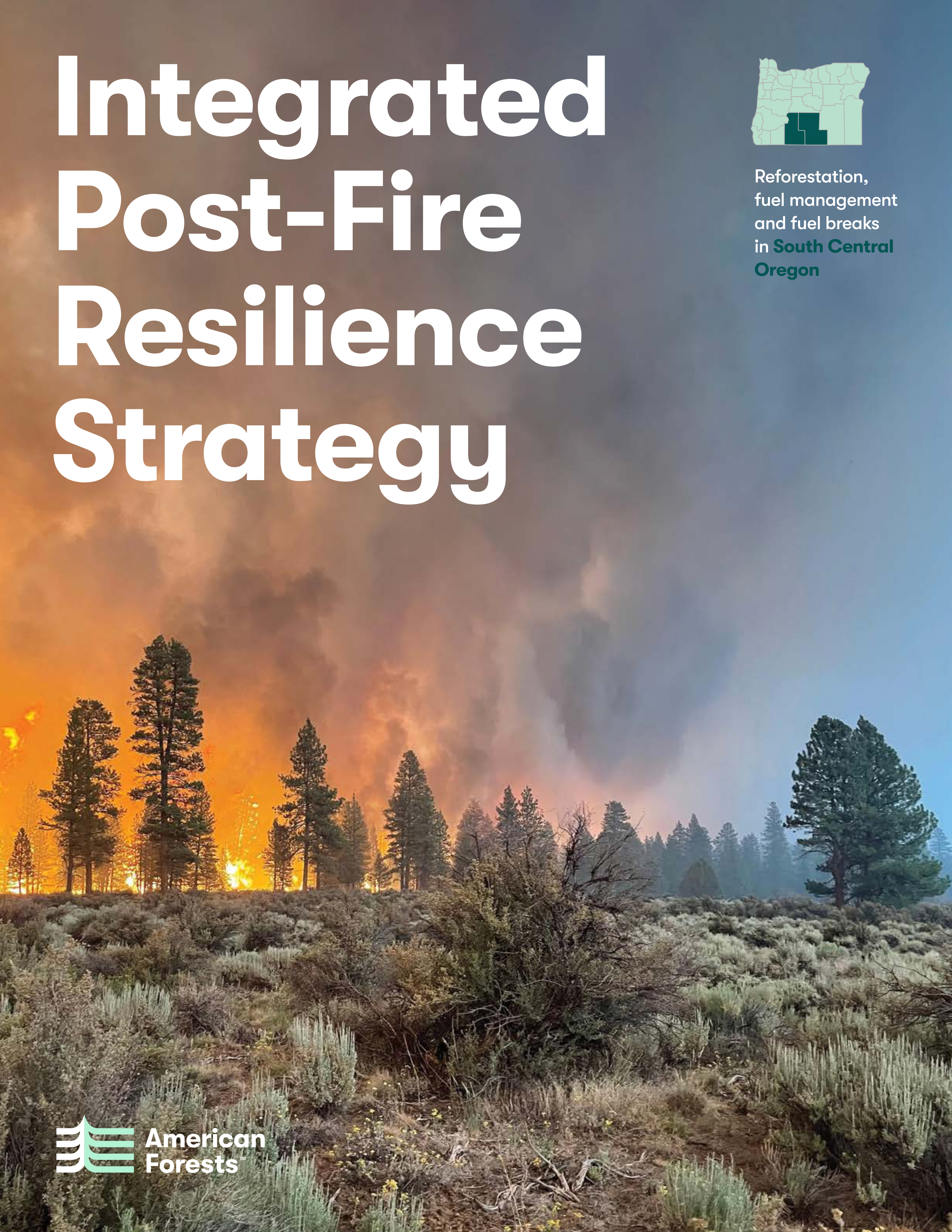
Integrated Post-Fire Resilience Strategy

Reforestation, fuel management and fuel breaks in **South Central Oregon**



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The Klamath Tribes
Natural Resources Department

The Klamath Tribes are the Klamath, Modoc and Yahooskin Paiute peoples, and are the first peoples of the land, having lived here since time immemorial.

The Klamath Tribes view the land as a cultural landscape with a focus on the holistic ecological, spiritual, and cultural values and traditions of the land. As Tribes work with our partners in a post-fire environment, we see all aspects of restoration interwoven into a larger ecological and cultural context that emphasizes ecosystems and their restoration as a whole. This means multiple forest ecosystems, their functions and processes, and the water, fish, wildlife, cultural plant communities, and habitats that are important to the Tribes.

The Tribes Natural Resources Department supports post-fire restoration, including reforestation as part of landscape level restoration. This is shown by our participation in basin partnerships, and our on-going grant applications with our neighbors to secure funding for private lands that include aquatic, meadow, and riparian restoration along with site prep and upland reforestation.

The Tribes have had virtual meetings, in person meetings, and field tours with the many US Department of Agriculture and Interior representatives over the past year. The Tribes specifically asked for all lands funding for post-fire restoration, emphasizing the need to include public and private upland forests, addresses future fire concerns, and links the upland forest and meadow systems to the lower stream and aquatic systems that support the

Introductory Letter

C'waam and Koptu, two endangered fish species that are of great cultural importance to the Tribes.

The Tribes Natural Resources Department supported and is glad to see that in 2023, the upper Klamath River Basin watershed became a designated landscape by the USDA Forest Service, which includes multi- million dollars in funding each year for nine years. This designation includes the Tribes homelands with Reserved and Treaty Rights on the Fremont-Winema National Forest, and the fireshed maps include our TNC and Green Diamond neighbors. This landscape designation will hopefully increase the attention to the entire area and therefore allow funding to go beyond the current USDA wildfire map and include the rest of the Fremont-Winema National Forest, Collins, and partner lands.

Many of the resource goals included in this post-fire strategy that were identified by Core Team members for post-fire reforestation align well with the restoration goals prioritized by the Tribes Natural Resources Department, such as ecosystem services and functions, forest diversity and fire, climate adaptation, wildlife needs, appropriate scale, and aspen regeneration. Similarly, some of the associated tactics, including within stand spatial heterogeneity (ICO), prescribed fire, founder stands, protecting and expanding natural and cultural resources important to the Tribes, meadows and non-forest plant communities, transition zones, riparian restoration areas identified by the Tribes, aspen regeneration, and snow and water capture, all fit with the Tribes Natural Resources restoration goals.

Some of the strategy components were of concern to the Tribes Natural Resources Department. As this is an all-lands document with many landowners and managers as partners, it is understandable that some items will be included for specific partners. For the concerns for the Tribes' Natural Resources Department, such as herbicide use or linear fuel breaks, those are for the Fremont-Winema National Forest lands that include the Tribes' Reserved Rights and Treaty Rights. The Tribes Natural Resources Department appreciates the Forest Service's recognition that there needs to be a government-to- government consultation with the Tribes many departments and Tribal Council when the Forest Service moves past a strategy and into proposed management activity on our federally managed homelands.

It is important to the Tribes Natural Resources Department to have met and continue to meet with our federal and private partners and neighbors to discuss a pathway forward in a post-fire landscape. Working as neighbors in partnership is the best way to help assure we solidify funding together and enhance opportunities to help restore the post-fire landscape.

Respectfully,

Steven Rondeau

Steve Rondeau

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Portions of this plan have been adapted from a previous forest-climate adaptation planning process for the Camp Fire scar in California, where land managers are facing similar climate-related challenges.

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Executive summary

Since 2018, approximately 660,000 acres — an area approximately the size of Rhode Island — have seen wildfire within Klamath and Lake Counties, two-thirds of which burned at high severity. These fires burned across multiple landowners, impacting private non-industrial forest lands, industrial timber lands, Bureau of Land Management and the Fremont-Winema National Forest. Addressing post-fire needs to promote ecological and economic function will require large-scale multi-jurisdictional efforts. Fortunately, this region has a long history of successful shared stewardship.

With their unique combination of partnership experience and restoration expertise, the people of Klamath and Lake Counties are positioned to grow a national model for post-wildfire recovery.

American Forests and the Fremont-Winema National Forest convened a group of individuals representing the Oregon Department of Forestry, two large private industrial forest owners — Green Diamond Resource Company and Collins Pine — and the Klamath Tribes Natural Resources Department to guide the development of an all-lands post-fire resilience strategy for the lands burned by the 2021 Bootleg, 2021 Cougar Peak, 2021 Patton Meadow, 2020 Brattain, 2020 242 and 2018 Watson Creek Fires. The message that emerged was that restoration over the next 10-20 years should focus on establishing a landscape that will be resilient to climate change and future wildfire in the short and long term (e.g., 50+ years), and forests should eventually be managed through a large-scale prescribed fire program. This strategy aims to continue landscape-scale, cross-jurisdictional collaboration for wildfire recovery to ensure long-term forest persistence, future forest and ecosystem health, and regional economic stability. This strategy integrates reforestation, fuel management and fuel breaks to create a climate- and fire-resilient landscape.

JADE ELHARDT

The cost of inaction

The forested landscapes in Klamath and Lake Counties evolved with wildfire — both natural and cultural. However, wildfire severity, frequency and fire-season length have increased because of fire exclusion policies, loss of cultural fire and climate change. Although recent fires have resulted in some positive ecological outcomes, recovery mechanisms have been eroded by large extent and continuity of high-severity burns. Without efforts to holistically restore fire-impacted landscapes, there is high risk of losing forest cover, water resources, carbon storage capacity and the ability to leverage natural climate solutions to fight climate change, and habitat for endangered and culturally valued species. Widespread restoration activities are necessary to prevent these losses and ensure forest structure and composition are well-suited to future climate and disturbance regimes. This strategy is a roadmap for integrated restoration of areas across the fire footprints.

Seizing the moment

Recent legislation brings more funding and momentum for post-fire restoration and reforestation than ever before, at the federal and state levels. This strategy is poised to use these new funds to develop capacity for integrated post-fire restoration, an issue of emerging importance within the state of Oregon and the U.S. Forest Service, addressed in both the Forest Service 10-year Wildfire Crisis Strategy and its new Reforestation Strategy.

Strategy development

Strategy development was driven by the “Core Team” — individuals from partner organizations with long histories of management activity in Klamath and Lake Counties — and the Klamath Tribes Natural Resources Department. Early in the discussions, it became clear that a key goal for this restoration strategy is to establish fire- and climate-resilient forests within the burn scars in a manner that allowed for the development of a large-scale prescribed fire program for long-term forest management. The strategy takes a geospatial analysis approach to categorize the landscape into broad categories of restoration need and provides general guidelines on how to approach planning and implementation. The strategy does not prescribe site-specific activities. Implementation planning will require ground truthing and must consider jurisdiction-specific desired outcomes, rules and regulations, including consultation with the Klamath Tribes where required.

Needs assessment

Restoration

A geospatial assessment was conducted to identify necessary restoration activities and fuel break locations across the focal fire footprints. The resulting maps and geospatial layers will facilitate planning of site-specific prescriptions. Restoration needs were divided into eight categories to determine areas in need of reforestation (both planting and natural regeneration), fuel management, meadow restoration and areas that are candidates for immediate management via prescribed fire.

Nearly 250,000 acres of forested area across all landowners may require reforestation with or without fuel treatments, another ~92,000 acres of current or historical meadow lands may require restoration and/or conifer removal, ~203,000 acres may require fuel treatment but no reforestation activities, and an additional ~33,000 acres may be candidates for immediate use of prescribed fire and other maintenance treatments.

Fuel breaks

Potential fuel break locations were identified to facilitate future suppression activities, protect assets (both economic and ecological) and facilitate widespread use of prescribed fire. This framework leverages previous collaborative work that identified locations to stage fire suppression efforts and provide ingress/egress for wildland firefighters. In moderate-fire weather conditions, fuel breaks will facilitate reductions in fire behavior and can prevent fire spread. However, during extreme fire weather, fuel break utility is an access for suppression and firing operations and firefighter safety, not in preventing fire spread.

A total of 586 miles of potential fuel breaks were identified, 439 miles on National Forest System lands, 116 on private industrial lands and 32 on private non-industrial lands. Fuel break segments were prioritized based on distance to population centers, distance to private lands and landowner category (public or private).

Costs

The total cost of actions identified in the assessment across all jurisdictions is over $652 million. Of the estimated $652 million required to accomplish all restoration activities, approximately 72% is required for mechanical site preparation or fuel treatment. Another ~25% of the total costs are associated with reforestation, and the remainder with maintenance prescribed fire.

Implementation

Partnership is at the center of this post-fire strategy. Partners will be needed to grow post-fire reforestation capacity across all ownerships and to secure external funding for fuel management, reforestation treatments and monitoring.

National Forest System lands

To coordinate implementation on National Forest System lands, the Fremont-Winema National Forest identified implementation units — 3,000-5,000-acre units within which fuel reduction and reforestation activities will be coordinated. Implementation units are intended to promote treating larger acreages and facilitate the eventual reintroduction of prescribed fire. After completing restoration actions within an implementation unit, prescribed fire will be used as the predominant management tool. Implementation units also facilitate prescribed fire use as a site-preparation tool for delayed planting.

Implementation units on the Fremont-Winema National Forest were prioritized based on the number of acres of high- and moderate-priority reforestation within each unit.

U.S. Forest Service implementation scenarios

The Core Team defined two implementation scenarios for restoration across National Forest System lands:

1 Reforest all REPLANT Act obligations, ~205,000 acres, by 2030.

- Increase reforestation by 65% annually through 2030 to reforest all acres identified within this strategy and the additional ~45,000 acres of backlog. This would leave limited capacity to address needs generated by future wildfires.
- By 2030, complete all additional treatment needs identified by this strategy.

2 Scale reforestation to 15,000 acres per year to reforest ~87,000 acres by 2030.

- Increase annual acres reforested to 15,000 per year by 2027 and continue at this pace.
- By 2030, complete treatment of lands within implementation units that have been reforested.

To successfully scale to either scenario, the Fremont-Winema National Forest will require support from the Regional and Washington offices of the Forest Service and from partners.

Workforce capacity

Workforce capacity **MUST** increase to accomplish either implementation scenario. A reforestation program must be built to support post-fire needs across the forest. Considering the less ambitious of the two implementation scenarios, the forest would need to add an additional ~56 new staff across the forest to support cone collection and reforestation activities.

Private lands

Priorities and implementation approaches vary across private lands; therefore, the implementation scenarios presented for private lands reflect a more modular summary of potential ways to prioritize implementation. The scenarios focus on areas where reforestation is a priority, as this is a major focus of private industrial companies focused on regrowing investments and on private non-industrial lands where aesthetic, economic or other values may have priority. Other restoration needs are presented in a stepwise manner to illustrate the costs to reduce future risks and increase ecological function. The scenarios presented in the strategy highlight the costs associated with fuel and maintenance treatments, as well as meadow restoration.

An estimated 30,000 acres are high priority for planting across private lands, with 23,000 on private industrial lands and 7,000 on private non-industrial lands. To address the other needs totaling more than 227,000 acres, and including fuel treatments, meadow restoration and maintenance treatments, would require $58.5 million on private industrial lands and $18.5 million on private non-industrial lands.

Key considerations for restoration success

Climate change

In Klamath and Lake Counties, climate change is expected to manifest as increasing temperatures, a thirstier atmosphere and more variable precipitation patterns. These changes will have large implications for land managers, including:

- Longer fire seasons and more severe burns, making vegetation and fuel management critical. Risk of repeated high-severity fires make fuel management in in post-fire environments especially critical.
- Warming and increased wildfire activity facilitate the spread of non-native invasive plants.
- Insect and disease outbreaks will be more frequent and sustained.
- Droughts will increase large-scale tree mortality on drier sites and in dense stands.
- Seed collection efforts will become more challenging and require greater attention and investment.
- Hot, dry weather will increase seedling mortality rates, necessitating more post-planting maintenance.

Climate-adapted reforestation

Post-fire landscapes are the frontlines for ecosystem change and offer a narrow opportunity to manage transitions in vegetation and fuel loads that may restore forest resilience and desirable ecosystem processes that are better adapted to future climates. Climate-adaptation reforestation principles should be considered primarily at three scales:

1. **Landscape scale:** e.g., reforestation prioritization integrates variables like aspect, soil productivity and climate water deficit, honing in on sites where trees are most likely to survive in the future.
2. **Site and/or project scale:** e.g., planting prescriptions for lower density planting, “strategic spacing” or novel seed sources.
3. **Temporal scale:** e.g., monitoring and adaptive management to ensure long-term goals are being met.

Monitoring and research are necessary to determine whether these approaches are creating desired outcomes or if implementation approaches need to be shifted to ensure long-term success.

Seed supply and seed transfer guidance

Current seed inventory and collection is not sufficient to support current or future reforestation needs. On National Forest System lands, current inventory will support planting of 70,000 acres. Seed collection activities must increase for reforestation to scale appropriately. Developing collaborative approaches to seed collection and reforestation are necessary. American Forests is developing the Western State Seed Collaborative to ramp up seed collection collaboratively across all landownerships.

The R6 regional geneticist and Southwest Oregon area geneticist are developing guidelines for selecting alternative seed sources appropriate for current and future climates, which may be useful for all jurisdictions in the region.

Monitoring will be especially important where seeds are moved beyond typical transfer guidelines and can help update transfer guidelines based on recent data, which are scarce on operational projects. Standard monitoring protocol for plantings will not capture the necessary information. Engaging geneticists, U.S. Department of Agriculture Research Stations and universities will be key for these long-term studies.

Fuel reduction

Fuel management activities and their prioritization should vary according to burn severity, pre-fire stand density and how dense shrubs and fine fuels return. Over the next 5-20 years, areas that experienced high-severity fire are expected to come back as dense shrub fields with significant volumes of dead wood as snags and downed woody material. Such conditions facilitate repeated high-severity burns and can, under certain conditions, delay or preclude forest recovery. Without addressing heavy fuel loads across the fire footprints, areas will not be fully restored and will instead be more likely to experience future catastrophic wildfire, waste expensive investments and not accomplish the goal of creating climate- and fire-resilient forests.

Managing competing vegetation

Managing competing vegetation is key to promoting fast seedling growth and quickly developing fire-resilient forests as well as maintaining fuels in reforested areas and fuel breaks. Management of competing vegetation across much of the post-fire landscape will be key to reforestation and fuel break success. Approaching this challenge at such a large scale requires evaluation of the tradeoffs resulting from the methods chosen to reduce competing vegetation, because choices will impact cost and ecological outcomes drastically. Openness to different and innovative methodologies may mean the difference between large-scale versus localized success.

Monitoring

Monitoring is integral to responding to changing on-the-ground conditions, successfully adapting forests to climate change and maintaining fire-resilient forests. A strong commitment to monitoring already exists within Klamath and Lake Counties; a suite of local groups and collaboratives are focused on monitoring, including the Lakeview Stewardship Group, Klamath Forest Health Partnership and Klamath Basin Monitoring Program. Existing efforts provide a foundation for post-fire monitoring efforts to ensure long-term ecosystem restoration.

I

Introduction

MIKE MCMILLAN / U.S. FOREST SERVICE

Coinciding with persistent drought, 1 Klamath and 2 Lake Counties have experienced a significant uptick in fire activity in recent years. Since 2018, approximately 660,000 acres—an area approximately the size of Rhode Island—have seen wildfire (**Figure 1**) across federal, state, industrial, non-industrial, tribal and NGO-managed lands.

Fire knows no boundaries. Recovery will require a cross-jurisdictional, landscape-scale strategy.

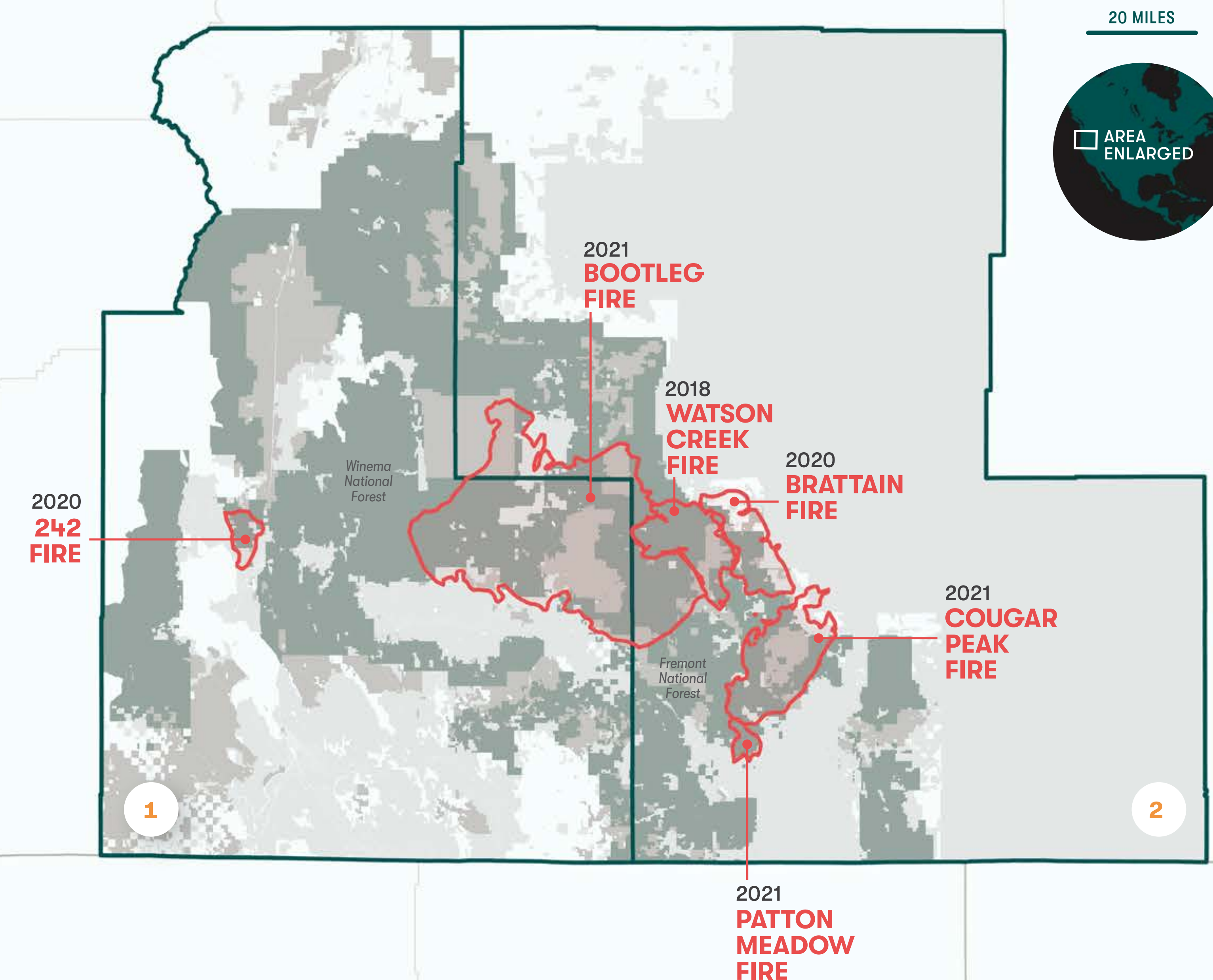

Figure 1

The six focal fires addressed by this restoration strategy include the 2021 Bootleg, 2021 Patton Meadow, 2021 Cougar Peak, 2020 Brattain, 2020 242 and 2018 Watson Creek fires.

Forested lands
- Public - U.S. Forest Service
- Private non-industrial
- Private industrial

The Bootleg Fire (~427,000 acres) and Cougar Peak Fire (~92,000 acres), which burned in the summer of 2021, were the largest incidents since 2018. The Bootleg Fire began near the aptly named Fuego Mountain, doubling in size in four days. This incident largely was a fuel-driven event, in contrast with other recent fires in the region that were wind driven. Fuel moisture was at record lows—less than half the fuel moisture content that is expected for that time of year. Like other recent very large and severe wildfires, both Bootleg and Cougar Peak progressed extremely rapidly and became plume-dominated fires. Suppression efforts could not keep pace.

Landowners and communities affected by these fires have come together to develop an all-lands post-fire restoration strategy. The scale of the challenges demands such an approach—after witnessing the consequences of the Bootleg Fire, a participant in an October 2021 field tour remarked, "that is the answer going forward: we need to partner."

Fortunately, the region has a long history of successful shared stewardship in realms including planning, implementation and monitoring, as documented in the Shared Stewardship in Klamath and Lake Counties Memorandum of Understanding[1], the Klamath Tribes and U.S. Forest Service Master Stewardship Agreement, and in the article the "Klamath Tribes—Managing their Homeland Forests in Partnership with the USDA Forest Service" (Hatcher et al. 2017). Over time, this cooperation has led to a steady increase in funding, treated acres and scale of treatments across federal and private lands. The post-fire recovery work in this region will be a continuation and an expansion of this approach. With a unique combination of partnership experience and restoration expertise, the people of Klamath and Lake Counties are positioned to grow a national model for post-wildfire recovery. This strategy was borne of an acknowledged need for continued collaboration and partnerships across the landscape in the face of exceptional challenges. The size and severity of recent fire and drought events are unprecedented in modern history and require landscape-scale, cross-jurisdictional restoration to ensure long-term forest recovery and persistence, future forest and ecosystem health, and regional economic stability.

Working with the Fremont-Winema National Forest, American Forests convened a process involving the Oregon Department of Forestry, two large private industrial forest owners—Green Diamond Resource Company and Collins Pine—to guide the development of this all-lands post-fire resilience strategy for the lands burned by the 2021 Bootleg, 2021 Cougar Peak, 2021 Patton Meadow, 2020 Brattain, 2020 242 and 2018 Watson Creek Fires. The Klamath Tribes Natural Resources Department also participated in Core Team meetings and document review. This strategy document aims to outline the scope of the restoration need at a landscape scale across all ownerships within these fire footprints, provide cost estimates for the identified restoration needs and highlight project planning considerations that include climate change, adaptive management and uncertainties. The strategy does not set forth site-specific prescriptions; it is intended to provide a landscape-scale overview of the need for reforestation, fuel treatments and fuel breaks. All site-specific planning and implementation efforts will need to consider and adhere to relevant regulations.

Introduction

What's at risk?

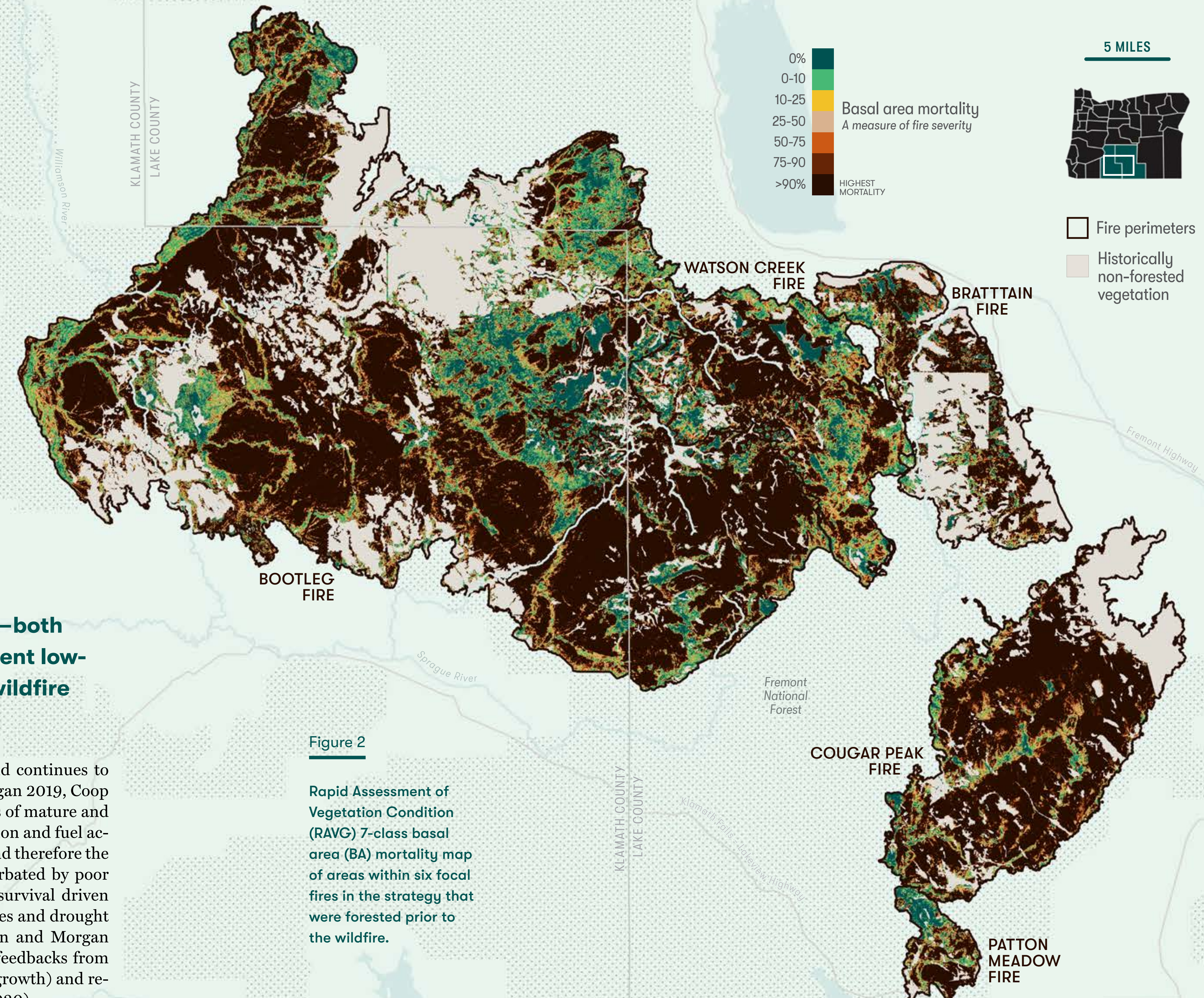

Figure 2

Rapid Assessment of Vegetation Condition (RAVG) 7-class basal area (BA) mortality map of areas within six focal fires in the strategy that were forested prior to the wildfire.

