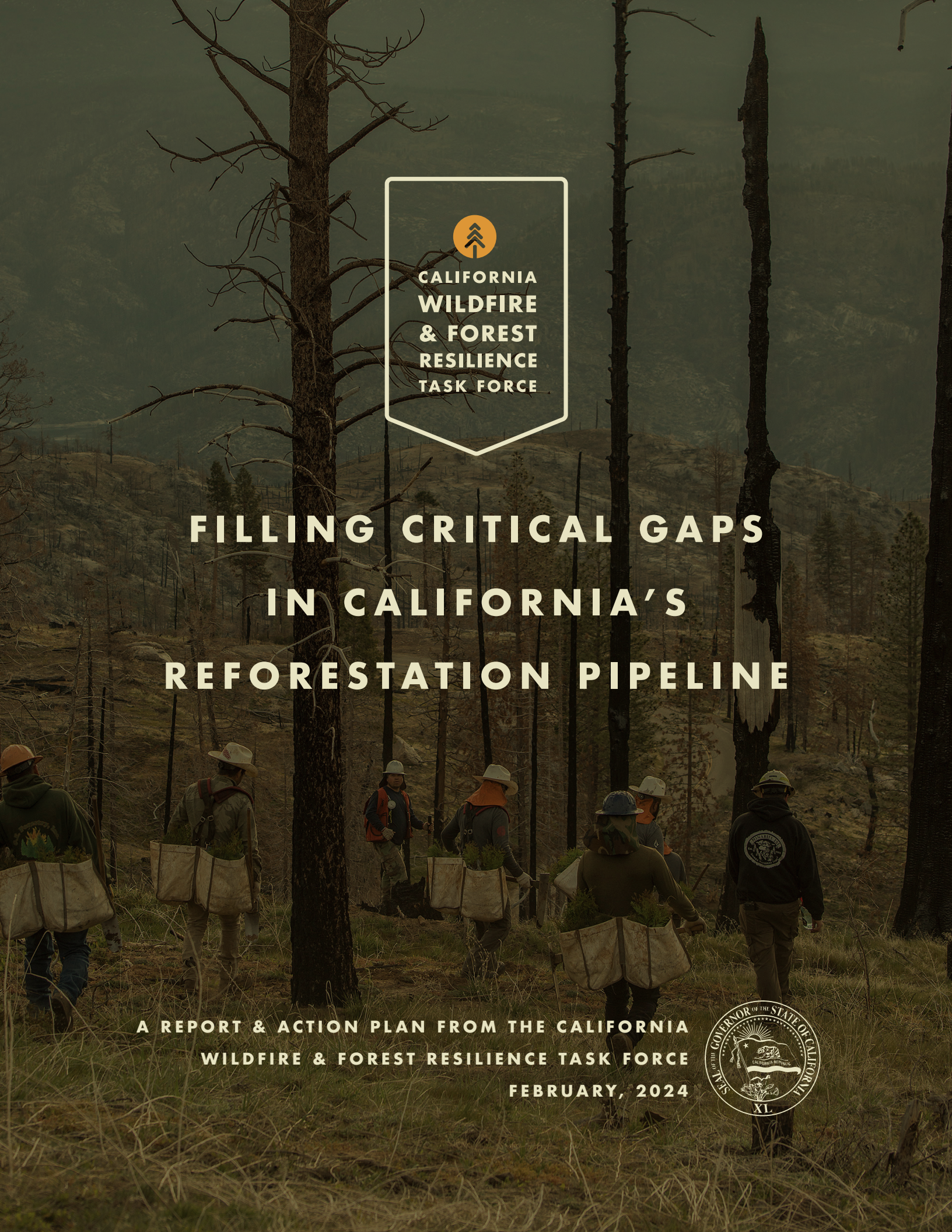

CALIFORNIA
WILDFIRE
& FOREST
RESILIENCE
TASK FORCE

FILLING CRITICAL GAPS IN CALIFORNIA'S REFORESTATION PIPELINE

A REPORT & ACTION PLAN FROM THE CALIFORNIA WILDFIRE & FOREST RESILIENCE TASK FORCE

FEBRUARY, 2024

CALIFORNIA WILDFIRE & FOREST RESILIENCE TASK FORCE

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EXECUTIVE SUMMARY

Wildfires, drought, and pests are threatening California's forests. Without active reforestation (i.e. planting trees and associated management actions), many of these areas may convert to shrubs and grasslands. To address this challenge, the California Wildfire and Forest Resilience Task Force convened a Reforestation Work Group to help accomplish two Key Actions identified in California's Wildfire and Forest Resilience Action Plan: a restoration strategy for federal lands (Action 1.33) and a coordinated state restoration strategy (Action 1.34).

This report represents key progress toward these goals by providing an assessment of California's reforestation needs and offering solutions to address critical supply gaps through a Reforestation Pipeline Partnership. The Reforestation Pipeline Partnership is a strategic collaboration between American Forests, the USFS and CAL FIRE formed to identify issues and address how the reforestation process can be improved and accelerated.

Without active reforestation, California may lose 1.5 million acres of forest resulting from high severity wildfires between 2019 and 2021 alone. To respond to this need, California must expand its reforestation sector across an entire supply chain of activities (hereafter referred to as the reforestation pipeline). This includes expanding capacity for seed collection and processing, nursery production, project planning and environmental compliance, site preparation, planting, maintenance, and monitoring.

The report's action plan includes a broad range of strategies to address challenges in California's reforestation sector, including strategies to:

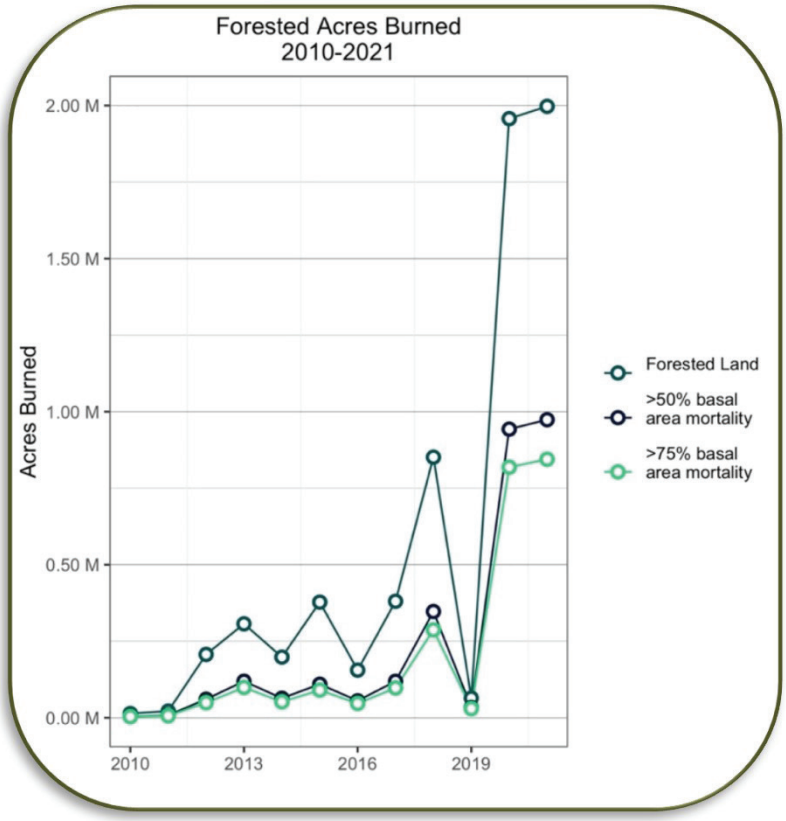
- Bolster seed collection efforts;
- Increase capacity for reforestation planning and coordination;
- Grow the workforce and improve the skillsets of current and potential future reforestation practitioners;
- Streamline regulatory compliance to ensure environmental analysis and permitting keep scale with addressing current and future needs;
- Increase existing nurseries' capacity and support building new nurseries;
- Increase site preparation activities to promote worker safety and reduce fuel loading;
- Improve data science and management to better plan future reforestation projects;
- Develop place-based climate informed technical guidance for on-the-ground reforestation application; and
- Assess the statewide active reforestation need annually.

To ensure California's critical reforestation goals are met, the Task Force and its Reforestation Work Group will be partnering with the USDA California Climate Hub to develop a more comprehensive, climate-informed reforestation strategy for California in 2024. The strategy will build from this report's action plan to set targets, identify lead agencies, establish priorities by landowner type, enable cross-boundary stewardship, break down and streamline policy, regulatory, and permitting barriers, and identify funding needs. It will aim to include regional, vegetation type-specific, and climate-informed technical guidance for land managers.

INTRODUCTION

California is losing its forests to catastrophic fires (Wang 2022, Steel et al. 2022). The beneficial effects that fire often provides—improving forest health and resilience by promoting biodiversity and reducing fuels and tree density—are threatened as increasing fire frequency, extent, and severity are killing more mature trees (Steel et al. 2015, Westerling et al. 2016, Parks and Abatzoglou 2020, Dennison et al. 2014). Since 2010, more than 8.2 million acres of forested land have burned in wildfires across the state of California (CALFIRE 2022; Figure 1). Fifteen of the twenty most destructive and seven of the twenty most deadly wildfires on record have occurred in the last ten years (CALFIRE 2022).

Figure 1. Forested acres burned at high severity during 2010-2021 (CALFIRE 2022). This report focuses on 2019-2021 but trends over the last decade are highlighted to illustrate the dramatic increase in acres burned at high severity in the last several years.



