California Department of Forestry & Fire Protection (CAL FIRE) Reforestation Services Program 2025 Assessment of Needs for the State Seed Bank, May 20, 2025

EXECUTIVE SUMMARY

Scope and objective: Establish an analytical process for targeted conifer seed collection throughout California.

Methods Used: Geographic Information Systems (GIS) data layers were used to provide baseline forest land mass areas, seed zones, elevation bands, total and high-severity wildfire perimeters, and tree mortality areas. The dataset generated was then exported for further analytics to target desired species, incorporate CAL FIRE's Seed Bank inventory, nursery requirements, and CAL FIRE Units to obtain the target number of conifer cone bushels to reforest 25 percent of forest land area in California.

Findings and recommendations: A grand total of 55,978 bushels of conifer cones would need to be collected throughout the various seed zones, elevations bands, and species to address 2025 needs that target a 25% reforestation goal statewide on included lands and under the current vegetation distribution. While this Assessment of Needs (AON) is extensive, the recommendation is to use this document as a guide with the datasets subject to amendments as variables change.

New features in 2025 since the last publication of this report (July 2024): The 2025 analysis includes (1) a more recent version of the Landscape Ecology, Modeling, Mapping, and Analysis (LEMMA) vegetation data published by Oregon State University (version 2023.1) and (2) a new data source for productive timberlands. Timberlands boundary is still mapped internally by

CAL FIRE, but the underlying data source has been updated from the U.S. Forest Service CalVeg data, a fine-scale vegetation mapping product, to the even higher resolution current and historic LEMMA vegetation. This update resulted in an expanded area of interest for our analysis compared to July 2024 and masks some of the seed collection progress over the past year. However, this update also makes our analysis more consistent, as the entire AON area of interest is now derived from the same underlying LEMMA vegetation data source.

Limitations: The current version of the assessment does not explicitly exclude privately-owned industrial land. However, the Seed Bank primarily collects seed on state-owned and non-industrial private forestlands. The estimated seed collection need statistics therefore somewhat overestimate the actual need, which is lower due to industrial seed reserves.

ABSTRACT

The purpose of the Assessment of Needs for the State Seed Bank (AON) is to provide a structured framework for directing the seed collection resources of the California Department of Forestry & Fire Protection's (CAL FIRE's) Reforestation Services Program (RSP), targeting and prioritizing efforts across all 85 seed zones and all 500-foot elevation bands for all native conifer tree species within all forested landscapes of State and Local Responsibility Areas (SRA and LRA) within the State of California. The information contained within this document should be seen as first, a tool for RSP staff, second, as a guide for internal and external collaborators, and third, as a resource for general consumption.

CAL FIRE has a need for a systematic way to estimate the number of bushels needed for collection that will be needed to grow sufficient seedlings for reforestation on state and private forest lands. In this analysis, spatial data layers were used to identify areas of productive conifer species and where they intersected with elevation, seed zones, and, as a proxy for disturbance, wildfire history and historic tree mortality due to insects and disease. That information was then used to calculate carrying capacity and deviation below those productive thresholds (or seed lots). When combined with the results of the RSP's existing seed inventory, a concerted approach to cone surveying and collection can be made to replenish seed lots of

greatest need. The results of this exercise for 2025 are to be shared with internal and external cooperators with the expectation that datasets are revisited, and a corresponding report and table produced annually.

BACKGROUND

Healthy forests provide a multitude of benefits. Wood products, wildlife habitat, clean water and air, recreation, education, and steady employment are but a handful of the immense values they support. Recognizing the vast environmental, economic, and social benefits of this natural resource, it is incumbent on resource managers to improve forest conditions and lessen threats in the face of climate change and persistent drought, as well as forest disturbances including catastrophic wildfire, insect and diseases, and poor forest management and land conversion.

Table 1 presents an overview of disturbance statistics within productive conifer forests on non-federal lands of California between 2018 and 2024. These years were chosen as they are more recent (and larger) fires that still have reforestation potential. 2023 is the most recent year of tree mortality and wildfire severity data available at the time of publication. The numbers are based on our calculations using a variety of state and federal data. The details of these calculations are outlined in the methodology section, in subsection C. An estimated 1.5 million acres burned on non-federal conifer forestlands, with 0.36 million acres burning at high severity. Among our conifer species of interest, 22.5 million trees died from exposure to insects and diseases. Data on tree mortality is missing for 2020, so this number is an underestimate. Due to the devasting tree mortality (including that of parent seed trees), increased wildfire, as well as other biotic and abiotic factors, there grew an increasing need for post-disturbance reforestation and thus a surging demand for seeds and seedlings.

Year	Tree Mortality due to Insects and Diseases (in Millions)	Acres Burned by Wildfires	High-Severity Acres Burned by Wildfires
2018	2.7	273,113	68,369
2019	2.0	32,378	5,306
2020	-	623,868	185,261
2021	1.9	356,392	78,586
2022	9.7	73,705	20,679
2023	6.2	5,918	981
2024		142,456	
Total	22.5	1,507,830	359,182

Table 1: Disturbance Statistics by Year

To help meet the mounting need for reforestation services on SRA lands, CAL FIRE operates a single Reforestation Center for the entire state, located in Davis, California. The center encompasses the only remaining State-run conifer seed bank and nursery. Established in 1921, the Lewis A. Moran Reforestation Center (LAMRC) has provided reforestation resources to public and private non-industrial landowners throughout the state of California in the form of seeds and seedlings for over 100 years. Unfortunately, due to budget restrictions, the nursery portion of LAMRC was shut down in 2006. The seed bank remained functional and continued to collect, process, and store seeds with drastically reduced staffing. In 2017, a Budget Change Proposal adopted by California State Legislature allowed for additional staffing for the RSP as well as related infrastructure and facility upgrades at LAMRC to expand seed storage capacity along with the necessary nursery equipment to eventually increase production of up to 1 million seedlings annually for forestland owners. While those improvements have yet to fully materialize, and despite fluctuations in yearly funding, the RSP has maintained CAL FIRE's ongoing mission to serve and safeguard the people and protect the property and resources of California.

RSP staffing remains minimal, employing 8 full-time employees and 5-10 seasonal or limited-term hires engaged in both seed bank and nursery operations. The employees not only manage seed requests made by forestland owners but engage in the day-to-day processing of cones and

seeds, as well as the coordination of surveys and collections of cones from field locations at optimal times of year. In 2024, staff and cooperators collected 4,630 bushels of cone which resulted in more than 3,696 pounds of processed seed destined for the public seed bank or set aside privately as cooperator orchard seed shares. Exact final amounts are unavailable at the time of this report given ongoing processing. The Seed Bank staff also facilitated the sale and distribution of 801 pounds of seed, while Nursery staff processed 24 unique seedling orders, growing a quarter million seedlings, amounting to 182,551 seedlings distributed in 2024 with the remainder distributed in Spring 2025. While very dedicated and productive, the RSP suffers not only from limited staffing, but antiquated processing and accounting systems, as well as restricted storage and growing capacity.

