Lake Tahoe West

Landscape Restoration Strategy

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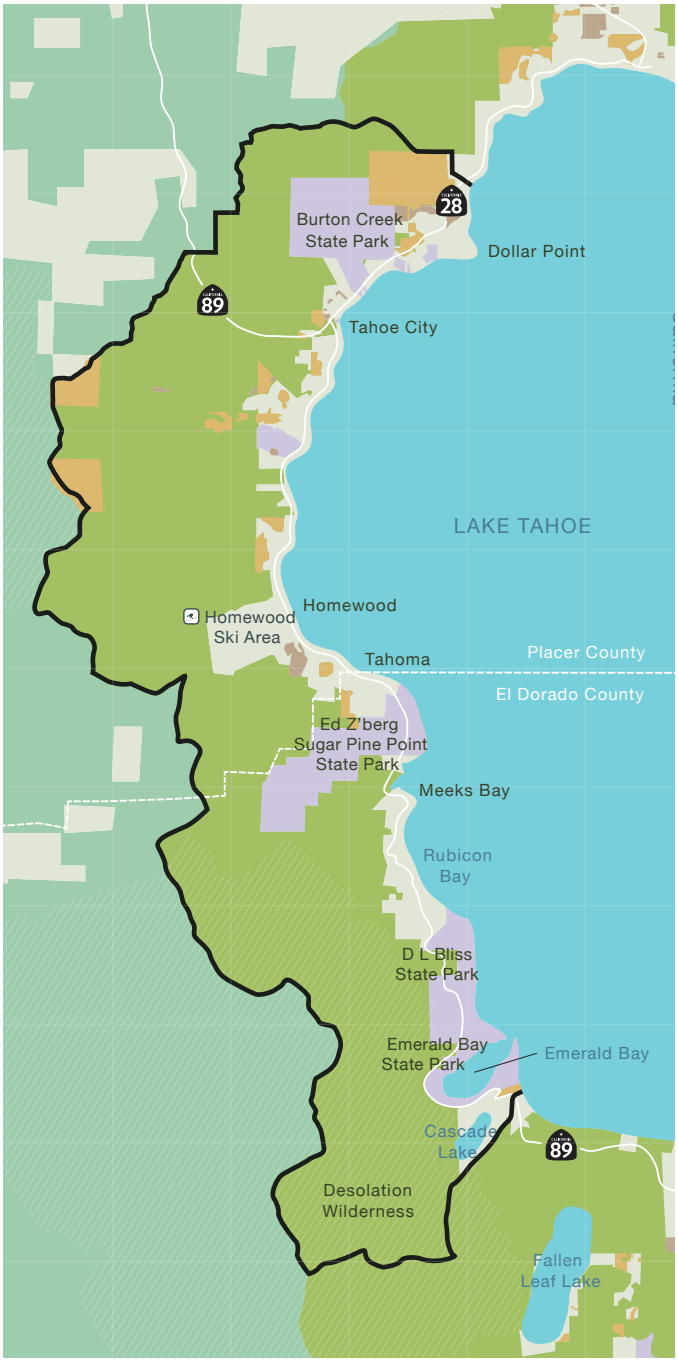
Photo: NASA

Dear Reader,

Forests in the Sierra Nevada and the Lake Tahoe Basin are undergoing rapid and alarming change, putting at risk both human safety and the natural landscapes that sustain us. As of 2017, 129 million trees in California's forests had died from bark beetle infestations driven by climate change, dense forest conditions, and several years of drought. In 2018, California experienced its deadliest and most destructive wildfire season in history. In the Sierra Nevada, the Camp Fire ripped through the foothill town of Paradise and killed 85 people, and the Ferguson Fire burned 96,901 acres in and around Yosemite National Park, killing two firefighters. Heavy smoke from these and several other massive fires blanketed Northern California, creating critically unhealthy air for weeks at a time and impacting millions of people. Poor air quality forced school closures, event cancellations, and closures of campgrounds, trails, and parks throughout the state, impacting people, businesses, and recreation-dependent economies.

California leaders and land managers recognize the urgent need to increase forest restoration to reduce threats and adapt to a warming and changing climate. Conventional planning approaches, limited in scope and size and yet complex and time-consuming, fall short. To succeed, managers must coordinate their efforts across large landscapes to achieve comprehensive restoration goals for people and ecosystems. The Lake Tahoe West Restoration Partnership has been working together since 2016 to understand and identify consensus-based solutions to these challenges. The Lake Tahoe West Landscape Restoration Strategy provides a collaborative framework to restore 60,000 acres of federal, state, local, and private lands on the west shore of Lake Tahoe. Time is critical, and the moment to act is now. Actions identified in this Strategy will restore and build more resilient forests, wildlife habitat, meadows and streams, communities, recreation opportunities, and local economies in the Lake Tahoe Basin.

Contents



Lake Tahoe West Landscape Boundary

- Planning Area (entirely within Lake Tahoe Basin)
- USDA Forest Service, Other National Forests
- USDA Forest Service, Lake Tahoe Basin Management Unit
- California Tahoe Conservancy
- California State Parks
- Local
- Private
- Wilderness

Executive Summary

The Lake Tahoe West Restoration Partnership (Lake Tahoe West) is a multi-agency, collaborative effort to increase the resilience of the forests, watersheds, recreational opportunities, and communities on Lake Tahoe's west shore. Stretching from shoreline to ridgetop, and from Emerald Bay north to Dollar Point, these 60,000 acres constitute one of America's most iconic and treasured landscapes, with towering forests, clear blue lakes, and high alpine peaks. Yet this landscape, its communities, and visitors are increasingly at risk from extreme wildfire, climate change, drought, and insect and disease outbreaks.

This Landscape Restoration Strategy (Strategy) provides a science-based framework to guide watershed and forest restoration approaches on the west shore over the next two decades to increase social-ecological resilience. Social-ecological resilience refers to the landscape's ability to adapt to change and withstand disturbance while continuing to support cultural, ecological, and economic values such as clean water, wildlife habitat, and thriving communities. In the context of California's recent devastating wildfires, a key component of resilience is reducing fire risk in and around west shore communities

To advance social-ecological resilience on the west shore, the Strategy:

- Provides an integrated framework for multi-benefit restoration, developed through a collaborative process with key partners and stakeholders.
- Identifies restoration approaches, grounded in robust science, necessary to achieve long-term social-ecological resilience.
- Provides detailed guidance to managers to plan and implement restoration approaches to achieve a comprehensive set of goals and objectives for resilience.
- Provides a framework to guide restoration for 20+ years into the future, even as conditions on the landscape change.
- Supports current and future actions to protect communities from high-severity wildfire.
- Establishes the need to fund comprehensive restoration of the Lake Tahoe West landscape.

Fully implemented, the Strategy will:

Scientific modeling conducted to develop this Strategy indicates that full implementation of the Strategy would:

- Reduce the risk of high-severity fire on 60,000 acres, more than one-third of the Lake Tahoe Basin. Reduce by 50% the amount of forest expected to burn in future high-severity fires.
- Reduce risk of property losses from future wildfire in west shore communities by as much as $4 million per year on average. Reduce days with very high smoke emissions by 90%, translating to millions of dollars' worth of avoided health costs annually in the future.
- Over the next half century, allow for a tripling in the amount of old forests (with trees over 130 years old) to sustain populations of old-forest associated wildlife including spotted owls, goshawks, and martens in the face of climate change.
- Protect native fish, water resources, and lake clarity by reducing the risk of high-severity fires in sensitive watersheds, improving the forest road network, increasing water availability to streams, and enhancing the quality of meadows and riparian habitats.
- Restore a safer, more natural fire regime by substantially increasing (by eight times or more) the amount of managed, low-intensity surface fires in the forest. By doing so, enhance plant and wildlife diversity and cultural resources important to the Washoe Tribe.
- Allow for continued increases in carbon sequestration by 40% over the next century.
- More than double the acres of forest restored per year, on average.

Landscape Restoration Strategy Goals

The Strategy identifies six Goals for a resilient landscape. The Goals reflect long-term desired conditions for forests, fire, native species and ecological communities, water and watersheds, communities, and regional economies, as follows:

Goal 1 Forests recover from fire, drought, and insect and disease outbreaks.

Goal 2 Fires burn at primarily low to moderate severities and provide ecological benefits.

Goal 3 Terrestrial and aquatic ecosystems support native species.

Goal 4 Healthy creeks and floodplains provide clean water, complex habitat, and buffering from floods and droughts.

Goal 5 People live safely with fire and enjoy and steward the landscape.

Goal 6 Restoration is efficient, collaborative, and supports a strong economy.

The Strategy calls for managers to substantially increase the pace and scale of restoration actions across the landscape compared to current efforts. Key recommendations of the Strategy include:

- Work collaboratively with all land management agencies, tribes, and stakeholders to develop and implement restoration projects that meet a wide range of objectives across land ownership boundaries.
- Substantially increase forest thinning and prescribed fire across the landscape and land ownerships to reduce fire risk, improve resilience, and create forest conditions that would allow for a gradual increase in the use of naturally ignited wildfire where feasible and safe.
- Actively manage forested habitat, including Protected Activity Centers, to reduce the risk of high-severity fire and conserve habitat quality for species like the California spotted owl and northern goshawk.

Photo: USDA Forest Service

Sierra Nevada Yellow-Legged Frog

- Restore meadow, riparian, aquatic, and aspen ecosystems to support native biodiversity, increase habitat connectivity, and provide refugia as the climate warms.
- Restore streams and streamside habitat to benefit native species, increase the ability of watersheds to absorb flooding and withstand drought conditions, and protect water quality. Restore roads to reduce erosion and transport of sediments and nutrients to Lake Tahoe, including sediments potentially released from wildfires or restoration treatments.
- Prioritize early detection and rapid response programs to manage and reduce invasive species.
- Continue to build and invest in programs that protect communities from high severity fire, such as defensible space, home hardening and retrofitting, community wildfire protection planning, evacuation planning, early warning systems, fire suppression capacity, and community water infrastructure.
- Increase the use of smoke forecasting, interagency coordination, and public outreach to minimize smoke impacts from prescribed and natural wildfire. Increase public understanding of the benefits of prescribed fire for ecological values and wildfire risk reduction.
- Enhance engagement with the Washoe Tribe of Nevada and California in stewardship activities that foster tribal cultural resources and support tribal people.
- Support and build resilience into the local economy and recreation industry.

The Lake Tahoe West Approach

Lake Tahoe West's resilience-based approach emphasizes scaling up and accelerating restoration efforts to address a large landscape and all land ownerships, planning for a dynamic and changing future, and addressing a comprehensive set of landscape values.

The Strategy reflects an extraordinary amount of collaboration and consensus building among agencies, scientists, and stakeholders. Four public agencies – the Forest Service Lake Tahoe Basin Management Unit (Forest Service LTBMU), California Tahoe Conservancy, California State Parks, and Tahoe Regional Planning Agency – joined with the non-profit National Forest Foundation, Forest Service Pacific Southwest Research Station, and interagency Tahoe Fire and Fuels Team to launch Lake Tahoe West in 2016. The partners also convened a Science Team of university and Forest Service researchers and a diverse group of stakeholders to develop this Strategy. Stakeholders represent conservation, fire protection, the recreation community, homeowners and businesses, scientists, local government, and others with a stake in the resilience of Lake Tahoe's west shore.

The Lake Tahoe West partners developed this Strategy using the best available science, including a Landscape Resilience Assessment and computer modeling of future forest conditions and wildfire risk in the Lake Tahoe Basin. The 2017 Landscape Resilience Assessment concluded that many of Lake Tahoe West's terrestrial and aquatic ecosystems are not currently resilient to disturbances including severe wildfire, drought, climate change, and insects and disease. For example, forests are overly dense and susceptible to high-severity fire, nearly half of streams support more non-native than native species, and two-thirds of meadows likely cannot provide adequate refuge for meadow species under future climate change.

The Lake Tahoe West Science Team conducted a series of computer modeling exercises to evaluate a suite of management approaches under a changing climate up to 100 years into the future. The partners worked collaboratively to set up the models to address conditions specific to the Lake Tahoe Basin. The models evaluated vegetation, fire, water quality, snowpack and water flows, emissions and air quality, wildlife habitat, and economics. This uniquely integrated analysis enabled the Lake Tahoe West partners to look forward and develop a Strategy that anticipates expected future conditions. The modeling revealed opportunities for managers to protect landscape values and improve resilience, and it revealed some changes that will likely occur regardless of management interventions. Key insights from the modeling include:

- The landscape is at risk of large high-severity wildfires now and into the future, and management actions, specifically thinning, prescribed fire, and use of naturally ignited wildfire across a broad landscape at an accelerated pace, will help to reduce this risk and improve landscape resilience.
- Prescribed burning is a cost-effective complement to thinning to reduce wildfire risk and to achieve ecological benefits of restoring fire. Prescribed fire poses some risks to air and water quality, and planning these treatments will require thoughtful analysis and design. These risks are offset by the long-term benefits of increasing landscape resilience and reducing high-severity wildfire.

Photo: Forest Service LTBMU

Photo: Todd Gilens

The Lake Tahoe West Restoration Partnership will continue to build and invest in programs that protect communities from high severity fire, such as defensible space, home hardening and retrofit, community wildfire protection planning, evacuation planning, early warning systems, fire suppression capacity, and community water infrastructure.

- Accelerating the pace and scale of forest thinning, prescribed fire, and natural wildfire will facilitate the continued growth of large trees and the development of old-forest conditions that will store more carbon and improve habitat conditions for many wildlife species.

What Comes Next: Implementing This Strategy

The Strategy lays out a comprehensive and balanced approach to increase resilience on the west shore. Partner agencies are already implementing key elements of the Strategy by treating forests near communities to reduce fire risks through efforts like the West Shore Wildland Urban Interface Healthy Forest and Fuels Reduction Project. Partners are also planning for new treatments, including developing a Program Timberland Environmental Impact Report to complete fuel reduction projects on private, local government, and California Tahoe Conservancy lands within the Wildland Urban Interface. Other regional efforts that complement and support the goals of Lake Tahoe West include the Tahoe Fire and Fuels Team's implementation of Community Wildfire Protection Plans, the Lake Tahoe Aquatic Invasive Species Coordination Committee, and the Lake Tahoe Sustainable Recreation Working Group.

Based on the Strategy, the Lake Tahoe West partner agencies will plan additional forest and watershed restoration treatments throughout the west shore landscape in the next phase of Lake Tahoe West, starting in fall of 2019. The agencies will begin implementing these projects on the ground in 2022. The Strategy will continue to guide forest and watershed restoration approaches on the west shore over the next 20 years as partners plan and implement additional projects using this framework. The estimated annual average cost to implement the forestry projects in this Strategy is $7 million. Treatments to improve watershed function and habitats could cost $5 - 8 million annually. The total annual cost to implement the Lake Tahoe West Landscape Restoration Strategy is approximately $12 million. The partners are developing a funding and implementation strategy to identify potential funding sources for this work.

In the planning phase, Lake Tahoe West partners will analyze two policy updates that could provide managers with more effective tools to restore forests and increase landscape resilience: 1) allowing ground-based mechanical thinning treatments on slopes 30-50%, and 2) expanding available management activities in California spotted owl and northern goshawk Protected Activity Centers outside the Wildland Urban Interface.

Changes that managers set in motion now may not fully come to fruition for many decades as the landscape responds to restoration and natural disturbances and as the west shore's forests continue to grow and change. The Strategy uses a condition-based approach that provides managers with flexibility to adapt their efforts as conditions change. During the next phase of the project, the partners will develop a monitoring plan for continued assessment and adaptive management of this dynamic landscape.

Introduction

Background and Context – Why here? Why now?

The Lake Tahoe West Restoration Partnership (Lake Tahoe West) is part of a broader shift in ecosystem management and policy occurring regionally in response to a widespread forest health crisis. Changes in forested landcapes can have cascading effects on many important ecosystem services and benefits that people value, such as wildlife habitat, carbon sequestration, and clean air and water. Over the last decade, California has experienced extensive tree mortality, especially in the Sierra Nevada, and several large catastrophic wildfires including the Camp, Mendocino Complex, Tubbs, and King Fires. The devastating 2018 Camp Fire killed 85 people in the Sierra Nevada foothill community of Paradise and destroyed most of the town and surrounding forest. These fires have served as a wake-up call locally, statewide, and nationally, and have spurred significant legislative and regulatory changes.

Much of the Lake Tahoe Basin, including the west shore, is at risk for both high-severity wildfire and extensive tree mortality. The California Department of Forestry and Fire Protection (CAL FIRE) has rated the Lake Tahoe West area as high hazard due to high probability of tree mortality near communities, roads, and power lines and as a very high priority for reducing wildfire threat to communities and ecosystem services.

Current stand-scale forest management approaches are not improving ecosystem health and resilience fast enough or at a broad enough spatial scale to keep pace with the threats posed by current stressors. Managers throughout the region are in a race to reduce immediate threats from fire, climate change, and insects and disease. At the same time, managers are considering how restoration efforts can now and in the long term benefit a myriad of other values including water quality and stream flows, wildlife habitat, and recreation. Restoration treatments that managers undertake now may not fully come to fruition for many decades as forests continue to grow, change, and respond to natural disturbance. Increasingly, collaborative efforts are addressing broader and cross-jurisdictional landscapes, highlighting dynamic processes like tree growth and mortality, natural disturbance regimes, and watershed processes that will continue to shape the larger landscape.