The forested landscapes in Klamath and Lake Counties evolved with wildfire—both natural and cultural—and, historically, most of the landscape relied on frequent low-severity fires to maintain a forest structure and composition that promoted wildfire resiliency, supported landscape heterogeneity and fostered biodiversity.

These processes also facilitated ecosystem services including water provisioning and cultural values (e.g., (Hagmann et al. 2013)). However, wildfire severity, frequency and fire season length have increased because of the accumulation of excess fuels due to fire exclusion policies, the loss of cultural fire and warmer, drier conditions associated with climate change (Westerling 2016, Stevens et al. 2017, Hessburg et al. 2021). Although recent fires continue to have positive ecological outcomes across some portions of the landscape, the extent and continuity of areas burned at high severity have eroded forest recovery mechanisms (Coop et al. 2020, Hessburg et al. 2021). Approximately 66% of the area impacted by the focal wildfires of this strategy burned at high severity (**Figure 2**). Without efforts to holistically restore the landscapes impacted by these fires, we risk losing forested landscapes (Coop et al. 2020), water resources, carbon storage capacity and the ability to leverage natural climate solutions to fight climate change, habitat for endangered and culturally valuable species, and sustainable economic communities reliant on forest stewardship. Integrated landscape-scale restoration also offers an opportunity to prepare the landscape for future climates and promote resiliency to future wildfires.

Wildfire-driven forest conversion, the transition from one forest type to another or from forest to non-forest vegetation, is occurring across the Western United States and continues to be a looming threat (Stevens-Rumann and Morgan 2019, Coop et al. 2020). These transitions are driven by loss of mature and old growth forest and shifts in species composition and fuel accumulation. Loss of seed-bearing individuals, and therefore the seed necessary to begin recovery, can be exacerbated by poor conditions for seed germination and seedling survival driven by climate-change induced temperature increases and drought (Stevens-Rumann et al. 2018, Stevens-Rumann and Morgan 2019). Non-forest states may be reinforced by feedbacks from surrounding vegetation (e.g., shrubs delay tree growth) and reburns that kill regenerating trees (Coop et al. 2020).

A large portion of the affected areas burned at high severity and may be at risk of forest recovery that is delayed or halted altogether. This risk is more pronounced because the forests in this region are transitional in nature. Lower elevation and transitional forests tend to be those at highest risk of negative impacts from high-severity wildfire in the era of climate change (Stevens-Rumann and Morgan 2019, Wolf et al. 2021). This is not to say that the wildfires were entirely negative in their impacts. Conditions within stands that burned at low or moderate severity may have been improved by the fires, reducing tree density and removing less fire-tolerant species that have encroached in fire's absence.

In addition to reforestation activities, fuel management will be necessary within the fire footprints across most severity classes. Fuel treatments will promote resistance to future wildfire, restore ecological function, protect natural and planted seedlings from reburns, and create landscapes that are receptive to maintenance treatments, namely prescribed fire (Prichard et al. 2021).

Widespread restoration activities in post-fire areas are necessary to prevent forest loss and ensure that forest structure and composition are well-suited to future climate and disturbance regimes (Lynch et al. 2021). Ensuring long-term ecosystem health and fire resiliency at a landscape scale requires integration of post-fire activities, including green tree management, reforestation and management of heavy fuel loading in a coordinated fashion across public and private lands. This strategy offers a unique opportunity to consider restoration as an integrated process across the many areas impacted by high-severity wildfire, coupled with appropriate vegetation management in areas where forest cover was not lost in these wildfires. Together, this will create fire- and climate-resilient forests that limit negative consequences of future inevitable fires.

The funding and policy landscape

The Fremont-Winema National Forest has ~45,000 acres of reforestation backlog in addition to the acres identified by this strategy.

Several recent state and federal policies and initiatives support the implementation of this strategy. Following the 2020 wildfire season, which burned 1 million acres of Oregon's forests, the state legislature passed S.B. 762 — which expands funding for wildfire-risk reduction and forest-resilience treatments, prepares communities and calls for the development of a statewide 20-year strategic plan for landscape resilience. The legislature also passed H.B. 5006 to provide grants to forest nurseries to help provide seedlings to non-industrial forest owners following the 2020 Labor Day fires, which includes the 242 Fire in Klamath County.

At the federal level, President Biden's April 22, 2022 Executive Order (EO 14072) specifically calls out the need for reforestation on public lands due to climate-driven disturbances like those occurring in Klamath and Lake Counties. This was followed by Secretary of Agriculture Thomas J. Vilsack issuing a memorandum to the Forest Service directing the agency to use innovative policies and incentives to increase climate-smart reforestation and forest management to foster carbon stewardship and improve climate resilience. Specifically, the memorandum calls for increased climate-informed reforestation, especially in fire scars, and expanded cone collection and nursery capacity, with heavy emphasis on collaborative cross-jurisdictional efforts. The activities outlined in this plan also align with goals of the Forest Service's Climate Adaptation Plan (USDA Forest Service 2022), released in July 2022, which identifies increases in wildfire activity and extreme events like droughts as key vulnerabilities facing the agency in its ability to meet its mission, and discusses their implications for reforestation workload. The Climate Adaptation Plan identifies climate-informed reforestation and prescribed burning as key activities that support managing ecosystems for long-term change. The development and implementation of this plan will also help the Fremont-Winema National Forest with reporting associated with the agency's Climate Action Tracker. On the same day, the Forest Service released its national reforestation strategy calling for increased reforestation capacity to "grow and nurture resilient forests for tomorrow," a focus on work like the scope outlined in this strategy.

The national policy landscape is shaped by the recent influx of funds that support forest health and reforestation initiatives. The Infrastructure Investment and Jobs Act (Infrastructure Act; Pub.L. 117–58) could signal a new era of climate-informed post-fire restoration by providing funds to restore tree cover where natural regeneration may be precluded. The REPLANT Act (section 70301-70303 of the Infrastructure Act) removes the $30 million annual cap on the Forest Service's largest source of reforestation funding on National Forest System lands — the Reforestation Trust Fund (RTRT), which generates funds through imported lumber tariffs. The Infrastructure Act increased available reforestation funding for National Forests to over $200 million per year in the near term, although annual additions vary. **Notably, changes to RTRT are permanent.**

Simultaneously, the REPLANT Act requires the Forest Service to address its reforestation backlog within 10 years, including lands deforested by wildfire and other non-harvest disturbances. Prior to 2018 and the focal fires of this strategy, the reforestation backlog on the Fremont-Winema National Forest was ~45,000 acres. These acres, in addition to many that burned on private lands prior to 2018, and those described in this strategy, also need to be addressed.

Lastly, the Forest Service recently released its Reforestation Strategy, highlighting the need to reforest federal lands urgently and with climate change in mind. The strategy calls for the creation of regional plans that address the reforestation backlog and prioritize climate-adapted resilient forests for the future. The strategy emphasizes the need for reforestation in post-fire environments and calls for reforestation projects to be guided by science, collaborative in nature and for the development of the reforestation pipeline to support national needs.

Additional policy considerations are discussed in broader detail in the section **Policy flexibility for reforestation.**

JADE ELHARDT

Vision of success

This strategy document aims to outline the scope of the restoration need across all ownerships within these fire footprints, provide cost estimates for the identified restoration needs and highlight project planning considerations that include climate change, adaptive management and uncertainties.

In the early stages of strategy development, partners articulated what they believed a successful post-fire strategy would comprise. The consistent message that emerged was that restoration efforts over the next 10-20 years should focus on establishing a landscape that will be resilient to climate change and future wildfire in the short and long term (e.g., 50+ years), and that forests should eventually be managed through a large-scale prescribed fire program. This strategic plan highlights opportunities for positive change and calls for a cultural shift in how forests are managed in order to get fire back into the system.

This means establishing forests quickly in a manner that considers climate-smart reforestation activities, ensures trees establish quickly to withstand fire to minimize losses from eventual reburns (prescribed or wild), and consists of site preparation and post-fire maintenance and monitoring. Fuel treatments should remove excess fuels that threaten human safety, economies and resource benefits, and reduce the risk of high-severity reburns. Fuel breaks should provide opportunities to protect people, property, economic resources and reforestation investments. Successful implementation of all three components will increase the likelihood that this strategy has the desired impacts of creating a landscape that is sustainable in the long term.

Employ climate-adapted reforestation tactics to ensure long-term

50+ years

resiliency and/or adaptation of recovering forests to disturbances and climate change.

The Core Team's vision for landscape-scale success includes the following:

1

Create wildfire-, insect and disease- and climate-resilient forests that can be managed using large-scale prescribed fire.

- Employ climate-adapted reforestation tactics to ensure long-term (50+ years) resiliency and/or adaptation of recovering forests to disturbances and climate change.
- Establish forests quickly to ensure they can survive reburns in the short term and be maintained with repeated application of prescribed fire in the long term.
- Reforest to provide integrated outcomes for plant and wildlife habitat, clean water, future timber yield, resource benefits including recreation, and healthy, vibrant communities. Optimally, reforestation will also maximize resource benefits to the public, including recreation, cultural use and forest products.
- Promote landscape-scale heterogeneity and age-class diversity.
- Ensure that an appropriate number of fire-resistant conifers exist on the landscape and that they will grow quickly enough to survive future fires — by managing early stand establishment in a way that the regenerating forests developed heterogeneous stand structure, thick bark and self-pruning.
- Extend reforestation efforts beyond planting — site preparation, post-planting maintenance and monitoring maximize success in the long term.
- Manage intact green islands within the burned landscape and create new green islands via reforestation.

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2

Create fuel breaks to protect economic and ecological resources and provide safe access to wildland firefighters for wildfire suppression efforts.

- Provide opportunities for safe ingress and egress of wildland firefighters.
- Reduce fire spread and fire behavior during mild- and moderate-fire weather.
- Leverage fuel breaks as openings in different forest types. Shaded and unshaded fuel breaks allow soil and light resources to go to plant and shrub communities, increasing big game forage, cultural plant communities and non-forest wildlife habitat, creating permeable landscapes for wildlife species that need open corridors.
- Integrate fuel breaks not just as potential control lines where suppression efforts can reduce risk of future large severe fires, but where the fuel breaks integrate with the future use of fire as a fuel management tool to promote resiliency in the regenerating forest within these burned landscapes.

Introduction

3

Manage fuels to maximize human safety and minimize risk of high-severity reburns, while promoting wildlife habitat and ecosystem services.

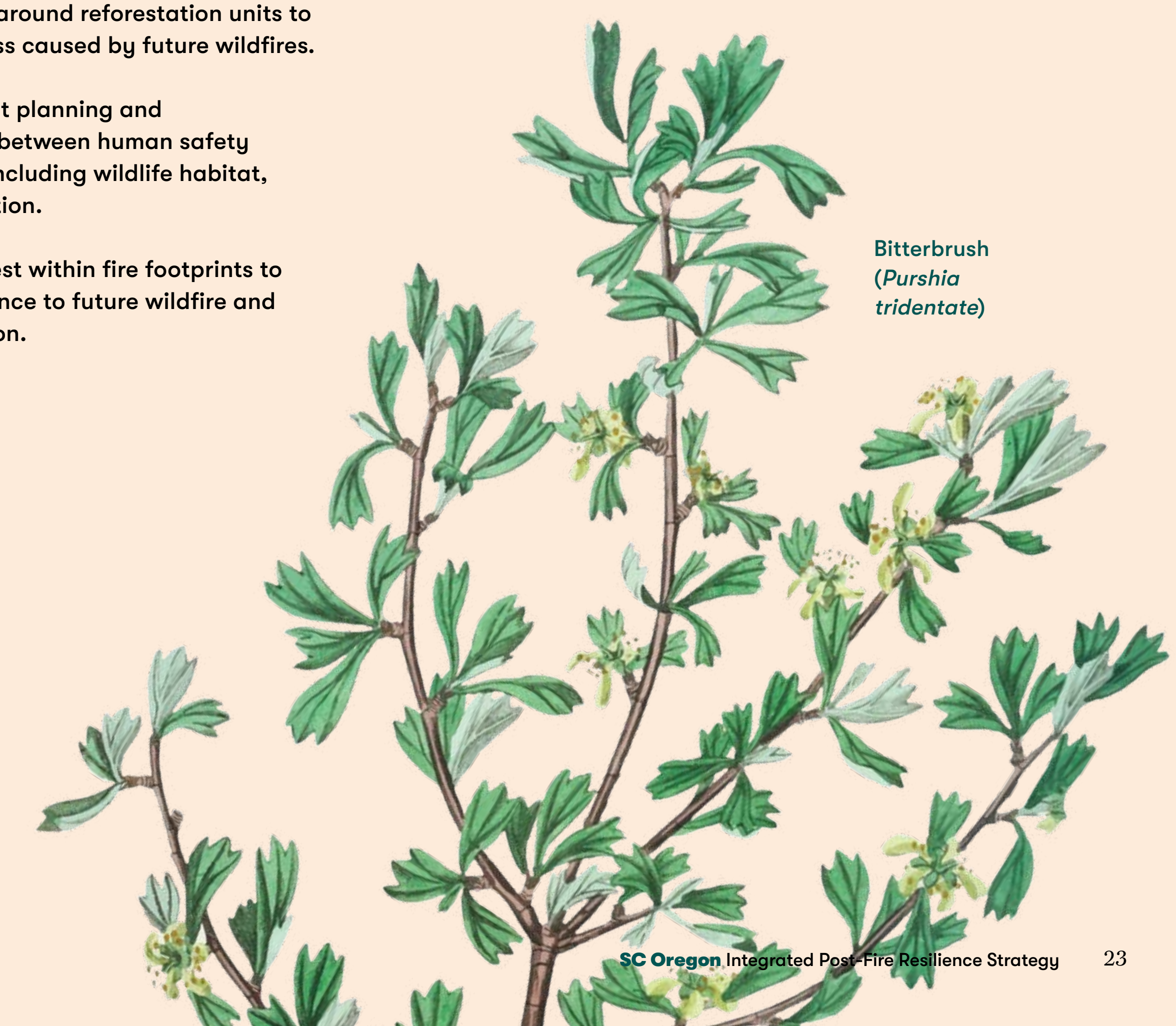
- Manage fuel loads in and around reforestation units to reduce the likelihood of loss caused by future wildfires.
- Consider fuel management planning and implementation tradeoffs between human safety with ecological benefits, including wildlife habitat, biodiversity and reforestation.
- Treat remaining green forest within fire footprints to promote long-term resistance to future wildfire and promote climate adaptation.

4

Consider other key systems.

Although this strategy focuses on reforestation, fuel management and fuel breaks, primarily in conifer-dominated forest types, implementation of the strategy will impact other ecosystems and forest types. The Core Team and the Klamath Tribes Natural Resources Department recognize that other restoration activities are priorities and should be recognized:

- Invest early in high-value habitats (e.g., riparian areas, meadow complexes, aspen stands) that offer other ecosystem services like water filtration and retention, wildlife habitat values (e.g., bitterbrush (*Purshia tridentate*) planting) and biodiversity.
- Support integrating landscape-level restoration such that meadow complexes, riparian areas and aspen will be restored and resistant to future wildfire (e.g., forest structure and composition, stand-to-landscape fire-behavior mapping, retention of conifer encroached areas chronic to this landscape).



Bitterbrush (*Purshia tridentate*)

Establish conifers on at least

60%

of places best adapted for long-term forest cover and resilience (e.g., high priority reforestation opportunities) across all jurisdictions.

5

Prioritize cross-boundary work driven by partner priorities.

- Establish a restoration framework that outlines a suite of activities for all ownerships that can be implemented according to owner-specific objectives and an assessment that identifies potential opportunities for cross-ownership coordination of post-fire management actions.
- Recognize and honor the treaty rights of the Klamath Tribes and prioritize restoration of their natural and living cultural resources, offer opportunities for tribal departments to be heard, and respect government-to-government consultation.
- Ensure that private landowners have access to the technical assistance, funding, seedlings and workforce to undertake fuel reduction and reforestation treatments.
- Build focus and continuity across the landscape and jurisdictions.
- Build the collective capacity for post-fire work through learning from each other and leveraging the resources, knowledge and expertise of the partners.
- Promote restoration across ownership boundaries and at large scale — larger than any previous planning efforts — and support resiliency of all vegetation types to future wildfires.

6

Learn by doing.

- Consider learning as a key objective of the strategy — monitoring and adaptive management. These large high-severity wildfires bring new challenges and monitoring questions that have never been studied.
- Utilize wildfires of this scale as a living laboratory to assess post-fire recovery in the era of climate change.

7

Record short-term success metrics.

- Provide early successes and visual examples of post-fire restoration in each fire footprint on all land ownerships.
- Address hazard trees and risk of delayed regeneration or permanent forest loss within 10 years. This includes establishing conifers on at least 60% of places best adapted for long-term forest cover and resilience (e.g., high priority reforestation opportunities) across all jurisdictions. Jurisdiction-specific outcomes should consider legal requirements for reforestation over the short and long term and plan accordingly (e.g., REPLANT Act on National Forest System lands and Forest Practices Act on private lands).
- Create a history of early success to build momentum and continued support from all partners.

Components of the strategy

To realize the vision and achieve these ambitious goals, the strategy contains four integrated elements:

A A landscape assessment for fuel reduction, reforestation, meadow and riparian restoration, and fuel breaks.

B Cost estimates for a landscape-scale post-fire restoration program.

C Strategic elements of a landscape-scale post-fire program for Klamath and Lake Counties.

D Implementation timeline for the post-fire program.

The Core Team and the Klamath Tribes Natural Resources Department recommend that this strategy be updated periodically to report on the progress that has been made towards achieving the restoration options presented in the strategy. We recommend that along with the updates, that a departure analysis (Barrett et al. 2010, Demeo et al. 2018) be conducted once every five years to assess recovery progress in terms of disturbance and successional departure with respect to historical reference conditions, and when available, expected future climate conditions.


KARA CAPALDO / ADOBE STOCK

II

Expected climate changes

In keeping with recent climate trends, land managers in Klamath and Lake Counties should expect temperatures to increase, resulting in less cold weather and snowpack retention, more record heat waves, longer and more frequent summer droughts, more severe insect outbreaks, earlier springs and longer fire seasons. Here, the Core Team has summarized the expected impacts of climate change in the region through the end of the century, as synthesized in the General Technical Report "Climate Change Vulnerability and Adaptation in South-Central Oregon," and the management implications of these changes (Halofsky et al. 2019).

Increased temperatures, more variable precipitation cycles and a "thirstier atmosphere"

Under a no-mitigation/business-as-usual/worst-case emissions scenario (RCP 8.5), the region is projected to warm 40.5 °F, on average, by the end of the century (2070–2099) relative to temperatures in recent history (1970–1999). There are no scenarios that project future cooling. Annual average temperatures in Klamath and Lake Counties have risen ~0.3 °F per year over the past century (NOAA.gov).

Projections of future precipitation are more uncertain than those for temperature, and there is disagreement among models as to whether annual precipitation will increase or decrease. However, there is some indication that there may be slight increases in precipitation during winter months, outside of the growing season. Mean precipitation during the growing season is expected to decrease from 0.87 to 0.79 inches — a 9.2% decline — by the end of the century.

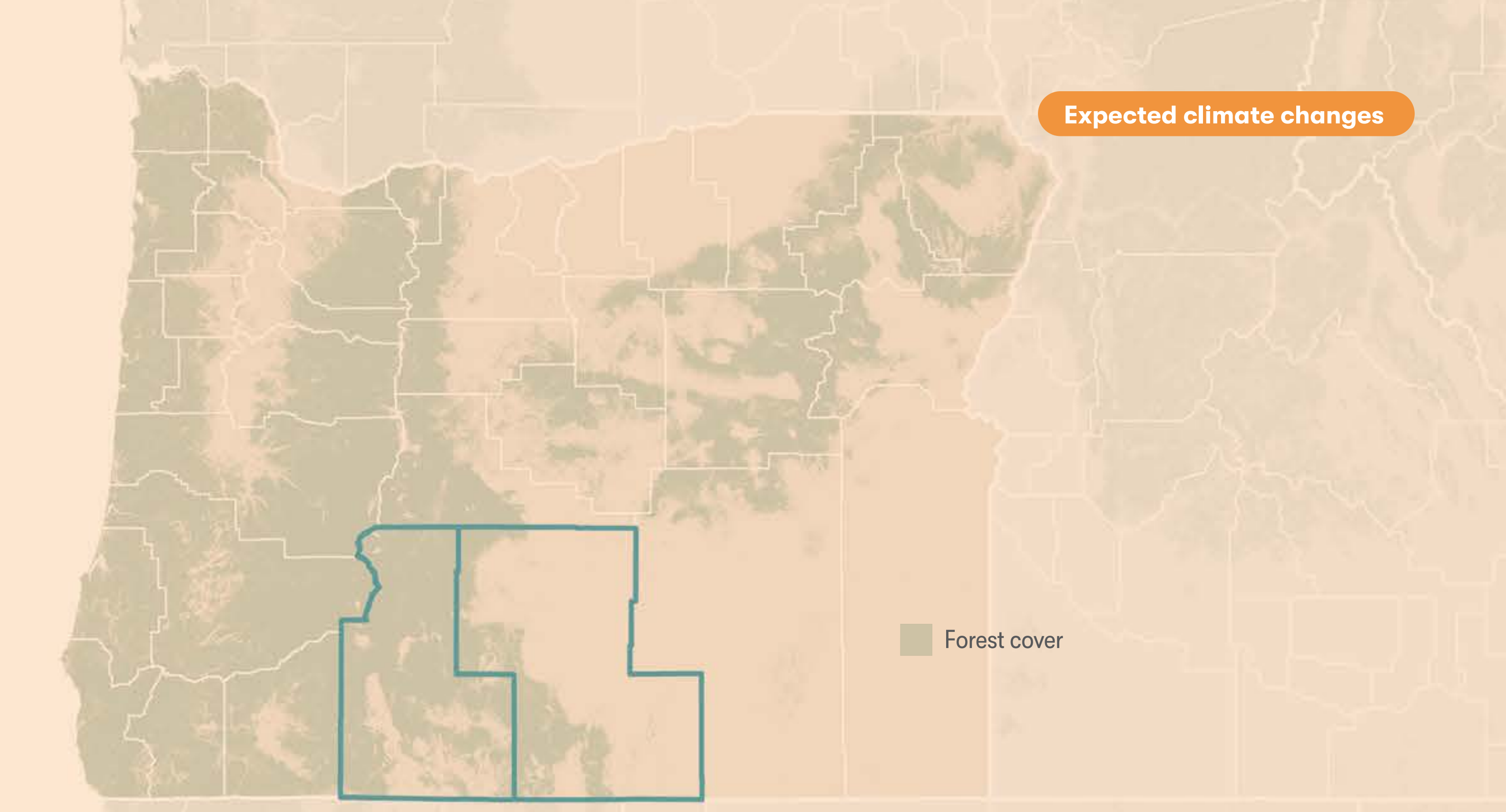
Moisture balance deficit (MBD), also known as climatic water deficit, describes the annual evaporative demand that exceeds water availability. In other words, it is a measure of the potential effects of drought stress on trees. MBD is projected to nearly double by the end of the century for most elevations in the region, largely because of increased temperatures. Increases in MBD correlate with dryer fuels and higher tree mortality rates. Increased water stress may increase the probability of mortality caused by wildfire, insects and disease, although effects have been shown to be reduced when stands are managed for climate change (e.g., Levin et al. 2022). Drought-sensitive seedlings and larger, older trees near the limits of their range are particularly at risk.

Longer fire seasons, with larger and more frequent fires

Forest managers should expect more frequent wildfires, increases in area burned, greater extent of stand-replacing high-severity fire, longer wildfire durations and longer fire seasons. Climate change is linked to larger, more frequent fires in part because it increases probability of heat waves and drought, thereby reducing live fuel moisture and increasing tree mortality caused by outbreaks of insects and disease. Although climate change effects interact with legacies of fire suppression and the resultant fuels build up, fire starts coinciding with heatwaves and dry spells are more likely to behave like the Bootleg Fire, presenting heightened danger for communities and firefighters and creating large areas with complete tree mortality across all age classes, unless properly treated and maintained (especially with prescribed fire and managed wildfire).

Management implications

These climate trends will reshape and inherently reduce forest cover in **Klamath** and **Lake Counties** over the coming century. The main implications for forest managers in the region are presented below, with more in-depth adaptation options explored throughout the report.



Longer fire seasons with more severe burning conditions will make vegetation and fuel management even more critical, especially in the wildland-urban interface. Fuel breaks and landscape-level fuel implementation plans are a priority.

Warming and increased wildfire activity will further facilitate the spread of non-native invasive plants, which should be managed for community safety and forest conservation. Many non-native invasive plants—especially annual grasses like cheatgrass (*Bromus tectorum*), medusahead (*Taeniatherum caput-medusae*) and ventenata (*Ventenata dubia*)—benefit from, and encourage, fire activity. Wildfire clears native vegetation, facilitating non-native species establishment. In addition to outcompeting native species, invasives increase future fire risk (e.g., Fusco et al. 2019) because they dry earlier and burn more readily than native species. Invasives should be treated as fuels that threaten human communities and forest stands, as well as biodiversity. Further, controlling invasive species in reforestation units may increase reforestation success by increasing seedling survival and growth rates and reducing the risk of seedling mortality caused by reburns (North et al. 2019, Larson et al. 2022).

Insect and disease outbreaks will be more frequent and sustained, making low-stand densities, diverse tree sizes and appropriate tree species diversity a management priority (e.g., Douglas-fir and incense cedar are not preferred hosts of mountain pine beetle and can therefore maintain forest cover where pine species decline during outbreaks) (Guo et al. 2019, Restaino et al. 2019). Lodgepole and Ponderosa pine forests will face increased risks from mountain pine beetle outbreaks, as increased drought stress will limit trees' ability to resist insects, and warmer temperatures will facilitate increases in beetle populations. Similar patterns can be expected for western spruce budworm and Douglas-fir tussock moth outbreaks (e.g., Pureswaran et al. 2018).

During severe and/or prolonged droughts, large-scale tree mortality will occur on drier sites and in dense stands due to greater competition for soil moisture. Tree species that are more sensitive to drought are likely to decline in lower elevations and latitudes. Treatments that reduce stand density, like variable density thinning and prescribed fire, may help alleviate some of these impacts (Knapp et al. 2017, Zhang et al. 2019). Maintaining or increasing the diversity of tree species and genotypes at a site may also help reduce susceptibility to drought (Anderegg et al. 2018).

Wild seed collection efforts will become more challenging and require greater attention and investment. Driven by heat and drought as well as mortality caused by wildfire, cone crops will be smaller, mast years less frequent and the seeds that are produced will likely suffer from greater predation by insects (Wright, J. personal communication). These trends will be especially acute at lower elevations and for species at the lower limits of their range. Natural regeneration may also be negatively impacted by these trends. Seed orchards may mitigate some of these impacts through irrigation, fertilization and stimulation of cone crops.

Hot, dry weather will cause higher mortality rates and slower growth for tree seedlings (Moran et al. 2019, Boag et al. 2020). Natural regeneration will fail more often following wildfires and other mortality events. While planting success will decrease, it will become more important in places where forests are desired. Planting seasons will start earlier and end sooner in the year. Planning fall plantings, rather than just the traditional spring plantings, will be a strategy to deal with more variable precipitation patterns. Climate-smart forestry extends to proper seedling handling, which can include thresholds for wind, humidity, air temperature, snow cover, soil moisture, etc. Specific thresholds will vary by species, stock type and landowner. More resource-intensive planting practices, like site preparation, herbicide treatments or micrositing and shade cards, will become ever more important for project success.