The severity of recent wildfires, driven by fire exclusion, loss of cultural fire, and climate change, threatens natural forest recovery mechanisms and the ability of these systems to return to pre-fire conditions (Hessburg et al. 2021). Large continuous areas of high severity fire reduce the likelihood of natural tree regeneration (Coop 2020). Climate change is also inhibiting recovery as stressful post-fire environmental conditions reduce the likelihood of seed germination and seedling survival (Harris and Taylor 2020, Stevens Ruman et al. 2018). Post-fire regeneration failure is becoming increasingly common, especially in low elevation dry forests (Harris and Taylor 2020). As a result, many forested landscapes in California have not recovered and have transitioned to shrub and grass dominated vegetation types (Steel et al. 2020, Wang et al. 2022). These transitions are reinforced by fire-vegetation feedbacks, where high severity wildfire creates landscapes with high densities of snags and heavy fuel loads that are more likely to reburn at high severity, killing regenerating trees and accelerating a transition to non-forested vegetation types (Keeley et al. 1999, Enright et al. 2015, Coppoletta et al. 2016, Turner et al. 2019, Coop et al. 2020). Without active reforestation efforts, forest loss may be permanent in many locations throughout California.

Modern reforestation efforts in California date to the late 1800s, when it was originally implemented to generate merchantable timber. Today, reforestation includes multiple-use management policies to promote and protect healthy forest ecosystems. At its peak in 1960, California had eight public forest tree nurseries that could produce 47.5 million seedlings per year (Baldwin 2020). In the 1970s, clearcutting on public lands declined as forestry practices evolved and environmental reforms were enacted. Demand for reforestation declined significantly by the end of the 20th century, and only two public forest tree nurseries remain operational today.

The current pace and scale of reforestation in California is not adequate to address existing and anticipated reforestation needs. Between 2010 and 2020, the USDA Forest Service (USFS) reforested an average of 11,646 acres per year, with a high of ~35,000 acres planted in 2010 (Figure 2a; USFS 2021). On National Forest System lands, 36.6% of areas impacted by high severity wildfire were planted between 2010 and 2014 (Figure 2b; USFS 2021). That amount decreased to 7.8% for the period between 2015 and 2020, reflecting the increasing need for active reforestation.

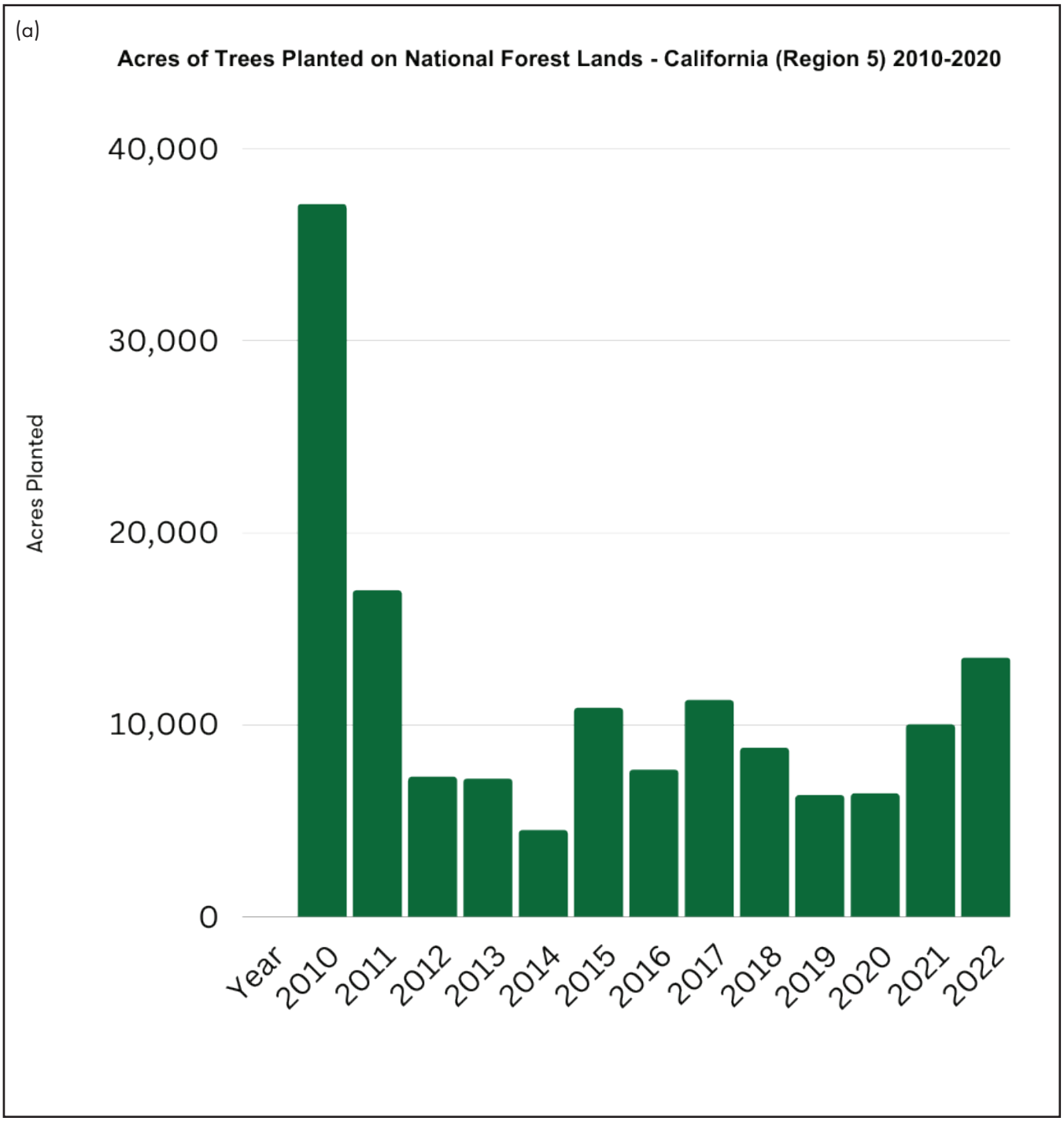


Figure 2: (a) Number of acres planted during the period 2010-2020 on National Forest System lands (USFS 2021);

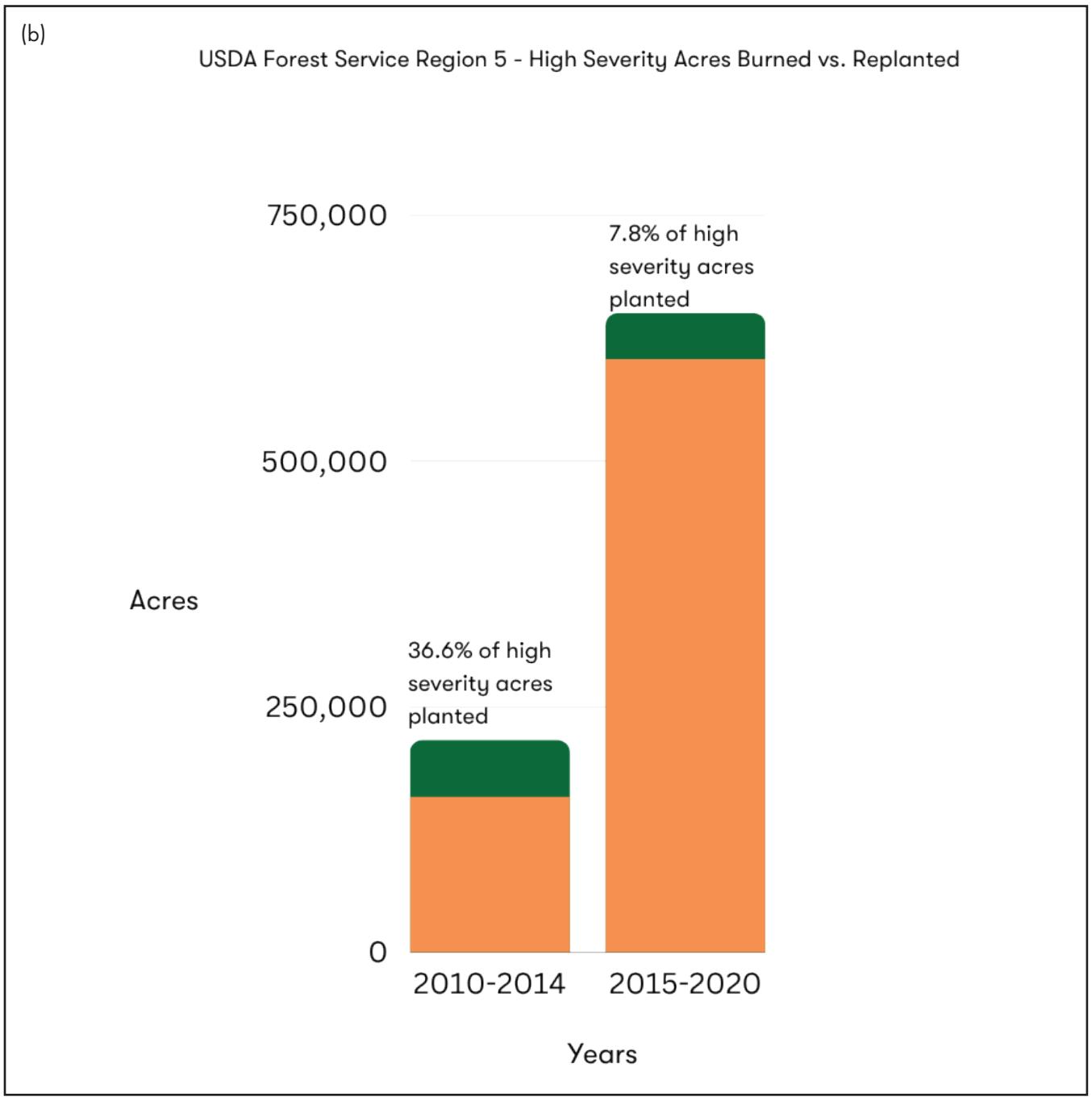


Figure 2:(b) Number of acres planted compared to acres burned at high severity across two periods, 2010-2014 and 2015-2020, on National Forest System (NFS) lands (USFS 2021). During the latter period, only 7.8% of acres that burned at high severity were planted. These values showcase the increasing reforestation backlog across NFS lands.