Federal, State, and Local Responses to Wildfire and Tree Mortality Crisis in California

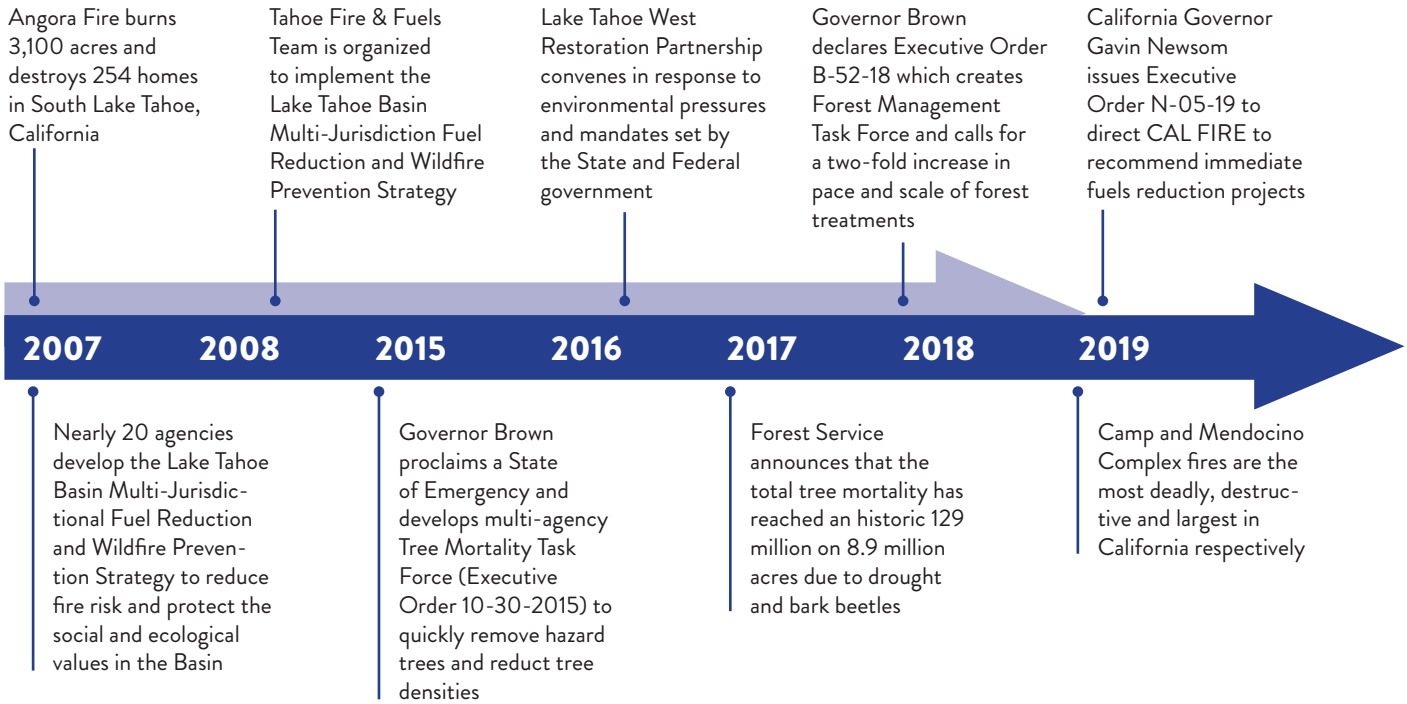


Photo: California Tahoe Conservancy

The Lake Tahoe West Restoration Partnership

Lake Tahoe West formed in 2016 to focus on scaling up and accelerating restoration and increasing the social-ecological resilience of forests, watersheds, recreational opportunities, and communities across 60,000 acres of Lake Tahoe's west shore. Social-ecological resilience refers to the landscape's ability to adapt to change and withstand disturbance while continuing to support cultural, ecological, and economic values such as clean water, wildlife habitat, and thriving communities.

Lake Tahoe West builds on a strong foundation of cooperation among resource, research, and regulatory agencies and other interested organizations in the Lake Tahoe Basin. The Environmental Improvement Program, formed in 1997, represents the collaborative body of all private, local, state, and federal partners and the Washoe Tribe in the Lake Tahoe Basin. The members of the Environmental Improvement Program combine efforts to prioritize projects, acquire funding, and track and monitor progress towards shared goals of ecosystem health, watershed restoration, sustainability, and economic security for the region. Lake Tahoe West is building on this collaborative foundation to increase the pace and scale of restoration projects and is the largest-scale environmental improvement project in the Lake Tahoe Basin to date.

The Landscape Restoration Strategy and Lake Tahoe West reflect a departure from land management agencies' conventional approaches to forest management (see following table). Although a key component is to reduce fire risk and improve forest health, Lake Tahoe West also advances a broader paradigm based on promoting landscape-wide resilience to benefit ecosystems, communities, and Lake Tahoe. Agencies' conventional forest management approaches may be the most effective and appropriate in many cases, and agencies will continue to use these approaches in the proper contexts. However, expanding restoration efforts to the level needed in the Lake Tahoe Basin, and throughout the American West, requires scaling up to cross-boundary landscapes, planning for a dynamic and changing future, and addressing a more comprehensive and inclusive set of landscape values.

Photo: Anthony Cupaiuolo

Conventional Forest Management Approach	Lake Tahoe West's Resilience-Based Approach
Often the most appropriate for smaller scale, single-jurisdiction projects with a relatively narrow set of objectives.	Scales up restoration to address a cross-boundary large landscape and multiple objectives over the long term.
Projects are led by a single agency and fall within that agency's jurisdictional boundaries.	Process is collaboratively led by multiple agencies, spans land ownerships, and engages stakeholders across a broad spectrum of interests. Partners identify a landscape-wide restoration strategy and priorities based on landscape needs rather than land ownership.
Projects focus on fewer goals. In the Lake Tahoe Basin, often the primary goal has been community fire protection with a secondary focus on forest structure.	Landscape restoration strategy promotes multiple integrated benefits for ecosystems and communities such as forest complexity, diverse habitat, high quality water and air, and carbon storage. An overarching goal is to build resilience into complex and dynamic systems.
Projects tend to focus on the most feasible areas for treatment and are likely to avoid sensitive areas that are more difficult to treat due to cost and policy requirements. For example, projects are likely to avoid stream zones, steep slopes, and sensitive species habitats.	Landscape restoration strategy addresses the entire landscape, including areas that may be more sensitive or difficult to treat, to improve their resilience and that of the system overall. Partners explore whether changes in policy are needed to treat these challenging areas and achieve resilience.
Managers plan projects using on-the-ground conditions and best available science. Managers consider climate change impacts to the project.	In addition to best available science, managers use models of climate change and future disturbances to develop a forward-looking landscape restoration strategy.
Monitoring addresses implementation and effectiveness of individual projects rather than the trajectory of the overall landscape.	Monitoring and adaptive management will address the whole landscape and focus on areas of high scientific uncertainty.
Engages scientists in review of individual projects, typically after they are planned.	Engages scientists collaboratively and proactively to develop a restoration strategy based on landscape-specific scientific analysis and modeling.
Agencies plan projects without a formal or collaboratively developed landscape restoration strategy. Agencies may collaborate with stakeholders in planning on-the-ground projects.	Agencies develop the restoration strategy and on-the-ground projects with ongoing engagement of stakeholders, scientists, and managers. The public is invited to comment during all stakeholder meetings.

The governance structure of Lake Tahoe West supports the search for collaborative solutions to restore landscape resilience. Four public agencies – the Forest Service Lake Tahoe Basin Management Unit (Forest Service LTBMU), California Tahoe Conservancy, California State Parks, and Tahoe Regional Planning Agency – joined with the non-profit National Forest Foundation, Forest Service Pacific Southwest Research Station, and interagency Tahoe Fire and Fuels Team to launch Lake Tahoe West in 2016. Five interagency teams comprising resource managers, technical experts, and agency leaders drive Lake Tahoe West: the Executive, Core, Interagency Design, Monitoring, and Environmental Review Teams. The Interagency Design Team leads development of Lake Tahoe West work products, including this Strategy, and includes experts and managers in the fields of forest management, ecology, hydrology, wildlife biology, and fire science.

In addition to these interagency teams, the partners convened a diverse group of stakeholders and a Science Team of over 20 university and Forest Service researchers. Stakeholders represent conservation groups, fire protection agencies, the recreation community, homeowners and businesses, scientists, local government, and others with a stake in the resilience of the west shore. The Science Team and two Stakeholder Committees work on an ongoing basis with the other teams to develop all products for Lake Tahoe West, including the Landscape Restoration Strategy.

Prior collaborative efforts in the Sierra Nevada have also provided foundations for the Strategy. Lake Tahoe West adopted elements of the Dinkey Collaborative's process for assessing conditions and developing a strategy for landscape restoration in the Sierra National Forest near Fresno. An initiative at the Sagehen Creek Field Station, managed by the University of California, Berkeley, was one of the first projects to plan for landscape heterogeneity to benefit wildlife habitat. The Mokelumne Watershed Avoided Cost Analysis project with the Sierra Nevada Conservancy, The Nature Conservancy, Stanislaus and Eldorado National Forests, and stakeholders demonstrated a way to link vegetation, fire, water supply, and water quality models. Lake Tahoe West took these approaches a step further by learning from and applying them in one landscape.

The Landscape Restoration Strategy culminates Phase 2 of the Lake Tahoe West process. In Phase 1, the Lake Tahoe West partners completed a Landscape Resilience Assessment (2017) that identified landscape attributes and their current level of resilience to key disturbances. Phases 3 and 4 will comprise project planning, environmental analysis, and permitting. Partners will implement the project in Phase 5, followed by ongoing monitoring and adaptive management. Actions to reduce the risk of high-severity wildfire near communities are continuing during all of the Phases.

Concurrent with the multi-year Lake Tahoe West planning process, the partner agencies are also implementing a variety of projects that overlap the Lake Tahoe West landscape. These projects include efforts to reduce fuels and protect communities on the west shore, remove aquatic invasive species, and restore meadows and streams. These projects are complementary and contribute to achieving the Goals in this Strategy.

Phase 1
Landscape Resilience Assessment

Phase 2
Landscape Restoration Strategy

Phase 3
Project Planning

Phase 4
Permitting

Phase 5
Implementation

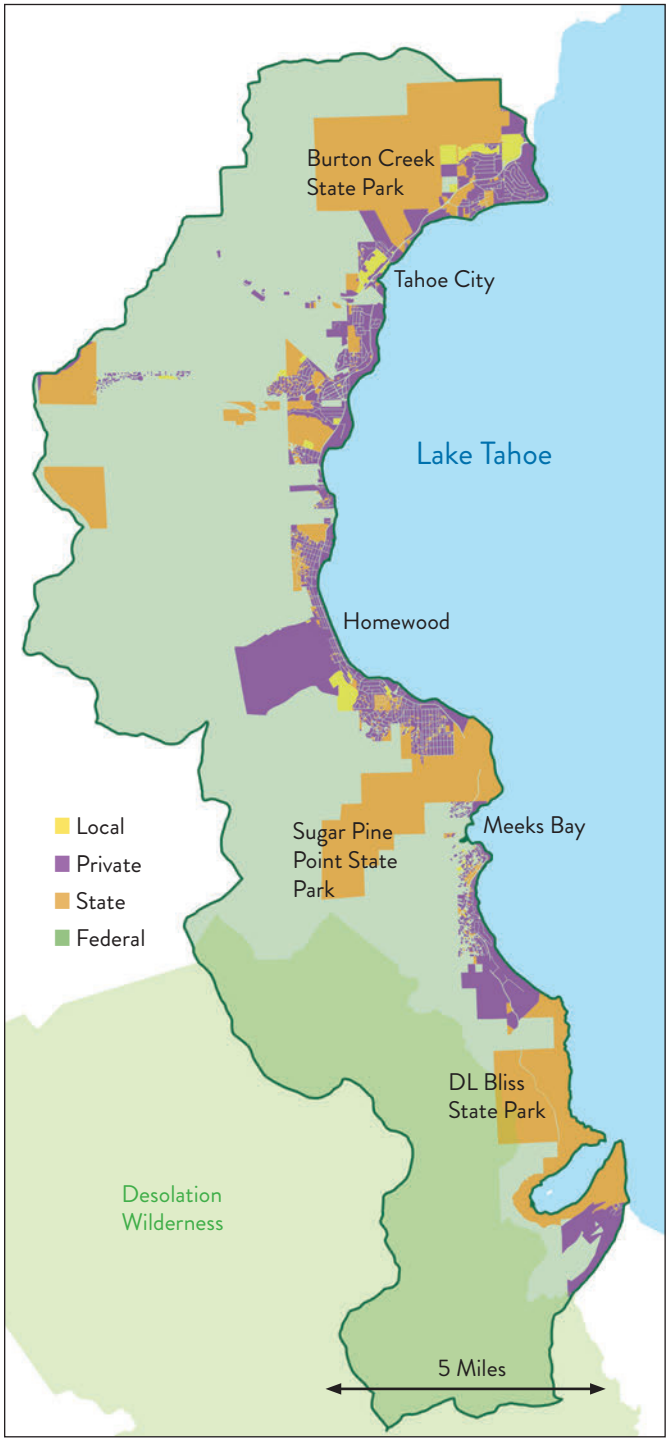
Ongoing
Monitoring and Adaptive Management

Ongoing
Community Protection Actions

Challenges and Opportunities in the Lake Tahoe Basin

The Lake Tahoe Basin is a unique and challenging place to conduct natural resource planning and management. The landscape surrounding the west shore of Lake Tahoe has immense ecological and social value. Steep slopes cascade down from the Sierra Nevada crest to Lake Tahoe, supporting forests and meadows with diverse wildlife and plant communities and clear streams that feed into the blue waters of Lake Tahoe. The region attracts very high levels of tourism and is home to about 54,000 full-time residents. The National Visitor Use Monitoring Program reported 7.7 million visitors on National Forest System lands in the Lake Tahoe Basin in 2015. This recreation hotspot has miles of roads and trails that penetrate forests, meadows, and alpine areas. Mountain biking and rock climbing are increasingly popular recreation activities, along with hiking, skiing, fishing, paddle boarding, nature watching, boating, and more. The Lake Tahoe Basin's recreation-based economy relies on the setting of snow-covered mountains, forests, streams, lakes, meadows, wetlands, and beaches.

Lake Tahoe's high profile garners both local and national political attention. This attention has created a highly complex multi-jurisdictional framework for decision-making, where several local, state, regional, and federal agencies have overlapping requirements for environmental compliance and planning. Land management in the Lake Tahoe Basin is divided among multiple public agencies, including the Forest Service LTBMU (managing 78% of the land), California Tahoe Conservancy, California State Parks, Nevada Department of Conservation and Natural Resources (including Division of State Parks and Division of State Lands), and five counties. Additionally, the Washoe Tribe of Nevada and California regards the Lake Tahoe Basin as an essential part of its indigenous homeland and cultural identity. Regulatory agencies including the Tahoe Regional Planning Agency, California's Lahontan Water Quality Control Board, and Nevada's Division of Environmental Protection provide environmental oversight. The Tahoe Regional Planning Agency provides a unique bi-state presence for regional coordination, collaboration, and environmental planning and governance.



The Lake Tahoe West landscape comprises public and private lands and many landowners. California Tahoe Conservancy and California State Parks manage the state lands (8,900 acres) and the Forest Service LTBMU manages the federal lands (43,270 acres). Source: County Assessors, Tahoe Regional Planning Agency.

The multi-layered jurisdictional and regulatory framework in the Lake Tahoe Basin makes coordination among local, state, regional, and federal agencies essential. Regional environmental organizations including The League to Save Lake Tahoe, the nonprofit organization behind the iconic Keep Tahoe Blue tagline and bumper sticker, provide an additional layer of accountability. The high public visibility of environmental and economic values in the Lake Tahoe Basin provides the opportunity to conduct planning with significant stakeholder participation and coordination. With an outsized political spotlight, the Lake Tahoe Basin can also attract funding to test innovative approaches that may not be feasible elsewhere.

With such cross-cutting agency and stakeholder activity in this region, many projects tackle multiple resource objectives and agencies always give special consideration to the waters of Lake Tahoe. The clarity of Lake Tahoe is an important shared value in the Lake Tahoe Basin. The most important indicator of lake clarity is the presence of fine sediments in Lake Tahoe. Any event that can cause erosion, such as road construction, forest management practices, or wildfires, may ultimately affect lake clarity. Land managers always aim to minimize any impacts from these types of activities and events to continue to protect Lake Tahoe.

Climate change is adding another layer of complexity to this landscape. Climate change is causing changes to the west shore now, and continued climate warming in the coming decades will further amplify these impacts. Scientific assessments clearly predict increases in temperature and length of fire seasons along with likely increases in extreme storms and extended droughts. Changes in precipitation are more uncertain, but there may be shifts toward more rain and less snow, and warm rain may increasingly fall on snow, resulting in flooding. High precipitation years that spur increased vegetation growth could be followed by years of drought, escalating wildfire risk. Climate change interacts with and may exacerbate impacts of other stressors, resulting in widespread tree mortality, proliferation of aquatic and terrestrial invasive species, and decreases in lake clarity. There is an urgent need to build resilience in the Lake Tahoe Basin to protect the ecosystem services and values that characterize this region.

The Lake Tahoe Basin Multi-Jurisdictional Fuels Strategy

There is a long history of strategic planning to reduce fuels and wildfire risk to communities within the Lake Tahoe Basin. In response to the Healthy Forest Restoration Act of 2003, Community Wildfire Protection Plans were developed for the communities surrounding Lake Tahoe. These plans are updated every five years. In 2007, the Tahoe Fire and Fuels Team, in response to the White Pine County Conservation, Recreation, and Development Act of 2006, created the Lake Tahoe Basin Multi-Jurisdictional Fuels Reduction and Wildfire Prevention Strategy (Multi-Jurisdictional Fuels Strategy). The Multi-Jurisdictional Fuels Strategy incorporated the six local Tahoe Basin Community Wildfire Protection Plans and provided a framework to collaboratively treat hazardous fuels in priority areas on federal, state, local, and private lands.

In 2014, the Multi-Jurisdictional Fuels Strategy was updated ahead of schedule to incorporate the goals of the National Cohesive Wildland Fire Management Strategy: restore and maintain fire-resilient landscapes; create fire-adapted communities; and provide effective and efficient wildfire response.

Amended again in 2017, the current Multi-Jurisdictional Fuels Strategy highlights the need for collaborative landscape-scale fuels reduction and forest restoration planning efforts encompassing both the Wildland Urban Interface and the General Forest. The 2017 Amendment recognizes the potential to develop multiple large-landscape fuels reduction and restoration plans in the Tahoe Basin, starting with the Lake Tahoe West Restoration Partnership, and describes how these plans will be incorporated by reference into the Multi-Jurisdictional Fuels Strategy. The Multi-Jurisdictional Fuels Strategy is updated every ten years, with the next update anticipated in 2024.

Development of a Science-Based Restoration Strategy

Landscape Resilience Assessment

In 2017, the Lake Tahoe West partners completed a Landscape Resilience Assessment to evaluate the current condition and resilience of the west shore. The Assessment concluded that west shore forests and watersheds are not currently resilient to fire, drought, and climate change. Forests are overly dense and uniform, leaving them vulnerable to high-severity wildfire, water stress during droughts, and insect and disease outbreaks. Higher elevations and wilderness areas are currently more resilient to most disturbances, whereas canyons and lower elevations are especially vulnerable.

Existing Science and Expertise

This Strategy incorporates the best available science and the scientific expertise of the Interagency Design Team, Science Stakeholder Committee, and Science Team. The members of these Teams and Committees have decades of experience in scientific disciplines that include forest health, fire, wildlife biology, and watershed processes. Their expertise largely stems from work conducted in the Lake Tahoe Basin or Sierra Nevada ecoregion.