Cone surveys, which serve as the first step in reforestation pipeline, are inconsistently done, historically, by regional unit foresters with many conflicting duties, and the results of which are usually submitted to the RSP on paper sheets with limited accuracy or utility. Personnel, experience, and leveraged technology are not only lacking for the surveying of ripening cones but in their collection as well. Current practices see but a handful of experienced surveyors and collectors utilizing binoculars and traditional climbing practices to gather intelligence and materials from forest stands which are not always themselves accessible or practical for harvesting. Aside from minor investments in cooperative seed orchards out of state, the RSP lacks a steady supply of farmed or genetically bred seed stock, and thus, relies on the intricacies

of wild seed collections on lands not owned by the Department which require access agreements and other negotiations. In factoring in the related struggle of demand for reforestation materials far outweighing supply, and the compounding obstacles that add to site preparation as time before replanting lengthens, the entire industry is facing increasing adversity.

All these processes are in some form of being updated and modernized as staffing/funding increase and attention is given to the importance of growing the reforestation supply pipeline, however this does illustrate the challenges we currently face. With the many challenges that hamper adequate reforestation of degraded forestlands, a methodical approach needs to be employed routinely to evaluate a prioritized and enhanced response to the needs of these crucial landscapes in California.

Further enabled by the goals of the 2021 California Wildfire and Forest Resilience Action Plan, CAL FIRE is working to meet the following key actions relative to its RSP, as follows:

> 1.15 Provide Seedlings for Restoration: CAL FIRE will expand its nursery and seed bank to deliver seeds and seedlings to small landowners whose properties are affected by wildfire or diseases. Experts will focus on using native seed selections that are best suited to current and future landscapes.
>
> 1.34 Develop Coordinated State Restoration Strategy: California Natural Resource Agency (CNRA) will partner with the California Office of Emergency Services (Cal OES),

The Office of Planning and Research (OPR), and other federal, state, and local agencies to develop a coordinated strategy to prioritize and restore non-federal burned areas and communities as part of the state's overall long-term recovery and resilience strategies.

METHODOLOGY

RSP staff realizes that a rational approach is needed to estimate the number of seeds to grow sufficient numbers of seedlings to restore California's state and private forests. An Assessment of Needs (AON) was developed in conjunction with this report to determine how many bushels of seed need to be collected to reforest 25% of productive conifer forests on non-federal lands at any given time throughout the state of California. Twenty-five percent was determined to be an obtainable goal for the affected lands realizing the inventory of seeds, capacity of nurseries, and site considerations and practicality of regeneration practices in those areas. This AON for the State Seed Bank was developed using a spatial approach identifying conifer forest on state and private lands. Information on individual tree species growing on these lands was then extracted for each seed zone and 500-ft elevation band and matched against the State Seed

Bank inventory. The AON allows a methodical approach for allocating State-held resources to areas of highest priority for reforestation as well as defining programmatic areas necessary for increased success. The assessment not only allows us to best allocate our resources in the form of surveying and collecting cones but can give us internal directives as to how to strategize other initiatives like investment in related seed tree orchards, prioritizing limited processing and freezer space, collaborating with industry partners to formulate response plans, directing funding for local projects, and other endeavors.

It may be deemed that a regional approach, based on more delineated topographic and climatic descriptions, other than seed zone, could be further assistive. Support of advanced tools and protocols should also be considered to make the process more streamlined and efficient. CAL FIRE's Fire and Resource Assessment Program (FRAP), along with the Reforestation Services Program staff, used spatial data and Geographic Information System (GIS) overlay analysis using Environmental Systems Research Institute (ESRI) and Python software. The data comes from a variety of federal and state government sources, including CAL FIRE, the U.S. Forest Service, and the U.S. Geological Survey. The results of the analysis are both a visual representation of the data as well as a functional tool that allows the user to estimate the bushels needed to successfully regenerate specific species of conifer forests. The following is a list of the steps followed to perform the analysis.

A. <u>Establish the spatial extent of the analysis, focused on productive conifer forests</u>

The LA Moran seed bank collects seed primarily for regenerating conifer forests on non-industrial private forestlands as well as State-owned public lands. We estimated the spatial extent of these lands using three data sources described in the following paragraphs.

To identify areas of conifer vegetation, we used most recent vegetation data hosted by the Landscape Ecology, Modeling, Mapping, and Analysis (LEMMA) program at Oregon State University and supported by researchers at the U.S. Forest Service. This data maps current vegetation type, an attribute that identifies up to two dominant tree species based on basal

area, and groups vegetation type into a broader vegetation class, such as a conifer or a broadleaf forest. We first filtered LEMMA vegetation class to include only conifer and mixed forests.

LEMMA vegetation data reports what is on the ground at the time of remote sensing. CAL FIRE has a spatial layer that depicts productive timberlands, whether the areas are currently forested or not (Forest Practice Timberlands 22_3). This dataset is a manipulation of both current and historic LEMMA data and spatially incorporates multiple vegetation years into one composite footprint. For example, an area that has been recently harvested will not be classified as a forest in the most recent LEMMA data but will be reported as productive timberland in Timberlands. To complete a depiction of conifer forests that may not be currently forested, our second step was to add productive timberland areas to conifer and mixed forests flagged in step 1.

The analysis focused on state and private lands and so needed to exclude federal lands. We used the CAL FIRE State Responsibility Area (SRA) layer, which identifies lands that fall within the State Department's jurisdiction for fire protection, Federal Responsibility Area for fire protection (FRA), and Local Responsibility Area for fire protection (LRA). We identified conifer forest and timberland areas that fall within the federal jurisdiction and dropped them from our analysis. This final step left us with a boundary of productive conifer forests on non-federal lands. We refer to it as the "footprint" of the analysis (Figure 1).

B. Control for climate and elevation – seed zones and elevation bands

The collection of seed for successful regeneration should account for environmental variables as species differ in growth and success depending on climate, soils, and elevation. We used seed zones to account for climactic and soil variation throughout the state. Seed zones are defined by major areas in California having similar climatic, topographic, and soil conditions. The original mapped seed zones were first proposed in 1946 with the most recent version having been revised in 1966 and published as part of a joint report between the USDA Forest Service and CAL FIRE in 1970. Denoted by a three-digit identifier and broken out into 85

distinct zones within 32 subregions contained within 6 overarching regions, the map attempts to base the location of native tree plantings within close proximity and elevation to the collected seed source from which those trees were propagated.

The regions, known as Physiographic and Climatic Regions, are depicted by the first digit in the three-digit designation for each seed zone. Divisions of the regions, called subregions, were delineated based on the next lower level of environmental changes known to affect growth and adaptability of plants. These are designated by the second digit in the three-digit seed zone number. Divisions of the subregions, called subzones, are indicated by the third digit in the three-digit seed zone number. Individual subzones within subregions were defined based on the overall framework of approximately 50 miles in latitude and further refinement in uniformity of environment within subregion. Subzone boundaries were made to follow natural or physical features (FRAP, 2003) (Figure 2).

We used elevation to further refine climatic and soil variation boundaries. A 10-meter resolution digital elevation model (DEM) from the USGS depicting elevation was converted into smoothed elevation contours that delineate the 500-foot bands (Figure 3).

