Soil Conservation Service
4700 Northgate Blvd., Suite 015
Sacramento, CA 95814

Patti Novak
Los Angeles Department of Water & Power
873 N. Main
Bishop, CA 93514

Tom Oberbauer
3739 Oleander St.
San Diego, CA 92106

Steven Orr
Nature Landscapes
12545 Quito Rd.
Saratoga, CA 95070

Rexford Palmer
Palmer Honeysett Consulting
Route 2 Box 660
Dixon, CA 95620

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Sequoia & Kings Canyon National Parks
Three Rivers, CA 93271

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1276 Moreno Blvd.
San Diego, CA 92110

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Consultant
7573 Terrace Drive
El Cerrito, CA 94530

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Mills College
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Palo Alto, CA 94302

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Santa Barbara, CA 93105

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Oakland, CA 94607

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Napa, CA 94559

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Roseville, CA 95661

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30800 Bouquet Canyon Road
Saugas, CA 91350

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GENREC
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Oakland, CA 94602

Fred Riley
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Sacramento, CA 9582:

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Desert Studies
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Death Valley, CA 92328

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San Francisco, CA 94122

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CalTrans
1449 Hollister Lane
Los Osos, CA 93402

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Felton, CA 95018

Jake Ruygt
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Napa, CA 94558

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San Luis Obispo, CA 93403

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Mycorrhizal Services
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Menfee, CA 92355

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Sacramento, CA 15002

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John Zenter
Zentner & Zentner
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Walnut Creek, CA 94596

APPENDIX C. PERSONS RESPONDING TO QUESTIONNAIRE AND SUMMARY RESPONSES

Appendix C. Persons And/Or Agencies Responding to Questionnaire and Summary Responses

Person and/or Agency	Response/Species Involved/Comments
Lowell Ahart Oroville, CA	Never Involved[1]
Bob Allen Larkspur, CA	Never Involved
David Amme Berkeley, CA	Never Involved[2]
Joseph Aparicio Biology Department American River College Sacramento, CA	Never Involved
Wayne Armstrong Department of Biology Palomar College San Marcos, CA	Never Involved
Mike Baad Department of Biological Sciences California State University Sacramento, CA	*Arabis macdonaldiana*
Balance Hydrologics Berkeley, CA [Contact: Barry Hecht]	*Orcuttia viscida*

[1]Never involved refers to the non-involvement of the person, agency or specific branch thereof, in a mitigation-related transplantation, relocation, or reintroduction of a state-listed endangered, threatened or rare species. The party may have been involved in the transplantation of a state- or federally-listed rare, endangered or threatened species, but the project was not related to mitigation.

[2]Mr. Amme reported that he had developed a restoration plan for the Alameda manzanita (*Arctostaphylos pallida*) for the East Bay Regional Park District, but it was never implemented.

Ellen Bauder Dept. Biological Sciences San Diego State University	Never Involved[3]
R.W. Benseler Dept. Biological Sciences California State University Hayward, CA	Never Involved
Albin Bills Department of Biology Butte College Oroville, CA	Never Involved
Charles Black Department of Biology California State University San Diego, CA	Answered with Paul Zedler; *Pogogyne abramsii*, *Eryngium aarissulatum*
Geoff Burleigh San Fernando, CA	Never Involved
California Conservation Corps Sacramento, CA [Contact: Walt Auburn]	Never Involved[4]
California Department of Fish & Game Bishop, CA [Contact: Denyse Racine]	Never Involved
California Department Fish & Game Denair, CA [Contact: Holman E. King]	Never Involved
California Department of Fish & Game Fresno, CA [Contact: Leland K. Ashford, Jr.]	Never Involved
California Department of Fish & Game Grass Valley, CA [Contact: Jeff Finn]	Never Involved[5]

[3]Dr. Bauder sent information on research-related work on San Diego vernal pools.

[4]Recommended contacting others, specifically Chris Sauer at the CCC's nursery.

[5]Mr. Finn mentioned two vernal pool creation/restoration projects near Roseville.

California Department of Fish & Game Lodi, CA [Contact: Sandy Harrison]	Never Involved
California Department of Fish & Game Marysville, CA [Contact: Dale Whitmore]	Never Involved
California Department of Fish & Game Rancho Cordova [Contact: Response not signed]	*Lilaeopsis masonii*
California Department of Fish & Game Springville, CA [Contact: James V. Crew]	Never Involved
California Department of Fish & Game Endangered Plant Program Sacramento, CA [Contact: Ann Howald]	*Oenothera wolfii* *Sidalcea pedata*
California Department of Fish & Game San Diego, CA [Contact: Denise Racine]	Never Involved
California Department of Fish & Game Yountville, CA [Contact: Carl Wilcox]	*Lasthenia burkei*
California Department of Forestry Jackson State Forest Ft. Bragg, CA [Contact: Dana Cole]	Never Involved
California Department of Parks & Recreation Lodi, CA [Contact: Sandy Harrison]	Never Involved
California Department Parks & Recreation Monterey, CA [Contact: Jean Ferreira]	Never Involved[6]
California Department of Parks & Recreation Sacramento, CA [Contact: Frederica Bowcutt]	*Lupinus tidestromii, Lilaeopsis masonii, Chorizanthe howellii, Erysimum menziesii*
California Department of Parks & Recreation, OHMVR	

[6]Ms. Ferreira mentioned briefly a non-mitigation related project involving *Erysimum menziesii*, but did not send any information regarding the project.

Sacramento, CA [Contact: Roy Woodward]	Never Involved
California Department of Transportation Los Osos, CA [Contact: Gary Ruggerone]	Never Involved[7]
California Department of Transportation Redding, CA [Contact: Sharon Villa]	*Sedum albomarginatum*
California Department of Transportation Sacramento, CA [Contact: Craig Martz]	*Eriastrum densifolium* ssp. *sanctorum* *Sedum albopurpureum*
California Department of Transportation San Diego, CA [Contact: John Rieger]	San Diego Vernal Pool Species
California Department of Transportation San Francisco, CA [Contact: Sid Shadle]	Never Involved
California Department of Transportation Stockton, CA [Contact: Deborah McKee]	Never Involved
California Department of Water Resources Sacramento, CA [Contact: John Squires]	Recommended contacting Phil Wendt re: *Lilaeopsis masonii*
California Energy Commission Sacramento, CA [Contact: James Brownell and Rick York]	*Opuntia basilaris* ssp. *treleasei*[8] *Eriophyllum mohavense*

[7]Mr. Ruggerone sent information on the transplantation work on federal candidate species *Circium occidentale* var. *compactum* in two projects, Little Pico Bridge replacement and the Piedras Blancas shoulder widening.

[8]Neither of these species is state-listed, but *Eriophyllum mohavense* meets CEQA criteria. *Opuntia basilaris* ssp.*treleasei* is a "candidate" for state listing.

California Native Plant Society Dorothy King Young Chapter Gualala, CA	Never Involved
California State Food and Agriculture Sacramento, CA [Contact: Doug Barbe]	Never Involved
Joe Callizo St. Helena, CA	Never Involved
City of Chico Planning Office Chico, CA [Contact: Cliff Sellers]	Never Involved
Curcurt Riders Productions Windsor, CA [Contact: Rocky Thompson]	Never Involved[9]
Katherine Culligan Piedmont, CA	Never Involved
Michael Curto California Department of Parks & Recreation San Diego, CA	Never Involved[10]
CWESA Sanger, CA [Contact: Curt Upiain]	Never Involved
Dames & Moore Goleta, CA [Contact: John Gray]	Never Involved
Mary DeDecker Independence, CA	Never Involved
LauraMay Dempster Jepson Herbarium University of California Berkeley, CA	Never Involved
Desert Studies	

[9]Mr. Thompson sent information on a research project involving *Dichanthelium lanuginosum* ssp. *thermale*.

[10]Mr. Curto is no longer with CDFR, and sent personal comments about mitigation-related work with rare plant species.

Fullerton, CA [Contact: Alan Romspert]	Never Involved
Wendie Duron Clovis, CA	Never Involved
EA Engineering Science & Technology Lafayette, CA [Contacts: Sia Morhardt & R. Douglas Stone]	Never Involved
East Bay Regional Park District Oakland, CA [Contact: Kevin Shea]	Never Involved[1]
EIP Associates Sacramento, CA [Contact: Brian Hoffman]	Never Involved
Envicom Corporation Calabasas, CA [Contact: Carl Wishner]	*Pentachaeta lyonii*
Envirosphere Co. Culver City, CA [Contact: David Bradford]	Never Involved
Phyllis Faber Mill Valley, CA	Never Involved
Roman Gankin Redwood City, CA	Never Involved
GENREC Oakland, CA [Contact: Larry Riggs]	Never Involved
Betty & Jack Guggolz Cloverdale, CA	Never Involved
GW Consulting Engineers Citrus Heights, CA [Contact: Jerry Anders]	Never Involved
Nancy Harrison Dept. Life Sciences Santa Rosa Junior College Santa Rosa, CA	Never Involved

[1]Mr. Shea sent non-mitigation related information concerning a research project on *Amsinkia grandiflora* conducted in the EBRPD.

Larry Heckert Jepson Herbarium University of California Berkeley, CA	*Cordylanthus palmatus* *Castilleja uliginosa*
Mary Ann Henry Ridgecrest, CA	Never Involved[12]
Doris A. Hoover Woodland Hills, CA	Never Involved[13]
Barbara Hopper Kenwood, CA	Never Involved
Hydrozoology Newcastle, CA [Contact: Wayne Fields]	Never Involved
J & M Land Restoration Bakersfield, CA [Contact: Diane Mitchell]	Never Involved
Dave Keil Department of Biological Sciences California Polytechnic Institute San Luis Obispo, CA	Never Involved
David B. Ketley Sacramento, CA	Never Involved

[12]Ms. Henry sent comments about her concern over *Eriophyllum mohavense* as potentially threatened.

[13]Never involved in a transplantation, reintroduction or relocation project, but sent information on non-mitigation-related restoration project for *Hemizonia minthornii* and *Dudleya cymosa* ssp. *marcescens*

Kleinfelder Walnut Creek, CA [Contact: Charles G. Wolfe]	Never Involved
L & M Land Restoration Bakersfield, CA [Contact: Diane Mitchell]	Never Involved
Leitner Biological Consulting Oakland, CA [Contact: Barbara Leitner]	Never Involved
The Living Desert Palm Desert, CA [Contact: Jon Mark Stewart]	Never Involved
Los Angeles Department of Water & Power Bishop, CA [Contact: Patti Novak]	Never Involved
Joe McBride Department of Forestry & Resource Management University of California, Berkeley	Never Involved
Niall McCarten Department of Integrative Biology University of California, Berkeley	*Lilaeopsis masonii*
Elizabeth McClintock San Francisco, CA	Never Involved
Malcolm McLeod Dept. Biological Sciences California Polytechnic Institute San Luis Obispo, CA	Never Involved
Dale McNeal Dept. of Biology University of the Pacific Stockton, CA	Never Involved
Jack Major Dept. of Botany University of California, Davis	Never Involved
Jerry Meral Planning & Conservation League Sacramento, CA	Never Involved
Rhonda & Carl Meyers McKinleyville, CA	Never Involved

Maynard Moe Dept. Biology California State University Bakersfield, CA	Never Involved
Gilbert Muth Biology Department Pacific Union College Angwin, CA	Never Involved
Mycorrhizal Services Menifee, CA [Contact: Theodore St. John]	Never Involved
Pacific Gas and Electric Company Department of Engineering Research San Ramon, CA [Contact: Sally deBecker]	Never Involved
Pacific Gas and Electric Company San Francisco, CA [Contact: Frank Chan; Ken DiVittorio]	Never Involved
Pacific Southwest Biological Services, Inc. National City, CA [Contact: Mitchel Beauchamp]	Refused to Answer
V.T. Parker Department of Biology San Francisco State University	Never Involved
Charlie Patterson El Cerrito, CA	*Lasthenia burkei*, *Blennosperma bakeri*
Phillip Williams & Associates San Francisco, CA [Contact: Bob Coats]	Never Involved
Placer County Community Development Dept. Auburn, CA [Contact: Thomas Kubik]	Never Involved
Planning Associates Redding, CA [Contact: Don Burke]	Never Involved[14]

[14]Recommended contacting Dr. Kingsley Stern at Chico State regarding *Orcuttia tenuis*.

Bob Powell Davis, CA	Never Involved
Rancho Santa Ana Botanical Garden Claremento, CA [Contact: Orlando Miscenta]	Indirectly Involved[15]
Thomas Reid Associates Palo Alto, CA [Contact. Taylor Peterson]	Never Involved[16]
Peter Rubtzoff San Francisco, CA	Never Involved
Jake Ruyg: Napa, CA	Never Involved
City of Sacremento Planning Dept. Sacramento, CA [Contact: Holly Keeler]	Never Involved[17]
Sacramento County Dept. of Parks and Recreation Sacramento, CA [Contact: Steve Flannery]	Never Involved
Sacramento County Environmental Impact Section [Contact: Doug Peterson]	Never Involved

[15]Provided nursery stock of *Pentachaeta lyonii* to Envicom Corporation, *Acanthomintha ilicifolia* to ERCE, *Cercocarpus traskiae* to the Catalina Island Conservancy, and *Eriastrum densifolium* ssp. *sanctorum* to the U.S. Bureau of Land Management.

[16]Firm was not involved in any transplantation, reintroduction or relocation projects for State-listed species, but did devise a plan for *Castilleja neglecta* that was never implemented due to project postponement.

[17]Ms. Keeler recommended contacting the consulting firm Zentner and Zentner regarding the Laguna Creek Project.

Sacramento County Planning Department [Contact: Robert Burness]	Never Involved
City of San Diego [Contact: Keith A. Greer]	*Monardella linoides* ssp. *viminea*; *Eryngium aristulatum* var. *parishii*[18]
San Diego Department of Public Works San Diego, CA [Contact: Maggie Loy]	Never Involved
Santa Barbara County Santa Barbara, CA [Contact: John Storrer]	*Hemizonia increscens* ssp. *villosa*
City of Santa Rosa [Contact: Denise Peters]	Responded; see Sonoma County Planning Dept.
John Sawyer Biology Department Humbolt State University Arcata, CA	*Erysimum menziesii* *Lilium occidentale*
Marie Simovich Biology Department University of San Diego	Never Involved
James P. Smith, Jr. Dept. Biological Sciences Humbolt State University Arcata, CA	Never Involved
Susan Smith San Francisco, CA	Never Involved
Solano County/ Environmental Management Fairfield, CA [Contact: Karen Wyeth & Cynthia Copeland]	Never Involved
Sonoma County Planning Dept. Santa Rosa, CA [Contact: Ken Milam]	Santa Rosa Plains Vernal Pools

[18]Mr. Greer also sent information for several other plant species that are not state-listed, but have some form of federal status.

Siskiyou County Dept. Agriculture Montague, CA [Contact: Bill Ferlatte]	*Calochortus greenei*
Sonoma State Botanical Garden Sebastopol, CA [Contact: Karen Tatarish]	Never Involved
Sonoma County Planning Department Santa Rosa, CA [Contact: Ken Milam]	*Navarretia plieantha* *Limnanthes vinculans* *Lasthenia burkei*
Stanford University Jasper Ridge Biological Preserve [Contact: Alan Grundman]	Never Involved
John Stebbins Clovis, CA	*Pseudobahia peirsonii*, *Brodiaea insignis*
Sugnet & Associates Roseville [Contact: John Ranlett]	Never Involved
The Nature Conservancy San Francisco, CA [Contact: Robin Cox & Leslie Friedman]	Never Involved
The Nature Conservancy Santa Barbara, CA Peter Schuyler	Never Involved[19]
Tierra Madre Consultants Riverside, CA [Contact: Larry LaPre]	Never Involved[20]

[19]Mr. Schuyler is no longer with The Nature Conservancy.

[20]Tierra Madre Consultants is planning projects that involve the mitigation-related manipulation of *Brodiaea filifolia* and *Eriastrum densifolium* ssp. *sanctorum*.

Tree of Life Nursery San Juan Capistrano, CA [Contact: Mike Evans]	Indirectly Involved[21]
Trust For Public Land San Francisco, CA [Contact: Bennett Johnston]	Never Involved
Tulare County Planning Visalia, CA [Contact: Hector Guerro]	Never Involved
Tuolumne County Planning Dept. Sonora, CA [Contact: John Anderson]	Never Involved
U.S. Army Corps of Engineers Sacramento, CA [Contact: Larry Vinzant]	Never Involved
U.S. Bureau of Land Management Arcata, CA [Contact: Carol Tyson & Steve Hawks]	Never Involved
U.S. Bureau of Land Management Folsom, CA [Contact: D.K. Swickard]	Never Involved
U.S. Department of Energy Sacramento, CA [Contact: No name forwarded on questionnaire]	Never Involved
U.S. Bureau of Land Management Riverside, CA [Contact: Gerald Hillier & Connie Rutherford]	*Croton wigginsii*
U.S. Bureau of Land Management Susanville, CA [Contact: Gary Schoolcraft]	*Antennaria flagellaris*

[21]Mr. Evans forwarded a list of rare, endangered and threatened plants handled by Tree of Life Nursery. State-listed species include: *Acanthomintha ilicifolia, Arctostaphylos imbricata, Brodiaea filifolia, Ceanothus hearstiorum, Ceanothus maritimus, Eriastrum densifolium* ssp. *sanctorum, Eriogonum crocatum, Fremontodendron mexicanum, Hemizonia minthornii, Mahonia nevinii, Malacothamnus clementinus,* and *Monardella linoides* ssp. *viminea.*

U.S. Bureau of Land Management Ukiah, CA [Contact: Pardee Bardwell]	*Arabis macdonaldiana* Contracted with M. Baad
U.S. Fish and Wildlife Service San Francisco Bay Wildlife Refuge Complex Newark, CA [Contact: Joy Albertson]	*Erysimum capitatum* var. *angustifolium ,Oenothera deltoides* ssp. *howellii*
U.S. Forest Service Alpine, CA [Contact: Maribeth Kotuman]	Never Involved
U.S. Forest Service Klamath National Forest Yreka, CA [Contact: Barbara Williams]	*Calochortus greenei*
U.S. Forest Service Lake Tahoe Basic Mgmt. Unit S. Lake Tahoe, CA [Contact: Helen Soderberg]	Never Involved[22]
U.S. Forest Service Modoc National Forest Tulelake, CA [Contact: Laura Thompson]	Never Involved
U.S. Forest Service Pacific Southwest Forest & Range Experiment Station Berkeley, CA [Contact: Connie Millar]	Never Involved
U.S. Forest Service Six Rivers National Forest Eureka, CA [Contact: Dave Imper]	*Bensoniella oregana, Oenothera wolfii*
U.S. National Park Service Channel Island NP Ventura, CA [Contact: Karen Danielson & William Halvorsen]	Never Involved

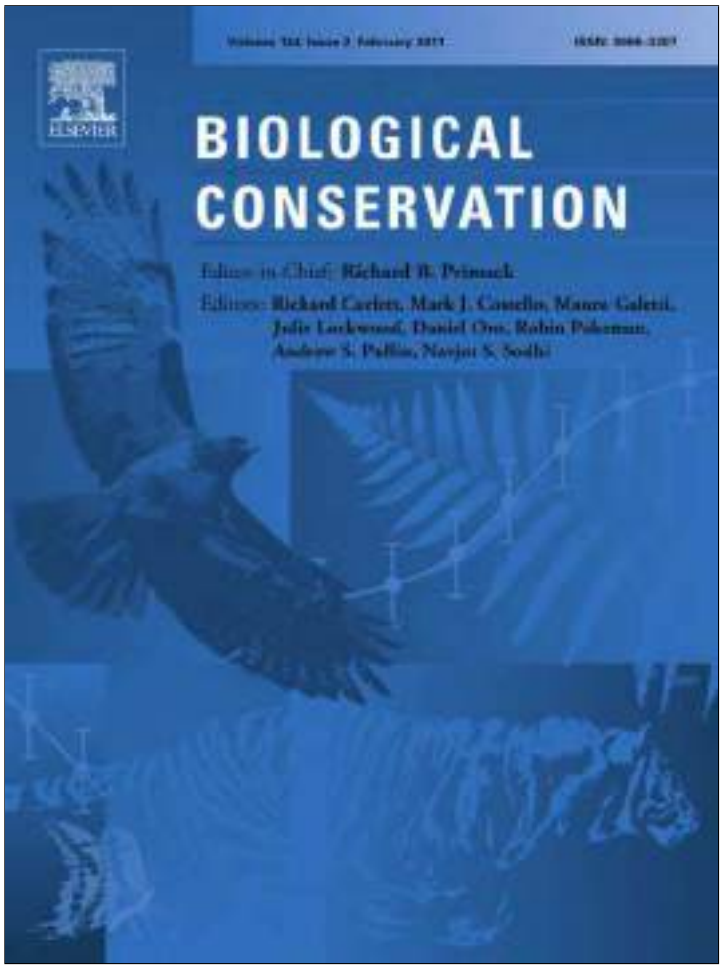
[22]Never involved in a mitigation-related transplantation, reintroduction or relocation project, but mentioned that the USFS had reintroduced *Rorippa subumbellata* to three historic locations. No additional information was received.

U.S. National Park Service Golden Gate National Recreation Area San Francisco, CA [Contact: Terri Thomas]	*Arctostaphylos hookeri* var. *ravenii*
U.S. National Park Service Yosemite National Park Yosemite, CA [Contact: Susan Buis]	Never Involved
U.S. National Park Service Monterey, CA [Contact: Robert Branson]	Never Involved
U.S. Navy Public Works Dept. San Diego, CA [Contact: Mike E. Scott]	Never Involved[23]
U.S. Soil Conservation Service Sacramento, CA [Contact: Jack Wright]	Never Involved
University of California Botanical Garden Berkeley, CA [Contact: Holly Forbes]	Never Involved
University of California Hastings Natural History Reservation Carmel Valley, CA [Contact: Susan Schettler]	Never Involved
University of California James San Jacinto Mtns. Reserve Idyllwild, CA [Contact: Michael Hamilton]	Never Involved
University of California Natural Reserves System Oakland, CA [Contact: Norden H. Cheatham]	Never Involved
WESCO Novato, CA [Contact: Diane Hickson]	*Lasthenia burkei*
Western Area Power Administration	

[23]Mr. Scott recommended contacting Zentner and Zentner regarding Miramar.

Sacramento, CA [Contact: Nancy Weintraub]	Never Involved
Williams Enterprises, Inc. Seattle, WA [Contact: Mike Williams]	Never Involved
Vernal Yadon Pacific Grove, CA	Never Involved
Yolo County Resource Conservation District Winters, CA [Contact: John Anderson]	Never Involved
Paul Zedler Department of Biology San Diego State University	Answered with C.A. Black; *Pogogyne abramsii* & *Eryngium aristulatum*
John Zenter Zentner & Zentner Walnut Creek, CA	Called; Never received information on several projects involving *Grahiola heterosepala, Saginaria sanfordii & Hibiscus californicus*

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Biological Conservation 144 (2011) 672–682

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

Review

How successful are plant species reintroductions?

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ARTICLE INFO

Article history:
Received 15 April 2010
Received in revised form 24 September 2010
Accepted 2 October 2010
Available online 30 October 2010

Keywords:
Species translocation
Population reinforcement
Population supplementation
Population augmentation
Restored populations

ABSTRACT

Reintroduction of native species has become increasingly important in conservation worldwide for recovery of rare species and restoration purposes. However, few studies have reported the outcome of reintroduction efforts in plant species. Using data from the literature combined with a questionnaire survey, this paper analyses 249 plant species reintroductions worldwide by assessing the methods used and the results obtained from these reintroduction experiments. The objectives were: (1) to examine how successful plant species reintroductions have been so far in establishing or significantly augmenting viable, self-sustaining populations in nature; (2) to determine the conditions under which we might expect plant species reintroductions to be most successful; (3) to make the results of this survey available for future plant reintroduction trials. Results indicate that survival, flowering and fruiting rates of reintroduced plants are generally quite low (on average 52%, 19% and 16%, respectively). Furthermore, our results show a success rate decline in individual experiments with time. Survival rates reported in the literature are also much higher (78% on average) than those mentioned by survey participants (33% on average). We identified various parameters that positively influence plant reintroduction outcomes, e.g., working in protected sites, using seedlings, increasing the number of reintroduced individuals, mixing material from diverse populations, using transplants from stable source populations, site preparation or management effort and knowledge of the genetic variation of the target species. This study also revealed shortcomings of common experimental designs that greatly limit the interpretation of plant reintroduction studies: (1) insufficient monitoring following reintroduction (usually ceasing after 4 years); (2) inadequate documentation, which is especially acute for reintroductions that are regarded as failures; (3) lack of understanding of the underlying reasons for decline in existing plant populations; (4) overly optimistic evaluation of success based on short-term results; and (5) poorly defined success criteria for reintroduction projects. We therefore conclude that the value of plant reintroductions as a conservation tool could be improved by: (1) an increased focus on species biology; (2) using a higher number of transplants (preferring seedlings rather than seeds); (3) taking better account of seed production and recruitment

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doi:10.1016/j.biocon.2010.10.003

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when assessing the success of reintroductions; (4) a consistent long-term monitoring after reintroduction.

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1. Introduction

Wild plants are under increasing threat throughout the world. Humans may have accelerated the rate of extinction by 100- to 1000-times the natural rate (Ricketts et al., 2005; Thuiller, 2007). The best place to conserve plant biodiversity is in the wild, where a large number of species present in viable populations can persist in their natural habitats with their associated ecological interactions (Mc Naughton, 1989). However, degraded and altered habitats have become a major portion of the landscape mosaic (Vitt and Havens, 2004). For the foreseeable future, accelerating demands for natural resources will continue to degrade habitat and push an increasing number of plants towards extinction (Havens et al., 2006). Habitat restoration is a good conservation approach that may allow many plant populations to recover without the use of introduced propagules (Menges, 2008). However, as many plants have transient seed banks (Thompson et al., 1997), and many are dispersal-limited (Clark et al., 2007), spontaneous recovery of rare plant populations in restored sites may be constrained by the absence of naturally occurring propagules. In this case, the reintroduction of individual plants in the wild is an essential measure to conserve threatened species (Akeroyd and Wyse Jackson, 1995). The basic biological purpose of reintroductions is establishing new or augmenting existing populations in order to increase a species' survival prospects (Pavlik, 1996; van Groenendael et al., 1998; Luijten et al., 2002).

Reintroduction of native species has become increasingly important in conservation worldwide (e.g., Maunder, 1992; Hodder and Bullock, 1997; Rout et al., 2009). The value of species reintroduction has been increasingly acknowledged in international treaties and legislation, including the Convention on Biological Diversity, the Bern Convention, the Global Strategy for Plant Conservation, the European Strategy for Plant Conservation, the Gran Canaria Declaration on Climate Change and Plant Conservation, and the European "Habitat" Directive 92/43/EEC. These agreements increase public acceptance of reintroduction efforts as an integral component of biodiversity conservation. As a result, many reintroduction efforts have been initiated. In the last 10 years the European Union consistently supported reintroductions through specific projects approved under the LIFE programme (http://ec.europa.eu/environment/life/index.htm). However, with few exceptions, there has been little effort to report reintroduction protocols and outcome. Only a few studies have reported reintroduction trials in plant species (Bottin et al., 2007). Furthermore, case studies, best practices and experiences of reintroduction most often remain in the grey literature, rather than published in the scientific literature (Hodder and Bullock, 1997; Fischer and Lindenmayer, 2000). Moreover, published literature suffers from a bias towards positive results (Deredec and Courchamp, 2007). The lack of adequate documentation may therefore be especially acute for reintroductions that are regarded as failures (Griffith et al., 1989). In reviewing the grey literature we found that reintroduction projects exist for at least 234 plant species in Europe. This information was compiled from various sources, e.g. the IUCN Reintroduction Practitioners Directory (Soorae and Seddon, 1998), the ENSCONET Database (enscobase.maich.gr) and the Italian Botanical Society Database (www.societabotanicaitaliana.it). However, the existence of different databases does not facilitate information retrieval. Furthermore, no information is available on the techniques used or the results obtained.

Recently, Menges (2008) reviewed factors that contribute to the success of reintroduction, examining the ways reintroductions have been evaluated at various stages during the process of restoration. By answering the question "when is a reintroduction successful?" this paper is a major contribution in restoration ecology. However, Menges (2008) did not answer the question

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"how successful are reintroductions?" Such work has been carried out for animal species by various authors (e.g., Griffith et al., 1989; Cade and Temple, 1995; Wolf et al., 1996; Cade, 2000; Fischer and Lindenmayer, 2000). Except for Guerrant and Kaye's (2007) review of 10 plant reintroduction projects, we are unaware of any comprehensive reviews despite an earlier call for a synthesis of data on specific reintroductions to improve overall success of these efforts (Hodder and Bullock, 1997). Indeed, many projects illustrate that various plant species seem to be particularly difficult to reintroduce (e.g. Allen, 1994; Parsons and Zedler, 1997; Helenurm, 1998; Morgan, 1999; Krauss et al., 2002). Consequently, reintroduction trials have sometimes been criticised (Fahselt, 2007). However, negative results must be viewed as an advancement of knowledge (MacNab, 1983). As reintroduction is recognised as a relatively high-risk, high-cost activity (Maunder, 1992; Gorbunov et al., 2008), disseminating the results of successful – and unsuccessful – experiments is important to provide examples and case studies that will allow development of common standards and methodologies.

This study analyzes plant species reintroduction trials worldwide by focusing on the methods used and the results obtained. Three main goals were identified. The first is to examine how successful plant reintroductions have been in establishing or significantly augmenting viable, self-sustaining populations in nature. The second is to determine the conditions required for plant reintroductions to be successful. Specifically, we test whether project type, material type, number of founder individuals, number of individuals introduced, provenance of material introduced, demographic status of source population, introduction method and field manipulations play a major role in the success of reintroductions. Our third objective is to use our results to inform future plant reintroduction efforts.

2. Material and methods

2.1. Definitions

In this study, we use the terms reintroduction, reinforcement and translocation according to Akeroyd and Wyse Jackson (1995) and IUCN (1998). Reintroduction is a general term that describes the controlled placement of plant material into a natural or managed ecological area. It has also a stricter definition, i.e., the release and management of a plant into an area in which it formerly occurred, but in which it is now extinct or believed to be extinct (also called reinstatement or reestablishment). Each time we use this term in the stricter sense, we will utilize the abbreviation s.s. Reinforcement is an effort to increase population size or diversity by adding individuals to an existing population (also called supplementation, enhancement, augmentation or restocking). Translocation is the transfer (direct transportation or transplantation) of material from one part to another of the existing range of a species. In this review, the few introductions to which we refer took place within the historic range of the species but in a site in which it has never been known to occur.

Success is defined here as the ability of the population to persist and reproduce. To assess the success of a reintroduction, we focused on the survival, flowering and fruiting rates of the reintroduced plants. Seed production and recruitment are also important metrics for measuring the success of a reintroduction, but these data were rarely available in the studies we review here.

2.2. Literature review

We reviewed the literature through a search in Thomson's online Web of Science database, using the following query: (reintroduc* OR translocat* OR outplant* OR re-establish* OR transplant* OR reinforce*) AND plant. We found 82 papers on plant reintroductions, published between 1989 and 2009. These papers were examined for suitability of inclusion in the analysis. For inclusion, an article had to give sufficient methodological details (e.g. number of individuals reintroduced, material type and provenance, demography of source population, introduction method, field manipulations) and to provide data on survival, flowering or fruiting percentages, or recruitment. Consequently, 26 papers were included in the analysis (Appendix 1), yielding 114 reintroductions involving 94 plant species. Reintroductions of the same taxon to multiple locations were considered as different case studies, because of variations in methodology or environmental factors. Each reintroduction project is indeed unique with regard to the species involved, technical approach and external circumstances in which the work is conducted (Guerrant and Kaye, 2007).

2.3. Questionnaire survey

As many data are currently unpublished or in reports with restricted access, a survey was also conducted among 473 botanic gardens, universities or conservation organisations that we knew or suspected had undertaken reintroductions without having published the results. The survey was also published in the BGCI e-bulletin sent to over 4000 recipients (http://www.bgci.org/resources/news/0586/). The survey addressed biological and technical aspects of the reintroduction programmes, e.g., source and status of the reintroduced population, cultivation and reintroduction methodology, site attributes, results of the reintroduction (Appendix 2). Forty-six institutions replied to the survey (10% feedback). Fifty-five forms were correctly completed and were included in the analysis, yielding 135 reintroductions involving 82 plant species in 11 countries. Eighty-nine percent of the returned forms covered reintroduction programmes in Europe, with the remainder (11%) covering Africa, North America and Australia. Altogether our study includes 249 reintroductions involving 172 taxa belonging to 62 families (Appendix 3).

2.4. Multivariate analyses

To identify significant predictors of reintroduction outcomes, we first conducted a Canonical Correspondence Analysis (CCA; Ter Braak and Gremmen, 1987) using Canoco 4.5 for Windows (Ter Braak and Šmilauer, 2002). In order to maximize the number of cases that could be included in the analysis, we used survival rate after 1 year and flowering and fruiting rates after 2 years (after applying an arcsine-square-root transformation) as measures of reintroduction success. This initial analysis provided a check on the unimodality of the data. Because the length of the gradient was 0.38 SD, we assumed that the response curve would be monotonic and we considered a redundancy analysis (RDA). The advantage of using RDA is that its biplot provides more quantitative information than the joint plot in CCA (Jongman et al., 2000). One explanatory variable was a quantitative variable, representing the number of individuals reintroduced. The other variables were qualitative: type of project (i.e., reintroduction s.s., translocation, reinforcement, introduction), site protection status (unprotected vs. protected, the latter being either national parks, regional parks, nature reserves or Natura 2000 sites), material type (seeds vs. seedlings), material provenance (single or multiple source populations), field manipulations (fencing vs. not fencing, removing surrounding plants vs. not removing, burning vs. not burning) and good knowledge of cause of decline/extinction and environmental characteristics.

Multivariate analyses are appropriate because the success or failure of a reintroduction is likely caused by numerous factors

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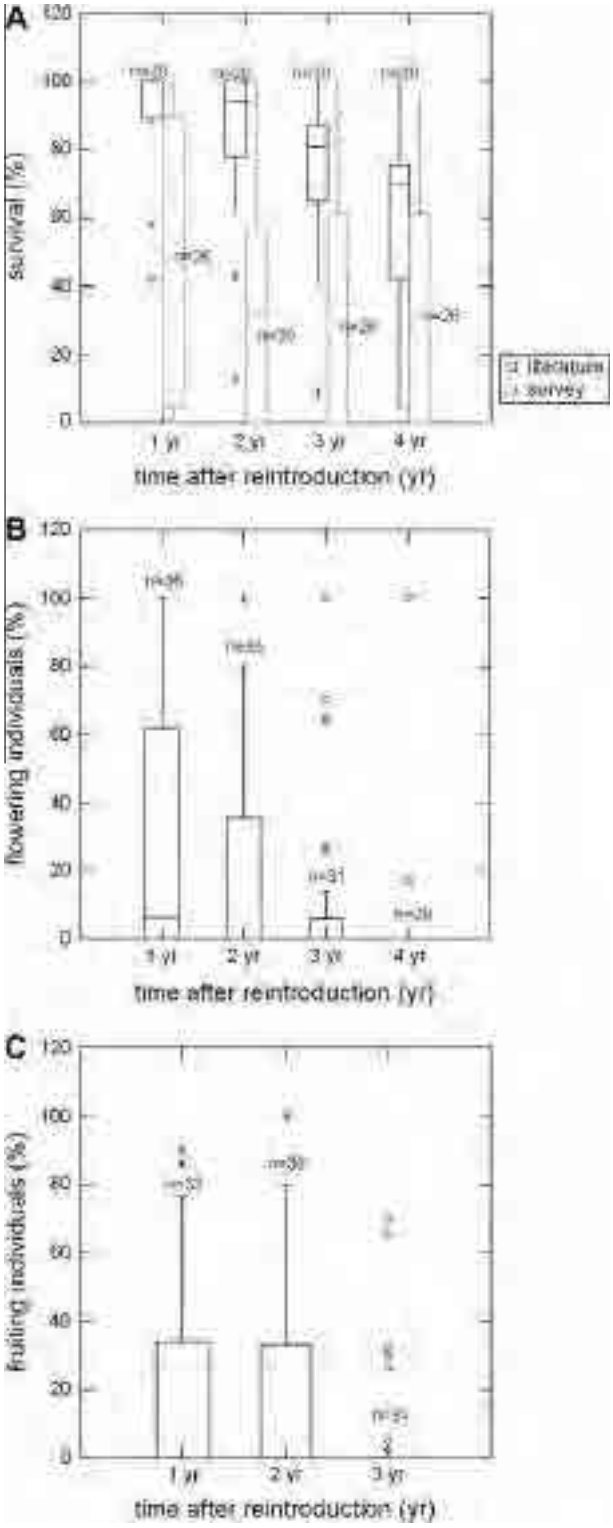


Fig. 1. Success parameters of reintroductions over time. (A) Survival percentage, showing literature data and survey data separately. (B) Percentage of flowering individuals. (C) Percentage of fruiting individuals. Outside (*) and far out values (°) are plotted as asterisks and circles, respectively.

(Wolf et al., 1996). This approach incorporates the effects of all variables on the responses of interest across multiple dimensions. However, it requires the availability of a dataset where information on the variables to be used is complete for all the reintroductions under consideration, which was the case for only 24 of reintroductions included in our study.

2.5. Univariate analyses

We also conducted univariate analyses because success variables (survival, flowering and fruiting rates) were not provided by all respondents (consequently these trials were not considered in our multivariate analysis) and because univariate analyses can identify factors potentially associated with reintroduction success (Wolf et al., 1996). In order to answer our first research aim, we evaluated the success of plant reintroductions by examining survival, flowering and fruiting rates plotted against time since reintroduction in years. Only years 1–4 were sufficiently represented in the dataset to be included in this analysis. Our second aim was then addressed by investigating the influence of each explanatory variable individually on the success-related variables, using Kruskal–Wallis and Mann Whitney tests using SYSTAT 8.0 (Wilkinson, 1998). Time was again plotted in the graphs in order to add a temporal dimension (years 1 and 3 were used here as they maximized the number of cases included). The 0.05 level of probability was accepted as threshold of significance throughout this work. Predictor variables were: number of founder individuals (individuals from which the material was collected), number of individuals reintroduced, type of project, site protection status, material type and provenance, demography of source population, introduction method, field manipulations, and knowledge of genetic variation. Literature data and survey data are displayed together on the graphs, unless otherwise stated.

2.6. Cause of reintroduction outcome

In addition to the biological and technical aspects of the reintroduction, we asked survey participants about their perceptions regarding the success or failure of the reintroduction, and the reason for the outcome. This allowed us to compare their perceptions

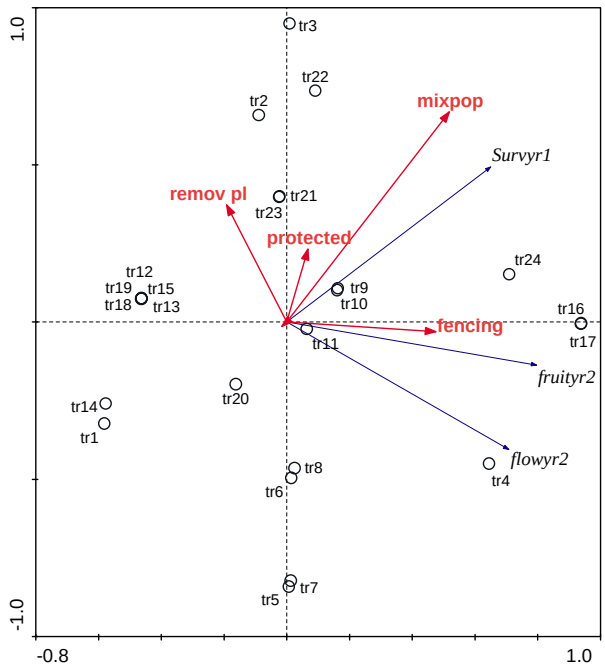


Fig. 2. RDA ordination of success-related variables (survival percentage after 1 year, flowering percentage after 2 years and fruiting percentage after 2 years) in 24 reintroduction trials. Only the variables contributing significantly to the explained variation are shown (see Table 1 for statistics on all variables). Trial position is given along axis 1 (horizontal) and axis 2 (vertical). Both axes scaled in SD-units. Vectors indicate the direction of largest change in the explanatory and success-related variables.

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with their data, and to independently evaluate the reasons for failure. Such explanations are seldom recorded in the literature (Milton et al., 1999).

3. Results

3.1. Success of plant reintroductions

Overall, both the literature (Kruskal–Wallis test $H = 22.1$, $n = 80$, $P < 0.001$) and the survey data (Kruskal–Wallis test $H = 10.8$, $n = 104$, $P = 0.013$) show a significant downward trend over time in the survival of reintroduced plants (Fig. 1A). However, survival rates reported in the literature are remarkably higher than those mentioned by survey participants (Mann Whitney test: $U = 6854.0$, $n = 184$, $P < 0.001$). The percentages of flowering (Kruskal–Wallis test $H = 13.0$, $n = 122$, $P = 0.005$) and fruiting (Kruskal–Wallis test $H = 5.0$, $n = 102$, $P = 0.08$) individuals also show a decreasing trend over time since reintroduction (Fig. 1B and C), although results are only significant for the former.

3.2. Variables associated with success

The arrangement of the 24 trials in the RDA ordination is shown in Fig. 2. Eigenvalues of first and second axis were 0.498 and 0.166, respectively. Table 1 shows the variance explained by each of the variables tested and the cumulative variance explained (69%). Only three variables explained significant amounts of variation in reintroduction success: material provenance (mixpop; 21%), removing surrounding plants (remov pl; 16%) and site protection (protected; 12%). Fencing the target area explained 6% of the reintroduction success, but was only marginally significant ($P = 0.06$).

By examining each variable separately, we can confirm that reintroducing a species in protected areas significantly increases survival rate compared with reintroduction into unprotected areas (Fig. 3A; Mann Whitney test: $U = 693.0$, $n = 64$, $P = 0.012$ after 1 year; $U = 433.0$, $n = 47$, $P < 0.001$ after 3 years). Interestingly, differences become even greater after 3 years. Reintroductions s.s., reinforcements and translocations resulted in somewhat similar survival rates, significantly higher than those for introductions, especially after 3 years when it appeared that all introduced plants had died (Fig. 3B; Kruskal–Wallis test: $H = 8.9$, $n = 99$, $P = 0.030$ after 1 year; $H = 16.4$, $n = 51$, $P = 0.001$ after 3 years). Use of seedlings provided higher survival rates than use of seeds, although results were only significant in the first year after reintroduction (Fig. 3C; Mann Whitney test: $U = 537.0$, $n = 86$, $P = 0.007$ after 1 year; $U = 81.5$, $n = 40$, $P = 0.662$ after 3 years).

Table 1
Percentage variation in reintroduction success explained by explanatory variables and level of significance (Monte Carlo test, 999 permutations). Only 24 trials could be included in this analysis.

Explanatory variable	Variance explained by single variable (%)	Cumulative variance explained (%)	*P*-level
Plants from diverse source populations	21	21	0.007
Knowledge of cause of decline/extinction	9	30	0.096
Reducing competition by removing surrounding plants	16	46	0.008
Protected area	12	58	0.005
Fencing of the reintroduction area	6	64	0.061
Knowledge of environmental characteristics	2	66	0.310
Project type: reintroduction/ reinforcement	2	68	0.498
Number of individuals reintroduced	0	68	0.857
Burning before reintroduction	1	69	0.672
Material type: seeds	0	69	0.859

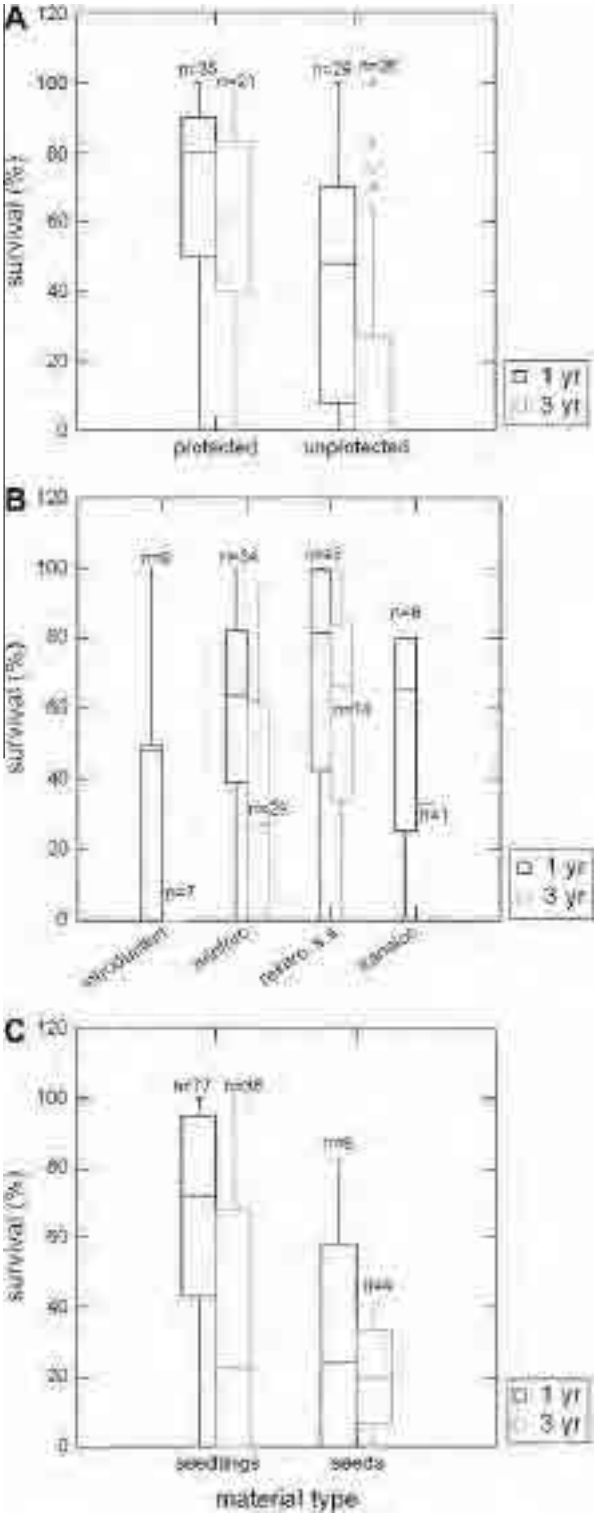


Fig. 3. Relationship between survival percentage after 1 or 3 years and (A) protection status of the reintroduction area, (B) type of project, (C) type of propagule material. Outside (°) and far out values (°) are plotted as asterisks and circles, respectively.

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The number of founder individuals (individuals from which the material was collected) had no influence on the survival of the restored taxa (Fig. 4A; Kruskal–Wallis test: $H = 2.9$, $n = 58$, $P = 0.396$ after 1 year; $H = 1.8$, $n = 29$, $P = 0.611$ after 3 years), in contrast to the significant influence of the number of reintroduced individuals (Fig. 4B; Kruskal–Wallis test: $H = 14.2$, $n = 88$, $P = 0.003$ after 1 year; $H = 16.6$, $n = 45$, $P = 0.001$ after 3 years). The difference in survival rate declines over time as propagule number used increases to up to 1000 individuals (Fig. 4B).

Reintroducing a species by mixing material from diverse populations promoted a higher survival rate than using material from a single population. However, contrary to the multivariate analysis, this result was not significant in the univariate analysis (Fig. 5A; Mann Whitney test: $U = 535.5$, $n = 76$, $P = 0.401$ after 1 year; $U = 170.0$, $n = 48$, $P = 0.404$ after 3 years). Based on 3 years of data following reintroduction, we have found that using material from stable source populations (instead of decreasing ones) exhibit a positive influence on the survival rate, even if the results were significant only from the third year after reintroduction (Fig. 5B; Mann Whitney test: $U = 92.0$, $n = 44$, $P = 0.228$ after 1 year; $U = 31.0$, $n = 37$, $P = 0.010$ after 3 years).

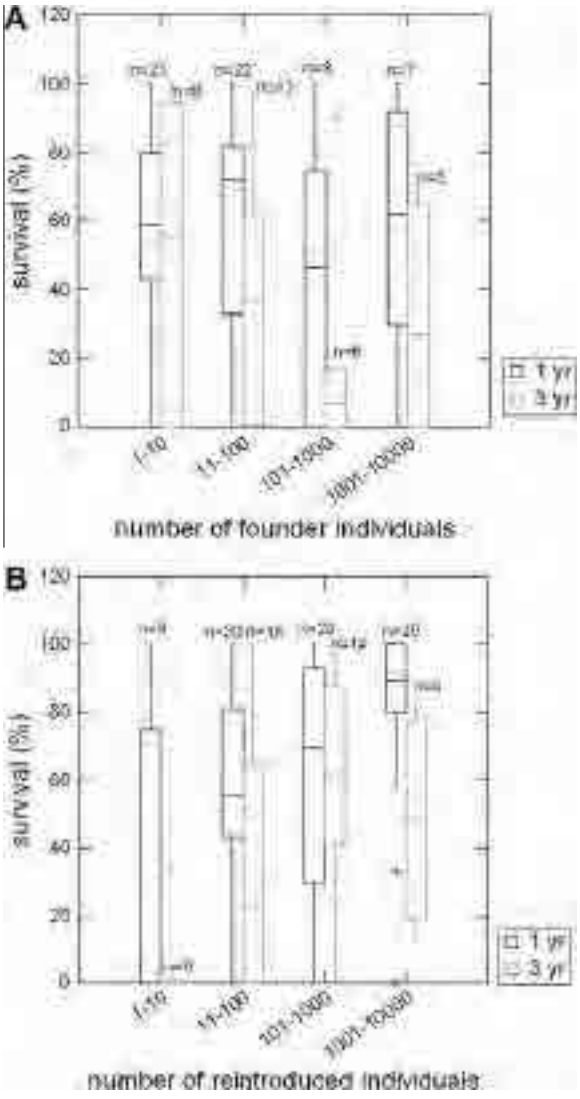


Fig. 4. Relationship between survival percentage after 1 or 3 years and (A) number of founder individuals, (B) number of individuals reintroduced. Outside (*) and far out values (°) are plotted as asterisks and circles, respectively.

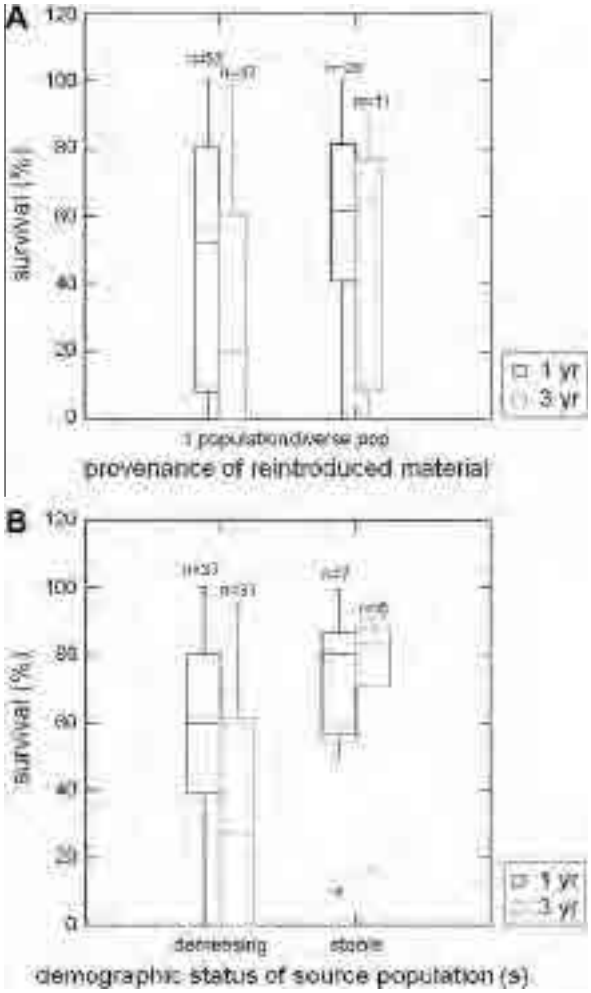


Fig. 5. Relationship between survival percentage after 1 or 3 years and (A) provenance of reintroduced material, (B) demographic status of source population(s). Outside (*) and far out values (°) are plotted as asterisks and circles, respectively.

Using bare-root seedlings resulted in a significantly higher survival rate after 3 years than when seedlings rooted in potting soil were planted (Fig. 6A; Mann Whitney test: $U = 90.0$, $n = 60$, $P = 0.513$ after 1 year; $U = 301.5$, $n = 47$, $P = 0.023$ after 3 years). Reintroduction trials accompanied by at least one site preparation or management effort (e.g., fencing, top-soil removal, nutrient enrichment, soil loosening, reducing competition by removing surrounding plants, watering, burning or protection from herbivores) resulted in significantly higher survival rates starting in the first year (Fig. 6B; Mann Whitney test: $U = 364.5$, $n = 66$, $P = 0.050$ after 1 year; $U = 185.0$, $n = 47$, $P = 0.051$ after 3 years).

Having some knowledge of the genetic variation of the target species significantly enhanced the survival rate from the first year after reintroduction, and the difference increases over time (Fig. 7; Mann Whitney test: $U = 225.5$, $n = 66$, $P = 0.054$ after 1 year; $U = 70.0$, $n = 47$, $P = 0.033$ after 3 years).

3.3. Perceived cause(s) of reintroduction outcome

Equal numbers of respondents (29%) reported successful and unsuccessful reintroduction trials (Fig. 8A). For programs of 10 years and over, this proportion increased substantially to 34%. Forty-two percent reported that it was too early to judge the success of their projects (after 10 years and more this proportion fell

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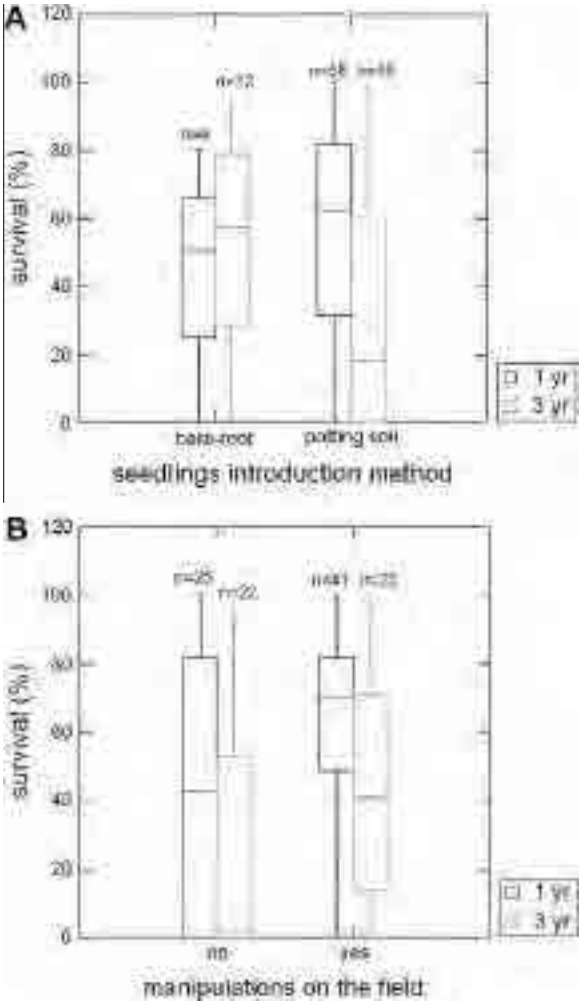


Fig. 6. Relationship between survival percentage after 1 or 3 years and (A) seedlings introduction method, (B) management of out-planting sites. Outside (*) and far out values (°) are plotted as asterisks and circles, respectively.

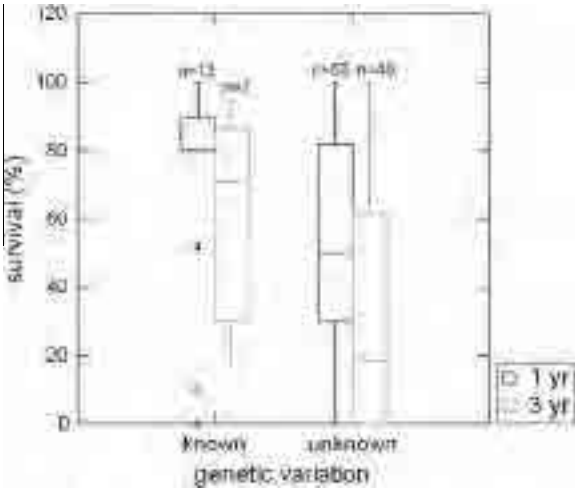


Fig. 7. Relationship between survival percentage after 1 or 3 years and knowledge of genetic variation of the reintroduced species. Outside (*) and far out values (°) are plotted as asterisks and circles, respectively.

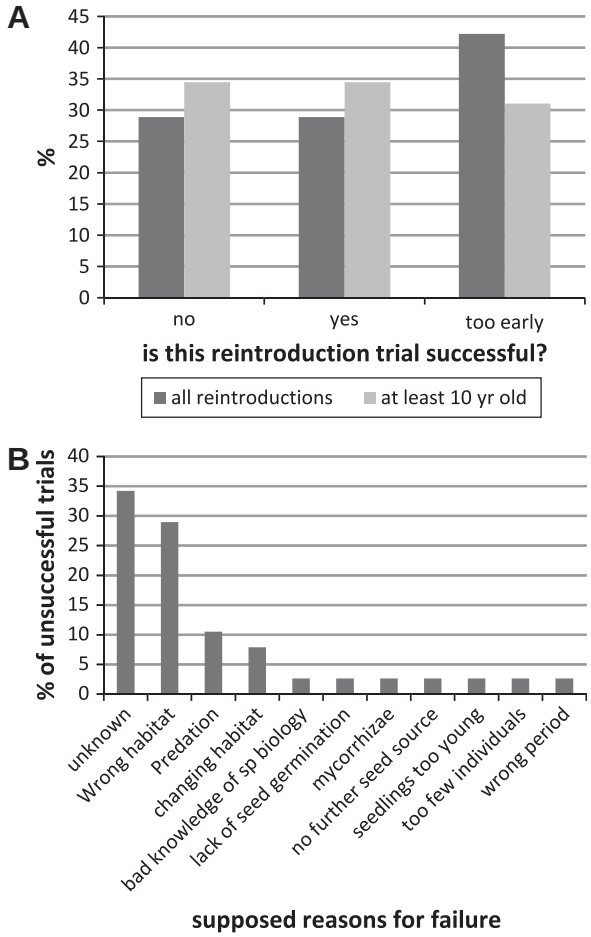


Fig. 8. (A) Distribution frequency of survey participants' perceptions regarding the success or failure of their reintroduction trials ($n = 135$). (B) Perceived causes of reintroduction failure ($n = 38$).

to 31%). The supposed reasons for failure were grouped into 11 categories (Fig. 8B). In 34% of the cases, the reason was unknown. An unsuitable habitat was the most frequently attributed reason for failure (29%). Predation (10%) and changing (degrading) habitat (8%) were also repeatedly cited as factors causing failure. Remaining causes were cited only once.

4. Discussion

4.1. Success of plant reintroductions

A key qualitative measure of the ultimate fate of reintroductions is the ability of transplants to flower and set fruit (Morgan, 2000; Tyndall and Groller, 2006; Menges, 2008). Our study reveals that survival, flowering and fruiting rates in reintroduction projects are generally quite low. Furthermore, the data indicate a downward trend with time (e.g., after 4 years, flowering percentage was only 6% on average). Few studies included data on seed production and recruitment, which would allow more direct assessment of population viability. Recruitment is considered the highest measure of success (Pavlik, 1996; Sutter, 1996), because it indicates that the population is self-sustaining through the development of successive generations (Primack, 1996). We obtained information about recruitment from the survey and from the literature for only 32% and 39% of the reintroduction attempts, respectively. In most cases, respondents reported no or only sporadic recruitment.

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These data suggest that most plant reintroductions will not be successful over the long-term. However, almost one third of the survey participants categorised their project as successful. Many practitioners, therefore, may be overly optimistic in their assessments (see also Reading et al., 1997). The majority of the respondents felt it was too early to gauge success, likely concluding that 3 years may not be sufficient to indicate a long-term trend (Seddon, 1999; Guerrant and Kaye, 2007). While we agree that this timeframe is short, we were constrained by the available data. However, the declining trends in vital rates over the first few years of projects strengthens the conclusion that reintroduction is generally unlikely to be a successful conservation strategy as currently conducted.

Our results have also shown that publications are biased towards the most successful experiments. This is not surprising as many failed attempts probably remain unpublished (Berg, 1996) because negative findings are less publishable or regarded as uninteresting (Fahselt, 2007; Menges, 2008). The distorted view provided from literature review alone supports the value of the additional survey conducted. One could argue that survey results might also be biased by an over-representation of successful programs as participants in more successful programs may be more likely to respond (Reading et al., 1997). However, the significant difference between survival rates from the survey and those from the literature (two to three times higher) shows that any bias is substantially lower in the survey data.

4.2. Variables associated with success

This study has identified various parameters that seem to influence plant reintroduction outcomes. As demonstrated by our multivariate analysis and by Vergeer et al. (2005), reintroduction success is increased by using material originating from multiple populations. These authors observed that origin influenced the survival of introduced *Arnica montana* within 2 years (Vergeer et al., 2005). Multiple source populations may not be necessary if individual populations have sufficient genetic variability and may be undesirable if conservation of genetic differentiation among populations is a goal (Gordon, 1994). Where use of multiple source populations appears necessary for reintroduction success, establishment of the new composite population should be sufficiently distant from existing wild populations to preclude gene flow. Some authors have also raised concerns about outbreeding depression when using multiple source populations (Montalvo et al., 1997; Storfer, 1999; Krauss et al., 2002). Outbreeding depression is normally measured in the second and following generations (Lynch, 1991; Fenster and Galloway, 2000). As our data set included little data on seed production and recruitment, we cannot evaluate the eventual risks of outbreeding depression in the reintroductions reviewed here.

Our results also highlight a positive relationship between the number of reintroduced individuals and their survival. Demographic and genetic theories both predict that the persistence time of a population increases with its initial size (Robert et al., 2007). This prediction is consistent with findings from studies of animal (Griffith et al., 1989; Fischer and Lindenmayer, 2000) and invasive species (Lockwood et al., 2005; von Holle and Simberloff, 2005) introductions. Simulation studies have shown that demographic stochasticity is only important in populations of 50 or fewer individuals (Pollard, 1966; Menges, 1991). As 25% of the cases in our dataset reintroduced fewer than 50 individuals, demographic stochasticity may partially explain the results. Conversely, reviews by Reed and Frankham (2003) and Reed (2005) demonstrated a significant and positive relationship between population size and population fitness. The introduction of few individuals can lead to loss of genetic diversity due to inbreeding depression or post-introduction genetic drift (e.g., Barrett and Kohn, 1991; Frankham et al., 2002; Pierson et al., 2007). Consequently, smaller populations are generally less capable of adapting to novel environments, as the result of the loss of adaptive genetic variation through genetic drift (Reed et al., 2003).

While these data suggest that reintroductions should include a large number of individuals (Frankham et al., 2002), we noticed that most restoration projects include a very limited number of individuals (fewer than 100 in 43% of the cases). When considering the propagule stage, we found that the average number was 1551 (median: 830) when using seeds and 400 (median: 100) when using transplants. Small numbers are understandable because (1) reintroduction often involves rare species for which numerous propagules are not available and (2) it is a labour-intensive and costly process. Although there is danger in seeking universal levels for minimum viable population sizes (Given, 1994; Robert et al., 2007), the number of reintroduced individuals in the projects reviewed were generally substantially lower than those suggested by various authors: 500 (Given, 1994), 1000 (McGlaughlin et al., 2002), 2000 (Whitlock, 2000), 1500–2500 (Pavlik, 1996), 5000 (Reed, 2005).

The lower success rate obtained when seeds rather than seedlings were planted has previously been highlighted by various published studies (e.g. Milton et al., 1999; Drayton and Primack, 2000; Jusaitis et al., 2004; Maschinski and Duquesnel, 2006; Guerrant and Kaye, 2007; Menges, 2008). The disadvantage of using seeds to start new populations is that seeds will only rarely germinate and grow into new plants in the wild, and that the seedling stage is the most vulnerable part of the plant life-cycle (Primack and Drayton, 1997). Physically adverse environments may therefore limit the possible success with directly sown seeds. It is therefore sometimes necessary to bypass the hazards of germination in the field and use seedlings or mature plants in order to establish populations (Davy, 2002).

This study also provides some evidence that the demographic status of source populations influences reintroduction outcomes. Survival of propagules from stable source populations were up to twice the rate of those from declining populations after 3 years. As declining populations have most likely lost some rare alleles, their genetic diversity is likely to be lower than that of stable populations. Genetic diversity in the source gene pool may influence the colonising ability and prolonged persistence of a population (Polans and Allard, 1989). Diversity is also essential for the adaptability of a population (Booy et al., 2000). Although few restoration efforts include investigation of genetic diversity (see also Schemske et al., 1994), we found that survival rates of target species were much higher when genetic diversity was incorporated into the project design.

Finally, management of the out-planting site through either preparation for planting (e.g., fencing) or post-planting management (e.g., fire, reduced competition) increased the probability of reintroduction success. This focus on site management may explain the earlier result that reintroductions are more successful in protected than in unprotected sites, as management may be more probable in protected sites. Incorporation of management effort into reintroduction design may also reflect greater commitment to the reintroduction, which may also contribute to the higher success rate.

4.3. Perceived cause(s) of reintroduction outcome

The survey outcome suggests that reintroduction failure resulted from reasons predominantly intrinsic to the methodology (wrong habitat) or environmental factors (predation, changing habitat) as opposed to the biology of the introduced plants. In the literature, desiccation and herbivory are often cited as the

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major factors causing mortality in reintroduction experiments (e.g., Helenurm, 1998). Concerns about habitat quality have also been raised by Vergeer et al. (2005). In their review, Bottin et al. (2007) showed that previous failures in restoration programs were mainly due to unsuitable restoration sites or the low number of plants reintroduced in the wild. Translocations involving species at risk are especially challenging because their ecological requirements are often narrower than common species (Berg, 1996; Davy, 2002). The outcome of this study illustrates the difficulty of identifying whether a habitat is (still) adequate for the target species. However, in most cases survey respondents did not investigate the reasons for failure.

Plant conservationists carrying out reintroductions often underestimate the potential importance of species biology, as shown by the partial data obtained from most survey respondents. We expect that some traits may make species good or poor candidates for reintroductions, as population persistence may depend on longevity, mating system, and dispersal ability (Picó and van Groenendael, 2007). Other plant traits that have been found to promote population persistence and spread are competitive ability, vegetative reproduction, seed bank persistence, wind pollination, plant size, growth rate and leaf area (e.g. Kolar and Lodge, 2001; Pywell et al., 2003; Farnsworth, 2007; Milbau and Stout, 2008; Cornwell and Ackerly, 2010; van Kleunen et al., 2010). In their review, Leimu et al. (2006) found a positive association between mean genetic diversity and fitness in self-incompatible but not in self-compatible species, which may be the result of a greater susceptibility to small population size in the former than in the latter (Picó and van Groenendael, 2007). Information on breeding systems is therefore essential for ex situ conservation and reintroduction programs (Weller, 1994; McKay et al., 2005). However, from the survey it appeared that the breeding system of target plants was known only for a limited number of species.

4.4. Suggestions for the design of future reintroductions

Our review suggests that propagule material type, number of individuals reintroduced, provenance of material introduced, demographic status of source population, introduction method and management of out-planting sites seem to play a key role in the success of reintroduction trials. The detection of an effect of these variables on plant reintroduction success is of considerable importance for conservation management. However, we also identified many weaknesses in reintroduction programs: (1) Insufficient monitoring following reintroduction (usually ceasing after 4 years); (2) Inadequate documentation, which is especially acute for reintroductions that are regarded as failures; (3) Lack of understanding of the underlying reasons for decline in existing plant populations; (4) Overly optimistic evaluation of success based on short-term results; and (5) Poorly defined success criteria for reintroduction projects. Clearly different practitioners have different definitions of success, which it is why it is important for introduction proposals to have explicit objectives and a monitoring plan adequate for determining if the objectives have been met.

Documenting what went wrong in reintroductions helps define the set of what could be right, and helps subsequent restoration ecologists to design more efficient efforts (Menges, 2008). According to the weaknesses we identified, we believe that the value of plant reintroductions as a conservation tool could be improved by the following:

4.4.1. Increased focus on propagule material and site protection

The success of a reintroduction remains a question of population viability involving demographic, genetic, behavioural and ecological processes (Sarrazin and Barbault, 1996). Reviews of the common practices in plant re-establishment programs have shown that reintroductions are rarely preceded by demographic and genetic studies (Hodder and Bullock, 1997; Bottin et al., 2007). While it may not be realistic to expect to have genetic data on all populations to be reintroduced, some proxies like demographic data could be used. Schemske et al. (1994) suggest that demographic criteria are far better indicators of the biological status of rare species than is information on the magnitude and distribution of genetic variation. From our survey data, it appears that reintroduced populations originate in many cases from a very small number of founder individuals (even a single founder individual in 7% of the reported experiments). In this case, reproductive failure and genetic decline in the reintroduced populations is likely to accelerate in subsequent generations (Krauss et al., 2002). Plants should also only be reintroduced from material (preferably seedlings) originating from non-decreasing populations. Therefore, the number of individuals reintroduced should be increased and based on factors like the breeding system of target species (selfing species would need fewer transplants than outcrossing species). Finally, results presented here indicate that plant species should preferably be reintroduced in an area that has legal protection status.

4.4.2. Definition of success criteria for reintroductions

Various authors have highlighted the need to define successful reintroductions of plant populations across a range of demographic and time scales (e.g., Morgan, 2000). Even if the definition of success varies among authors, it always includes the ability of a population to survive and reproduce, and to adapt to changing environmental conditions. According to the survey and literature data, it appears that more attention is paid to the survival of plants than their flowering or fruiting rates and recruitment. Many respondents to the questionnaire replied that these data were not available, not tracked, or too complex to measure. As it is clear that a newly reintroduced population that has not yet reproduced cannot be considered a success (Menges, 2008), managers should bear in mind these reproduction criteria when assessing the success of their experiments. A very precise and clear definition of success has been given by Primack and Drayton (1997): *"A* reintroduction *can be considered truly successful only when a population is expanding in numbers and area, when individuals are flowering and fruiting, when a second and third generation of plants are appearing on their own, and the population gives every indication that it will persist into future decades. Further success would involve the population dispersing seeds into the surrounding countryside and producing satellite populations*". What we seek is actually a "viable population". This trait can be assessed implementing a monitoring scheme that allows carrying out a population viability analysis (PVA).

4.4.3. Consistent long-term monitoring after reintroduction

Success criteria as recommended above obviously involve an appropriate monitoring which should not only be improved in quality but also in its time span. Long-term monitoring is necessary because initially high survival rates are often followed by reversals over time (Fahselt, 2007; Hutchings, 2010). Any reintroduction project should operate on a longer time scale than 10 years (Maunder, 1992). Some believe that monitoring to measure success is necessary for up to 25 years (Allen, 1994) or even several decades (McMahan, 1990; Milton et al., 1999; Bell et al., 2003), but these timeframes will depend on the generation time of the species involved. Similar recommendations have been suggested for animal reintroductions (Fischer and Lindenmayer, 2000).

Given the apparent low success rate of many plant reintroduction programs compared to the effort invested, we hope this paper will contribute to better design of future efforts. However, we consider the use of ex situ collections for plant species recovery only a

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last resort and never a first option; the aim is to avoid ever having to reintroduce, but being able to do it if it is deemed necessary (Offord et al., 2004).

Acknowledgements

The authors wish to thank Christophe Lavergne, Ian Taylor, Joanna Markiewicz, Catherine Gaultier, Mari Miranto, Frédéric Blanchard, Andreas Groeger, Bert van den Wollenberg, Peter Enz, Hector Correa Cepeda, and the Italian Botanical Society for providing information on reintroduction programmes in their country. Maïté Delmas, Frédéric Hendoux and Daniel Malengreau have strongly advocated this study by encouraging participation from members of their networks. Richard Primack and three anonymous reviewers provided valuable comments on an earlier draft of this paper.

Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.biocon.2010.10.003.

References

Akeroyd, J., Wyse Jackson, P., 1995. A Handbook for Botanic Gardens on the Reintroduction of Plants to the Wild. BGCI, Richmond.
Allen, W.H., 1994. Reintroduction of endangered plants. BioScience 44, 65–68.
Barrett, S.C.H., Kohn, J., 1991. The genetic and evolutionary consequences of small population size in plant: implications for conservation. In: Falk, D., Holsinger, K.E. (Eds.), Genetics and Conservation of Rare Plants. Oxford University Press, Oxford, pp. 3–30.
Bell, T.J., Bowles, M.L., McEachern, A.K., 2003. Projecting the success of plant population restoration with viability analysis. In: Brigham, C.A., Schwartz, M.W. (Eds.), Population Viability in Plants. Springer, Berlin, pp. 313–350.
Berg, K.S., 1996. Rare plant mitigation: a policy perspective. In: Falk, D.A., Millar, C.I., Olwell, M. (Eds.), Restoring Diversity: Strategies for Reintroduction of Endangered Plants. Island Press, Washington, DC, pp. 279–292.
Booy, G., Hendriks, R.J.J., Smulders, M.J.M., Van Groenendael, J.M., Vosman, B., 2000. Genetic diversity and the survival of populations. Plant Biology 2, 379–395.
Bottin, L., Le Cadre, S., Quilichini, A., Bardin, P., Moret, J., Machon, N., 2007. Re-establishment trials in endangered plants: a review and the example of *Arenaria grandiflora*, a species on the brink of extinction in the Parisian region (France). Ecoscience 14, 410–419.
Cade, T.J., 2000. Progress in translocation of diurnal raptors. In: Chancellor, R.D., Meyburg, B.U. (Eds.), Raptors at Risk. Proceedings of the 5th World Conference on Birds of Prey and Owls. Hancock House Publishers and World Working Group on Birds of Prey and Owls, pp. 343–372.
Cade, T.J., Temple, S.A., 1995. Management of threatened bird species: evaluation of the hands-on approach. The American Naturalist 137, 161–172.
Clark, C.J., Poulsen, J.R., Levey, D.J., Osenberg, C.W., 2007. Are plant populations seed limited? A critique and meta-analysis of seed addition experiments. The American Naturalist 170, 128–142.
Cornwell, W.K., Ackerly, D.D., 2010. A link between plant traits and abundance: evidence from coastal California woody plants. Journal of Ecology 98, 814–821.
Davy, A., 2002. Establishment and manipulation of plant populations and communities in terrestrial systems. In: Perrow, M.R., Davy, A.J. (Eds.), Handbook of Ecological Restoration. Principles of Restoration, vol. 1. Cambridge University Press, Cambridge, pp. 223–241.
Deredec, A., Courchamp, F., 2007. Importance of the Allee effect for reintroductions. Ecoscience 14, 440–451.
Drayton, B., Primack, R.B., 2000. Rates of success in the reintroduction by four methods of several perennial plant species in eastern Massachusetts. Rhodora 102, 299–331.
Fahselt, D., 2007. Is transplanting an effective means of preserving vegetation? Canadian Journal of Botany 85, 1007–1017.
Farnsworth, E.J., 2007. Plant life history traits of rare versus frequent plant taxa of sandplains: implications for research and management trials. Biological Conservation 136, 44–52.
Fenster, C.B., Galloway, L.F., 2000. Inbreeding and outbreeding depression in natural populations of *Chamaecrista fasciculata* (Fabaceae). Conservation Biology 14, 1406–1412.
Fischer, J., Lindenmayer, D.B., 2000. An assessment of the published results of animal relocations. Biological Conservation 96, 1–11.
Frankham, R., Ballou, J.D., Briscoe, D.A., 2002. Introduction to Conservation Genetics. Cambridge University Press, Cambridge.
Given, D.R., 1994. Principles and Practice of Plant Conservation. Timber Press, Portland.
Gorbunov, Y.N., Dzybov, D.S., Kuzmin, Z.E., Smirnov, I.A., 2008. Methodological Recommendations for Botanic Gardens on the Reintroduction of Rare and Threatened Plants. Grif & Co., Tula.
Gordon, D.R., 1994. Translocation of species into conservation areas: a key for natural resource managers. Natural Areas Journal 14, 31–37.
Griffith, B., Scott, J.M., Carpenter, J.W., Reed, C., 1989. Translocation as a species tool: status and strategy. Science 245, 477–480.
Guerrant, E.O., Kaye, T.N., 2007. Reintroduction of rare and endangered plants: common factors, questions and approaches. Australian Journal of Botany 55, 362–370.
Havens, K., Vitt, P., Maunder, M., Guerrant, E.O., Dixon, K., 2006. Ex situ plant conservation and beyond. BioScience 56, 525–531.
Helenurm, K., 1998. Outplanting and differential source population success in *Lupinus guadalupensis*. Conservation Biology 12, 118–127.
Hodder, K.H., Bullock, J.M., 1997. Translocations of native species in the UK: implications for biodiversity. Journal of Applied Ecology 34, 547–565.
Hutchings, M.J., 2010. The population biology of the early spider orchid *Ophrys sphegodes* Mill. III. Demography over three decades. Journal of Ecology 98, 867–878.
IUCN, 1998. IUCN Guidelines for Re-introductions. Prepared by the IUCN/SSC Re-introduction Specialist Group, IUCN, Gland, Switzerland and Cambridge, UK.
Jongman, R.H.G., Ter Braak, C.J.F., Van Tongeren, O.F.R., 2000. Data Analysis in Community and Landscape Ecology. Cambridge University Press, Cambridge.
Jusaitis, M., Polomka, L., Sorensen, B., 2004. Habitat specificity, seed germination and experimental translocation of the endangered herb *Brachycome muelleri* (Asteraceae). Biological Conservation 116, 251–266.
Kolar, C.S., Lodge, D.M., 2001. Progress in invasion biology: predicting invaders. Trends in Ecology & Evolution 16, 199–204.
Krauss, S.L., Dixon, B., Dixon, K.W., 2002. Rapid genetic decline in a translocated population of the endangered plant *Grevillea scapigera*. Conservation Biology 16, 986–994.
Leimu, R., Mutikainen, P., Koricheva, J., Fischer, M., 2006. How general are positive relationships between plant population size, fitness and genetic variation? Journal of Ecology 94, 942–952.
Lockwood, J.L., Cassey, P., Blackburn, T., 2005. The role of propagule pressure in explaining species invasions. Trends in Ecology and Evolution 20, 223–228.
Luijten, S.H., Kéry, M., Oostermeijer, J.G.B., den Nijs, H.C.M., 2002. Demographic consequences of inbreeding and outbreeding in *Arnica montana*: a field experiment. Journal of Ecology 90, 593–603.
Lynch, M., 1991. The genetic interpretation of inbreeding depression and outbreeding depression. Evolution 45, 622–629.
MacNab, J., 1983. Wildlife management as scientific experimentation. Wildlife Society Bulletin 11, 397–401.
Maschinski, J., Duquesnel, J., 2006. Successful reintroductions of the endangered long-lived Sargent's cherry palm, *Pseudophoenix sargentii*, in the Florida Keys. Biological Conservation 134, 122–129.
Maunder, M., 1992. Plant reintroductions: an overview. Biodiversity and Conservation 1, 51–61.
Mc Naughton, S.J., 1989. Ecosystems and conservation in the twenty-first century. In: Western, D., Pearl, M. (Eds.), Conservation for the Twenty-first Century. Oxford University Press, New York, pp. 109–120.
McGlaughlin, M., Karoly, K., Kaye, T.N., 2002. Genetic variation and its relationship to population size in reintroduced populations of the pink sand verbena, *Abronia umbellata* subsp. *brevifolia*. Conservation Genetics 3, 411–420.
McKay, J.K., Christian, C.E., Harrison, S., Rice, K.J., 2005. "How local is local?"– a review of practical and conceptual issues in the genetics of restoration. Restoration Ecology 13, 432–440.
McMahan, L.R., 1990. Propagation and reintroduction of imperiled plants, and the role of botanical gardens and arboreta. Endangered Species Update 8, 4–7.
Menges, E.S., 1991. Seed germination percentage increases with population size in a fragmented prairie species. Conservation Biology 5, 158–164.
Menges, E.S., 2008. Restoration demography and genetics of plants: when is a translocation successful? Australian Journal of Botany 56, 187–196.
Milbau, A., Stout, J.C., 2008. Factors associated with alien plants transitioning from casual, to naturalized, to invasive. Conservation Biology 22, 308–317.
Milton, S.J., Bond, W.J., Du Plessis, M.A., Gibbs, D., Hilton-Taylor, C., Linder, H.P., Raitt, L., Wood, J., Donaldson, J.S., 1999. A protocol for plant conservation by translocation in threatened lowland fynbos. Conservation Biology 13, 735–743.
Montalvo, A.M., Williams, S.L., Rice, K.J., Buchmann, S.L., Cory, C., Hamdel, S.N., Nabhan, G.P., Primack, R., Robichaux, R.H., 1997. Restoration biology: a population biology perspective. Restoration Ecology 5, 277–290.
Morgan, J.W., 1999. Have tubestock plantings successfully established populations of rare grassland species into reintroduction sites in western Victoria? Biological Conservation 89, 235–243.
Morgan, J.W., 2000. Reproductive success in reestablished versus natural populations of a threatened grassland daisy (*Rutidosis leptorrhynchoides*). Conservation Biology 14, 780–785.
Offord, C.A., McKensy, M.L., Cuneo, P.V., 2004. Critical review of threatened species collections in the New South Wales Seedbank: implications for ex situ conservation of biodiversity. Pacific Conservation Biology 10, 221–236.
Parsons, L.S., Zedler, J.B., 1997. Factors affecting reestablishment of an endangered annual plant at a California salt marsh. Ecological Applications 7, 253–267.
Pavlik, B.M., 1996. Defining and measuring success. In: Falk, D.A., Millar, C.I., Olwell, M. (Eds.), Restoring Diversity: Strategies for the Reintroduction of Endangered Plants. Island Press, Washington, DC, pp. 127–155.

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Picó, F.X., van Groenendael, J., 2007. Large-scale plant conservation in European semi-natural grasslands: a population genetic perspective. Diversity and Distributions 13, 920–926.
Pierson, S.A.M., Keiffer, C.H., McCarthy, B.C., Rogstad, S.H., 2007. Limited reintroduction does not always lead to rapid loss of genetic diversity: an example from the American Chestnut (*Castanea dentata*; Fagaceae). Restoration Ecology 15, 420–429.
Polans, N.O., Allard, R.W., 1989. An experimental evaluation of the recovery potential of rye grass populations from genetic stress resulting from restriction of population size. Evolution 43, 1320–1324.
Pollard, J.H., 1966. On the use of the direct matrix product in analyzing certain stochastic population models. Biometrika 53, 397–415.
Primack, R.B., 1996. Lessons from ecological theory: dispersal, establishment, and population structure. In: Falk, D.A., Millar, C.I., Olwell, M. (Eds.), Restoring Diversity: Strategies for Reintroduction of Endangered Plants. Island Press, Washington, DC, pp. 209–233.
Primack, R., Drayton, B., 1997. The experimental ecology of reintroduction. Plant Talk 97 (October), 25–28.
Pywell, R.F., Bullock, J.M., Roy, D.B., Warman, L., Walker, K.J., Rothery, P., 2003. Plant traits as predictors of performance in ecological restoration. Journal of Applied Ecology 40, 65–77.
Reading, R.P., Clark, T.W., Griffith, B., 1997. The influence of valuational and organizational considerations on the success of rare species translocations. Biological Conservation 79, 217–225.
Reed, D.H., 2005. Relationship between population size and fitness. Conservation Biology 19, 563–568.
Reed, D.H., Frankham, R., 2003. Correlation between population fitness and genetic diversity. Conservation Biology 17, 230–237.
Reed, D.H., Lowe, E.H., Briscoe, D.A., Frankham, R., 2003. Fitness and adaptation in a novel environment: effect of inbreeding, prior environment, and lineage. Evolution 57, 1822–1828.
Ricketts et al., 2005. Pinpointing and preventing imminent extinctions. PNAS 102, 18497–18501.
Robert, A., Couvet, D., Sarrazin, F., 2007. Integration of demography and genetics in population restorations. Ecoscience 14, 463–471.
Rout, T.M., Hauser, C.E., Possingham, P., 2009. Optimal adaptive management for translocation of a threatened species. Ecological Applications 19, 515–526.
Sarrazin, F., Barbault, R., 1996. Reintroduction: challenges and lessons for basic ecology. Trends in Ecology and Evolution 11, 474–478.
Schemske, D.W., Husband, B.C., Ruckelshaus, M.H., Goodwillie, C., Parker, I.M., Bishop, J.G., 1994. Evaluating approaches to the conservation of rare and endangered plants. Ecology 75, 584–606.
Seddon, P.J., 1999. Persistence without intervention: assessing success in wildlife reintroductions. Trends in Ecology and Evolution 14, 503.
Soorae, P.S., Seddon, P.J., 1998. Re-introduction Practitioners Directory. Published Jointly by the IUCN Species Survival Commission's Re-introduction Specialist Group, Nairobi, Kenya, and the National Commission for Wildlife Conservation and Development, Riyadh, Saudi Arabia.
Storfer, A., 1999. Gene flow and endangered species translocations: a topic revisited. Biological Conservation 87, 173–180.
Sutter, R.D., 1996. Monitoring. In: Falk, D.A., Millar, C.I., Olwell, M. (Eds.), Restoring Diversity: Strategies for Reintroduction of Endangered Plants. Island Press, Washington, DC, pp. 235–265.
Ter Braak, C.J.F., Gremmen, N.J.M., 1987. Ecological amplitudes of plant species and the internal consistency of Ellenberg's indicator values for moisture. Vegetatio 69, 79–87.
Ter Braak, C.J.F., Šmilauer, P., 2002. CANOCO Reference Manual and CanoDraw for Windows. User's Guide: Software for Canonical Ordination (Version 4.5). Microcomputer Power, Ithaca, NY.
Thompson, K., Bakker, J., Bekker, R., 1997. The Soil Seed Bank of North West Europe: Methodology, Density and Longevity. Cambridge University Press, Cambridge.
Thuiller, W., 2007. Biodiversity: climate change and the ecologist. Nature 448, 550–552.
Tyndall, R.W., Groller, P.L., 2006. Transplant survival, reproductive output, and population monitoring in *Desmodium ochroleucum*. Castanea 71, 329–332.
Van Groenendael, J.M., Ouborg, N.J., Hendriks, R.J.J., 1998. Criteria for the introduction of plant species. Acta Botanica Neerlandica 47, 3–13.
Van Kleunen, M., Weber, E., Fischer, M., 2010. A meta-analysis of trait differences between invasive and non-invasive plant species. Ecology Letters 13, 235–245.
Vergeer, P., van den Berg, L.J.L., Roelofs, J.G.M., Ouborg, N.J., 2005. Single-family versus multi-family introductions. Plant Biology 7, 509–515.
Vitt, P., Havens, K., 2004. Integrating quantitative genetics into ex situ conservation and restoration practices. In: Guerrant, E.O., Havens, K., Maunder, M. (Eds.), Ex situ Plant Conservation: Supporting Species Survival in the Wild. Island Press, Washington, pp. 286–304.
Von Holle, B., Simberloff, D., 2005. Ecological resistance to biological invasion overwhelmed by propagule pressure. Ecology 86, 3212–3218.
Weller, S.G., 1994. The relationship of rarity to plant reproductive biology. In: Bowles, M.L., Whelan, C.J. (Eds.), Restoration of Endangered Species. Cambridge University Press, Cambridge, pp. 90–117.
Whitlock, M.C., 2000. Fixation of new alleles and the extinction of small populations: drift load, beneficial alleles, and sexual selection. Evolution 54, 1855–1861.
Wilkinson, L., 1998. SYSTAT 8.0 Statistics. SPSS, Inc., Chicago.
Wolf, C.M., Griffith, B., Reed, C., Temple, S.A., 1996. Avian and mammalian translocations: update and reanalysis of 1987 survey data. Conservation Biology 10, 1142–1154.

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NATIONAL ACADEMIES PRESS Washington, DC

An Assessment of Native Seed Needs and the Capacity for Their Supply

Final Report

Committee on an Assessment of Native Seed Needs and Capacities

Board on Agriculture and Natural Resources

Division on Earth and Life Studies

Committee on National Statistics

Division of Behavioral and Social Sciences and Education

Consensus Study Report

PREPUBLICATION COPY

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NATIONAL ACADEMIES PRESS 500 Fifth Street, NW Washington, DC 20001

This activity was supported by Contract No. 140L0618C0052 between the National Academy of Sciences and the Department of the Interior's Bureau of Land Management. Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of any organization or agency that provided support for the project.

International Standard Book Number-13: 978-0-309-XXXXX-X
International Standard Book Number-10: 0-309-XXXXX-X
Digital Object Identifier: https://doi.org/10.17226/26618

Additional copies of this publication are available from the National Academies Press, 500 Fifth Street, NW, Keck 360, Washington, DC 20001; (800) 624-6242 or (202) 334-3313; http://www.nap.edu.

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Printed in the United States of America

Suggested citation: National Academies of Sciences, Engineering, and Medicine. 2023. *An Assessment of Native Seed Needs and the Capacity for Their Supply: Final Report.* Washington, DC: The National Academies Press. https://doi.org/10.17226/26618.

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Acknowledgments

This Consensus Study Report was reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise. The purpose of this independent review is to provide candid and critical comments that will assist the National Academies of Sciences, Engineering, and Medicine in making each published report as sound as possible and to ensure that it meets the institutional standards for quality, objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

We thank the following individuals for their review of this report:

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Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations of this report, nor did they see the final draft before its release. The review of this report was overseen by **PETER H. RAVEN (NAS)**, Missouri Botanical Garden (Emeritus) and **MAY R. BERENBAUM (NAS)**, University of Illinois at Urbana-Champaign. They were responsible for making certain that an independent examination of this report was carried out in accordance with the standards of the National Academies and that all review comments were carefully considered. Responsibility for the final content rests entirely with the authoring committee and the National Academies.

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Preface

Since the publication of our Interim Report in late 2020, the need to strengthen the nation's supply of native seed for ecological restoration and related purposes has only become clearer. The year 2021 came in just behind 2020 in terms of number of multi-billion-dollar climatic disasters (20 versus 22) and third in total costs (behind 2017 and 2005), with a price tag of $145 billion (www.ncei.noaa.gov/access/billions/). Major climate-related events in 2021 alone included a severe cold wave in the South, massive wildfires and continued drought in the West, flooding in California and Louisiana, 3 tornado outbreaks, 4 tropical cyclones, and 8 other severe weather events. The increasing magnitude and frequency of such climatic mega-disturbances is straining not only our economy but the recovery capacity of ecosystems, in synergy with other unceasing stresses including invasive species, energy and mineral extraction, urbanization, and land conversion. As the vulnerabilities of humans, wildlife, and critical ecosystem services to these disruptions grow, the need for ecological restoration in the 21st century will continue its trajectory toward a previously unmatched scale. In the US just as elsewhere in the world, a limited supply of native seeds and other native plant materials is a widely acknowledged barrier to fulfilling our most critical restoration needs.

In our efforts to analyze the nation's system of producing and using native plant materials for restoration and to identify the most impactful steps toward improving the supply, we were not helped by the COVID-19 pandemic. Our meetings, presentations, and information gathering were slowed significantly, and the availability of our committee members, National Academies staff, and expert informants across the nation were drastically altered by the many changes to people's professional and personal lives. "Nevertheless, we persisted." We are now honored to release what we believe is a well-supported set of key recommendations for improving the native seed supply, backed by findings and conclusions reached through collecting input from native seed producers and users in the public, private, nonprofit, and academic sectors across the US.

I'd like to thank the committee members who have worked so hard to bring this report to its fruition, along with the staff from the National Academies of Sciences, Engineering, and Medicine. And together, all of us thank the expert informants whose professional dedication to the supply and use of native plant materials made this report possible.

Sincerely,

Susan P. Harrison, *Chair*
Committee on an Assessment of Native Seed Needs and Capacities

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Acronyms and Abbreviations

AOSA	Association of Official Seed Analysts
AOSCA	Association of Official Seed Certifying Agencies
ARS	Agricultural Research Service
BLM	Bureau of Land Management
DOD	Department of Defense
DOI	Department of the Interior
DOT	Department of Transportation
EPA	Environmental Protection Agency
G_0, Gx,	Generation zero, Generation x
IDIQ	Indefinite Delivery, Indefinite Quantity
NASEM	National Academies of Sciences, Engineering, and Medicine
NIFA	National Institute of Food and Agriculture
NPS	National Park Service
NRCS	Natural Resources Conservation Service
PCRP	Plant Conservation and Restoration Program
PLS	Pure live seed
PMC	Plant Materials Centers
REPLANT	Repairing Existing Public Land by Adding Necessary Trees
RFP	Request for Proposal
SCST	Society of Commercial Seed Technologists
SESRC	Social and Economic Sciences Research Center

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SI	Source-Identified Seed
USDA	US Department of Agriculture
USFS	US Forest Service
USFWS	US Fish and Wildlife
USGS	US Geological Survey

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Glossary

Accession: A distinct, uniquely identified sample of seeds or plants.

Adaptive management: A structured process of using management as an experiment, so that new information is gained that reduces uncertainty about the managed system and enables management to improve over time.

Agronomically: Related to growing a crop, with a focus on managing the soil, nutrients, and the physical and biological environment to support crop production.

Cultivar: A named variety of a plant species with distinct genetically-based morphological, physiological, cytological, or chemical characteristics, produced and maintained by cultivation.

Ecological restoration: The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.

Ecoregion: A relatively large unit of land or water that is characterized by a distinctive climate, ecological features, and plant and animal communities.

Ecosystem: A biological community of interacting organisms and their physical environment.

Ecotype: A genetically distinct subset of a species (a population, subspecies, or race) that is adapted to local environmental conditions.

Empirical seed zone: Area within which plant materials are believed to be transferrable with little risk of being poorly adapted to their new location, developed by combining species-specific information on local adaptation with environmental information.

Establishment: The stage at which the seedling has exhausted the food reserves stored in the seed and must grow, develop, and persist independently.

Extractory: Facility for the cleaning, testing, and short-term storage of wild-collected seed.

Forbs: Vascular plants that are not woody and also not grasses or members of the grass family, sometimes colloquially called “wildflowers.”

Genetically adapted: See Local Adaptation.

Genetically appropriate: Native plant materials that are likely to establish, persist, and promote ecological relationships at a restoration site. Such plants would be: sufficiently genetically diverse to respond to changing environmental conditions; unlikely to cause genetic contamination of resident native species; unlikely to become invasive and displace other native

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species; unlikely to be a source of nonnative pathogens; and likely to maintain relationships with other native species.

Germplasm: Living genetic resources such as seeds or tissues that are maintained for breeding, research, and conservation efforts.

Habitat: The place or environment where a plant or animal naturally or normally lives and grows.

Invasive species: A species that is nonnative to the ecosystem under consideration and which is likely to cause economic or environmental harm.

Local adaptation: Evolution of genetically distinct traits that make certain populations of a species better able to establish and persist in their particular local environment than other populations of the same species from other locations.

Maladaptation: Having traits that are poorly suited or adapted to a particular situation or set of conditions.

Native plants: Species that occur naturally in a particular region, ecosystem, or habitat, having either evolved there or dispersed there unaided by humans.

Native plant communities: Recurring assemblages of native plant species associated with particular regions and environmental conditions.

Nonnative species: Species that have been accidentally or deliberately introduced by humans to a continent, region, ecosystem, or habitat in which they did not previously occur.

Plant materials: Any portion of a plant that can be propagated, including seeds, cuttings, and entire plants.

Provenance: The geographic origin of a seed source.

Provisional seed zone: Area within which plant materials are believed to be transferrable with little risk of being poorly adapted to their new location, developed using climatic and other environmental data, but not using species-specific information.

Pure live seed: The living seed of the intended species that will germinate from a seed bag, which is weight of the bag minus weeds, impurities, and inviable seed.

Rehabilitation: Restoring a particular function such as erosion control to a damaged or degraded area, using native or nonnative species.

Restoration continuum: The variation from ecological restoration to other related activities such as rehabilitation and revegetation.

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Revegetation: Restoring plant cover to a damaged or degraded area, using native or nonnative species.

Seed bank: A storage facility intended to preserve seeds for the future, which requires low humidity and low temperatures.

Seed certification: A legally controlled system of quality control over seed multiplication and production.

Seed increase: Cultivation of a plant with the goal of obtaining a larger quantity of seeds for future cultivation.

Seed quality: The combination of correct genetic identity, germination fraction, and vigor in a batch of seeds.

Seed viability: The capacity of a seed or batch of seeds to germinate under suitable conditions, including dormant seeds for which dormancy must be broken before viability can be measured by germination.

Seed zone: A mapped area within which plant materials are believed to be transferrable with little risk of being poorly adapted to their new location.

Taxon: A collection of one or more populations of organisms. Taxa are the hierarchical classifications of a species (e.g., species, sub-species).

Traditional Ecological Knowledge: Also called Indigenous Knowledge or Native Science, the evolving knowledge of a specific location acquired by indigenous and local peoples, including relationships between plants, animals, the physical environment, and their uses for activities including but not limited to hunting, fishing, trapping, agriculture, and forestry.

Workhorse species: Native species with the potential for broad use in restoration across a region, selected because they are abundant across a wide range of ecological settings, establish quickly, and support important ecological processes.

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Summary

BACKGROUND

Millions of acres of public and private land in the United States are at risk of losing the native plant communities that are central to the integrity of ecosystems. As plant communities decline, the biodiversity they embody is also being rapidly lost, along with a wealth of ecosystem goods and services important to society. There is a long and growing list of threats to plant communities-invasive species, overgrazing, climate change, and altered fire regimes, to name a few, that have collectively accelerated the deterioration of natural landscapes across the country.

Ecological restoration is the process of bringing back native biological diversity and ecosystem function to deteriorated landscapes, one aspect of which involves planting seeds of native plants on the degraded site. This report examines the prospects for developing the large and sustainable supply of native seeds (as a shorthand term for all forms of native propagative plant material[1]) that is needed for many uses but primarily to carry out successful ecological restoration across our nation's landscapes.

More than 20 years ago, as severe wildfires began to burn with increasing frequency and severity in the western United States, Congress urged the Department of the Interior (DOI) to move beyond sowing non-native grass seed for emergency soil stabilization and towards the rapid introduction of native plant species to rebuild natural communities and prevent invasive plant encroachment in newly burned areas. Congress requested the Secretaries of the Interior and Agriculture to prepare "specific plans and recommendations to supply native plant materials for emergency stabilization and longer-term rehabilitation."[2]

In early 2002, the agencies responded with a 17-page plan and five action items:

1. Undertake a comprehensive assessment of needs for native plant materials,
2. Make a long-term commitment to native plant materials production, research and development, education, and technology transfer,
3. Expand efforts to increase the availability of native plant materials,
4. Invest in partnerships with state and local agencies and the private sector,
5. Ensure adequate monitoring of restoration and rehabilitation efforts.

The plan cited the histories of success by US Forest Service (USFS) nurseries in the 1920s to produce conifer tree seedlings and by the US Department of Agriculture's (USDA) Plant Material Centers in the 1930s Dust Bowl era to develop plant species for soil conservation.

The USFS, Bureau of Land Management (BLM), National Park Service (NPS), Department of Defense (DOD), and US Fish and Wildlife Service (USFWS), many states, and tribal nations have access to native plant communities on lands they manage, which provide the source material for the native seed supply. Seeds collected from these communities can either be used directly or increased through agricultural cultivation before being used as seeds or plants. A key consideration in restoration is for native plants to be genetically adapted to the specific sites or regions where they are used, so recording source locations and maintaining the genetic identity of wild-collected native seeds is critical.

A relatively small segment of the nation's commercial seed industry produces seeds of native plant species for ecological restoration, in an enterprise that demands considerable specialized knowledge

[1] The statement of task (Box S-1) specifically refers to "native plant seed." The report uses native plant seed to encompass not only seeds but other native plant materials, such as containerized stock, bare root seedlings, cuttings, rhizomes, tissue culture, callus material, and other plant propagules.

[2] House Committee on Appropriations Report, to accompany H.R. 2217, Department of the Interior and Related Agencies Appropriations Bill, 2002, 107th Congress.

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An Assessment of Native Seed Needs and the Capacity for Their Supply: Final Report

and equipment, and that requires several years of lead time to produce a specified batch of seeds. Public agencies and other users of native seed acquire most of their supply from these private growers, using requests for bids, production agreements, and off-the-shelf purchases. Currently, however, users describe the supply of native seeds on the market as severely insufficient. Suppliers describe the buyers' unpredictable levels of demand and excessively short planning horizons as significant obstacles to being able to meet their needs.

ASSESSMENT OF NATIVE SEED NEEDS AND CAPACITIES

This report was requested by the BLM and prepared by a committee of experts appointed by the National Academies of Sciences, Engineering, and Medicine. It was not commissioned as a review of the original 2002 plan, but as an independent assessment of the federal, state, tribal and private sector needs and capacity for supplying native plant seeds for ecological restoration and other purposes (See the abbreviated Statement of Task in Box S-1). This report reflects the product of phase two of the assessment, in follow up to the committee's interim report released in October 2020.[3] That report presented an overview of the native seed supply chain, preliminary observations of some of the challenges facing native seed use and supply, and a strategy for additional information-gathering.

BOX S-1
Statement of Task

An ad hoc study committee appointed by the National Academies of Sciences, Medicine, and Engineering will assess federal, state, tribal and private sector needs and capacity for supplying native plant seeds for ecological restoration and other purposes. The assessment will focus on the western continental United States and incorporate information from assessments of other US regions, as available, towards the goal of a nationwide perspective. The assessment will be carried out in two phases. In phase one, the committee will conduct fact-finding, develop a framework for information gathering for the assessment, and prepare an interim report describing the framework and implementation strategy. In the second phase, the committee will oversee the data and information-gathering process, analyze the information obtained, and prepare a final report summarizing the committee's findings and conclusions. The final report also will provide recommendations for improving the reliability, predictability, and performance of the native seed supply.

In phase two, the committee used the preliminary observations as the basis for two nation-wide surveys, the first of native seed and plant suppliers, and a second, of personnel from state government departments of natural resources, parks, wildlife, transportation, and agriculture.

Activities carried out in 2021 and 2022 also included semi-structured interviews with federal agency personnel, examination of agency records, presentations by participants in the seed supply chain, and reviews of the relevant scientific literature.

THE NATIVE SEED SUPPLY

Federal, State, and Tribal Needs and Capacities

Native seeds are used in pursuit of a wide range of objectives on public land. Table S-1 lists the primary uses of native plant seeds by federal and state agencies. Tribal native seed needs often parallel those of federal and state agencies. The tribes' needs for native plants also include food, spiritual, and medicinal uses.

[3] An Assessment of Native Seed Needs and the Capacity for Their Supply: Interim Report. National Academies Press. https://nap.nationalacademies.org/catalog/25859/an-assessment-of-the-need-for-native-seeds-and-the-capacity-for-their-supply.

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TABLE S-1 Uses of Native Seeds by Federal and State Agencies

Creation or restoration of wildlife habitat (other than pollinator habitat)
Pollinator habitat projects
Stream erosion mitigation or restoration
Restorative activity on land in a natural area or wilderness
Soil protection
Invasive species suppression
Roadside seeding and maintenance
Landscaping
Green infrastructure (bioswales)
Natural disaster recovery
Rangeland grazing
Energy development remediation
Green strips (vegetative fuel breaks)

As mentioned earlier, many public agencies, including all the federal agencies, will contract for seed to be collected from the land they manage and use it onsite, or have the collected seed increased in a production field prior to use. The NPS almost exclusively uses this approach for park restoration projects. However, some agencies need a very large quantity of seed for restoration projects, particularly after wildfire, so the largest land-management agencies turn to commercial suppliers. For perspective, in 2020, BLM field offices purchased about 1.5 million pounds of seed (a little less than in a typical year) of which two-thirds was used for post-fire seeding on over 422,000 acres of burnt land. BLM has two warehouses for storing purchased seed on a short-term basis.

Field offices are encouraged, but not required, to request native seed genetically adapted to where it will be planted. In 2020, about 1/8 of the grasses, 1/4 of the forbs, and 2/3 of the shrubs purchased were native seed of certified (source-identified) origins. Another portion of the purchased seed (particularly of grasses and forbs) included native seed types more available in the market and at lower relative cost, but that originate from plant communities in geographic locations mismatched to the environments where the seed is likely to be planted. Similarly, non-native plant seeds, that are less expensive and more available, were a sizeable portion of the seed purchased.

Recently, the USFS announced plans to address the fire-prone condition and reforestation backlog across the National Forests. The USFS will use funds of up to $123 million annually[4] to reforest over 4 million acres in the next 10 years. The Service's six nurseries will produce tree seedlings and other plants, but private growers will be needed to expand the capacity for production. The USFWS, NPS, DOD, and most states have at least one nursery to grow native plants or trees for use in restoration. Several of the tribal nations have established nurseries, more want to, but efforts to expand a network of tribal nurseries have been limited by lack of resources.

Filling the Native Seed Pipeline

The ability of the commercial sector to provide the seed needed for projects in different landscapes is important, because existing native plant communities do not produce the same amount of seed each year and can be degraded by over-collecting. The committee's survey of state agencies and presentations by federal agency personnel suggest that buyers often settle for substitutions because their preferred seed is simply not available at any price during the timeframe in which the seed is needed. Timeframe is an issue for BLM field offices that rely on annually appropriated funds for post-fire needs that must be spent before the end of the federal fiscal year, forcing them to buy whatever is available.

[4] The funds will be available through the Repairing Existing Public Land by Adding Necessary Trees Act (REPLANT Act), which was included in the 2021 Infrastructure Investment and Jobs Act, commonly referred to as the Bipartisan Infrastructure Law (BIL).

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Seed suppliers in the committee's survey reported that the greatest challenges they face in supplying native seed are unpredictable demand, "difficult to grow" species, and a lack of stock (starter) seed from appropriate seed transfer zones (seed zones, for short), which are geographically mapped zones inside of which plants can be relocated and are presumed to be genetically adapted. They suggested that better communication from buyers about their seed needs, more realistic timelines for delivery that account for the time needed to acquire and propagate seed, and greater technical assistance in growing native plants would help them meet user needs.

In 2018, the BLM's Plant Conservation and Restoration Program began to address the issues of communication, timeframe, and availability of stock seeds using a native seed Indefinite Delivery-Indefinite Quantity (IDIQ) production contract with suppliers to have them grow and increase native seed types from seed transfer zones not readily available on the commercial market. Although seed production IDIQ contracts are not a new financial instrument, the focus on seed production by seed transfer zone is a new approach for BLM. The seed given to suppliers for increase came from the *Seeds of Success* (SOS) program initiated by the BLM in 2001. To secure the genetic diversity of native plants, BLM partnered with six non-federal seed banks (SOS Partners)[5] to store native seed collected from numerous seed zones across different ecoregions (see Figure S-1), mostly in the western United States. Although the quantities being increased are small and the funding for the new program is modest, the IDIQ approach is a significantly new approach to meeting seed needs.

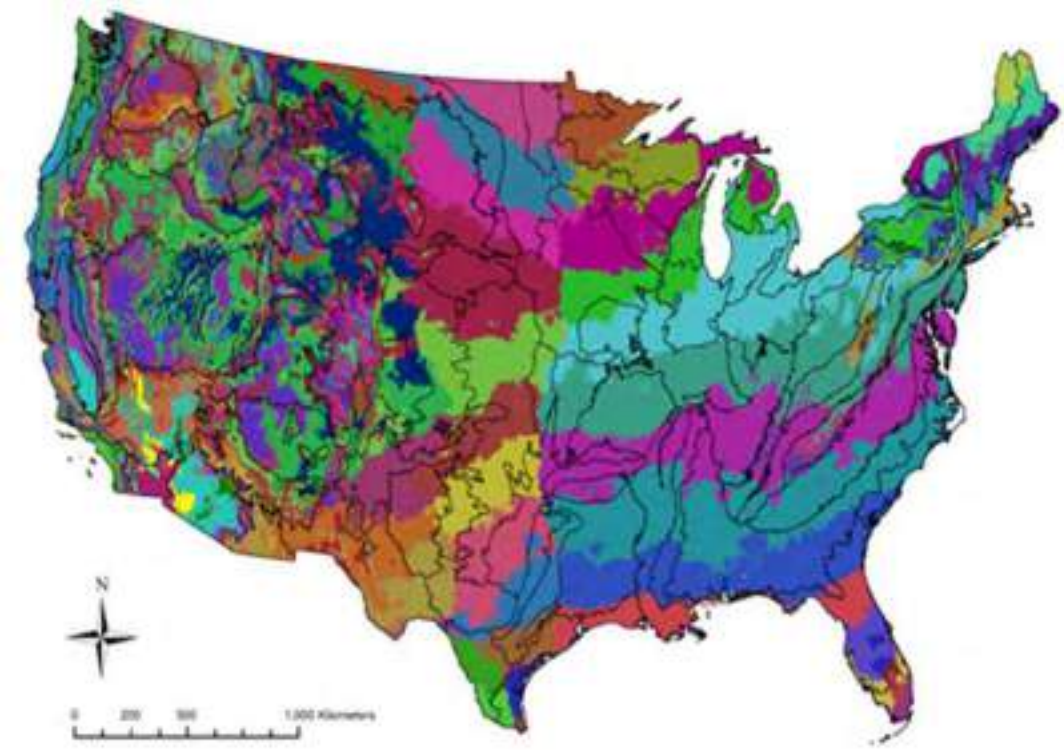


FIGURE S-1 Seed Zones Overlayed with Ecoregions.[6]
Note: Generalized provisional seed zones (colored areas) are overlain by Omernik Level III Ecoregions).
SOURCE: USFS, Bower et al., 2014; DOI and EPA, 2018; Omernik, 1987.

[5] Text was added after the prepublication release to clarify that the seed banks store the seed for the SOS program; they are not the seed suppliers that increase the seed.

[6] The EPA (Omernik,1987) created a map of ecosystems (ecoregions) across the United States defined by major differences in geography and climate. Subsequent refinements have led to more discrete ecoregions. In Figure S-1, the boundaries of ecoregions are shown by the black lines.

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State and Regional Partnerships

Because locally adapted native seed for a wide range of species has been difficult to find in the commercial marketplace, cooperative partnerships have arisen inside and outside of the federal government to develop native seed supplies for restoration and other applications, including to provide stock seed to commercial growers. For example, in the 1980s, the Iowa Tallgrass Prairie Center partnered with the Iowa Department of Transportation to collect seed from the state's remaining stands of tallgrass prairie found along rural roadsides. The program began increasing the seed in fields and has since released stock material for 100 species of Iowa natives to commercial suppliers. In addition to prairie restoration projects, the seeds are now used on roadsides across the state, and are available to farmers and other landowners who participate in the USDA-supported Conservation Reserve Program (CRP), which puts marginal farmland into conservation use for a decade or more. The approach offers one model for supplying and developing a native seed industry on a state level.

Several regional native plant materials development and restoration programs have been established by the BLM and the USFS that are broadly cooperative, involving government at all levels, the tribes, colleges, nongovernmental organizations, and native seed producers. These include programs situated in the Pacific Northwest, the Colorado Plateau, the Great Basin, and the Mojave Desert that collect and bank seeds, release seeds for commercialization, conduct landscape genetic studies, and carry out research on restoration techniques and strategies, among other things. Some of those efforts involve more than 30 partner organizations and demonstrate what public-private partnerships can achieve working together toward focused goals.

Such partnerships, developed on a regional basis, may have been envisioned in the plan given to Congress in 2002 in response to its challenge to build a seed supply, but the native seed supply requires transformation on a broader scale. In 2015, the *National Seed Strategy*, a plan "to foster interagency collaboration to guide the development, availability, and use of seed needed for timely and effective restoration" was released by the Plant Conservation Alliance, which now includes more than 400 non-federal organizations and 17 federal agencies.[7] That Strategy is not a funded program but under its umbrella, many diverse projects have been pursued by different agencies and their partners. It is a sound blueprint for native seed development and continues to be a call for action.

Developing a sustainable, national native seed supply is not likely to be achieved for many years, however, because the ongoing efforts are focused beneath the ambitions of that goal. Moreover, current efforts have been outpaced by needs that have escalated very quickly over the last decade as the result of converging threats to natural ecosystems. Although the federal agencies collaborate productively with one another and other partners on a project-by-project basis, they could have a greater impact if they turned their focus to the bigger picture and committed to a unified agenda to develop a native seed supply that meets the nation's diverse needs. Now more than ever is an opportunity to pursue that goal, with the recent passage of the *Infrastructure Investment and Jobs Act (Bipartisan Infrastructure Law)* (2021),[8] *The Great American Outdoors Act* (2020)[9] and fresh new thinking about the nation's natural resources, such as through *America the Beautiful* initiative (2021).[10]

SUMMARY CONCLUSIONS

The following conclusions summarize the committee's investigation of the experiences of federal land-management agencies, state governments, tribal nations, collaborative partnerships, and suppliers.

[7] The text was corrected after the prepublication release to update Plant Conservation Alliance numbers.

[8] H.R. 3684, Infrastructure Investment and Jobs, see Act https://www.congress.gov/bill/117th-congress/house-bill/3684.

[9] H.R. 1957, Great American Outdoors Act, see https://www.congress.gov/bill/116th-congress/house-bill/1957.

[10] America the Beautiful, see https://www.doi.gov/priorities/america-the-beautiful.

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Conclusion 1-0: *There is urgency to building a native seed supply for the restoration of native plant communities. Developing reliable seed supplies for ecological restoration is an achievable goal by the federal agencies, but one that demands accelerated, inter-institutional commitment to a comprehensive vision, at a much more intensive level than is currently underway.*

Conclusion 2-0: *In some regions (at, above or below the state level), native seed needs are being addressed by networks or partnerships that include federal agencies, states, tribes, local governments, and the private and non-profit sectors. Further development of these regional networks, plus greater coordination among them, is a promising way to stabilize demand, expand supply, and increase the sharing of information and technology that is critical to meeting native seed needs.*

Conclusion 3-0: *Tribal uses for native plants parallel those of federal and state agencies and their needs include seed collection, increase, seed testing, implementation of seed zones, storage, and contracting for ecological restoration. The historic complexity of land management issues and interactions with federal and state governments, former Bureau of Indian Affairs (BIA) policies associated with cultural assimilation, and a lack of resources have constrained all aspects of tribal land management including activities to build capacity to meet native plant needs.*

Conclusion 4-0: *Suppliers view unpredictable demand as their leading challenge. Suppliers indicate that seed contracts with adequate lead time, clear delivery timelines, price guarantees, and a guarantee to purchase a predetermined quantity of seed of the specified ecotypes are most important to them.*

Conclusion 5-0: *Suppliers indicate that difficult-to-grow species and lack of stock seed from appropriate seed zones or locations are their top two technical challenges. They identified communicating demand (issues related to planning, communication, funding, and the economics of the seed markets) as key to helping them achieve success in providing seeds to buyers.*

Conclusion 6-0: *Many technical and scientific information gaps affect the ability of the native seed supply to function efficiently and effectively. Addressing them would inform decision-making, reduce uncertainty, and improve restoration outcomes.*

Conclusion 7.0: *To enable more producers to enter the supply chain for native, ecoregional seed of diverse species, there is a need to expand cooperative seed cleaning facilities and humidity-controlled seed warehouses in areas where commercial facilities with specialized equipment do not exist.*

Conclusion 8-0: *BLM is the nation's largest user of native seed for restoration and has the largest capacity for seed storage, but many constraints currently limit its capacity to act as a reliable purchaser of native seeds and thereby to support a more robust native seed industry. The capacity and staffing of its seed warehouses are also inadequate to meet existing and projected needs.*

Conclusion 9-0: *BLM manages extensive areas of natural and seminatural land that constitute an important in-situ repository of seed stock for restoration, but conserving this critical resource is not yet recognized as a land management objective. The agency's native seed needs depend on the native plant communities that are the source of seeds, adding to the urgency for recognizing and protecting native plant communities and biodiversity on BLM lands.*

Conclusion 10-0: *Developing reliable seed supplies for restoration is an achievable goal for the BLM and other public-sector users of native seed, but one that demands substantial institutional commitment to make restoration a high-priority objective, the cultivation and empowerment of botanical and ecological expertise in decision-making, and the creation of sustainable funding streams for restoration that enable long-term planning, successful implementation, and learning from experience.*

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RECOMMENDATIONS

Recommendation 1.0: The leadership of the Departments of the Interior (DOI), Agriculture (USDA), and Defense (DOD) should move quickly to establish an operational structure that facilitates sustained interagency coordination of a comprehensive approach to native plant materials development and restoration.