The partners used key concepts from the best available science to inform the restoration approaches in the Strategy. Some of these pivotal concepts emphasize managing for resilient forest structures based on topographic variables like slope shape, position, aspect, and site-specific water availability. For example, General Technical Report 220 and General Technical Report 237 synthesize the evolving scientific understanding that a resilient mixed conifer forest structure is one with clumps of trees separated by sparsely-treed or open gap conditions. Forest openings provide growing space for the roots and canopies of the adjacent trees. Drier sites with poorer, thinner soils like ridge tops or south-facing aspects generally support fewer and smaller clumps or widely spaced individual trees. Wetter, lower areas including those on north-facing aspects and canyon bottoms have the water capacity to support more trees and possibly larger clumps of trees than drier sites.

Fire is also a crucial tool in restoring the landscape and maintaining resilient conditions because Sierra Nevada forests are adapted to frequent fire. Management actions that incorporate prescribed and naturally ignited wildfire of mixed intensities will enhance forest structural and habitat diversity, control the accumulation of dead wood on the forest floor, and reduce high-severity fire hazards.

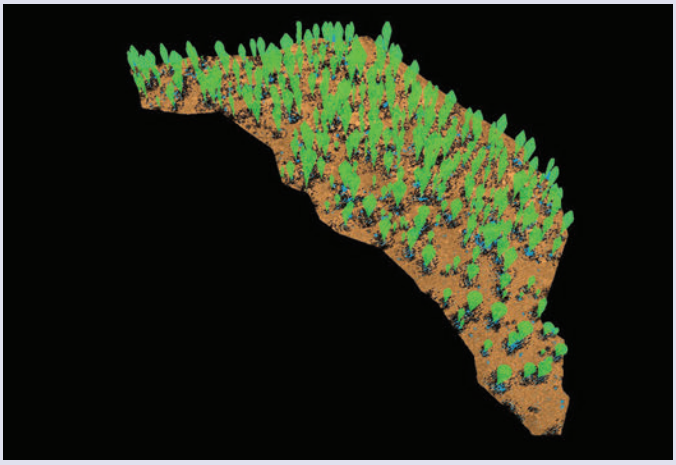
Another significant concept utilized in this Strategy comes from General Technical Report 247 that emphasizes taking a holistic perspective for managing the landscape. A holistic approach focuses on building resilience into terrestrial and aquatic ecosystems as well as local economies and communities. The Online Resources and Appendix - References sections provides links to significant papers used in Strategy development.

Key Findings of the Landscape Resilience Assessment

The Landscape Resilience Assessment evaluated the current resilience of ecological and social values on the Lake Tahoe West landscape. The Interagency Design Team led the Assessment through an iterative process with input from the Lake Tahoe West Stakeholder Committees and Science Team. These groups worked together to first identify ecological and social landscape values and services important for resilience of the west shore. The Interagency Design Team then used the best available quantitative and spatially explicit data to compare current conditions to historic and/or contemporary reference conditions.

The analysis showed which portions of the landscape and which landscape values and services are the least resilient to disturbances, particularly fire, drought, insects and disease outbreaks, and climate change. The results indicate that much of the Lake Tahoe Basin's west shore lacks resilience to a variety of disturbances. Key findings include:

- Fire has been largely excluded on the landscape since Euro-American settlement, and over 75% of the landscape has not experienced the regular return of fire. These areas tend to have higher fuel loading and tree density, conditions that increase susceptibility to high-severity fire, drought stress, and outbreaks of insects and disease.
- Current forest structure and composition decrease resilience and wildlife habitat quality. Forests are continuous, lacking small openings and patches of lower tree density that would provide diverse wildlife habitat and slow the spread of fire. Forests lack large trees that take time to grow. Forests are homogenous, containing relatively few early- and late-seral stands and a predominance of mid-seral stands. (Seral stage refers to progression of plant communities and forest structure, or how far along an ecosystem is in its development.) Today's forests are in the process of re-growing following widespread clearcutting in late 1800s, and current conditions reflect this history.
- Trees and plants are dense near the ground, creating ladder fuels that could carry fire into the tree tops. When a fire starts on the west shore, one-third of the area is susceptible to large patches of high-severity fire. The most susceptible locations include Blackwood and Ward canyons, Truckee River and General Creek drainages, and upland areas near Tahoe City and Emerald Bay.
- Approximately two-thirds of west shore meadows likely cannot provide adequate refuge for meadow species under future climate scenarios.
- Eighty percent of streams have barriers that may block fish and other aquatic organisms from passing upstream. Nearly half (47%) contain more non-native than native aquatic species.
- With three-quarters of the west shore landscape within one-quarter mile of a road or trail, the west shore of Lake Tahoe is highly influenced by human presence.
- Higher elevations and wilderness areas are currently more resilient to most disturbances, whereas canyons and lower elevations are especially vulnerable.



The Landscape Resilience Assessment evaluated indicators of resilience quantitatively and spatially using remote sensing data and an innovative object-based data classification technique called EcObject. EcObject uses high-resolution Light Detection and Ranging (LiDAR) data collected by airplane to derive tree height, health, vigor and canopy cover (left) and lumps these trees into ecologically relevant units (right). This tool enabled Lake Tahoe West to analyze the landscape at fine spatial scales and evaluate forest conditions with high accuracy.

Landscape Modeling and Analysis

Every landscape has its own nuances and complexities that shape ecosystem dynamics. Moreover, climate change introduces substantial uncertainties as to how best to manage today to create resilient conditions into the future. The Lake Tahoe West Science Team conducted computer modeling to evaluate the performance of four different management scenarios across the landscape under a changing climate over 100 years. The Science Team also conducted finer-scale modeling to understand potential effects of management on water yield, fire behavior, and road-based erosion. All models were based on conditions specific to the Lake Tahoe Basin.

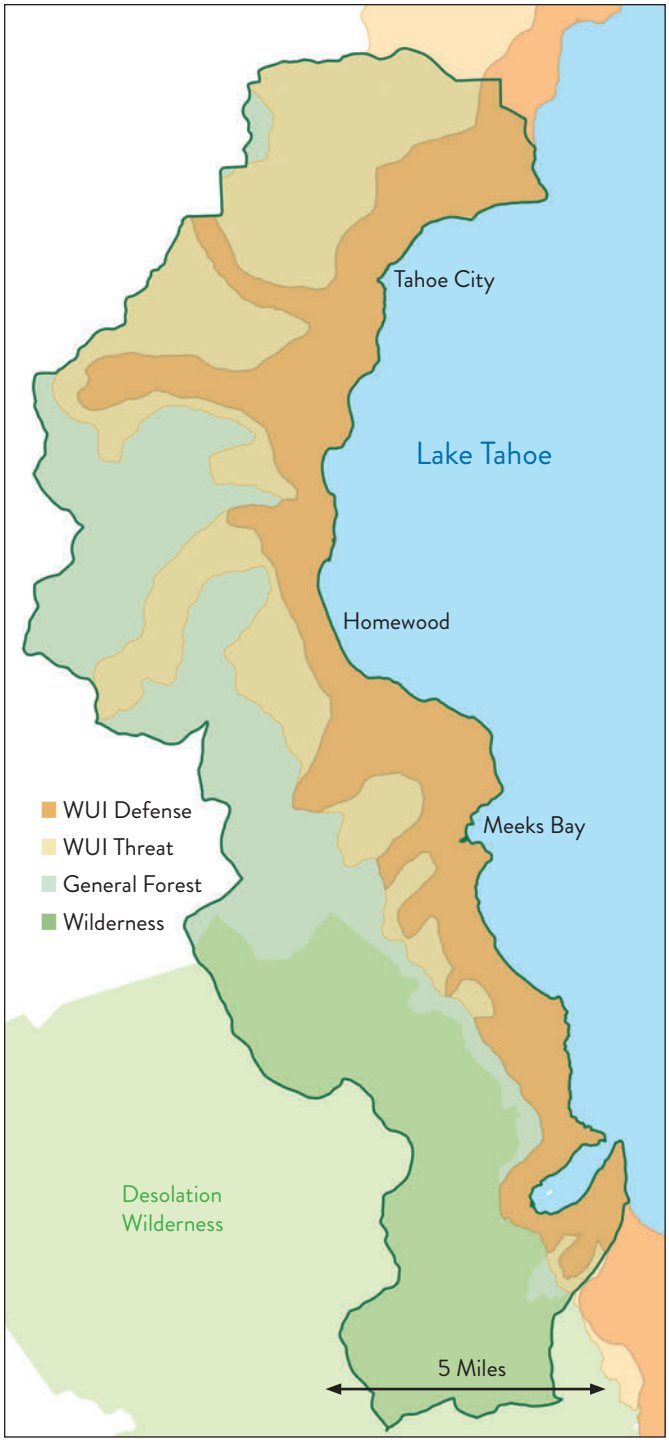
This section briefly summarizes the modeling methods and findings. Refer to the online Science Briefs and the Science Team Report for more detail.

The partners collaboratively designed four landscape management scenarios to vary by predominant management action, number of acres treated, and treatment across three geographic zones. These geographic zones represent areas on the landscape where managers emphasize different values:

- Wildland Urban Interface Defense and Threat Zones (31,811 acres). Areas closest to communities.
- General Forest (13,675 acres). Area outside the Wildland Urban Interface and farther from communities.
- Wilderness (13,257 acres). Land managed strictly for wilderness values.

The goal of the modeling was to understand how differing management scenarios are likely to interact with forest development and climate-related disturbances over time to affect landscape resilience. The goal was not to precisely model a preferred restoration strategy, which would be impracticably complex. The results reflect the composite effects of the amount, type, and intensity of treatments associated with each management approach. The relative and absolute performance of the scenarios provided many insights to ecosystem dynamics, costs, and benefits that informed this Strategy.

The models evaluated common landscape indicators such as forest development and mortality, wildfire size and intensity, and changes in wildlife habitat, along with indicators of particular importance in California and the



Partners designed the modeling scenarios to differ in the Wildland Urban Interface, General Forest, and Wilderness. The zones are defined by the Lake Tahoe Basin Community Wildfire Protection Plan based on distance from values-at-risk and local conditions. Source: Tahoe Fire and Fuels Team.

The Four Scenarios:

Scenario 1 Suppression-Only: No land management actions except fire suppression in all management zones.

Scenario 2 Wildland Urban Interface: Forest thinning in the Wildland Urban Interface only. (This scenario is most like current management actions implemented in the Lake Tahoe Basin.)

Scenario 3 Thinning-Focused: Forest thinning in the Wildland Urban Interface, General Forest, and Wilderness.

Scenario 4 Fire-Focused: Forest thinning in the Wildland Urban Interface, prescribed fire in all management zones, and allowance of naturally ignited wildfire for resource objectives outside of the Wildland Urban Interface.

Lake Tahoe Basin. For example, the clarity of Lake Tahoe is strongly regulated and an important social and ecological value in the Lake Tahoe Basin. The Science Team modeled effects of management and fire on erosion and water quality in 19 Lake Tahoe West watersheds and also analyzed potential impacts from forest roads. Because California experiences regular droughts, the Science Team modeled how tree thinning influenced water yield and snow pack retention. The Science Team evaluated carbon sequestration because many state and federal initiatives have directed agencies to consider carbon in all planning efforts. Finally, given the large human population in the Lake Tahoe Basin and the dependence of the local economy on recreation and tourism, the Science Team evaluated how wildfire and prescribed fire influenced potentially harmful smoke emissions.

The Science Team used a combination of different global climate models and emissions pathways to evaluate climate change trajectories. Different emissions pathways (called Representative Concentration Pathways or RCPs) represent different possible trajectories of greenhouse gas and aerosol emissions based on human activities. Emissions pathway RCP4.5 is regarded as an optimistic scenario (humans take action to control emissions), while RCP8.5 represents business-as-usual (uncontrolled) emissions.

The Science Team generated a wide range of model outputs to evaluate the landscape indicators. Working closely with the Interagency Design Team and Stakeholder Committees, the Science Team translated many of the model outputs into an Ecosystem Management Decision Support (EMDS) tool. The EMDS tool provided an integrated evaluation of scenario performance over time across 16 topic areas addressing key social and ecological values including vegetation health, fire, treatment costs, water and air quality, recreation, cultural resources, and other values.

Photo: Forest Service LTBMU

Modeling Results

The Lake Tahoe West modeling results were generally consistent with other research findings from the Lake Tahoe Basin and the Sierra Nevada.

Overall resilience. Scenarios 3 and 4, with the most treatment across more of the landscape, best promoted overall resilience and achieved many of the same ecological benefits. In particular, Scenarios 3 and 4 were more effective than Scenarios 1 and 2 in reducing the risk of high-severity fire to ecosystems and communities on the west shore.

These results indicate that forest thinning and prescribed and natural fire are all effective tools to restore the landscape and promote resilience. Scenario 4 achieved these benefits at a lower cost but with some greater risks to water and air quality; however the reduction in high-severity fire and its impacts offset these risks, as discussed below. It should be noted that Scenario 4 simulated prescribed fire at far greater extent and frequency than recommended in this Strategy.

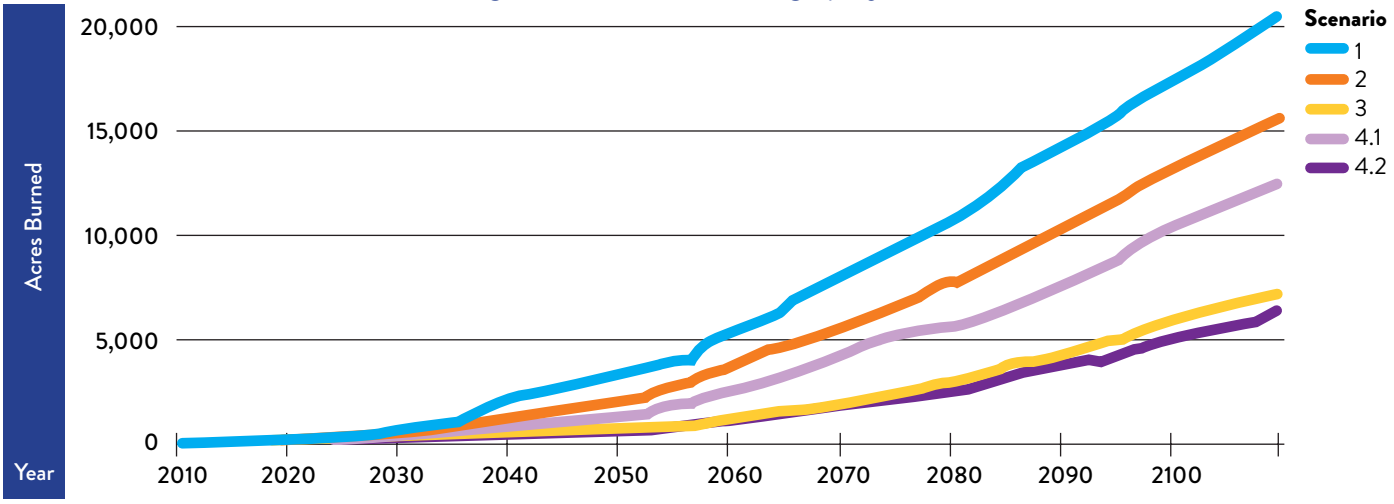
Sensitivity to climate change. Modeling results were sensitive to how much the climate changes, particularly since that influences the extent and intensity of fire. However, relative performance of the scenarios was similar across all modeled climate futures. For managers, this means that the optimal restoration strategy does not vary based on different climate models or emissions pathways.

Fire. Under all scenarios, wildfires increased as climate change led to longer fire seasons and drought periods. Scenarios 3 and 4 performed best in terms of reducing the extent and frequency of high-severity wildfires and associated risk of property loss, extreme emission days, and large patches of high-severity burns. Scenarios 3 and 4 best promoted indicators of cultural resource quality of importance to the Washoe Tribe, including the extent of low-intensity fire, aspen-dominated areas, and several animal species (deer, mountain quail, and flicker). Scenario 4 results suggest that, to increase the use of prescribed fire and achieve the benefits of this tool, managers may need to implement much larger prescribed fires than they do currently.

Fine-scale modeling of fire behavior in forest stands showed that thinning moderated fire intensity and decreased canopy consumption and that under historical forest conditions, when trees were less dense and more patchy, fires resulted in less tree canopy consumption compared to current forests.

Forest development and habitat. All four management scenarios performed similarly in terms of overall forest development and wildlife habitat. Lake Tahoe West's current forests are recovering from intensive harvest in the late 1800s. Under all management scenarios, forests continued to grow and develop through time, storing more carbon and

Cumulative Area Burned at High Severity by Scenario
(average across climate change projections)



The modeling effort showed that Scenarios 3 and 4, with a greater amount and extent of forest restoration treatments than Scenarios 1 and 2, resulted in fewer acres of high-severity fire on the landscape over time. The Science Team modeled two versions of Scenario 4; Scenario 4.2 had greater use of prescribed fire as a restoration tool than Scenario 4.1 and resulted in less high severity fire.

Photo: USDA Forest Service

improving habitat for many wildlife species. These include old-forest associated species like the California spotted owl, pacific marten, and northern goshawk.

Scenario 3 showed the highest benefit for total biodiversity by promoting habitat diversity and reducing high-severity wildfires. Scenario 3 achieved these gains despite allowing thinning of trees in Wilderness and Protected Activity Centers and some removal of trees between 30 and 38 inches in diameter. Although the modeling did not quantify the intensity of application or determine the particular influence of these three management actions, the results suggest that, at the intensity applied by the model, they did not imperil wildlife habitat at the landscape scale.

While Scenarios 3 and 4 both increased old trees, Scenario 4 resulted in less area of old trees than did Scenario 3; it is possible that widespread prescribed fire in Scenario 4 increased tree mortality including among large trees. On the other hand, Scenario 3 promoted large-diameter (i.e., old) trees somewhat more than did the other scenarios. This result is consistent with monitoring data, reported by the Science Team, which showed increased tree growth in thinned stands on the west shore. Thinning may promote increased growth of remaining trees by reducing mortality from fires and insects and by reducing competition for water, sunlight, and nutrients.

Tree species composition continued to change into the future as a result of climate and altered fire regimes. Jeffrey pine, aspen, and red fir declined while incense cedar and white fir increased. Scenario 3 helped to mitigate but did not prevent these shifts. Finally, stand-scale modeling found that thinning of trees up to 30 inches in diameter promoted aspen forest and helped prevent conversion to conifer forest; thinning was most effective when large conifers rather than smaller conifers were removed.