C. Calculate measures of disturbance to conifer forests

To include measures of natural disturbances to conifer forests, we used data on wildfire perimeters, wildfire burn severity, and areas of tree mortality due to insects and disease between 2018 and 2024. These are the areas where heavy reforestation may be necessary. In addition to seed need calculations for each species at a particular seed zone and elevation band, site-specific analyses of seed needs will be targeted to these disturbed areas to influence collection needs.

Perimeters of large wildfires at least 100 acres in size come from CAL FIRE FRAP's fire perimeter dataset that includes wildfires managed by state, local, or federal agencies for the past 100 years (Figure 4). We focused on perimeter areas that burned non-federal conifer forests defined by the analysis footprint and calculated the total acreage burned in each seed

zone and elevation band area using overlay analysis. A list of wildfire names and complex names if any wildfires were part of a complex are also included for each area.

To account for the variation in burn severity, and thus variation in disturbance and need for reforestation across the spatial extent of the fire, we performed similar calculations for wildfire areas that burned at high severity only (Figure 5). The result was the total high-severity acreage burned in each seed zone and elevation band area. Boundaries of high-severity wildfire burn patches are mapped for wildfires of at least 1000 acres by the Monitoring Trends in Burn Severity (MTBS), an interagency program that includes contributors like the U.S. Forest Service and the Department of Interior.

A final measure of disturbance to conifer forests is based on the U.S. Forest Service's Aerial Detection Surveys (ADS). This data maps areas of forest damage and mortality due to insects and disease (Figure 6). From this data, we derived measures of acreage affected by insects and disease and total tree mortality due to such diseases in a way analogous to wildfire acreage calculations. We restricted the damaged forest areas to those that contain our conifer species of interest (listed in the next section) and to the analysis footprint. Using the resulting damage boundaries and the recorded average tree mortality per acre, we estimated total acreage and total mortality count in each seed zone and elevation band area.

D. Determine species distribution and calculate reforestation acres per target species for each 500' elevation band in each seed zone

We subset vegetation data that maps dominant tree species described in step A to our footprint of non-federal productive conifer forests. We further filtered all species identified by the vegetation data to the 15 conifer species of interest:

1. Big-Cone Douglas Fir
2. Coast Redwood
3. Coulter Pine
4. Douglas Fir

5. Giant Sequoia
6. Incense Cedar
7. Jeffrey Pine
8. Knobcone Pine
9. Lodgepole Pine
10. Ponderosa Pine
11. Red Fir
12. Subalpine Fir
13. Sugar Pine
14. Western White Pine
15. White Fir

While not the only species present in the State Seed Bank, the above-mentioned species are the primary species or forest types that are requested and focused on due to demand and storability. As such, hardwoods, like oaks, maples, and walnuts, as well as native conifer species of less commercial value, such as Torrey pine and Monterey pine, are not included. This is not to suggest that the RSP will not collect these species, but for the purposes of prioritizing the most requested tree species to support reforestation, the above species were the initial focus. The RSP will always serve as a genetic library for native tree species in California and will employ more localized prioritization for special status species when available for collection. As the RSP matures and expands, we will begin to include hardwoods and other native shrubs.

We overlayed the resulting subset of the vegetation layer with seed zone and 500-ft elevation band boundaries to extract information on share of area covered by each species in each unique seed zone and elevation band combination. We converted this area share to acres based on the resolution of the vegetation data to get targeted reforestation acres for all species of interest within each seed zone and elevation band.

E. <u>Generate trees per acre and total bushels per target species for each 500’ elevation band in each seed zone</u>

An average stocking requirement of 200 trees per acre (TPA) was applied to targeted reforestation acres for all species found above. This number was derived as an acceptable average carrying capacity for forestlands relative to CA Forest Practice Rule (FPR) requirements that can range between 50 and 200 TPA depending on location and forest management prescriptions. This stocking requirement was applied and generated the number of total trees needed to reforest target acres in each seed zone and elevation within a 500’ elevation band with the assumption of each acre needing maximum stocking in the worst-case hypothetical scenario.

Conifer seed collections are classified as number of bushels needed in terms of harvesting based on species. One bushel consists of 8 dry gallons of opened cones. A conversion is needed to get from acres to number of bushels. The process comprises determining, on a per species basis; the average seed per pound, average seedling produced per pound, number of pounds needed to collect, and finally number of bushels needed.

Datasets for those processes were obtained as follows:

Average seed per pound

LAMRC inventory data were used to obtain data averages per species.

Average seedlings produced per pound

= (average seed per pound/average seed per pot) x percent survival rate in nursery x average probability of a tree in nursery.

Historical LAMRC nursery datasets were used for:

i. number of seeds per pot—is determined based on the germination calculations.
ii. percent survival in nursery—seed that germinated and grew to a two-year seedling.
iii. average probability of tree in nursery—seedlings that were thinned and were able to be transplanted.

Number of pounds needed to collect

= (number of trees in reforestation acres/average seedlings per pound)

Number of bushels needed

= (number of pounds needed to collect/average pounds of clean seed per bushel).

Clean seed is defined as seed that has been processed to have >95% purity, <9% moisture content, and is ready for long-term storage. Bushels were rounded to whole numbers. Average pound of clean seed per bushel was obtained via historical records shown in Table 2. For species not represented in the table, a conversion of one bushel of seed equaling one pound of seed was assumed.

Species	Avg. No. Cones/Bushel	Avg. Lbs. Clean Seed/Bushel
Big-Cone Douglas Fir	300-400	0.75
Coast Redwood	1000s	0.75
Coulter Pine	10-12	0.9
Douglas Fir	900-1000	0.5
Giant Sequoia	1000s	0.75
Incense Cedar	1000s	0.7
Jeffrey Pine	35-50	1.2
Ponderosa Pine	90-100	1
Red Fir	50-65	0.9
Sugar Pine	12-18	1.4
White Fir	170-200	1.1

Table 2: LAMRC records of average number of cones and clean seed obtained per species.

Current LAMRC seed bank inventories (comprised of wild and orchard seeds) are measured in pounds which were also converted to bushels needed based on process # 4 detailed above. Inventory datasets were matched to the spatial dataset with estimated need based on species, elevation, and seed zone. The final result shows deficits as positive bushel counts and excess as negative bushel counts. It is worth noting that the final values of bushel deficit/excess do not take into account private, industrial seed bank inventories. Figure 7 shows the spatial logic of the entire AON creation process and provides an excerpt of the final data.

F. Supplementary data for coordination of seed collection

The most recent analysis includes supplementary information on CAL FIRE timber harvesting operations, demonstration state forests, and parcel ownership data designed to facilitate coordination of seed collection. For each unique seed zone and elevation band combination, we present a list of Timber Harvesting Plans, Notices of Timber Operations, and Nonindustrial Timber Management Plans that are at least 100 acres in size and are either approved or unlogged. We identify any demonstration state forests that appear within each seed zone and elevation band area boundary. We also flag parcels 40 or more acres in size that overlap with the non-federal conifer forest footprint boundary and that are located in each seed zone and elevation band. Additional data on parcel ownership, zoning, and other sensitive information is available conditional on completion of restricted parcel data access agreement paperwork.

H. Final bushel needs and collection priority index

The 2025 Seed Bank AON is an extensive list representing a spatial analysis baseline of the number of bushels required to reforest 25% of productive conifer forests on non-federal lands, along with natural disturbance statistics, CAL FIRE timber harvesting operations, demonstration state forests, and parcel data within each seed zone and 500' elevation band.