III

Restoration assessment

The Core Team performed a geospatial assessment to identify necessary restoration activities across the burn scars and locations for fuel breaks (Appendix A**). The analysis is a landscape-scale analysis based on existing geospatial data. Resulting maps and geospatial layers are meant to facilitate the identification of potential locations; areas will need to be ground-truthed prior to or during implementation.**

The geospatial analysis allowed the Core Team to divide the landscape into eight categories based on the general restoration approach required according to pre- and post-fire conditions. Details are provided in subsequent sections. The team then divided areas within the fire footprints into eight different restoration categories (**Figure 3**). Acreage by ownership type are shown in **Table 1**.

Restoration opportunity

Geospatial assessment is designed to identify where restoration activities may be needed across the landscape.

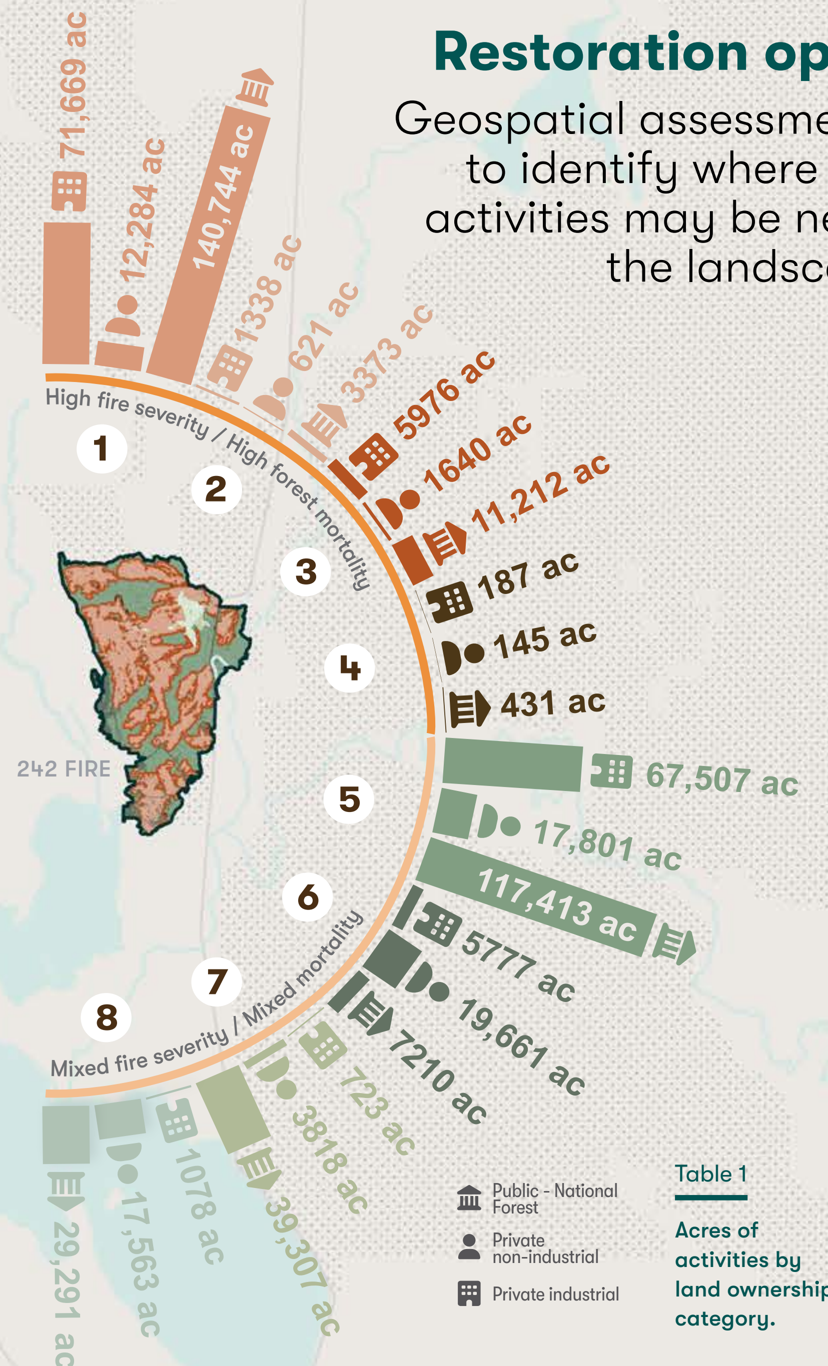


Table 1

Acres of activities by land ownership category.

	Reforestation by planting *Far from seed source (>130 feet)*	Reforestation by natural regeneration *Close to seed source (<130 feet)*	Maintenance	Meadow
High fuel load *high risk for high-severity fire*	**1** Pre-fire forested areas that are candidates for planting and fuel reduction. *Total: 224,697 acres*	**3** Pre-fire forested areas that are candidates for natural regeneration with fuel reduction. *Total: 18,828 acres*	**5** Pre-fire forested areas that are candidates for fuel reduction only. *Total: 202,721 acres*	**7** Candidate area for fuel reduction and meadow restoration. *Total: 43,848 acres*
Low fuel load *low risk for high-severity fire*	**2** Pre-fire forested areas that are candidates for planting with no fuel reduction. *Total: 5,332 acres*	**4** Pre-fire forested areas that are candidates for natural re-generation without fuel reduction. *Total: 763 acres*	**6** Other vegetation types that may require maintenance treatments. *Total: 32,648 acres*	**8** Candidate area for meadow restoration. *Total: 47,932 acres*

High fire severity / High forest mortality
Includes forested areas only with >75% BA mortality

Mixed fire severity / Low forest mortality OR Mixed non-forest mortality
Includes forested areas with <75% BA mortality and non-forested areas with mixed mortality

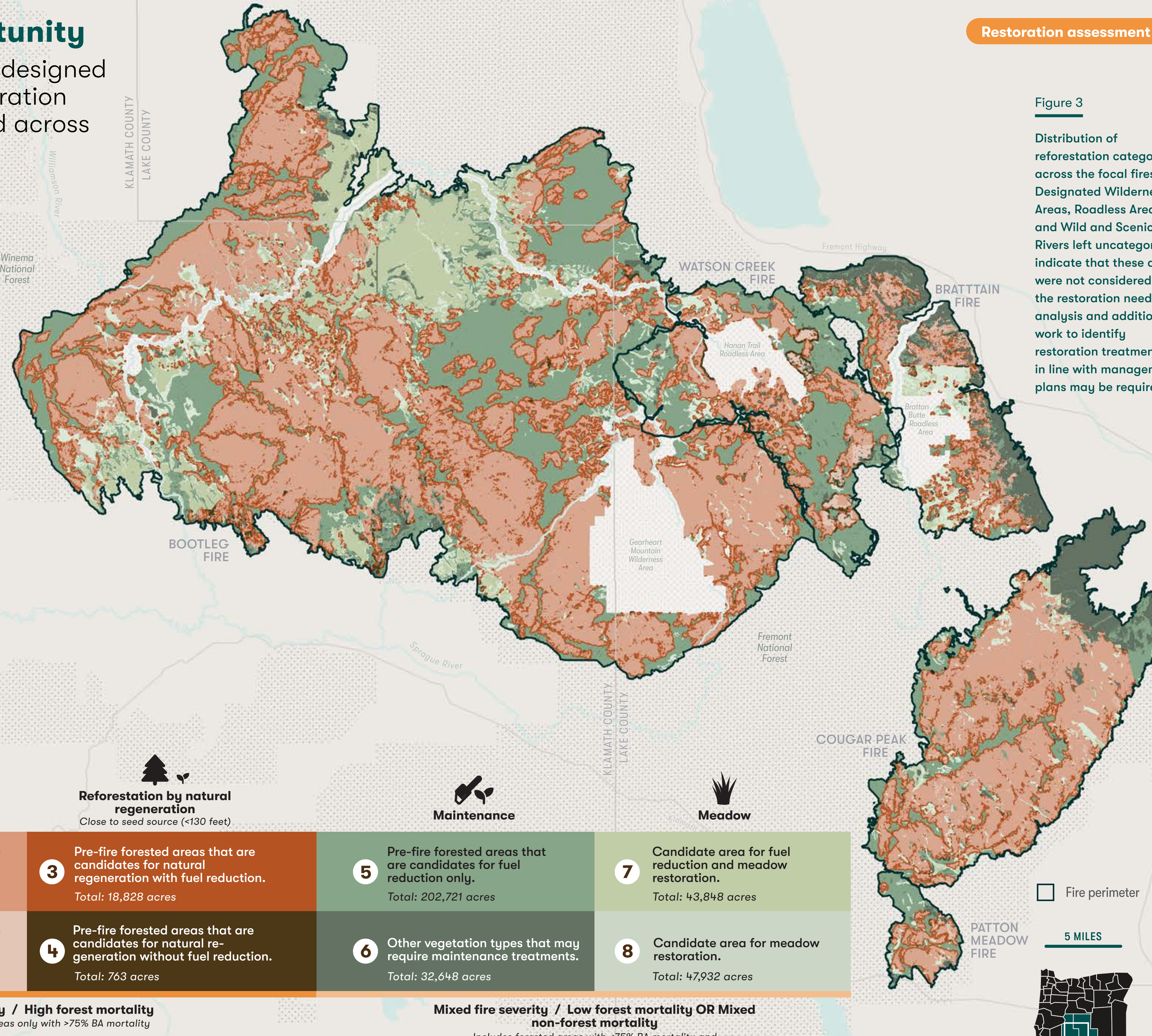


Figure 3

Distribution of reforestation categories across the focal fires. Designated Wilderness Areas, Roadless Areas and Wild and Scenic Rivers left uncategorized indicate that these areas were not considered in the restoration needs analysis and additional work to identify restoration treatments in line with management plans may be required.

Reforestation opportunity

Reforestation opportunities were classified as being candidates for either reforestation via planting or for natural regeneration. Because areas that burned at low or moderate severity likely experienced good fire effects (e.g., reduction of tree density), and/or need trees removed from the landscape because of overstocking, reforestation opportunities were restricted to areas that experienced >75% BA mortality. Further, contiguous patches of high-severity fire smaller than 50 acres were not considered a reforestation opportunity. This threshold was chosen for the landscape-scale analysis to allow for heterogeneity across the landscape consistent with historical fire regimes; high-severity patches within the predominantly mixed-conifer forests that existed within the focal fire footprint historically were dominated by many small high-severity patches, the majority of which were 50 acres or smaller (Perry et al. 2011). Consistent departure analyses over time can help ensure that this approach is working as expected. An appropriate specialist may determine that reforestation activities should occur in smaller patches or in areas not identified by this landscape-scale geospatial analysis. This promotes spatial heterogeneity across the landscape and facilitates reforestation activities at a scale relevant to land managers. The remaining areas were then categorized into those in need of planting or natural regeneration based on the distance to nearest potential seed source, as regeneration potential declines steeply as distance to seed source increases. The Core Team estimated the distance to the nearest seed source (either a forested area within the fire perimeter that experienced <50% BA mortality, or to a forested area identified using plant association group (PAG) outside of the fire perimeter). The team then used a threshold distance to differentiate between areas that may be candidates for natural regeneration — distance to nearest seed source ≤130 feet (Welch et al. 2016) — and those that are candidates for planting — distance to nearest potential seed source <130 feet. This conservative threshold was chosen to ensure that forests reestablish in these areas. Others have found that regeneration may occur at farther distances, but those probabilities are drastically reduced (e.g., Boag et al. 2020). On National Forest System lands, additional assessments to differentiate areas slated for natural recovery versus natural regeneration must be completed by a certified Forest Service silviculturist. Areas within designated Wilderness Areas, Roadless Areas and Wild and Scenic River Areas were removed from consideration because management activities associated with reforestation (e.g., site preparation, seedling planting) were removed from consideration due to additional constraints which were not included in this analysis. Future analysis should consider relevant management requirements and plans for these land designations to accurately prioritize restoration work. However, these areas — which cover approximately 60,000 acres across the focal fires — should be monitored to assess the trajectory of natural regeneration as they are at higher risk of forest conversion due to lack of planting. Additionally, areas within meadows as mapped by the Klamath Tribes were removed to avoid exacerbating tree encroachment. Further, transitions zones and shrub- and grass-dominated habitats between meadows and the associated conifer forest type should not be planted. Preliminary data from the Klamath Tribes shows a 30 to 40-foot elevation gain is a coarse proxy for the transition zone between meadows, swales, riparian and other open ecosystems and conifer forest.

Of the forested area burned at high severity in permitted (i.e., outside of Wilderness, Roadless and Wild and Scenic River) areas, approximately 250,700 acres may require planting because of no seed source in the vicinity. An additional 21,060 acres likely will have seed dispersal and may be able to regenerate on their own; however, monitoring will be necessary to ensure recovery is following an acceptable trajectory to meet ecosystem and management goals. The distribution of reforestation opportunity is shown in **Figure 4**. Many sites suitable for natural regeneration are within/adjacent to candidate planting locations, and implementation efficiencies may be exploited by planting some of these areas, where indicated, through field verification by an appropriate specialist.

Fuel treatments

To identify areas that may require fuel treatments, either as part of reforestation efforts or to mitigate fuel loading and make landscapes more resilient to future wildfire, the Core Team classified fuel loading into two groups, high and low. Polygons outlining high- and low-fuel loads were identified using a combination of the Forest Service Pacific Northwest Research Station and Oregon State University Landscape Ecology, Modeling, Mapping and Analysis (LEMMA) models of average stand diameter and average stand density, and Rapid Assessment of Vegetation Condition (RAVG) percent BA mortality. Classification logic is shown in **Table 2**. We assumed that areas with estimated tree densities greater than 200 TPA need fuel treatments. However, density was estimated for pre-fire forest, and as such, impact of wildfire on tree density was considered. In small diameter stands, the Core Team assumed that low- and moderate-severity

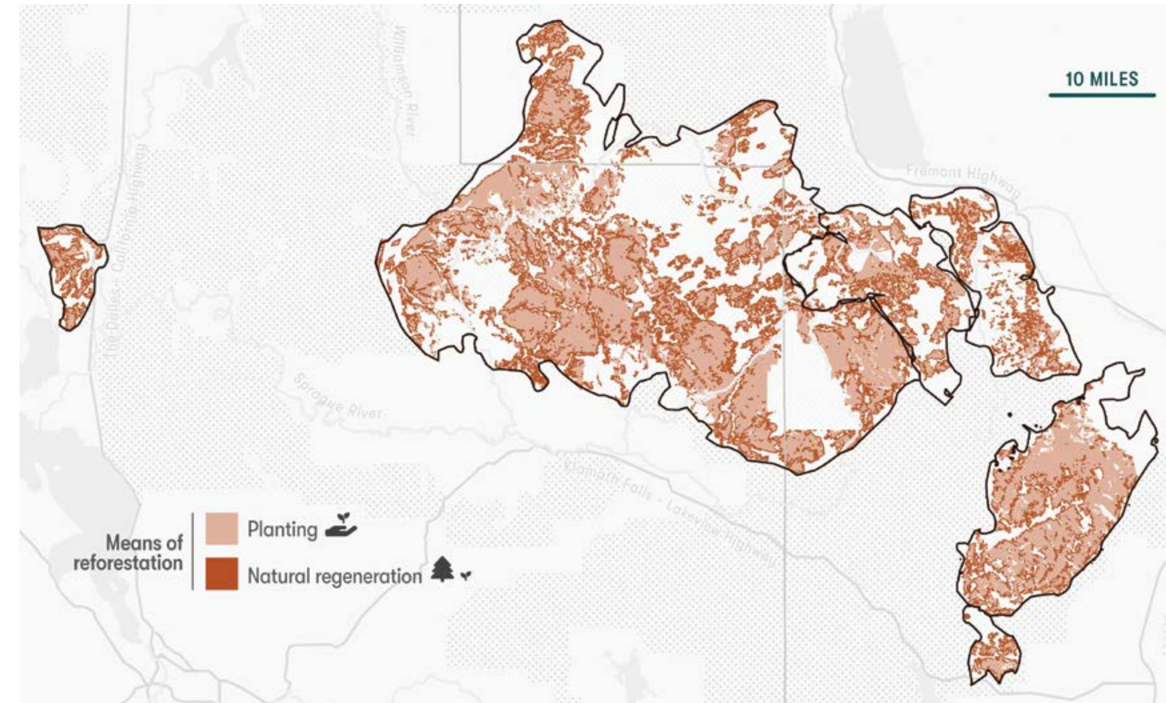


Figure 4

Distribution of reforestation opportunity across the focal fires of this report. Reforestation opportunity includes planting and natural regeneration. Reforestation opportunities via tree planting were defined as areas that burned with 75% BA mortality and ≤130 feet from the nearest potential seed source. Areas identified for natural regeneration are small in extent, but present across the landscape (**Appendix A**).

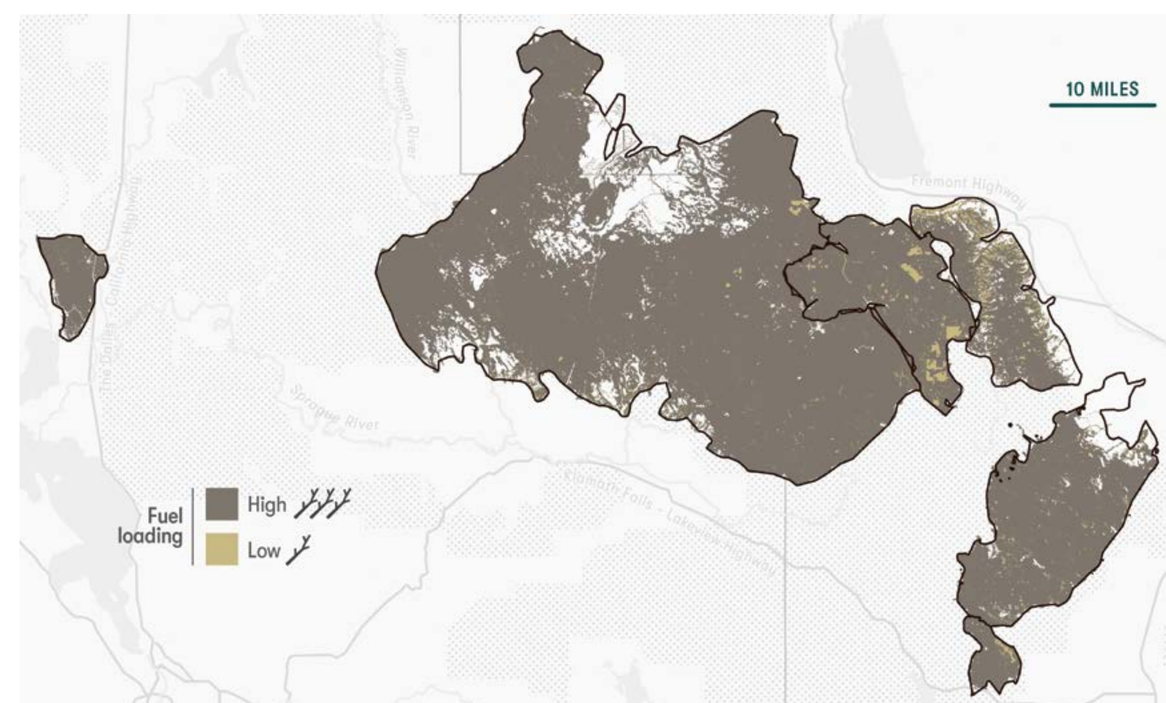


Figure 5

Fuel loading across the focal fires. White areas indicate non-forested areas other than meadows.

fire reduced densities below the 200 TPA threshold, because small diameter trees are killed more readily by wildfire than large trees (Whittier and Gray 2016).

Table 2

Fuel loading classification logic. Areas were designated as having high- or low-fuel loading potential based on average stand diameter class, average stand density and fire severity indicated by percent BA mortality.

Fuel loading category	Diameter class (inches)	Density class (trees per acre)	BA mortality (%)
Low	<12.7	>200	>25
Low	Any	≤200	Any
High	Any	>200	Any

There is an extensive need for fuel treatments across the entire landscape. Not only does the areal extent of fuel treatment need exceed 440,000 acres, but it is also nearly contiguous across all adjacent fire footprints (**Figure 5**). High snag and downed woody debris in post-fire areas can promote high-severity wildfire in the event of reburns (Coppoletta et al. 2016, Lydersen et al. 2019). The risks these heavy contiguous fuel loads pose for future wildfires highlight the need for a substantial investment in fuel treatments across the landscape.

Meadows

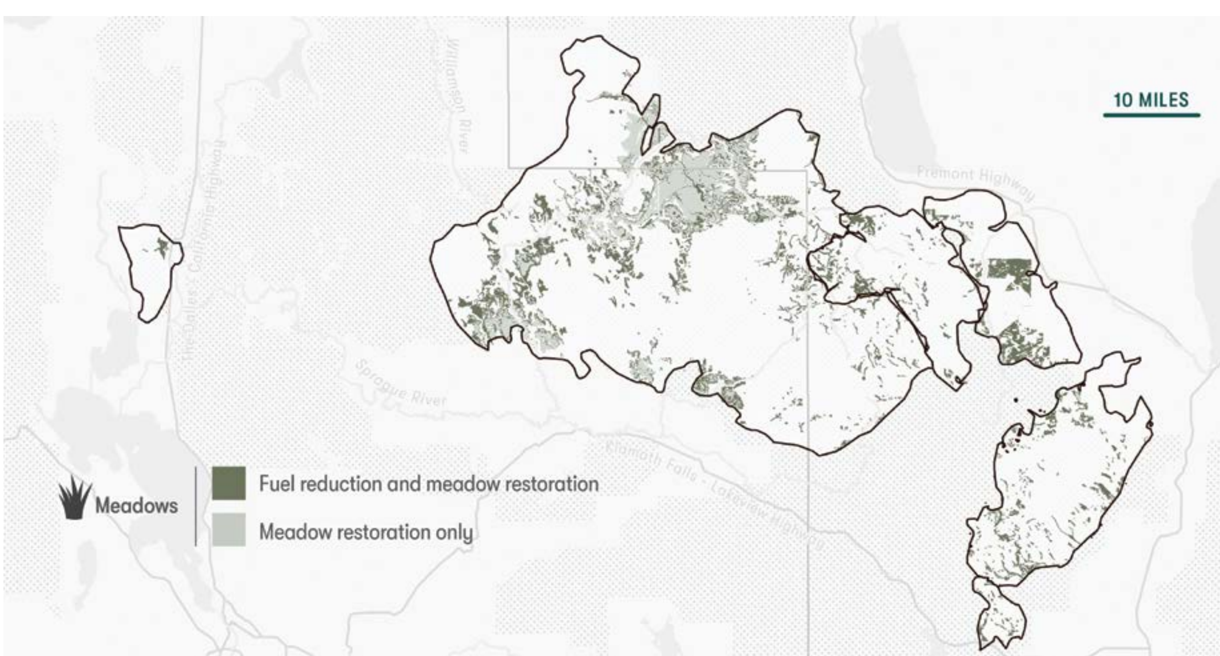
Meadows were identified using the Klamath Tribes meadow layer (**Figure 6**). Although meadow restoration was identified as a key priority of the Core Team and the Klamath Tribes Natural Resources Department for landscape-scale restoration of post-fire environments, it generally falls outside of the scope of this strategy, which focuses more broadly on forested lands.

However, there are elements where meadow restoration and the strategy intersect, namely in preventing further encroachment of conifer trees and forests into meadow spaces, in areas where fuel treatments may be needed to reverse the effects of encroachment and remove fuel from within meadows, and where meadows may buffer the effects of future wildfire because they create natural breaks in the system that may impact fire behavior (Syphard et al. 2011). As such:

- Meadows are not included as candidate locations for reforestation, and crews should assess reforestation units to ensure reforestation does not occur within a 30- to 40-foot elevation gain (site dependent), which translates to a 150- to 2,000-foot buffer surrounding meadow boundaries to preserve biodiversity, wildlife habitat, culturally important plant species and support meadow functioning and hydrology (see Klamath Tribes preliminary data and associated U.S. Geological Survey topo and Gaia topo maps for reference and examples).
- Areas predicted to have high-fuel loading are identified (see Fuels section above) as candidate locations for fuel treatments (Restoration category 7: Meadows requiring fuel treatments, **Figure 6**).
- Deciduous tree planting and reforestation could be considered to help in areas where (1) willow, aspen, cottonwood or alder are present post-fire; or (2) areas where these deciduous trees and shrubs were previously document and/or indication of pre-fire presence (e.g., stumps, logs, crowns seen in post-fire).

Figure 6

Meadows across the fire footprint as identified by the Klamath Tribes, distinguishing those likely to require removal of encroaching conifers as a component of their restoration.



Restoration assessment

Prioritizing reforestation

This strategy focuses on broad restoration tactics to create a fire- and climate-resilient landscape within the focal fire footprints, yet with the vast amount of need across the landscape, prioritization of activities is necessary.

The Core Team focused prioritization around reforestation needs to ensure that fire-resilient forests are established quickly in high-priority areas to increase the reforestation success, because reforestation becomes more expensive, more difficult to complete and the conversion to non-forest becomes more likely with time since fire. Reforestation opportunities were prioritized by weighting variables known to influence reforestation activities and partner priorities. In some cases, variables used to identify restoration opportunity also were considered for prioritization. Whereas identifying reforestation opportunity identified areas in need of reforestation, prioritization weights the importance of specific characteristics. Weights for all variables were scaled to be between 0 and 1, except for areas legally mandated to be reforested. The following data layers were considered when assigning priority values:

Areas required to be reforested within five years of harvest

- SOURCE Forest Service Facts database query returning any activities associated with harvest and sale dating back to 2016. Ongoing salvage efforts need to be considered for site-specific planning and implementation.
- WEIGHTING Areas within harvest and sale polygons were given a priority weight of five, whereas areas outside of these polygons were given a priority of zero.

Forest Service timber management units

- Fremont MA05 and Winema MA12
- SOURCE Forest Service management unit layer
- WEIGHTING Areas within timber management units were given a priority weight of one, whereas areas outside of these management areas were given a priority weight of zero.

Forest Service trails and campgrounds

- SOURCE Fremont-Winema National Forest
- WEIGHTING Areas within a quarter-mile buffer of trails and a half-mile buffer of campgrounds were given a priority weight of one, whereas areas outside of these management areas were given a priority weight of zero.

Ungulate winter range

- SOURCE Oregon Department of Forestry elk and deer winter range
- WEIGHTING Areas within the wintering range of elk and deer were given a priority weight of zero, and areas outside of the wintering range were given a weight of one. This promotes the growth of winter forage, although cover might need to be considered in some areas.

High-severity patch size

- SOURCE RAVG 7-class BA mortality
- METHOD All pixels depicting percent BA mortality >75% were aggregated into polygons. Holes within a high-severity patch smaller than 30 acres were considered part of that patch, and patches smaller than 50 acres were omitted to avoid focusing reforestation efforts on areas where natural heterogeneity is promoted and natural regeneration is likely. Although this approach differs slightly from how reforestation opportunity was identified, it does not impact the area of reforestation opportunity, only priority weight.
- WEIGHTING Weights were derived by uniformly scaling the distribution of patch sizes, with the largest patches receiving the highest weight and smallest patches receiving the lowest weight.

Forest type

- SOURCE PAG
- METHOD To account for rarer tree species, forested PAGs were modified to become a new category for

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areas where whitebark pine and sugar pine are known to occur.

- **WEIGHTING** For each PAG (standard and modified), weights were derived by scaling the area of occurrence within the fire footprints relative to the area throughout Klamath and Lake Counties. Therefore, rarer forest types received a higher weight.

Fuel loading

- **SOURCE** LEMMA Gradient Nearest Neighbor live tree BA, RAVG 7-class BA mortality
- **METHOD** Estimated dead BA (proportion BA mortality * live BA)
- **WEIGHTING** Scaled dead BA uniformly to give high weight to low-fuel loads and low weight to high-fuel loads. This prioritizes planting in areas where lower fuel loads might facilitate rapid reforestation without needing large fuel mitigation projects and hazard tree removal to start.

NOTE Incorporating fuel loading into the prioritization scheme promotes implementation in areas where fuel treatments may not be needed to ensure areas can be reforested quickly, but it does not change the categorization of areas presented in Figure 3 that shows areas across the landscape where fuel treatments are necessary for restoration.

Productivity

- **SOURCE** Forest Inventory and Analysis Forest Productivity 2014-2018 (FIA 2022)
- **WEIGHTING** Forest productivity was uniformly scaled so higher productivity received a higher weight and lower productivity received a lower weight.

Percent change in end of century MBD/climatic water deficit

- **SOURCE** PNW-GTR-974 based on the MRI-CGCM3 global climate model for RCP 8.5
- **METHOD** Raw values were weighted
- **WEIGHTING** Uniformly scaled such that areas expected to experience high increases in MBD received low weights and those expected to experience low increases in MBD received high weights.