Carbon. All four scenarios, including 3 and 4, increased total carbon stored on the landscape. Carbon sequestration was highest under Scenarios 1 and 2, since less management leaves more trees and therefore more carbon on the landscape. However, based on the modeling results, maximizing carbon storage by avoiding treatment would be inconsistent with achieving other resilience objectives.

Scenarios 3 and 4 stored less carbon than Scenarios 1 and 2 over the long term despite reducing high-severity fire on the landscape. This result is consistent with other models showing that, at a landscape scale, forest treatments do not reduce future wildfire emissions enough to balance carbon losses that occur from treatment. Management actions that help to sequester carbon, such as using harvested wood rather than burning it in piles, can reduce (but not entirely eliminate) carbon losses from treatments.

Water quality. Expanded management increased sediment and nutrient loads but at levels far below natural background erosion. Scenario 3 showed slight increases in erosion following widespread thinning treatments but these increases were minimal compared to natural background erosion. Scenario 4 showed more erosion following prescribed and naturally ignited fire than following thinning, but still far less than natural background erosion. The results show that the relatively small water quality risks from expanded management could be offset by the long-term reduced risk of large and severe wildfire. Individual wildfire events, especially on sensitive soils, were rare but resulted in high sediment and nutrient loads when they occurred.

Scenario 3 showed little adverse impact to water quality despite simulating widespread thinning, including mechanical treatments on slopes up to 50%. A supplemental analysis by the Science Team found that thinning treatments on slopes up to 50% with deeper soils would not likely increase sedimentation, even in sensitive areas, based on the expectation of high residual ground cover and other best management practices such as buffers below treatment areas on steep slopes.

Scenario 4, which expanded prescribed and naturally ignited wildfire over large areas, resulted in higher sediment

Photo: USDA Forest Service

and nutrient loads than the other scenarios. Soil type and residual ground cover following fire strongly influenced sediment and nutrient loading. Ward, Blackwood, Eagle, and Cascade were major source watersheds for sediment and phosphorus due to presence of volcanic and/or steep soils. The modeling results were highly sensitive to assumptions about residual ground cover following fire; the estimates from the modeling could be overstated if prescribed burns are managed very conservatively to reduce surface consumption and avoid steep slopes.

The Science Team found that additional road use associated with forestry treatments increases road-based erosion, but that those loads diminish quickly after roads are no longer actively used. Some segments are at higher risk due to their location within certain slopes and soil conditions. In some cases, managers may be able to re-open old "ghost" or "legacy" roads with less impact than building new roads, but often such roads were built in locations, such as along watercourses or across steep slopes, that would make them unsuitable today.

Water yield. Hydrologic modeling showed that thinning understory trees increased water yield by increasing the amount of snow reaching the ground. The increase in water yield could increase groundwater and surface water availability for streams, meadows, downslope forests, and the lake. However, regrowth of forests following thinning could limit these effects. Removing trees up to 60 feet tall in relatively dense forest stands, particularly at lower elevations, resulted in the greatest benefit.

Air quality. Scenario 3 performed best in terms of air quality because forest treatments reduced fuel consumption by fires, leading to overall lower emissions and fewer days of high emissions. Scenario 1, with the most high-severity fire, performed worst. Scenario 4, with extensive prescribed fire, resulted in many days of emissions, but these emissions were much lower than extreme emissions that would occur during large, severe wildfires. Results did not account for the ways that managers can time and manage prescribed fires to mitigate smoke and air quality impacts.

Economics. The expanded restoration work modeled under Scenario 3 cost nearly double what is being spent today, but provided substantial payoffs in avoiding risks to life and property (e.g., 50% reduction in homes lost to fire) and smoke impacts from extreme emission days. While increased management was costly, the resulting benefits from avoiding high-severity wildfire were substantial. Society may also be willing to pay more for management to avoid the harm from infrequent but catastrophic fires. The modeling showed that prescribed burning was a cost-effective complement to thinning.

Scenarios 3 and 4 greatly reduced risks to residential properties in the Wildland Urban Interface. These trends would likely reduce loss of life from high-severity wildfire and costs from suppression and evacuations. The modeling could not differentiate between suppression costs of high versus low-intensity fires and thus did not find large differences in suppression costs between the scenarios, which all had similar total amounts of wildfire.

Overall scenario performance. The EMDS analysis showed that Scenarios 3 and 4 improved overall forest conditions over time compared to Scenarios 1 and 2. Scenarios 3 and 4 led to very good landscape conditions over the modeled century while Scenarios 1 and 2 led to conditions that generally started out in very good condition but then deteriorated. Forest condition was more stable under Scenarios 3 and 4 and was more variable decade-to-decade in Scenarios 1 and 2. Scenario 3 consistently achieved the most optimal forest conditions of the four scenarios.

Modeling Uncertainties

Modeling the future inherently involves uncertainties that managers and scientists must consider when interpreting and applying the findings. All models are imperfect representations of complex real-life systems. For example, models cannot simulate all feedback loops in an ecosystem or account for how managers may change their approaches over time. Scientists parameterize and run models using the best available data, but sometimes these data are incomplete, dated, or not available at the correct spatial scale. The following are important uncertainties and caveats regarding the Lake Tahoe West modeling effort:

- **Scale.** The landscape modeling results are best interpreted over decades and at the landscape- or management-zone scale, rather than at specific points in time or locations.
- **Wildfire.** Several factors introduce uncertainties into the modeling of future wildfires and impacts. Models use data about the past to help predict what is likely in the future, but there is little historical data on wildfire in the Lake Tahoe Basin, and wildfire behavior may change in the future as climate change accelerates. Finally, while effects of wildfire on vegetation are well-studied, effects on water quality, soils, and particularly air quality are more uncertain.
- **Air quality.** Emissions, used in the modeling as an indicator of air quality impacts, do not factor in wind conditions and movement of smoke toward human populations. The modeling of individual future wildfires suggests how air quality impacts would differ by scenario but does not provide a direct comparison of long-term impacts. Finally, the modeling did not assess effects from fires outside of the Lake Tahoe Basin or the interactions with non-fire pollutant sources.
- **Economics.** Modeling cannot account for how economic conditions will change over time with changes in societal preferences, policies, markets, and technologies. The economic modeling was based on broad estimates of treatment costs and returns from estimates of harvested biomass; actual costs and returns may differ substantially, especially if treatments are conducted at larger scales.

Photo: Roland Shaw

Pyro-cumulus clouds generated from the King Fire, on the western slope of the Sierra Nevada, billow over Lake Tahoe on September 17, 2014.

Economic conditions associated with sawmills and biomass facilities are a source of considerable uncertainty. For example, large wildfires in the region have often disrupted the markets for harvested biomass by saturating mill capacity with burned trees. The costs of treatments, such as prescribed burning or thinning, might decrease with greater economies of scale or policy shifts to favor biomass utilization, or alternatively they could increase if costs of mitigating impacts increase.

- **Climate impacts.** Both climate and ecological systems are highly complex. There are large uncertainties about trends in future climate, how ecosystems will respond, and potential interaction between disturbances. For example, there is high uncertainty about how future climate will affect insect outbreaks and resulting tree mortality in forests. While the landscape modeling addressed future climates, subsequent modeling of economics, water quantity, and air quality did not directly incorporate changes in future climate and associated factors.

While acknowledging these challenges, the Lake Tahoe West partners have confidence in the modeling results and their ability to inform strategies to increase landscape resilience. The Lake Tahoe West partners paid closest attention to the results projected over the next 50 years with the expectation that adaptive management will help to recalibrate future management approaches.

Photo: Forest Service LTBMU

Implications for the Landscape Restoration Strategy

Informed by the modeling results, the Strategy combines aspects of Scenarios 3 and 4 to increase the pace and scale of restoration across the landscape in ways that maximize benefits for social-ecological resilience while minimizing impacts. The Strategy recommends that managers continue to reduce fire risks near communities while greatly expanding forest and watershed restoration to the General Forest. Expanding restoration across the landscape is essential to reducing the risk of high-severity wildfire to the west shore's human communities. Supported by the modeling, the Strategy calls for a substantial increase in forest thinning and prescribed fire as complementary tools to reduce fire risks, improve forest structure and diversity, protect and enhance wildlife habitat, and increase water yields.

The modeling results inform ways to minimize potential impacts of expanded restoration treatments. All modeled scenarios predicted substantial increases in fire and smoke due to a changing climate. However, forest treatments such as thinning and prescribed fire will influence the conditions under which fires occur and whether outcomes are positive or negative for key resource values. Work completed under this Strategy would spread out smoke impacts among many smaller prescribed and naturally ignited wildfire events, where smoke dispersal is easier to predict and mitigate, and minimize the risk of a large high-severity fire that could blanket population centers in unhealthy levels of emissions for extended periods. Informed by modeling results, the Strategy similarly identifies how managers can minimize risks of forest treatments to erosion and water quality including by using adaptive management and taking special care in areas with highly erosive soils.

During the next phase of the Lake Tahoe West process, the partners will develop a monitoring plan for continued assessment and adaptive management of the landscape. Monitoring and adaptive management will help managers proceed in areas of uncertainty and to course-correct in response to new information. Scientists can also use monitoring results to improve future modeling efforts.

The Strategy

The Strategy comprises six overarching Goals, 27 Objectives, and a set of Strategy and Prioritization Guidelines intended to move the Lake Tahoe West landscape towards a resilient condition over a 20-year implementation period. Rather than identifying specific sites for restoration, the Strategy uses a condition-based approach that provides the flexibility to adaptively manage the landscape as conditions change. The Lake Tahoe West partners will evaluate and identify specific treatment locations during the project planning phase, taking into consideration current conditions, goals and objectives for multiple resources, geographic constraints and opportunities, and other factors.

This chapter summarizes each Goal and its associated Objectives. For the full suite of Goals, Objectives, and Strategy and Prioritization Guidelines, refer to the Appendix. A separate online document provides the technical Rationale and Supporting Information for this framework.

Photo: California Tahoe Conservancy

Photo: USFS–Brian Hornberger

Goals

The Strategy includes six primary Goals. These Goals focus on forest composition and structure, fire, native species and sensitive habitats, aquatic systems, community safety, and regional economics. Goals do not include completion dates but should generally be achieved and endure for 50 - 100 years or longer. The Goals are derived from a group of principal ecosystem values and services identified by the Stakeholder Committees, Interagency Design Team, and Science Team early in the Lake Tahoe West process. The uniqueness of this Strategy is that all these Goals are equally important and project planning will focus on developing projects that simultaneously advance these Goals on the landscape. The Strategy aims to provide guidance for prioritizing projects that have multiple resource benefits.

Objectives

Objectives are specific intentions that land managers will seek to accomplish in the next 20 years. Objectives serve as milestones towards achieving the longer-term Goals. Objectives may shift as disturbance, monitoring results and adaptive management, and other factors influence landscape conditions and management priorities and capacity.

Strategy and Prioritization Guidelines

These Guidelines are recommended management approaches for achieving the 20-year Objectives. The Guidelines provide managers with geographic, topographic, and condition-based direction for where and/or how to focus restoration efforts to achieve ecological Objectives. To achieve social Objectives, the Guidelines recommend actions to improve cultural values, reduce risks to communities, reduce or mitigate impacts to recreation, and support local economies. Managers will use monitoring and adaptive management to continually refine treatment approaches throughout Strategy implementation.

Goal 1 – Forests recover from fire, drought, and insect and disease outbreaks

Goal 1 emphasizes restoring the structure and species composition of forest ecosystems to promote resilience to natural and human disturbances. Past logging and fire suppression have decreased forest age, structural complexity, and species diversity on the west shore. Much of the landscape is currently occupied by overly dense forests at risk of mortality from fire, insect and disease outbreaks, and drought. These dense forests have low complexity and resilience. Older (late-seral) forests are not as abundant on the west shore as they should be. Instead, the area is now dominated by younger (mid-seral) forests.

Structural and genetic diversity are important attributes to help forests withstand fire, drought, and insect and disease outbreaks. Heterogeneity, or diversity in forest structure and composition, is important at both the landscape scale and at smaller stand scales. Management actions focused on increasing structural variability and reducing stand density through thinning and careful use of prescribed fire will build forest resilience. A resilient forest structure requires a mix of tree species, a range of older and younger trees, and a variety of spatial arrangements and densities ranging from few to abundant trees. Maintaining this heterogeneity is a dynamic process as forests respond and adapt to disturbance processes.

Managers should treat upland, aspen, and riparian forest types to reduce tree densities where they are overly dense, reduce mid-seral and increase late-seral forests, maintain a mix of tree species, and create small forest openings. Both management and natural disturbance can contribute to achieving this Goal. This Strategy identifies Objectives to achieve each of these values; in practice, treatments would be designed to meet multiple Objectives on the same acreage. Key management tools include thinning using hand crews or mechanical equipment, prescribed and naturally ignited fire, and reforestation after large disturbance events. A combination of these tools will best achieve resilience. For example, after conducting initial treatments, managers can follow up with prescribed fire to maintain resilient structure and composition. Fire naturally creates patchiness through varying mortality levels and fire effects.

Forest resilience based on the number of trees per acre. Approximately 40,500 acres of the Lake Tahoe West forested area has more trees per acre (non-resilient) than historic or contemporary reference conditions. Source: EcObject v2.1 Tahoe Basin.

Photo: Forest Service LTBMU

Developing resilient forest conditions, especially late-seral forest conditions, will take decades as trees grow bigger and older. Small openings and gaps created by targeted forest thinning and natural disturbance will contribute to development of heterogeneous conditions over time, and trees will continue to grow and fill into existing and new gaps. Managers should consider reforestation after large disturbances to promote or maintain species and genetic diversity in anticipation of changing climate. Removal of large trees may be important in certain limited circumstances, including when restoring aspen forests or when stand density of large trees puts the stand at risk of imminent mortality.

Goal 1 Objectives

- Decrease tree density on 40,000 acres to move forests closer to within the range of natural variation for tree densities and to increase forest structural heterogeneity.
- Reduce over-represented seral stages, increase under-represented seral stages, and set the landscape on a trajectory toward the natural range of variation on 23,000 acres.
- Use management actions and natural disturbance events to create or maintain forest openings on an aggregate of 21% of the forested landscape to increase structural heterogeneity.
- Conduct restoration treatments in approximately 400 acres of aspen and/or other riparian hardwood forest types.
- Facilitate reforestation after large-scale disturbance events that result in openings greater than 40 acres or when openings exceed 34% of the forested area.

Photo: Forest Service LTBMU

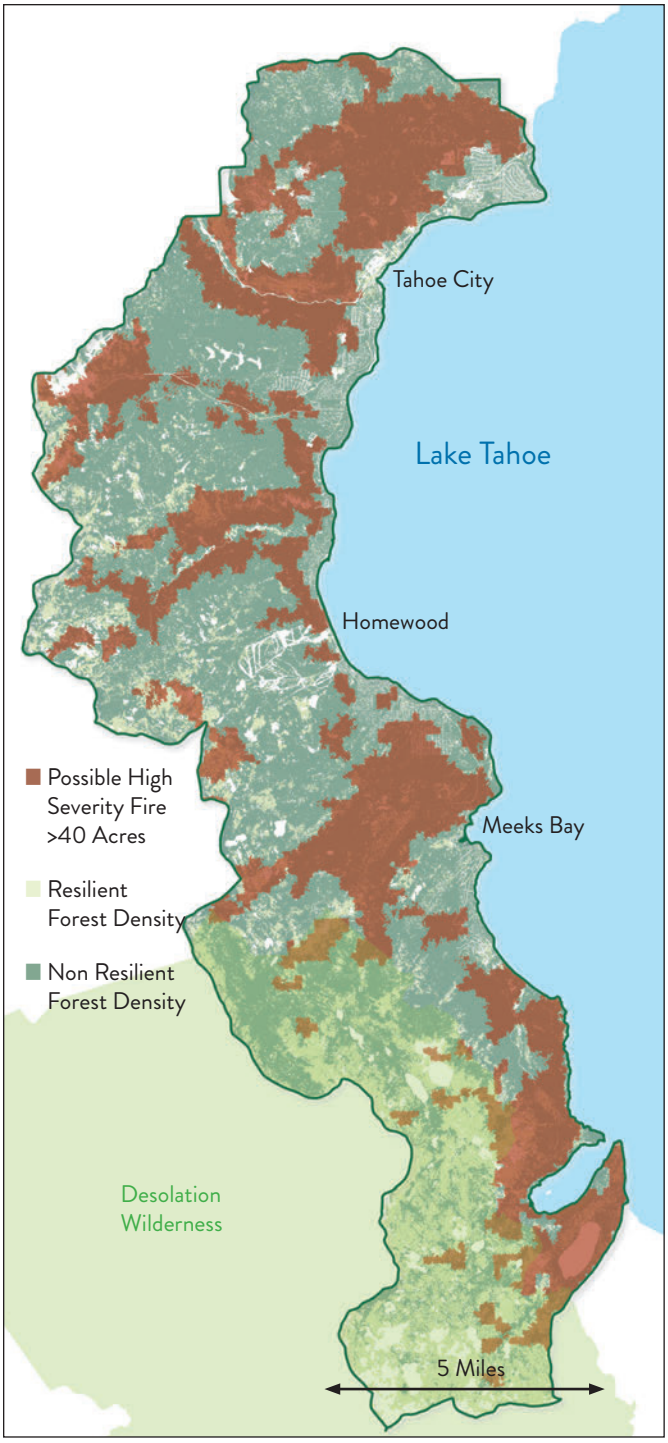
Mixed conifer forest before (above) and after (below) hand thinning treatment.

Goal 2 – Fires burn at primarily low to moderate severity and provide ecological benefits

The forests of the Lake Tahoe Basin are historically adapted to frequent low- and moderate-severity fires, with some small patches of high-severity fire. Fire once played an important role in maintaining ecosystem processes and functions like forest thinning, biogeochemical cycling, and soil development. For the past 100 years or more, managers have mostly excluded fire from the dry forests of the Lake Tahoe Basin, resulting in dense and water-stressed vegetation with large fuel accumulations. These conditions create a high fire hazard, where wildfires burn at much higher severity than they did historically, as demonstrated by recent large fires in the Lake Tahoe Basin (Gondola and Showers Fires in 2002, Angora Fire in 2007, and Emerald Fire in 2017). Climate change projections suggest that fires will become more frequent in the Lake Tahoe Basin in the coming decades.

Goal 2 seeks to create landscape conditions that sustain primarily low- and moderate-severity wildfires rather than large, high-severity wildfires. These conditions would also allow land managers to increase natural and prescribed fire as tools to manage forest fuel accumulations and provide ecological benefits. The Strategy includes treatments to prevent high-severity fire from occurring within the Defense Zone, which is the area closest to communities. Outside of the Defense Zone, the Strategy recommends treatments to minimize high-severity fire to patches less than 40 acres. In these small patches, high-severity fire can generate ecological benefits such as new forest gaps and early-seral stands.