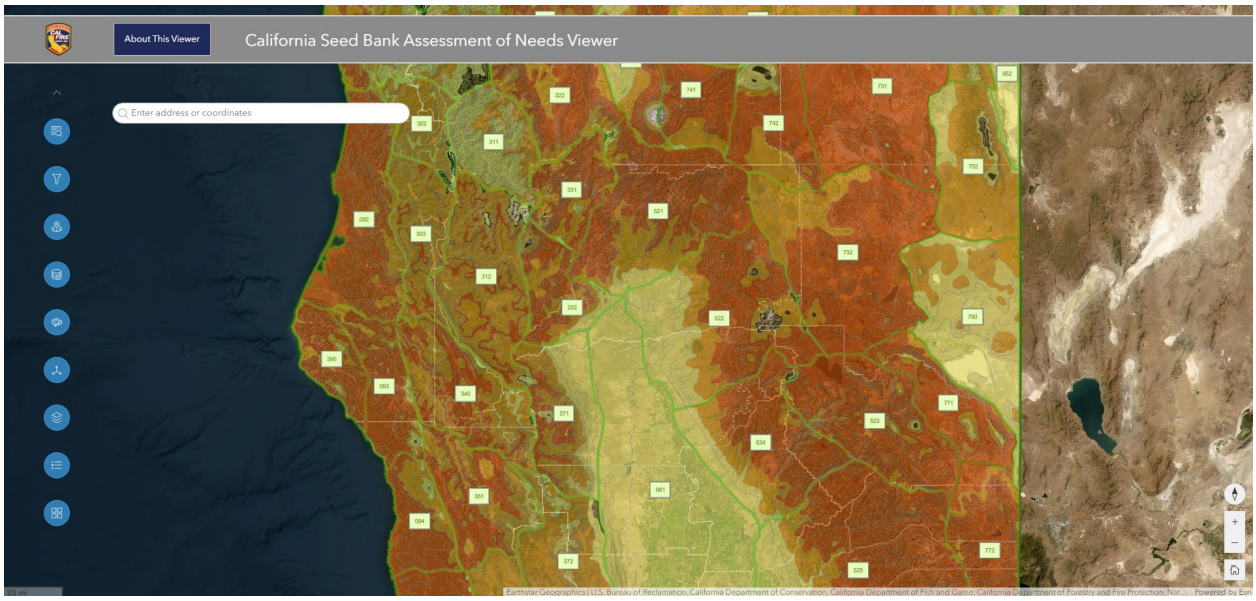
Final bushel needs statistics are color-coded to aid in visualizing collection priority based on an assigned priority index ranging from 1 to 3. Bushel needs higher than 100 are colored in red and are coded as priority 1. Bushel needs between 11 and 100 are colored in orange and receive priority level 2. Bushel needs of 10 or less are colored in yellow and are marked as the lowest priority 3.

CONCLUSION

As of May 2025, a total of 55,978 bushels of conifer seed needs to be collected throughout the entire state of California to accomplish the 25% reforestation goal statewide on the lands included. This total number shows a reduction of 900 bushels from last year's estimate. The change reflects total seed collected in 2024 and updates to the underlying vegetation and timberlands data described above.

Internally, the AON is being used to assist CAL FIRE Unit Foresters and their staff by providing a list of species, per seed zone, and elevation band that can be tailored to match cone survey routes when possible. Externally, CAL FIRE is using the AON to assist with discussions surrounding seed acquisition and collaborations with private industrial timberland owners, other government organizations, non-profits, and research institutions. A public viewer that summarizes AON results is also available on the RSP website here to anyone interested in California's reforestation efforts. The viewer maps statistics on bushel needs and other supplementary data for each seed zone and elevation band boundary. It includes a variety of filters and queries based on geographic boundaries or bushel needs distribution, a summary of aggregate need for filtered areas, and a tool to upload additional data of choice to the viewer

from a variety of sources.



The intent of the AON approach is to incorporate quantitative data to provide a guide for areas to focus resources and collection efforts on. Logic and rationale still need to be implemented with the AON acting synergistically with recommendations from a Registered Professional Forester or other qualified land managers in the field. CAL FIRE's Reforestation Services Program looks forward to making annual updates to this document, related tools, and guidance in hopes that refined methodologies and enhanced data will better serve the purposes of this assessment. Please refer to the contributors section below with any questions or concerns.

GLOSSARY OF TERMS

Assessment of Needs (AON) - Also referred to as the "Seed Needs Assessment", i.e. this document. Accompanied by quantified, tabular, localized data, this analysis is designed to be conducted yearly by CAL FIRE staff and shared internally as well as with cooperators to better assess where source tree materials are needed at defined levels.

Budget Change Proposal (BCP) - A formal document required when an office needs additional resources or reduction of resources to change the level of funding for activities that need to be authorized by the State Legislature.

Bushel - Measurement of dry volume of tree cones, represented as 8 dry gallons.

California Department of Forestry and Fire Protection (CAL FIRE) - California Natural Resources Agency's fire department whose mission is to serve and safeguard the people and protect the property and resources of California. It does this by supporting staff engaged in engineering; research, development, and adoption of regulations; fire and life safety programs; fire prevention, law enforcement, and public information and education; resource protection; and emergency response.

California Wildfire and Forest Resilience Action Plan - A strategy to restore the health and resilience of California forests, grasslands, and natural places. In addition, improve fire safety of communities and sustain the economic viability of rural forested areas.

Digital Elevation Model (DEM) - A computer graphic based on elevation data. It is comprised of cells of a certain length and width as well as their elevation above zero. They are used to represent topography and elevation.

Federal Responsibility Area (FRA) - Areas where the federal government has jurisdiction to first respond to emergencies to include wildfires. These areas are marked primarily by federal ownership, such as National Forests, National Parks, lands owned by the Bureau of Land Management, the United States Military and others.

Fire and Resource Assessment Program (FRAP) - A CAL FIRE program whose primary function is to analyze spatial data, model environmental variables, and create environmental spatial data

layers to inform land management. FRAP assesses the amount and extent of California's forests and rangelands, analyzes their conditions, and identifies alternative management and policy guidelines.

Forest Practice Rules (FPRs), aka Forest Practice Act – Laws enacted in 1973 and enforced by CAL FIRE that regulate logging on privately-owned lands in California to ensure it is done in a manner that will preserve and protect fish, wildlife, forests, and streams.

Lewis A. Moran Reforestation Center (LAMRC) - See ***Reforestation Services Program*** and ***State Nursery***.

Local Responsibility Area (LRA) - An incorporated area where the local government is responsible for providing emergency services including fire protection. Emergency response in these areas is typically provided by city fire departments, fire protection districts, counties, and by CAL FIRE under contract.

Reforestation - Replanting trees (aka artificial regeneration) or supporting the regrowth of trees from seed and stump sprouting (aka as natural regeneration), in previously forested areas that have been affected by both natural and/or unnatural disturbances.

Reforestation Services Program (RSP) - Based out of the LAMRC in Davis, CA, the RSP is a CAL FIRE Resource Management Program whose mission is to provide California landowners and managers with resources needed to restore disturbed lands to maximize the values of highly productive forests.