The Governor's Wildfire & Fire Resilience Task Force Reforestation Work Group was tasked with two Key Actions identified in California's Wildfire and Forest Resilience Action Plan:

- **Key Action 1.33, Develop Restoration Strategy for Federal Lands, and**
- **Key Action 1.34, Develop Coordinated State Restoration Strategy.**

Participating contributors include the U.S. Forest Service, the Bureau of Land Management (BLM), the California Department of Forestry and Fire Protection (CAL FIRE), American Forests, University of California Cooperative Extension, Sierra Nevada Conservancy, California State Water Resources Control Board, California Association of Resource Conservation Districts, and the California Forestry Association.

CALIFORNIA'S CURRENT REFORESTATION NEEDS

The Reforestation Work Group performed an assessment of the reforestation need in California resulting from the 2019-2021 wildfire seasons, during which more than 4.9 million acres burned. The assessment focuses on the 2019-2021 fire seasons; however, this does not suggest that areas deforested outside of this time period, or from causes other than wildfire are not priorities for reforestation.

Reforestation need was assessed using a geospatial approach, where forest vegetation types were selected within the boundaries of fires that burned between 2019 and 2021. Rapid Assessment of Vegetation following Wildfire (RAVG) fire severity maps, produced by the USDA Geospatial Technology Applications Center, were then used to determine the extent of forest loss. Fire severity was evaluated based on percent basal area loss, the estimated percent loss of total cross-sectional area of tree stems, which provides a strong proxy for tree biomass. Because RAVG maps are only produced for wildfires that burn more than 1,000 acres of National Forest System lands, smaller wildfires and those occurring predominantly outside of National Forest System lands were not included, indicating an underestimate of reforestation needs. At the same time, certain species regenerate after high-severity fire independently of human intervention, potentially reducing the need for active reforestation in certain forest types.

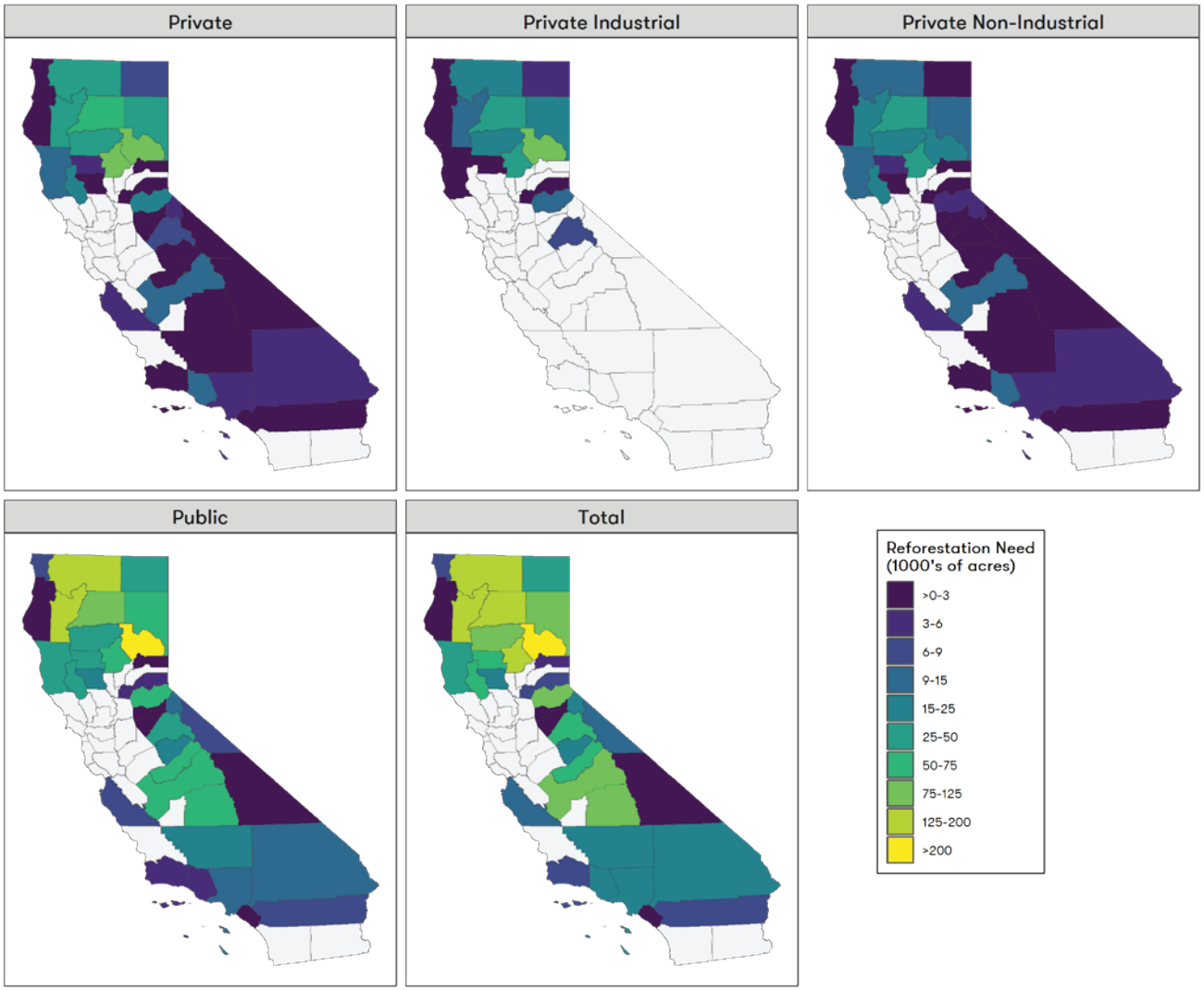


Figure 3: California reforestation need summarized by county and land jurisdiction type including private (all), private industrial, private non-industrial, public, and all lands (total).

On public lands, reforestation need was derived by filtering data by acres impacted by high severity fire, defined as having >75% basal area (BA) mortality, that are outside of Wilderness Areas, within one mile of the nearest road and which have a slope of 70 degrees or less. Proximity to the nearest road and slope helped refine the assessed area to locations where reforestation is logistically feasible to accomplish. Areas more than 115 feet from the nearest potential seed source were also selected because they are considered unlikely to recover without planting. Wind usually carries seeds less than 325 ft, so seed dispersal is limited in the interior of large patches burned at high severity. These filters did little to restrict the reforestation needs and fewer than 100,000 acres did not meet these criteria.

Based on the analysis, active reforestation need generated by the 2019-2021 wildfire seasons encompasses an estimated 1.1 million acres on public lands (Figure 4). Although this estimate of reforestation need on public lands excludes areas with proximity to seed sources, there may be valid reasons to actively replant in these areas, for example to restore desired species composition or to account for any potential failure of natural regeneration.

On private lands, all areas that were previously forested and experienced >50% BA mortality were identified as reforestation needs because a landowner's tolerance for tree loss may be lower than the threshold expected on public lands. Private landowners may reforest for a variety of reasons that go beyond ecological restoration and resiliency or economic interests. Based on this analysis, active reforestation needs generated by the 2019-2021 wildfire seasons encompass 158,000 acres on private non-industrial lands and 184,000 acres on private industrial lands (Figure 4).

Figure 4. California's reforestation need generated by the 2019-2021 wildfire seasons by land ownership category.

WHY SHOULD WE REFOREST?

Forests clean the air, filter water supplies, control floods and erosion, sustain biodiversity, provide habitat for wildlife, sequester, and store carbon, and provide opportunities for recreation, education, and cultural enrichment. Healthy forests can promote both fire and climate resilience at the landscape scale. Maintaining forests is critical to economies supported by forests and forest products and supports the sustainability of forest product infrastructure and markets. Forests are a critical component of many statewide initiatives, including the State Wildlife Action Plan and the California Water Plan.

REFORESTATION CAN HELP TO:

- Restore forest ecosystem services and watershed function after high severity fire
- Protect water quality
- Support biodiversity
- Sequester carbon to mitigate greenhouse gas emissions
- Re-establish forests for cultural and recreational uses
- Supply forest products to support local economies
- Adhere to State and federal mandates

"Reforestation provides one of the main tools for National Forests to adapt to and mitigate the effects of climate change. By reforesting in the right place, at the right time, with the right trees, we foster the development of future resilient forests and the ecosystem benefits they provide for us and future generations."

Testimony of Chief Randy Moore of the U.S. Department of Agriculture-Forest Service before the U.S. House of Representatives Committee on Oversight and Reform Subcommittee on Environment, March 16, 2022.