While land managers have successfully reduced forest fuels and stand density with forest thinning treatments, these treatments often leave behind duff, surface litter, or masticated or chipped fuels. Even when designed to increase stand heterogeneity, thinning treatments tend to create a more homogenous forest stand structure than in stands that have experienced fire. Mixed-severity fire, with primarily low and moderate intensities, can reduce duff and surface-litter fuels and increase the spatial complexity of the forest through varying fire effects, benefiting wildlife habitat, forest resilience, and water flows.



Areas in red (19,317 acres) have the potential for patches of high-severity fire to exceed 40 acres. The remainder of the landscape may have high-severity fire, but the patches likely will not exceed 40 acres except under extreme conditions. Source: EcObject v2.1 Tahoe Basin, FSIM.

Photo: USDA Forest Service

This Strategy recommends that managers use fire as a landscape restoration tool in combination with techniques to minimize risk to human safety, property, and public health. Strategies for implementation of fire treatments will vary based on proximity to the Wildland Urban Interface, current fuel levels, and landscape position including aspect, elevation, and slope. Opportunities to use fire as a restoration tool will likely increase over time, as managers complete more acres of fuels reduction and forest thinning treatments across the landscape. Completing and maintaining thinning and fuels reduction treatments within and adjacent to communities will be critical prior to wide-scale use of fire. Managers should consider ridges, roads and trails, and riparian corridors for strategically placed thinning and fuels reduction treatments to create firebreaks that can allow for the increased use of fire as a restoration tool.

Prescribed fire following thinning treatments can improve the longevity and effectiveness of fuels reduction. Managers may use low- to moderate-intensity prescribed fire as a primary tool in areas with less hazardous fuel conditions such as some meadows and aspen stands. Prescribed burning in meadow restoration efforts offers particularly important benefits, including promoting native fire-adapted plants and improving meadow soils through incorporation of charcoal.

Numerous factors bound managers' ability to use natural and prescribed fire on the Lake Tahoe West landscape. These include limited resources, prolonged fire seasons, and weather conditions. Managers also must limit smoke impacts, particularly during the summer recreation season. However, smoke impacts from prescribed fire are substantially less than impacts from wildfires, which, according to modeling, will increase in the coming decades along with resulting smoke impacts.

There are a limited number of operational burn days, where fuel moisture conditions, resource availability, and weather conditions align to allow managers to implement prescribed fire treatments. Because prescribed fire and use of naturally ignited fire can only happen in short seasonal windows, and under opportune weather conditions, it is critical to have staffing available during those times. Agencies typically rely on the same personnel to suppress fires and to conduct prescribed fire treatments, which in practice limits staff availability for prescribed fire. An increase in staffing will be necessary to increase the amount

of prescribed fire conducted on the Lake Tahoe West landscape, as described in Goal 6. Because of these constraints on using fire, thinning treatments will remain an important tool for enhancing stand structure and reducing forest density.

Managers may consider staging restoration treatments to restore floodplain connectivity in streams (Goal 4) prior to large-scale use of fire. This approach would take advantage of the capacity of restored floodplains to accumulate loads of fine sediment, phosphorus, and burned wood into the floodplain soils. The Lake Tahoe West modeling suggested that increased use of fire has potential to increase loads of fine sediment and phosphorus, which could have negative effects if discharged directly into the lake, but those loads could be restorative if they are deposited within floodplains and meadows. Managers can design and conduct prescribed burns to minimize these impacts by limiting fire severity and using buffers. However, allowing a wide range of fire intensity (from either prescribed fires or naturally-ignited wildfires) could help to restore both terrestrial and aquatic structure and function.

Prescribed burns should be arranged, timed, and staged to mitigate potential impacts to air quality and water quality. Managers can achieve this by taking advantage of buffers, favorable weather conditions for smoke dispersal, and other elements. To protect soils and other resources, managers should incorporate best management practices into recovery from any fire that occurs on the landscape. Adaptive management will be critical for scaling up the use of fire as a management tool on the landscape.

Photo: Forest Service LTBMU

California Spotted Owl

Goal 2 Objectives

- Strategically locate and treat 7,900 - 9,000 acres of the Threat Zone and General Forest to limit high-severity fire to contiguous patches less than 40 acres in size.
- Increase the use of prescribed fire to remove understory fuels and promote changes in vertical structure; by year 20, prescribed fire is used on approximately 80% of operational burn days.
- Increase the use of wildfire from natural ignitions that occur within the Wildland Urban Interface Threat Zone, General Forest, and Wilderness to mimic natural or desired fire regimes, and to remove understory fuels and promote changes in vertical structure.

Goal 3 – Terrestrial and aquatic ecosystems support native species

Goal 3 aims to provide a resilient landscape for native terrestrial and aquatic wildlife and plants and their habitats. A resilient landscape is one that supports a network of well-connected habitat for native species that can adapt to disturbances through time. This Goal focuses on restoring resilience to forest, meadow, riparian, and aquatic ecosystems to support habitat for native flora and fauna.

Forest-dominated habitats within Lake Tahoe West are denser than historic and contemporary reference forests. Current forest conditions increase wildlife habitat vulnerability to wildfire, drought stress, and insect and disease outbreaks. Throughout the Sierra Nevada, high-severity wildfires and massive tree mortality events increasingly impact these protected habitats. High fuel loads make them vulnerable to stand-replacing fire and resulting habitat loss. An increase in short (less than 50-feet tall), small-diameter trees make this habitat increasingly unsuitable for species like the spotted owl that prefer tall, large-diameter trees characteristic of older forests.

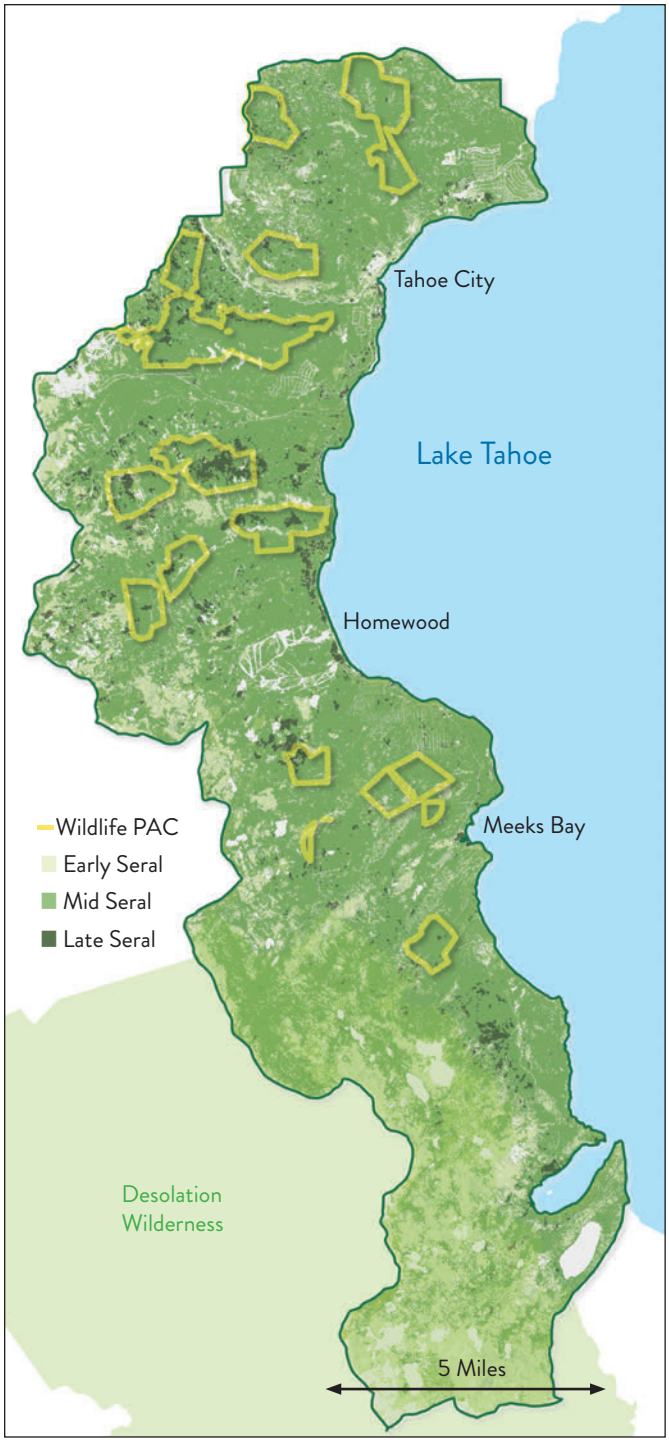
Managers typically avoid treating sensitive wildlife habitat (i.e. Protected Activity Centers) for species like California spotted owls and northern goshawks. However, given the increasing trend in the loss of forested habitat, managers and scientists are becoming more comfortable

Photo: AdobeStock

Pacific Marten

with carefully designed forest restoration treatments in Protected Activity Centers. This Strategy recommends using management actions including thinning and prescribed fire in Protected Activity Centers to reduce the risk of large, high-severity fire and increase the amount and quality of old-forest conditions. Restoration would improve habitat not just for these sensitive species but also for the greater forest community including other wildlife species, plants, and soil microorganisms. As described in Goal 2, the Strategy prioritizes using fire as a management tool in these areas where it can be used safely.

Meadows are important biodiversity hotspots and contribute to plant and animal species diversity disproportionate to their relatively small size on the landscape, so the function of meadows is imperative to sustaining current and future species communities. Meadow function is at risk because of altered hydrology from meadow draining and grazing, fire suppression, and fragmentation from trails and roads. The altered hydrology and lack of fire has led to conifer encroachment in many meadows. This encroachment further alters hydrology by decreasing the water table and increases competition among native meadow vegetation for light, space, and nutrients. With climate change, meadows will get drier, leaving them vulnerable to conversion to other vegetation types. This Strategy calls



California spotted owl and northern goshawk Protected Activity Centers include a range of late-, mid-, and early- seral forest conditions. Source: Forest Service, Tahoe Regional Planning Agency, EcObject v2.1 Tahoe Basin.

Photo: Forest Service LTBMU

The Highway 89 bridge over Meeks Creek is an example of a fish passage barrier on the west shore.

for an assessment of meadow location and condition in the Lake Tahoe West landscape to provide informed guidance for meadow restoration. For meadows that are already documented and mapped (780 acres), the Strategy focuses first on restoring meadows that are predicted to be resilient to climate change. Managers should aim to restore a variety of meadow types (wet, dry, riparian, etc.) and support meadow systems that provide habitat to sensitive species.

Stream ecosystems are an important component of landscape resilience because they provide habitat that supports life history requirements of native species. Connected stream habitat that offers diverse microhabitats such as pools and overhanging banks will offer climate refugia for native species in the future. However, many streams and streamside habitats in the Lake Tahoe West landscape are degraded and fragmented. For example, 80% of streams in the Lake Tahoe West landscape have man-made barriers that prevent the movement of native fish upstream to spawning areas. Many of these barriers result from culverts underneath trails and roads; they not only impede movement of fish but can also prevent downstream transport of wood and sediment important for maintaining in-stream habitat. Decades of non-native fish stocking for sport fishing has further exacerbated habitat degradation. Restoration of these habitats under this Strategy could include improving connectivity, increasing stream-channel heterogeneity, maintaining late-season water flows, and removing barriers to aquatic organism passage.

Goal 3 includes a broad Objective to improve habitat condition for all native species where habitat is degraded, where opportunities exist to improve conditions, or where an area may provide refugia under future climate conditions. For example, managers could re-route, upgrade, or remove roads or trails that are degrading sensitive habitats or bisecting nesting or denning areas. Managers can incorporate species-specific habitat features, like dense cover areas for the Pacific marten, into project designs. Managers may remove non-native fish species from streams and improve habitat complexity for native fish species. These are simply a few examples; priorities and needs for habitat improvement will shift over time.

Photo: Forest Service LTBMU

Cold Creek / High Meadows restoration project by the LTBMU Forest Service.

Terrestrial and aquatic invasive species fundamentally change ecosystems and negatively affect water quality. Invasive species can directly compete with or predate upon native species. They also change ecosystem processes such as plant succession patterns, soil properties, and water quality in ways that make the habitat inhospitable for native species. Recreational activities including boating and driving off-highway vehicles can introduce and spread aquatic and terrestrial invasive species. Forest disturbances such as thinning and wildfire rehabilitation can promote terrestrial invasive species like bull thistle and cheat grass. Climate change exacerbates these risks because warmer temperatures are favorable to non-native species currently limited by cool temperatures. Prevention of new invasive species introductions, coupled with early detection and rapid response, are the two most effective ways to protect native ecosystems from invasive species. This Strategy includes an Objective to support and expand existing terrestrial and aquatic invasive species prevention, surveys, and rapid response.

Goal 3 Objectives

- Create an increasing trend in the acres and quality of reproductive habitat for late-seral associated species.
- Restore and maintain at least 780 acres of meadows.
- Improve the habitat condition and promote climate refugia for native aquatic and terrestrial wildlife species.
- Resize, replace, remove, and/or reconfigure 10 identified barriers to improve passage of native aquatic organisms.
- Implement new and expand existing early detection rapid response programs for invasive species management.

Photo: Forest Service LTBMU

Meadow restoration in the Lake Tahoe Basin.
Above: Dense conifer growth in Baldwin Meadow near South Lake Tahoe.
Below: Baldwin Meadow recovery eight months after conifer removal and prescribed fire.

Goal 4 – Healthy creeks and floodplains provide clean water, complex habitat, and buffering from floods and droughts

Goal 4 emphasizes restoring natural processes in creeks and floodplains to increase resilience to future disturbances and climate change, maintain water quality and lake clarity, and increase water quantity. Historic management practices significantly impacted stream and watershed hydrology on the landscape. For example, historic logging created an extensive road and skid-trail system and diverted streams for timber mill operations, practices that damaged hillslopes, altered stream alignments, and increased soil erosion potential. Extensive grazing compacted soils in sensitive meadows and riparian areas and limited or prevented re-establishment of vegetation.

A resilient Lake Tahoe West landscape includes creeks with healthy vegetation and natural water cycles that buffer against variability in precipitation, including more frequent rain-on-snow events predicted to occur with climate change. Rivers and streams are naturally dynamic systems that change based on the geologic setting, valley type, channel shape, and sediment transport processes, and as such they are different across the west shore. A resilient creek includes erosion and deposition in varying places such that the system does not experience ongoing sediment overloading or accelerated (human-caused) bank and bed erosion. In some streams, fallen trees become woody debris that form and maintain pools and cover habitats

This Strategy includes treatments to improve the physical structure and vegetative condition of streambanks, enhance stream bed complexity, and restore stream channel functions. These actions will minimize erosion and sustain wildlife habitat diversity. Restoration work will also improve connectivity of stream channels to associated floodplains and meadows to enable beneficial sediment deposition. Meadows and floodplains, especially in a resilient condition, can capture sediment and nutrients from hillslope erosion. Completion of stream channel and floodplain restoration prior to upland forestry work could help maximize the benefits of disturbances such as fires, while reducing transport of fine sediments and nutrients to Lake Tahoe. Such restoration efforts could also enable managers to use variable-intensity prescribed and natural wildfire to promote ecological goals, as described in Goal 2.

Photo: California Tahoe Conservancy

Steep slopes with rock outcrops and naturally erosive soils categorize much of Ward and Blackwood Creeks' upper watersheds. This photograph shows the northwest corner of the Ward Creek watershed.

Not only water quality but also the quantity of water in stream channels matters for watershed resilience. In-stream water flows sustain healthy aquatic habitat and reproductive populations of native plant and animal species. The Strategy prioritizes conifer thinning in relatively dense forest stands, particularly at lower elevations, where it may increase snow retention and duration of water flow in streams. Retaining more water from snowfall will increase forest stand resilience and increase late-summer water levels in downslope streams. Maintaining water levels late into the summer is critical to maintain cold-water habitat for native fish species.

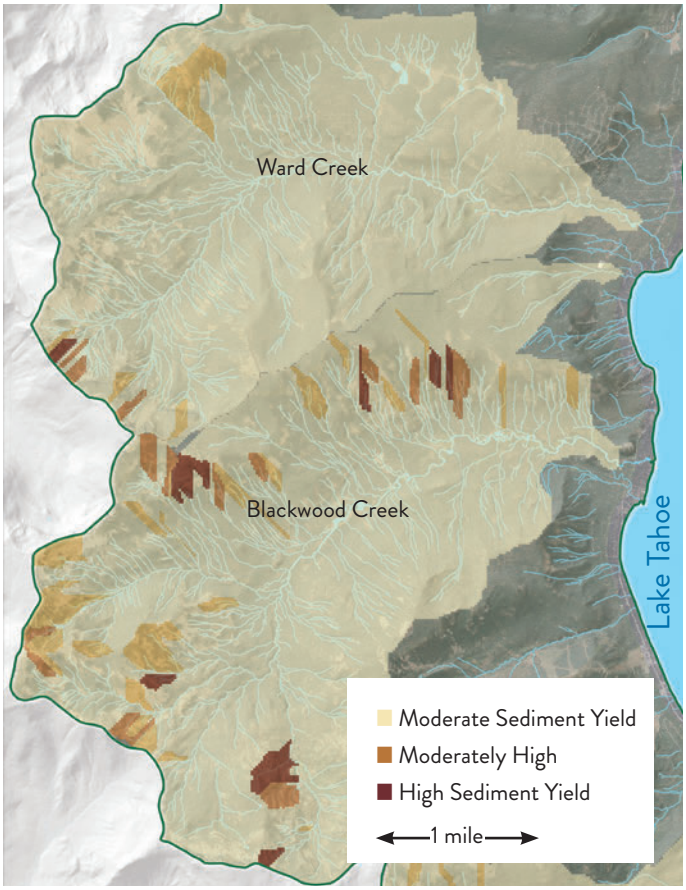
Forest restoration treatments can help to protect water quality and lake clarity. Modeling results show that large high-severity wildfires, particularly if they occur on sensitive soils, can generate significant erosion and water quality impacts. On the other hand, on most of the west shore landscape, expanded management would only

slightly increase sedimentation risks compared to natural background erosional processes. These risks are closely monitored and regulated in the Lake Tahoe Basin; to mitigate risks and protect water quality, managers use best management practices when implementing forest restoration projects. As described above, stream and floodplain restoration can also minimize impacts, since functioning downstream streams and floodplains can capture sediments and prevent them from reaching the lake. The Lake Tahoe West modeling effort indicated that prescribed fire may generate more sedimentation than forest thinning; monitoring and adaptive management can help managers understand these risks and adjust management practices accordingly.