An interagency approach focused on fulfilling the long-standing Congressional mandate to develop a native seed supply for public lands could unify the agencies' independent efforts to meet seed needs for restoration and rehabilitation. This focused effort would maximize returns on investments in native plant materials development and restoration and would augment existing activities within agencies. One possible model for agency coordination on a national basis, organized regionally, is the National Interagency Fire Center.

Among the activities that could be the focus of interagency efforts are:

- Serve as the central coordinating platform for developing a national native seed supply.
- Assist the launch, support, and oversight of regional native seed supply development activities.
- Coordinate the prioritization of species and ecotypes to meet seed needs for different regions.
- Co-develop national policy for native seed collection, seed sharing, and seed use.
- Co-develop and share best management practices for seed choice in restoration.
- Coordinate, prioritize and support basic and applied research such as described in Chapter 8 and other region-specific research needs identified in the National Seed Strategy.
- Review and strengthen policy guidance for the use of native seeds on public lands.
- Co-develop adaptive management approaches that use experimentation during restoration, gather data on outcomes, and use these data to guide future restoration.
- Provide a national, central data collection platform and analytical capability.
- Serve as a focal point for training on seed collection protocols, storage practices, seed cleaning and testing, and other technologies.
- Produce information and technology for stakeholders in the native seed supply and native plant restoration.

Recommendation 2.0: Federal land-management agencies should participate in building regional programs and partnerships to promote native plant materials development and native plant restoration, helping to establish such regional programs in areas where they do not yet exist. Ideally, the existing regional programs and partnerships would grow into a complete nationwide network, assisted by the federal interagency coordinating structure envisioned in Recommendation 1.0. The size, geographic coverage, and membership of the regional programs would vary based on regional needs and would include many existing entities such as the USDA Plant Material Centers and Agricultural Research Service seed banks, other seed banks, botanic gardens, public nurseries, universities, and other organizations.

2.1 Develop seed priorities. Each region has its workhorse native plant species, ones that are easily grown and highly abundant in natural communities, as well as its other priority species such as those that are important for pollinators and wildlife. Developing region-specific lists of priority species will enable suppliers to focus on developing stocks of the species, and ecotypes of these species, that are likeliest to be in high demand.

2.2 Conduct scenario planning and monitoring. To enable suppliers to anticipate and meet future needs, scenario planning at the regional level should be used to estimate the kinds and

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quantities of seeds likely to be in demand over multi-year horizons. Such planning scenarios would be based on estimates of current degraded land and future events likely to cause further degradation. These would be periodically updated through ongoing monitoring.

2.3 Collect and curate stock seed: Regional programs should conduct, or oversee the conducting of, the collection and curation of wildland-sourced seed to make it available for future production. Seed must be collected using protocols to record source locations, maximize genetic diversity, and protect wild populations. As banked stocked seed accessions deplete, additional wild collections will be necessary. As source populations are lost, or better ones located, ongoing monitoring and re-evaluation will be needed.

2.4 Share information. Regional programs should develop informational tools derived from monitoring regional seed use practices and the success or failure of outcomes. This will inform smarter, more predictable selections of species for procurement in the regional marketplace and more effective restoration strategies.

Recommendation 3.0: The Bureau of Indian Affairs should work with the Inter-Tribal Nursery Council to promote and expand tribal nurseries. The Bureau of Indian Affairs should prioritize and support tribal native plant uses and capacities, consistent with the Bureau's legal and fiduciary obligation to protect tribal treaty rights, lands, assets, and resources held under the Federal-Tribal Trust. Recognizing tribal sovereignty and self-determination, expanding the cultural, economic, and restoration uses of native plants by tribes will require the promotion and expansion of tribal nurseries and greater support for the Inter-Tribal Nursery Council. Additionally, tribal leaders and land managers should be fully engaged in planning, conducting, and applying results from scientific projects related to seed production and conservation, native plant restoration, and ecosystem management on tribal land.

Recommendation 4.0: The public agencies that purchase native seed should assist suppliers by taking steps to reduce uncertainty, share risk, increase the predictability of purchases, and help suppliers obtain stock material.

4.1 Conduct proactive restoration on a large scale. Millions of acres of US public land are ecologically impaired. With new federal resources for restoration, federal and state agencies should plan restoration projects on a 5-year basis, ensure that stock seed has been made available to suppliers, and set annual purchase targets for the collection and acquisition of needed ecotypes of native plant species. These actions will result in considerable expansion and stabilization of the market for native seeds, benefitting suppliers and users alike.

4.2 Establish clear agency policies on native seed uses. Land management agencies should establish clear policies on seed use on lands under their stewardship that support the use of locally adapted native plant materials in management activities, along with clearly delimiting the circumstances for allowing exceptions. This will send a strong signal of species and provenance needs to suppliers.

4.3 Support responsible seed collection and long-term seed banking. Intensive and carefully managed seed collection is needed to supply the native plant material enterprise and conserve native plant diversity for the long term.

In cases where native seed is collected from public lands by private suppliers for direct sale and use in restoration, land management agencies should employ adequate personnel to issue permits and ensure responsible collection.

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In other cases, where seed is collected for increase and native plant materials development, the Federal agencies should facilitate this activity by extending the Seeds of Success program to include all regions of the United States, and better supporting its activities.

In still other cases, native seed is collected and banked for long-term conservation. To continue building a species-diverse and genetically diverse long-term native seed bank, the Federal agencies, led by BLM and the ARS National Plant Germplasm System, should accelerate their collaboration under the Seeds of Success program.

4.4 Contract for seed purchases before production. Public sector buyers of native seed should amend their policies to enable contracting for purchases before the seed production cycle begins. Forward contracting, in which the buyer agrees to purchase specific seed at a future date, reduces grower risk by ensuring them a market.

4.5 Use marketing contract features that reduce demand uncertainty. Public sector buyers of native seed should adopt marketing contract features that specify the delivery timeline, guaranteed prices, and guaranteed purchase of predetermined quantities that meet the buyer's specifications.

4.6 Experiment with native seed contract designs. Public sector buyers of native seed should experiment with cost- and risk-sharing contract designs, such as BLM's Indefinite Delivery-Indefinite Quantity (IDIQ) contracts, which are partially supported by a working capital fund.[11] Other approaches also merit investigation, including Blanket Purchase Agreements. In special circumstances, such as where high-priority species or ecotypes are unavailable, Federal agencies should consider issuing contracts to suppliers for research and development.

4.7 Consider providing premiums for local ecotype use in USDA conservation programs. USDA's Farm Service Agency and state departments of agriculture should explore whether higher co-payments for landowners' use of local ecotypes of native species in conservation program plantings would enhance environmental benefits while supporting a regional native seed industry. A requirement for the use of certified seed would assure growers that their efforts and expenses are not being undercut by seeds of unverified origins.

Recommendation 5.0: Federal land-management agencies should work with their regional partners to launch an outreach program to provide seed suppliers with critical tools and information.

5.1 Strengthen the role of the National Resources Conservation Services (NRCS) in supporting native seed suppliers. The NRCS Plant Materials Centers (PMCs) can build on their historical role by developing materials and techniques and advising commercial growers on native seed production, emphasizing non-manipulated germplasm and production methods that minimize genetic change.

5.2 Support information sharing on restoration outcomes. Public land-management agencies should share new research and technical knowledge on restoration in publicly available technical progress reports.

5.3 Facilitate communication with growers. To support existing native seed growers and to encourage new ones, Federal agencies should provide tools such as an on-line marketplace, and

[11] The text of the recommendation was modified after release of the pre-publication to clarify that the BLM IDIQ is not intrinsically tied to the working capital fund and can be supported from other funding sources.

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resources such as workshops and information on propagation, seed cleaning, and other techniques.

Recommendation 6.0: **The federal government should commit to an expanded research and development agenda aimed at expanding and improving the use of native seeds in ecological restoration.**

6.1 Support basic research. Basic research to support restoration in an era of rapid change should be a priority for NSF, USDA-NIFA, and USGS. Some critical topics include restoration under rapid environmental change, species selection to promote ecological function, traditional ecological knowledge, and the economics of the seed market.

6.2 Build technical knowledge. Development and dissemination of new technical knowledge for restoration should be important priorities for the research arms of federal land management agencies, such as the USDA-ARS, USFS, DOD and USGS. Priority topics include improving techniques for production, maintenance of genetic integrity and quality, testing, storage, and deployment of native seeds.

6.3 Adaptive management. Public land agencies and their partners should commit to using a rigorous adaptive management approach that documents all features of the restoration plan, uses restoration treatments as experiments to address critical areas of uncertainty, gathers data on outcomes, and uses these data to guide future restoration actions.

6.4 Seed zones. USDA-ARS, USFS, and USGS, in conjunction with regional programs, should seek to develop a more uniform national system of seed zones, which will be an important step in sending clearer signals to both seed suppliers and seed users.

Recommendation 7.0: Federal agencies and other public and private partners, including seed suppliers, should collaborate on expanding seed storage and seed-cleaning infrastructure that can be cooperatively cost-shared regionally. Additional storage can improve the availability of seed ready for restoration when urgent but hard-to-predict needs arise. Greater refrigerated and freezer storage availability would protect the viability of purchased seed until its use. Seed cleaning is also a significant technical challenge for new and small-scale suppliers. Regional native seed cleaning facilities would encourage more growers to enter the supply chain.

Recommendation 8.0: The BLM's Seed Warehouse System needs to be expanded, particularly its capacity for cold storage, and supported by staff with up-to-date knowledge of seed science to manage the seed inventory. The BLM seed warehouses belong in a national program within the BLM or DOI to ensure they are funded, well managed, expanded to meet national needs, and shared among agencies. With more warehouses, seed can be kept near the location where it will be used, reducing transportation costs, time, and seed viability loss.

Recommendation 9.0: BLM should identify and conserve locations in which native plant communities provide significant reservoirs of native seeds for restoration. Public land management agencies should actively recognize and protect the natural plant communities that provide the ultimate sources of native seeds for ecological restoration, using protective designations such as Area of Critical Environmental Concern or Research Natural Areas.

Recommendation 10.0: The Plant Conservation and Restoration Program (PCRP) should be empowered with the capacity to plan and oversee restoration and to build stocks of seed. The BLM should give greater authority and resources to the PCRP to oversee seed purchasing and

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warehousing decisions, monitor restoration outcomes, engage in long-term restoration planning, and ensure that staff with plant expertise are available to guide restoration planners and seed purchasers across BLM. This expanded role for PCRP will hasten the pace of change toward the use of natives that is already underway. The PCRP should expand the use of IDIQ or other innovative, risk-sharing contracts to build a diverse supply of native seed in BLM warehouses.

FINAL THOUGHTS

These recommendations represent an ambitious agenda for action, commensurate to the challenges facing our natural landscapes, and to the responsibility for public sector leadership of a coordinated public-private effort to build a national native seed supply. The committee is optimistic that the many public and private parties engaged in ecological restoration across the nation will be willing partners in ensuring this agenda's success.

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1

Introduction

In 2020, the National Academies of Sciences, Engineering, and Medicine released *An Assessment of the Need for Native Seeds and the Capacity for Their Supply: Interim Report* (NASEM, 2020), completing the first of a two-phase study of the national need for and supply of native seeds for ecological restoration and other purposes. The National Academies appointed an ad hoc committee of experts to conduct the study at the request of the Bureau of Land Management (BLM), which needs large quantities of native seed to meet its public-land management responsibilities, particularly in the aftermath of wildland fires.

The interim report provided an overview of the participants in the native seed supply chain in the United States, made preliminary observations about the dynamics of the seed supply, and proposed an information-gathering strategy for the second phase of the study to obtain deeper insights into the nation's capacity for providing the seeds needed by users with various objectives.

This final report presents findings of the information-gathering process carried out in 2021 and 2022. During this period, the committee sought information from, and about, various actors in the native seed supply chain including federal, state, tribal, and municipal agencies, private landowners in conservation programs, native seed collectors and suppliers, seed testing associations, seed banks, land trusts, environmental groups, and other non-governmental organizations.

Using surveys and interviews, presentations to the committee, expert consultations, and the considerable experience of its own members, the committee explored the diverse set of needs and activities in the native seed supply chain to identify opportunities for progress. Based on its findings and conclusions, the committee offers a set of recommendations for increasing the supply of native seeds to meet the increasing and evolving demand for native seeds.

STATEMENT OF TASK

To guide the assessment, the committee was given a Statement of Task (Box 1-1) which focused the committee on a list of straightforward questions: What entities use native seeds, how do they use them and at what scale, what shapes their decisions, how do seed buyers and suppliers communicate, and what is the nature of procurement? How does seed availability for restoration relate to other agricultural, land management, and conservation activities? What activities make up the seed supply chain and how well are they working to meet seed needs?

Simple answers to these questions were not as straightforwardly obtained, however, and there were limits to the committee's ability to obtain a complete picture of the native seed supply. In addition, the questions in the Statement of Task belie considerable nuance and complexity, beginning with the term 'native seed',[1] which, in addition to its natural history, can be defined by many distinguishing characteristics that are important to seed buyers who plan to use them in restoration projects. Apart from the fact that native seed in the United States comprise a diversity of species and of forms (trees, shrubs,

[1] The statement of task (see Box 1-1) specifically refers to "native plant seed." The report uses native seed as a shorthand-term for seed and all other "native plant materials" such as containerized plants (see Glossary). These terms are used separately in Chapters 4 and 7, in the results of surveys in which questions were asked specifically about the use or production of either native seed or native plant materials (such as nursery stock).

Native seed is obtained from terrestrial and aquatic plant species that have evolved and occur naturally in a particular region, ecosystem, or habitat. Species native to North America are generally recognized as those occurring on the continent prior to European settlement (PCA, 2015).

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grasses, forbs), factors such as where exactly the seed or its progeny was sourced, the populations from which it was collected, and the way the seed was developed into the final product offered for sale vary significantly.

BOX 1-1
Statement of Task

An ad hoc study committee appointed by the National Academies of Sciences, Medicine, and Engineering will assess federal, state, tribal and private sector needs and capacity for supplying native plant seeds for ecological restoration and other purposes. The assessment will focus on the western continental United States and incorporate information from assessments of other US regions, as available, towards the goal of a nationwide perspective. The assessment will be carried out in two phases. In phase one, the committee will conduct fact-finding, develop a framework for information gathering for the assessment, and prepare an interim report describing the framework and implementation strategy. In the second phase, the committee will oversee the data and information-gathering process, analyze the information obtained, and prepare a final report summarizing the committee's findings and conclusions. The final report also will provide recommendations for improving the reliability, predictability, and performance of the native seed supply.

The assessment may include information on:

- how native seeds are being used by public (federal, state, tribal) and private (land trusts, companies, and nongovernmental organizations in ecological restoration and other activities;
- the frequency and scale of the demand and the characteristics of the seeds pursued by users, as well as the diversity of applications for which they are sought;
- how users find seeds that are appropriate for their intended purpose and how users communicate their needs for seeds to potential suppliers;
- how suppliers make known their capacity to potential users;
- the different kinds of entities and roles that compose the seed supply chain (from professionals and organization involved in the identification of site-specific needs, to the collection, propagation, cleaning, storage, and supply of seed) and their respective capacities;
- the relationship of seed availability to other agricultural, land management, and conservation activities generally;
- procurement processes for native seeds and the cost, availability of funds, infrastructure, market, and other factors that influence decision-making on the part of users and suppliers of native seeds;
- opportunities to increase the size and capacity of the native seed supply chain (and number of suppliers); and
- other relevant issues identified by native seed users and suppliers and other stakeholders.

Buyers of native seed, whether in the public or private sector, are not monolithic in their preferences for seed characteristics. Describing a "need" for native seed therefore requires a frame of reference relative to the view of the user with respect to the activities in which seed will be used. They might describe their "needs" for seed in terms of soil stabilization, creation of pollinator habitat, or stormwater mitigation. Native plants are regarded as inherently valuable for providing essential ecosystem goods and services that support users' objectives, but users may not consider their objective as one of ecological restoration. They may be willing to use native plants manipulated by breeding or selection which would not be acceptable to others or for other applications (or even qualify as 'native' by some users).

An important frame of reference for the assessment are the needs of federal agencies such as the BLM and the US Forest Service, and those of some state agencies, charged with the mission of managing public lands for multiple uses, like grazing, recreation, wildlife habitat, and hunting, and for responding to the effects of major disturbances, such as wildfire. These agencies use thousands of pounds of native seed

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every year for these activities. Because agencies have finite resources to address their land management responsibilities, the "needs" for native seed are partially defined by priorities handed to them—first, to address post-fire emergency stabilization; secondly, to support ongoing priorities (Sage-Grouse habitat) and other multiple uses of the land, and finally, to address restoration and conservation needs. Decision-making in large agencies is distributed, and the basis of seed choices and outcomes of seed use are not routinely documented, thus making it challenging to pin down users' perception of needs. The point here is that seed needs are shaped by a broader context.

Preliminary Observations as the Context for Phase Two

The committee's interim report included eight preliminary observations about the native seed supply (Box 1-2), which were used as an informal set of hypotheses that shaped the questions developed for the information-gathering phase. In this respect, they provide a useful context for the findings from all the chapters but particularly semi-structured interviews with federal agency personnel (Chapter 3), and the results of the survey of state agency personnel (Chapter 4), and native seed suppliers (Chapter 7).

BOX 1-2
Preliminary Observations about the Native Seed Supply from the Interim Report

Observation 1. Users of native seed have varied objectives and needs.
Observation 2. The seed market in the western United States is strongly affected by decision making by the large land management agencies, such as the Bureau of Land Management (BLM) and United States Forest Service (USFS).
Observation 3. Timeframe, quantity, and quality strongly limit the overlap between what seed is available and what seed is desired.
Observation 4. Seed choices do not always support restoration success, and outcomes do not always inform choices.
Observation 5. The budgets and seed specifications of users vary greatly, as do the unit costs of suppliers.
Observation 6. Seed procurement may be hampered by market volatility, risk, and contract structure.
Observation 7. The seed market may be strongly affected by a limited capacity for seed banking and for adequate and appropriate storage conditions.
Observation 8. Issues affecting urban, mid-western, and eastern settings are somewhat distinct from those affecting public lands in the West.

BROADER CONTEXT FOR THE ASSESSMENT

It is important that readers of this report be aware of a broader context for the native seeds assessment that includes the historical efforts to build a native seed supply, and the high stakes, which some might argue, are existential in nature, to achieving that goal, as well as recent opportunities that offer an optimism for success. Described here, they played a role in shaping the committee's deliberation for actions that might be taken to supply native seed needs.

The Congressional Mandate for a Native Seed Supply

In June 2001, with increasing acres of public land affected by wildland fire, Congress urged the Department of the Interior's (DOI) Burned Area Emergency Rehabilitation (BAER) Program to go beyond emergency stabilization and towards the rapid use of native plant species to prevent invasive species encroachment in newly burned areas. In the committee report accompanying the House *2002 Appropriations Bill for DOI and Related Agencies*, the Secretaries of the Interior and Agriculture were

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directed to report jointly to Congress by the end of 2001, "with specific plans and recommendations to supply native plant materials for emergency stabilization and longer-term rehabilitation."[2]

The response to Congress was prepared by the BLM and three other land-management agencies, the Forest Service (FS), National Park Service (NPS), and the Fish and Wildlife Service (FWS), with input from USDA's Natural Resources Conservation Service (NRCS) and Agricultural Research Service (ARS), along with the DOI's Geological Survey (USGS), and the Office of Surface Mining (OSM). The plan conceived by the interagency group put forward three elements key to the success of a long-term program for native plant materials development:

1. Support for Federal, State, and Tribal Production, Development, Storage, and Research Facilities
2. Public-Private Partnerships
3. Education and Outreach

The report to Congress (DOI, USDA 2002) cautioned that the infrastructure to build a native seed supply was in its infancy but pointed to the achievements of the past as evidence that the nation could address the challenge. The report noted the history of successful plant material development by FS nurseries in the 1920s with conifer tree seedlings and by NRCS Plant Material Centers in the 1930s Dust Bowl era with plant species for conservation.

The 17-page plan put forward five action items:

1. Undertake a comprehensive assessment of needs for native plant materials,
2. Make a long-term commitment to native plant materials production, research and development, education and technology transfer,
3. Expand efforts to increase the availability of native plant materials,
4. Invest in partnerships with state and local agencies and the private sector,
5. Ensure adequate monitoring of restoration and rehabilitation efforts.

Twenty years later the plan submitted to Congress in 2002 seems rational, but the continued shortages of native seed suggest that its aspirations are not yet realized. The final paragraph of the 2002 report to Congress alluded to the potential for inertia, mentioning the need to recognize the "different missions" of agencies and the reality that the infrastructure needs of one agency "are not necessarily shared" by others. The *National Seed Strategy* developed in 2015 by the Plant Conservation Alliance, a coalition of public and private partners dedicated to native plant conservation, included the establishment of a Memorandum of Understanding between 12 federal agencies to work that signified a willingness to coordinate separate ongoing activities of the agencies and to pursue opportunities for cooperation. There are many productive activities taking place under the umbrella of the Strategy, but not necessarily at the scale needed to meet the needs. The next section of the report provides a lens through which the high stakes of this national effort should be viewed.

The Dual Crises of Biodiversity Loss and Climate Change

As part of an ongoing human-mediated biodiversity crisis, organisms face many threats, not only fire, but water and air pollution, climate change, the negative impact of introduced species, and disease. The destruction of natural habitats in the US as well as worldwide is a major threat to the survival of species (Pimm et al., 2014; International Union for the Conservation of Nature[3]). Biodiversity loss is a major threat to ecosystem function and human well-being. One widely accepted estimate is that extinction

[2] House Committee on Appropriations Report, to accompany H.R. 2217, Department of the Interior and Related Agencies Appropriations Bill, 2002, 107th Congress.

[3] See www.iucn.org.

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rates (largely human-mediated) are now 1000 times higher than what would be considered a typical background rate (De Vos et al., 2015; Pimm et al., 2014). Similarly, the "broad footprint" of climate change ranges from alterations in fine scale genetic variation to entire ecosystems, with impacts on every ecosystem on the planet (Scheffers et al., 2016).

The assessment of native seed needs and capacity has taken place over sequential years in which climate change has become a major influence on the environment. The release of the interim report in October 2020 coincided with one of the most expansive western wildland fire seasons on record, with large fires consuming more than 10 million acres (NIFC 2021). That summer was also the most active Atlantic hurricane season of all time, with seven (7) major hurricanes out of 14 total in 2020 (NOAA, 2021). In 2021, the western United States and Canada experienced a record-breaking heat wave unprecedented in the region's history, with temperatures above 113 degrees F for consecutive days, and during which British Columbia recorded a record high of 115.8 degrees F. This year, 2022, the long-term drought in the western United States continued through its 23nd year, a time span of dry conditions not believed to have occurred since the year 800 AD (Williams, 2022), while deadly flash floods in the spring and late summer swept across Yellowstone, Las Vegas, St. Louis, Kentucky, and Death Valley.

These extraordinarily severe events reflect a widespread shift in the norm of weather patterns. Extreme events can and do damage landscapes; wildfire is after all one reason public land managers seek native seeds. Intact native plant populations have evolved to be resilient, however, and are thought to be able buffer the impacts of climate change on ecosystems and support recovery of animal species. Land-management priorities have not always considered the fact that native plant communities are a key natural resource underpinning different uses of the land. Thus, conserving and restoring the integrity of native plant communities has emerged as an important, if neglected ecological "need," particularly on the millions of acres of public lands experiencing environmental degradation.

From a land management standpoint, conserving and supporting the integrity of existing plant communities across environmentally diverse landscapes is relevant to climate adaptation and mitigation, and gives additional urgency to the conservation of plant communities as an important genetic resource and a source of seed to assist plant community restoration elsewhere in the future (Havens et al 2015).

As a final point of perspective, the Seeds of Success[4] (SOS) program initiated by the BLM in 2000 to collect seed from wild stands of native plants nationwide, is estimated to have collected and placed in storage approximately one-third of the nation's native plant biodiversity (5,600 species of 18,000). A recent analysis of the location of fire incidence relative to SOS collection in the western United States documents where collections sites have been burned. It predicts that 14 percent of the sites of SOS collections will have burned by 2050 if fire frequency follows the trajectory it has taken since 2011 (facilitated in part by the spread of invasive grasses that support an accelerated fire regime). While recovery after fire is possible, the stored collections may be the only source of seed representing the genetic variation if wild stands are lost (Barga et al., 2020).

Land Ownership and Native Seed Needs

Land ownership is also a relevant lens for the assessment. The committee focused largely on understanding of public sector (state and federal) seed needs. As shown in Figure 1-1, almost 40% of the 2.3 billion acres of land in the United States is under public ownership or management. Federal agencies control 27.1% of US land, or about 640 million acres. The other major public landowners are state governments (8.0%) and tribal governments (3.0%).

[4] See https://www.blm.gov/programs/natural-resources/native-plant-communities/native-plant-and-seed-material-development/collection.

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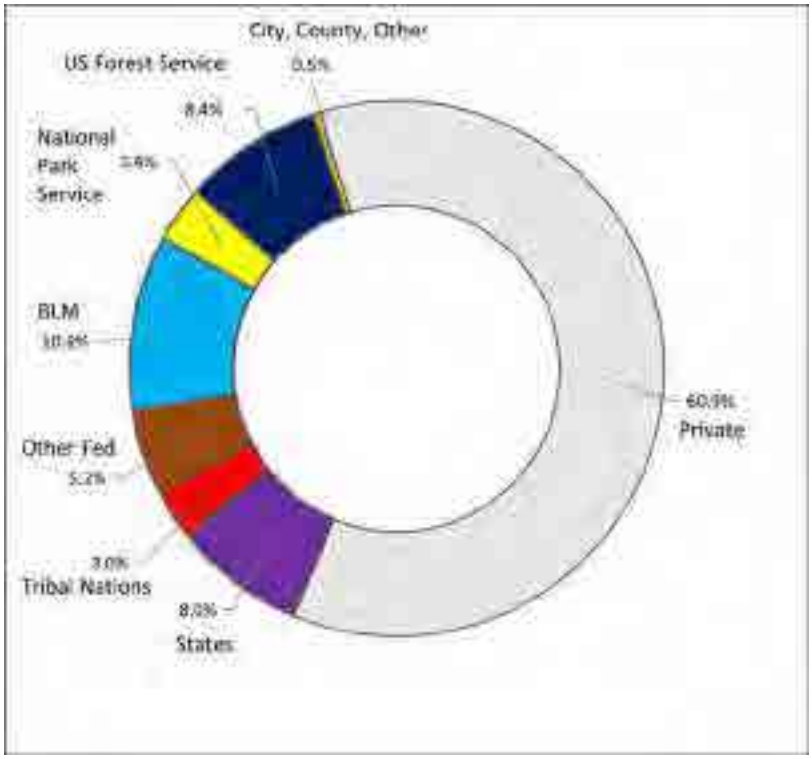


FIGURE 1-1 Land Ownership in the United States.
SOURCE: Adapted with permission from Headwaters Economics, based on U.S. Geological Survey, Gap Analysis Program 2018. Protected Areas Database of the United States, Version 2.0.

Ninety-two percent of all the US land under federal control is in the 11 western states of the contiguous United States and Alaska (Figure 1-2), and with Hawaii, amounts to almost 51% of all those states combined (CRS, 2020). Important native plant resources are distributed across the intertwined land holdings under federal, state, tribal and private ownership.

Preliminary Observation 2 of the committee's interim report postulated that the native seed market in the western United States is strongly affected by decision-making by the large land management agencies, such as the BLM and FS. The survey of state agency personnel partially supported this hypothesis, as seed shortages were associated with bad fire years, but another federal program, the USDA Conservation Reserve Program (CRP) was also shown to play a strong role in how suppliers anticipated the demand for native seed (see Chapter 7). That may be because 63% of privately owned land in the nation is occupied by farms and ranches, and CRP funding produces a relatively consistent demand for seed mixes with stock material for production available to seed suppliers.

In eastern states, there are fewer Federal lands (4 percent of total land) and a greater percentage of state managed land. The amount of state land differs by state (for example, New Jersey 21%; Florida 16%; Pennsylvania 14%; Michigan 13%; and Minnesota 11%). The assessment could not discern if there are more suppliers in the West than in the East because of a federal presence to support a larger industry, but observations about the federal use of native seeds and their impact on the supply chain may differ in the eastern states.

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FIGURE 1-2 Federal Lands Map.
SOURCE: Geographic Information Systems (GIS) Geography 2022, see https://gisgeography.com/federal-lands-united-states-map/.

New Opportunities for Ecological Restoration

A final contemporary context for the native seed assessment is the significant development during the past two years of national directives that recognize the value of natural assets in relation to jobs and the national economy. At no time in recent legislative history has the US Congress been more supportive of calls to protect natural areas and their biodiversity. Bills passed in 2021 and 2022 include the *Infrastructure Investment and Jobs Act (Bipartisan Infrastructure Law* (BIL)[5], which includes $200 million for the *National Seed Strategy* ($70 million for the DOI, and $130 million to USDA) in the next 5 years, as well as the *Repairing Existing Public Land by Adding Necessary Trees* (REPLANT) *Act*, providing up to $140 million annually for reforestation on National Forests. *The Great American Outdoors Act*[6] will provide up to $1.9 billion for the next 4 years to maintain infrastructure at national parks, forests, wildlife refuges, and recreation areas, and $900 million in annual funds to the Land and Water Conservation Fund to allow federal and state acquisitions of recreational land. The current executive administration has put forward ambitious plans for nature-based solutions to climate change (*America the Beautiful*[7]) and to take stock of the contribution of natural capital to the national economy (Earth Day Executive Order for a natural capital accounting[8]). With the resources allocated by these

[5]Text modified after the pre-publication release to correct the allocation of funds to DOI and USDA for the National Seed Strategy from the Infrastructure Investment and Jobs Act: Public Law 117-58 .

[6] Great American Outdoors Act: Public Law 116-152. Footnote added after the prepublication release for clarity.

[7] See https://www.doi.gov/priorities/america-the-beautiful.

[8] See https://www.whitehouse.gov/ostp/news-updates/2022/04/24/accounting-for-nature-on-earth-day-2022/.

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initiatives, federal, state, and tribal agencies have an unprecedented opportunity to conserve and restore the natural assets that underpin multiple uses of public lands.

REPORT ORGANIZATION

A list of Acronyms and Abbreviations and a Glossary are included in the Front Matter of the report before the Summary. Chapter 2 provides an overview of the information gathering strategy described in the interim report, including the methods used to identify target populations for surveys of state agencies and seed suppliers, and of semi-structured interviews of a sample of federal agency personnel.

Sitting at the end of the native seed supply chain are the users of native seed. They are a diverse group, with the Federal government the largest. Chapter 3 focuses on the five agencies managing the most Federal land. Chapter 4 explores the uses of native seed in state programs, and the activities surrounding that usage, through a survey of state staff discussing seed use, decision-making, and concerns about the supply chain. Chapter 5 looks at native seed uses on tribal lands, along with a description of historical factors that affect tribal native seed capacities. Chapter 6 examines cooperative partnerships for native seed and plant development, some involving federal agencies, and others pursued at the state and regional levels. It also describes the effect of Federal programs on the use of native seed on private lands. Seed suppliers, their activities, and their concerns, are the focus of Chapter 7, with results from the survey of seed suppliers. Additional science is critical in support of restoration and seeds, and Chapter 8 discusses specific areas of basic and applied research that are needed to fully support the native seed supply. Chapter 9 provides important conclusions and overarching recommendations for actions to strengthen the native seed system.

The appendices include committee biographies (Appendix 1); federal agency interview tool (Appendix 2A); the state survey invitation letter (Appendix 2B), survey questions (Appendix 2C) and tabulated summary responses (Appendix 2D); the supplier invitation letter (Appendix 2E), survey questions (Appendix 2F), survey questions (Appendix 2G), and tabulated summary responses (Appendix 2G); and, the list of presentations made to the committee since the inception of the study over the years of 2019-2022 (Appendix 2H).

CONCLUSIONS

Conclusion 1-1: *Native seed needs are defined by both the characteristics of the seed desired by users for ecological restoration and other purposes, and by the overall goal that require their use.*

Conclusion 1-2: *In 2002, the Department of the Interior and Department of Agriculture put forward a plan for developing a native plant seed supply involving greater interagency coordination, partnerships with states and the private sector, and monitoring of restoration outcomes. Native seed shortages continue to be a barrier to restoration, and the aspirations of the plan, which is conceptually sound, have not been fulfilled.*

Conclusion 1-3: *The nation's native seed needs depend on the native plant communities that are the source of seeds. There is urgency to the need for conserving the biodiversity that is present in existing native plant communities and therefore, for building a native seed supply through seed collection, plant development, and restoration, because climate change, extreme events, and destructive human activities have put these genetically and ecologically valuable natural resources at increasing risk.*

Conclusion 1-4: *Because more than half of the land in 11 western states is under Federal management, it is likely that federal seed purchases, especially after wildfires, have a major influence on the native seed industry in the western United States.*

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Conclusion 1-5: *Recent congressional legislation and executive orders have provided an unprecedented opportunity to address the nation's natural heritage on public lands.*

REFERENCES

Barga, S.C., P. Olwell, F. Edwards, L. Prescott, and E.A. Leger. 2020. Seeds of Success: A conservation and restoration investment in the future of US lands. Conservation Science and Practice 2(7): e209.

De Vos, J.M., L.N. Joppa, J.L. Gittleman, P.R. Stephens, and S.L. Pimm. 2015. Estimating the normal background rate of species extinction. Conservation Biology, 29: 452-462. https://doi.org/10.1111/cobi.12380.

Havens, K., P. Vitt, S. Still, A.T. Kramer, J.B. Fant, and K. Schatz. 2015. Seed Sourcing for Restoration in an Era of Climate Change. Natural Areas Journal 35(1):122-133.

Pimm, S.L., Jenkins, C.N., Abell, R., Brooks, T.M., Gittleman, L., Joppa, N., Raven, P.H., Roberts, C.M., and J.O. Sexton. 2014. The biodiversity of species and their rates of extinction, distribution, and protection. Science 344(6187): 1246752. https://www.science.org/doi/10.1126/science.1246752.

Scheffers, B.R., L. De Meester L, T.C. Bridge, A.A. Hoffmann, J.M. Pandolfi, R.T. Corlett, S.H. Butchart, P. Pearce-Kelly, K.M. Kovacs, D. Dudgeon, M. Pacifici, C. Rondinini, W.B. Foden, T.G. Martin, C. Mora, D. Bickford, and J.E. Watson. 2016. The broad footprint of climate change from genes to biomes to people. Science. 2016 Nov 11;354(6313): aaf7671. doi: 10.1126/science.aaf7671. PMID: 27846577.

Williams, A.P., B.I. Cook, and J.E. Smerdon. 2022. Rapid intensification of the emerging southwestern North American megadrought in 2020–2021. Nature Climate Change 12(3):232-234.

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2

Description of the Information-Gathering Strategy

The Committee undertook several information-gathering activities to obtain a thorough understanding of the native seed supply chain. The data-gathering strategy varied, depending on the specific type, projected use, and availability of the information. This section describes the main activities, which included (a) semi-structured interviews with federal seed buyers; (b) surveys of state government seed buyers (c) surveys of seed suppliers; (d) public information-gathering sessions; (e) a review of existing data; and (f) a review of the published literature.

SEMI-STRUCTURED INTERVIEWS WITH FEDERAL SEED BUYERS

To better understand native seed purchases at the federal government level, the Committee conducted a series of semi-structured interviews with staff from five federal agencies, including: the Bureau of Land Management, the US Forest Service, the National Park Service, the US Fish and Wildlife Service, and the military service branches (the Army, Air Force, Navy, and Marine Corps). Within each agency, the Committee attempted to identify a few key staff members who were especially likely to have broad knowledge about the use of native seed and plant materials within the agency.

Appendix 2A shows the interview guide, which was developed by the Committee, and covered the following broad topics:

- Purchase and use of native seed and plant materials
- Contracting arrangements
- Sources of information about native seed availability
- Communication with suppliers
- Decision-making about the use of native seed and plant materials
- Substitutions when the desired natives are not available
- Monitoring of projects after planting
- Expectations for the future

The interviews were conducted by the study director (the director of the Board on Agriculture and Natural Resources) with assistance from a research associate. A total of 19 interviews were completed between August of 2021 and May of 2022. The interviews were conducted via Zoom or telephone and were typically 1-1.5 hours in length.

SURVEYS

The Committee conducted two surveys, one of seed suppliers and another one of state government agencies that buy native seed. This section describes the methods used to collect the survey data.

Survey of State Government Seed Buyers

The Committee conducted a survey of departments within state government that use seed and plant materials. Appendix 2C shows the wording of each of the questions included in the survey, which covered the following broad topics:

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- Purchase and use of native seed and plant materials
- Sources of native seed and plant materials
- Importance of specific seed characteristics
- Purposes of native seed purchases
- Seed storage availability
- Contracting arrangements used
- Sources of information about native seed availability
- Communication with suppliers
- Substitutions when the desired natives are not available
- Monitoring of projects after planting
- Availability of in-house expertise
- Barriers to using native seed
- Expectations for the future

The survey was carried out by the Social and Economic Sciences Research Center at Washington State University (SESRC) based on specifications provided by the committee. SESRC staff also provided input on the survey questions and the implementation methods.

The survey included state agencies that are most likely to use seed and plant materials due to their mission. The list of departments was compiled by National Academies of Sciences, Engineering, and Medicine staff and included departments focused on the general areas of: natural resources, forestry, fish and wildlife, state parks, and transportation. States vary in how the relevant departments are structured and named, and staff used public websites to generate the list, along with contact information for the heads of each department (such as director or commissioner). The final list contained 160 departments (an average of 3.2 departments per state). The survey was sent to all 160 departments. While the goal was to include all departments that are likely to use native seed and plant materials, the list was not a comprehensive list of all state departments that could potentially do so. These results should not be generalized to all state departments in the United States beyond the list of departments compiled for this survey. The survey included departments of different sizes from all regions of the country (see below).

The survey was carried out between May and July of 2021, online and by telephone. The survey was conducted during the COVID-19 pandemic, when many state agency employees were working from home, so the first contact was an email sent to the department head. The letter provided a link and access code for the online survey and asked that the survey be completed by the person who is most knowledgeable about the use of native seed and plant materials in the department (See Appendix 2B). Reminders were sent by email, and trained SESRC interviewers also conducted telephone follow-up in the final stages of the fieldwork for those who did not complete the survey online. A small subset (3 percent) of the departments that responded completed the survey by telephone.

Table 2-1 shows the final outcome of the cases included in the survey, including the cases that were determined to be ineligible because the department did not use either native seed or plant materials. See Appendix 2C for the screening questions that were used to determine eligibility. The response rate was 63 percent.

The survey included both closed and open-ended questions. Open ended questions were coded into thematic categories by two trained SESRC coders. For each question, the coders created a codebook together with one coder starting the codebook and the other testing the validity of each code and further refining the codebook as necessary. The coders regularly met throughout the coding process to compare the cases coded and discuss discrepancies. After completing the coding for each question, 20 percent of cases were randomly selected for an intercoder reliability check. The coders then used the codebook to code those cases again to ensure at least 80 percent agreement on all codes. While all codes were above the 80 percent threshold, the coders discussed discrepancies until agreement was found and revised the codebook where necessary.

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TABLE 2-1 Outcome of Cases for the Survey of Departments within State Government Agencies

Case disposition	Frequency	Percent
(A) Completed	92	57
(B) Partially completed	5	3
(C) Refusal to participate	3	2
(D) Non-response	52	33
Total eligible	**152**	**95**
Response rate (A+B)/(A+B+C+D)	**Response Rate: 63%**	
(E) Ineligible (not using native seed or plant materials)	8	5
Total ineligible	**8**	**5**
Total sample	**160**	**100**

Table 2-2 shows the distribution of the responses by geographic area. While the geographic area categorized as the East for the purposes of this report includes a larger number of states and therefore a larger number of departments than the West, the response rate was higher among the Western states than the East. It is possible that more departments from the eastern states felt that the survey did not apply to them and chose not to respond. Table 2-3 shows the distribution of the responses by size of the department's expenditures on natives, determined based on the approximate average annual expenditure on native seed and plant materials between 2017 and 2019. Key results from the survey, including the open-ended questions, are discussed in subsequent chapters of this report. Response frequency distributions for the questions are shown in Appendix 2D.

TABLE 2-2 Distribution of Responses to the Survey of State Government Departments by Geographic Region

Region	Number of departments	Percent
East	65	67
West	32	33
Total	97	100

NOTE: East includes AL, AR, CT, DE, FL, GA, IA, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, NC, ND, NE, NH, NJ, NY, OH, OK, PA, RI, SC, SD, TN, TX, VA, VT, WI, WV; West includes AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY.

TABLE 2-3 Distribution of Responses to the Survey of State Government Departments by Size

Department expenditures on natives	Number of departments	Percent
$100,000 and below	43	56
Over $100,000	26	34
Don't know	8	10
Total responses to question	77	100
Missing	20	
Total	97	

NOTE: Size is based on the question: "Thinking about the three-year period from 2017 to 2019, what was [DEPARTMENT]'s approximate average annual expenditure on native seed and plant materials combined?"

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Survey of Seed Suppliers

To better understand the experiences of seed suppliers, the Committee conducted a survey of sellers of native seed and plant materials. Appendix 2F shows the wording of each of the questions included in the survey, which covered the following broad topics:

- Types of business activities
- Types of seed and plant materials sold
- Capacity for collecting seed
- Capacity for growing seed
- Seed storage availability
- Types of buyers and methods of communication with potential buyers
- Contracting arrangements used
- Challenges and barriers encountered
- Ability to plan ahead
- Expectations for the future
- Suggestions for improving how the market for native seed functions

This survey was also carried out by the Social and Economic Sciences Research Center at Washington State University (SESRC) based on specifications provided by the committee. SESRC staff provided input on the survey questions and the implementation methods.

Given that there is no definitive list of all seed suppliers that could have served as a sampling frame for the survey, the Committee built a list based on information from the following sources that contained the names and contact information of vendors with an interest in native seed:

- US Department of Agriculture (USDA) National Nursery and Seed Directory (Native Plants Journal list)
- Native Seed Network
- American Seed Trade Association's Environmental and Conservation Seed Committee
- BLM seed vendors
- USFS seed vendors

After a list based on the above sources was assembled, the list was deduplicated, and entities that were not commercial vendors located in the United States were removed. The deduplication was primarily focused on identifying duplicate organization names, but the list was small enough that staff were able to also manually flag and resolve a few additional exceptions, such as two separate organization names listed with the same address (due for example to name changes or acquisitions). The final list contained 1,259 suppliers, and the survey was a census of all the suppliers on the list (in other words, not a sample survey of a subset of the suppliers). As discussed, this was not a comprehensive list of all suppliers of native seed, so the results cannot be generalized to all suppliers in the United States. However, the survey included the suppliers used by BLM in recent years. The survey also included non-BLM suppliers of different sizes from all regions of the country (see below), but it is ultimately not possible to know how this list compares to the theoretical universe of all native seed suppliers in the country.

The survey was carried out between May and July of 2021, online and by telephone. The first form of contact with those selected into the survey was a physical letter mailed to the business. The letter provided a link and access code for the online survey and asked that the survey be completed by the person who is most knowledgeable about the sales of native seed and plant materials at the particular business (see Appendix 2E). The letter was followed by both email and postal reminders. Trained SESRC interviewers also conducted telephone follow-up in the final stages of the fieldwork for those who did not

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complete the survey online. This approach resulted in 78 percent of the completed interviews being completed online and 22 percent by telephone.

Table 2-4 shows the final outcome of the cases included in the survey. The response rate, defined as the ratio of completed and partially completed interviews to the total eligible cases, was 27 percent. Approximately 20 percent of the cases were determined to be ineligible on the basis of their responses to a set of screening questions (see Appendix 2F), and in some cases information obtained from other sources. Ineligible cases included vendors that were no longer in business or were not selling native seeds or plants. Due to the focus of this study, vendors that were exclusively focused on the home market were also excluded from the survey.

TABLE 2-4 Outcome of Cases for the Supplier Survey

Case disposition	**Frequency**	**Percent**
(A) Completed	223	18
(B) Partially competed	48	4
(C) Refusal	83	7
(D) Non-response	650	51
Total eligible	**1,004**	**80**
Response rate (A+B)/(A+B+C+D) Response Rate: 27%		
(E) Doesn't sell native seed or plants	78	6
(F) Sells only to the home market	110	9
(G) No longer in business	65	5
(H) Other	2	0
Total ineligible	**255**	**20**
Total sample	**1,259**	**100**

The survey included both closed and open-ended questions. Open ended questions were coded into thematic categories by two trained SESRC coders. For each question, the coders created a codebook together with one coder starting the codebook and the other testing the validity of each code and further refining the codebook as necessary. The coders regularly met throughout the coding process to compare the cases coded and discuss discrepancies. After completing the coding for each question, 20 percent of cases were randomly selected for an intercoder reliability check. The coders then used the codebook to code those cases again to ensure at least 80 percent agreement on all codes. While all codes were above the 80 percent threshold, the coders discussed discrepancies until agreement was found and revised the codebook where necessary.

Table 2-5 shows the distribution of the responses by geographic area and Table 2-6 shows the distribution of the responses by the size of the business, determined based on the average annual sales and operating revenues between 2017 and 2019. As discussed, an inventory of all native seed suppliers and their characteristics does not exist, so it is not possible to determine how these breakdowns compare to the universe of vendors as a whole. Key results from the survey, including the open-ended questions, are discussed in subsequent chapters of this report. Response frequency distributions for the questions are shown in Appendix 2G.

PUBLIC INFORMATION-GATHERING SESSIONS AND OTHER PUBLIC INPUT

In addition to the structured data collection efforts, an important source of input for the Committee was the public information-gathering meetings held with a variety of stakeholders and experts working in areas related to native seed and plant materials. The Committee met with representatives from

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BLM, and with staff from other federal and state government agencies that have projects related to native seed. The Committee also met with suppliers of native seed, operating businesses of various sizes. Other stakeholders who provided input to the Committee included representatives of organizations with an interest in native seed and plant materials, researchers, seed cleaners, seed certifiers, and seed storage providers. Appendix 2H shows the list of individuals who participated in meetings with the committee. In addition, a call for public comments was also posted to the study page on the National Academies website. The website provided a link to a form for submitting comments to the Committee.

TABLE 2-5 Distribution of Responses to the Supplier Survey by Geographic Region

Region	Number of suppliers	Percent
East	147	54
West	124	46
Total	271	100

NOTE: East includes AL, AR, CT, DE, FL, GA, IA, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, NC, ND, NE, NH, NJ, NY, OH, OK, PA, RI, SC, SD, TN, TX, VA, VT, WI, WV; West includes AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY.

TABLE 2-6 Distribution of Responses to the Supplier Survey by Supplier Size

Supplier size	Number of suppliers	Percent
$499,999 or less	112	53
between $500,000 and $4,999,999	67	32
$5,000,000 or more	30	14
Don't know	1	1
Total of respondents to question	210	100
Missing	61	
Total	271	

REVIEW OF EXISTING DATA

To learn as much as possible about the native seed supply chain, the committee obtained relevant information that was available in the form of administrative records held by various agencies and other entities that are part of the supply chain. While the committee was not aware of any existing data source that could provide a comprehensive picture of either the native seed supply or demand in the United States, these records provided a granular view of some segments of the supply chain and enriched the committee's understanding of a few specific market players. The main sources of existing data reviewed by the committee included consolidated seed buy records from the Bureau of Land Management (BLM).

REVIEW OF PUBLISHED LITERATURE

The Committee's work builds on a rich literature that exists on a broad range of topics related to the role and use of native seed and plant materials. The Committee reviewed recent research, with particular focus on topics related to the study charge. These topics ranged from restoration successes to the challenges associated with the use of native seed, as well as research on choosing native seed. The Committee also benefited from the published literature on the experiences of other countries and groups focused on specific geographic areas, and from gaining an understanding of a variety of approaches, systems, and processes.

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3

Native Seed Needs and the Federal Government

The first section of this chapter provides a high-level view of what is driving native seed needs of the federal land-management agencies, the scale of the need, and how each agency is attempting to address those needs. The second part provides a summary of collective insights from individuals working in those agencies to shed light, from a boots-on-the-ground perspective, of the day-to-day challenges related to native seed used in ecological restoration and other purposes. The information in the first part is derived from public presentations by agency representatives and public information about agency activities. The second part is based on semi-structured interviews with agency personnel. The chapter ends with a discussion of the significance of the findings and the committee's conclusions.

TOP FIVE FEDERAL LAND-MANAGEMENT AGENCIES

The Committee's Interim Report identified the five largest Federal land management agencies with management responsibilities for more than 600 million acres (Table 3-1), the amount of land each manages, and provides a brief description of the mission of each agency. Each of these agencies makes direct purchases of native seed. The four largest agencies have a major environmental focus as part of their missions.

TABLE 3-1 Land Managed by Five major Federal Agencies (acres, 2018)

Bureau of Land Management (BLM)	244,391,312
US Forest Service (USFS)	192,919,130
US Fish and Wildlife Service (USFWS)	89,205,999
National Park Service (NPS)	79,045,679
Department of Defense (DOD)	8,845,476
Total for Five Agencies	615,311,596

SOURCE: US Congressional Research Service. 2020. Federal Land Ownership: Overview and Data. Vincent, C.H. and L.A. Hanson. Report R42346. http://crsreports.congress.gov. Accessed December 1, 2022.

Bureau of Land Management

As its name implies, the BLM (within the Department of the Interior) is the Federal government's largest land manager and uses the largest quantities of native plant seed in the nation. Thus, it is particularly important to the Committee's work. The BLM manages extensive regions in the western states, and oversees approximately a tenth of the overall land area in the United States. Its mission directly relates to sustaining and utilizing natural resources on that land.

The BLM's Plant Conservation and Restoration Program (PCRP) operates out of the Bureau's Resources and Planning Directorate to ensure that seeds are available for the projects of over 100 BLM field offices in 11 western states. Most of the seed purchased by the BLM is through Consolidated Seed Buys which typically take place 3-4 times a year.[1] The procurement process begins with the development

[1] Text was modified after the pre-publication was released to correct number of BLM offices with seeding projects and the number of Consolidated Seed Buys annually.

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of a list of seed types and amounts requested from the field offices, which is then put out for public bid. The winning bids are paid from a Working Capital Fund, which is then reimbursed from field offices or other project-specific sources. The purchased seed is stored temporarily in one of the BLM's seed warehouses until used.

Native Seed and Wildfire

Wildland fire is the major driver for native seed needs for BLM, and for other federal land-management agencies, as well as for all state and tribal land in the West. As Table 3-2 shows, wildfire is a frequent occurrence and has significant impacts on all public and private lands in the West, with more than 9.5 million acres burned in 2020, and over 1.1 million on BLM land.

TABLE 3-2 Wildfires in Western United States in 2020 (Number and acres across all jurisdictions, and the acres under BLM management)

	All Lands		BLM Lands
	Number	*Acres*	*Acres*
Alaska	349	181,169	45,256
Arizona	2,524	978,568	76,204
California	10,431	4,092,150	142,201
Colorado	1,080	625,357	167,723
Idaho	944	314,352	60,147
Montana	2,433	369,633	11,670
Nevada	770	259,276	223,052
New Mexico	1,018	109,513	6,809
Oregon	2,215	1,141,613	234,047
Utah	1,493	329,735	102,355
Washington	1,646	842,370	30,180
Wyoming	828	339,783	30,390
Total	**25,731**	**9,583,519**	**1,130,034**

SOURCE: Public Land Statistics 2020, Department of the Interior, Bureau of Land Management.

After wildfires, seeds are used to establish vegetation to stabilize and protect soils and assist the process of natural recovery. Because the number and severity of wildland fires vary from year to year, the total annual seed purchases from the Consolidated Seed Buys fluctuates annually, for example, from a high of 7.5 million pounds in 2007 to a low of approximately 300,000 pounds in 2009. BLM estimates that on average, 2.4 million pounds of pure live seed are purchased each year through this process, at an average annual cost of $20 million. About 30-40 seed suppliers each year respond to the Consolidated Seed Buys (Ricardo Galvin, presentation to the committee).

In a presentation to the committee, Molly Anthony, the Program Lead for BLM Emergency Stabilization and Rehabilitation (ESR) Program noted that in 2020, the field offices of the ESR program purchased $14.9 M in seed and conducted post-fire seeding on over 422,000 acres of burnt land. Anthony explained to the committee the institutional limitations on the effectiveness of postfire emergency stabilization and rehabilitation, which accounts for fully two-thirds of BLM seed procurement. Seed purchases for this program are dependent on funds allocated for the current fiscal year, not future years. Further, federal spending rules curtail purchasing for current year in a black-out period before September 30, the end of the federal fiscal year, even though most seeding is conducted in fall. These institutional restrictions limit the capacity for advance planning and procurement and make the program dependent on seed supplies that are already in warehouses or commercially available. In turn, desired seeds are often unavailable, and substitutions of less-desired seeds are common.

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Seeds purchased through the Consolidated Seed Buys are grasses, forbs (small flowering plants that are not grasses), and shrubs. The major portion of seed purchases is grasses, of which more than half (by weight) of seed requests from field offices have been for native species. In contrast, the large majority (by weight) of forb seed purchases are of non-native species. Field office requests for native forbs have exceeded what is provided in the purchases. Purchases of shrub seed (mainly related to sagebrush) are about two-thirds native (Patricia Roller, personal comm., based on historical BLM seed purchase data).

Seed Transfer Zones and Source-Identified Seed

BLM does not have an agency-wide requirement that seed purchased by the field offices be native plant seed, although its Best Management Practices call for the use native seed of known origin when available (BLM 2008)[2] and its use is encouraged by program offices, such as the ESR unit. The PCRP would prefer that field offices request and buy native, certified Source-Identified (SI) seed, for which the geographic location of the origins of the seed was verified by an official seed certification agency. Having that information increases the likelihood of selecting a seed type from a location or "seed transfer zone"[3] that is appropriate for where it will be used, using guidance developed by the US Geological Survey, USFS, and other research agencies that have studied the genetics of plant species across the landscape.

However, it is unlikely that the field offices will or can meet this preference. In 2020, BLM field units purchased 1.4 million pounds of grasses, 220,000 pounds of forbs, and 110,000 pounds of shrub seed. Of these seeds, about 1/8 of the grasses, ¼ of the forbs, and 2/3 of the shrubs were native SI seed (BLM Seed Purchase data). The rest of the seed was either non-native seed or seed of released native germplasms or cultivars.[4]

It is quite possible that the type of seed desired by the field offices is simply not available from suppliers, so buyers have had to accept substitutions, as Anthony described. However, the choices made between different types of seed (native vs. nonnative, grass vs. forb, cultivar vs. source-identified) also appear correlated with the costs per pound of these types, so price is likely to be a factor in the decision-making of BLM field offices.

Proactive Stockpiling of Native, Source-Identified Seed with the IDIQ

The PCRP has no authority to require that field offices purchase native seed or native SI seed, and until recently, has had no budget with which to stock BLM warehouses with native, SI seed in advance of post-fire operations and other uses. However, in 2018, BLM created a seed production component of its Working Capital Fund and established an Indefinite Delivery-Indefinite Quantity (IDIQ) procurement vehicle designed to streamline contracting for seed increases.[5] As a result, contracts were awarded to produce SI seed collected by the BLM Seeds of Success program (discussed in Chapter 6), with a focus on native grasses and forbs from six ecoregions.[6]

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[2] The text was modified after the prepublication release to clarify the BLM policy on the use of native plant seed.

[3] Seed transfer zones are geographically distinct areas within which seeds can be sourced and introduced with low risk of maladaptation (Bower et al. 2014; Breed et al. 2018), and minimal loss of biodiversity (Malaval et al., 2010).

[4] Most of the native releases are genetically non-manipulated (not created through selection or breeding), but due to their greater availability and less expensive pricing in the marketplace, they are often planted in geographic areas not matching their geographic source; that is, they originate from a different seed transfer zone than the one where they will be used.

[5]The text was modified after the prepublication release to clarify that the Working Capital Fund can support the IDIQ but the two are not intrinsically linked.

[6] The EPA (Omernik,1987) created a map of ecosystems (ecoregions) across the United States defined by major differences in geography and climate. Subsequent refinements of the map have led to more discrete ecoregions.

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The goal of the program is for the seed increases to be completed over 3-5 years, and then stored in the BLM warehouses for future purchase by field offices when needed. Currently, there are six suppliers holding IDIQ contracts and the award has a 5-year cap at $49 million total, significantly less than the approximately $20 million average each year spent on the Consolidated Seed Purchases.

It is a significant first step toward the proactive stockpiling of native seed to meet the Bureau's needs. Between 2019 and 2021, purchases through the IDIQ included 42 species and 94 combinations of taxa and seed zones, of which approximately 94,200 pounds of seed are expected to be delivered in the next three years (PCA, 2022). Anne Halford, BLM Idaho State Botanist, told the committee that the IDIQ contract structure is meant to increase the supply of priority native forbs and so-called workhorse species (widespread, quickly establishing, native plant species) for targeted seed zones. She stated that about 85% of BLM's seeds are used in three[7] seed zones in the Great Basin. That fact, she noted, underscores the importance of improving seed source protection of the wild plant populations that exist in these seed zones, and for collection of seeds from these areas for seed banking and future increase.

Warehouse Needs

The IDIQ initiative is promising, though it is unclear at this stage how far the initiative can be expanded to meet the Bureau's growing needs. In addition, if BLM were able to upscale native seed and plant material supplies, the current National Seed Warehouse System would soon be inadequate in terms of physical climate-controlled capacity, staff, and expertise. Currently, BLM has two major warehouses, one staffed, state seed warehouse in Boise, Idaho, and the other in Ely, Nevada, which combined can accommodate 2.6 million pounds of seed (Patricia Roller, BLM, presentation to the committee). There is some refrigerated storage space at the Ely site. The Ely warehouse was not staffed earlier in 2022 (personal communication, BLM).

Other Needs for Native Seed Within BLM

Although post-wildfire stabilization and long-term rehabilitation purchases the most seed through the BLM seed procurement processes, there are several other important units that also need seed to fulfill their targeted missions in the BLM, including accompanying fuels reduction, wildlife habitat, including pollinators, forest and riparian areas, rangeland, recreation, and mines, oil, and gas wells, and energy development.

In a presentation to the committee, Anne Halford, BLM Botanist in Idaho, emphasized the different ways in which plant conservation and restoration activities contribute to revenue generation for the Department of the Interior and BLM, from the $23 million in recreation fees in 2017 that brought visitors to witness the "super bloom" of native wildflowers, to supporting the preferred native habitat for fish and game species on which $348 million is spent annually, and the increased productivity of rangeland on which ranchers in the West rely.

An important consideration related to the current biodiversity crisis is the ecosystem value of native plant communities as food and shelter for the iconic sage-grouse or other rare species. Plant materials are also needed to address orphaned oil and gas wells on federal lands, for which BLM has taken the lead with remediation funds of $250 million in the Bipartisan Infrastructure Legislation.[8] There are massive numbers of orphaned wells in the country (over 130,000 by one estimate[9]) that dot the

[7] Development of a climate-smart restoration tool led researchers to suggest combining provisional seed zones for sage brush in the Great Basin into three zones, making it easier to source seed appropriate for the Great Basin region.

[8] Infrastructure Investment and Jobs Act (Bipartisan Infrastructure Legislation), see https://www.blm.gov/sites/default/files/docs/2021-05/Congressional_20210415_HR2415.pdf.

[9] See https://iogcc.ok.gov/sites/g/files/gmc836/f/documents/2022/iogcc_idle_and_orphan_wells_2021_final_web_0.pdf.

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national landscape (see Figure 3-1). The Bipartisan Infrastructure Legislation (BIL) includes $4.4 billion for the Department of the Interior to provide grants to the tribes, states, and private landowners to plug the wells and restore the soil and habitat, at an average cost of $25,000 per well pad. One study estimated that to address the 1-4% of west Texas land with well pads and pipelines between now and 2050 would require between 247,000–1,330,000 lbs. of seed of native grasses valued between US $10–57 million (Smith et al., 2020).



FIGURE 3-1 Oil and gas well pads in Jonah Field, Wyoming. SOURCE: Ecoflight.

US Forest Service

The mission of the USFS (within the US Department of Agriculture) is to sustainably manage national forest land for multiple uses. The agency also supports management of forest land under private, state, and tribal ownership. Trees species are the major focus of the agency's seed collection, development, and seedling production activities, but in the last decade that has expanded to include grasses and forbs.

Wildfire and Restoration Needs

Like the BLM, wildfire is driving the restoration needs of the USFS. In 2020, the USFS Pacific Northwest Region-6, home to 17 National Forests across Oregon and Washington, experienced the worst fire season in a century. According to a Rapid Assessment Team[10] report evaluating the Slater Fire in the Rogue River-Siskiyou National Forest, a half million acres of Forest Service managed land was burned

[10] See https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd887614.pdf.

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by wildfires in 2020. Seventy-five percent of the trees in the core fire area (about 200,000 acres) were killed. The report said the event would "more than double our existing reforestation needs in the region and will put a strain on seed or seedling availability for some forests." The report added that the USFS Region 6 Geneticist (Vicky Erickson) had already reached out to develop agreements with other land-management agencies from which seed might be used or purchased and was working with other USFS geneticists to identify genetically appropriate tree seed sources that might be acquired.

The pressing need for an adequate supply of tree seeds for restoration after wildfire is reminiscent of the challenges that BLM faces annually. The USFS has generally preferred to allow burned forest to recover naturally and has previously lacked the resources to address its 4-million-acre backlog in reforestation needs—the USFS estimates that only 6 percent of current reforestation needs are met annually.[11] In 2017, the agency reported that more than half of its budget (including non-fire programs) was used to fight wildfires.[12] In the wake of two extreme fire years, in January 2022, the USFS released *Confronting the Wildfire Crisis Strategy*, a 10-year plan to dramatically increase fuels removal and forest health activities on millions of forested acres, which was followed in July 2022 by the *National Forest System Reforestation Strategy*, a plan to address the reforestation deficit (see Box 3-1).

BOX 3-1
A New Level of Forest Management on Public Lands

In January of 2022, the USFS released Confronting the Wildfire Crisis Strategy, calling for a "paradigm shift" in the scale and pace at which fuels removal and forest health treatments take place, anticipating four times as much intensive management activity than in the past. The 10-year plan will treat 20 million acres of USFS property and 30 million acres of other Federal, State, Tribal and Private land.

According to the Strategy, the goal is to manage the lands in the West as one landscape, with the work carried out under the direction of the *National Interagency Fire Center* in Boise, Idaho, where agencies have worked together "seamlessly" on wildfire since 1965.

The large-scale effort to remove dead trees, conduct thinning, and other work, will be complemented by a National Forest System Reforestation Strategy, with funds from the REPLANT (Repairing Existing Public Land by Adding Necessary Trees) Act, part of the Infrastructure Investment and Jobs Act known informally as the Bipartisan Infrastructure Law (BIL) passed in 2021. The Act will result in as much as $123 million annually available for reforestation activities from import duties on wood products. which will support the reforestation effort of 4.1 million acres over the next 10 years.

Seed Acquisition through the BPA

To address seed needs, Region-6 has in-house capacity for tree production at the Clarno Propagation Center, and production of conifer trees, grasses, and other plant types at the J. Herbert Stone Nursery. Because many more trees and other native plants will be needed, production and other activities will need to be scaled up to engage many more public and private nurseries and growers.[13] In a presentation to the committee, Erickson said Region 6 uses a Blanket Purchase Agreement (BPA) to commission this work, having switched from an IDIQ in 2017. The advantages of the BPA over the IDIQ it used previously included no up-front obligations, a higher dollar spending limit ($10 million) , and the ability to add new vendors over the 10-year term of the agreement. She added that the USFS BPA is available to other federal agencies, and overall, provides a relatively fast and easy mechanism for accessing vetted contractors and quickly obligating funds as they become available.

[11] See https://www.usda.gov/sites/default/files/documents/reforestation-strategy.pdf.
[12] See https://www.fs.usda.gov/sites/default/files/fy-2017-fs-budget-overview.pdf.
[13] See https://www.americanforests.org/wp-content/uploads/2021/02/Ramping-Up-Reforestation_FINAL.pdf.

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Work orders under the BPA list grow-out specifications for each species. The pool of qualified growers can submit proposals on a 1-page form. Seed stock is provided by the agency, either collected on USFS land by agency staff or via contracting, following guidelines for obtaining genetic diversity and recording of the collection site data. Growers are normally paid per-pound, but per-acre prices can be used for higher-risk species or small quantities. Production data are maintained to guide future seed increase. Compared with previous contract structures, Erickson said the BPA is better in recruiting good producers (though there are still not enough of them), being flexible and fast, reducing risk to producers, maintaining quality control, and building expertise. The USFS uses its BPA to contract for a wide range of services, such as invasive plant treatment, cone collection, monitoring, and other tasks.[14]

Erickson noted that an important goal is for seed production to benefit rural economies, both through long-term partnerships for the USFS and through secondary markets (commercial seed sales). For example, the White River National Forest in Colorado initiated a native grass seed development program through collections and increases that ultimately resulted in the release of certified SI seed of two grass species (slender wheatgrass and mountain brome) to commercial suppliers in Colorado, which are now able to grow these grass species in large quantities to sell to private landowners and to land-management agencies.

The USFS has an institutional policy directing the National Forests to cooperate in developing and using native plants. However, each National Forest has decision-making autonomy and its own priorities. Forests vary in their approach to native seeds. Region 6 has a national reputation for a well-functioning native plant and genetics program that plays a strong advisory role to the National Forests in its region, which includes developing projections of seed needs in the National Forests as the climate changes, assisting in the collection of seed from the National Forests, and the processing, storage, and planting of seeds and seedlings. The USFS does not have large seed warehouses like the BLM, but in Region 6 there is some ambient storage at the Bend Seed Extractory (in Bend, Oregon), which is a seed cleaning and conditioning facility that extracts conifer seeds from their cones and cleans the smaller, tiny seeds of more than 3,500 other native plant species prior to seed viability testing. The Bend facility is available to clean seed for other public agencies and is the seed cleaning facility of choice for the BLM Seeds of Success (SOS) program.

US Fish and Wildlife Service

The USFWS (within the US Department of the Interior) currently holds title to the chair position of the Federal Committee of the Plant Conservation Alliance and participates in many activities that contribute to the fulfillment of the National Seed Strategy. The USFWS administers the National Wildlife Refuge System, consisting of more than 560 wildlife refuges and administers the Endangered Species Act of 1973. A key regulatory and advisory function of the USFWS is carried out through consultations with public and private entities to moderate activities that might affect threatened and endangered species (TES) of plants and animals.

The Service uses native seeds for conservation activities, such as developing pollinator habitat, and conducting post-wildfire restoration, and invasive species removal in the refuges.
The Service frequently works in partnership with other public and private organizations to carry out its activities related to protecting habitat. It uses voluntary conservation easements on private lands and other tools to assemble conservation areas to unite fragmented habitat and can acquire land and easements through the Land and Conservation Fund, which was recently bolstered with an annual appropriation of $900 million through the Great American Outdoors Act. In addition to wildlife, many native plants are themselves threatened and endangered species (TES). There are 876 plants on the federal TES list that the Service seeks to conserve.

[14] This section was modified to clarify that USFS BPA is being compared to its previously used IDIQ, not the BLM IDIQ.

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Wildfire and Climate Change Threats

Unlike the BLM and USFS, the National Wildlife Refuges are not concentrated in the West but spread across the entirety of the Unites States. More wildfires occur each year in the Midwest and the eastern United States (35,000 in 2021) but at much smaller scale (1.0 million acres) than in the West (23,000 fires, 6.2 million acres) (CRS, 2022). The USFWS reports that 398,000 acres of land under its management burn annually on average, but also notes that a large proportion of the wildlife refuges are fire-adapted, that is, their ecosystems have evolved along with periodic, moderate fires that play a role in habitat regeneration and maintaining a balanced ecology. The Service conducts prescribed fires on many refuges as a fire management tool. It also carries out post-fire, Burned Area Rehabilitation (BAR) Projects on the refuges in partnership with other organizations and volunteers that assist in the production and installation of native plants, seeding, and other rehabilitation activities. One example is the current activity on the Keālia Pond National Wildlife Refuge following the 2019 central Maui fire, in which the USFWS has commissioned a local nursery to produce "1000 native plants per month for the next three years" to be installed by Americorp volunteers on a weekly basis.

Just as wildfire is challenging, so are the daunting and complex impacts of climate change to the National Wildlife Refuges, given the variation and degrees of impact of climate change that will be unique to each refuge. The Service is adopting a Resist-Accept-Transition framework to help it chart a management course, that among other decisions, will affect its habitat restoration and TES decisions, both with implications for native plant seed and materials.

USFWS Partnerships in Support of Native Seed

The total amount of seed and plant materials procured across all the National Wildlife Refuges used for BAR projects or other, non-fire related restoration projects is unknown, in part because the activities are widely distributed. The Department of the Interior (DOI) has received $325 million over five years (2021-2026) to expand BAR activities on lands of all the DOI federal land management agencies.

The USFWS does not have its own seed production or storage facilities but does contract for seed collection on the National Refuges, uses the seed banking capacity of botanical gardens, such as through the Center for Plant Conservation, and collaborates with different nurseries, depending on the project, such as the Southern Highlands Reserve, for the collection and propagation of red spruce.

In 2022, the USFWS announced that $2 million in funds from the 2021 Bipartisan Infrastructure Law (BIL) will help it launch collaborative activities for the collection of native seed following Seeds of Success (SOS) protocols. Notably, in partnership with the Southeastern Grasslands Initiative, the Service will collect and bank seed from across 10 states in the southeastern United States in a new SOS-Southeast program.

National Park Service

The NPS (within the Department of the Interior) manages over 400 individual parks, monuments, and other units with the mission of conserving these natural and historic lands and their wildlife to make these available for future generations. According to NPS Management Policy, Chapter 4, the Parks "will try to maintain all the components and processes of naturally evolving park ecosystems, including the natural abundance, diversity, and genetic and ecological integrity of the plant and animal species native to those ecosystems"[15].

Wildfire Impacts

National Parks in the western United States are increasingly at risk for high-severity fires. In 2020, thirty thousand acres burned in Sequoia and Kings Canyon National Parks, killing more than 7,500

[15] Page 46, NPS Management Policy, see https://www.nps.gov/subjects/policy/upload/MP_2006.pdf.

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sequoia trees, about 10 percent of the sequoias in the Sierra Nevada. The 2021 Dixie Fire, the largest single wildfire in California history, burned almost a million acres, of which 73,240 acres were in Lassen Volcanic National Park. In, 2022 wildfires fires occurred in Yosemite and Yellowstone, and a wildfire of 18,000 acres in New Mexico threatened Bandelier National Monument and Valles Calder National Preserve. Such events are wholesale change to forest management by reintroducing low-level fire into these landscapes.

Native Seed Use

The National Parks use native seed for roadside seeding, revegetation, erosion control, and wildlife habitat. Most seed used in National Parks is collected from the Parks by staff and increased by growers under a BPA. The committee could find no source of information on the total scale of use by the National Parks, which operate as independent units. One estimate was that cost of seed collection and increase at a national park would be approximately $1 million annually, while commercial purchase of native seed will not likely exceed $10,000. Source-identified (SI) seed is preferred, and non-native seed is never used. In some cases, Parks have seed-sharing agreements with surrounding counties. In addition, in the past, National Parks have relied on the Natural Resources Conservation Service's Plant Material Centers (PMCs) for small increases of seed collected from the parks, and for their ability to help growers produce native plants.

Department of Defense

The DOD does not have a direct environmental mission but manages nearly 9 million acres of land in over 440 military installations in the United States (and many more overseas). DOD lands play a significant and perhaps outsized role in maintaining regional and global biodiversity. Many DOD sites contain significant habitats and surviving populations of species in decline or extirpated from other public lands, and over 500 federally listed TES of plants and animals, and at least as many that are considered at-risk, more than on any other federal lands. Additionally, the Army Corps of Engineers maintains more than 600 dams, 12,000 miles of commercially navigable inland waterways and harbors. Much of the Corps' work impacts federal, and all other lands, and contributes to the demands on the native seed supply in ways that are significant to this report but are not specifically quantified here.

The DOD has different internal authorities for the use of native seed on military installations, for example, one for remediating disturbances caused by training activities, and another for natural ecological restoration, thus, the size of projects varies greatly. Natural resource managers at the installations operate under the framework of the Sikes Act[16], passed in 1960, to ensure conservation of fish, wildlife, and natural resources on military lands in the context of ongoing military operations. The Act requires that a collaborative 5-year, Integrated Natural Resource Management Plan (INRMP), be developed between installations and Department of the Interior, typically the USFWS. The INRMP is updated annually and contains a limited number of projects.

Wildfire and Climate Change

The INRMP provides a source of budgetary predictability to the trajectory of restoration activities. However, different sources of funding within DOD are used to address impacts of wildfire, flooding, and other natural disasters each year. Some projects are supported by funds from the USFWS and other agencies. The DOD has developed guidance for its natural resource managers with respect to the incorporation of climate adaptation in the INRMP that incorporates planning, risk assessment, evaluation of implications of options, and adaptive management, including monitoring and adjustment (Stein et al., 2019).

[16] 16 US Code § 670 et seq., as amended.

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Seed Use

Military installations obtain seed in several ways, including purchases from the commercial market and commissioned collections of seed from installations for both direct use and increase. Because the INRMP is a 5-year plan, advance preparations can be made to acquire seed when needed; however, because some military bases are ecologically unique, some seed types are not available on the commercial market. The DOD has one native seed nursery, on O'ahu, Hawaii at the Makua Military Reservation.

DISCUSSION

The collective view of the native seed activities of the five large land-management agencies is that of a diversity of approaches to acquiring and using native seed. One key attribute shared by all the Federal land agencies is the distributed nature of their decision-making structures. The BLM Field Offices, USFS National Forests, USFWS Refuges, each National Park in the NPS, and individual DOD military bases are the units that ultimately determine seed needs and how to respond to them, what species to use, how much to purchase, and how to implement restoration and revegetation. The Federal land agencies also resemble one another in facing several common threats to their natural resource base, in particular the growing frequency and severity of wildfires. Because fires cross jurisdictional boundaries, there is a history of interagency collaboration on projects related to wildfire.

Beyond these similarities, there are also considerable differences among the agencies that are reflected in divergent patterns of procurement and use of native seeds. The USFWS, National Parks, and military bases are focused on activities related to ecological restoration, are generally oriented toward the use of genetically appropriate native seed and pursue their needs on a project-by-project basis. These agencies appear to have the leeway to seek native seed proactively, or at least to have a longer planning horizon for obtaining the specific native seeds needed for their projects. The INRMP process used by military installations is an example; one of its key features is a strong role for scientific guidance, in that military bases are required to have the oversight of the USFWS on their seed choices. The partnership of the USFWS with local nurseries to provide plants and volunteer organizations to conduct restoration activities also suggest that such projects are implemented through relationship building over time.

In contrast, the two large multiple-use land agencies, USFS and BLM, are concerned with ensuring a supply of seed for a variety of needs. The USFS, with its history of forest commodity production, has developed in-house capacity to meet its own needs for plant materials for ecological restoration (as well as for reforestation) in at least in some regions. It is also committed as an agency to ecosystem-based management and has a hard requirement rather than a soft guideline to use genetically appropriate native species in restoration, so the use of non-natives and cultivars in USFS is minimal. Burned forests are allowed to regenerate naturally in many cases.

The BLM is committed to a wider range of land uses than USFS, with a greater emphasis on livestock grazing, energy and mineral production, recreation, and other uses, in addition to wildlife conservation and other ecosystem-based activities. Because the BLM manages enormous areas of sagebrush, where novel large wildfires made possible by the introduction of cheatgrass are threatening irreversible loss of habitat for sage- grouse and other wildlife, the BLM faces a tremendous need to implement postfire restoration to protect endangered animal species. However, ecological restoration activities within BLM are generally highly intertwined in practice with other activities such as improving forage for livestock. There are no programs within the BLM dedicated to ecological restoration as the primary goal, as opposed to being an aspect of programs dedicated to other uses of the land. The expert advisory function is also weakest within the BLM; for example, some of its field units and State offices have restoration ecologists, but many do not.

It is very difficult to get a clear picture of the extent of ecological restoration that is pursued by each agency on an acreage basis. The Burned Area Rehabilitation (BAR) program offers the opportunity to pursue plant community restoration a year or more after a fire, but it is not clear how much restoration

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has been supported (recognizing that BAR funds have been very limited until they were recently increased through the Bipartisan Infrastructure Law.).

Finally, although each of the agencies are working toward building the stocks of native plant seed for their respective needs, their activities do not clearly relate to the methodical fulfillment of the plan put forth to Congress in 2002 to provide for a native plant supply to meet emergency stabilization and longer-term rehabilitation.

FINDINGS FROM SEMI-STRUCTURED INTERVIEWS

This summary of the seed needs of federal land-management agencies is a high-level overview of the current and potential magnitude of native seed uses, and reveals, in part, the directions in which the agencies, or parts of them, are moving with respect to native seed use and capacities. To broaden its understanding of the decision-making process of the agencies, the committee wanted to obtain the bottom-up perspective of agency staff who carry out activities related to native seed use, native seed and plant materials development, research, restoration, and other work.

The Committee used a series of semi-structured interviews of personnel from the five major federal agencies that make direct seed purchases. Each respondent talked about the specifics of typical projects involving the use of native seed. This information helped inform the Committee's understanding of the process, and the diversity of paths used in developing and funding a project, selecting and obtaining native seeds for use in that project, and understanding whether the project goals were met. In this section we provide a summary of key topics raised in those interviews. Appendix 2A contains the protocol for the interviews.

These semi-structured interviews of staff from five federal agencies used a somewhat similar line of questions to those asked in the survey of state agency personnel (see Chapter 4). This proved to be difficult to administer because of the widely divergent roles of federal agency staff, which ranged from researchers to natural resource specialists, with many job titles and work locations. The interviews did provide insights about projects within these agencies including the approval process and contracting methods used in purchasing seed, how the seed supplier was identified and selected, and whether the projects had follow-on activities to monitor survival. However, it is important to stress that this process looked at a snapshot of projects with a relatively small number of participants in federal native seed activities and is not considered comprehensive and conclusions should not be drawn to reflect opinions across these agencies.

A list of possible uses of native seeds (Table 3-3) was read to agency staff. They were asked if they had used native seed for any of those purposes in their work.

TABLE 3-3 BLM, NPS, USFWS, USFS, and DOD Uses of Native Seeds (2017-2019)

Purpose of use
Creation or restoration of wildlife habitat (other than pollinator habitat)
Pollinator habitat projects
Stream erosion mitigation or restoration
Restorative activity on land in a wilderness or natural area
Soil protection
Invasive species suppression
Roadside seeding
Landscaping
Green infrastructure
Roadside maintenance
Natural disaster recovery
Rangeland grazing
Energy development remediation
Green strips (vegetative fuel breaks)

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From the list given to them, no respondent identified green infrastructure as an activity for which native seed was used. But for all other purposes, native seed was used. However, the committee notes that the Army Corps of Engineers, which is increasingly focusing on mitigating the impacts of climate change, stages many projects on and off federal lands that include at least a component of green infrastructure; for many of these efforts, native plant materials are required (Windhoffer et al., 2022). Agency staff noted that leaseholders of grazing permits on federal land were responsible for carrying out agency management prescriptions, which may include seeding activities, with a list of approved plants. It was also pointed out by some respondents that restoration, as a matter of their agency's policy, is conducted on natural areas but not in the wilderness.

When asked for the most common application for using native seeds, the answers included:

- rehabilitation to prevent soil erosion and non-native grass incursion
- wildlife habitat restoration of invaded habitats, pollinator habitat restoration
- range improvement and rehabilitation
- natural disaster recovery including post wildfire restoration
- restoration after disturbance (construction projects, military drills, etc.)
- stream restoration for native salmon
- reforestation

The typical sizes of projects mentioned ranged from one acre to tens of thousands of acres. The amount of funds spent annually ranged from "no more than $5,000" to more than $1,000,000, which included the cost of seed. Most respondents did not have a good estimate for the amount they spent on seed annually. Topics that arose during various interviews with agency personnel, and some of their observation, can be summarized as follows:

- The populations of native plant communities on land under agency control are important as a supply of seeds for future restoration needs.
- There appears to be a lack of interest by some decision-makers in the agencies to pursue ecological restoration relative to other priorities.
- There is a benefit to having a planning horizon of 3 to 5 years, which enables seed to be acquired (or wild collected and increased) and projects implemented according to plans. This allows the ability to anticipate and budget for seed needs annually.
- The typical duration of monitoring the outcome of seeding projects was 2-3 years, though experimental projects (which tended to be smaller in scale) are monitored indefinitely.
- Success in restoration and rehabilitation projects was frequently defined as the amount of "coverage" resulting from the seeding, but this metric may not capture the progressive structure of successful native plant restoration.
- Funding obtained from multiple sources, including grants, funds from the USFWS, and Pollinator Pathways and other sources enable projects that would not happen otherwise. There is no shortage of projects that needed native seed if funding could be found.
- Cooperative efforts exist among botanists, as a group, to prioritize, collect and develop supplies of seed of non-workhorse species on an annual basis.
- There is a need for more wild collections and increases of native seed to bring more species into use for restoration projects.
- There are labor shortages throughout the agencies, in nurseries, as scouts, and in all manner of fieldwork.
- There is a need for expertise in botany and ecology to inform seed selection and restoration success in different applications. Sources of expertise include the USFWS, PMCs, University extension, and seed producers. Botanists are not equally distributed in all units and regions of the individual agencies.

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- There is a need for growers specializing in native plant production for specific environments (e.g., high altitudes or arid) and a need for more growers generally.
- There is a need for more long-term monitoring of restoration efforts to better assess the performance of various natives.
- The performance of natives is not consistent, nor is it *de facto* accepted as superior by everyone.
- There is some ambiguity about the definition of "local" when purchasing seed from the commercial market. Not all seed purchased is certified Source-Identified.

DISCUSSION

The personnel interviewed for this chapter generally expressed satisfaction in the outcome of their seeding projects. Although not necessarily reflective of all personnel in the land-management agencies, many of the interviewees described, as a natural part of their work, how they pieced together different sources of funds to pursue their projects—funds from different authorities within their agencies, funds from other agencies, and funds from external partners, which supported the committee's perception of the lack of dedicated program funding for ecological restoration of native plant communities. The committee observed that native plant communities are the source of seed that underpin many of the activities for which public land is managed, from wildlife habitat creation to oil and gas well pad rehabilitation—and that a central function of land management should elevate the protection and restoration of plant communities.

The committee heard from advocacy groups who commented on BLM challenges in meeting seed needs for restoration. Representatives from Defenders of Wildlife said that there is no single institutional unit that has a budgetary mandate and responsibility for undertaking plant conservation and restoration in BLM, which leads to inadequate long-term planning and accountability for outcomes of seed projects. Advocates from the Western Watersheds Coalition added the need for stronger policy direction to preserve seed sources, perhaps using the Areas of Critical Environmental Concern designation. These speakers described USFS as being more effective in restoration than BLM and attributed this to USFS' adoption of a strong ecosystem management paradigm.

Staff from some but not all agencies pointed out difference in attitudes among decision-makers about native seeds, which were attributed to reliance on past practices, or strongly held ideas of what works and what does not, and, with limited funds and time, no inclination to change. All noted that there was much more to be done than funds available. Despite many challenges, agency personnel were optimistic given new federal legislation related to the conservation, restoration, and reforestation of public lands. The personnel interviewed expressed both dedication to land management and concern for the natural resources on public land.

CONCLUSIONS

Conclusion 3-1: *The federal government is a major user of native seed, and its uses of native seed have many purposes along the continuum from restoration to rehabilitation and revegetation. Approaches to seed acquisition differ among federal agencies, and these are focused on providing for immediate needs.*

Conclusion 3-2: *The federal land-management agencies are not prepared to provide the native seed necessary to respond to the increasing frequency and severity of wildfire and impacts of climate change. If this challenge is to be met, the agencies will need to move quickly toward an expanded, proactive effort to develop a supply of native seeds for emergency stabilization and long-term ecological restoration.*

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Conclusion 3-3: *Existing native plant communities on public lands that are managed for multiple uses are an essential resource for developing a native seed supply, but those plant communities are at risk, and their conservation has not been a priority relative to other uses.*

Conclusion 3-4: *Developing reliable seed supplies for ecological restoration is an achievable goal for large Federal agencies, but one that demands substantial institutional commitment to elevating restoration to a high-priority objective, cultivating and empowering ecological expertise to inform their decision-making, and creating sustainable funding streams for restoration that support agency personnel to carry out planning, successful implementation, and learning from experience.*

REFERENCES

Bower, A.D., J.B.S. Clair, and V. Erickson. 2014. Generalized provisional seed zones for native plants. Ecological Applications 24(5):913-919.

Breed, M., M. Stead, K. Ottewell, M. Gardner, and A. Lowe. 2013. Which provenance and where? Seed sourcing strategies for revegetation in a changing environment. Conserv Genet 14: 1-10. Conservation Genetics 14:1-10.

BLM, Bureau of Land Management. 2008. Integrated Vegetation Management Handbook H-1740-2. https://www.blm.gov/sites/blm.gov/files/uploads/Media_Library_BLM_Policy_Handbook_H-1740-2.pdf (Accessed January 20, 2022).

Malaval, S., B. Lauga, C. Regnault-Roger, and G. Largier. 2010. Combined definition of seed transfer guidelines for ecological restoration in the French Pyrenees. Applied Vegetation Science, 13(1), 113–124. http://www.jstor.org/stable/40928281.

Omernik, J.M. 1987. Ecoregions of the Conterminous United States. Annals of the Association of American Geographers, 77:1, 118-125, doi:10.1111/j.1467-8306.1987.tb00149.x.

Smith, F., J. Pierre, M. Young, and D. Devitt. 2020. Estimation of Future Native Grass Seed Demand for Restoring Oil and Gas-Energy Sprawl in West Texas, USA. Ecological Restoration 38:237-245.

Stein, B.A., D.M. Lawson, P. Glick, C.M. Wolf, and C. Enquist. 2019. Climate Adaptation for DoD Natural Resource Managers: A Guide to Incorporating Climate Considerations into Integrated Natural Resource Management Plans. Washington, D.C.: National Wildlife Federation.

Windhoffer, E., S. Hughes, T. Hughes, A. Grismore, A. Littman, A. Haertling, and J.R. Fischbach. 2022. Consideration of Nature-Based Solutions in USACE Planning Studies. The Water Institute of the Gulf. Funded by the US Army Corps of Engineers Engineer Research and Development Center, Vicksburg, MS.

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4

State Government Uses of Native Seed

INTRODUCTION

In the first phase of the assessment leading up to its interim report, the committee heard that native seed shortages in the commercial market were caused by agencies such as the Bureau of Land Management (BLM) buying up all the available seed after wildfires. It put forward the hypothesis that the seed market in the West was strongly affected by decision-making of the BLM and the US Forest Service, and wanted to know if state governments, which also purchase native seed for land-management activities, were experiencing shortages, and if so, whether this phenomenon was limited to the western states or was more widespread.

The committee felt that a survey of state departments that use native seed or plant materials might shed light on some of the committee's other preliminary observations about native seed needs, such as how the timeframe in which seeds are needed and the objectives of users affect availability, among other factors (Box 1-2). The committee felt that a perspective from state governments would provide another lens with which to assess how well the native seed supply functions across the nation. This chapter presents the survey findings.

Chapter 2 describes the survey methodology. The committee sent surveys to an average of three government departments in each state likely to use native plant seed and plant materials (to include seedlings, mature plants, and other vegetative materials). As indicated in Chapter 2, this was not a comprehensive list of all state government departments in the United States, so the results cannot be generalized to all such departments. These responses reflect the opinions of the sample that was generated by National Academies of Sciences, Engineering, and Medicine staff based on an internet search of state government webpages to identify those with responsibilities related to land management, fish and wildlife habitat, parks and recreation, roadside vegetation and maintenance, and natural heritage conservation. The departmental staff who responded to the survey were asked to answer questions about the use of seed in the department's work. The staff was also asked about their individual roles related to their department's purchase or use of seed, including project planning, providing biological expertise, purchasing or contracting, project management, or fieldwork (such as site preparation, seeding, and monitoring). Figure 4-1 shows that at least three out of four respondents were involved in planning, advisory, and management roles, while slightly fewer than three out of four were involved in purchasing or fieldwork. The spread across areas shows many respondents appear to have played multiple roles.

Native and Non-native Seed Use

Most state departments surveyed use both native and non-native seeds and plant materials (other than seed) in their projects. Almost 95% of respondents to the committee's survey indicated that their department uses native seed or native plants, while three-quarters (74%) of the departments use non-native seed and two-thirds (65%) use non-native plants. About one-fourth of the departments who responded to the survey do not use non-native seed at all and more than a third do not use non-native plants (Figure 4-2).

Most of the survey questions focused on issues related to the use of native seed and plants. To provide a consistent reference timeframe, respondents were asked to focus on projects carried out by between 2017 and 2019.

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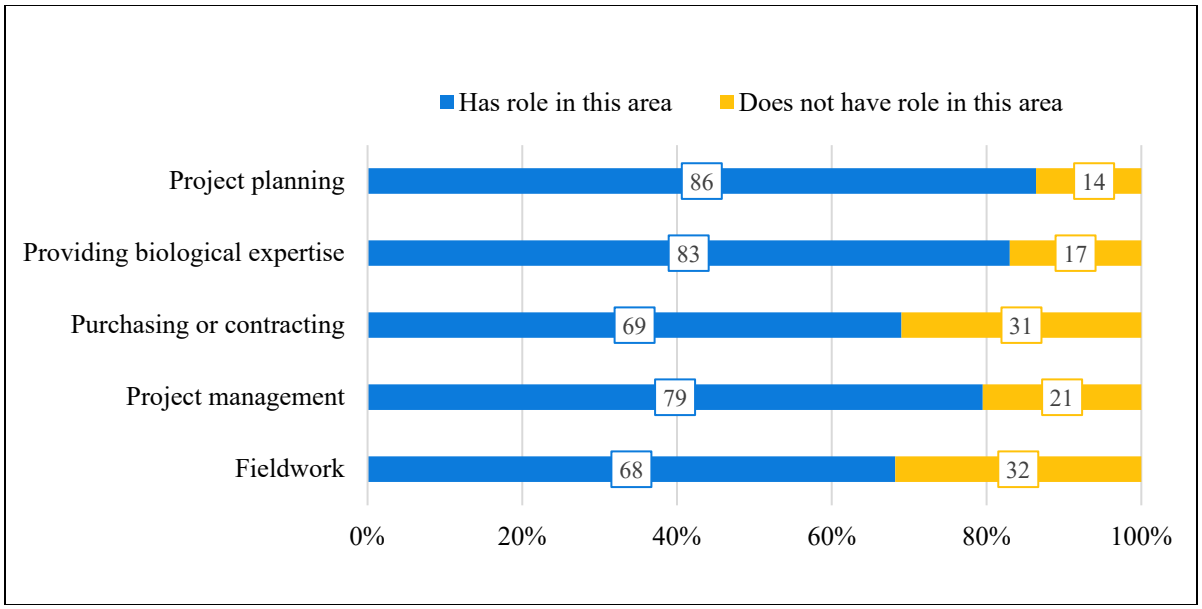


FIGURE 4-1 State survey respondents' role related to the purchase and use of seed and plants, by project area.

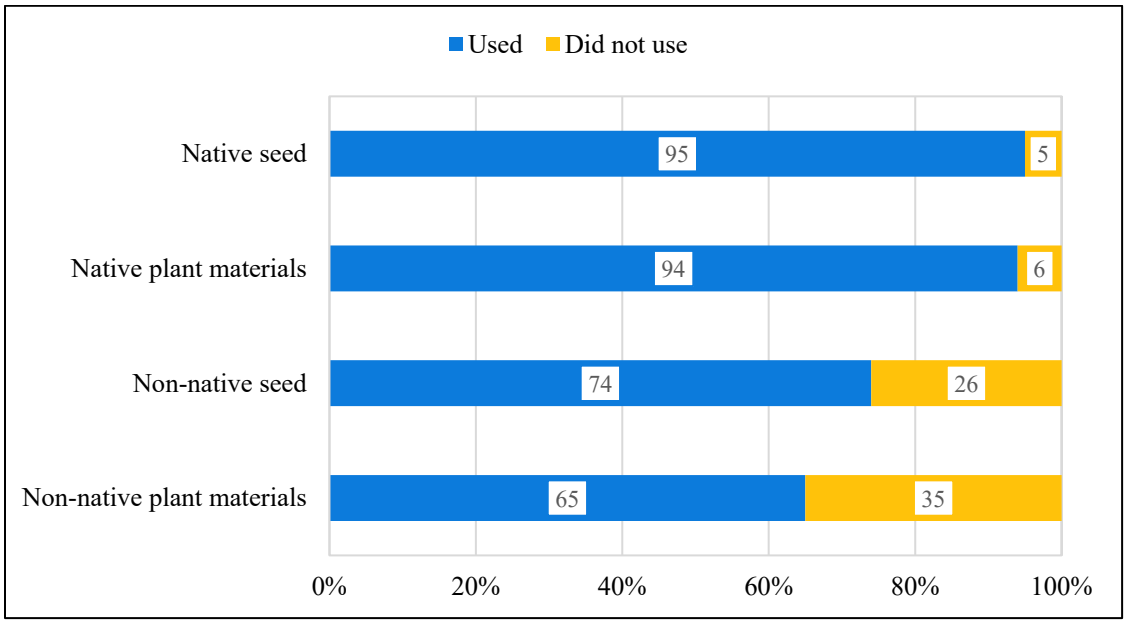


FIGURE 4-2 State departments' use of native and non-native seed and plant materials.

For example, the survey provided a list of purposes and asked if the department used native seed or plant materials for any of these purposes between 2017-2019 (Table 4-1). Appendix 2C shows the exact wording of all of the questions.

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TABLE 4-1 State Departments' Use of Native Seed or Plant Materials for Specific Purposes

Purpose of use	Percent of departments
Creation or restoration of wildlife habitat (other than pollinator habitat)	87
Pollinator habitat projects	83
Stream erosion mitigation or restoration	80
Restorative activity on land in a wilderness or natural area	75
Soil protection	72
Invasive species suppression	59
Roadside seeding	67
Landscaping	61
"Green" infrastructure	49
Roadside maintenance	47
Natural disaster recovery	37
Another purpose	31

When asked about "another purpose" for uses of native seed or plant material, topics mentioned included: public education/giveaways, used to restore riparian and wet meadows, provided to producers for seed increase, coastal zone protection, forest management, screening, and the sale of native tree and shrub seedlings for conservation. The survey did not ask if non-native seed or plants were used for these same purposes. When asked if their states have programs to assist private landowners with the use of native seed or plant materials, about half (46%) of the state respondents indicated that they did.

Where do Departments Obtain Seeds and Plant Materials?

Nearly all the state departmental respondents (96%) who were asked the question said that commercial suppliers are among the sources their department uses to buy native seed or plant materials. Approximately two out of three (63%) said that they obtained native seed or plant materials from project collaborators, and half (49%) said that they collect or grow their own (Figure 4-3).

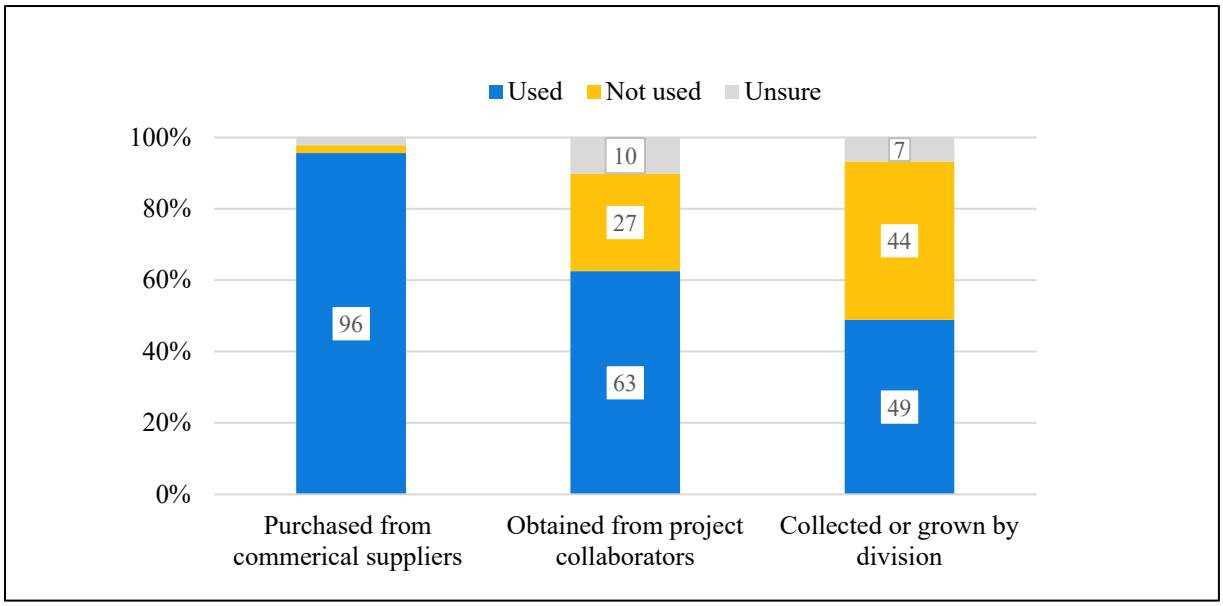


FIGURE 4-3 State departments' sources of native seed and plant materials.

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Collection of Native Seed from State Land and How the Collected Seed Was Used

Figure 4-4 shows that just under half (44%) of the respondents said that the native seed they used between 2017-2019 included seed that was wild collected on state land (29% were unsure of whether the seed used had been collected on state land). Of those respondents who responded that wild seed was collected on state land, 92% said that at least some of the seed was used to plant directly at a project site, and 79% said that at least some of the seed was used to grow plants with the purpose of harvesting seed or plant materials for future use.

When asked about "Other" uses of wild collected seeds from state land, the answers included: harvested and given out to landowners, grown into seedlings for sale to residents, frozen for storage or given to seed banks for future use, and used for projects on partner lands.

Ambient, Refrigerated, and Frozen Storage

Respondents were asked about the availability to their departments of different types of seed storage. Sixty-four percent said they had ambient storage space, 28% had refrigerated storage, and 16% had freezer storage of some kind. (13% were unsure about whether they had refrigerated storage and 15% were unsure about freezer storage).

Sources of Information about Native Seed and Plant Materials Availability

Respondents were given a series of questions asking whether a given option is used as a source of information to find out about the availability of native seed and plant materials. The options included in-house knowledge, advertising (about needs), preapproved vendors, or requests for proposals. Figure 4-5 shows that 98% of departments rely on in-house knowledge to find the seed and plant materials. Preapproved vendors and Requests for Proposals are used by most departments, while advertising is the least common method.

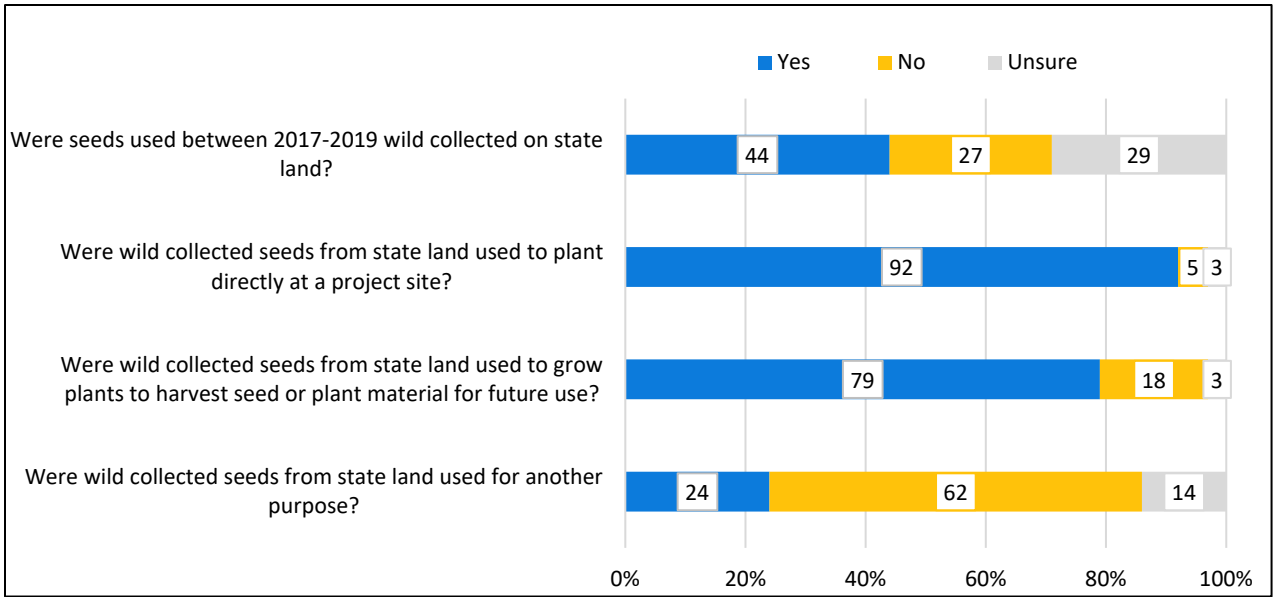


FIGURE 4-4 State departments' use of wild collected seed from state land.

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State Government Uses of Native Seed

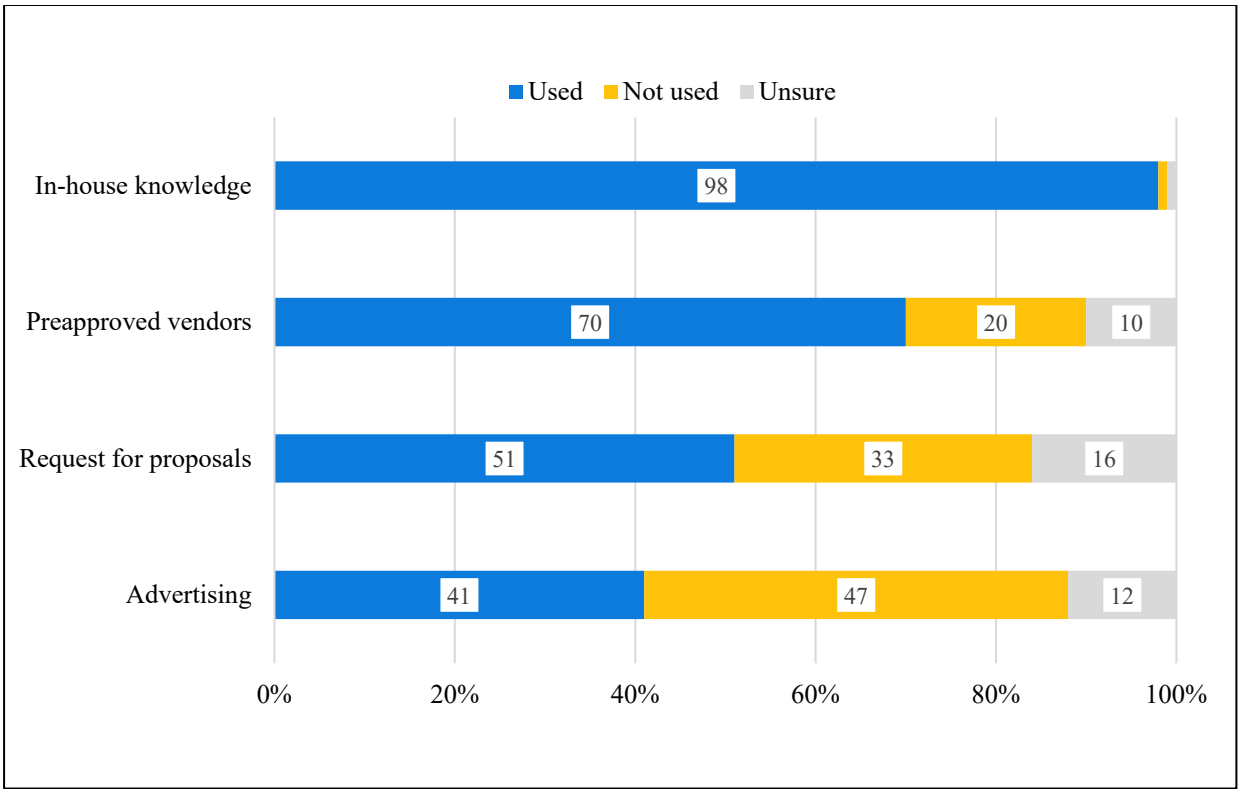


FIGURE 4-5 Sources of information used by state departments to learn about native seed and plant material availability.

Departmental representatives were asked if there were other sources of information used to obtain information about native seed and plant materials availability. Responses included: direct calls to vendors, annual meetings with registered suppliers, online vendor postings, other state departments, state crop associations, state university extension offices, native plant databases, BLM seed buys, and state seed bank.

Relationships with Suppliers

How Seeds Are Obtained from Commercial Suppliers

Among those who said that their departments bought native seed or plant materials from commercial suppliers, 81% of the respondents said that this involved purchases directly on the open market, and 66% said that purchases were made via a formal bidding process. To gain a sense of the differences between eastern and western states, the responses were compared by region. As described in Chapter 2, the survey included a relatively small number of departments, and therefore the comparisons by region should be interpreted with caution.[1] Figure 4-6 shows that in the eastern states, a larger percentage of departments appear to use purchases from the open market (87%) as compared to 69% in the western states. In addition, 63% of respondents located in the eastern states said that they use the bidding processes while this value was 70% in the western states.

[1]East includes AL, AR, CT, DE, FL, GA, IA, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, NC, ND, NE, NH, NJ, NY, OH, OK, PA, RI, SC, SD, TN, TX, VA, VT, WI, WV; West includes AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY.

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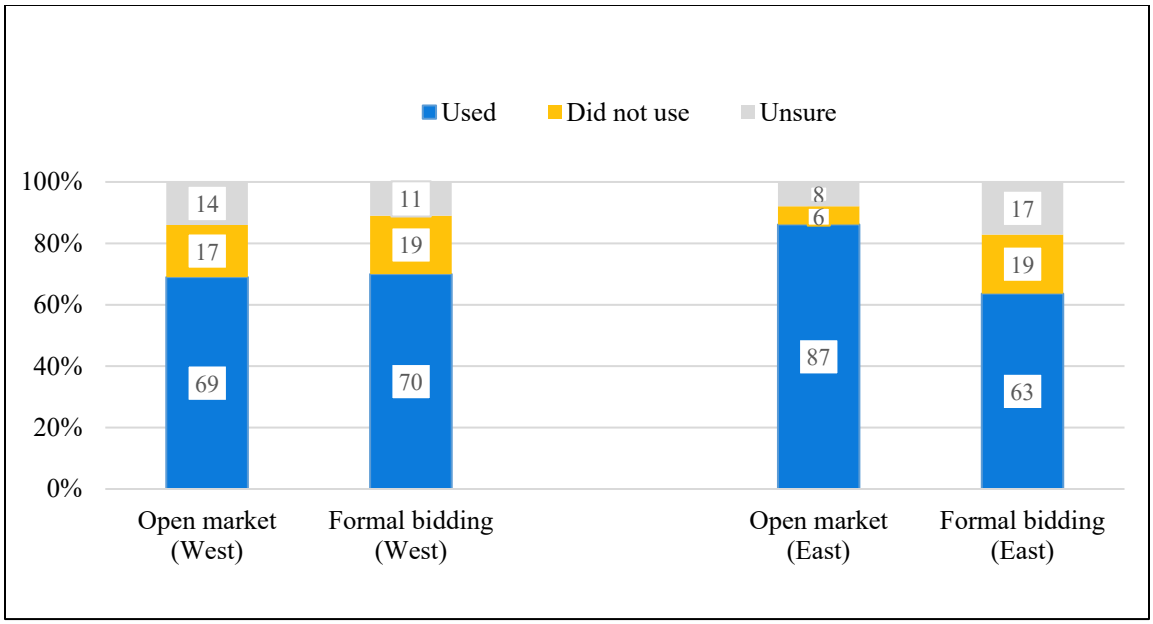


FIGURE 4-6 State departments' use of open market and formal bidding when purchasing native seed or plant materials from commercial suppliers, by region.

Marketing Contract and Production Contracts

Respondents were asked about contracting arrangements, and specifically whether their department used marketing and/or production contracts to procure seeds from suppliers. Marketing contracts specify the type, price, quantity, and delivery date of seed or plant materials. By contrast, production contracts specify the desired type, quantity and delivery date of native seed and plant materials, while mitigating production risk by sharing some production costs or by providing flexibility on the quantity delivered and/or the delivery date. They may or may not specify a price. Only 22% of departments said that they used production contracts, compared with 39% who used marketing contracts (Figure 4-7). Marketing contracts may offer more certainty to buyers and sellers, but production contracts might be used to encourage growers to take on the production of a difficult to grow species. About 18% of state respondents were unsure if marketing contracts were used and about 25% were unsure if production contracts were used. This is consistent with the variety of different positions and responsibilities held by respondents who may lack individual knowledge about the purchasing process.

Timing of Contracts Relative to Production

Two out of five respondents from the state departments were unsure about whether the contracts are established before or after the supplier begins the seed production process. Thirty-seven percent said that the contract was usually established before the supplier begins the seed production process, and 24% said that it was after (Table 4-2).

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State Government Uses of Native Seed

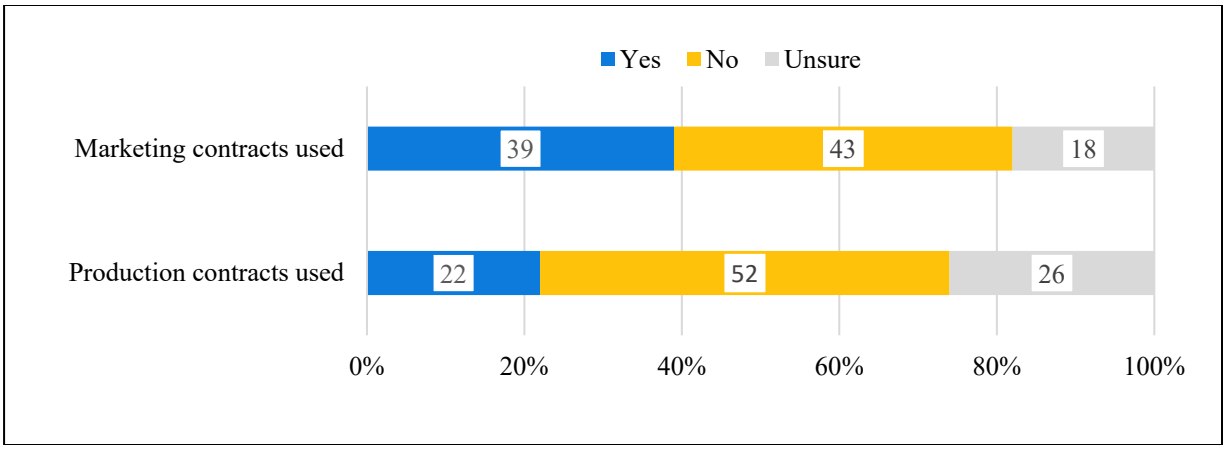


FIGURE 4-7 State departments' use of marketing and production contracts.

TABLE 4-2 Timing of When State Departments Usually Establish a Contract with Seed Suppliers

Contract is usually established	Percent of departments
Before the supplier begins seed production	37
After the supplier begins seed production	24
Unsure of timing of contract	39
Total	100

Communicating Future Seed Needs to Suppliers

No single method dominated the state departments' methods of communicating their anticipated future needs to suppliers. Approximately half of the respondents mentioned word of mouth (55%), requests for proposals (49%), conferences or other professional meetings (49%), and informal meetings with growers (45%).

Importance of Seed Attributes

Departmental representatives were asked to reflect on projects between 2017-2019 and to indicate how important it was to obtain seed with the following attributes: native seed; native seed sourced from a specific geographical location or seed zone; and certified native seed. Nearly all departments nationwide indicated that native seed was very important or somewhat important. As Figure 4-8 shows, a higher proportion of departments in western states indicated that native seed was very important (90%) relative to departments in eastern states (79%). Departments in western states were also more likely to view native seed sourced from a specific geographical location or seed zone as very important (57%) relative to eastern states (46%). The responses with respect to certified seed were similar across the country, 42% of departments from East and 43% of departments from the West indicated that certified native seed was very important.

Responses were also compared based on the departments' average annual expenditures on native seed and plant materials. Similar to the geographic comparisons, the comparisons by the level of expenditure should be interpreted with caution due to the small sample size. In addition, approximately 10% of the state respondents were unable to provide an estimate of the amount their department spends on native seed and plant materials, and some respondents skipped this question.

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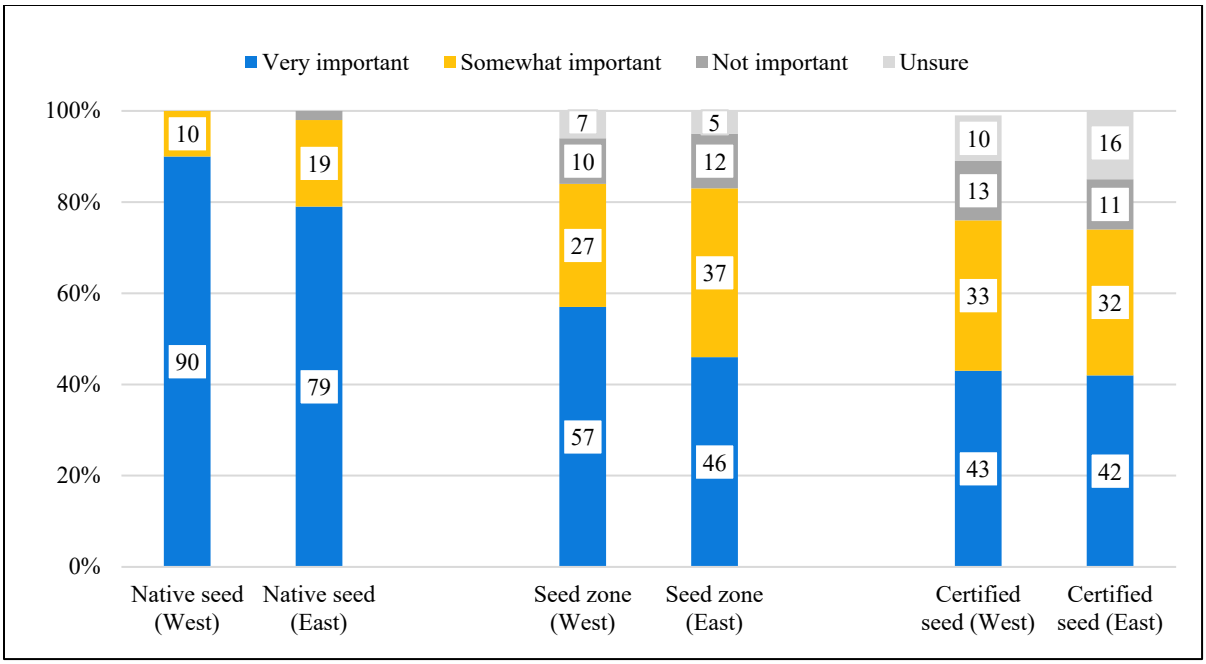


FIGURE 4-8 Importance of certain seed attributes to state departments, by region.

When responses were examined relative to the level of departments' annual expenditures on native seed and plant materials, those with larger annual expenditures (over $100,000) were generally somewhat more likely than those with small annual expenditures ($100,000 and under) to indicate that each of the three seed attributes were very important. Figure 4-9 shows that certified seed was very important to departments with larger expenditures (54%) relative to departments with smaller expenditures (31%).