Restoration assessment

Category	Values	Weights
Legally mandated	0: Not required; 1: Required	5x
Forest Service timber management areas	0: Outside MA; 1: Within MA	x
Recreation (campgrounds and trails)	0: Not within buffer surrounding campgrounds or trails; 1: Within buffer surrounding campgrounds and trails	x
Ungulate winter range	0: Within winter range; 1: Not within winter range	x
High-severity patch size	50-95,000 acres	$\frac{x_i - \min(\bar{x})}{\max(\bar{x}) - \min(\bar{x})}$
Modified PAG	X = area of each PAG category	$\frac{x}{\text{(total acres in K\&L Counties)}}$
Fuel loading	0-Infinity TPA	$\frac{x_i - \min(\bar{x})}{\max(\bar{x}) - \min(\bar{x})}$
Productivity	1-7 productivity classes	$\frac{x_i - \min(\bar{x})}{\max(\bar{x}) - \min(\bar{x})}$
Percent change in end of century climatic water deficit	-Inf, Inf%	$1 - \frac{x_i - \min(\bar{x})}{\max(\bar{x}) - \min(\bar{x})}$
Slope aspect	1:0-45° 2:315-360° 3:45-90° 4:90-135° 5:270-315° 6:225-270°:135-180° 8:180-225°	$1 - \frac{x_i - \min(\bar{x})}{\max(\bar{x}) - \min(\bar{x})}$

Table 3

Variables considered to prioritize candidate areas for reforestation. Each variable was scaled between 0 and 1, except timber sale areas which must be reforested by law. Values show how variables are fed into the weighting equation, and weights shows the scaling function to estimate the weight.

Note that this prioritization matrix and the associated maps provide insight into where reforestation activities could be prioritized. Ground truthing should be conducted prior to planning to verify ground conditions meet expectations. Further, local priorities and compliance with all relevant regulations may inform project selection and implementation.

Slope aspect

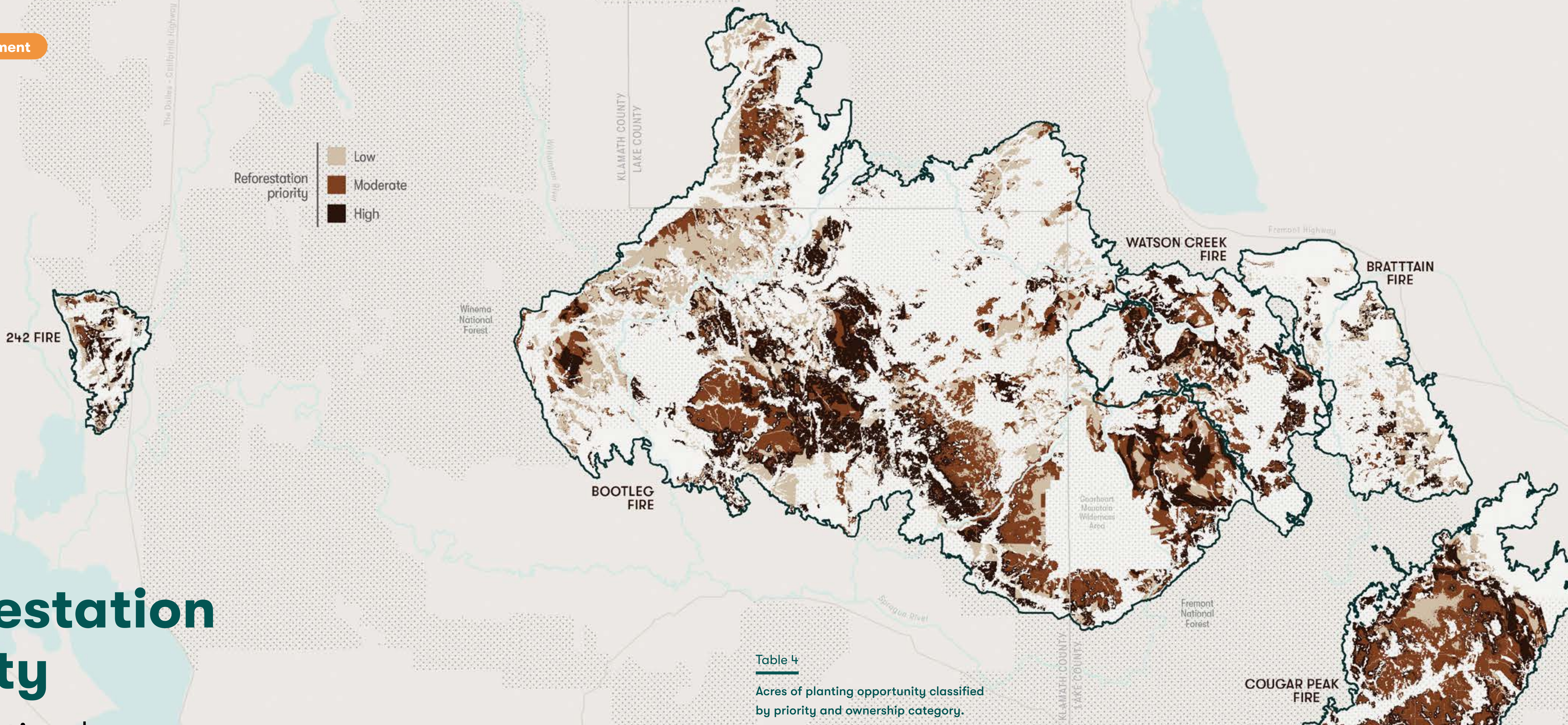
- **SOURCE** U.S. Geological Survey GTOPO30 digital elevation model
- **METHOD** Converted to slope aspect using the terrain function in the R Package Terra
- **WEIGHTING** North and east aspects received highest weights, south and west aspects received low weights.

In contrast to other regions where accessibility is limited by roadless areas and access, the Core Team did not consider accessibility for this strategy as the region is well-roaded and slopes are gentle. Table 3 depicts the weighting functions and prioritization variables used.

After weights for each pixel were calculated for all variables, the priority weight was calculated for each pixel by adding all variable weights. Higher priority weights reflect higher reforestation priority. To bin priorities into low, medium or high categories, the Core Team divided the weights into three bins based on weight quantiles. However, because some categories were restricted to Forest Service lands, the team first divided the priority areas into private and public lands. The weights of each land group were categorized into three groups based on land-base-specific thresholds. This ensured that private lands were not penalized because Forest Service lands have additional priority variables. The distribution of priority reforestation areas is shown in **Figure 7**, and acreage breakdowns by priority category and land jurisdiction are shown in **Table 4**.

Figure 7

Reforestation priority across all wildfires categorized into high, medium and low priority.

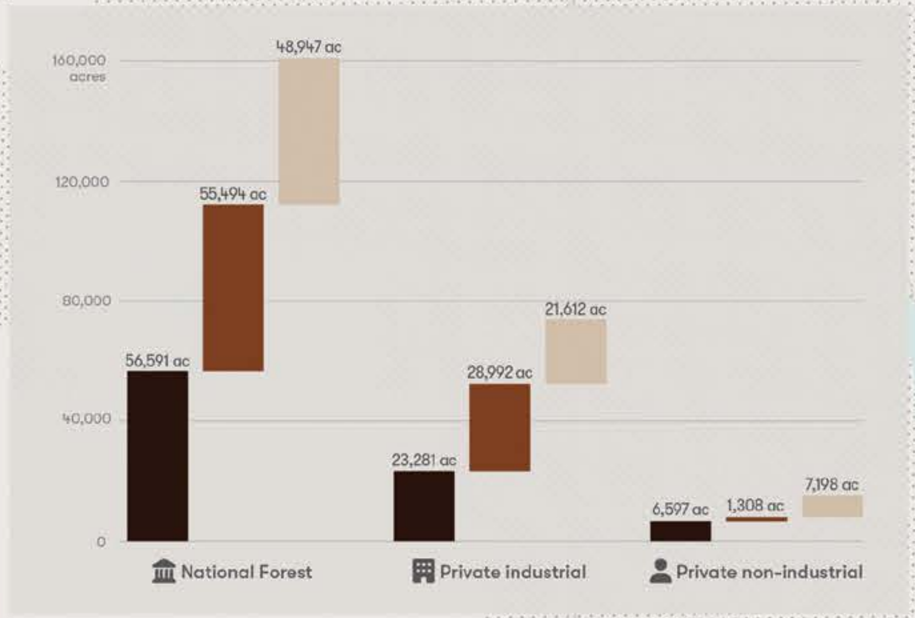


Reforestation Priority

Reforestation becomes more expensive, more difficult to complete and the conversion to non-forest more likely with time since fire. The Core Team focused prioritization to ensure that fire-resilient forests are established quickly in high-priority areas to increase reforestation success.

Table 4

Acres of planting opportunity classified by priority and ownership category.



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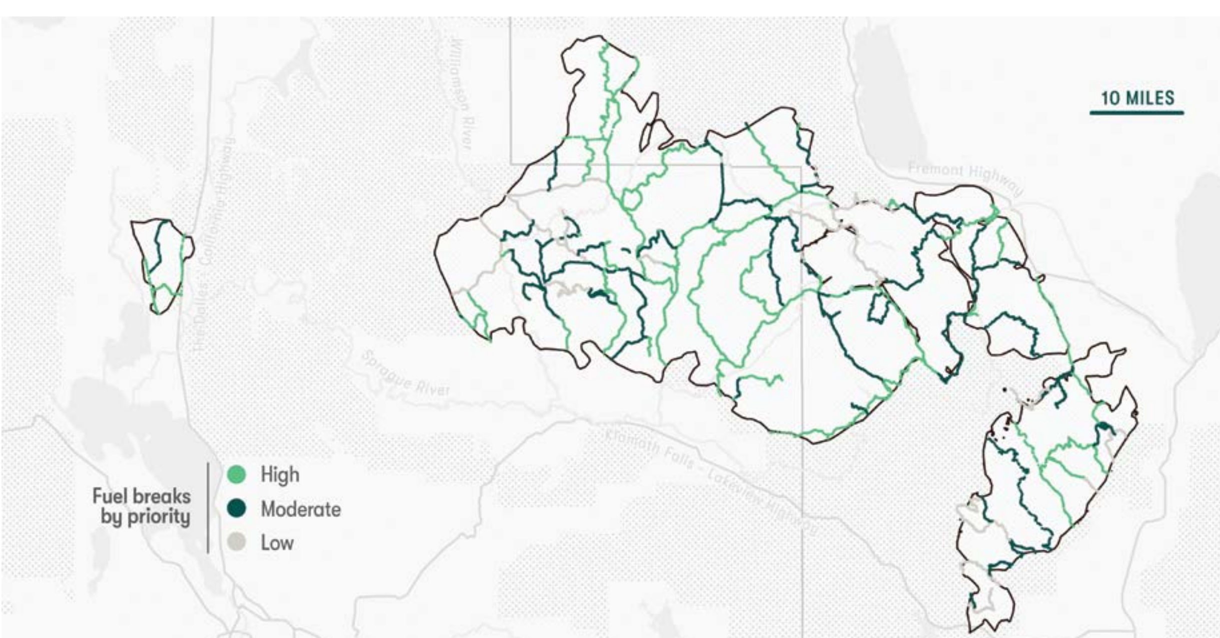

Figure 8

Proposed fuel break locations throughout the focal fires. Most of the proposed fuel breaks overlap with previously identified POD boundaries that follow roads. Additional proposed fuel breaks were intended to provide protection near land jurisdiction transitions.

Restoration assessment

Fuel breaks

Within the fire perimeter boundaries of the six fires, the Core Team recommend that fuel breaks be created along the boundaries of potential operational delineations (POD) boundaries that align with road systems, as well as additional roads that break up or run adjacent to large parcels of private lands. POD boundaries have been delineated as a collaborative approach by the Fremont-Winema National Forest. Using POD boundaries as a framework for the development of new fuel breaks leverages these previous collaborative efforts to identify potential locations to stage fire-suppression efforts and provide ingress/egress for wildland firefighters. In moderate-fire weather conditions, these will also facilitate reductions in fire behavior and can prevent fire spread. However, it is important to note that during conditions like those seen during the 2021 fire weather, fuel break utility is in access for suppression and backfire operations as well as firefighter safety, and not in preventing fire spread.

Fuel break implementation will leverage the work done by the fire to reduce fuels and understory vegetation. Additional work identified below will be conducted to keep boundaries prepared for the next fire.

The Core Team identified a total of 586 miles of fuel breaks within the fire perimeters (**Table 5**). These areas are predominantly POD boundaries, but much of the fuel break locations identified on private lands are new. These areas are intended to provide opportunities to mitigate potential economic and ecological losses and protect life and property.

Fuel break segments are defined as a continuous length of fuel break between intersections with other fuel breaks (including the boundary of the analysis area). Fuel break segments were prioritized based on four factors: 1 distance to Paisley, 2 distance to Chiloquin, 3 landowner category (public or private), and 4 distance to nearest private land parcel.

Additional factors were considered, including the acres of designated old growth forest within polygons created by the fuel breaks and fire perimeters, however the remaining old growth patches within the fire perimeters were generally impacted by stand replacing fire.

1. Distance to Paisley was weighted as the inverse of the average distance to each town in miles.
2. Distance to Chiloquin was weighted as the inverse of the average distance to each town in miles.
3. Fuel breaks within private lands were assigned a weight of one, and zero otherwise.
4. Distance to nearest private land parcel was weighted as the inverse of the average distance to the nearest private parcel.

The Core Team summed the weights for each of the fuel break segments to obtain the overall prioritization weight for each individual segment (**Figure 8**).

Table 5

A total 586 miles of proposed fuel breaks were identified within three ownership categories.

IV

Cost estimates

The total cost of actions identified in the assessment is over $652 million.

Appendix B shows the cost estimates and sources for activities considered in this strategy. Estimates include staff and contracting costs, but costs do not include those associated with environmental compliance and oversight. Costs currently do not include maintenance of fuel breaks or prescribed fire treatments for management after implementation. Costs of specific actions per landowner type are presented in **Appendix B**, **Table B1**. Of the estimated $652 million dollars required to accomplish all restoration activities, approximately 70% is required for mechanical site preparation or fuel treatment (**Table 6**). Another ~25% of the total costs are associated with reforestation, and the remainder are associated with maintenance prescribed fire. **Table 4** shows the cost breakdown by the restoration categories outlined in the assessment.

On the Fremont-Winema National Forest, there are over 270,000 acres that ideally will see some type of treatment, with the total costs exceeding $250 million in fuel reduction and nearly $105 million in reforestation (**Table B2**). There are over 150,000 acres of private industry land identified as needing some type of treatment, with over $101 million in fuel treatment/mechanical site-preparation costs and over $47 million in accompanying reforestation expenses (**Table B3**). On non-industrial private land, there are over 73,000 acres that will ideally see some type of treatment over 5,000 distinct owners. All told, costs on private non-industrial lands will require over $27.5 million in fuel reduction treatments and over $18.5 million in reforestation. Costs related to private landowner education and outreach need to be estimated (**Table B4**).

Implementation scenarios

Because the need across the landscape is vast and resources are limited, this strategy outlines various scenarios for each jurisdiction type to provide examples of the acres treated and costs, given various strategies, targets and availability of resources. An important consideration is that post-fire reforestation costs increase with time since fire. In addition, standing dead trees fall, generally between five and 20 years after fire (Dunn et al. 2019, Grayson et al. 2019), creating challenging conditions for forest managers and elevating risks of high-severity reburns. Hence, moving quickly to address needs will result in the most cost-effective approach with increased chances for long-term success.

National Forest System lands

The Fremont-Winema National Forest plans to approach the post-fire restoration across "implementation units," 3,000-5,000-acre units within which fuel reduction and reforestation activities will be coordinated within an entire implementation unit and approached sequentially. The national forest is approaching post-fire restoration in this fashion intentionally to treat larger-scale areas and promote the reintroduction of prescribed fire. Once an entire implementation unit is treated in its entirety, prescribed fire can be reintroduced as the predominant maintenance tool. The size of the units aligns with the size of broadcast burning units implemented across the national forest. Prescribed fire ideally will be reintroduced 15-20 years after restoration treatments are concluded (Bellows et al. 2016, York et al. 2021), following historical fire return intervals and ensuring that trees have grown to a size at which they are likely to survive prescribed fire. Implementation units of this scale should also better facilitate the use of prescribed fire as a site-preparation tool for delayed planting (i.e., over six years after the initial entry into the management unit). Because reforestation activities become more costly to implement over time and success rates can decline, prescribed fire can be a successful site-preparation tool to reduce costs and increase success following a long delay between fire and reforestation. The use of these implementation

Table 6

Summary of post-fire restoration costs across all ownerships. This includes all restoration needs identified by the needs assessment.

National Forest System, private industrial and private non-industrial owners

Restoration category	Acres	Mechanical site preparation and/or fuel treatment cost	Reforestation cost	Other treatment cost	TOTAL
Planting with fuel treatment	224,697	$207,033,000	$155,308,000	$0	$362,341,000
Planting without fuel treatment	5,332	$0	$3,749,000	$0	$3,749,000
Natural regeneration with fuel treatments	18,828	$17,149,000	$3,700,000	$0	$20,849,000
Natural regeneration without fuel treatments	763	$0	$142,000	$0	$142,000
Fuel treatments only	202,721	$193,135,000	$0	$0	$193,135,000
Maintenance treatments (prescribed fire within 10 years)	32,648	$0	$0	$19,589,000	$19,589,000
Meadow restoration including removal of encroaching conifers	43,848	$43,848,000	$0	$0	$43,848,000
Meadow restoration not likely to include removal of encroaching conifers	47,932	$0	$0	$0	$0
Fuel breaks	586 miles	$0	$0	$8,790,000	$8,790,000
TOTAL	576,769	$461,165,000	$162,899,000	$28,379,000	$652,443,000

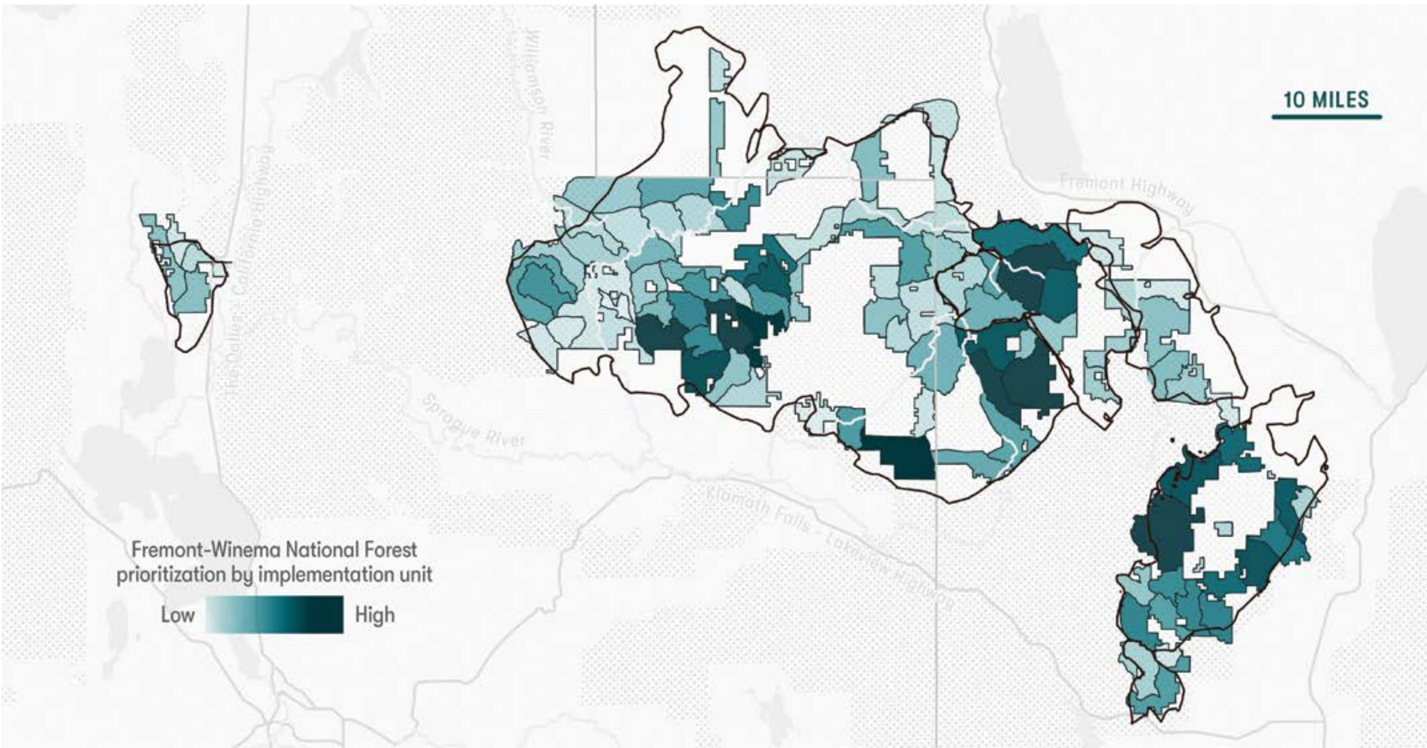

Figure 9

Implementation units are defined by the Fremont-Winema National Forest and the number of high- and moderate-reforestation acres per unit. These units will be restored in their entirety (i.e., reforestation and fuel management) before moving on to the next unit. These 3,000-5,000-acre units are intended to facilitate the reintroduction of prescribed fire and promote fire resiliency across the landscape. Implementation units will be prioritized based on the number of acres of high- and moderate-reforestation priority within each unit, with higher number of priority acres corresponding to a higher priority implementation unit.

units will provide a unique opportunity to investigate the impacts of widespread use of broadcast burning, including: the age at which prescribed fire can be successfully introduced into planted areas; how different species, stock types, age classes and genetic stock respond to prescribed fire; the effects on competing vegetation and invasive species; and the effects of varying prescribed fire frequency on metrics of interest (e.g., tree survival, stand structure and composition, abundance of competing vegetation and invasive species). Reintroduction of prescribed fire should generally follow the historical fire return intervals for the region and forest type, and impacts should be monitored to ensure that desired outcomes are achieved and approaches adjusted over time.

The Fremont-Winema National Forest created 106 implementation units across the forest (**Figure 9**). The boundaries of implementation units follow roads. Most lands within the implementation units are managed by the Forest Service, but there are areas of private lands within the units. These areas are one of many opportunities for cross jurisdictional collaboration of activities.

The Fremont-Winema National Forest will prioritize implementation units based on the number of acres of high- and moderate-priority reforestation within each unit (**Figure 10**), with higher number of acres of high- and moderate-reforestation priority corresponding to a higher priority implementation unit (**Table C1**). Although restoring the entire implementation unit will result in reforestation of some low-priority areas, the approach facilitates the long-term goals of reintroducing prescribed fire and developing heterogenous landscapes of varying stand age.

Cost estimates

Implementation scenarios on National Forest System lands

Scenario 1: Reforestation ramps up to 15,000 acres per year by 2027

Over the next 10 years, the Fremont-Winema National Forest anticipates ramping up from its current pace and scale of reforesting 2,500-3,000 acres per year to 15,000 acres per year — across three to five implementation units, amounting to over 87,000 acres of reforestation treatment in the first 10 years of the strategy. This ramp-up schedule would result in the reforestation of nearly 31 implementation units accounting for ~74,000 acres of high- and moderate-reforestation priority. Utilization of the newly expanded Reforestation Trust Fund may make this possible if the Forest Service addresses its seed and workforce constraints. **Table 10** shows the ramp up over time and associated costs.

Table 10

Projected number of acres per year reforested on National Forest System lands, the associated planting and fuel treatment costs, assuming the Fremont-Winema National Forest ramps up reforestation acres to 15,000 per year by 2027. Costs assume all acres need fuel treatment. All cost estimates assume stagnant costs over time.

Year	Annual total	Reforestation cost	Fuel treatment cost ($)	Total cost ($)
2023	2,700	$1,890,000	$2,970,000	$4,860,000
2024	4,000	$2,800,000	$4,400,000	$7,200,000
2025	8,000	$5,600,000	$8,800,000	$14,400,000
2026	12,500	$8,750,000	$13,750,000	$22,500,000
2027	15,000	$10,500,000	$16,500,000	$27,000,000
2028	15,000	$10,500,000	$16,500,000	$27,000,000
2029	15,000	$10,500,000	$16,500,000	$27,000,000
2030	15,000	$10,500,000	$16,500,000	$27,000,000
TOTAL	87,200	$61,040,000	$95,920,000	$156,960,000

Scenario 2: All acres are reforested by 2030 per the REPLANT Act

Scenario 2 presumes that by 2030 all acres in need of reforestation identified in the strategy are reforested as well as the ~45,000 acres of additional backlog. This would require a 62% increase in reforestation output each year through 2030. **Table 10** shows the increase in acres over time and associated costs.

Table 11

Projected number of acres per year planted on National Forest System lands, the associated planting and fuel treatment costs, assuming the Fremont-Winema National Forest ramps up reforestation by 62% per year through 2030. This ramp up would be required to reforest the acres identified in the strategy as well as the additional 45,000 acres of backlog that must be reforested under the REPLANT Act. Costs assume all acres need fuel treatment.

Year	Acres planted	Reforestation cost	Fuel treatment cost	TOTAL
2022	2,500	$1,750,000	$2,750,000	$4,500,000
2023	2,700	$1,890,000	$2,970,000	$4,860,000
2024	4,374	$3,062,000	$4,811,000	$7,873,000
2025	7,086	$4,960,000	$7,794,000	$12,755,000
2026	11,479	$8,035,000	$12,627,000	$20,662,000
2027	18,596	$13,017,000	$20,456,000	$33,473,000
2028	30,126	$21,088,000	$33,138,000	$54,226,000
2029	48,804	$34,163,000	$53,684,000	$87,847,000
2030	79,062	$55,344,000	$86,968,000	$142,312,000
TOTAL	204,727	$143,309,000	$225,198,000	$368,508,000

Implementation scenario on private lands

Because the need across the landscape is vast and resources are limited, the scenarios in **Table 13** identify the costs of implementing the three tiers of prioritized reforestation coupled with fuel reduction treatments in the first 10 years. Working to complete reforestation needs over 10 years increases the chances of establishing forests and is the most cost-effective option because reforestation costs increase with time since fire. Because private lands implementation differs from approaches on National Forest System lands, this strategy presents a more modular summary of potential ways to prioritize implementation, focusing on areas where reforestation is a priority, as this is a major focus of private industrial companies focused on regrowing their investments, and on private non-industrial lands where aesthetic, economic or other values may have priority. Other restoration needs are presented in a stepwise manner to illustrate the costs associated with addressing other needs that will reduce future risks and increase ecological function.

Addressing the 29,878 acres of high-priority acres for reforestation with fuel reduction treatments will cost an estimated $38.5 million dollars over the next 10 years, or $3.9 million per year over the next 10 years. **Table 13** shows the breakdown by private industrial and private non-industrial lands. Private industrial lands hold ~78% of the high-priority reforestation need across private lands, with private non-industrial landowners comprising the remaining 22%.

Table 13

Estimated costs of a reforestation scenario where all reforestation needs are completed over 10 years.

	Reforestation priority	Acres	Fuel reduction + reforestation cost	Annual cost to implement over 10 years
Private industrial	High	23,281	$29,077,969	$2,907,797
	Moderate	28,992	$36,211,008	$3,621,101
	Low	21,612	$26,993,388	$2,699,339
Private non-industrial	High	6,597	$9,475,601	$947,560
	Moderate	1,308	$1,878,746	$187,875
	Low	7,198	$10,338,847	$1,033,885

Table 14

Estimated costs of other treatment types: natural regeneration, natural regeneration with fuel treatments, fuel treatments only, maintenance with prescribed fire within the first 10 years and removing conifers from meadows.

	25% of the assessed need for all other treatment types	50% of the assessed need for all other treatment types	Total assessed need for all other treatment types
Private industrial	$14,601,263	$29,202,525	$58,405,050
Private non-industrial	$4,599,687	$9,199,375	$18,398,750

In addition to targeting implementation of the highest priority reforestation projects within the first 10 years of the strategy, other needed treatments amount to $76.8 million (**Table 14**). Across all jurisdictions within the fire footprint, 22% of the need falls on industrial lands and 7% on non-industrial lands. Considering private lands only, private industrial lands carry 76% of the cost burden, with the remaining 24% falling to private non-industrial lands. **Table 13** illustrates the estimated costs for implementing 25% and 50% of this assessed need across private lands.

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V

Strategic elements

Addressing wood utilization and contractor constraints

The assessment identifies over 446,000 acres in need of some type of fuel treatment. Contractor capacity is limited in Klamath and Lake Counties for this type of work. A proxy indicator of limited contractors, the current pace and scale of density reduction treatments in green forests on private industrial lands in the region is 2,500-7,000 acres. Cutting and decking burned timber for fuel reduction and mechanical site preparation will need this same workforce. Offering multi-year contract opportunities (e.g., Stewardship Contracts) for this type of work at competitive per-acre costs will help secure and develop the workforce needed.