Promote Carbon Sequestration and Storage

Postfire recovery and reforestation can have short and long-term climate benefits. Seedlings immediately initiate carbon sequestration and storage. Transitions to shrub or grass dominated systems result in significantly less carbon sequestration and storage capacity than the forest replaced (Hurteau and Brooks 2011, Meigs et al. 2009). Lack of active reforestation in the face of increasing wildfire-induced carbon storage losses means California risks backsliding against its greenhouse gas (GHG) reduction targets under the California Global Warming Solutions Act of 2006 (AB 32), which mandates GHG emissions be reduced to 1990 levels by 2045. Replanting areas unlikely to naturally regenerate is integral to a number of other urgent plans and policies to address climate change in California, including:

Forest Carbon Plan;
AB32 Climate Change Scoping Plan;
Safeguarding California Climate Adaptation Plan;
Natural and Working Lands Climate Smart Strategy; and
Executive Order B-55-18 to achieve Carbon Neutrality (by 2045).

Climate driven changes in disturbance regimes, including wildfires, drought events and insect outbreaks, can compromise forest permanence and threaten the fate of carbon stored in forests (Andregg et al. 2020). Careful management of forests to maintain sustainable carbon levels is necessary to realize their potential climate benefits.

Create Fire and Climate Resilient Forests

Correctly implemented reforestation is an act of restoration to establish forests that will be more resilient to frequent fire and other long-term climate-induced changes. Postfire restoration and reforestation go hand-in-hand in the context of forested landscapes; restoration treatments in unburned forests paired with postfire reforestation efforts results in forests that can be maintained with ecologically appropriate frequent fire. Considering reforestation need at a larger landscape scale can also help achieve a wider variety of objectives such as restoring habitat connectivity for dispersal-limited and forest-dependent species (Meyer et al. 2021).

Protect Water Quality

Moderate to high severity wildfire can deliver a significant amount of sediment to surface waters impacting critical aquatic habitat and stressing drinking water systems especially in rural areas (Hohner et al. 2019). Strategic and targeted reforestation efforts can significantly reduce the amount of time it takes to reestablish riparian zones that protect aquatic habitat and drinking water sources.

Support Healthy Communities

California's forests provide important public access to a variety of cultural and recreational opportunities. People indigenous to California have long histories with its forests. Hunting and fishing, wild-tending of myriad species of plants for medicine and food, and the use of trees for home and canoe-making are just some of the culturally and ecologically significant activities people indigenous to California have engaged in for thousands of years. The US Forest Service estimates that as many as 109 federally recognized Indian tribes and at least 50 non federally recognized Tribes may have interest in California's forests. Reforestation can protect these forests and promote culturally significant harvest species.

Many present-day rural communities depend on the economic foundation provided by a variety of natural resource-based activities including forest products and tourism. Hiking, biking, motorsports, camping, horseback riding, hunting, fishing, foraging and more all draw visitors and locals into the forests. These activities generate local spending in the rural communities nearby, creating steady jobs and helping retain residents.

Comply With State and Federal Laws, Policies and Regulations

There are a number of State and federal laws, policies and regulations that direct reforestation efforts, as well as guidelines developed by many collaborating and partnering organizations for forest conservation and preservation. After a wildfire, reforestation on public and private lands may be managed differently based on varied management objectives, policies, capacity, and available resources.

Public Lands

The Federal Government is the largest forest stakeholder in California with 58% of California's forests are public lands (USDA California Climate Hub). National Forest lands are subject to the National Forest Management Act of 1976 (NFMA), and BLM lands are governed by the Federal Land Policy and Management Act of 1976. NFMA includes several requirements related to reforestation in the National Forest System, stipulating that:

- Lands must be maintained in "appropriate forest cover" (16 U.S.C. 1606 Sec. 4 (d)(1));
- Managers use "sound silvicultural practices" (16 U.S.C. 1606 Sec.6 (m)(1));
- Lands must "provide for a diversity of plant and animal communities" (16 U.S.C. 1604 Sec. 6 (g)(3)(B));
- First- and third-year reforestation surveys be conducted and reported; and
- NFMA requires prompt reforestation following timber harvest, but not after wildfire.

While NFMA focused on planned timber harvests and associated reforestation, Title III of the 2021 Infrastructure Investment and Jobs Act incorporated the REPLANT Act, which amended the Forest and Rangeland Resources Planning Act of 1974 to add "unplanned events" such as a wildfire, infestations of insects or disease, weather events, and animal damage as focal areas for reforestation. Lands affected by these events are now covered by Congressional policy that "all forested lands in the National Forest System shall be maintained in appropriate forest cover with species of trees, degree of stocking, rate of growth, and conditions of stand designed to secure the maximum benefits of multiple use sustained yield management in accordance with land management plans."

Private Lands

Nearly 39% of California's forestland is owned and managed by private entities, including 4.7 million acres of industrial forests and 9 million acres of non-industrial forestland. These private forestlands have diverse ownerships and land management objectives and represent the largest forested areas of both the Wildland Urban Interface (WUI) and productive timberlands. Reforestation is voluntary across the majority of burned private acres; reforestation activities are only required following non-salvage related harvest. Reforestation on private lands is governed by the California Forest Practice Act.

CHALLENGES

The Reforestation Pipeline faces with significant challenges including capacity, cost, and specific issues associated with each of its steps.

Workforce Capacity

California's forestry workforce has declined by ~38% over the last two decades, with a public sector shortage of about 1,450 employees as of 2023 and the need to add ~9,400 new employees to deploy the funding allocated in the last two state budgets (Heard and Franklin 2023). Workforce capacity is currently insufficient to successfully accomplish the various components of postfire reforestation.

Cost

With limited funding sources for reforestation, many non-industrial landowners and industrial landowners do not have the financial or technical capacity to reforest in the wake of the wildfire crisis. For example, the California Forest Improvement Program (CFIP), the State's most financially significant program aimed at non-industrial landowners, has lacked a consistent base-budget year to year. Between 2014 and 2021, the program only provided enough funding for reforestation of 10,870 acres (Figure 5).

Landowner category	Reforestation Opportunity (Acres)	Cost
Private non-industrial	158,000	$476.8 million – $914.8 million
Private industrial	184,000	$555.3 million - $ 1.1 billion
Public	1.1 million	$1 billion – $3.2 billion

Table 1: Overall reforestation opportunity and estimated cost by landownership category.

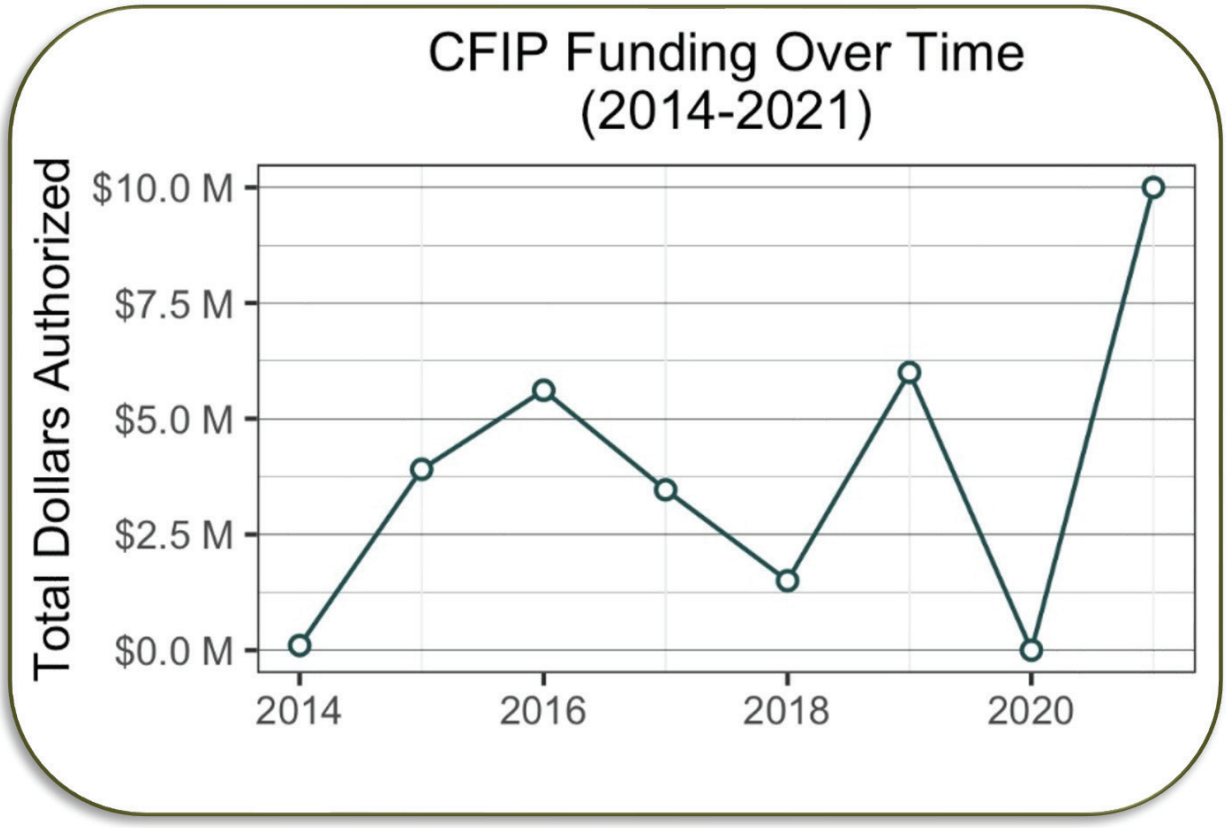


Figure 5: California Forest Improvement Program (CFIP) funding from 2014-2021 (CALFIRE 2022)

REFORESTATION PIPELINE

Reforestation is a multi-year process that requires continued financial investment, sufficient infrastructure, and a skilled workforce. Specific elements of the reforestation process, known as the Reforestation Pipeline, include seed collection, project planning, nursery production, site preparation, planting, vegetation management and monitoring (Figure 6). Each step in California's reforestation pipeline faces challenges as described below.