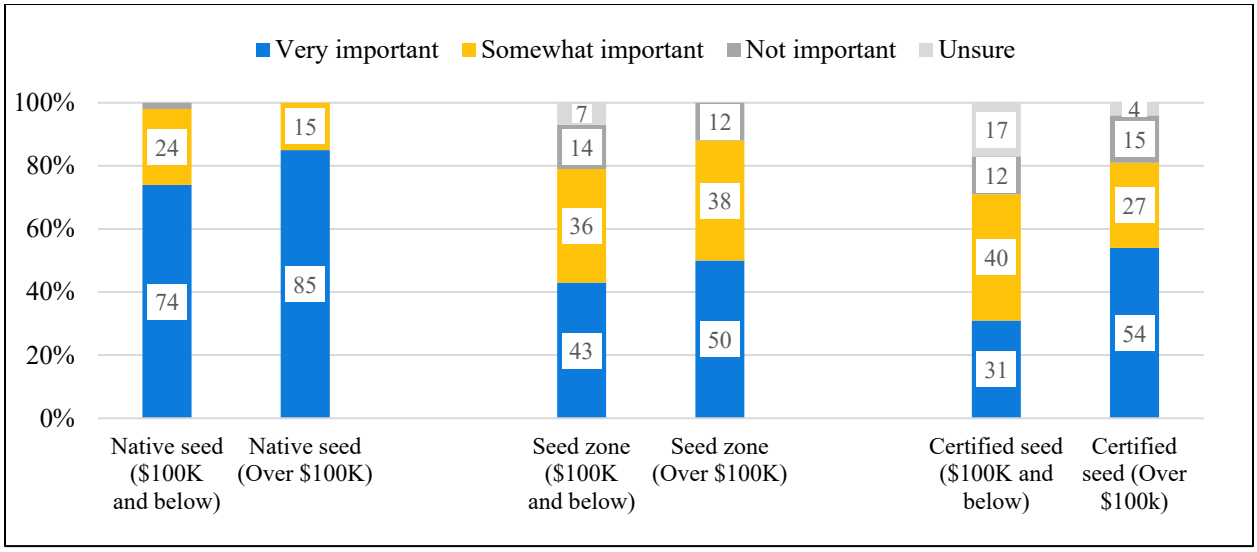


FIGURE 4-9 Importance of certain seed attributes to state departments, by annual seed expenditures.

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In general, the results show that using native seed was more important to states than using native seed sourced from a specific geographic location or certified seed (in which the geographic source of the originally collected seed was verified by a certification agency, along with the genetic integrity of subsequent generations of increase. Seed certification is not required for the sale of seed (in contrast to seed viability analysis, see Chapter 8), but it is sometimes required by buyers. The cost of certified seed is a little more than non-certified seed because of the fee associated with certification.

Departments were asked to list other characteristics of seed obtained during 2017-2019 that were important. Table 4-3 is a summary of responses received.

TABLE 4-3 Other Seed Attributes Specified as Important by State Departments

Desired attributes	Number of Responses
Genetic appropriateness	7
Weed-free	6
% Purity	6
High germination rate	6
Prior track record	6
Other	6
Cost	5
Total	42

Attributes mentioned related to basic market conditions included cost (5), quantity (2), and availability (2). Cost corresponds to price (cost per unit), or price multiplied by quantity (total cost). Many other attributes mentioned regard quality dimensions that are independent (or potentially independent) of source specificity, e.g., weed-free, with genetically appropriate mentioned most often.

Seed Substitutions

State representatives were asked questions about how often their departments substituted other kinds of seed or plant materials when their preferred native seed or plant material was unavailable, specifically substituted with non-native seed or plant material, native seed or plant material of another species, or native seed or plant material from a different geographic region. In some cases, the responses to different kind of substitutions varied regionally or according to the level of a department's annual seed expenditures. Figure 4-10 shows how departmental representatives across all states answered these questions.

Substituting Non-Natives for Natives

The responses of state representatives, asked how often their departments substitute non-native seed or plant materials when native seed or plants are unavailable, was examined by region and by the level of annual expenditures of a state department ($100,000 and below, or over $100,000). The responses were similar by region and size and the overall national numbers. About a quarter (24%) of departments frequently substitute with non-natives, and about half said that they substitute non-natives infrequently. A quarter (24%) indicated that their agency never substitutes non-natives for natives, even if natives are unavailable.

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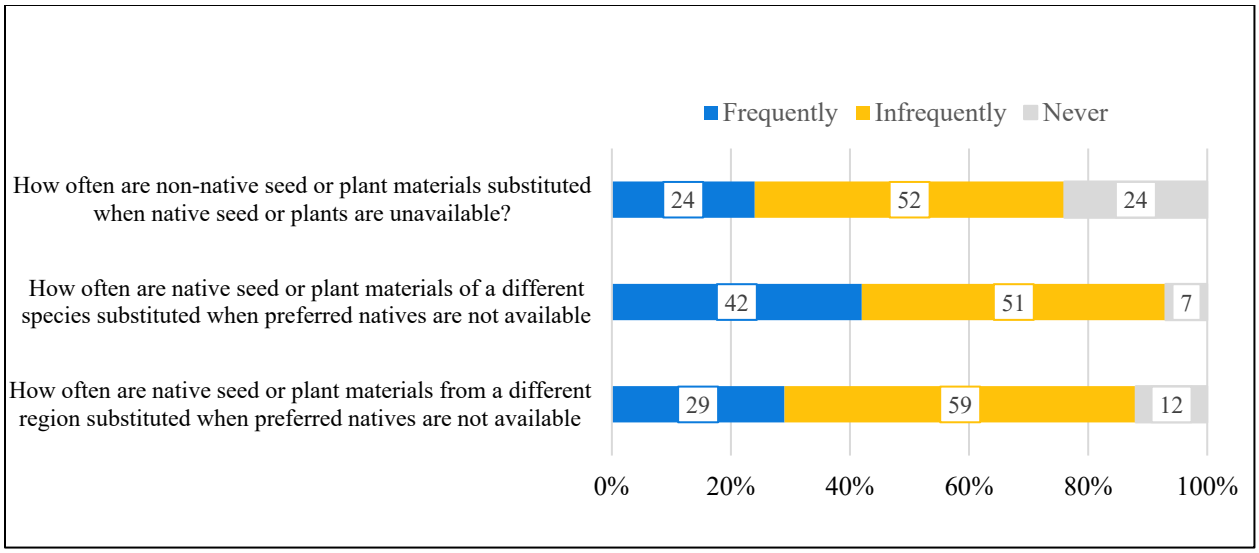


FIGURE 4-10 Frequency of substitution when preferred native seeds and plants materials are unavailable.

Respondents from those departments that said that they substituted non-native seed or plant materials (either frequently or infrequently) were asked about several potential reasons for the substitutions: native seed or plant material were available but too expensive; native seed or plant material were available but not within the timeline needed; and native seed or plant material were unavailable regardless of price and timing. Figure 4-11 shows the agency responses overall. The most commonly cited reason by state departments overall (58%) was that native seed or plant material were unavailable regardless of price and timing. The second most cited reason was that preferred natives were available but too expensive (43%). Timing considerations were cited by 34%. Approximately two out of five respondents cited at least two of these three market-related reasons, and a fifth of respondents cited all three reasons, meaning that they cited price and timing reasons as well as "unavailable regardless of price and timing." One potential explanation for this finding is that some native seed species were entirely unavailable, while others were available but costly or at the wrong time.

Figure 4-12 shows responses by region to the questions about reasons for substitution with non-natives. Departments in western states found cost, availability, or both to force a substituting with non-natives 50-70% of the time, versus 26-52% in the East. Notably, 70% of departments in the West encountered situations when native seed or plant material were unavailable regardless of price and or in the timeframe needed.

Other Reasons for Substituting with Non-natives

In an open-ended question, state staff were also asked if there were other reasons besides the three offered by the survey that explain why non-native seeds and plant materials were substituted when preferred natives are not available. Table 4-4 provides a summary of the reasons given, grouped into categories.

Substituting with Natives of a Different Species or from a Different Region

When preferred native seed or plants are not available, departments sometimes substitute with native seed or plant materials having different characteristics. As shown in Figure 4-13, 42% of the respondents stated that they frequently substitute with native seed or plant material of different species,

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and this was similar for eastern and western states. When the responses were examined by the level of annual expenditure on seeding projects, 50% of state departments with $100K or more in expenditures indicated that they frequently substitute with natives of different species versus 36% of departments with expenditures of $100K or below. This suggests that those departments with larger projects may have more difficulty getting the quantity of natives they need.

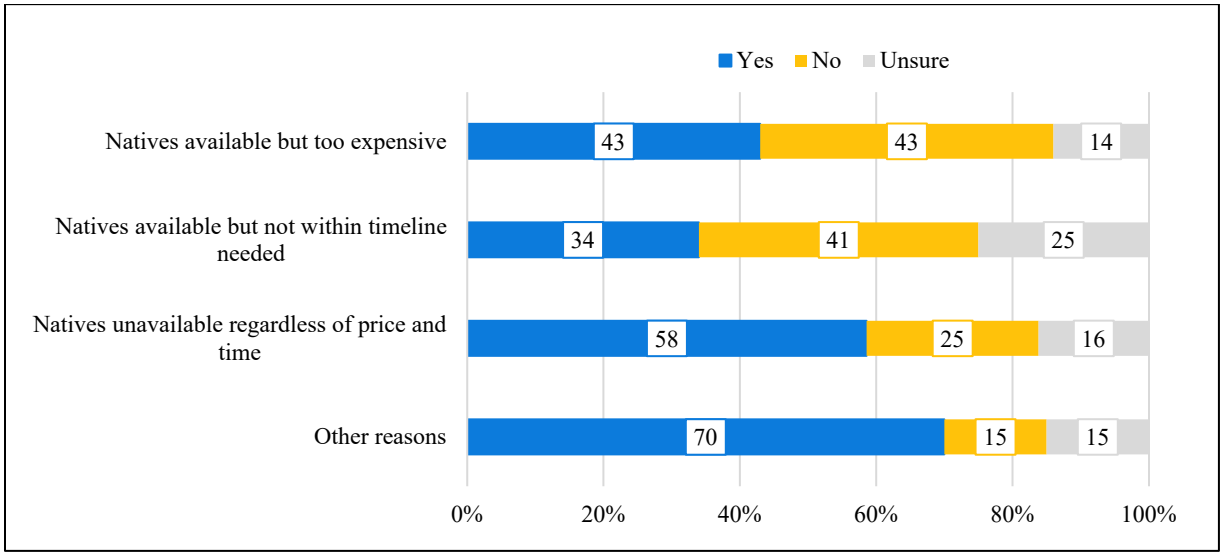


FIGURE 4-11 Typical reasons for substituting with non-natives.

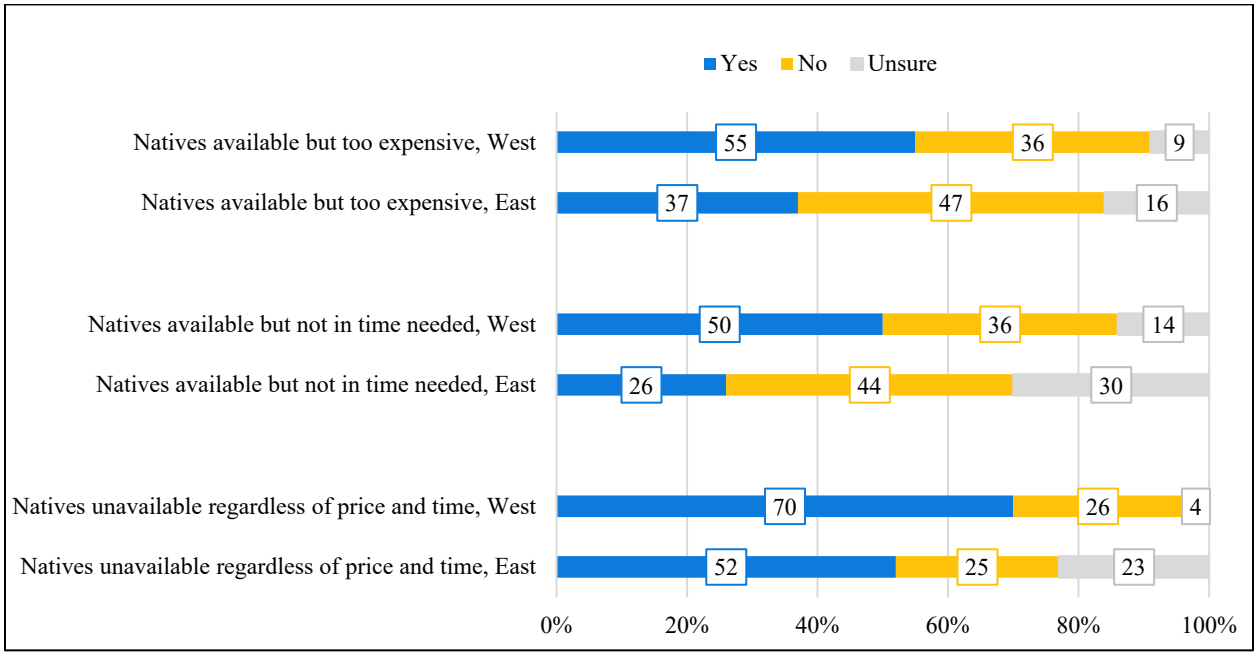


FIGURE 4-12 Typical reasons for substituting with non-natives, by region.

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TABLE 4-4 Other Reasons Provided by State Departments for Substituting Non-Natives for Preferred Natives

Reason for substitution (categories)	Description of the types of reasons given in each category	Number of responses
Effectiveness	Non-native seed or plant materials are associated with better performance with respect to areas prone to erosion, such as near infrastructure or buildings, on steep slopes, for soil stabilization. Non-natives are associated with a stronger ability to compete with invasive species. Non-natives meet requirements to provide a % ground cover. Better performance of mixtures.	10
Specific purpose	Non-native seeds and plants are specifically selected for ornamental and fruit trees, landscaping, and agricultural plantings, and for wildlife food/forage.	7
Preference for non-natives	Land manager discretion, preference, previous experience, lack of knowledge of natives, lack of options	6
Other	Seed offered was not certified, insufficient quantities available, poor seed quality/viability, lack of ecoregional genotypes, no inexpensive native forbs	5
Total		28

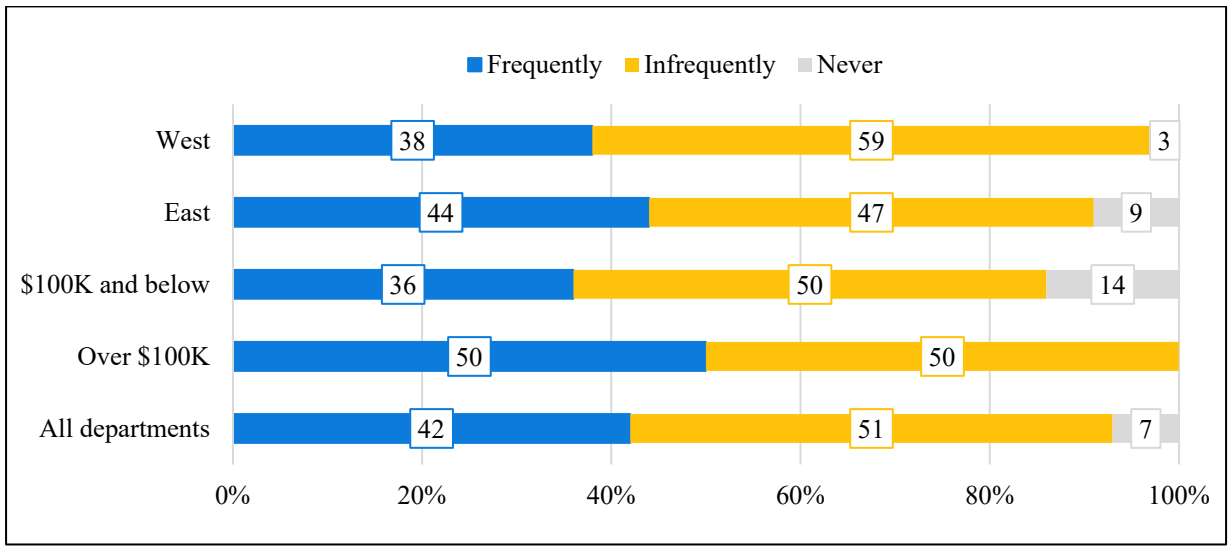


FIGURE 4-13 Substitution with natives of different species when preferred natives are unavailable, by region and annual seed expenditures.

As shown in Figure 4-14, 29% of state representatives responding to the survey indicated that their departments frequently substitute with native seed or plant materials from a different geographical source location when their preferred native seed or plant materials are not available. Examined on a regional basis, 45% of respondents from western states substitute with natives from a different geographical location, versus 21% from eastern states. One possible explanation for this difference is that there is a greater diversity of landscapes and seed zones in the West so it may be harder for suppliers to provide a sufficient diversity of ecotypes to meet all needs. The responses were similar across state departments with different levels of annual expenditures on seed.

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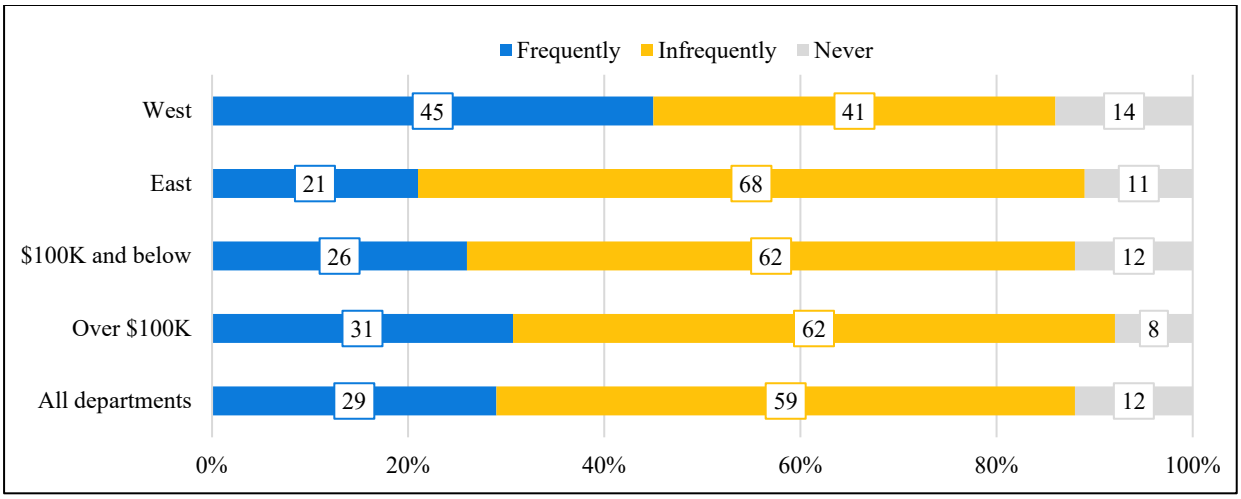


FIGURE 4-14 Substitution with natives from different region when preferred natives are unavailable, by region and annual expenditures.

Among the reasons for substitutions with natives having different characteristics, the lack of availability regardless of price or timing was mentioned by 81% of respondents overall, lack of availability within the timeframe required by 61%, and price by 35% (Figure 4-15). All three reasons were cited by 25% of respondents. Unavailability was cited in conjunction with one of the other reasons more than half of the time. Thus, the respondents citing unavailability and at least one other reason are a substantial share of the 81% reporting unavailability as a reason. Almost half of respondents (48%) indicated that the price of available seed was not a reason.

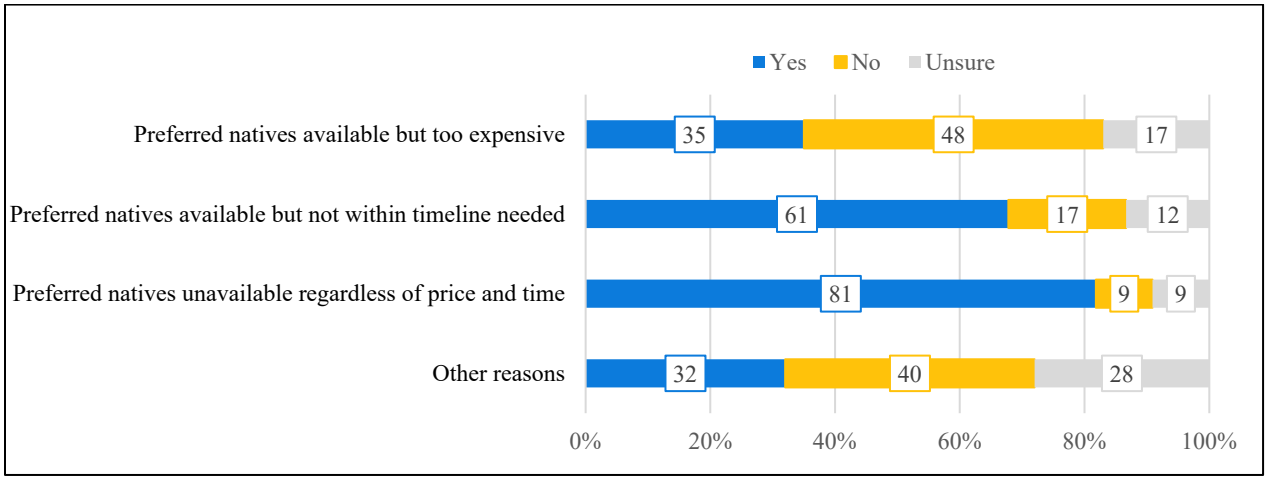


FIGURE 4-15 Typical reasons for substituting with natives having different characteristics.

Figure 4-16 shows that the lack of availability appears to be a bigger challenge for departments in the West than the East. Lack of availability in the time needed was mentioned by a higher proportion of respondents in the West (79%) versus the East (51%). It is possible that buyers in western states have smaller windows of time for purchasing seed than those in the eastern states, due to the need to obtain seed for emergency stabilization after wildfire, for example. About one in three staff in both the East and West indicated that substitutions with native seeds of other species or from other regions were made

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because the seeds they wanted were available but too expensive. Eighty-nine percent of state staff in the West and 77% in the East said that substitutions were made because the preferred seeds were unavailable regardless of price and timing. Departments with seed expenditures over $100,000 were more likely (92%) to say that substitutions with native seed with other characteristics were made because preferred seed were unavailable regardless of price and timing than departments with seed expenditures of $100,000 and under (78%) (data not shown).

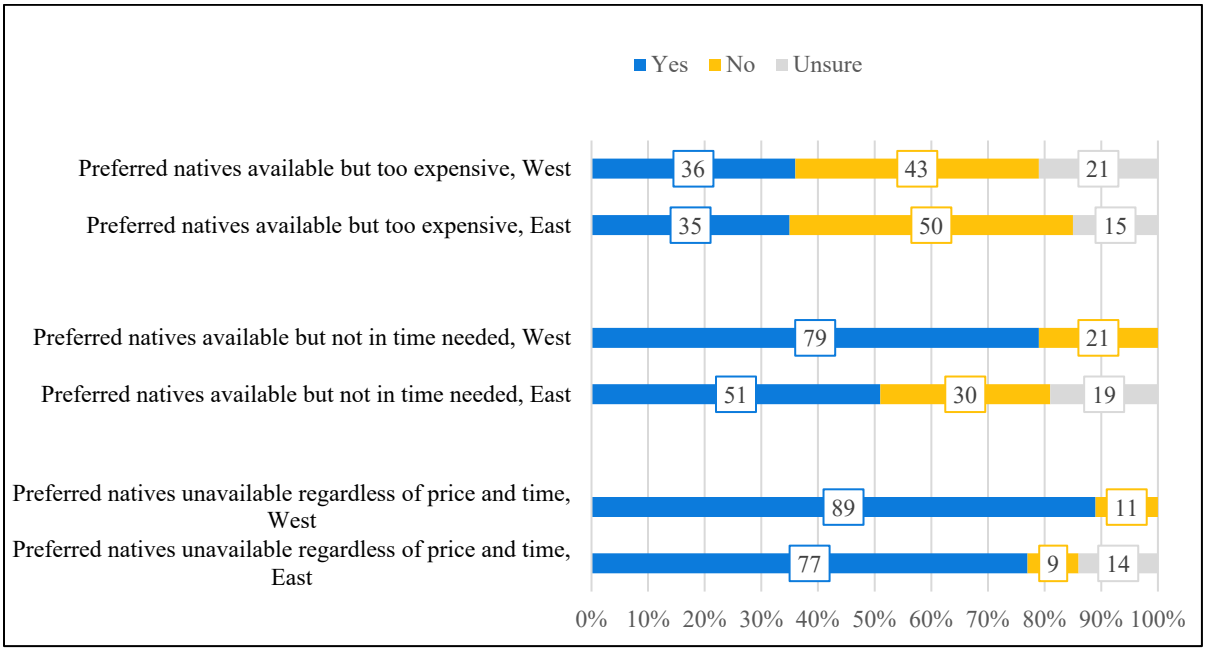


FIGURE 4-16 Typical reasons for substituting with natives having different characteristics, by region.

Biggest Barriers to Using Native Seed

When asked (in the form of an open-ended question) about the biggest barriers or disincentives to using native seed and plant materials in the state departments' work, approximately half of the respondents mentioned availability of plant material (48%). The second most frequently mentioned barrier or disincentive was price (38%). These two reasons are interdependent in a market. If buyers, such as these survey respondents, are unwilling or unable to pay a price that at least covers the suppliers' cost of production or collection for some species then none of the desired seed will be produced. In turn, buyers will experience a lack of availability. Because nothing is produced, buyers will perceive the outcome as "unavailable regardless of price and timing." Likewise, if buyers fail to signal their intent to purchase seed of designated species in time to produce that seed, suppliers may deem it too risky to incur production costs with the market in doubt. Both of these reasons for unavailability result from market forces.

Expertise and Labor

Monitoring Seeding Projects

Most state respondents said that they check on the survival of the seed or plant materials after planting for most or some of their projects (72% do this for most projects and 26% do this for some

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projects). These responses were also examined by region: 80% of the respondents in the West said that they do this for most projects, compared to 67% in the East. As shown in Figure 4-17, 27% of departments in the East check on survival of seeding or planting project for a year or less, versus 20% of departments in the West. A final survival check was typically completed within 1-3 years by 57% of departments in the West versus 39% in the East. About a third of departments in the East and about a quarter of departments in the West continue to monitor seedings and plantings for survival for greater than 3 years.

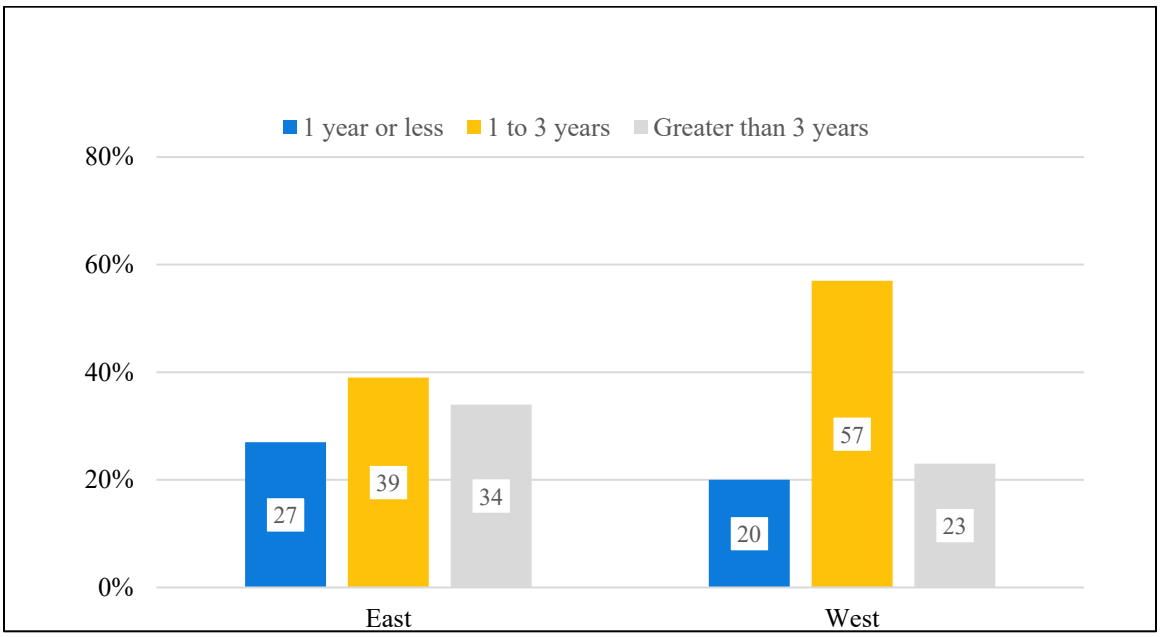


FIGURE 4-17 Time of last check on the survival of seed or plant materials after planting for a typical project, by region.

In-House Expertise and Gaps in Expertise

Department representatives were asked whether they have the range of in-house expertise needed for the various aspects of projects that use native seeds or plants. Overall, 58% said that they have the expertise needed, and 39% said that they had some gaps in expertise (the remaining 3% did not know). Responses to this question did not differ by region (57% said that they had the needed expertise in the West and 59% said the same in East). Responses were also examined by the amount of annual native seed and plant materials expenditures of the department (Figure 4-18). Those with larger annual expenditures were more likely to have in house-expertise than those with smaller expenditures (77% of the departments with budgets over $100,000 said that they had the expertise compared to 47% of the departments with budgets of $100,000 and under).

Those who said that they had some gaps in in-house expertise were asked to describe the expertise they were missing. In addition to mentions of inadequate levels of staffing, the responses covered a broad range of gaps in specialized knowledge, including agronomy, seed production, propagation protocols, and collection methods, native plant species identification, and planning for seeding with natives and maintenance. Some respondents said that they were able to meet their needs with various forms of collaborations with outside experts, and some clarified that the gaps only affect certain parts of the state.

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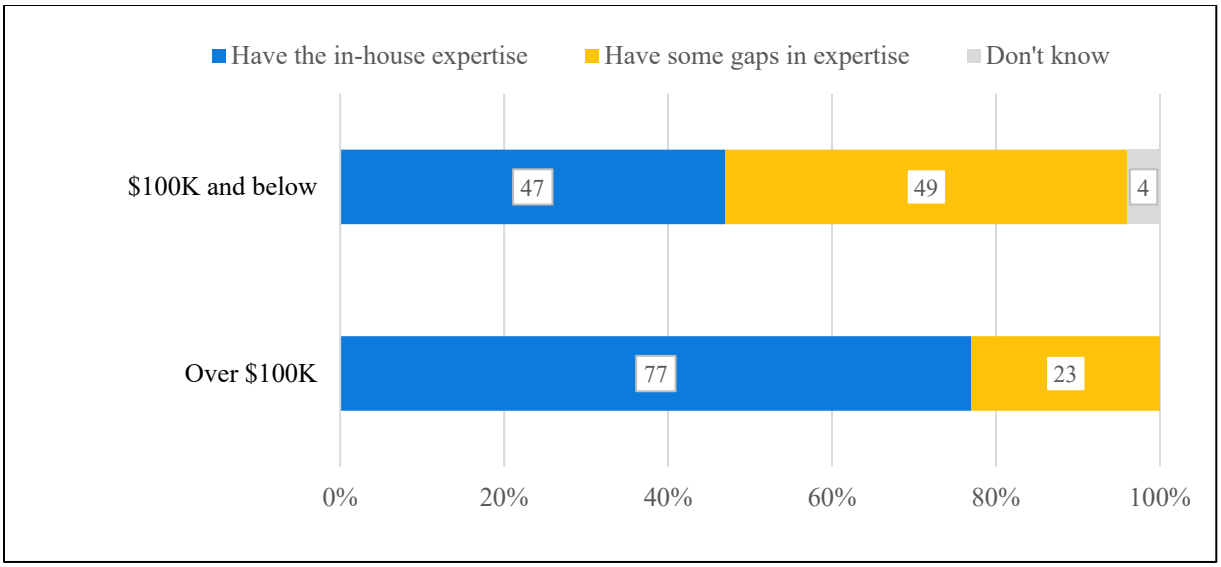


FIGURE 4-18 Availability of in-house expertise for projects that use native seed and plant materials, by annual expenditures.

Role of Policy in Decision-making

Most respondents said that a variety of specifications and guidelines apply to their projects that involve native seed and plant materials, including technical specifications (91%), federal regulations, guidelines, and policy (71%), state regulations, guidelines, and policy (84%), and funding source specifications (57%). The survey did not ask the extent to which these factors influence decision-making, and respondents did not bring them up in the open comment section.

Barriers to Using Native Seed

In answers to an open-ended question, state representatives provided perspectives on the key barriers that prevent them from using native seeds in their department's work. Table 4-5 summarizes the count of responses, coded into categories.

Availability and cost of genetically appropriate native seed were the concerns most strongly expressed by respondents to our survey of state seed buyers. Project timing was also cited as a limitation for obtaining sufficient supply. Desired plant materials are often unavailable in the quantities needed, and buyers' project timelines do not allow for the time that it might take suppliers to obtain and/or propagate these materials. High quality native seed may also be prohibitively expensive, and even when state departments have a policy of using it, their project contractors may substitute lower-cost seed. The interrelationship of price and availability through the native seed market indicates that basic market considerations drove most responses. However, especially in the West, native seed with the species and traits needed was sometimes unavailable at any price or time.

Lack of support in the context of the state bureaucracy was also cited by some respondents. Ecological restoration and the use of locally adapted native seed are not seen as a high priority in some state departments, leading to a lack of clout to improve the process or increase the funding for seed purchases. State agency staff or their project contractors may lack the technical knowledge to carry out restoration with native plant species. However, some state respondents reported the perception that the mandate to use native species in restoration is increasing in their agency.

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TABLE 4-5 State Department Respondent Comments on Barriers to Using Native Seeds

Barriers (category)	Description of the types of comments included in each category	Number of responses
Availability	The lack of genetically appropriate or local ecotypes of natives in large quantities in the timeframe needed is a major barrier. The period in which funding is available does not match the time needed to contract out the production of appropriate seed.	48
Cost	The costs of natives are likely to be prohibitive in many cases unless natives are mandated by policy. Project contractors often substitute lower-cost seed or mixes.	38
Genetics	A source of genetically diverse, locally adapted ecotypes of native plants is not available on the open market.	16
Lack of support for native plants/seeds	Lack of support for native plants and/or an established reliance on non-native species. Lack of support could be from engineers, landowners, public, etc. The historical reliance on non-native plants makes the transition to native plants difficult. Respondents mention a kind of "mentality" or suggestions of a certain mindset.	13
Lack of knowledge	Staff do not know how to establish or maintain native plant communities. On roadsides inappropriate mowing and use of herbicide are frequent.	11
Geographic or ecosystem limitations/ conditions	Natives often do not perform well at meeting regulatory specifications: establishing rapidly, meeting a certain percent cover in a specified time, preventing erosion on steep slopes, persisting under automobile pollution, tolerating degraded or compacted soils, inhibiting invasion, and resisting pests/diseases. This is an important research need.	9
Timing	Project timelines do not allow for the delays inherent in obtaining genetically appropriate native plant material, nor for the time it takes to monitor outcomes	9
Procurement barriers	State procurement systems are cumbersome when coupled with a lack of understanding about native seeds.	5
Communication issues	There is not enough native seed expertise throughout the agency to be able to communicate what kind of seeds are to be used in seeding projects. The definition of what is “native” is more restrictive in some parts of the agency than others.	1

Some of the respondents commented that native species do not tend to meet their agency’s regulatory mandates for successful post-disturbance revegetation. Desirable attributes that native species may lack include establishing rapidly, meeting a certain percent cover in a specified time, preventing erosion on steep slopes, persisting under automobile pollution, tolerating degraded soils, inhibiting weeds. and resisting pests and diseases. These responses may be a reflection of the fact that the state survey included departments of transportation and departments of natural resources, parks, and wildlife, which are somewhat divergent in their interests and perspectives.

Prospects for Native Seed and Plant Material Use

The majority of respondents anticipate that their department’s use of native seed or plant materials is likely to increase in the future, both near-term (76%) and long-term (73%). In answers to an open-ended question, state agency representatives explained why they thought the use of native seed or plant materials by their departments is likely to increase or decrease. A high-level summary of responses to perspectives in the short term is provided in Table 4-6 and in the long term in Table 4-7.

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TABLE 4-6 Reasons for Anticipated Increase or Decrease in State Departments' Near-Term Use of Native Seed or Plant Materials

Reasons native seed and plant materials use is likely to INCREASE in the near-term (category)	**Description of the types of comments included in each category**	**Number of responses**
Preference, demand, interest	There is increasing preference for native seed/plants over non-native seed/plants. Demand and interest for native seed/plants is growing.	13
Habitat programs, restoration	The number of habitat and/or restoration projects that will use native seed/plants is growing both in the public and private sectors.	12
Awareness, education	There is increasing awareness of the public and more public education about the benefits of using native seeds/plants.	11
Environmental reasons	The ecological and environmental benefits of using native seed/plants are becoming clearer.	8
Projects	Construction projects, road-building and other activities will necessitate seeding projects.	7
Research, funding	Research and funding are beginning to increase to allow for further investment in native seed/plants.	6
Relationships	Relationships with suppliers to collaborate on growing native plants and partnerships that support investment in, and further development of, native plant/seed programs, such as pollinator programs	4
Reasons native seed and plant materials use is likely to DECREASE in the near-term (category)	**Description of the types of comments included in each category**	**Number of responses**
Staffing	There are not enough staff to undertake the work at every level, from writing grants to obtaining funds for native seed projects, to actually managing those projects.	1
Reasons respondent is UNSURE about whether native seed and plant materials use is likely to increase or decrease in the near-term (category)	**Description of the types of comments included in each category**	**Number of responses**
Natives already	The existing seedbank of natives is the main source of natives that is used.	4
Funding dependent	Many seeding projects are cost-shared with private landowners, and some in conjunction with USDA conservation projects.	3
Remain the same	Given current project needs, the use of natives will be similar in the future	3
Climate dependent	Persistent drought will make the use of native seed more difficult.	1
Innovation dependent	Some environments, soils, slopes are not conducive to the establishment of native vegetation, but new seeding techniques may help.	1

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TABLE 4-7 Reasons for Anticipated Increase or Decrease[a] in State Departments' Long-Term Use of Native Seed or Plant Materials

Reasons native seed and plant materials use is likely to INCREASE in the long-term (category)	**Description of the types of comments included in each category**	**Number of responses**
Preference, demand, interest	Legislative mandates, habitat programs, conservation efforts, and new initiatives to create partnerships to develop native seed supplies will support long-term use.	13
Habitat programs, restoration	The number of habitat and/or restoration projects that will use native seed/plants is growing both in the public and private sectors.	9
Environmental reasons	Resilient ecosystems will adapt more readily to climate change and native plants contribute to resilient soils, wildlife habitat, and ground cooling.	7
Awareness, education	Recognition that native plants will be lower maintenance in the long run will get more people on board.	7
Same reasons as for short-term increase	Same reasons as for short-term increase	5
Research, funding	There will continue to be an increase of funds for restoration due to Monarch butterflies, pollinators, endangered species, and efforts to build a stock of native plant seeds/materials.	4
Population growth	Increase in numbers of people moving into former agricultural areas will likely mean shifts in land use that will favor conversion and use of natives.	2
Reasons respondent is UNSURE about whether native seed and plant materials use is likely to increase or decrease in the long-term (category)	**Description of the types of comments included in each category**	**Number of responses**
Markets	Economic markets may determine how private land is used.	3
Climate dependent	Global warming and natural disasters will play a role in ability to successfully restore native plant communities.	2
Needs dependent	Establishment of plant communities is difficult, but in the long-term a move from establishment to maintenance could be possible.	2
Funding, research dependent	There are so many needs for restoration and so many research needs to help make those successful. If research funding is available to address these issues, the use of natives will continue.	1

[a]None of the respondents provided a reason why native seed and plant materials would likely decrease in the long-term.

DISCUSSION

Different departments within one state have restoration projects that can be very diverse in purpose, making it difficult to represent the view of "the state" with any one answer, so the responses to the survey may be a partial picture of state native seed users. Some of the respondents noted that different answers might come from a more targeted approach to different departments within their state. Thus, this survey should be considered a first step in elucidating the seed needs of states.

The survey showed that there is growing recognition of native seed and plant materials by states as being valuable for their environmental benefits, from improving water quality to providing wildlife

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habitat, and the use of native seeds by states is expanding. Although the survey found that virtually all state departments say it is important to use natives, not everyone in state departments agree that native plants are the best choice for their restoration projects. They can be difficult to grow, there is a deficit in the knowledge base about how to grow native plant communities, and there is historical reliance on non-natives.

States are on a learning and experience curve in forging a common understanding about the use of natives. Respondents made the point that proponents of native seeds should recognize that native seeds and plants have limitations in very altered environments, in which pollution, salt operations (on roads), compacted soils, and invasive plants, pathogens and pests make native plant communities unsustainable. They cautioned that the debate about 'what is native in a region' tends to be so granular as to work against encouraging the broader use of natives including cultivars.

The survey results showed that most states have policies that require the use of natives, but respondents suggested that factors such as "greater awareness," "scientific evidence," and "availability" were more likely than policy (which often has loopholes) to play a role in increasing the use of native seeds and plant materials by department staff. The survey found that all states prefer natives but having local ecotypes of natives is a little less important and having the source location of seed verified by certification is slightly less important. On the other hand, non-certified seed obscures the geographic origins of plant materials and may lead to the use of inappropriate seed and materials for a region, leading to restoration failures that reinforce a perception that natives don't work. Many respondents stated that seed and seed mix selection guidance would be helpful.

The survey results suggested some differences between states in the East versus West, keeping in mind that the results need to be interpreted cautiously, given the small numbers of participants in the survey. Respondents from Western state had more difficulty than their counterparts in the East finding their preferred seed types regardless of timeframe needed or price, which might be related to the larger number of seed zones in the West than in the East, and the fact that obtaining seed from a particular seed zone was more likely to be very important to state respondents in the West than the East. More western state respondents said that their preferred seeds were also not available in the timeframe in which seed was needed, which might reflect a shortage during the years of frequent wildfire, when seeds are being sought in large quantities by the BLM and other agencies.

States in the East were more likely to buy off the shelf from seed suppliers than request a formal bid. All states were less likely to engage in production contracts than marketing contracts, but many respondents in the survey were not familiar with the procurement details of seed acquisition. In open comments, some respondents said there is difficulty in using project funds intended for immediate needs to try to collect and store seeds for increase for future needs. The mismatch between time constraints on the use of funding and seed production was noted as a major barrier to the native seed supply.

Finally, some states have a good supply of existing native plant communities which, if maintained can be the basis of a seed supply for restoration, and there is hope to be able to use those native stands effectively, without needing to buy seeds.

CONCLUSIONS

Conclusion 4-1: *Virtually all state departments prefer to use native seeds in their seeding projects relative to non-native seeds, with a few exceptions, and most states have policy guidance requiring natives to be used. Obtaining native seed from a specific geographic source or seed zone was also important to a majority of departments, but less so relative to the importance of using native seeds. A slightly smaller percentage of department respondents said that obtaining certified seed was very important for their department, relative to using native seed or seed from a specific geographic origin or seed zone*

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Conclusion 4-2: *Many state departments appear to have faced difficulty maintaining a diverse supply of genetically appropriate native plant seeds and plant materials and consequently substitute non-natives, different species, or the same species of plant but from another region. The major reasons cited for substitutions are a lack of availability at any price, and the price, when seed is available.*

Conclusion 4-3: *Almost all the state departments obtain seeds from commercial suppliers and about half of the departments collect seed from state lands or grow their own, primarily for use on state lands. The timeframe during which funds are available and must be spent is mismatched to timing of seed production. This was noted as a major barrier to the native seed supply. Ambient storage for seed is not available in all states, and less than a third have refrigerated storage available.*

Conclusion 4-4: *The lack of knowledge on establishing native plants was mentioned as a barrier to native seed use. Seed selection tools, greater knowledge about restoration outcomes, and better information about the performance of native seed mixes used in different applications would be helpful to states.*

Conclusion 4-5: *There is growing recognition of native seed and plants as valuable for their environmental benefits, from water quality to wildlife habitat, but procurement processes and lack of cooperation by some departments and private sector contractors undermine the use of high-quality natives*.

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5

Tribal Uses of Native Seed

HISTORICAL FACTORS AFFECTING TRIBAL NATIVE SEED CAPACITIES

Tribal needs concerning native plants often parallel those of federal and state agencies, and private enterprise described in this report including, seed collecting, increase, testing, seed zone implementation, storage, contracting, and dedicated funding. Still, tribes face unique issues that complicate actions needed to enhance native plant needs and uses. These include historical federal land policies and complex government to government interactions. In addition to ecological restoration, native plant uses also include food, spiritual, and medicinal applications (Mike et al., 2018).

The Dawes Act, also known as the Allotment Act of 1887, resulted in the loss of two-thirds of reservation land deemed "in excess of Indian needs."[1] It also assigned small land allotments within reservations to tribal members. The allotted land could be sold to non-tribal entities and so privately owned land became scattered within reservation borders and is commonly referred to as checker boarding. Additionally, there has been a fractionalization of land by the legal requirement that inheritance be equal and undivided among heirs and over generations, resulting in some parcels with hundreds of owners (National Congress of American Indians, 2020).

After the federal cultural assimilation policies ended with 1975 Indian Self-Determination and Education Assistance Act, tribes have sought and obtained new levels of self-determination and sovereignty, and pursued active reclamation and maintenance of traditional culture, including native plant uses (Mike et al., 2018). Still, land management is a balancing act between tribal sovereignty, complicated land ownership categories, and the BIAs legal and fiduciary obligation under the Federal-Tribal Trust to protect tribal treaty rights, lands, assets, and resources.[2] Limited resources and the multifaceted interactions of tribal governments with federal and state governments, and the Bureau of Indian Affairs (BIA), continue to complicate land management actions in general, including native plant uses for restoration and cultural needs.

Although viewpoints on land use, conservation, and management differ widely among and within tribes, there are unifying aspects of conservation and use of native plants. With enhanced self-determination, tribal nurseries supporting cultural uses and ecological restoration have been strengthened over the last 20 years by the Inter-Tribal Nursery Council (INC). There are also efforts to expand tribal conservation districts in partnership with NRCS.[3] These districts can assist tribes and tribal members in agricultural production, including growing native seed for tribal use and general sales. Since indigenous people traditionally lived close to the land and its resources, they developed management regimes over centuries to secure and benefit their livelihoods (Reyes-Garcia et al., 2019). This has led to the recognition and implementation of tradition ecological knowledge (TEK) as an asset to tribal land management and ecological restoration (Eisenberg et al., 2019).

THE INTER-TRIBAL NURSERY COUNCIL

Jeremy Pinto, a USFS Research Plant Physiologist, presented information about the Inter-Tribal Nursery Council to the committee. Starting in 2001, Tribal emphasis and outreach programs were

[1] See https://www.archives.gov/milestone-documents/dawes-act, accessed October 23, 2022.
[2] See https://www.bia.gov/bia, accessed October 23, 2022.
[3] Indian Nations Conservation Alliance, see https://inca-tcd.org/about-tcds/.

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developed within the Reforestation, Nurseries, and Genetics Resources Program (RNGR),[4] a USFS sponsored effort to supply growers with needed technical information for growing native plants. The first meeting of tribal nurseries under the aegis of RNGR was in 2001 at Fort Lewis College in Durango, Colorado, which led to the establishment of the INC. The Council is critical to improving nursery operations and management, and to strengthening connections among tribal nursery leaders. The INC meets annually to focus on topics that include technology transfer, conservation, education, traditional ecological knowledge, and general restoration.

The Tribal Nursery Needs Assessment (2003) documented the scope, interest, and potential for nurseries to serve tribal needs. In a related need, tribes also requested native plant propagation literature and guidelines including cultural, medicinal, and spiritual plants. This resulted in the Nursery Manual for Native Plants (Dumroese, 2009). Both the Needs Assessment and the Nursery Manual still provide critical information concerning tribal nursery activities and technical needs, though funding constraints and limited personnel have delayed their updating, a reoccurring theme among tribal nurseries.

The 2003 assessment included responses from 68 tribes, 7 tribal colleges, and 2 non-profits. Fifty-two respondents (86%) requested further nursery and restoration training and 38% requested environmental education information and lesson plans for their schools. Twenty-seven (35%) of the tribes and tribal colleges had existing nurseries. Most respondents were from small nurseries, ranging from outdoor planting beds for basket materials to small, prefabricated greenhouses. Twenty-four (31%) did not have a nursery but wanted to start one. Most small, existing nurseries wanted to expand the scope of their projects. Ongoing issues identified in the assessment still resonate today:

- Little if any permanent funding for INC activities.
- Lack of availability of some native plants that have high cultural value.
- Loss of traditional ecological knowledge.
- Fragmentation and degradation of important habitats.
- Unemployment and lack of new natural resource professionals to work on reservations.
- Poor relationships among federal, state, and tribal governments.

TRADITIONAL ECOLOGICAL KNOWLEDGE

Although viewpoints on land use, conservation, and management differ widely among and within tribes, to native peoples the land represents their sense of place; a physical, cultural, and spiritual connection which relates to the traditional use of land for subsistence, livelihoods, and well-being (e.g., Hornborg, 2006; Viveiros de Castro, 2004). Dr. Christina Eisenberg of Oregon State University described traditional ecological knowledge as the indigenous wisdom which native people have successfully used to manage natural systems. Such knowledge and practices are passed as narrative histories from one generation to the next to enhance ecosystem management for stability and productivity for food, medicine, and ceremonial items. This knowledge was disregarded by white settlers, who introduced destructive land management practices, the effects of which persist today (Eisenberg et al., 2019). Historically, research on tribal land has rarely included tribal perspectives even though they often differ from those of non-tribal scientists (Dockry et al., 2022). The integration of tribal viewpoints and traditional knowledge into land management and research (see Chapter 8) is an emerging practice that will advance the capacity of tribal land management to improve ecological restoration and ecosystem function.

INNOVATIVE TRIBAL PLANT PROGRAMS

The Diné Native Plant Program

The committee learned of a 2017/2018 feasibility study conducted to assess nursery interest and needs in the Navajo Nation. One questionnaire was developed for Navajo Agencies and organizations

[4] See https://www.rngr.net under Tribal.

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(tribal, federal, and state agencies, and non-profits working on Navajo land), and one for Navajo community members. As a result, a comprehensive report and plan for native plant needs was developed (Mike et al., 2018). Among agency responses, 67% used native plant materials. Common uses included restoration (68%), education (61%) and range rehabilitation (35%). Eighty percent expected a growing need for local plants in the next 5-10 years. Among Navajo communities, 95% of respondents reported using native plant materials, most commonly for food (68%), cultural/ceremonial (63%), and medicine (58%). There was an interest in learning about traditional uses of plants (69%) and in partnering with a native plant program to grow and utilize native plants.

The Diné Native Plants Program (DNPP) was established in response to the documented interest and needs of the Navajo Nation. It is designed to meet the needs of both the agency/organizational groups and the interests of community members. For agencies, the focus is on collection of workhorse species for ecological restoration, and for communities, to provide members access to culturally important species. There is no base funding, so grants are essential. Current support for the DNPP comes from the Navajo Nation Government, BIA, Bureau of Land Management (BLM)[5], a nongovernmental organizations, and a private foundation.

The Fort Belknap Native Seed and Restoration Program

In fall 2019, the Fort Belknap Indian Community launched a 5-year partnership with the BLM and the Society for Ecological Restoration (SER) to implement the Seeds of Success (SOS) Native Seed and Grassland Restoration Program (Eisenburg, 2021). The program focuses on the role of traditional ecological knowledge in ecological restoration, working in close partnership with the Fort Belknap Indian Community on BLM and adjacent tribal lands in Montana's Northern Great Plains. The program applies seed collection in compliance with BLM's SOS program, BLM Assessment, Inventorying, and Monitoring protocols, and ecological restoration based on the SER International Principles and Standards for the Practice of Ecological Restoration.

Tribal Native Plant Materials Program Development Plan for the Confederated Tribes of Grand Ronde

The Institute for Applied Ecology partnered with Confederated Tribes of Grand Ronde **(**CTGR), the Oregon Parks and Recreation Department, the Oregon Department of Fish and Wildlife, the City of Corvallis, and the NRCS to obtain an Oregon Watershed Enhancement Board restoration grant, which was implemented from 2016-2019. The resulting "Plants for People" project focused on utilizing culturally significant plants applying traditional ecological knowledge to restoration. The Institute for Applied Ecology and CTGR created a development plan for an expanded tribal native plant materials program. Continued restoration at Herbert Farm and Natural Area near Corvallis Oregon and the Champoeg State Park adjacent to the Willamette River includes invasive weed control and prescribed burns prior to planting native seed. Prairie and riparian monitoring and photo points are tracking the establishment of native vegetation at these sites.[6]

DISCUSSION

There is undoubtedly much more to uncover about the activities of the tribal nations with respect to native seed that was beyond the ability of the committee to reach, and a deeper exploration of these activities would shed light on seed needs and the tribes' ecological understanding of the landscape. In addition to the insights the tribes could bring to the federal land-management agencies, it is hoped that

[5] The sentence was modified to add BLM as a supporting organization of the DNPP.

[6] See https://appliedeco.org/report/plants-for-people-bringing-traditional-ecological-knowledge-to-restoration-2018-post-implementation-status-and-plant-establishment-report/, accessed October 26, 2022.

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tribal nations would benefit from greater partnership and support that could contribute to their land management objectives.

CONCLUSIONS

Conclusion 5-1: *The historic complexity of land management issues and interactions with federal and state governments, and former Bureau of Indian Affairs (BIA) policies associated with cultural assimilation have constrained all aspects of tribal land management including native plant needs and capacities.*

Conclusion 5-2: *Tribal nurseries are producing plant materials for native plant programs, but the capacity of current nurseries, and interest of many tribes to establish nurseries, is resource limited relative to the needs for native plants among tribes.*

Conclusion 5-3: *Historically, tribal nations have rarely had their perspectives fully integrated into research projects conducted by non-tribal scientists. This has led to mistrust and a dampening of innovative approaches to restoration and integration of traditional ecological knowledge with western science.*

REFERENCES

Dockry, M.J., S.J. Hoagland, A.D. Leighton, J.R. Durglo, and A. Pradhananga. 2022. An Assessment of American Indian Forestry Research, Information Needs, and Priorities. Journal of Forestry: 1-15 https://doi.org/10.1093/jofore/fvac030.

Dumroese, R.K., N. Balloffet, J.W. Crockett, J.A. Stanturf, and L.E. Nave. 2019. A national approach to leverage the benefits of tree planting on public lands. New For 50:1-9. Doi:1-.1007/s11056-019-09703-2.

Eisenberg, C., C. Anderson, A. Collingwood, R. Sissons, C. Dunn, G. Meigs, D. Hibbs, S. Murphy, S. Kuiper, J. SpearChief-Morris, L. Bear, B. Johnston, and C. Edson. 2019. Out of the Ashes: Ecological Resilience to Extreme Wildfire, Prescribed Burns, and Indigenous Burning in Ecosystems. Front. Ecol. Evol. 7:436 doi: 10.3389/fevo.2019.00436.

Eisenberg, C. 2021. Seeds of restoration success: Fort Belknap Indian Community/BLM/SER Native Seed and Grassland Restoration Program. https://ser-insr.org/news/2021/3/13/seeds-of-restoration-success-fort-belknap-indian-communityblmser-native-seed-and-grassland-restoration-program. Accessed September 22, 2022.

Hornborg, A. 2006. Animism, fetishism, and objectivism as strategies for knowing (or not knowing) the world. Ethnos 71(1):21-32.

Mike, J., K. Jensen, N. Talkington. 2018. Diné Native Plants Program: Navajo Nation Native Plant Needs and Feasibility Assessment. Navajo Fish and Wildlife.

Reyes-García, V., Á. Fernández-Llamazares, P. McElwee, Z. Molnár, K. Öllerer, S.J. Wilson, and E.S. Brondizio. 2019. The contributions of Indigenous Peoples and local communities to ecological restoration. Restoration Ecology 27(1):3-8.

Viveiros de Castro, E. 2004. Exchanging Perspectives: The Transformation of Objects into Subjects in Amerindian Ontologies. Common Knowledge 10(3):463-484.

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6

Cooperative Partnerships for Native Seed Development, Supply, and Usage

Because locally adapted native seed can be difficult to find in commercial markets, public and private partnerships have arisen to develop local and regional native seed supplies for restoration, remediation, and other applications, including to provide stock seed to commercial growers. The committee learned of several notable activities taking place at municipal, state, and regional levels, which are described in this chapter. These include state and municipal-level programs, regional programs for seed development, national partnerships for strategies and seed collections, and partnerships for more effective usage of native seed.

STATE AND MUNICIPAL-LEVEL PROGRAMS

The longest-lived of these projects is Iowa Tallgrass Prairie Center, operating in some form for more than 30 years. The newest, the Nevada Seed Strategy, was established in 2020. Some of the partnerships are focused on collection and seed banking, others include plant development, while still others are research-oriented activities to better understand seed zones, soil, and genetics, technologies to improve seed survival, and tools to anticipate how climate change will affect plant communities. Many local partnerships have individual ties to different federal agencies which also collaborate with each other in major regional efforts. They offer models of the building blocks needed for a collective nationwide effort for native seed and plant development and restoration.

Iowa Tallgrass Prairie Center[1]

The Native Roadside Vegetation Center, later renamed the Iowa Tallgrass Prairie Center, was established at University of Northern Iowa in the late 1970s. The aim of the Center is to restore resilient diverse tallgrass prairies, which have virtually disappeared from Iowa (99.9% lost). The remaining stands of tallgrass prairie are mostly located along gravel roadsides in rural areas of the state, which combined equal about 1.73 million acres. The Center has worked to develop a supply of diverse, local natives to bring back these once ubiquitous landscapes.

According to Laura Jackson, the Center Director who spoke to the committee, it was the Integrated Roadside Vegetation Management (IRVM) legislation passed by the Iowa legislature in 1987 that was a turning point for the Center. State Code 314.22 directed the state to adopt roadside management for state and federal roads and emphasized the establishment of long-lived vegetation matched to the unique environment found on roadsides, with an emphasis on native plant species. The Iowa Department of Transportation (IDOT) was assigned responsibilities for roadside management, and county participation was encouraged. Specific instructions were given related to mowing, spot spraying, prescribed burning for brush control, and the planting of diverse perennial vegetation. At the time the law was passed, the only plant materials available were western plant cultivars. The Living Roadway Trust Fund, established under State Code 314.22, used tax revenue to support a competitive grants program that provides support for the IRVM work at the county, municipal, and state level and the plant materials development work of the Iowa Tallgrass Prairie Center. The Center now helps counties in adopting and implementing voluntary Roadside Management Plans for their roads by developing seeds and other plant

[1] See https://tallgrassprairiecenter.org/, accessed December 1, 2022.

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materials through an annual grant from the Federal Highway Administration which enables their free distribution to county roadside projects.

The Center developed a map with three seed zones, has accessioned 100 species through collections, and developed 180 ecotypes (called Iowa Ecotypes) of 88 species. Of those, 155 ecotypes of 82 species have been provided to growers with a total of 531 distributions. Species over time have expanded from warm season to cool season grasses, forbs, and legumes. More recently sedges and shrubs were added to expand functional group diversity. About 1000 acres of county roadsides are planted annually with seeds from the Center. Iowa Ecotype seed is certified as Source-Identified (SI) (see Box 8-2 in Chapter 8 for more information on certified seed), which receives a preference in bids submitted to the IDOT for its roadside maintenance projects. The Center's work has also stimulated the development of similar plant materials by the private sector.

Jackson told the committee that the lessons learned are that public support is needed to help decision-makers understand and endorse change. Seed quality, communication, monitoring, adequate funding, and maintaining good records are critical to success. She added that applied research is needed to refine methods and tools for practitioners and managers.

Texas Native Seeds Program[2]

The Texas Native Seeds Program is a not-for-profit native plant seed development program that began as South Texas Natives in 2001, when the revegetation activities associated with the construction of the Interstate 69 highway project attracted the attention of local landowners concerned about non-native invasive plants. The Texas Department of Transportation provided a grant to establish the program, which has since been supported by public and private funders. Keith Pawelek, Associate Director of Texas Native Seeds, told the committee that the program collects, develops, and produces locally adapted seeds of native grasses, forbs, legumes, and woody plants for different regions in Texas. The seeds are released as natural-track certified, Selected (S) (see Box 8-2) Texas Native Germplasm and offered to commercial suppliers for large-scale increase, sometimes in blends of selected accessions to broaden the diversity and utility of the seed for locations in different ecoregions or with different soil types. Texas Native Seed has supported the commercialization of 17 native seed lines and now has projects to provide regionally adapted seed to six different regions in Texas. The NRCS E. "Kika" De La Garza Plant Materials Center has been a partner in the Texas Native Seeds Program, along with the Texas AgriLife Research Station, representing a partnership of a non-profit organization, a state university, the federal government, and the private sector.

Nevada Native Seed Strategy[3]

The Nevada Seed Strategy is a product of the Nevada Native Seed Partnership,[4] whose initial members include the Bureau of Land Management (BLM), US Forest Service (USFS), National Fish and Wildlife Service (NFWS), US Geological Survey (USGS), Natural Resources Conservation Service (NRCS), University of Nevada, Reno, Nevada Department of Agriculture, Nevada Department of Wildlife, Great Basin Institute, the Nature Conservancy, and the Walker Basin Conservancy. Modelled on the National Seed Strategy, its overall aim is "to increase the quantity and quality of [native] seed available for large-scale rehabilitation, reclamation, and restoration (i.e., post-fire seeding) as well as for smaller-scale projects (i.e., wildlife corridors)." The group was formed in 2017, and the first iteration of the Strategy was released in April 2020, putting forward four goals:

[2] See https://www.ckwri.tamuk.edu/research-programs/texas-native-seeds-program-tns.

[3] See https://agri.nv.gov/uploadedFiles/agrinvgov/Content/Plant/Seed_Certification/FINALStrategy_with%20memo_4_24_20_small.pdf.

[4] See https://www.nature.org/en-us/about-us/where-we-work/united-states/nevada/stories-in-nevada/native-seed-restoration/.

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1. Identify seed needs, and ensure reliable availability of genetically appropriate seed
2. Identify research needs to improve technology for native seed production and ecosystem restoration
3. Develop and implement tools that enable managers and producers to make decisions about collecting, increasing, and using genetically appropriate seed
4. Develop and implement strategies for internal and external communications

Each of these goals is being pursued through activities related to several subgoals and objectives that engage different stakeholders and partners. Each year the Nevada Department of Agriculture hosts a Nevada Native Seed Forum to bring producers, research, and land managers and other members of the Nevada Native Seed Partnership together to discuss restoration goals, technologies, and native seed production, fostering both unity and flexibility in the collective approach to the conservation of Nevada's natural heritage. Members work together to identify the most promising seeds for restoration (e.g., Leger et al., 2020), and many of these collections are being agriculturally produced for use in restoration, though seeds are being grown by established seed growers outside the state. To further support the seed industry in Nevada, in 2022, the group began a foundation seed program, providing free seeds of desirable collections to qualified growers within Nevada.[5] Further, partners have multiple field experiments ongoing across the state, designed to test the performance of locally collected seeds in restoration settings.

Utah Great Basin Research Center

The Utah Division of Wildlife Resources (DWR) Great Basin Research Center and Seed Warehouse (GBRC) in Ephraim, Utah has operated as the technical and logistical hub for revegetation efforts in Utah since 2004. The GBRC's seed warehouse, with capacity for ambient storage of 1.2 million pounds of native and non-native seed and cold (34F) humidity-controlled (5%) space for 150,000 pounds, makes it one of the largest climate-conditioned restoration seed warehouses in the United States. Utah's Watershed Restoration Initiative[6] (WRI) provides programmatic and administrative support for the GBRC, which purchases seed from wild-seed collectors and agricultural growers in the western United States through a consolidated seed buy of the DWR, and, along with some of its own produced seed, has been building a seed supply for the WRI's proactive restoration efforts that amounts to about 100,000 acres annually as well as fluctuating reactive wildfire revegetation demands. The GBRC coordinates the contracting and implementation of seeding projects, as part of an effort to maintain a strong private industry in Utah and surrounding states. The BLM and USFS store limited quantities of seed at the warehouse, and the GBRC also makes seed available to the agencies for purchase through the DWR (Kevin Gunnell, personal communication).

Greenbelt Native Plant Center and Mid-Atlantic Regional Seed Bank

The Greenbelt Native Plant Center (GNPC) is the municipal native plant nursery of New York City's (NYC's) Department of Parks and Recreation and is the nation's largest and longest running city-operated native plant nursery. Since the early 1990's, the Center has provided over 13 million live plants of over 500 species, produced from local plant populations in support of restoration and management of the city's parks and other valuable natural areas. Materials from the GNPC have been used in projects staged by multiple city agencies as well as on state and federal projects in the city. When Hurricane Sandy destroyed critical coastal habitat from Maine to the Carolinas in 2012, and including areas of New York City itself, the center, as a Seeds of Success partner, was able to provide seed and plant material for regional restoration projects.

[5] See https://agri.nv.gov/uploadedFiles/agrinvgov/Content/Plant/Seed_Certification/Foundation%20Seed%20Program%20Application.pdf.

[6] See http://wildlife.utah.gov/watersheds/.

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Ed Toth, a member of the study committee and former director of the GNPC, notes that NYC, not unlike some federal and state agencies, does not employ policies for advanced planning and the City does not pre-fund production of those materials to ensure a supply at the time projects are staged, leaving purchase from the seed supply available "on-hand." Other budgeting and procurement rules and practices, perhaps unique to NYC, prevented fuller use of the facility, despite the tremendous investment the City has made in the nursery.

The GNPC banks about 2,000 collections to meet the production needs of the nursery. These must be replenished on an ongoing basis. Over the last 20 years, almost 13,000 collections have been made towards that end. The City of New York has 27 extant ecosystems and the GNPC has played a role in reintroducing common native species to those habitat niches. The Center's expertise in the production of two-thirds of the extant flora of the NYC guarantees that a high level of biodiversity is built into projects. Commercial producers, bound by market constraints and realities, most often are unable to meet these biodiversity needs. This points to the importance of public sector production of native plant materials as part of the supply chain, in concert with the commercial sector.

The GNPC created the Mid-Atlantic Regional Seed Bank as a programmatic extension of its seed banking resources out into the larger region. To-date the regional seed bank contains 750 accessions and cooperatively banks seed for other native seed programs in the mid-Atlantic region. It has collected seed from the region for the BLM's Seeds of Success program, USFS, National Parks Service, US National Arboretum, and New York State Department of Parks. MARSB sees itself as a natural partner to any future seed networking efforts in the mid-Atlantic.

Other State-Level Partnerships

The committee learned of other state-level or non-federal regional partnerships that have formed or are forming. These include: The Northeast Seed and Plant Supply Chain Network; The Willamette Valley Native Plant Partnership; The North Coast Native Plant Partnership; The Southwest Seed Partnership; Rhody Native (Reseeding Rhode Island); and The California Native Seed Supply Collaborative.

REGIONAL PROGRAMS FOR NATIVE SEED DEVELOPMENT

Pacific Northwest Region

The Pacific Northwest Region of the USFS (Region 6 of the service's nine regions) is situated across Oregon and Washington and includes 17 national forests, a national grassland, and other scenic lands. Within the region, the service has developed programs to address all aspects of the seed supply chain. This includes research, seed needs projections under climate change, the refinement of the Seed Selection Tool for decision-making in reforestation, as well as the collection, production, cleaning, and storage of seeds of native grasses, forbs, conifers, willows, and other tree species. The program also encompasses infrastructure development, partnerships, funding, and training.

The aim has been to integrate projects among disciplines, with botanists writing plans and coordinating efforts. Projecting seed needs for unplanned disturbances is done by looking at seeding records, fire risk modeling, and use of other tools. For major seed zones, workhorse species have been selected that have broad ecological applicability, establish well on disturbed sites, are easy to collect and propagate, reliably produce seed, and can be stored for reasonable periods.

Home to the USFS' J. Herbert Stone Nursery, the Clarno Propagation Center, the Dorena Genetic Resources Center, the Bend Seed Extractory, and in conjunction with private nurseries and growers, Region 6 has the infrastructure to provide plant materials and restoration advice to its National Forest

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managers as well as to other federal, state, tribal, and county partners in the region, including Canada. With the passage of the REPLANT Act of 2021,[7] Region 9 will have the resources to do much more restoration work, which is needed to address post-wildfire needs, if it can obtain the personnel needed to carry it out.

Colorado Plateau Native Plant Program

The Colorado Plateau lying at the intersection of Colorado, Utah, Arizona, and New Mexico, is an arid, challenging environment for plant restoration. The BLM established the Colorado Plateau Native Plant Program (CPNPP) in 2007 in partnership with the USFS, Northern Arizona University and state wildlife agencies in the region. In 2010, an interagency agreement established the USGS Southwest Biological Science Center in Flagstaff, Arizona, as the lead scientific agency for plant material research in the program. There are numerous partners involved in a wide range of activities in the program, including federal, state, and local government agencies; tribal nations; non-governmental conservation organizations; university researchers and curators; commercial plant materials industry (seed and seedling growers and sellers); and seed testing and certification entities.

The lead scientific agency for plant materials research for the Colorado Plateau project is the US Geological Survey (USGS). As the science agency for the US Department of the Interior, the USGS scientists plays an active role in uncovering the interactions of plant genetics and biophysical aspects of ecological systems, in the context, for example, of the need to identify native plant materials for restoration in the dryland environment of the Colorado Plateau Native Plant Program (Massatti et al., 2022). (See Box 8-1 for a brief description of the research activities of the USGS for the CPNPP).

Great Basin Native Plant Project

The Great Basin Native Plant Project[8] (GBNPP) was established in 2002 as a cooperative program of the BLM Plant Conservation and Restoration Program and the Grassland, Shrubland, and Desert Ecosystem Research Program of the USFS Rocky Mountain Research Station. Its initiation was part of an interagency response to a 2000 Congressional directive asking for a plan to develop a native seed supply for emergency stabilization and restoration. The Great Basin is an expansive swath of land that encompasses large portions of Nevada and Utah, and pieces of California, Idaho, Wyoming, and Oregon. It is called the Great Basin because it is hydrographically contained, with no drainage to the oceans, and ecologically diverse.

The goal of the GBNPP is to develop useful information for land managers faced with decisions about the selection of plant materials for vegetation restoration. The project website boasts of "more than 30 major cooperators in 9 states" working on wide variety of native plant research, development, and restoration projects. At any given time, a dozen or more projects are ongoing. These include understanding the genetic diversity of Great Basin plant species, looking at seed zones considering climate change, investigating cultivation practices for increasing Great Basin seed, species interactions, restoration strategies and equipment, and others. The research activities in the Project have produced a great number of published studies that document, such things as: variation in local adaptation of Great Basin natives (Baughman et al., 2019); climate niches among forbs in the sagebrush steppe (Barga et al., 2018); and using the genetic structure and history of blue-bunch wheatgrass populations as foundational knowledge for developing plant materials for restoration (Massatti et al., 2018).

[7] The REPLANT (Repairing Existing Public Land by Adding Necessary Trees) Act will support the reforestation of 4.1 million acres over the next year. It is an element of the Bipartisan Infrastructure Legislation (Infrastructure Investment and Jobs Act) that became law in 2021.

[8] See http://www.greatbasinnpp.org/.

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Mojave Desert Native Plant Program

The Mojave Desert ecoregion is situated across Nevada, California, and parts of Arizona and Utah in some of the most diverse and arid landscapes in the nation. The region is challenged by the impacts of invasive species, recreational activities, and a megadrought—the driest decade in 1200 years (Williams et al., 2022). Initiated by the BLM in 2017, it has developed into a partnership with the USGS, the Rancho Santa Ana Botanic Garden, NRCS Tucson Plant Materials Center, Utah Division of Wildlife Resources, Texas State University, Victor Valley College, and others, to collect and bank seeds, develop germplasm releases for commercialization, conduct landscape genetic studies, and develop empirical seed transfer zones. The program also conducts research on restoration techniques and strategies. It has identified priority plant species for collection (Esque et al., 2021), and developed a "Mojave seed menu" (Shyrock et al., 2022) as a decision-making tool for restorationists, incorporating climate change projections.

NATIONAL PARTNERSHIPS

Seeds of Success

The BLM Seeds of Success (SOS) program, which collects and banks seed to preserve the genetic diversity of native plant populations for future use in restoration, was developed in 2001 as a partnership with the Kew Gardens Millennium Seed Bank project. It was also one of the first steps taken that addressed the Congressional mandate of 2002 for the development of a supply of native seeds for emergency stabilization and restoration. Federal partners include the USFS Bend Seed Extractory, USDA's Agricultural Research Service, and the USFWS. In 2008, BLM signed a Memorandum of Understanding (MOU) with six non-federal partners to perform collections under a common protocol and to store seed for research and working collections. The agreement formalized SOS as the national native seed collection program for conservation and restoration across the United States, with BLM's Plant Conservation and Restoration Program as the lead. The MOU states, in part:

> While the Federal land managing agencies purchase large quantities of native seed to meet their needs, the demand for native seed is also felt by state and local land managing agencies and other non-governmental organizations engaged in land management and conservation. A reliable, sustainable, and ecologically appropriate source of seeds is needed to meet all these needs and can best be met within a national framework for management and conservation of the nation's seed resources. Such a framework should seek to equitably address the demand for regional and local seed by assuring a ready supply through appropriate planning, coordinating, collection and storage, while protecting the resources. It is vitally important for the BLM to work with partners such as the Botanic Gardens, to achieve nationwide restoration goals.

The SOS program has continued to add non-federal partners over the years, and by the end of 2021, had made over 27,000 accessions of 5,800 unique taxa. From 2014 through 2016, the BLM funded an eastern collection program, Seeds of Success East. This effort successfully made 2,124 seed collections and has made that seed available to 27 federal, state, and municipal agencies for post-hurricane Sandy recovery and resiliency projects.

Most recently the SOS has supported two new partnerships, one between BLM Montana and the Fort Belknap Indian Community to use SOS seed collection protocols and Traditional Ecological Knowledge for collecting and restoring tribal lands, and a second, to establish a Seeds of Success Southeast program. With BLM support, the USFWS Partners for Fish and Wildlife Program and the Southeastern Grasslands Initiative (SGI) will coordinate with the national SOS to develop a collection strategy over 10 states in the southeastern United States.

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Agricultural Research Service and SOS

The Agricultural Research Service (ARS) provides research in many areas, and Brian Irish and Stephanie Greene provided the Committee with information about two programs that are particularly germane to this report.[9] The National Plant Germplasm System (NPGS) has 25 gene banks, many partnering with land grant universities, with the goal of conserving plant germplasm for agricultural and other uses. About 600,000 accessions are in storage; most are available in small quantities to private and public users for research, plant breeding, evaluation, and education. Currently, the NPGS provides long-term storage for small accessions of collections from the Seeds of Success program. The Germplasm Resources Information Network (GRIN) includes data for about 16,000 species stored at the NPGS.

Irish and Green expressed a need for a dedicated curatorial program for natives within the NPGS because most have no curatorial support and often lack production and germination protocols, making their conservation and curation difficult. Such a program might require resources of $2 million annually for a subset of natives; native species that are wild-crop relatives would have greater relevance to a larger group of stakeholders and would be more attractive targets for curation at the NPGS.

Seed Cleaning for SOS

The USFS Bend Seed Extractory in Bend, Oregon, currently cleans all the seed collected by the western SOS seed collection program with fees paid by the BLM through an agreement with the FS and cleans seed for other government clients on a fee-based system. However, it is not of unlimited capacity, and maybe increasingly focused on cleaning conifer seed as forest restoration efforts under the REPLANT Act begin to increase. It could serve, at least in part, as a useful template for establishing cooperative seed cleaning efforts across the United States.

There are limited examples of cooperative efforts to provide seed cleaning and seed warehousing. Yet they are needed for a national supply chain based on ecoregional seed of many different species. Many seed producers of sufficient size can clean their own seed crops. However, the more species that are grown, especially if they are forbs, the more specialized cleaning equipment is needed. This can be cost prohibitive, especially to smaller producers, and creates a significant disincentive for such producers to consider entering the restrictive markets that ecoregional seed production imposes.

Seed Warehousing and SOS

Apart from the long-term frozen storage of SOS accessions in the seed banks of the ARS National Plant Germplasm System, seed collected through SOS is stored in seed banks of partner organizations. Seed banking of wild seed, both for conservation purposes and to meet restoration and other land management needs, can be effectively managed at regional seed banks that have appropriate storage capacity for wild collections and appropriate technical staff to curate wild collections and ensure their long-term quality and viability.

Seed warehousing is an extension of seed banking, but particularly focused on large quantities of increased seed typically held for relatively short periods of time because seeds are short-lived in ambient warehouse conditions. It is most relevant to the other end of the supply chain, where an adequate supply of increased seed must be maintained to insure a timely source for end-users. This is necessitated by the long timeline for development and production of increased seed, which in turn dictates the need for timely planning, production, and storage well in advance of need. Only a handful of federal native seed warehouses exist, and all are in the arid West. Similarly, some states in the arid West maintain native seed warehouses to meet their needs. If the supply and demand for ecoregional native seed increases, as is anticipated, seed warehousing space will become an issue.

[9] See https://www.plantconservationalliance.org/sites/default/files/PCA%20NPGS%20-%20Native%20PGRs%20%2805-10-2021%29_1.pdf.

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The essential storage requirements for seed are low temperatures and low levels of relative humidity. Although in the arid West seed warehouses naturally experience low relative humidity for most of the year, temperature and humidity both can vary over the year. Nonetheless, most storage is at ambient temperature without any controls and therefore seed typically does not last more than a few years. Outside of the arid West, both control of relative humidity and cold temperatures are essential for maintenance of seed viability during the extended storage periods that are needed to maintain adequate supplies in advance of need. To-date there are no federal seed warehouses in the East. In all cases, warehouses with dry and cold and/or frozen storage would greatly extend shelf-life of seeds.

Since 2018 BLM has used its IDIQ to contract for the increase of SOS seed of different species collected from across numerous seed zones. As of 2021, BLM had contracted for over 94,000 pounds of seed expected to arrive between now and 2025, which will be put into the BLM seed warehouses for use by BLM emergency stabilization, wildlife habitat, pollinator, oil and gas, and other programs.

National Seed Strategy

In 2015, the Plant Conservation Alliance, an association of more than 400 non-federal cooperators and (initially) 12 federal agencies, produced the *National Seed Strategy* "to foster interagency collaboration to guide the development, availability, and use of seed needed for timely and effective restoration." That document describes itself as a framework that puts forward four broad goals and objectives:

1. identifying and quantifying seed needs
2. conducting research
3. developing tools for land managers
4. ensuring communications.

Much like the 2002 plan requested by Congress, it offers a conceptual structure for activities of the agencies. The 4 Goals, divided into 14 Objectives, which are further divided into 51 Actions, are all directed at the overall goal of increasing the supply of "the right seed, in the right pace, at the right time." The *National Seed Strategy* is the call to action. In FY2021, that call generated a robust response of a combined investment of $271 million and the involvement of 17 federal agencies, 27 tribes, and 481 non-federal partners in projects contributing to the 163 projects that were underway.

A summary of achievements in FY2021 include the collection of 1,434 native species, agricultural production of 1,118 native species, research on 692 species, production of 91,208 pounds of native seed, support for 118 farmers, 20 new facilities, 153 federal and 138 new non-federal jobs, and the restoration of 30,466 acres (Plant Conservation Alliance [PCA], 2022).

New Funds for the National Seed Strategy

The Bipartisan Infrastructure Legislation has allocated $200 million ($70 million to the Department of the Interior, $130 million to the Department of Agriculture, the latter for significant increase in tree planting by the USFS) over the next 5 years for the implementation of the Strategy, which may present an opportunity to begin to scale up the efforts currently underway.

PARTNERSHIPS FOR MORE EFFECTIVE SEED USAGE

In addition to buying and using native seed directly, the Federal government also affects native seed sales and usage through its support of programs and encourage, fund, and guide native seed usage in the private sector and with state and tribal governments. One of the largest of these is the USDA

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Conservation Reserve Program (CRP), which covers 21 million acres. Roughly half of that area is planted with native plant species. Other federal agencies provide awards and grants for seed purchases by states, or provide financial and technical assistance, such the USFS Cooperative Forestry program.

USDA Conservation Reserve Program

The CRP is a 35-year-old Farm Bill program of the USDA that incentivizes landowners to place marginal farmland into conservation uses via a 10-to-15-year contract, which may be renewed. These uses may include improving soil health, water quality, wildlife habitat, carbon sequestration, and pollinator support, although they do not include full ecosystem restoration or ecological integration into existing natural habitats. The program is voluntary, and landowners receive financial incentives and technical assistance. For larger areas, landowners competitively bid for inclusion in the CRP by indicating the conservation practice they will use on the land. For smaller areas, the program is non-competitive and funded on a first come, first served basis.

There are different practices for which landowners can subscribe, some using native plants and some using non-native plant species. In a presentation to the committee, Rich Iovanna of the NRCS and Bryan Pratt, Economic Research Service (ERS) estimated that 10 to 13 million acres of the CRP's current 21 million acres are planted with native species, although some non-natives are included in some "native" mixes. The species mix used by a given CRP landowner is specified by a conservation plan prepared by the landowner and approved by the NRCS, following recommendations made by NRCS county and state staff. In competitive proposals submitted by landowners, the inclusion of natives can increase the points given to bidders. The native species that are recommended and used in these mixes are typically based on native seed developed by the NRCS Plant Material Centers (PMCs). The majority of these natives are commercially viable and are derived from the 575 plant lines developed and maintained by the NRCS-PMC's and released to commercial growers for further increase. The seeds are purchased by landowners from private vendors, assisted by cost-sharing from the CRP.

The influence of CRP on the native seed market was noted by Laura Jackson (Director, Tallgrass Prairie Center, Iowa), who told the committee that the recent initiation of a pollinator-enhancing conservation practice in CRP created shortages of certain native seeds because of their popularity in many plans. Landowners receive about $200/acre reimbursement as a cost-share for adopting this pollinator practice. However, because the seed was not required to be of a local ecotype, there was an influx of less-expensive seed that caused certified seed to be comparatively expensive. Coincident with the arrival of the pollinator seed, growers reduced the use of certification services, which are optional for seed sellers. Certification validates the geographic origins of seed, but the service adds to the cost of seed (see Chapter 8, Box 8-2).

A report from the USDA Economic Research Service (Pratt and Wallender, 2022), concluded that landowners most often bid to install a "premium" native grass mix (which includes forbs), which is 4 times more expensive than a simpler "base" mix of non-native grasses ($107 versus $25 per acre). The paper observes that the cost of seed is a significant fraction of the total cost of installing the practice and that it is significantly more expensive in the Midwest to upgrade from base to premium ($65 to $112 per acre) than in the Plains and Mountain states ($21-$43 per acre). The authors calculate that decreasing the cost of the seed by $10 per acre would move 0.6 percent of acreage to the higher quality practice. Alternatively, they postulate that increasing the cost-share provided to landowners would also incentivize an upgrade to plant a higher quality mix of natives.

John Englert (NRCS National Program Leader) observed that the diversity and ecosystem functionality of CRP lands, as well as other lands on which NRCS assists private landowners, could be improved if PMCs could devote more resources to developing native materials, including local ecotypes.

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USFS Programs that Support Private Land

The USFS manages Federal forested lands, but its mission reaches beyond Federal lands through its State and Private Forestry outreach to states, tribes, communities, and non-industrial private landowners. Programs in this area provide technical and financial assistance to landowners and resource managers to help sustain forest and grasslands, protect communities from wildland fires, and restore fire-adapted ecosystems. In doing this, the federal investment leverages the capacity of its partners to manage state, tribal, and private lands. Examples include forest health protection that provides technical assistance on such things as native and non-native insects, pathogens, and invasive plants. The Cooperative Forestry program provides financial and technical assistance to landowners, communities, and businesses to actively manage and sustain long-term investment in non-federal forest land.

US Department of Transportation's Federal Highway Administration

The U.S. Department of Transportation (USDOT) allots funds to the state DOTs through the Federal Highway Administration (FHWA) to state DOTs. Since 1987, the use of native plants in roadside construction and maintenance has been incentivized by FHWA requirements for at least ¼ of 1% of the cost of roadside landscaping include native wildflowers. Many state DOTs have pursued the expansion of native plantings that support pollinators and the Monarch butterfly. As described in this chapter, the DOTs in both Iowa and Texas have played important roles in assisting efforts to develop local ecotypes of native plants.

DISCUSSION

The committee's investigation into cooperative partnerships further broadened its view of the national capacity to generate a supply of native seeds and revealed their potential in growing the native seed supply. First, federal agencies have developed, engaged in, and supported cooperative partnerships for over twenty years and these partnerships play a central role in helping them to meet their needs for seed. The large, regional native plant materials development and restoration programs initiated in the West by the BLM and USFS are broadly cooperative, and involve government at all levels, the tribes, colleges, nongovernmental organizations, and native seed producers. BLM established a national native seed collection program, in partnership with six non-federal seed banks as the stewards of those collections. And, along with more than 400 non-federal cooperators, twelve federal agencies have committed to an expansive strategy with 51 Action Steps of the National Seed Strategy, each step a collaboration of different players, collectively aimed at bringing land-managers the plant materials and decision tools they need to lead successful ecological restorations.

Second, time and again, independent efforts have arisen in states and regions across the United Sates in response to the need for native plant materials. New efforts continue to develop, some including federal partners, some without, but all involve cooperators, and several have developed business plans for expansion. These findings suggest that:

- Regional cooperative efforts have shown to be successful approaches to tackle the native plant material supply issues.
- Seed resources and seed needs cross jurisdictional lines. With climate change and fragmented, shrinking habitat, it will increasingly be essential to develop cooperative arrangements that ensure that jurisdictional authorities are not barriers to securing a reliable supply of restoration materials for everyone.
- Existing regional efforts can benefit by expanding to include additional federal and non-federal partners.

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Despite these efforts, these partnerships have not yet been able to move the native seed supply chain over the threshold to achieve a level of reliability and predictability that is needed to offer a sustainable supply of a diverse native seed. Continued shortages of seed suggest that the supply chain is underdeveloped, and in some places lacking all together, when what is required to meet the growing needs is an enterprise that is more robust and at a much larger scale. In the committee's assessment, achieving that goal will not be possible without all the key players that play a central role in the native seeds supply chain, including native seed suppliers. In the next chapter, the committee provides its findings from suppliers, who are central to solving the supply puzzle.

In addition, the committee sees a critical role for leadership at the federal level to complement, extend and strengthen the work of regional partnerships. Some regions do not yet have seed partnerships, and federal agencies can take the lead in their establishment. Existing and future regional partnerships will function more effectively if there is a coordinated nationwide approach to policies, research, data collection and information sharing.

CONCLUSIONS

Conclusion 6-1: *There are several examples of successful seed development, seed production, and restoration programs initiated at the state level, sometimes begun with state support and sometimes with federal support.*

Conclusion 6-2: *Over the last twenty years, regional programs initiated by the BLM and USFS to meet their native seed needs have included an array of partners from state and local governments, universities, and the private sector native seed and restoration industries.*

Conclusion 6-3: *The Seeds of Success program should continue as a national effort and expand its collection activities across the United States and increase its cooperative relationships with regional seed banks. The availability of seed supplies for native shrubs will remain reliant on private sector collectors, as to date, efforts to produce shrubs in seed fields have not proven economical.*

Conclusion 6-4: *An expansion of temperature and humidity-controlled seed warehouses across all regions of the United States would support the ability to have seed available for when it is required.*

Conclusion 6-5: *The ready availability of cooperative seed cleaning facilities is important to encourage smaller-scale producers to enter the native seed supply chain, especially in areas where commercial facilities do not exist, or are unwilling to clean native seed.*

Conclusion 6-6: *Although the Conservation Reserve Program is not an ecosystem restoration program, the use of native seeds on private lands contributes to functioning ecosystems and plays a role in supporting the native seed supply. Private landowners seem willing to implement conservation practices with higher ecological values on their land to enhance the competitiveness of their bids for inclusion in the program. Lowering the cost of native seeds to landowners, potentially through a subsidy or premium, would incentivize more landowners to plant native seeds.*

REFERENCES

Barga, S.C., T.E. Dilts, and E.A. Leger. 2018. Contrasting climate niches among co-occurring subdominant forbs of the sagebrush steppe. Divers Distrib.24: 1291– 1307. https://doi.org/10.1111/ddi.12764.

Baughman, O.W., A.C. Agneray, M.L. Forister, F.F. Kilkenny, E.K. Espeland, R. Fiegener, M.E. Horning, R.C. Johnson, T.N. Kaye, J. Ott, J.B. St. Clair, and E.A. Leger. 2019. Strong patterns of

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intraspecific variation and local adaptation in Great Basin plants revealed through a review of 75 years of experiments. Ecol Evol. 2019; 9: 6259– 6275. https://doi.org/10.1002/ece3.5200.

Esque, T. C., L.A. Defalco, G.L. Tyree, K.K. Drake, K.E. Nussear, and J.S. Wilson. 2021. Priority species lists to restore desert tortoise and pollinator habitats in Mojave Desert Shrublands. Natural Areas Journal, 41(2), 145– 158. https://doi.org/10.3375/043.041.0209.

Leger, E. A., S. Barga, A.C. Agneray, O. Baughman, R. Burton, and M. Williams. 2021. Selecting native plants for restoration using rapid screening for adaptive traits: Methods and outcomes in a Great Basin case study. Restoration Ecology, 29(4), e13260.

Massatti, R., H.R. Prendeville, S. Larson, B.A. Richardson, B. Waldron, and F.F. Kilkenny. 2018. Population history provides foundational knowledge for utilizing and developing native plant restoration materials. Evol Appl 11(10):2025-2039.

Massatti R, D.E. Winkler, S. Reed, M. Duniway, S. Munson, and J.B. Bradford. 2022. Supporting the development and use of native plant materials for restoration on the Colorado Plateau (Fiscal Year 2021 Report). Report submitted to the US Department of the Interior Bureau of Land Management on May 5th, 2022.

Shryock, D.F., L.A. DeFalco, and T.C. Esque. 2022. Seed Menus: An integrated decision-support framework for native plant restoration in the Mojave Desert. Ecology and Evolution 12(4): e8805.

Williams, A.P., B.I. Cook, and J.E. Smerdon. 2022. Rapid intensification of the emerging southwestern North American megadrought in 2020–2021. Nature Climate Change 12(3):232-234.

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7

Seed Suppliers

INTRODUCTION

This chapter reports on findings of the Committee from its survey of firms that supply native seed and native plants (seedlings and vegetative materials). As with the state agency buyer survey, methodology details appear in Chapter 2.

The supplier survey sought to explore supply-side observations from the Committee's 2020 interim report (see Box 1-2). In particular, the survey explored the research questions that emerge from the interim report's Observations 3, 5, 6, 7, and 8:

- How do timeframe, quantity, and quality affect the production decisions of native seed suppliers?
- What factors affect buyer costs of production for native seed?
- How and to what degree do communication, market and production risk, and the design of contracts with buyers affect what and how much native seed suppliers elect to produce?
- How adequate are suppliers' storage facilities for native seed?
- How do the factors above vary by region of the country (West vs. East) and scale of production?

The chapter begins by characterizing the firms that supply native seed by size, region, product mix, and source of seed genetics. It proceeds to examine the buyers and contract arrangements used, as well as how suppliers anticipate likely demand. Given time lags for seed production and the time and cost of producing locally adapted native seed, the chapter examines how suppliers cope with risky production conditions and uncertainty about which native seed species will have markets at the end of the production cycle. The chapter reports supplier responses on the share of year-end unsold native seed inventories and the adequacy of storage facilities to keep seed in good condition. The chapter closes with suppliers' views on the challenges to expanding the supply of native seeds and native plants.

BUSINESS ACTIVITIES OF FIRMS – PRODUCTS OFFERED

As discussed, the Committee's goal for the supplier survey was to focus on businesses that sell native seed and/or plants, either exclusively or as part of their broader offerings. At the beginning of the survey, respondents were asked several questions about the seed and plants they sell. Among the firms contacted, 81% said that they sell native plants, while 56% indicated that they sell native seed, 33% sell non-native seed, and 45% sell non-native plants (Figure 7-1). Because the intent of the survey was to learn about the experiences of suppliers of native seeds and plants, respondents who said that they do not sell natives of either seed or plants were deemed ineligible and not asked further questions about their business.

Among the eligible respondents, businesses from the West were more likely than those in the East to sell non-native seed (38% versus 29%), but for other types of seed or plant material, the answers from East and West suppliers were similar.[1] To obtain a sense of the size of the businesses included in the

[1] The committee used the same definition of East and West as for the survey of state departments. East includes AL, AR, CT, DE, FL, GA, IA, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, NC, ND, NE, NH, NJ, NY, OH, OK, PA, RI, SC, SD, TN, TX, VA, VT, WI, WV; West includes AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY.

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survey, suppliers were asked to provide an estimate (choose from six categories) of their average annual sales and operating revenues during the period between 2017-2019. Suppliers with larger sales revenues were more likely to sell seed (native and non-native) than businesses with smaller sales. This may be related to a customer base that includes private landowners that buy native and non-native seed for hay or rangeland. Smaller businesses were more likely to sell native plants than larger businesses (Figure7-2).

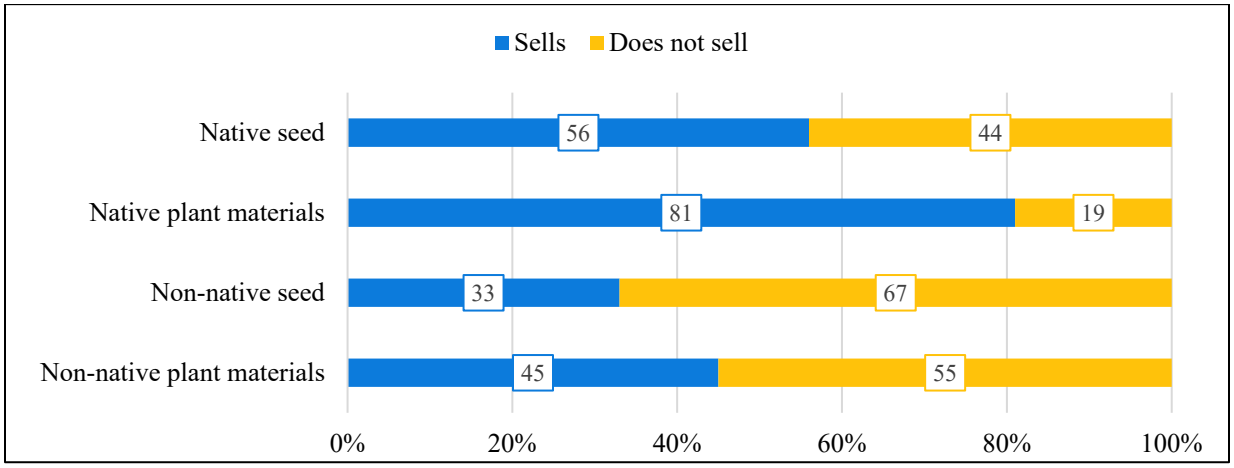


FIGURE 7-1 Types of seed and plants sold by respondents to the supplier survey.

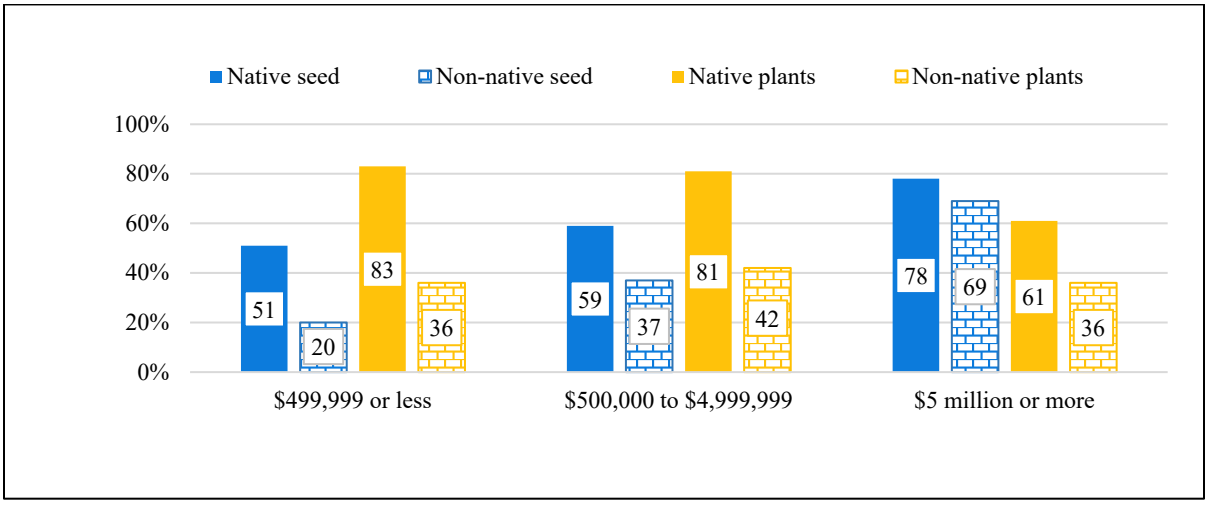


FIGURE 7-2 Types of seed and plants sold by suppliers, by annual sales.

Suppliers who sold native seed were asked questions about where they obtain the seed they sell (Figure7-3). More than half sell seed they have collected from the wild, and about two-thirds purchase seed on the market to resell directly. This suggests that many suppliers may be seed consolidators, or that buy seed to expand their range of product offerings. Fifty-seven percent will plant seed they wild collected to grow plants to increase seed for sale, and one-third will use seed they purchased on the market for that purpose. A little less than half will do the same with wild collected seed obtained from another source, such as a collaborating organization.

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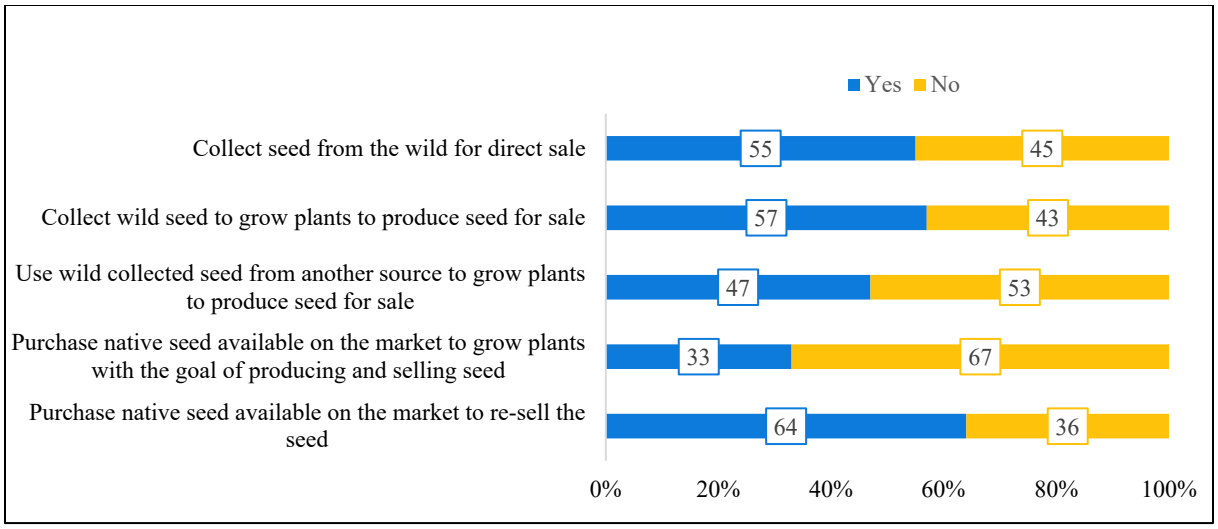


FIGURE 7-3 Supplier's source of native seed.

Suppliers who said they sold native seed were asked whether they sold several different categories of native seed (Figure7-4). Approximately two out of three (68%) reported selling "Uncertified seed of claimed wild origin" and two out of three (65%) sell "Certified source-identified seed."

This question was further examined for differences in regions. Around 70% of western suppliers and 61% of eastern suppliers indicated they sold certified source-identified seed. Suppliers from the West were more than twice as likely to sell "Seed types meeting Bureau of Land Management (BLM) requirements" than Eastern suppliers (49% versus 22%). About half (48%) of suppliers from the East and two out of five (40%) of Western suppliers said that they sell "Seed mixes complying with USDA conservation programs".

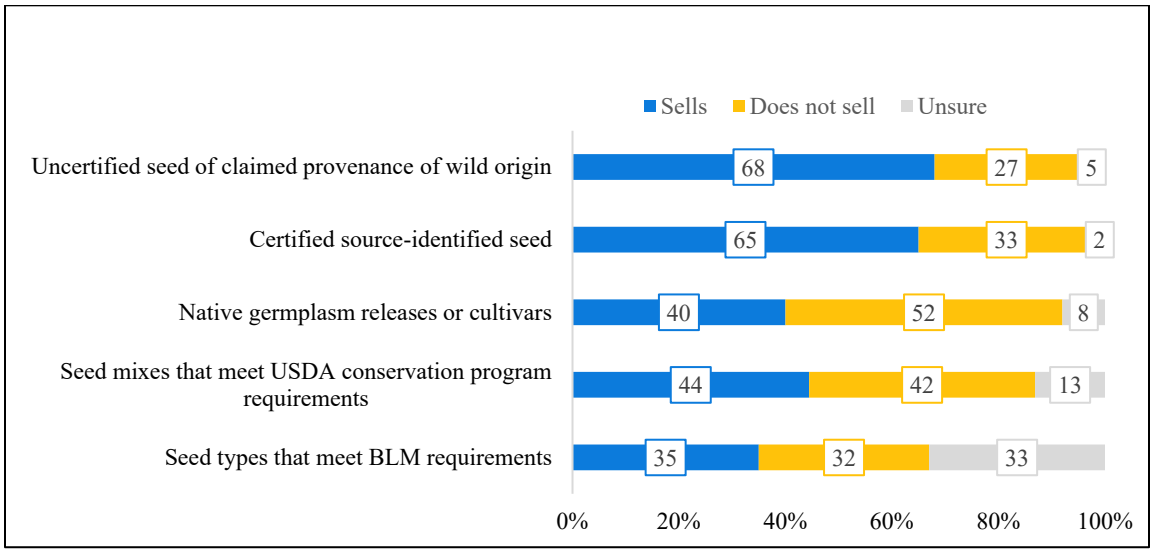


FIGURE 7-4 Types of seed sold by native seed suppliers.

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Seed Suppliers

Native plant and seed suppliers were asked if they sold plants or seeds from different locations, to match different geographic conditions or seed zones, as in different ecotypes of the same species. This question was summarized by region and by sales revenue (Figure 7-5). While nearly 70 percent of suppliers overall offered plants or seed of this nature, they were more likely to be offered by suppliers with the largest sales revenue (87%). Western suppliers were more likely than eastern suppliers (78% vs 60%) to offer plants or seeds matched to different geographies or seeds zones.

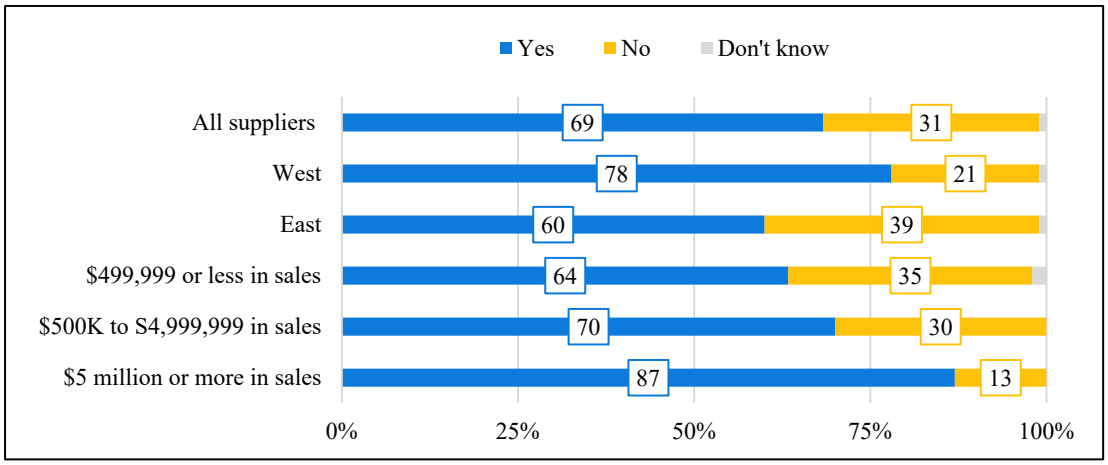


FIGURE 7-5 Sale of native plants or seeds sourced from different locations to match different geographical conditions or seed zones (different ecotypes of the same species), by region and size.

Suppliers were asked the percent of their total native seed sales that were represented by native seed of different plant types (grasses, forbs, shrub, trees, or other). Figure 7-6 shows a profile of suppliers and the concentration of product types as a proportion of their total native seed sales, ranging from zero percent of their total sales to 100 percent of sales on the x-axis. For example, the first set of bars on the left show that almost sixty percent (58%) of growers reported that seeds of native trees represented zero percent of total sales. The set of bars on the far right of the graph shows that seeds of native trees make up 100% of the total native seed sales of about 8% of suppliers.

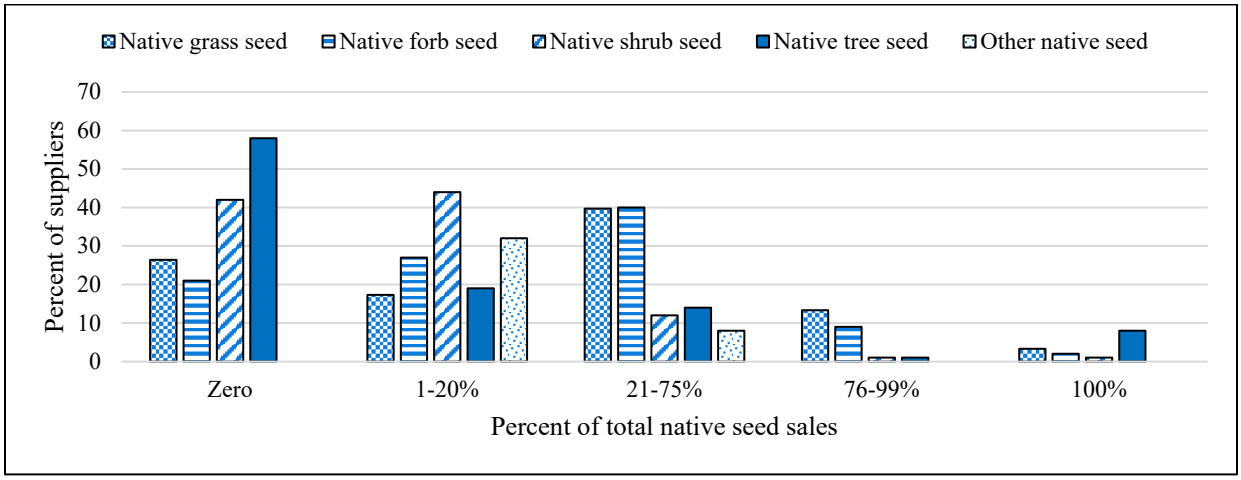


FIGURE 7-6 Types of native seed sold by suppliers in relation to total native seed sales.

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In the middle set of bars, 40% of suppliers said that seed of native grasses and forbs made up between 21-75% of total sales. Much lower proportions of suppliers said seeds of native shrubs, trees, or "other" made up between 21-75% of total sales. The figure suggests that seeds of native shrubs and native trees represented a smaller proportion of total sales, relative to grasses and forbs, for the majority of suppliers in the survey. The means (M) and medians (Mdn) for the supplier responses to the question about what percentage of their total native seed sales were represented by each category were as follows: native grass seed M=37, Mdn=30; native forbs seed M=32, Mdn=25; native shrub seed M=9, Mdn=2; native tree seed Mean=17, Mdn=0, other native seed M=5, Mdn=0.

Similarly, suppliers of native plants (as opposed to native seed) material were asked the percent of their total native plant sales that were represented by each native plant material of different type (native grasses, forbs, shrubs, trees, or other). Figure 7-7 shows a profile of suppliers and the concentration of product types as a proportion of sales (expressed in groups of increasing proportion).

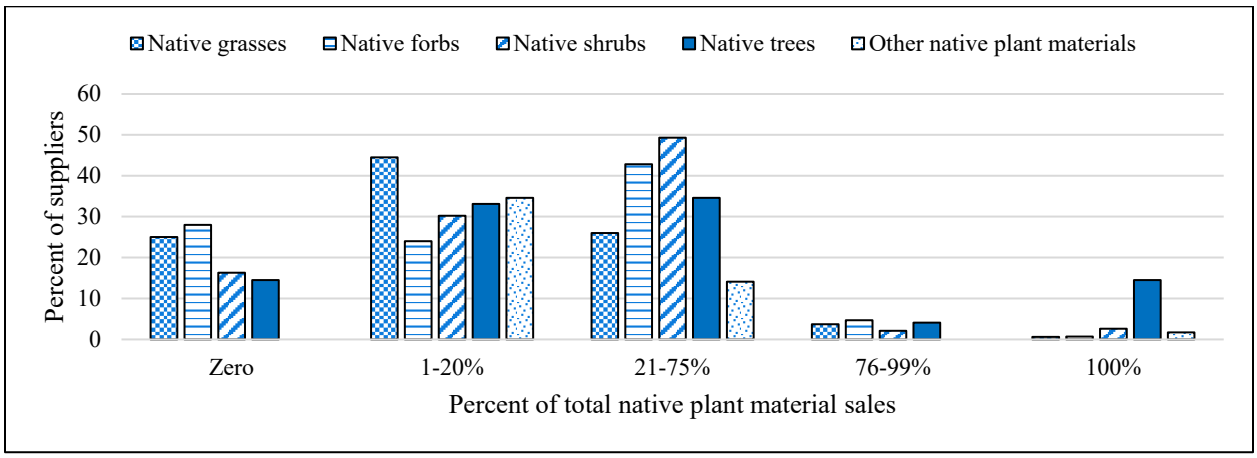


FIGURE 7-7 Types of native plants sold by suppliers in relation to total plant material sales.

The bars in the middle of the figure show that about half (49%) of the suppliers indicated that native shrub plant material made up 21-75% of their total plants sales. Forty-three percent and 35% of suppliers, respectively, said that native forbs and native trees made up 21-75% of their total sales. Forbs appear to be sold as much in plant form as seed, given that 40% or more suppliers indicate they make up between 21-75% as a percent of sales of both seeds and plants. The mean (M) and median (Mdn) for the supplier responses to the question were as follows: native grasses M=18, Mdn=10; native forbs M=25, Mdn=20; native shrubs M=25, Mdn=25; native trees Mean=35, Mdn=25, other native plants M=10, Mdn=1.

Business Activities of Suppliers – Other Services

Suppliers were asked in an open-ended question if they sell services and if so, to specify the services they offer. Thirty-six percent of those that answered the question said they provide services. Seed cleaning and installation (site preparation and planting of seeds and trees) were the two most frequently offered services, each mentioned by approximately one in three of those who said that they offered services in addition to selling seed or plants. Other services mentioned included consulting and design, seed collection, ecological restoration, and contracting growing. A few suppliers said that they offer landscaping and weed management.

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Business Activities of Suppliers—Clients

The survey asked suppliers to indicate what relative portion of their annual sales were represented by sales to different buyers. Figure 7-8 shows the importance of private contractors to most suppliers—over 60% of suppliers said that private contractors represent a major portion of their sales. Approximately one in four suppliers said that state agencies were a major portion of sales. About the same fraction of suppliers (23% and 22% respectively) indicated that municipalities and not-for-profit organizations were a major portion of sales. About 19% of suppliers said that farmers and ranchers and federal agencies represented a major portion of sales, and even fewer (7%) said that tribal governments were a major portion of sales. As states, municipalities, tribes, and the federal government often contract out seeding work, the importance of contractors in sales may obscure the true "buyers" of seed for seeding projects.

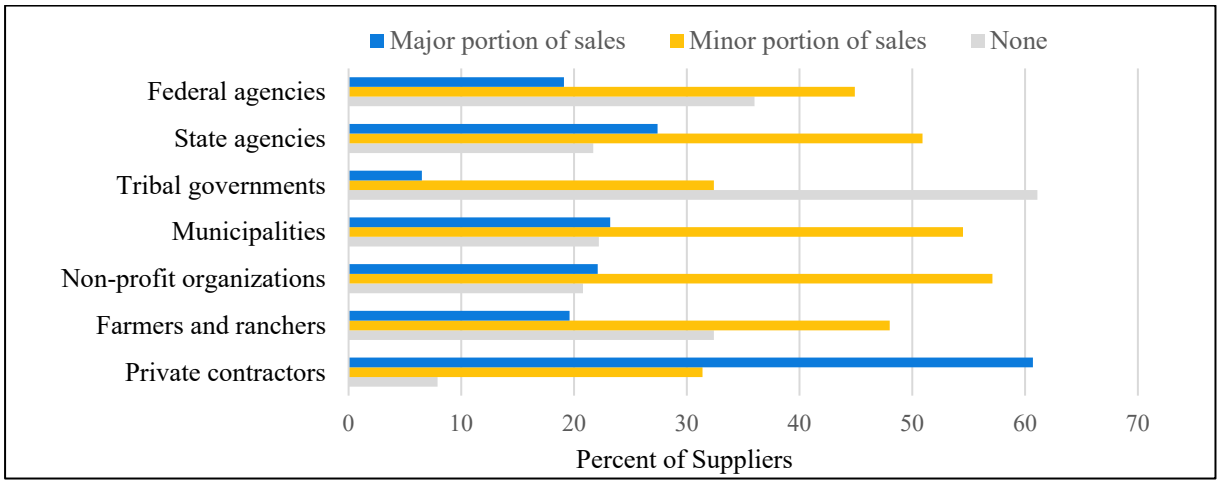


FIGURE 7-8 Portion of annual sales of native seed and plants represented by various customer types.

Business Activities of Suppliers—Communications

Suppliers were asked about possible methods for communicating with potential buyers about what their business offers (Figure7-9). The great majority of suppliers indicated that a company website (85%) and/or word of mouth (97%) were used. Three out of four suppliers communicate through their bids to requests for proposals (RFPs) and two out of four mentioned vendor registries.

When asked to specify what "other" methods suppliers use to communicate with potential buyers, social media was the most frequent method mentioned, along with emails and newsletters. Some suppliers also mentioned trade shows, seed associations, and native seed groups. A few said that their long history in the business and long-standing customers serve as a means of communication with potential buyers.

Business Activities – Contracting Arrangements

- The survey asked suppliers whether they used certain types of contracting arrangements: "Bids on consolidated seed buys," which are responses to public procurement requests made by government agencies;
- "Spot market sales of available seed or plants," which are exchanges between buyers and sellers that do not specify any conditions of sale or production;

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- "Marketing contracts," which specify the type, price, quantity, and delivery date of seed or plants and guarantee a purchaser for that seed or plants; and guarantee a purchaser for that seed or plant materials; and
- "Production contracts" which share some production costs and/or production risks by providing flexibility in the quantity delivered and/or delivery date.