Fuel treatments are needed across an estimated 85% of the areas in need of restoration treatments and account for 70% of the total costs. Utilization is a key challenge. If material cannot be removed and utilized but instead is burned, it becomes more difficult to leverage forests as a natural climate solution and meet carbon sequestration goals. This is likely to be a hurdle moving forward because there are limited mills in the area and few outlets for burned commercial timber and non-commercial biomass. The region could benefit from new capacity to utilize burned timber for some type of commercial product. Developing such market outlets in the region could help address some of the high costs involved with post-fire restoration. There are few markets and commercial-scale utilization technologies for such wood currently available. Private enterprise, government and philanthropy should work together to identify and support new burned wood utilization market opportunities in Klamath and Lake Counties. The Forest Service Wood Innovation Grants program is one of many possible avenues to support market development.

Increasing workforce capacity and coordination

Reforestation workforce capacity

Reforestation workforce capacity consideration for private lands

Private non-industrial forest owners are disadvantaged in several ways, largely given their small size. Accessing reforestation assistance (planning help, seedling orders, contractors, etc.) will be a challenge in this region. The Klamath-Lake Forest Health Partnership provides a unique collaborative forum for replicating the successful Private Forestlands Network (PFLN) from northeast Oregon.

PFLN is a nonprofit private landowner seedling cooperative in La Grande, Ore., that has been solving the seedling needs of non-industrial and industrial landowners for 30 years. An annual PFLN seedling order is coordinated by a state forestry employee who spends about 1.5 months of their time as the go between a nursery and the landowner cooperative. This individual also connects landowners to state Stewardship Foresters to help landowners fund, plan and implement activities. Seedling orders are 100% contracted for the nursery, but for the landowners in the network the order is 70% batched orders for members completing planned reforestation projects and 30% speculative orders anticipated to be needed by other PFLN members. The coordinator helps ensure that the right seedlings are ordered and matched to the appropriate seed zones and elevation bands and that seedlings go to planned projects that are ready for planting. The nonprofit cooperative has also secured grants to fund seed collections for storage at the state seedbank, and the cooperative also runs a centralized tree cooler.

Working with only the current reforestation staffing and contracting capacity of the northeast zone, the Fremont-Winema National Forest would require **10 years** to complete layout and **48 years** to plant the 144,000 acres of planting identified in the assessment.

Private industrial lands have significant experience with post-fire reforestation and early stand-establishment programs. Companies have developed efficiencies and relationships for seed and seedling acquisition that place them at an advantage relative to non-industrial owners. For instance, one year after the Bootleg and Cougar Peak fires, industrial forest owners have already planted hundreds of thousands of seedlings, with one owner operating six planting crews in the first planting season following Bootleg and Cougar Peak. Industry has also long invested in seed procurement, largely through the establishment of seed orchard cooperatives. Consequentially, tree seed is less of a bottleneck to reforestation for industry than it is for non-industrial forest owners and the Fremont-Winema National Forest, both of whom lack the seed supplies needed for a robust reforestation campaign.

Reforestation workforce capacity considerations for the Fremont-Winema National Forest

The Fremont-Winema National Forest's current reforestation program is in the northeast zone (Silverlake and Paisley Ranger Districts) and is focused on the Watson Creek and Brattain fires. The 242, Bootleg and Cougar Peak fires will require the other zones of the forest to grow their own reforestation capacity. The recent experience in the Paisley and Silver Lake Districts offer a glimpse into how capacity will need to grow across the forest. In general, it is not feasible for existing staff to accomplish both work on post-fire reforestation and the timber program (e.g., pre-commercial thinning and sale layout and administration). To advance both and restore this landscape, the forest needs to identify a different staffing model in combination with innovation to advance reforestation and fuel management staffing, planning and implementation models, as well as partnerships and technology.

Working with only the current reforestation staffing and contracting capacity of the northeast zone, the Fremont-Winema National Forest would require 10 years to complete layout and 48 years to plant the 144,000 acres of planting identified in the assessment. Ramping up reforestation workforce capacity to 15,000 acres by 2027 following the current staffing model — the ramp-up scenario the forest feels is realistic — would require an additional 67 new staff to address cone collection, reforestation and fuel management (**Appendix D**). If seed were not a constraint, the ~144,000 of planting could be accomplished by the end of 2034 under implementation Scenario 1. Additional staff and innovation will be required to address the REPLANT Act requirement to reforest by 2030 the ~144,000 acres identified in this strategy and plan and reforest the additional ~45,000 acres of backlog generated by other previous wildfires as well as areas that burn in the future. **The substantial ramp-up required to achieve the less ambitious implementation scenario highlights the challenges associated with staffing required to achieve the mandates of the REPLANT Act, which will require support from the Regional and Washington offices, innovation and the experimentation and learning approaches that will allow land managers to improve outcomes, exploit efficiencies and improve methodologies.**

Partnership is at the center of this post-fire strategy. Partners will be needed to grow post-fire reforestation capacity across all ownerships and for securing external funding for fuel management, reforestation treatments and monitoring.

Leveraging new and existing partnerships

This region is a partnership powerhouse, and this post-fire strategy can play to that strength. The community of partners can bounce back from the wildfires and begin to recover what has been lost, creating a more resilient landscape for the future. Opportunities to use partner organizations to meet the staffing and resources needs have already begun with American Forests' staff conducting field work on behalf of the Fremont-Winnema National Forest. However, the current scale of this partnership will not meet the full need. In addition to reforestation, an increase in the scale of partnership opportunities to include more shared staff and shared resources through development of a multi-state and multi-landowner, collaborative approach will be needed. American Forests is developing the Western State Seed Collaborative to ramp up seed collection collaboratively across all landownership types. Partnership is at the center of this post-fire strategy. Partners will be needed to grow post-fire reforestation capacity across all ownerships and for securing external funding for fuel management, reforestation treatments and monitoring.

The Klamath-Lake Forest Health Partnership has been a successful locally-led effort since the early 1990s — planning and implementing wildfire risk reduction and forest resilience work in an all-lands manner. The Lakeview Stewardship Group has also been a collaborative partner for the Fremont-Winema National Forest since the late 1990s. Likewise, the Klamath Tribes and other partners hold Stewardship Agreements to add capacity for national forests and implement components of the Accelerated Restoration and Priority Landscape Framework of the Fremont-Winema National Forest.[2]

All partners have successfully brought more funding and capacity for forest restoration and resilience treatments in Klamath and Lake Counties, securing at least $20 million in funding external to the base budget of the Fremont-Winema National Forest for work both on and off the forest (e.g., 100,000 acres of thinning treatments near Lakeview in recent years). This has included large successful grants from the Collaborative Forest Restoration Program, the U.S. Department of Agriculture Joint Chiefs' Restoration Partnership, Oregon Watershed Enhancement Board and state funding. Of course, none of this partner-driven forest resilience work would be possible without the region's industry partners. Collins Pine and Green Diamond milling infrastructure is the essential market outlet. Beyond those mentioned here, several other partners have also contributed funding and financial resources, knowledge, leadership and energy to advance the stewardship of this landscape.

Seed collection is another area of partnership potential across all landowners in the study area. Across Oregon and Washington, several cone/seed collection and genetic resource cooperatives exist in which land managers pool resources to collect seed. However, the geographic scope of many of these organizations does not include the counties and/or landowners discussed in this strategy. Given the seed limitations of the various landowners represented in this analysis, establishing some type of new all-lands cone collection effort will be necessary. As detailed in the seed section of this strategy, the strategy will need to engage new partners outside of this region to source seed from offsite sources that will be better suited in the future climate.

Advancing reforestation

Policy flexibility for reforestation

Policy context for private lands

The Oregon Forest Practices Act, associated rules (ORS 527.745) and rule (OAR 629-610-0000 et seq.)[3] mandate that private forest owners and state lands are reforested following the sale, barter or trade of timber if the number of remaining trees does not meet stocking standards. Post-harvest reforestation must be completed within two years of the date of harvest. Trees must be healthy and "free to grow" by the end of the fifth growing season, and the number of trees must meet minimum stocking standards (100-200 TPA, depending on site productivity class) unless a plan for alternate practice is filed with an Oregon Department of Forestry stewardship forester. Filing for a plan for alternate practice may be an option for landowners who are struggling to find appropriate seedlings or who wish to plant at a lower density.

Policy context on National Forest System lands

Reforestation on National Forest System lands is largely dictated by the National Forest Management Act of 1976 and subsequent amendments, including the REPLANT Act of 2021 as part of the Bipartisan Infrastructure Law. Policy related to the REPLANT Act is still under development. The REPLANT Act applies to reforestation following wildfires and other unplanned events. The Act requires the Forest Service to complete reforestation on areas affected by unplanned events prior to enactment by 2030 (NOTE: REPLANT Act states both 2030 and within 10 years of enactment).

Forest Service Manual (FSM) 2470 — Silvicultural Practices contains National Forest System policy relating to reforestation. This manual is currently being revised, and due to a determination of significance, forthcoming public notice and comment are required. The excerpts below are not under revision.

This strategy uses a geospatial approach to identify areas that may require reforestation and/or fuel treatments at a landscape scale, but site-specific diagnosis and prescription that comply with relevant regulations and direction, including NFMA, FSM 2470, Region 6 Regional Direction, the Fremont or Winema Land Management Plans, and the National Environmental Protection Act (NEPA). Relevant excerpts to this strategy are presented in **Appendix E**.

Regional priorities for post-disturbance reforestation

The highest priority for Region 6 is the re-establishment of disease-resistant five-needle pines (western white pine, sugar pine, whitebark pine) and Port-Orford-cedar that have been impacted by mortality from invasive disease. Their restoration is important for ecosystem function and resilience to disturbance and climate change. Additional priorities include the restoration of species where distribution has been reduced by past management and no natural seed source is available, as species diversity enhances ecosystem function and resilience to disturbance and climate change.

Where tree planting is needed for post-disturbance reforestation, and no salvage logging has occurred, the highest priority are Timber Suitable lands — those that are identified to produce regularly scheduled timber harvests and managed (i.e. previously regenerated) stands. Reforestation planning must consider the following:

- Careful examination of desired and minimum stocking levels applicable to post-disturbance reforestation is strongly suggested.
- For lands that are unsuitable for timber production, stocking levels must be set to meet the land management objectives for the area.
- Reforestation prescriptions for planting, natural regeneration and natural recovery should be developed in an interdisciplinary manner and aim to reduce disturbance risk by avoiding creation of large contiguous areas of similar age/density.

Strategic elements


JADE ELHARDT

Three options for the Forest Service in reforestation treatments

A Forest Service silviculturist is responsible for silvicultural prescriptions written to meet site-specific requirements. When a disturbance reduces a forest cover to an understocked or non-stocked condition (as measured against stocking rates in the Forest Plan), the Silviculturist makes an initial diagnosis to identify acres in need of reforestation treatment (i.e., planting or assisted natural regeneration) or acres identified for "natural recovery."

This assessment identifies: 1 areas prioritized for planting and 2 areas identified as candidates for natural regeneration. These areas may either be defined as areas for natural recovery or areas that could be scheduled for reforestation in the future. Field surveys will be used to ground-truth that the designations made in the spatial assessment are correct, and Forest Service field staff will make adjustments as necessary.

For areas selected for natural recovery, a Forest Service silviculturist identifies areas where natural processes will be relied upon for re-establishment of forest vegetation without any site preparation or other treatments. The selection of natural recovery depends on conditions such as slope, soil productivity and cost-benefit analysis associated with investments on these sites; local knowledge of site conditions; successional pathways; and management objectives. The recommendation must address monitoring and assessment of the recovery process which occur over longer timeframes than the reforestation or natural regeneration options. With natural recovery, if expected results are not achieved, follow-up reforestation treatments are to be prescribed. Areas designated for natural recovery due to low site productivity, erosion potential, slopes and other physical or ecological barriers need to be considered for land suitability re-classification in Forest Plan monitoring reports.

This strategy lays out a prioritization for planting-based reforestation, identifies where natural regeneration may occur and identifies areas where natural regeneration is unlikely but for which planting is a lower tier priority.

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Defining and setting goals for reforestation

The Core Team and the Klamath Tribes Natural Resources Department identified the following goals and associated tactics for fuel management in the post-fire landscape. The tactics list can be used in developing the region's post-fire reforestation programs. Government-to-government consultation must happen prior to implementation planning and on-the-ground activity.

GOALS	ASSOCIATED TACTICS
A Restore ecosystem services (e.g., wildlife habitat—such as mule deer winter range cover, watershed function and carbon sequestration) and meet management objectives.	• Reforest priority areas—high-productivity sites will sequester carbon and promote more rapid growth. • Restore riparian areas early on. • Identify aspen restoration sites and protect regenerating stands. Consider targeting protection activities in areas that will hold moisture longer (e.g., north facing aspects, higher elevations, near streams, etc.) • Prepare and plant high-priority reforestation area sites as soon as possible to allow for maintenance with prescribed fire ~15+ years after planting, when the trees are tall enough and at least 7 inches in diameter at breast height (DBH). • Ensure plantings are prepared for maintenance with prescribed fire, use herbicide application and/or mechanical treatments for maintenance every three to five years. • Use cost-effective tools to manage competing vegetation where fast forest establishment is a priority and cultural resources allow. Managing competing vegetation allows planted trees to grow more quickly than suppressed trees, which will facilitate the use of prescribed fire more quickly, versus waiting +30 years for trees to grow through brush and potentially killing trees when fire is used due to the understory brush. Once trees are tall enough, they will begin to shade out understory brush. • Design for wildlife permeability—some species prefer meadows and swales, whereas others prefer forest. • Protect and expand natural and living cultural resources of the Klamath Tribes (e.g., big game forage and cover, cultural plant communities, old growth, water capture and filtration). • Ensure trees are not, and are unable to become, dominant in meadows, swales or other areas dominated by herbaceous vegetation (sedges, rushes, grasses and/or forbs) with most supported by surface and/shallow ground water. • Reforest in watersheds with threatened and endangered aquatic species to address immediate and long-term risks of sedimentation. • Increase leaf area index through reforestation to appropriate level and spatial pattern to capture and retain more snow.

GOALS	ASSOCIATED TACTICS
B **Promote forest diversity in the post-fire landscape with appropriate levels of successional heterogeneity to help create a resilient uneven-aged forest structure that supports the restoration of fire as a key process and promotes resilience and adaptation to climate change.**	• Sequence reforestation treatments to achieve a multi-aged forest. • Create founder stands — small groups of trees planted in less fire-prone locations that can act as seed sources for surrounding areas (North et al. 2019) — across the landscape to create stand age and structural diversity. • Monitor founder stands to determine if inter-planting is desired. • Consider planting in an Individual Clumps and Openings (ICO) spatial pattern (i.e., areas with groups and clumps as well as planting individual trees in microsites).
C **Use climate-adapted reforestation at the planting unit scale.**	• Use burned trees on site to reduce erosion (contour felling) and create microsites for planting. • Use prescribed fire for site preparation and fuel management where possible. • Assist private non-industrial forest owners with applying for a plan for alternate practices to reforest at lower densities. • Source seed from a wider geographic area as guided by professional judgement and climate consideration. New transfer guidelines are being developed, and the Seedlot Selection Tool (St.Clair et al. 2022) may provide additional guidance. • Maintain planting units with a combination of pre-commercial thinning, pruning, selective herbicide application and hand grubbing around individual trees to manage understory vegetation in the next three to 15 years post planting. • Shift to a maintenance routine using prescribed fire in planting units and managed wildfire at smaller and larger scales in the next 10-15 years post planting. • Prioritize planting areas that do not overlap with priority locations for maintenance burns in the next 10-15 years. • Consider reforesting via seeding in suitable sites where seed limitation is not an issue.
D **Balance conifer re-establishment with wildlife needs.**	• Maintain ungulate winter range as early successional habitat rather than maturing conifer forest. The wildfires created new opportunities for forage for deer and elk. Future departure analyses can help identify which seral stages may be in deficit or surplus. • Promote appropriate tree species and densities within meadows and in transition zones — i.e., the gradual rise away from meadows where larger trees, large stumps or large downed logs may be present, using 30- to 40-foot elevational gain as a proxy. Plant at low densities (one to three TPA) in transition zones.

GOALS	ASSOCIATED TACTICS
E **Work at the right scale, and integrate fuel management and reforestation.**	Within a Forest Service implementation unit: • Years 1-2: Remove danger trees and conduct any mechanical fuel treatments required — if site conditions (i.e., soils and slope) allow for this; • Years 2-4: Prepare site via prescribed burn, herbicide application or additional mechanical treatment, depending on jurisdictional priorities; • Year 5: Plant; • Year ~20: Prescribe fire to promote and maintain resilience in year 20. Repeat prescribed fire every ~15 years following, depending on conifer forest or ecosystem type and associated fire-return interval. • Coordinate timing and treatment (reforestation, fuels) of implementation units and areas that span public and private lands.
F **Encourage post-fire aspen regeneration.**	• Do not plant conifers in areas where aspen are regenerating, and monitor regeneration closely. Planted conifers likely will outcompete aspen. Do not plant within 50-150 feet around existing aspen clones (defined as five or more trees at least 5 feet in height), 50 feet from last sucker, or 150 feet from last tree. • Protect aspen regeneration (e.g., with fencing and/or jackstraw). Emphasize protection in ungulate winter range where sprouts are at greater risk of herbivory. • Do not allow lodgepole to re-encroach in regenerating aspen stands. • Monitor where stands are being browsed or consumed. • Monitor aspen seeding due to large fires. After a big fire, there may be new aspen stands established by seeding, facilitating climate adaptation. Newly seeded aspen stands should be protected.
G **Restore riparian vegetation.**	• Review priority riparian restoration areas identified by the Klamath Tribes, specifically those tied into water capture, filtration and yield. • Prioritize riparian restoration and/or mandate annual assessment or acre restored in recognition of the importance of this habitat type for Endangered Species Act-listed fish species downstream, biodiversity, ecological processes, natural fuel breaks and wildlife species of conservation concern.

Strategic elements

Climate-adapted reforestation

Climate-smart reforestation actions aim to create resilient and adaptable forests, specifically addressing the risks of climate change to forests. Reforestation approaches that consider and incorporate expected changes to forest structure, composition and function may be better suited to long-term sustainability than those managed without a critical evaluation of priorities, goals and likelihood of long-term success. Approaches can range from planting more diverse native species to removing invasive species that compete with regenerating seedlings, planting trees at lower densities to accommodate for increased drought stress, and changing spatial patterns to promote landscape-scale heterogeneity. It is important to acknowledge that these approaches are in their infancy; many uncertainties still exist around expected outcomes and variability, as well as best practices. Each of the following components should be approached from an adaptive-management framework that allows comparison between climate-smart and traditional approaches, as well as use of bet-hedging approaches where appropriate. Restoration across these broad-scale landscapes is an opportunity to assess outcomes and learn how we can better respond to future large wildfire events in the era of climate change. Climate-smart principles come into this strategy at primarily three scales:

1. **Landscape scale:** This assessment and prioritization integrates variables like aspect, soil productivity and climate water deficit—attempting to locate sites where trees are most likely to survive in the future.

2. **Site and/or project scale:** This scale uses the Seedlot Selection Tool (St.Clair et al. 2022) to locate desirable seed sources, plant at lower densities and is willing to accept lower stocking or try an ICO planting design, using site-preparation techniques that promote robust tree growth so that prescribed fire can be reintroduced sooner.

3. **Temporal scale:** This is a multi-decadal restoration strategy that hinges on monitoring and adaptive management over time, including areas of possible natural regeneration or natural recovery, and areas of modelled forest-type transition (Mote, P. et al. 2014, Halofsky et al. 2019). This strategy is proceeding in tandem with a large west-coast-wide assisted migration trials study. The concept of "planting across time" was also introduced by the Core Team and the Klamath Tribes Natural Resources Department, whereby reforestation efforts will need to take advantage of climate windows to collect seed or to plant during favorable conditions.

Reforestation challenges and barriers

- Planting windows in Klamath and Lake Counties usually last four to six weeks in the spring. Land managers should investigate fall planting opportunities to spread the planting workload over multiple seasons and increase the total number of days during which weather and soil conditions are favorable for planting. This should include monitoring to assess success by season and stock type, as well as discussion with nursery managers to coordinate seeding container demands associated with fall planting. Plantings should be planned across at least three consecutive years to maintain momentum across bad years.

- Labor availability is maxed out for both planting crews and nursery capacity. Planning over longer time scales and communicating early and often with contractors will signal long-term demand but will require unprecedented flexibility with respect to timing. Willingness to try new approaches to staffing, planning and planting will benefit outcomes over the long term, and failures at small scales should be viewed as learning opportunities. Lessons learned should be shared widely.

Planting unit and site-scale considerations

- Mitigate, to an extent, some of the effects of dry sites by prioritizing planting in deep soils, along with other prioritization schemes outlined in this report (e.g., MWD/Climatic Water Deficit, Heat Load Index). Managers should test seed that comes from drier areas and adhere to strict micrositing requirements, using artificial shade where necessary.

- Plant sensitive species, like white fir, into stands on north aspects.

- Pay attention to ongoing vegetation transitions. For example, do not replant in juniper-sage habitat type where Ponderosa has encroached down slope over time.

- Think long term (e.g., seedling survival vs. long-term tree survival in a hotter/drier climate).

- Plant seedling stock (species, genetics, stock type) adapted to drier conditions than a site has experienced historically—for example, plant xeric pine stock on north-facing slopes that historically might have supported mesic forests.

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- Consider snow melt timing when planning reforestation activities. Total snowpack and snow water equivalent are not the same as timing of melt and may not provide adequate information for planning climate-adapted projects.

- Lower planting density to reduce the need for follow up treatments like pre-commercial thinning.

- Clump where trees facilitate one another through hydraulic lift and share resources.

Planting density

Considering climate change and silvicultural objectives, an assessment of the literature on planting densities for this region suggests that planting densities should be determined on a site-by-site basis. Considerations for the site-planting density will include the ability to conduct follow up density-management treatments (e.g., pre-commercial thinning), the carrying capacity of the site and the operational need to reintroduce large-scale prescribed fire as quickly as possible. Forest managers on the Core Team and the Klamath Tribes Natural Resources Department suggested avoiding planting at densities that would be high enough to warrant pre-commercial thinning. Planting densities should be prescribed based on site-specific characteristics, but lower planting densities than have been used

TERRANCE REIMER / AMERICAN FORESTS

historically should be considered across the landscape, especially on less productive sites with dry sandy soils. Due to the scale of reforestation need in the area, it is likely that prescriptions will, on occasion, not succeed as planned. This could be due to abnormal weather events or misinterpretation of site quality and result in planting 125 TPA with only 40 TPA surviving the first few growing seasons. These should not be treated as failures, rather they should be used as learning experiences and investigated to determine what could be done better in the future. Each ownership has rules and stocking standards related to reforestation that may require additional flexibility to accommodate acceptance of lower stocked areas. Non-industrial landowners may require assistance with preparing a plan for alternate practice under the Oregon Forest Practices Act to plant below minimum stocking densities.

Spatial pattern of planting

Climate-smart reforestation practices in dry forest ecosystems of the Pacific Coast aim to create fire-resilient forests largely by focusing on promoting a spatial patterning comprised of the individual trees, clumps of trees and open areas (ICO) approach. The ICO approach has more recently been studied (North et al. 2019) and is being practiced in reforestation programs in the Sierra Nevada Mountains and elsewhere. ICO plantings are intended to promote heterogeneous stand structure that mimics natural regeneration pattern and prepare forests to better persist under fire, drought and other disturbances (e.g., insects, disease). Clumps of trees may allow for use of prescribed fire and facilitate hydraulic lift as trees work together to access limited water resources. However, it can be difficult for planters to implement an ICO-style planting design in practice, or desired outcomes may not align with ICO plantings. Each landowner should be intentional about their desired tree density and spacing. Even-spaced planting should be avoided on Forest Service land to meet the treaty resource needs of the Klamath Tribes.

Findings from research by North et al. (2019) suggest zoning reforestation projects into three areas: "1 the areas adjacent to green trees where natural recruitment is likely; 2 the zone further out where the dispersal constraint ensures that natural regeneration will range from zero to sparse; and 3 a zone which lumps all stands that might otherwise be in the second category but are too costly to plant for reasons of remoteness or topography." Large-scale planting in the third zone may prove cost prohibitive, and managers may instead focus resources toward establishing founder stands — planted stands from which new, naturally-regenerated stands can begin via natural seed dispersal (North et al. 2019) based on site-specific prescriptions (e.g., Roadless Areas, Wild and Scenic Rivers, adjacent to Wilderness Areas, within and adjacent to private industrial lands). Inaccessible areas due to remoteness or steep topography are rare across this landscape, but other constraints such as soils may be considered for this third category. This approach is being practiced in tropical areas but less so in temperate North America. In fire-prone landscapes, founder stands must be protected from reburns; this can be done by locating founder stands in areas likely to be persistent fire refugia (Meddens et al. 2018), such as in comparably moist areas and in and around topographical features. Reducing competition and fuels around founder stands is also required to protect long-term re-establishment.

Invasive species

Invasive plants present additional challenges. In addition to causing loss of native habitat, native species and biodiversity, invasive species have wide-ranging effects on disturbance dynamics. Wildfire, particularly high-severity wildfire, can facilitate the spread of invasive grasses into previously forested areas. Once established, invasives compete with regenerating conifers and other native species for moisture, limiting forest recovery and reducing the biodiversity of native species across the landscape (Reilly et al. 2020). In addition to the negative effects of direct competition with native species, invasive grasses can impact fire regimes (Fusco et al. 2019, Kerns et al. 2020). Invasive grasses alter the spatial distribution of fuels on the landscape, making fuels more contiguous, and they tend to be more flammable than natives and dry out earlier in the year. This results in a positive feedback loop that can increase fire frequency, severity and spread (D'Antonio and Vitousek 1992). As a result, mitigating invasive species is key to post-fire restoration and the successful introduction of large-scale prescribed fire.

Early implementation of the Early Detection and Rapid Response (Reaser et al. 2020) framework to minimize the impacts of invasives on ecosystem structure and function and cultural interests, as well as support landowner-specific objectives and requirements (e.g., USDA Forest Service 2005). Early detection and action can increase the efficacy of eradication and control efforts, as well as make these efforts more cost effective (Leung et al. 2002).

Additionally, the impact of prescribed fire on the occurrence and spread of invasive species should be considered on a site-specific basis. Prescribed fire can create suitable conditions for the spread and growth of invasives, and their presence on the landscape may affect burn outcomes. The effects of prescribed fire on invasives and vice versa should be considered target learning outcomes to better understand their interaction and potential impacts of climate change.

Seeding with native grasses and other methods can proactively prevent the establishment and spread of invasive species while simultaneously helping support reforestation efforts.

- McDonald (1986) reported that *"Grasses are not desirable in conifer plantations less than five years old, but after five years, they can aid conifer seedling growth by physically and chemically excluding more competitive vegetation. In plantations over 5 years old on good sites with deep soils, grasses can be beneficial by excluding deeper rooted shrubs. On poor sites with shallow soils, grasses and shrubs often compete throughout the profile and no benefit accrues to conifer seedlings by converting to grasses."*
- Several climate scenarios suggest that grasslands could be the most suitable vegetation type for many parts of the study area. Steps could be taken to test or speed up this transition by establishing desirable grass species, rather than cheatgrass (Gornish and Shaw 2017). However, monitoring will be needed to determine whether seeded native grasses persist in treated areas over the long term (Busby and Southworth 2014).
- Native bunchgrasses are desirable and can carry a low-intensity underburn more effectively than woody shrubs. Once planted trees are taller than 3-6 feet, and especially if the lower whorls have been pruned, the hazard from burning grass is reduced.