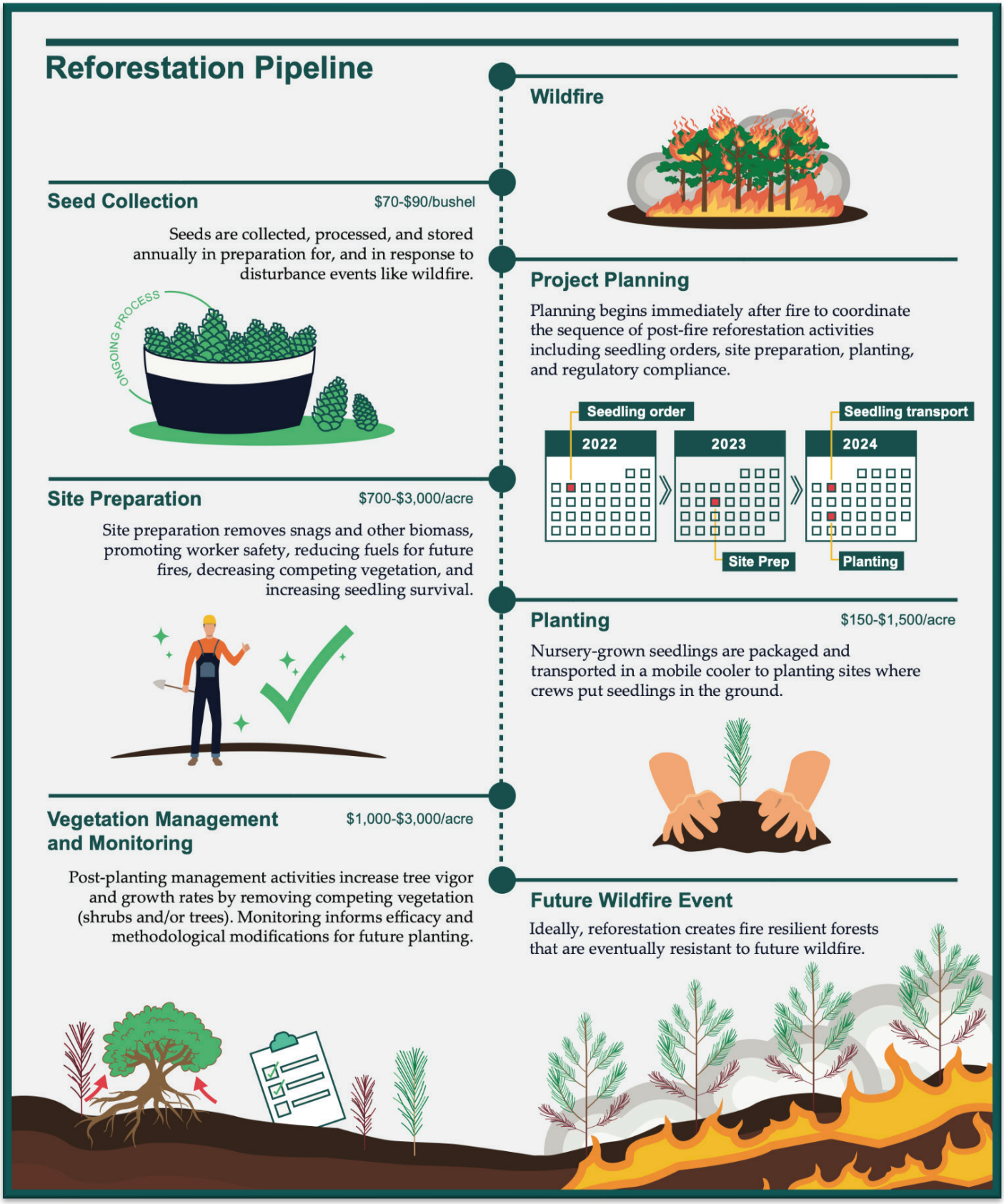


Figure 6: Sequence of reforestation activities. Timelines and specifics may vary by ownership and goals.

Seed Collection

Availability of adequate seed supply from geographically distinct seed zones is a prerequisite for reforestation. Maintaining sufficient seed stores requires monitoring cone production and rapid mobilization of staff during infrequent cone production years. Alternatively seed orchards and progeny sites managed for cone production may also be utilized for seed supply. Challenges associated with seed collection include:

- A significant shortage of collected tree seed in California to meet reforestation needs. Wildfire, insects, and disease are reducing cone production as mature cone bearing trees are damaged and killed.
- Failure to collect during infrequent, heavy cone production years can delay reforestation by multiple years and risks permanent loss of seed sources.
- Climate change is expected to disrupt seed production, while continued tree mortality events have the potential to reduce the genetic diversity of species that can negatively impact the success of reforestation projects (Hacket-Pain and Bogdziewicz 2021).
- Only a handful of cone collection contractors operate in California, with one holding ~90% of contracts. Agency employees often lack the training necessary to collect cones.
- Seed collection costs between $60-120 on average per bushel of cones collected, despite great variance in seed weight among different species of conifers.
- The three existing USFS seed orchards have limited representation of the state's seed zones, species, and elevations. Private seed orchards operate independently of the public agencies and their seed needs.

PROJECT PLANNING

Project planning often starts immediately following a disturbance and includes determining where reforestation is needed, ensuring regulation compliance, and coordinating complex, multi-year projects. Key challenges include:

- **Data Availability** - Timely reforestation planning requires fire severity maps for initial assessments of reforestation need and prioritization. Data sources, including RAVG and Burned Area Emergency Response maps are restricted to fires greater than 1000 acres on forested public lands which presents a challenge to reforestation following smaller fires or on private lands.
- **Environmental Analysis and Regulatory Compliance** - All reforestation projects must adhere to relevant regulatory compliance mechanisms including National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) if public funding is allocated to the effort. Regulatory and environmental compliance extends project planning timelines and increases costs. Environmental compliance costs are not well documented and not often incorporated into reforestation cost estimates.

NURSERY PRODUCTION

Reforestation requires sufficient native tree seedling nursery infrastructure and skilled staff to support current and future reforestation needs. Current infrastructure capacity is insufficient to supply sufficient seedlings to support reforestation needs, although recent public and private investments will significantly increase seedling output capacity in the coming years. Per unit prices for seedlings vary by species and age, but typically range from ~$0.40-$1.00 per seedling.

- In 2020, total statewide seedling production was 28 million seedlings (Fargione et al. 2021). It would take 14 years at the current rate of production to propagate enough seedlings to reforest all of the ~1.5 million acres of postfire reforestation need generated by the 2019-2021 wildfire seasons, with no capacity to address needs generated prior to the 2019 fire season or those resulting from future fires.
- Inconsistent ordering patterns from year-to-year are a significant barrier to increasing nursery production levels.
- Labor shortages reduce nursery capacity. Nurseries compete for the same limited-sized seasonal labor pool as the broader agricultural sector. Skilled permanent workers are difficult to find and retain.
- Immigration policies directly impact staffing. Since the 1980s, the H2B nonimmigrant program for temporary non-agricultural workers have been an integral part of the forest sector. Variability in the number of H2B workers due to immigration policies influence reforestation capacity statewide (McDaniel and Casanova 2023).

Site Preparation

Site preparation readies a site for planting and can include salvage logging, treatment of non-merchantable dead trees, fuel treatments, seedbed preparation, and management of competing vegetation through a variety of methods including mechanical, manual, chemical, and fire. Site preparation activities promote worker and public safety by removing overhead hazards, create site conditions and/or microsites suitable for planting, and can modify fuel development to moderate future fire behavior and allow fire to be safely and effectively used. Removing snags and woody debris is essential to decreasing the risk for high severity reburns (Thompson et al. 2007).

Salvage logging of merchantable standing dead timber can also generate revenue to invest in reforestation (Figure 7). However, snags are also a key component of postfire wildlife habitats, and salvage operations may negatively impact some wildlife (e.g., early successional vegetation or wildlife the rely upon browse or cavities for nesting), soils, and water quality. By retaining some snags and logs in postfire landscapes, balance can be sought between recovering economic loss, providing for both worker safety and wildlife habitat, and leaving sufficient deadwood features (Neemans et al. 2019, Leverkus et al. 2020).