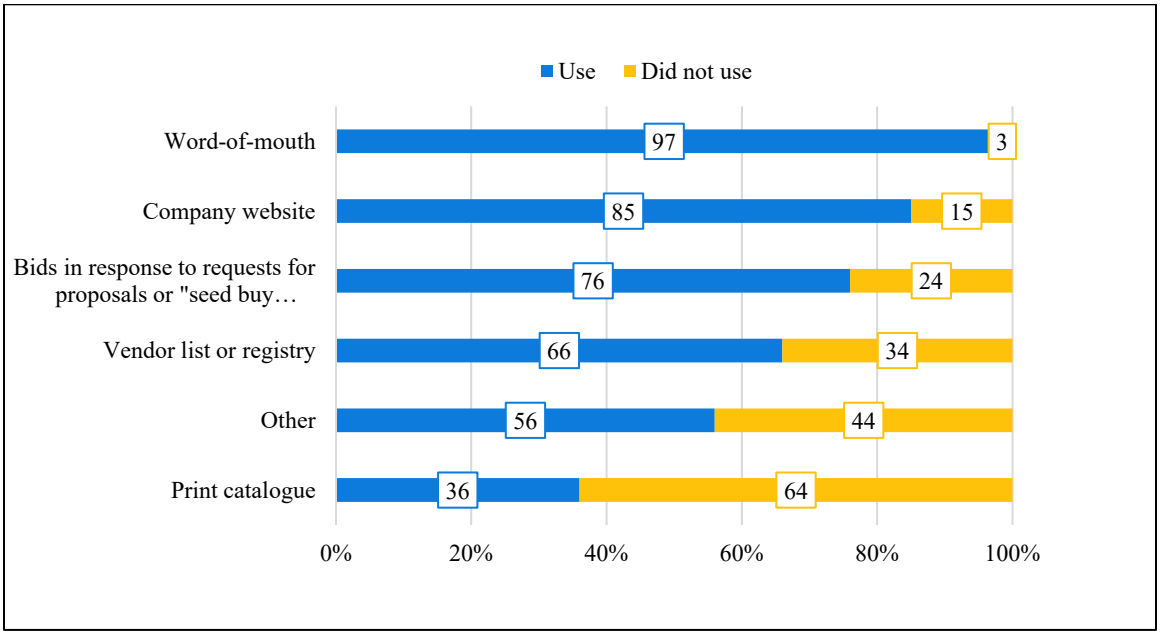


FIGURE 7-9 Suppliers' methods of communicating about what the business offers.

Figure 7-10a shows that about 23% of all suppliers bid on consolidated seed buys. For each of the other three types of contracting arrangements. Thus, slightly less than half as many suppliers bid on consolidated seed buys than use any of the other contracting arrangements, around half the suppliers said they used it. BLM operates the consolidated seed buys to obtain seeds largely to address post-wildfire needs in the West.

Approximately half of the suppliers who provided an answer to the questions about contracting arrangements said that they use more than one type. Utilizing multiple contracting types may reflect differences in buyer and/or supplier preferences. It may also reflect differences in suppliers' revenues and regional markets.

The analyses were also examined by location of the supplier in the United States. Figure7-10b shows that about one in four (24%) suppliers in the West and one in five (21%) suppliers in the East indicated that they bid on consolidated seed buys, which is surprising because the BLM consolidated seed buys typically seek species and ecotypes for use in the West. Suppliers in the West were more likely to use marketing and production contracts than suppliers in the East. Suppliers in the West appeared slightly less likely to sell via spot market sales than to sell using marketing and production contracts. In contrast, suppliers in the East appeared slightly more likely to sell via spot markets than to sell using marketing and production contracts.

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Seed Suppliers

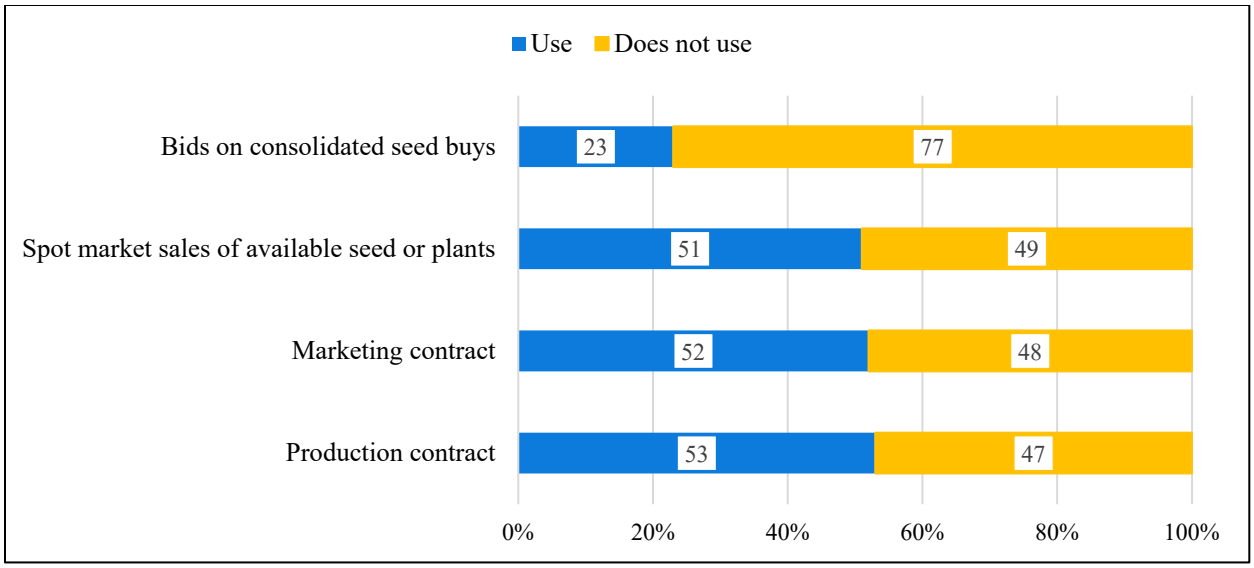


FIGURE 7-10a Types of contracting arrangements used by suppliers.

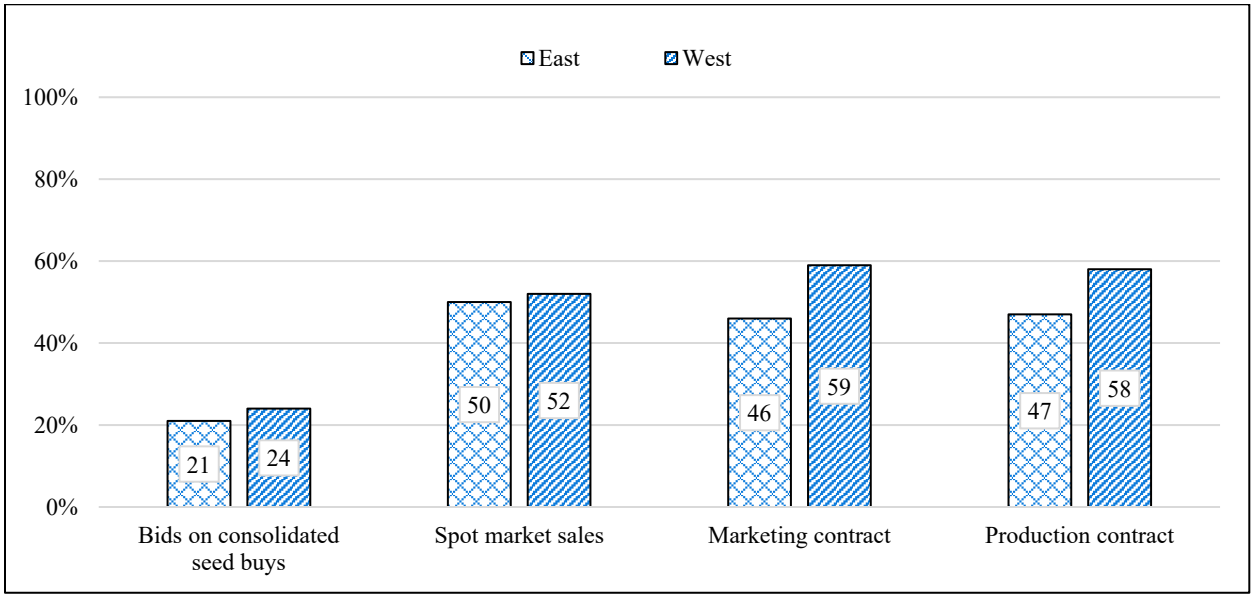


FIGURE 7-10b Types of contracting arrangements used by suppliers by region.

The analyses were next summarized by categories of sales revenue. Figure 7-10c shows that a higher percent (57%) of firms in the category of highest annual sales revenue ($5 million or more) bid on consolidated seed buys versus suppliers with mid-size or smaller revenues (26% and 13%), respectively. The same is true for spot market sales and marketing contracts: a higher percentage of firms in the highest annual sales revenue category use these arrangements as compared to the other sales categories: (79% for the $5 million or more versus 52% and 47% for the next two lower categories, respectively) and marketing contracts (70% for the $5 million or more versus 55% [mid] and 45% [small]). A larger percentage of suppliers in the category of middle-sized sales revenue ($500,000 to $4,999,999) said that they use production contracts (64%) than those in the largest sales category (59%) or smallest sales category (47%) sales. Thus, it appears that suppliers with middle-sized sales revenues were more likely to

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engage in risk-sharing contracting arrangements than large or small suppliers were. In general, the largest respondents are more likely to utilize multiple contracting arrangements. Twenty-eight percent of large suppliers used all four, while only 14% of mid-size firms and 8% of small firms did.

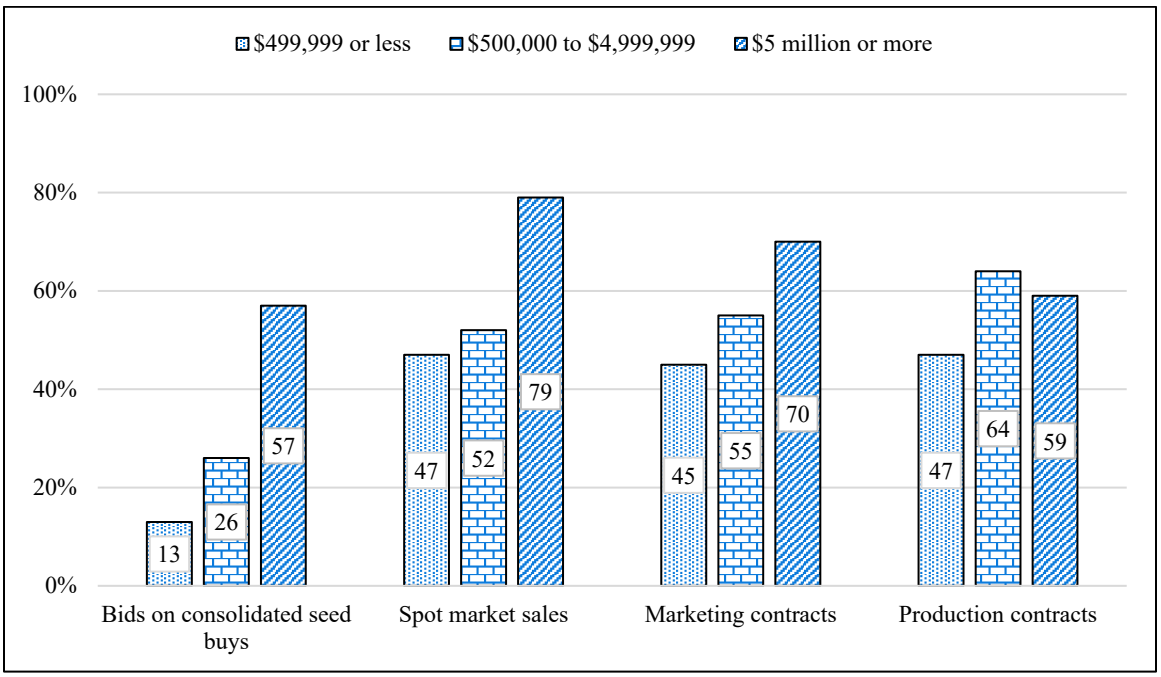


FIGURE 7-10c Types of contracting arrangements used by suppliers, by annual sales.

The survey asked suppliers how important different contract characteristics are to them (Figure7-11a). A prior positive experience with a buyer and delivery timeline, were both identified as "important" or "somewhat important" to over 80% of suppliers. A price guarantee and the guaranteed purchase of a predetermined quantity of seeds or plant material were similarly important. In contrast, a much smaller proportion of suppliers (35% and 29%, respectively) found that multi-production cycle contracts or production cost-sharing was important or somewhat important. Guaranteeing a sufficiently high price can substitute for sharing the expected production cost. However, a higher price may not necessarily substitute for sharing production risk, which depends on the relative magnitude of price compared to production cost and also the supplier's attitude toward risk. Due to the substitutability across price guarantee, purchase quantity guarantee, and production cost sharing that are characteristics of marketing and/or production contracts, a substantial majority of respondents deemed market factors a significant consideration.

Responses to this question were also disaggregated by the location and sales revenue categories of the supplier. Suppliers from the East and West were generally similar in their views on the importance of these characteristics. A slightly higher proportion of western suppliers (83%) than eastern growers (76%) indicated that a purchase guarantee for a predetermined quantity was important or somewhat important. As shown in Figure 7-11b, for most contract characteristics, suppliers in the highest sales category were most likely to state that the characteristic was important or somewhat important. However, approximately three out of four or more respondents in all sales revenue categories said that price guarantee, purchase guaranteed for predetermined quantity, delivery timeline, and prior positive expertise with the buyer were somewhat or very important characteristics.

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Seed Suppliers

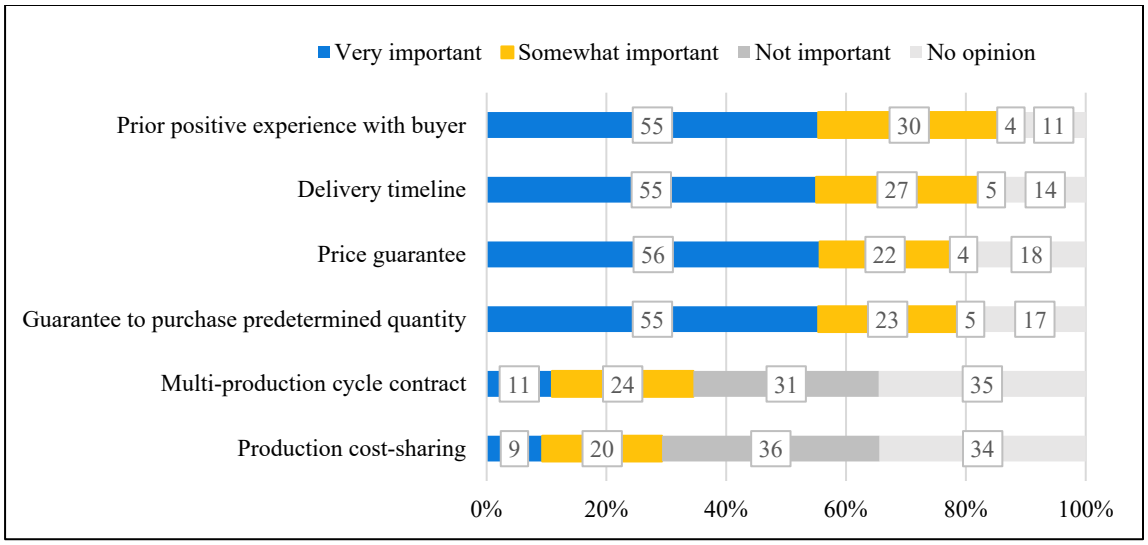


FIGURE 7-11a Importance of contract characteristics to suppliers.

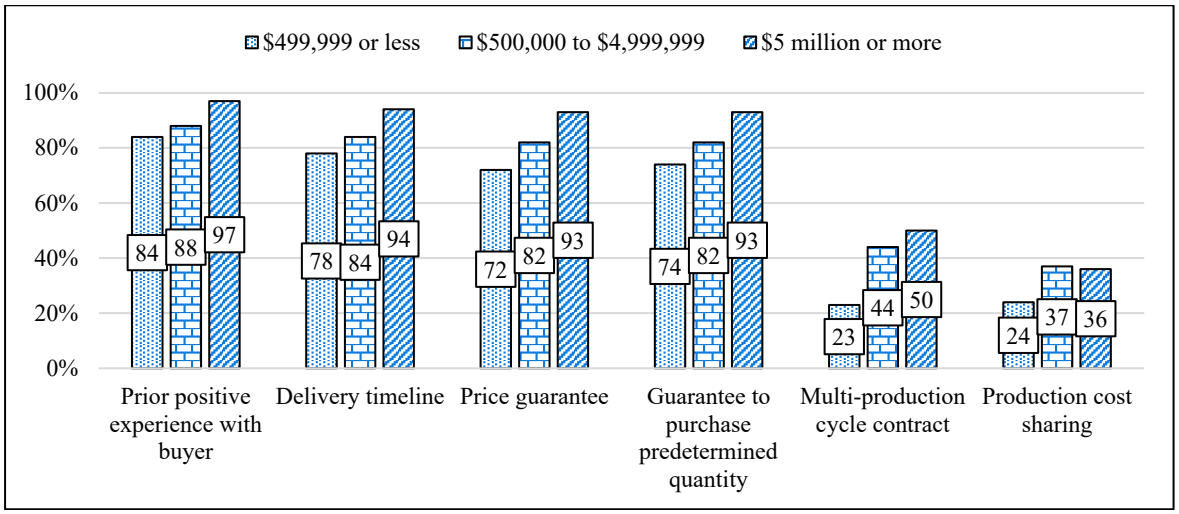


FIGURE 7-11b Importance of contract characteristics to suppliers, by annual sales (very important or somewhat important responses).

When suppliers were asked about the timing of signing a contract relative to when they would start to produce native seeds or plant material for sale, about half (47%) of all suppliers indicated they normally sign a contract after seed production is complete. This suggests they have seed stored and ready for testing and delivery. Figure 7-12 shows some nuances for groups of suppliers for the three categories of overall sales, and this might further vary by plant species. The first two sets of bars in Figure 7-12 should be interpreted with caution, as suppliers were asked about "foundation seed" as a proxy for any seed used as starting material for production, however the term has specific meaning with respect to seed certification.

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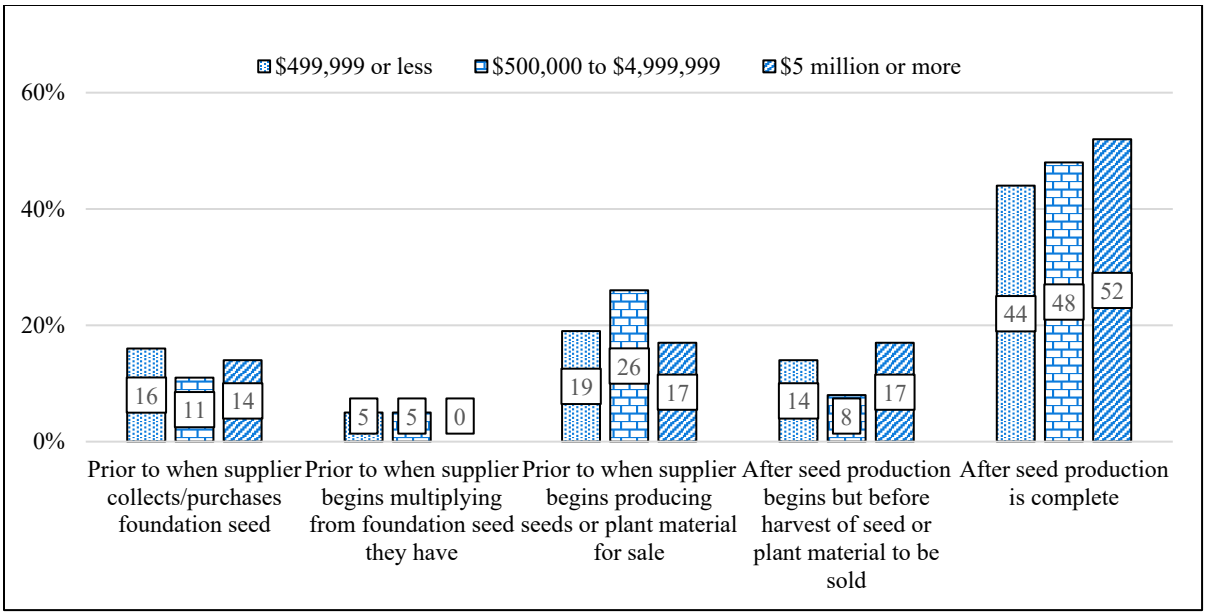


FIGURE 7-12 Typical timing of when a contract is signed, by annual sales.

Business Activities of Suppliers—Anticipating Demand

Suppliers were asked about the role different types of information play in how they anticipate future demand for native seed or plants in order to plan ahead. Figure 7-13 shows that "past purchases or requests from buyers" plays a major (56%) or moderate (28%) role for nearly all suppliers. More than half said that "demand for urban and home landscaping" plays a major (32%) or moderate (26%) role. The broad range of responses in the "Other" category reflected suppliers' interest in monitoring developments and opportunities related to native seed and plants both locally and nationally. Notably, the Conservation Reserve Program administered by USDA plays major and moderate roles for a larger share of suppliers in our survey than either wildfire activity or BLM seed buy history.

Not being able to accurately anticipate demand can result in unsold seed, and suppliers were asked to provide an estimate of approximately what percentage of their inventory of native seed and plants was left unsold at the end of the marketing year during 2017-2019. Seventy-seven percent of the responding suppliers said that the percentage of native seed and plants left unsold was about what they anticipated. About 10% indicated that there was more left than anticipated, and 13% indicated that it was less than they had anticipated. Figure 7-14 shows the approximate percentage of inventory unsold at the end of the marketing year.

Interestingly, pairing these responses with buyers' responses about the availability and price of desired native seed and plants suggests that suppliers are able to market seed by anticipating buyers' willingness to substitute. Moreover, demand for seed that is an acceptable second choice for many buyers may be more predictable than demand for more specialized seed, which is more limited and potentially more variable. Of the respondents who replied that less than or about what they anticipated was left unsold, 44% considered insufficient demand a major or moderate challenge and 74% deemed unpredictable demand a major or moderate challenge. Another potential reason that the great majority of suppliers were on target at selling inventory may be that most have adequate storage (see below) and planned for inventory carryover.

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Seed Suppliers

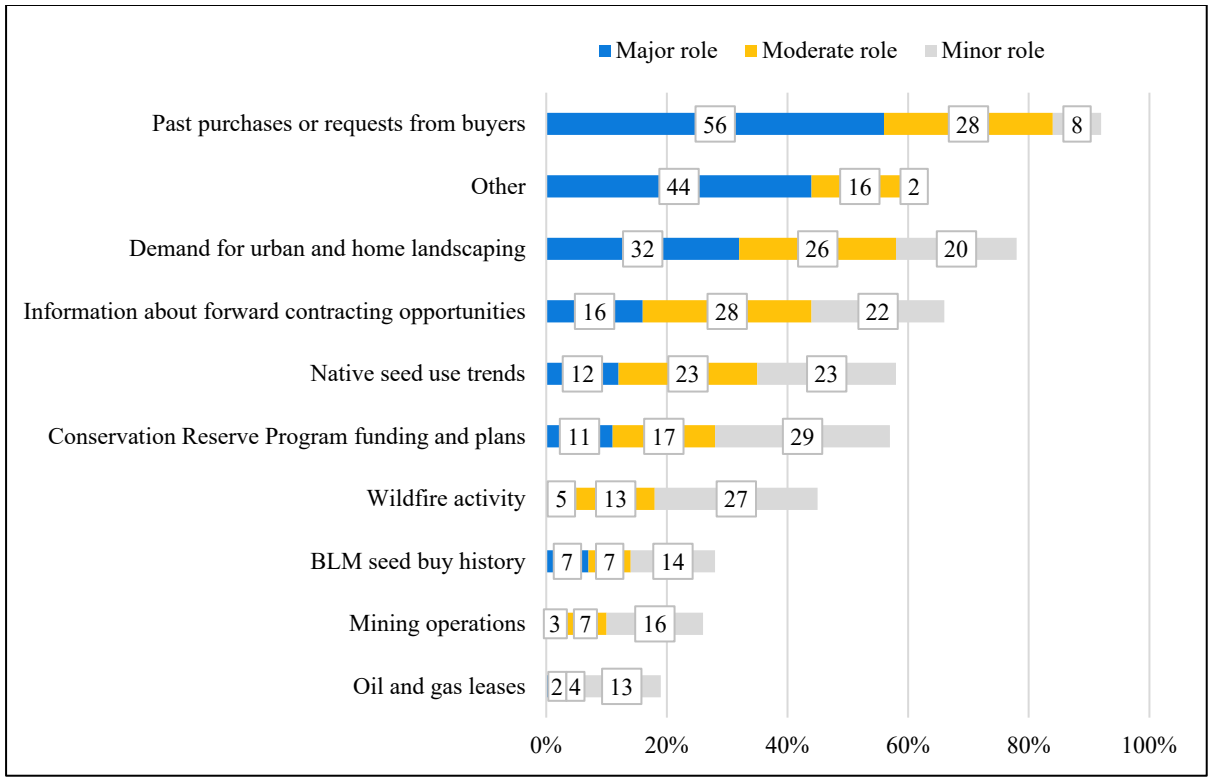


FIGURE 7-13 Types of information used by suppliers in anticipating future demand.

Responses were examined by the three categories of overall sales. Among middle-sized suppliers ($500,000 to $4,999,999 in sales) 18% indicated that there was less left unsold than they anticipated, compared to 10% among small-size suppliers and 14% among large suppliers. It is not immediately clear why middle-size supplier had less unsold than they anticipated. This could be related to the markets served and business models of middle-sized companies.

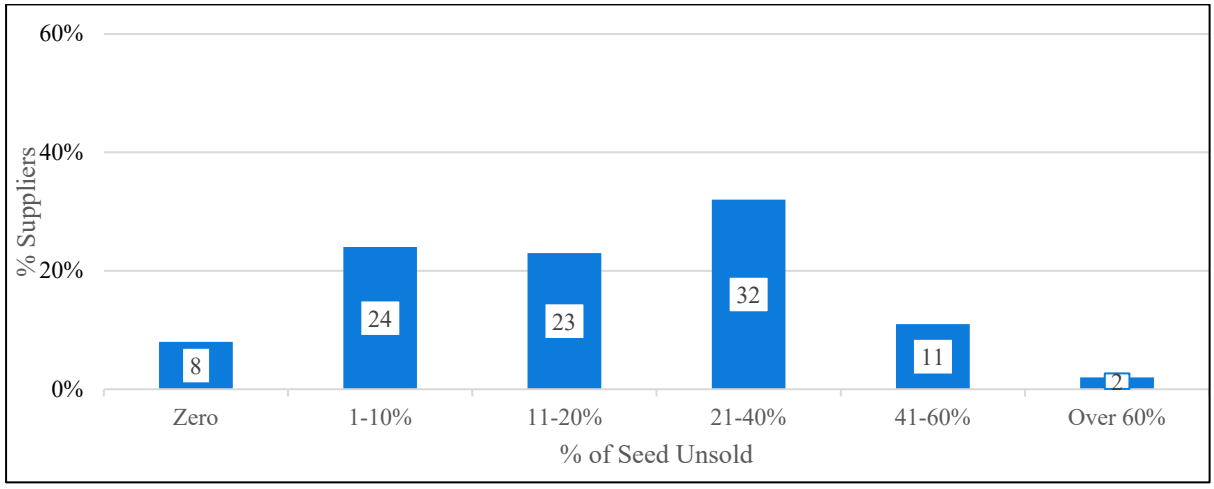


FIGURE 7-14 Approximate percentage of inventory unsold at the end of the marketing year.

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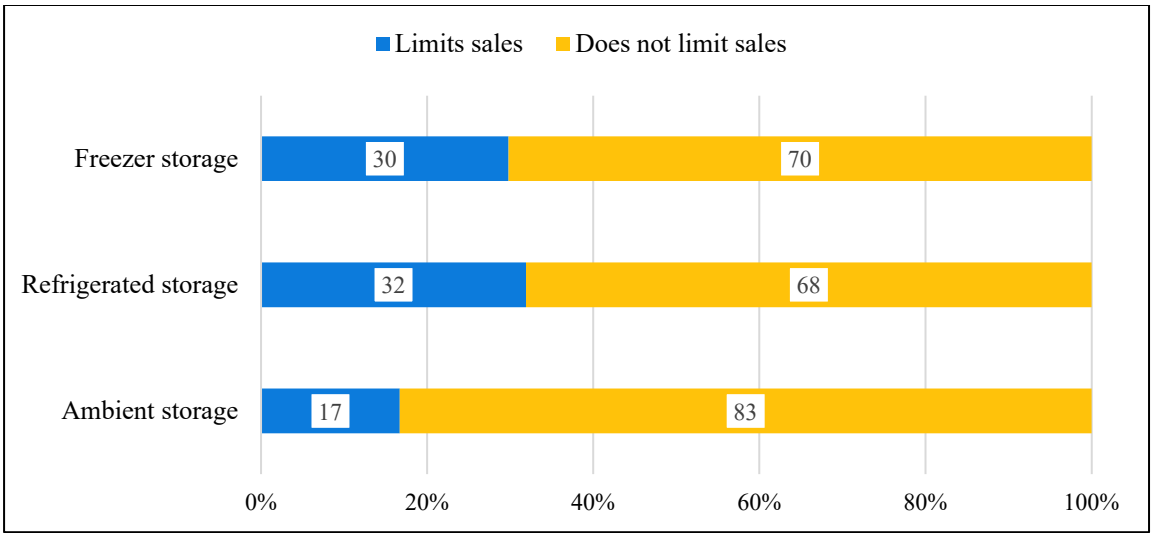


FIGURE 7-15a Impact of lack of storage on the quantity of seed suppliers can sell, by storage type.

Suppliers were asked about the extent to which the availability (or lack thereof) of different types of storage (freezer storage, refrigerated storage, and ambient storage) limits the quantity of seed they can sell. Approximately 30% of the responding suppliers said that the lack of freezer storage and/or refrigerated storage (32%) limits their sales (Figure 7-15a). There were no differences between how suppliers in the East and West answered this question. However, as shown in Figure 7-15b, storage is more of a limiting factor for quantity of seed potentially sold relative to the size of the suppliers (based on annual sales). In particular, nearly 40% of smaller firms said that they are constrained by limits on refrigerated storage.

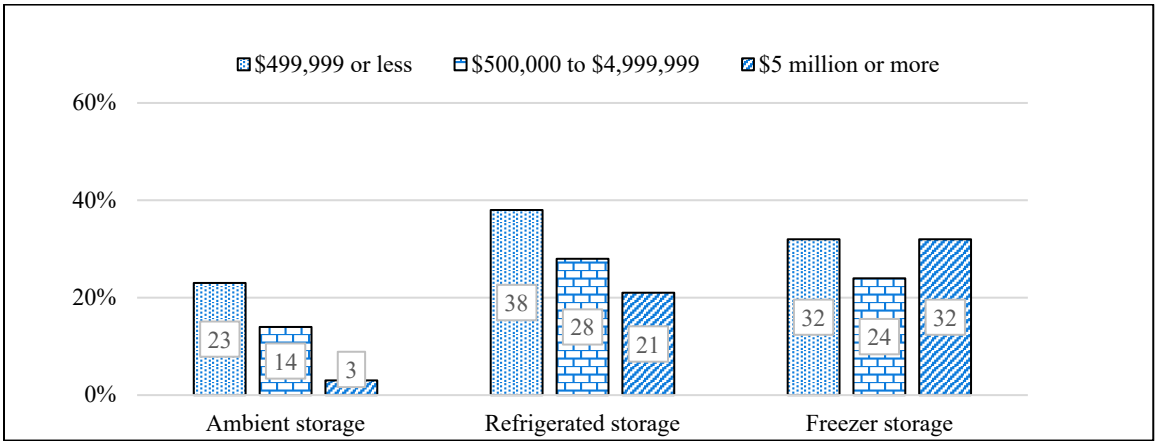


FIGURE 7-15b Impact of lack of storage on the quantity of seed suppliers can sell, by storage type and annual sales.

CHALLENGES FACED BY SUPPLIERS

Respondents were asked about the challenge they face as suppliers of native seed or plants. Figure 7-16a shows that unpredictable demand was described as a major or moderate challenge by 74% of

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suppliers. Given the large share of suppliers who responded that the quantity of native seed or plant materials left un-marketed was either about or less than what they expected, this suggests that they believed that their sales could have been higher if they had been better able to anticipate demand for particular species or species by seed zone. Over half of the respondents (60%) indicated that "difficult to grow species" are a major or moderate challenge, and half (49%) mentioned the lack of stock seed from appropriate seed zones or other specified locations are a major or moderate challenge. Insufficient demand was a major or moderate challenge for a little under half of the suppliers (46%). As with responses regarding unpredictable demand, the responses about insufficient demand are likely based on specific species or species by seed zone rather than overall seed output. Fewer respondents mentioned lack of seed testing protocols (34%) and demand for plants without propagation protocols (24%) as a major or moderate challenge.

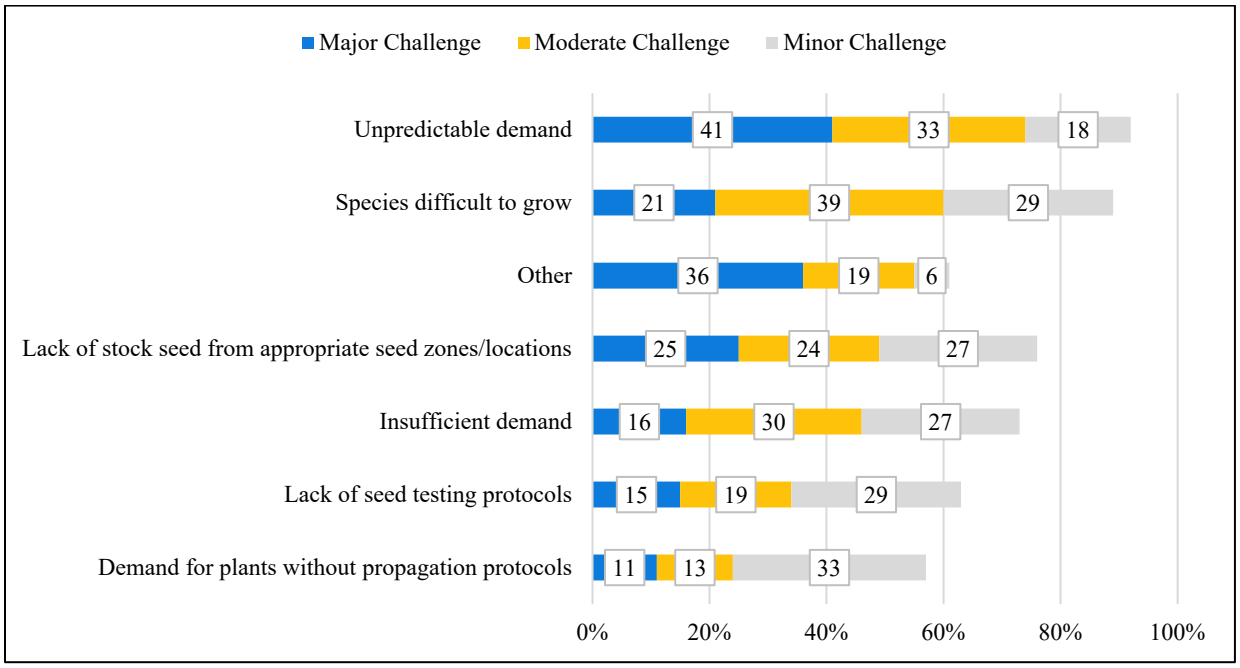


FIGURE 7-16a Challenges faced by suppliers of native seed and plants materials.

This question was also summarized by total sales categories and location of supplier, Figures 7-16b and 7-16c, respectively. Generally, larger suppliers and suppliers in the West were more likely to describe most of these challenges as a major or moderate problem. Demand for plants without propagation protocols seemed to be an exception that was more likely to be a challenge to smaller suppliers and suppliers in the East.

Ability to Expand Capacity

To better understand capacity, suppliers were asked whether they could expand their operations in response to anticipated higher demand. Specifically, suppliers were asked about ability to (1) wild-collect more seed; (2) grow more native plants with the goal of producing and selling native seed; and (3) grow and sell more native plants. Suppliers were also asked about perceived barriers and disincentives that might stand in the way of expanding in these areas.

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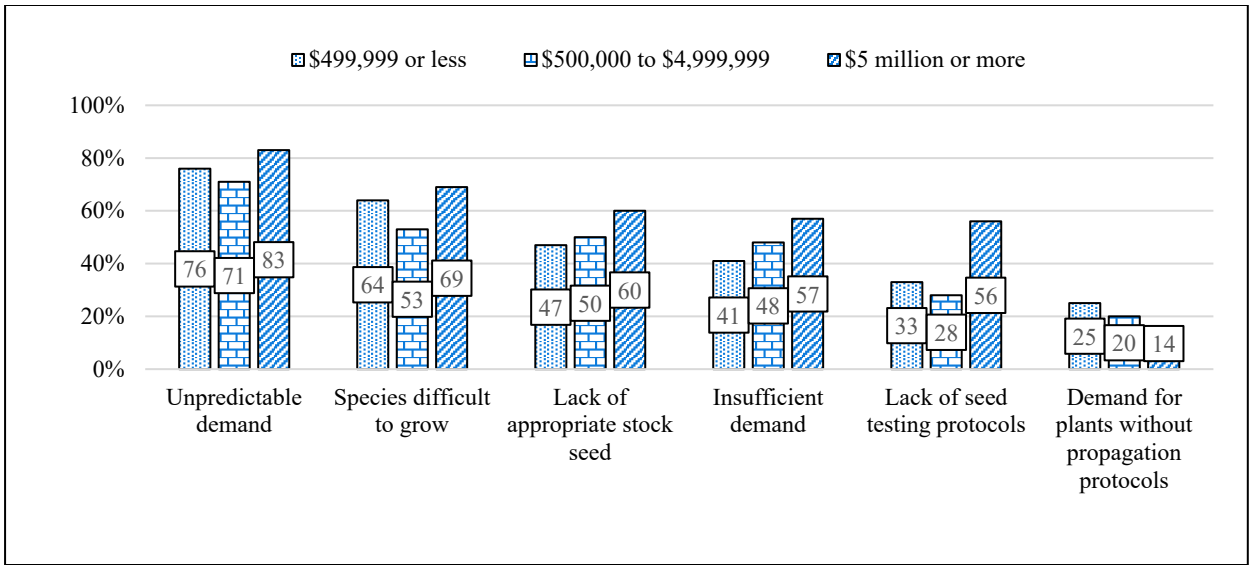


FIGURE 7-16b Challenges (major or moderate) faced by suppliers of native seed and plants materials, by annual sales.

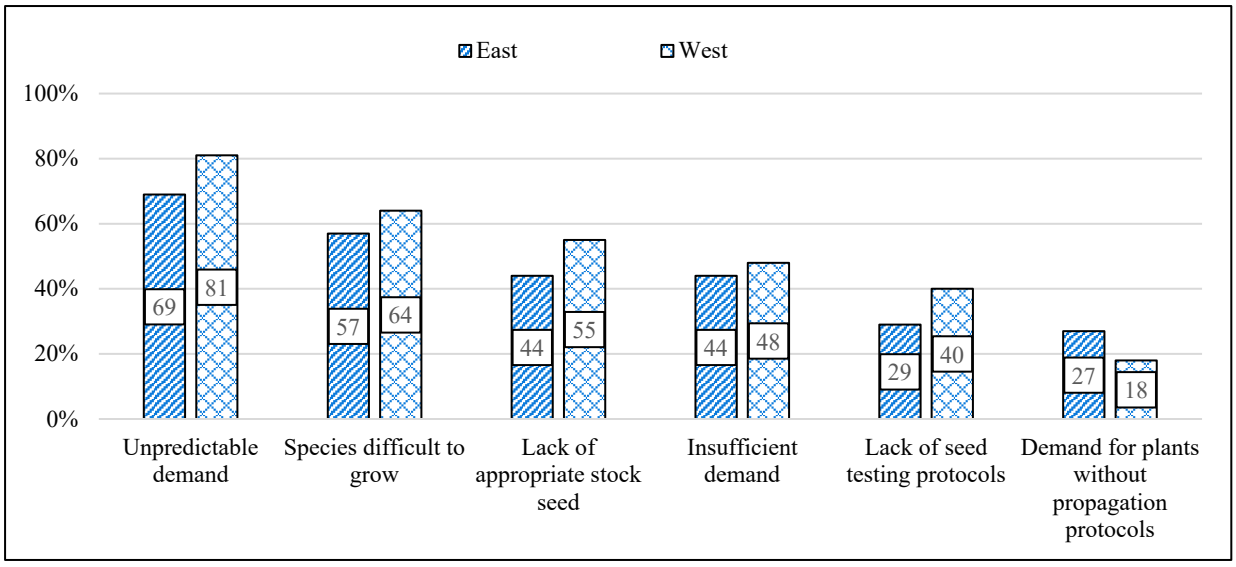


FIGURE 7-16c Challenges (major or moderate) faced by suppliers of native seed and plants materials, by region.

In response to the question "If you were to anticipate higher demand for directly wild-collected native seed, would your business be able to expand to collect more seed?" Sixty-two percent of suppliers said, "Likely yes" and 38% answered "Likely no." A higher percentage of suppliers in the East (66%) thought they could expand their business than in the West (55%). Seventy-six percent of the suppliers with the highest annual sales felt they could expand their wild-seed collection efforts. Figure 7-17 presents responses to this question for all suppliers, and by the overall sales categories and by the location of the supplier.

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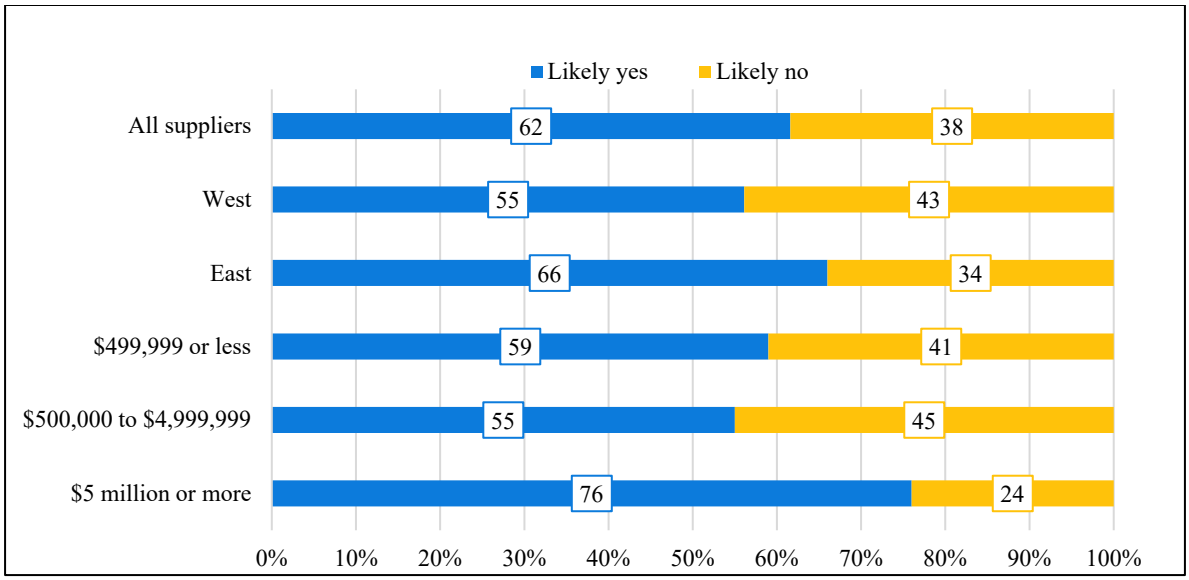


FIGURE 7-17 Suppliers' ability to expand wild collection of seed if they were to anticipate higher demand, by region and annual sales.

When asked about barriers or disincentives to wild-collecting native seed, 71% of suppliers said that major barriers exist. Table 7-1 provides a summary of the types of barriers that were described by the respondents and the number of respondents that mentioned this barrier. Because access to land is a barrier for many, the largest suppliers may have more access to private land from which to collect than companies with lower revenues.

TABLE 7-1 Supplier Perspectives on Major Barriers and Disincentives to Wild-Collecting Native Seed

Barrier	Count
Access to land	62
Availability of seed on the land	26
Labor	22
Depletion of the resource	17
Cost	13
Time	12
Markets	10
Knowledge	10
Environmental factors	7
Ethical reasons	6
Quality of seed	6
Resources available	4
Other	2

In response to the question "If you were to anticipate higher demand, would your business be able to expand to grow more native plants with the goal of producing and selling native seed?", 75% said "Likely yes" and 25% said "Likely no". Larger suppliers were more likely to respond affirmatively. Figure 7-18 presents responses to this question for all suppliers, and by the overall sales categories and by the location of the supplier.

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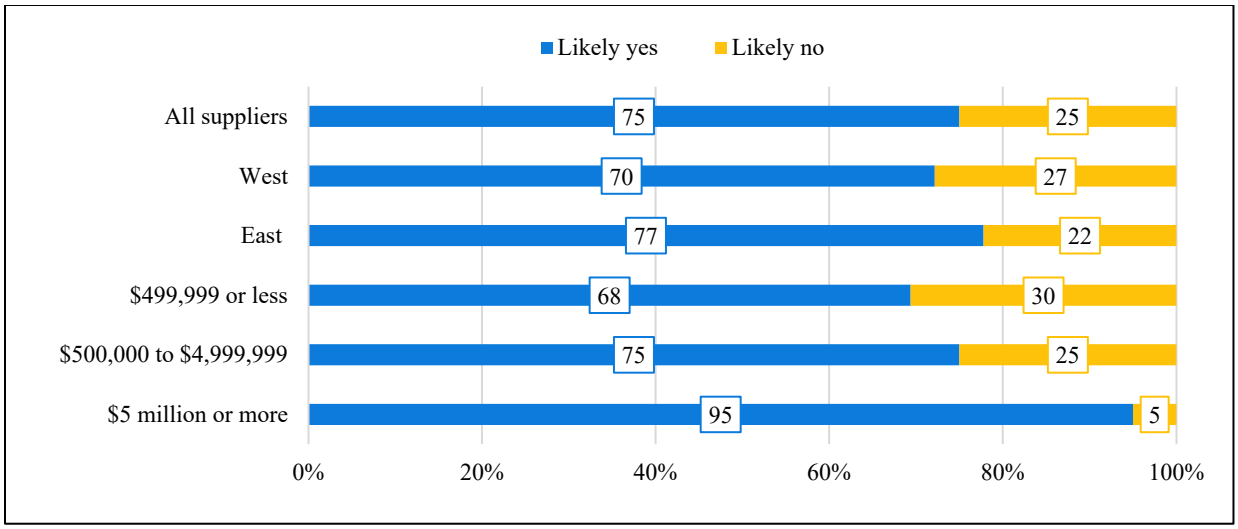


FIGURE 7-18 Suppliers' ability to grow more native plants with the goal of producing and selling native seed if they were to anticipate higher demand, by region and annual sales.

When asked about barriers to growing native plants with the goal of producing and selling native seed, 43 % of suppliers said that there were major barriers. Table 7-2 provides a high-level summary of the types of barriers that were described by the respondents and the number of respondents that mentioned this barrier. Twenty-four cited reasons categorized as "market," 14 cited "cost," and 8 cited "availability." Respondents may have cited more than one barrier. As noted earlier, cost and availability considerations are jointly driven by market forces. So, the dominant category of barrier to greater native seed supply appears to be the market-driven confluence of uncertain demand, high production costs, and availability of native plants as an input to the production process.

TABLE 7-2 Supplier Perspectives on Major Barriers and Disincentives to Growing Native Plants with the Goal of Producing and Selling Native Seed

Barrier	Count
Markets	24
Seed/plant viability	14
Cost	14
Availability	8
Space	8
Environmental factors	7
Labor	6
Knowledge	6
Time	5
Resources	4
Zoning Requirements	3
Permits	3
Other	3

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Seed Suppliers

In response to the question "If you were to anticipate higher demand, would your business be able to expand to grow and sell more plant materials?", 83 % of suppliers said, "Likely yes" and 17% said "Likely no." The responses were similar among suppliers in the eastern and western states. The smallest suppliers were somewhat less likely to say that they could likely expand. Figure 7-19 presents responses to this question for all suppliers, and by the overall sales categories and by the location of the supplier.

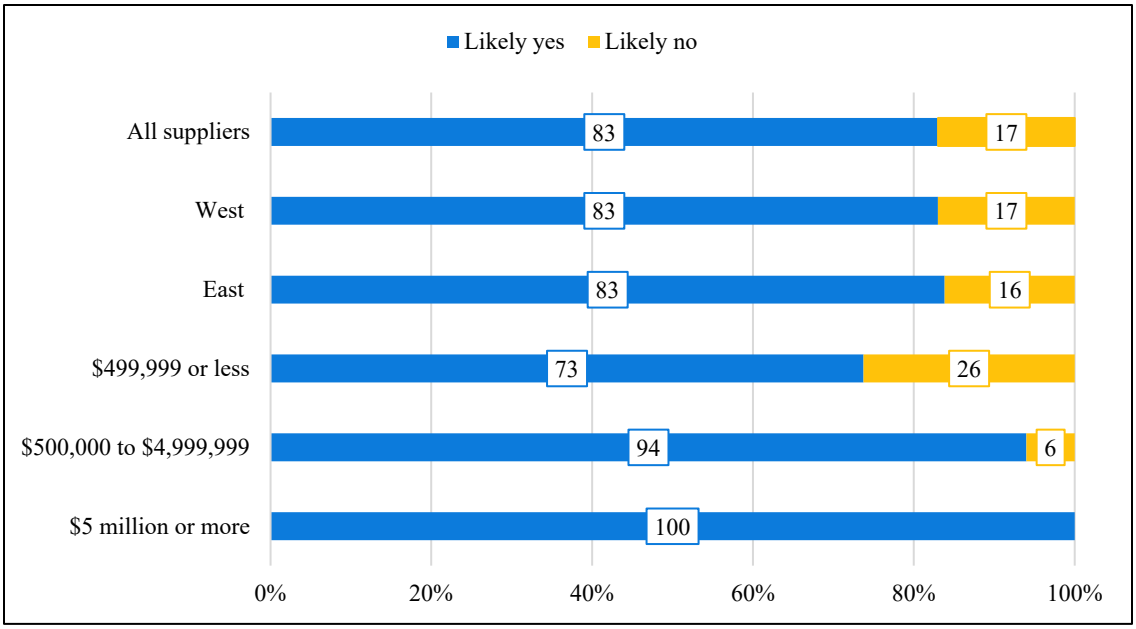


FIGURE 7-19 Suppliers' ability to grow and sell more plants if they were to anticipate higher demand, by region and annual sales.

In terms of barriers, 45% of the suppliers said that there were major barriers or disincentives to growing and selling plants. Table 7-3 provides a summary of the types of barriers that were described by the respondents and the number of respondents that mentioned this barrier. Similar to the types of barriers that surfaced in the responses about growing native plants with the goal of producing and selling native seed, the characteristics of the market were seen as the top barrier to growing and selling plants as well. Twenty-nine cited reasons categorized as "markets," 10 cited "cost," and 8 cited "availability."

TABLE 7-3 Supplier Perspectives on Major Barriers and Disincentives to Growing and Selling Plants

Barrier	Count
Markets	29
Knowledge, education, perception	13
Cost	10
Viability	9
Labor	8
Availability	8
Time	3
Space	3
Environment	4
Permits	1
See previous comment	5
Other	6

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SUGGESTIONS FOR ADDRESSING THE CHALLENGES

The survey asked suppliers to provide suggestions that might help address the challenges they have encountered as suppliers of native seeds or plant materials. Table 7-4 provides a high-level summary of the types of suggestions and the number of respondents that provided these comments.

TABLE 7-4 Supplier Suggestions to Address the Challenges Encountered

Category	Description of the Types of Suggestions in the Category	Count
Planning	Better planning about native seed or plant needs (includes comments about how long it takes to grow a plant before it is ready to sell and disconnect between planning needs and time for a plant to grow).	31
Awareness, education	Need for more and/or better education around native seeds or plant materials.	25
Coordination	Better coordination or communication between entities.	20
Source	Need for more native seed/plant sources, and issues related to availability and production.	15
Funding	Need for more funding and/or consistent funding.	14
Policy	Changing policies that impact growing seed.	10
Markets or economics	Addressing economic or market concerns	10
Value shift	Need to change paradigms, philosophy, mindset, etc.	9
Seed specific	Suggestions specific to seed/climate change/germination/growing situation (coded as seed and not planning when it is about a specific type of seed or plant or crop).	8
Regional focus	More focus on regional/local seed production and/or sharing of collections	7
Standards	Need for better standards, uniformity.	7
Labor	Addressing labor needs or requirements.	5
Access	Addressing issues of access (without reference to policies)	4
Other	Other responses not categorized elsewhere	2

DISCUSSION

Suppliers are pivotal to the native seed supply chain. The strongest message that came from the survey was that suppliers need greater consistency and predictability from their buyers. In an open ended question asking for final thoughts, some specific suggestions were: that buyers should plan projects and communicate their seed needs on realistic timelines that account for the time needed to acquire and/or propagate material; that an information clearinghouse could be a useful mechanism for better connecting buyers and suppliers, thus reducing market friction; and that risk-sharing mechanisms such as contracting or down payments could help create a more stable business environment for suppliers. Several respondents pointed out that an unstable market is especially disadvantageous to small growers, who are important suppliers of diverse locally adapted native species.

The suppliers who responded to this survey most often anticipated demand not trying to predict wildfire frequency or what was previously requested by the BLM consolidated buys, but by more consistently growing markets such as the urban and landscaping sector, and the USDA Conservation Reserve Program. That does not mean that the seeds they supply to these markets would be appropriate for all restoration purposes, only that markets that are predictable and stable are able to get the focus of suppliers.

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Another theme of the open-ended comments was that buyers are not always knowledgeable about the use of native plants in restoration and other uses. They may not be aware of which native plants to use in a given project, how to propagate these materials successfully, or even why it is important to use native species in restoration. There is confusion around seed zones, with some buyers being unaware of the need to use genetically appropriate material, while others have unrealistic expectations about how local the material should be. Better education of the personnel involved in seed buying and restoration, greater collaboration between buyers and knowledgeable suppliers, and a clear and agreed-upon system of seed zones were among the suggestions in this area. Even more broadly, suppliers suggested, a more thriving seed industry could emerge if agencies and their contractors, and the general public, had a better understanding of the importance of native plant species.

Multiple suppliers commented on the need for improved access to native seed collection sources on public lands, calling for a more streamlined permit process, protection of important source areas, and even the potential use of successfully restored sites for seed collection. Several growers also called for Plant Material Centers to play a larger role in developing and distributing stock seed. The lack of stock seed of the local ecotypes desired by buyers is a barrier to their supply. Given that about two-thirds of suppliers sell seed of claimed wild origin, getting certified seed stock seed into the hands of producers would increase the confidence of seed users that the origins of the seed purchased has been verified.

In addition to establishing clear seed zones and an information clearinghouse, another function that suppliers suggested could be an improved system of seed testing, quality control, and labeling, which would protect high-quality suppliers. Some suppliers also called for technical assistance, such as the development of techniques for cleaning and propagation.

CONCLUSIONS

Conclusion 7-1: *Suppliers view unpredictable demand as their leading challenge (75% of respondents). The problem is particularly acute among Western suppliers of native seeds and plants (81%).*

Conclusion 7-2: *The top two technical challenges reported by suppliers are difficult-to-grow species of native plants (60%) and lack of stock seed from appropriate seed zones or locations (50%).*

Conclusion 7-3: *If they could reliably anticipate demand, the majority of suppliers who replied to these questions said that they could 1) expand wild collection of native seed (62%), 2) produce more native seed (75%), and 3) grow more native plants (83%).*

Conclusion 7-4: *Suppliers use past purchases to predict future demand, although suppliers also know that buyers will take substitutions, which creates a circular system that does not serve to expand the diversity of species and ecotypes for the market.*

Conclusion 7-5: *For increasing the supply of wild-collected native seed, the principal barrier is access to land. For expanding production of native seed and plants materials, 43-45% of suppliers reported barriers, with markets cited as the leading barrier in both cases.*

Conclusion 7-6: *Sixty-five percent of suppliers report that they sell certified source-identified seed. About the same percentage (68%) also sell seed of claimed wild origin or provenance.*

Conclusion 7-7: *Lack of refrigerator or freezer storage limited sales for roughly 30% of native seed suppliers.*

Conclusion 7-8: *Among supplier suggestions to address the challenges that they encounter, four of the top seven response categories were related to communicating demand to suppliers (i.e., planning, communication, funding, and markets or economics).*

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Conclusion 7-9: *Some suppliers suggested that a more thriving seed industry could emerge if agencies and their contractors, and the general public, had a better understanding of the importance of native plant species.*

Conclusion 7-10: *Marketing or production contracts were used by half of supplier respondents. The most highly valued contract characteristics (described as "very important" or "somewhat important" by 75% or more of suppliers) were delivery timeline, price guarantee, and guarantee to purchase a predetermined quantity.*

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8

Knowledge Gaps and Research Needs to Support the Native Seed Supply

For the seed supply to work efficiently, there is a need for a strong foundation of knowledge to underpin decision-making. Because native seed is a high-value product and decisions about its use have consequences, not the least of which is the success or failure of restoration projects, the effective management of the nation's seed supply must be supported by knowledge drawn from many sources.

Over the course of the assessment the committee learned of multiple types of information needs. There are some issues that call for innovative and even transformative research with potentially broad applicability across the nation, for example, seed sourcing with particular attention to climate change, the integration of traditional ecological knowledge into restoration practices, and the economics of native seed production and markets.

Other issues call for the accelerated development and wider dissemination of improved technical knowledge relevant to specific regions and/or species, including how to improve the genetic diversity, viability, quality testing, long-term storage, and deployment of seeds and other native plant materials for restoration. While not a research topic, per se, the utility of seed certification is highlighted (Box 8-2) as an avenue whereby the genetic research suggested in this chapter can be supported with a consistent set of definitions of germplasm status and development and cultivation protocols.

SEED SOURCING AND SEED ZONE DELINEATION

There is a considerable body of research showing that plant populations can become locally adapted to climate, soils, competitive regimes, pests and pathogens, and many other factors (Linhart and Grant 1996; Hufford and Mazer 2003). This has led to local seed sourcing preferences for restoration, although the definition of "local" can be quite divergent between projects. For several species, seed transfer zones have been empirically derived from common garden studies. A summary of these, with maps, data, and citations, can be found on the US Forest Service's Threat and Resource Mapping site.[1] Seed transfer zones are geographic areas within which seeds can be planted with minimal risk of maladaptation (Kramer and Havens, 2009). Local adaptation can vary significantly between species so seed transfer zones are ideally determined on a species-by-species basis (Leimu and Fischer, 2008; Johnson et al. 2010).

For taxa where seed transfer zones have not been studied, provisional seed zones have been developed (Bower et al., 2014; Doherty et al., 2017) (See Figure 8-1a) including those that augment climate-only zones with molecular genetics (Massatti et al., 2020) and arbitrary geographic distance (Saari and Glisson, 2012) to source seeds. However, many studies suggest that using an ecologically similar source site leads to better outcomes (Johnson et al., 2010; Johnson et al., 2015, Hereford, 2009). See Figure 8-1b for a map of Omernik Level III ecoregions used to source seeds for all species.

Despite the existence of considerable case-by-case research on local adaptation, there is still a great need to improve the overall scientific basis for seed zone definitions, with the goal of creating widely accepted standards for seed zone delineation which could significantly improve the functioning of the native seed market.

[1] See https://www.fs.usda.gov/wwetac/threat-map/TRMSeedZoneMapper.php).

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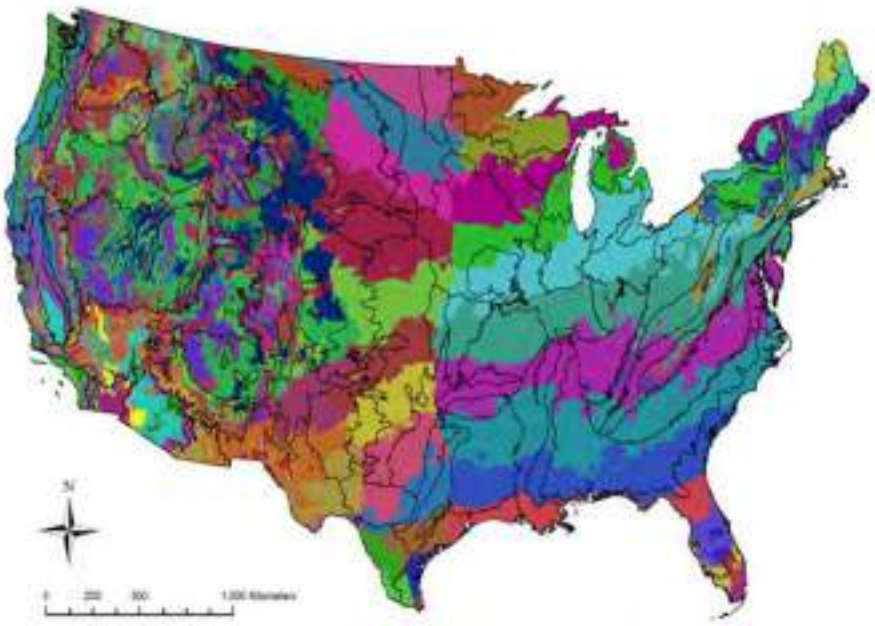


FIGURE 8-1a Provisional seed transfer zones (colored areas) developed by the USDA Forest Service for the continental United States with an overlay of Omernik Level III ecoregional boundaries (black outlines) that distinguish areas with similar climate, but that differ ecologically.
SOURCE: US Forest Service (Bower et al., 2014; Omernik et al., 1987).



FIGURE 8-1b Omernik Level III Ecoregions.
SOURCE: Environmental Protection Agency (Omernik et al., 1987).

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SEED SOURCING AND CLIMATE CHANGE

Rapid climate change now poses a fundamental challenge to traditional approaches to seed sourcing in restoration. Many restoration projects are now obtaining seed from more distant sources (provenances), employing strategies such as broadening the definition of local (relaxed local provenancing), creating mixtures from different source areas (composite provenancing, admixture provenancing), and obtaining seeds from regions where the climate resembles the predicted future climate of the restoration location (predictive provenancing; Broadhurst et al., 2008; Breed et al., 2013; Havens et al., 2015; Breed et al., 2018).

Mixed-provenance strategies have also been proposed to increase genetic diversity and therefore the potential for climate adaptation (Prober et al., 2015; Bucharova et al., 2019; but see Kramer et al., 2018). The Climate Smart Restoration Tool[2] maps current and future seed transfer limits for seed lots based on empirical or provisional data.

The science of climate-adapted restoration is new and rapidly evolving, and conclusive empirical tests of proposed strategies are scarce. This creates tremendous needs and opportunities for basic and applied research, which could include conducting an actual restoration project in a rigorous experimental fashion using the principles of adaptive management. We note that seed of known provenance (such as source-identified seed) is a critical requirement for such research (Havens et al., 2015; Vitt et al., 2022).

SPECIES DIVERSITY AND COMPOSITION

Just as seed selection will be informed by studies on the role of genetic diversity and provenance within a species and population, there are many research questions to be addressed about the appropriate selection of species and species mixes for restoration projects. Of course, the basic goal in many cases is to re-establish as many as possible of the plant species that were present at a site prior to disturbance. However, there are other instances in which this goal is not achievable because of highly altered site conditions, lack of pre-disturbance information, or scarcity of the necessary plant material. Also, there are cases in which the selection of species mixes is directed at outcomes such as supporting pollinators or wildlife, regenerating depleted soil microbiota, or maintaining stable plant cover under challenging physical conditions. For selecting species mixes, an extensive literature based primarily on controlled small-scale experiments suggests the general principle that higher levels of plant diversity at the species, functional, and/or phylogenetic levels will lead to higher average biomass, temporal stability of biomass, or other desirable aspects of ecosystem function (Loreau et al., 2001; Kinzig et al., 2002; Hector and Bagchi, 2007; Gross et al., 2014; Cardinal et al., 2006, 2007, 2012; Hooper et al., 2012; and Gamfelt et al., 2013). The application of this ecological principle to actual restoration practice, especially at the scales of heterogeneous landscapes, is highly deserving of further research. Many other questions concerning species composition in relation to restoration success are also in need of further attention. For example, either functional traits (e.g., Leger et al., 2021), or patterns of species co-occurrence in undisturbed sites (e.g., Agneray et al., 2022), may be valuable tools for designing species mixes that are capable of achieving such goals as withstanding harsh environments, co-occurring stably, and resisting invasion.

Research on general principles of restoration success is the provenance of the Federal research agencies, including NSD, USDA-NIFA, and USGS. For example, applied research being pursued by the US Geological Survey in the context of the Colorado Plateau Plant Program seeks answers to fundamental questions with practical applications (see Box 8-1).

[2] See https://climaterestorationtool.org/csrt/, accessed on December 1, 2023.

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TRADITIONAL ECOLOGICAL KNOWLEDGE

Indigenous cultures traditionally place tremendous importance on the links between human and nonhuman domains, which is reflected in the diverse practices with which they historically managed their plant and animal resources (e.g., Hornborg, 2006; Viveiros de Castro, 2004). Former federal policies reducing tribal land and forced cultural assimilation threatened traditional knowledge for much of the 19th and 20th centuries (see Chapter 5). Recovering and maintaining traditional knowledge was of high importance in the Tribal Nursery Needs Assessment (2003).

For land management and native plant restoration, there is a growing realization that combining traditional ecological knowledge (TEK) with western science can benefit both tribal needs and western science approaches to native plant research (Anderson and Barbour, 2003; Berkes, 2008; Berkes et al., 2000; Dockry et al., 2022; Eisenberg et al., 2019; Pierotti et al., 2000); a theme also highlighted in recent popular books (e.g., Kimmer, 2013). The Fort Belknap Native Seed and Restoration Program and the Grand Ronde Tribal Native Plant Materials Program described in Chapter 5 show how native knowledge and western science can successfully engage.

A critical area for research is to better understand the collecting, growing, harvesting and storage of native plants on tribal lands, in the context of managing and promoting ecological restoration and ecosystem management and the cultural uses of native plants. This need was also noted in the Tribal Nursery Needs Assessment (2003) and the Nursery Manuel for Native Plants (Dumroese, 2009), yet it remains largely unmet. Critical to this process is engaging Tribes in all aspects of planning, carrying out, and applying results from scientific projects to promote ecosystem management and native plant restoration (Dockry et al., 2022, Farley et al., 2015).

BOX 8-1
Research Agenda for the Colorado Plateau Native Plant Program

The US Geological Survey (USGS) is conducting applied research for the Colorado Plateau Native Plant Program, a collaborative partnership with the BLM, and long list of partners in academe, industry, and nongovernmental organizations. Using restoration activities as a platform for experimentation, the Survey's work in the arid Plateau will provide insights that are important for seed selection and restoration success. For example, in the USGS research agenda for 2021-2022 has set out the following research tasks, seeking answers to practical questions:

- Resolve patterns and drivers of genetic diversity, structure, and adaptation (i.e., landscape genetics): *How does the degree of genetic diversity (too diverse, too little diversity) in plant materials used for restoration affect restoration outcomes?*
- Determine adaptive phenotypic variation in natural populations (i.e., common gardens and plant traits): *Can experimental plantings of a species sourced from different locations in a prospective new site provide clues to local adaptation?*
- Quantify seed survival and establishment in the context of growing aridity: *If soil moisture is critical for seed establishment, how will weather variability under climate change affect regeneration success in restoration projects?*
- Investigate the impact of seed increase on the genetic identity of restoration materials: *How does the size of an accession used for seed increase affect the genetic identity of seeds relative of the wildland population?*
- Investigate the long-term impacts of restoration materials on the genetic identity of plants in their natural communities: *How do "non-local" plant materials affect pre-existing plant communities?*

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ECONOMICS OF NATIVE SEED PRODUCTION AND MARKETS

This report offers a general sense of availability and uses of native seed and plant materials, but data gaps prevented it from offering a clear, quantitative picture at the national level. Not only is the magnitude of total native seed use currently not clear, by extension so too is our overall quantitative understanding of how native seeds are used and the costs to produce them. Economic research is needed to understand (1) the nature of demand and supply in the current native seed market; (2) the evolution of native seed uses over time; (3) costs of production for major types of native seed; and (4) sources of production and price risk, as well as the effectiveness of alternative contract designs at mitigating those risks.

A comprehensive market study is needed simply to characterize the magnitude and details of the US native seed and plant material market. As noted in the introduction to this report, one third of US territory is in government hands, with the rest held privately (Figure 1-1). For certain Federal agencies, land areas under direct management are well known (Table 3-1), and some Federal, state, and tribal agencies can report the use of native seed on their lands. Although tracking native seed use on private agricultural land is trickier because of the many buyers, the area planted with native seed under USDA programs like the large Conservation Reserve Program (see Iovanna and Pratt presentation reported in Chapter 6) is fairly clear (although seed species and quantities are not). On non-agricultural private land, there is no central data source to estimate native seed use. So, the first step is to measure the total land area planted with native species and the annual demand for native seed and plant materials.

As this report has shown, the uses of native seeds and plant materials vary widely. Some users aim to restore native plant ecology, while others seek to serve specific functions, such as soil conservation, pollination, or aesthetics. In effect the larger market for native seeds is composed of many submarkets of seed users with specific preferences. Users in some of those submarkets are more willing to substitute one species for another, meaning that they are more price sensitive. Research in the Colorado Plateau (Camhi, et al., 2019) has found that where users are more open to substitutions (e.g., to meet a particular ecosystem function, like supporting rangeland grazing), they are more likely to choose seed that meets that goal at a lower price. By contrast, where seed demand must meet rigid specifications (e.g., to restore plant ecology with locally adapted genotypes), buyers are less willing to change species because of prices (so demand is more "price inelastic" in economist parlance). A quantitative, national assessment of native seed user requirements is needed to characterize those submarkets and how best to meet the component demands. Such a study should be done on a regional basis, not only because of the difference in land ownership regionally (e.g., more public land in the West), but also because certain uses are more urgent than others (e.g., establishing native rangeland species ahead of invasives versus planting roadsides with pollinator-friendly species).

Understanding future demand for native seeds calls for understanding past patterns. As wildfires have covered more acreage in the United States, the demand for seed to re-establish vegetative cover has grown. In recent years, it has become higher priority to meet that demand with native species—rather than exotics. On agricultural land too, the emphasis on native species has certainly expanded under the USDA Conservation Reserve Program. Thoughtful projection of future native seed needs will require an understanding of past patterns, both quantitatively and by species. This understanding must be paired with an awareness of how climate change is altering the demands for native seed.

Complementing demand-side studies there is a need to understand better the cost and time needed to produce native seed and plant material. Such information underpins the economic supply that makes native seed available. Here again, there is a need to study market segments, as costs of production will be strongly affected by such factors as the need for locally adapted genetics, availability of wild seed collection sites, plant life cycle (perennial versus annual), seed yields, and scale of production. Such production cost research would provide the basis for survey research on producer willingness to supply native seed under varying conditions.

Risk management is a high priority for producers of native seed and plant materials, as reported in the supplier survey here. Much risk research is needed at the regional level for key native species.

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Research to improve understanding of production and price risks would inform better designs for production and marketing contracts. To date, there have been important innovations, such as the BLM Indefinite Delivery-Indefinite Quantity (IDIQ) contracts and the USFS Blanket Purchase Agreements, but there exists a plethora of alternative contract designs that could be adapted to meet the needs of the market for native seeds. Separate from characterizing native seeds production and market risks is the need for research to test the alternative contract designs at connecting market demand with producer supply.

BASIC SEED PRODUCTION INFORMATION FOR MORE SPECIES

Species-specific applied research is needed to improve the protocols for planting, growing, and harvesting many species. For many native grasses, production protocols are available and large quantities of seed can easily be produced using standard farming equipment. Native forbs are more problematic as they belong to a variety of plant families, with variable fruit and seed morphology and timing of ripening. Seed production may not begin until the second year or beyond, pollinator requirements may be unknown or may include native pollinators not present at the farm site, and insect and disease issues may emerge when the species is grown in a seed field monoculture (Cane, 2008; Shaw and Jensen, 2014). Very basic planting requirements (seeding date, rate, depth, etc.) must be determined, and specialized planting or harvesting equipment may be needed, when bringing new species into production. Stock seed supplies are often limited, necessitating an initial increase before field production can begin. The results of on-farm trial and error is usually unavailable to other growers of the same species. Conducting and disseminating applied research has considerable potential to expand the diversity and volume of native seeds for restoration.

MAINTAINING GENETIC INTEGRITY DURING CULTIVATION

Maintaining the genetic integrity of seed through the increase process is also an important concern. Native seed farming to increase amounts of seed sourced from wild populations aims to maintain genetic diversity but may cause unintended genetic changes, particularly when plants are grown under conditions quite different from the wild source population. Cultivated populations can become maladapted to conditions in the wild (Havens et al., 2004; Husband and Campbell, 2004; Ensslin et al., 2015; Espeland et al., 2017). In production, plants may receive irrigation, be protected from herbivores, be grown in rich or fertilized soils and under novel climatic conditions that could make them less fit when reintroduced. (Espeland et al., 2017; Conrady et al., 2022). For example, cultivated *Carlina vulgaris* and *Jasione montana* exhibited loss of tolerance for drought and competition (Ensslin et al., 2015), and farmed *Clarkia pulchella* (of non-certified seed) showed strong increases in mortality especially in simulated drought conditions (Pizza et al., 2021), although some other studies found less evidence for cultivation-induced losses of genetic integrity of native seed (Conrady et al., 2022).

Seed certification requirements (see Box 8-2) are designed to reduce genetic changes by limiting the number of generations that can be produced from stock seed. Since generations grown, species mating system, the production environment, and on-farm methodology all may differ and affect seed genetic integrity, more species-specific research is needed on genetic changes and how they can be managed during agronomic production.

SEED BIOLOGY AND SEED ANALYSIS

Accurate information about seed quality is essential for setting seed prices and calculating seeding rates. Seed tests that do not represent accurate seed quality affect costs and project success for users and income for producers. There are two difficulties in achieving quality information. First, there are federal, state, and private entities involved with analyzing and labeling native seed sold in the

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marketplace. Both regulations and lab quality across entities can be uneven. Second, the tests needed to assess quality are difficult to conduct accurately.

State seed laboratories in most states are members of the Association of Official Seed Analysts (AOSA and SCST 2022) and follow AOSA seed analysis rules. State seed acts and regulations provide for truth in labeling and enforcement for seed lots of species covered by AOSA rules sold within the state. These requirements may differ across states. The Federal Seed Act (USDA 1940 with revisions) takes precedence for seeds sold in interstate commerce but includes few native species. In addition to state seed labs there are commercial and private seed laboratories and a federal regulatory seed lab. There are several seed testing and accreditation programs (ASTA 2022) to which seed labs and individual seed analysts may apply for accreditation. This section discusses these issues and newer technology that may help with solutions.

Labeling seed for sale requires results of germination, purity, and noxious weed seed tests and that the date of each test be listed on the seed tag. Percent germination includes the germinated, hard, and dormant seed in the tested sample. Purity testing requires examination of 2,500 seeds to determine the percent pure seed, other crop seed, weed seed and inert material. A sample of 25,000 seeds is required for noxious weed testing and the species and number of seeds of each noxious species found must be listed. Seed lots cannot be transported through or offered for sale in a state if the seed lot contains a species that is either prohibited (Prohibited Weed Seed), or present in excess of the number per pound (Restricted Weed Seed) as designated in the state seed law. Seed lots cannot be sold if they contain any seeds of species designated as a restricted noxious in the state where sold. Testing must be conducted within the period specified by the FSA (if applicable) for interstate shipment and by the state where the seed is sold.

There are more than 900 native species with official AOSA germination rules (about 5% of the US native flora). For some other species there are unofficial protocols that have come into use but have not received formal review and acceptance. These are provided in an AOSA database: Test Methods for Species without Rules (AOSA and SCST 2022). For the many native species lacking any guidance, analysts often use procedures found in the literature or rules or protocols developed for members of the same genus or for species from similar habitats. The result is that for these species, different procedures may be used by different laboratories, often resulting in disparate results.

Seed quality data is essential for setting seed prices and calculating seeding rates. Because both initial germination and total viability (includes dormant seed) of native seed lots are often highly variable, seed price and seeding rates are generally calculated on a basis of pure live seed (PLS) per pound. PLS pounds in a seed lot = [% purity/100] X [% viability/100] X pounds of bulk seed. Seed tests that do not accurately represent actual seed quality affect costs and project success for users and income for producers. In addition, seeding rates calculated on such inaccurate tests will not represent the actual PLS seeded per area, leading to misinterpretations of seeding outcomes and monitoring data.

Discrepancies in test results can arise from several factors including:

- The number of Registered Seed Technologists at seed laboratories may be insufficient to meet the needs of the native seed industry
- Many species lack official testing rules or protocols, thus different labs may use different test procedures and obtain differing results
- Analysts often have little or no experience with many native species that are only rarely submitted for testing
- Germination tests for dormant seeds requiring cold or warm stratification may take weeks or months. A viability test using tetrazolium chloride (TZ) is often requested as a substitute for a germination test as it can be completed relatively rapidly. The TZ tests do not reflect germination ability; but rather whether the seed is alive or respiring, or not (total viability). The tests must be conducted by experienced analysts and can represent additional costs.
- Equipment availability and quality (e.g., germinators, balances, microscopes, seed herbaria) varies among laboratories

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Solutions to these problems will require seed biology research, leading to the development of additional AOSA rules. Increased laboratory accreditation and training of analysts in native seed testing could also contribute to more uniform results among laboratories. Improved funding to enable acquisition of high-quality equipment would reduce differences among analysts in their ability to identify seeds and evaluate test results. Blind referee tests can identify discrepancies in test results among laboratories and point to training needs. New technologies being developed for crop seed testing and variety development may lead to more consistent results and require far less time than current methods that require examination of individual seeds. X-ray imaging in combination with ad hoc image analysis software can be used to automatically calculate fill and seed weight. By calibrating the interpretation of x-ray images to germination results, it would be possible to determine viability without the need for destructive and time-consuming tests, such as germination and TZ. Moreover, computer vision and AI technology applied to seed images can aid in seed identification and recognition of defects. These techniques require extensive image galleries for individual species, and the greater morphological variability in wild populations compared to highly selected crop varieties create challenges.

BOX 8-2
Seed Certification and Genetic Integrity

Seed quality testing and a tag listing the testing results are required legally to sell seed. However, seed laws do not currently require the verification of the source location of seed and other attributes that aid in identifying the best seed for a particular project or seed zone. Some private and public organizations procure seed from trusted collectors and growers without such verification, but for most native plant materials offered for sale, independent, third-party verification can be provided by state seed certification agencies (SCAs). This is an optional, fee-based service paid by plant materials producers, but the nominal cost is passed on to buyers desiring verification of source and production protocols that maintain genetic integrity.

As the genetic composition of "locally" sourced native plant material used for restoration ostensibly provides an adaptive advantage and promotes ecological relationships needed for desirable ecosystem services, the SCAs introduced a process to verify seed collected and increased from wild plant populations through "natural track" certification in the early 1990s. The categories on the natural track are Source Identified (SI), Selected (S), Tested (T), and Variety/Cultivar (see "How AOSCA Tracks Wildland Sourced Seed"[3]).

All natural-track germplasm is genetically non-manipulated and may be advanced from SI (geographic origin known) to S, T, and Variety/Cultivar categories. The latter designations may be used to indicate that the intact population from which the seed was collected is recognized to have desired traits and ecological attributes (e.g., drought tolerance, wide geographic adaptation, etc.) applicable to specific revegetation and restoration needs of seed buyers.

Seed zones to promote the use of locally adapted genetic material for ecological restoration are being developed and utilized although additional research and experience are needed. Seed zone or other geographic designations for single or pooled accessions of native plant populations can be accommodated by SCAs if they are provided with appropriate documentation as to source locations and collection procedures used.

Population changes and inadvertent selection with successive seed generations can alter the properties of plant materials. Although inevitable, they can be mitigated by ensuring that the initial population size collected and subsequent seed increase generations are adequate, conducting seed increases in similar environments to those of the original seed source, monitoring seed increases as part of the certification process, and long-term maintenance of seed sample from the initial G_0 population and all seed increases (G_x) for future comparisons and use as stock seed as necessary. Given the need for third-party verification and tracking of germplasm source, seed increase generations, genetic distinctions, and cultivation protocols, certification is a valuable tool to protect the interests of participants in the native seed supply chain.

[3] How AOSCA Tracks Wildland Sourced Seed, see https://www.aosca.org/programs and services, accessed December 30, 2022.

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DISCUSSION

Restoration ecology has existed as a scientific discipline since the first half of the 20th century, and has made many important strides, yet is also noted for suffering a substantial disconnect between science and practice (Cabin et al., 2010; Burbidge et al., 2011; Dickens et al., 2013). In this chapter we have identified what we believe are the most important knowledge gaps that impede the ability of the native seed supply to develop more fully and function effectively.

Some of the knowledge gaps lie in the realm of investigator-driven, conceptually innovative research, which is traditionally supported by competitive funding from research agencies including NSF and USDA-NIFA. To maximally influence the nation's seed supply chain, such basic research will need to be carried out at large scales, and using environments and species, that reflect the real-world challenges and constraints of restoration practice.

Other critical knowledge gaps lie in technical areas that are typically addressed by applied research organizations including USGS, USDA-ARS and others. While much applied research has already been carried out on many of the subjects we have discussed, there remains a need to identify solutions that are broader and more generally applicable—a nationwide system of seed zones being a notable example.

Conclusion 8-1: *Many information gaps affect the ability of the native seed supply to function efficiently and effectively. Addressing them would inform decision-making, reduce uncertainty, and improve restoration outcomes.*

Conclusion 8-2: *Important gaps in basic research include: developing and testing strategies for seed sourcing that take rapid climate change into account; integration of traditional ecological knowledge into ecological restoration; the role of species diversity, traits that contribute to survival, and the economics of the native seed industry.*

Conclusion 8-3: *Critical needs for the development and dissemination of improved technical knowledge include identifying basic growing requirements for more species, maintaining genetic integrity during cultivation, improved approaches to seed analysis, and greater use of seed certification.*

Conclusion 8-4: *Tribal leadership and collaboration are essential features of research on traditional ecological knowledge and tribal uses of native plant materials.*

REFERENCES

Agneray, A., F. Matthew, T. Parchman, and E. Leger. 2022. Does a history of co-occurrence predict plant performance, community productivity, or invasion resistance? BioRxiv. 10.1101/2022.09.20.508783.

Anderson, M.K., and M.G. Barbour. 2003. Simulated Indigenous Management: A New Model for Ecological Restoration in National Parks. Ecological Restoration 21(4):269-277.

Berkes, F. 2008. Sacred Ecology: Traditional Ecological Knowledge and Resource Management. 2 ed: Routledge.

Berkes, F., J. Colding, and C. Folke. 2000. Rediscovery of discovery of traditional ecological knowledge as adaptive management. Ecological Applications 10(5):1251-1262.

Bower, A.D., J.B.S. Clair, and V. Erickson. 2014. Generalized provisional seed zones for native plants. Ecological Applications 24(5):913-919.

Breed, M., M. Stead, K. Ottewell, M. Gardner, and A. Lowe. 2013. Which provenance and where? Seed sourcing strategies for revegetation in a changing environment. Conserv Genet 14: 1-10. Conservation Genetics 14:1-10.

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Breed, M.F., P.A. Harrison, A. Bischoff, P. Durruty, N.J.C. Gellie, E.K. Gonzales, K. Havens, M. Karmann, F.F. Kilkenny, S.L. Krauss, A.J. Lowe, P. Marques, P.G. Nevill, P.L. Vitt, and A. Bucharova. 2018. Priority Actions to Improve Provenance Decision-Making. BioScience 68(7):510-516.

Broadhurst, L.M., A. Lowe, D.J. Coates, S.A. Cunningham, M. McDonald, P.A. Vesk, and C. Yates. 2008. Seed supply for broadscale restoration: maximizing evolutionary potential. Evol Appl 1(4):587-97.

Bucharova, A., O. Bossdorf, N. Hölzel, J. Kollmann, R. Prasse, and W. Durka. 2019. Mix and match: Regional admixture provenancing strikes a balance among different seed-sourcing strategies for ecological restoration. Conservation Genetics 20.

Camhi, A.L., C. Perrings, B. Butterfield, and T. Wood. 2019. Market-based opportunities for expanding native seed resources for restoration: A case study on the Colorado Plateau. Journal of Environmental Management 252:109644.

Cane, J.H. 2008. Pollinating bees crucial to farming wildflower seed for US habitat restoration. In: R.R. James, and T.L. Pitts -Singer, eds. Bee pollination in agricultural systems, 48-63. Oxford, UK: Oxford University Press.

Cardinale, B.J., J.E. Duffy, A. Gonzalez, D.U. Hooper, C. Perrings, P. Venail, A. Narwani, G.M. Mace, D. Tilman, D.A. Wardle, A.P. Kinzig, G.C. Daily, M. Loreau, J.B. Grace, A. Larigauderie, D.S. Srivastava, and S. Naeem. 2012. Biodiversity loss and its impact on humanity. Nature 486(7401):59-67.

Cardinale, B.J., J.P. Wright, M.W. Cadotte, I.T. Carroll, A. Hector, D.S. Srivastava, M. Loreau, and J.J. Weis. 2007. Impacts of plant diversity on biomass production increase through time because of species complementarity. Proc Natl Acad Sci U S A.; 104(46):18123-8. doi: 10.1073/pnas.0709069104. Epub 2007 Nov 8. PMID: 17991772; PMCID: PMC2084307.

Cardinale, B.J., D.S. Srivastava, J.E. Duffy, J.P. Wright, A.L. Downing, M. Sankaran, and C. Jouseau. 2006. Effects of biodiversity on the functioning of trophic groups and ecosystems. Nature 443(7114):989-92.

Conrady, M., C. Lampei, O. Bossdorf, W. Durka, and A. Bucharova. 2022. Evolution during seed production for ecological restoration? A molecular analysis of 19 species finds only minor genomic changes. Journal of Applied Ecology.

Dockry M.J., S.J. Hoagland, A.D. Leighton, J.R. Durglo, and A. Pradhananga. 2022. An Assessment of American Indian Forestry Research, Information Needs, and Priorities. Journal of Forestry: 1-15 https://doi.org/10.1093/jofore/fvac030.

Doherty, K.D., B.J. Butterfield, and T.E. Wood. 2017. Matching seed to site by climate similarity: Techniques to prioritize plant materials development and use in restoration. Ecological Applications 27(3):1010-1023.

Eisenberg, C., C. Anderson, A. Collingwood, R. Sissons, C. Dunn, G. Meigs, D. Hibbs, S. Murphy, S. Kuiper, J. SpearChief-Morris, L. Bear, B. Johnston, and C. Edson. 2019. Out of the Ashes: Ecological Resilience to Extreme Wildfire, Prescribed Burns, and Indigenous Burning in Ecosystems. Front. Ecol. Evol. 7:436 doi: 10.3389/fevo.2019.00436.

Ensslin, A., O. Tschöpe, M. Burkart, and J. Joshi. 2015. Fitness decline and adaptation to novel environments in ex situ plant collections: Current knowledge and future perspectives. Biological Conservation 192:394-401.

Espeland, E.K., N.C. Emery, K.L. Mercer, S.A. Woolbright, K.M. Kettenring, P. Gepts, and J.R. Etterson. 2017. Evolution of plant materials for ecological restoration: insights from the applied and basic literature. Journal of Applied Ecology 54(1):102-115.

Farley, C., T. Ellersick, and C. Jasper. 2015. "Forest Service Research and Development Tribal Engagement Roadmap." FS-1043. https://www.fs.usda.gov/research/docs/tribal-engagement/consultation/roadmap.pdf. Accessed December 13, 2022.

Gamfeldt L, T. Snäll, R. Bagchi, M. Jonsson, L. Gustafsson, P. Kjellander, M.C. Ruiz-Jaen, M. Fröberg, J. Stendahl, C.D. Philipson, G. Mikusiński, E. Andersson, B. Westerlund, H. Andrén, F. Moberg,

Copyright National Academy of Sciences. All rights reserved.

J. Moen, and J. Bengtsson. 2013. Higher levels of multiple ecosystem services are found in forests with more tree species. Nat Comm 4:1340. doi: 10.1038/ncomms2328. PMID: 23299890; PMCID: PMC3562447.

Gross, K., B.J. Cardinale, J.W. Fox, A. Gonzalez, M. Loreau, H.W. Polley, P.B. Reich, and J. van Ruijven. 2014. Am. Nat. Vol. 183, pp. 1–12. DOI: 10.1086/673915.

Havens, K., P. Vitt, S. Still, A.T. Kramer, J.B. Fant, and K. Schatz. 2015. Seed Sourcing for Restoration in an Era of Climate Change. Natural Areas Journal 35(1):122-133.

Havens, K., E.O. Guerrant, M., Maunder, and P. Vitt. 2004. Guidelines for ex situ conservation collection management: Minimizing risks. In E. O. Guerrant, K. Havens, & M. Maunder (Eds.), Ex situ plant conservation: Supporting species survival in the wild (pp. 454–473). essay, Island Press.

Hector, A., and R. Bagchi. 2007. Biodiversity and ecosystem multifunctionality. Nature 448, 188–190. https://doi.org/10.1038/nature05947Hereford, J. 2009. A quantitative survey of local adaptation and fitness trade-offs. Am Nat 173(5):579-88.

Hooper, D.U., E.C. Adair, B.J. Cardinale, J.E. Byrnes, B.A. Hungate, K.L. Matulich, A. Gonzalez, J.E. Duffy, L. Gamfeldt, and M.I. O'Connor, 2012. A global synthesis reveals biodiversity loss as a major driver of ecosystem change. *Nature*, *486*(7401), pp.105-108.

Hornborg, A. 2006. Animism, fetishism, and objectivism as strategies for knowing (or not knowing) the world. Ethnos 71(1):21-32.

Hufford, K.M., and S.J. Mazer. 2003. Plant ecotypes: genetic differentiation in the age of ecological restoration. Trends in Ecology & Evolution 18(3):147-155.

Husband, B. C., and L.G. Campbell. (2004). Population responses to novel environments: Implications for ex situ plant conservation. In E. O. Guerrant, K. Havens, & M. Maunder (Eds.), Ex situ plant conservation: Supporting species survival in the wild (pp. 231–266). essay, Island Press.

Johnson, R., L. Stritch, P. Olwell, S. Lambert, M. Horning, and R. Cronn. 2010. What are the best seed sources for ecosystem restoration on BLM and USFS lands? Native Plants Journal 11:117-131.

Johnson, R.C., M.E. Horning, E.K. Espeland, and K. Vance-Borland. 2015. Relating adaptive genetic traits to climate for Sandberg bluegrass from the intermountain western United States. Evolutionary Applications 8(2):172-184.

Kramer, A.T., and K. Havens. 2009. Plant conservation genetics in a changing world. Trends in Plant Science 14(11):599-607.

Kramer, A. T., S. Wood, S. Frischie, and K. Havens. 2018. Considering ploidy when producing and using mixed-source native plant materials for restoration. Restoration Ecology 26.

Kimmerer, R.W. 2013. Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge, and The Teachings of Plants: Milkweed Editions.

Kinzig, A. P., S.W. Pacala, and D. Tilman, Editors. 2002. The Functional Consequences of Biodiversity: Empirical Progress and Theoretical Extensions. Princeton UniversityPress, Princeton, New Jersey, USA.

Leger, E. A., S. Barga, A.C. Agneray, O. Baughman, R. Burton, and M. Williams. 2021. Selecting native plants for restoration using rapid screening for adaptive traits: Methods and outcomes in a Great Basin case study. Restoration Ecology, 29(4), e13260.

Leimu, R., and M. Fischer. 2008. A Meta-Analysis of Local Adaptation in Plants. PLOS ONE 3(12): e4010.

Linhart, Y.B., and M.C. Grant. 1996. Evolutionary significance of local genetic differentiation in plants. Annual Review of Ecology and Systematics 27(1):237-277.

Loreau, M. and A. Hector. 2001. Partitioning selection and complementarity in biodiversity experiments. Nature 412, 72–76. https://doi.org/10.1038/35083573.

Massatti, R., R.K. Shriver, D.E. Winkler, B.A. Richardson, and J.B. Bradford. 2020. Assessment of population genetics and climatic variability can refine climate-informed seed transfer guidelines. Restoration Ecology 28(3):485-493.

Omernik, J.M. 1987. Ecoregions of the Conterminous United States. Annals of the Association of American Geographers, 77:1, 118-125, DOI: 10.1111/j.1467-8306. 1987.tb00149.x.

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Pierotti, R., and D. Wildcat. 2000. Traditional ecological knowledge: the third alternative (Commentary). Ecological Applications 10(5):1333-1340.

Pizza, R., E. Espeland, and J. Etterson. 2021. Eight generations of native seed cultivation reduces plant fitness relative to the wild progenitor population. Evolutionary Applications 14(7):1816-1829.

Saari, C., and W. Glisson. 2012. Survey of Chicago Region Restoration Seed Source Policies. Ecological Restoration 30:162-165.

Vitt, P., J. Finch, R.S. Barak, A. Braum, S. Frischie, and I. Redlinski. 2022. Seed sourcing strategies for ecological restoration under climate change: A review of the current literature. Frontiers in Conservation Science 3.

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Summary Conclusions and Recommendations for the Native Seed Supply

DISCUSSION

The seeds of native plant species are unique, and their supply is closely tied to the natural landscape from which they originate. At a time when the demand for native seed in ecological restoration and other applications is increasing sharply, many of those landscapes are subject to human-induced environmental stressors that imperil the immense biodiversity they embody. Therefore, native seeds are needed from natural landscapes to improve the ecosystem functionality of degraded landscapes, and for many other applications that benefit from their use.

This is also a time of major transition in the types of demand for native seed, and the needs are evolving. Over the last several decades, there has been a shift from the use of non-native seed species to an increased use of native species in restoration and rehabilitation. A greater diversity of native species of some types, such as grasses, is now available, but far less so for others, such as forbs. For some applications, such as on eroded slopes, and after fires, there is a lack of native seed that meet short-term performance needs such as rapid soil coverage, so non-native seeds are used.

Public sector seed buyers at the federal and state level are increasingly requesting native seed sourced from specific geographic locations or that is otherwise considered locally adapted. This demand trend is also happening in restoration projects on private land. The committee learned from seed buyers that the availability of native seed is insufficient, both in terms of its availability when needed, and from the standpoint of the desired diversity of species, ecotypes, geographic origin, and other characteristics. Substitutions for desired species or seeds from desired seed zones are not rare even for routine uses (e.g., maintenance, conservation program uses, habitat creation) and a common occurrence with respect to emergency needs.

On the other hand, the committee learned from suppliers of native seed that uncertain demand is a major barrier to their ability to provide what buyers need. They indicate that they are poised to produce additional seed of much needed diverse species and ecotypes if they have access to the necessary source material to begin production and a clearer and more consistent signal for demand.

As the committee pondered the juxtaposition of how this increasing demand for native seed apparently is not enough to stimulate a sufficient supply response to fill the need, several puzzle pieces began to connect. One large piece of the puzzle is that a large diversity of existing native plant populations is on public lands, and in the West, managed by several federal agencies, with their properties intertwined across almost half of the land area, adjacent to state, tribal land, and private lands. The federal government is far less present in the eastern part of the United States, but many natural areas are under management of state and local governments and by land trusts on private reserves. In some cases, as the committee learned in the case of Iowa, virtually the only remaining natural prairies in the state exist along the sides of public roads. Thus, the source of much of the stock seed that suppliers need to produce primarily exists on publicly managed lands.

The solution to the native seed supply shortage is not to rely solely on the direct use of wild collections for all public projects, which would dangerously decrease the resource. The native plant communities on public land would be better used as the building blocks for the comprehensive assembly of a sustainable, public-private native seed industry. Congress charged the federal land-management agencies to carry out a plan for a native seed supply. The collection of seed from public lands needs to be

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managed as a critical renewable resource with the goal of a building that supply—one that is scoped to be representative of the genetic diversity across the landscape and scaled to meet the nation's growing needs.

The implications to addressing this need include employing sufficient human resources and expertise dedicated to carrying out this comprehensive effort. Additional personnel are needed on multiple fronts, including for the responsibility of monitoring native plant populations across public lands, their overall health, and the genetics they embody, and for oversight of a methodical approach to seed collection based on rigorous protocols. The Seeds of Success program, with more than 27,000 accessions so far, is the example of a coordinated, high-quality collecting and seed banking effort to target wild populations of plant species in geographical locations of interest. To meet the need, that program needs to be conducted under the framework of a larger vision, at a bigger scale and in a wider breadth of geographies nationwide.

The next fundamental step to building the seed supply involves bringing banked seed into field cultivation through the complex transition from conditions in the wild to that of managed agriculture, and providing oversight of the seeds' genetics during increase and multiplication—essentially the process of native seed development—that would result in more than just a single increase for one or two projects, but also in stock seed material for distribution to suppliers to produce seed with transparent origins, and clear identities and attributes.

Who can do this? A precedent for a process like this is currently led by the US Department of Agriculture's Natural Resources Conservation Service (USDA NRCS) Plant Materials Centers (PMCs), which have for many years conducted plant development to feed the seed industry's pipeline for soil conservation programs on private lands. Many public land projects have used seed from the PMCs and continue to do so today. The PMCs maintain lines of stock seed for the private sector seed industry, and help producers learn how to best grow the seeds economically. That work is complemented by USDA NRCS's technical staff who provide advice to private landowners enrolled in conservation programs on the appropriate seeds to use for different conservation practices. Because the PMCs already supplied the industry with stock seed, these advisers support the demand for conservation seed purchases and direct landowner-buyers to seed types they know are available in the market.

This business model is an important example for consideration, although for several reasons, it does not solve all the problems of the native seed supply. The PMCs have become oriented to meeting primarily private sector soil conservation needs. They also maintain some seed lines developed using a degree of selection or genetic manipulation for agronomic traits, such as yield, that many would consider inappropriate for restoration, but they also develop natural track plant materials. For example, the PMCs do collaborate with efforts like the not-for-profit Texas Natives Seeds to develop supplies of native seeds (certified, natural track germplasm) that serve both restoration and revegetation goals.

There also does not yet exist a widespread advisory function for buyers of seed for restoration needs that parallels the one that the NRCS provides to landowners on soil conservation programs. Finally, at present, the PMCs are very leanly staffed, so an expansion of both the PMC mission and its capacity would be needed to meet the diverse needs of the federal land-management agencies, states, and private users of the nation.

To make the seed supply more robust, the many information gaps that affect the ability of the native seed supply to function efficiently and effectively need to be filled. Some of the needs are described in Chapter 8, and addressing them would inform buyers' decision-making, reduce uncertainty for suppliers, and improve restoration outcomes. Native seed suppliers also need production knowledge about difficult-to-grow species, and suppliers and users would benefit from more consistent seed testing methodologies. Progress is being made, but too slowly, and the resources needed to fill these gaps are insufficient, which holds the seed supply back. In addition to research needs, information about native seed use, prices paid for seed, seed contracting arrangements that share risk between buyers and suppliers, acres restored, outcomes of seeding projects, and species used is not routinely documented and shared by land-management or statistical agencies. Better documentation would facilitate better planning.

The common needs of land-management agencies are a central piece of the puzzle. In addition to oversight for the public lands on which many native plant populations grow, the federal, state, and tribal

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land-management agencies have similar uses and needs for native seeds, and in many regions, the lands under their control are physically contiguous, so they have common plant biodiversity needs. Generally, however each agency addresses its seed needs independently and all find it difficult to obtain the supply of seeds needed to fully address their continual needs. Some, like the US Forest Service (USFS), have nurseries and seed-cleaning capacity to address a portion of its needs. The Bureau of Land Management (BLM) has warehouses that provide short-term storage for purchased seed. Other agencies and groups, such as the National Park Service, and most tribal nations, do not have internal units dedicated to planning or tracking native seed needs or purchases, and simply work on a project-by project basis when funds are available. The committee found that agencies with multiple-year planning horizons, with priorities updated on a yearly basis, such as the Integrated Natural Resource Management Plans (INRMPs) used by Department of Defense land managers appeared to be more successful in obtaining their desired seeds. Why not bring the considerable expertise, infrastructure, best practices, and assets that exist across the federal agencies together to address their common goals?

The committee found that the agencies do engage in collaborations on an *ad hoc* basis. In response to the 2001 Congressional mandate to develop a native seed supply, the BLM and the USFS began to establish regional programs for native plant restoration and native plant materials development but have not been able to expand those programs to the geographic scale required to meet the seed needs of the federal agencies, much less the nation**.** The projects led by these agencies such as those in the Pacific Northwest, Great Basin, Colorado Plateau, and Mohave Desert, are examples of the productive direction that cooperative action can take, but those are pilot level efforts. These programs are limited relative to the need, and most regions across the nation lack any similarly focused programs. The National Seed Strategy developed in 2015 by BLM and other federal agencies and non-federal partners conceptually recognized the need for extensive interagency and regional cooperation to meet its stated goals. For now, however, it is largely an aspirational blueprint pointing the way forward, and independent activities on elements of the blueprint comprise the extent of collective action.

The committee concluded that there is much to gain by taking interagency coordination a step further to build a national native seed supply for public lands, and beyond. Such a step necessitates a greater and more sustained level of engagement and funding. The extensive coordination required to address native seed needs is comparable to that employed for wildland fire response, and carried out through the National Interagency Fire Center, a home for the fire management programs of the federal land-management agencies and other federal units that deal with fire. It coordinates wildland firefighting across the United States using a regional approach to engage all levels of federal and state governments, the tribes, and the private sector in planning fire responses, mobilizing emergency resources, conducting research, carrying out data collection and analysis, and communicating policy and best practices.

The same kind of focus and cooperative structure for addressing native seed needs could unify the agencies' independent efforts to meet seed needs for restoration and rehabilitation, if consistent long-term funding was provided to carry out those activities on a large scale. Rather than compete with existing activities within agencies, it could reduce duplication, facilitate sharing of resources, and generate momentum to build the native seed supply that Congress requested more than twenty years ago.

The committee recognizes that bringing separate agencies together in this vision is not a simple task. However, the native seed needs and ecological restoration needs of the country are significant and the current pace at which they are being addressed will be overwhelmed in the coming years as climate change, habitat destruction, and species extinction intensifies. It is an understatement to say that time is of the essence to bank the seeds and the genetic diversity our lands hold for future extensive planting projects that will require large-scale seed production.

Recent legislation to provide funding for federal and state level restoration efforts signifies that the congressional interest in restoring the nation's natural heritage is a priority. The needs of millions of acres of ecologically impaired landscapes across the nation have largely been unaddressed for lack of funds to conduct proactive restoration activities. At this moment in time there is both the opportunity and the financial resources to act, so it is urgent that a supply of native seeds appropriate to these landscapes be developed. The funds associated with this legislation represent a tremendous opportunity for the native

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seed supply and for the conservation and restoration of native plant communities. Addressing them proactively is a unique opportunity to build and stabilize the native seed supply chain.

The committee provides the following conclusions that represent a summary of those in the preceding chapters, as noted in the chapter numbers and conclusion numbers at the end of each conclusion. The summary conclusions provide an overarching rationale for the recommendations that follow them. The recommendations are for actionable steps that can be taken to move the nation closer to the important goal of achieving a robust native seed supply.

Conclusion 1.0: *Native plant communities are the source of seed for a diversity of seeding needs. There is urgency to the conservation and restoration of native plant communities and to building a native seed supply, as climate change and biodiversity loss have put many natural landscapes at increasing risk. Seed shortages continue to be a major barrier to restoration. The implementation of federal plans to build a native seed supply for public lands needs to be accelerated. Developing reliable seed supplies for ecological restoration is an achievable goal, but one that demands substantial inter-institutional commitment to work together on a comprehensive vision to support the development of a more robust seed supply industry, and at a much more intensive and expansive level than is currently underway.* (Conclusions 1-2, 1-3, 1-4, 1-5, 3-2, 3-4, and 4-2)

Recommendation 1.0: The leadership of the Departments of the Interior (DOI), Agriculture (USDA), and Defense (DOD) should move quickly to establish an operational structure that facilitates sustained interagency coordination of a comprehensive approach to native plant materials development and native plant restoration. An interagency approach focused on fulfilling the long-standing Congressional mandate to develop a native seed supply for public lands could unify the agencies' independent efforts to meet seed needs for restoration and rehabilitation. This focused effort would maximize returns on investments in native plant materials development and restoration and would augment, not replace, or compete with existing activities within agencies. One possible model for agency coordination on a national basis, organized regionally, is the National Interagency Fire Center.

Among the types of activities that could be the focus of concerted efforts include the following:

- Serve as the central coordinating platform for implementing the development of a national native seed supply for rehabilitation and restoration.
- Assist the launch, support, and oversight of regional native seed supply development activities.
- Coordinate the prioritization of species and ecotypes to meet seed needs for different regions.
- Co-develop national policy for native seed collection, seed sharing, and seed use.
- Co-develop and share best management practices for seed choice in restoration.
- Coordinate, prioritize and support basic and applied research such as described in Chapter 8 and other region-specific needs identified in the National Seed Strategy.
- Review, and strengthen policy guidance for the use of native seeds on public lands.
- Co-develop adaptive management approaches that use experimentation during restoration, gather data on outcomes, and use these data to guide future restoration actions.
- Provide a national, central data collection platform and analytical capability.
- Serve as a focal point for training on seed collection protocols, storage practices, seed cleaning and testing, and other technologies.
- Produce informational resources for stakeholders in native seed supplies and native plant restoration.

Conclusion 2.0: *In some regions (at, above or below the state level), native seed needs are being addressed by networks or partnerships that include Federal agencies, states, tribes, local governments,*

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and the private and non-profit sectors. Further development of these regional networks, plus greater coordination among them, is a promising way to stabilize demand, expand supply, and increase the sharing of information and technology that is critical to meeting native seed needs. (Conclusions 4-1, 5-1, 5-2, 6-1, 6-2, 6-3)

Recommendation 2.0 Federal land-management agencies should participate in building regional programs and partnerships to promote native plant materials development and native plant restoration, helping to establish such regional programs in areas where they do not yet exist. Ideally, the existing regional programs and partnerships would grow into a complete nationwide network, assisted by the federal interagency coordinating structure envisioned in Recommendation 1.0. The size, geographic coverage, and membership of the regional programs would vary based on regional needs and would include many existing entities such as the USDA Plant Material Centers and Agricultural Research Service seed banks, other seed banks, botanic gardens, public nurseries, universities, and other organizations. The regional partnerships could take on the following responsibilities:

> **2.1 Develop seed priorities.** Each region has its workhorse native plant species, ones that are easily grown and highly abundant in natural communities, as well as its other priority species such as those that are important for pollinators and wildlife. Developing region-specific lists of priority species will enable suppliers to focus on developing stocks of the species, and ecotypes of these species, that are likeliest to be in high demand.
>
> **2.2 Conduct scenario planning and monitor climate change and habitat loss effects.** To enable suppliers to anticipate and meet future needs, scenario planning at the regional level can be used to estimate the kinds and quantities of seeds likely to be in demand over multi-year horizons. Such planning scenarios would be based on estimates of current degraded land and future events likely to cause further degradation. These would be periodically updated through ongoing monitoring.
>
> **2.3 Collect wildland seed and curate stock seed.** Regional programs should conduct or oversee the collection, increase, and curation of wildland-sourced seed to make it available for future production. Seed must be collected using protocols to record source locations, maximize genetic diversity, and protect wild populations. As banked stocked seed accessions deplete, additional wild collections will be necessary. As source populations are lost, or better ones located, ongoing monitoring and re-evaluation will be needed.
>
> **2.4 Share information.** Regional programs should develop informational tools derived from monitoring regional seed use practices and the success or failure of outcomes. This will inform smarter, more predictable selections of species for procurement in the regional marketplace and more effective restoration strategies.

Conclusion 3.0: *Tribal uses for native plants parallel those of federal and state agencies and their needs include seed collection, increase, seed testing, implementation of seed zones, storage, and contracting for ecological restoration. The historic complexity of land management issues and interactions with federal and state governments, former Bureau of Indian Affairs (BIA) policies associated with cultural assimilation, and a lack of resources have constrained all aspects of tribal land management including activities to build capacity to meet native plant needs.* (Conclusions 5-1, 5-2, 5-3)

Recommendation 3.0: The Bureau of Indian Affairs should work with the Inter-Tribal Nursery Council to promote and expand tribal nurseries. The Bureau of Indian Affairs should prioritize and support tribal native plant uses and capacities, consistent with the Bureau's legal and fiduciary obligation to protect tribal treaty rights, lands, assets, and resources held under the Federal-Tribal Trust. Recognizing

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tribal sovereignty and self-determination, expanding the cultural, economic, and restoration uses of native plants by tribes will require the promotion and expansion of tribal nurseries and greater support for the Inter-Tribal Nursery Council. Additionally, tribal leaders and land managers should be fully engaged in planning, conducting, and applying results from scientific projects related to seed production and conservation, native plant restoration, and ecosystem management on tribal land.

Conclusion 4.0: *Suppliers view unpredictable demand as their leading challenge. Suppliers indicate that seed contracts with clear delivery timelines, price guarantees, and a guarantee to purchase a predetermined quantity of seed of the specified ecotypes are most important to them.* (Conclusions 3-1, 4-3, 6-6, 7-1, 7-2, 7-3, 7-4, 7-5, 7-6, 7-8, and 7-10)

Recommendation 4.0: The public agencies that purchase native seed should assist suppliers by taking steps to reduce uncertainty, share risk, increase the predictability of purchases, and help suppliers obtain stock material.

To stabilize the native seed supply, seed buyers could take the following actions:

4.1 Conduct proactive restoration on a large scale. Millions of acres of US public land are ecologically impaired. With new federal resources for restoration, federal and state agencies should plan restoration projects on a 5-year basis, ensure that stock seed has been made available to suppliers, and set annual purchase targets for the collection and acquisition of needed ecotypes of native plant species. These actions will result in considerable expansion and stabilization of the market for native seeds, benefitting suppliers and users alike.

4.2 Establish clear agency policies on native seed uses. Land management agencies should establish clear policies on seed use on lands under their stewardship that support the use of locally adapted native plant materials in management activities, along with clearly delimiting the circumstances for allowing exceptions. This will send a strong signal of species and provenance needs to suppliers.

4.3 Support responsible seed collection and long-term seed banking. Intensive and carefully managed seed collection is needed to supply the native plant material enterprise and conserve native plant diversity for the long term.

In cases where native seed is collected from public lands by private suppliers for direct sale and use in restoration, land management agencies should employ adequate personnel to issue permits and ensure responsible collection.

In other cases, where seed is collected for increase and native plant materials development, the Federal agencies should facilitate this activity by extending the Seeds of Success program to include all regions of the United States, and better supporting its activities.

In still other cases, native seed is collected and banked for long-term conservation. To continue building a species-diverse and genetically diverse long-term native seed bank, the Federal agencies, led by BLM and the ARS National Plant Germplasm System, should accelerate their collaboration under the Seeds of Success program.

4.4 Contract for seed purchases before production. Public sector buyers of native seed should amend their policies to enable contracting for purchases before the seed production cycle begins. Forward contracting, in which the buyer agrees to purchase specific seed at a future date, reduces grower risk by ensuring them a market.

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4.5 Use marketing contract features that reduce demand uncertainty. Public sector buyers of native seed should adopt marketing contract features that specify the delivery timeline, guaranteed prices, and guaranteed purchase of predetermined quantities that meet the buyer's specifications.

4.6 Experiment with native seed contract designs. Public sector buyers of native seed should experiment with cost- and risk-sharing contract designs, such as BLM's Indefinite Delivery-Indefinite Quantity (IDIQ) contracts, which are partially supported by a working capital fund.[1] Other approaches also merit investigation, such as Blanket Purchase Agreements. In special circumstances, such as where high-priority species or ecotypes are unavailable, Federal agencies should consider issuing contracts to suppliers for research and development.

4.7 Consider providing premiums for local ecotype use in USDA conservation programs. USDA's Farm Service Agency and state departments of agriculture should explore whether higher co-payments for landowners' use of local ecotypes of native species in conservation program plantings would enhance environmental benefits while supporting a regional native seed industry. A requirement for the use of certified seed would assure growers that their efforts and expenses are not being undercut by seeds of unverified origins.

Conclusion 5.0: *Suppliers indicate that difficult-to- grow-species and lack of stock seed from appropriate seed zones or locations are their top two technical challenges. They identified communicating demand (issues related to planning, communication, funding, and the economics of the seed markets) as key to helping them achieve success in providing seeds to buyers.* (Conclusions 1-1, 1-4, 7-2, 7-3, 7-4, 7-8, and 8-3)

Recommendation 5.0: Federal land-management agencies should work with their regional partners to launch an outreach program to provide seed suppliers with critical tools and information. This outreach task should include the following elements:

5.1. Strengthen the role of the National Resources Conservation Services (NRCS) in supporting native seed suppliers. The NRCS Plant Materials Centers (PMCs) can build on their historical role by developing materials and techniques and advising commercial growers on native seed production, emphasizing non-manipulated germplasm and production methods that minimize genetic change.

5.2 Support information sharing on restoration outcomes. Public land-management agencies should share new research and technical knowledge on restoration in publicly available technical progress reports.

5.3 Facilitate communication with growers. To support existing native seed growers and to encourage new ones, Federal agencies should provide tools such as an on-line marketplace, and resources such as workshops and information on propagation, seed cleaning, and other techniques.

Conclusion 6.0: *There are many information gaps that affect the ability of the native seed supply to function efficiently and effectively. Addressing them would inform decision-making, reduce uncertainty, and improve restoration outcomes.* (Conclusions 4-4, 5-3, 8-1, 8-2, 8-3, and 8-4)

[1] The text of the recommendation was modified after release of the pre-publication to clarify that the BLM IDIQ is not intrinsically tied to the working capital fund and can be supported from other funding sources.

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Recommendation 6.0: The federal government should commit to a rigorous research and development agenda aimed at expanding and improving the use of native seeds in ecological restoration. This includes the following actions:

6.1 Support basic research. Basic research to support restoration in an era of rapid change should be a priority for NSF, USDA-NIFA, and USGS. Some critical topics include restoration under climate change, species selection to promote ecological function, traditional ecological knowledge, and the economics of the seed market.

6.2 Build technical knowledge. Development and dissemination of new technical knowledge for restoration should be important priorities for the research arms of federal land management agencies, such as the USDA-ARS, USFS, DOD and USGS. Priority topics include improving techniques for production, maintenance of genetic integrity and quality, testing, storage, and deployment of native seeds.

6.3 Adaptive management. Public land agencies and their partners should commit to using a rigorous adaptive management approach that documents all features of the restoration plan, uses restoration treatments as experiments to address critical areas of uncertainty, gathers data on outcomes, and uses these data to guide future restoration actions.

6.4 Seed zones. USDA-ARS, USFS, and USGS, in conjunction with regional programs, should seek to develop a more uniform national system of seed zones, which will be an important step in sending clearer signals to both seed suppliers and seed users.

Conclusion 7.0: *An expansion is needed of humidity-controlled seed warehouses across all regions of the United States for temporary storage of seed. To encourage smaller-scale producers to enter the supply chain for native, ecoregional seed of many diverse species, there is a need to expand cooperative seed cleaning facilities in areas where commercial facilities with specialized equipment capable of handling small lots of native seeds do not exist.* (Conclusions 6-4, 6-5, and 7-7)

Recommendation 7.0: Federal agencies and other public and private partners, including seed suppliers, should collaborate on expanding seed storage and seed-cleaning infrastructure that can be cooperatively cost-shared regionally. Additional storage can improve the availability of seed ready for restoration when urgent but hard-to-predict needs arise. Greater refrigerated and freezer storage availability would protect the viability of purchased seed until its use. Seed cleaning is also a significant technical challenge for new and small-scale suppliers. Regional native seed cleaning facilities would encourage more growers to enter the supply chain.

Conclusion 8.0: *BLM is the nation's largest user of native seed for restoration and has the largest capacity for seed storage, but many constraints currently limit its capacity to act as a reliable purchaser of native seeds and thereby to support a more robust native seed industry. The capacity and staffing of its seed warehouses are also inadequate to meet existing and projected needs. (Conclusion 6-4)*

Recommendation 8.0: The BLM's Seed Warehouse System needs to be expanded, particularly the capacity for cold storage, and supported by staff with up-to-date knowledge of seed science to manage the seed inventory. The BLM seed warehouses belong in a national program within the BLM or DOI to ensure they are funded, managed, expanded to meet national needs, and shared among agencies. With more warehouses, seed can be kept near the location where it will be used, reducing transportation costs, time, and seed viability loss.