> "Invasive plants will likely present a significant challenge in coming years. *Ventenata dubia* is established in the area, and the fire is likely to facilitate its spread. We were told by [a District Ranger], that invasive plants establish themselves slowly after a fire, but expand rapidly three to five years after the fire." —CORE TEAM MEMBER

Competing vegetation

The importance of managing competition

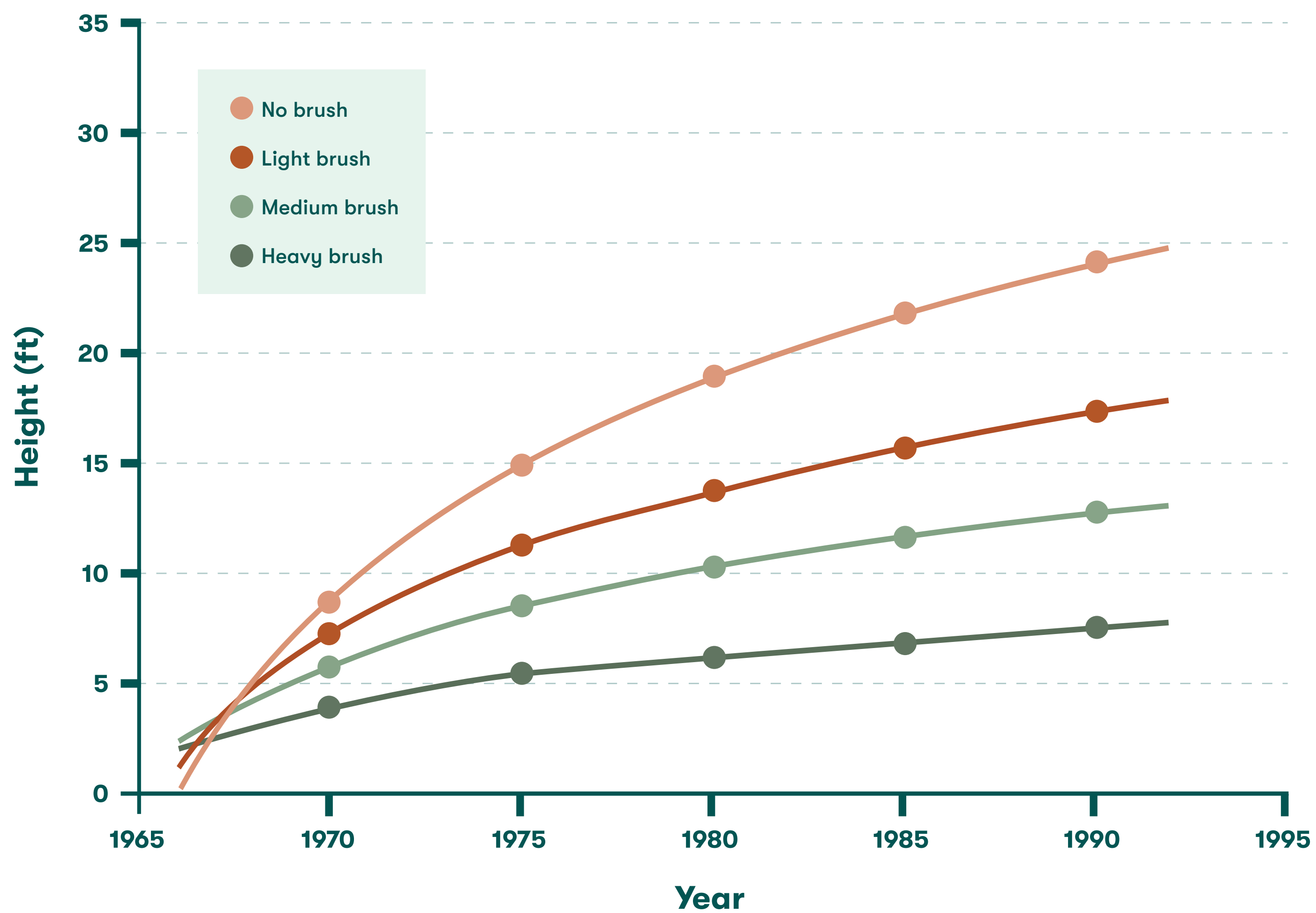
Managing competing vegetation is key to promoting fast seedling growth and quickly developing fire-resilient forests, as well as maintaining fuels in reforested areas and fuel breaks (Zhang et al. 2013). This is not to say that shrubs and other early successional vegetation types are not desirable across the landscape; certain shrub species are important cultural resources and comprise key components of important vegetation communities. However, shrubs outcompete regenerating conifers for water, nutrients and light, thereby significantly reducing tree survival and growth. After 25 years, planted trees can be more than 15 feet taller in areas treated to remove shrub competition than in untreated areas (**Figure 11**) (McDonald and Fiddler 1989). In areas where quick establishment of mature trees is a priority, a general goal is to reduce shrub cover to below 30% to minimize competition and maximize tree growth. Further, areas that experienced high-severity wildfire with high shrub and snag density are more prone to reburning at high severity, promoting a cycle that facilitates transitions to non-forested communities (Coppoletta et al. 2016). Lastly, research suggests that managing competing vegetation can benefit understory plant communities, with increased native plant species richness in areas where shrubs have been effectively managed that can persist for over 40 years since the last wildfire (Bohlman et al. 2016). Although seedlings may eventually overtop and shade out the shrub layer, decreasing the time required before canopy closure can have profound effects on fire resistance, seed production and mature/old growth forest structures.

Most of the research relating to competing vegetation — and its impacts on seedling survival, seedling growth and native understory plant richness — is based upon traditional even-spaced plantings with timber production being a primary objective. As the region implements more non-uniform (i.e., ICO) planting prescriptions, monitoring and research designed to better understand the relationship between competing vegetation and success of these prescriptions will be necessary. Increasing tree-growth rates is critical for the development of fire resistance, earlier seed production (resilience) and mature/old growth forest structures. Competing vegetation captures water and nutrients needed by young trees, which causes decreased root expansion, poor growth and, in many instances, mortality. Even if the seedling survives, these early losses in growth are seldom made up.

Management of competing vegetation across much of the post-fire landscape will be key to reforestation and fuel break success. Approaching this challenge at such a large scale requires evaluation of the tradeoffs resulting from the methods chosen to reduce competing vegetation, because choices will impact cost and ecological outcomes drastically. Openness to different and innovative methodologies may mean the difference between large-scale vs. localized success.

Figure 10

The relationship between height and brush. As brush density increases, growth decreases (*Figure 9, (McDonald and Fiddler 1989)*).



“ … it goes back to survival versus growth. We’re not looking just for survival — where trees are barely hanging in there and competing with shrubs — because we have quite a bit of that on our forest. What we’re looking for is survival and good growth, and that good growth is what is going to get that tree to the point where it can develop on its own, start forming a canopy and start controlling the shrubs, and then it’d be off on its way to being a forest. I think on some sites, selective herbicide application is going to be key to overall reforestation success.”

— CORE TEAM MEMBER

Goals for managing competing vegetation:

- Manage shrubs and other competing vegetation in a manner that supports forest recovery, maintains a shrub presence across the landscape and promotes diverse native understory vegetation.
- Establish climate-viable forests in areas identified within the strategy by managing competing vegetation — primarily non-native invasive grasses and native shrubs — to improve survival and early growth of planted tree seedlings, as well as native grasses and forbs.
- Reduce undesirable flammable vegetation within fuel breaks and build a bridge to wider use of prescribed fire on the landscape over time.

Strategic elements

Methods for managing competing vegetation

Careful planning and evaluation are necessary to ensure that plans are cost effective and consistent with land management objectives, desired duration of vegetation management and desired outcomes for all partners and stakeholders. Additionally, the scope and scale of the need across the landscape must be considered when determining implementation plans. Competing vegetation can be managed through a variety of methods, some of which that may be particularly relevant to this landscape are discussed below. It is worth noting that many of these options are appropriate for site preparation as well.

Herbicides

Herbicides remain the most efficient and cost-effective (not considering potential permitting requirements) method for reducing competing vegetation and fuels over the long term, but social barriers to application remain high in many areas. Where herbicides cannot be used, costs may be so high that reforestation may be unaffordable, and no-herbicide treatment options are two to five times more expensive and lead to growth rates one-fourth as fast as early herbicide application (Oester and Fitzgerald 2016).

Herbicides are most important at stand origination and initiation stages, as a precursor and near-term bridge to large-scale use of prescribed fire. Tree growth following herbicide application is significantly greater, allowing much quicker use of prescribed fire. A typical project envisioned in this plan would be to establish a stand in high-productivity areas, get it growing vigorously and then from about 10-15 years on maintain it with repeated use of prescribed fire.

Herbicide choice and application methods should be determined at the project level by site-specific analysis during the environmental permitting process and will include monitoring and enforcement plans. The collective comfort level with using herbicides, and agreement on the effectiveness of safeguards, will be a significant determinant of how many acres can be successfully reforested at this key window in time. That said, climate-viable reforestation requires cost-effective management of competing vegetation, and many land managers find herbicides to be the most efficient use of limited resources.

Other reports provide detailed technical guidance for managing competing vegetation in the region, including:

- Oester, P.T., 2000. **Enhancing reforestation success in the inland northwest.** This publication provides an in-depth look at various vegetation management methods, such as scalping, mulch mats and herbicides, including the costs and effectiveness of each treatment.
- David C. Powell. 2017. **Competing vegetation analysis for southern portion of Tower Fire area.** This white paper examines options for managing competing vegetation in the context of a large fire scar in Northeastern Oregon. It provides a detailed literature review on the effectiveness of various vegetation management treatments, risks and safety measures for herbicides, and as well as monitoring protocols.
- Emmingham, W.H., Oester, P.T., Fitzgerald, S.A., Filip, G.M. and Edge, W.D., 2005. **Ecology and management of eastern Oregon forests: a comprehensive manual for forest managers.** See "Chapter 6 – Reforestation methods and vegetation control features."

Non-chemical management options

A variety of non-chemical management options for competing vegetation exist. Here we cover some that may play a role in vegetation management moving forward.

PRESCRIBED GRAZING

- Grazing, typically by goats, is a socially accepted form of site preparation and maintenance and should be considered when herbicides are not an option. Goats are an effective tool for treating small acreages. Goats are not a preferred treatment option in areas with non-native invasive species.
- Grazing for shrub management becomes much more difficult when shrubs get too tall to be reached by the animal. Goats do not remove shrub root systems so treatments must be repeated regularly (approx. every two years). Grazing may be more effective for managing shrubs if conducted during the growing season. Multiple cycles of return grazing (~10 years) may be able to exhaust shrubs' underground root stores, weakening them and allowing grasses and/or conifers and hardwoods to dominate. Grazing treatments could also make future herbicide applications more effective.
- Grazing *after* planting conifers is not recommended as a maintenance treatment since grazers will likely browse on the planted trees. Goats will eat conifer seedlings, especially in the spring. It is ideal to wait until young trees are 8-10 feet in height.
- Goats should be kept off very sensitive soils as they can create erosion.

The cost of grazing includes the goats, portable fencing, a goat herder for daily supervision, water and transportation. On the Cleveland National Forest in Southern California, about 1,400 goats were used to reduce surface fuels on an existing 100-acre fuel break. The goats were contained inside a portable electric fence, surrounding 2 or 3 acres, and moved every few days. Costs ranged from $400 to $500 per acre. Based on this example, 1,400 goats can reduce surface fuels on 100 acres per month (0.0024 acres, or 100 square feet of brush, per goat per day) (Kendrix 2017).

Climate-viable reforestation requires **cost-effective** management of competing vegetation, and many land managers find **herbicides** to be the most efficient use of limited resources.

Goats can effectively manage shrub growth in certain situations, but should not be used after seedlings are planted to avoid damage to seedings.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PRESCRIBED AND CULTURAL FIRE

- Prescribed burning (i.e., broadcast burning) has been used as a site-preparation tool prior to planting across the western U.S. It can be effective at reducing fuel loading and altering soil nutrient loading to encourage growth of planted conifers. In drier sites it has historically been used to encourage natural regeneration of serotinous species.
- Traditional site-preparation broadcast burns were primarily aimed at reducing slash loading following bole-only harvesting.
- Broadcast burning as a site-preparation tool in the studied landscape could result in increased prevalence of invasive species following burning which may require additional site-preparation treatments to reduce competition with planted conifers.
- Cultural fire can be used to target competing vegetation surrounding planted and natural conifers. This method should be explored and effects monitored.
- Fire does have the potential to remove understory vegetation and prime the landscape for the establishment and growth of invasive species. Care should be taken in areas at high risk of invasion or with a history of invasives (D'Antonio and Vitousek 1992).

HAND GRUBBING

- Hand grubbing removes shrubs and other undesired vegetation manually using shovels, hoes and other tools. First application generally occurs after seedlings have been planted. The goal is to remove root systems, and as such it is prudent to implement in late spring after vegetation has greened up.
- Treatments are generally reapplied every two to four years to ensure efficacy, but site-specific characteristics should be considered prior to each implementation to ensure cost efficiency and use of labor.

MULCH MATS AND WEED BARRIERS

- Mulch mats prevent shrubs from resprouting and increase soil moisture. This option is expensive and labor intensive but can be effective. Mats may be well suited to small-scale founder plantings, in conjunction with defensive handlines.
- Mats have been used successfully in large-scale reforestation projects. For example, the Fremont-Winema National Forest has used 36-by-36-inch mulch mats on the Paisley District, and California State Parks used 12-by-12-foot mats extensively in planting projects after the 2003 Cedar Fire in Southern California. Mats can be doubled up and/or combined with weed barriers.

Risk management

If applied improperly or indiscriminately, herbicide use can endanger ecosystem health by removing rare or desired native plant species. Every landowner in this partnership must minimize these risks and downsides by following existing regulations and, where feasible, implementing extra safeguards voluntarily. A typical Forest Service herbicide application and permit includes 34 separate mitigation measures designed to protect human health, water quality, sensitive plants, wildlife and soils.

Other recommendations made by the Core Team in the context of competing vegetation and herbicides were:

- Only treat where it is necessary. This prioritization and planning process is a foundation for selective herbicide application. Environmental analysis and implementation of herbicide use must be focused and situational (e.g., analyzing herbicide application for specific situations vs. blanket authority to spray anywhere).
- Herbicides can be beneficial for native grasses and forbs, not just tree seedlings. Managers should choose herbicides for specific shrub species and which will not harm native grass and forbs. Studies suggest there is greater understory diversity with herbicide use, which is supported by the Core Team's field observations across the region. Instead of a continual shrub field, herbicides can help to achieve a mosaic of shrub and native grasses and forbs.
- Maintain vegetation diversity at every scale. Leave gap selection areas (e.g., shrub recruitment islands, for management as shrub habitat) and/or untreated 'leave islands' of shrubs. In areas where shrub cover is maintained, thinning can be important to create space two times the height of retained shrubs to meet fuel management goals in these areas.

Addressing seed supply constraints and seed transfer guidance

The Fremont-Winema National Forest is barely meeting their seed needs. There is a very active cone collection program, but, even before the fires, it only scratches the surface of the forest's needs.

Seed supplies

The last large cone collection on the Fremont-Winema was 35 years ago. The forest's current seed inventory could plant ~70,000 acres (**Table 15**). Most seed is wild collected by tree climbers (i.e., not from seed orchards and requiring specialized labor), and the seed orchard infrastructure on private lands in the area is virtually non-existent. A dedicated cone collection workforce for systematically monitoring crops in this region and potential seed transfer regions (discussed in next section), and organizing collections across landowners, has been recommended by members of the Core Team and the Klamath Tribes Natural Resources Department.

The Fremont-Winema National Forest is still fortunate to have 11 seed orchards that cover a variety of species, including Ponderosa, sugar, western white and lodgepole pines, as well as an additional 52 sites — including evaluation plantations, mass selection plantations and seed production areas — that should be leveraged for seed collection. Evaluation plantations and seed production areas recently started to be managed for future collections. All orchards and stands have fuel breaks and have been thinned. Developing new and supporting existing orchard and collection sites will be key to addressing the seed need across the region, especially with climate change. New orchards should have irrigation infrastructure. Existing seed orchards must be maintained and protected from future fires as a top priority.

Another key recommendation is to broaden sharing and cooperation around collections. The Oregon Department of Forestry can help to involve private lands, and the Forest Service should engage with state and private landowners as a member and leader of collaborative seed collection efforts.

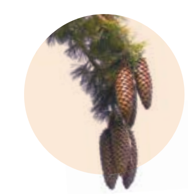
Species	Total balance (lbs.)	Median germination (%)	Seedlings expected (No.)
 **Incense cedar** (Libocedrus decurrens)	30	26	78,554
 **Whitebark pine** (Pinus albicaulis)	112	21	52,410
 **Lodgepole pine** (Pinus contorta)	89	93	4,341,762
 **Sugar pine** (Pinus lambertiana)	201	64	219,399
 **Western white pine** (Pinus monticola)	17	72	183,692
 **Ponderosa pine** (Pinus ponderosa)	1,757	88	8,933,367
 **Doulas-fir** (Pseudotsuga menzeisii)	5	92	100,425
TOTAL	**2,211**	**512**	**13,909,610**

Table 15

Current seed inventory on the Fremont-Winema National Forest. Total balance includes collections across all breeding zones and does not consider the area in need of planting within each zone. In total, this inventory could plant ~70,000 acres of land across the Fremont-Winema National Forest.

Strategic elements

Seed transfer

Any reforestation activities that plan to use transferred seed should target the following outcomes:

- Introduce genetics that will lead to more healthy forests that can deal with future climates.
- Achieve higher seedling survival.
- Facilitate faster growth so seedlings can produce fire resistance and hardiness and establish mature/old forest cover sooner.
- Lessen the need for ongoing interventions/care/treatments/investments.

With the rapid pace of climate change, trees in the study area may not be adapted to the current climate, much less the climate expected over the coming century.

Based on provenance studies and climate projections from nearby regions, a decline in tree volume or productivity of approximately 25% using on-site seed could be expected (Knapp et al. 2017). This could mean, for example, that the growth and development one would normally expect to see in a 50-year-old stand of Ponderosa pine grown from local seed may now take over six years to achieve. Traditionally one could expect Ponderosa seedlings to be able to survive an underburn by age 15, but, going forward, using on-site seed may mean that it will take seedlings nearly 20 years to develop this same level of resistance.

This stark projected decline in adaptation, theoretical though it may be, means as many seed options as possible should be proactively investigated and tested. The Core Team and the Klamath Tribes Natural Resources Department recommend testing a bet hedging strategy by mixing in seed from current seedlots and elevations with off-site seed from places identified in climate modelling. This highlights a bet-hedging strategy that calls for use of both local and putatively climate-adapted seed sources. Further, this should be prescribed based on site-specific characteristics by an appropriate specialist. Careful monitoring of reforestation outcomes by seedlot and other relevant variables will help to inform how climate change will impact reforestation and ecological outcomes across the landscape. This is consistent with the learning by doing approach identified as a goal by Core Team members and the Klamath Tribes Natural Resources Department. Further, transitioning seed collection data requirements to include GPS coordinates for wild-collected seed will allow for better modeling and outcome tracking to ensure inferences from any learning activity or other research are consistent with how activities are implemented on the ground.

Even with increased cone collection capacity, the Fremont-Winema National Forest may need to look beyond a breeding zone to acquire sufficient seed or to implement climate-smart reforestation activities. The R6 regional geneticist and Southwest Oregon area geneticist are developing guidelines for selecting alternative seed sources appropriate for current and future climates using the Seedlot Selection Tool (St.Clair et al. 2022), which identifies potential seed collection locations with climates like current and expected future conditions at a given planting location. “Climate analog” areas may be good places to collect future-adapted seed that produce seedlings with improved growth rates, or at least a less-pronounced decline, relative to on-site seed sources. The areas may also help to identify species, forest types and forestry plans and techniques that may be well suited to future conditions. Transfer rules may vary by specific species based on phenotypic plasticity.

Planting genotypes from these seed zones could help increase genetic diversity and adaptive capacity of local seed sources in the region through cross pollination. Additional work will determine locations within proposed transfer zones for cone production potential, ensuring that areas targeted for collection have not been impacted by wildfire, pests or pathogens.

Their approach proposes selecting seed from appropriate locations within three regional pools:

1. Historical Fremont-Winema National Forest breeding zones
2. Select Oregon National Forests (e.g., Deschutes, Ochoco)
3. Select National Forest lands in Region 5 (e.g., Modoc, Klamath)

Enhanced wild collections and maintenance of seed orchards will need to be a bi-regional priority. American Forests’ Western States Seed Collaborative is one model for how to support this need.

An example of seed source movement includes the managers on the Fremont-Winema who have become comfortable with moving seed uphill 1,000 feet when seed- and site-specific analysis suggests that uphill seed movement is warranted. This has partially been out of necessity to make use of available seed lots as seed supplies dwindle. Private industrial operations have also been moving seed beyond typical transfer guidelines.

The recommendations here are part of a new, experimental approach to deal with rapid shifts in climate and mega disturbances, acknowledging that there is substantial uncertainty surrounding what seedlots will be suitable in future conditions. While using off-site seed might prove beneficial to project-specific outcomes, it can also produce poor results if not well suited for current or future site conditions, resulting in low tree survival and growth over the short and long term. This could manifest itself as plantings failing at the seedling stage, or after several decades, sometimes necessitating costly removal of stands to avoid damaging local genetics. This was the historical rationale for existing seed transfer guidelines. Considering this, the plan may limit off-site seed tests to areas of the national forest that are buffered from private industrial lands and any other landowners that are uncertain of this approach.

It often takes decades to tell how well seed sources truly perform. Monitoring will be especially important in areas where seeds are being moved beyond typical transfer guidelines and may be of use in helping to update transfer guidelines based on best available and more recent data. This data is scarce on operational projects, and data collection for these purposes should be considered during project planning phases. Standard monitoring protocol for plantings will not capture the necessary information. Engaging geneticists, U.S. Department of Agriculture Research Stations and universities will be key for these long-term studies. Operational provenance tests administered by regional geneticists are already underway in tandem with broader silvicultural adaptation trials, with implementation scheduled for 2024 and 2025. A key component of this strategy will be establishing ongoing trials across the burned landscape.

JESSE ROOS / AMERICAN FORESTS

Reducing fuels in the post-fire landscape

Goals for fuel management

The assessment within this strategy shows that fire behavior across the six focal fires was mainly high severity; 66% of the impacted area burned at high severity (>75% BA mortality). Fuel management activities and their prioritization will vary according to the burn severity, pre-fire stand density and how dense shrubs and fine fuels return. While the recent wildfires in Klamath and Lake Counties have reduced fuel loading, the fires also killed trees of all sizes and ages. Over the next 5-20 years, areas that experienced high-severity fire are expected to come back as dense shrub fields with significant volumes of dead wood as snags and downed woody material. Such conditions facilitate repeated high-severity burns (Hurteau and Brooks 2011, Coppoletta et al. 2016, Lydersen et al. 2019) and can, under certain conditions, delay or preclude forest recovery (Coop et al. 2020). Risks of regeneration failure type conversion are likely higher in these transitional, low-elevation forests (Stevens-Rumann and Morgan 2019). Climate change is making the risk of these outcomes more likely in the absence of fuel management and reforestation interventions after the primary burn (Meyer et al. 2021, Larson et al. 2022).

Due to the massive scale of need, it will be virtually impossible to treat all areas in need of fuel reduction. This strategy is designed to address areas of greatest priority for fuel reduction. The prioritization contained herein is based on burn severity and pre-fire BA metrics. Within the first 10 years of implementing the strategy, the validity of this prioritization approach needs to be ground-truthed and adjustments made as necessary. This is one component of the strategy's adaptive management framework.

The strategy is designed to facilitate hazard tree removal, fuel reduction and reforestation treatments in a manner that promotes landscape heterogeneity and a return of desired ecological processes (e.g., snow capture and retention and frequent low-intensity surface fires). Core Team members and the Klamath Tribes Natural Resources Department expressed that all fuel management tools should be considered and evaluated for their cost effectiveness and tradeoffs. Recognizing and embracing the role of fire as an ecological process, the Core Team and the Klamath Tribes Natural Resources Department expressed a clear desire for increasing the use of prescribed fire as a maintenance tool, while also acknowledging that mechanical treatment or hand treatments are likely needed in most places prior to use of prescribed fire. Core Team members want to return fire to this landscape on their own terms if possible.

The recent wildfires provide a case example where restoration thinning, coupled with the reintroduction of prescribed fire, resulted in a forest more resilient to wildfire, a proven forest resilience technique in this region and other parts of the western U.S. (Prichard et al. 2021). Core Team members and the Klamath Tribes Natural Resources Department toured an area of the Bootleg Fire that burned through over 10,000 acres of recent green forest treatment. While a quantitative fire effects analysis is still being conducted, early qualitative assessment suggests that thinning alone proved far less resilient than areas that had been thinned and underburned with prescribed fire (**Figure 11**).

STEVE RONDEAU / KLAMATH TRIBES

Figure 11

Restoration thinning units marked by the Klamath Tribes and subsequently treated with prescribed fire by the Forest Service are a striking visual symbol of successful partnership.

Fuel management

The Core Team identified the following goals and associated tactics for fuel management in the post-fire landscape. The tactics list can be used in developing the region's post-fire management programs.

GOALS	ASSOCIATED TACTICS
A **Maintain areas where wildfire did beneficial work towards achieving resilience objectives (e.g., low-severity ground fire, fire improved stocking density, fire killed conifers in meadow complexes, fire helped regenerate aspen and killed competing conifers).**	• Aim for moving conifer stands to a targeted BA and density appropriate for a given forest type and desired current and future conditions of the land manager in areas seeing low- to moderate-fire severity. • Maintain these stands using prescribed fire in the future, re-entering stands every 5-10 years.
B **Protect naturally regenerating areas and investments in restoring upland forests and special habitats.**	• Prioritize fuel reduction treatments within high-severity patches in and around planting units and founder stands; in and around aspen stands; in and around meadow complexes and riparian areas, recreation sites and infrastructure; and within fuel breaks. • Thin areas with high volumes of standing dead trees, if feasible, in areas where natural regeneration may occur. Deprioritize mechanical fuel treatments if there are relatively low levels of standing and down dead trees. • Allow natural regeneration to occur and grow to a point where it will not be killed with prescribed fire—the preferred long-term maintenance tool for such areas. • Re-enter stands with prescribed fire every 5-10 years.
C **Protect remnant green islands within the burned landscape. These areas are a seed source of the future and represent the only commercially viable stands across large areas.**	• Thin these stands to reduce risk of crown fire. • Prioritize fuel and snag density reduction in areas adjacent to green islands. • Maintain these stands using prescribed fire in the future, re-entering such stands every 5-10 years.
D **Reduce the risk of high-severity reburns in moderate- and high-severity patches.**	• Prioritize fuel treatments in units with heavy fuel loading (i.e., over-abundance of standing and down dead trees); reduce density of 100-1,000-hour fuels within units targeted for prescribed fire maintenance and/or reforestation treatments. • Maintain these stands using prescribed fire in the future, re-entering such stands every 5-10 years. • Maintain deadwood according to guidance offered in this strategy or Land Resource Management Plan Standards.

GOALS	ASSOCIATED TACTICS
E **Reduce the risk of fire from moving from public land to private land.**	• Prioritize cross-boundary treatments in advantageous areas.
F **Increase opportunities for fire to help install resilience in the regenerating forest—either through prescribed fire or increased opportunities for managing future wildfires for resource benefit.**	• Complete prioritized mechanical fuel treatments largely within 3,000-5,000-acre implementation units. • Create several 3,000-5,000-acre implementation units as the target scale for prescribed fire within the wildfire footprints on public lands, and to the extent feasible on private lands. • Consider prescribed fire treatment as a site-preparation tool in reforestation units.
G **Scale the prescribed burn program on the Fremont-Winema National Forest from burning 10,000-15,000 acres annually to 100,000 acres annually.**	• Create several 3,000-5,000-acre implementation units as the target scale for prescribed fire within the wildfire footprints on public lands, and to the extent feasible on private lands. • Consider prescribed fire treatment as a site-preparation tool in reforestation units. • Examine opportunities to integrate prescribed burns in the black forest into the green forest. • Work collaboratively across governments and with non-governmental organizations to scale up the prescribed fire workforce during the narrow prescribed burn windows (mid- to late-April through the end of May and October into early November). • Re-enter an area with prescribed fire at least every 10 years, if not earlier. • Plan and work with the Klamath Tribes and partners to implement cultural burns to maintain resilience and vegetation composition of meadow complexes, transition areas and other plant community habitat types of cultural significance. • Use prescribed fire in meadow complexes to reduce lodgepole pine encroachment and restore ecosystem processes.
H **Recognize that use of prescribed fire may not be realistic for all landownerships in the short term.**	• Consider mechanical treatments on private lands where use of prescribe fire is not likely an option until legal liability and capacity issues are addressed. Consider grazing management plans in relation to landscape-level fuel management plans given how important grazing is for private non-industrial landowners.
I **Learn by doing**	• Design projects with a monitoring component to track and improve outcomes over time, as adaptive management was highlighted as a core tenant of this plan. • Develop a standard protocol for all fire-affected areas, though specific outcomes from monitoring may differ by landowner objectives.

Guidance on dead wood removal and retention

As a disturbance mechanism, wildfires often create a large pulse of dead wood. Snags and down woody material (DWM) play essential roles in forest ecosystems, but when this material is excessive across large areas, it can fuel intense wildfires in the future.

Managers should evaluate individual units and determine snag removal and retention needs, balancing worker and public safety and fuel mitigation with wildlife habitat, soil health, old growth, larger diameter snags (>20 inches), cultural relevance and other ecosystem service provisioning. From a fuel management perspective, large snags are preferred to smaller ones, and they also provide wildlife habitat for a longer period (Saab et al. 2007, Nemens et al. 2019). Both safety and ecological needs should be considered when developing retention plans.

Areas particularly dense with smaller diameter snags (<9 inches DBH) should be prioritized for snag removal where simple felling is likely to exceed recommended retention guidance for downed woody material. This is prioritized for areas likely to pose a direct risk to people and reforestation investments and where an abundance of fuels would contribute to more intense reburns. Across all stand types (i.e., DBH classes and density), managers will need to decide how many snags to retain. Snags left in clumps, as opposed to scattered individual snags, are preferred by wildlife and reduce the area of safety concern (Dunn et al. 2019, Nemens et al. 2019).