The modeling effort identified sensitive soils that warrant particular attention from managers. These include many of the volcanic-derived soils within the Blackwood and Ward watersheds. These areas are characterized by rock outcrops that, while reducing fire spread, can also increase sediment generation when fire occurs. In areas with sensitive soils, managers should minimize wildfire risks and use special care when conducting treatments.

When roads and trails are poorly designed and/or unmaintained they can be a significant source of erosion and sediment in the waterbodies of the Lake Tahoe West landscape. Modeling of the road network in Lake Tahoe West has highlighted forest road segments that pose greater erosion risk and therefore represent restoration opportunities. Compacted road and trail surfaces increase the rate of water runoff and prevent precipitation from infiltrating. Road cuts can also intercept surface and groundwater and concentrate flows in new locations. When water is redirected and unable to infiltrate into the soils, it has the potential to cause erosion and deliver large amounts of sediment and nutrients to stream channels and potentially Lake Tahoe. Fine sediment entering Lake Tahoe can remain suspended in the water column and nutrients can drive algal growth in the Lake, reducing lake clarity.

The Lake Tahoe Total Maximum Daily Load (TMDL) provides a science-based plan to understand the causes of clarity loss, determine levels of pollution reduction needed to reinstate historic clarity levels, and develop a workable, cost-effective implementation strategy. To reduce the risk of sediment reaching Lake Tahoe and impacting lake clarity, land managers will meet TMDL recommendations through implementation of standard best management practices to prevent, capture, and treat storm water and erosion runoff from all landings, roads, and trails consistent with regional regulations and TMDL implementation plan recommendations. In addition, the native surface road system within Lake Tahoe West will be restored to upgrade and stormproof, or decommission where appropriate. Ensuring that road systems are restored and maintained will reduce erosion and sediment delivery and increase resilience to high-intensity storms or rain-on-snow events predicted with climate change.



In Blackwood and Ward Creek watersheds, naturally erosive soil types contribute the majority of sediment yield from each hillslope area. The Blackwood Creek watershed contains an especially high proportion of these soils. In Blackwood Canyon, Melody-Rock Outcrop soil type and Ellispeak-rock Outcrop soil type cover 26% of the area and deliver 95% of the sediment. Source: WEPP modeling at 30m x 30m pixels.

Photo: Forest Service LTBMU

Cold Creek / High Meadows following restoration by the LTBMU Forest Service.

Goal 4 Objectives

- Restore road and trail networks including stream crossing structures (e.g. culverts, rock fords) to accommodate future increased stream flows and prevent erosion and water quality impacts.
- Restore currently identified stream reaches and enhance up to 9 miles of stream channel to improve function, reduce excessive bed and bank erosion, and meet Total Maximum Daily Load recommendations.
- Complete upland thinning treatments to increase snowpack retention, groundwater recharge, and resultant late-summer water availability.
- Treat around areas with highly erosive soils to reduce fire risk and conduct thinning where necessary with special considerations.

Photo: USDA Forest Service

Lahontan Cutthroat Trout

Photo: Forest Service LTBMU

Goal 5 – People live safely with fire and enjoy and steward the landscape

Goal 5 focuses on protecting Lake Tahoe's communities and enhancing stewardship and recreation. Increasing risk of high-severity fire poses the most pressing threat to communities on the west shore. In the face of this threat, managers will continue to place the highest priority on the safety and well-being of communities. In addition, cultivating stewardship and high-quality recreational access will have benefits that flow back to the natural environment by increasing communities' understanding and connection to the landscape.

Previous and ongoing activities by Lake Tahoe West partners have promoted a widespread culture in the Lake Tahoe Basin of wildfire awareness and risk reduction. Ongoing efforts to create communities where citizens are engaged in preparing for wildfire and smoke are critical to creating a resilient landscape. Stewardship actions that residents take, such as managing vegetation around homes to create defensible space, will support this and other Goals of the Strategy.

Ongoing agency efforts to reduce fuels in the Wildland Urban Interface and to restore forests across the landscape complement this work. Lake Tahoe West partners are currently planning and implementing several projects on the west shore to reduce fire risks near communities and along transportation and power line corridors. In addition, Lake Tahoe West partners aim to increase understanding and social acceptability of prescribed burning as a management tool that can complement other approaches. Water supply and infrastructure are important components to making communities resilient to fire because they improve fire suppression capability and provide needed water to support prescribed fire activities. These efforts reduce the likelihood of high-severity fires, enable safer and more effective fire suppression, and allow for increased use of fire as a restoration tool as described in Goal 2. Lake Tahoe West partners will continue to coordinate across land ownerships to plan restoration treatments, protect communities, and minimize exposure to smoke resulting from prescribed fire treatments.

The vitality and resilience of Lake Tahoe's human communities and natural landscape have long been inextricably linked. The Washoe Tribe of Nevada and California has a 10,000-year history of environmental stewardship in the Lake Tahoe Basin. The Washoe Tribe's unique knowledge and guardianship of the Lake Tahoe Basin and its plants and animals will guide and support partner restoration activities. The Lake Tahoe West partners will continue working with the Tribe on efforts to restore Meeks Meadow and other sites of importance to the Tribe and seeking opportunities to employ field crews that include tribal members.

The Landscape Restoration Strategy places high importance on restoring the landscape and the many ecosystem services that it provides to human communities. For example, residents and visitors depend on the Lake Tahoe Basin's recreational opportunities, clean water, and natural beauty. Diverse year-round recreational opportunities strengthen the regional economy and connect residents and visitors to the landscape. Collaborating with the Lake

Tahoe Basin's Sustainable Recreation Working Group, partners implementing the Strategy will maintain recreation access and seek opportunities to enhance high-quality and equitable recreation experiences. For example, forest restoration activities can benefit hikers, skiers, and others by improving vistas and enhancing public safety. Reducing the risk of high-severity fire overall also lessens the risk of extreme emissions and air quality impacts that can make recreation unsafe.

Effective communications with residents, key stakeholders, and the general public about benefits and potential short-term impacts of restoration projects are an important strategy to achieve this Goal. Common concerns to these groups include potential smoke impacts of prescribed fire, impacts to parking and trailhead access, and immediate aesthetic impacts from forest treatments. Agencies can proactively provide information and seek input to minimize impacts, help residents plan for smoke, and identify opportunities to enhance recreation. The Lake Tahoe West partners will use multiple avenues for communication such as direct outreach, social media, videos, public events, brochures, and trailhead signage. Local businesses, homeowners associations, recreation advocates, and other groups can also help Lake Tahoe West reach and inform their constituencies.

Photo: Todd Gilens

Photo: Forest Service LTBMU ??

Forest Service staff meet with Washoe Tribal elders at Meeks Meadow to talk about restoration approaches for culturally important plants.

Goal 5 – Objectives

- Within the Wildland Urban Interface Defense Zone, complete 100% (5,000 acres) of initial entry fuels reduction treatments within the first 5 years and maintain fuels conditions to meet fire behavior objectives.
- Achieve compliance with fire clearing requirements for habitable structures.
- Increase actions to mitigate smoke impacts to downwind communities and vulnerable populations.
- Increase actions to improve public awareness of the benefits of prescribed fire as a means to reduce the risk of high-severity wildfire.
- Continue engaging with the Washoe Tribe and tribal members in stewardship of the area, including the application of tribal traditional knowledge and practices.
- Support and maintain existing recreation access, opportunities, and experience. Where opportunities exist, incorporate actions into project design to enhance high-quality, equitable recreation experiences while protecting natural resources.
- Communicate proactively and effectively with residents, businesses, the public, and other stakeholders about restoration activities.

Goal 6 – Restoration is efficient, collaborative, and supports a strong economy

A resilient Lake Tahoe West landscape will have benefits for local and regional economies. Healthy forests that are resilient to wildfire and other disturbances provide a wide variety of ecosystem services such as wildlife habitat, snowpack, clean water, wood products, biomass for energy and ethanol production, forest products, and stable soils. These ecosystem services in turn provide a foundation for many local and regional economic activities and employment opportunities, including recreation, tourism, and natural resource management industries.

Goal 6 recognizes that restoration actions should support and enhance regional economies and local employment opportunities while promoting healthy and resilient ecosystems. Lake Tahoe's economy is highly reliant on both summer and winter recreation opportunities. Resilient forest ecosystems with low risk of high-severity fire, abundant snow pack, and flows of clean water are foundational to a sustainable recreation economy. Lake Tahoe West partners will seek opportunities to support existing businesses, recreation, and regional property values through landscape restoration.

Through this Strategy, Lake Tahoe West partners seek to provide an ecologically sustainable supply of biomass to support regional facilities that utilize forest products, including for bioenergy production or to create wood products that can store carbon over the long term. Currently, adequate markets for forest products do not exist near Lake Tahoe. The Lake Tahoe West partners are working as part of the broader Tahoe Central Sierra Initiative on efforts to build a wood industry that would stabilize and improve markets. In implementing this Strategy, Lake Tahoe West partners will also aim to create consistent work and local training and employment opportunities for forestry and restoration workers.

This Strategy recognizes that meeting shared goals will require coordinated effort among agencies to increase efficiency and capacity. More capacity, particularly staff, is needed to safely utilize natural wildfire and prescribed burning as described in Goal 2. For example, currently fire suppression crews are the primary resource for both conducting prescribed fire treatments and fighting wildland

Photo: California State Parks

fires. With the trend towards a year-round fire season, these crews are frequently called away to fight wildfires throughout California. Managers have limited seasonal windows, primarily fall, in which to conduct prescribed fires, and the lack of staffing further limits their ability to use this management tool. Sharing resources and conducting work across property lines can increase efficiency and capacity for landscape restoration.

Goal 6 Objectives

- Harvest forest products sustainably and utilize them to minimize carbon emissions through long-term carbon storage, bioenergy, or other products.
- Increase consistent business opportunities that provide regional economic growth and additional benefits to vulnerable populations.
- Increase the number of projects that incorporate multi-benefit restoration objectives across multiple ecosystem types and land jurisdictions.

Currently, adequate markets for forest products do not exist near Lake Tahoe. Lake Tahoe West and other regional initiatives can increase availability of forest products, which may incentivize developing or re-opening facilities throughout the region.
Source: Forest Service, Tahoe Regional Planning Agency.

Strategy Implementation

The Strategy provides a framework to guide planning and implementation of restoration projects and related activities over approximately the next 20 years. With a shared commitment to attaining all Goals, partners will strategically design, sequence, and locate restoration treatments to maximize benefits and minimize impacts. Priorities may shift over time based on changing landscape conditions.

Reducing wildfire risk and improving forest resilience is a key current priority of the Lake Tahoe West partners. In the near term, the partners will focus on completing planned community protection and forest resilience treatments in the Wildland Urban Interface; the Strategy calls for completion of treatments near communities within five years. In fall of 2019, partners will also begin planning broad-scale restoration work in the General Forest. Reducing high-severity fire risks in the General Forest will be an important early priority for Strategy implementation.

Improving forest resilience and reducing high-severity wildfire risk can also advance other Goals, and the partners will design and implement projects to achieve multiple benefits simultaneously. For example, treatments that increase late-seral forest and reduce tree density can benefit sensitive wildlife species (Goal 3), increase snowpack retention and groundwater recharge (Goal 4), and meet economic goals such as job creation (Goal 6). As forest conditions improve with thinning, managers can use more low- to moderate-intensity prescribed fire (Goal 2). Meadow restoration can enhance both meadow condition and landscape heterogeneity (Goal 3). When restoring overly dense riparian forests, managers can fell wood into streams to improve channel stability and habitat conditions (Goals 3 and 4). Where stream crossings are needed to access forests and meadows, managers can use the opportunity to redesign inadequate stream culverts and improve fish passage (Goals 3 and 4).

Strategy in Action: Current Projects

Multiple projects are already under way across the Lake Tahoe West landscape, including many fuels and forestry projects near communities that are essential to achieving the Goals of this Strategy. The main projects that Lake Tahoe West partners are currently planning and implementing include the following (not exhaustive; excludes some smaller projects):

- **West Shore Wildland Urban Interface Healthy Forest and Fuels Reduction Project:** This project addresses forest health and fuel reduction needs on National Forest System lands. The project covers 4,947 acres and is currently being implemented. Thinning treatments are anticipated to be completed by 2023 and follow-up pile burning by 2026.
- **Meeks Meadow Restoration Project:** This project will conduct conifer removal and prescribed fire treatments in Meeks Meadow using a combination of mechanical equipment and hand treatment followed by prescribed fire. The total project size is 293 acres. Meeks Meadow is located in the Wildland Urban Interface Defense Zone in the Lake Tahoe West landscape. The project may be implemented as early as 2020. The Forest Service LTBMU is implementing the project in partnership with the Washoe Tribe of Nevada and California. The project includes implementation of cultural practices as means for maintaining the meadow.
- **Meeks Marina Restoration Project:** This Forest Service LTBMU project will conduct channel and lagoon restoration work in Meeks Creek. The purpose is to restore the Meeks stream channel and wetland/lagoon below State Route 89 to a more natural condition while continuing to support sustainable recreation opportunities. The Forest Service LTBMU, in partnership with the Tahoe Regional Planning Agency, is currently developing an Environmental Impact Statement (EIS).
- **Dollar Creek Forest Health and Biomass Project:** The California Tahoe Conservancy will conduct fuel treatments on 151 acres of state land using mechanical forest thinning, including a combination of commercial timber harvest and biomass removal. Project implementation began in 2019, with completion anticipated in 2020.

Photo: Forest Service LTBMU

- **North Tahoe and Meeks Bay Community Wildfire Protection Plan Implementation Project:** Areas targeted for fuel treatment include 514 priority acres of private and local government lands, of which 150 are within Lake Tahoe West. The project lead is the North Tahoe Fire Protection District, and implementation is occurring from 2015-2021.
- **California Lake Tahoe Basin Regional Hazardous Fuels Reduction and Wildfire Prevention Project:** The California Tahoe Conservancy, in partnership with the Tahoe Fire and Fuels Team, aims to treat 1,200-1,800 priority acres within a 3,000-acre area. One-thousand acres of anticipated treatments are within Lake Tahoe West. The project implementation window is from 2017-2023.
- **Program Timberland Environmental Impact Review:** This project will address fuel reduction on private, local jurisdiction, and California Tahoe Conservancy lands in the Wildland Urban Interface throughout the 8,500 acres on the California side of the Lake Tahoe Basin. Four-thousand acres are within Lake Tahoe West. Implementation is expected to begin in summer 2020.
- **California State Parks Mitigated Negative Declaration:** This plan covers vegetation management, fuel reduction, and prescribed fire on all California State Parks in the Lake Tahoe Basin for a total of 6,282 acres within Lake Tahoe West. This plan is in place, and implementation of projects is ongoing. Current projects include Burton Creek Forest Health, DL Bliss Forest Health, Sugar Pine Forest Health, and Ward Creek Forest Health.
- **Liberty Utilities Resilience Corridors Project:** This project is a multi-agency effort to reduce fire risk along utility infrastructure including power lines. The majority of the power lines are within the Wildland Urban Interface, and many areas have already received fuels reduction treatments. This project is designed to fill in gaps where treatment needs remain, with three primary goals: remove trees that pose a risk of striking utility lines, reduce fuels near utility lines, and improve forest health near utility lines.

Planning and Implementing Future Projects

Starting in fall 2019, the Lake Tahoe West partners will plan additional on-the-ground restoration actions to implement this Strategy. The planning effort will incorporate a suite of integrated goals for the landscape such as wildlife habitat enhancement and meadow and stream restoration. Addressing all of the Goals of the Strategy will likely require additional future planning efforts.

This Strategy does not identify specific locations on the landscape for restoration. Rather, it describes conditions that managers should target and prioritize for restoration. During project planning, the partners will use the Landscape Resilience Assessment, the Strategy, and other site-specific information to identify and prioritize restoration treatment locations across the Lake Tahoe West landscape. Partners will consider the timing and spacing of treatments to minimize adverse impacts to sensitive resources. A geospatial database, including data from the Landscape Resilience Assessment and modeling effort, will enable managers from across the partner agencies to derive information about a wide range of landscape features and conditions to inform project planning.

Tools for Managers

The Lake Tahoe West partners developed the following tools to guide managers to implement this Strategy and locate treatment areas:

- **Strategy Matrix (Appendix):** Matrix of Goals, Objectives, and Strategy and Prioritization Guidelines with quantitative and qualitative direction for land managers.
- **Rationale and Supporting Information:** Supporting technical information and science for the Objectives and Strategy and Prioritization Guidelines (available online).

Development of additional tools is in progress:

- **Opportunity Maps:** A set of maps that correspond to many of the Goals and Objectives within the Strategy Matrix. The partners will use these maps to develop a proposed action and conduct project planning. The maps will allow land managers and stakeholders to visualize ecosystem conditions and values on the landscape; how conditions overlap; and where opportunities exist to achieve multiple goals in the same location.
- **Lessons Learned & Broader Applicability:** A forthcoming report that will highlight lessons learned during development of this Strategy and broader applicability of the Strategy. While developed for the west shore, the elements of this Strategy are widely applicable in areas with similar current conditions, and managers can adapt many of them to their specific context, whether the Lake Tahoe Basin, other parts of the Sierra Nevada, or beyond. Managers should take care to adapt the Strategy to their own regions by assessing landscape-specific current conditions and by adapting objectives and approaches to that context. When completed, these tools will be available online.

Road Analyses and Access

Managers will conduct road analyses during project planning to determine needs for additional road access. Roads are an important tool for implementing fuels treatments and prescribed fire, and limited road access could constrain managers' ability to complete forest restoration. Approximately 22% of the landscape is currently accessible to ground-based mechanical treatment; these areas are within 1,000 feet of a road and on terrain less than 30% slope. Additional roads may be needed to achieve the Goals of the Strategy.

Finer-scale analyses conducted during project planning will identify if and when new roads are needed to meet restoration goals for Lake Tahoe West. Agencies will analyze the most appropriate locations for road construction and any potential water quality impacts, avoiding sensitive areas identified by the Lake Tahoe West modeling. For any new temporary or permanent forest road construction, managers will use the most current best management practices to minimize impact to the surrounding landscape and to maximize the benefits for access and treatment of the landscape. The Strategy also suggests improving, re-routing, or removing roads that impact sensitive species habitat, stream environment zones, or water quality.