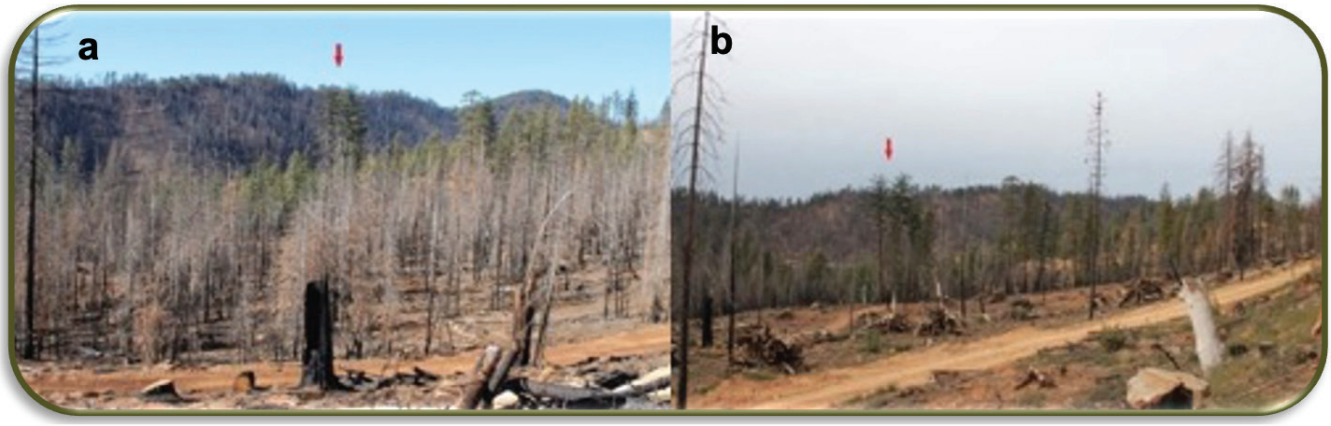


Figure 7: Two-step salvage operations after the 2012 Chips Fire on the Plumas National Forest. (a) Initial post-salvage harvest, where hundreds of small sub-merchantable trees per acre remained on site. (b) Follow up site preparation funded by salvage harvest receipts (~$1.5 million) removed additional tress to better manage fuel loads and mitigate safety. Note red arrow as reference point.

Challenges to effective site preparation include:

- Site preparation activities range in cost from ~$700-3,000 per acre. The most significant cost is removing excess tree biomass, particularly where commercial salvage is not an option to offset costs.
- The economic value of dead wood timber that could be removed via salvage logging deteriorates with time.
- Recent increases in area burned have produced more dead trees than milling infrastructure and wood markets can handle.
- There is a lack of public awareness around herbicide use to manage competing vegetation.
- Piling and burning activities that may be necessary to reduce fuels not removed via salvage logging are subject to limited burning windows and frequent delays.

Planting

Planting requires a sufficient and skilled workforce which has become increasingly difficult to recruit and maintain as the need for reforestation continues to increase. Planting costs can vary greatly, between $150 and 1,500 per acre.

Contract crew readies for planting on the French fire burn scar on the Sierra National Forest in April 2022.

Vegetation Management

Maintenance of planted areas is an important final step in the reforestation pipeline that improves wildfire and climate-resilience, increases growth and survival rates, and prevents wasting limited resources such as seed, workforce effort, and expense (Zhang et al. 2013). Vegetation management often includes the use of chemical treatments to inhibit growth of competing vegetation. Other treatments, such as fire, can reduce surface fuel loading and competing vegetation where feasible. Allowing some shrub cover in regenerating forests may increase the resilience and habitat diversity of reforested areas (North et al. 2019). Non-conifer plant communities, such as shrub and resprouting hardwoods, are an important component of forest ecosystems that help restore soil nutrients (particularly after fires), minimize erosion, and create habitat heterogeneity and biodiversity, both long-term and as a successional stage in forest development.

Monitoring

Monitoring and sharing results with reforestation managers helps practitioners and researchers modify methodologies to promote long-term success. Challenges to developing successful monitoring programs include:

- Funding and workforce capacity limit creating new monitoring programs.
- Monitoring data are collected via different field protocols and housed in disparate, proprietary systems, creating barriers to data access, sharing, and analysis.
- Monitoring is often deprioritized to address other management needs.

REFORESTATION PROJECTIONS

The USFS, BLM, CAL FIRE and private industrial forest landowners estimate they may be able to reforest as much as 186,270 acres through 2025 if substantial investments into the Reforestation Pipeline are made (Table 2). Costs associated with planning and environmental analysis, regulatory compliance, administration, and monitoring are not included in these cost estimates. For the USFS, the projected acreage by 2025 represents a 40% increase in area reforested compared to the 2010-2020 annual average. Even with these increased efforts, the state will have collectively reforested only 15% of the reforestation need created by the 2019-2021 wildfire seasons. These projections fall short of the amount required by the RE-PLANT ACT, which mandates an approximate 1000% increase by the end of 2030. Therefore, continued expansion of funding and capacity beyond the year 2025 will be necessary to address the 2019-2021 need, the backlog of reforestation needs generated prior to 2019 (~200,000 acres from 2010-2018), and the need generated by future wildfires, drought, and pests.

Table 2: Estimates of reforestation acres that could be achieved through 2025 by jurisdiction (land owner category) including planting, site preparation (completed one year prior to planting) and annual costs, which include post-planting maintenance.

Jurisdiction	Year	Planting Acres	Site Preparation Acres (to be planted the following year)	Estimated Cost*
Private Industrial	2023	50,000	32,500	$73.2 M
	2024	32,500	32,500	$94.0 M
	2025	32,500	42,250	$142.8 M
	TOTAL	**115,000**	**107,250**	**$310.0 M**
Private Non-Industrial	2023	2,350	3,055	$7.7 M
	2024	3,055	3,972	$10.3 M
	2025	3,972	5,958	$15.5 M
	TOTAL	**9,377**	**12,985**	**$33.5 M**
USFS	2023	13,754	19,256	$31.6 M
	2024	19,256	28,883	$49.5 M
	2025	28,883	43,325	$73.6 M
	TOTAL	**61,893**	**91,464**	**$154.7 M**

* Cost estimates do not include planning, environmental compliance, regulatory compliance, administration or monitoring costs and are therefore conservative. Estimates provided here represent only the funds required to complete the work on the ground.


A society grows great when people plant trees in whose shade they will never sit.
-Anonymous

SOLUTIONS TO THE REFORESTATION CHALLENGE

Solutions to address the reforestation challenge include recent funding initiatives and opportunities, the development of new cooperative efforts and collaborations, and strategies for maximizing the probability of success where resources are limited.

Existing Funding Opportunities

Recent public and private investments will significantly increase capacity in the coming years. More than $200 million per year nationally was allocated to National Forests with the passage of the Infrastructure Investment and Jobs Act (H.R. 3684, Public Law 117–58) in 2021, signaling a major shift toward funding climate-informed postfire restoration. The REPLANT Act (Repairing Existing Public Land by Adding Necessary Trees) is contained in section 70301-70303 of the Infrastructure Investment and Jobs Act and removes the $30 million per year cap on the Reforestation Trust Fund (RTRT)—the largest source of reforestation funding on National Forest System lands, generated by tariffs on imported lumber. Additionally, the REPLANT Act requires the USFS to address its reforestation backlog within 10 years, including lands deforested by wildfire and other non-harvest disturbances, such as mortality from drought, insects, and disease.

The Infrastructure Investment and Jobs Act includes other significant new funding for reforestation related actions, including:

- $225 million over five years for burned area recovery projects on National Forests;
- $400 million to the Department of Interior to provide grants to states, territories, and tribes for implementing voluntary ecosystem restoration projects on private or public land;
- $200 million to establish and implement a national revegetation effort on federal and non-federal land, including implementation of the National Seed Strategy for Rehabilitation and Restoration ($70 million to the Department of Interior and $130 million to USDA);
- $225 million over five years for Burned Area Rehabilitation programs on lands managed by Department of Interior agencies (excluding the BLM).
- In 2022, CAL FIRE awarded a $3 million grant to Sierra Pacific Industries to build and operate a new nursery in Siskiyou County that will produce tree seedlings for California. Six million seedlings are projected to be sown in 2024, with an eventual capacity of producing 25 million seedlings annually.

Other financial assistance grants and programs that support reforestation on private lands include:

- CAL FIRE California Forest Improvement Program (CFIP)
- Natural Resource Conservation Service Environmental Quality Incentives Program
- USDA Farm Service Agency Emergency Forest Restoration Program
- California Climate Investments (CCI) CAL FIRE Forest Health Program

In 2022, $100 million in State funding was dedicated to post fire recovery. CAL FIRE received over $98 million in project requests and awarded $49.5 million for fiscal year 2022-23 through its Forest Health Postfire Reforestation and Regeneration grants. CAL FIRE received $58 million in project requests for the remaining $50 million in their FY23-24 solicitation but have not yet awarded funds.

USFS grants for Disaster Recovery and through the Community Wildfire Defense Grant Program have also provided tens of millions of dollars for recovery and reforestation of private forest lands in the state in 2022 and 2023 and are likely to continue to support post fire work in future years.

Collaborative and Cooperative Organizations

A number of collaborative efforts are underway to expand reforestation capacity across California. One example is the California Reforestation Pipeline Partnership, a strategic collaboration between American Forests, the USFS and CAL FIRE, was formed in 2022 to identify issues and address how the reforestation process can be improved and accelerated. The partnership features two programs:

1) The "California Reforestation Pipeline Cooperative" is convening diverse stakeholders to meet quarterly to exchange information and explore ways to leverage strategies while building a reforestation-focused network in the state. Small work groups will take on short-term project work, such as hosting training events for reforestation practitioners.
2) "Cone Corps" is a workforce development program to recruit and place new talent into California's reforestation pipeline through on-the-job training while filling critical capacity gaps, from seed collection to nursery growing to planting and research.

Another collaborative example is the California Wildfire and Forest Resilience Task Force Private Landowner Work Group, established to create a common framework and shared goals to expand forest management across non-industrial private forestlands and to support private landowners in wildfire resilience initiatives.

Targeting Success

Identifying areas where reforestation is most likely to be successful can limit waste of resources. Focusing reforestation efforts on areas where forests are likely to persist under current and future climate conditions is one way to increase the probability of success (Hill et al. 2023), particularly as postfire regeneration failure is becoming increasingly common, especially in low elevation dry forests (Harris et al. 2021).