There are several estimation methods to help managers balance management targets for fuel reduction and ecosystem service provision. Two metrics for retention of deadwood are percent ground cover of DWM and the number of larger snags per acre. Reference points for these metrics include:

- **Retain DWM across 1%-3% ground cover** in mixed conifer forests in the east Cascades with DWM that is **>5 inches in diameter** on the small end (Forest Stewards Guild, 2013).
- **Leave 5-10 tons per acre of DWM <9 inches on the small end and leave 10 pieces per acre of DWM >12 inches on the small end and > 8 feet in length** (Fremont and Winema Land Management Plans). On the Tool Box and Barry Point Fires, woodpecker analysis allowed treatments with specific leave areas for key woodpecker species (e.g., Lewis, Black-backed, White-headed).
- **Leave at least two snags >10 inches DBH per acre** in eastside mixed conifer green forests, with a range of **2-14 snags per acre** being found in unmanaged green east Cascades forests (Forest Stewards Guild, 2013). Snags >9 inches DBH are particularly important for cavity nesting birds (Saab et al. 2007).

U.S. FISH AND WILDLIFE SERVICE NORTHEAST REGION / WIKIMEDIA COMMONS


JADE ELHARDT

Strategic elements

Installing and maintaining fuel breaks

Defining and setting goals for fuel breaks

Fuel breaks are linear features within a forest landscape featuring a comparably lower density of vegetation and fuels than the surrounding landscape. When wildfires are stopped at fuel breaks, it is largely because the breaks facilitated fire management activities, providing firefighters safe access to engage the fire and opportunities to set backburns (Syphard et al. 2011a, 2011b). In other words, fuel breaks are unlikely to stop fires passively; firefighter presence is key to controlling fires at fuel breaks. During extreme weather, fuel breaks will be largely ineffective because of dangerous firefighting conditions and higher probability of spotting ahead of the fire front. This was the lived experience with the Bootleg fire.

> "Strategic fuel breaks will be the skeleton upon [which] the whole strategy will stand." — CORE TEAM MEMBER

Fuel breaks did not contain the Bootleg or Cougar Peak fires, and they are unlikely to do so for other large, intense and fast-moving wildfires in the future. In Bootleg, spot fires from ember throw went well past control lines. While fuel breaks did not contain the fire, suppression efforts were able to use fuel breaks to conduct nighttime burn-out operations.

Prior to the recent set of wildfires, the Fremont-Winema National Forest mapped a network of PODs and potential control lines (PCLs) as places where fuel breaks should be maintained or created. In this landscape, the majority of existing or potential fuel breaks are identified in these POD boundaries and/or PCLs. These lines exist along roads and natural features such as rocky areas or meadow complexes. POD boundaries will need to be re-evaluated based on altered fuel conditions post-fire.

The Core Team coalesced around the idea that installing new or improving existing strategic fuel breaks in the post-fire landscape should be an early and important investment of the strategy. As one Core Team Member put it, "*strategic fuel breaks will be the skeleton upon [which] the whole strategy will stand.*" Maintenance of fuel breaks will be a constant program of work in this landscape, centering on brush maintenance every few years using herbicide application, prescribed fire or mechanical treatments, with mechanical treatments being the most expensive option. The Core Team also recognized that there are multiple objectives for fuel breaks and different definitions of fuel breaks within the strategy — varying in terms of width, vegetative composition and objectives.

Project-specific goals and tactics for fuels

- On the Fremont-Winema National Forest, a common fuel break design in the post-fire landscape will be a **500-foot-wide section on both sides of a road**. Up to 3,000-acre fuel breaks can be implemented in the near term as a 1,000-foot-wide break (500 feet on either side of a road) using a categorical exclusion. If green trees are present, the Fremont-Winema National Forest targets **at least 50 feet of spacing between trees** with trees averaging >16 inches DBH. Such trees may be pruned so that the distance from the ground to the first limb is increased. Cross-boundary fuel breaks may look similar and require collaborative planning and execution between public and private land managers.
  - **Larger and wider breaks along mainline roads will serve the dual purposes of providing safety corridors (i.e., ingress and egress during wildfires for suppression efforts and limiting wildfires from making large runs). Such breaks can either be outright cleared of trees, planted at low densities or created by thinning existing trees.**
  - **Smaller breaks can exist within the network of larger POD boundary breaks adjacent to mainline roads. Smaller fuel breaks branching off the larger fuel breaks are designed as smaller PODs in which fuel reduction, prescribed fire and planting projects can occur.**
- The effect of a fuel break may be extended beyond the 500-foot-break by **progressively decreasing planting densities** as distance to fuel break decreases.
- Fuel breaks can be integrated into the landscape and managed in a way that offers **summer forage for deer and elk** — increasing wildlife permeability throughout the landscape.
- Natural breaks can also be maintained for low fuel loading — **removing encroaching conifers from meadows, wetlands and aspen stands** while creating low-density conifer stands in the transition areas directly adjacent to these natural fuel breaks — serving dual habitat and ecosystem service benefits (e.g., improving snow capture and groundwater recharge).

NATIONAL INTERAGENCY FIRE CENTER / FLICKR

Strategic elements

While fuel breaks are an important component of this integrated strategy, the Core Team and the Klamath Tribes Natural Resources Department envision the end objective of this strategy being the creation of a post-fire landscape that ***is the fuel break***.

Such a landscape features a heterogeneous fabric of low-density regenerated upland conifer forests existing within a network of verdant meadow and wetland complexes, stream corridors, and aspen stands, creating a resilient forest landscape that facilitates the return of frequent low-intensity surface fire as the dominant fire pattern.

With this vision in mind and consensus on the need for a network of fuel breaks, the Core Team outlined specific goals and associated tactics for fuel breaks to set this landscape on a trajectory toward resilience.

GOALS	ASSOCIATED TACTICS
A Reduce likeliness of crown fire spread in the future forest.	• Create gaps in canopy structure. • Restore and maintain natural fuel breaks and transitions to upland forest. • Create an architecture in the short-term (~10-20 years) on which fuel reduction and planting units can be planned and implemented. • Integrate implementation units and PODs.
B Create more fire-resilient, post-fire forest structure and composition.	• Design fuel breaks to account for future wildfire behavior and frequency based on +90% fire conditions and burn severity under future climate regimes (i.e., worst case scenarios), if possible.
C Create a more fire-ready landscape and help limited future fires from making large, severe, fast-moving runs through the forest.	• Create a network of fuel breaks that is landscape focused in that it integrates topographical features and elevation gradient. • Collaborate to refine the existing POD analysis to integrate post-fire conditions, integrating fuel breaks across boundary lines and on private lands.
D Increase opportunities for managing wildfire for resource benefit.	• Plan fuel breaks to integrate with landscape vegetation and fuel management objectives such that less preparation work is needed for planning and executing prescribe burns or making the call with regards to managing wildfire for resource benefit. • Prepare site and plant areas as soon as possible, if fuel breaks are deemed to coincide with a reforestation opportunity, to allow for these areas to be maintained with prescribed fire ~15 years after planting when those trees are tall enough and at least 7 inches DBH. • Consider herbicide application and mechanical treatments, in advance of planted fuel breaks being ready for maintenance with prescribed fire, for the primary maintenance approach every three to five years. Use of herbicides or other techniques to control competing vegetation allows planted trees to grow much more quickly than suppressed trees, which will facilitate the use of prescribed fire much more quickly, versus waiting +30 years for suppressed trees to grow up through brush fields and then potentially killing these trees when fire is used due to the brush understory. Once the trees can get tall enough, they will shade out some of the brush component.
E Protect private lands by reducing risk of undesirable fire moving from federal land to private land. This is no small order as the region's largest private landowner shares 1,200 miles of property with the national forest.	• Collaborate to refine the existing POD analysis to integrate post-fire conditions, integrating fuel breaks across boundary lines and on private lands. • Provide private landowners financial and technical assistance when applying for a plan for alternative practice under the Oregon Forest Practices Act to allow for low-density plantings or no planting at all, within fuel breaks. • Acknowledge that while an area may be identified as a strategic fuel break on private lands, not all landowners will want them.
F Protect investments such as reforestation treatments.	• Conduct fuel-reduction and reforestation treatments in a way that an increasing density of planted trees and residual dead wood is more acceptable as the distance from a POD boundary increases.
G Provide safe access for future fire suppression activities.	• Create corridors of low snag density connecting fuel breaks, planting units and units prioritized for receiving fuel-reduction treatments only.
H Aid future suppression efforts.	• Create a map of maintained fuel breaks across all lands to give incoming incident management teams and firefighters a clear picture of where suppression efforts are most likely to have greatest success.
I Create opportunities for permeability for wildlife and plants and other ecosystem functions on the landscape.	• Design and maintain fuel breaks in ways that provide forage for big game and habitat niches for a diverse array of wildlife.

ELIZABETH PANSING / AMERICAN FORESTS

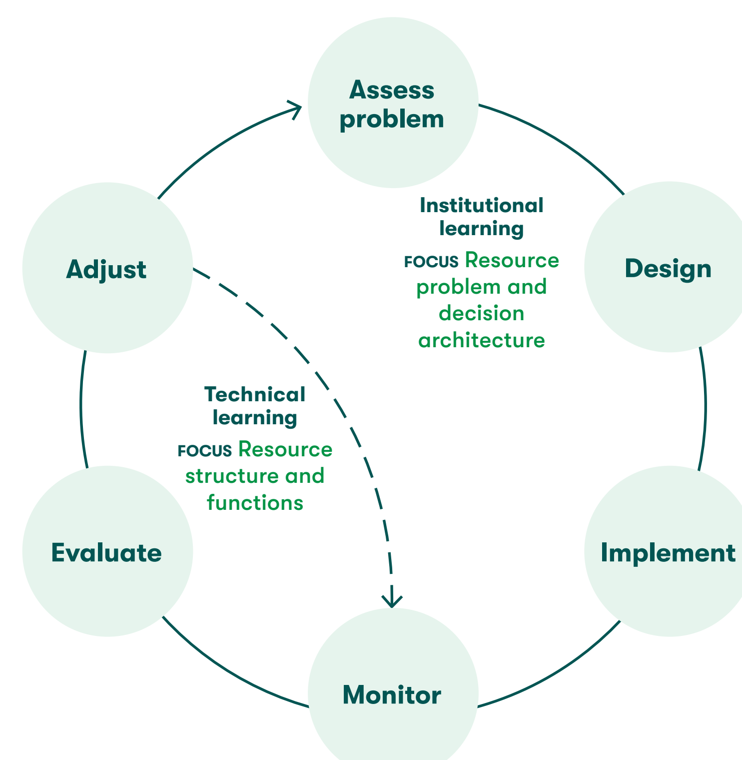
Monitoring

Monitoring should be a component of any post-fire plan, and its importance is heightened in a rapidly changing environment.

As more severe wildfires ravage the West and climate change shifts community boundaries and impedes post fire recovery, the ability to respond to changing on-the-ground conditions is key to successfully adapting our forests to climate change and maintaining fire-resilient forests (Lynch et al. 2022, Schuurman et al. 2022). Monitoring allows land managers to learn from management activities and respond intentionally to what is learned, increasing the probability that objectives are achieved and ensuring efficient use of limited funds, materials and workforce capacity. During the era of climate change, conditions suitable for tree regeneration are shifting, and broad-scale community reorganization is occurring. As a result, outcomes of historical practices are not guaranteed, and changes to historical practices may be necessary to ensure long-term success. A goal for this strategy is to use adaptive management (learning by doing) and climate-adapted forestry to plan for and respond to the impacts of climate change (**Figure 12**).

Figure 12

The adaptive management framework figure from Williams and Brown (2018).



A strong commitment to monitoring exists throughout the focal region of the strategy. The Lakeview Stewardship Group (LSG) forest collaborative has monitored restoration outcomes within the Lakeview Federal Yield Unit since 1988. The Lakeview Collaborative Forest Landscape Restoration (CFLR) Project Monitoring Plan was released in 2015, and the Klamath-Lake Forest Health Partnership (KLFHP) All-Lands Monitoring Plan was released in 2021, after LSG and KLFHP joined forces, expanding the overall reach of the collaborative's restoration and monitoring footprint. The Klamath Basin Monitoring Program, a collaborative group including tribes, NGOs, and state and federal government agencies, has actively monitored water quality throughout the Klamath Basin since 2006. The Klamath Tribes are also in the process of developing their own post-fire monitoring protocol. These existing efforts provide a solid foundation for focal post-fire monitoring efforts to ensure long-term ecosystem restoration.

The broader landscape will require monitoring efforts to assess whether restoration goals are being met, unforeseen outcomes are emerging and if changes are necessary to align on-the-ground-conditions with outcomes or modify approaches to meet those conditions. Successful monitoring will require that specific questions and objectives are defined. Monitoring approaches should be long term in nature and occur at specified temporal benchmarks. Cross-jurisdictional consistency of protocols should be ensured to address landscape-scale questions and recovery. Protocols should define baseline post-fire conditions and assess over time the effects of management activities on community structure and composition, fuel loading, fire potential, and plant species abundance and diversity. Careful consideration of monitoring objectives and sound statistical design will help ensure monitoring outcomes are relevant to the goals of the strategy, that inference is sound, and any modifications to the strategy or on the ground activities improve outcomes and avoid unintended consequences. Expansion and integration of existing monitoring protocols may provide opportunities to support ongoing initiatives and long-term restoration goals.

Strategic elements

The Core Team and the Klamath Tribes Natural Resources Department identified the following **components of particular interest** to include in any monitoring protocol. Further refinement of monitoring priorities, questions and methodologies, including the potential use of developing technologies, will be required.

Natural regeneration/ recovery

Determine whether areas left unplanted in favor of recovery via natural regeneration are at risk of vegetation type conversion because of regeneration failure, are recovering as expected and whether desired stocking conditions are likely to be realized. This information can help inform whether planting efforts may be desirable to help achieve long-term goals and determine if precommercial thinning is necessary to improve fire resiliency and achieve other stated objectives.

Develop temporal benchmarks to determine whether vegetation type conversion is likely to occur and a framework of options to respond.

Include all areas identified as natural regeneration opportunity in the strategy as well as areas that burned with 25%-50% BA mortality.

Planting

Assess seedling survival, species composition, densities and natural vs. planted seedlings. Information can help determine whether desired stocking conditions are likely or if infilling or density reduction are required; whether appropriate species composition exists; and whether methodologies used to assess planting needs were adequate or require revision. This information can help assess the efficacy of climate-smart reforestation methodologies and provide insights into how a changing climate is impacting management activities and outcomes.

Develop temporal benchmarks to determine whether vegetation type conversion is likely to occur and a framework of options to respond.

Track outcomes where seed movement has occurred in a manner that allows for differentiation between seed sources in areas where seed lots have been mixed.

Invasive species

Determine the distribution and rate of spread of invasive species, and whether management activities are associated. Understanding spread of invasives can help develop management activities to mitigate ecosystem impacts and provide insight into future consequences of spread (e.g., increased fire severity if cheatgrass becomes a problem in fuel breaks). These may focus on dispersal corridors such as roads.

Integrate Early Detection and Rapid Response (EDRR) framework into monitoring protocols to support early action (Reaser et al. 2020).

Natural recovery in Wilderness, Wild and Scenic River and Roadless Areas

Develop site-specific activities in line with management plans. These areas (e.g., Wilderness Areas, Wild and Scenic Rivers, Roadless Areas) are at high risk of vegetation type conversion because these areas largely burned at high severity and some restoration activities are precluded.

Gather data on the natural recovery of these areas will provide valuable insight into the consequences of specific management decisions across the focal fire scars.

Monitor for invasive species in a manner that supports the EDRR framework.

Ecotones

Monitor ecotonal areas closely for signs of vegetation transitions. This includes lower treeline ecotones to determine whether seedling survival is decreasing over time and the ecotone between Ponderosa and subalpine forest types for evidence that Ponderosa is moving up in elevation. Within all ecotones, understory vegetation should be monitored to assess community composition to detect changes in species composition or relative abundance.

Green tree monitoring

PROGRESSIVE MORTALITY

Track additional mortality in areas burned at moderate severity (25%-75% BA mortality) to ensure stocking densities are within desired range for ecological benefit and management goals.

STAND STRUCTURE AND DENSITY

Assess whether remaining patches of green trees have desired stand structure characteristics.

Determine whether reintroduction of prescribed fire is warranted or if additional management activities are needed.

Strategic elements

Watershed health

Consider the impacts of sedimentation, runoff timing, nutrients, erosion and turbidity on watershed health and desired restoration outcomes.

Collaborate with the Klamath Basin Monitoring Program.

Wildlife health and habitat use

Assess wildlife habitat and use across the post-fire landscape to ensure that species of management interest and cultural value are recovering as expected.

Prescribed fire readiness and impacts

Determine when stands are ready to receive prescribed fire.

Monitor the impacts of prescribed fire on vegetation structure and composition as well as fuel loads.

Landscape-scale metrics

Track distribution and landscape proportion within each successional class (or departure class) using Terrestrial Condition Assessment.

Conduct departure analyses once every five years to ensure that restoration activities are having desired landscape-scale effects and that successional and disturbance classes are adequately represented.

Stand structure

Determine whether species composition, relative abundance and densities are consistent with desired outcomes.

Aspen regeneration and browse

Track aspen regeneration and recruitment of overstory trees in known stands and the consequences of browse on stand health and survival.

Post-fire forest conversion and vegetation shifts

Monitor for signs of vegetation transition (e.g., forest loss or community composition shifts) to ensure stocking densities are within desired range for ecological benefit and management goals.

U.S. FOREST SERVICE PACIFIC NORTHWEST REGION / FLICKR

VI

Implementation timeline

1 **2022-2025**
Install demonstration and adaptive implementation units.

2 **2022-2024**
Plan priority cross-boundary fuel and fuel break projects. Re-evaluate POD boundaries considering altered fuel conditions post-fire.

3 **2022-2023**
Fuels staff on the Fremont-Winema National Forest work with each District and, as appropriate, adjacent landowners to advance the fuel breaks priority mapping in this strategy; planning when and where individual breaks will be installed and/or maintained — and what type of break will be used to meet resource objectives (e.g., using fuel breaks to prep an area for prescribed fire).

4 **2022-2032**
Install and begin regular fuel maintenance within fuel breaks with herbicides, mechanical treatments or prescribed fire as feasible. Need to be retreated approximately every 10 years depending on site productivity.

5 **2022-2032**
In high-severity Category 3 areas, mechanical treatments and hand piling will be the focus of fuels and site preparation in the first 10 years, while prescribed fire will likely be a useful tool in these areas as carrier fuels return, but herbicide application will likely also be necessary.

6 **2022-2027**
Evaluate fuel management options within priority planting units. Prioritize treatment of "excessive fuels" so that the funding and work meets multiple benefits.

7 **2022-2032**
Ground-truth prioritization of units for fuel reduction treatments and adjust the prioritization as necessary.

8 **2022-2032**
Continue site-prep, planting and maintenance treatments within planting units in the Watson Creek and Brattain fires.

9 **2022-2027**
Conduct planting on industrial lands within the Bootleg Cougar Peak and Patton Meadow perimeters and initiate maintenance treatments where appropriate.

10 **2025-2035**
On public lands, complete first cycle of establishing founder stands of varying sizes within the 242, Bootleg and Cougar Peak fire perimeters. Along fuel breaks, one of the advantages for reforestation is that it provides safe access to the units, and there could be planting in a fuel break. Prioritize planting areas that were not also identifying as areas that we may want to maintenance burn in the next 10-15 years: Restoration Category 6, completed management units.

11 **2022-2027**
Prescribe appropriate site-preparation and fuel reduction treatments for each priority planting unit across all six wildfire perimeters (e.g., harvest, grapple skid, pile and burn; mastication; fall dead trees and retain as coarse woody debris; buffer planting units with perimeter low-density shaded fuel breaks; herbicide application; site preparation with prescribed fire followed by planting). The strategy prioritizes high-severity burn patches with significant volumes of residual fuels.

12 **2022-2030**
Prescribe appropriate fuel reduction treatments for areas identified as priorities for fuel management without planting (e.g., harvest, grapple skid, pile and burn; mastication; fall dead trees and retain as coarse woody debris; prescribed fire). Mechanical treatment will be the initial focus prior to carrier fuels returning. The strategy prioritizes high-severity burn patches with significant volumes of residual fuels, especially around recreation sites, infrastructure, natural regeneration (e.g., aspen) and/or founder stands.

13 **2022-No end date**
Target assistance funding for mechanical fuel reduction with non-industrial private forest owners to those areas seeing 25% to 75% BA mortality.

14 **2022-No end date**
Collect seed for the reforestation effort.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Appendix

A Restoration assessment

Interactive maps and additional assessment information are **available online here**.

B Restoration cost by ownership

Cost estimates

Table B1

Cost estimates for various restoration activities considered throughout the strategy and their sources.

	Category	Source	Additional detail on practice	Cost/ acre	Notes
REFORESTATION	**Reforestation** (Planting)	**USFS Region 6**	**Total average reforestation costs on national forests in R6**	**$700**	
			Seedlings	**$105**	Approx. 15% of cost of planting-based reforestation
			Site preparation	**$203**	Approx. 29% of cost of planting-based reforestation
			Planting labor	**$350**	Approx. 50% of cost of planting-based reforestation
			Project overhead	**$42**	Approx. 6% of cost of planting-based reforestation is Forest Service contract administration/ surveys — stocking and survival, post fire assessment/analysis
		Private forest land mangers in Northern California	**California non-industrial full post-fire total costs (low)**	**$3,500**	
			California non-industrial full post-fire total costs (high)	**$5,000**	
			Non-industrial (based on Collins estimate)	**$1,436**	
			Industrial full post-fire total costs (low)	**$1,200**	
			Industrial full post-fire total costs (high)	**$1,500**	
		Forest Service	**Herbicide site prep — backpack (low)**	**$240**	Efficacy 1-10 years
			Herbicide site prep — backpack (high)	**$340**	Efficacy 1-10 years
	Reforestation (Planting contract)	**Fremont-Winema NF**	**Fremont-Winema NF (2022)**	**$129**	

Table B1 (continued)

	Category	Source	Additional detail on practice	Cost/ acre	Notes
REFORESTATION	**Reforestation** (Rodent control)	Fremont Winema NF	Fremont-Winema NF (2022)	$100	
	Reforestation (Planting contract + chemical site prep + seedlings + rodent control + project admin/oversight)	Fremont Winema NF	Fremont-Winema NF (2022)	$716	
	Reforestation (Natural regeneration)	USFS Region 6	Site prep for natural regeneration on national forests in R6	$300	
			Certification of natural regeneration on national forests in R6	$30	
FUEL REDUCTION	**Fuel reduction** (Cut + skid + deck + burn)	Oregon Department of Forestry	Private non-industrial land (low)	$500	
			Private non-industrial land (high)	$750	
		Forest Service	California national forests (low)	$1,500	
			California national forests (high)	$2,000	
		Fremont-Winema NF	Fremont-Winema NF (2022) (low)	$900	
			Fremont-Winema NF (2022) (high)	$1,100	
	Fuel reduction (Mechanical site prep, danger tree removal, fuel reduction)	Fremont-Winema NF	Fremont-Winema NF (2022)	$1,100	
	Fuel reduction (Mastication)	Private forestry consultants	NorCal (private lands)	$600	
		Oregon Department of Forestry	2022 Klamath-Lake (low)	$700	
			2023 Klamath-Lake (high)	$900	
	Fuel reduction	California Reforestation Strategy	low	$300	
			high	$900	
OTHER	**Post-planting maintenance**	Forest Service	Herbicide release spray (low)	$300	Efficacy 2-+10 years
			Herbicide release spray (high)	$370	Efficacy 2-+10 years
			Hand grubbing (low)	$400	Efficacy 1 year
			Hand grubbing (high)	$900	Efficacy 1 year
	Seed collection	California Reforestation Strategy	Northern California national forests (low)	$70	
			Northern California national forests (high)	$90	
	Rehabilitating fire lines (miles)	Private forest land managers	per mile	$15,000	
	Roadside hazard	Private forest land managers	per mile	$20,000	

National Forest System lands

Table B2

Summary of estimated post-fire strategy costs for the Fremont-Winema National Forest broken down by district.

**Note: N.E. represents costs that were not estimated.*

Restoration category	Ranger district	Acres of treatment	Fuel treatment cost estimate	Reforestation cost estimate	Additional restoration action cost estimate	TOTAL
Planting with fuel treatments	Bly	54,305	$59,736,000	$38,014,000	$0	$97,750,000
	Chiloquin	29,061	$31,967,000	$20,343,000	$0	$52,310,000
	Lakeview	22,997	$25,297,000	$16,098,000	$0	$41,395,000
	Paisley	33,905	$37,296,000	$23,734,000	$0	$61,030,000
	Silver Lake	476	$524,000	$333,000	$0	$857,000
Planting with no fuel treatments	Bly	159	$0	$111,000	$0	$111,000
	Chiloquin	85	$0	$60,000	$0	$60,000
	Lakeview	848	$0	$594,000	$0	$594,000
	Paisley	2,277	$0	$1,594,000	$0	$1,594,000
	Silver Lake	4	$0	$3,000	$0	$3,000
Natural regeneration with fuel treatments	Bly	3,622	$3,984,000	$1,195,000	$0	$5,179,000
	Chiloquin	2,022	$2,224,000	$667,000	$0	$2,891,000
	Lakeview	1,415	$1,557,000	$467,000	$0	$2,024,000
	Paisley	4,087	$4,496,000	$1,349,000	$0	$5,845,000
	Silver Lake	66	$73,000	$22,000	$0	$95,000
Natural regeneration with no fuel treatments	Bly	54	$0	$18,000	$0	$18,000
	Chiloquin	17	$0	$6,000	$0	$6,000
	Lakeview	45	$0	$15,000	$0	$15,000
	Paisley	314	$0	$104,000	$0	$104,000
	Silver Lake	1	$0	$0	$0	$0
Fuel treatments only	Bly	9,986	$10,985,000	$0	$0	$10,985,000
	Chiloquin	5,862	$6,448,000	$0	$0	$6,448,000
	Lakeview	3,956	$4,352,000	$0	$0	$4,352,000
	Paisley	19,485	$21,434,000	$0	$0	$21,434,000
	Silver Lake	19	$21,000	$0	$0	$21,000
Maintenance treatments (prescribed fire within 10 years)	Bly	1,930	$0	$0	$1,158,000	$1,158,000
	Chiloquin	398	$0	$0	$239,000	$239,000
	Lakeview	644	$0	$0	$386,000	$386,000
	Paisley	4,168	$0	$0	$2,501,000	$2,501,000
	Silver Lake	71	$0	$0	$43,000	$43,000
Meadow restoration including removal of encroaching conifers	Bly	9,986	$10,985,000	$0	N.E.	$10,985,000
	Chiloquin	5,862	$6,448,000	$0	N.E.	$6,448,000
	Lakeview	3,956	$4,352,000	$0	N.E.	$4,352,000
	Paisley	19,485	$21,434,000	$0	N.E	$21,434,000
	Silver Lake	19	$21,000	$0	N.E	$21,000
Meadow restoration not likely to include removal of encroaching conifers	Bly	6,949	$0	$0	N.E.	$0
	Chiloquin	2,421	$0	$0	N.E.	$0
	Lakeview	706	$0	$0	N.E.	$0
	Paisley	19,208	$0	$0	N.E.	$0
	Silver Lake	7	$0	$0	N.E.	$0
Fuel breaks	Bly	158.5	$2,378,000	$0	$0	$2,378,000
	Chiloquin	49.9	$749,000	$0	$0	$749,000
	Lakeview	57	$855,000	$0	$0	$855,000
	Paisley	172.5	$2,588,000	$0	$0	$2,588,000
	Silver Lake	0.9	$14,000	$0	$0	$14,000
TOTAL		270,878	$260,218,000	$104,727,000	$4,327,000	$369,272,000

Table B3

Summary of total estimated post-fire strategy costs across private industrial forestland.

Note *N.E. represents costs that were not estimated.*

Restoration category	Acres of treatment	Mechanical site preparation and/ or fuel treatment cost estimate	Reforestation cost estimate	Additional restoration action cost estimate	TOTAL
Planting with fuel treatment	71,669	$43,001,000	$46,513,000	$0	$89,514,000
Planting without fuel treatment	1,338	$0	$868,000	$0	$868,000
Natural regeneration with fuel treatments	5,976	$3,586,000	$0	$0	$3,586,000
Natural regeneration without fuel treatments	187	$0	$0	$0	$0
Fuel treatments only	67,507	$50,630,000	$0	$0	$50,630,000
Maintenance treatments (prescribed fire within 10 years)	5,777	$0	$0	$3,466,000	$3,466,000
Meadow restoration including removal of encroaching conifers	723	$723,000	$0	N.E.	$723,000
Meadow restoration not likely to include removal of encroaching conifers	1,078	$0	$0	N.E.	$0
Fuel breaks	116 miles	$0	$0	$1,740,000	$1,740,000
TOTAL	154,255	$97,940,000	$47,381,000	$ 5,206,000	$150,527,000

Private non-industrial forest lands

Table B4

Summary of total estimated post-fire strategy costs across private non-industrial forestland.