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Conclusion 9.0: *BLM manages extensive areas of natural and seminatural land that constitute an important in-situ repository of seed stock for restoration, but conserving this critical resource is not yet recognized as a land management objective. The agency's native seed needs depend on the native plant communities that are the source of seeds. There is urgency to the need for conserving the biodiversity that is present in existing native plant communities on BLM land.* (Conclusions 1-3, 1-5, 3-3, and 6-3)

Recommendation 9.0: BLM should identify and conserve locations in which native plant communities provide significant reservoirs of native seeds for restoration. Public land management agencies should actively recognize and protect the natural plant communities that provide the ultimate sources of native seeds for ecological restoration, using protective designations such as Area of Critical Environmental Concern or Research Natural Areas.

Conclusion 10.0: *Developing reliable seed supplies for ecological restoration is an achievable goal for the BLM and other public-sector users of native seed, but one that demands substantial institutional commitment to make restoration to a high-priority objective, cultivate and empower botanical and ecological expertise in decision-making, and create sustainable funding streams for restoration that enable long-term planning, successful implementation, and learning from experience.* (Conclusions 1-4, 3-1, 3-4, and 8-1)

Recommendation 10.0: The Plant Conservation and Restoration Program (PCRP) should be empowered with additional capacity to plan, oversee restoration, and to build stocks of seed. The BLM should give greater authority and resources to the PCRP to oversee seed purchasing and warehousing decisions, monitor restoration outcomes, engage in long-term restoration planning, and ensure that staff with plant expertise are available to guide restoration planners and seed purchasers across BLM. This expanded role for PCRP will hasten the pace of change toward the use of natives that is already underway. The PCRP should expand the use of IDIQ or other innovative, risk-sharing contracts to build a diverse supply of native seed in BLM warehouses.

Collectively, these recommendations represent an ambitious agenda for action. The committee believes that agenda is commensurate to the challenges facing our natural landscapes, and to the responsibility of the federal public land-management agencies to take a focused, coordinated leadership role in addressing them. The committee is optimistic that the many public and private parties involved in land stewardship on behalf of tribal nations, states, and other landowners will be willing partners in ensuring their success.

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Appendix 1

Committee Biographies

Susan P. Harrison (NAS), ***Chair*** is a Distinguished Professor in the Department of Environmental Science and Policy of the University of California, Davis. She was elected into the National Academy of Sciences in 2018 for her excellence in Environmental Science and Ecology. Harrison is a leader in the study of ecological diversity at different spatial and temporal scales, and of the mechanisms and processes that maintain diversity. Her work is of fundamental importance for understanding the impact of global change on ecological communities, and for conservation biology from local to global scales. Dr. Harrison received her B.S. in 1983 in Zoology and M.S. in 1986 in Ecology from University of California, Davis, and Ph.D. in 1989 in Biology from Stanford University.

Delane Atcitty is Executive Director of the Indian Nations Conservation Alliance, an organization that connects underserved native ranchers and farmers to federal agencies and Tribal Leadership that share an interest in conservation and natural resource management. Mr. Atcitty also is the principal of Arrowhead Resource Management, LLC, which provides ranch management and agri-business consulting services to native communities. Previously, he was a Natural Resource Specialist at the Department of the Interior's Bureau of Indian Affairs, a Rangeland Specialist with the Bureau of Land Management, and before that, a Rangeland Specialist for the Nature Conservancy SVR Ranch, overseeing management of cattle and bison on the ranch. Mr. Atcitty is a Board member of the Navajo Agricultural Products Industry (NAPI), Holistic Management International Board of Director, National Grazing Lands Coalition Advisory Board Member, and Past Chair of the Native American Rangeland Advisory Committee of the Society for Range Management. Mr. Atcitty received a Bachelor of Applied Science (B.A.Sc.) degree in Agribusiness in 2007 from Oklahoma Panhandle State University, and in 2009 a Masters in Ranch Management from Texas A&M University's King Ranch Institute.

Rob Fiegener is an independent consultant who previously served as Director of Plant Materials at the Institute for Applied Ecology. Mr. Fiegener led the Institute's native seed collection, production, and distribution activities, including participation in Seeds of Success, the Willamette Valley Native Plant Partnership, and other regional plant materials efforts. He served as director of the Native Seed Network from 2004 to 2020 and produced the series of National Native Seed Conferences from 2010-2017. Previously he worked for Oregon State University's Institute for Natural Resources, the US Forest Service, and the National Park Service. He currently serves as chair of the Society for Ecological Restoration's International Network for Seed-based Restoration and is a member of the IUCN Species Survival Commission Seed Conservation Specialist Group. He holds a B.S. in Natural Resources Management from Humboldt State University and a M.S. in Ecology from University of California, Davis.

Rachael E. Goodhue is Professor and Department Chair in Agricultural and Resource Economics at University of California, Davis. She earned her Ph.D. and M.S. from University of California, Berkeley and her B.A. from Swarthmore College. Her research interests include agricultural marketing and organization, agri-environmental policy, pest management, regulation, and contract design. She is on the editorial boards of Agricultural and Food Economics, California Agriculture, and Review of Industrial Organization. Currently she teaches intermediate microeconomic theory for undergraduates in the Managerial Economics major, and courses on agricultural markets and the economics of California

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agriculture for graduate students. Goodhue works regularly with the California Department of Food and Agriculture to assess the economic impact of proposed pesticide regulations. Goodhue serves on the California Walnut Board and California Walnut Commission. She is active in university service and served as Chair of the Davis Division of the Academic Senate from 2016-2018.

Kayri Havens is Director of Plant Science and Conservation and Senior Scientist at the Chicago Botanic Garden. She is also an Adjunct Professor of Biology at the University of Illinois-Chicago and at Northwestern University. Previously Dr. Havens was a Conservation Biologist at the Missouri Botanical Garden. Since 1999, she has been a member of the Conservation Committee of the American Public Gardens Association and served as Chair from 2006-2008. She is a board member and treasurer of Botanic Gardens Conservation International-US, co-director of the citizen science program Budburst, and a member of the IUCN Seed Conservation Specialist Group. Dr. Havens is also a past president of the Illinois Native Plant Society and founder of the Midwestern Rare Plant Task Force. She has received many awards including the American Horticultural Society Liberty Hyde Bailey Award in 2019 and the Secretary of the Interior's Partners in Conservation Award in 2010. Dr. Havens received her B.A. and M.S. in Botany from Southern Illinois University and Ph.D. in Biology from Indiana University.

Carol House is an independent consultant who served as a senior program officer for the National Academies of Sciences, Engineering, and Medicine's Committee on National Statistics. Prior to the National Academies, she held several positions at the National Agricultural Statistics Service of the US Department of Agriculture, including deputy administrator for programs and products, associate administrator, director of research and development, and director of survey management. She also served as chair of the Agricultural Statistics Board. She has provided statistical consulting on sample surveys in China, Colombia, the Dominican Republic, and Poland. She is a fellow of the American Statistical Association and an elected member of the International Statistical Institute. Her graduate training was in mathematics at the University of Maryland.

Richard C. Johnson is an adjunct professor at the Regional Plant Introduction Station, Washington State University. He is also a retired Research Agronomist from the US Department of Agriculture – Agricultural Research Service where he worked for over 30 years on plant germplasm conservation and utilization. From 2005 to 2016, Johnson led a cooperative program between the National Plant Germplasm System (NPGS) and the BLM-Seeds of Success (SOS) program. As a result, more than 10,000 new native plant collections have been acquired for conservation, and thousands of native seed collections have been distributed to private and public entities for research and development. He has also worked extensively with the US Forest Service, BLM, and the Great Basin Native Plant Project for enhancement and utilization of native plant materials. Dr. Johnson has published numerous scientific articles on adaptation of key native species and has developed seed zones to guide the use of germplasm for restoration projects. In 2010 Johnson was a recipient of the US Department of the Interior "Partners in Conservation Award" through Ken Salazar, then Secretary of the Interior. In 2014, he chaired the Interagency Committee to "Identify Research Needs and Conduct Research to Provide Genetically Appropriate Seed, and to Improve Technology for Native Seed Production and Ecosystem Restoration." This contributed to the "Plant Conservation Alliance's National Seed Strategy for Rehabilitation and Restoration, 2015-2020." Dr. Johnson received B.S. degrees in Wildlife Biology (1974) and Agronomy (1976), and a M.S. in Agronomy in 1978, all from Washington State University. In 1981 he received a Ph.D. in Agronomy from Kansas State University.

Elizabeth Leger is Professor in the Department of Biology at the University of Nevada, Reno (UNR), where she has been faculty since 2006. She received a Ph.D. in plant ecology from UC Davis, and did a post-doc focused on invasive plants at SUNY Stony Brook. Her current research focuses on native plant ecology and restoration in invaded areas of the Great Basin, and she has advised multiple post-doctoral,

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graduate, and undergraduate students studying the plants of the Great Basin. Dr. Leger served on the UNR faculty senate as the representative for the College of Agriculture, Biotechnology, and Natural Resources for a three-year term, and served a three-year term as the associate director for the Ecology, Evolution and Conservation Biology graduate program. She serves the greater scientific community with review and editorial work and has served on multiple grant review panels for federal organizations including the USDA and NSF. In addition to her work in plant ecology and restoration, Dr. Leger is the co-creator and director of the University of Nevada, Reno Museum of Natural History, which is a major research, teaching and outreach institution at UNR.

Virginia Lesser is Professor of Statistics and Director of the Survey Research Center at Oregon State University. She conducts research on survey methodology, applied statistics, environmental statistics, and ecological monitoring. Dr. Lesser currently works on survey research examining methods to improve response rates through using multiple contact modes, such as Web and mail, and other methods incorporated during administration of the surveys. She has designed and administered over 200 surveys conducted by the Survey Research Center at Oregon State University. She is a fellow of the American Statistical Association and an elected member of the International Statistical Institute. She has served on several National Academies committees including: the Committee on Capitalizing on Science, Technology, and Innovation: An Assessment of the Small Business Innovation Research Program-Phase II; Panel on the Review of the Study Design of the National Children's Study Main Study; Panel on Survey Options for Estimating the Illegal Alien flow at the Southwest Border; Panel to Review the Occupational Information Network; Committee to Assess the Minerva Research Initiative and the Contribution of Social Science to Addressing Security Concerns; and Committee on the Review of the National Institute of Safety and Health/Bureau of Labor Statistics Respirator Use Survey Program. She has a Doctorate in Public Health in Biostatistics from the University of North Carolina, Chapel Hill.

Jean Opsomer is a vice president at Westat in Rockville, Maryland. He was formerly a professor and department chair in the Department of Statistics at Colorado State University, as well as a faculty member at Iowa State University. His research focuses on shape-constrained and nonparametric methods in survey estimation and on several interdisciplinary projects with survey components on a range of topics. He is a member of Statistics Canada's Advisory Committee on Statistical Methods. He previously served on the Bureau of Labor Statistics' Technical Advisory Committee and the USDA's Advisory Committee on Agricultural Statistics. He has served on two National Academies' study committees, including the Panel to Review USDA's Agricultural Resource Management Survey, and the Panel on Improving Data Collection and Reporting about Agriculture with Increasingly Complex Farm Business Structures. Opsomer is an elected fellow of the Institute of Mathematical Statistics and the American Statistical Association, as well as an elected member of the International Statistical Institute. He holds a Ph.D. in statistics from Cornell University.

Nancy Shaw is Emeritus Scientist with the US Forest Service's Rocky Mountain Research Station in Boise, Idaho. Her research over the last 35 years has focused on native plant materials development and restoration of riparian and terrestrial systems in the Intermountain West. From 2003 to 2013, she was Team Leader for the Great Basin Native Plant Project, an interdisciplinary program to develop seed transfer guidelines, seed technology, seed production protocols, and improved methodology for re-establishing native plant communities. The project involved collaboration with 20 federal, state, and private cooperators, including researchers, academics, the native seed industry, practitioners, and students. She is currently a Board member of the Society for Ecological Restoration (SER) and Chair-elect for the International Network for Seed-based Restoration (INSR), and she served as a member of the Steering Committee for the National Seed Strategy (2014-2015). Awards include the National Grasslands Research Award (USDA FS and NRCS, 2007), National Service First Award (USDA FS, co-awarded, 2007), National Plant Materials Development Award (USDA 4651 FS, 2013), and the Asa Gray Career

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Achievement Award (USDA FS, 2013). Dr. Shaw holds a Ph.D. in Crop Science with a Seed Science emphasis from Oregon State University.

Douglas E. Soltis (NAS) is Distinguished Professor in the Florida Museum and the Department of Biology, University of Florida. Prior to moving to Florida in 2000, he was Professor of Botany at Washington State University. Research interests include building the tree of all life, flowering plant evolution, and genome doubling (polyploidy). He was born in Sewickley, Pennsylvania. He graduated from the College of William and Mary with a B.A. in Biology in 1975. He received his Ph.D. in 1980 from Indiana University. He was named a Distinguished Professor at the University of Florida in 2008. He was president of the Botanical Society of America (1999-2000). He has received the Centennial Award and the Distinguished Fellow Award from the Botanical Society of America. With Pam Soltis, he received the Dahlgren International Prize in Botany (2002) and the Asa Gray Award in Plant Systematics (2006) and Darwin-Wallace Medal (2016). With coauthors P. Soltis, P. Endress, M. Chase, he received the Stebbins Medal in 2006 (for Phylogeny and Evolution of Angiosperms). He was elected to the American Academy of Arts and Sciences and to the National Academy of Sciences in 2017.

Scott M. Swinton is University Distinguished Professor and Chairperson of the Department of Agricultural, Food, and Resource Economics at Michigan State University. His economic research looks at agriculture as a managed ecosystem, focusing on management and policy analysis for enhanced ecosystem services. He concentrates on problems involving crop pest, pollination, and nutrient management; precision agriculture; resource conservation; bioenergy crop production; and management of risks to human health and income. Besides his work on US farming, he has extensive experience with agricultural and natural resource management in Latin America and Africa. He teaches undergraduate managerial economics and graduate research design and writing. He is a Fellow in the Agricultural and Applied Economics Association and served as its President in 2018-19. MSU granted him its William J. Beal Outstanding Faculty award in 2015. Dr. Swinton served on the NAS-IOM Committee on a Framework for Assessing the Health, Environmental, and Social Effects of the Food System and the NAS Committee on Status of Pollinators: Monitoring and Prevention of their Decline in North America. He holds a B.A. from Swarthmore College, a M.S. from Cornell University, and a Ph.D. from the University of Minnesota.

Edward Toth is Director of the Mid-Atlantic Regional Seed Bank (MARS-B). Previously, he founded and directed New York City Parks' Greenbelt Native Plant Center (GNPC) until his retirement in 2021. The GNPC is one of the U.S.'s oldest and largest municipally owned native plant nurseries, operated in support of conservation and management of the city's natural resources and green infrastructure. In 2012, he initiated the MARS-B, a partner of the national Seeds of Success program, which promotes the use of ecoregionally-based seed collection and banking in support of meeting the region's needs for genetically appropriate wild seed. In 2018 he was awarded the Sloan Public Service Award from the Fund for the City of New York. Upon retirement he has incorporated MARSB as an independent not profit and is expanding its work throughout the region.

Stanford A. Young is Professor Emeritus of Plant Science at Utah State University (USU) in Logan, Utah. He led the seed certification and foundation seed program at USU and was instrumental in developing native plant germplasm seed certification requirements and standards (both wildland collected and field produced) for the Association of Official Seed Certifying Agencies (AOSCA). He is an Honorary Member of AOSCA. Receiving B.S. and M.S. degrees from USU, Dr. Young attended Oregon State University in Corvallis, Oregon and earned a Ph.D. in Plant Pathology and Plant Breeding in 1977. He worked as a Biochemical Field Specialist for PPG Industries, Inc. based in Fresno, California and was part time faculty member at California State University, Fresno, before accepting the position as Seed Certification Specialist in the Plants, Soils, and Climate Department at USU in 1980. Dr. Young served as Chair of AOSCA National Variety Review Boards for Grass and Alfalfa. He was appointed to the Team

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for DOI-BLM Core Indicators for Monitoring, Plant Materials, and Data Standards in 2011. He is the author of many scholarly publications, newsletters, and bulletins regarding seed certification and seed quality for agronomic crops and native plants. He presently serves as Treasurer for the Great Basin Chapter of the Society for Ecological Restoration.

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Appendix 2A

Semi-Structured Interview Guide for Federal Agencies

For any of these questions, if someone else could answer better, please give us the name and contact information for that person(s).

1. Let's begin by describing your position and responsibilities within _____*insert Agency name*_____. Please provide a brief description of your job and the geographic focus of your work.
   Interviewer's prompts if missing from respondent's description:
   - *Position title*
   - *Location of office (city/state)*
   - *Geographic focus of work/responsibility*
   - *How position relates to the purchase/use of native seeds or plants for land management*

Now we are going to focus on native seed and/or plant material purchased and/or used in projects within your scope of responsibility. By "native" we mean seed or plants indigenous to North America prior to European settlement. Plant material would include such things as plants, seedlings and vegetative material, except seed.

2. Do you use any of the following for any purpose on the projects within your scope of responsibility?
   a. Native seed (Y or N)
   b. Non-native seed (Y or N)
   c. Native plant materials (Y or N)
   d. Non-native plant materials (Y or N)

   [If NO to both Q2a and Q2c (no native seed or native plant materials) skip to Q26]

3. For the projects within your scope of responsibility, how often are purchases made of native seed and plant material? Are purchases made on a routine schedule or an "as needed" basis?
   Interviewer's prompt if needed -- e.g. several times a year, once a year, once every few years, rarely, etc.
   Interviewer's prompt: Can you share purchase records (3 years) with us?
4. For purchases of native <u>seed</u>, thinking over the 3-year period, 2017-2019 (before the COVID-19 pandemic), for projects within your scope of responsibility, what were the most common species of native seed purchased?
   Interviewer's note: Here we are only referring to seed and not other plant materials. If the agency provides purchase records, this information may be included in those records. If the respondent reports mixes of native and non-native seed, try to ascertain the most common species of native seed in those mixes.

5. During this same 3-year period, roughly what were the average yearly expenditures for native <u>seed</u>? Your best estimate is fine.
   Interviewer's note: Here we are only referring to seed and not other plant materials.

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Interviewer's note: If not asked in Q4, ask whether they can share purchase records (3 years). If the respondent reports mixes of native and non-native seed, try to separate the cost of the native seed. If this is not possible, record the expediture for the mix.

6. Now I am going to list a number of potential uses of native seed or plant materials. For each of the following, please indicate whether you used or did not use native seed or plant materials for each purpose during the 3-year period between 2017-2019.

    a. Pollinator habitat projects
        i. Used
        ii. Not Used
        iii. Unsure
    b. Creation/restoration of wildlife habitat (other than pollinator habitat projects)
        i. Used
        ii. Not Used
        iii. Unsure
    c. Restorative activity on land in a wilderness/natural area
        i. Used
        ii. Not Used
        iii. Unsure
    d. Invasive species suppression
        i. Used
        ii. Not Used
        iii. Unsure
    e. Natural disaster recovery from such events as a hurricane, flood, fire, severe drought, etc.
        i. Used
        ii. Not Used
        iii. Unsure
    f. Roadside seeding (after construction)
        i. Used
        ii. Not Used
        iii. Unsure
    g. Roadside maintenance
        i. Used
        ii. Not Used
        iii. Unsure
    h. Stream erosion mitigation/restoration
        i. Used
        ii. Not Used
        iii. Unsure
    i. Soil protection (conservation plantings)
        i. Used
        ii. Not Used
        iii. Unsure
    j. Landscaping (around structures and in parks)
        i. Used
        ii. Not Used
        iii. Unsure
    k. Green infrastructure (stormwater management, etc.)
        i. Used
        ii. Not Used

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iii. Unsure

l. Rangeland grazing
   i. Used
   ii. Not Used
   iii. Unsure

m. Energy development remediation (example coalmine, oil drilling, fracking, etc.)
   i. Used
   ii. Not Used
   iii. Unsure

n. Green strips or vegetative fuel breaks to mitigate wildfire spread
   i. Used
   ii. Not Used
   iii. Unsure

o. Another purpose, please specify _____

Interviewer note: If the respondent thinks a particular usage fits in more than one category (for example – h) stream erosion may be part of e) natural disaster recovery – then code both uses.

What would you say was the most common use?

7. During this same 3-year period, did any of the procurements specifically seek native seed appropriate for use in a specific local area, or from a specific source location or seed zone.
   a. Yes
      What is your best estimate of the percent of those seeds that were actually purchased versus substitutions that did not fully meet these locality specifications?
   b. No

   Interviewer's note: Here we are trying to determine whether the intended location of seed usage was part of the procurement process. If so, were they actually able to purchase the seed they sought, or was a substitution made?

8. For purchases of native plant material (other than seed), thinking over the 3-year period, 2017-2019, for projects within your scope of responsibility, what were the most common species of native plant materials purchased?
   Interviewer's note: Here we are only referring to plant materials and not seed.
   Interviewer prompt: Can you share purchase records (3 years) with us?

9. During this same 3-year period, roughly what were the average yearly expenditures for these native plant materials? Your best estimate is fine.
   Interviewer's note: Here we are only referring to plant materials and not seed.
   Interviewer prompt: Can you share purchase records (3 years) with us?

10. I am going to list several ways to communicate to suppliers your future needs for native seed. Please indicate which ones you use.
    a. Requests for proposals
       Use
       Not Use
       Unsure
    b. General publicity around projects
       Use
       Not Use
       Unsure

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c. Public meetings with suppliers
    i. Use
    ii. Not use
    iii. Unsure
d. Conferences or other professional meetings
    Use
    Not Use
    Unsure
e. Informal communication with suppliers
    Use
    Not Use
    Unsure
f. Other, please specify _____

11. In order to evaluate projects that involve native seed or plant materials within your scope of responsibility, do you check on the survival of the seed or plant materials after planting?
    a. Yes, for most project
    b. Yes, for some projects
    c. No → Skip Q12

12. Generally, when is the last time you typically check on the survival of the seed or plant materials after planting?
    a. About 1 year or less after seeding or planting
    b. 1 to 3 years after seeding or planting
    c. More than 3 years after seeding or planting

It is important for the Committee to better understand the decision-making process when [AGENCY NAME] purchases native seed. For these next questions we request details on a "typical project" in which you have been involved.

13. We would like you to identify a typical project involving native seed use in which you have played a fairly major part in the decision-making about purchasing those seed -- what species to buy, when to buy, from whom to buy, etc. What is the project's name and can you provide a brief description?
    Interviewer prompt if needed about general description of project, ask more about:
    - *Purpose of project (and what makes it "typical")*
    - *Approximate amount and type of native seed (species, certification, etc.) Acres covered.*
    - *Geographical area of use*
    - *If the project involves both native seed and plant material, include both.*
    - *Regulatory framework – whether regulations or policy is required or encouraged the use native seed and/or locally sourced native seed on the project.*

14. For this specific "typical" project, how was it determined exactly how much and which type of seed (species, germplasm within species, geographic identity, etc.) and plant materials were needed for this project?

15. From what source(s) did you obtain information about the availability of native seed (and plant materials) needed for this project?
    a. In-house knowledge
        Use

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Not Use
Unsure

b. Advertising
   Use
   Not Use
   Unsure
c. Preapproved vendors
   Use
   Not Use
   Unsure
d. Request for proposals
   Use
   Not Use
   Unsure
e. Other, please specify _____

16. Please describe the approval and funding process for this project.
Interviewer prompt if needed –
    - *Did you determine what was needed and then ask for that funding? Did you get the funding you asked for?*
    - *Was the budget for the project determined in another part of your agency, causing you to modify the project specifications to match the budget?*
    - *Were you given an annual budget and had to work within it for multiple projects?*
    - *Were funds leveraged through special programs or other agencies or sources of funding such as partnerships or collaborations?*
    - *What was the specific source of funds for this project?*
    - *Is this process typical for other projects as well?*

17. To purchase the seed used in this project:
    a. Were your seed requirements included in a consolidated buy with other projects in your agency?
    b. Were seeds for this project purchased separately from those needed for other projects?
    c. Other, specify (Example, seed was obtained from stored seed in agency warehouse.)

18. What type of contracting method was used to purchase the seed? Common methods might include purchase directly from a spot market sale, use of a marketing contract ahead of delivery date, or use of a production contract in which there is a sharing of production costs or risks.
Interviewer prompt if needed – types of contracting arrangements.
    - *Spot market sale of available seed or plant materials from the supplier's current inventory. For example, a bid on a BLM Consolidated Seed Buy. Price and quantity are unknown in advance of the production process.*
    - *Marketing contract that specifies seed or plant materials type, price, quantity, and delivery date. Approved in advance of the sale, this contract may or may not be signed before production decisions have been made or seed is available.*
    - *Production contract that specifies seed or plant materials type, desired quantity and delivery date. Contract shares some production costs and/or production risk (by providing flexibility on the quantity delivered and/or the delivery date), such as IDIQ. It may or may not specify a price.*
    - *Buying from agency warehouse*
    - *Other contracting arrangement – please describe*

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19. What input did you have in deciding which supplier was picked?
    Interviewer prompt if needed?
    - *You made the final decision*
    - *You had input but not the final decision*
    - *Decision was made elsewhere, you had little input*

20. I want to understand the timeline for this project. I am going to list six activities and ask for when they took place. Reporting month and year would be helpful.
    a. When did the planning for the project commence?
    b. When was the decision made on what seed were needed?
    c. When was funding authorization finalized?
    d. When were seeds purchased or collection/production contracts awarded?
    e. When were the seeds delivered?
    f. When were the seeds actually utilized on the land?

21. Did project developers reach out to suppliers during the planning stage for technical information and/or information on availability?

22. Did this project eventually receive the amount and type of native seed (plant material) that was in your original "needs assessment?"
    a. Yes
    b. No. What occurred?
        - *Was less seed purchased than requested? Why?*
        - *Was non-native seed substituted for native seed? If yes, because natives were too expensive, natives not available within project timeline, or just not available in general?*
        - *Was native seed having different characteristics substituted for preferred native seed? If yes, because preferred natives were too expensive, preferred natives not available within project timeline, or just not available in general?*

23. In order to evaluate this project, did you check on the survival of the seed after seeding or planting?
    a. Yes
        i. About 1 year or less after seeding or planting
        ii. 1 to 3 years after seeding or planting
        iii. Greater than 3 years after seeding or planting
    b. No

24. How successful was the project in reaching its goals? Was the evaluation useful in setting parameters for similar future projects?

25. What was your overall satisfaction with the decision-making process and availability of native seed for this project? Why?

26. Do you anticipate that native seed and plant material purchase and use on projects within your scope of responsibility is likely to increase or decrease in the short term? …in the longer term? Explain:

END. Thank you for your help!

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Appendix 2B

State Departments Survey Invitation Letter

The National Academies | SCIENCES ENGINEERING MEDICINE

May 24, 2021

<AGENCY NAME>
<DIR NAME>, <TITLE>

The National Academies of Sciences, Engineering, and Medicine is conducting an important assessment of the challenges faced by state government agencies that use native seed and plant materials. I am writing because it is my understanding that your agency uses native seed or plant materials for ecological restoration or other purposes. The assessment will benefit agencies, like yours, by identifying ways for improving connections between supply and demand for native seed and plant materials.

We would greatly appreciate your asking the person who is most knowledgeable about the use of native seed and plant materials at the [Agency Name] to complete this brief online survey that is being sent to state agencies throughout the United States. The survey will ask about how the [Agency Name] uses native seed and plant materials, and the challenges encountered with obtaining native seed.

The online survey is located here: https://qtrial.wsu.edu/StateSeedNeeds
Your survey access code is: <ResponseID>

Responses to this survey are voluntary and your answers will be kept completely confidential by the National Academies and the Washington State University Social and Economic Sciences Research Center that is implementing the survey for us. No individual or agency/department will ever be identified in our results. For this study to be successful it is vitally important that we hear from as many agencies as possible.

If you have any questions about why this survey is being done, please contact Kristina Marion at the National Academies at KMarion@nas.edu. If you have questions about accessing the survey, please contact Thom Allen at Washington State University, ted@wsu.edu, or call him toll-free at 1-800-853-0867.

Thank you for considering our request and we hope to hear from you soon.

Sincerely,

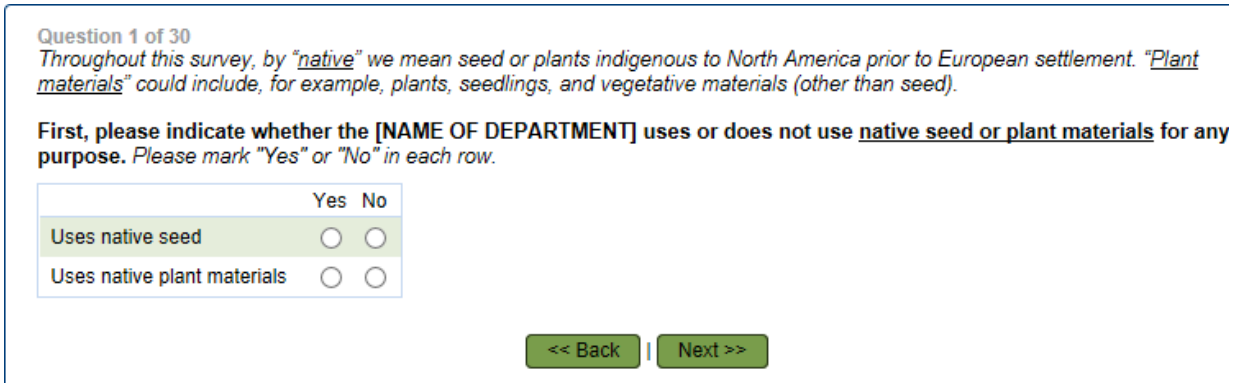
Robin Schoen

Robin Schoen
Director, Board on Agriculture and Natural Resources
The National Academies of Sciences, Engineering, and Medicine

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Appendix 2C

State Departments Web Survey Instrument



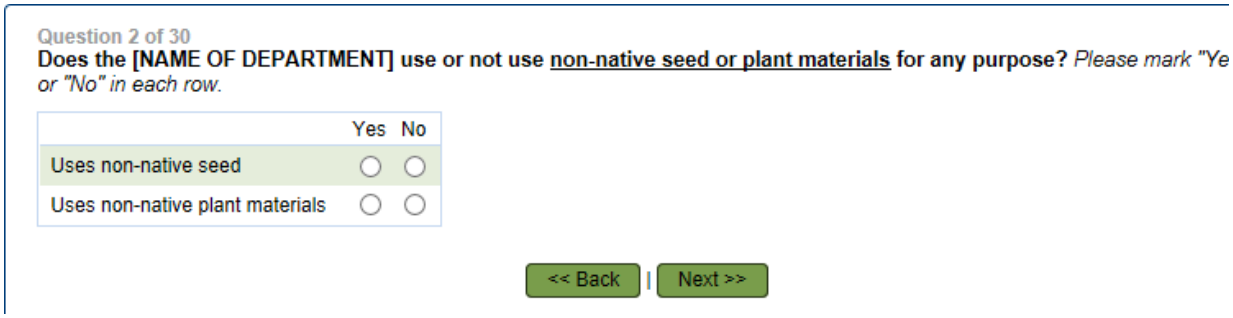
Question 1 of 30

Throughout this survey, by "native" we mean seed or plants indigenous to North America prior to European settlement. "Plant materials" could include, for example, plants, seedlings, and vegetative materials (other than seed).

First, please indicate whether the [NAME OF DEPARTMENT] uses or does not use native seed or plant materials for any purpose. *Please mark "Yes" or "No" in each row.*

	Yes	No
Uses native seed	○	○
Uses native plant materials	○	○

<< Back | Next >>



Question 2 of 30

Does the [NAME OF DEPARTMENT] use or not use non-native seed or plant materials for any purpose? *Please mark "Ye or "No" in each row.*

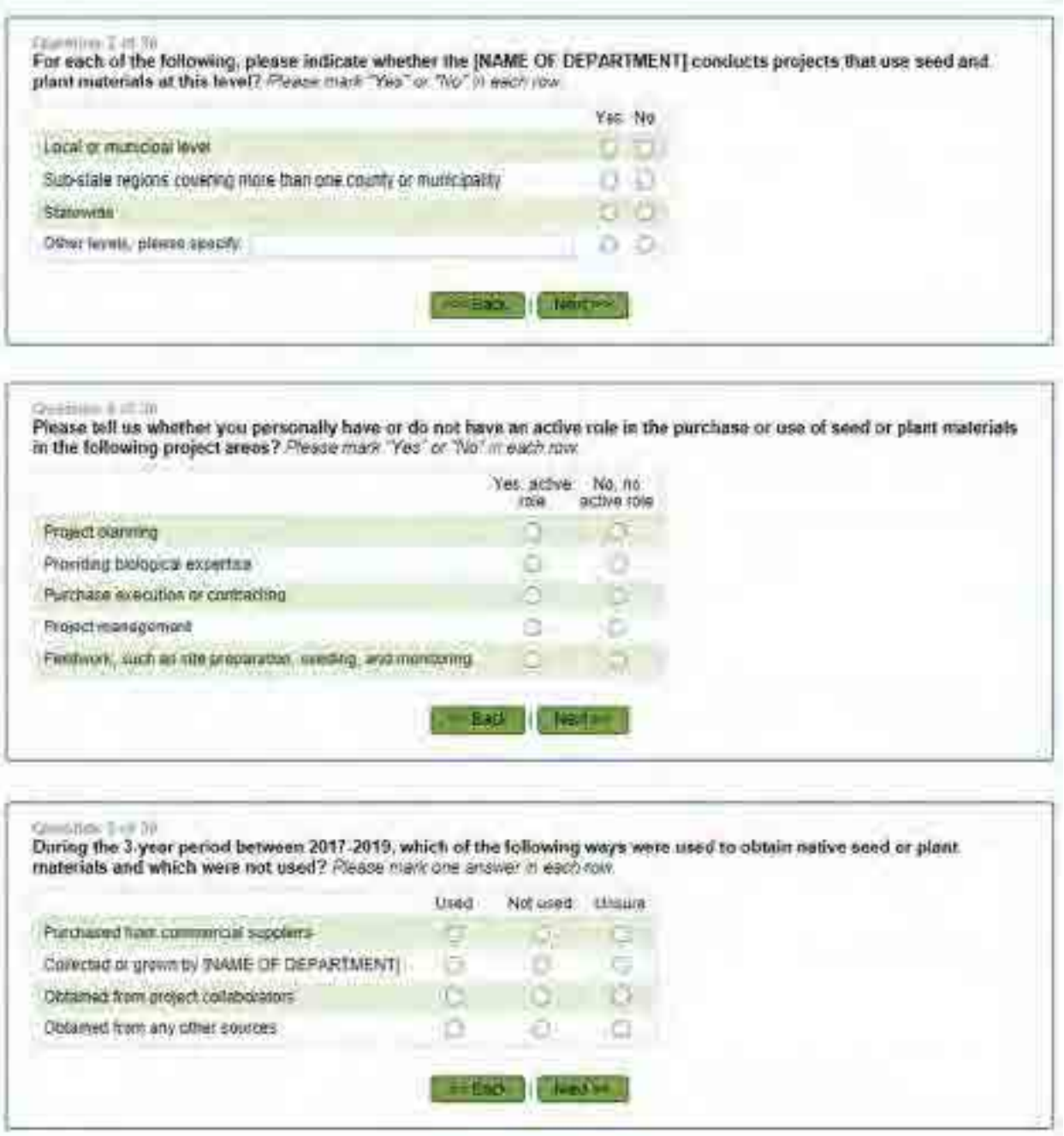
	Yes	No
Uses non-native seed	○	○
Uses non-native plant materials	○	○

<< Back | Next >>

[BRANCH: IF NO TO BOTH USES NATIVE SEED AND NATIVE PLANTS IN Q1 THEN SKIP TO Q27]

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Appendix 2C



[BRANCH: IF <u>NOT USED OR UNSURE</u> TO 5a (COMMERCIAL SUPPLIER) GO TO Q7]

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An Assessment of Native Seed Needs and the Capacity for Their Supply: Final Report





[BRANCH: IF <u>NO OR UNSURE</u> TO Q07 GO TO Q09]



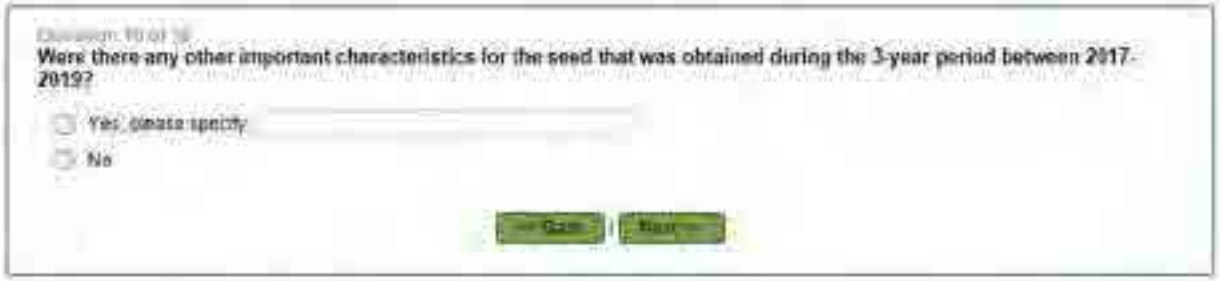
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Appendix 2C



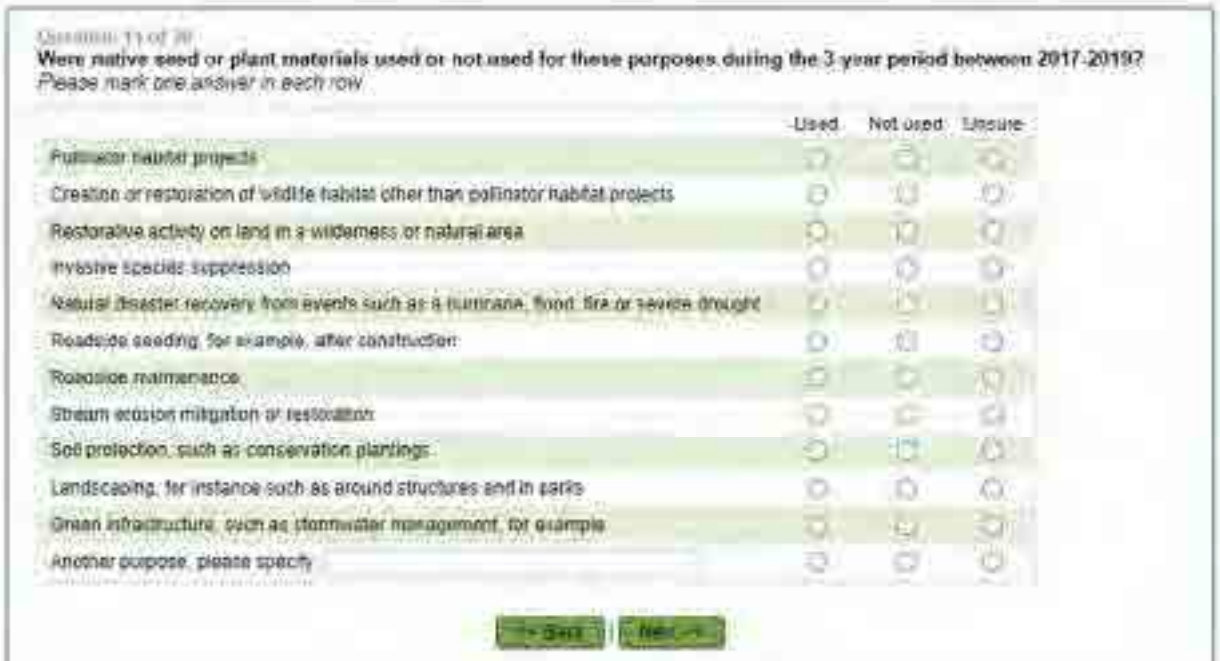
In obtaining seed for the [NAME OF DEPARTMENT] projects during 2017-2019, how important or unimportant was it to obtain the following general types of seed? *Please mark one answer in each row*

	Very important	Somewhat important	Not important	Unsure
Native seed				
Certified native seed				
Native seed that was collected from a designated geographic area or specified seed zone				



Were there any other important characteristics for the seed that was obtained during the 3-year period between 2017-2019?

- Yes, please specify
- No



Were native seed or plant materials used or not used for these purposes during the 3 year period between 2017-2019? *Please mark one answer in each row*

	Used	Not used	Unsure
Pollinator habitat projects			
Creation or restoration of wildlife habitat other than pollinator habitat projects			
Restorative activity on land in a wilderness or natural area			
Invasive species suppression			
Natural disaster recovery from events such as a hurricane, flood, fire or severe drought			
Roadside seeding, for example, after construction			
Roadside maintenance			
Stream erosion mitigation or restoration			
Soil protection, such as conservation plantings			
Landscaping, for instance such as around structures and in parks			
Green infrastructure, such as stormwater management, for example			
Another purpose, please specify			

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[BRANCH: IF Q5A (PURCHASED FROM A COMMERCIAL SUPPLIER) IS NO OR UNSURE SKIP TO Q17]



[BRANCH: IF BOTH Q15a AND Q15b ARE "NO" OR "UNSURE" SKIP TO Q17]

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Appendix 2C

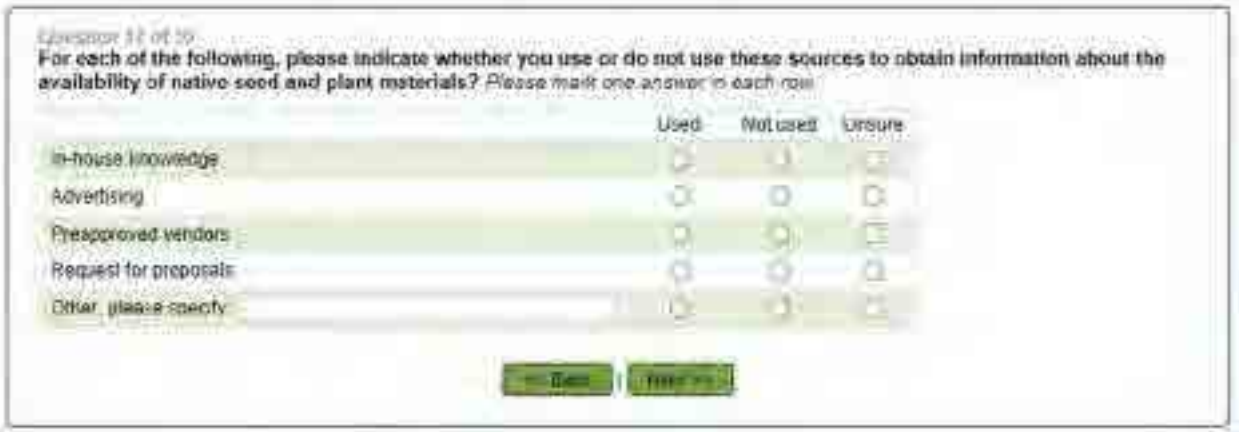


Question 10 of 20

Are the contracts usually established . . .

- before the supplier begins the seed production process?
- after the supplier begins the seed production process?
- unsure of timing of contract

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Question 11 of 20

For each of the following, please indicate whether you use or do not use these sources to obtain information about the availability of native seed and plant materials? *Please mark one answer in each row.*

	Used	Not used	Unsure
In-house knowledge			
Advertising			
Preapproved vendors			
Request for proposals			
Other, please specify			

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Question 12 of 20

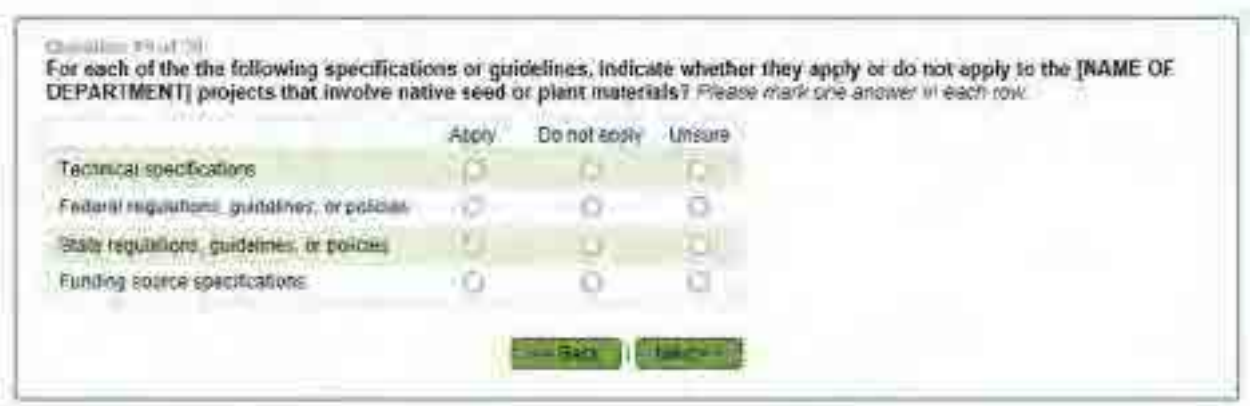
For each of the following, indicate whether you use or do not use these methods to communicate to suppliers about your anticipated future need for native seed or plant materials? *Please mark one answer in each row.*

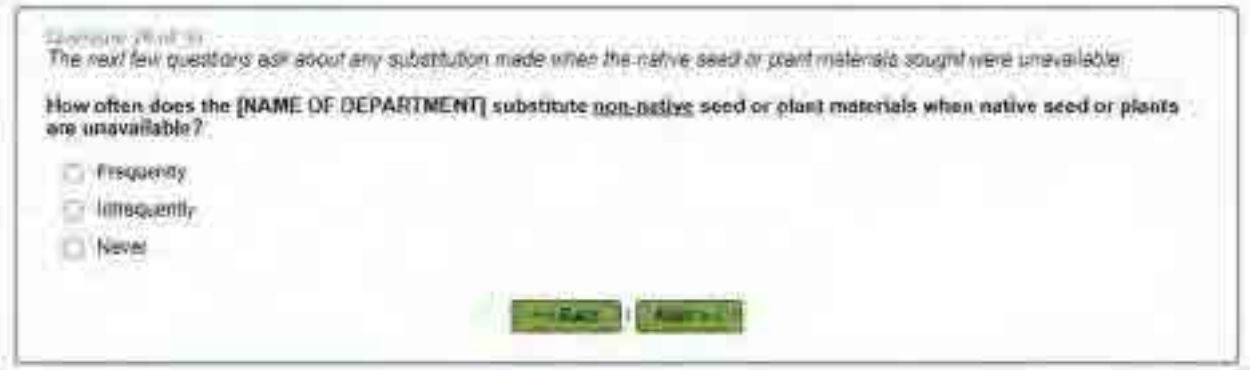
	Used	Not used	Unsure
Requests for proposals			
General publicity around projects			
Conferences or other professional meetings			
Informal meetings with growers			
Word of mouth			
Other, please specify			

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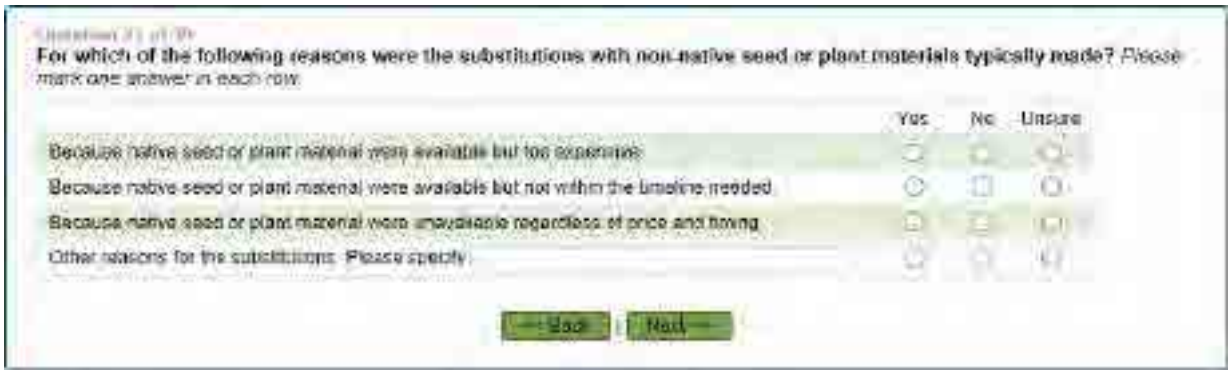
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[BRANCH: IF NEVER TO Q20 SKIP TO Q22]

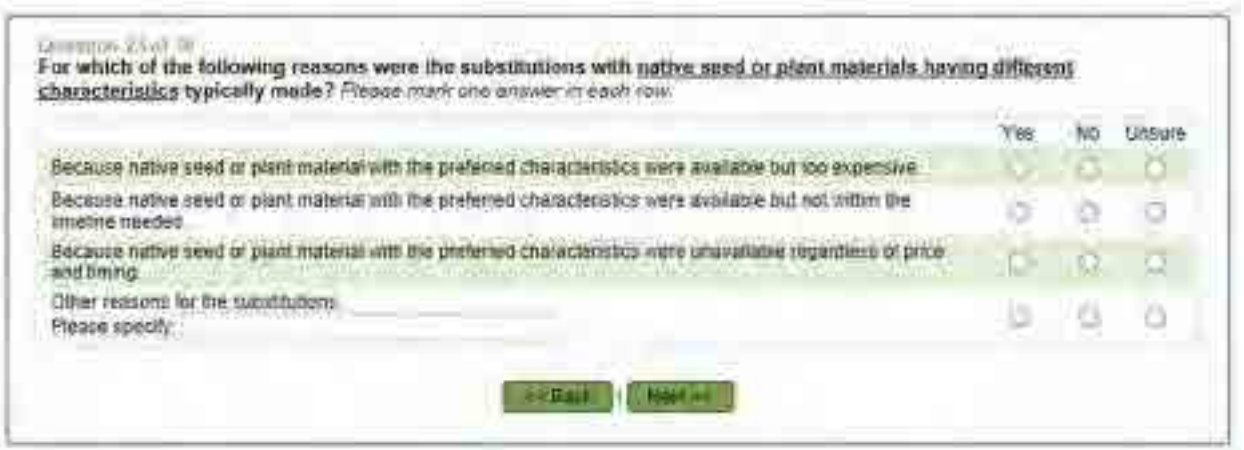


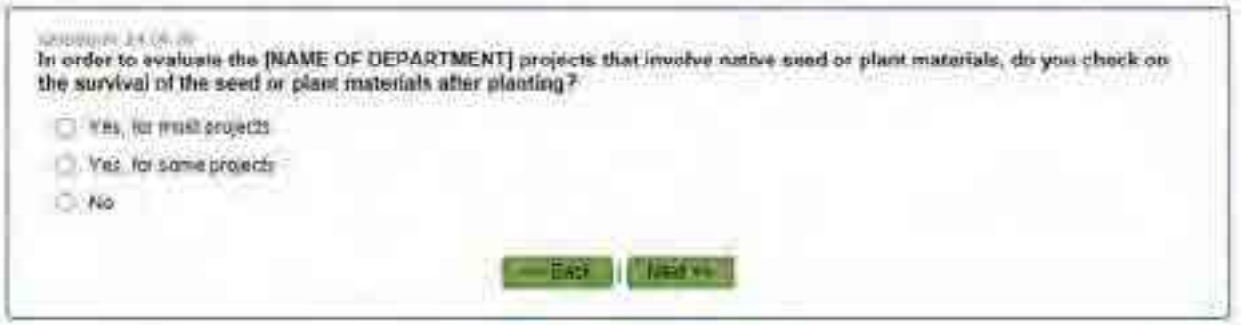
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Appendix 2C



[BRANCH: IF "NEVER" TO ALL SKIP TO Q24]





[BRANCH: IF "NO" SKIP TO Q26]

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Appendix 2D

State Departments Survey Frequency Distributions

Q01A Does [DEPARTMENT] use native seed for any purpose?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	89	91.8	94.7	94.7
	No	5	5.2	5.3	100.0
	Total	94	96.9	100.0	
Missing	No answer	3	3.1		
Total		97	100.0		

Q01B Does [DEPARTMENT] use native plant materials for any purpose?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	85	87.6	94.4	94.4
	No	5	5.2	5.6	100.0
	Total	90	92.8	100.0	
Missing	No answer	7	7.2		
Total		97	100.0		

Q02A Does [DEPARTMENT] use non-native seed for any purpose?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	69	71.1	74.2	74.2
	No	24	24.7	25.8	100.0
	Total	93	95.9	100.0	
Missing	No answer	4	4.1		
Total		97	100.0		

Q02B Does [DEPARTMENT] use non-native plant materials for any purpose?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	60	61.9	65.2	65.2
	No	32	33.0	34.8	100.0
	Total	92	94.8	100.0	
Missing	No answer	5	5.2		
Total		97	100.0		

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Appendix 2D

Q03A Does [DEPARTMENT] conduct projects that use seed and plant materials at this level? Local or municipal level.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	64	66.0	80.0	80.0
	No	16	16.5	20.0	100.0
	Total	80	82.5	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	1	1.0		
	No answer	13	13.4		
	Total	17	17.5		
Total		97	100.0		

Q03B Does [DEPARTMENT] conduct projects that use seed and plant materials at this level? Sub-state region covering more than one county or municipality.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	66	68.0	83.5	83.5
	No	13	13.4	16.5	100.0
	Total	79	81.4	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	1	1.0		
	No answer	14	14.4		
	Total	18	18.6		
Total		97	100.0		

Q03C Does [DEPARTMENT] conduct projects that use seed and plant materials at this level? Statewide.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	76	78.4	88.4	88.4
	No	10	10.3	11.6	100.0
	Total	86	88.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	1	1.0		
	No answer	7	7.2		
	Total	11	11.3		
Total		97	100.0		

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Q03D Does [DEPARTMENT] conduct projects that use seed and plant materials at this level? Other levels, please specify.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	12	12.4	38.7	38.7
	No	19	19.6	61.3	100.0
	Total	31	32.0	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	1	1.0		
	No answer	62	63.9		
	Total	66	68.0		
Total		97	100.0		

Q04A Do you personally have an active role related to the purchase or use of seed or plant materials in this project area? Project planning.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes, active role	76	78.4	86.4	86.4
	No, no active role	12	12.4	13.6	100.0
	Total	88	90.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	2	2.1		
	No answer	4	4.1		
	Total	9	9.3		
Total		97	100.0		

Q04B Do you personally have an active role related to the purchase or use of seed or plant materials in this project area? Providing biological expertise.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes, active role	73	75.3	83.0	83.0
	No, no active role	15	15.5	17.0	100.0
	Total	88	90.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	2	2.1		
	No answer	4	4.1		
	Total	9	9.3		
Total		97	100.0		

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Appendix 2D

Q04C Do you personally have an active role related to the purchase or use of seed or plant materials in this project area? Purchase execution or contracting.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes, active role	60	61.9	69.0	69.0
	No, no active role	27	27.8	31.0	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	2	2.1		
	No answer	5	5.2		
	Total	10	10.3		
Total		97	100.0		

Q04D Do you personally have an active role related to the purchase or use of seed or plant materials in this project area? Project management.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes, active role	70	72.2	79.5	79.5
	No, no active role	18	18.6	20.5	100.0
	Total	88	90.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	2	2.1		
	No answer	4	4.1		
	Total	9	9.3		
Total		97	100.0		

Q04E Do you personally have an active role related to the purchase or use of seed or plant materials in this project area? Fieldwork, such as site preparation, seeding, and monitoring.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes, active role	60	61.9	68.2	68.2
	No, no active role	28	28.9	31.8	100.0
	Total	88	90.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	2	2.1		
	No answer	4	4.1		
	Total	9	9.3		
Total		97	100.0		

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Q05A Between 2017-2019 did you obtain native seed or plant materials in this way? Purchased from commercial suppliers.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	85	87.6	95.5	95.5
	Not used	2	2.1	2.2	97.8
	Unsure	2	2.1	2.2	100.0
	Total	89	91.8	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	3	3.1		
	No answer	2	2.1		
	Total	8	8.2		
Total		97	100.0		

Q05B Between 2017-2019 did you obtain native seed or plant materials in this way? Collected or grown by you.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	43	44.3	48.9	48.9
	Not used	39	40.2	44.3	93.2
	Unsure	6	6.2	6.8	100.0
	Total	88	90.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	3	3.1		
	No answer	3	3.1		
	Total	9	9.3		
Total		97	100.0		

Q05C Between 2017-2019 did you obtain native seed or plant materials in this way? Obtained from project collaborator.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	55	56.7	62.5	62.5
	Not used	24	24.7	27.3	89.8
	Unsure	9	9.3	10.2	100.0
	Total	88	90.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	3	3.1		
	No answer	3	3.1		
	Total	9	9.3		
Total		97	100.0		

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Q05D Between 2017-2019 did you obtain native seed or plant materials in this way? Obtained from any other sources.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	26	26.8	32.1	32.1
	Not used	27	27.8	33.3	65.4
	Unsure	28	28.9	34.6	100.0
	Total	81	83.5	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	3	3.1		
	No answer	10	10.3		
	Total	16	16.5		
Total		97	100.0		

Q06A Between 2017-2019 did you use this way of purchasing native seed or plant materials from commercial suppliers? Purchased directly on the open market.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	66	68.0	80.5	80.5
	Not used	8	8.2	9.8	90.2
	Unsure	8	8.2	9.8	100.0
	Total	82	84.5	100.0	
Missing	Branching skip	7	7.2		
	Partial breakoff	4	4.1		
	No answer	4	4.1		
	Total	15	15.5		
Total		97	100.0		

Q06B Between 2017-2019 did you use this way of purchasing native seed or plant materials from commercial suppliers? Purchased via a formal bidding process.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	52	53.6	65.8	65.8
	No	15	15.5	19.0	84.8
	Unsure	12	12.4	15.2	100.0
	Total	79	81.4	100.0	
Missing	Branching skip	7	7.2		
	Partial breakoff	4	4.1		
	No answer	7	7.2		
	Total	18	18.6		
Total		97	100.0		

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Q07 Were any of the native seeds used between 2017-2019 wild collected on state land?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	38	39.2	44.2	44.2
	No	23	23.7	26.7	70.9
	Unsure	25	25.8	29.1	100.0
	Total	86	88.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	3	3.1		
	Total	11	11.3		
Total		97	100.0		

Q08A How did the [Department] use the native seed that was wild collected on state land between 2017 and 2019? The seed was used to plant directly at a project site.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	36	37.1	92.3	92.3
	No	2	2.1	5.1	97.4
	Unsure	1	1.0	2.6	100.0
	Total	39	40.2	100.0	
Missing	Branching skip	51	52.6		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	58	59.8		
Total		97	100.0		

Q08B How did the [Department] use the native seed that was wild collected on state land between 2017 and 2019? The seed was used to grow plants with the purpose of harvesting seed or plant materials for future use.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	30	30.9	78.9	78.9
	No	7	7.2	18.4	97.4
	Unsure	1	1.0	2.6	100.0
	Total	38	39.2	100.0	
Missing	Branching skip	51	52.6		
	Partial breakoff	5	5.2		
	No answer	3	3.1		
	Total	59	60.8		
Total		97	100.0		

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Q08C How did the [Department] use the native seed that was wild collected on state land between 2017 and 2019? The seed was used for another purpose. Please specify.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	7	7.2	24.1	24.1
	No	18	18.6	62.1	86.2
	Unsure	4	4.1	13.8	100.0
	Total	29	29.9	100.0	
Missing	Branching skip	51	52.6		
	Partial breakoff	5	5.2		
	No answer	12	12.4		
	Total	68	70.1		
Total		97	100.0		

Q09A In obtaining seed for [DEPARTMENT] projects between 2017-2019, how important was it to obtain this type of seed? Native seed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very important	72	74.2	82.8	82.8
	Somewhat important	14	14.4	16.1	98.9
	Not important	1	1.0	1.1	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

Q09B In obtaining seed for [DEPARTMENT] projects between 2017-2019, how important was it to obtain this type of seed? Certified native seed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very important	37	38.1	42.5	42.5
	Somewhat important	28	28.9	32.2	74.7
	Not important	10	10.3	11.5	86.2
	Unsure	12	12.4	13.8	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

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Q09C In obtaining seed for [DEPARTMENT] projects between 2017-2019, how important was it to obtain this type of seed? Native seed that was collected from a designated geographic area or specified seed zone.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very important	43	44.3	49.4	49.4
	Somewhat important	29	29.9	33.3	82.8
	Not important	10	10.3	11.5	94.3
	Unsure	5	5.2	5.7	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

Q10 Were there any other important characteristics for the seed that was obtained during the 3-year period between 2017-2019?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes, please specify:	36	37.1	41.4	41.4
	No	51	52.6	58.6	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

Q11A Were native seed or plant materials used for this purpose between 2017-2019? Pollinator.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	72	74.2	82.8	82.8
	Not used	10	10.3	11.5	94.3
	Unsure	5	5.2	5.7	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

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Q11B Were native seed or plant materials used for this purpose between 2017-2019? Creation/restoration of wildlife habitat (other than pollinator habitat projects).

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	76	78.4	87.4	87.4
	Not used	6	6.2	6.9	94.3
	Unsure	5	5.2	5.7	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

Q11C Were native seed or plant materials used for this purpose between 2017-2019? Restorative activity on land in a wilderness/natural area.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	65	67.0	74.7	74.7
	Not used	13	13.4	14.9	89.7
	Unsure	9	9.3	10.3	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

Q11D Were native seed or plant materials used for this purpose between 2017-2019? Invasive species suppression.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	51	52.6	58.6	58.6
	Not used	24	24.7	27.6	86.2
	Unsure	12	12.4	13.8	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

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Q11E Were native seed or plant materials used for this purpose between 2017-2019? Natural disaster recovery from events such as a hurricane, flood, fire, severe drought, etc.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	32	33.0	37.2	37.2
	Not used	39	40.2	45.3	82.6
	Unsure	15	15.5	17.4	100.0
	Total	86	88.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	3	3.1		
	Total	11	11.3		
Total		97	100.0		

Q11F Were native seed or plant materials used for this purpose between 2017-2019? Roadside seeding.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	58	59.8	66.7	66.7
	Not used	19	19.6	21.8	88.5
	Unsure	10	10.3	11.5	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

Q11G Were native seed or plant materials used for this purpose between 2017-2019? Roadside maintenance.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	40	41.2	46.5	46.5
	Not used	27	27.8	31.4	77.9
	Unsure	19	19.6	22.1	100.0
	Total	86	88.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	3	3.1		
	Total	11	11.3		
Total		97	100.0		

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Q11H Were native seed or plant materials used for this purpose between 2017-2019? Stream erosion mitigation/restoration.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	69	71.1	80.2	80.2
	Not used	10	10.3	11.6	91.9
	Unsure	7	7.2	8.1	100.0
	Total	86	88.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	3	3.1		
	Total	11	11.3		
Total		97	100.0		

Q11I Were native seed or plant materials used for this purpose between 2017-2019? Soil protection.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	63	64.9	72.4	72.4
	Not used	14	14.4	16.1	88.5
	Unsure	10	10.3	11.5	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

Q11J Were native seed or plant materials used for this purpose between 2017-2019? Landscaping.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	53	54.6	60.9	60.9
	Not used	24	24.7	27.6	88.5
	Unsure	10	10.3	11.5	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

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Q11K Were native seed or plant materials used for this purpose between 2017-2019? Green infrastructure.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	43	44.3	49.4	49.4
	Not used	27	27.8	31.0	80.5
	Unsure	17	17.5	19.5	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

Q11L Were native seed or plant materials used for this purpose between 2017-2019? Another purpose, please specify.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	11	11.3	31.4	31.4
	Not used	9	9.3	25.7	57.1
	Unsure	15	15.5	42.9	100.0
	Total	35	36.1	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	54	55.7		
	Total	62	63.9		
Total		97	100.0		

Q12 Does DEPARTMENT] have programs to assist private landowners with the use of native seed or plant materials?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	40	41.2	46.0	46.0
	No	42	43.3	48.3	94.3
	Unsure	5	5.2	5.7	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

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Q13 Does [DEPARTMENT] contract out seeding or planting activities with native seed or plant materials?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	68	70.1	78.2	78.2
	No	16	16.5	18.4	96.6
	Unsure	3	3.1	3.4	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

Q14A Does the [DEPARTMENT] have this form of seed storage? Ambient storage.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	56	57.7	64.4	64.4
	No	28	28.9	32.2	96.6
	Unsure	3	3.1	3.4	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

Q14B Does the [DEPARTMENT] have this form of seed storage? Refrigerated storage.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	24.7	27.6	27.6
	No	52	53.6	59.8	87.4
	Unsure	11	11.3	12.6	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

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Q14C Does the [DEPARTMENT] have this form of seed storage? Freezer storage.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	14	14.4	16.3	16.3
	No	59	60.8	68.6	84.9
	Unsure	13	13.4	15.1	100.0
	Total	86	88.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	3	3.1		
	Total	11	11.3		
Total		97	100.0		

Q15A Does [DEPARTMENT] use this type of contract? Marketing contracts that specifies the type, price, quantity, and delivery date of seed or plant materials.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	32	33.0	38.6	38.6
	No	36	37.1	43.4	81.9
	Unsure	15	15.5	18.1	100.0
	Total	83	85.6	100.0	
Missing	Branching skip	7	7.2		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	14	14.4		
Total		97	100.0		

Q15B Does [DEPARTMENT] use this type of contract? Production contracts that specifies the desired type, quantity and delivery date of native seed and plant materials.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	18	18.6	22.0	22.0
	No	43	44.3	52.4	74.4
	Unsure	21	21.6	25.6	100.0
	Total	82	84.5	100.0	
Missing	Branching skip	7	7.2		
	Partial breakoff	5	5.2		
	No answer	3	3.1		
	Total	15	15.5		
Total		97	100.0		

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Q16 Are the contracts usually established . . .

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	before the supplier begins the seed production process?	15	15.5	36.6	36.6
	after the supplier begins the seed production process?	10	10.3	24.4	61.0
	Unsure of timing of contract	16	16.5	39.0	100.0
	Total	41	42.3	100.0	
Missing	Branching skip	49	50.5		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	56	57.7		
Total		97	100.0		

Q17A Do you use this source to obtain information about the availability of native seed and plant materials? In-house knowledge

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	86	88.7	97.7	97.7
	Not used	1	1.0	1.1	98.9
	Unsure	1	1.0	1.1	100.0
	Total	88	90.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	1	1.0		
	Total	9	9.3		
Total		97	100.0		

Q17B Do you use this source to obtain information about the availability of native seed and plant materials? Advertising.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	33	34.0	40.7	40.7
	Not used	38	39.2	46.9	87.7
	Unsure	10	10.3	12.3	100.0
	Total	81	83.5	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	8	8.2		
	Total	16	16.5		
Total		97	100.0		

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Q17C Do you use this source to obtain information about the availability of native seed and plant materials? Preapproved vendors

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	60	61.9	69.8	69.8
	Not used	17	17.5	19.8	89.5
	Unsure	9	9.3	10.5	100.0
	Total	86	88.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	3	3.1		
	Total	11	11.3		
Total		97	100.0		

Q17D Do you use this source to obtain information about the availability of native seed and plant materials? Request for proposals

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	43	44.3	51.2	51.2
	Not used	28	28.9	33.3	84.5
	Unsure	13	13.4	15.5	100.0
	Total	84	86.6	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	5	5.2		
	Total	13	13.4		
Total		97	100.0		

Q17E Do you use this source to obtain information about the availability of native seed and plant materials? Other, please specify.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	19	19.6	51.4	51.4
	Not used	10	10.3	27.0	78.4
	Unsure	8	8.2	21.6	100.0
	Total	37	38.1	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	52	53.6		
	Total	60	61.9		
Total		97	100.0		

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Q18A Do you use this method to communicate to suppliers about your anticipated future need for native seed or plant materials? Requests for proposals.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	43	44.3	48.9	48.9
	Not used	37	38.1	42.0	90.9
	Unsure	8	8.2	9.1	100.0
	Total	88	90.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	1	1.0		
	Total	9	9.3		
Total		97	100.0		

Q18B Do you use this method to communicate to suppliers about your anticipated future need for native seed or plant materials? General publicity around projects.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	26	26.8	29.9	29.9
	Not used	44	45.4	50.6	80.5
	Unsure	17	17.5	19.5	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

Q18C Do you use this method to communicate to suppliers about your anticipated future need for native seed or plant materials? Conferences or other professional meetings.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	43	44.3	49.4	49.4
	Not used	36	37.1	41.4	90.8
	Unsure	8	8.2	9.2	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

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Q18D Do you use this method to communicate to suppliers about your anticipated future need for native seed or plant materials? Informal meetings with growers.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	39	40.2	45.3	45.3
	Not used	38	39.2	44.2	89.5
	Unsure	9	9.3	10.5	100.0
	Total	86	88.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	3	3.1		
	Total	11	11.3		
Total		97	100.0		

Q18E Do you use this method to communicate to suppliers about your anticipated future need for native seed or plant materials? Word of mouth.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	48	49.5	54.5	54.5
	Not used	29	29.9	33.0	87.5
	Unsure	11	11.3	12.5	100.0
	Total	88	90.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	1	1.0		
	Total	9	9.3		
Total		97	100.0		

Q18F Do you use this method to communicate to suppliers about your anticipated future need for native seed or plant materials? Other, please specify.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Used	9	9.3	28.1	28.1
	Not used	14	14.4	43.8	71.9
	Unsure	9	9.3	28.1	100.0
	Total	32	33.0	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	57	58.8		
	Total	65	67.0		
Total		97	100.0		

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Q19A Does this specification or guideline apply to [DEPARTMENT] projects that involve native seed or plant materials? Technical specifications.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Apply	79	81.4	90.8	90.8
	Do not apply	5	5.2	5.7	96.6
	Unsure	3	3.1	3.4	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

Q19B Does this specification or guideline apply to [DEPARTMENT] projects that involve native seed or plant materials? Federal regulations, guidelines, or policy.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Apply	61	62.9	70.1	70.1
	Do not apply	12	12.4	13.8	83.9
	Unsure	14	14.4	16.1	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

Q19C Does this specification or guideline apply to [DEPARTMENT] projects that involve native seed or plant materials? State regulations, guidelines, or policy.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Apply	73	75.3	83.9	83.9
	Do not apply	8	8.2	9.2	93.1
	Unsure	6	6.2	6.9	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

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Q19D Does this specification or guideline apply to [DEPARTMENT] projects that involve native seed or plant materials? Funding source specifications.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Apply	51	52.6	58.6	58.6
	Do not apply	17	17.5	19.5	78.2
	Unsure	19	19.6	21.8	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

Q20 How often does [DEPARTMENT] substitute non-native seed or plant materials when native seed or plants are unavailable?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Frequently	21	21.6	24.1	24.1
	Infrequently	45	46.4	51.7	75.9
	Never	21	21.6	24.1	100.0
	Total	87	89.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	10	10.3		
Total		97	100.0		

Q21A Was this a reason substitutions with non-native seed or plant materials were typically made? Because native seed or plant material were available but too expensive.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	28	28.9	43.1	43.1
	No	28	28.9	43.1	86.2
	Unsure	9	9.3	13.8	100.0
	Total	65	67.0	100.0	
Missing	Branching skip	24	24.7		
	Partial breakoff	5	5.2		
	No answer	3	3.1		
	Total	32	33.0		
Total		97	100.0		

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Q21B Was this a reason substitutions with non-native seed or plant materials were typically made? Because native seed or plant material were available but not within the timeline needed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	22	22.7	33.8	33.8
	No	27	27.8	41.5	75.4
	Unsure	16	16.5	24.6	100.0
	Total	65	67.0	100.0	
Missing	Branching skip	24	24.7		
	Partial breakoff	5	5.2		
	No answer	3	3.1		
	Total	32	33.0		
Total		97	100.0		

Q21C Was this a reason substitutions with non-native seed or plant materials were typically made? Because native seed or plant material were unavailable regardless of price and timing.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	39	40.2	58.2	58.2
	No	17	17.5	25.4	83.6
	Unsure	11	11.3	16.4	100.0
	Total	67	69.1	100.0	
Missing	Branching skip	24	24.7		
	Partial breakoff	5	5.2		
	No answer	1	1.0		
	Total	30	30.9		
Total		97	100.0		

Q21D Was this a reason substitutions with non-native seed or plant materials were typically made? Other reasons for the substitutions. Please specify.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	24	24.7	70.6	70.6
	No	5	5.2	14.7	85.3
	Unsure	5	5.2	14.7	100.0
	Total	34	35.1	100.0	
Missing	Branching skip	24	24.7		
	Partial breakoff	5	5.2		
	No answer	34	35.1		
	Total	63	64.9		
Total		97	100.0		

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Q22A How often does your agency substitute native seed or plant materials having different characteristics when your preferred natives are not available? Native seed or plant material of different species.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Frequently	36	37.1	41.9	41.9
	Infrequently	44	45.4	51.2	93.0
	Never	6	6.2	7.0	100.0
	Total	86	88.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	3	3.1		
	Total	11	11.3		
Total		97	100.0		

Q22B How often does your agency substitute native seed or plant materials having different characteristics when your preferred natives are not available? Native seed or plant material from a different region.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Frequently	25	25.8	29.1	29.1
	Infrequently	51	52.6	59.3	88.4
	Never	10	10.3	11.6	100.0
	Total	86	88.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	3	3.1		
	Total	11	11.3		
Total		97	100.0		

Q22C How often does your agency substitute native seed or plant materials having different characteristics when your preferred natives are not available? Other, please specify.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Frequently	2	2.1	10.5	10.5
	Infrequently	5	5.2	26.3	36.8
	Never	12	12.4	63.2	100.0
	Total	19	19.6	100.0	
Missing	Branching skip	6	6.2		
	Partial breakoff	5	5.2		
	No answer	67	69.1		
	Total	78	80.4		
Total		97	100.0		

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Q23A Was this a reason substitutions with native seed or plant materials having different characteristics were typically made? Because native seed or plant material with the preferred characteristics were available but too expensive.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	29	29.9	35.4	35.4
	No	39	40.2	47.6	82.9
	Unsure	14	14.4	17.1	100.0
	Total	82	84.5	100.0	
Missing	Branching skip	8	8.2		
	Partial breakoff	5	5.2		
	No answer	2	2.1		
	Total	15	15.5		
Total		97	100.0		

Q23B Was this a reason substitutions with native seed or plant materials having different characteristics were typically made? Because native seed or plant material with the preferred characteristics were available but not within the timeline needed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	49	50.5	60.5	60.5
	No	22	22.7	27.2	87.7
	Unsure	10	10.3	12.3	100.0
	Total	81	83.5	100.0	
Missing	Branching skip	8	8.2		
	Partial breakoff	5	5.2		
	No answer	3	3.1		
	Total	16	16.5		
Total		97	100.0		

Q23C Was this a reason substitutions with native seed or plant materials having different characteristics were typically made? Because native seed or plant material with the preferred characteristics were unavailable regardless of price and timing.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	68	70.1	81.0	81.0
	No	8	8.2	9.5	90.5
	Unsure	8	8.2	9.5	100.0
	Total	84	86.6	100.0	
Missing	Branching skip	8	8.2		
	Partial breakoff	5	5.2		
	Total	13	13.4		
Total		97	100.0		

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Q23D Was this a reason substitutions with native seed or plant materials having different characteristics were typically made? Other reasons for the substitutions. Please specify.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	8	8.2	32.0	32.0
	No	10	10.3	40.0	72.0
	Unsure	7	7.2	28.0	100.0
	Total	25	25.8	100.0	
Missing	Branching skip	8	8.2		
	Partial breakoff	5	5.2		
	No answer	59	60.8		
	Total	72	74.2		
Total		97	100.0		

Q24 In order to evaluate [DEPARTMENT] projects that involve native seed or plant materials, do you check on the survival of the seed or plant materials after planting?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes, for most project	63	64.9	71.6	71.6
	Yes, for some projects	23	23.7	26.1	97.7
	No	2	2.1	2.3	100.0
	Total	88	90.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	1	1.0		
	Total	9	9.3		
Total		97	100.0		

Q25 For a typical project, when is the last time you checked on the survival of the seed or plant materials after planting?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	About 1 year or less after seeding/planting	21	21.6	24.4	24.4
	1 to 3 years after seeding/planting	39	40.2	45.3	69.8
	Greater than 3 years after seeding/planting	26	26.8	30.2	100.0
	Total	86	88.7	100.0	
Missing	Branching skip	5	5.2		
	Partial breakoff	5	5.2		
	No answer	1	1.0		
	Total	11	11.3		
Total		97	100.0		

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Q26 Does [DEPARTMENT] have the range of in-house expertise needed for the various aspects of projects that use native seeds or plants, or are there some gaps in the expertise available in-house?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	We have the expertise we need in-house	51	52.6	58.0	58.0
	We have some gaps in expertise. Pease specify:	34	35.1	38.6	96.6
	Don"t know	3	3.1	3.4	100.0
	Total	88	90.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	1	1.0		
	Total	9	9.3		
Total		97	100.0		

Q27_O What are the biggest barriers or disincentives to using native seed and plant materials in your work? (Open-ended response coding frequencies)

Code	Count
1. Availability	48
2. Cost	38
3. Communication issues	1
4. Genetics	16
5. Geographic or ecosystem limitations conditions	9
7. Systems	5
8. Timing	9
9 Other	0
10. Lack of knowledge	11
11. Lack of support for native plants/seeds	13
11. Not applicable, no comment	7

Q28 Do you anticipate that the use of native seed or plant materials by the [DEPARTMENT] is likely to increase or decrease in the near-term future?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Increase	65	67.0	75.6	75.6
	Decrease	2	2.1	2.3	77.9
	Unsure	19	19.6	22.1	100.0
	Total	86	88.7	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	3	3.1		
	Total	11	11.3		
Total		97	100.0		

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Q28_O Do you anticipate that the use of native seed or plant materials by the [DEPARTMENT] is likely to increase or decrease in the near-term future? Please explain why. (Open-ended response coding frequencies)

Increase	
CODE	**Count**
Preference, demand, interest	13
Research, Funding	6
Relationships	4
Environmental reasons	8
Awareness, education	11
Habitat programs, restoration	12
Projects	7
Decrease	
CODE	
Staffing	1
Unsure	
CODE	
Funding dependent	3
Natives already	4
Climate dependent	1
Innovation dependent	1
Remain the same	3

Q29 Do you anticipate that [DEPARTMENT]'s use of native seed or plant materials is likely to increase or decrease in the long-term future?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Increase	62	63.9	72.9	72.9
	Decrease	1	1.0	1.2	74.1
	Unsure	22	22.7	25.9	100.0
	Total	85	87.6	100.0	
Missing	Branching skip	3	3.1		
	Partial breakoff	5	5.2		
	No answer	4	4.1		
	Total	12	12.4		
Total		97	100.0		

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Appendix 2D

Q29_O Do you anticipate that [DEPARTMENT]'s use of native seed or plant materials is likely to increase or decrease in the long-term future? Please explain why. (Open-ended response coding frequencies)

Increase	
CODE	**Count**
Awareness, education	7
Preference, demand, interest	13
Environmental reasons	7
Funding, research	4
Population growth	2
Habitat programs, restoration	9
See Q28	5
Unsure	
CODE	
Funding, research dependent	1
Markets	3
Project dependent	2
Needs dependent	2
Climate dependent	2
See Q28	3
No answer	
Natives already	1
See Q28	1

Q30 Thinking about the three-year period from 2017 to 2019, what was [DEPARTMENT]'s approximate average annual expenditure on native seed and plant materials combined? (Open-ended response coding frequencies)

	Total	
	Freq	%
$100,000 and below	43	56%
Over $100,000	26	34%
Don't know	8	10%
Total	77	100%
Missing	20	
Total	97	

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Q31_O If you have any additional comments, please feel free to type them in the space provided below. Thank you for your help! (Open-ended response coding frequencies)

DESCRIPTION	count
Talked about managing or using nonnative seeds/plants and/or why non-native seed/plants are used instead of native seed/plants.	4
Talked about research or need for research.	4
Questioning whether the term "native" to a region is actually true, and/or difficult to determine the origin of non-certified seed	2
Talked about something specific to a survey question or how they answered.	8
Specific to what their business does	11
Said NA	1

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Appendix 2E

Supplier Survey Invitation Letter

May 2021

<Business Name>
<Business Address>
<City> <State> <Zip> <Zip4>

The National Academies of Sciences, Engineering, and Medicine is conducting an important assessment of the challenges faced by seed and plant suppliers in the United States. I am writing because it is my understanding that your organization is a supplier of native seed or plant materials. The assessment will benefit suppliers throughout the nation by identifying ways for improving connections between supply and demand for native seed and plant materials.

We would greatly appreciate your asking the person at [Business Name] who is most knowledgeable about your sales of native seed and plant materials to answer this brief online survey that is being sent to seed and plant suppliers throughout the United States. The survey asks about experiences your organization might have with the sale of native seed. We would also like to hear your ideas for improving future opportunities for native seed and plant suppliers.

The online survey is located here: https://opinion.wsu.edu/SeedSales/
Your survey access code is: KeyID

Responses to this survey are voluntary and your answers will be kept completely confidential by the National Academies and the Washington State University Social and Economic Sciences Research Center that is implementing the survey for us. No individual or business will ever be identified in our results. For this study to be successful it is vitally important that we hear from as many suppliers as possible.

If you have any questions about why this survey is being done, please contact Kristinae Marion at the National Academies at KMarion@nas.edu. If you have questions about accessing the survey, please contact Thom Allen at Washington State University, ted@wsu.edu, or call him toll-free at 1-800-833-0867.

Thank you for considering our request and we hope to hear from you soon.

Sincerely,

Robin Schoen

Robin Schoen
Director, Board on Agriculture and Natural Resources
The National Academies of Sciences, Engineering, and Medicine

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Appendix 2F

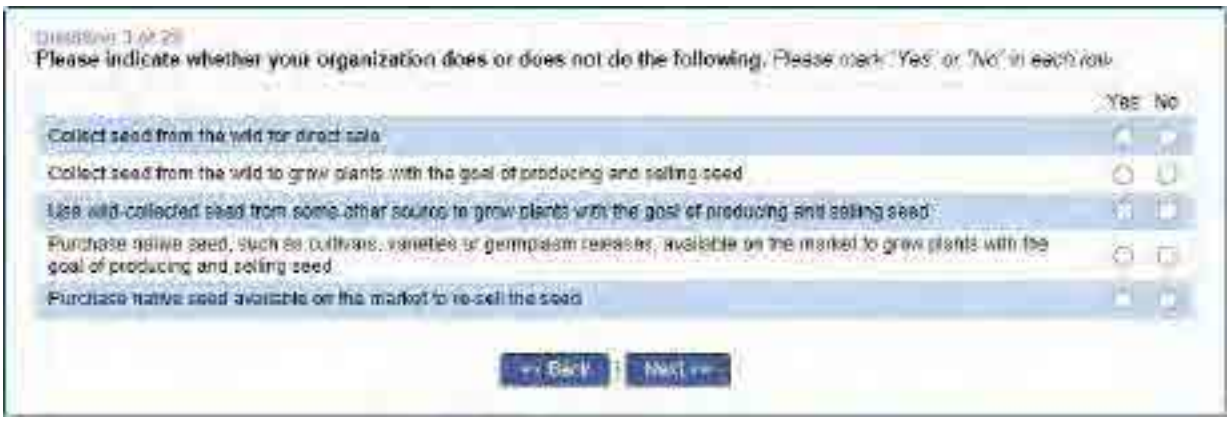
Supplier Web Survey Instrument



[BRANCH: IF "DOES NOT SELL' TO BOTH NATIVE SEED AND NATIVE PLANT MATERIALS, END SURVEY

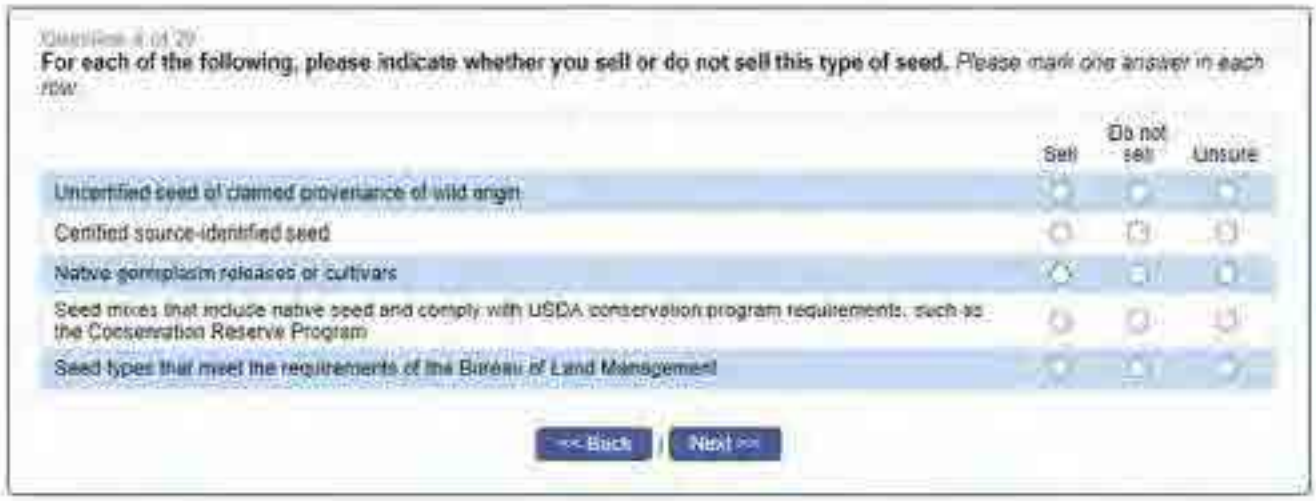


[BRANCH: IF "Yes" TO Q2 (Focus on home market), END SURVEY] [BRANCH: IF "No" TO Q1a (Native seed), GO TO Q6]



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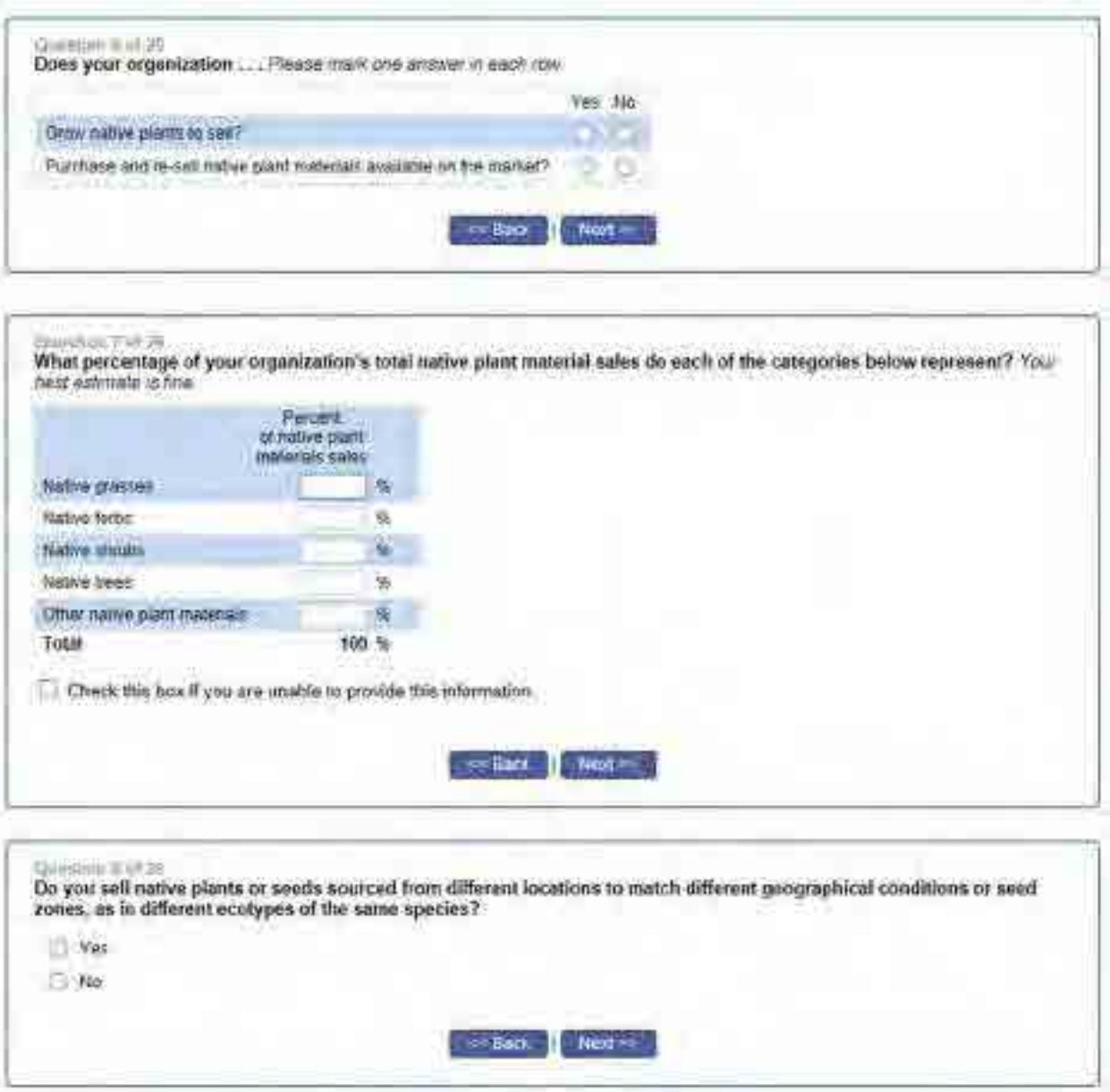




[BRANCH: IF 'NO' TO Q1c (Native plant materials) SKIP TO Q8.]

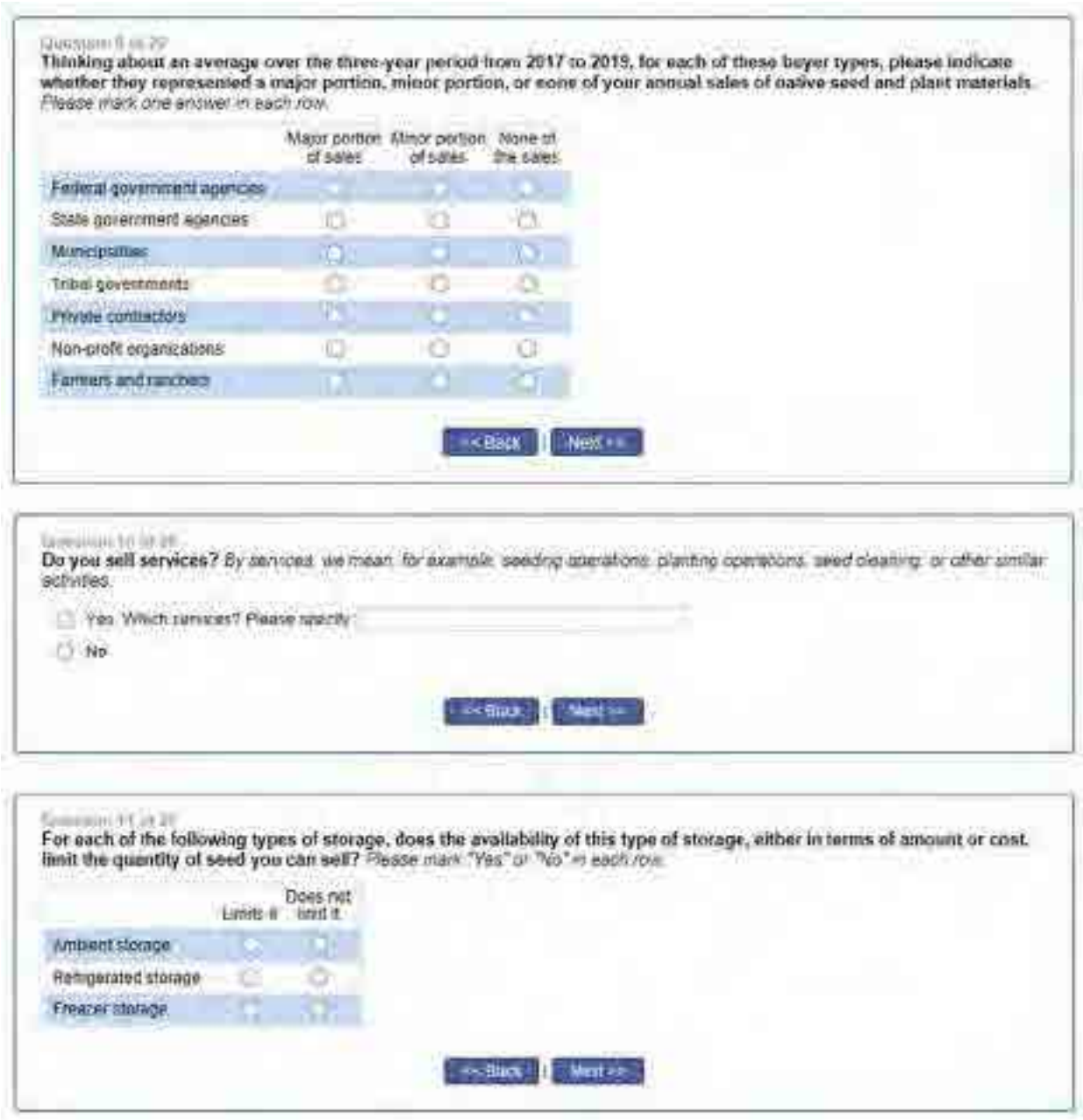
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Appendix 2F



Question 9 of 29

Thinking about an average over the three-year period from 2017 to 2019, for each of these buyer types, please indicate whether they represented a major portion, minor portion, or none of your annual sales of native seed and plant materials. *Please mark one answer in each row.*

	Major portion of sales	Minor portion of sales	None of the sales
Federal government agencies			
State government agencies			
Municipalities			
Tribal governments			
Private contractors			
Non-profit organizations			
Farmers and ranchers			

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Question 10 of 29

Do you sell services? *By services, we mean, for example, seeding operations, planting operations, seed cleaning, or other similar activities.*

- Yes. Which services? Please specify:
- No

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Question 11 of 29

For each of the following types of storage, does the availability of this type of storage, either in terms of amount or cost, limit the quantity of seed you can sell? *Please mark "Yes" or "No" in each row.*

	Limits it	Does not limit it
Ambient storage		
Refrigerated storage		
Freezer storage		

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For each of the following, please indicate whether you use or do not use this method to communicate to potential buyers about what your business offers. *Please mark one answer in each row*

	Use	Do not use
Company website		
Print catalogue		
Vendor listings or registries		
Bids in response to "requests for proposals" or "seed buy requests"		
Word-of-mouth		
Other, please specify		

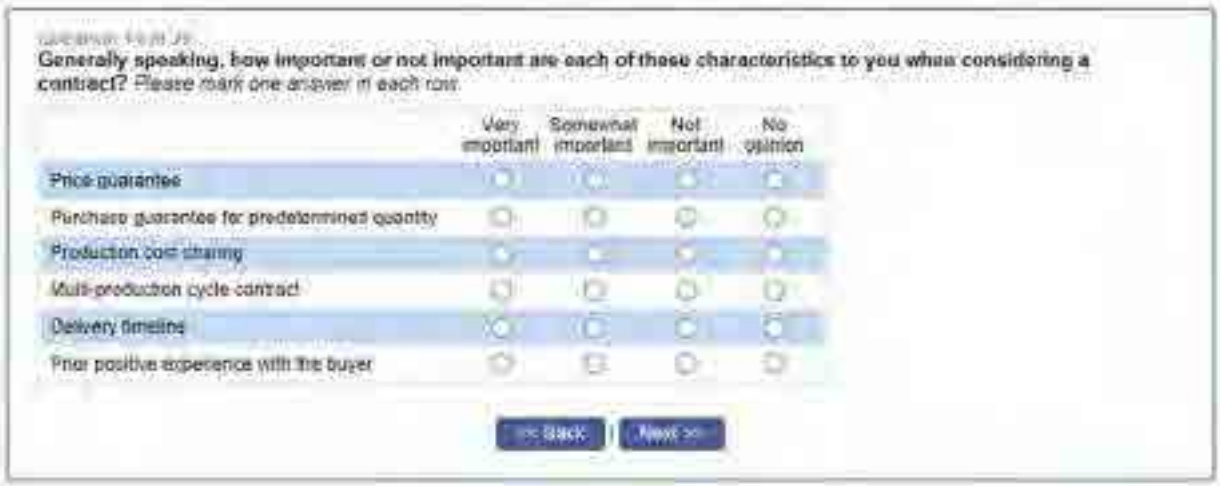
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For each of the following contracting arrangements, please indicate whether you use them with buyers. *Please mark "Yes" or "No" in each row*

	Yes	No
Bids on periodic consolidated seed buys, such as the Bureau of Land Management or state seed buys		
Other spot market sales of available seed or plant materials. Click here for a definition		
Marketing contracts that specify the type, price, quantity, and delivery date of seed or plant materials. Click here for a definition		
Production contracts that specify the desired type, quantity and delivery date of seed or plant material. It may or may not specify a price. Click here for a definition		

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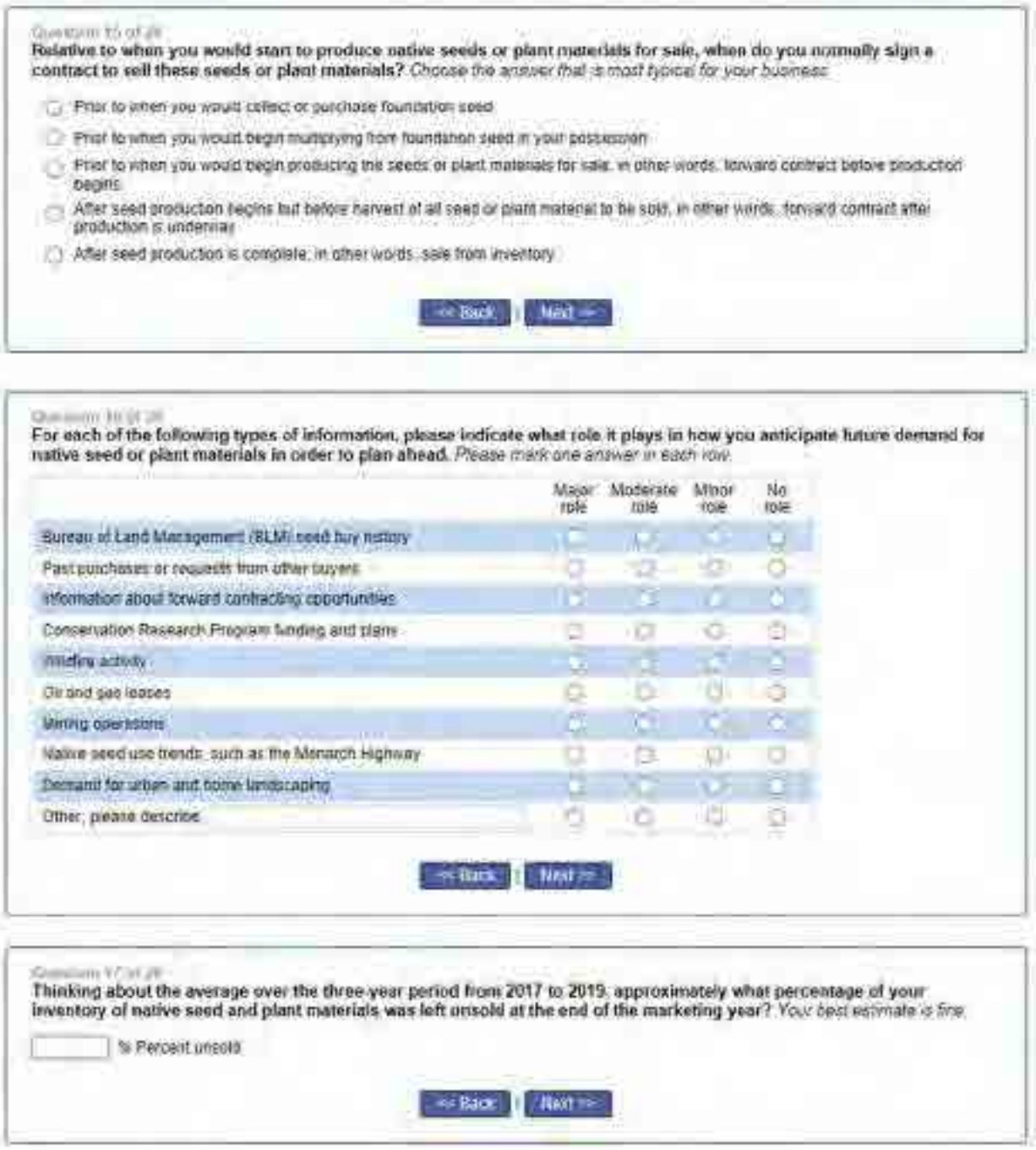
Generally speaking, how important or not important are each of these characteristics to you when considering a contract? *Please mark one answer in each row*

	Very important	Somewhat important	Not important	No opinion
Price guarantee				
Purchase guarantee for predetermined quantity				
Production cost sharing				
Multi-production cycle contract				
Delivery timeline				
Prior positive experience with the buyer				

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Appendix 2F



Question 10 of 28

Relative to when you would start to produce native seeds or plant materials for sale, when do you normally sign a contract to sell these seeds or plant materials? *Choose the answer that is most typical for your business.*

- Prior to when you would collect or purchase foundation seed
- Prior to when you would begin multiplying from foundation seed in your possession
- Prior to when you would begin producing the seeds or plant materials for sale; in other words, forward contract before production begins
- After seed production begins but before harvest of all seed or plant material to be sold; in other words, forward contract after production is underway
- After seed production is complete; in other words, sale from inventory

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Question 11 of 28

For each of the following types of information, please indicate what role it plays in how you anticipate future demand for native seed or plant materials in order to plan ahead. *Please mark one answer in each row.*

	Major role	Moderate role	Minor role	No role
Bureau of Land Management (BLM) seed buy history				
Past purchases or requests from other buyers				
Information about forward contracting opportunities				
Conservation Research Program funding and plans				
Wildfire activity				
Oil and gas leases				
Mining operations				
Native seed use trends, such as the Monarch Highway				
Demand for urban and home landscaping				
Other, please describe				

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Question 12 of 28

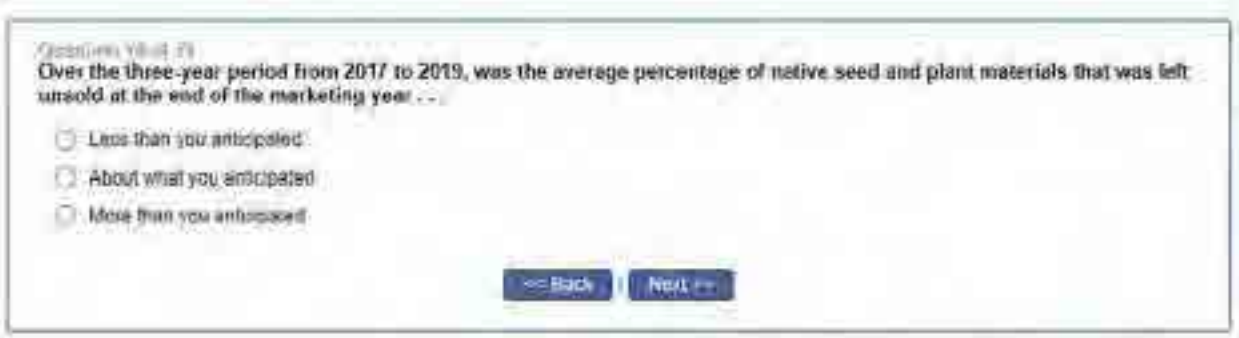
Thinking about the average over the three-year period from 2017 to 2019, approximately what percentage of your inventory of native seed and plant materials was left unsold at the end of the marketing year? *Your best estimate is fine.*

[ ] % Percent unsold

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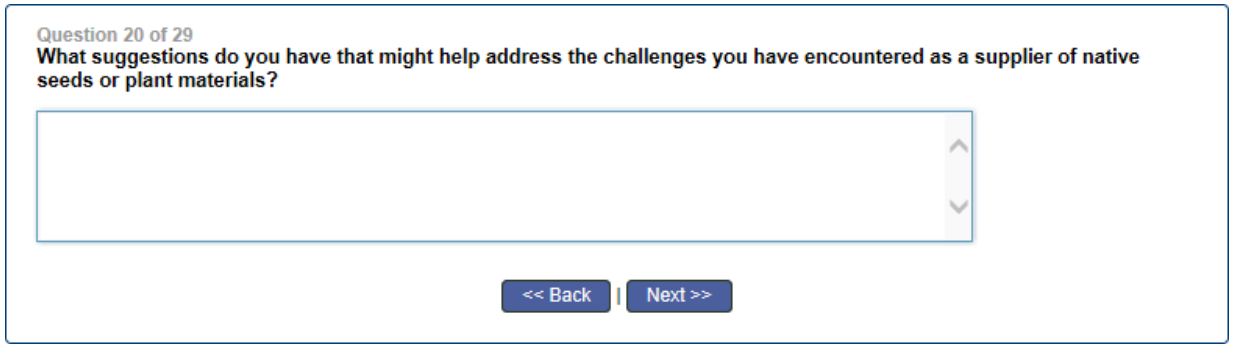
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[BRANCH: IF REPLIED "NOT A CHALLENGE" TO EVERYTHING, SKIP TO Q21]



[BRANCH: If YES TO Q3a OR Q3b (COLLECTS NATIVE SEED), CONTINUE. OTHERWISE SKIP TO Q22

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Appendix 2F



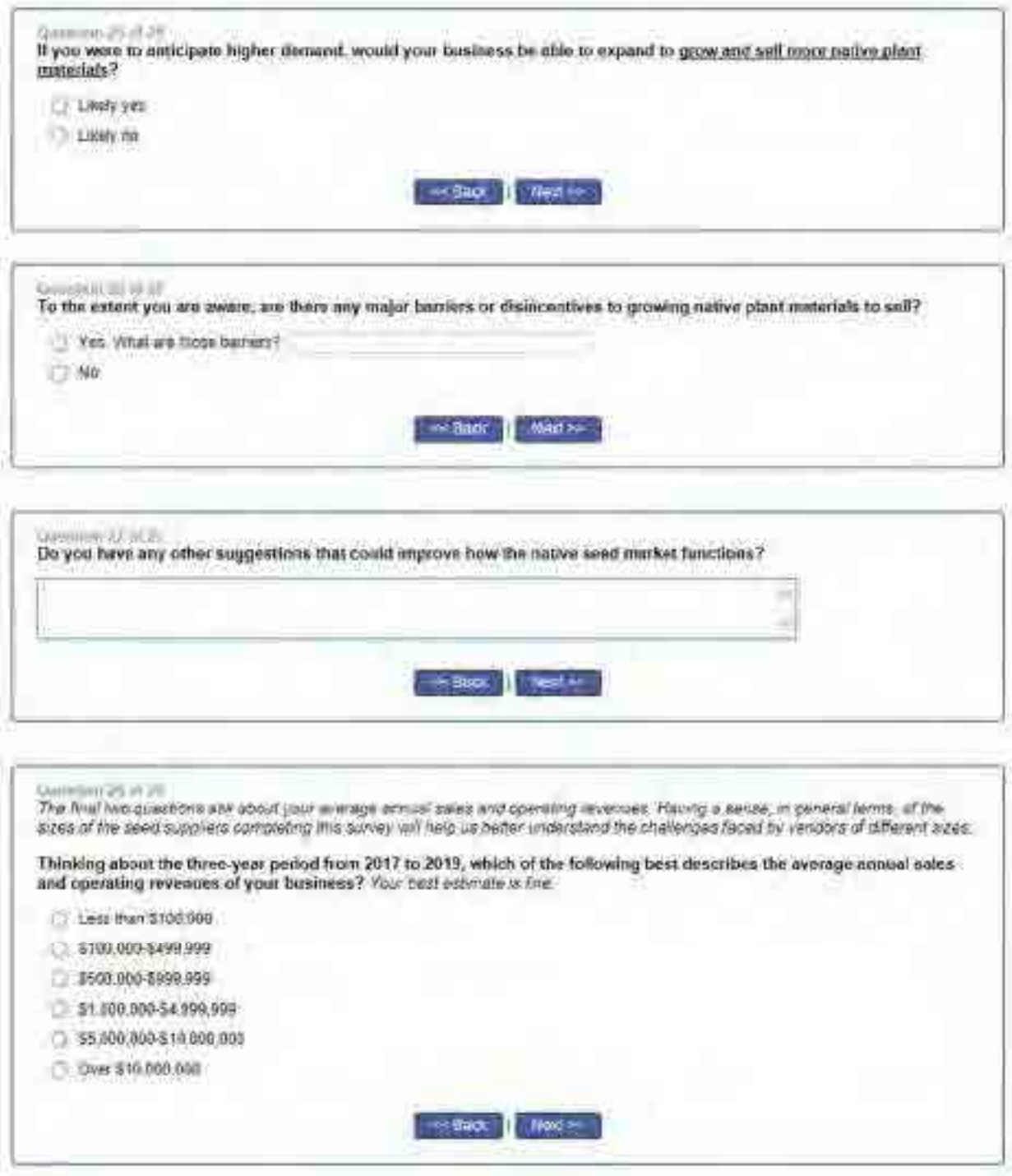
[BRANCH: If YES TO Q3b, Q3c, or Q3d (GROWER OF NATIVE SEED) CONTINUE. OTHERWISE SKIP TO Q24]



[BRANCH: If YES TO Q6a (GROWS PLANT MATERIALS TO SELL) CONTINUE. OTHERWISE SKIP TO Q26

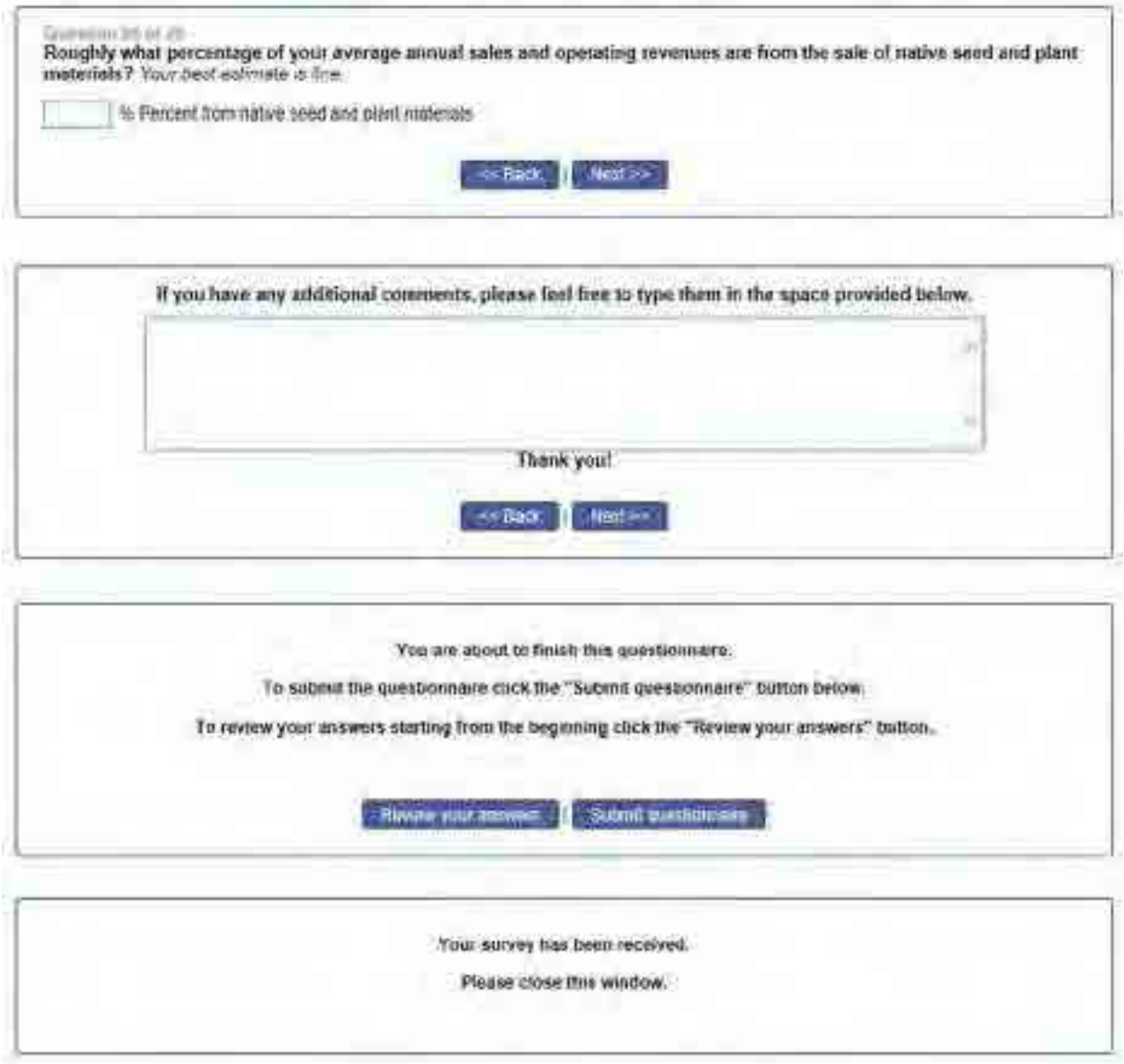
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Appendix 2F



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Appendix 2G

Supplier Survey Frequency Distributions

Q01A Does your business sell any of the following products? Native seed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sell	141	52.0	56.0	56.0
	Does not sell	111	41.0	44.0	100.0
	Total	252	93.0	100.0	
Missing	Dont know (phone only)	1	.4		
	No answer	18	6.6		
	Total	19	7.0		
Total		271	100.0		

Q01B Does your business sell any of the following products? Non-native seed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sell	77	28.4	33.0	33.0
	Does not sell	156	57.6	67.0	100.0
	Total	233	86.0	100.0	
Missing	Dont know (phone only)	3	1.1		
	Partial breakoff	1	.4		
	No answer	34	12.5		
	Total	38	14.0		
Total		271	100.0		

Q01C Does your business sell any of the following products? Native plant materials, other than seed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sell	202	74.5	81.1	81.1
	Does not sell	47	17.3	18.9	100.0
	Total	249	91.9	100.0	
Missing	Partial breakoff	2	.7		
	No answer	20	7.4		
	Total	22	8.1		
Total		271	100.0		

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Appendix 2G

Q01D Does your business sell any of the following products? Non-native plant materials, other than seed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sell	102	37.6	44.5	44.5
	Does not sell	127	46.9	55.5	100.0
	Total	229	84.5	100.0	
Missing	Dont know (phone only)	2	.7		
	Partial breakoff	3	1.1		
	No answer	37	13.7		
	Total	42	15.5		
Total		271	100.0		

Q02 Are the seed and plant material sales at your business mainly focused on selling to the home market, such as the sale of seed packets or individual plants for residential projects?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	249	91.9	100.0	100.0
Missing	Partial breakoff	12	4.4		
	No answer	10	3.7		
	Total	22	8.1		
Total		271	100.0		

Q03A Does your organization do this? Collect seed from the wild for direct sale.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	81	29.9	55.5	55.5
	No	65	24.0	44.5	100.0
	Total	146	53.9	100.0	
Missing	Branching skip	100	36.9		
	Partial breakoff	21	7.7		
	No answer	4	1.5		
	Total	125	46.1		
Total		271	100.0		

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Q03B Does your organization do this? Collect seed from the wild to grow plants with the goal of producing and selling seed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	80	29.5	56.7	56.7
	No	61	22.5	43.3	100.0
	Total	141	52.0	100.0	
Missing	Branching skip	100	36.9		
	Partial breakoff	21	7.7		
	No answer	9	3.3		
	Total	130	48.0		
Total		271	100.0		

Q03C Does your organization do this? Use wild-collected seed from some other source to grow plants with the goal of producing and selling seed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	66	24.4	46.8	46.8
	No	75	27.7	53.2	100.0
	Total	141	52.0	100.0	
Missing	Branching skip	100	36.9		
	Partial breakoff	21	7.7		
	No answer	9	3.3		
	Total	130	48.0		
Total		271	100.0		

Q03D Does your organization do this? Purchase native seed, such as cultivars, varieties or germplasm releases, available on the market to grow plants with the goal of producing and selling seed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	46	17.0	32.6	32.6
	No	95	35.1	67.4	100.0
	Total	141	52.0	100.0	
Missing	Branching skip	100	36.9		
	Partial breakoff	21	7.7		
	No answer	9	3.3		
	Total	130	48.0		
Total		271	100.0		