Considering site productivity class and whether the location is within or in proximity to the Wildland Urban Interface (WUI) can also help focus on the most pressing and feasible reforestation needs. Reforestation in the WUI, particularly in communities impacted by devastating fires, promotes forest cover and provides important economic and social values. Focusing reforestation in locations with high biodiversity that are important for water provisioning and other ecosystem services, are more likely to be successful and yield the most rapid returns on investment. Reforestation opportunities on federal lands based on productivity class and proximity to the WUI is shown in Table 3.

Table 3: Reforestation need from 2019-2021 by category across Federal Jurisdiction lands in California.

Federal Jurisdiction	Total Acres of Need*	WUI Category	Productivity Category	Acres of Need
USDA Forest Service	895,540	WUI Influence Zone	High	34,240
			Moderate	17,641
		Outside of WUI Influence Zone	High	473,310
			Moderate	370,350
National Park Service	31,886	WUI Influence Zone	High	145
			Moderate	104
		Outside of WUI Influence Zone	High	18,429
			Moderate	13,209
Bureau of Land Management	7,967	WUI Influence Zone	High	1,512
			Moderate	511
		Outside of WUI Influence Zone	High	3,123
			Moderate	2,821
Bureau of Indian Affairs	2,435	WUI Influence Zone	High	50
			Moderate	13
		Outside of WUI Influence Zone	High	1,199
			Moderate	1,173
Other Federal Lands	105	WUI Influence Zone	High	0
			Moderate	0
		Outside of WUI Influence Zone	High	98
			Moderate	7

ACTION PLAN - WORKING TOWARDS A FORESTED FUTURE

To address the significant challenges to meet the reforestation need identified in this report, this plan includes the following nine actions. These actions will promote rural economic revitalization, equitable workforce development (career paths into forestry), and contribute to the achievement of urgent climate change mitigation and adaptation strategies. The time to take coordinated, inclusive, ambitious action that enables a forested future for California is now.

1. **Increase seed collection, production, and procurement through inter-agency sharing of data, tactics, workforce development, and supplies.**
    a. The USFS, CAL FIRE, BLM, tribal, and private sector interests will participate in the California Reforestation Pipeline Cooperative platform to develop a California Forest Seed Strategy by the end of 2024 that addresses quantity targets for wild and orchard seed, staffing needs, database upgrades, workforce development, and cross jurisdictional coordination to ensure sufficient seed supply for reforestation activities across all lands in California.
    b. The USFS and CAL FIRE will scale up training and capacity for cone surveys and/or collection activities with a target of expanding wild seed collection by the end of 2024.
    c. USFS and BLM are expanding production capability at their existing seed orchards and will look at the potential to develop additional seed orchards through conversion of progeny sites and other means.

2. **Increase capacity for postfire reforestation planning and coordination.**
    a. The USFS and BLM will assess staffing needs and seek to build additional workforce capacity through hiring, partnerships, and contracting for:
        i. Culturists, silviculturists, and/or creation of regeneration specialists capable of designing and supporting multi-year postfire reforestation projects; and
        ii. Reforestation coordinators adept at overseeing contractors and coordinating partnerships with external entities.
    b. The California Reforestation Pipeline Cooperative will survey agency staff to estimate and track labor associated with contracting and inspection of reforestation work, including work completed through agreements with non-profits and other organizations. The survey and interview data will be used to provide estimated personnel costs required for successful reforestation to the appropriate Reforestation Work Group agency delegates, who will elevate them within their agency to receive allocation consideration.
    c. The USFS and Natural Resource Conservation Service (NRCS) will expand grants and assistance for non-industrial landowners, supported in part with funds from the Inflation Reduction Act.
    d. The USFS will increase acres of reforestation and reforestation success on federal lands in California using funding from the Reforestation Trust Fund (RTRT), Inflation Reduction Act, Supplemental Disaster Recovery, and other sources.

e. The USFS will integrate postfire fuels management and reforestation projects within the Potential Operational Delineations (PODs) concept that gives land managers a formal pre-fire planning process for landscape-scale wildfire response options to approach restoration of postfire landscapes more holistically.

f. CAL FIRE, NRCS and the USFS will continue to allocate funds through existing grant programs to support Emergency Forest Restoration Teams (EFRTs) to scale up landowner engagement in reforestation planning and implementation as recommended by the Private Forest Landowner Assistance Work Group of the California Wildfire and Forest Resilience Task Force. EFRT managers will seek to coordinate seed collections and batch seedling orders where feasible.

3. Grow the workforce and improve the skillsets of current and future reforestation practitioners.

a. UCANR Forestry Extension in partnership with the USFS and CAL FIRE, will expand and develop new continuing education trainings and other curricula targeted to a wide variety of agency managers, non-industrial landowners (a goal of the Private Forest Landowner Assistance Work Group), requests for proposals, and natural resource management students, to bolster workforce skills and knowledge about postfire reforestation. These will range from courses on the suite of possible reforestation activities, postfire ecology, to project planning and logistical coordination.

b. The USFS, BLM, and CAL FIRE will continue to utilize and expand partnerships with private, non-profit, and other partners to increase reforestation capacity.

    i. The USFS will use partnership staff positions across the majority of National Forests in California as well as two partnership coordinator positions in the USFS Regional Office of State and Private Forestry to support reforestation work.

    ii. The USFS will increase staffing in their Grants and Agreements department to be able to process additional agreements with partners.

    iii. The USFS will develop a pilot postfire recovery stewardship agreement in California with a neighboring private industrial landowner, Sierra Pacific Industries, to perform reforestation related work on National Forest System lands.

c. The USFS, BLM, and CAL FIRE will develop cooperative relationships with private industry and Tribal representatives to facilitate knowledge transfer about reforestation approaches on public and private non-industrial lands.

d. The Reforestation Pipeline Cooperative will identify opportunities for developing reforestation curriculum at the college level to increase the foundational knowledge of the next generation of reforestation practitioners.

4. Streamline regulatory compliance to ensure environmental analysis and permitting keep scale with addressing current and future reforestation needs.

a. The USFS will examine the efficacy of a Regional-level programmatic and conditional National Environmental Policy Act (NEPA) for postfire reforestation that includes a range of planting

techniques and methods for managing competing vegetation, including herbicide application. Options for streamlining the NEPA process include the use of categorical exclusions/exemptions, Emergency Declarations, and Proclamations.

b. The USFS will be proactive in identifying which areas are prioritized for reforestation if lost to fire, particularly during the development of large, landscape-scale management efforts.
c. The USFS will compile a clearinghouse of NEPA resources relevant to postfire reforestation in California.

5. Increase capacity at existing nurseries and support building new nurseries.

a. The State and USFS will explore how Infrastructure Investment and Jobs Act funding and State funding can support reforestation infrastructure investments, such as nursery upgrades, seed extraction facilities, tree coolers, and mobilized refrigeration units.
    i. USFS will provide grant opportunities to CAL FIRE and other nurseries to increase nursery and seed orchard capacity and production.
    ii. CAL FIRE will continue to support and provide funding for the Workforce and Business Development grant program, including for nursery development and expansion.
    iii. USFS will invest in the expansion of seedling growing capacity at the USFS Placerville Nursery.
b. CAL FIRE will seek to increase staffing and support infrastructure upgrades at the L.A. Moran Reforestation Center including new seedling nurseries, seed storage, and seed sorting facilities, based on availability of funding.

6. Increase site preparation activities to promote worker safety and reduce fuel loading via salvage logging, piling and burning, biomass treatment or removal, or other mechanisms.

a. CAL FIRE will seek to provide continued support for post-fire reforestation on private and State lands when timber salvage is unable to cover the costs, including through the California Forest Improvement Program.
b. USFS will seek to increase investments in wood utilization, site preparation, hazard reduction and fuels treatment through allocated fund investments, including Supplemental Disaster Recovery, Inflation Reduction Act, Infrastructure Investment and Jobs Act, and other sources.
c. CAL FIRE will invest in wood utilization through the Workforce and Business Development grant program.
d. NRCS will provide funding for the Environmental Quality Improvement Program (EQIP) to support reforestation on private non-industrial lands.

7. Improve data science and management to better plan future reforestation projects and

apply adaptive management frameworks to learn from and improve outcomes.

a. CAL FIRE will structure its investments in reforestation to be contingent on shovel-ready reforestation projects guided by management plans.
b. The Reforestation Pipeline Cooperative will support agency and non-agency stakeholders to track and report progress towards meeting the reforestation needs identified in this report using the Task Force Interagency Tracking System beginning in 2024.
c. In 2024, the Reforestation Pipeline Cooperative will facilitate a multi-stakeholder group to clarify rigorous monitoring and data management protocols to evaluate the effectiveness of reforestation projects over time, helping streamline agency implementation.
d. CAL FIRE, USFS, American Forests and others will quantify the carbon storage and climate change mitigation potential of a broad range of management and wood utilization practices including post-fire reforestation and provide data to support land managers' decision making and State goal setting.
e. CAL FIRE will partner with the Geospatial Technology and Applications Center (GTAC) and others to process and release postfire vegetation condition maps (RAVG) on all significant wildfires that burn over 1,000 acres of forested lands in California following a similar timeline to current fire mapping protocols, to allow for rapid planning following fire containment and annual updates to reforestation targets on non-federal lands.

8. Develop regionally specific climate informed reforestation technical guidance.

a. Leveraging state and federal reforestation strategies, and in partnership with leading federal, state and NGS scientists, the USDA California Climate Hub will develop regional and major vegetation type-specific climate informed reforestation technical guidance.
    i. Products will include a practitioner technical user guide (e.g. USFS general technical report or similar), a peer reviewed paper and associated translational materials (e.g., factsheets, trifolds, webpages, etc.)
    ii. Products will be publicly available on a "reforestation toolshed" website, which will serve as a single electronic source to curate the many existing resources currently available to assist involved end users in achieving effective reforestation.