Note *N.E. represents costs that were not estimated.*

Restoration category	Acres of treatment	Mechanical site prep and/ or fuel treatment cost	Reforestation cost	TOTAL
Planting with fuel treatment	12,284	$9,213,000	$17,644,000	$26,857,000
Planting without fuel treatment	621	$-	$892,000	$892,000
Natural regeneration with fuel treatments	1,640	$1,230,000	$0	$1,230,000
Natural regeneration without fuel treatments	145	$0	$0	$0
Fuel treatments only	17,801	$13,351,000	$0	$13,351,000
Maintenance treatments (prescribed fire within 10 years)	19,661	$0	$0	$0
Meadow restoration including removal of encroaching conifers	3,818	$3,818,000	N.E.	$3,818,000
Meadow restoration not likely to include removal of encroaching conifers	17,563	$0	N.E.	$0
Fuel breaks	32 miles		$480,000	$480,000
TOTAL	73,533	$27,612,000	$19,016,000	$46,628,000

C National Forest System implementation strategy

Table C1

Implementation unit priorities. Implementation units are shown by priority rank, which was estimated based on the sum of high- and moderate-priority reforestation acres within each implementation unit. The higher number of priority acres, the higher the implementation unit's priority rank.

Priority rank	Implementation unit ID	Priority acres	High-priority acres	Moderate-priority acres	Low-priority acres
1	35	5,677	3,001	2,676	1,571
2	15	4,443	1,900	2,543	436
3	81	3,878	1,864	2,014	722
4	38	3,126	1,478	1,647	587
5	42	3,070	417	2,653	335
6	52	2,973	2,487	486	352
7	30	2,912	2,118	794	94
8	20	2,904	809	2,095	1,848
9	36	2,623	1,171	1,453	961
10	57	2,506	2,078	429	98
11	29	2,452	1,237	1,215	350
12	12	2,451	1,198	1,254	243
13	64	2,355	1,201	1,154	425
14	17	2,268	1,586	682	303
15	10	2,129	986	1,143	75
16	58	2,121	1,600	521	574
17	21	2,106	1,168	938	128
18	93	1,904	1,390	514	96
19	6	1,846	1,019	827	84
20	22	1,833	1,098	735	546
21	54	1,811	749	1,062	548
22	5	1,785	939	846	116
23	41	1,777	630	1,147	128
24	7	1,737	810	928	226
25	86	1,703	1,467	236	492
26	9	1,671	403	1,268	347
27	67	1,653	841	812	1,082
28	14	1,585	485	1,100	142
29	63	1,550	1,262	288	566
30	49	1,540	1,394	146	119

Table C1 (continued)

Priority rank	Implementation unit ID	Priority acres	High-priority acres	Moderate-priority acres	Low-priority acres
31	1	1,430	822	608	322
32	78	1,414	966	448	24
33	74	1,357	335	1,021	919
34	26	1,349	435	914	277
35	83	1,335	511	824	606
36	100	1,302	232	1,070	2,555
37	4	1,220	754	466	172
38	19	1,195	325	870	464
39	43	1,118	184	934	1,140
40	60	1,041	468	573	394
41	55	1,039	112	928	235
42	72	1,026	847	179	250
43	24	989	854	135	179
44	87	908	527	381	530
45	66	894	816	78	428
46	31	870	270	600	131
47	53	862	532	330	133
48	92	836	496	340	415
49	39	834	716	118	1,148
50	8	751	385	366	221
51	76	739	491	248	315
52	85	723	350	373	520
53	104	719	310	409	1,126
54	48	712	127	585	446
55	99	710	54	656	1,135
56	69	666	489	177	255
57	32	647	334	312	43
58	44	631	437	193	100
59	82	601	252	349	909
60	89	556	159	398	1,333
61	3	553	358	195	75
62	16	543	246	297	199
63	75	499	282	217	143
64	13	472	27	445	27
65	33	465	28	437	625
66	37	446	153	293	129
67	102	432	136	296	874
68	106	426	159	267	377

Table C1 (continued)

Priority rank	Implementation unit ID	Priority acres	High-priority acres	Moderate-priority acres	Low-priority acres
69	97	416	59	357	1,176
70	95	414	103	311	2,199
71	79	400	355	45	321
72	61	397	215	182	386
73	98	387	104	283	1,398
74	68	346	88	258	791
75	50	336	216	120	322
76	34	334	180	155	589
77	62	332	15	317	1,035
78	80	311	47	264	2,359
79	88	305	198	107	478
80	47	294	65	228	409
81	84	294	205	89	148
82	105	291	156	135	186
83	51	247	196	51	169
84	11	237	13	225	0
85	103	217	6	211	251
86	27	189	0	189	173
87	94	188	93	95	214
88	96	170	74	95	79
89	65	154	4	150	1,189
90	91	132	29	103	111
91	2	126	54	73	11
92	90	124	82	42	226
93	45	119	22	97	657
94	40	103	97	6	45
95	46	86	1	85	635
96	71	75	31	44	37
97	70	64	64	0	81
98	18	61	57	3	0
99	28	55	46	8	40
100	101	37	7	31	28
101	59	9	0	9	145
102	25	1	1	1	212
103	73	1	0	1	6
104	56	0	0	0	0
105	77	0	0	0	20

D National Forest System workforce capacity

The Fremont-Winema National Forest's silviculture workforce is stretched and will need to grow through utilizing seasonal staff and core staff to expand the reforestation program in each zone. Increasing reforestation to 15,000 acres per year represents a five-fold increase over current reforestation efforts. Achieving increases to address the REPLANT Act successfully will require additional staffing support that will require support from the regional and Washington offices and partner organizations, as well as innovation and experimentation. These increases represent a large program and will need to be staffed as such. The forest's seasonal forestry workforce is being rebuilt after being consolidated and reduced, with each resource discipline needing to work together to prioritize and access a limited pool of seasonal labor. In years past, each zone averaged 17-20 seasonal field staff, with consolidation reducing this seasonal workforce to eight permanent positions to make up for the same workload.

The northeast zone is currently accomplishing 2,500-3,000 acres of reforestation treatment annually. This program is being run with six positions (foresters and technicians) — with supplemental staff helping with planting inspections. While the southeast and west zones have similar staffing in the silviculture program area, these zones do not currently include reforestation within their programs of work. Whereas, in the northeast zone, reforestation occupies approximately 85% to 90% of the field season for the silviculture program. In the northeast zone, reforestation contract administration proceeds during the four- to six-week spring planting season, layout for the subsequent year proceeds in early- to mid- summer, and big game repellant spraying occurs in newly planted stands in the late summer or fall while staff conduct survival/stocking surveys. During planting season, four to six staff work together to coordinate the planting program. An additional four staff are brought in to assist with contract administration and planting inspections. This entire workforce equals approximately eight staff working six days a week for about six weeks in a row (~36 days total). This core staff currently oversees and inspects the work of one contract planting crew that has 15-25 people, each of whom plant on average 500-800 trees per day, which amounts to approximately 30-100 acres planted per day.

To prepare for each planting season, planting unit layout can be conducted using reforestation technicians who can each prepare approximately 75-100 acres per day, with a crew of four laying out 1,200-1,600-acre unit in a workweek.

The assessment identified up to approximately 144,000 acres of layout and planting need on the national forest. It would take a four-person seasonal crew approximately 120 weeks (approximately 10 field seasons) to complete this whole reforestation layout task. **Working with only the current reforestation staffing and contracting capacity of the northeast zone, it would take that workforce 48 years to complete all 144,000 acres of planting identified in the assessment. This does not include the additional acres mandated to be reforested across the landscape, including ~45,000 acres of backlog burned by other fires prior to 2018, or need that will be generated by future wildfire.**

To scale up the reforestation workforce to accomplish Scenario 1, ramping up to 15,000 acres planted annually by 2026, the national forest will start by replicating the northeast zone's reforestation workforce for the other three zones while innovative approaches are explored and deployed simultaneously. Replication of the northeast zone's workforce would add at minimum 10 new permanent staff and 12 seasonal positions. In each zone, this staffing would cover planting contract oversight, surveys, site preparation and any post-planting activities or treatments. This includes:

- **1** One forest-wide reforestation coordinator to oversee the reforestation staff and staffing structure in each zone
- **1** One GS-9 forester/lead zone reforestation coordinator per zone (**three new positions**)
- **2** Two GS-7 technicians per zone (**six new positions**)
- **2–4** Two to four GS-4/5 seasonal workers (**6-12 new positions**)

If more than one planting crew is operating in a zone, additional staff will be needed to oversee loading and unloading at the tree cooler. Additionally, contracting officer representatives are in short supply and will be a bottleneck to all types of contracts, from planting to tree cooler refurbishment and construction. If additional planting capacity is needed to meet agency goals (i.e., REPLANT Act), from the staffing needs listed above it can be assumed that, after ramping up staffing to plant 15,000 acres a year, each additional 5,000 acres per year would require four to six additional staff with two GS-7 positions and two to four GS-4/5 seasonal workers.


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E National Forest Service policy

The National Federation of Municipal Analysts states:

Reforestation Sec. 4. Section 3 of the Forest and Rangeland Renewable Resources Planning Act of 1974, as redesignated by section 2 of this Act, is amended by adding at the end thereof of new subsections (d) and (e) as follows: "(d)(1) It is the policy of the Congress 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.*** Accordingly, the Secretary is directed to identify and report to the Congress annually at the time of submission of the President's budget together with the annual report provided for under section 8 (c) of this Act, beginning with submission of the President's budget for fiscal year 1978, ***the amount and location by forests and States and by productivity class, where practicable, of all lands in the National Forest System where objectives of land management plans indicate the need to reforest areas that have been cut-over or otherwise denuded or deforested, and best potential rate of growth.*** All national forest lands treated from year to year shall be examined after the first and third growing seasons and certified by the Secretary in the report provided for under this subsection as to stocking rate, growth rate in relation to potential and other pertinent measures. Any lands not certified as satisfactory shall be returned to the backlog and scheduled for prompt treatment. The level and types of treatment shall be those which secure the most effective mix of multiple use benefits.

Forest Service Policy (FSM 2470) states:

On National Forest System lands, all activities that cut, burn, establish, or otherwise modify forest vegetation, must have a silvicultural diagnosis and prescription prepared or approved by a certified silviculturist prior to implementing the project or treatment.

The diagnosis considers and evaluates the site capability, management direction, and landscape context relative to desired stand conditions. The diagnosis compares the existing conditions to the desired conditions to determine treatment options to achieve the management objectives. The diagnosis process first considers whether deferring action would be expected to achieve the management objectives.

The prescription is the documented description of activities required to implement any silvicultural treatment on National Forest System lands. The prescription includes site preparation and regeneration, natural and activity fuel management, and the long-term treatment sequence needed to achieve the desired condition. Most fuel treatments in forest vegetation are considered silvicultural treatments and require a silvicultural prescription. Ensure burn plans in forest vegetation settings are reviewed by a certified silviculturist and are consistent with silvicultural objectives.

Regional Foresters can set general reforestation priorities and other reforestation direction. In Oregon and Washington, the Regional Forester last issued direction on post-disturbance reforestation in 2018.

Post-disturbance reforestation assessment policy

Forest Service policy is to conduct a post-disturbance reforestation assessment

(FSM 2472.03). In addition to identifying reforestation needs and areas for natural recovery monitoring, the assessment should also identify areas that cannot, or should not, be planted due to site conditions (e.g., site more suited for non-forest vegetation, low productivity or where high levels of planted tree mortality are likely).

Reforestation after salvage logging

Where post-disturbance salvage logging occurs, and the resulting conditions indicate a need for reforestation (planted or natural), Forest Service policy — because of the Bighorn Decision (*Sierra Club v. Cargill*) — is to use "best efforts and best judgment to assure that restocking occurs within five years." "Assure" is defined by noting that a failure is not a per se indicator of a violation, but the Forest Service might be required to "show that its determination that restocking would occur was reasonable."

Appendix

F The Klamath Tribes Natural Resources Department comment letter

After reviewing the strategy, the Klamath Tribes Natural Resources Department provided the following letter to outline key areas of alignment between the Natural Resources Department and the strategy with respect to the vision for the landscapes and specifics throughout the strategy, as well as areas of concern.

Dear American Forests team,

On behalf of the Klamath Tribes Natural Resources Department, I want to thank you for reaching out so that our staff could review and provide this comment letter on the final draft of your document, *South-Central Oregon Integrated Post-fire Resilience Strategy: Reforestation, Fuels Management, and Fuel Breaks*.

The Klamath Tribes view the land as a cultural landscape with a focus on the holistic ecological, spiritual, and cultural values and traditions of the land. As you and our Forest Service partners have shared, the Post-fire Resilience Strategy document is focused specifically on reforestation, fuels management, and fuel breaks. For the Tribes, these are interwoven into a larger ecological and cultural context that emphasizes restoration as a whole. This means multiple forest ecosystems, their functions and processes, and the cultural plant communities, wildlife, and their habitats important to the Tribes.

A Support for Post-fire and Landscape Restoration

The Klamath Tribes natural resources department supports post-fire restoration, including reforestation, as part of landscape level restoration. This is shown by our participation in the Klamath Investment Partnership, and our application with Green Diamond, The Nature Conservancy, and Sustainable Northwest for the America The Beautiful Challenge $5 million grant for restoration on Green Diamond land focused on aquatic, meadow, and riparian restoration that included site prep and upland reforestation.

The Tribes have had virtual meetings, in person meetings, and field tours with the Department of Agriculture, Office of Management and Budget, and the Department of Interior over the past year. We specifically asked for all lands funding for post-fire restoration. We emphasized the need for post- fire restoration that includes public and private upland forests, addresses future fire concerns, and links the upland forest and meadow systems to the lower stream and aquatic systems that support the C'waam and Koptu, two endangered fish species that are of great cultural importance to the Tribes.

B Support for Landscape Designation

The Tribes supported and are glad to see that the upper Klamath River Basin watershed became a designated landscape by the USDA Forest Service, which includes multi-million dollars in funding each year for nine years. This designation includes the Tribes Treaty Rights Reservation boundary, much of our ceded lands on the Fremont-Winema, and our TNC and Green Diamond neighbors. This landscape designation will hopefully increase the attention to the entire area and therefore allow funding to go beyond the current USDA wildfire map and include the rest of the Fremont-Winema National Forest, Collins, and partner lands.

C Important Strategy Components

I want to highlight some of the strategy components that align well with and are important to the Tribes Natural Resources Department, and to thank you for capturing many of the suggestions and feedback our staff gave during meetings and field trips on these components.

Resource Goals

Many of the goals the strategy identifies from Core Team members for post-fire reforestation align well with the restoration goals prioritized by the Natural Resources Department, such as ecosystem services and functions, forest diversity and fire, climate adaptation, wildlife needs, appropriate scale, and aspen regeneration. Similarly, some of the associated tactics, including ICO, prescribed fire, founder stands, protect and expand natural and cultural resources important to the Tribes, meadows and non- forest plant communities, transition zones, riparian restoration areas identified by the Tribes, aspen regeneration, and snow and water capture fit with our restoration goals.

Meadows and Transition Zones

As the meadow boundary map and tables of acres within the fire boundary show, meadows cover nearly 20% of the larger 580,000 acres analyzed by the strategy, and more importantly cover greater than 25% of the National Forests lands within the fire boundaries. These are ecosystems that provide cultural plant communities and habitats for animals that are important Treaty Resources for the Tribes. Some of the fires helped to restore meadow systems by reducing evapotranspiration, removing encroaching conifers, and increasing water flow. There is an opportunity in a post-fire environment to let meadows restore to their original hydric soil boundaries without tree encroachment. Post-fire restoration costs and acres of activity include meadow restoration throughout the document, for both meadow restoration with and without conifer encroachment. We would note that it is rare to have a meadow that is not encroached by conifers, so we are unsure how those were designated. Meadows are an important restoration strategy component for the Tribes.

Transition zones also provide habitat for cultural plant communities and animals. These have been emphasized in our work on landscape scale restoration projects by the Forest Service. The strategy both highlights this and includes our recent field data and information show how these areas can be identified at a coarse scale by elevational gain, and then ground-truthed. As with meadows, transition zones should not be reforested.

Aspen

Aspen are high value habitats for big game, cultural plants, and food webs found throughout the forest systems, riparian areas, and meadow complexes. These ecosystems are important for the Tribes Treaty Resources. The strategy's emphasis on these areas match those of the Natural Resources Department, including protecting regenerating aspen stands, and stopping conifer encroachment post- fire. Monitoring for aspen seeding and assessing the strategic role aspen and meadow complexes can play in shifting the dynamic interplay between hydrologic and fire regimes. Protecting aspen regeneration is important to the Tribes, and therefore it is key to make sure aspen stands aren't over browsed, especially if the stands are also a part of grazing allotments.

Big Game and Wildlife

Deer, elk, and many types of animals are important to the Tribes for subsistence hunting and for cultural reasons as part of our Treaty Resources. Post-fire landscapes may represent habitats that are dramatically improved for some species while decreasing quality for others. Changes in habitat quality may also influence spatial occupancy and whether it is accessible to animals. Big game are typically forage limited in unrestored dry forest systems, as shown by the heavy pre-fire use of aspen and willow. After a fire, deer and elk may have a great increase in forage but not be able to access all of it because of cover limitations. It is important to think of standing snags, green trees, and downed logs as hiding and thermal cover for big game. It is also important to not restore and reforest the same way on summer, migration, and winter range. Big game forage and cover and other habitat needs can be enhanced by restoration, as included in your fuels treatment areas for increased forage and permeability.

Prescribed Fire

The Natural Resource Department agrees with the success of our TNC partners, that prescribed fire is an important best management tool to help restore these dry and fire-prone forests. Prescribed fire also helps to prepare the forest systems for drought and future fire, and to help restore ecosystem functions and processes, including the cultural plant communities and wildlife habitat as Treaty Resources for the Tribes. Your strategy emphasizes the need for prescribed fire immediately and across time playing many key functions to remove fuels, protect fire refugia, protect founder stands, and provide on-going maintenance. You list prescribed fire as the predominant management tool in your strategy, and this aligns with the best available science and the natural resource needs of the Tribes.

Prescribed fire is included throughout your strategy, showing the importance of it overall, and the key role it plays in removing fuel, recycling nutrients, and setting up even post-fire systems to prepare for future fire and habitat restoration.

Climate Change

Uncharacteristic wildfire is increasing due to climate change. Restoration in unburned areas and in post-fire areas must address climate change and the expected drier growing seasons and unpredicted snowpack accumulation and spring snowmelt. The Natural Resources Department uses tree species composition and their spatial patterns that have been growing on the land for hundreds of years as an important guide to account for future climate variation. Just as important are the interconnected ecosystems that have functioned together to allow 300-year-old trees to persist during drought years by meadows capturing snow, filtering it, and slowing it down before flowing into riparian areas and eventually downhill streams. The capture of moisture in the uplands is just as critical for upland reforestation and restoration as it is for the connected hydrology, water quality (sediment and nutrient transport), and habitat for downstream C'waam and Koptu. The importance of climate change is emphasized throughout your strategy, with the associated stressors of drought and subsequent insects, pathogens, and extended fire seasons. The holistic ecological approach of the Tribes ties post-fire restoration into a larger ecological and cultural context, and therefore allowing holistic restoration of the cumulative effects to help address climate change within a watershed context, across the landscape.

Monitoring and Adaptive Management

Monitoring and adaptive management are critical to assure the Tribes what was agreed to and implemented is working, and if not, how to adapt to meet our Treaty and Reserved Rights. Monitoring must happen for adaptive management, and these are important components of learning the effectiveness of our strategies and when necessary make changes that works on this land, during this time. While research and analysis can provide insight, it is important to the Tribes that management be site specific. Your strategy notes that the Natural Resources Department is working to finalizing a cooperative monitoring plan with the Fremont-Winema National Forest in addition to one specifically for post-fire. The document includes the importance of monitoring different components, such as stand structure, aspen regeneration, ecotones, green trees, landscape scale metrics, watershed health and runoff, and wildlife health and habitat use among others. These are important to the Tribes, as are other monitoring components such as plant communities and vegetation recovery and restoration in forested and non-forested areas. The Natural Resources Department looks forward to working with partners on monitoring, sharing our findings, and learning from what others are finding to address adaptive management.

D Concerns

Some of the strategy components were of concern to the Tribes Natural Resources Department. My staff and I shared some of this with you and partners during our field trips and meetings. I wanted to list these here, so you know what our specific concerns are and our requests on how to address them. As this is an all-lands document with many landowners and managers as partners, I understand that some items will be included for specific partners. In the list below, I would want to note that the concerns for the Tribes' Natural Resources Department are for the Fremont-Winema National Forest lands that include our Treaty Rights Reservation Boundary and ceded lands. I also want to highlight that until the concerns over herbicides listed below are addressed to our satisfaction, the Klamath Tribes Natural Resources Department cannot be listed as a preparer, nor affiliated with the document.

Reforestation: seedling planting vs. seeding

The document offers a lot of analysis for priorities for reforestation, including strategic thinking on foundational stands to help generate future seed base for natural reforestation into the future, and on identifying areas where natural reseeding will occur in such a largescale post-fire footprint. However, even as natural seeding for conifer trees is addressed in the document as potentially the greatest source of reforestation, the active management approach is only planting seedlings. Working with The Nature Conservancy and researchers from universities, we are hearing about success with tree seeding. This approach takes less time, is more efficient, and allows greater areas to be covered with tree seeds. I would want to see options for seeding and not just a focus on planting tree seedlings. Where, what, and how to seed with a climate adapted tree seeds and a climate analog approach would be important.

What could work and where it could work might be similar with your climate change and environmental analysis for seedlings


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as it would be for seeding. It would be good to discuss this more and consider this a viable option as we learn from TNC.

Plant Communities

While shrubs and plant communities are discussed in your document, they are not differentiated. The plant associations are critical for defining and understanding overstory and understory, and a good indicator of what to expect after a disturbance. The strategy uses plant association group to account for rarer tree species. We would prefer that even within ponderosa pine dominated stands across much of the fire that plant communities and associations be considered as the understory baseline for biodiversity. The Natural Resources Department is working with 70 different plant communities within the post-fire footprint, and these can't be treated as the same. Distinction between the communities would be important for reforestation and for how to think about shrubs and plant communities in successional stages. Using shrubs as a general term doesn't allow the Tribes to determine which plant community and associated restoration needs. Bitterbrush is only listed once in the strategy, and we are unsure if snowberry, snowbrush, willow, currant, and many other species of shrubs are all being lumped together.

Within the analysis and strategy of a nearly 600,000-acre post-fire footprint, the many species of shrubs are lumped together as one and only considered as a problem for replanting. This is not compatible with the Tribes approach to cultural and natural resource management. It is also not compatible with any ecological evaluation of a post-fire environment. The shrub species listed above, among others, are important to the Tribes as cultural plants and as important food and cover for animals. This includes invertebrates and foodwebs expected in post-fire environments for many culturally important animals such as woodpeckers, deer, and elk. Since shrubs play such a vital role ecologically, multiple diverse species should not be lumped together and listed as a problem for planting and reforestation.

RAVG Data

The Natural Resources Department is unsure how good the RAVG data is for foundational analysis.

The classes of data didn't align well with what we observed or were expecting. Instead of suggesting reanalysis, my department would like to be involved in helping review data and prioritizations of areas to be restored on burned areas within the Fremont-Winema National Forest. I understand that this is a strategy, and that before any management planning and during pre-NEPA that the Forest Service would reach out to the Tribes and begin ground truthing. That approach would allow us to better understand the data, offer our insights, and help with prioritization.

Herbicides

Herbicides are addressed throughout the document. Our partners with private land shared that this is a tool they use in reforestation and management. In the competing vegetation section, herbicide is listed as one of many options to help tree survival and growth. As I shared above, shrubs are not a single species and should not only be seen as a problem. Throughout the document herbicides show up in many tables, sections, and management approaches. It starts to read as if herbicide use on Forest Service land is a foregone conclusion. I shared during field trips, and my staff and I commented during meetings that we had concerns over using herbicides on native vegetation and cultural plants. The document analyzes nearly 600,000 acres including 270,000 of Forest Service land. Having herbicides throughout and in management recommendations in tables starts to read as pre-decisional. It is unclear if herbicides are included in the budgets or how far down the road the decision has been made.

Tribal subsistence uses as outlined in our Treaty and Reserved Rights includes gathering plants and hunting animals that eat plants, and this is a direct reason and one of many reasons why herbicides are a concern. Tribal members consume the plants themselves and the animals that eat those plants. The strategy document analyzed the need for herbicides across 270,000 acres of federal land. The issue at that scale creates a direct impact on Tribes Treaty Rights and Resources and our subsistence uses.

The Tribes Natural Resources Department did not agree to herbicide use on the National Forest, and to the contrary, shared our concerns over using herbicides on native plants. We did not participate in or support an analysis of potential herbicide use across hundreds of thousands of acres of the Fremont- Winema National Forest.

Our Department policy is that we are opposed to spraying herbicide on native vegetation to enhance conifer reforestation on National Forest land, as it is incompatible with the principles and philosophy of the Klamath Tribes Natural Resource Department.

Fuel Breaks

I appreciate that in your strategy document you highlighted that, "fuel breaks are unlikely to stop fires passively; firefighter presence is key to controlling fires at fuel breaks", and "During extreme weather, fuel breaks will be largely ineffective because of dangerous firefighting conditions and higher probability of spotting ahead of the fire front. This was the lived experience with the Bootleg fire."

Fuel breaks have long been considered for use in limiting the size of wildfires. They can be useful, particularly where vast expanses of unroaded wildlands are subject to wildfires. In these situations, fuel breaks serve as roadways or foot-trails for firefighter ingress and egress. Additionally, they can be used as pre-constructed indirect firelines from which firefighters may conduct backfiring operations. Most peer-reviewed literature on the topic suggests that fuel breaks typically do not stop fires. Most of the area burned on the Fremont-Winema National Forest in the last decade has burned under conditions that can be characterized as "extreme". When conditions are not extreme, our Forest Service partners have been very successful in stopping wildfire spread without pre-constructed fuel breaks.

Instead of the proposed 439 miles of fuel breaks (53,000 acres) of 500' wide on both sides of the road reducing trees ≥16" dbh to <50 per acre with repeat herbicide or mechanical treatments for maintenance every 3-5 years (indifferent to forest type and associated habitat and HRV), we would prefer to consider an approach such as to conduct a Quantitative Risk Assessment (QRA), implement landscape-scale prescribed fires starting where the QRA indicates locations that would be best for intervening in large fire spread (in line with most of the strategy), and then follow-up with maintenance burning every 5-10 years. This along with conducting prescribed fire across the entire Fremont-Winema NF at intervals appropriate for each site would help create the landscape scale resilience outlined in the strategy.

Conclusion

I recognize that my comments are to assure the Tribes Natural Resource Department will have the opportunity to work in staff-to-staff coordination and government-to-government consultation with our Forest Service partners. As this document begins to solidify a strategy forward, it is important that I capture the support my department has for many of the important restoration strategies and to also share some concerns.

I understand that NEPA would come after this document, as it is a strategy, and that this document does not provide site-specific analysis that would be covered under NEPA and tribal consultation. This document can be a support tool for all partners, though for the Forest Service starts to read as pre- decisional. As such, this document begins to set in motion a framework of post-fire response. It contains almost 100 pages of information and analysis that helps to guide decision making for the Forest Service. As outlined in this letter, the Tribes Natural Resource Department would guide our decision making, and therefore our consultation with the Forest Service, based on a cultural landscape with a focus on the holistic ecological, spiritual, and cultural values and traditions of the land. That holistic approach is not represented in this document.

As a Tribal Government with a Treaty and Sovereign Rights, we have a unique government-to- government relationship with the Forest Service. My department meets with and supports our partners and neighbors, and TNC, Green Diamond, and Collins are among those. When we also meet with a federal agency, then it is important that the Klamath Tribes are represented by our Culture & Heritage Department, Ambodat Department, and Tribal Council who would all have an interest in post-fire landscape resilience.

It is important to me to have met and continue to meet with our federal and private partners and neighbors to discuss a pathway forward in a post-fire landscape. We have already been working on more ways to apply for funding together and partner to help restore the post-fire landscape.

Thank you for your consideration of the points made in this letter, and I look forward to continuing to work with American Forests and our many partners to bring attention to this important landscape, including all lands funding for the many priorities.

Respectfully

Steve Rondeau

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