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Appendix 2G

Q03E Does your organization do this? Purchase native seed available on the market to re-sell the seed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	94	34.7	64.4	64.4
	No	52	19.2	35.6	100.0
	Total	146	53.9	100.0	
Missing	Branching skip	100	36.9		
	Partial breakoff	21	7.7		
	No answer	4	1.5		
	Total	125	46.1		
Total		271	100.0		

Q04A Do you sell this type of seed? Uncertified seed of claimed provenance of wild origin.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sell	97	35.8	67.8	67.8
	Does not sell	38	14.0	26.6	94.4
	Unsure	8	3.0	5.6	100.0
	Total	143	52.8	100.0	
Missing	Branching skip	100	36.9		
	Partial breakoff	23	8.5		
	No answer	5	1.8		
	Total	128	47.2		
Total		271	100.0		

Q04B Do you sell this type of seed? Certified source-identified seed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sell	92	33.9	64.8	64.8
	Does not sell	47	17.3	33.1	97.9
	Unsure	3	1.1	2.1	100.0
	Total	142	52.4	100.0	
Missing	Branching skip	100	36.9		
	Partial breakoff	23	8.5		
	No answer	6	2.2		
	Total	129	47.6		
Total		271	100.0		

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Q04C Do you sell this type of seed? Native germplasm releases or cultivars.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sell	56	20.7	39.7	39.7
	Does not sell	74	27.3	52.5	92.2
	Unsure	11	4.1	7.8	100.0
	Total	141	52.0	100.0	
Missing	Branching skip	100	36.9		
	Partial breakoff	23	8.5		
	No answer	7	2.6		
	Total	130	48.0		
Total		271	100.0		

Q04D Do you sell this type of seed? Seed mixes that include native seed and comply with USDA conservation program requirements.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sell	64	23.6	44.4	44.4
	Does not sell	61	22.5	42.4	86.8
	Unsure	19	7.0	13.2	100.0
	Total	144	53.1	100.0	
Missing	Branching skip	100	36.9		
	Partial breakoff	23	8.5		
	No answer	4	1.5		
	Total	127	46.9		
Total		271	100.0		

Q04E Do you sell this type of seed? Seed types that meet the requirements of the Bureau of Land Management.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sell	50	18.5	34.7	34.7
	Does not sell	46	17.0	31.9	66.7
	Unsure	48	17.7	33.3	100.0
	Total	144	53.1	100.0	
Missing	Branching skip	100	36.9		
	Partial breakoff	23	8.5		
	No answer	4	1.5		
	Total	127	46.9		
Total		271	100.0		

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Appendix 2G

Q05a What percentage of your organization's total native seed sales does this represent? Native grass seed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	32	11.8	26.4	26.4
	5	5	1.8	4.1	30.6
	8	1	.4	.8	31.4
	10	8	3.0	6.6	38.0
	15	1	.4	.8	38.8
	20	6	2.2	5.0	43.8
	24	1	.4	.8	44.6
	25	3	1.1	2.5	47.1
	30	5	1.8	4.1	51.2
	37	1	.4	.8	52.1
	40	4	1.5	3.3	55.4
	45	4	1.5	3.3	58.7
	48	3	1.1	2.5	61.2
	49	2	.7	1.7	62.8
	50	7	2.6	5.8	68.6
	55	1	.4	.8	69.4
	60	6	2.2	5.0	74.4
	62	1	.4	.8	75.2
	70	8	3.0	6.6	81.8
	75	2	.7	1.7	83.5
	80	3	1.1	2.5	86.0
	85	6	2.2	5.0	90.9
	90	4	1.5	3.3	94.2
	97	1	.4	.8	95.0
	98	2	.7	1.7	96.7
	100	4	1.5	3.3	100.0
	Total	121	44.6	100.0	
Missing	Branching skip	24	8.9		
	Partial breakoff	27	10.0		
	No answer	99	36.5		
	Total	150	55.4		
Total		271	100.0		

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Q05b What percentage of your organization's total native seed sales does this represent? Native forbs seed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	26	9.6	21.5	21.5
	1	3	1.1	2.5	24.0
	2	1	.4	.8	24.8
	4	1	.4	.8	25.6
	5	4	1.5	3.3	28.9
	9	1	.4	.8	29.8
	10	13	4.8	10.7	40.5
	15	4	1.5	3.3	43.8
	17	1	.4	.8	44.6
	19	1	.4	.8	45.5
	20	4	1.5	3.3	48.8
	24	1	.4	.8	49.6
	25	3	1.1	2.5	52.1
	30	7	2.6	5.8	57.9
	35	1	.4	.8	58.7
	40	5	1.8	4.1	62.8
	45	4	1.5	3.3	66.1
	48	1	.4	.8	66.9
	49	1	.4	.8	67.8
	50	11	4.1	9.1	76.9
	55	1	.4	.8	77.7
	58	1	.4	.8	78.5
	60	2	.7	1.7	80.2
	65	1	.4	.8	81.0
	70	5	1.8	4.1	85.1
	75	4	1.5	3.3	88.4
	80	4	1.5	3.3	91.7
	85	1	.4	.8	92.6
	90	4	1.5	3.3	95.9
	95	2	.7	1.7	97.5
	100	3	1.1	2.5	100.0
	Total	121	44.6	100.0	
Missing	Branching skip	24	8.9		
	Partial breakoff	27	10.0		
	No answer	99	36.5		
	Total	150	55.4		
Total		271	100.0		

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Appendix 2G

Q05c What percentage of your organization's total native seed sales does this represent? Native shrubs seed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	44	16.2	41.9	41.9
	1	1	.4	1.0	42.9
	1	4	1.5	3.8	46.7
	2	6	2.2	5.7	52.4
	3	1	.4	1.0	53.3
	5	19	7.0	18.1	71.4
	6	2	.7	1.9	73.3
	8	1	.4	1.0	74.3
	10	5	1.8	4.8	79.0
	15	1	.4	1.0	80.0
	20	6	2.2	5.7	85.7
	24	1	.4	1.0	86.7
	25	4	1.5	3.8	90.5
	30	3	1.1	2.9	93.3
	35	1	.4	1.0	94.3
	45	1	.4	1.0	95.2
	50	3	1.1	2.9	98.1
	90	1	.4	1.0	99.0
	100	1	.4	1.0	100.0
	Total	105	38.7	100.0	
Missing	Branching skip	24	8.9		
	Partial breakoff	27	10.0		
	No answer	115	42.4		
	Total	166	61.3		
Total		271	100.0		

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Q05d What percentage of your organization's total native seed sales does this represent? Native tree seed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	56	20.7	58.3	58.3
	1	5	1.8	5.2	63.5
	2	1	.4	1.0	64.6
	4	1	.4	1.0	65.6
	5	2	.7	2.1	67.7
	10	4	1.5	4.2	71.9
	15	2	.7	2.1	74.0
	20	3	1.1	3.1	77.1
	24	1	.4	1.0	78.1
	25	2	.7	2.1	80.2
	30	1	.4	1.0	81.3
	45	1	.4	1.0	82.3
	50	5	1.8	5.2	87.5
	55	1	.4	1.0	88.5
	65	1	.4	1.0	89.6
	70	1	.4	1.0	90.6
	98	1	.4	1.0	91.7
	100	8	3.0	8.3	100.0
	Total	96	35.4	100.0	
Missing	Branching skip	24	8.9		
	Partial breakoff	27	10.0		
	No answer	124	45.8		
	Total	175	64.6		
Total		271	100.0		

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Appendix 2G

Q05e What percentage of your organization's total native seed sales does this represent? Other native seed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	53	19.6	60.2	60.2
	1	3	1.1	3.4	63.6
	2	4	1.5	4.5	68.2
	3	1	.4	1.1	69.3
	4	3	1.1	3.4	72.7
	5	11	4.1	12.5	85.2
	10	3	1.1	3.4	88.6
	11	1	.4	1.1	89.8
	20	2	.7	2.3	92.0
	25	1	.4	1.1	93.2
	29	1	.4	1.1	94.3
	40	3	1.1	3.4	97.7
	50	2	.7	2.3	100.0
	Total	88	32.5	100.0	
Missing	Branching skip	24	8.9		
	Partial breakoff	27	10.0		
	No answer	132	48.7		
	Total	183	67.5		
Total		271	100.0		

Q05a_dk What percentage of your organization's total native seed sales does this represent? Check this box if you are unable to provide this information.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Checked	9	3.3	5.5	5.5
	Not checked	156	57.6	94.5	100.0
	Total	165	60.9	100.0	
Missing	Branching skip	100	36.9		
	Partial breakoff	6	2.2		
	Total	106	39.1		
Total		271	100.0		

Q06A Does your organization . . . Grow native plants to sell.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	165	60.9	85.5	85.5
	No	28	10.3	14.5	100.0
	Total	193	71.2	100.0	
Missing	Branching skip	43	15.9		
	Partial breakoff	28	10.3		
	No answer	7	2.6		
	Total	78	28.8		
Total		271	100.0		

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Q06B Does your organization . . . Purchase and re-sell native plant materials available on the market?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	110	40.6	59.5	59.5
	No	75	27.7	40.5	100.0
	Total	185	68.3	100.0	
Missing	Branching skip	43	15.9		
	Partial breakoff	28	10.3		
	No answer	15	5.5		
	Total	86	31.7		
Total		271	100.0		

Q07a What percentage of your organization's total native plant material sales does this represent? Native grass seed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	39	14.4	25.0	25.0
	1	5	1.8	3.2	28.2
	2	6	2.2	3.8	32.1
	3	2	.7	1.3	33.3
	5	11	4.1	7.1	40.4
	7	1	.4	.6	41.0
	8	1	.4	.6	41.7
	10	22	8.1	14.1	55.8
	12	1	.4	.6	56.4
	15	5	1.8	3.2	59.6
	18	1	.4	.6	60.3
	20	15	5.5	9.6	69.9
	24	1	.4	.6	70.5
	25	9	3.3	5.8	76.3
	30	4	1.5	2.6	78.8
	33	1	.4	.6	79.5
	35	2	.7	1.3	80.8
	40	9	3.3	5.8	86.5
	45	3	1.1	1.9	88.5
	50	8	3.0	5.1	93.6
	60	3	1.1	1.9	95.5
	75	1	.4	.6	96.2
	85	2	.7	1.3	97.4
	90	1	.4	.6	98.1
	97	1	.4	.6	98.7
	98	1	.4	.6	99.4
	100	1	.4	.6	100.0
	Total	156	57.6	100.0	
Missing	Branching skip	43	15.9		
	Partial breakoff	32	11.8		
	No answer	40	14.8		
	Total	115	42.4		
Total		271	100.0		

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Appendix 2G

Q07b What percentage of your organization's total native plant material sales does this represent? Native forbs seed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	42	15.5	28.0	28.0
	1	5	1.8	3.3	31.3
	2	3	1.1	2.0	33.3
	5	4	1.5	2.7	36.0
	10	11	4.1	7.3	43.3
	15	5	1.8	3.3	46.7
	19	1	.4	.7	47.3
	20	7	2.6	4.7	52.0
	25	13	4.8	8.7	60.7
	28	1	.4	.7	61.3
	30	4	1.5	2.7	64.0
	32	1	.4	.7	64.7
	33	1	.4	.7	65.3
	35	5	1.8	3.3	68.7
	40	9	3.3	6.0	74.7
	45	7	2.6	4.7	79.3
	50	7	2.6	4.7	84.0
	55	2	.7	1.3	85.3
	60	8	3.0	5.3	90.7
	70	2	.7	1.3	92.0
	75	4	1.5	2.7	94.7
	79	1	.4	.7	95.3
	80	4	1.5	2.7	98.0
	85	2	.7	1.3	99.3
	90	1	.4	.7	100.0
	Total	150	55.4	100.0	
Missing	Branching skip	43	15.9		
	Partial breakoff	32	11.8		
	No answer	46	17.0		
	Total	121	44.6		
Total		271	100.0		

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Q07c What percentage of your organization's total native plant material sales does this represent? Native shrubs seed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	25	9.2	16.3	16.3
	1	4	1.5	2.6	19.0
	2	3	1.1	2.0	20.9
	5	7	2.6	4.6	25.5
	10	14	5.2	9.2	34.6
	15	4	1.5	2.6	37.3
	18	1	.4	.7	37.9
	20	13	4.8	8.5	46.4
	22	1	.4	.7	47.1
	25	24	8.9	15.7	62.7
	30	13	4.8	8.5	71.2
	33	1	.4	.7	71.9
	34	1	.4	.7	72.5
	35	3	1.1	2.0	74.5
	38	1	.4	.7	75.2
	40	13	4.8	8.5	83.7
	45	2	.7	1.3	85.0
	50	10	3.7	6.5	91.5
	55	1	.4	.7	92.2
	60	2	.7	1.3	93.5
	70	1	.4	.7	94.1
	75	2	.7	1.3	95.4
	87	1	.4	.7	96.1
	89	1	.4	.7	96.7
	90	1	.4	.7	97.4
	100	4	1.5	2.6	100.0
	Total	153	56.5	100.0	
Missing	Branching skip	43	15.9		
	Partial breakoff	32	11.8		
	No answer	43	15.9		
	Total	118	43.5		
Total		271	100.0		

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Appendix 2G

Q07d What percentage of your organization's total native plant material sales does this represent? Native tree seed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	22	8.1	14.5	14.5
	1	3	1.1	2.0	16.4
	2	3	1.1	2.0	18.4
	5	9	3.3	5.9	24.3
	8	1	.4	.7	25.0
	10	9	3.3	5.9	30.9
	13	1	.4	.7	31.6
	15	8	3.0	5.3	36.8
	17	1	.4	.7	37.5
	20	15	5.5	9.9	47.4
	22	1	.4	.7	48.0
	25	14	5.2	9.2	57.2
	30	8	3.0	5.3	62.5
	32	1	.4	.7	63.2
	33	1	.4	.7	63.8
	35	4	1.5	2.6	66.4
	40	3	1.1	2.0	68.4
	42	1	.4	.7	69.1
	45	3	1.1	2.0	71.1
	50	10	3.7	6.6	77.6
	59	1	.4	.7	78.3
	60	3	1.1	2.0	80.3
	65	1	.4	.7	80.9
	70	1	.4	.7	81.6
	80	3	1.1	2.0	83.6
	85	1	.4	.7	84.2
	89	1	.4	.7	84.9
	98	1	.4	.7	85.5
	100	22	8.1	14.5	100.0
	Total	152	56.1	100.0	
Missing	Branching skip	43	15.9		
	Partial breakoff	32	11.8		
	No answer	44	16.2		
	Total	119	43.9		
Total		271	100.0		

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Q07e What percentage of your organization's total native plant material sales does this represent? Other native seed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	57	21.0	49.6	49.6
	1	1	.4	.9	50.4
	2	3	1.1	2.6	53.0
	3	3	1.1	2.6	55.7
	4	3	1.1	2.6	58.3
	5	8	3.0	7.0	65.2
	8	3	1.1	2.6	67.8
	10	11	4.1	9.6	77.4
	15	3	1.1	2.6	80.0
	20	5	1.8	4.3	84.3
	25	4	1.5	3.5	87.8
	30	3	1.1	2.6	90.4
	35	1	.4	.9	91.3
	36	1	.4	.9	92.2
	40	1	.4	.9	93.0
	50	4	1.5	3.5	96.5
	60	1	.4	.9	97.4
	74	1	.4	.9	98.3
	100	2	.7	1.7	100.0
	Total	115	42.4	100.0	
Missing	Branching skip	43	15.9		
	Partial breakoff	32	11.8		
	No answer	81	29.9		
	Total	156	57.6		
Total		271	100.0		

Q07a_dk What percentage of your organization's total native plant material sales does this represent? Check this box if you are unable to provide this information.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Checked	15	5.5	6.8	6.8
	Not checked	205	75.6	93.2	100.0
	Total	220	81.2	100.0	
Missing	Branching skip	43	15.9		
	Partial breakoff	8	3.0		
	Total	51	18.8		
Total		271	100.0		

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Appendix 2G

Q08 Do you sell native plants or seeds sourced from different locations to match different geographical conditions or seed zones, as in different ecotypes of the same species?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	155	57.2	69.2	69.2
	No	69	25.5	30.8	100.0
	Total	224	82.7	100.0	
Missing	Dont know (phone only)	3	1.1		
	Partial breakoff	32	11.8		
	No answer	12	4.4		
	Total	47	17.3		
Total		271	100.0		

Q09A Between 2017 and 2019 how much did this buyer type represent your annual sales of native seed and plant materials? Federal government agencies.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major portion of sales	43	15.9	19.1	19.1
	Minor portion of sales	101	37.3	44.9	64.0
	None of the sales	81	29.9	36.0	100.0
	Total	225	83.0	100.0	
Missing	Partial breakoff	35	12.9		
	No answer	11	4.1		
	Total	46	17.0		
Total		271	100.0		

Q09B Between 2017 and 2019 how much did this buyer type represent your annual sales of native seed and plant materials? State government agencies.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major portion of sales	62	22.9	27.4	27.4
	Minor portion of sales	115	42.4	50.9	78.3
	None of the sales	49	18.1	21.7	100.0
	Total	226	83.4	100.0	
Missing	Partial breakoff	35	12.9		
	No answer	10	3.7		
	Total	45	16.6		
Total		271	100.0		

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Q09C Between 2017 and 2019 how much did this buyer type represent your annual sales of native seed and plant materials? Municipalities.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major portion of sales	52	19.2	23.2	23.2
	Minor portion of sales	122	45.0	54.5	77.7
	None of the sales	50	18.5	22.3	100.0
	Total	224	82.7	100.0	
Missing	Partial breakoff	35	12.9		
	No answer	12	4.4		
	Total	47	17.3		
Total		271	100.0		

Q09D Between 2017 and 2019 how much did this buyer type represent your annual sales of native seed and plant materials? Tribal governments.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major portion of sales	14	5.2	6.5	6.5
	Minor portion of sales	70	25.8	32.4	38.9
	None of the sales	132	48.7	61.1	100.0
	Total	216	79.7	100.0	
Missing	Partial breakoff	35	12.9		
	No answer	20	7.4		
	Total	55	20.3		
Total		271	100.0		

Q09E Between 2017 and 2019 how much did this buyer type represent your annual sales of native seed and plant materials? Private contractors.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major portion of sales	139	51.3	60.7	60.7
	Minor portion of sales	72	26.6	31.4	92.1
	None of the sales	18	6.6	7.9	100.0
	Total	229	84.5	100.0	
Missing	Partial breakoff	35	12.9		
	No answer	7	2.6		
	Total	42	15.5		
Total		271	100.0		

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Q09F Between 2017 and 2019 how much did this buyer type represent your annual sales of native seed and plant materials? Non-profit organizations.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major portion of sales	50	18.5	22.1	22.1
	Minor portion of sales	129	47.6	57.1	79.2
	None of the sales	47	17.3	20.8	100.0
	Total	226	83.4	100.0	
Missing	Dont know (phone only)	1	.4		
	Partial breakoff	35	12.9		
	No answer	9	3.3		
	Total	45	16.6		
Total		271	100.0		

Q09G Between 2017 and 2019 how much did this buyer type represent your annual sales of native seed and plant materials? Farmers and ranchers.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major portion of sales	44	16.2	19.6	19.6
	Minor portion of sales	108	39.9	48.0	67.6
	None of the sales	73	26.9	32.4	100.0
	Total	225	83.0	100.0	
Missing	Partial breakoff	35	12.9		
	No answer	11	4.1		
	Total	46	17.0		
Total		271	100.0		

Q10 Do you sell services?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes. Which services? Please specify:	84	31.0	36.8	36.8
	No	144	53.1	63.2	100.0
	Total	228	84.1	100.0	
Missing	Partial breakoff	36	13.3		
	No answer	7	2.6		
	Total	43	15.9		
Total		271	100.0		

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Q11A Does the availability of this type of storage limit the quantity of seed you can sell? Ambient storage.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Limits it	35	12.9	16.7	16.7
	Does not limit it	175	64.6	83.3	100.0
	Total	210	77.5	100.0	
Missing	Dont know (phone only)	6	2.2		
	Partial breakoff	37	13.7		
	No answer	18	6.6		
	Total	61	22.5		
Total		271	100.0		

Q11B Does the availability of this type of storage limit the quantity of seed you can sell? Refrigerated storage.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Limits it	67	24.7	31.9	31.9
	Does not limit it	143	52.8	68.1	100.0
	Total	210	77.5	100.0	
Missing	Dont know (phone only)	7	2.6		
	Partial breakoff	37	13.7		
	No answer	17	6.3		
	Total	61	22.5		
Total		271	100.0		

Q11C Does the availability of this type of storage limit the quantity of seed you can sell? Freezer storage.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Limits it	61	22.5	29.8	29.8
	Does not limit it	144	53.1	70.2	100.0
	Total	205	75.6	100.0	
Missing	Dont know (phone only)	7	2.6		
	Partial breakoff	37	13.7		
	No answer	22	8.1		
	Total	66	24.4		
Total		271	100.0		

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Appendix 2G

Q12A Do you use this method to communicate to potential buyers about what your business offers? Company website.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Use	195	72.0	85.2	85.2
	Do not use	34	12.5	14.8	100.0
	Total	229	84.5	100.0	
Missing	Partial breakoff	38	14.0		
	No answer	4	1.5		
	Total	42	15.5		
Total		271	100.0		

Q12B Do you use this method to communicate to potential buyers about what your business offers? Print catalogue.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Use	80	29.5	35.6	35.6
	Do not use	145	53.5	64.4	100.0
	Total	225	83.0	100.0	
Missing	Partial breakoff	38	14.0		
	No answer	8	3.0		
	Total	46	17.0		
Total		271	100.0		

Q12C Do you use this method to communicate to potential buyers about what your business offers? Vendor listings or registries.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Use	146	53.9	65.8	65.8
	Do not use	76	28.0	34.2	100.0
	Total	222	81.9	100.0	
Missing	Dont know (phone only)	1	.4		
	Partial breakoff	38	14.0		
	No answer	10	3.7		
	Total	49	18.1		
Total		271	100.0		

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Q12D Do you use this method to communicate to potential buyers about what your business offers? Bids in response to "requests for proposals" or "seed buy requests".

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Use	173	63.8	75.9	75.9
	Do not use	55	20.3	24.1	100.0
	Total	228	84.1	100.0	
Missing	Partial breakoff	38	14.0		
	No answer	5	1.8		
	Total	43	15.9		
Total		271	100.0		

Q12E Do you use this method to communicate to potential buyers about what your business offers? Word-of-mouth.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Use	219	80.8	96.5	96.5
	Do not use	8	3.0	3.5	100.0
	Total	227	83.8	100.0	
Missing	Partial breakoff	38	14.0		
	No answer	6	2.2		
	Total	44	16.2		
Total		271	100.0		

Q12F Do you use this method to communicate to potential buyers about what your business offers? Other, please specify.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Use	53	19.6	56.4	56.4
	Do not use	41	15.1	43.6	100.0
	Total	94	34.7	100.0	
Missing	Dont know (phone only)	1	.4		
	Partial breakoff	38	14.0		
	No answer	138	50.9		
	Total	177	65.3		
Total		271	100.0		

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Appendix 2G

Q13A Do you use this type of contracting arrangement with buyers? Bids on periodic consolidated seed buys.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	51	18.8	22.6	22.6
	No	175	64.6	77.4	100.0
	Total	226	83.4	100.0	
Missing	Dont know (phone only)	2	.7		
	Partial breakoff	38	14.0		
	No answer	5	1.8		
	Total	45	16.6		
Total		271	100.0		

Q13B Do you use this type of contracting arrangement with buyers? Other spot market sales of available seed or plant materials.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	115	42.4	51.3	51.3
	No	109	40.2	48.7	100.0
	Total	224	82.7	100.0	
Missing	Dont know (phone only)	1	.4		
	Partial breakoff	38	14.0		
	No answer	8	3.0		
	Total	47	17.3		
Total		271	100.0		

Q13C Do you use this type of contracting arrangement with buyers? Marketing contract that specifies the type, price, quantity, and delivery date of seed or plant materials.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	117	43.2	52.0	52.0
	No	108	39.9	48.0	100.0
	Total	225	83.0	100.0	
Missing	Partial breakoff	38	14.0		
	No answer	8	3.0		
	Total	46	17.0		
Total		271	100.0		

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Q13D Do you use this type of contracting arrangement with buyers? Production contract that specifies the desired type, quantity and delivery date of seed or plant materials.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	119	43.9	52.9	52.9
	No	106	39.1	47.1	100.0
	Total	225	83.0	100.0	
Missing	Dont know (phone only)	1	.4		
	Partial breakoff	38	14.0		
	No answer	7	2.6		
	Total	46	17.0		
Total		271	100.0		

Q14A How important is this characteristic when considering a contract? Price guarantee.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very important	125	46.1	55.6	55.6
	Somewhat important	49	18.1	21.8	77.3
	Not important	10	3.7	4.4	81.8
	No opinion	41	15.1	18.2	100.0
	Total	225	83.0	100.0	
Missing	Partial breakoff	40	14.8		
	No answer	6	2.2		
	Total	46	17.0		
Total		271	100.0		

Q14B How important is this characteristic when considering a contract? Purchase guarantee for predetermined quantity.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very important	124	45.8	55.4	55.4
	Somewhat important	52	19.2	23.2	78.6
	Not important	10	3.7	4.5	83.0
	No opinion	38	14.0	17.0	100.0
	Total	224	82.7	100.0	
Missing	Partial breakoff	40	14.8		
	No answer	7	2.6		
	Total	47	17.3		
Total		271	100.0		

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Q14C How important is this characteristic when considering a contract? Production cost sharing.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very important	20	7.4	9.3	9.3
	Somewhat important	43	15.9	20.0	29.3
	Not important	78	28.8	36.3	65.6
	No opinion	74	27.3	34.4	100.0
	Total	215	79.3	100.0	
Missing	Dont know (phone only)	2	.7		
	Partial breakoff	40	14.8		
	No answer	14	5.2		
	Total	56	20.7		
Total		271	100.0		

Q14D How important is this characteristic when considering a contract? Multi-production cycle contract.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very important	24	8.9	10.9	10.9
	Somewhat important	52	19.2	23.6	34.5
	Not important	68	25.1	30.9	65.5
	No opinion	76	28.0	34.5	100.0
	Total	220	81.2	100.0	
Missing	Dont know (phone only)	3	1.1		
	Partial breakoff	40	14.8		
	No answer	8	3.0		
	Total	51	18.8		
Total		271	100.0		

Q14E How important is this characteristic when considering a contract? Delivery timeline.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very important	122	45.0	55.0	55.0
	Somewhat important	60	22.1	27.0	82.0
	Not important	10	3.7	4.5	86.5
	No opinion	30	11.1	13.5	100.0
	Total	222	81.9	100.0	
Missing	Dont know (phone only)	1	.4		
	Partial breakoff	40	14.8		
	No answer	8	3.0		
	Total	49	18.1		
Total		271	100.0		

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Q14F How important is this characteristic when considering a contract? Prior positive experience with buyer.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very important	124	45.8	55.4	55.4
	Somewhat important	68	25.1	30.4	85.7
	Not important	8	3.0	3.6	89.3
	No opinion	24	8.9	10.7	100.0
	Total	224	82.7	100.0	
Missing	Partial breakoff	40	14.8		
	No answer	7	2.6		
	Total	47	17.3		
Total		271	100.0		

Q15 Relative to when you would start to produce native seeds or plant materials for sale, when do you normally sign a contract to sell these seeds or plant materials?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Prior to when you would collect or purchase foundation seed	29	10.7	14.5	14.5
	Prior to when you would begin multiplying from foundation seed in your possession	8	3.0	4.0	18.5
	Prior to when you would begin producing the seeds or plant materials for sale	44	16.2	22.0	40.5
	After seed production begins but before harvest of all seed or plant material to be sold	25	9.2	12.5	53.0
	After seed production is complete	94	34.7	47.0	100.0
	Total	200	73.8	100.0	
Missing	Dont know (phone only)	5	1.8		
	Partial breakoff	42	15.5		
	No answer	24	8.9		
	Total	71	26.2		
Total		271	100.0		

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Q16A What role does this type of information play in how you anticipate future demand for native seed or plant materials in order to plan ahead? BLM seed buy history.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major role	14	5.2	6.5	6.5
	Moderate role	14	5.2	6.5	13.0
	Minor role	29	10.7	13.5	26.5
	No role	158	58.3	73.5	100.0
	Total	215	79.3	100.0	
Missing	Dont know (phone only)	2	.7		
	Partial breakoff	43	15.9		
	No answer	11	4.1		
	Total	56	20.7		
Total		271	100.0		

Q16B What role does this type of information play in how you anticipate future demand for native seed or plant materials in order to plan ahead? Past purchases or requests from other buyers.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major role	122	45.0	55.5	55.5
	Moderate role	62	22.9	28.2	83.6
	Minor role	17	6.3	7.7	91.4
	No role	19	7.0	8.6	100.0
	Total	220	81.2	100.0	
Missing	Partial breakoff	43	15.9		
	No answer	8	3.0		
	Total	51	18.8		
Total		271	100.0		

Q16C What role does this type of information play in how you anticipate future demand for native seed or plant materials in order to plan ahead? Information about forward contracting opportunities.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major role	35	12.9	16.4	16.4
	Moderate role	59	21.8	27.7	44.1
	Minor role	46	17.0	21.6	65.7
	No role	73	26.9	34.3	100.0
	Total	213	78.6	100.0	
Missing	Dont know (phone only)	2	.7		
	Partial breakoff	43	15.9		
	No answer	13	4.8		
	Total	58	21.4		
Total		271	100.0		

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Q16D What role does this type of information play in how you anticipate future demand for native seed or plant materials in order to plan ahead? Conservation Research Program funding and plans.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major role	24	8.9	11.2	11.2
	Moderate role	37	13.7	17.3	28.5
	Minor role	62	22.9	29.0	57.5
	No role	91	33.6	42.5	100.0
	Total	214	79.0	100.0	
Missing	Dont know (phone only)	2	.7		
	Partial breakoff	43	15.9		
	No answer	12	4.4		
	Total	57	21.0		
Total		271	100.0		

Q16E What role does this type of information play in how you anticipate future demand for native seed or plant materials in order to plan ahead? Wildfire activity.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major role	11	4.1	5.1	5.1
	Moderate role	29	10.7	13.4	18.4
	Minor role	58	21.4	26.7	45.2
	No role	119	43.9	54.8	100.0
	Total	217	80.1	100.0	
Missing	Partial breakoff	43	15.9		
	No answer	11	4.1		
	Total	54	19.9		
Total		271	100.0		

Q16F What role does this type of information play in how you anticipate future demand for native seed or plant materials in order to plan ahead? Oil and gas leases.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major role	4	1.5	1.9	1.9
	Moderate role	9	3.3	4.2	6.1
	Minor role	27	10.0	12.6	18.7
	No role	174	64.2	81.3	100.0
	Total	214	79.0	100.0	
Missing	Partial breakoff	43	15.9		
	No answer	14	5.2		
	Total	57	21.0		
Total		271	100.0		

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Q16G What role does this type of information play in how you anticipate future demand for native seed or plant materials in order to plan ahead? Mining operations.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major role	6	2.2	2.8	2.8
	Moderate role	15	5.5	7.0	9.9
	Minor role	33	12.2	15.5	25.4
	No role	159	58.7	74.6	100.0
	Total	213	78.6	100.0	
Missing	Partial breakoff	43	15.9		
	No answer	15	5.5		
	Total	58	21.4		
Total		271	100.0		

Q16H What role does this type of information play in how you anticipate future demand for native seed or plant materials in order to plan ahead? Native seed use trends.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major role	26	9.6	12.1	12.1
	Moderate role	50	18.5	23.3	35.3
	Minor role	50	18.5	23.3	58.6
	No role	89	32.8	41.4	100.0
	Total	215	79.3	100.0	
Missing	Partial breakoff	43	15.9		
	No answer	13	4.8		
	Total	56	20.7		
Total		271	100.0		

Q16I What role does this type of information play in how you anticipate future demand for native seed or plant materials in order to plan ahead? Demand for urban and home landscaping.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major role	70	25.8	32.1	32.1
	Moderate role	56	20.7	25.7	57.8
	Minor role	43	15.9	19.7	77.5
	No role	49	18.1	22.5	100.0
	Total	218	80.4	100.0	
Missing	Dont know (phone only)	1	.4		
	Partial breakoff	43	15.9		
	No answer	9	3.3		
	Total	53	19.6		
Total		271	100.0		

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Q16J What role does this type of information play in how you anticipate future demand for native seed or plant materials in order to plan ahead? Other, please describe.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major role	28	10.3	44.4	44.4
	Moderate role	10	3.7	15.9	60.3
	Minor role	1	.4	1.6	61.9
	No role	24	8.9	38.1	100.0
	Total	63	23.2	100.0	
Missing	-7	1	.4		
	Partial breakoff	43	15.9		
	No answer	164	60.5		
	Total	208	76.8		
Total		271	100.0		

Q17 Between 2017 and 2019, approximately what percentage of your inventory of native seed and plant materials was left unsold at the end of the marketing year?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	16	5.9	7.5	7.5
	1	4	1.5	1.9	9.3
	2	4	1.5	1.9	11.2
	3	3	1.1	1.4	12.6
	5	14	5.2	6.5	19.2
	7	1	.4	.5	19.6
	8	1	.4	.5	20.1
	9	1	.4	.5	20.6
	10	24	8.9	11.2	31.8
	12	1	.4	.5	32.2
	15	18	6.6	8.4	40.7
	17	1	.4	.5	41.1
	20	29	10.7	13.6	54.7
	25	17	6.3	7.9	62.6
	30	29	10.7	13.6	76.2
	33	1	.4	.5	76.6
	35	9	3.3	4.2	80.8
	40	12	4.4	5.6	86.4
	45	1	.4	.5	86.9
	50	19	7.0	8.9	95.8
	60	4	1.5	1.9	97.7
	70	2	.7	.9	98.6
	75	2	.7	.9	99.5
	90	1	.4	.5	100.0
	Total	214	79.0	100.0	
Missing	Partial breakoff	43	15.9		
	No answer	14	5.2		
	Total	57	21.0		
Total		271	100.0		

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Q18 Between 2017 and 2019, was the average percentage of native seed and plant materials that was left unsold at the end of the marketing year . . .

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than you anticipated	28	10.3	13.0	13.0
	About what you anticipated	166	61.3	77.2	90.2
	More than you anticipated	21	7.7	9.8	100.0
	Total	215	79.3	100.0	
Missing	Dont know (phone only)	1	.4		
	Partial breakoff	43	15.9		
	No answer	12	4.4		
	Total	56	20.7		
Total		271	100.0		

Q19A How much of a challenge is this for you as a supplier of native seed or plant materials? Insufficient demand.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major challenge	33	12.2	15.6	15.6
	Moderate challenge	64	23.6	30.3	46.0
	Minor challenge	56	20.7	26.5	72.5
	Not a challenge	58	21.4	27.5	100.0
	Total	211	77.9	100.0	
Missing	Partial breakoff	44	16.2		
	No answer	16	5.9		
	Total	60	22.1		
Total		271	100.0		

Q19B How much of a challenge is this for you as a supplier of native seed or plant materials? Unpredictable demand.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major challenge	89	32.8	41.2	41.2
	Moderate challenge	72	26.6	33.3	74.5
	Minor challenge	39	14.4	18.1	92.6
	Not a challenge	16	5.9	7.4	100.0
	Total	216	79.7	100.0	
Missing	Dont know (phone only)	1	.4		
	Partial breakoff	44	16.2		
	No answer	10	3.7		
	Total	55	20.3		
Total		271	100.0		

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Q19C How much of a challenge is this for you as a supplier of native seed or plant materials? Demand for plants without propagation protocols.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major challenge	22	8.1	10.8	10.8
	Moderate challenge	26	9.6	12.7	23.5
	Minor challenge	68	25.1	33.3	56.9
	Not a challenge	88	32.5	43.1	100.0
	Total	204	75.3	100.0	
Missing	Dont know (phone only)	5	1.8		
	Partial breakoff	44	16.2		
	No answer	18	6.6		
	Total	67	24.7		
Total		271	100.0		

Q19D How much of a challenge is this for you as a supplier of native seed or plant materials? Lack of seed testing protocols.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major challenge	31	11.4	15.0	15.0
	Moderate challenge	40	14.8	19.3	34.3
	Minor challenge	59	21.8	28.5	62.8
	Not a challenge	77	28.4	37.2	100.0
	Total	207	76.4	100.0	
Missing	Dont know (phone only)	3	1.1		
	Partial breakoff	44	16.2		
	No answer	17	6.3		
	Total	64	23.6		
Total		271	100.0		

Q19E How much of a challenge is this for you as a supplier of native seed or plant materials? Species difficult to grow.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major challenge	45	16.6	21.2	21.2
	Moderate challenge	82	30.3	38.7	59.9
	Minor challenge	62	22.9	29.2	89.2
	Not a challenge	23	8.5	10.8	100.0
	Total	212	78.2	100.0	
Missing	Partial breakoff	44	16.2		
	No answer	15	5.5		
	Total	59	21.8		
Total		271	100.0		

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Q19F How much of a challenge is this for you as a supplier of native seed or plant materials? Lack of stock seed from appropriate seed zones or other specified locations.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major challenge	54	19.9	25.4	25.4
	Moderate challenge	51	18.8	23.9	49.3
	Minor challenge	57	21.0	26.8	76.1
	Not a challenge	51	18.8	23.9	100.0
	Total	213	78.6	100.0	
Missing	Partial breakoff	44	16.2		
	No answer	14	5.2		
	Total	58	21.4		
Total		271	100.0		

Q19G How much of a challenge is this for you as a supplier of native seed or plant materials? Other, please describe.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Major challenge	23	8.5	35.9	35.9
	Moderate challenge	12	4.4	18.8	54.7
	Minor challenge	4	1.5	6.3	60.9
	Not a challenge	25	9.2	39.1	100.0
	Total	64	23.6	100.0	
Missing	Dont know (phone only)	2	.7		
	Partial breakoff	44	16.2		
	No answer	161	59.4		
	Total	207	76.4		
Total		271	100.0		

Q20_O What suggestions do you have that might help address the challenges you have encountered as a supplier of native seeds or plant materials? (Open-ended response coding frequencies)

CODE	count
Planning	31
Coordination	20
Awareness, education	25
Source	15
Funding	14
Policy	10
Value shift	9
Regional focus	7
Seed specific	8
Markets or economics	10
Standards	7
Labor	5
Access	4
Other	2
Not in Business	2
None, No comment, no suggestions, etc.	6

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Q21 If you were to anticipate higher demand for directly wild-collected native seed, would your business be able to expand to collect more seed?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Likely yes	69	25.5	61.6	61.6
	Likely no	43	15.9	38.4	100.0
	Total	112	41.3	100.0	
Missing	Refusal (phone only)	1	.4		
	Dont know (phone only)	1	.4		
	Branching skip	102	37.6		
	Partial breakoff	48	17.7		
	No answer	7	2.6		
	Total	159	58.7		
Total		271	100.0		

Q22 To the extent you are aware, are there major barriers or disincentives to wild-collecting native seed?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes. What are those barriers?	143	52.8	70.8	70.8
	No	59	21.8	29.2	100.0
	Total	202	74.5	100.0	
Missing	Dont know (phone only)	2	.7		
	Partial breakoff	48	17.7		
	No answer	19	7.0		
	Total	69	25.5		
Total		271	100.0		

Q22_O To the extent you are aware, are there major barriers or disincentives to wild-collecting native seed? What are those barriers? (Open-ended response coding frequencies)

CODE	count
Access to land	62
Availability of seed/land	26
Labor	22
Depletion	17
Cost	13
Time	12
Markets	10
Knowledge	10
Environmental factors	7
Ethical reasons	6
Quality of seed	6
Resources Available	4
Other	2

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Q23 If you were to anticipate higher demand, would your business be able to expand to grow more native plants with the goal of producing and selling native seed?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Likely yes	77	28.4	75.5	75.5
	Likely no	25	9.2	24.5	100.0
	Total	102	37.6	100.0	
Missing	Dont know (phone only)	2	.7		
	Branching skip	118	43.5		
	Partial breakoff	48	17.7		
	No answer	1	.4		
	Total	169	62.4		
Total		271	100.0		

Q24 To the extent you are aware, are there any major barriers or disincentives to growing native plants with the goal of producing and selling native seed?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes. What are those barriers?	83	30.6	42.8	42.8
	No	111	41.0	57.2	100.0
	Total	194	71.6	100.0	
Missing	Dont know (phone only)	2	.7		
	Partial breakoff	48	17.7		
	No answer	27	10.0		
	Total	77	28.4		
Total		271	100.0		

Q24_O To the extent you are aware, are there any major barriers or disincentives to growing native plants with the goal of producing and selling native seed? What are those barriers? (Open-ended response coding frequencies)

CODE	count
Markets	24
Seed/plant viability	14
Cost	14
Availability	8
Space	8
Environmental factors	7
Labor	6
Knowledge	6
Time	5
Resources	4
Zoning Requirements	3
Permits	3
Other	3

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Q25 If you were to anticipate higher demand, would your business be able to expand to grow and sell more plant materials?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Likely yes	124	45.8	83.2	83.2
	Likely no	25	9.2	16.8	100.0
	Total	149	55.0	100.0	
Missing	Dont know (phone only)	1	.4		
	Branching skip	71	26.2		
	Partial breakoff	48	17.7		
	No answer	2	.7		
	Total	122	45.0		
Total		271	100.0		

Q26 To the extent you are aware, are there any major barriers or disincentives to growing and selling plant materials?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes. What are those barriers?	91	33.6	45.3	45.3
	No	110	40.6	54.7	100.0
	Total	201	74.2	100.0	
Missing	Dont know (phone only)	1	.4		
	Partial breakoff	48	17.7		
	No answer	21	7.7		
	Total	70	25.8		
Total		271	100.0		

Q26_O To the extent you are aware, are there any major barriers or disincentives to growing and selling plant materials? What are those barriers? (Open-ended response coding frequencies)

CODE	count
Markets	29
Knowledge, education, perception	13
Viability	9
Cost	10
Labor	8
Availability	8
Time	3
Space	3
Environment	4
Permits	1
See previous comment	5
Other	6

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Q27_O Do you have any other suggestions that could improve how the native seed market functions? (Open-ended response coding frequencies)

CODE	count
Coordination	21
Education	14
Standards	12
Regional focus	11
Predictability	9
Policy	8
Availability	5
Transparency	4
Market/Economy	4
Resilience	2
Specialty crop focus	2
More Collectors or producers	2
Monopolies	1
Atypical Grower	1
Research	1
None	14
Other	8

Q28 Between 2017 and 2019, which of the following best describes your business's average annual sales and operating revenues?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than $100,000	49	18.1	23.4	23.4
	$100,000-$499,999	63	23.2	30.1	53.6
	$500,000-$999,999	26	9.6	12.4	66.0
	$1,000,000-$4,999,999	41	15.1	19.6	85.6
	$5,000,000-$10,000,000	20	7.4	9.6	95.2
	Over $10,000,000	10	3.7	4.8	100.0
	Total	209	77.1	100.0	
Missing	Refusal (phone only)	1	.4		
	Dont know (phone only)	1	.4		
	Partial breakoff	48	17.7		
	No answer	12	4.4		
	Total	62	22.9		
Total		271	100.0		

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An Assessment of Native Seed Needs and the Capacity for Their Supply: Final Report

Q29 Roughly what percentage of your average annual sales and operating revenues are from the sale of native seed and plant materials?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	4	1.5	1.9	1.9
	3	1	.4	.5	2.4
	5	6	2.2	2.8	5.2
	6	1	.4	.5	5.7
	8	2	.7	.9	6.6
	10	4	1.5	1.9	8.5
	15	8	3.0	3.8	12.3
	20	10	3.7	4.7	17.1
	25	3	1.1	1.4	18.5
	27	1	.4	.5	19.0
	30	8	3.0	3.8	22.7
	33	2	.7	.9	23.7
	35	1	.4	.5	24.2
	40	3	1.1	1.4	25.6
	45	2	.7	.9	26.5
	50	13	4.8	6.2	32.7
	55	1	.4	.5	33.2
	60	11	4.1	5.2	38.4
	65	5	1.8	2.4	40.8
	70	8	3.0	3.8	44.5
	75	7	2.6	3.3	47.9
	80	10	3.7	4.7	52.6
	85	7	2.6	3.3	55.9
	90	15	5.5	7.1	63.0
	95	8	3.0	3.8	66.8
	98	4	1.5	1.9	68.7
	99	7	2.6	3.3	72.0
	100	59	21.8	28.0	100.0
	Total	211	77.9	100.0	
Missing	Partial breakoff	47	17.3		
	No answer	13	4.8		
	Total	60	22.1		
Total		271	100.0		

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Appendix 2H

Public Information Gathering Sessions
In-Person and Virtual Agendas

COMMITTEE ON AN ASSESSMENT OF NATIVE SEED NEEDS AND CAPACITIES

AUGUST 18-19, 2019
National Academy of Sciences Lecture Room
Washington, D.C.

Sunday, August 18, 2019

OPEN SESSION – Public Welcome (Zoom and in person)

3:00 pm	Welcome and Introductions
3:15 pm	Discussion with Sponsor Peggy Olwell, *Plant Conservation Program Lead,* Bureau of Land Management (BLM), Department of the Interior (in person)
4:30 pm	Roles of different federal agencies to the native seed system: USFWS Sarah Kulpa, *Botanist,* US Fish and Wildlife Service (USFWS) (Nevada), Department of the Interior (via Zoom)
5:15 pm	Public comment period
5:30 pm	Adjourn

Monday, August 19, 2019

OPEN SESSION – Public Welcome (Zoom and in-person)

10:00 am	Opening remarks – Susan Harrison, *Committee Chairwoman*
10:10 am	Roles of different federal agencies to the native seed system: USFS William Carromero, *National Botanist,* US Forest Service (USFS) (in person) and Carol Spurrier, *Ecologist,* USFS (by phone)
10:50 am	Roles of different federal agencies to the native seed system: USDA/NRCS John Englert, *National Program Leader—Plant Materials,* Natural Resource Conservation Service (NRCS), US Department of Agriculture (in person)
11:30 am	Seed company perspectives on the supply and demand for native seed Dustin Terrell, *Partner,* Buffalo Brand Seed, LLC (via zoom)
12:10 pm	Brief break
12:40 pm	Seed company perspectives on the supply and demand for native seed Ed Kleiner, *General Manager,* Comstock Seed, LLC (via zoom)
1:20 pm	Roles of different federal agencies to the native seed system: USDA/NIFA Jim Dobrowolski, *National Program Leader,* National Institute for Food and Agriculture, US Department of Agriculture (in person)
1:50 pm	Public comment period
2:05 pm	Adjourn public session

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An Assessment of Native Seed Needs and the Capacity for Their Supply: Final Report

OCTOBER 10, 2019
USFS Facility (Sage and Lupine Rooms)
Bend, Oregon

Thursday, October 10, 2019

OPEN SESSION – Public Welcome (Zoom and in-person)

8:00 am	Holly Jewkes, *Supervisor,* Deschutes National Forest, USFS — Welcome
8:15 am	Susan Harrison, *Committee Chair* — Appreciation and Introductions
8:25 am	Robin Schoen, *Study Director* — Overview of the Assessment Process
8:40 am	Pause in Zoom broadcast
8:45 am	Visit to the Bend Seed Extractory – Kayla Herriman, *USFS Extractory Manager*
10:45 am	Return to Conference Room, Prepare for Open Zoom Session
11:00 am	Susan Harrison, *Committee Chair* – Welcome, Review of the Agenda, and Introductions
11:20 am	Vicky Erickson, *Geneticist,* Pacific Northwest Region, US Forest Service
12:15 pm	Barry Schrumpf, *Seed Certification Specialist,* Oregon State University Seed Certification Service/Oregon Seed Association
1:00 pm	Lunch break – pause in Zoom broadcast
1:45 pm	Trish Roller and Ricardo Galvan, *BLM National Seed Warehouse System, seed buys and contracting considerations* (via Zoom)
2:35 pm	Greg Eckert, *Restoration Ecologist,* Biological Resources Division, National Park Service (via Zoom)
3:30 pm	Break—pause in Zoom broadcast
3:45 pm	Jerry Benson, *President,* BFI Native Seeds
4:40 pm	Bonnie Harper-Lore, *Restoration Ecologist* (retired) Federal Highway Administration Department of Transportation (via Zoom)
5:30 pm	Public comments
5:45 pm	Adjournment of Open Session

JANUARY 28-29, 2020
National Academy of Sciences Beckman Center
Irvine, California

Tuesday, January 28, 2020

OPEN SESSION – Public Welcome (Zoom and in-person)

12:40 pm	Welcome, Susan Harrison
12:45 pm	US Tribal Nursery Council and Understanding Tribal Needs for Native Seed Jeremy Pinto, *US Forest Service* (Moscow, Idaho)
1:30 pm	Economics of the native seed supply Charles Perring, *Arizona State University*
2:45 pm	End of Open Session

Wednesday, January 29, 2020

OPEN SESSION – Public Welcome (Zoom and in-person)

9:00 am	Welcome, Susan Harrison The Role of Native Seeds on Highway Roadsides John Krouse, *Maryland Department of Transportation* Ken Greave, *Minnesota Department of Transportation*
10:00 am	End of Open Session

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Appendix 2H

FEBRUARY 22, 2021
Via Zoom

Monday, February 22, 2021
OPEN SESSION – Public Welcome (via Zoom)

3:00 pm	Welcome, Brief Committee Introductions and Introduction of Panelists Susan Harrison, *Committee Chair*
3:10 pm	Panel discussion, The Nature Conservancy Representatives Olga Kildisheva, *Innovative Restoration Project Manager*, Sagebrush Sea Program, TNC Oregon Catherine Schloegel, *Watershed Forest Manager*, TNC Colorado Anne Bradley, *Forest Conservation Program Director (or Collin Haffey, Forest and Watershed Health Manager*), TNC New Mexico Kevin Badik, *Rangeland Ecologist*, TNC Nevada --Description of TNC projects and responses to key questions --Questions from the committee
4:15 pm	Adjourn public session

MARCH 8, 2021
Via Zoom

Monday, March 8, 2021
OPEN SESSION – Public Welcome (via Zoom)

4:00 pm	Welcome, Brief Committee Introductions and Introduction of Panelists Susan Harrison, *Committee Chair*
4:10 pm	Panel Discussants 1: Rick Iovanna, *Agricultural Economist,* USDA Natural Resources Conservation Service, Washington, DC Bryan Pratt, *Research Agricultural Economist,* USDA Economic Research Service, Kansas City, MO
4:30 pm	Clarifying Q&A for Panel 1 from Committee and other Discussants
4:40 pm	Panel Discussants 2: Laura Jackson, *Director and Professor of Biology,* Tallgrass Prairie Center, University of Northern Iowa, Cedar Falls, IA Justin Meissen, *Research and Restoration Program*, Tallgrass Prairie Center, University of Northern Iowa Laura Walter, *Plant Materials Program Manager*, Tallgrass Prairie Center of the University of Northern Iowa Kristine Nemec, *Integrated Roadside Vegetation Manager*, Tallgrass Prairie Center of the University of Northern Iowa
5:00 pm	Clarifying Q&A for Panel 2 from Committee and other Discussants
5:10 pm	Committee Q&A and Discussion with all Discussants
5:30 pm	Adjourn

MARCH 16, 2021
Via Zoom

Tuesday, March 16, 2021
OPEN SESSION – Public Welcome (via Zoom)

4:00 pm	Welcome, Brief Committee Introductions and Introduction of Discussants Susan Harrison, *Committee Chair*

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4:05 pm	Monica Pokorny, *Plant Materials Specialist*, USDA Natural Resources Conservation Service, Washington, DC Gord Pearse, *Agronomist*, Bruce Seed Farm, and *Past-President*, Montana Seed Trade Association
4:35pm	Committee Q&A
5:00 pm	Adjourn Public Session

MARCH 31, 2021
Via Zoom

Wednesday, March 31, 2021
OPEN SESSION – Public Welcome (via Zoom)

1:00pm	Welcome, Brief Committee Introductions and Introduction of John Englert Susan Harrison, *Committee Chair*
1:05 pm	John Englert, *National Program Leader*, USDA Natural Resources Conservation Service
1:35 pm	Committee Q&A
2:00 pm	Adjourn Public Session

APRIL 12, 2021
Via Zoom

Monday, April 12, 2021
OPEN SESSION – Public Welcome (via Zoom)

4:00 pm	Welcome, Brief Committee Introductions and Introduction of Presenters Susan Harrison, *Committee Chair*
4:05 pm	Keith Pawelek, *Associate Director*, Texas Native Seeds
4:30 pm	Committee Q&A
4:45 pm	Ed Toth, *Founder and Director*, Greenbelt Native Plants Center, NYC Parks
5:10 pm	Committee Q&A
5:25 pm	Additional questions, discussion if needed
5:30 pm	Adjourn

APRIL 20, 2021
Via Zoom

Tuesday, April 20, 2021
OPEN SESSION – Public Welcome (via Zoom)

4:00 pm	Welcome, Brief Committee Introductions and Introduction of Ed Toth Susan Harrison, *Committee Chair*
4:10 pm	Ed Toth, *Founder and Director*, Greenbelt Native Plants Center, NYC Parks
4:45 pm	Committee Q&A Questions from public (submitted in chat)
5:30 pm	Adjourn

MAY 4, 2021
Via Zoom

Tuesday, May 4, 2021
OPEN SESSION – Public Welcome (via Zoom)

3:30 pm	Susan Harrison, *Committee Chairperson* --Welcome and Introductions

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3:35 pm	Gil Waibel, *Seed Physiologist Technologist Lead*, Bayer CropSciences --Presentation on Seed Testing
4:15 pm	Committee Q&A
4:30 pm	Dustin Terrell, *Buffalo Brand Seeds* Andy Ernst, *Ernst Conservation Seeds* --Comments on Testing from the Seed Supplier perspective
4:45 pm	Committee Q&A
5:00 pm	Adjourn

JUNE 29, 2021
Via Zoom

Tuesday, June 29, 2021

OPEN SESSION – Public Welcome (via Zoom)

3:30 pm	Susan Harrison, *Committee Chair* --Welcome
3:40 pm	Molly Anthony, *Program Lead*, BLM Emergency Stabilization and Rehabilitation Program BLM Post-Wildfire Recovery: Emergency Stabilization & Burned Area Rehabilitation
4:00 pm	Q&A (Committee)
4:20 pm	Anne S. Halford, *State Botanist*, BLM Idaho [Pre-Taped] Native Seed Production Tools to Procure Increase and Distribute Source Identified Seed via Seed Transfer Zones at an Ecoregional Scale in the Western U.S
4:40 pm	Patricia Roller, *National Seed Coordinator*, BLM National Seed Warehouse System and Ricardo Galvan, *Administrative & Financial Seed Specialist*, BLM National Seed Warehouse System Trends in the Periodic Regional Seed Purchases of the BLM
5:10 pm	Q&A (Committee)
5:30 pm	Adjourn

NOVEMBER 12, 2021
Via Zoom

Friday, November 12, 2021

OPEN SESSION – Public Information-Gathering Session

11:00 am	Susan Harrison (*Chair*) – Welcome and disclaimer
11:05 am	Vera Smith and Bart Johansen-Harris, of *Defenders of Wildlife*
11:25 am	Q&A from committee
11:35 am	Josh Osher and Laura Welp, of *Western Watersheds*
11:55 am	Q&A from committee
12:05 pm	Cristina Eisenberg, *Oregon State University*
12:25 pm	Q&A from committee
12:35 pm	Discussion/Q&A from committee

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January 22, 2026

Los Angeles County Regional Planning Commission
Hall of Records
320 West Temple Street, Room 150
Los Angeles, CA 90012

RE: Support for the Northlake Project – Project No. R2015-00408 January 28, 2026 Regional Planning Commission Hearing

Honorable Chair and Members of the Commission:

On behalf of the Santa Clarita Valley Chamber of Commerce, I am pleased to submit this letter in strong support of the Northlake Project, scheduled for public hearing before the Los Angeles County Regional Planning Commission on Wednesday, January 28, 2026.

As the region's largest business advocacy organization, the Chamber views housing availability—particularly price-attainable housing for working families—as one of the most pressing economic development issues facing the Santa Clarita Valley and Los Angeles County today. Northlake directly addresses that need in a manner that is policy-consistent, environmentally responsible, and economically essential.

Housing as Economic Infrastructure
Employers throughout the Santa Clarita Valley consistently identify housing costs as a primary barrier to workforce recruitment and retention. Teachers, healthcare workers, first responders, skilled tradespeople, and service-sector employees are increasingly priced out of the communities they serve. Northlake's diversified housing program—including 315 affordable units representing approximately 10 percent of the total project—provides critically needed options for working families and seniors while supporting long-term regional economic stability.
Housing is economic infrastructure. Projects such as Northlake ensure that businesses can grow, expand, and retain talent locally rather than losing workers to longer commutes or other regions entirely.

A Proven, Longstanding Planning Framework
The Northlake Specific Plan was unanimously approved by the Los Angeles County Board of Supervisors in 1992, and the current proposal remains fully within the envelope of that approved plan, while updating the community to reflect modern standards for sustainability, walkability, and environmental performance.

The project is consistent with the Los Angeles County General Plan and the Santa Clarita Valley Area Plan, "One Valley, One Vision" (OVOV), which explicitly identifies this area for future growth and housing opportunity.

Economic and Fiscal Benefits
In addition to meeting housing needs, Northlake will:

- Support local businesses through population growth and consumer demand
- Generate construction and permanent employment opportunities
- Strengthen local school enrollment and funding stability

- Deliver commercial and mixed-use development that supports services closer to where people live and work

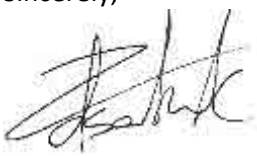
These benefits contribute to a more resilient and balanced regional economy.

Responsible Growth and Environmental Stewardship
The Chamber also recognizes the project's significant environmental and recreational commitments, including expanded open space, enhanced parks, wildlife connectivity, and an integrated trail and active transportation network. This approach demonstrates that economic growth and environmental stewardship are not mutually exclusive, but rather complementary when guided by sound planning.

Northlake represents the type of thoughtful, long-term investment needed to support a healthy regional economy—one that balances housing affordability, job creation, environmental protection, and quality of life.

For these reasons, the Santa Clarita Valley Chamber of Commerce respectfully urges the Regional Planning Commission to support approval of the Northlake Project.
Thank you for your consideration.

Sincerely,



Ivan Volschenk
President & CEO, Santa Clarita Valley Chamber of Commerce



January 22, 2026

Los Angeles County Regional Planning Commission
Hall of Records
320 West Temple Street, Room 150
Los Angeles, CA 90012

RE: Support of Northlake Project – Project No. R2015-00408

Chair and Members of the Commission:

On behalf of the Golden State Gateway Coalition, we write to renew our strong support for the Northlake project.

The Golden State Gateway Coalition represents public-private sector stakeholders committed to improving transportation infrastructure, goods movement, and economic competitiveness along the Interstate 5 corridor and throughout the greater Southern California logistics and industrial network. From this perspective, Northlake represents a critical, long-planned investment that advances both transportation efficiency and workforce sustainability.

Northlake has been an active participant and supporter of the Golden State Gateway Coalition for decades, recognizing early on that land use, transportation, and economic development must be planned together. The project has consistently engaged in regional discussions around mobility, infrastructure funding, and corridor performance, and its development framework reflects that long-term commitment.

As the project moves forward, Northlake is anticipated to deliver approximately tens of millions in transportation infrastructure investments, supporting roadway improvements, system connectivity, and regional mobility. These investments are essential to maintaining efficient movement of people and goods along the I-5 corridor and within the Santa Clarita Valley.

Equally important is Northlake's role in addressing a structural imbalance that directly affects congestion and infrastructure performance: the growing disconnect between housing supply and employment centers.

Manufacturing, logistics, and industrial jobs in nearby commerce and industrial centers depend on a workforce that is increasingly forced to commute long distances due to housing costs and limited supply. Northlake's inclusion of housing priced for working families helps place workers closer to their jobs, reducing long-distance commuting, lowering vehicle miles traveled, and easing pressure on regional freeways.

Providing housing near employment centers is one of the most effective, and cost-efficient, ways to address congestion and improve transportation system performance.

Northlake represents the type of integrated land use and transportation planning that regional mobility strategies depend upon. Its long-standing engagement with the Golden State Gateway Coalition, significant infrastructure investment, and contribution to workforce housing make it a project of regional importance.



For these reasons, the Golden State Gateway Coalition respectfully urges the Los Angeles County Regional Planning Commission to support approval of the Northlake project.

Thank you for your leadership and consideration.

Sincerely,

John Musella

John Musella
Executive Director, Golden State Gateway Coalition

From:	Chad Christensen
To:	PublicHearing; ExecutiveOffice
Subject:	MRCA comments regarding Northlake appeal
Date:	Monday, March 16, 2026 4:25:04 PM
Attachments:	MRCA - Northlake Fire Recurrence (1992-2025) Map.pdf MRCA - Northlake Puma Observation Map.pdf MRCA - References Cited Exhibit.pdf MRCA Comment Letter 2026-03-16 - Northlake Project Appeal.pdf

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Good afternoon,

Please find attached a letter from MRCA providing comments to the County Board of Supervisors regarding the appeal of the Northlake Project R2015-00408-(5), Vesting Tentative Tract Map No. 073336, Vesting Tentative Parcel Map No. 073335, Conditional Use Permit No. RPPL2023004316, Environmental Assessment NO. RPPL2023004887 (Project) in the Fifth Supervisorial District.

Attached are the following documents:

- MRCA Comment Letter 2026-03-16 – Northlake Project Appeal
- MRCA – References Cited Exhibit
- MRCA – Northlake Fire Recurrence (1992-2025) Map
- MRCA – Northlake Puma Observation Map

Please confirm receipt of this email and attachments for inclusion in the record for File ID 26-1204 and the Board of Supervisors meeting on March 24, 2026.

Thank you,
Chad

Chad Christensen
Deputy Chief of Natural Resources and Planning
Mountains Recreation and Conservation Authority
26800 Mulholland Highway
Calabasas, California 91302
o: 310-589-3230, x.121
c: 213-392-0495

MOUNTAINS RECREATION & CONSERVATION AUTHORITY
King Gillette Ranch
26800 Mulholland Highway
Calabasas, California 91302
PHONE (818) 878-0886

March 16, 2026

Board of Supervisors
Hall of Administration
County of Los Angeles
500 West Temple Street
Los Angeles, California 90012

Northlake Project No. R2015-00408 - Justification for Support of Appeal
Omission of Wildlife Presence Evidence and Imperils Mountain Lion Population

Hon. Chairperson Solis and Supervisors:

The Mountains Recreation and Conservation Authority (MRCA) recommends the County of Los Angeles (County) Board of Supervisors uphold the appeal of the Regional Planning Commission's decision to approve the Partial Creek Avoidance Alternative (PCAA) of the Northlake Phase 1 Project No. R2015-00408, Vesting Tentative Tract Map No. 073336, Vesting Tentative Parcel Map No. 073335, and Conditional Use Permit No. RPPL2023004316 (Project). MRCA recommends that the Board of Supervisors deny the Project as-is due to the Applicant's serious misleading statements leading to the Regional Planning Commission (RPC) approval of the Project's PCAA on January 28, 2026.

To greatly lessen regionally significant biological impacts, it is imperative that the Board of Supervisors grant the appeal in part and permanently eliminate the Phase 2 portion of the PCAA from the project approvals by adding a new condition to deed restrict all of Phase 2 as permanent open space. As proposed, Phase 1 must be a feasible, standalone project. With almost 3,000 housing units, it provides ample housing, sport facilities, public amenities, and a strong economic return.

Applicant and County Staff Mislead Decision Makers with Key Data Omissions

At the January 28, 2026, RPC hearing, Commissioner Hastings (Supervisorial District 5) asked Applicant representative, Damon Mamalakis of Armbuster Goldsmith & Delvac, LLP, about the Project's impacts to local wildlife.

Hastings: Before you go, for all the acreage you guys are building on here [in Grasshopper Canyon], you said your cameras never picked up any wildlife movement? (Unofficial Transcript, RPC Hearing 1/28/2026, 13:09:55 – 13:10:05)[1]
Mamalakis: No wildlife movement. We put the cameras where all of the crossings are on the property. I think it was for three or four months. We did not pick up any [wildlife movement]. (Ibid, 13:10:05 – 13:10:18)
Hastings: You did not pick any? That's amazing. (Ibid, 13:10:18 – 13:10:22)

Mr. Mamalakis' unequivocal answer following a direct question from Commissioner Hastings about the Project's likely impacts to wildlife movement must be viewed as part of a pattern by the Applicant to mislead decision makers. In addition, at no time did County staff attempt to correct the record about Mr. Mamalakis' false statement. Subsequently, the RPC voted to approve the Project under the false impression that zero wildlife were observed in Grasshopper Canyon.

On February 12, 2026, MRCA filed a Public Records Act (PRA) request with the County to obtain wildlife movement-related materials including camera studies, movement data, and/or wildlife monitoring projects within the proposed Project and within 500 feet of the Project. When the County did not respond to the PRA after 10 days, MRCA followed up on February 25th to which County staff replied with a link to County Planning File No. 26-013 materials and indicated more time would be required to provide responsive materials. On March 4, 2026, County provided a link to a 3.5-gigabyte zip folder with included documents indexed by bates numbers (i.e., "AR" followed by a unique sequential number indicating a page reference within the comprehensive Administrative Record).

Within the administrative record, MRCA found a letter dated September 13, 2018, from Tony Bomkamp, Technical Director and Senior Biologist for Glenn Lukos Associates (GLA) to Applicant representative Damon Mamalakis (AR015999)[2] that summarizes the wildlife captured by 12 wildlife cameras deployed by GLA staff between July 12 and September 4, 2018. Of the 12 cameras deployed, nine (9) "picked up" wildlife movement including deer, coyote, red-tail hawk, Cooper's hawk, barn owl, skunk, raccoon, cow, and more. For the cameras that were deployed in the proposed Project Area within Grasshopper Canyon (Camera Stations 3, 4, 5, 6, and 7 per Exhibit 1; AR016046),[2] only Camera Station 5 failed to "pick up" wildlife movement; otherwise, four of five cameras did "pick up" wildlife movement in Grasshopper Canyon. The GLA wildlife study continues "Bobcat, gray fox, and coyote were also detected by tracks or other 'sign' (e.g., scat)" (AR016007).[2] This GLA wildlife study directly contradicts Mr. Mamalakis' testimony at the January 28, 2026, RPC hearing that no wildlife were detected.

The RPC Approval Package published on the County's Legistar webservice (File No. 26-013, RPC Hearing 1/28/2026, Attachment 2) is an incomplete record due to omitting the relevant information from the September 2018 GLA letter (AR015999)[2] documenting wildlife movement in Grasshopper Canyon. County staff's error of omission, combined with Applicant's erroneous statements made during the RPC hearing that zero wildlife were detected, renders County Finding No. 14 for California Environmental Quality Act (CEQA) Determination insufficient for impacts to existing wildlife using Grasshopper Canyon. Confirmed wildlife usage of Grasshopper Canyon, whether from GLA, MRCA, or another entity, appears to be new and significant information denied to decision makers and represents a substantial increase in the environmental impacts not previously analyzed by the EIR resulting in an inadequate public review process and conclusory findings not supported by the complete administrative record.

Cumulative Impacts Fragment a Regional Wildlife Corridor and Imperil "Threatened" Mountain Lions

Since 2020, MRCA has documented numerous wildlife using I-5 Undercrossing No. 2 including, but not limited to, mountain lion, deer, coyote, bobcat, roadrunner, and quail.[3]

In 2024, MRCA initiated the I-5 (Sierra Madre-Castaic) Wildlife Crossing Infrastructure Assessment and Implementation Plan (I-5 Wildlife Crossing Plan), funded in part by the Wildlife Conservation Board, The Nature Conservancy, and Wildlife Conservation Network, to improve wildlife connectivity across the 26-mile stretch of I-5 between State Route 138 and State Route 126. This segment of I-5 is designated as a critical wildlife barrier (Barrier W231)[4] by California Department of Fish and Wildlife (CDFW). CDFW's fact sheet for Barrier W231: "The Sierra Madre-Castaic linkage is vitally important for restoring gene flow to southern California mountain lion populations. This section of the I-5 is a roadkill hotspot with multiple mountain lions being hit and killed over the years. There are also some development projects in the works along this segment …" which, if completed, would further degrade wildlife connectivity to extensive protected lands on either side of I-5. The Northlake Project proposes to add approximately 11 miles of wildland-urban interface (perimeter of Phases 1 and 2) to the currently "vacant" Grasshopper Canyon and add approximately 2 linear-miles of development barrier to the western approach/dispersal route to/from Castaic Lake. While individual, high-mobility, more human tolerant wildlife might be able to occasionally navigate this newly fragmented environment, less human tolerant and low-mobility wildlife will encounter permanent barriers from both phases of the Project.

In support of MRCA's I-5 Wildlife Crossing Plan, MRCA contracted for extensive wildlife monitoring of culverts, bridges, and other I-5 crossing structures along CDFW Barrier W231. Between the Templin Highway interchange and the Violin/Marple Canyon concrete culvert identified in the Northlake Project as Undercrossing No. 1—the stretch of I-5 closest to the Northlake Project—MRCA contractors completed field deployment of wildlife cameras in November 2025 and have since captured numerous wildlife (e.g., mountain lion, bobcat, coyote, and grey fox) moving between Grasshopper Canyon and Marple Canyon.[3]

Combined, MRCA's efforts document that the Project area contributes to a regional wildlife corridor and undermine Tentative Tract Map Finding No. 43 that the Project is "… not likely to cause substantial environmental damage or substantially and avoidably injure fish or wildlife or their habitat." MRCA-controlled Undercrossing No. 2 represents one of the only wildlife-safe connection points between Grasshopper Canyon and Marple Canyon. Northlake's PCAA Phase 2 exhibits depict a major new access road that essentially cuts across and through the habitat leading to Undercrossing No. 2. Cumulative impacts of Northlake Phase 1 and Phase 2 would degrade wildlife connectivity across I-5 and CDFW Barrier W231, especially at Undercrossing No. 2, as additional Project-related Vehicle Miles Traveled (VMT) will result in more wildlife-vehicle

collisions, more road noise, light and microplastic tire pollution, and wider dispersal of litter that attracts nuisance wildlife.

The Northlake Project is adjacent to a particularly dangerous section of southbound I-5 near the end of the descent from Violin Summit. Downhill car, bus, and tractor-trailer speeds regularly exceed the posted speed limit. For every wildlife-vehicle collision, for every near-miss or high-speed swerve to avoid a wildlife collision, numerous people are at risk of serious injury and death. The proposed Project will degrade access to one of I-5's extremely rare safe-crossing structures (i.e., Undercrossing No. 2), add thousands of VMT to Ridge Route Road and I-5, and result in additional vehicle strikes to wildlife. A January 21, 2026, news article in the Los Angeles Times[5] described how "An injured mountain lion cub was captured by wildlife officials Wednesday after it was seen huddled in the middle of a roadway in the Castaic Area, probably after being struck by a car, officials said." This lion cub was found cowering in the intersection of Hillcrest Parkway and Olympic Street approximately 2.5 miles south of the Northlake Project site in a similar 1990s/2000s-era development that contributed to habitat fragmentation on the west side of I-5.

At the February 2026 meeting of the California Fish and Game Commission[6], the Central Coast and Southern California evolutionary significant unit of mountain lion was unanimously listed as a "threatened" species for protection by the California Endangered Species Act (CESA). According to CDFW, individual mountain lion territory can range up to 300-500 square miles. Preserving and enhancing functional habitat within and near the South Coast Missing Linkages Project's *Sierra Madre-Castaic Connection* (*Connection*) is critical to support the genetic heterogeneity of mountain lions in the Santa Monica Mountains, Simi Hills, and Santa Susana Mountains. Extensive research by National Park Service (NPS) and CDFW staff indicates Santa Monica Mountain lions are already suffering from deleterious inbreeding. The Northlake Project's impacts to Undercrossing No. 2 will degrade wildlife connectivity in the southern extent of the *Connection*, and the Board of Supervisors has a responsibility to act on new and significant information to require the Northlake Project avoid, or fully mitigate, cumulative impacts to one of the extremely few now-functional, wildlife-safe undercrossings of I-5 north of Santa Clarita.

In the County's "Findings of Fact and Statement of Overriding Conditions regarding the Northlake Specific Plan Project" (AR000230),[7] the County generally recognizes the importance of "north-south linkage between the mountainous open space of the National Forest and resource rich riparian zones along the Santa Clara River" and then erroneously asserts, "However, construction of Castaic Dam, Lake, Lagoon, [Castaic Lake State Recreation Area] SRA and its associated facilities along with residential development west of the Lagoon has essentially eliminated this linkage" (AR000273).[7] That might be true for Castaic Canyon/Creek and its connection five miles further south to the Santa Clara River, but Grasshopper Canyon is vacant and connects public lands adjacent to the Angeles National Forest with the SRA—an important north-south linkage between the ANF and perennial, accessible water in Castaic Lagoon.

Nonetheless, the key regionally significant biological impact is east-west wildlife movement between mountain ranges that are bisected by I-5, CDFW Barrier W231.

The County's "Findings of Fact …" (AR000230) then proceeds to make unsubstantiated assumptions about potential wildlife utilization of I-5 Undercrossing No. 2:

> However, use of this undercrossing is expected to be minimal for a variety of factors. The location of the crossing is not associated with any notable natural landscape feature, which typically would concentrate movement such as a ridge line, water feature, or drainage. The location is associated with an unimproved road but the road travels across a slope providing vehicular access to transmission towers but offering little to no cover for wildlife. In addition, the location is not associated with any corresponding crossing in the vicinity that allows wildlife to travel under the north bound lanes of the I-5. There are no ridge lines or drainages or similar features that typically convey concentrated movement to or from a crossing of the northbound lanes of I-5. In fact, the nearest under-crossings of the northbound lanes are located approximately one mile north and approximately two miles south of this crossing. (AR000273 – AR000274)[7]

The fact is: wildlife are regularly using I-5 Undercrossing No. 2 as documented by MRCA since 2020. The County has never incorporated into its Findings the September 13, 2018, GLA letter to Mr. Mamalakis (AR015999) that wildlife were documented using Grasshopper Canyon (via Camera Stations 3, 4, 5, 6 and 7) as a north-south linkage between Angeles National Forest and Castaic Lagoon. In the nearly eight (8) years since the Applicant's expert biologists *did* detect wildlife movement in Grasshopper Canyon, during which time mountain lions were nominated as "candidate species" for CESA listing to State-listed as "threatened," neither the Applicant nor the County have followed up with any additional wildlife movement surveys. When directly asked at the RPC hearing by Commissioner Hastings about wildlife movement through the Project site, Mr. Mamalakis claimed, "We did not pick up any," and County staff did not correct the facts or note the eight-year data gap for the record.

The above assertion that I-5 Undercrossing No. 2 has low regional ecological value both because it does not have the requisite natural landscape features and is by a road, underscores Undercrossing No. 2's importance because, as is, it is vital to maintain regional habitat connectivity despite its minor imperfections. Plus, there is an equivalent undercrossing to the west across Marple Canyon to facilitate wildlife movement under the northbound lanes of I-5. A complete I-5 undercrossing system across Marple Canyon is in place but depends on no development occurring in the Phase 2 portion of the PCAA. The MRCA invested in lands on both sides of Undercrossing No. 2 because of its regional and local significance. Today a high-quality intact system for wildlife movement across I-5 is fully in place with no additional public investment required. That is the baseline condition, the efficacy of which the data now in the public record clearly proves. The Phase 2 portion of the PCAA destroys the eastern pathway into that intact system. A

portion of this critical east-west linkage can only be retained if the entire Phase 2 portion of the PCAA is deed restricted as permanent open space as a tract map condition for Phase 1.

MRCA also questions the feasibility of the Applicant to secure sufficient, suitable lands for extensive off-site compensatory habitat preservation and/or establishment as summarized in the August 28, 2018, "Feasibility Analysis of NorthLake Biological Mitigation Requirements" Psomas Memorandum (AR015235).[8] This Memorandum identifies "properties with the appropriate biological resources and of sufficient acreage" to satisfy anticipated mitigation requirements. The largest property identified, Temescal Ranch (Castaic area) is now owned by MRCA and is not legally available for mitigation. Similarly, the lands identified as Tract 42537 are now largely owned by MRCA with complete acquisition anticipated by June 2026. As provided in MRCA's comment letter to the RPC on January 26, 2026, MRCA also owns the majority of land within Marple Canyon that was identified specifically for southwestern spiny rush mitigation, and it is not available for that purpose. The Applicant's options to find properties with the required acreages of specific habitat types are extremely limited and costly.

The MRCA points to the probable infeasibility of multiple required off-site mitigation land requirements that may be unobtainable because of a dearth of appropriate, now-privately-held habitat to work with. The current mitigation measures are further inadequate because there is no direction provided on either the Applicant's rights or the public's protection if the required quantity of habitat cannot be protected or restored. If the complete package of offsite mitigation cannot be provided because of a lack of suitable or obtainable offsite mitigation properties, then the Project must be commensurately downscaled to reduce impacts to specified impacted habitat types.

Climate Risks Will Stress Already Burdened County Resources

Since the Northlake Specific Plan was adopted in 1992, the Project site has been State-designated as Very High Fire Hazard Severity Zone, and there have been at least 111 recorded wildfires within seven (7) miles of the Project as shown on MRCA – Northlake Fire Recurrence Map. This wildfire count does not include small fire starts (generally an acre or less) along the I-5 Freeway that do not get archived. Despite the best intentions of structure hardening, fuel modification zones, pre-event evacuation routing for vehicles, and risk disclaimers to future residents, the Project adds approximately 11 miles of additional wildland-urban interface for County firefighters to protect. The 2025 Palisades and Eaton Fires showed some of the most well-resourced, quick-responding, and mutual aid-supported fire departments could be overmatched by wildfires supercharged by climate change conditions. In 2024, The Center for Climate Integrity released the "Los Angeles County Climate Cost Study"[9] that provides a list of the local governments facing the highest costs for climate adaptations through 2040 with the unincorporated Santa Clarita Valley costing County taxpayers an estimated $96,832,000. MRCA cautions the Board of Supervisors' approval of the Project given the current federal regime's antipathy towards matching funds for local climate change mitigation.

Partial Creek Avoidance Alternative Must be Reduced to Phase 1 Limits

If the Board of Supervisors acts to approve a version of the Northlake Project, that project should be limited to just the Phase 1 footprint in the PCAA. As proposed in the CEQA documentation, Phase 1 is a standalone project that does not need elements of Phase 2 to be feasible. The complete elimination of Phase 2's development footprint would retain minimum viable wildlife access to and from the critical I-5 Undercrossing No. 2. The elimination and deed restriction of all of Phase 2 is the only project footprint adjustment that can substantially reduce the biological impacts associated with the proposed development impeding wildlife access to and from I-5 Undercrossing No. 2. However, to ensure that wildlife access to the undercrossing is permanently protected, the County approval of Phase 1 must deed restrict development of the remainder of the property from immediately north of the Phase 1 boundary with recordation of that specific deed restriction being an irrevocable condition of map recordation. If the proposed water tank on County-owned land adjacent to Phase 2 is required for Phase 1, that relatively benign unlit, road-gated, unmanned landscape feature will still work for adequate wildlife movement through Undercrossing No. 2.

Please address any correspondence to me by email at chad.christensen@mrca.ca.gov, by phone at (310) 589-3230, ext. 121, or at the above letterhead address.

Sincerely,



Chad Christensen
Deputy Chief, Natural Resources and Planning

Attachments:
MRCA – References Cited Exhibit
MRCA – Northlake Fire Recurrence (1992-2025) Map
MRCA – Northlake Puma Observation Map

MRCA – References Cited Exhibit

1. Los Angeles County Regional Planning Commission Hearing 01/28/26. Unofficial Transcript. Excerpted Pages: 1, 6-7, and 55-56 of 61 PDF pages. Retrieved from: https://lacdrp.granicus.com/DocumentViewer.php?file=lacdrp_349fea00f6572ca8593b652587fb7bf6.pdf&view=1

2. Bomkamp, T. (2018, September 13). Indepenent Review of Biological Resources Assessment by BonTerra Psomas for the Northlake Final Supplemental EIR. Glenn Lukos Associates. Excerpted Pages: AR015999, AR016007, AR016046.

3. MRCA I-5 (Sierra Madre-Castaic) Wildlife Crossing Infrastructure Assessment & Implementation Plan – Prelim Data of Main Animal Categories: 2025-11-18 through 2026-01-01.

4. California Department of Fish & Wildlife. (n.d.) Region 5 Barrier ID: W321. I-5 *Sierra Madre to Castaic Ranges Barrier*. Retrieved from: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=229701

5. Toohey, G. (2026, January 21). *Baby mountain lion found with 'concerning' injuries in middle of L.A. County roadway*. Retrieved from Los Angeles Time: https://www.latimes.com/california/story/2026-01-21/injured-mountain-lion-cub-found-in-la-county-road

6. California Fish and Game Commission, February 20, 2026, News Release: California Fish and Game Commission Finds CESA Protections Warranted for Southern California and Central Coast Mountain Lion. Retrieved from: https://wildlife.ca.gov/News/Archive/california-fish-and-game-commissionfinds-cesa-protections-warranted-forsouthern-californiaandcentral-coastmountain-lion

7. County of Los Angeles, Department of Regional Planning. (2019, April 2). Findings of Fact and Statement of Overriding Conditions regarding the Northlake Specific Plan Project. *Findings and SOC.* Excerpted Pages: AR000230, AR000273, AR000274.

8. Blain, M. (2018, August 28). Feasibility Analysis of NorthLake Biological Mitigation Requirements. Psomas. Excerpted Pages: AR015235, AR015239.

9. The Center for Climate Integrity. (2024, April). Los Angeles County's Climate Cost Challenge: A $12.5 Billion Bill to Protect Communities Through 2040. *Los Angeles County Climate Cost Study.* Retrieved from: https://climateintegrity.org/projects/climate-costs-studies/los-angeles-county

11:47:33
>>
11:47:41
>>
11:48:02
>>
11:48:16
>> LA COUNTY REGIONAL PLANNING
11:48:31
>> JANUARY 28, 2026
11:48:37
>>
11:51:42
>>
11:58:32
>>IT IS JANUARY 28, WELCOME TO THE
12:00:38
REGIONAL PLANNING COMMISSION. WE WILL
12:00:38
START WITH THE LAND ACKNOWLEDGMENT. PAY
12:00:42
ATTENTION TO THE SCREEN ABOVE.
12:00:51
THE COUNTY OF LOS ANGELES RECOGNIZES
12:01:01
THAT WE OCCUPY LAND ORIGINALLY
12:01:03
INHABITED AND CARED FOR BY THE
12:01:05
TONGA, TATAVIAM, SERRANO, KIZH
12:01:7
AND CHUMASH PEOPLES. WE HONOR AND PAY
12:01:08
RESPECT TO THE OUR ELDERS AND
12:01:11
DEFENDANTS PAST PRESENT AND EMERGING AS
12:01:14
THEY CONTINUE THEIR STEWARDSHIP OF
12:01:18
THESE LANDS AND WATER WE ACKNOWLEDGE
12:01:22
THAT SETTLER COLONIZATION RESULTED IN
12:01:24
LAND SEIZURE DISEASE SUBJUGATION SLAVERY
12:01:31
 RELOCATION BROKEN PROMISE GENOCIDE AND
12:01:36
MULTIGENERATIONAL TRAUMA. THIS

12:06:25
CARRIES THANK YOU
12:06:25
>> WE WILL MOVE TO THE PUBLIC HEARING
12:06:25
SECRETARY PLEASE GIVE US A DECISION FOR
12:06:25
THE HEARING THIS MORNING
12:06:27
>> IF YOU ARE JOINING VIA ZOOM ON YOUR
12:06:30
COMPUTER OR MOBILE DEVICE AND WANT TO
12:06:34
PROVIDE COMMENT, STAFF WILL OBTAIN YOUR
12:06:34
INFORMATION THROUGH THE CHAT BOX
12:06:38
FEATURE. PLEASE PROVIDE STAFF WITH THE
12:06:40
AGENDA ITEM NUMBER YOUR FIRST NAME LAST
12:06:44
NAME AND EMAIL ADDRESS. IF YOU ARE
12:06:45
JOINING VIA TELEPHONE AND WANT TO
12:06:45
PROVIDE COMMENT ON THE ITEMS PLEASE
12:06:56
SEND AN EMAIL TO
12:06:56
COMMENT@PLANNING.LACOUNTY.GOV AND
12:06:56
PROVIDE THE AGENDA ITEM NUMBER YOUR
12:06:56
FIRST NAME LAST NAME EMAIL ADDRESS AND
12:07:00
PHONE NUMBER. ALL PARTICIPANT
12:07:01
MICROPHONES WILL BE MUTED UNLESS YOU
12:07:01
HAVE SIGNED UP TO PROVIDE COMMENT. IF
12:07:07
YOU HAVE SIGNED UP TO PROVIDE COMMENT
12:07:08
YOUR MICROPHONE WILL BE UNMUTED WHEN
12:07:08
IT'S TIME TO SPEAK AND I CALL YOUR NAME.
12:07:13
I WILL SWEAR IN THE MEMBERS OF THE

12:07:14
PUBLIC INCLUDING IN PERSON AND REMOTE
12:07:16
SPEAKERS REQUESTING TO [INDISCERNIBLE]
12:07:21
ON PUBLIC HEARING ITEMS. THOSE OF YOU
12:07:21
ADDRESSING PUBLIC HEARING ITEMS PLEASE
12:07:21
STAND AND RAISE YOUR RIGHT HAND. IN THE
12:07:33
TESTIMONY YOU MAY GIVE BEFORE THE
12:07:33
COMMISSION DO YOU SOLEMNLY SWEAR TO
12:07:33
TELL THE TRUTH THE WHOLE TRUTH AND
12:07:33
NOTHING BUT THE TRUTH SO HELP YOU GOD?
12:07:35
THANK YOU YOU MAY HAVE A SEAT
12:07:39
>> THANK YOU. WE WILL HEAR FROM STAFF
12:07:45
ON PROJECT 201500408 IN THE FIFTH
12:07:50
DISTRICT. STAFF YOU HAVE THE FLOOR
12:07:55
>> THANK YOU GOOD MORNING COMMISSIONERS
12:07:55
AND MR. CHAIR I AM JODY SENIOR PLANNER
12:07:58
WITH THE SUBDIVISION SECTION. TODAY'S
12:07:59
ITEM 7 IS NORTHLAKE PHASE I PROJECT.
12:08:07
THE ADOPTED NORTHLAKE SPECIFIC PLAN
12:08:10
AREA IS LOCATED EAST OF RIDGE ROOT ROAD
12:08:17
AND THE FREEWAY AND WEST OF
12:08:17
[INDISCERNIBLE] IN THE UNINCORPORATED
12:08:24
COMMUNITY OF [INDISCERNIBLE]. NORTHLAKE
12:08:25
PHASE I PROJECT ENTITLEMENT SHOWN IN
12:08:29
THIS MAP CONSISTS OF VESTING TENTATIVE

13:08:45
PATHWAYS THIS VERSION OF THE
13:08:45
ALTERNATIVE WOULD ALLOW FOR WILDLIFE
13:08:48
MOVEMENT. YOU CAN SEE IT CIRCLED IN
13:08:51
YELLOW, THAT IS THE CULVERT BOX CROSSING
13:08:59
MR. EDELMAN AND JOHN CHRISTIANSEN WERE
13:09:04
MENTIONING. YOU SEE IT IS OFF THE
13:09:04
PROPERTY YOU SEE THE DEVELOPMENT IS NO
13:09:07
WAY IMPEDING IT. AND THERE'S A 70 FOOT
13:09:11
GRADE DIFFERENCE. THIS SLIDE SHOWS THE
13:09:14
WILDLIFE MOVEMENT PATTERNS THAT WOULD
13:09:16
HAVE BEEN PROVIDED FOR WITH THE
13:09:21
PREVIOUSLY APPROVED PROJECT. AS YOU CAN
13:09:21
SEE THERE'S ONLY ONE CORRIDOR MOVEMENT
13:09:24
IN THE NORTH. VERSUS WITH A PARTIAL
13:09:29
CREEK AVOIDANCE ALTERNATIVE THERE ARE
13:09:34
NOW THREE PROVIDED FOR. I BELIEVE THAT
13:09:39
ADDRESSES ALL THE ISSUES.
13:09:39
>> THAT CONCLUDES YOUR? OKAY THANK YOU.
13:09:45
LET'S CLOSE THE PUBLIC COMMENT PERIOD.
13:09:52
THIS IS IN YOUR DISTRICT DISTRICT 5 I
13:09:52
WILL ASK YOU TO TAKE THE LEAD
13:09:55
>> BEFORE YOU GO, FOR ALL THE ACREAGE
13:09:57
YOU GUYS ARE BUILDING ON HERE, YOU SAID
13:10:00
YOUR CAMERAS NEVER PICKED UP ANY ANIMAL

13:10:05
MOVEMENT? NO WILDLIFE MOVEMENT. WE PUT
13:10:07
THE WILDLIFE CAMERAS WHERE ALL OF THE
13:10:10
CROSSINGS ARE ON THE PROPERTY. I THINK
13:10:14
IT WAS FOR THREE OR FOUR MONTHS, WE DID
13:10:18
NOT PICK UP ANY
13:10:18
>> YOU DID NOT PICK UP ANY, THAT'S
13:10:22
AMAZING
13:10:22
>> THE INTERESTING THING IS THE TWO
13:10:26
BOTTOM CROSSINGS THAT GO UNDER THE
13:10:30
FREEWAY, THEY DON'T FULLY GO UNDER THE
13:10:30
FREEWAY BECAUSE THAT'S WHERE FIVE
13:10:32
SPLITS. IF YOU GO UNDER IT THE ANIMALS
13:10:35
GET STUCK IN THE MIDDLE OF THE
13:10:42
FREEWAYS. THERE'S GOOD REASON FOR WHY
13:10:42
WE DID NOT CATCH ANYTHING THERE. THE
13:10:47
NORTHERN ONE....
13:10:52
>> THANK YOU. THE GAS LINE RUPTURE CAME
13:10:54
UP QUITE A BIT YET IT WAS ADDRESSED? I
13:10:59
HEAR IT WILL BE RELOCATED WITH THE NEW
13:10:59
GAS LINE WHICH WILL BE BUILT BETTER?
13:11:04
YOU WANT TO DO A QUICK RESPONSE TO THAT
13:11:04
PLEASE
13:11:07
>> I AM THE [INDISCERNIBLE] SECTION
13:11:10
HEAD. THERE WAS A GAS LEAK AFTER

GLENN LUKOS ASSOCIATES
Regulatory Services



September 13, 2018

Damon P. Mamalakis
Armbruster Goldsmith & Delvac LLP
12100 Wilshire Boulevard, Suite 1600
Los Angeles, California 90025

Subject: Independent Review of Biological Resources Assessment by BonTerra Psomas for the Northlake Final Supplemental EIR

I have conducted an independent peer review of the biological resources section for the Northlake Final Supplemental EIR (FSEIR) to determine whether the FSEIR accurately identifies significant impacts of the project on various biological resources and where impacts are determined to be significant, whether the proposed mitigation is sufficient to reduce identified significant impacts to less than significant.

In conducting the independent review, the following resources were evaluated in detail[1]:

- Draft Supplemental EIR (DSEIR) Project Description, Biological Resources Section, Supporting Biological Technical Report (DSEIR Appendix D), and related documents (e.g., appendices to Appendix D);
- FSEIR, including public comments from Blum Collins (Blum Collins), California Department of Fish and Wildlife (CDFW), California State Parks (CSP), Center for Biological Diversity (CBD), Santa Monica Mountains Conservancy (SMMC), and Shawn Smallwood (Smallwood) along with the associated responses to comments prepared by BonTerra Psomas (BonTerra); and
- Additional Biological Surveys conducted in support of the FSEIR including, Appendix B: Biological Resources Downstream Impacts Assessment; Appendix C: Mitigation Plans, Appendix D: Wildlife Crossing Assessment Memo;

[1] Additional documents were reviewed as well, including the First Errata to the NorthLake SEIR as well as BonTerra's responses to comments submitted to the Los Angeles County Regional Planning Commission.

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2018 by Mr. Ahrens and Ms. Stephanie Cashin, GLA Wildlife Biologist,with additional cameras deployed by Ms. Cashin on July 23, 2018. Data was collected on July 30 and September 4, 2018 with the cameras retrieved on September 4, 2018 for final data collection. Cameras were not installed at the paired undercrossings associated with Undercrossing 3 because it was determined that wildlife movement associated with this crossing would not be affected by the project as already noted above.

Results

Animals recorded by the camera stations, are summarized in Table 1. Large mammals detected include mule deer and coyote. Direct observations were also made of mule deer. Bobcats, gray fox, and coyote were also detected by tracks or other "sign" (e.g., scat). Mountain lions were not recorded at any of the Wildlife Camera Stations and were not otherwise detected (e.g., by sign). Other species as indicated in the last column of Table I include woodrat, screech owl, desert cottontail, raccoon, striped skunk, ground squirrel, red-tail hawk, barn owl, Virginia opossum, and Cooper's hawk. Humans and cows were also captured.

The results of the camera study, which did not detect mountain lions in Grasshopper Creek provide additional evidence that Grasshopper Creek is not an important north-south movement corridor for mountain lions as already reported by BonTerra in the SDEIR and in FSEIR Appendix D.

Table 1: Summary of Wildlife Detected at Camera Stations

Station	Mule Deer	Bobcat	Coyote	Mountain Lion	Other
1	--	--	X	--	X
2	--	--	--	--	--
3	X	--	X	--	X
4	--	--	X	--	X
5	--	--	--	--	--
6	X	--	X	--	X
7	X	--	X	--	X
8	--	--	--	--	--
9	--	--	X	--	X
10	--	--	X	--	X
11	--	--	--	--	X
12	--	--	X	--	X



Parcel Boundary

Wildlife Camera Location

NORTHLAKE SPECIFIC PLAN

Glenn Lukos Associates Wildlife Camera Access

GLENN LUKOS ASSOCIATES

AR016046

MRCA I-5 (Sierra Madre-Castaic) Wildlife Crossing Infrastructure Assessment & Implementation Plan Prelim Data of Main Animal Categories: 2025-11-18 through 2026-01-01													
Vicinity	**Camera Name**	**Bear**	**MtLion**	**Bobcat**	**Coyote**	**Grey Fox**	**Deer**	**Skunk**	**Raccoon**	**Opossum**	**Ground Squirrel**	**Road runner**	**Grand Total**
South of Project	1B			36	21	6							63
	1D				3				3				6
	1E				3								3
	2A			3					27			13	43
	2C								12				12
North Project Lake	3A								291				291
	3B				3								3
	3C			3					117				120
	3F			9	3				6				18
	4A			12	171								183
	4B			15	180						8		203
	5A			192	18								210
	5B			9	60				9				78
	5D				3				12				15
	5E			3	15				6				24
	6B								9	3			12
	7A		6		9			3	3				21
	7E		6			18		33					57
North of Project	8B					6							6
	8C		9	3	3	33		33	30				111
	8D			15	12				48				75
	8H		15			3		6	3		18		45
	11D							3			3		6
	12C	3			9								12
	12D	3		72	102	120		9	72				378
	13A					6	111						117
	13B				66	18			3				87
	13C					6							6
	15A												3
	11C			3		3		12					18
	12B			3		3			9				18
	15C			6	90				9				108
	H01					3		3	3				9
	Grand Total	**6**	**36**	**384**	**771**	**225**	**111**	**102**	**672**	**3**	**29**	**13**	**2361**

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News Releases, 2022-Present

California Fish and Game Commission Finds CESA Protections Warranted for Southern California and Central Coast Mountain Lion

February 20, 2026

In Other Regulatory Action, Commission Streamlines Charitable Donation of Sport-Caught Fish

The California Fish and Game Commission (Commission) at its Feb. 11-12 meeting voted to list mountain lion populations in parts of southern California and the central coast as a threatened species under the California Endangered Species Act (CESA).

In a unanimous vote, the Commission determined that listing a distinct population segment of mountain lions in southern California and the central coast is warranted due to threats such as habitat loss, habitat fragmentation and isolation of small populations as a result of expanding human infrastructure, among others. The Commission considered presentations from the California Department of Fish and Wildlife (CDFW) on its species status review and from the listing petitioner the Center for Biological Diversity, as well as public comment. The Commission will adopt its findings at a future meeting.

“This segment of the mountain lion population is clearly at risk from distinct threats,” said President Eric Sklar. “Habitat loss, habitat fragmentation by roads, freeways and housing, and mortality from vehicle strikes, rodenticides and risks of isolation and inbreeding would lead to the extinction of these mountain lions if we remained on the same trajectory.”

Following the 1974 ban on hunting mountain lions in California, in 1990 voters approved Proposition 117,

which designated mountain lion a specially protected mammal in the state and established some exemptions for lethal removal of mountain lions to preserve public safety and to protect private property and livestock. The Commission noted that those statutory provisions remain intact and that this listing is focused specifically on preventing the potential loss of the identified population segment through science-based management and conservation action.

Donation of Sport-Caught Fish

The Commission adopted regulatory amendments related to processing and donating sport-caught fish. Sport fishing license holders who exchange fish for processing will be able to donate their fish to charities directly through fish processors rather than having to deliver the fish themselves as presently allowed. The adopted amendments streamline the donation of sport-caught fish to nonprofit organizations, California Native American tribes, public schools within a California unified school district and California city or county government programs. The changes will provide sport fishing license holders the opportunity to support nonprofit, community, school and tribal initiatives addressing food insecurity, access and distribution.

Commission Elections, Committee Assignments and Meeting Participation

In its first meeting of 2026, Commissioner Eric Sklar was elected Commission president and Commissioner Darius Anderson vice president. The Commission moved to retain Marine Resources, Wildlife Resources and Tribal Committee co-

chair assignments — Sklar and Commissioner Samantha Murray will continue to serve on the Marine Resources
Committee, Anderson and Commissioner Erica Zavaleta on the Wildlife Resources Committee and Commissioner Jacque Hostler-Carmesin on the Tribal Committee.

Sklar, Zavaleta and Murray were in attendance for both days of the February Commission meeting held in Sacramento; Hostler-Carmesin and
Anderson were absent both meeting dates.

The complete agenda for the meeting, along with supporting information, is available on the Commission website. Archived video of past Commission meetings is available online. The next meeting of the Commission is scheduled for April 15-16, 2026, at the California Natural Resources Agency building in Sacramento. Participants are encouraged to attend in person, with options available for Zoom or phone; for more information visit the Commission website.

The Commission authorized public notice of upcoming potential regulation changes related to:

Central Valley and Klamath River Basin sport fishing regulations: A discussion hearing is scheduled for April 15-16 and an adoption hearing for May 6 on proposed amendments related to Central Valley and Klamath River Basin sport fishing regulations.

Media Contacts:
Krysten Kellum, CDFW Communications, (916) 825-7120
Jen Benedet, CDFW Communications, (916) 202-4465

Categories: FGC, Marine, Species, Wildlife

Tagged: mountain lion | sport-caught fish donation | California Fish and Game Commission | California Department of Fish and Wildlife

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Los Angeles Times

CALIFORNIA

Baby mountain lion found with ‘concerning’ injuries in middle of L.A. County roadway



A mountain lion cub was found injured on a roadway in the Castaic area early Wednesday. (RMG Media)



By Grace Toohey
Staff Writer | 𝕏 Follow

Jan. 21, 2026 **Updated** 10:47 PM PT

An injured mountain lion cub was captured by wildlife officials Wednesday after it was seen huddled in the middle of a roadway in the Castaic area, probably after being struck by a car, officials said.

The juvenile mountain lion was taken to a local veterinarian to be assessed, Cort Klopping, a spokesperson for the California Department of Fish and Wildlife, said Wednesday afternoon.

“You never want to see any animal, but especially a juvenile, injured,” Klopping said. “It’s certainly concerning … and we’re hoping for a good outcome on this.”

The cub was found sitting, motionless, in the middle of Hillcrest Parkway near Olympic Street in Castaic just before 1 a.m. Wednesday, according to April Elliott, a spokesperson for the California Highway Patrol, which first responded to the call about the animal.

The juvenile sat there for more than an hour as troopers waited for wildlife officials to arrive, with local broadcasters capturing gripping footage of the cub in the middle of the roadway.

The cub eventually got up and walked off on its own just after 2 a.m., Elliott said.

When wildlife officials arrived at the scene, they began searching for the injured cat, eventually finding it in some thick brush, Klopping said.

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The team was able to capture the cub to take it to be examined.

Tiffany Yap, urban wildlands science director at the nonprofit conservation organization the Center for Biological Diversity, called this incident the latest example of why the region's mountain lions deserve specific protections under the Endangered Species Act, something the state's Fish and Game Commission will consider next month.

"It's dangerous and frightening for mountain lions to navigate our roads and developments, especially for cubs like this one in Castaic," Yap wrote in a statement. "These wide-ranging animals need room to roam and they need their habitat connected. ... Mountain lions like this young kitten should get a proper chance to grow up and live healthy lives alongside us."

More to Read

Mountain lion sightings close Orange County park. Expert calls cat behavior 'super' unusual

Nov. 5, 2025



Two mountain lions that were found malnourished and alone as cubs are released back into the wild

Sept. 29, 2025



Mother of two mountain lion cubs struck and killed on State Route 74

Sept. 21, 2025



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Grace Toohey

Grace Toohey is a reporter at the Los Angeles Times covering breaking news for the Fast Break Desk. Before joining the newsroom in 2022, she covered criminal justice issues at the Orlando Sentinel and the Advocate in Baton Rouge. Toohey is a Maryland native and proud Terp.

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Region 5 Barrier ID: W231 (Barrier).

Barrier Name: I-5 Sierra Madre to Castaic Ranges.

Linear Infrastructure: I-5.

Geographic Area: Bisects the linkage of Sierra Madre to Castaic Ranges within Los Padres National Forest. Castaic Lake is to the east and Pyramid Lake is to the west. Runs from Santa Clarita to Caswell.

Length: 41.20 km (25.6 mi).

Target Species: Mountain lion (*Puma concolor*), deer (*Odocoileus hemionus*), black bear (*Ursus americanus*), striped skunk (*Mephitis mephitis*), spotted skunk (*Spilogale gracilis*), Virginia opossum (*Didelphis virginana*), raccoon (*Procyon lotor*), gray fox (*Urocyon cinereoargenteus*).

Connectivity Concerns: The I-5 through this segment is a major barrier to wildlife movement, and there are likely only two to four existing bridges (that also carry vehicles) in the entire study area that may be functioning, at some level, for wildlife movement. The Sierra Madre-Castaic linkage is vitally important for restoring gene flow to southern California mountain lion populations. This section of the I-5 is a roadkill hotspot with multiple mountain lions being hit and killed over the years. There are also some development projects in the works along this segment, so land acquisition is an important thing to consider.

Remediation Goals: Restore functional connectivity across I-5 between the Sierra Madre and Castaic Ranges to support: day-to-day movements of wildlife seeking food, shelter, or mates; juvenile dispersal; seasonal migration, healthy mixing of genes among populations, recolonizing unoccupied habitat after a local population goes extinct, and for species to shift their geographic range in response to global climate change. To accomplish this, we will need to find areas of highest usage/risk to wildlife. We aim to expand and enhance existing infrastructure such as culverts and creek bridges, add new under/over-crossings and wildlife exclusion fencing. Removing barriers to wildlife movement across I-5 would reconnect extensive protected lands and provide measurable benefits to a wide diversity of natural communities and numerous native species.



Figure: I-5 Sierra Madre to Castaic Ranges is a Region 5 wildlife connectivity barrier.

FINDINGS OF FACT and

STATEMENT of OVERRIDING CONSIDERATIONS

regarding the NORTHLAKE SPECIFIC PLAN PROJECT

PROJECT NUMBER: R2015-00408-(5)

VESTING TENTATIVE TRACT MAP: TR073336

CONDITIONAL USE PERMIT: CUP201500019

STATE CLEARINGHOUSE NUMBER: 2015031080

COUNTY OF LOS ANGELES DEPARTMENT OF REGIONAL PLANNING

320 WEST TEMPLE STREET

LOS ANGELES, CALIFORNIA 90012

Restoration Program be developed and approved by USACE, CDFW, and LACDRP prior to issuance of grading permits, and which will reduce impacts to a less than significant level.

Potential Impacts Regarding Wildlife Movement

The Project Site is utilized by resident and migratory wildlife for both movement and breeding of various degrees. On the Project Site, Grasshopper Canyon is undeveloped and is adjacent to open space in the Angeles National Forest and Castaic Lake SRA, both of which provide high-quality wildlife habitat. Historically, the Castaic Creek drainage adjacent to the Project Site may have been an important north-south linkage between the mountainous open space of the National Forest and resource rich riparian zones along the Santa Clara River. However, construction of Castaic Dam, Lake, Lagoon, SRA and its associated facilities along with residential development west of the Lagoon has essentially eliminated this linkage. Only local movement of species habituated to an urban landscape (e.g., coyote) are expected to navigate the extensive set of existing barriers. Regional movement along the east-west-aligned Transverse Range north of the site has also been restricted through the Project Site as a result of construction of I-5. As discussed in the Biological Technical Report appended to the Draft SEIR and the Independent Review of Biological Resources Assessment, results of regional landscape linkage studies identify the importance of this east-west connection. However, Castaic Lake and Lagoon to the east and I-5 to the west substantially reduce the Project Site's potential to provide significant east-west linkage value. Although Castaic Lake and Lagoon are sources of water, they are unpassable for nearly all but avian species and are difficult to access due to unvegetated and steep shorelines surrounding nearly all these water bodies other than the northern edge of Castaic Lake. West of the Project Site, a single underpass beneath I-5 could feasibly be utilized by a variety of wildlife as a safe crossing to and from either side of the highway. However, use of this undercrossing is expected to be minimal for a variety of factors. The location of the crossing is not associated with any notable natural landscape feature, which typically would concentrate movement such as a ridge line, water feature, or drainage. The location is associated with an unimproved road but the road travels across a slope providing vehicular access to transmission towers but offering little to no cover for

wildlife. In addition, the location is not associated with any corresponding crossing in the vicinity that allows wildlife to travel under the north bound lanes of the I-5. There are no ridge lines or drainages or similar features that typically convey concentrated movement to or from a crossing of the northbound lanes of I-5. In fact, the nearest under-crossings of the northbound lanes are located approximately one mile north and approximately two miles south of this crossing. As a result, potential undercrossing events of both the northbound lanes and the southbound lanes at this location are expected to be rare at best. A second crossing west of the southern tip of the Project includes both northbound and southbound lanes. However, the southbound crossing stretches over 700 feet within a narrow concrete-lined channel rendering it as low potential for use by most wildlife. Furthermore, the northern entrance extends upstream into the un-vegetated concrete lined-channel with adjacent developed land offering no cover for wildlife.

A third under-crossing of the southbound lanes is located immediately west of the northwestern portion of the site. Similar to the undercrossing to the south described above, this location is not associated with any notable natural landscape feature, which typically would concentrate movement such as a ridge line, water feature, or drainage. However, this location does have a corresponding undercrossing directly opposite under the northbound lanes, 1,600 feet to the west, which may render it more likely than others to be utilized on occasion. In addition, the east side of this crossing provides access to the northeast without significantly steep slopes rendering it more compatible to movement events.

Due to the constraints of the southern and eastern edges of the site, wildlife using these crossings are expected to move to and from the crossing and areas north of the Project Site to allow continued east-west movement. Under existing conditions, and as verified by a review of literature as well as recent wildlife surveys as described in the Draft SEIR and a recent camera study documented in the Independent Review of Biological Resources Assessment, these crossings do not represent an important component of the regional movement of the area. Therefore, Project implementation would result in adverse but less than significant impacts on regional wildlife movement.

Potential Impacts to Wildlife Nursery Sites

MEMORANDUM

August 28, 2018

To:
John Arvin
NorthLake

From:
Marc Blain

Subject: Feasibility Analysis of NorthLake Biological Mitigation Requirements

---

An analysis was conducted to confirm the feasibility of implementing NorthLake biological mitigation measures for the NorthLake Project. Specifically, requirements for preservation of existing vegetation or preservation with restoration of potentially suitable habitat for select wildlife species were reviewed and required amounts of mitigation by habitat type were calculated. Using a two-pronged approach, potential mitigation properties were identified and then evaluated using a GIS tool to rank potential mitigation parcels based on biological values relative to NorthLake mitigation needs. The results of this analysis, as discussed below, indicate that properties with the appropriate biological resources and of sufficient acreage are currently available or are in process towards becoming available within the region. Properties were considered to be "available" if they are currently listed for sale, if there are no recorded development plans for the sites, where information provided by sellers or brokers indicated that offers would be considered or potentially considered, where properties have other constraints to development such as USFWS designated Critical Habitat, and where the properties have not been used as mitigation for prior projects. As such, biological resources mitigation for the NorthLake Project is feasible.

The attached tables and maps include properties identified based on communication with sellers, brokers, mitigation bank managers, and/or other publicly available information, and the results of a preliminary analysis of on-site vegetation and soils. The purpose of the analysis was to identify available properties with native habitat that exhibit sufficient acreage to offset the potential loss of native habitats associated with Project development. Properties were identified by Psomas staff based on (1) staff's previous knowledge of properties; (2) inquiries with approved mitigation banks; (3) inquiries with entities such as the Trust for Public Lands, Mountains Recreation and Conservation Authority, and California Department of Fish and Wildlife; and (4) review of properties listed for sale (and thus assumed to be available). Potential properties were given priority based on size, proximity to the Project site, proximity to other preserved open space areas, and overall level of disturbance and quality of habitat. Aerial photos were reviewed for each site to determine the general type of habitat (e.g. scrub, riparian, grassland, etc.) as were soil maps to determine each site's suitability for establishment/translocation of special status plant species and seasonal pools for western spadefoot toad. In addition, estimated vegetation types and acreage was extracted from Cal Fire Regional Vegetation Maps.

Psomas' Ecologists and GIS Specialists then developed a searchable database, using existing ecological/geographic data (federal/State/local), to assess the suitability of identified properties as well as other potentially suitable parcels of undeveloped land in the Project region. For this purpose, undeveloped land was defined as parcels that were totally or nearly totally undeveloped.

TABLE 1
SUMMARY OF NORTHLAKE MITIGATION REQUIREMENTS and PARTIAL LIST OF MITIGATION OPPORTUNITIES

BIOLOGICAL RESOURCE	IMPACTS *	REQUIRED MITIGATION @ 2:1	APPROPRIATE HABITAT CURRENTLY OWNED BY NORTHLAKE: ON-SITE (WITHIN NORTHLAKE BOUNDARY) **	APPROPRIATE HABITAT CURRENTLY OWNED BY NORTHLAKE: OFF-SITE (OUTSIDE NORTHLAKE BOUNDARY) **	REQUIRED MITIGATION NOT CURRENTLY OWNED BY NORTHLAKE	PARTIAL LIST OF OFF-SITE MITIGATION PROPERTIES WITH APPROPRIATE HABITAT NOT OWNED BY NORTHLAKE: A	B	C	D	E	F	G	H	I	J	K	L	M	N	TOTAL OFF-SITE OPPORTUNITIES (A-N) (ACRES)	TOTAL OFF-SITE OPPORTUNITIES (A-N) (% of REQ'D)
VEGETATION TYPE (ACRES)																						
Sage Scrub	635	1269	330	189	751		324	1800	65	10	200	120	300	130	20	35				3004	400%
Native Grassland	24	48	1	3	45	250														250	560%
Annual Grassland	399	798	51	18	729	250	72	700		40	400									1462	201%
Riparian/Open Water Communities	13	27	1	1	24			500			10									510	2146%

PLANT SPECIES (INDIVIDUALS)	IMPACTS	REQUIRED MITIGATION @ 1:1																		TOTAL OFF-SITE OPPORTUNITIES (A-N) (INDIVIDUALS)	TOTAL OFF-SITE OPPORTUNITIES (A-N) (% OF REQ'D)
Round-leaved Filaree	39	39	100	170	0		1000	2000	300	200	1000	300	1000	300	100	100	100	100	100	No offsite property required	
Paniculate Tarplant	300	300	100	170	30		1000	2000	300	200	1000	300	1000	300	100	100	100	100	100	6600	22000%
Southwestern Spine Rush	300	300	100	170	30		1000	2000	300	200	1000	300	1000	300	100	100	100	100	100	6600	22000%
Slender & Club-haired Mariposa Lily	3000	3000	300	450	2250		3000	6000	1000	1000	3000	1000	3000	1000	300	300	300	300	300	20500	911%

JURISDICTIONAL WATER (ACRES)	IMPACTS *	REQUIRED MITIGATION @ 1:1					TOTAL OFF-SITE OPPORTUNITIES (A-N) (ACRES)	TOTAL OFF-SITE OPPORTUNITIES (A-N) (% OF REQ'D)
Waters of the United States	11	11	0	0	11	26	26	246%

WILDLIFE (INDIVIDUALS)	IMPACTS	REQUIRED MITIGATION				TOTAL OFF-SITE OPPORTUNITIES (A-N) (INDIVIDUALS)	TOTAL OFF-SITE OPPORTUNITIES (A-N) (% OF REQ'D)
Burrowing Owl ***	2	13	25	55	0	No offsite property required	
Coastal California Gnatcatcher	2	2	0	0	2	Will be part of Sage Scrub acreage listed above	
Western Spadefoot Toad	0.5	0.5	2	4	0	No offsite property required	

PARTIAL LIST OF OFF-SITE MITIGATION PROPERTIES WITH APPROPRIATE HABITAT NOT OWNED BY NORTHLAKE

A - Peterson Ranch Mitigation Bank
B - Gilmore Ranch Property Val Verde
C - Temescal Ranch Property, Castaic
D - Castaic APN 3247-010-011
E - Val Verde APN 3247-032-031
F - Santa Clarita San Martinez Grande Canyon Road
G - Acton APN 3217-005-018
H - Lannan Ranch Agua Dulce
I - Tract 42537
J - Castaic APN 3247-010-056
K - Castaic APNs 3247-039-007/3247-039-008
L - Templin Highway Undercrossing APN 3247-008-003
M - Templin Highway Undercrossing APN 3247-005-035
N - Templin Highway Undercrossing APN 3247-009-004

Note: The above properties are either: 1) currently part of an established mitigation bank, 2) currently for sale, or 3) have been known to be for sale on the open market.

Footnotes:

* Acreage numbers includes Permanent and Temporary Impact Areas.

** Acreage numbers includes Non-impacted and Temporary Impact Areas.

*** Burrowing Owl mitigation shown hereon is a conservative estimate. As stated in the SEIR, the actual mitigation amount will be determined by field surveys conducted prior to construction.



Los Angeles County's Climate Cost Challenge

A $12.5 Billion Bill to Protect Communities Through 2040

CENTER FOR CLIMATE INTEGRITY

The Center for Climate Integrity

April 2024

Los Angeles County's Climate Cost Challenge

A $12.5 Billion Bill to Protect Communities Through 2040

CENTER FOR CLIMATE INTEGRITY

The Center for Climate Integrity empowers communities and elected officials with the knowledge and tools they need to hold oil and gas corporations accountable for the massive costs of climate change.
climateintegrity.org

RESILIENT

Resilient Analytics helps organizations and communities protect against the impacts of climate change. With a proven climate, engineering, and economic model, Resilient Analytics helps clients understand how climate stressors will impact infrastructure and people.
resilient-analytics.com

This study and the data it produced are available at climateintegrity.org/la-county-costs.