Seed Lot - A uniform quantity of seed within a permitted tolerance for percentage of pure seed and other crop and inert matter.

Seed Zones - An inventory system that classifies seeds for collection and planting by physiographic zones. Major areas in California having similar climatic, topographic, and soil conditions are given the name "Physiographic and Climatic Regions." These are areas where plant materials can be moved or transferred with minimal risk of being poorly adapted to new location.

State Nursery - CAL FIRE-owned and operated facility that grows tree species for forest

restoration purposes for private and public landowners utilizing native seed stored at the State Seed Bank. While there were previously multiple sites operating as such, the only facility in operation currently is the Lewis A. Moran Reforestation Center (LAMRC) in Davis capable of growing approximately 250,000 1-year seedlings.

State Responsibility Area (SRA) - Areas where the State of California has the primary responsibility for providing emergency services including fire protection. The emergency service is typically provided by CAL FIRE.

State Seed Bank - CAL FIRE-owned and operated facility in Davis, CA that processes and stores native tree seed for on or off-site growing at nurseries for forest restoration purposes for private and public landowners. A zero-degree freezer currently is able to preserve over 40,000 pounds of various seed at this site.

Stocking - A measure of the degree to which space is occupied by well-distributed countable trees on forested land per the California Forest Practice Rules.

Timberland - Land, other than land owned by the federal government and land designated by the board as experimental forest land, which is available for, and capable of, growing a crop of trees of a commercial species used to produce lumber and other forest products, including Christmas trees.

Trees Per Acre (TPA) - The average number of trees, of a given size, present on any one acre of a forested tract.

Unit - Also known as a CAL FIRE Administrative Unit, these represent the 21 geographical response areas within California that provide resource management and fire protection services.

USDA Forest Service (USFS) - Agency of the U.S Department of Agriculture that administers the nation's 154 national forests and 20 national grasslands.

United States Geological Survey (USGS) - Agency of the U.S. Department of Interior that studies the landscape of the U.S., its natural resources and the natural hazards that threaten it. It is the nation’s largest water, earth, and biological science and civilian mapping agency.

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RESOURCES

Aerial Detection Survey (ADS) tree mortality data - https://www.fs.usda.gov/science-technology/data-tools-products/fhp-mapping-reporting/detection-surveys

California Department of Forestry & Fire Protection's (CAL FIRE's) Forest & Resources Assessment Program (FRAP) (including maps) - https://www.fire.ca.gov/what-we-do/fire-resource-assessment-program

CAL FIRE's Reforestation Services Program (Reforestation Center) - https://www.fire.ca.gov/what-we-do/natural-resource-management/wildfire-resilience/reforestation-services-program

California Forest Practice Rules - https://bof.fire.ca.gov/regulations/bills-statutes-rules-and-annual-california-forest-practice-rules/

California Tree Seed Zones (publication, 1970) - https://www.fs.usda.gov/research/treesearch/41438

California's Wildfire & Forest Resilience Action Plan (2021) - https://wildfiretaskforce.org/the-plan/

Landscape Ecology, Modeling, Mapping, and Analysis (LEMMA) vegetation data - https://lemma.forestry.oregonstate.edu/data/home

Monitoring Trends in Burn Severity (MTBS) wildfire severity data -

https://www.mtbs.gov/direct-download

USFS Reforestation Toolbox - https://www.fs.usda.gov/t-d/seedlings/conecoll/colmeth.htm

PHOTO CREDIT

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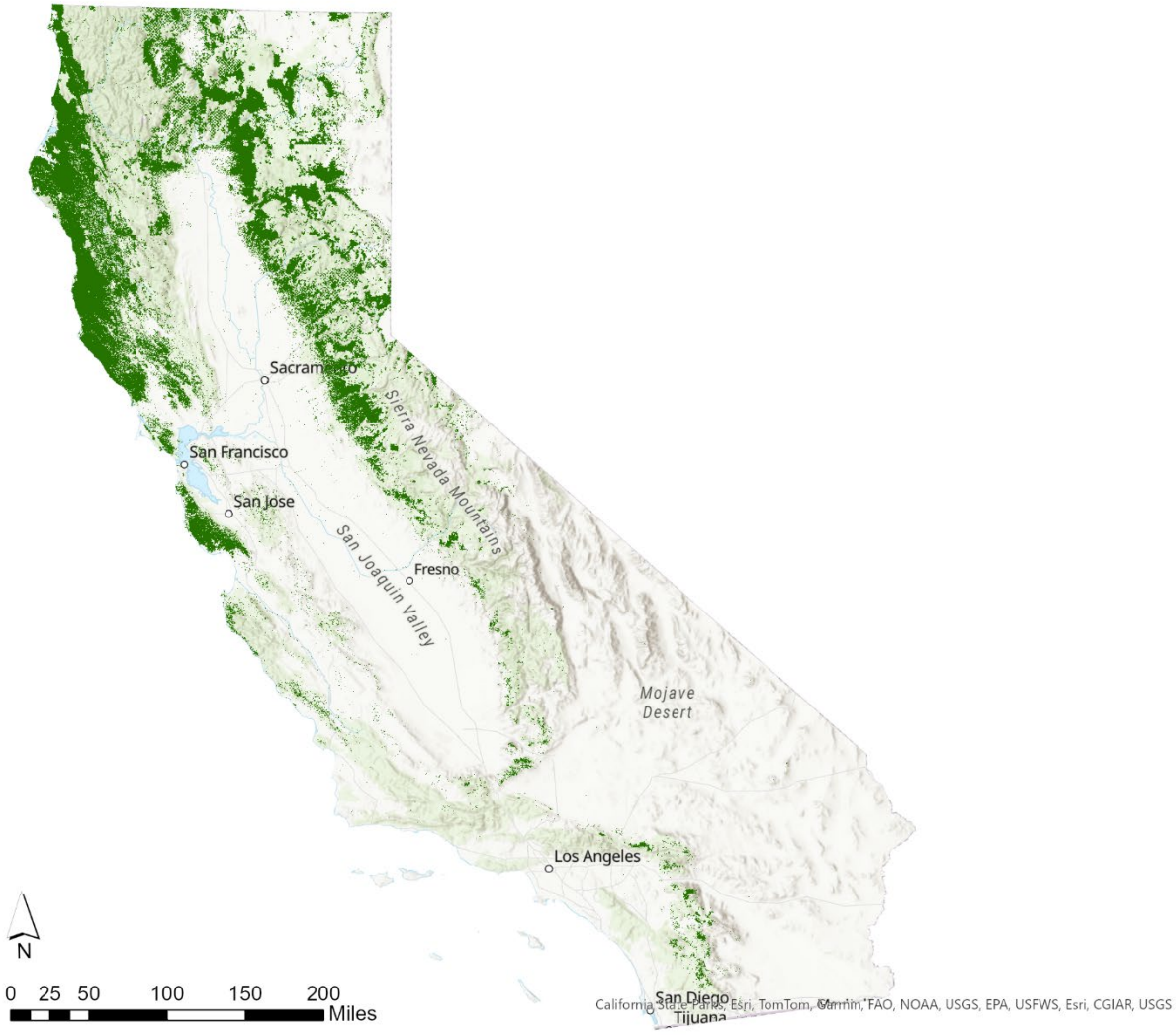
APPENDIX