Protecting Resources During Project Implementation

Increasing the pace and scale of restoration may have temporary negative impacts to some resources. For example, although critical for improving resilience, thinning and prescribed fire can create short-term erosion risks. Prescribed fire can also impact air quality, while reducing the potential for high-severity wildfires with devastating consequences for many social and ecological values. Such risks are closely monitored and regulated in the Lake Tahoe Basin, and any project developed to implement this Strategy will include measures to prevent or mitigate impacts.

Every project or action of consequence in the Lake Tahoe Basin must comply with multiple local, state, regional, and federal regulations that protect environmental quality. The Tahoe Regional Planning Agency created the Lake Tahoe Regional Plan, which established environmental standards for the Lake Tahoe Basin and a Code of Ordinances with stringent provisions to protect and enhance the natural environment of Lake Tahoe. California's Lahontan Regional Water Quality Control Board regulates projects with potential to discharge pollutants into the waters of the Lake Tahoe Basin. The Army Corps of Engineers also regulates many projects in streams and wetland areas. California and Nevada have multiple state and regional bodies tasked with regulating and protecting air quality. Projects with potential to affect species listed under the federal or California Endangered Species Act must consult with the U.S. Fish and Wildlife Service and/or the California Department of Fish and Wildlife.

Projects incorporate resource protection measures and best management practices to comply with regulations and to protect species and habitat, air quality, scenic integrity and access, water quality, and lake clarity from impacts associated with project implementation. Managers develop and use resource protection measures and best management practices based on guidance provided by regulatory agencies and knowledge of project-specific sensitive resources. For work on federal lands, managers are also guided by the Forest Service LTBMU Land Management Plan and Forest Service National Best Management Practices Program. The latter program was developed specifically to ensure agency accountability in managing water quality consistent with federal, state, and local water quality programs.

Photo: Nick Spannagel, California Tahoe Conservancy

Some examples of resource protection measures include flagging and avoiding sensitive resources like rare plants, archaeological sites, and nesting or denning areas; retaining or creating snags and coarse woody debris; and re-seeding project areas with native seed sources. Examples of best management practices include locating landings and refueling equipment outside of stream environment zones; buffering equipment use around waterbodies; and ensuring soils are not saturated, which helps to prevent rutting, compaction, and erosion from treatment operations.

Policy to Support Strategy Implementation

Targeted shifts in policy and practice could provide managers with more effective tools to restore forests and increase landscape resilience. In the planning phase, Lake Tahoe West will analyze two potential policy updates:

- Increasing access on slopes 30 - 50% for mechanical thinning treatments.
- Expanding available management activities in California spotted owl and northern goshawk Protected Activity Centers outside the Wildland Urban Interface.

Access on Slopes 30 - 50% for Mechanical Thinning Treatments

Currently the Tahoe Regional Planning Agency Code of Ordinances limits steep slope access with ground-based mechanical thinning equipment. This policy was written decades ago to prevent erosion from the use of heavy mechanical equipment. Today, managers are still limited to using hand thinning or aerial yarding systems on slopes greater than 30%. While costs for hand thinning combined with post-thinning pile burning are similar to mechanical thinning, aerial yarding techniques are substantially more expensive and are cost prohibitive to employ widely. For these reasons, managers currently rely on hand thinning as the primary tool for treating on steep slopes.

Hand thinning is an appropriate technique in certain areas, but in many areas is not ideal. The effectiveness of hand thinning is often limited due to operational constraints. Densely forested stands often have too many trees and not enough space for slash piles, resulting in higher than desired stand density after thinning. Water course protection buffers and other exclusion areas place additional limitations on where managers can place piles, making some areas untreatable without a means to remove biomass. Hand crews have difficulty piling large material, and hand thinning treatments are generally limited to trees under 14 inches in diameter; yet in many stands larger trees must be thinned to meet desired conditions.

Slash piles with large wood greater than nine inches in diameter take two to three years to dry before managers can burn them. It currently takes three to eight years after hand thinning to complete pile burning. With short burn windows, long fire seasons and other constraints, pile burning has not kept pace with thinning. The Forest Service LTBMU currently has a backlog of more than 5,000 acres of slash piles that are ready to burn and an additional 1,000 acres of new slash piles in the drying stage. Continuing to create slash piles faster than they can be burned significantly limits managers' ability to use fire for ecological benefit.

Approximately 20% of the Lake Tahoe West landscape has slopes 30 - 50%. Treatment of these slopes is a limiting factor in achieving the Goals of this Strategy and restoring

Approximately 14,960 acres of the forested area is on slopes 30 - 50%, shown in orange. Of this area, 10,900 acres is currently non-resilient due to high tree density and is a priority for mechanical treatment. Source: EcObject v2.1 Tahoe Basin.

Photo: Forest Schafer

Members of the Lake Tahoe West Restoration Partnership discuss management options for protected habitats of sensitive species.

the resilience of the forest. Allowing ground based mechanical treatments on slopes up to 50% can significantly reduce the number of acres that will require hand thinning and pile burning treatments. By reducing the number of acres that require follow up pile burning, there will be less risk of exacerbating the pile burning backlog. Reducing the need to burn piles allows managers to focus prescribed fire treatments on ecologically beneficial landscape burns. Access to slopes 30 - 50% also reduces smoke emissions associated with pile burning, allows managers to thin stands to desired conditions, and provides opportunity for utilization of restoration by-products that can provide long-term carbon storage and reduced greenhouse gas emissions.

In developing this Strategy, the Science Team found that the modeled scenario that allowed mechanical treatment on steep slopes consistently promoted resilience for a wide range of landscape values; this result was not directly attributable to operations on steep slopes but does indicate that such operations do not have detrimental impacts. Techniques that provide high residual ground cover are more important for preventing hillslope erosion than the steepness of the slope.

In the past decade, new innovative technologies and harvest methods for mechanical thinning have made it possible for managers to treat steeper slopes while still providing resource protections. These newer technologies have low-pressure systems that significantly reduce soil impacts. Special attention to areas with sensitive soils, most notably in Ward and Blackwood canyons, can further limit erosion risks in these areas. Managers would consider soil operability conditions when proposing mechanical thinning and would not propose this treatment for shallow erodible soils but for deeper more stable soils. During project planning, partners will analyze the environmental effects of updating the Tahoe Regional Planning Agency Code of Ordinances to allow ground-based mechanical treatment of forested areas on 30-50% slopes.

Management Activities in Protected Activity Centers

Throughout the Sierra Nevada, loss of protected habitats to high-intensity fire and tree mortality is driving a new urgency to enable restoration to protect these areas and the species that depend on them. From 1993 to 2016, approximately 450,000 acres of forest within the California spotted owl range in the Sierra Nevada burned at high severity. Over this same period, approximately 125,000 acres (22%) of California spotted owl Protected Activity Centers burned across the range, and 40,000 acres (32%) of these areas burned with high severity. Forty-six owl Protected Activity Centers were affected by the King Fire on the Eldorado National Forest adjacent to the Lake Tahoe Basin. Between 2014 and 2017, tree mortality levels increased more than 100-fold in many areas of the Southern Sierra, and 55% of California spotted owl Protected Activity Centers lost more than 20 trees per acre, with the greatest loss in the large diameter trees most strongly associated with owls.

During project planning, the Forest Service LTBMU will likely write and analyze a project-specific Forest Plan amendment to expand available management treatments in California spotted owl and northern goshawk Protected Activity Centers in the General Forest (outside of the Wildland Urban Interface). Prescribed fire and hand thinning trees up to six inches in diameter are the primary management tools allowed in Protected Activity Centers in the General Forest under the current Forest Service LTBMU Land Management Plan (2016). This Strategy

Photo: AdobeStock.

Northern Goshawk

encourages prescribed fire as a management tool in Protected Activity Centers. In some situations managers may need to thin larger diameter trees (by hand or mechanical equipment) to achieve habitat restoration and/or safely use prescribed fire in these sensitive areas.

The current constraint on tree thinning in Protected Activity Centers in the General Forest is based on Forest Service direction from 2004 (Sierra Nevada Forest Plan Amendment Record of Decision) for all National Forest System lands in the Sierra Nevada. The focus was to use hand thinning of small diameter trees and prescribed fire to improve resilience in these areas. At that time, land managers and scientists knew very little about the effects of different management actions (such as hand thinning and mechanical thinning) on owl and goshawk habitat and occupancy, and land managers were discouraged from thinning trees greater than six inches in diameter in these sensitive areas.

In April 2019 the Forest Service released a new Conservation Strategy for the California spotted owl (CSO) in the Sierra Nevada (Version 1.0). While some gaps remain in the science regarding effects of various management actions on habitat and species occupancy, there is an increasingly clear need for active forest restoration in Protected Activity Centers, on a case-by-case basis, to reduce fire risk, promote heterogeneity, decrease tree competition and drought stress, and promote the growth of tall, large diameter trees.

Not all of Lake Tahoe West's Protected Activity Centers may require active forest restoration treatments. For those that do, managers would prioritize prescribed fire as a restoration tool both in and around these areas. Managers could use tree thinning to prepare the landscape for desired fire effects and remove trees that are competing with larger diameter trees. Through tree thinning, managers would also reduce ladder fuels and short (less than 53 feet tall) trees in the forest understory to prevent the spread of fire into the forest canopy. Managers would develop treatments based on needs of the Protected Activity Center (and surrounding larger landscape), taking into consideration forest structure and site capacity characteristics (such as water table, aspect, and topographic position) that are important to species like spotted owl and goshawk and their prey.

The Forest Service LTBMU Land Management Plan includes a standard (SG.93) and criteria to guide managers in identifying which Protected Activity Centers to restore. These criteria preferentially avoid Protected Activity Centers with the highest likely contribution to owl productivity (i.e. those that are currently or historically reproductive). A Protected Activity Center with a nesting pair may be less likely to need restoration than one that was reproductively active in the past but seemingly abandoned, or one that experienced a recent disturbance like a tree mortality event. Any restoration effort within a Protected Activity Center would protect nesting pairs and reproduction. For example, Limited Operating Periods would be implemented when nesting pairs are present.

Funding and Markets to Support Strategy Implementation

The estimated annual average cost to implement the forestry actions recommended in this Strategy is $7 million. Management actions to improve watershed function and habitats could cost $5 - 8 million annually. The total annual cost to implement all elements of the Strategy is approximately $12 million.

The following table provides an approximate cost of treatments called for in the Strategy. The table is not a prioritization tool and does not include all treatments called for in the Strategy. The costs, derived from the past 10 years of treatment, are averaged and include relatively inexpensive treatments, such as natural wildfire and prescribed fire, and extremely expensive treatments, such as helicopter yarding. As more treatments are completed on the landscape, managers could likely increase the use of lower-cost treatments such as fire to achieve restoration objectives.

Not every Goal has Objectives that specify quantitative restoration treatments, and many of the actions associated with those Objectives have related costs that are not included in table. Increasing agency capacity for restoration would also increase costs associated with staffing. Because these costs are difficult to quantify, they are not included in the cost estimate.

Lake Tahoe West Restoration Strategy Cost Estimate

Treatment Needs	Primary Objectives[1]	Secondary Objectives[1]	Estimated Cost Range[2]	Estimated Total Cost[2]	Implementation Timeframe
5,000 acres Defense Zone forestry treatments	5A – treat Defense Zone to protect communities	1A 6A, 6B, 6C	$1,529 - $2,559 /acre, with an average cost of $2,034 /acre	$10,170,000	First 5 years
7,000-9,000 acres of forestry treatments in Threat Zone and General Forest	2A – reduce risk of high-severity fire	1A, 1B, 1C 3A, 3C 4C, 4D 6A, 6B, 6C	$750 - $7,422 /acre, with an average cost of $2998/acre	$26,982,000	First 10 -15 years
26,000 acres of forestry treatments in Threat Zone, General Forest, and Wilderness	1A – reduce stand density 1B – seral stage development 1C – create and maintain forest openings	1D 2B, 2C 3A, 3C 4C, 4D 6A, 6B, 6C	$414 - $7422 /acre, with an average cost of $2,629 /acre	$68,354,000	Over 20 years
780 acres of forestry treatments in meadows	3B – restore and maintain meadows	3C 5E 6B, 6C	$750 - $3,711 /acre, with an average cost of $2,600	$2,028,000	Over 20 years
Repair road networks, including stream crossings	4A – restore road and trail networks	3D 6C	$10,000 - $2.3M / year, with an average of $1.1M /year	$22,517,031	Over 20 years
Up to 9 miles of stream restoration treatments	4B – improve stream function	3C, 3D 6C	$12,500 - $48M per mile, with an average of $5.8M /mile	$52,500,900	Over 20 years

[1] *Primary and Secondary Objectives refer to Strategy Goals and Objectives. For example, 5A refers to Goal 5, Objective A. See the Appendix for the full Objectives.*
[2] *Costs are estimated from contracts and Lake Tahoe Environmental Improvement Program Project Tracker for projects in the last ten years, and could increase over time*

Photo: Sarah Di Vittorio

Lake Tahoe West agencies and stakeholders visit a cable yarding operation on the East Shore in June 2018.

Successfully implementing the Landscape Restoration Strategy will require funding from state, federal, and private landowners and other partners. The partners are developing a funding and implementation strategy to identify potential funding sources for this work. While the harvest of forest products during restoration treatments will provide some economic value, the value will not offset the cost to implement forest health and fuels reduction projects recommended in this Strategy. Currently, adequate markets for forest products do not exist near Lake Tahoe, necessitating costly long-distance transport of any materials removed from the forest through restoration treatments. This factor combined with congested traffic corridors reduces the value of forest products. Moreover, much of the Lake Tahoe West landscape that needs treatment has large quantities of small trees with little to no value. Treating these areas will require supplemental funding for service work such as small tree thinning and biomass removal. New efforts to partner with private investors and stakeholders to fund cross-boundary forest restoration, such as the Forest Resilience Bond with the public benefit group Blue Forest Conservation, are emerging opportunities that could help to fund Lake Tahoe West restoration efforts. While promising, these models are in their infancy, and the continued availability of state and federal funding – currently the largest source for forest restoration – remains essential.

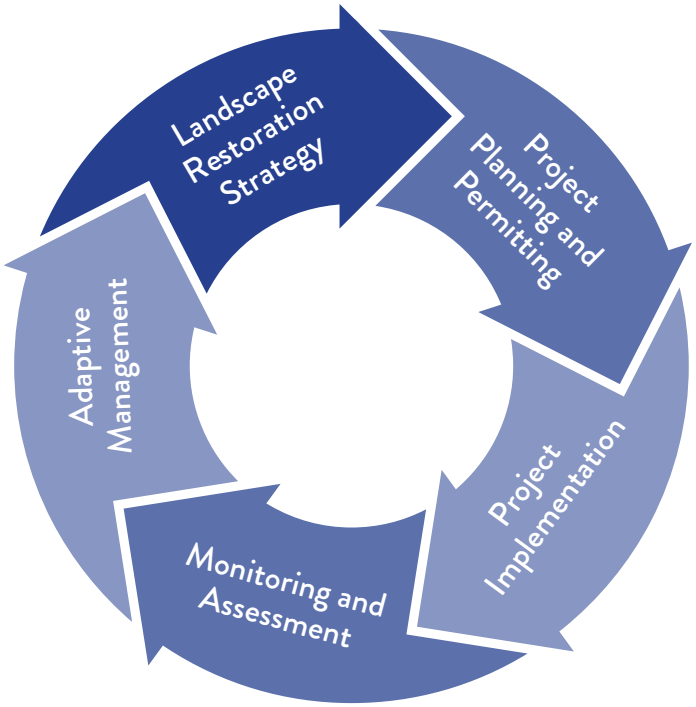
Land management agencies in the Lake Tahoe Basin will continue to engage in regional efforts, such as the Tahoe Central Sierra Initiative and the California Forest Management Taskforce, to address barriers and increase the pace and scale of forest restoration. These efforts, for example, are working to develop a restorative wood industry, increase capacity for sawmills, and increase the number of contactors working in the forest products industry. In addition, agencies and partners must continue to collaboratively develop local opportunities for alternative forest products markets, including opportunities in nearby Nevada communities with industrial lands. Increased markets, more contractors, and shorter haul distances will increase the value of restoration by-products, reduce the costs of restoration treatments, and support long-term regional sustainable forest products utilization.

Adaptive Management and Monitoring

The Lake Tahoe West landscape will continue its recovery from the extensive clearcutting that occurred in the mid-to-late 1800s and will continue to undergo change in the coming decades. Key factors that will drive landscape changes include climate change, growing population pressures, and restoration efforts. The partners are working to develop an ecological and socioeconomic monitoring plan for continued assessment and adaptive management of the landscape. The monitoring plan will utilize existing monitoring efforts in the Lake Tahoe Basin as much as possible, while identifying key attributes for assessing resilience of the west shore landscape specifically.

Monitoring will provide important information to land managers to adjust treatment methods and priorities where needed to reach the desired resilient conditions. Managers can use monitoring to resolve potential value tradeoffs, to assess if landscape management is significantly impacting sensitive resources such as wildlife or water quality, and to determine whether approaches used to minimize these impacts are effective. Incorporating an adaptive management approach that uses the best available information, monitors social and ecological conditions, and adjusts management approaches based on these conditions is critical. Adaptive management is also important to ensure accountability, build shared understanding and trust, and increase the effectiveness of landscape restoration treatments.

Tracking progress towards achieving the six Goals outlined in this Strategy is crucial to ensure the success of Lake Tahoe West and determine future investment in forest and watershed treatments. The Goals acknowledge that restoration actions undertaken now may not immediately result in resilience but will set the trajectory for achieving a resilient outcome. In some cases, resilience may take decades to achieve as west shore forests grow and ecosystems change. Therefore, the monitoring plan should address the Strategy Goals and Objectives and the Landscape Resilience Assessment target resilient conditions, and should include indicators that track project implementation, effectiveness, and regulatory compliance. For each indicator, the monitoring plan will include trigger points of exceedance to minimize risk to landscape values.



The monitoring plan should define a process for gathering and managing monitoring data, including periodic synthesis and more thorough adaptive management adjustments. The monitoring plan may include use of updated LiDAR and other remote sensing data for a comprehensive mapping of current forest and watershed structure, wildlife habitat, and fuel conditions. Regular updates to the forest inventory data will reflect changes in forest conditions from wildfires, insect outbreaks, disease, and management actions. By reviewing updated information, the partners can identify whether the Lake Tahoe West landscape and entire Tahoe Basin is trending towards resilience.