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Cost to Protect Infrastructure from Sea Level Rise
$576 Million 19

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$1.1 Billion 20

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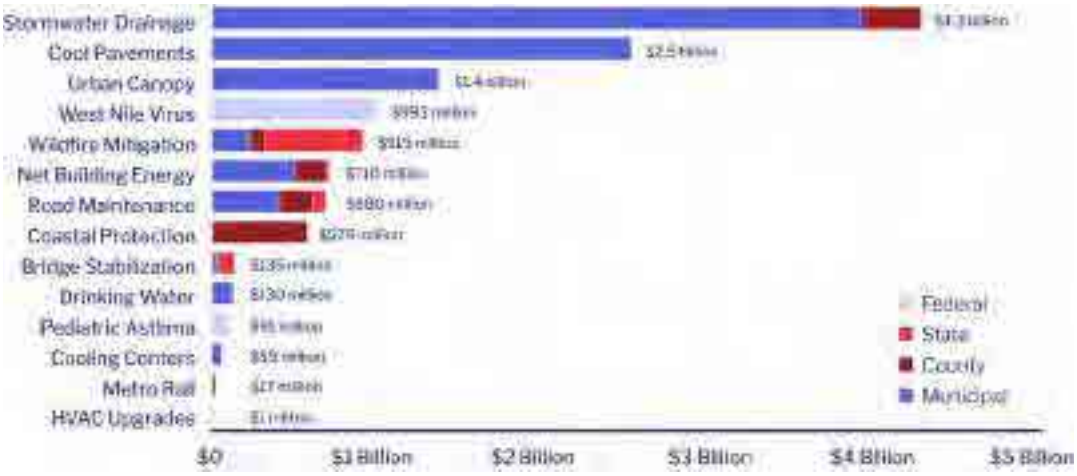
Executive Summary

Within the first two months of 2024, the City of Los Angeles had already exceeded its average annual rainfall, receiving nearly 15 inches of rain in back-to-back deluges.[1] The storms flooded roads, brought massive wind gusts, ripped down trees, and killed nine people.[2] The year prior was the hottest year ever recorded, including unseasonably hot weather into the fall months in Southern California. In October 2023, a wildfire ripped through rural lands southeast of the City of Los Angeles, destroying multiple buildings and forcing approximately 4,000 people to evacuate.[3]

With climate-driven disasters in Southern California growing more intense every year, it's more important than ever for communities to invest in a growing range of climate adaptation and resilience projects. This study is the first-ever attempt to calculate the costs of preparing for and adapting to 14 different climate impacts on municipal, county, state, and federal governments in Los Angeles County.

We estimate municipal, county, state, and federal governments will need to spend at least $12.5 billion through 2040, over $9 billion of which will be incurred by municipal governments. The total cost equates to approximately $780 million per year to protect communities in Los Angeles County from extreme heat, changing precipitation, wildfires, rising sea levels, and climate-induced public health threats.

Figure 1: Total cost for each adaptation strategy from 2024 through 2040.



1 Kathryn Prociv, "Soaked California Faces Another Day of Flood Watches as Los Angeles Already Hits Yearly Rainfall Average," *NBC News*, February 21, 2024, https://www.nbcnews.com/news/weather/soaked-california-faces-another-day-flood-watches-los-angeles-already-rcna139745.

2 Grace Toohey, "9 People Killed in California's Massive Storm: Here's How They Died," *Los Angeles Times*, February 8, 2024, sec. California, https://www.latimes.com/california/story/2024-02-07/californias-storm-claimed-nine-lives-heres-what-we-know.

3 Dani Anguiano, "California Wildfire Threatens 1,300 Homes South-East of Los Angeles," *The Guardian*, October 31, 2023, https://www.theguardian.com/us-news/2023/oct/31/california-wildfire-evacuation-santa-ana-winds.

We calculate taxpayers in Los Angeles County will face the following climate adaptation costs through 2040:

- **$4.3 billion** to improve stormwater management to mitigate flooding
- **$2.5 billion** to invest in cool pavements to combat heat
- **$1.4 billion** to plant and maintain trees to combat urban heat islands
- **$1.1 billion** to respond to an increase of childhood asthma and West Nile Virus cases
- **$919 million** to mitigate wildfire damage
- **$710 million** to heat and cool public buildings in response to changing temperatures
- **$680 million** to increasing road maintenance because of heavy rain and heat stress
- **$576 million** to build coastal defenses to protect infrastructure from rising seas
- **$135 million** to reinforce bridges against anticipated climate wear and tear
- **$130 million** to treat drinking water during increased droughts
- **$59 million** to expand and operate cooling centers
- **$17 million** to make metro rail tracks resilient to increasing temperatures
- **$1 million** to upgrade air conditioning in public buildings

Across the country, local governments are paying for the vast majority of climate adaptation and resilience measures. Taxpayers in Los Angeles are no exception, and as climate impacts grow more destructive, the need for these adaptive measures will only become more acute. While local leaders could seek additional financial support from the federal government, there is no source of federal funds for adaptation at this scale — and the funding that is available is still coming from taxpayers.

How to Interpret These Costs

Where possible, this report delegates the costs of climate adaptations to each local government type that would be responsible for paying for the costs depending on ownership of structures, land, and/or services. In cases where it is not clear how governments divide responsibility, costs have been assigned to the municipality where the adaptations are being made, or based on the entity that owns the infrastructure in question — for example stormwater infrastructure improvements are assigned to the municipality the infrastructure is in, while the state is assigned costs for a state-owned highway.

For a full explanation of how costs are assigned for each climate adaptation, see Table A2 in Appendix A.2.

Meanwhile, the major oil and gas companies that knew their products would lead to catastrophic climate change, and then deceived the public and policy-makers about it for decades, pay nothing.[4] A more just alternative would be to make the polluters most responsible for the climate crisis pay their fair share of the climate adaptation and resilience costs facing Los Angeles County communities. We are in a climate crisis because Big Oil companies lied about their products for decades; it's only right that they pay their share for the costs they have imposed on communities.

Dozens of states and communities, including the State of California and eight California municipalities, have filed lawsuits to recover the costs of climate damages from major oil companies, following the same legal framework as landmark tobacco and opioid lawsuits.[5] Each and every community in Los Angeles County should consider bringing similar legal actions to hold climate polluters accountable and ensure that taxpayers aren't left to pay the bill alone.

How We Calculated These Costs

These findings are based on a moderate climate scenario (Shared Socioeconomic Pathway 2 - 4.5 [SSP2-4.5]) and do not account for the costs of recovering from any climate-driven disasters that will almost certainly occur, creating additional damages. This study is confined to costs created by only 14 out of many climate impacts (see Appendix Table A3) that communities will ultimately face (Figure 1). The costs are calculated in 2023 dollars, use generally accepted standard engineering protocols, and assume that governments will make less expensive proactive adaptation repairs as opposed to potentially more expensive reactive repairs. This report uses publicly available data to determine which local governments will be responsible for paying for the evaluated climate costs. Local governments, in turn, will ultimately be responsible for deciding whether or not to implement the adaptations necessary to protect their constituents from worsening climate change. Failing to spend these dollars will almost certainly result in much larger costs in the future, both to recover from preventable climate damages, and to implement more costly adaptive measures down the road. Finally, these calculations are limited to the cost of adapting to these climate impacts, not reversing them.



Wildfire smoke obscures Los Angeles skyscrapers: September 12, 2020.

4 René Marsh, "Big Oil Has Engaged in a Long-Running Climate Disinformation Campaign While Raking in Record Profits, Lawmakers Find | CNN Politics," *CNN*, December 9, 2022, https://www.cnn.com/2022/12/09/politics/big-oil-disinformation-record-profits-climate/index.html.

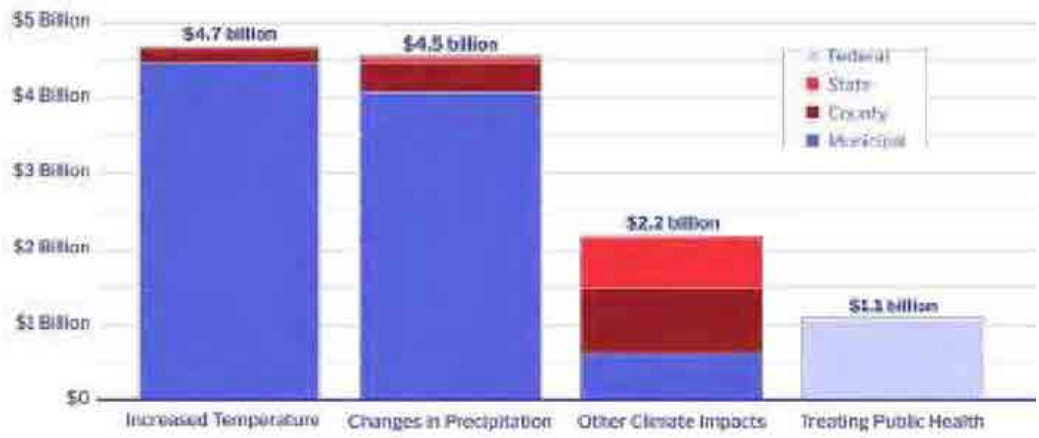
5 Center for Climate Integrity, Cases, accessed March 14, 2024, https://climateintegrity.org/cases.

Key Findings

Combating floods from increased precipitation and more severe storms is the most expensive climate cost we identified facing communities in Los Angeles County. Investing in stormwater drainage infrastructure such as porous pavement, bioswales, and bioinfiltration — the least expensive stormwater infrastructure — to manage increased precipitation will cost communities in Los Angeles County $4.3 billion from 2024 through 2040. That is equivalent to about $252 million per year, or approximately 14% of the county's Water Resources budget for Fiscal Year 2023 (Appendix G.2).[6]

The second most expensive climate adaptation measure identified is the cost to address urban heat islands — areas where heat is intensified because of the near total absence of trees or green space, allowing buildings and roads to absorb, intensify, and radiate the sun's heat, making these areas up to 20°F hotter than surrounding, less urbanized areas.[7] To help counteract rising temperatures, it will cost $2.5 billion to install cool pavements — pavement that doesn't absorb as much heat — in public parking lots and $1.4 billion to plant and maintain urban trees across the county from 2024 through 2040. The yearly average cost of installing cool pavements across the Los Angeles County area would be about $149 million, equivalent to 16% of the county's 2023 transportation budget (Appendix G.2).[8]

Figure 2: The total costs local governments in Los Angeles County face through 2040 to protect communities from the worsening impacts of climate change.[9]



6 LA County, "LA County Open Budget Appropriation (Auditor-Controller)," January 3, 2024, https://data.lacounty.gov/datasets/lacounty::la-county-open-budget-appropriation-auditor-controller/explore.

7 Anna Tzavali et al., "Urban Heat Island Intensity: A Literature Review," *Fresenius Environmental Bulletin* 24, no. 12b (2015): 4537–54, https://www.researchgate.net/publication/298083233_Urban_heat_island_intensity_A_literature_review.

8 LA County, "LA County Open Budget Appropriation (Auditor-Controller)."

9 The increased temperature adaptations are installing cool pavements, increasing urban canopy, net building energy usage, protecting residents during heatwaves, applying reflective coating to metro rail tracks, and upgrading HVAC capacity. The changes in precipitation adaptations are increasing stormwater drainage capacity, bridge stabilization, and increased drinking water treatment. The other climate impact adaptations are wildfire mitigation, proactive road maintenance, and protecting infrastructure from sea level rise. Treating public health includes pediatric asthma and West Nile Virus treatment.

Table 1: Local governments facing the highest costs for 10 municipal climate adaptations from 2024 through 2040.

Rank	Municipality	Total Cost	Municipal Cost	County Cost	State Cost	Federal Cost
1	Los Angeles	$3,753,831,000	$3,656,890,000	$66,433,000	$30,482,000	$26,000
2	Antelope Valley	$538,925,000	N/A* *unincorporated	$226,995,000	$308,443,000	$3,487,000
3	Long Beach	$507,080,000	$505,544,000	$204,000	$1,332,000	N/A* *no wildfires
4	Santa Clarita	$340,237,000	$313,518,000	$2,700,000	$23,969,000	$50,000
5	Santa Clarita Valley	$271,629,000	N/A* *unincorporated	$96,832,000	$173,691,000	$1,106,000

Climate impacts present enormous and difficult choices for communities. With finite resources and growing budget demands, investing in climate resilience may mean not spending on other services such as firefighting, police, schools, senior centers, libraries, sanitation, and more. Faced with these trade offs, communities often delay or fail to implement climate adaptation initiatives until after a major disaster, if even then. This invariably costs taxpayers more in the end.[10]

As an example, we examined proactive road maintenance versus reactive repairs. We found that Los Angeles County communities are not only more likely to repair roads after they are damaged rather than upgrade them beforehand, but that this will cost at least $340 million more than proactive road repairs through 2040. In addition, climate adaptation projects in unincorporated areas of Los Angeles County — home to about one million residents — will fall on the responsibility of the county and stress the county budget, as the unincorporated areas do not have municipal governments.[11] The cost of climate adaptations in the unincorporated areas of the county is estimated at about $86 million per year, or about 60% of Los Angeles County's 2023 Municipal Services budget, which is the budget used for services in unincorporated areas of Los Angeles County.

Figure 3: The total cost of implementing 10 municipal climate adaptations through 2040. The costs are concentrated in high-population urban cities and large unincorporated areas.



10 The costs associated with protecting infrastructure from rising sea levels, applying reflective coating to metro rail tracks, treating pediatric asthma, and treating West Nile Virus are unable to be assigned to municipalities (Appendix A.2).

11 Public Works Los Angeles County, "Municipal Services," LA County Public Works, 2024, https://content.pw.lacounty.gov/core-service-areas/municipal-services/.

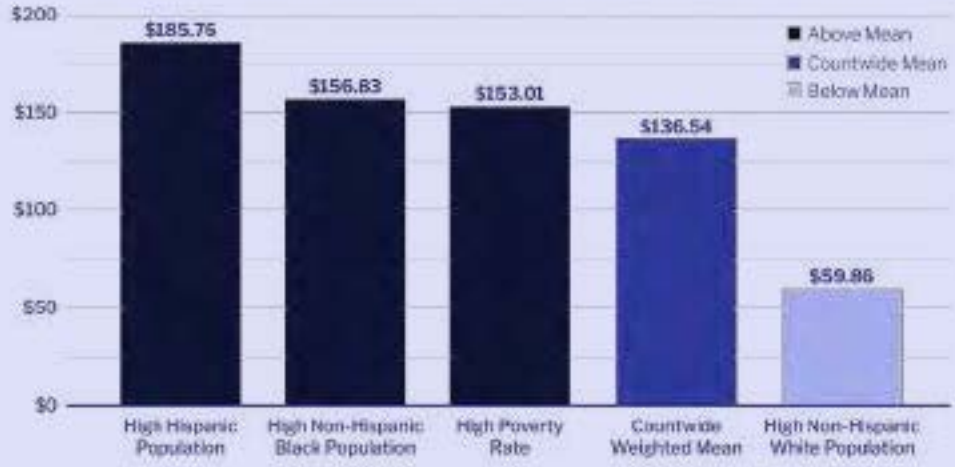
Finally, while there is no community that can escape the impacts of climate change, the burden of the climate crisis does not fall equally on Los Angeles municipalities. Of all 162 municipalities in this study, the City of Los Angeles faces the highest climate adaptation costs. The city is also very diverse and has significant wealth disparity[12] across various racial and ethnic groups, meaning the costs for climate adaptation will be felt differently throughout the city (see Appendix A.4 for more information).

The burden of life-threatening heat does not fall equally across Los Angeles County communities.

Lower income and higher diversity communities disproportionately lack green spaces that can cool urban environments, meaning these same populations will face the highest per capita costs to combat worsening heat islands. Our analysis confirmed that the costs of adapting to climate impacts, particularly heat, are greatest in communities of color and those with lower income. The per capita costs of heat adaptation and cooling measures in census tracts with high non-Hispanic Black and Hispanic populations is nearly three times higher than those with higher than average white populations.

Statistics of demographic characteristics in Los Angeles County come from the 2020 American Community Survey 5-Year Data (ACS-5) compiled by the U.S. Census Bureau (Appendix G.1). We use the demographic terminology reported in the ACS-5 throughout this report.

Figure 4: The cost to increase urban canopy is disproportionately higher in areas of the county with higher Hispanic (3.1 times higher compared to high white areas) and non-Hispanic Black (2.6 times higher compared to high white areas) populations, as well as communities with higher rates of poverty (2.6 times higher compared to high white areas).



12 "The Color of Wealth in Los Angeles," *The Samuel DuBois Cook Center on Social Equity at Duke University* (blog), March 16, 2016, https://socialequity.duke.edu/portfolio-item/the-color-of-wealth-in-los-angeles/.

Cost to Adapt to Hotter Temperatures $4.7 Billion

As the climate crisis continues to escalate, Los Angeles County's traditionally moderate climate will get much hotter. The region is expected to experience an average of 48.5 days above 90°F per year during the study period (2024 through 2040), or about 12.5 more hot days per year than communities experienced from 1994 to 2013. The increase in days above 90°F will vary significantly across the county, leaving some communities with many more extreme heat days than others.

To combat the dangers of this rising heat risk, communities in Los Angeles County can invest in installing cool pavements, expanding urban green space, painting metro rail tracks with reflective paint to keep them at an operable temperature, and upgrading cooling systems for public buildings like schools. (See Appendix A.3 for a more comprehensive list of adaptations).

Converting public parking lots to cool pavements that reflect instead of absorb sunlight, thus lowering the proximal temperature and reducing heat islands, is an effective and simple way to moderate the urban heat island effect. It is also the highest temperature-related cost facing communities in the county at $2.5 billion through 2040. Per year, cool pavements will cost an average of about $149 million to implement throughout the Los Angeles County region, or the equivalent of 16% of the county's 2023 transportation budget. In the City of Long Beach, the cost to install cool pavement is about $9 million annually, which is 55% of what the city budgeted annually for their 5-year Climate Adaptation and Action Plan ($16 million).[13]



City of Los Angeles during a record-breaking heatwave: September 7, 2022.

13 The City of Long Beach, "Innovation & Efficiency," 2023, https://longbeach.gov/globalassets/finance/media-library/documents/city-budget-and-finances/budget/budget-documents/fy-24-proposed-budget/fy-24-innovation-and-efficiency?_gl=1*10yobop*_ga*MTM2MjAxOTc0MS4xNzA5MTU1OTQ2*_ga_DH0765KYTY*MTcwOTE1NTk0Ni4xLjEuMTcwOTE1NjEyOC41My4wLjA.

Cool pavements are a complementary investment to tree planting — another proven way to reduce dangerous urban heat islands — which is the second largest temperature adaptation cost facing the Los Angeles County area. Notably, tree planting requires additional water usage for maintenance.

Figure 5: Percent of the total temperature cost for each of five[14] temperature-related adaptation strategies.

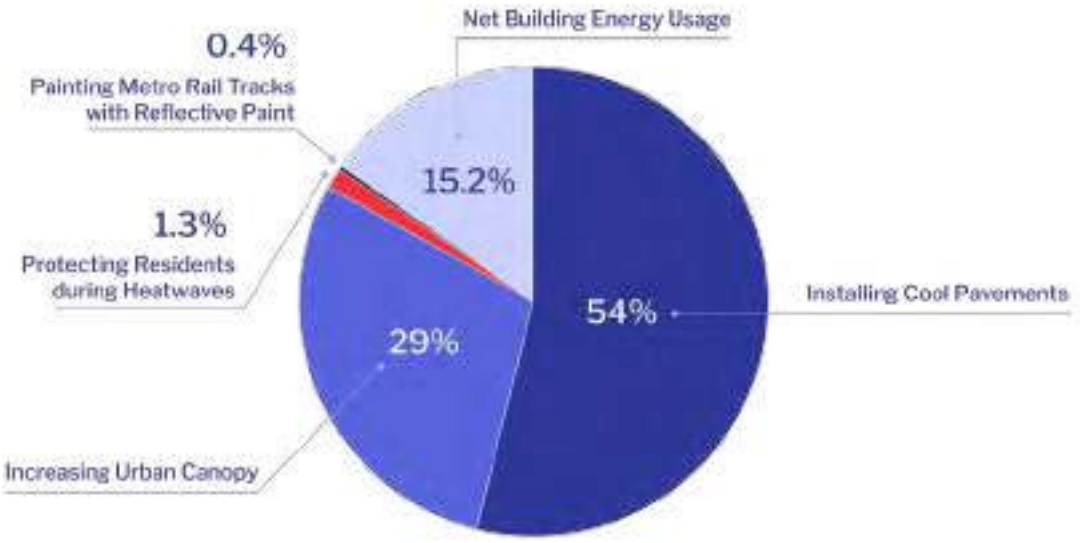


Table 2: Local governments facing highest costs from five temperature-related climate impacts[15] through 2040. County and state costs are incurred for net building energy costs and upgrading air conditioning capacity.

Rank	Municipality	Total Cost	Municipal Cost	County Cost	State Cost
1	Los Angeles	$1,469,324,000	$1,394,112,000	$66,433,000	$8,779,000
2	Long Beach	$242,676,000	$241,965,000	$204,000	$507,000
3	Lancaster	$197,197,000	$182,006,000	$7,804,000	$7,387,000
4	Carson	$149,278,000	$149,070,000	$19,000	$189,000
5	Palmdale	$135,301,000	$135,243,000	$58,000	N/A

14 Upgrading air conditioning capacity, the sixth temperature adaptation cost, will cost around $1 million, which is equivalent to 0% of the total cost. As such, it is not illustrated in the pie chart.

15 The county is responsible for making metro rail tracks more resilient to increased temperature through application of reflective paint. As such, this cost is not reflected in this table.

The inequitable impact of climate change is apparent when it comes to the costs of combating urban heat islands across Los Angeles County. Heat islands are typically more prevalent in low income areas with higher than average populations of non-Hispanic Black and Hispanic residents[16] that have historically received less investments in green space. Because of this deficit, these areas of the county will require greater investment costs to combat the rising risk of heat. While the average per capita tree planting cost for the county is $136.54, high Hispanic and high non-Hispanic Black areas of the county face $185.76 and $156.83 per capita planting costs, respectively. Areas of the county with a higher than average non-Hispanic white population[17] face $59.86 per capita to plant trees through 2040. It will cost the City of Los Angeles about $28 million per year to increase green space by planting and maintaining trees, which is equal to the city's entire Street Tree and Parkway Maintenance Appropriated Budget for 2024.[18]

Figure 6: Per capita costs to combat urban heat islands through planting and maintaining urban trees (increasing urban canopy) across Los Angeles County (left). Areas with high poverty rate (above 13.9%) across Los Angeles County correspond to areas with higher per capita urban canopy costs (right).



16 Municipalities that are high non-Hispanic Black have more than 7.9% non-Hispanic Black populations and municipalities that are high Hispanic have more than 48% Hispanic populations.

17 Municipalities that have above average non-Hispanic white populations have more than 32.5% non-Hispanic white populations.

18 City of Los Angeles, "LA City Open Budget: Bureau of Street Services," 2024, https://openbudget.lacity.org/#!/year/2024/operating/0/department_name/Bureau+of+Street+Services/0/program_name.

Cost to Adapt to Changes in Precipitation $4.5 Billion

Studies show that climate change will increase the number of severe storms and extreme wet years,[19] creating bouts of significant rainfall that will increase flood risk in Los Angeles County.[20] This shift can already be observed: a series of major storms hit Los Angeles County in the winter of 2023-24, flooding streets, creating life-threatening conditions, and revealing how the region's stormwater system is unprepared for the increasing threat of precipitation.[21] Expanding stormwater drainage capacity to manage this increase in rainfall is the most expensive climate adaptation cost analyzed by this report facing the Los Angeles County area. To mitigate the impacts of climate-driven rainfall, communities in Los Angeles County will face $4.3 billion to expand stormwater drainage infrastructure, like installing bioswales and porous pavement, through 2040. These 'green infrastructure' upgrades are the least expensive option to cope with increasing extreme rainfall events, and easier to implement in urban areas where increasing the size and scale of hard infrastructure like drain pipes is far more expensive and unwieldy. Investing in green infrastructure represents 94% of the total precipitation-related costs calculated by this report.

Water Treatment

While Los Angeles County can expect an increase in heavy rainfall, a changing climate will also contribute to an increase in drought conditions. Times of drought lead to an increase in sediment and nutrient concentration in drinking water, which causes additional drought-induced water treatment costs. Los Angeles County will experience an annual average of 1.4 more months of climate-induced drought from 2024 through 2040 compared to the baseline period of 1965 through 2014. If residents are restricted to 80 gallons of water per day per person, as they are encouraged to during times of drought,[21] it will cost Los Angeles County about $130 million more to treat residential water from 2024 through 2040. However, if Los Angeles County residents do not cut water use and continue to use their average of 120 gallons per person per day[22] during times of drought, it will cost the region $176 million more to treat the water over the next 17 years.

19 Lu Dong et al., "Contributions of Extreme and Non-Extreme Precipitation to California Precipitation Seasonality Changes Under Warming," *Geophysical Research Letters* 46, no. 22 (2019): 13470–78, https://doi.org/10.1029/2019GL084225.

20 Alex Hall et al., "California's Fourth Climate Change Assessment: Los Angeles Region Report," University of California, Los Angeles, 2019, https://www.energy.ca.gov/sites/default/files/2019-11/Statewide_Reports-SUM-CCCA4-2018-013_Statewide_Summary_Report_ADA.pdf.

21 Andrew Freedman, "Deadly Storm Pummeling California Dumps Historic Rains over LA," *Axios*, February 7, 2024, https://www.axios.com/2024/02/05/california-storm-floods-los-angeles.

22 Hayley Smith and Ian James, "To Survive Drought, Parts of SoCal Must Cut Water Use by 35%. The New Limit: 80 Gallons a Day," *Los Angeles Times*, April 30, 2022, sec. California, https://www.latimes.com/california/story/2022-04-30/can-you-get-by-on-just-80-gallons-of-water-a-day.

23 "Our County Water Briefing," 2018, https://ourcountyla.lacounty.gov/wp-content/uploads/2018/08/Our-County-Water-Briefing_For-Web.pdf.

Table 3: Local governments facing highest costs from three precipitation-related climate impacts through 2040.

Rank	Municipality	Total Cost	Municipal Cost	County Cost	State Cost
1	Los Angeles	$2,048,702,000	$2,048,702,000	N/A	N/A
2	Long Beach	$250,566,000	$250,566,000	N/A	N/A
3	Santa Clarita	$141,432,000	$122,268,000	$1,640,000	$17,524,000
4	El Monte	$91,147,000	$91,147,000	N/A	N/A
5	Lakewood	$84,280,000	$84,280,000	N/A	N/A

On average, mitigating the impact of increased rainfall by increasing stormwater drainage capacity will cost the region about $252 million per year from 2024 through 2040. Some municipalities could be especially hard hit. In Santa Clarita, it will cost about $6 million per year to mitigate the rising flood risk by increasing stormwater drainage capacity, equivalent to 121% of the city's Stormwater Utility budget for 2023-2024."[24] In the City of Los Angeles, the annual cost of about $118 million is nearly four times the city's Capital Improvements - Flood Control budget for 2024.[25] The per capita costs are also expected to be higher for communities that have greater non-white populations compared to areas of the county with predominantly white populations.[26]

Figure 7: The per capita cost for each municipality across Los Angeles County to increase stormwater drainage capacity from 2024 through 2040. The largest per capita costs will be incurred by residents in urban areas with large amounts of impervious surfaces (left). Areas with low non-Hispanic white populations (below 32.5%) across Los Angeles County correspond to areas with higher per capita costs to increase stormwater drainage capacity (right).



24 City of Santa Clarita, "Annual Operating Budget & Capital Improvement Program: FY2023-2024," 2023, https://filecenter.santa-clarita.com/cmo/FY%202023-24%20Budget%20-%20opt.pdf.

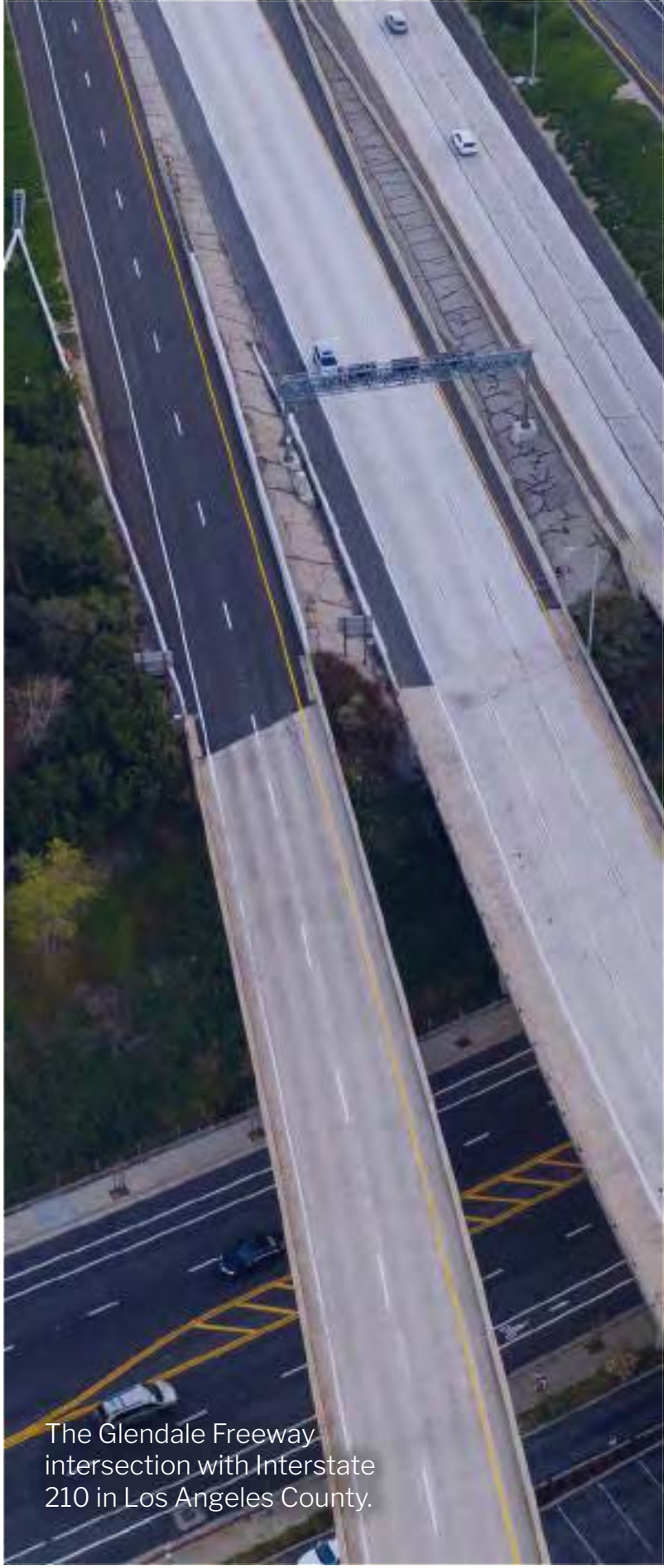
25 City of Los Angeles, "LA City Open Budget: Capital Improvements - Flood Control," 2024, https://openbudget.lacity.org/#!/year/2024/operating/0/program_name/Capital+Improvements+-+Flood+Control/0/department_name?vis=barChart.

26 Predominantly white areas are areas with ≥32.5% non-Hispanic white population (see Appendix G.1; Table G4).

Cost to Proactively Maintain Roads $680 Million

Climate change is brutal on roads. Higher temperatures soften road surfaces and increase degradation rates, making roadways cracked and rutted. Higher precipitation increases erosion, which weakens the road base and creates more maintenance demands in order to keep the infrastructure functioning as designed. Southern California will experience both from now through 2040. Even if regional governments take the less expensive, proactive approach to maintain the current service level of roads across the county, governments still face $680 million in climate-related adaptations for roads in the Los Angeles County area through 2040. Like the other analyses in this report, this cost only covers adapting to climate-impacts on roads and does not include costs that may be associated with additional unexpected climate disasters.

The City of Los Angeles faces the highest costs of proactive road investments at $164 million through 2040. It will cost the city $10 million per year to proactively maintain its municipal roads, which is comparable to 8.5% of the City of Los Angeles' 2024 $112 million budget for pavement preservation.[27]



The Glendale Freeway intersection with Interstate 210 in Los Angeles County.

27 City of Los Angeles, "LA City Open Budget: Pavement Preservation," 2024, https://openbudget.lacity.org/#!/year/2024/operating/0/department_name/Bureau+of+Street+Services/0/program_name/Pavement+Preservation/0/source_fund_name.

Table 4: Top five municipalities with the greatest difference in total reactive vs. proactive road maintenance costs from 2024 through 2040.

Municipality	Reactive Cost	Proactive Cost	Difference in Cost	Percent Increase
Los Angeles	$356,012,000	$185,842,000	$170,170,000	92%
Glendale	$33,329,000	$21,233,000	$12,096,000	57%
Santa Clarita	$44,632,000	$33,614,000	$11,018,000	33%
Downey	$13,428,000	$4,633,000	$8,795,000	190%
Torrance	$17,248,000	$9,713,000	$7,535,000	78%



Freeway overpasses in Los Angeles County.

Cost to Mitigate Wildfires $919 Million

Los Angeles County will face an average of 36 more high fire days[28] through 2040 and up to 58 more high fire days in certain areas like West Los Angeles under a moderate climate change scenario, as compared to a baseline of high fire days from 1994 to 2013. Wildfires regularly wreak havoc on the county. The Woolsey Fire in 2018 burned nearly 100,000 acres, destroyed more than 1,000 residential and commercial buildings, and killed three people, not to mention the additional health damages that result from wildfire smoke.[29] It's estimated the Woolsey Fire cost between $3 to $5 billion in insured losses alone.[30] In the past two years, two major insurance companies have stopped writing home and business insurance policies in California, citing increasing wildfire risk and the massive cost recovery associated with it.[31]

Wildfire mitigation through mechanical intervention, or clearing fuel from land around infrastructure in Los Angeles County will cost municipal, county, state, and federal governments $919 million from 2024 through 2040. Antelope Valley, an unincorporated community at the western tip of the Mojave Desert, will face the highest preventative costs at $356 million.



Wildfire scorches the Santa Clarita Valley: August 2016.

28 High fire days are defined by the KBDI index. See methods section for more information.

29 "Los Angeles County, California," Community Planning Assistance for Wildfire, accessed March 6, 2024, https://cpaw.headwaterseconomics.org/project/los-angeles-county-california/.

30 Ibid.

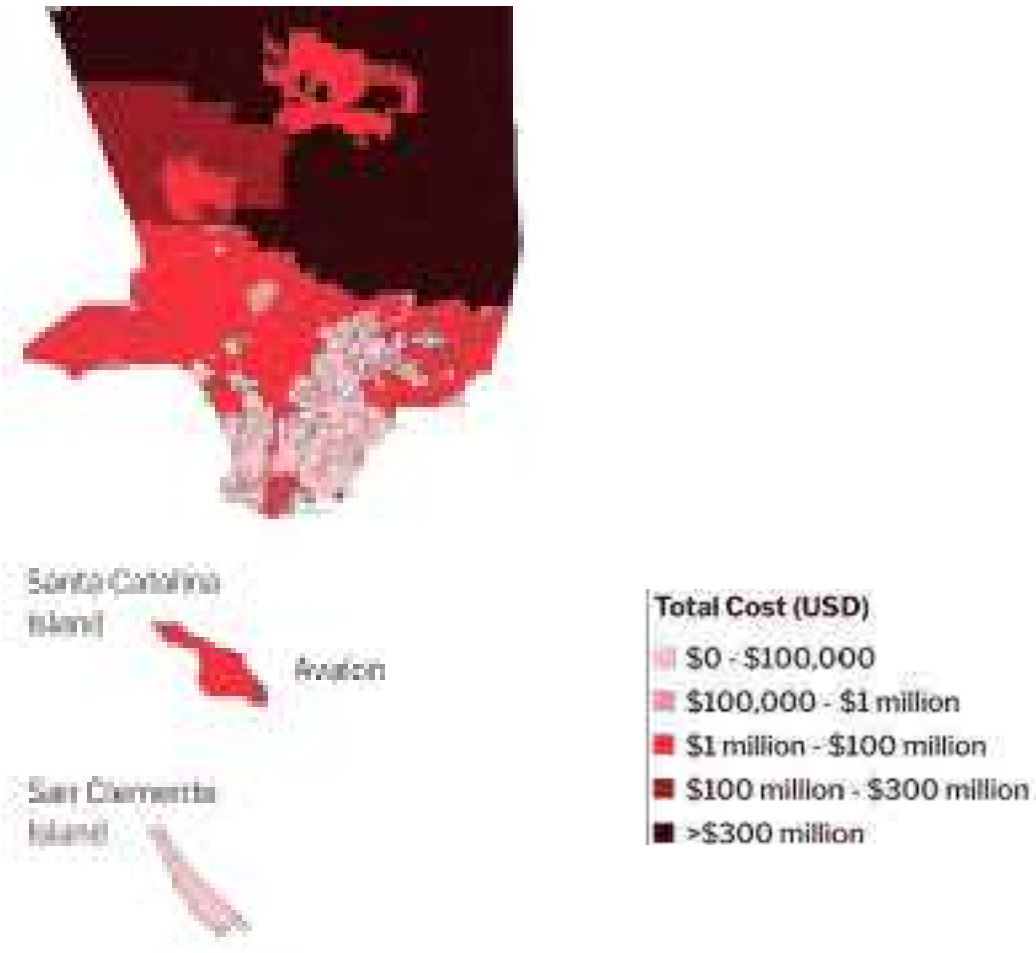
31 Michael R. Blood, "California Insurance Market Rattled by Withdrawal of Major Companies," *AP News*, June 5, 2023, https://apnews.com/article/california-wildfire-insurance-e31bef0ed7eeddcde096a5b8f2c1768f.

The costs to fight and recover from wildfires are dramatically higher than the costs to mitigate wildfire impacts presented here.

Table 5: Local governments facing highest costs to mitigate wildfires through 2040.

Rank	Municipality	Total Cost	Municipal Cost	County Cost	State Cost	Federal Cost
1	Antelope Valley	$355,828,000	N/A* *unincorporated	$91,409,000	$260,932,000	$3,487,000
2	Santa Clarita Valley	$146,952,000	N/A* *unincorporated	$777,000	$145,069,000	$1,106,000
3	Santa Monica Mountains Coastal Zone	$83,233,000	N/A* *unincorporated	$41,000	$82,128,000	$1,064,000
4	Los Angeles	$46,963,000	$49,748,000	N/A* *incorporated	$189,000	$26,000
5	Santa Clarita	$48,875,000	$48,709,000	N/A* *incorporated	$116,000	$50,000

Figure 8: The total cost by municipality for wildfire mitigation from 2024 through 2040. The costs are concentrated in areas near the wildland-urban interface and largely affect unincorporated areas.



Cost to Protect Infrastructure from Sea Level Rise $576 Million

By 2050, sea levels are expected to rise by about one foot along the Los Angeles County coast,[32] putting coastal communities at greater risk for flooding and other infrastructure damage. Investing in coastal protection to mitigate the risk of rising seas will cost the region approximately $576 million.[33] The costs could be broken down to an annual price of about $34 million, which is equivalent to 34% of Los Angeles County's FY2023 Beaches & Harbors budget.[34]



High tides erode berms in Long Beach during Tropical Storm Kay: September 10, 2022.

32 William V. Sweet et al., "Global and Regional Sea Level Rise Scenarios for the United States: Updated Mean Projections and Extreme Water Level Probabilities Along U.S. Coastlines" (National Ocean Service, Silver Spring, MD: National Atmospheric and Oceanic Administration, 2022), https://aambpublicoceanservice.blob.core.windows.net/oceanserviceprod/hazards/sealevelrise/noaa-nos-techrpt01-global-regional-SLR-scenarios-US.pdf.

33 Sverre LeRoy et al., "High Tide Tax: The Price to Protect Coastal Communities from Rising Seas" (Center for Climate Integrity and Resilient Analytics, 2019), https://climatecosts2040.org/files/ClimateCosts2040_Report.pdf.

34 LA County, "LA County Open Budget Appropriation (Auditor-Controller)."

Cost to Treat Climate-Induced Public Health Threats $1.1 Billion

As climate change alters temperatures, precipitation rates, and other weather patterns in the Los Angeles area, ecological conditions that contribute to various insect populations — and the corresponding diseases they carry — will also shift. Increasing populations of mosquitoes are expected to lead to about 500,000 new cases of West Nile Virus in Los Angeles County from 2024 through 2040, infecting about 5% of the population. This is equivalent to a 270% increase in West Nile Virus cases in Los Angeles County in 2040 as compared to 2024, which will cost an estimated $993 million to treat, or 92% of the total public health cost estimated in this study.

Climate change will also lead to an increase in pollen, leading to higher rates of pediatric asthma. **We estimate there will be about 160,000 new cases of pediatric asthma in Los Angeles County from 2024 through 2040, or about a 60% increase in cases in 2040 as compared to 2024.**

These findings only consider pediatric asthma triggered by increased allergen levels due to increased temperature. Wildfire- and other climate-induced pediatric asthma cases were not analyzed in this study, but they also pose a significant risk to children in the Los Angeles County area.

The yearly average treatment cost for both West Nile Virus and pediatric asthma cases in Los Angeles County is about $64 million from 2024 through 2040.



Comparison of Costs Across Governments

The majority of the climate adaptation costs analyzed in this report — about $9.2 billion — are expected to fall on municipal governments in Los Angeles County. Adaptation costs in the unincorporated areas of the county — areas that do not have a local municipal government — will fall on the county itself, ballooning Los Angeles County's climate adaptation costs through 2040 to about $1.5 billion, or to about $86 million annually, which is roughly 60% of the county's yearly municipal services budget.[35] The state will be responsible for $781 million and the federal government will face $1.1 billion in costs to adapt to the 14 climate impacts analyzed in this report.

Conclusion and Recommendations

This report identifies at least $12.5 billion in climate adaptation and resilience costs that governments in Los Angeles County face through 2040. These figures capture only a portion of the total bill that major climate polluters have racked up for local taxpayers. Without seeking other funding options, the burden of paying for these necessary measures will fall on the same residents who are suffering from intense flooding, deadly heat, and threatened infrastructure. In reality, local governments — and their taxpayers — will simply not be able to afford these costs to protect communities and infrastructure.

Los Angeles County communities that are suffering the most from the climate crisis did not create it — fossil fuel companies did. Just 100 companies are responsible for more than 70% of global carbon emissions since 1988, with ExxonMobil, Shell, Chevron, and BP ranking among the most egregious polluters.[36] It's only fair that major polluters that knowingly caused and profited from the climate crisis pay their share of the resulting costs.

35 Ibid.

36 Paul Griffin, "New Report Shows Just 100 Companies Are Source of over 70% of Emissions," CDP, July 2017, https://www.cdp.net/en/articles/media/new-report-shows-just-100-companies-are-source-of-over-70-of-emissions.

When state and local governments have sought to hold corporations accountable and recover costs incurred by harmful products, they often turn to the courts. Successful legal actions to make tobacco companies, opioid manufacturers, and other deceitful actors pay for the damages they've caused provide a useful model.

In 2023, the State of California took legal action, suing BP, Chevron, ConocoPhillips, Exxon, Shell, and the American Petroleum Institute for climate damages and fraud. Previously in 2017 and 2018, eight California municipal governments — the counties of San Mateo, Santa Cruz, and Marin, as well as the cities of San Francisco, Oakland, Richmond, Santa Cruz, and Imperial Beach — filed suits to recover climate costs from many of the same defendants. Those cases are all advancing in varying stages in state court. Across the country, a growing number of state and local governments are taking legal action to hold oil majors accountable for the cost to protect communities from climate harms.

Los Angeles County municipal leaders have an opportunity to take bold action to protect their residents by holding fossil fuel companies accountable and demanding these polluters pay their fair share of the crisis they imposed on these communities.



Wildfire smoke visible above hills in Los Angeles County.

Appendix

Appendix A: Supplemental Information

Appendix A.1: Adaptation Definitions

Table A1: This report estimates the cost of 14 climate change adaptation strategies that Los Angeles County taxpayers will face, defined in the table below. Note that this report is not exhaustive and Los Angeles County taxpayers will likely incur further costs as a result of additional climate change adaptation strategies not assessed herein.

Climate Impact	Adaptation	Explanation	Taxpayer Costs	Analysis Method	Appendix
Increased temperature	Upgrading heating and cooling infrastructure.	Cost to upgrade HVAC system capacity in 100% of public buildings to cope with the need for increased usage due to climate change. Note we assume 100% of public buildings in Los Angeles County already have HVAC systems installed.	Municipal, county, state	One time cost	C.1
Increased temperature	Estimating the change in energy costs to heat and cool public buildings.	Changes in energy costs are estimated based on the number of days below (heating) or above (cooling) a certain threshold as compared to the climate baseline.	Municipal, county, state	Time series	C.1
Increased temperature	Expanding and operating cooling centers.	To help residents escape the increasing summer heat, cooling centers will need to be expanded and operated. The cost of opening and operating cooling centers due to increased days with temperatures above 80°F, as compared to the climate baseline are estimated.	Municipal (incorporated) and county (unincorporated)	Time series	C.2
Increased temperature	Planting and maintaining urban trees.	Planting trees can help decrease ambient air temperature by cooling the air through evapotranspiration. The adaptation is planting and maintaining trees in urban areas and accounts for both initial costs and yearly maintenance costs. The initial costs include labor and materials. The maintenance costs include water, fertilizer, pruning, and pest spraying.	Municipal	Time series	C.3
Increased temperature	Implementing cool pavements in public parking lots.	Converting existing areas of pavement to high-albedo cool pavement has been shown to decrease proximal ambient temperature and is a complementary approach to combat increased summer temperatures in urban areas. The cost to convert public parking lots to cool pavements is estimated.	Municipal	Time series	C.4

Climate Impact	Adaptation	Explanation	Taxpayer Costs	Analysis Method	Appendix
Increased temperature and precipitation	Proactively and reactively fixing roads.	When pavement temperature rises above its mixture threshold, increased degradation occurs. In the reactive scenario, this increased cracking requires more maintenance to avoid a decrease in the projected lifespan of the road. In the proactive scenario, adaptation includes installation of roads with pavement rated to projected future temperatures. Excess precipitation above what the road was designed to handle can also increase degradation. Road maintenance costs are informed by the percentage decrease in lifespan based on the level of projected damage as compared to the climate baseline. In the proactive road scenario, adaptation requires a strengthening the roadbase to resist the increased potential for erosion. In the reactive road scenario, adaptation is fixing roads after precipitation-induced damage.	Municipal, county, state	Time series	C.5
Increased high fire days	Implementing mechanical wildfire mitigation in intermix areas.	Mechanical intervention focuses on reducing fuel for a fire by manually cutting and removing undergrowth, as well as thinning the density of forested area. Due to an increase in the number of fire days (i.e., length of the fire season), controlled burns are not as feasible, as the available time for a controlled burn is being significantly reduced. Mechanical intervention costs $1,500 per acre.	Municipal, state, federal Unincorporated municipal costs assigned to the county.	Twice per decade	C.6
Increased temperature	Painting the metro rail tracks with high-albedo paint.	Los Angeles can avoid metro rail slow downs and shut downs by painting the tracks with a high-albedo (light reflecting) paint to keep the tracks cool. Australia, Italy, and Switzerland already implement this technique with success. For optimal results, we assume that Los Angeles should paint their rails every year.	County	Once per year	C.7

Climate Impact	Adaptation	Explanation	Taxpayer Costs	Analysis Method	Appendix
Increased precipitation	Installing drainage & stormwater infrastructure.	To combat increased inflow to the wastewater treatment plants, we estimate the cost to increase drainage area by implementing drainage & stormwater infrastructure. Drainage & stormwater infrastructure includes bio retention, porous pavement, bioinfiltration, and bioswale construction.	Municipal (incorporated) and county (unincorporated)	Time series	D.1
Increased precipitation	Proactively adapting bridges.	As rivers flow faster during extreme precipitation events, bridges will degrade faster due to enhanced scour. To combat enhanced damage to bridges, we estimate the cost to proactively rehabilitate bridges in order to prevent disruption. Rehabilitation consists of applying riprap to stabilize bridges and additional concrete to strengthen piers and abutments.	Municipal, county, state	One time cost	D.2
Increased drought	Increased drinking water treatment.	Drought increases sediment and nutrient concentration in drinking water. As such, municipalities incur drought-induced increased drinking water treatment costs. The cost has been estimated at $94.75 per million gallons more than water treatment during non-drought times. We estimate the excess cost to treat 80 gallons per capita for Los Angeles residents during the projected increase in drought conditions as compared to the climate baseline.	Municipal (incorporated) and county (unincorporated)	Time series	D.3
Sea Level Rise	Install coastal protection.	High tide flooding, storm surge, and coastal erosion from sea level rise threaten coastal infrastructure. We estimate the cost to protect critical infrastructure along Los Angeles County's coastline with seawalls.	County	One time cost	E
Public Health: Increased temperature	Increased costs from pediatric asthma hospital visits.	Increased temperatures correlates to increased pollen levels, which lead to more cases of pediatric asthma that require emergency room visits. We estimate the government-incurred cost of increased pediatric asthma visits as compared to the climate baseline.	Federal	Time series	F.1

Climate Impact	Adaptation	Explanation	Taxpayer Costs	Analysis Method	Appendix
Public Health: Increased temperature and increased precipitation	Initial and long-term costs to treat increased West Nile Virus manifestations.	Mosquitoes thrive in warm temperatures and near water, so increased temperatures and precipitation due to climate change will make West Nile Virus more prevalent. We estimate the increased government-incurred cost to treat both initial and long-term manifestations of West Nile Virus.	Federal	Time series	F.2

Appendix A.2: How to read this report.

In the report, we present municipal, county, state, federal, and total costs to adapt to climate change. We break down what each of these costs mean below:

Municipal Costs: Costs we assume will be incurred by the city/town government. When we cannot assign costs to specific government entities, we assume that municipalities are incurring the entirety of the cost. For example, the available data limit our ability to precisely assign the costs for increasing stormwater drainage capacity across multiple levels of government. As a result, we assume 100% of these costs will fall on the municipality, though we recognize that in some cases, the county, state, or federal government may incur some portion of this cost.

County Costs: Costs we can directly assign to Los Angeles County. We assume unincorporated municipalities cannot incur municipal costs and therefore assign those costs to the county.[1] Throughout the report, unincorporated municipalities will have $0 in municipal costs for all impacts analyzed. We also assign costs to the county when the data inventory allows us to assign ownership of structures and/or services to the county. In the case of metro rail, we assign all costs to the county because the county owns and operates this service.[2] Seawall costs are also aggregated county-wide, based on cost estimates from a previous study that calculated costs based on "census designated place."

State Costs: Costs we can assign directly to the State of California. We assign state costs when the data inventory allows us to assign ownership of land, structures, and/or services to the state.

Federal Costs: Costs we can assign directly to the Federal government. We assign federal costs when the data inventory allows us to assign ownership of land and health care costs to the federal government.

Total Costs: The aggregate of municipal, county, state, and federal costs for the 14 impacts included.

1 Public Works Los Angeles County, "Municipal Services," LA County Public Works, 2024, https://content.pw.lacounty.gov/core-service-areas/municipal-services/.

2 CALCOG, "Los Angeles County Metropolitan Transportation Authority (Metro)," California Association of Councils of Governments, July 17, 2020, https://calcog.org/los-angeles-county-metropolitan-transportation-authority-metro/.

Table A2: The 14 climate adaptations and the government entities we assign the costs to.

Climate Impact	Adaptation	Taxpayer Costs
Increased temperature	Upgrading heating and cooling infrastructure.	Municipal, county, state
	Estimating the change in energy costs to heat and cool public buildings.	Municipal, county, state
	Expanding and operating cooling centers.	Municipal (incorporated) and county (unincorporated)
	Planting and maintaining urban trees.	Municipal
	Implementing cool pavements in public parking lots.	Municipal
	Painting the metro rail tracks with high-albedo paint.	County
Changes in precipitation	Installing drainage & stormwater infrastructure.	Municipal (incorporated) and county (unincorporated)
	Proactively adapting bridges.	Municipal, county, state
	Increased drinking water treatment due to drought.	Municipal (incorporated) and county (unincorporated)
Increased temperature and increased precipitation	Proactively and reactively fixing roads.	Municipal, county, state
Increased high fire days	Implementing mechanical wildfire mitigation in intermix areas.	Municipal, state, federal Unincorporated municipal costs assigned to the county
Sea Level Rise	Install coastal protection.	County
Public Health: Increased temperature	Increased costs from pediatric asthma hospital visits.	Federal
Public Health: Increased temperature and increased precipitation	Initial and long-term costs to treat increased West Nile Virus manifestations.	Federal

Appendix A.3: Other costs Los Angeles County may incur due to climate change.

Table A3: Climate change impacts the Los Angeles County area faces and some of the potential costs associated with these impacts. **Items in bolded text were analyzed in this report.** This list is not exhaustive and other costs may be incurred as a result of additional climate change impacts.

Climate Impact	Category	Potential Costs Incurred by Communities in Los Angeles County
Increased Precipitation	Structure and Infrastructure Projects	Remove, relocate, acquire, or demolish structures to minimize future flood losses.
		Install, reroute, increase capacity, or implement a routine cleaning plan of the storm drainage system.
		Add extra culverts, increase dimensions of existing culverts, or implement routine cleaning and repairing.
		Install detention or retention basins, relief drains, spillways, drain widening/ dredging or rerouting, etc.
		Inspect and maintain drainage systems and flood control structures (dams, levees, etc.).
		Inspect bridges in order to identify and/or implement repairs or retrofits or clean under low bridges.
		Resurface roads with more permeable pavement and concrete.
		Elevate roads and bridges above the base flood elevation (BFE)[3] to maintain dry access.
		Elevate structures above the BFE, or relocate utilities, water heaters, etc. above BFE.
		Floodproof inside of municipal buildings, for example by installing check valves, sump pumps, or backflow prevention devices.
		Floodproof wastewater treatment facilities located in flood hazard areas.
		Floodproof water treatment facilities located in flood hazard areas.
		Protect emergency operations by requiring or moving all emergency operations centers, police stations, and fire department facilities outside of flood-prone areas.
		Protect critical and emergency facilities by requiring all critical facilities be built one foot above the 500-year flood elevation (to meet requirements of FEMA Executive Order 11988).[4]
		Protect critical and emergency facilities from floods using any other technique, for example, raising components above BFE, installing pumping systems or back-up generators for pumping, building dikes, or stabilizing banks.
		Construct floodwalls, small berms, revetments, bioengineered bank stabilization, or other small structural mitigants.
	Natural Flood Mitigation	Protect and enhance natural floodplain mitigation features (such as wetlands, dunes, and vegetative buffers) to help prevent flooding in other areas.

3 Base flood elevation (BFE), as defined by FEMA, is "the elevation of surface water resulting from a flood that has a 1% chance of equaling or exceeding that level in any given year."

4 Federal Emergency Management Agency, "Executive Order 11988: Floodplain Management," www.fema.gov/executive-order-11988-floodplain-management.

Climate Impact	Category	Potential Costs Incurred by Communities in Los Angeles County
	Local Planning and Regulation	Update flood risk maps and flood zones.[5]
		Develop a floodplain management plan.
		Adopt a stormwater management or drainage plan.
		Adopt, apply, and enforce building codes to ensure buildings can withstand flooding.
		Obtain easements to use privately-owned land for temporary water retention and drainage.
		Join or improve compliance with the National Flood Insurance Program (NFIP).[6]
		Apply for Floodplain Management, Protection, and Risk Awareness Grants through California Department of Water Resources.[7]
		Preserve floodplains as open space using any of several land use planning tools: develop a plan that targets hazard areas for acquisition, reuse, and preservation, a land banking program, use of transfer of development rights to keep floodplains vacant, easements to prevent development, or acquiring properties in the floodplain and turning them into open space.
	Education and Awareness Programs	Increase public outreach to encourage flood insurance purchase; educate residents in flood safety, flood mitigation, technical assistance availability, funding sources, and best practices.
		Locate new utilities and critical facilities outside of susceptible areas.
		Identify, map, or track erosion hazard areas.

5 Brett Sanders et al., "Large and Inequitable Flood Risks in Los Angeles, California," *Nature Sustainability* 6, no. 1 (2023): 47–57, https://doi.org/10.1038/s41893-022-00977-7.

6 U.S. Federal Emergency Management Agency (FEMA), The National Flood Insurance Program (NFIP), at www.fema.gov/national-flood-insurance-program Policy Information by State (https://nfipservices.floodsmart.gov//reports-flood-insurance-data), accessed August 10, 2023; Los Angeles County only has one active NFIP policy in place, which covers $212,000. For comparison, Kern County has over 1,755 active policies covering over $390 million.

7 California Department of Water Resources, "Floodplain Management, Protection, and Risk Awareness Grant Program," Accessed August 11, 2023, https://water.ca.gov/Work-With-Us/Grants-And-Loans/Flood-Management-Protection-Risk-Awareness-Program.

Climate Impact	Category	Potential Costs Incurred by Communities in Los Angeles County
Sea Level Rise	Structure and Infrastructure Projects	Stabilize susceptible coastal slopes and cliffs and shorelines using grading techniques, planting vegetation, riprap or geotextile fabric, or bioengineering.
		Refer to "Structure and infrastructure projects" from "Increased Precipitation," as they also apply here.
	Coastal Protection	Protect critical infrastructure using techniques like beach nourishment, jetties, and **seawalls**.
		Restore natural wetland areas.
	Local Planning and Regulation	Identify, map, and track coastal erosion and flood hazards.
		Develop and enforce a coastal zone management plan.
		Develop site and building standards.
		Other local planning and regulation as suggested by the Legislative Analyst's Office.[8]
	Education and Awareness Programs	Increase awareness by disclosing location of high-risk areas to current and future property owners; offer mitigation technique information.
		Locate new utilities and critical facilities outside of susceptible areas.
		Identify, map, or track erosion hazard areas.
		Other education and awareness programs as suggested by the Legislative Analyst's Office.[9]
Increased Temperature	Structure and Infrastructure Projects	Energy efficiency retrofits in public and private buildings and housing, including costs for the design and development of standards.
		Increased cooling costs for all public buildings, including green roofs or cool roofing systems on public buildings and new AC installation or upgrade costs for schools.
		Increased road damage due to more frequent extreme heat events.
		Plan for and increase capacity for increased energy demands due to both increased daytime and nighttime temperature.
		Increase high-albedo surfaces on buildings, roads, or where feasible.
	Public Health Projects	**Build and manage more cooling centers, including staffing and tracking of high-risk individuals.**
		Increased demand for publicly financed air conditioning targeted to low income families and public housing.
		Control the increase of vector borne illness – education and physical and chemical controls for ticks and mosquitoes.
		Treat victims of vector borne illness.
		Increase in asthma attacks requiring hospitalization (resulting from increased heat and ground level ozone, and the increase in airborne allergens).
		Reduce the urban heat island effect by planting trees.
		Protect drinking water supplies from hazardous algae blooms.

8 Gabriel Petek, "Preparing for Rising Seas: How the State Can Help Support Local Coastal Adaptation Efforts," Legislative Analyst's Office, 2019, https://lao.ca.gov/reports/2019/4121/coastal-adaptation-121019.pdf.

9 Ibid.

Climate Impact	Category	Potential Costs Incurred by Communities in Los Angeles County
Increased Drought	Water Management	Individual purchase of water during water scarce times.[10]
		Public health costs related to increased exposure to water-borne illnesses.[11]
		Replace old pipelines that have water leak issues.[12]
		Use climate science to update water treatment, wastewater treatment, and other energy infrastructure.[13]
		Reinforce roads, bridges, and buildings to withstand prolonged drought.
	Wildfires	Increase fire suppression, including staffing and aviation.
		Rebuild or relocate damaged properties and public infrastructure, such as homes and utility lines.
		Relocate public infrastructure where necessary.
		Update power lines to withstand dust from wildfires.
		Implement fire mitigation strategies for the future like burying utility lines underground.
		Plan for and disburse community aid after wildfires.
		Implement fire detection strategies, like solar-powered sensors.[14]
		Rehabilitate the landscape post-fire to reduce the risk of erosion and invasive species and mitigate future fire risk.
		Increased hospitalization costs for asthma attacks and other chronic health conditions (resulting from decreased air quality due to wildfire smoke).
	Local Planning and Regulation	Organize meetings to create water scarcity management plans.[15]
		Develop tools for monitoring ground and surface water resources for public use.[16]
	Education and Awareness Programs	Public education, outreach, and awareness campaigns about water conservation.[17]
		Increase public outreach to encourage wildfire risk management; educate residents in wildfire safety, technical assistance availability, funding sources, and best practices.
Other Extreme Weather	Structure and Infrastructure Projects	Increased costs of storm recovery and clean-up.
		Protect power lines through pruning trees.
		Bury overhead power lines or install systems that allow small sections of power lines to fail rather than the complete system.

10 Zoë Roller et al., "Closing the Water Access Gap in the United States: A National Action Plan," Dig Deep and US Water Alliance, 2022, https://static1.squarespace.com/static/5e80f1a64ed7dc3408525fb9/t/6092ddcc499e1b6a6a07ba3a/1620237782228/Dig-Deep_Closing-the-Water-Access-Gap-in-the-United-States_DIGITAL_compressed.pdf.

11 Ibid.

12 "Drought and Infrastructure - A Planning Guide" (Cybersecurity and Infrastructure Security Agency with the National Drought Resilience Partnership, 2021), https://www.cisa.gov/sites/default/files/publications/Drought_and_Infrastructure_A_Planning_Guide_508c.pdf.

13 Ibid.

14 Jennifer L, "Wildfires Cost Over $148B and 30% of Emissions," Carbon Credits, January 30, 2023, https://carboncredits.com/wildfires-cost-emissions/; Western Fire Chiefs Association, "What Is the Financial Cost of a Wildfire?," December 7, 2022, https://wfca.com/articles/cost-of-wildfires/.

15 CISA, "Drought and Infrastructure - A Planning Guide."

16 Ibid.

17 Ibid.

Climate Impact	Category	Potential Costs Incurred by Communities in Los Angeles County
Other Public Health Costs	Education and Awareness and Treatment	Increased allergen levels, food- and waterborne infections, and zoonotic diseases.[18]

Appendix A.4: City of Los Angeles.

We recognize that many cities across Los Angeles County have neighborhoods with vastly different demographic characteristics. To capture the disproportionate impacts on these demographics, we present a small case study of the City of Los Angeles that demonstrates some of the demographic differences within municipalities that should be accounted for when thinking about climate change and the costs associated with adaptation strategies (Table A4).

Table A4: Demographic characteristics for the City of Los Angeles. The minimum and maximum characteristic at the census tract level is presented along with the population-weighted mean characteristic, which was used in the equity analysis for this study.
The City of Los Angeles faces a per capita cost of $964.60 to adapt to the 14 climate impacts analyzed in this study. Demographic characteristics and social vulnerabilities vary widely across the city (Table A4; Figure A1). Therefore, it is likely that the per capita cost to adapt to climate change will be felt differently by residents within the city.

Demographic Characteristic	Minimum	Maximum	Weighted Mean
Median Household Income	$0	$250,001	$71,570
Poverty Rate	0%	100%	15%
Percent Non-Hispanic White	0%	94%	29%
Percent Non-Hispanic Black	0%	84%	8.5%
Percent Non-Hispanic Asian	0%	80%	12%
Percent Hispanic	0%	100%	47%
Percent without a High School Degree	0%	76%	21%
Percent with Limited Access to Internet	0%	100%	11%
Percent Disabled	0%	100%	10%
Percent Uninsured	0%	50%	11%
Percent Foreign Born	0%	82%	36%

18 Carmen Milanes et al., "Indicators of Climate Change in California," Office of Environmental Health Hazard Assessment, 2022, https://oehha.ca.gov/media/downloads/climate-change/report/2018caindicatorsreportmay2018.pdf.

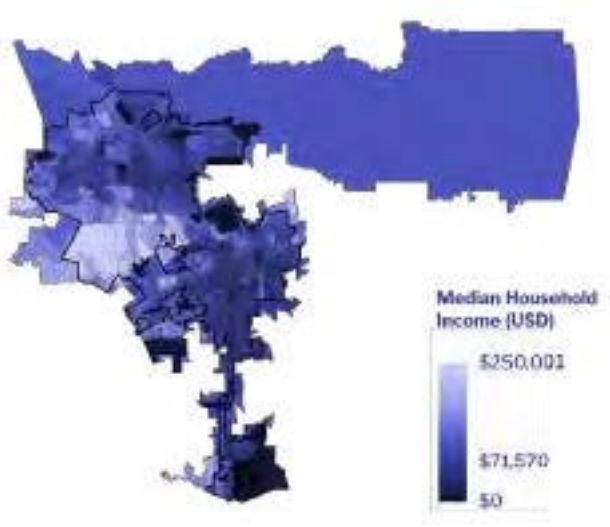


Figure A1: The black outline shows the Municipal boundary of the City of Los Angeles. Census tract bounds (gray) are colored by median household income. The map shows that in the City of Los Angeles, some census tracts have a median household income of $0, while others have a median household income of around $250,000. Dark blue areas highlight the census tracts in the City of Los Angeles that have lower household income than the citywide weighted average median household income ($71,570).

Appendix B: Climate Baselines

The climate projections in this report are derived from the Localized Constructed Analogs (LOCA) statistically downscaled Coupled Model Intercomparison Project Phase 6 (CMIP6) climate projections for North America. We selected different climate variables at 1/16th of a degree (approximately 3.7 mile^2) resolution[19] for 23 global climate models (GCMs) under a moderate greenhouse gas and aerosol emission scenario (Shared Socioeconomic Pathway 2-4.5 [SSP2-4.5]). In the report, the 50th percentile of the 23 model outputs is presented for each of the analyses. The projection time period used is a 17-year period that estimates total costs incurred through 2040 (2024-2040). We also make the data available for download. In the data download, the estimated cost through 2040 and through 2060 are presented. The projection time period for the 2060 cost is typically a 20-year period (2041-2060). The cost estimates for both time periods are also based on the 50th percentile of the 23 model outputs for SSP2-4.5 for each analysis. The climate baseline for temperature-related analyses in this study is derived from Livneh et al. (2015).[20] The climate baseline for precipitation-related analyses in this study is derived from Pierce et al. (2021).[21] We use at least a 20-year baseline time period for all analyses presented. A shapefile of Los Angeles County municipal boundaries is used throughout the study.[22]

We present a cumulative cost over the projection time period for all costs. The two main ways adaptation costs are estimated are either as a time series (Table A1) or assessed once in 2040 and then again in 2060 (one time costs; Table A1). Two adaptations, mechanical intervention for wildfires and painting metro rail tracks, are one time costs but are incurred twice per decade or once per year, respectively (Table A1).

We assume all municipal costs incurred in unincorporated municipalities are incurred instead by the county.

19 David W. Pierce, Daniel R. Cayan, and Bridget L. Thrasher, "Statistical Downscaling Using Localized Constructed Analogs (LOCA)," *Journal of Hydrometeorology* 15, no. 6 (December 1, 2014): 2558–85, https://doi.org/10.1175/JHM-D-14-0082.1; David W. Pierce et al., "Improved Bias Correction Techniques for Hydrological Simulations of Climate Change," *Journal of Hydrometeorology* 16, no. 6 (December 1, 2015): 2421–42, https://doi.org/10.1175/JHM-D-14-0236.1.

20 Ben Livneh et al., "A Spatially Comprehensive, Hydrometeorological Data Set for Mexico, the U.S., and Southern Canada 1950–2013," *Scientific Data* 2, no. 1 (August 18, 2015): 150042, https://doi.org/10.1038/sdata.2015.42.

21 David W. Pierce et al., "An Extreme-Preserving Long-Term Gridded Daily Precipitation Dataset for the Conterminous United States," *Journal of Hydrometeorology* 22, no. 7 (July 1, 2021): 1883–95, https://doi.org/10.1175/JHM-D-20-0212.1.

22 County of Los Angeles, "City and Unincorporated Community Boundary (Regional Planning)," 2023, https://data.lacounty.gov/datasets/lacounty::city-and-unincorporated-community-boundary-regional-planning/about.

Appendix C: Methodologies for estimating the cost to address temperature-related impacts

Appendix C.1: Installing and Upgrading Building Heating and Cooling Infrastructure and Estimating the Change in Energy Cost

Taxpayer costs were analyzed at the municipal, county, and state level.

Buildings Inventory

We create a buildings database that is based on public datasets to inform building location, area, owner, and use type. Building location and footprint are based on the USA Structures data published by the Federal Emergency Management Agency (FEMA).[23] Building height is assumed based on the classification as published within the United States Geological Survey (USGS) national dataset of average building height[24] using the United States Census (Census) block groups.[25] Each block group is sorted into one of four classifications based on the average number of stories per building. These classifications are sourced from a National Aeronautics and Space Administration (NASA) dataset of Census block group data, which is based on LiDAR data collected in 2000 and verified and published in 2016.[26] This data provides a conservative height estimate, as we assume that the building height classification in any given block group has either increased or remains unchanged since the dataset was verified. Total building floor area is calculated by multiplying a given building's footprint by the average number of stories in the block group where the building is located. Building owner is determined based on a text scrape algorithm of the Los Angeles County Assessor Publicly Owned Parcels database[27] for keywords in the building type related to each of the local governments of concern.[28] For example, buildings with "State" in their name are filtered into the state-owned category. Lastly, building type is based on the Homeland Security buildings database[29] and the Department of Housing and Urban Development public housing database.[30] Each building within the inventory is assigned a building type from the Department of Energy (DOE) energy models in order to inform the energy, install, and upgrade calculations. The costs associated with municipal buildings in unincorporated areas are assigned to the county. Please note that the buildings inventory may not be an exhaustive representation of all public buildings that exist.

Climate Metrics

The number of cooling degree days (CDD)[31] and heating degree days (HDD)[32] for the baseline and projection time periods for each building are computed to determine changes in energy costs. The 20-year average number of annual CDDs and HDDs are reported. A degree day base of 50°F[33] is utilized

23 FEMA, "USA Structures" (Federal Emergency Management Agency Geospatial Resource Center, 2022), https://gis-fema.hub.arcgis.com/pages/usa-structures.

24 James A. Falcone, "U.S. National Categorical Mapping of Building Heights by Block Group from Shuttle Radar Topography Mission Data" (U.S. Geological Survey, 2016), https://doi.org/10.5066/F7W09416.

25 United States Census Bureau, "Glossary," under "Block Group," (accessed September 27, 2023), https://www.census.gov/glossary/?term=Block+Group+%28BG%29.

26 Falcone, "U.S. National Categorical Mapping of Building Heights by Block Group from Shuttle Radar Topography Mission Data."

27 County of Los Angeles, "Assessor Publicly Owned Parcels (Current)," May 10, 2023, https://data.lacounty.gov/datasets/c42fd5850b5b40d88e79c7d4204b9371_0/about.

28 U.S. Department of Homeland Security, "Homeland Infrastructure Foundation-Level Data (HIFLD)" (Geospatial Management Office, 2021), https://hifld-geoplatform.opendata.arcgis.com/.

29 Ibid.

30 Department of Housing and Urban Development, "Public Housing Buildings" (HUD GIS Helpdesk: Office of Policy Development and Research (PD&R), 2023), https://hudgis-hud.opendata.arcgis.com/datasets/HUD::public-housing-developments/about.

31 Cooling degree days (CDD) is a daily measure of how much (in degrees) the average outside air temperature is above a specified temperature threshold.

32 Heating degree days (HDD) is a daily measure of how much (in degrees) the average outside air temperature is below a specified temperature threshold.

33 In this context, CDD and HDD with a base of 50°F are used as climate variables. The base temperature does not inform when any given building is in cooling or heating mode (which typically has a threshold of 65°F).

for each because it demonstrates a better relationship with building cooling capacity and energy usage than other temperature metrics, such as degree days with a base of 65°F.

Degree Day Relationships

The DOE Commercial Reference Building models define the characteristics of a representative building for each climate zone[34] based on nationwide survey data.[35] Models are available for buildings built pre-1980, post-1980, and new. We used only the post-1980 models for the purposes of this study. Cooling system type, heating system type, cooling system capacity, cooling system energy usage, heating system energy usage, and building square footage as defined by the DOE Reference Building Models were used to calculate cooling capacity intensity (ft^2/ton), cooling energy use intensity (kWh/ft^2) and heating energy use intensity (kWh/ft^2 for electricity or MJ/ft^2 for gas) for a representative building in each climate zone.

Each building type within the building inventory is matched with a building type from the DOE representative energy models as outlined in the table below (Table C1).

Table C1: Building types within the building inventory and their corresponding building type within the DOE reference building energy models.

Inventory Building Type	DOE Building Type
Court House	Office
EMS	Office
Fire Station	Office
Hospital	Hospital
Library	Office
Post Office	Office
Prison	Hotel
Public Health Department	Office
Public Housing	Midrise Apartment
Primary School	Primary School
Secondary School	Secondary School
Town Hall	Office

Cooling Days

A relationship was established between the annual CDDs with base 50°F (CDD50) reported in ASHRAE 90.1 2004[36] and both the cooling capacity intensity and the cooling energy use intensity for each representative building. This relationship was used to calculate cooling system capacity and energy usage for all buildings using inputs of baseline and projected CDD50, building area, and building type.

34 There are eight main climate zones that are subdivided into moist, dry, and marine subsets to make 16 total classifications. The zones are determined based on a location's historic weather characteristics, in this case as defined by Briggs et al., (2003), https://www.proquest.com/openview/d1c49b47cddf83d4cb8ffc7b2ec1b075/1?pq-origsite=gscholar&cbl=34619.

35 U.S. Department of Energy, "Commercial Reference Buildings" (Department of Energy: Office of Energy Efficiency & Renewable Energy, 2010), https://www.energy.gov/eere/buildings/existing-commercial-reference-buildings-constructed-or-after-1980.

36 ASHRAE, ANSI/ASHRAE/IESNA Standard 90.1-2004: Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings, distributed by ASHRAE, (2004).

Heating Days

A relationship was established between the annual HDD50 reported in ASHRAE 90.1 2004[37] and the heating energy use intensity for each representative building. This relationship was used to calculate heating system energy usage for all buildings using inputs of baseline and projected HDD50, building area, and building type.

Cost Estimates: Cooling System Capacity

Cost per ton of cooling is calculated for install and upgrade. System install and upgrade use the same $/ton costs based on RSMeans Assembly costs in the 2021 edition of the RSMeans Square Foot Cost Book.[38] System types in the DOE Commercial Reference Building documentation were matched with the most appropriate assembly type (Table C1) in the RSMeans construction cost estimating data.

Costs are in Q2-2023 dollars and include material, labor, sales tax (6%), general requirements (10%), general contractor overhead (5%) and profit (5%), and an average location factor for Los Angeles County based on the national average.[39] No architect fee or contingency was added. Percentages follow RSMeans methodology. Additional costs will vary on a case-by-case basis and are outside of the scope of this study.

Cooling system installation costs were calculated for each building in the database based on projected capacity needs. Cooling system upgrade costs were calculated for each building in the database based on the projected capacity increase from baseline. An upgrade was assumed to be necessary if the change in cooling system capacity in a given projection was more than 10% higher than the cooling system capacity for the baseline. Only the increased cost from the change in baseline capacity was estimated, rather than the full system capacity, so that only impacts on system size arising from anthropogenic climate change were captured. Costs are presented on a municipal, county, and state basis by summing upgrade and install costs for all buildings within the respective jurisdiction that are owned by the jurisdiction(s) of interest.

Since the prevalence of air conditioning within most building types is unknown, the upgrade and installation costs for these building types are presented in a series of bins according to the prevalence of air conditioning across the jurisdiction's building stock. As an example, the 25% bin implies that 25% of a jurisdiction's buildings have existing cooling, and so 25% of the upgrade costs are reported while 75% of the installation costs are reported. In Los Angeles County, we assume all buildings have air conditioning[40] and therefore only upgrade costs are reported (0% of buildings need air conditioning installed, 100% of buildings are subject to upgrade costs).

Cost Estimates: Cooling and Heating Energy

Cost per kWh of electricity and per MW of natural gas are based on statewide 2022 annual average values as reported by the United States Energy Information Administration (US EIA).[41] Costs presented are based on 2022 average utility costs rather than projected costs. Available energy cost projections include substantial uncertainty and only extend to 2050. Additionally, use of present-day dollar amounts maintains consistency with the other analyses, which do the same. Energy costs assume all buildings have cooling and heating, while the percent change in costs will apply to any prevalence of buildings with both cooling and heating.

37 ASHRAE, ANSI/ASHRAE/IESNA Standard 90.1-2004: Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings, distributed by ASHRAE, (2004).

38 RSMeans, Building Construction Cost Data, (2021), distributed by Gordian, https://www.rsmeans.com/.

39 Attilio Rivetti, "Turner Building Cost Index: 2023 Second Quarter Forecast" (Turner Construction Company, 2023), https://www.turnerconstruction.com/cost-index.

40 Matt Barnum, "Exclusive: Too Hot to Learn: Records Show Nearly a Dozen of the Biggest School Districts Lack Air Conditioning," June 14, 2017, https://www.the74million.org/article/exclusive-too-hot-to-learn-records-show-nearly-a-dozen-of-the-biggest-school-districts-lack-air-conditioning/.

41 U.S. Energy Information Administration, "Electricity Data Browser," 2022, https://www.eia.gov/electricity/data/browser/; U.S. Energy Information Administration, "Natural Gas Prices," 2022, https://www.eia.gov/dnav/ng/ng_pri_sum_a_EPG0_PCS_DMcf_a.htm.

Assumptions

System type is as reported in DOE Commercial Reference Building models. Only components[42] that are included in the RSMeans assemblies were included in our estimate. Other items that may incur costs but were not included in analysis include: required code improvements, structural improvements, asbestos abatement, redundant equipment, electrical upgrades, inflation, design fees, permitting, inspections, crane, constructability, demolition, waste and disposal. Costs are based on the average $/ton across all system capacities reported in RSMeans.

The cooling capacity intensity relationship with CDD50 was calculated without the equipment sizing factor of 1.2[43] used by the DOE Reference Building models.

Appendix C.2: Protecting Residents during Heatwaves

Taxpayer costs were analyzed at the municipal level. Costs for unincorporated municipalities are assigned to the county.

We quantified how much it will cost Los Angeles County to expand and operate cooling centers in order to protect residents from extreme heat in "vulnerable areas." We used 2019 U.S. Census block data and the Los Angeles County Municipal Bounds to identify the "vulnerable areas" within each municipality, defined as an area that has a median income at or below twice the poverty line for a family of four ($55,500).[44] We used ArcGIS to assess the vulnerable area (mile^2) within each municipality.

Using Census block groups[45] to identify vulnerable areas in rural communities results in large regions of undeveloped areas being considered vulnerable, and therefore overestimates the amount of cooling centers required. To remedy this, we only used areas classified as medium or high intensity developed areas by the National Land Cover Database (NLCD) developed areas. In ArcGIS, we layered the NLCD classifications over the previously created vulnerable block groups. We saved only the overlapping NLCD developed areas, which leaves developed areas that are within vulnerable areas. As such, we determined the quantity of vulnerable areas within each municipality.

We assume that a cooling center within a vulnerable area must be within a 0.5 mile radius walking distance, thus every cooling center covers 0.785 sq. mi. To determine the number of cooling centers required in a given municipality, we divided the vulnerable area of each municipality by 0.785. Based on a report from the Center for Disease Control,[46] we assume that 62% of cooling centers do not incur additional costs, 15% incur only additional HVAC costs, and 23% incur both additional HVAC and staffing costs when operating for 8-hours. Though 62% of cooling centers did not incur additional costs for the first 8-hours of operation, 54% of all cooling centers operate on a 12-hour schedule and will incur an additional 4-hours of HVAC and staffing costs.[47] For this reason, we separated costs into 8-hours and 4-hours (see example computation below; Table C2). We estimated operational costs by using a report

42 The RSMeans system costs include the parts typical to cooling systems like the air handling unit, piping, valves, insulation, etc. These costs are for a generalized system and any given installation would likely see variations to meet the specific needs of that system.

43 The DOE reference building models include a 20% safety factor when sizing a cooling system. We remove this safety factor to determine the minimum amount of cooling a building needs.

44 "What Is the Federal Poverty Level (FPL)?," healthinsurance.org, accessed December 13, 2023, https://www.healthinsurance.org/glossary/federal-poverty-level/.

45 United States Census Bureau, "Glossary," under "Block Group," accessed September 27, 2023, https://www.census.gov/glossary/?term=Block+Group+%28BG%29.

46 Stasia Widerynski et al., "The Use of Cooling Centers to Prevent Heat-Related Illness: Summary of Evidence and Strategies for Implementation Climate and Health Technical Report Series Climate and Health Program, Centers for Disease Control and Prevention," Climate and Health Technical Report Series (Climate and Health Program: Centers for Disease Control and Prevention, 2017), https://www.researchgate.net/publication/319112587_The_Use_of_Cooling_Centers_to_Prevent_Heat-Related_Illness_Summary_of_Evidence_and_Strategies_for_Implementation_Climate_and_Health_Technical_Report_Series_Climate_and_Health_Program_Centers_for_Disea.

47 Ibid.

from the City of Los Angeles that details the city's cooling center costs. They report that HVAC costs were $26.86 per hour (HC), and HVAC and staffing costs (HSC) were $292.79 per hour.[48]

Table C2: An example for how to calculate the cost to operate cooling centers in a Los Angeles County municipality.

Vulnerable Area (A)	# of Cooling Centers (CC)	Additional HVAC Costs (AHC)	Additional HVAC and Staffing Costs (AHSC)	8 Hour Costs (C8)	4 Additional Hours Costs (C4)	Total Daily Costs
	A/0.785, round up to nearest whole number	CC*0.15*HC*8	CC*0.23*HSC*8	AHC + AHSC	((CC*0.62)* 0.54)*HSC*4	C8 + C4

This method calculates the daily operation cost for cooling centers for each municipality in Los Angeles County. The next step is to multiply the daily costs by the number of days that each municipality experiences over 80°F. The resulting amount will be the rough estimation for each municipality's cooling center costs on a yearly basis.

Note that because some areas are vulnerable but will not require cooling centers (rural areas) there is an additional filter that if a municipality has a vulnerable area less than half of the area covered by a cooling center (0.785 sq. mi) then it is determined that area does not require a cooling center. Areas with this occurrence are most likely rural areas with low populations relative to other urban environments.

Appendix C.3: Combating Heat Islands – Urban Trees

Taxpayer costs were analyzed at the municipal level.

We quantified how much it will cost Los Angeles County municipalities to increase urban tree canopy in order to adapt to an urban heat island exacerbated by higher temperatures. An urban tree constitutes any tree located in a developed area of medium or high intensity according to the NLCD. We did not determine the cost of planting urban trees in municipalities with less than 500 pop/mi^2 or municipalities with less than 100 people as the total population as these are not "urban" areas and are excluded from the analysis.

Quantifying canopy coverage in Los Angeles County urban environments

We used NLCD 2021 Land Cover data and NLCD 2021 Canopy Coverage to quantify the current canopy coverage in municipalities across Los Angeles County.

Cost Data

We used RSMeans to collect cost data.[49] We broke the initial planting data into labor costs and material costs. Labor and material costs were estimated using an average across multiple planting sizes as well as a variety of representative sapling species. We calculated tree maintenance costs by combining water, fertilizer, pruning, and pest spraying. We adjusted the costs to 2023 values using an inflation rate of 13.84%, per the Turner Building Cost Index.[50] Additionally, we adjusted the national average to Los Angeles County specific city cost index data.

48 C.P. Parks, "Cooling Center Operations in Los Angeles City." (City of Los Angeles Emergency Management Department, 2022), https://clkrep.lacity.org/onlinedocs/2021/21-1277_rpt_07-29-22.pdf.

49 Derrick Hale, "Site Work & Landscape Costs with RSMeans Data" (The Gordian Group, 2021), https://www.rsmeans.com/media/wysiwyg/2021-SiteWork-TOCs.pdf.

50 Rivetti, "Turner Building Cost Index: 2023 Second Quarter Forecast."

Determining Ideal Canopy Numbers

We combined canopy cover from 16 metropolitan areas across the country to serve as representative models for different size municipalities in Los Angeles County including each city's canopy coverage goal percent, canopy goal year, current canopy coverage, the year the current canopy coverage was calculated, and the current population density. Regressing on these variables with goal canopy percent as the dependent variable resulted in an adjusted R squared value of 0.73.

The output regression formula is:

Canopy Cover Goal % = -5.4913424 + (-3.74075E-06 * (Pop Density))
+ (1.073584308 * (Initial Canopy Cover))
+ (0.003353585 * (Year Assessed))
+ (-0.000552275*(Target Year))

We used the formula to calculate goals for municipalities for each development level as shown below. We used a target year of 2033 based on a 10-year period for trees to reach their average canopy cover (Table C3).

Table C3: Los Angeles County urban canopy model. Note that each municipality has an average current and goal canopy cover. The percentages in this table represent the average of those current and goal canopy covers across all incorporated municipalities.

Incorporated Municipalities		
Population Density	6,411	
Year Assessed	2023	
Target Year	2033	
Developed Area	**Current Canopy Cover (%)**	**Goal Canopy Cover (%)**
Medium Intensity	5.60	6.16
High Intensity	0.85	1.05

Table C4: The urban tree canopy coverage increase needed to meet the goal canopy cover for Los Angeles County. The table also shows how much it will cost to increase canopy coverage and the approximate number of trees to do so.

Developed Area	**Needed Increase (sq. ft.)**	**Cost to Increase**	**~# of Trees**
Medium Intensity	219,087,480	$39,435,746	697,931
High Intensity	46,223,874	$8,320,297	147,252
Total	**265,311,353**	**$47,756,044**	**845,183**

Cost Estimates

Table C5: Cost model for urban canopy in Los Angeles County showing an initial planting cost and then the costs in Year 1 (Y1), Y2, and Y3.

Developed Area	Initial Planting Cost	Y1 (2023)	Y2 (2024)	Y3 (2025)
Medium & High Intensity	$330,764,632	$47,282,063	$47,282,063	$47,282,063
Tree Mortality Cost	–	–	$22,491,995	$22,491,995
Total	**$330,764,632**	**$47,282,063**	**$69,774,058**	**$69,774,058**

The cost model uses a variety of inputs to calculate a final cost value. Important inputs include:

- Average canopy cover per tree (sq. ft.)
  - Average canopy cover in Los Angeles was determined by referencing a document released by Tree People listing approved street trees for the City of Los Angeles.[51] This list was then cross referenced against the Southern Nevada Water Authority regional plant list[52] which provides canopy coverage in square feet. Together these documents provided a list of 27 recommended trees and their coverage to average.
- Average annual cost to maintain an urban tree ($)
  - Explained above
- Initial cost to plant a tree ($)
  - Explained above
- Cost per canopy ($/sq. ft.)
  - Calculated by dividing cost to maintain an urban tree by the average canopy cover per tree
- Tree mortality rate Years 1-5 and Year 6+[53]

Next, we priced out these costs into the future. Year one costs include both the initial maintenance cost as well as the initial cost to plant trees. After year one, the maintenance cost stays the same. However, there is a tree mortality cost: for years 1-5 there is an assumed 6.8% loss of trees per year, and there is an assumed 3.3% loss for year 6+.[54] Each year, this loss is translated into the cost to replace that amount of trees. The cost model can be extended for as many years as desired and inflation costs can be incorporated based on whatever rate is deemed appropriate. Note that the model does not specify where trees are planted within the municipalities.

51 TreePeople, "City of Los Angeles Approved Street Tree List," 2021, https://www.treepeople.org/wp-content/uploads/2021/02/TreePeoples-LA-City-Approved-Street-Tree-List.pdf.

52 Southern Nevada Water Authority and Southern Nevada Regional Planning Coalition, "Regional Plant List," 2021, https://www.snwa.com/assets/pdf/water-smart-plant-list.pdf.

53 Deborah R. Hilbert et al., "Urban Tree Mortality: What the Literature Shows Us," *Arborist News*. Oct: 22-26. Oct (2019): 22, https://www.fs.usda.gov/research/treesearch/59819.

54 Ibid.

Appendix C.4: Combating Heat Islands – Cool Pavements

Taxpayer costs were analyzed at the municipal level.

It is possible that future drought conditions will hinder Los Angeles County's ability to support a robust tree canopy. In such a scenario, other approaches to urban temperature reduction will be required to maintain a favorable temperature in the urban environment. Converting existing areas of pavement to high-albedo cool pavement has been shown to decrease proximal ambient temperature and is a complementary approach to urban tree canopy that was considered as part of this report, as the City of Los Angeles has enacted an ordinance to "reduce nonroof heat islands for 75% of pathways, patios, or other paved areas" by utilizing both urban trees and cool pavements, as well as other strategies not considered in this study.[55]

Quantifying parking lot area in Los Angeles County

Only parking lots were considered for cool pavement adaptations due to the large surface area that parking lots cover in Los Angeles County and to maintain a conservative cost estimate. Parking lots also offer a more consistent canvas for cool pavement conversion than the variation existing among driveways, sidewalks, and other impermeable surfaces. Los Angeles County's official GIS website hosts information on the boundary of all parking lots in the county and was used to determine the current square footage of parking lots in incorporated areas of Los Angeles County.[56]

Cost Estimates

RSMeans[57] and an Environmental Protection Agency (EPA) study on cool pavement costs[58] informed the cost estimates used herein. Labor and material costs were estimated using an average across several cool pavement methods, including white topping, micro surfacing, and chip seal. Costs from the EPA document were adjusted to 2023 dollars using the National Highway Construction Cost Index (NHCCI).[59] RSMeans nationwide average costs were adjusted by a city cost index of $109.85 from the national average based on cities within Los Angeles County and also adjusted to 2023 dollars.

To determine final unit costs, we used a conservative method utilizing the lower cost of the range presented by the EPA along with the longer estimated service life for each method. For example, the EPA lists ultra-thin white topping as costing $1.50-$6.50 per installed square foot with an estimated lifespan between 10-15 years. For this method we use $1.50 per square foot and a lifespan of 15 years to factor into an average across multiple methods. A mix of methods were used due to the variety of current surfaces and conditions parking lots may exist in. Thus, variations of white topping, micro surfacing, and chip seal were all averaged to result in a $0.06/ft^2 annual cost for a 20-year estimate (Table C6). We present the cumulative 17-year cost in this study.

55 Council of the City of Los Angeles, "Ordinance No. 187208" (2021), https://www.ladbs.org/docs/default-source/publications/ordinances/20-1139_ord_187208.pdf?sfvrsn=6acdc153_9.

56 County of Los Angeles, "Parking Lots (2014) from LARIAC," 2023, https://egis-lacounty.hub.arcgis.com/datasets/413ba9befacf41a68f7dcad55a08f9a8_0/explore?location=33.867487%2C-118.278003%2C15.90.

57 Hale, "Site Work & Landscape Costs with RSMeans Data."

58 U.S. Environmental Protection Agency, *Reducing Urban Heat Islands: Compendium of Strategies. Cool Pavements,* 2012, https://www.epa.gov/sites/default/files/2017-05/documents/reducing_urban_heat_islands_ch_5.pdf.

59 Federal Highway Administration, "National Highway Construction Cost Index (NHCCI)," 2023, https://data.bts.gov/Research-and-Statistics/National-Highway-Construction-Cost-Index-NHCCI-/wgzr-nyxc.

Table C6: The minimum cost per square foot, the minimum lifespan, and the total 20-year cost for the various cool pavement techniques used in this analysis.

Source	Technique	$/sq ft.	Lifespan (years)	20-Year Cost ($/sq ft.)
EPA	Ultra-thin whitetopping	2.63	15	3.51
EPA	Microsurfacing	0.61	10	1.23
EPA	Chip Seal with light aggregate	0.18	8	0.44
RSMEANS	Chip Seal, Medium Fine, Parking lot	0.38	8	0.95
RSMEANS	Chip Seal, Medium, Parking lot	0.43	8	1.08
RSMEANS	Microsurfacing, Type II-MSE, Parking Lot	0.37	10	0.73
RSMEANS	Microsurfacing, Type IIa-MSE, Parking Lot	0.53	10	1.06

Appendix C.5: Maintaining Roads

Taxpayer costs were analyzed at the municipal, county, and state level.

To determine the potential future damage to municipal, county, and state roads in Los Angeles County, we analyzed both the historic environment and projected future conditions to determine how climate change will affect the as-designed condition of road infrastructure. Increasing temperatures cause more surface degradation[60] and decreases road lifespan.[61] Increasing precipitation levels cause erosion, which weakens the roadbase, causing increases in cracking, potholes, and breakage.[62] We designed distinct stressor-response functions for paved (assumed to be asphalt), gravel, and unpaved roads. Furthermore, within each category we made refinements for primary, secondary, and tertiary roads.[63] We identified local roads using a database containing Los Angeles County roads that are owned by municipalities, counties, or states. Ownership is determined for each road segment based on classification from the Census.[64] The costs associated with municipal roads in unincorporated areas are assigned to the county.

Temperature

Pavement temperature determines the required pavement design or the ability for the pavement to withstand temperature-related degradation.[65] We find a relationship between pavement temperature and 7-day maximum ambient air temperature ($T\text{-}7_{max}$), so we use historic and projected $T\text{-}7_{max}$ to determine when a projected change in temperature will be significant enough to cause climate-based damage to road infrastructure.

60 Degradation is the projected increase in raveling and cracking that will occur due to pavement weakening.

61 Transportation Research Board, "Superpave: Performance by Design," 2005, https://www.trb.org/publications/sp/superpave.pdf.

62 James E. Neumann et al., "Climate Change Risks to US Infrastructure: Impacts on Roads, Bridges, Coastal Development, and Urban Drainage," *Climatic Change* 131, no. 1 (July 1, 2015): 97–109, https://doi.org/10.1007/s10584-013-1037-4.

63 Paul Chinowsky and Channing Arndt, "Climate Change and Roads: A Dynamic Stressor–Response Model," *Review of Development Economics* 16, no. 3 (2012): 448–62, https://doi.org/10.1111/j.1467-9361.2012.00673.x.

64 U.S. Census Bureau, "TIGER/Line Shapefiles," 2022, https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.html.

65 Patrick Lavin, *Asphalt Pavements: A Practical Guide to Design, Production and Maintenance for Engineers and Architects* (London: CRC Press, 2003), https://doi.org/10.1201/9781482267716.

We used guidance from Superpave increments of pavement temperature to determine the exceedance parameters.[66] When pavement temperature rose above the mixture threshold, we calculated the increased degradation based on published material studies.[67] In the reactive scenario, this increased cracking requires more maintenance to avoid a decrease in the projected lifespan of the road.[68] In the proactive scenario, adaptation includes installation of roads with pavement rated to projected future temperatures.

Precipitation

We used historic and projected maximum monthly precipitation amounts to determine if excessive erosion will increase damage to the roadbase. We compared the historic maximum monthly precipitation to the projected change in maximum monthly precipitation rates at the time-slice of interest. We used a threshold based on the type of road surface to determine whether increased damage will occur to the road. If a threshold is exceeded, then a percentage decrease in lifespan is calculated based on the level of projected damage. In the proactive road scenario, adaptation for this scenario requires a strengthening of the roadbase to resist the increased potential for erosion. In the reactive road scenario, adaptation is fixing roads after precipitation-induced damage.

Cost Estimates

We conducted this analysis with the goal of retaining the original design life and service level of the roadways. We present costs for both a proactive and reactive adaptation approach.

Proactive: The proactive scenario includes the additional costs required to adapt design and construction to defend against projected changes in climate expected to occur over the asset's lifespan. We estimated total costs based on the cost associated with enhancing the materials selected or alternate design requirements. First, we generated stressor-response values for infrastructure elements. Next, we designed infrastructure to a level that protects against the future changes in climate conditions and the accompanying changes in material or design requirements. Last, we subjected any new or rehabilitated structures to material changes when it was anticipated that a significant climate change stressor would occur during the lifespan.

Reactive: Reactive adaptation costs were calculated to understand the cost-benefit of proactive adaptation. Reactive adaptation involves fixing roads as problems arise and is usually more expensive than a proactive approach. Damage threshold exceedance data from each grid within the climate model data is used to determine the level of additional maintenance and repair required for any given segment of road on an annual basis. This is then fed into the cost module where a per-mile maintenance cost is applied to each mile of road segment within each affected grid. Lastly, road maintenance costs are aggregated from a grid-level to a municipality-level using an area-based weighted average approach.

66 Transportation Research Board, "Superpave: Performance by Design."

67 M Miradi, "Artificial Neural Network (ANN) Models for Prediction and Analysis of Ravelling Severity and Material Composition Properties," ed. M. Mohammadian, *CIMCA* 2004, 2004, 892–903, https://research.tudelft.nl/en/publications/artificial-neural-network-ann-models-for-prediction-and-analysis-.

68 Ibid.

Appendix C.6: Wildfires

Taxpayer costs were analyzed at the municipal, state, and federal level. Costs for unincorporated municipalities were then assigned to the county.

Wildfire mitigation typically consists of two different strategies: controlled burns and mechanical intervention. Controlled burns focus on reducing fuel areas by intentionally lighting a fire in a small area of forest to eliminate fuel while reducing potential burn area in a larger blaze. Mechanical intervention focuses on reducing fuel for a fire by manually cutting and removing undergrowth, as well as thinning the density of forested area. Due to an increase in the number of fire days (i.e., length of the fire season),[69] controlled burns are not as feasible, as the available time for a controlled burn is being significantly reduced.[70] Thus, we estimate the cost of mechanical intervention for vulnerable areas in Los Angeles County. This approach requires more effort and cost, but it has the advantage of potentially generating revenue with harvested timber. Additionally, mechanical intervention can take place at any time of the year (i.e., it is not limited to low fire days).

Determining At-Risk Areas

We first identify the extent of the at-risk areas by determining the amount of area that falls within local fire responsibility areas and wildland urban interface[71]/intermix that has increased fire risk, as quantified through the Keetch-Byram Drought Index (KBDI). We focus on the wildland urban interface (WUI) that is under the responsibility of municipal or county firefighters. These areas include both forested areas and scrub brush areas known as chaparral as determined by the NLCD.[72] We use data from Cal Fire to find the amount of area that falls within each of the firefighting responsibility bounds.[73]

Data

- Wildland Urban Interface[74]
- Firefighting Responsibility Bounds[75]
- Los Angeles County Boundary
- Los Angeles County Municipalities
- NLCD 2021 Landforms[76]
- Keetch-Byram Drought Index (KBDI)[77]

69 A.L. Westerling et al., "Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity," *Science* 313 (2006): 940–43, https://doi.org/10.1126/science.1128834.

70 Bruce R. Hartsough et al., "The Economics of Alternative Fuel Reduction Treatments in Western United States Dry Forests: Financial and Policy Implications from the National Fire and Fire Surrogate Study," *Forest Policy and Economics* 10, no. 6 (August 2008): 344–54, https://doi.org/10.1016/j.forpol.2008.02.001.

71 Emilio Chuvieco et al., "Towards an Integrated Approach to Wildfire Risk Assessment: When, Where, What and How May the Landscapes Burn," *Fire* 6, no. 5 (May 2023): 215, https://doi.org/10.3390/fire6050215.

72 Multi-Resolution Land Characteristics Consortium, "National Land Cover Database Class Legend and Description," accessed December 4, 2023, https://www.mrlc.gov/data/legends/national-land-cover-database-class-legend-and-description.

73 Cal Fire, "GIS Mapping and Data Analytics," 2023, https://www.fire.ca.gov/what-we-do/fire-resource-assessment-program/gis-mapping-and-data-analytics.

74 Franz Schug et al., "The Global Wildland–Urban Interface," *Nature* 621, no. 7977 (September 7, 2023): 94–99, https://doi.org/10.1038/s41586-023-06320-0; Spatial Analysis For Conservation and Sustainability Lab, "The Global Wildland-Urban Interface (WUI) – 2020," 2023, https://silvis.forest.wisc.edu/globalwui/.

75 Cal Fire, "GIS Mapping and Data Analytics."

76 "Multi-Resolution Land Characteristics (MRLC) Consortium," 2023, https://www.mrlc.gov/.

77 U.S. Forest Service, "Keetch-Byram Drought Index (KBDI)," accessed November 28, 2023, https://www.drought.gov/data-maps-tools/keetch-byram-drought-index.

Estimating Costs

We use a cost of $1,500 per acre for mechanical intervention.[78] Given the area of potential mitigation responsibility and the cost per acre of treatment, the final element in the calculation is to determine what areas will require additional treatment. Historically, the fire season in Southern California runs from approximately July-October, or 120 days of mixed fire-risk days from low to extreme. The season generally ends with autumn rains and lower temperatures that arrive in November. However, climate change has caused temperatures to increase on both sides of the traditional fire season.[79] With this trend continuing, we utilize a threshold of 100 high or extreme fire days (as determined by KBDI measurements) as the indicator of whether mechanical treatments should be employed. This threshold reflects both an increase in the number of severe days during the traditional season as well as an increase in the number of days that are occurring outside the traditional season. Where the threshold is exceeded, the cost per acre is applied to the WUI area impacted by the increased number of fire days.

Appendix C.7: Los Angeles Metro Rail Improvements

Taxpayer costs were analyzed at the county level.

The Los Angeles metro rail system, and other light rail systems, are susceptible to damage from increasing temperatures similar to commercial Class 1 rail. Specifically, rails will deform as temperatures increase above a neutral temperature. This can cause separation between the rails as well as the potential for significant deformation if trains are allowed to continue to run on the rails in the hot temperatures.[80]

Adaptation Strategies

The traditional approach to minimizing this impact is to put slow-down orders in place which require operations to be slowed or stopped for a period of time until the temperatures return to normal operating levels. The adaptation to this impact is to either enhance the detection of heated rails to target slow-down orders, or to implement an approach to reduce the heating of the rails themselves. Currently, Los Angeles Metro (LA Metro), the operator of the Los Angeles County metro rail system, implements a combination of slow-down orders and heat sensors to reduce temperature-induced delays.[81] Slow-down orders are put in place when temperatures exceed 90°F. Concurrently, heat sensors have been installed to enable the system to put slowdown orders in on specific lines rather than over the entire system.[82]

The next step in adaptation is to focus on reducing the temperature of the rails during heat events. The approach adopted for this study is to coat the rails with reflective paint. This is an approach currently adopted in Europe and Australia and has been shown to have positive effects for reducing the temperature of rails.[83] While this is a new approach, initial studies have demonstrated the potential to reduce temperatures by 10°C or more.[84]

78 Ibid.

79 Chunyu Dong et al., "The Season for Large Fires in Southern California Is Projected to Lengthen in a Changing Climate," *Communications Earth & Environment* 3, no. 1 (2022): 22, https://doi.org/10.1038/s43247-022-00344-6.

80 Paul Chinowsky et al., "Impacts of Climate Change on Operation of the US Rail Network," *Transport Policy* 75 (March 1, 2019): 183–91, https://doi.org/10.1016/j.tranpol.2017.05.007.

81 Ryan Fonseca, "Will LA Metro Be Ready To Take The Heat Of Climate Change? It's 'Complicated,'" *LAist*, September 20, 2019, sec. News, https://laist.com/news/la-metro-climate-change-extreme-heat.

82 Karen Gorman, "Office of Inspector General 'Is LA Metro Ready for Climate Change?,'" https://www.documentcloud.org/documents/6422665-la-metro-climate-change-presentation.html.

83 Federal Railroad Administration, "Quantification of the Effectiveness of Low Solar Absorptivity Coatings for Reducing Rail Temperature," 2015, https://railroads.dot.gov/sites/fra.dot.gov/files/fra_net/15600/Effectiveness_of_Solar_Coatings_final.pdf; Federal Railroad Administration, "Low Solar Absorption Coating for Reducing Rail Temperature and Preventing Buckling," 2018, https://railroads.dot.gov/sites/fra.dot.gov/files/fra_net/18062/Low%20Solar%20Absorption%20Coating%20for%20Reducing%20Rail%20Temperature%20and%20Preventin..._.pdf; Julian Turner, "Cool Runnings: Is White Paint the Perfect Solution to Overheated Rail Tracks?," *Railway Technology* (blog), December 4, 2019, https://www.railway-technology.com/features/solution-to-overheated-rail-tracks/.

84 Hao Wang, Milad Salemi, and P. N. Balaguru, "Multifunctional Coating System for Rail Track Applications" (2017 Joint Rail Conference, American Society of Mechanical Engineers Digital Collection, 2017), https://doi.org/10.1115/JRC2017-2323.

The cost estimate of the coatings approach is based on the need for a crew to apply the coating across the LA Metro system. The LA Metro system consists of 109 miles of track. The track requires one coat of primer plus two coats of topcoat. It is estimated based on product information that 10 buckets of primer and 20 buckets of topcoat are required per mile. This is equivalent to $7,500 per mile in materials. Over the entire system, this would equate to $817,500.

The labor cost is based on a method developed in Australia that utilizes a mechanized approach with a vehicle and spray application.[85] Using a crew of four painters and a laborer applying coating at 5 km/hr, it is estimated that it will take about one week to do each coat, or three weeks to complete the application over the entire system. Labor cost is anticipated to be less than $100,000 in total.

The result of this would be an estimated $1 million per required application of coating. We present the cost of painting rail every year, as the Los Angeles County climate is similar to Rome, Italy, where rails have been painted annually for several decades. The summer temperatures between the two locations are similar with average temperatures within 5°F of each other and max temperatures within 10°F. Winter temperatures and rain amounts are also similar, making Rome and Los Angeles good comparisons. Given this relationship, it is assumed that an annual application is needed. This equates to a cumulative cost of $17 million from 2024 through 2040.

Appendix D: Methodologies for estimating the cost to address precipitation-related impacts

Appendix D.1: Drainage & Stormwater Infrastructure: Mitigating Urban Flooding and Inflow to Water Treatment Plants

Taxpayer costs were analyzed at the municipal level. Costs for unincorporated municipalities were assigned to the county.

We assessed the impact of increases in extreme wet weather events to wastewater conveyance systems and wastewater treatment plants and processes. The most significant impact of increased rainfall on wastewater conveyance systems are increased overflows, blockages, and breakages. Increased rainfall intensity and extreme weather events are likely to lead to increased occurrence of inflow and infiltration (I&I) into wastewater networks. This occurs when stormwater directly enters combined networks or infiltrates the sewer network through cracks, direct connections, and corroded manholes.[86]

The most significant impacts likely to affect treatment plants and processes are increased inflows and power outages. Increased rainfall will result in larger volumes and peak inflows into wastewater treatment plants as a result of flow from combined systems and I&I. While the volume or 'flow' of the wastewater increases during increased stormwater infiltration, the total suspended solids (TSS) of the wastewater remains the same, resulting in a dilution of the influent to the wastewater treatment plant, which can affect biological treatment processes.[87] During extreme weather events, system bypasses can be activated, diverting flows past part or all of the treatment process. This causes partially treated or untreated wastewater to directly enter the receiving environment.[88]

85 Pacific Edge Pty Ltd, "Rail Painting Process," 2005, https://www.solacoat.com.au/wp-content/uploads/2020/07/6-Solacoat-Railway-Painting-Process-Report.pdf.

86 James Hughes et al., "Impacts and Implications of Climate Change on Wastewater Systems: A New Zealand Perspective," *Climate Risk Management* 31 (January 1, 2021): 100262, https://doi.org/10.1016/j.crm.2020.100262.

87 Benedek Gy Plósz, Helge Liltved, and Harsha Ratnaweera, "Climate Change Impacts on Activated Sludge Wastewater Treatment: A Case Study from Norway," *Water Science and Technology: A Journal of the International Association on Water Pollution Research* 60, no. 2 (2009): 533–41, https://doi.org/10.2166/wst.2009.386.

88 J. G. Langeveld, R. P. S. Schilperoort, and S. R. Weijers, "Climate Change and Urban Wastewater Infrastructure: There Is More to Explore," *Journal of Hydrology* 476 (January 7, 2013): 112–19, https://doi.org/10.1016/j.jhydrol.2012.10.021.

To combat increased inflow to wastewater treatment plants, we estimate how much it will cost to install drainage and stormwater infrastructure (referred to as green infrastructure in the engineering literature).[89] Drainage and stormwater infrastructure includes bio retention, porous pavement, bioinfiltration, and bioswale construction. By increasing pervious surfaces with drainage and stormwater infrastructure, flooding during wet weather events decreases, offsetting what would have been increased inflows to wastewater treatment plants from climate change. We choose this adaptation, as opposed to expanding or adding culverts and storm drains, as it is generally low-impact and less expensive. The California State Water Resources Control Board has a report on green (drainage and stormwater) infrastructure for Los Angeles.[90]

Change in wet weather events

We look at the change in magnitude of the 98% precipitation event and the 99.6% precipitation event. The 98% precipitation event represents the threshold for a "high-precipitation event," which occurs approximately seven times a year and could cause moderate increases of inflow into the wastewater treatment plants. The 99.6% precipitation event represents the extreme wet weather event that could cause large increases of inflow into the wastewater treatment plants and occurs approximately once per year.

We calculate the percent change in these events from the change in rainfall depth (inches) for a certain percentile between the two distributions (baseline distribution and the projected distribution). For example, if the 99.6% baseline wet weather event is 3 inches and the projected 99.6% wet weather event is 3.3 inches, then we would say the extreme wet weather event increased by 10%. We use the maximum of the high (98%) and extreme (99.6%) change for the next step.

Given a change in wet weather events, we assume that the municipality must invest to offset additional runoff (thus infiltration and inflow) into the wastewater treatment plant. We assume the offset is proportional to the change in wet weather events. For example, if the wet weather events are increasing by 10%, then 10% of the developed impervious area needs to be offset by drainage and stormwater infrastructure.

We calculate the developed impervious area using the NLCD.[91]

We derived the per-unit cost for drainage and stormwater infrastructure from the following equation:[92]

- Cost = A * ΔWWE * DSI
- Where:
  - A is area of developed impervious surfaces (acres)
  - ΔWWE is the change in wet weather events (%)
  - DSI is the unit cost of drainage and stormwater (green) infrastructure ($ per impervious acre controlled)

89 S.E Gill et al., "Adapting Cities for Climate Change: The Role of the Green Infrastructure," *Built Environment* 33, no. 1 (March 13, 2007): 115–33, https://doi.org/10.2148/benv.33.1.115.

90 California State Water Resources Control Board, "Green Infrastructure for Los Angeles: Addressing Urban Runoff and Water Supply Through Low Impact Development," 2009.

91 Earth Resources Observation and Science (EROS) Center, "National Land Cover Database" (U.S. Geological Survey, 2021), https://www.usgs.gov/centers/eros/science/national-land-cover-database.

92 Allegheny County Sanitary Authority, "Staring at the Source: How Our Region Can Work Together for Clean Water - Appendix E-3: GIS Cost Literature Review," 2015, https://www.alcosan.org/docs/default-source/clean-water-plan-documents/cwp-appendixe/cwp-appendix-e-3_gsi-cost-literature-review.pdf?sfvrsn=6d863977_2.

GSI unit costs are sourced from a green (drainage and stormwater) infrastructure report.[93] The unit costs are adjusted to Los Angeles County using an RSMeans location multiplier. Finally, the costs are adjusted to 2023 dollars.

Appendix D.2: Bridge Stabilization

Taxpayer costs were analyzed at the municipal, county, and state level.

Climate-driven changes in precipitation will increase the flow rates of waterways, thereby increasing the rate of wear and tear on the bridges that span them. To approximate bridge-related costs associated with the projected increase in precipitation, we developed a method that translates increases in 24-hour precipitation rates to changes in flow rates in waterways where bridges are present. From there, we calculated the potential increase in damage to bridges resulting from increases in scour around the base of the piers. While there are multiple climate-related costs associated with bridges, we chose to quantify the cost to proactively rehabilitate bridges in order to prevent disruption. We classify bridges into municipal, county, and state owned using the National Bridge Inventory ownership identifiers. The costs associated with municipal bridges in unincorporated areas are assigned to the county.

Methods based on the United States Department of Agriculture's Natural Resources Conservation Service (NRCS) TR-20 model were used to translate 24-hour rainfall "design-storm" depths to peak discharge.[94] This model is based on empirical runoff relationships referred to as the Soil Conservation Service Curve Number Method.[95] The bridge data is from the National Bridge Inventory,[96] from which we selected only inland bridges that spanned bodies of water. Changes in runoff were determined based on a study of the watersheds feeding the waterways. The location and details of the rivers were derived from the USGS Hydrologic Unit Code 8 (HUC 8) database for Los Angeles County.[97] We determine the increase in peak discharge based on a study of the watersheds at the HUC8 level feeding the local waterways. We utilize daily runoff data, which covers Los Angeles County. The LOCA Global Climate Model (GCM) projections provide daily precipitation outputs from the Coupled Model Intercomparison Project Phase 6 (CMIP6) as inputs.

Cost Estimates

We quantified the cost to proactively rehabilitate bridges to prevent disruptions by applying riprap to stabilize bridges and additional concrete to strengthen piers and abutments. We rehabilitate bridges only if they are known to be threatened by a near-term river flow level that crosses one of the thresholds. We stabilize bridges only if projected runoff increases by 20% compared to the baseline. We strengthen piers and abutments only when runoff increases by 60% compared to the baseline for bridges on non-sandy soils and by 100% compared to the baseline for bridges on sandy soils. The percent increase in runoff for the different soil types are based on federal guidelines and were also utilized in Wright et al. (2012).[98] This method may underestimate potential damages because proactive costs are likely far lower than repairing or rebuilding a failed bridge.[99] Notably, our analysis does not estimate damages associated with delays/disruptions from the bridge being closed.

93 Ibid.

94 Len Wright et al., "Estimated Effects of Climate Change on Flood Vulnerability of U.S. Bridges," *Mitigation and Adaptation Strategies for Global Change* 17, no. 8 (December 1, 2012): 939–55, https://doi.org/10.1007/s11027-011-9354-2.

95 Surendra Kumar Mishra and Vijay P. Singh, Soil Conservation Service Curve Number (SCS-CN) Methodology, vol. 42, *Water Science and Technology Library* (Dordrecht: Springer Netherlands, 2003), https://doi.org/10.1007/978-94-017-0147-1.

96 Federal Highway Administration, "National Bridge Inventory," 2023, https://www.fhwa.dot.gov/bridge/nbi/ascii.cfm.

97 "Hydrologic Unit Maps," United States Geological Survey, accessed December 13, 2023, https://water.usgs.gov/GIS/huc.html.

98 Wright et al., "Estimated Effects of Climate Change on Flood Vulnerability of U.S. Bridges."

99 Neumann et al., "Climate Change Risks to US Infrastructure."

Appendix D.3: Drought Impact on Drinking Water

Taxpayer costs were analyzed at the municipal level for incorporated municipalities and at the county level for unincorporated municipalities.

The impact of drought is broad, extending from agriculture to ground subsidence, and drinking water quality. In California, drought has been shown to impact water-related ecosystem services[100] and degrade drinking water quality[101] (both groundwater[102] and surface water). In this analysis, we focus on the additional cost of treating drinking water due to drought.[103]

Drinking water treatment costs are higher during drought events because increased sediment and nutrient concentration occur as drought conditions emerge. The Cadmus Group describes this effect as follows, "Because source water quality can be affected by drought conditions (i.e., sedimentation can increase and runoff is likely to have elevated concentrations of pollutants), drinking water utilities will likely face increased costs related to water treatment during drought."[104]

The cost of this impact is based on a study by Dearmont et al. (1998) that is still referenced as the basis for drought-based costs for water treatment.[105] Further from the study, "[the authors] determined that the cost of water treatment would increase by $94.75 per million gallons when elevated concentrations of chemical contaminants are present in source water." Adjusting this cost to 2023 dollars, the additional cost to treat drinking water during drought events is $223 per million gallons.

We use both the previous drought-related restriction of residential water use to 80 gallons per capita per day mandated by the Metropolitan Water District of Southern California[106] as a low-end estimate and the average consumptive demand for Los Angeles County of 120 gallons per capita per day as a high-end estimate of water use.[107] With a 2020 Census population of around 10 million,[108] the total residential water use for Los Angeles County is estimated at 801 million gallons per day during drought and 1.2 billion gallons per day on average. This means that it will cost Los Angeles County an additional $179,000 per day to treat water during drought events, depending on whether or not water restrictions are implemented and whether or not residents follow those restrictions. This equates to a monthly cost of around $5.4 million per additional month of projected drought.

We estimate the increase in drought days for the municipalities in Los Angeles County, which allows us to estimate an increase in water treatment costs due to climate change induced drought. This cost is divided among the municipalities in the county based on population as the individual municipalities contract with Los Angeles County for drinking water.

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100 Heejun Chang and Matthew Ryan Bonnette, "Climate Change and Water-Related Ecosystem Services: Impacts of Drought in California, USA," *Ecosystem Health and Sustainability* 2, no. 12 (2016): e01254, https://doi.org/10.1002/ehs2.1254.