Figure 1: Seed Needs Analysis Footprint

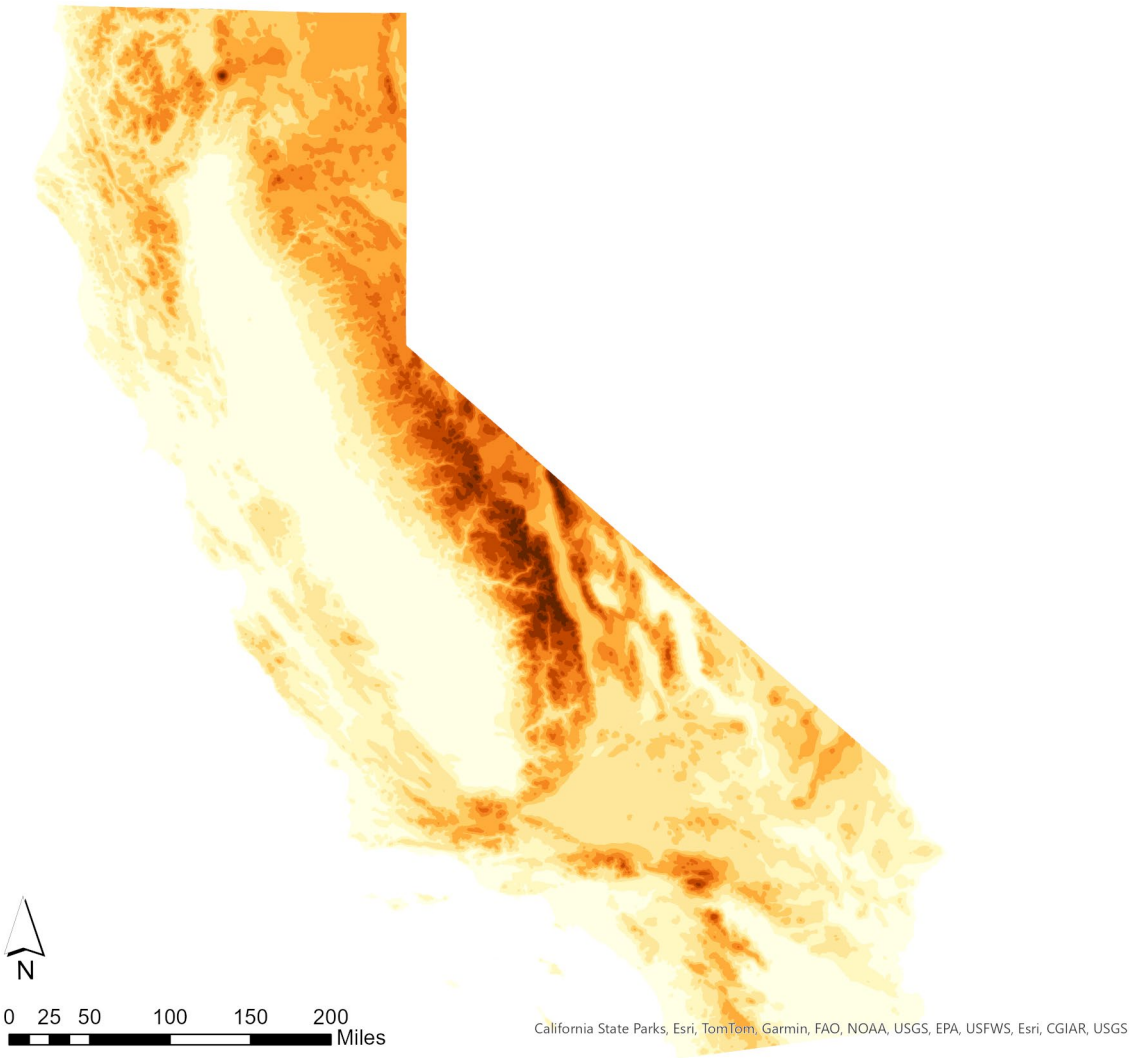


Notes: This footprint is a combination of conifer forests and productive timberlands defined in the California Forest Practice Rules restricted to non-federal lands. Sources: LEMMA for vegetation data; CAL FIRE for productive timberlands (derived from LEMMA) and federal, state, and local responsibility area boundaries.

Figure 2: California Seed Zones

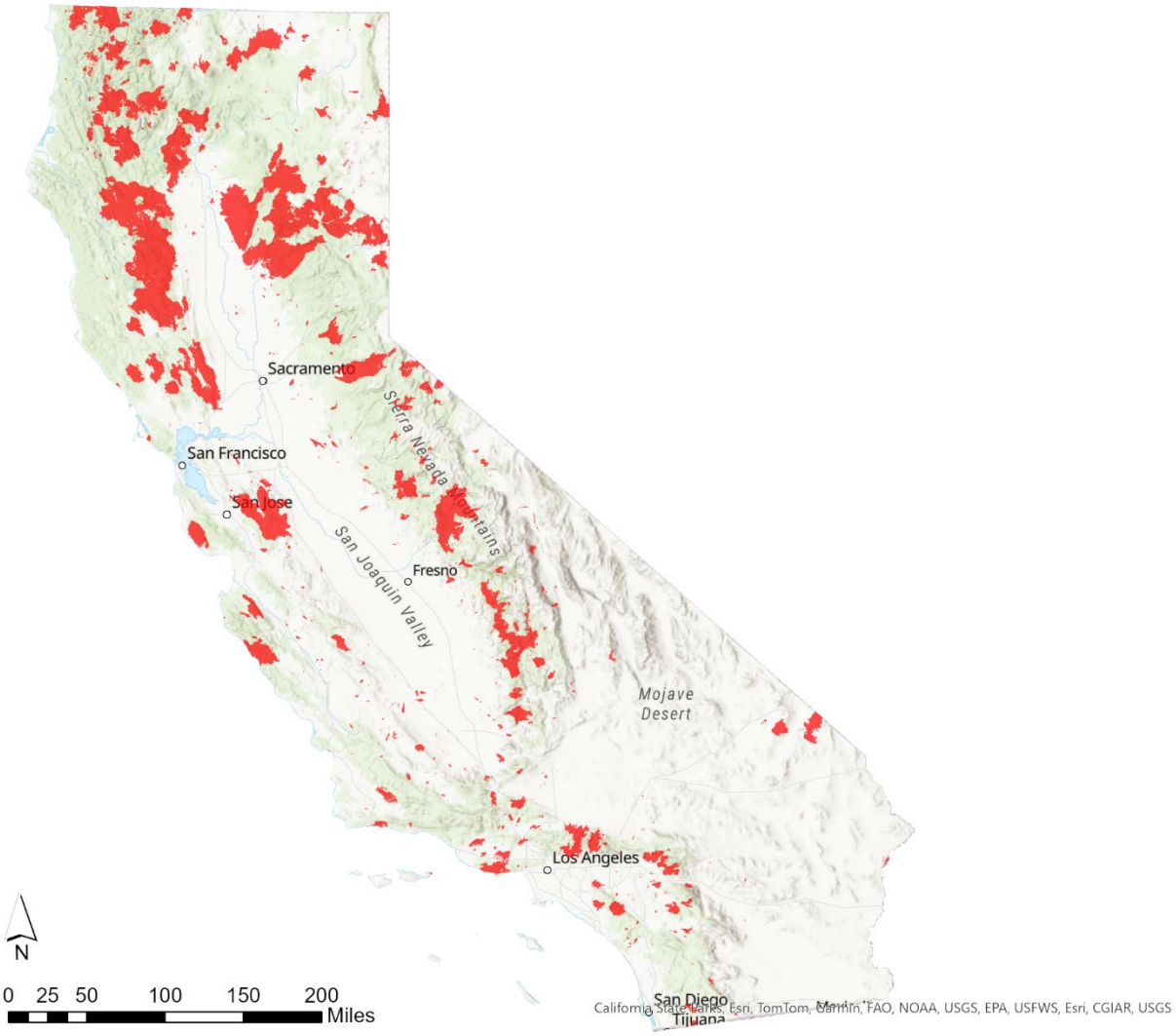
Notes: Seed zones are a three-digit numeric designation used to identify each seed collection zone. They are based on areas that have similar climatic, topographic, and edaphic conditions. Source: CAL FIRE.