9. Update the statewide postfire reforestation need annually.

a. The Reforestation Pipeline Cooperative will use data from the USFS Rapid Assessment of Vegetation Condition after Wildfire (RAVG) program to annually assess and update where restoration activities including reforestation are needed to prevent forest loss and/or vegetation type conversion.

LITERATURE CITED

Anderegg, W.R., Trugman, A.T., Dadgley, G., Anderson, C.M., Bartuska, A., Ciais, P., Cullenward, D., Field, C.B., Freeman, J., Goetz, S.J., Hicke, J.A., Huntzinger, D., Jackson, R.B., Nicerson, J., Pacala, S., Randerson, J.T. 2020. Climate-driven risks to the climate mitigation potential of forests. Science 368. [DOI: 10.1126/science.aaz7005].

Baldwin, H., Stewart, W., Sommarstrom, S. 2020. Reforesting California. Pages 1-28 in Stewart, W., editor. Reforestation Practices for Conifers in California. Pre copy-edited version of forthcoming University of California book.

Coppoletta, M., Merriam, K. E., Collins, B. M. 2016. Post-fire vegetation and fuel development influences fire severity patterns in reburns. Ecological Applications 26: 686–699.[https://doi.org/10.1890/15-0225].

Dennison, P. E., Brewer, S. C., Arnold, J. D. & Moritz, M. A. 2014. Large wildfire trends in the western United States, 1984-2011. Geophysical Research Letters 41:2928–2933. [doi:10.1002/2014GL059576].

Enright, N. J., Fontaine, J. B., Bowman, D. M. J. S., Bradstock, R. A., Williams, R. J. 2015. Interval squeeze: Altered fire regimes and demographic responses interact to threaten woody species persistence as climate changes. Frontiers in Ecology and the Environment 13: 265–272. [doi:10.1890/140231].

Fargione, J., Haase, D.L., Burney, O.T., Kildisheva, O.A., Edge, G., Cook-Patton, S.C., Chapman, T., Rempel, A., Hurteau, M., Davis, K.T., Dobrowski, S., Enebak, S., De La Torre, R., Bhuta, A.A, Cubbage, F., Kittler, B., Zhang, D., Guldin, R. 2021. Challenges to the Reforestation Pipeline in the United States. Frontiers for Global Change 4. [doi.org/10.3389/ffgc.2021.629198].

Forest Management Task Force. California's Wildfire and Forest Resilience Action Plan. California Department of Water Resources, Public Affairs Office, 2021. [wildfiretaskforce.org/action-plan/].

Hacket-Pain, A., Bogdziewicz, M., Kelly, D., Thomas, P.A., Lageard, J., Tanentzap, A.J. 2021. Climate change and plant reproduction: trends and drivers of mast seeding change. Global Change Biology 27:1952-1961. [doi.org/10.1111/gcb.15560].

Harris, L. B., and A. H. Taylor. 2020. Rain-shadow forest margins resilient to low-severity fire and climate change but not high-severity fire. Ecosphere 11.[doi.org/10.1002/ecs2.3258].

Harris, L.B., Drury, S., Taylor, A.H. 2021. Strong Legacy Effects of Prior Burn Severity on Forest Resilience to a High-Severity Fire. Ecosystems 24:1-14. [DOI:10.1007/s10021-020-00548-x].

Heard, S. and B. Franklin. 2023. Building California's Forest Resilience Workforce: A Critical Gap In Increasing the Pace and Scale of Wildfire Prevention. The Nature Conservancy. Available at: https://www.scienceforconservation.org/products/ Forest-Restoration-Workforce-Development.

Hessburg, P. F., Prichard, S. J., Hagmann, R. K., Povak, N. A., Lake, F. K. 2021. Wildfire and climate change adaptation of western North American forests: a case for intentional management. Ecological Applications 31. [doi.org/10.1002/eap.2432].

Hill, A.P., Nolan, C.J., Hemes, K.S., Cambron, T.W., Field, C.B. 2023. Low-elevation conifers in California's Sierra Nevada are out of equilibrium with climate. PNAS Nexus 2. [doi.org/10.1093/pnasnexus/pgad004].

Hohner, A. K., Rhoades, C. C., Wilkerson, P., & Rosario-Ortiz, F. L. (2019). Wildfires alter forest watersheds and threaten drinking water quality. Accounts of Chemical Research, 52(5), 1234-1244. [doi.org/10.1021/acs.accounts.8b00670]

Hurteau, M. D., Brooks, M. L. 2011. Short- and long-term effects of fire on carbon in US dry temperate forest systems. BioScience 61:139–146.[doi:10.1525/bio.2011.61.2.9].

Keeley, J. E., Ne'eman, G., Fotheringham, C. J. 1999. Immaturity Risk in a Fire Dependent Pine. Journal of Mediterranean Ecology 1: 41-48.

Leverkus, A.B., Gustafsson, L., Lindenmayer, D.B., Castro, J., Rey Benayas, J.M., Ranius, T., Thorn, S. 2020. Salvage logging effects on regulating ecosystem services and fuel loads. Frontiers in Ecology and the Environment 18: 391-400. [doi.org/10.1002/fee.2219].

McDaniel, J., Casanova, V. 2003. Pines in Lines: Tree Planting, H2B Guest Workers, and Rural Poverty in Alabama. Journal of Rural Social Sciences 19.

Meigs, G. W., Donato, D. C., Campbell, J. L., Martin, J. G., Law, B. E. 2009. Forest fire impacts on carbon uptake, storage, and emission: The role of burn severity in the Eastern Cascades, Oregon. Ecosystems 12: 1246–1267.

Meyer, M.D.; Long, J.W.; Safford, H.D., eds. 2021. Postfire restoration framework for national forests in California. PSW-GTR-270. Albany, CA, U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station.

North, M.P., Stevens, J.T., Greene, D.F, Coppoletta, M., Knapp, E.E., Latimer, A.M., Restaino, C.M., Tompkins, R.E., Welch, K.R., York, R.A., Young, D.J., Axelson, J.N., Buckley, T.N., Estes, B.L. Hager, R.N., Long, J.W., Meyer, M.D., Ostoja, S.M., Safford, H.D., Shive, K.L., Tubbesing,C.L., Vice, H., Walsh, D., Werner, C.M., Wyrsch, P. 2019. Tamm Review: Reforestation for resilience in dry western U.S. forests. Forest Ecology and Management. 432: 209-224. [doi.org/10.1016/j.foreco.2018.09.007].

Parks, S. A. & Abatzoglou, J. T. 2020. Warmer and Drier Fire Seasons Contribute to Increases in Area Burned at High Severity in Western US Forests From 1985 to 2017. Geophysical Research Letters 47:1–10. [doi.org/10.1029/2020GL089858].

Steel, Z. L., Safford, H. D. & Viers, J. H. 2015. The fire frequency-severity relationship and the legacy of fire suppression in California forests. Ecosphere, 6. [doi.org/10.1890/ES14-00224.1].

Steel, Z. L., Jones, G. M., Collins, B. M., Green, R., Koltunov, A., Purcell, K. L., Sawyer, S. C., Slaton, M.R.,

Stephens, S.L., Stine, P., Thompson, C. 2022. Mega-Disturbances Cause Rapid Decline of Mature Conifer

Forest Habitat in California. Ecological Applications. [doi.org/10.1002/eap.2763].
Stevens-Rumann, C.S., Kemp, K.B., Higuera, P.E., Harvey, B.J., Rother, M.T., Donato, D., Morgan, P., Veblen, T. 2018. Evidence for declining forest resilience to wildfires under climate change. Ecology Letters 21: 243-252. [doi:10.1111/ele.12889].

Stevens-Rumann, C. S. & Morgan, P. 2019. Tree regeneration following wildfires in the western US: a review. Fire Ecology 15: 1–17. [doi: 10.1186/s42408-019-0032-1].

Thompson, J.R., Spies, T.A., Ganio, L.M. 2007. Reburn severity in managed and unmanaged vegetation in a large wildfire. Proceedings of the National Academy of Sciences of the United States of America 104:10743-10748. [doi.org/10.1073/pnas.0700229104].

Turner, M. G., Braziunas, K. H., Hansen, W. D., Harvey, B. J. 2019. Short-interval severe fire erodes the resilience of subalpine lodgepole pine forests. Proceedings of the National Academy of Sciences of the United States of America 166: 11319–11328. [doi.org/10.1073/pnas.1902841116].

Westerling, A. L. 2016. Increasing western US forest wildfire activity: sensitivity to changes in the timing of spring. Philosophical Transactions of the Royal Society 371. [doi.org/10.1098/rstb.2016.0373].

Wang, J.A., Randerson, J.T., Goulden, M.L., Knight, C.A., Battles, J.J. 2022. Losses of Tree Cover in California Diven by Increasing Fire Disturbance and Climate Stress. AGU Advances. [doi.org/10.1029/2021AV000654].

Zhang, J., Powers, R. F., Oliver, W. W., Young, D. H. 2013. Response of ponderosa pine plantations to competing vegetation control in Northern California, USA: A meta-analysis. Forestry 86: 3–11. [doi.org/10.1093/forestry/cps054].

CALIFORNIA
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FILLING CRITICAL GAPS IN CALIFORNIA'S REFORESTATION PIPELINE

A REPORT & ACTION PLAN
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FOREST RESILIENCE TASK FORCE