101 Benjamen Wright et al., "Managing Water Quality Impacts from Drought on Drinking Water Supplies," *Journal of Water Supply: Research and Technology-Aqua* 63, no. 3 (November 7, 2013): 179–88, https://doi.org/10.2166/aqua.2013.123.

102 Zeno F. Levy et al., "Critical Aquifer Overdraft Accelerates Degradation of Groundwater Quality in California's Central Valley During Drought," *Geophysical Research Letters* 48, no. 17 (2021): e2021GL094398, https://doi.org/10.1029/2021GL094398.

103 "Water Utilities," 2023, Drought.gov, accessed December 13, 2023, https://www.drought.gov/sectors/water-utilities.

104 Julie Blue et al., "Drought Management in a Changing Climate: Using Cost-Benefit Analyses to Assist Drinking Water Utilities" (Water Research Foundation and NOAA, 2015), https://cadmusgroup.com/wp-content/uploads/2015/08/WaterRF_Drought-Management.pdf.

105 David Dearmont, Bruce A. McCarl, and Deborah A. Tolman, "Costs of Water Treatment Due to Diminished Water Quality: A Case Study in Texas," *Water Resources Research* 34, no. 4 (1998): 849–53, https://doi.org/10.1029/98WR00213.

106 Hayley Smith and Ian James, "To Survive Drought, Parts of SoCal Must Cut Water Use by 35%. The New Limit: 80 Gallons a Day," *Los Angeles Times*, April 30, 2022, sec. California, https://www.latimes.com/california/story/2022-04-30/can-you-get-by-on-just-80-gallons-of-water-a-day.

107 "Our County Water Briefing," 2018, https://ourcountyla.lacounty.gov/wp-content/uploads/2018/08/Our-County-Water-Briefing_For-Web.pdf.

108 U.S. Census Bureau, "U.S. Census Bureau QuickFacts: Los Angeles County, California," 2022, https://www.census.gov/quickfacts/fact/table/losangelescountycalifornia/PST045222.

Note that we assume that drought-related water use restrictions will be implemented and residents will follow those restrictions. As such, we present the increased cost to treat an average of 80 gallons of water use per capita per day in the total cost to taxpayers in Los Angeles County in the report. The associated data download presents the increased cost to Los Angeles municipalities to treat 80 gallons of water use per capita per day.

Appendix E: Protecting Infrastructure from Sea Level Rise

Taxpayer costs were analyzed at the county level.

The methods used to estimate the cost of protecting infrastructure from sea level rise in Los Angeles County are from a previous study that estimated the price to protect coastal communities from sea level rise by constructing seawalls.[109] Note that this previous study used the Relative Concentration Pathway 4.5 (RCP4.5) instead of the SSP2-4.5, which is used in all other analyses in this report.

Appendix F: Methodologies for estimating the cost to treat climate-induced illnesses

In all public health analyses, a baseline year of 2010 was used to determine increased costs of hospitalizations due to climate change.

Appendix F.1: Treating Pediatric Asthma

Taxpayer costs for pediatric asthma were analyzed at the federal level.

Pediatric asthma-related emergency room visits are directly correlated to pollen levels, and therefore to climatic conditions that are projected to change in the coming decades. We quantify the cost of treatment for climate-induced respiratory illness for both the baseline and projected time periods. We define the asthma baseline as the average number of hospital visits for asthma in Los Angeles County per year from 2002 to 2019, which are documented in the National Environmental Public Health Tracking Network.[110] The baseline does not use data from 2020 onward because COVID-19 significantly reduced the number of pediatric asthma emergency department visits.[111] We use a distribution curve relating the number of asthma cases to pollen levels[112] to determine weekly asthma cases, since the National Environmental Public Health Tracking Network only reports asthma cases annually and ages are not included in the data. We use the documented pollen counts for trees, weeds, and grasses (pollen types) from 2018-2021 to set an average weekly level.[113] Average pollen load is determined by adding all pollen counts together and then dividing by the time period to smooth peaks that occur in some of the years.

The annual minimum temperature is used to calculate pollen counts for the asthma baseline and projection time periods to see a general trend in case counts.

109 Sverre LeRoy et al., "High Tide Tax: The Price to Protect Coastal Communities from Rising Seas" (Center for Climate Integrity and Resilient Analytics, 2019), https://climatecosts2040.org/files/ClimateCosts2040_Report.pdf.

110 Centers for Disease Control and Prevention, "National Environmental Public Health Tracking Network," n.d., https://ephtracking.cdc.gov/DataExplorer/.

111 Tregony Simoneau et al., "Impact of the COVID-19 Pandemic on Pediatric Emergency Department Use for Asthma," *Annals of the American Thoracic Society* 18, no. 4 (April 2021): 717–19, https://doi.org/10.1513/AnnalsATS.202007-765RL.

112 Paul J Villeneuve et al., "Outdoor Air Pollution and Emergency Department Visits for Asthma among Children and Adults: A Case-Crossover Study in Northern Alberta, Canada," *Environmental Health* 6 (December 24, 2007): 40, https://doi.org/10.1186/1476-069X-6-40.

113 Allergy, Asthma, & Sinus Center, S.C., "Pollen Explorer," 2023, https://myaasc.com/pollen-explorer.

Asthma Cases

We determine the impact of climate change on pollen loads by using the relationship between pollen load and annual cumulative minimum temperature.[114] The relationship used to determine pollen counts based on temperature comes from the slope of the best fit line in Figure F1. Using this relationship, we calculate the percent change in pollen load for each type of pollen (tree, grass, weed) through time compared to the baseline year (2010).

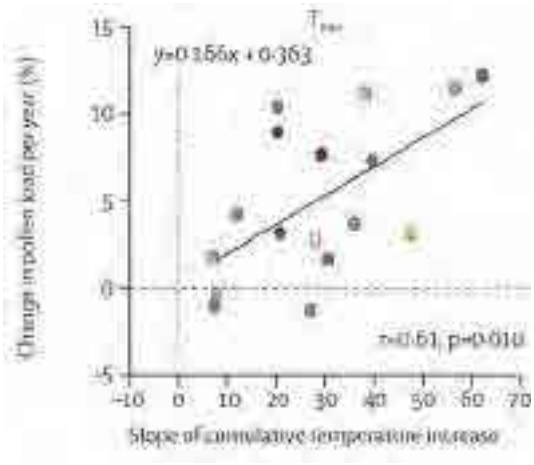


Figure F1: Slope of cumulative temperature increase (-) versus the change in pollen load per year (%) taken from Ziska et al. (2019).

Research has shown that pediatric emergency room visits increase in proportion to pollen loads.[115] Based on this research, we estimate the increase in cases from increase in pollen levels for each pollen type (Table F1).

Table F1: The 5-day average unit increase[116] for different pollen types and the corresponding increase in emergency room visits for pediatric asthma.

Pollen Type	5-day Average Pollen Concentration	5-day Average Pediatric Emergency Department Visits
Tree	664 unit increase	23% increase in visits
Grass	10 unit increase	2% increase in visits
Weed	10 unit increase	13% increase in visits

Cost Estimates

The yearly cost increase of the emergency room visits was established based on insurance type and what the individual scenarios cover.[117] The percent of patients with each insurance coverage and the corresponding cost per visit for that scenario (Table F2).

Table F2: The average breakdown of pediatric asthma visits in the United States.

Type of Insurance	Patient Count	Cost per Asthma Visit	Government Funded?
Uninsured	11.9%	$1,120	No
Medicaid	50.2%	$1,108	Yes – Federal
Medicare	0.5%	$414	Yes – Federal
Private	40.2%	$1,263	No

114 Lewis H. Ziska et al., "Temperature-Related Changes in Airborne Allergenic Pollen Abundance and Seasonality across the Northern Hemisphere: A Retrospective Data Analysis," *The Lancet. Planetary Health* 3, no. 3 (March 2019): e124–31, https://doi.org/10.1016/S2542-5196(19)30015-4.

115 Jessie A. Gleason, Leonard Bielory, and Jerald A. Fagliano, "Associations between Ozone, PM2.5, and Four Pollen Types on Emergency Department Pediatric Asthma Events during the Warm Season in New Jersey: A Case-Crossover Study," *Environmental Research* 132 (July 2014): 421–29, https://doi.org/10.1016/j.envres.2014.03.035.

116 1 unit increase is 1 grain per cubic meter. Since each source contains a different amount of pollen, unit increases are different for each source.

117 Tiffany Wang et al., "Emergency Department Charges for Asthma-Related Outpatient Visits by Insurance Status," *Journal of Health Care for the Poor and Underserved* 25, no. 1 (February 2014): 396–405, https://doi.org/10.1353/hpu.2014.0051.

Appendix F.2: Treating Increasing Incidence of West Nile Virus

Taxpayer costs were analyzed at the federal level.

West Nile Virus (WNV) is carried and transmitted by a genus of mosquitoes that thrive in warmer climates.[118] WNV was first detected in mosquitoes in Los Angeles in September 2003[119] and the first case in a human was reported the year after. Studies have shown that warmer temperatures are linked to accelerated mosquito breeding, bite rates, and the incubation of WNV within mosquitoes.[120] Increased rainfall can also contribute to expanding the suitable breeding grounds for mosquitoes.[121] While most people infected with WNV experience no symptoms, a small percentage develop life-threatening illness.[122]

We modeled the increasing number of cases of WNV in Los Angeles County and the associated health costs as a result of rising temperatures. We established a current WNV-infection rate for Los Angeles County using data provided by the CDC.[123] We used both mean weekly maximum temperature and daily maximum precipitation to model the future WNV incidence rate for Los Angeles County. We distribute cases by week by using the weekly incidence curve[124] since the county data is reported annually.

If the week's mean weekly maximum temperature is at least 5°C higher than the climate baseline (1991-2010), we assume the incidence increases by 40% that week and the following three weeks.[125] If the following three weeks also meet the same criteria, we do not increase the incidence by 40% again (i.e., the incidence will increase by 40% only once, even if all four weeks meet the temperature criteria).

If the week does not have increased incidences because of temperature, we then look at daily maximum precipitation per week.[126] If one or more days in a week have more than 50 mm of precipitation, then we assume the incidence increases by 33% that week and the following two weeks. If the following two weeks also meet that criteria, we *do not* increase the incidence by 33% again.

Because people cannot get WNV more than once, when the total case count reaches the county's population, we stop counting incidences.[127] Most of those infected with WNV experience no symptoms, while those that do get sick can have wide ranging symptoms. Using CDC data, we distributed the yearly incidences by manifestation (Table F3).[128]

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118 Pien Huang, "The U.S. Is Unprepared for the Growing Threat of Mosquito- and Tick-Borne Viruses," *NPR*, December 15, 2023, sec. Public Health, https://www.npr.org/sections/health-shots/2023/12/15/1219478835/arboviruses-mosquito-tick-borne-viruses-tropical-disease.

119 Jennifer L. Kwan et al., "West Nile Virus Emergence and Persistence in Los Angeles, California, 2003–2008," *The American Journal of Tropical Medicine and Hygiene* 83, no. 2 (August 5, 2010): 400–412, https://doi.org/10.4269/ajtmh.2010.10-0076.

120 David M. Hartley et al., "Effects of Temperature on Emergence and Seasonality of West Nile Virus in California," *The American Journal of Tropical Medicine and Hygiene* 86, no. 5 (May 1, 2012): 884–94, https://doi.org/10.4269/ajtmh.2012.11-0342; Shlomit Paz, "Climate Change Impacts on West Nile Virus Transmission in a Global Context," *Philosophical Transactions of the Royal Society B: Biological Sciences* 370, no. 1665 (April 5, 2015): 20130561, https://doi.org/10.1098/rstb.2013.0561; Nooshin Mojahed, Mohammad Ali Mohammadkhani, and Ashraf Mohamadkhani, "Climate Crises and Developing Vector-Borne Diseases: A Narrative Review," *Iranian Journal of Public Health* 51, no. 12 (December 2022): 2664–73, https://doi.org/10.18502/ijph.v51i12.11457.

121 C. B. Beard et al., "Ch. 5: Vectorborne Diseases," *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment* (U.S. Global Change Research Program, Washington, DC, April 4, 2016), https://health2016.globalchange.gov/vectorborne-diseases.

122 Centers for Disease Control and Prevention, "West Nile Virus," August 23, 2023, https://www.cdc.gov/westnile/index.html.

123 Centers for Disease Control and Prevention, "West Nile Virus Historic Data (1999-2022)," June 13, 2023, https://www.cdc.gov/westnile/statsmaps/historic-data.html.

124 Jonathan E. Soverow et al., "Infectious Disease in a Warming World: How Weather Influenced West Nile Virus in the United States (2001–2005)," *Environmental Health Perspective* 117, no. 7 (2009): 1049–52, https://doi.org/10.1289/ehp.0800487.

125 Ibid.

126 Ibid.

127 Centers for Disease Control and Prevention, "West Nile Virus."

128 Emily McDonald et al., "Surveillance for West Nile Virus Disease — United States, 2009–2018," *MMWR. Surveillance Summaries* 70 (2021), https://doi.org/10.15585/mmwr.ss7001a1.

Table F3: Initial and long-term cost to treat manifestations of West Nile Virus. Non-neuroinvasive manifestations only have an initial cost, and neuroinvasive manifestations have both an initial and long-term cost.

Manifestation Type	Initial Cost	Long-term Cost	Percent of Cases
Non-neuroinvasive	$5,873.07	$0	96.7%
Neuroinvasive			
Meningitis	$9,546.53	$181.44 per year	2.65%
Encephalitis	$19,900.34	$3,233,02 per year	0.35%
Acute Flaccid Paralysis	$27,313.00	$6,998.51 per year	0.15%

To account for death of a WNV patient due to the neuroinvasive WNV,[129] only 93.56% of the neuroinvasive cases are included in the long-term costs. This is because 6.44% of people with neuroinvasive WNV die within 90 days of symptom onset. To account for death for WNV patients that survive the first 90 days, 50% of the remaining 93.56% neuroinvasive WNV cases from 3 years prior starting in 2023 are removed. In other words, in 2023, 50% of the remaining 93.56% of neuroinvasive WNV cases are removed from 2020, in 2024, 50% of the remaining 93.56% of neuroinvasive WNV cases are removed from 2021, etc. This is because the median time between symptom onset and death is 3 years for people with neuroinvasive WNV if they did not die within the first 90 days. Thus, every year has an initial cost, a long-term cost, and a total yearly cost.[130]

Appendix G: Technical Documentation for Equity and Budget Analysis

Appendix G.1: Equity Analysis

All equity analysis was conducted in the R programming language.[131]

Data

The County of Los Angeles Enterprise GIS Hub[132] was used to determine census tract[133] and municipal[134] boundaries within Los Angeles County, as well as to obtain 11 demographic characteristics (Table G1) at the census tract level, which were collected by the Census Bureau as part of the 2020 American Community Survey 5-Year Data (ACS-5).[135]

129 David C.E. Philpott et al., "Acute and Delayed Deaths after West Nile Virus Infection, Texas, USA, 2002–2012," *Emerging Infectious Diseases* 25, no. 2 (February 2019): 256–64, https://doi.org/10.3201/eid2502.181250.

130 J. Erin Staples et al., "Initial and Long-Term Costs of Patients Hospitalized with West Nile Virus Disease," *The American Journal of Tropical Medicine and Hygiene* 90, no. 3 (March 5, 2014): 402–9, https://doi.org/10.4269/ajtmh.13-0206.

131 R Core Team (2023). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria, https://www.R-project.org/.

132 County of Los Angeles, "County Of Los Angeles Enterprise GIS," 2024, https://egis-lacounty.hub.arcgis.com/.

133 County of Los Angeles, "2020 Census Tracts," September 20, 2023, https://egis-lacounty.hub.arcgis.com/datasets/lacounty::2020-census-tracts-4/about.

134 County of Los Angeles, "City and Unincorporated Community Boundary (Regional Planning)."

135 United States Census Bureau, "American Community Survey 5-Year Data (2009-2022)," Census.gov, accessed January 29, 2024, https://www.census.gov/data/developers/data-sets/acs-5year.html.

Table G1: The 11 demographic characteristics from the ACS-5 analyzed in this study.

Equity Characteristic	County of Los Angeles Dataset Name136
Median Household Income	Census 2020 SRR and Demographic Characteristics[137]
Poverty Rate	
Percent Non-Hispanic White	
Percent Non-Hispanic Black	
Percent Non-Hispanic Asian	
Percent Hispanic	
Percent with Less Than a Highschool Education	
Percent without Internet	
Percent Disability	Disability Status (Census Tract)[138]
Percent Foreign Born Population	Foreign Born Population (Census Tract)[139]
Percent Uninsured	Health Insurance (Census Tract)[140]

Census tracts do not not align perfectly with municipal boundaries. A single census tract may intersect with more than one municipality and a municipality may contain multiple census tracts within its boundaries (Figure G1). Because the equity data is presented at the census tract level, it was first necessary to match each census tract to the municipality(s) that it intersects with and then determine the proportion of the census tract to be assigned to each intersecting municipality. First, we transform the coordinates for the municipal boundaries from World Geodetic System 84 (WGS84; decimal degrees) to North American Datum 83, Universal Transverse Mercator Zone 5 (NAD83, UTM Zone 5; US feet) to match the census tracts planar coordinate system. Then, we simply divide the area of a given municipality that intersects the given census tract by the total land area[141] of the given census tract. Assuming the population density in a given census tract is uniform, we estimate the population for each municipality by multiplying the fraction of the census tract that is in the municipality by the population of the census tract and round to the nearest whole number.[142] An example for census tract "400501" is shown below (Table G2).

136 The datasets for disability status, foreign born population, and health insurance contain information for one less census tract (990300) than the Census 2020 SRR and demographic characteristics dataset. Census tract 990300 has a population of 0, so this does not impact the equity analysis.

137 County of Los Angeles, "Census 2020 SRR and Demographic Characteristics," 2023, https://data.lacounty.gov/maps/e137518f57cf4dbc96ac7139a224631e/about.

138 County of Los Angeles, "Disability Status (Census Tract)," July 6, 2023, https://data.lacounty.gov/datasets/lacounty::disability-status-census-tract/about.

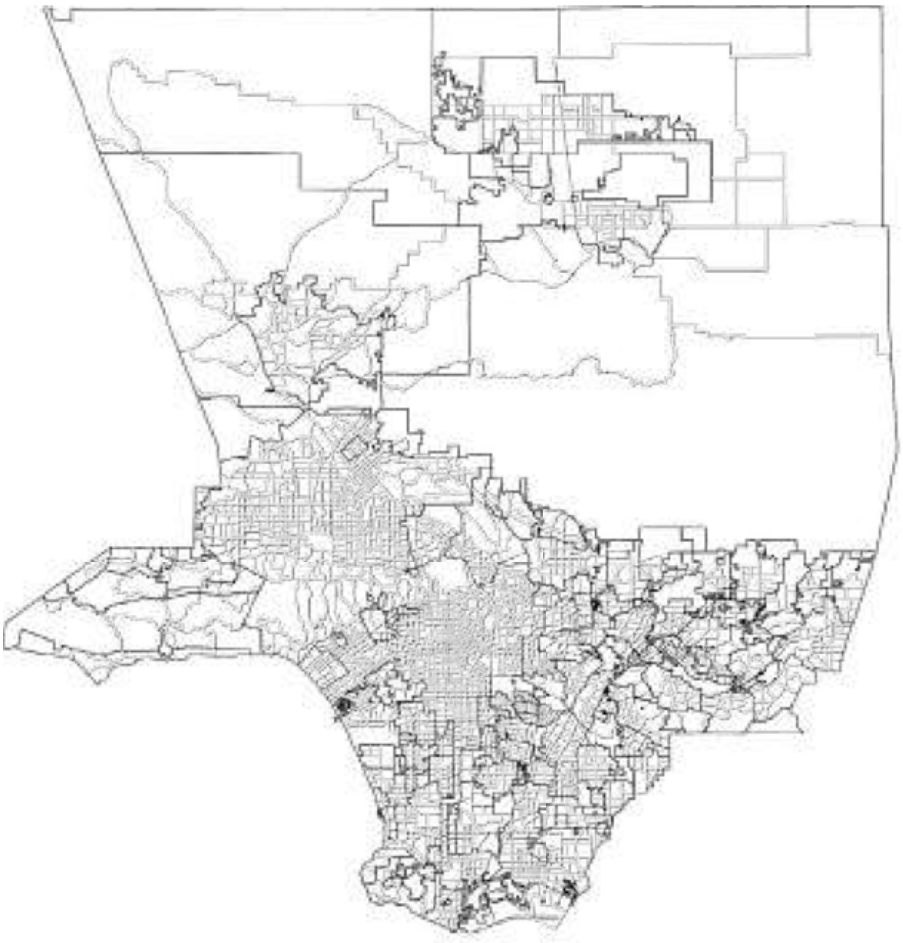
139 County of Los Angeles, "Foreign Born Population (Census Tract)," February 14, 2023, https://egis-lacounty.hub.arcgis.com/datasets/lacounty::foreign-born-population-census-tract/about.

140 County of Los Angeles, "Health Insurance (Census Tract)," https://egis-lacounty.hub.arcgis.com/datasets/lacounty::health-insurance-census-tract/about.

141 The municipal boundary shapefile contains "holes" in the data due to water (e.g. harbors). The census tracts do not contain these holes, so we use the land area of a census tract instead of total area, so that the area of the given census tract matches the area of all municipalities in the census tract. We do this by taking the sum of the area of all municipalities in the given census tract.

142 Due to rounding errors, we lose 25 residents or 0.00025% of the population of Los Angeles County.

Figure G1: Los Angeles County municipal boundaries (black outline) and census tract boundaries (gray outline).



Santa Catlina Island



Avalon

San Clemente Island



Table G2: An example of a population weighted estimate for census tract 400501, which exists within one incorporated municipality and three unincorporated areas.

Census Tract (CT20)	Municipality (CITY_COMM_)	Jurisdiction (JURISDICTI)	Area in CT20 (sq. ft.)	Proportion of CT20 in City	Area Weighted Population
400501	Antelope Valley	Unincorporated Area	22,032	0.0017	0
400501	Azusa	Incorporated City	1,806	0.000014	0
400501	East Azusa	Unincorporated Area	4,287,795	0.034	69
400501	Glendora	Incorporated City	118,637,700	0.94	1901
400501	Glendora Islands	Unincorporated Area	3,541,522	0.028	57
			Total Area	**Total Fraction**	**Total Population**
400501	–	–	126,490,830	1.00	2,027

We then take a population weighted average for each demographic dataset (Table G1) to determine an average characteristic for each municipality. The population (P) weighted average calculation for a given demographic characteristic in a given municipality is given by:

$$D_{muni} = \frac{P_{CT1} * D_{CT1} + P_{CT2} * D_{CT2} + P_{CT3} * D_{CT3} + \ldots + P_{CTx} * D_{CTx}}{P_{Total}} \quad \textit{(Eq. G1)}$$

where D_{muni} is the demographic characteristic in the city of interest, P_{CTx} is the area weighted population of the given census tract, D_{CTx} is the demographic characteristic in the given census tract, and P_{Total} is the total population in the given municipality. Table G3 outlines an example population (P) weighted average calculation (*Eq. G1*) for percent non-Hispanic white (NHW) residents in the City of Palos Verdes Estates following this logic.

Table G3: Non-Hispanic white population for each census tract (CT20) in Palos Verdes Estates and population weighted average non-Hispanic white population for the entire municipality.

City	CT20	Population (P)	Non-Hispanic White (D)
Palos Verdes Estates	651302	4	62.20%
Palos Verdes Estates	651304	1	63.25%
Palos Verdes Estates	670324	5117	74.59%
Palos Verdes Estates	670326	3706	63.73%
Palos Verdes Estates	670328	4500	55.76%
Palos Verdes Estates	670413	0[143]	39.55%
Palos Verdes Estates	670418	20	58.18%
Total: Palos Verdes Estates	**–**	**13,348**	**65.20%**

143 In some instances, a given census tract intersects such a small area of a municipality, that no population is assigned to the given municipality (see Table G3, census tract 670413). Note that the population of the census tract will be assigned proportionally to another municipality(s). We also note that the county has a "Split Tracts" dataset, which assigns census tracts to either incorporated municipalities or unincorporated Countywide Statistical Areas. Their method eliminates census tracts from a given municipality that intersect a negligible area of that given municipality (example census tracts 651302, 651304, 670413, 670418 in Palos Verdes Estates; Table G3).

We now have a dataset of all 11 population weighted demographic characteristics for all 162 municipalities in Los Angeles County. We use these data to assess how municipal per capita climate costs will impact residents across Los Angeles County. We define areas that are above or below, depending on the equity category, the Los Angeles County average statistic for that equity category (Table G4) as high priority equity areas.

Table G4: Los Angeles County mean demographic characteristics from the 2020 ACS-5 survey that are used to define the threshold for our equity categories.

Demographic Characteristic	Mean Characteristic for Los Angeles County[144]	Threshold	Number of Municipalities	Percentage of Municipalities
Median Household Income	$82,516	Low income if **below** $82,516	80	49%
Poverty Rate	13.9%	High poverty if **above** 13.9%	31	19%
Percent Non-Hispanic white	32.5%	Low white if **below** 32.5%	91	56%
Percent Non-Hispanic Black	7.9%	High Black if **above** 7.9%	32	20%
Percent Non-Hispanic Asian	15.0%	High Asian if **above** 15.0%	62	38%
Percent Hispanic	48.0%	High Hispanic if **above** 48.0%	66	41%
Percent Less Than High School Education	19.5%	Low education if **above** 19.5%	58	36%
Percent without Internet	7.4%	High if **above** 7.4%	94	58%
Percent Disabled	11.6%	High disability if **above** 11.6%	32	20%
Percent Uninsured	8.2%	High if **above** 8.2%	53	33%
Percent Foreign Born	33.1%	High foreign born if **above** 33.1%	63	39%

We note that municipalities can fall within multiple racial and ethnic demographic groups. For example, two municipalities fall within both the high white and high Hispanic groups,[145] 10 municipalities fall within both the high white and high non-Hispanic Black groups,[146] and 29 municipalities fall within the high white and high non-Hispanic Asian groups.[147]

144 U.S. Census Bureau, "Los Angeles County, California - Census Bureau Profile," Government, 2024, https://data.census.gov/profile/Los_Angeles_County,_California?g=050XX00US06037.

145 Avalon and Sylmar Island fall in both groups.

146 Altadena, Ballona Wetlands, Culver City, Lakewood, Marina del Ray, North Claremont, Northeast La Verne, Rolling Hills, West Fox Hills, and West Los Angeles fall in both groups.

147 Bradbury, Culver City, East Azusa, Gilmore Island, Kinneloa Mesa, La Canada Flintridge, La Crescenta - Montrose, La Habra Heights, La Habra Heights Islands, La Mirada, Lakewood, Lomita, North Claremont, Northeast La Verne, Oat Mountain, Palos Verdes Estates, Pasadena, Rancho Palos Verdes, Rolling Hills, Rolling Hills Estates, San Dimas, San Pasqual, Sierra Madre, South Pasadena, Torrance, Twin Lakes, West Fox Hills, West San Dimas, and Westfield fall in both groups.

Appendix G.2: Budget Analysis

As reported herein, communities in Los Angeles County face around $12.5 billion ($735 million per year) from 2024 through 2040 in adaptation costs to combat just 14 climate impacts. Using the adopted, appropriated budget for Los Angeles County for fiscal year 2023,[148] we examine how the 14 climate adaptation costs might stress the Los Angeles County departmental budgets (Table G5).

Table G5: Targeted county budget analysis for the Beaches & Harbors and Public Works (Water Resources, Transportation, Municipal Services) departments. Climate adaptations are assigned to each department of interest.

Fiscal Year	Department	Adopted Budget – Appropriated	Climate Adaptation
2023	Beaches & Harbors	$99,433,000	Coastal protection
	Public Works[149] – Water Resources	$1,836,914,000	Stormwater drainage and drinking water
	Public Works – Transportation	$882,475,000	Cool pavements, metro rail, road maintenance, bridge stabilization
	Public Works – Municipal Services[150]	$140,504,000	All services for unincorporated areas

We separate the adaptation strategies into the various departments based on publicly available information about which programs each department in Los Angeles County is responsible for. Since most of the adaptations are assigned to the Public Works Department, we separate the adaptations into different core service areas of the Public Works Department to better understand how implementing these climate change adaptations will stress the department.[151]

We also look at how the costs will stress municipal budgets within Los Angeles County. We use the publicly available budgets for the City of Los Angeles, the City of Long Beach, and the City of Santa Clarita, as those cities have some of the highest adaptation costs in the county (Table G6). Similar to our county budget analysis, we separate adaptation strategies into various departments based on publicly available information about which programs those departments are responsible for. We then compare the annual climate adaptation cost to the most recent annual budget for that department. We note that this can be done for any cost for any municipality estimated in this study.

148 LA County, "LA County Open Budget Appropriation (Auditor-Controller)," January 3, 2024, https://data.lacounty.gov/datasets/lacounty::la-county-open-budget-appropriation-auditor-controller/explore.

149 Public Works Los Angeles County, "FY2023-24 Core Services Areas Final Adopted Budget," https://content.pw.lacounty.gov/explore-public-works/budget/core-services-areas/.

150 Public Works Los Angeles County, "Municipal Services," LA County Public Works, 2024, https://content.pw.lacounty.gov/core-service-areas/municipal-services/.

151 Public Works Los Angeles County, "FY2023-24 Core Services Areas Final Adopted Budget."

Table G6: Targeted budget analysis for municipal climate adaptations are assigned to each department or budget line item of interest.

Fiscal Year	City	Department/Item	Budget	Climate Adaptation
2023	City of Long Beach	5-Year Climate Adaptation and Action Plan [152]	$16,350,000	Cool pavements
2024	City of Los Angeles	Street Tree and Parkway Maintenance[153]	$27,890,000	Urban canopy
2023	City of Santa Clarita	Stormwater Utility[154]	$4,802,000	Stormwater and drainage capacity
2024	City of Los Angeles	Capital Improvements - Flood Control[155]	$31,550,000	Stormwater and drainage capacity
2024	City of Los Angeles	Pavement Preservation[156]	$111,840,000	Proactive road maintenance

152 The City of Long Beach, "Innovation & Efficiency," 2023, https://longbeach.gov/globalassets/finance/media-library/documents/city-budget-and-finances/budget/budget-documents/fy-24-proposed-budget/fy-24-innovation-and-efficiency.

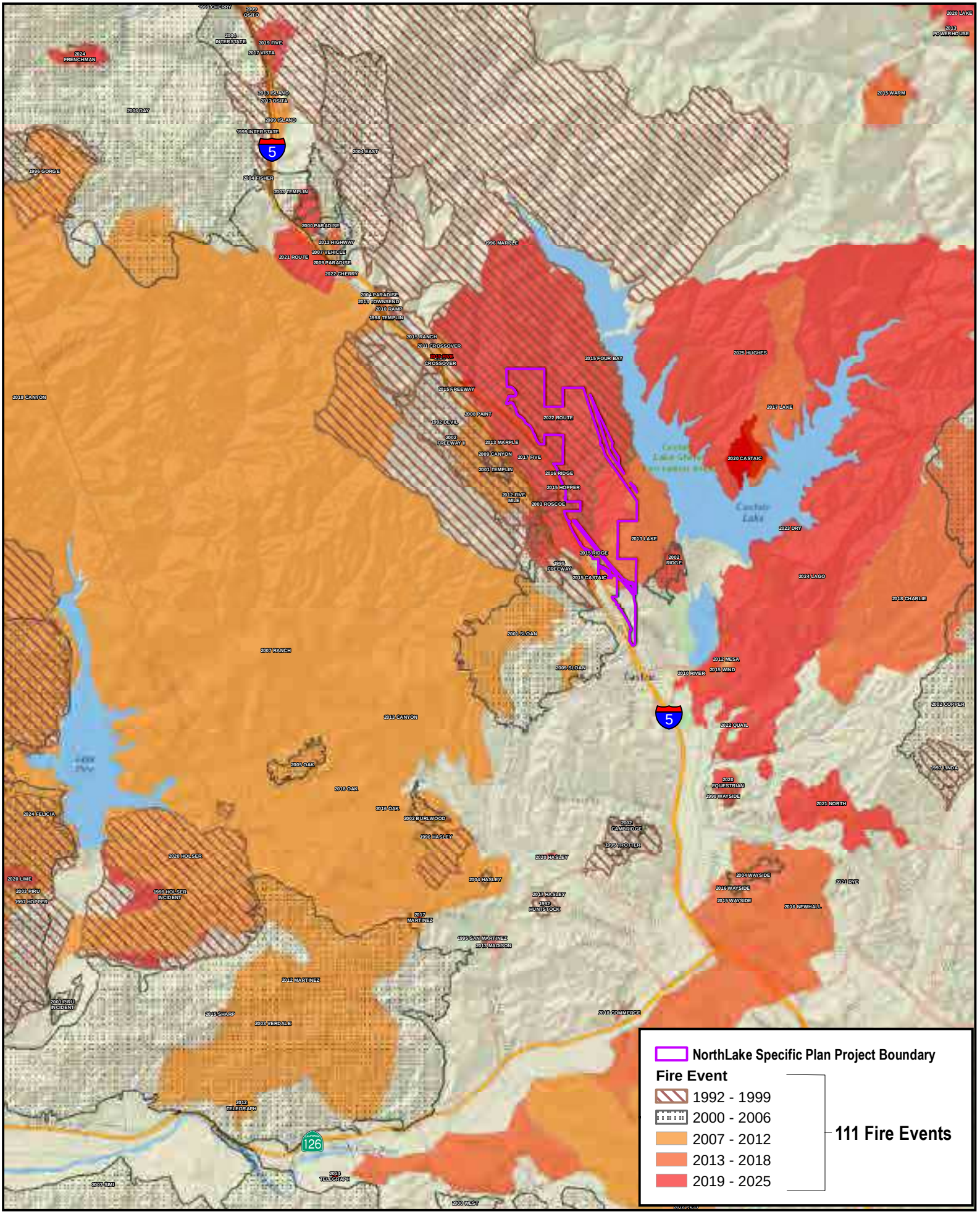
153 City of Los Angeles, "LA City Open Budget: Bureau of Street Services," 2024, https://openbudget.lacity.org/#!/year/2024/operating/0/department_name/Bureau+of+Street+Services/0/program_name.

154 City of Santa Clarita, "Annual Operating Budget & Capital Improvement Program: FY2023-2024," 2023, https://filecenter.santa-clarita.com/cmo/FY%202023-24%20Budget%20-%20opt.pdf.

155 City of Los Angeles, "LA City Open Budget: Capital Improvements - Flood Control," 2024, https://openbudget.lacity.org/#!/year/2024/operating/0/program_name/Capital+Improvements+-+Flood+Control/0/department_name.

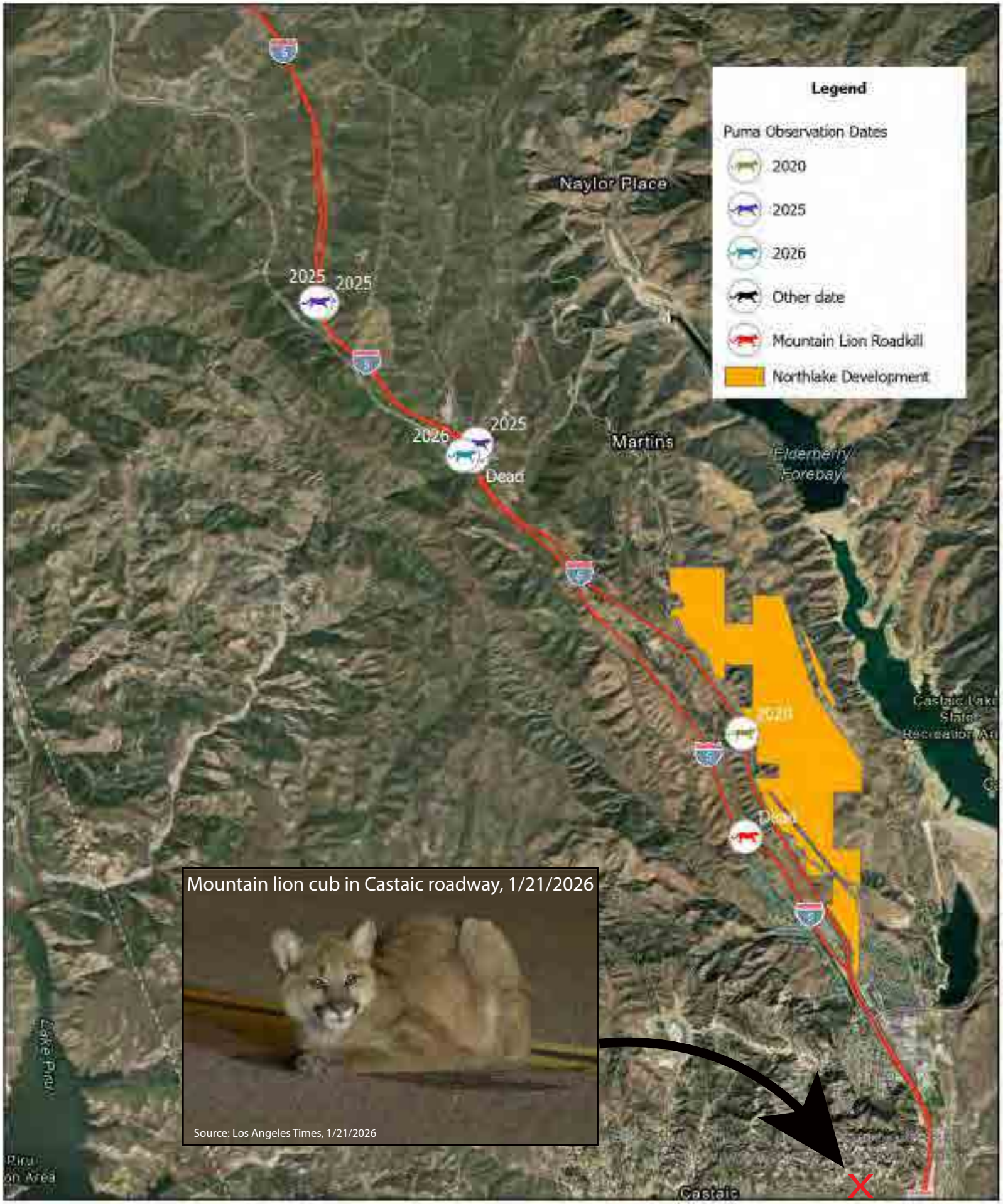
156 City of Los Angeles, "LA City Open Budget: Pavement Preservation," 2024, https://openbudget.lacity.org/#!/year/2024/operating/0/department_name/Bureau+of+Street+Services/0/program_name/Pavement+Preservation/0/source_fund_name.

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Northlake Project No. R2015-00408 Phase 1

Northlake Fire Recurrence Map (1992-2025 Fire Events Within Seven Miles)



Northlake Project No. R2015-00408 Phase 1

Northlake Puma Observation Map

Source(s):
UC Davis CA Roadkill Observation System &
wildlife camera data collected 2020, 2025-2026

0 0.25 0.5 1 Miles

From:	Karina Winkler
To:	PublicHearing; ExecutiveOffice; jsackett@planning.lacounty.gov
Cc:	Torres-Socarras, Ariel
Subject:	Northlake Appeal – March 24 Board Meeting
Date:	Monday, March 16, 2026 9:14:19 AM

Good morning Chair Solis, Supervisor Barger, and Honorable Members of the Board,

I am writing to express my support for the Northlake project and to encourage the Board to deny the appeal.

Los Angeles County continues to face a serious shortage of housing, particularly homes that are attainable for working families. Projects like Northlake play an important role in helping address that challenge while also delivering meaningful public benefits such as parks, trails, and preserved open space.

Beyond housing, the project will contribute to the local economy by creating jobs, supporting small businesses, and investing in transportation and community infrastructure.

Northlake reflects the type of balanced planning that our region needs—one that considers housing, environmental resources, and economic opportunity together.

Thank you for considering my comments.

Karina Winkler | **General Manager**
Holiday Inn Express & Suites Valencia - Santa Clarita
27501 Wayne Mills Pl.Valencia,Ca 91355
Hotel: 661-284-2101 Fax: 661-284-3550

From:	Kevin Durkin
To:	PublicHearing; ExecutiveOffice; jsackett@planning.lacounty.gov
Cc:	Torres-Socarras, Ariel
Subject:	Northlake: Deny Appeal – March 24, 2026 Board of Supes Hearing
Date:	Monday, March 16, 2026 8:18:38 AM
Attachments:	image002.png

Chair Solis, Supervisor Barger, and Members of the Board,

Please accept this note as my support for the Northlake project.

Beyond providing new housing opportunities, the project will also bring important economic benefits to the region. New residents help support local businesses, generate jobs, and contribute to a stronger local economy.

At the same time, the parks, trails, and open space included in the project will provide lasting recreational opportunities for the broader community.

I respectfully urge the Board to deny the appeal and allow Northlake to move forward.

Thank you for your time.

Respectfully,
Kevin Durkin

Kevin Durkin, AIF®

VP Employee Benefits and Qualified Plans
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Kevin Durkin is a Registered Assistant with **United Planners**, for financial professionals offering Investment advisory services through **PFG Advisors, LLC**, an SEC registered investment adviser, and Securities through **United Planners Financial Services**, member FINRA/SIPC. Insurance products offered through approved carriers. **Foundation Risk Partners DBA LBW Insurance and Financial Services**, **PFG Advisors LLC**, and **United Planners Financial Services** are separately owned entities and are not affiliated companies.

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From:	ExecutiveOffice
To:	PublicComments
Subject:	Fw: Northlake Project No. R2015-00408
Date:	Wednesday, March 18, 2026 11:52:58 AM
Attachments:	AttachedFile1.png SC Wildlands_Northlake_Appeal_3_17_2026.pdf Northlake Project No. R2015-00408.eml

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Good morning, the following correspondence is being forwarded for your attention and review.
Thank you!

Executive Office of the Board of Supervisors
Phone: (213) 974-1411 | Email: ExecutiveOffice@bos.lacounty.gov
Find us on Facebook, Instagram, LinkedIn, Twitter @ Youtube @LACountyBOS

From: Kristeen Penrod <kristeen@scwildlands.org>
Sent: Tuesday, March 17, 2026 4:31 PM
To: ExecutiveOffice <ExecutiveOffice@bos.lacounty.gov>
Cc: First District <firstdistrict@bos.lacounty.gov>; Holly J. Mitchell <HollyJMitchell@bos.lacounty.gov>; Third District <ThirdDistrict@bos.lacounty.gov>; Supervisor Janice Hahn (Fourth District) <fourthdistrict@bos.lacounty.gov>; Barger, Kathryn <Kathryn@bos.lacounty.gov>; jsackett@planning.lacounty.gov <jsackett@planning.lacounty.gov>
Subject: Northlake Project No. R2015-00408

Dear Chairperson Solis and Supervisors,

I have attached information and data relevant to the appeal hearing for Northlake Project No. R2015-00408, scheduled for next Tuesday, March 24, 2026. Many thanks in advance for considering the attached in your deliberations and please don't hesitate to contact me should you have any questions or need any additional details.

Respectfully submitted,
Kristeen Penrod, Director
SC Wildlands
Direct 626-497-6492
www.scwildlands.org

SC Wildlands

SC Wildlands
Science & Collaboration for Connected Wildlands
P.O. Box 1052, Fair Oaks, CA 95628
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March 17, 2026

Los Angeles County Board of Supervisors
500 West Temple Street
Room 383
Los Angeles, CA 90012
executiveoffice@bos.lacounty.gov

Northlake Project No. R2015-00408 - Justification for Appeal

Hon. Chairperson Solis and Supervisors:

SC Wildlands respectfully requests that the County of Los Angeles Board of Supervisors uphold the appeal of the Regional Planning Commission's decision to approve the Northlake Project and urges the Board to deny the Project as-is due to (1) new and significant information being omitted from the Regional Planning Commission Approval Package (File No. 26-013, RPC Hearing 1/28/2026), which should have been included in the record; (2) misleading statements by Mr. Damon Mamalakis, the applicant's representative, which lead to the Commission's approval of the Project; and (3) the fact that the significant and irreparable impacts that this project would most certainly cause to habitat connectivity and wildlife movement have never been properly analyzed and disclosed throughout the history of this project, as is required under CEQA. A new EIR is warranted.

At the January 28, 2026 Regional Planning Commission hearing, moments after my testimony about recent and ongoing camera trap studies, further described below, documenting extensive east to west and west to east wildlife movement through structures under Interstate 5 (I-5) directly west of the Northlake project boundary, Commissioner Hastings asked Damon Mamalaki, the applicant's representative about the wildlife movement camera study conducted by the applicant's consultants. Specifically, as documented in the hearing transcript:

Hastings: Before you go, for all the acreage you guys are building on here, you said your cameras never picked up any wildlife movement? (RPC unofficial transcript, 13:09:55 – 13:10:05)
Mamalakis: No wildlife movement. We put the cameras where all of the crossings are on the property. I think it was for three or four months. We did not pick up any [wildlife movement]. (Ibid, 13:10:05 – 13:10:18)
Hastings: You did not pick any? That's amazing. (Ibid, 13:10:18 – 13:10:22)

Following a direct question from Commissioner Hastings, Mr. Mamalakis gave inaccurate testimony, just moments before the Commissioners voted to approve the Project. Furthermore, County staff present at the hearing did not correct the record prior to the vote.

Information within the administrative record provided to Mountains Recreation and Conservation Authority (MRCA) on March 4, 2026 in response to a Public Records Act request to the County to obtain wildlife movement materials related to the Northlake Project (i.e., camera studies, movement data, wildlife monitoring), directly contradicts the above statement by Mr. Mamalakis. Paradoxically, the only place within the administrative record that mentions the results of a "movement study of Grasshopper Creek and environs using wildlife movement camera stations" is in a letter directed

to Mr. Mamalakis, dated September 13, 2018, from Tony Bomkamp, Technical Director and Senior Biologist for Glenn Lukos Associates (GLA) (AR015999), who, along with others at GLA, conducted the study. In the letter (AR015999), Mr. Bomkamp summarized the species detected by 12 wildlife movement camera stations (Exhibit 1; AR016046) deployed between July 12 and September 4, 2018, 75% (9/12) of which detected wildlife movement including deer, coyote, striped skunk, raccoon, desert cottontail, woodrat, ground squirrel, Virginia opossum, screech owl, red-tail hawk, Cooper's hawk, barn owl, and cow. Mr. Bomkamp's letter continues, "Bobcat, gray fox, and coyote were also detected by tracks or other 'sign' (e.g., scat)" (AR016007). This letter directed to Mr. Mamalakis contradicts his testimony at the January 28, 2026, Regional Planning Commission hearing that the cameras "did not pick up any wildlife movement".

Furthermore, a stand-alone technical document of the "GLA conducted movement study of Grasshopper Creek and environs using wildlife movement camera stations" doesn't exist anywhere in the administrative record. The 66-page letter dated September 13, 2018, from Mr. Bomkamp at GLA to Mr. Mamalakis (AR015999) only includes a brief 1.5-page summary of the approach and results of the "GLA conducted movement study of Grasshopper Creek and environs using wildlife movement camera stations". The full approach and results (e.g., frequency, diversity, photo documentation) for the "GLA conducted movement study of Grasshopper Creek and environs using wildlife movement camera stations" should have undoubtedly been included as an Appendix in the Partial Recirculated Draft Supplemental Environmental Impact Report (PRDSEIR 2025); analyzed and summarized in the PRDSEIR as part of the public review process; and included in the Regional Planning Commission Approval Package (RPCAP) for the hearing on January 28, 2026.

Moreover, considering the sheer number of comments throughout the administrative record from wildlife agencies, land management agencies, and conservation organizations on the potential impacts of the proposed project on habitat connectivity and wildlife movement, why wasn't the Applicant required to use track plate surveys or camera trap stations to document any evidence of wildlife use of the undercrossings on I-5 adjacent to Northlake? Since GLA prepared the *NorthLake Partial Creek Avoidance Alternative and Associated Wildlife Movement Enhancements Technical Memo* (GLA 2023a; Appendix G PRDSEIR) and conducted the "movement study of Grasshopper Creek and environs using wildlife movement camera stations", GLA could have arguably used the same cameras to document any evidence of wildlife use of the undercrossings on I-5 adjacent to Northlake (i.e., Undercrossings No. 1, 2 and 3 in Appendix D, Wildlife Crossing Assessment Memo (AR007847), included in the FSEIR).

Ironically, the only reference to a wildlife camera study in the FSEIR (OCR-2018-01) is in Responses to Comments at 2-135 on PDF page 280 of 387: "No focused field surveys (i.e., camera traps) were conducted to document wildlife movement on the Project. … In order to provide additional details, a highway crossing study was conducted to review potential crossing points [sic] and add the data to the overall Project impact analysis for wildlife movement. The technical memo is found in Appendix D of the Final SEIR." However, Appendix D, Wildlife Crossing Assessment, (AR007847), is not an actual "highway crossing study" of wildlife movement through the structures, but rather photographs and dimensions of structures; a cursory description of the habitat and terrain that surrounds the structures; and conveniently focused searches for evidence of wildlife. The methods section states, "Each of the identified I-5 undercrossings was visited on multiple occasions in the summer of 2017. Initial visits include photographic documentation of the undercrossing followed by recording dimensions and assessing the topographic features and vegetative cover within the area on either side and at the openings. Each visit included a search for evidence of wildlife use such as tracks or scat." The Results section states, "Field visits of each undercrossings were conducted on June 27, August 8, and 29, 2017. Presence/absence of animal sign was recorded in a field notebook (AR007848)." Three (3) days doesn't constitute "multiple occasions", especially if the majority of time at "initial visit**s**" was spent taking photographs and structure dimensions and assessing topography and vegetation. The only "evidence of wildlife" that happened to conveniently be recorded across all 3 structures (AR007848 to AR007850) visited in the field over 3 days was at Undercrossing #2, where "Tracks of small mammals such as striped skunk (*Mephitis mephitis*) and mouse (*Peromyscus* sp.) were observed in the sediment within the undercrossing." Did the searches for evidence of wildlife only occur within the structures, which have concrete flooring, or did they also include the approaches from either side of each structure? Camera trap stations should have been required at Undercrossings 1, 2, and 3.

Furthermore, descriptions of the habitat and terrain surrounding Undercrossing #2 in the FSEIR (AR007409) and Appendix D (AR007849) differ substantially, with conclusions in the body of the FSEIR (AR007409) directly conflicting with Appendix D (AR007849). The Final SEIR concludes that Undercrossing #2 (AR007409) "*is feasible to be utilized by a variety of wildlife as a safe crossing to and from either side of the highway. However, use of this undercrossing is expected to be minimal for a variety of factors. The location of the crossing is not associated with any notable natural landscape feature, which typically would concentrate movement such as a ridge line, water feature, or drainage. The location is associated with an unimproved road but the road travels across a slope providing vehicular access to transmission towers but offering little to no cover for wildlife. In addition, the location is not associated with any corresponding crossing in the vicinity that allows wildlife to travel under the north bound lanes of the I-5. In fact, the nearest under-crossings of the northbound lanes are located approximately one mile north and approximately two miles south of this crossing. As a result, potential undercrossing events of both the northbound lanes and the southbound lanes at this location are expected to be rare at best*." Appendix D describes the terrain and vegetation around Undercrossing No. 2 as, (AR007849) "*Predominantly open space with scattered Southern California Edison (SCE) transmission towers, and associated access roads, occurs between the northbound I-5 lanes and the southbound I-5 lanes (where this undercrossing occurs). A moderately large canyon runs north-south between the north and southbound lanes of the 1-5. East-west tributaries occur scattered down the length of the main canyon. West of the I-5, and visible from the undercrossing, is the expansive open space of the Sierra ~~Pelona~~ Madre Mountains. Vegetation types in the vicinity of this undercrossing include chaparral, sage scrub, riparian, and annual grasslands*." Figure 1 below shows an aerial view of the notable landscape features surrounding Undercrossing No. 2 with Grasshopper Canyon on the left and Marple Canyon on the right in between the north and southbound I-5 lanes, both oriented north-south. Note the many east-west tributaries scattered down the length of both major canyons, including a tributary that flows from Undercrossing No. 2 into Marple Canyon, leading animals to and from the crossing. Note also the less-traveled Ridge Rte. Road, situated on the ridge between Grasshopper and Marple Canyons.



Figure 1. Notable landscape features surrounding Undercrossing No. 2

There is extensive recent data documenting successful east to west and west to east wildlife passage across I-5 using all undercrossings west of Northlake. In 2020, MRCA conducted camera trap surveys at Undercrossing No. 2, documenting mountain lion, bobcat, coyote, mule deer, greater roadrunner, and other species using this structure. The top image in Figure 2 below documents mountain lion using Undercrossing No. 2 at 2:59 am on 11/05/2020 to travel from east to west, entering Marple Canyon. Mountain lions are known to prefer ridgetops and stream courses as travel corridors and hunting routes (Spotwart and Samson 1986, Beier and Barrett 1993, Dickson et al. 2004). Dirt roads do not impede and may facilitate mountain lion movement (Dickson et al. 2004). Thus, this lion likely traveled down Grasshopper Canyon, used one of the east-west drainages to ascend to the ridge, saw



Figure 2. Camera trap data documenting mountain lion using Undercrossing No. 2 traveling east to west and two mule deer traveling west to east (Mountains Recreation & Conservation Authority 2020).

Undercrossing No. 2 and used it to safely cross the southbound lanes of I-5, and followed the drainage clearly visible in Figure 1 down into Marple Canyon. While the bottom image documents a pair of deer using Undercrossing No. 2 to travel from west to east, out of Marple Canyon toward Grasshopper Canyon. Furthermore, the California Wildlife Conservation Board (WCB) recently granted MRCA funding to restore habitat in and around Undercrossing No. 2 to provide cover and screen nighttime lighting due to its strategic importance for wildlife movement and maintaining the genetic viability of mountain lion populations in this part of the Transverse Ranges. In addition, MRCA purchased the 6,065-acre Temescal Ranch in the Santa Felicia Significant Ecological Area (LA County 2019) west of their Marple Canyon property to conserve landscape connectivity between the foothills of the Sierra Madre and Castaic Ranges.

In January 2024, an I-5 Connectivity Working Group was established, whose members include US Fish and Wildlife Service, US Forest Service, National Park Service, Tejon Tribe, California State Parks, California Department of Fish and Wildlife, California Department of Transportation, Los Angeles County, MRCA, Santa Monica Mountains Resource Conservation District, UC Davis Wildlife Health Center, The Nature Conservancy, Trust for Public Land, Wildlife Conservation Network, The Wildlands Conservancy, and SC Wildlands. The I-5 Connectivity Working Group was formed to advance research, land protection and wildlife crossing infrastructure in two habitat linkages of regional and statewide importance (i.e., Sierra Madre-Castaic Linkage, Tehachapi Connection), with the ultimate goal of restoring functional connectivity across I-5 to support day-to-day movements of wildlife seeking food, shelter, or mates; juvenile dispersal; seasonal migration, gene flow, recolonizing unoccupied habitat after a local population goes extinct, and for species to shift their geographic range in response to global climate change.

In March of 2025, MRCA, in partnership with Wildlife Conservation Network, The Nature Conservancy, and SC Wildlands, initiated the *Interstate 5 (Sierra Madre-Castaic) Wildlife Crossing Infrastructure Assessment and Implementation Planning Project* in collaboration with the I-5 Connectivity Working Group. This project is currently developing a wildlife crossing infrastructure improvement "master plan" for a 26-mile stretch of I-5 in Los Angeles County between the SR138 interchange and where Castaic Creek crosses I-5 to restore functional habitat connectivity (e.g., wildlife movement and gene flow) between the Sierra Madre and Castaic Ranges. The lead consultant for the project is Rock Design Associates, with USGS, Tony Clevenger, and Pathways for Wildlife making up the Biology Team for the project. USGS is currently conducting a 1-year assessment of the functionality of existing structures to support wildlife movement and began deploying camera trap stations at existing bridge and culvert structures on I-5 on 11/18/25 (see Figure 3 for camera trap locations). Within hours of camera deployment, two lion photos were captured at a box culvert associated with a Caltrans sand shed (camera 8C) roughly 3 miles north of the proposed Northlake project, well within the distance an individual could cover in less than an hour. Between November 18, 2025 and January 31, 2026, USGS collected over 500,000 photos from 33 camera stations across the 26-mile stretch of the study area and of those 326,407 detected animal, vehicle or human. Of these, USGS summarized 2,361 animal photos that fell within the main categories created for the project (Table 1). While these are raw data not normalized by level of effort, a striking 48% (1,145) of the wildlife detections were at undercrossings directly across from Northlake for the north and southbound lanes. Table 1 identifies the camera station names with the undercrossings in Appendix D, Wildlife Crossing Assessments (FSEIR) and associated crossings. In fact, the most structures currently being monitored on I-5 directly west of the Northlake are being regularly used by wildlife, not "Limited East-to-West and West-to-East Movement" as suggested in the *Northlake Partial Creek Avoidance Alternative and Associated Wildlife Movement Enhancements*.

Most importantly, these ongoing camera trap surveys by USGS for the I-5 Wildlife Crossing Infrastructure Improvement Planning effort have documented regular use of "Undercrossing #2" at Marple Canyon. In fact, 16% (386) of the 2,361 wildlife detections between 11/18/2025 and 1/31/2026 across 33 cameras stations along the entire 26-mile stretch of I-5, have been at Undercrossing #2 (i.e., Cameras 4A and 4B of Table 1). Of the 1,145 wildlife detections at crossings directly across from Northlake, 34% (386/1145) are associated with Undercrossing #2. That's roughly 5.08 wildlife detections per day (386 detections / 76 camera trap days), a far cry from "use of this undercrossing is expected to be minimal" (AR007409), as stipulated in the FSEIR. Further, east to west and west to east wildlife movements have been documented, as shown in Figure 4 below.



Figure 3. I-5 Sierra Madre-Castaic Wildlife Crossing Infrastructure Improvement Plan and active camera trap stations

Table 1. I-5 Sierra Madre-Castaic Wildlife Crossing Infrastructure Improvement Planning Project Preliminary Results Camera Trap Data November 18, 2025 to January 31st 2026 (USGS)

Camera Name	Bear	Mountain Lion	Bobcat	Coyote	Grey Fox	Deer	Skunk	Raccoon	Opossum	Ground Squirrel	Road runner	Grand Total	Associated Northlake Structures
1B			36	21	6							63	
1D				3				3				6	
1E				3								3	
2A			3					27			13	43	
2C								12				12	
3A								291				291	#1 Crossing
3B				3								3	#1 Crossing
3C			3					117				120	#1 Crossing, at concrete channel
3F			9	3				6				18	0.4 miles north of #1 Crossing, Northbound
4A			12	171								183	#2 Crossing Southbound
4B			15	180						8		203	#2 Crossing Southbound
5A			192	18								210	#3 Crossing Northbound
5B			9	60				9				78	#3 Crossing Southbound
5D				3				12				15	0.5 miles North of Crossing #3
5E			3	15				6				24	#3 Crossing Southbound
6B								9	3			12	
7A		6		9			3	3				21	#4 Crossing
7E		6			18		33					57	#4 Crossing
8B					6							6	
8C		9	3	3	33		33	30				111	
8D			15	12				48				75	
8H		15			3		6	3		18		45	
11D							3			3		6	
12C	3			9								12	
12D	3		72	102	120		9	72				378	
13A					6	111						117	
13B				66	18			3				87	
13C					6							6	
15A												3	
11C			3		3		12					18	
12B			3		3			9				18	
15C			6	90				9				108	
H01					3		3	3				9	
Grand Total	**6**	**36**	**384**	**771**	**225**	**111**	**102**	**672**	**3**	**29**	**13**	**2361**	**1,145**



Figure 4. Recent documentation that Undercrossing #2 supports west to east (column 1) and east to west (column 2) wildlife movement (I-5 Wildlife Crossing Infrastructure Improvement Planning Project).

Camera stations 5B and 5E in Table 1 are associated with Undercrossing #3 of Appendix D, Wildlife Crossing Assessment and are placed on either side of the structure under the southbound lanes, while camera station 5A is across from this structure under the northbound lanes. USGS found that 13% (312) of the 2,361 wildlife detections between 11/18/2025 and 1/31/2026 across 33 cameras stations along the entire 26-mile stretch of I-5 were associated with these two structures. Of the 1,145 wildlife detections associated with crossings directly across from Northlake, 27% (312/1145) are associated with these two structures. However, as shown in Table 1, 210 of these detections were at camera station 5A under the northbound lane, with the great majority of these being detections of bobcats (192) and only 12 of the 102 wildlife detections documented at camera stations 5B and 5E at the structure under the southbound lanes were bobcat. In fact, 50% (192/384) of the bobcat detections across the entire 26-mile study area were at camera station 5A under the northbound lanes, suggesting the home range of one or more individuals spans the I-5 northbound lanes and includes habitat within Marple Canyon. These preliminary results do not jive with the assumption that Undercrossing #3 and the northbound structure across from it "render it more likely than others to be utilized on occasion" and are "more compatible to movement events". Perhaps, it's because of the Paintball facility in between these two structures, which is most active at night may deter animal movement. It may also be that Marple Canyon, like Grasshopper and Violin canyons are oriented north-south and the habitat and terrain within these canyons funnel wildlife movement.

Not surprising, 96% (414/432) of the wildlife detections at 4 camera stations (3A, 3B, 3C, 3F) associated with Undercrossing #1 at the southernmost boundary of the Northlake development at the edge of the urban-wildland interface were raccoons (Table 1). Coyote and bobcat were also detected at a few of these structures.

Between November 18, 2025 and January 31, 2026, USGS has documented 36 puma events at 4 camera stations (7A, 7E, 8C, and 8H) across the entire 26-mile study area (Table 1). The Templin Highway underpass (camera stations 7A and 7E) have both recorded mountain lions 6 times. The box culvert near the Caltrans sand shed just north of Templin Highway, similar to the box culverts for Undercrossings 2 and 3 across from Northlake, has recorded 9 puma events. Camera station 8H, a habitat cam situated a slight distance away from I-5, recorded 15 puma events during this timeframe. All of the mountain lion detections at camera stations during this timeframe were within a few miles of the Northlake Project, well within the daily movement range of mountain lions. Some highlights of these mountain lion events are depicted in Figure 5.

While the *I-5 Sierra Madre-Castaic Wildlife Crossing Infrastructure Assessment and Implementation Plan* will address connectivity improvements for a taxonomically diverse group of species, emphasis is being placed on benefits to at-risk wide-ranging species such as mountain lion. In April 2020, the CDFW Commission found that listing the mountain lion as threatened under the California Endangered Species Act (CESA) may be warranted and designated mountain lion in southern California as a candidate species. Under CESA, species classified as a candidate species are afforded the same protection as listed species. Yet, the **mountain lion was not reviewed as a protected species within the Northlake PRDSEIR. I-5 bisects almost continuous lion habitat (Dellinger et al. 2020; Figure 6), including nearly the entirety of the proposed Northlake Project area. Figure 6 identifies high quality mountain lion habitat all along Grasshopper Creek that the Northlake PRDSEIR proposes to fill, and upland habitat throughout the Northlake Project area that connect to conserved lands to the north, south, east and west. Highly suitable habitat leads directly to Undercrossing #2 (camera stations 4A and 4B in Table 1) and MRCA's Marple Canyon property, which was documented to be used by a mountain lion in 2020 (Figure 2). The only area within the Northlake boundary not identified as highly suitable habitat for mountain lions, is the area generally covered by Phase 1**. In December of 2025, CDFW released A Status Review of the Petitioned Southern California/Central Coast ESU of Mountain Lion in California, which recommended listing all six petitioned populations as threatened. On February 12, 2026, The California Fish and Game Commission granted threatened species status under CESA to these mountain lion populations. To ensure compliance with CESA, potential impacts to this species must be evaluated, disclosed and mitigated.



Figure 5. Recent documented mountain lion crossings and detections on I-5 within daily movement range of Northlake (I-5 Wildlife Crossing Infrastructure Improvement Project).

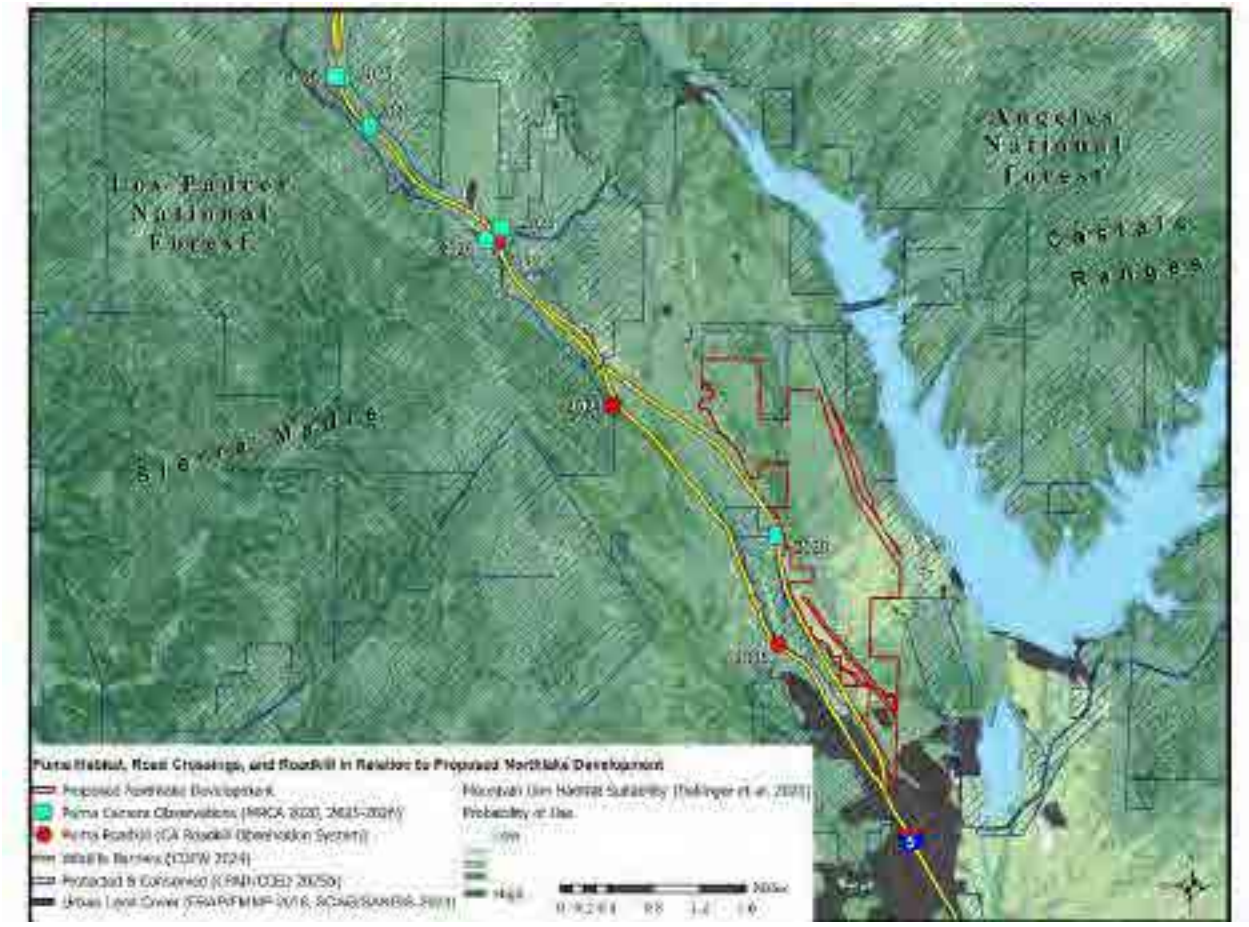


Figure 6. Puma Habitat, Road Crossings and Roadkill in Relations to Proposed Northlake Development.

Territorial carnivores like mountain lions that occur at low densities and have large individual area requirements are particularly sensitive to habitat loss and fragmentation (Fahrig 2002, Henle et al. 2004, Gálvez et al. 2018) and at higher risk of extirpation (Soulé and Terborgh 1999). Dispersal is crucial for healthy cougar population dynamics but freeways and major roadways in southern California significantly limit demographic connectivity, juvenile dispersal, and cause direct mortality (Riley et al. 2014, Vickers et al. 2015, Gustafson et al. 2022). Mountain lion populations in the highly fragmented landscape of southern California lack adequate connectivity to one another (Riley et al. 2006, Beier et al. 2006, Riley et al. 2014, Zeller et al. 2017, Dellinger et al. 2020a) and have become genetically isolated (Vickers et al. 2015, Benson et al. 2016, Dellinger et al. 2020b**).** The recent state-wide mountain lion genetic study (Gustafson et al. 2022) indicates the Sierra Madre-Castaic Linkage is a vitally important connectivity area between the Sierra Nevada, Coast and Transverse Ranges and identifies the Sierra Madre population as a valuable source population for restoring genetic diversity to lion populations in the Transverse Ranges to the south and west (and beyond). The ecological consequences of losing mountain lions in southern California could have cascading effects through the entire ecosystem (Soulé and Terborgh 1999, Thorne et al. 2006, Ripple et al. 2014, Dellinger et al. 2020 a,b). Connectivity between the Sierra Madre and Castaic Ranges is vitally important for restoring gene flow to southern California mountain lion populations.

The I-5 Sierra Madre-Castaic Wildlife Crossing Infrastructure Improvement plan is using existing data, such as connectivity analyses, roadkill and camera trap efforts described above, as well as collecting new data through field studies, including camera trap surveys, wildlife transects, and opportunistic roadkill, to identify locations and recommendations for a system of wildlife crossings including enhancement of existing and creation of new crossings

and associated features such as wildlife exclusion fencing and jump-outs, along I-5 between the SR138 interchange and where Castaic Creek crosses I-5, which includes the Northlake Project area. Once the master plan is complete, feasibility and constraints analyses will be conducted for at least 4 priority wildlife crossing locations, and at least one priority wildlife crossing will be advanced through the Caltrans planning, design, and environmental review process (PID, PA/ED, PS&E) of appropriate level CEQA/NEPA documents to deliver 35% and 65% design plans/specifications and cost estimates for at least one priority structure. The primary outcome will be a wildlife crossing infrastructure improvement "master plan" to improve habitat connectivity across I-5 to maintain viable wildlife populations, reduce dangerous wildlife-vehicle collisions, allow species to shift their ranges in response to climate change, and ensure the ecological integrity of California's existing conservation investments.

The camera trap currently being collected for the ***Interstate 5 (Sierra Madre-Castaic) Wildlife Crossing Infrastructure Assessment and Implementation Plan*** **can be provided to the County to inform the impact analyses related to wildlife movement in a new EIR for the Proposed Northlake development, which should have been completed as part of the environmental review processes to date, as required by CEQA.**

The Project Team for the I-5 Sierra Madre-Castaic Wildlife Crossing Infrastructure Improvement Plan is also coordinating with the UC Davis California Carnivores Program, which has been investigating mountain lion habitat use, movement and mortality in the region since 2022. From 2022-2025, their focus was on collaring individuals further north in the Tehachapi Connection (Penrod et al. 2003), where they captured several individuals west of I-5 and east of SR58. Figure 7 below depicts GPS data of several individual collared lions, showing the barrier effects of I-5 but also successful crossings of I-5 and SR58 by a few individuals that established home ranges in the Tehachapi Mountains, with a few individuals making their way southward into the Sierra Madre-Castaic Linkage.

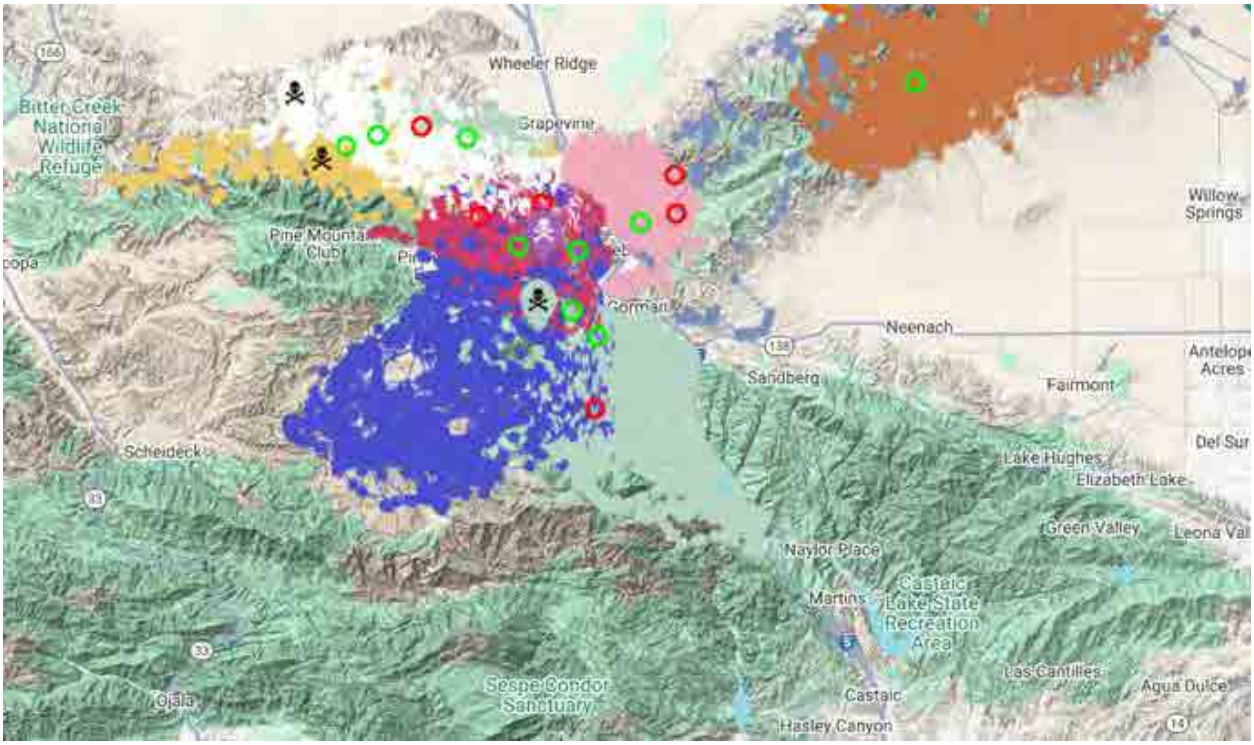


Figure 7. GPS collar data for several mountain lions (UC Davis California Carnivores Program).

The current phase of the study, *"Understanding ecological and human-related factors affecting felid movement in a critical wildlife linkage"* is focused on the Sierra Madre and Castaic Ranges. UC Davis scientists began efforts to collar lions east of I-5 and south of SR138 on Forest Service lands in January 2026. Thus far, three lions have been collared west of I-5 and are currently being monitored in this area (Figure 8), including 1 male (M445) and 2 females (F449 and

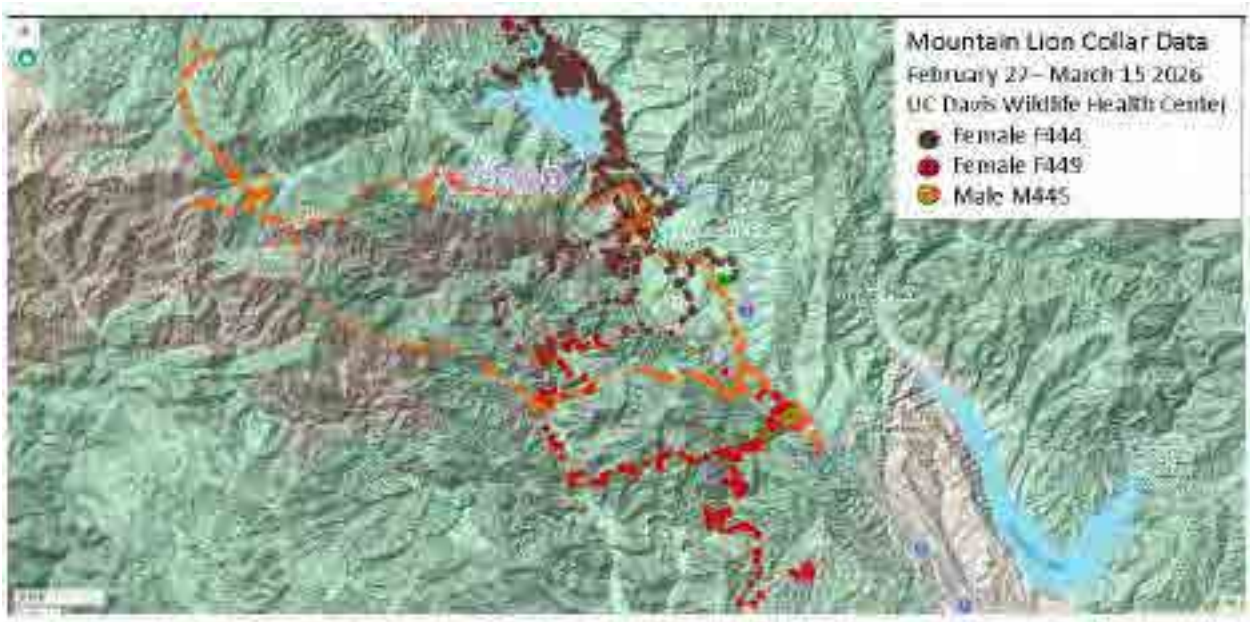


Figure 8. Mountain lion GPS-collar data for 3 individuals west of I-5 (UC Davis Wildlife Health Center 2026)

F444). UCUC Davis currently has active bait stations out on the Angeles National Forest east of I-5, and is coordinating with the I-5 Project Team to locate their stations in proximity to where camera traps have recorded lions east of I-5, so UC Davis should have mountain lions collared east of I-5 any day now. We expect that the forthcoming data from collared mountain lions in the Sierra Madre and Castaic Ranges will show similar patterns to those in the Tehachapi Connection -- that mountain lions are utilizing suitable habitat throughout these ranges and that at least some individuals are successfully navigating across or under I-5. This UC Davis effort is expected to extend through 2028.

The April 23, 2023 Memo entitled, *NorthLake Partial Creek Avoidance Alternative and Associated Wildlife Movement Enhancements***, a 2-page analysis + maps, even in conjunction with Appendix D, Wildlife Crossing Assessment, AND the "GLA conducted movement study of Grasshopper Creek and environs using wildlife movement camera stations", is utterly insufficient to determine the adverse impacts of the project on habitat connectivity and wildlife movement.** As stated in the NorthLake Partial Creek Avoidance Alternative and Associated Wildlife Movement Enhancements memo, "The purpose of the biological analysis was to determine the effects on Wildlife Movement of the PCAA," yet this analysis relied entirely on regional least-cost corridor analyses specifically designed to link medium to high suitable habitat in Roadless Areas for select focal species within Los Padres and Angeles National Forests in the Sierra Madre-Castaic Linkage (Penrod et al. 2005). The intent of least-cost corridor analyses is to identify the best potential movement routes between habitat areas targeted by the analysis, it does not identify all potential movement routes of importance at the local scale, as required by CEQA. The Applicant's Consultants appear to have cherry-picked from the analyses included in the Sierra Madre-Castaic Linkage (Penrod et al. 2005) to make their argument of less than significant impacts to "regional" wildlife movement. Yet the thresholds of significance to wildlife movement under CEQA, must address will the project "Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors or impede the use of native wildlife nursery sites?", which has not been adequately addressed throughout the 33-year history of this project!

The Applicant's Consultants cherry-picked from the analyses included in the South Coast Missing Linkages: A Linkage Design for the Sierra Madre-Castaic Linkage (Penrod et al. 2005). The least-cost corridor analyses is only one of four analyses conducted as part of the South Coast Missing Linkages Project. Penrod et al. (2005) also conducted habitat

suitability, patch size, and patch configuration analyses for the focal species. In SC Wildlands April 15, 2018 letter on the DSEIR, we offered this spatial data to the County for use in the analyses to assess potential impacts to wildlife movement, "The GIS (Geographical Information System) spatial data was also available for the linkage, from SC Wildlands, on CDFW's BIOS (Biological Information and Observation System) website, and from the County of Los Angeles, the Lead Agency. Yet, the environmental consulting firm Bon Terra Psomas failed to acquire and utilize this data in their analyses of project impacts to wildlife movement." The 2005 habitat suitability analysis for mountain lion (Penrod et al. in Figure 9) shows highly suitable habitat in Northlake, including well south of Undercrossings 2 and 3 all the way across to Castaic Lake, all along Grasshopper Canyon, and through Marple Canyon.

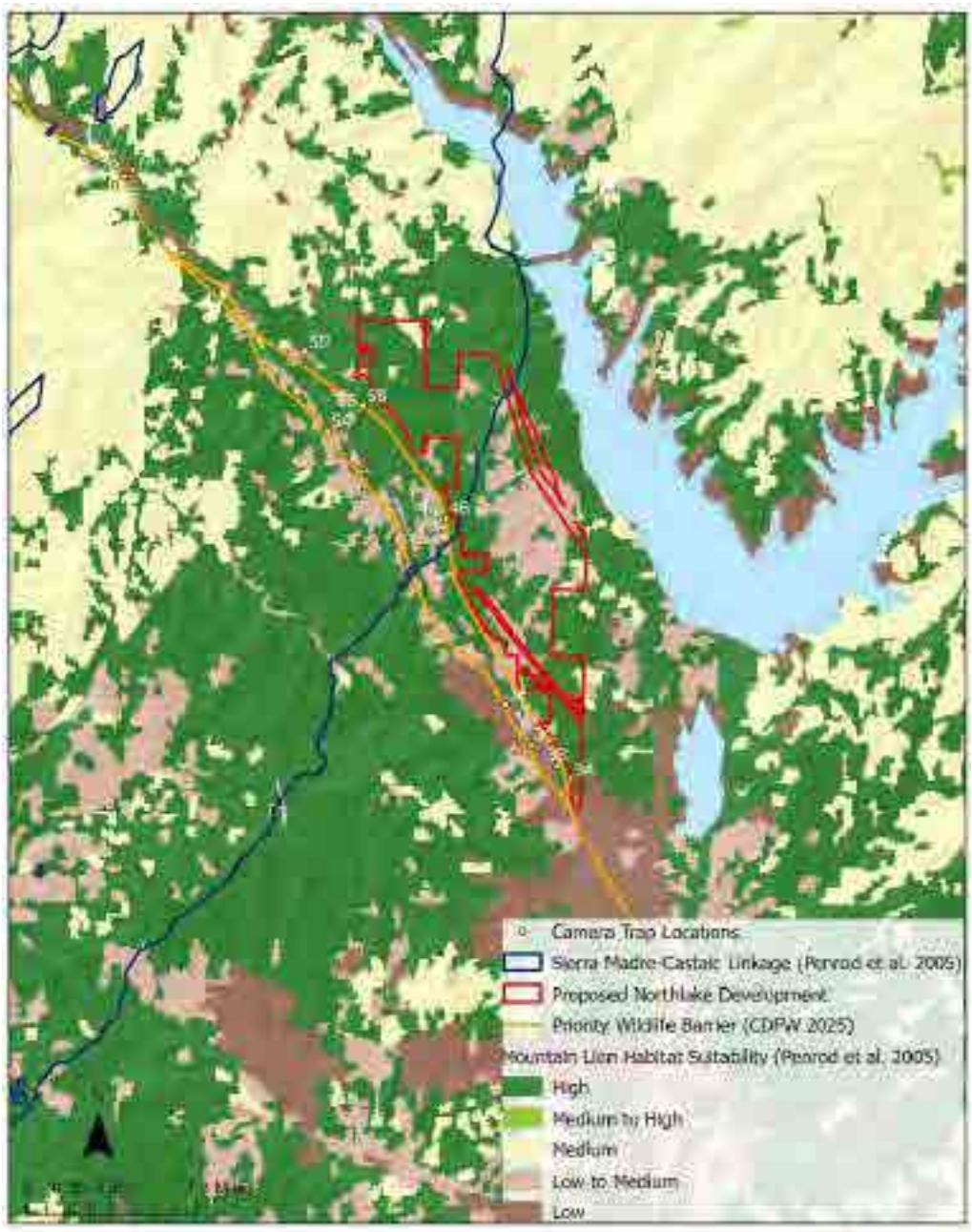


Figure 9. Mountain lion habitat suitability analyses (Penrod et al. 2005)

Penrod et al. (2005) also conducted *Patch Size Analysis,* as described on P. 13, "Potential core areas were defined as the amount of contiguous suitable habitat necessary to sustain at least 50 individuals. A *patch* was defined as the area of contiguous suitable habitat needed to support at least one male and one female, but less than the potential core area. Potential cores are probably capable of supporting the species for several decades (although with erosion of genetic material if isolated). Patches can support at least one breeding pair of animals (perhaps more if home ranges overlap greatly) and are probably useful to the species if the patch can be linked via dispersal to other patches and core areas." Figure 10 below is the patch size analyses conducted for mountain lion (Penrod et al. 2005), with the zoomed in inset showing the overlap with Northlake. Note the purple throughout Northlake and Grasshopper Canyon including well south of Undercrossings No. 2 and 3, which connect to green in Marple Canyon and the Sierra Madre Ranges. The modification to the proposed project footprint that eliminated the northernmost approximately 2,200 feet of development, as described in NorthLake Partial Creek Avoidance Alternative and Associated Wildlife Movement Enhancements in Appendix G of the PRDSEIR is not sufficient to reduce impacts to wildlife movement to less than significant, especially for mountain lions. The Northlake development should not encroach upon any contiguous purple in Figure 10 (i.e., only Phase 1). At a minimum, the Northlake development should be entirely out of the Sierra Madre-Castaic Linkage, allowing mountain lions and other species using Undercrossing 2 & 3 to travel unimpeded to the east and north.

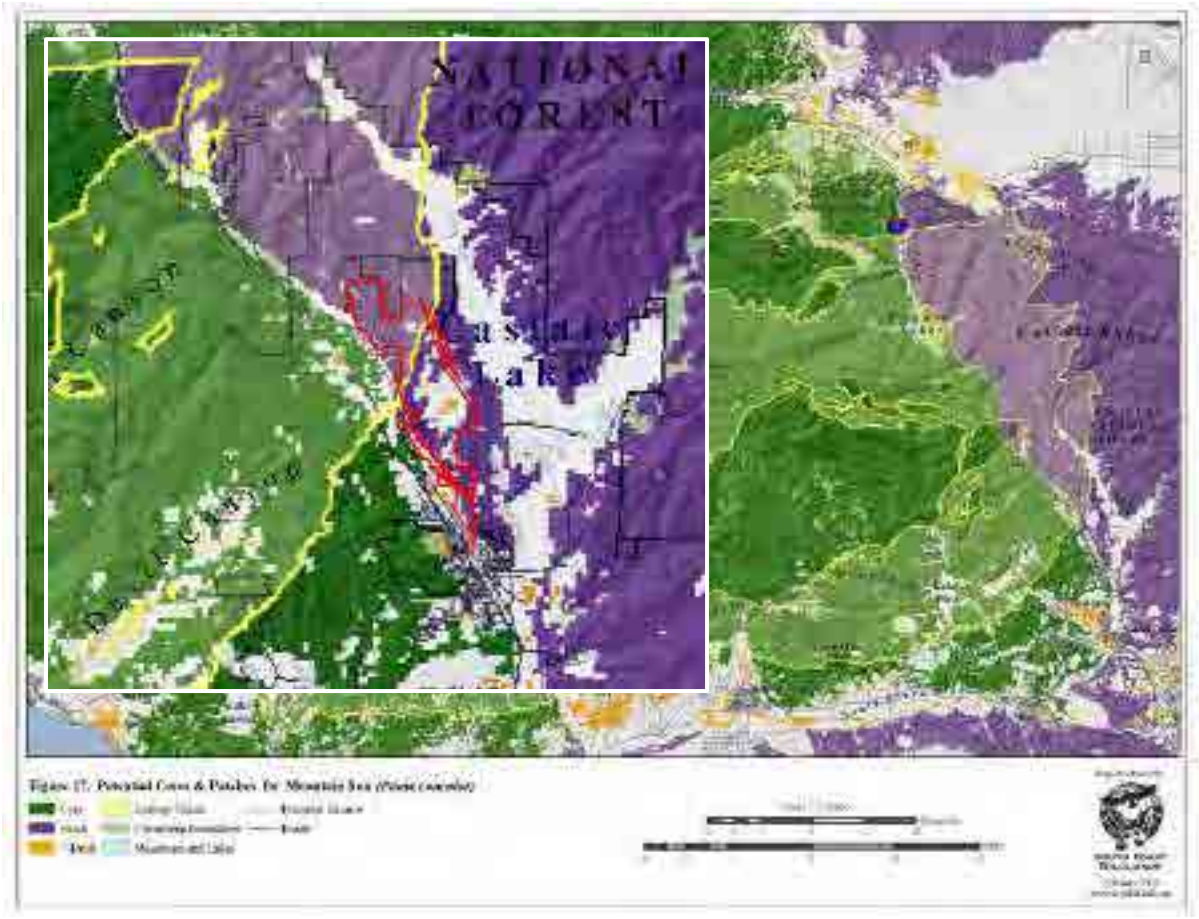


Figure 10. Potential Cores and Patches for Mountain Lion (Penrod et al. 2005)

The Sierra Madre-Castaic Linkage (Penrod et al. 2005), first identified at the landmark California Missing Linkages: Restoring Connectivity to the California Landscape (Penrod et al. 2001) is one of several regionally important connections in the South Coast Missing Linkages Network (Figure 11; Beier et al. 2006, SC Wildlands 2008), which is

widely considered the backbone of a regional conservation strategy for southern California, stitching together over 18 million acres of existing conservation lands, and maintaining connected wildlife populations from Baja California Norte to the southern Sierra Nevada, and from the beaches of Camp Pendleton eastward to the deserts of Anza-Borrego Desert State Park. The Sierra Madre-Castaic Linkage is an essential landscape connection for east-west connectivity through the South Coast Ecoregion, providing connectivity between mountain ranges within the Transverse Ranges and between the Transverse and Coast Ranges.



Figure 11. South Coast Missing Linkages Network

While it's been over two decades since the Sierra Madre-Castaic Linkage design was completed in 2005, more recent connectivity and climate assessments, such as the California Essential Habitat Connectivity Project (Spencer et al. 2010), Omniscape Present-Day Connectivity (TNC and Conservation Science Partners 2017), Climate Resilient Connectivity for the South Coast Ecoregion of California (Jennings et al. 2019), Resilient and Connected Landscapes (TNC 2020), and Connectivity for Climate Adaptation (TNC 2020, Schloss et al. 2021) have all reinforced the landscape level importance and continued permeability of the South Coast Missing Linkages Network. Most importantly, several of these subsequent analyses evaluated the connectivity importance of every pixel across California, and highlight the importance of the Northlake project area both under existing conditions and for climate adaptation. For example, The Nature Conservancy's (2020) Connectivity and Climate Flow analysis (Figure 12) underscores the critical importance of maintaining and restoring connectivity three regionally significant linkages associated with Los Angeles County, the Sierra Madre-Castaic Ranges, San Gabriel Mountains-Castaic Ranges, and Santa Monica Mountains-Sierra Madre Ranges, both today and for species to shift their ranges in response to climate change. This analysis identifies the entire Sierra Madre-Castaic Linkage as extremely intact with continuous, diffuse flow in much of the linkage with several wide east-west present-day and climate informed linkages. Importantly, this analysis indicates that the Proposed Northlake Project area and the Santa Felicia SEA recently conserved by MRCA support intact, diffuse connectivity flow, including beyond the Sierra Madre-Castaic Linkage. Maintaining intact habitat and connectivity and restoring functional connectivity across I-5 is essential to allow species and full communities to shift their ranges in response to

changing habitat conditions related to climate change, and to recolonize areas after environmental perturbations exacerbated by climate change (e.g., wildfire, floods). Nearly 90-million dollars have been spent on the Wallis Annenberg wildlife overpass currently under construction, largely to restore connectivity for mountain lion populations between the Santa Monica Mountains and Sierra Madre Mountains, so individuals can access other regionally important connections, like Sierra Madre-Castaic Linkage.

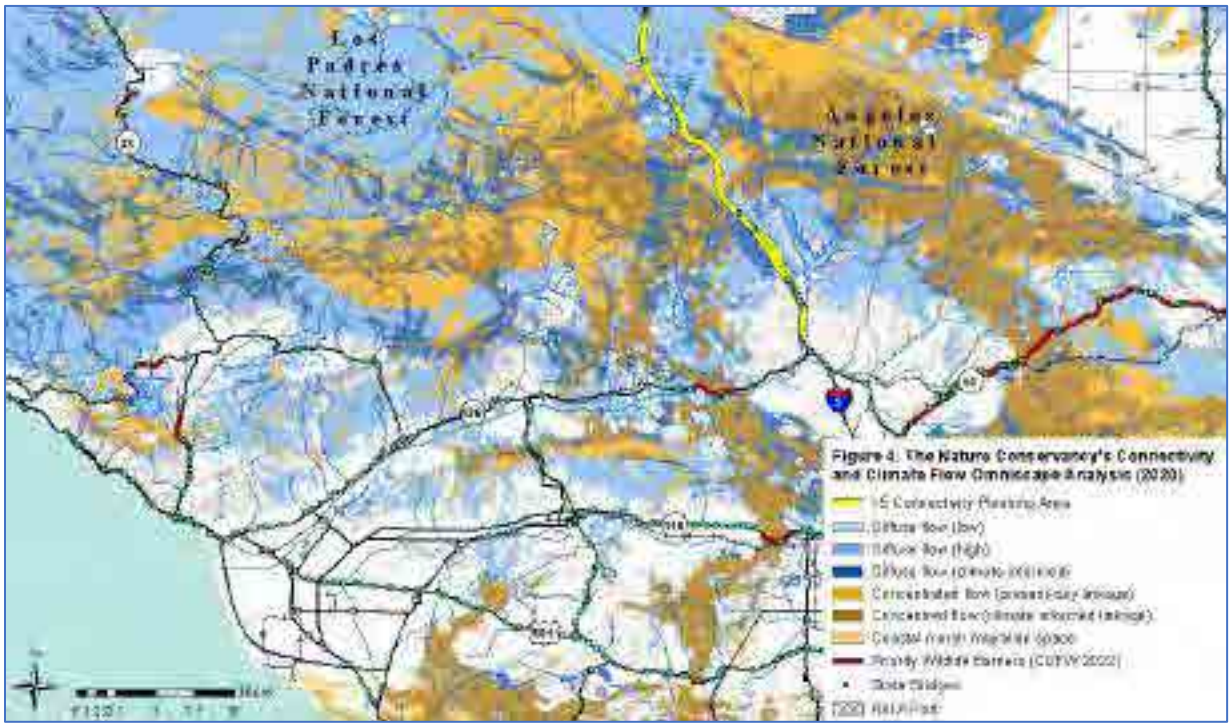


Figure 12. Connectivity and Climate Flow (The Nature Conservancy 2020)

The qualitative argument for low permeability across I-5 used by the Applicant's Consultants to make a determination that the project would have less than a significant impact on wildlife movement is utter nonsense, as the camera trap data above clearly shows. Furthermore, Caltrans serves on the I-5 Connectivity Working Group and attended each of the four workshops of the South Coast Missing Linkages effort back in 2002. Caltrans District 7 has consistently demonstrated leadership with their willingness to improve wildlife crossings as part of their transportation improvement projects over the last few decades. In addition, the Safe Roads and Wildlife Protection Act (AB 2344) integrated Wildlife Connectivity into Transportation Law (i.e., Streets and Highways Code 158, Division 1, Chapter 1, Article 3.8). It became effective January 1, of 2022 and requires Caltrans to assess, prioritize, fund, and remediate barriers on the State Highway System for terrestrial species.

California Department of Fish and Wildlife has also identified a Wildlife Barrier (I-5 Sierra Madre to Castaic Ranges W231) for remediation on I-5 for mountain lion, mule deer, black bear, and mesocarnivores, which is adjacent to, and extends the entire length of the proposed Northlake Specific Plan (see web map Terrestrial Wildlife Connectivity Barriers). The I-5 Sierra Madre to Castaic Ranges Wildlife Barrier meets 7 of the 10 criteria that CDFW uses to evaluate each potential barrier segment (Penrod 2020, CDFW 2022):

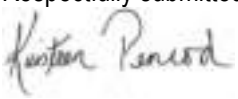
- Important habitat or landscape linkage identified in a species movement or regional connectivity study, or necessary for connectivity between or within important habitat blocks.
- Movement corridors for sensitive, keystone, or other high priority species according to species-specific studies, genetic studies, or published recovery plans.

- Areas suggested by available data to be important or functionally significant crossing locations where barrier improvement would benefit wildlife populations, as identified by cameras or GPS data, or by the presence of landscape features where animals are known to cross more frequently than other areas (e.g., riparian corridors, canyon bottoms, ridges, and open space corridors).
- Areas where animals actively approach but are unable or refuse to cross.
- Quality of adjacent habitat surrounding the barrier within a landscape context.
- Durability of conservation status of adjacent lands (public lands, conservation easements, or lands with committed partners/landowners) and patch size.
- Linkages that could facilitate range shifts due to climate change (e.g., connects lower to higher elevations or habitats latitudinally).

The County is currently in the process of updating the Open Space Element of its General Plan to address the Room to Roam Act (AB 1889) passed in 2024, providing an opportunity to address landscape connectivity based on existing conditions at Northlake. The Sierra Madre-Castaic Linkage (Penrod et al. 2005) is one of the most important landscape linkages within the jurisdiction of Los Angeles County, with the others being the San Gabriel-Castaic Linkage (Penrod et al. 2004) and the Santa Monica-Sierra Madre Linkage (Penrod et al. 2006), all of which should be fully captured in the forthcoming update to the County's Open Space Element. As described in the fact sheet, *the County's role in the protection, conservation, and preservation of natural resources and open space areas is vital for the region. The Open Space Element was last updated in 2015 and is required to be updated by January 1, 2026, by recent State laws SB 1425 and AB 1889. SB 1425 requires local governments to revise their open-space plans by January 1, 2026, to enhance equitable access to open spaces, promote climate resilience, and explore rewilding opportunities, ensuring these elements are integrated with environmental justice policies. AB 1889, also known as the Room to Roam Act, focuses on enhancing wildlife connectivity, supporting biodiversity, and mitigating the impact of human activities on natural habitats, must be completed by January 2028* CNR-Element-Update_FAQ.pdf. SC Wildlands applauds the County for being proactive in their efforts to comply with SB 1425 and AB 1889 to address the impacts of development on wildlife movement and habitat connectivity and ensure climate resilience and equitable access to open space.

SC Wildlands urges the County to uphold the appeal of the Regional Planning Commission's decision to approve the Northlake Project and implores the Board to deny the Project as-is, due to the above-described issues and noncompliance with CEQA. Phase 2 should be completely eliminated but at a minimum, all development should be entirely outside of the Sierra Madre-Castaic Linkage. The County could also require a new EIR so that potential impacts to habitat connectivity and wildlife movement can be thoroughly analyzed and disclosed, and appropriate mitigation measures developed, as required by CEQA.

Respectfully submitted,



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Literature Cited:

Beier, P.B., K.L. Penrod, C.L. Luke, W.D. Spencer, and C.R. Cabanero. 2006. South Coast Missing Linkages: restoring connectivity to wildlands in the largest metropolitan area in the United States. In KR Crooks and MA Sanjayan, editors. Connectivity and Conservation. Oxford University Press.

Beier, P. and R. Barrett. 1993. The cougar in the Santa Ana Mountain Range, California. Final Report for Orange County Cooperative Mountain Lion Study.

Benson, J.F., P.J. Mahoney, J.A. Sikich, L.E. Serieys, J.P. Pollinger, H.B. Ernest, and S.P. Riley. 2016 Interactions between demography, genetics, and landscape connectivity increase extinction probability for a small population of large carnivores in a major metropolitan area. Proceedings of the Royal Society Biological Sciences 283: 20160957. (doi:10.1098/rspb.2016.0957)

California Department of Fish and Wildlife. 2025. Report to the California Fish and Game Commission A Status Review of the Petitioned Southern California/Central Coast Evolutionarily Significant Unit (ESU) of Mountain Lion (Puma concolor couguar) in California. A Status Review of the Petitioned Southern California/Central Coast ESU of Mountain Lion in California,

California Department of Fish & Wildlife (CDFW). 2024. Wildlife Movement Barriers - CDFW [ds2867]. https://filelib.wildlife.ca.gov/Public/BDB/GIS/BIOS/Public_Datasets/2800_2899/ds2867.zip
California Department of Fish and Wildlife. 2022. Restoring California's Wildlife Connectivity. 33pp.
County of Los Angeles. 2019. Ordinance No. 2019-0072. An Ordinance Amending Los Angeles County Code, Title 22 Planning and Zoning, updating the regulations for Significant Ecological Areas and associated provisions. Pp. 52.
County of Los Angeles. 2015. Los Angeles County General Plan. Adopted October 6, 2015. Available online at http://planning.lacounty.gov/assets/upl/project/gp_final-general-plan.pdf.
Dellinger, J.A., B. Cristescu, J. Ewanyk, D.J. Gammons, D. Garcelon, P. Johnston, Q. Martins, C. Thompson, T.W. Vickers, C.C. Wilmers, H.U. Wittmer, and S.G. Torres. 2020a. Using mountain lion habitat selection to inform management. Journal of Wildlife Management 84:359-371. [GIS dataset; Raster ds2916]. Metadata and link to SDE Raster Dataset Mountain Lion Habitat Suitability – Summer – CDFW [ds2916] GIS Dataset (ca.gov).
Dellinger, J.A., K.D. Gustafson, D.J. Gammons, H.B. Ernest, and S.G. Torres. 2020b. Minimum habitat thresholds required for conserving mountain lion genetic diversity. Ecology and Evolution doi: 10.1002/ece3.6723.
Dickson, BG, JS Jenness, and P Beier. 2004. Influence of vegetation, roads, and topography on cougar movement in southern California. Journal of Wildlife Management 68:
Fahrig, L. 2002. Effect of habitat fragmentation on the extinction threshold: A synthesis. Ecological Applications 12:346–353.
Gálvez, N., G. Guillera-Arroita, F.A.V. St John, E. Schüttler, D.W. Macdonald, and Z. Davies. 2018. A spatially integrated framework for assessing socio-ecological drivers of carnivore decline. Journal of Applied Ecology 55:1393–1405.
Gustafson, K.D., R.B. Gagne, M.R. Buchalski, T.W. Vickers, S.P.D. Riley, J.A. Sikich, J.L. Rudd, J.A. Dellinger, M.E.F. LaCava, and H.B. Ernest. 2022. Multi-population puma connectivity could restore genomic diversity to at-risk coastal populations in California. Evolutionary Applications 2022;00:1–14.
Henle, K., D.B. Lindenmayer, C.R. Margules, D.A. Saunders, and C. Wissel. 2004. Species survival in fragmented landscapes: Where are we now? Biodiversity and Conservation 13:1–8.
Jennings, M., Conlisk, E., Hauser, E., Foote, D., & Lewison, R. 2019. *Climate Resilient Connectivity for the South Coast Ecoregion of California*. San Diego State University. https://www.conservationecologylab.com/uploads/1/9/7/6/19763887/sdsu_climateresilient connectivity_finalreport_48p.pdf
Penrod, K. 2020. Northeast California Connectivity Symposium Summary Report. Prepared for California Department of Fish and Wildlife and Pew Charitable Trusts. Prepared by Science & Collaboration for Connected Wildlands. 87 pp. plus appendices.
Penrod, K., C. Cabañero, P. Beier, C. Luke, W. Spencer, E. Rubin, R. Sauvajot, S. Riley, and D. Kamradt. 2006. South Coast Missing Linkages Project: A Linkage Design for the Santa Monica-Sierra Madre Connection. South Coast Wildlands, Idyllwild, CA. www.scwildlands.org.
Penrod, K., C. Cabañero, P. Beier, C. Luke, W. Spencer, and E. Rubin. 2005. South Coast Missing Linkages Project: A Linkage Design for the Sierra Madre-Castaic Connection. South Coast Wildlands, Idyllwild, CA. www.scwildlands.org.
Penrod, K., C. Cabañero, P. Beier, C. Luke, W. Spencer, and E. Rubin. 2004. South Coast Missing Linkages Project: A Linkage Design for the San Gabriel-Castaic Connection. South Coast Wildlands, Idyllwild, CA. www.scwildlands.org.
Penrod, K., C. Cabanero, C. Luke, P. Beier, W. Spencer, and E. Rubin. 2003. South Coast Missing Linkages Project: A Linkage Design for the Tehachapi Connection. South Coast Wildlands Project, Idyllwild, CA. www.scwildlands.org.
Penrod, K., R. Hunter, and M. Marrifield. 2001. Missing Linkages: restoring connectivity to the California landscape. California Wilderness Coalition, The Nature Conservancy, US Geological Survey, Center for Reproduction of Endangered Species, and California State Parks.
Riley, S.D., L.K. Serieys, J.P. Pollinger, J.A. Sikich, L. Dalbeck, R.K. Wayne, and H.B. Ernest. 2014. Individual Behaviors Dominate the Dynamics of an Urban Mountain Lion Population Isolated by Roads (PDF)(opens in new tab). Current Biology 24(17):1989-1994.

Riley, S.P.D., R.M. Sauvajot, J. Sikich, and E. York. 2006b. Mountain lion ecology, behavior, and conservation in the fragmented urban landscape of Santa Monica Mountains National Recreation Area and surrounding parklands, 2002-2006. National Park Service Technical Report submitted to the California Department of Parks and Recreation.

Ripple, W. J., J.A. Estes, R. L. Beschta, C.C. Wilmers, E.G. Ritchie, M. Hebblewhite, J. Berger, B. Elmhagen, M. Letnic, M.P. Nelson, O.J. Schmitz, D.W. Smith, A.D. Wallach, and A.J. Wirsing. 2014. Status and ecological effects of the world's largest carnivores. Science 343:1241484.

Schloss, Carrie et al. (2021). Connectivity for climate change adaptation in California [Dataset]. Dryad. https://doi.org/10.5061/dryad.d7wm37q1m

Soulé, M.E., and J. Terborgh, editors. 1999. Continental conservation: scientific foundations of regional reserve networks. Island Press.

South Coast Wildlands (SC Wildlands). 2008. South Coast Missing Linkages: A Wildland Network for the South Coast Ecoregion. Produced in cooperation with partners in the South Coast Missing Linkages Initiative. Pp. 67 + appendices. Report available online at http://www.scwildlands.org. [GIS dataset; Feature Layer South_Coast_Missing_Linkages.shp; SDE Feature Class ds419]. Link to metadata and data South Coast Missing Linkages [ds419] GIS Dataset (ca.gov).

Spencer, W.D., P. Beier, K. Penrod, K. Winters, C. Paulman, H. Rustigian-Romsos, J. Strittholt, M. Parisi, and A. Pettler. 2010. California Essential Habitat Connectivity Project: A Strategy for Conserving a Connected California. Prepared for California Department of Transportation, California Department of Fish and Game, and Federal Highways Administration.

Spowart, R.A. and F.B. Samson 1986. Carnivores. Pp. 475-496 In: A.Y. Cooperrider, R.J. Boyd, and H.R. Stuart (eds). Inventory and monitoring of wildlife habitat. U.S. Department of the Interior, Bureau of Land Management, Service Center. Denver, Colorado

The Nature Conservancy. 2020. Resilient and Connected Landscapes. https://crcs.tnc.org/pages/land

The Nature Conservancy and Conservation Science Partners. 2017. Present-Day Connectivity Omniscape https://omniscape.codefornature.org/

Thorne, J.H., R. Cameron, and J.F. Quinn. 2006. A Conservation Design for the Central Coast of California and the Evaluation of Mountain Lion as an Umbrella Species. Natural Areas Journal. 26:137-148.

Vickers, T., W., J. Sanchez, C. Johnson, S. Morrison, R. Botta, T. Smith, B. Cohen, P. Huber, H. Ernest, and W. Boyce. 2015. Survival and mortality of pumas (Puma concolor) in a fragmented, urbanizing landscape. *PloS one* 10 (7): e0131490.

Zeller, K.A., T.W. Vickers, H.B. Ernest, and W.M. Boyce. 2017. Multi-level, multi-scale resource selection functions and resistance surfaces for conservation planning: pumas as a case study. Plos One 12:e0179570.

From:	Jack Crawford
To:	PublicHearing; ExecutiveOffice; jsackett@planning.lacounty.gov
Cc:	Torres-Socarras, Ariel
Subject:	Support Northlake – March 24th BOS Meeting
Date:	Monday, March 16, 2026 1:08:19 PM

Chair Solis, Supervisor Barger, and Members of the Board,

I wanted to take a moment to share my support for the Northlake project.

Castaic has been waiting for this project for the better part of two decades. While I am now retired, I owned a local business in Castaic that I opened with the understanding that the Northlake development would be coming and bringing many new residents to our community. Like many other business owners, we waited patiently. Many didn't survive. We managed to hang on for twenty years but eventually had to close the business and walk away. Had this development come online as scheduled we most likely could have sold the business for a profit and it would continue to serve the community under new ownership. Castaic needs the Northlake development, desperately, in order for the town to realize its full potential and thrive.

And Northlake isn't just about economic development for our local businesses. Like many people in our region, I see how difficult it has become for families to find attainable housing. Northlake is a thoughtful project that helps address that challenge while also adding parks, trails, and open space for the community.

I hope the Board will allow this project to move forward and deny the appeal.

Thank you for your time and service.

Best,

Jack Crawford

From:	Lia Tafarella
To:	PublicHearing; ExecutiveOffice; jsackett@planning.lacounty.gov
Cc:	Torres-Socarras, Ariel
Subject:	Support Northlake, Deny Appeal - Board Meeting - March 24
Date:	Monday, March 16, 2026 9:01:31 AM

Dear Chair Solis and Members of the Board,

I am writing to share my support for the Northlake project and respectfully ask the Board to deny the appeal.

The project helps address our region's housing needs while also providing parks, trails, and open space that will benefit the community.

Thank you for your consideration.

Sincerely,

Lia Tafarella

From: Brian Schlick
To: PublicHearing; ExecutiveOffice; jsackett@planning.lacounty.gov
Cc: Torres-Socarras, Ariel
Subject: Support Northlake, Deny Appeal – March 24th BOS Meeting
Date: Monday, March 16, 2026 9:14:23 PM

Dear Board Members:

We're writing to you today as local residents and business owners to share our support for the Northlake project and the positive impacts it will have on our community.

Our community needs more housing options, including affordable housing, and Northlake appears to be a responsible and thoughtfully planned development that addresses that need while also providing parks, trails, and open space for the public to enjoy.

It's encouraging to see a project that combines housing, community amenities, and economic investment. I hope the Board will deny the appeal so the project can move forward and bring with it all that the businesses and residents in Castaic have been waiting for to see the community prosper and thrive.

Thank you for considering my perspective.

Thank you,

Lindsay & Brian Schlick

Brian Schlick
www.SchlickArt.com
661-309-5326

From:	Richard Provincia
To:	PublicHearing; ExecutiveOffice; jsackett@planning.lacounty.gov
Cc:	Torres-Socarras, Ariel
Subject:	Support Northlake, Deny Appeal – March 24th BOS Meeting
Date:	Monday, March 16, 2026 1:53:59 PM
Attachments:	image001.png image002.png image003.png image004.png image005.png image006.png image007.png image008.png image009.png image010.png

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Hello,

Dear Members of the Board,

I would like to offer my support for the Northlake project and respectfully ask that the Board deny the appeal currently before you.

Housing affordability continues to be one of the most pressing issues facing our region. Northlake provides an opportunity to add much-needed housing while also incorporating community amenities such as parks, trails, and preserved open space.

Projects like this also contribute to the economic health of our communities by generating jobs and bringing new investment to the area. New housing supports local businesses and helps build stronger, more sustainable neighborhoods.

For these reasons, I believe Northlake represents responsible and forward-thinking planning. I hope the Board will allow the project to proceed.

Thank you for considering my perspective. I hope you all have a great week ahead!

PMP MANAGEMENT

Richard Provincia

Senior Community Asset Manager

Rprovincia@pmpmanage.com

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From:	Barbara Myler
To:	PublicHearing; ExecutiveOffice; jsackett@planning.lacounty.gov
Cc:	Torres-Socarras, Ariel
Subject:	Support Northlake, Deny Appeal - March 24th BOS Meeting
Date:	Wednesday, March 18, 2026 12:40:51 PM
Attachments:	img-3fe46d6a-3688-4f4e-a87a-0b6a3bb487ab

Chair Solis, Supervisor Barger, and Honorable Board Members,

As a local resident of more than 30 years, I want to take a moment to voice my support for the Northlake development and respectfully request that the Board deny the appeal.

Our community is in real need of additional housing options, particularly homes that are attainable for middle-income residents. Northlake is an important step toward addressing that need while also creating parks, trails, and open space that will benefit residents throughout the area.

Beyond housing, the project will contribute to the local economy by creating jobs, supporting nearby businesses, and investing in transportation and infrastructure improvements that serve the broader community.

In my view, Northlake reflects careful planning and a balanced approach that considers both housing and environmental stewardship. I encourage the Board to move the project forward.

Thank you for your attention and for the work you do on behalf of our communities.

Sincerely,

Barbara Myler

Barbara C. Myler
President/CEO
Summit West Public Relations & Marketing
Valencia Jazz & Blues Concert Series
P.O. Box 55133
Valencia, CA 91385
cell: 661.373.8700
email: Barbara@SummitWestPR.com

From:	Eric Angle
To:	PublicHearing; ExecutiveOffice; jsackett@planning.lacounty.gov
Cc:	Torres-Socarras, Ariel
Subject:	Support Northlake, Deny Appeal – March 24th BOS Meeting
Date:	Monday, March 16, 2026 8:19:02 AM
Attachments:	C2_signature_logo_pmp(sized)_c1cbfc6e-32f3-44be-b03d-1677c800c429.png C2_signature_icon_mail(sized)_f3a5a6db-8cf2-48c3-ac9d-e2298f02832f.png C2_signature_icon_web(sized)_e7498707-597f-4284-8fb3-3befc4a9461b.png C2_signature_icon_phone(sized)_a4541d80-0812-4305-a826-b8171196973f.png C2_signature_signature-topworkplaces2025(sized)_6f112b78-f9e6-4ab3-9ef5-fffee23ae014.png C2_signature_icon_aamc(sized)_e50eec13-74bb-4c8e-ab1e-eaaf7b6348a5.png C2_signature_icon_instagram(sized)_64869a75-b7e4-4ba5-8e61-4329167428ad.png C2_signature_icon_facebook(sized)_f3017730-dcfd-4078-baaf-3e26a1d0949c.png C2_signature_icon_twitter(sized)_854b15af-ab27-43d5-84ec-e9886856dc63.png C2_signature_icon_linkedin(sized)_19730f88-24e0-403a-af42-5c01b70ec666.png

Madam Chair and Members of the Board:

I am writing as a resident of the community to express my support for the Northlake project and to respectfully ask that the Board deny the appeal.

Los Angeles County continues to face a major shortage of housing that working families can afford. Projects like Northlake help address this challenge while also providing meaningful community benefits, including parks, trails, and preserved open space that residents will be able to enjoy for generations.

In addition to expanding housing opportunities, the project will generate jobs, support nearby businesses, and contribute to the long-term economic vitality of the region.

Northlake represents a balanced approach to planning that considers housing needs, environmental protection, and community investment. I hope the Board will allow this project to move forward.

Thank you for your service and for considering my comments.

Sincerely,

PMP MANAGEMENT

Eric Angle - CMCA, AMS, PCAM

Division Vice President

eangle@pmpmanage.com

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From:	Jordin Hopkins
To:	PublicHearing; ExecutiveOffice; jsackett@planning.lacounty.gov
Cc:	Torres-Socarras, Ariel
Subject:	Support Northlake, Deny Appeal – March 24th BOS Meeting
Date:	Monday, March 16, 2026 8:48:11 AM

Dear Chair Solis, Supervisor Barger, and Members of the Board,

As a resident of the area, I'm writing in support of the Northlake project and respectfully ask that the Board deny the appeal.
Northlake provides several important community benefits:

- Much-needed housing opportunities for our region
- Parks, trails, and open space for residents and families
- Job creation and support for local businesses
- Long-term investment in transportation and infrastructure

Projects that thoughtfully combine housing, environmental stewardship, and economic opportunity are exactly what our region needs.
Thank you for your consideration.

Sincerely,

Jordin Hopkins