Figure 3: 500-Foot Elevation Bands



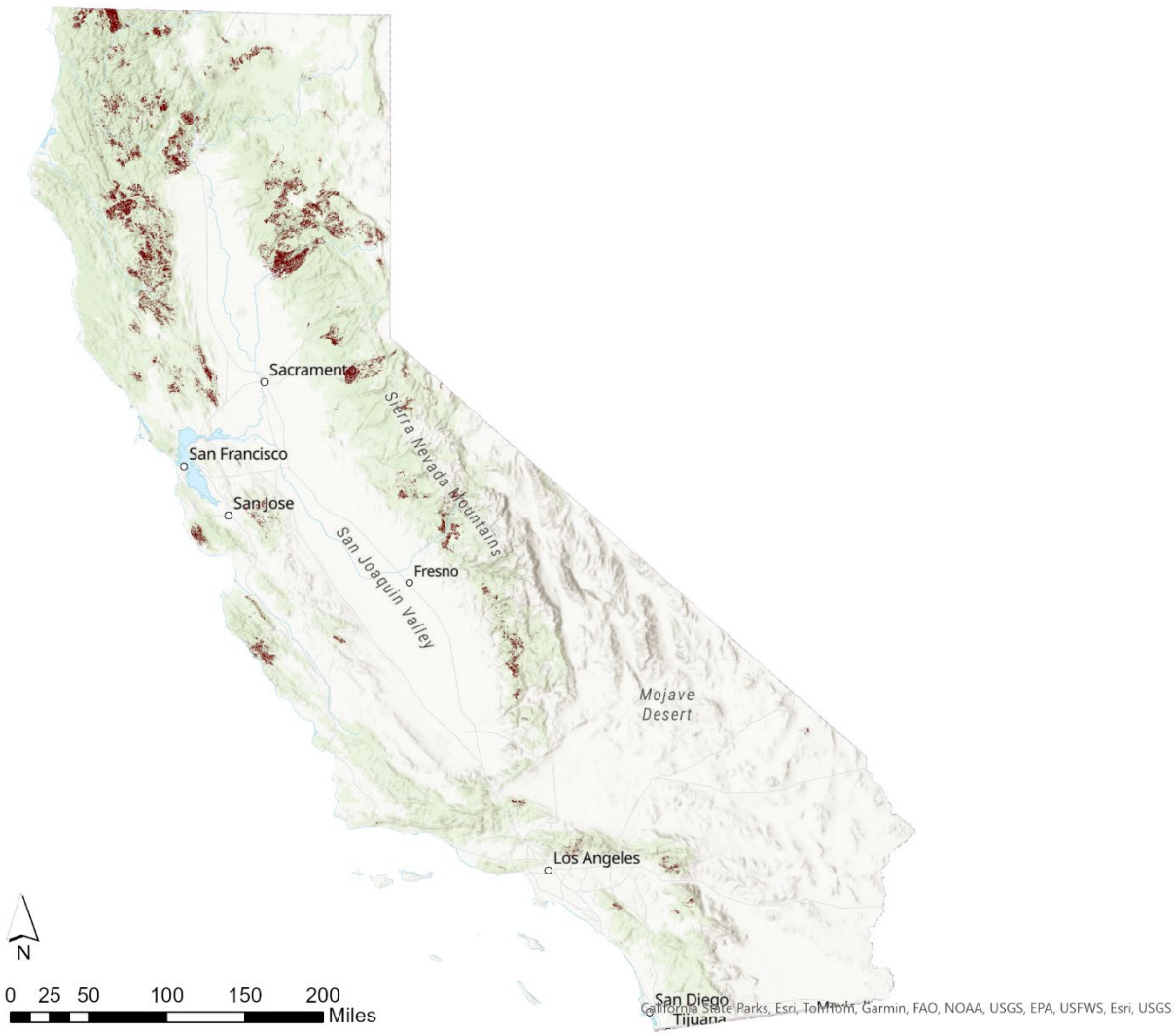
Source: Authors' calculations of smoothed elevation contours based on USGS 10-meter resolution DEM data.

Figure 4: Wildfire Perimeters in 2018-2024



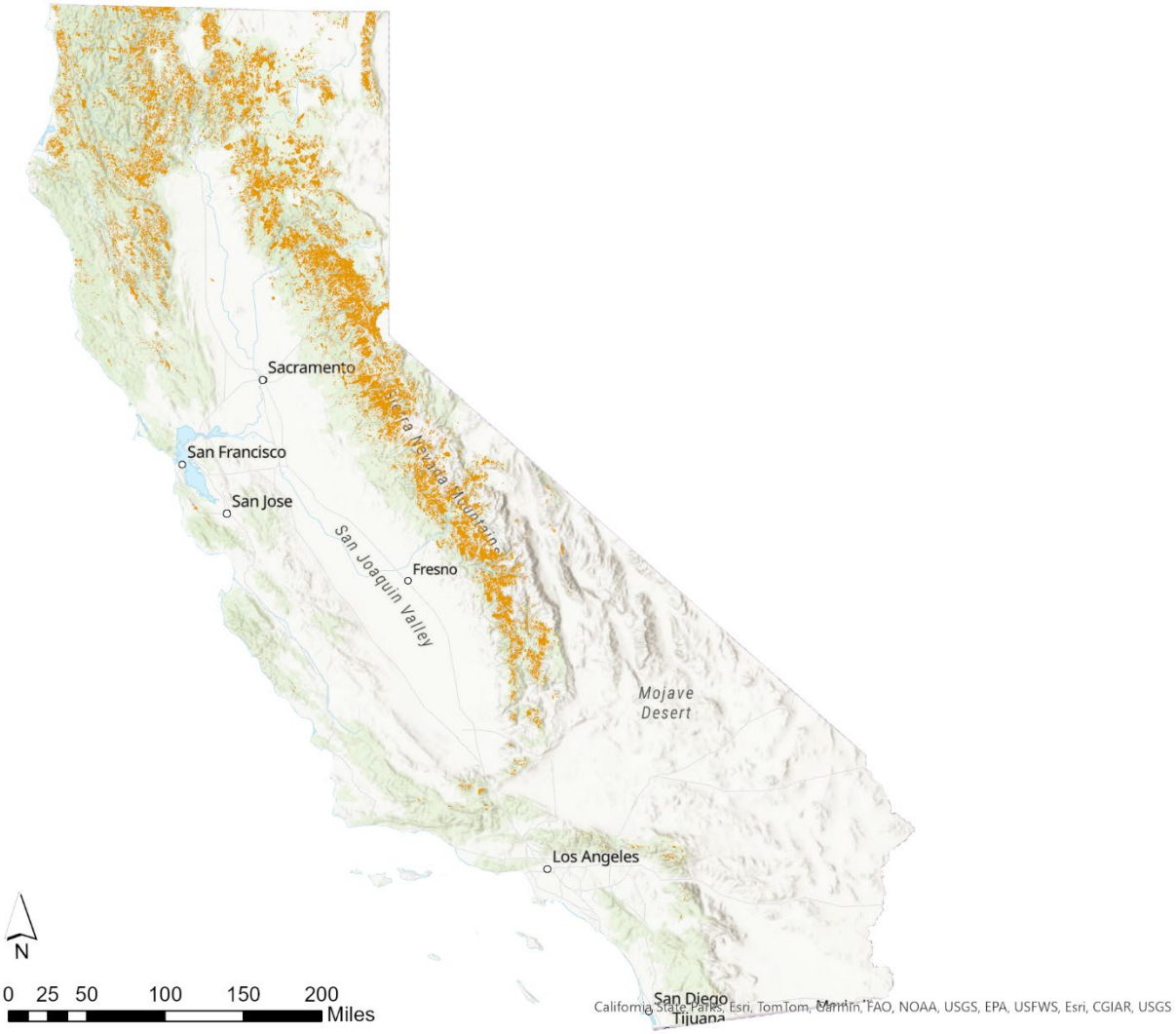
Notes: Only wildfires that burned 100 acres or more are included. Source: CAL FIRE.

Figure 5: High-Severity Wildfire Burn Perimeters in 2018-2023



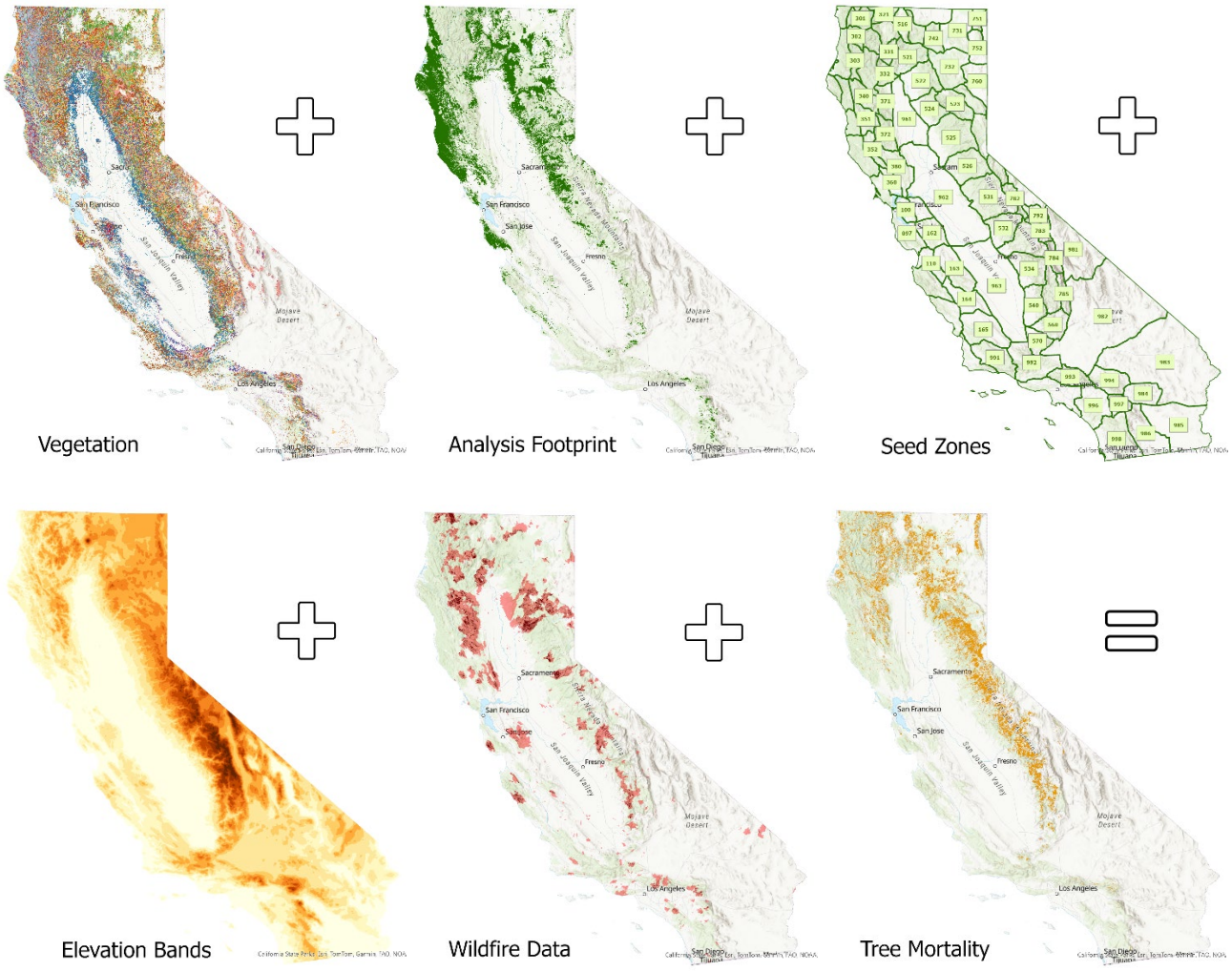
Notes: Severity data is mapped only for wildfires at least 1000 acres in size. Source: Monitoring Trends in Burn Severity (MTBS).

Figure 6: Areas of Tree Mortality Due to Insects and Disease for Conifers of Interest in 2018-2023



Notes: Mortality data was not collected in 2020. Source: Aerial Detection Surveys (ADS).

Figure 7: Spatial Analysis Logic



Species	Seed Zone	Elevation (max)	Bushel Need	Collection Priority	Acres Burned	High-Severity Acres Burned	Tree Mortality Acres	Tree Mortality Count
Coast Redwood	092	500	145	1	0	0	26,792	96,723
Coast Redwood	092	1000	284	1	0	0	62,217	225,921
Coast Redwood	092	1500	105	1	0	0	58,139	185,607
Coast Redwood	093	1000	140	1	39	0	7,932	31,695
Coast Redwood	094	1000	160	1	0	0	15,534	136,437
Coast Redwood	095	500	151	1	1,238	8	1,733	3,908
Coast Redwood	095	1000	124	1	23,202	3,104	5,692	86,999

Notes: The table included in this figure is an example of what the final data looks like for some zones that grow high-priority Coast Redwood