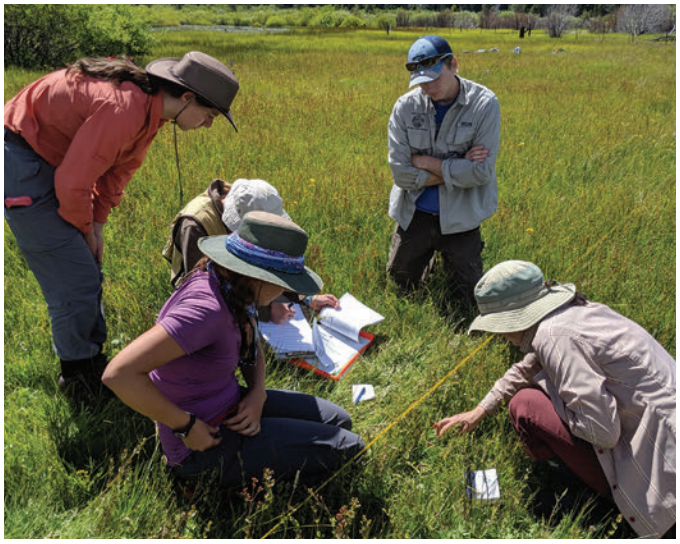


Photo: Forest Service LTBMU

Online Resources

Lake Tahoe West Resources

- Lake Tahoe West Homepage
- Lake Tahoe West Interactive Web Map
- Lake Tahoe West Landscape Resilience Assessment (2017)
- Rationale and Supporting Information: Lake Tahoe West Landscape Restoration Strategy Framework
- Opportunity Maps
- Science Briefs: Lake Tahoe West Landscape Modeling
- Science Team Report: Lake Tahoe West Landscape Modeling

Regional Resources

- Conservation Strategy for the California Spotted Owl (CSO) in the Sierra Nevada (Forest Service, Version 1.0, April 2019)
- Forest Service LTBMU Land Management Plan
- General Technical Report 220 – An Ecosystem Management Strategy for Sierran Mixed-Conifer Forests
- General Technical Report 237 - Managing Sierra Nevada Forests
- General Technical Report 247 - Science Synthesis to Support Socioecological Resilience in the Sierra Nevada and Southern Cascade Range
- General Technical Report 254 - The California Spotted Owl: Current State of Knowledge
- Lake Tahoe Basin Multi-Jurisdictional Fuels Reduction and Wildfire Prevention Strategy
- Lake Tahoe Maximum Daily Load (TMDL) Program
- Lake Tahoe Regional Plan (Tahoe Regional Planning Agency)

Photo: USDA Forest Service

Appendix. Strategy Matrix

This Appendix provides the full suite of Goals, Objectives, and Strategy and Prioritization Guidelines that constitute the Lake Tahoe West Landscape Restoration Strategy. This framework provides land managers with detailed quantitative and qualitative direction to implement the Strategy.

The primary sources that informed this framework were the Lake Tahoe West Landscape Resilience Assessment, best available science, Lake Tahoe West modeling, and professional judgement (see References). The online Rationale and Supporting Information provides additional supporting documentation.

Goals: Resource management under the Lake Tahoe West project should aim for these ecological, social, and economic attributes of a resilient landscape. Goals do not include completion dates but should generally be achieved and endure for 50-100 years or longer.

Objectives: Land managers will accomplish these specific intentions in the next 20 years. Objectives are milestones towards achieving longer-term goals. Objectives could shift as disturbances and other factors influence conditions. The Objectives with quantitative values (e.g. acres treated) are based on feasibility and need and are not exclusive of a value associated with another Objective. Managers are encouraged to design treatments that concurrently achieve multiple Objectives; for example decrease tree density (Objective 1A) and reduce over-represented seral stages (Objective 1B).

Strategy and Prioritization Guidelines: These Guidelines are recommended management approaches for achieving the 20-year Objectives. The Guidelines provide managers with geographic, topographic, and condition-based direction for where and how to focus restoration efforts to achieve ecological Objectives. To achieve social Objectives, the Guidelines recommend actions to improve cultural values, reduce risks to communities, reduce or mitigate impacts to recreation, and support local economies. The Interagency Design Team led development of the Guidelines based on information including the Landscape Resilience Assessment, modeling results, literature (including General Technical Reports like GTR 220, 237, 247, and 254), the Forest Service LTBMU Land Management Plan, comments from stakeholders, and professional opinion.

Photo: Anthony Cupaiuolo

Goal 1

Forests recover from fire, drought, and insect and disease outbreaks

Forest structure and composition - Forest stand density, age and species distribution, and variable stand structure across the landscape promote resilience toward fire, drought, and insect outbreaks.

Objective	Strategy and Prioritization Guidelines
1A: Decrease tree density on 40,000 acres to move forests closer to within the range of natural variation for tree densities and to increase forest structural heterogeneity.	**I.** Per the Landscape Resilience Assessment, decrease tree density in forest stands for all forest types. Use biomass extraction (Objective 6A) in stands where intermediate and co-dominant size trees need to be removed to meet stand density and fire behavior goals. Utilize hand and prescribed fire treatments in areas where the reduction of small diameter trees would be needed to meet stand density objectives or where other resource concerns limit the ability to conduct treatments that remove biomass offsite. Use prescribed fire in any stand with factors that enable the use of this tool (e.g. stands with low initial tree densities, secondary treatments) (Objective 2A). In Wilderness Areas, use prescribed fire to reduce stand density, while allowing some hand thinning as needed to support prescribed fire treatments. **II.** Create stands with multiple tree age and size classes, multiple canopy layers, and variable tree spacing, especially outside of the Wildland Urban Interface Defense Zone. With increasing proximity to communities prioritize fire and fuels objectives; with increasing distance from communities prioritize restoration of forest structure, composition, and wildlife habitat. **III.** Per the Landscape Resilience Assessment, increase vegetative cover at the top of the canopy compared to the other strata, and decrease vegetative cover in the bottom of the canopy. Create vertical heterogeneity by separating groups of trees of similar sizes/canopy heights/structure (North et al. 2009). **IV.** When reducing tree density across the landscape, consider topography and microsite conditions. In general, greater tree densities and canopy cover can be supported in low lying areas such as valley bottoms, drainages, riparian areas, seeps, and concave pockets, with tree density decreasing at midslope and lowest levels near and on ridgetops (North et al. 2009). Higher tree density and canopy cover can be supported on northeast aspects (North et al. 2009), but consider reducing tree density in trees up to 33-65 feet tall to improve snowpack retention and water quantity yield (Harpold, Lake Tahoe West modeling results). (Objective 4C).

Objective	Strategy and Prioritization Guidelines
1A: *(continued)* Decrease tree density on 40,000 acres to move forests closer to within the range of natural variation for tree densities and to increase forest structural heterogeneity.	**V.** Retain dead and declining trees, especially the largest dead trees, to provide for snags and course woody debris across the landscape. Adjust snag density and course woody debris by forest ecotype and seral stage (Objective 3A) except in Wildland Urban Interface Defense Zone; where they should be retained only if they do not cause a hazard to life and property. **VI.** Consider prioritizing thinning activities in watersheds that have a greater number of meadows in them. **VII.** In some limited circumstances, removal of large trees may be needed when: **a.** the average dbh of overstory trees (dominant and co-dominant trees) within the stand is greater than 30 inches dbh; **b.** the stand density index (SDI) indicates that widespread mortality is imminent (e.g. SDImax) and reducing SDI to a prescribed level for the forest type will maintain the stand below SDImax for 15-20 years; **c.** tree removal would allow competitive release for growth of the largest trees; or **d.** when managing for blister rust resistant sugar pines, which require removal of competing trees within a sufficient radius to improve tree vigor. **VIII.** When selecting trees for removal, give preference to shade tolerant trees, and where they exist, retain clumps of large trees. These exceptions do not apply to Protected Activity Centers - do not remove trees ≥ 30 inches DBH in areas occupied by threatened, endangered, candidate, proposed and sensitive (TECPS) species or known nesting, denning, roosting trees and adjacent high-habitat-value trees (e.g. trees that provide thermal or protective cover). When considering removal of large trees, managers should utilize the Duncan Dunning tree classification (Dunning 1928) and prioritize retention of large trees that have old tree characteristics (Class 4, 5, and 7). When considering removal of trees 30 inches dbh or larger, managers should consult an interdisciplinary team during development of silvicultural prescriptions.
1B: Reduce over-represented seral stages, increase under-represented seral stages, and set the landscape on a trajectory toward the natural range of variation on 23,000 acres.	**I.** Per the Landscape Resilience Assessment, increase the representation of late-seral in all forest types through thinning of mixed conifer mid-seral forests. Treat a minimum of 2,400 acres of mixed conifer mid-seral forests to transition to yellow pine or red fir late-seral forests. **II.** Prioritize treatments within and adjacent to late-seral forest stands to retain this underrepresented seral stage on the landscape. Thin trees from overly dense late-seral stands to reduce mortality during natural disturbance events on the landscape. Improve connectivity between late-seral stands to also support connectivity of important wildlife habitat (Objective 3A).

Objective	Strategy and Prioritization Guidelines
1B: *(continued)* Reduce over-represented seral stages, increase under-represented seral stages, and set the landscape on a trajectory toward the natural range of variation on 23,000 acres.	**III.** Prioritize thinning treatments in mid-seral stage stands that have a greater amount of large diameter trees (i.e. stands with quadratic mean diameter (QMD) > 15") represented by a variety of species, especially in mixed conifer habitats, to facilitate a shift towards late-seral forest conditions. **IV.** Prioritize the development of late-seral stands outside of the built environment.
1C: Use management actions and natural disturbance events to create or maintain forest openings on an aggregate of 21% of the forested landscape to increase structural heterogeneity.	**I.** Per the Landscape Resilience Assessment, set a target for creating and maintaining openings on 21-34% of the forested landscape for optimal resilience. Create forest openings using multiple techniques suitable to the location (e.g. hand thinning, mechanical thinning, prescribed fire). Use disturbance events as opportunities to create, maintain, or increase size of openings. Opportunistically create openings in areas with thin soils, currently lacking pine, and among fir groups with evidence of root disease (North and Sherlock 2012, Knapp et al. 2012). **II.** Design openings to be 0.1-1.25 acres in size, with an average size of 0.25 acres (North and Sherlock 2012, Knapp et al. 2012). Consider openings up to 1.25 acres or with diameters roughly less than twice the average tree height surrounded by forest cover to create optimal conditions for snowpack retention (Kittreadge 1953 and Stevens 2017 in North et al. 2018; Objective 4C). Design openings with variable placement on the landscape and variable sizes and shapes, while orienting to maximize direct sunlight, and feathering edges by thinning trees, particularly on southern edges (Knapp et al. 2012). **III.** Consider placing openings adjacent to areas where clumps of trees are being left to maximize the resilience of the trees being left on the landscape. **IV.** Openings 1.25 - 10 acres may be created by tree thinning, prescribed fire, and/or naturally ignited wildfire on rare occasions to increase heterogeneity. **V.** Openings 10 - 40 acres can occur from natural disturbances with white fir/mixed conifer and red fir forest types generally supporting larger openings than Jeffrey pine forest types (Forest Service LTBMU Land Management Plan). **VI.** Plan for locations of openings being dynamic and changing over time as openings transition to forests and new openings are created. The number and distribution of openings created should be commensurate with: the

Objective	Strategy and Prioritization Guidelines
1C: *(continued)* Use management actions and natural disturbance events to create or maintain forest openings on an aggregate of 21% of the forested landscape to increase structural heterogeneity.	forest type; topography; presence of late-seral associated wildlife species; connectivity/and proximity to suitable wildlife reproductive habitat; proximity to developed recreation sites, scenic resources, and cultural resources; proximity to riparian areas and stream environment zones; surrounding seral stages; and spread of invasive species (Forest Service LTBMU Land Management Plan). **VII.** Openings ≥ 1 acre may retain some mature trees (Objective 1E). Large seed-tree pines retained in openings to provide reliable seed source are ideally located near the edge of the northern end of the opening to maximize light availability to regenerating pines and/or uphill if possible (North and Sherlock 2012). **VIII.** Pre-identify potential areas to expand openings, retain regeneration or existing tree groups (i.e. clumps), or conduct general thinning. Clumps may still require thinning to improve resilience to fire effects. Additional effort will be needed to break up current homogenous conditions (North and Sherlock 2012, North and Rojas 2012, Knapp et al. 2012).
1D: Conduct restoration treatments in approximately 400 acres of aspen and/or other riparian hardwood forest types.	**I.** Treat aspen and riparian hardwoods by conifer thinning, prescribed or natural wildfire, and/or other management actions. Apply prescribed fire as the preferred restoration tool to stimulate aspen restoration and/or to follow-up on conifer thinning (Objective 2B). Remove all size classes of conifers, and make sure treatments include removal of short (under 4.5' tall) trees that are fast-growing and the largest size classes (including over 30" diameter) that shade aspen and serve as seed sources for future conifers (Berrill et al. 2016). **II.** Prioritize treating aspen stands and riparian hardwood stands that are adjacent to or overlap with other management activities(e.g. vegetation treatments, stream channel restoration, and meadow restoration), are largest in area, and/or have significant cultural value. **III.** Use innovative techniques (e.g. aerial thinning, cable-yarding, prescribed fire) to remove biomass, especially in areas far from roads, where restoration is impeded by dense conifer conditions and a lack of space to pile removed conifers.

Objective	Strategy and Prioritization Guidelines
1E: Facilitate reforestation after large-scale disturbance events.	**I.** Consider reforestation when disturbances result in openings (Objective 1C) greater than 40 acres or when total acreage of openings exceeds 34% of the entire forested area. Rely on reforestation techniques that work with natural recruitment where live tree seed sources exist. **II.** Plant trees in combinations of clustered and regularly spaced seedlings that vary with microsite water availability, so that a balance is created between planted tree stands dense enough to outcompete vegetation with minimal intervention and more open conditions where shrub development will occur (North et al. 2018). Clumps could be in areas associated with concavities, slope positions, and soil conditions with greater water holding capacity, and in areas of potential fire refugia (i.e. lower slopes, slope breaks, and wet zones) (North et al. 2018). **III.** Plant founder stands (i.e. small groups of trees strategically planted to seed the surrounding area) to break up and decrease the extent of openings that are larger than 40 acres. Founder stands could be planted in mesic, less fire-prone locations (i.e. concavities, slope breaks, lower slope positions). **IV.** Limit planting in sites with high long-term moisture stress over recent past periods, and areas likely to become unsuitable in the next few decades (i.e. "marginal" forested areas with low mean annual precipitation and high mean annual temperatures), identified by examining climate datasets (such as Young et al. 2017 and Shive et al. 2018 in North et al. 2018). Alternatively, plantings in challenging sites can be placed strategically in favorable microclimates and microsites (e.g. tree, shrub, rock nurse). **V.** Use prescribed fire where feasible early in stand development to ensure planted trees are more resilient to drought and fire (Objective 2B) – this may require acceptance of higher mortality rates in planted trees than is generally accepted (North et al. 2018). **VI.** Evaluate the topographic position, slope, and aspect to determine the desired future condition of the disturbed area and whether reforestation is appropriate. Some areas should not be reforested as the disturbance may have had a restorative effect, such as in meadows or riparian areas and in areas where the extent of shrub fields has declined below reference levels due to fire suppression (Objective 3B, North et al. 2018). **VII.** Promote species and genetic diversity and give high priority to local and diverse seed sources (Maloney et al. manuscript in preparation). Design management actions and strategies that facilitate opportunities for natural selection across biological and environmental conditions to promote adaptive responses, acclimatization, and ecological reorganization (Webster et al. 2017).

Goal 2

Fires burn at primarily low to moderate severity and provide ecological benefits

Fire - Fire burns in an ecologically beneficial way that perpetuates a mosaic of forest conditions, has predominantly low and moderate intensities, and retains or improves wildlife habitat quality.

Objective	Strategy and Prioritization Guidelines
2A: Strategically locate and treat 7,900 - 9,000 acres of the Threat Zone and General Forest to limit high-severity fire to contiguous patches less than 40 acres in size.	**I.** Strategically place treatments designed to modify fire behavior in locations that act as a barrier to slow or stop the progress of wildfire (i.e. firebreak), which may be natural or created and maintained by human action. **II.** Reduce conifer densities and fuels accumulations on road networks, powerlines, and other critical infrastructure, as well as on ridges and in stream environment zones (e.g. riparian corridors, meadows, and aspen forest). Wet meadows and stream environment zones can be utilized by fire managers for holding or slowing fire spread when they have low fuel accumulations. **III.** Use prescribed fire as a primary firebreak treatment where thinning is not required to successfully implement fire treatments. Use prescribed fire as a follow-up treatment in all thinning treatments designed as strategic firebreaks (Objective 2B). Where feasible, thin areas using mechanical treatments where biomass can be extracted off site (Objective 6A). **IV.** Conduct work concurrent with community-focused Wildland Urban Interface Defense Zone treatments in the first 5 years (Objective 5A).
2B: Increase the use of prescribed fire to remove understory fuels and promote changes in vertical structure; by year 20, prescribed fire is used on approximately 80% of operational burn days.	**I.** Conduct prescribed burning in all management zones, when conditions allow, to restore a more frequent fire return interval. Use prescribed fire on stands that require minimal or no thinning to successfully implement fire treatments, such as in previously burned areas where fuel loads may be more easily maintained. **II.** Increase the use of prescribed fire after the first 10 years as the percent of the landscape treated increases to a level that allows safe and effective management of fire (Objective 2A). Use prescribed fire as a follow-up treatment in thinned stands to improve resilience of these stands to fire disturbance. **III.** Use prescribed fire in lower elevation forests that are more departed from historic fire regimes than higher elevation forests. The lower elevation forest would have burned more frequently than higher elevation forests under historic conditions.

Objective	Strategy and Prioritization Guidelines
2C: Increase the use of wildfire from natural ignitions that occur within the Wildland Urban Interface Threat Zone, General Forest, and Wilderness to mimic natural or desired fire regimes, and to remove understory fuels and promote changes in vertical structure.	**I.** When conditions allow, manage natural ignitions to burn safely in an ecologically beneficial way, outside of the Wildland Urban Interface Defense Zone. **II.** Create conditions through treatments described in Objectives 1A and 1B that allow for the gradual increase in the use of naturally ignited wildfire after the first 10 years as the percent of the landscape treated increases to a level that allows safe and effective management of fire (Objective 2A), recognizing that natural fire regimes have less smoke emissions than high-severity wildfire.

Goal 3

Terrestrial and aquatic ecosystems support native species

Native species and ecological communities - The diverse and interacting networks of native species and ecological communities, and the habitats that support them, are present across the landscape to support and sustain their full suite of ecological and cultural roles, life history requirements, and to enhance plant and wildlife diversity

Objective	Strategy and Prioritization Guidelines
3A: Create an increasing trend in the acres and quality of reproductive habitat for late seral-associated species.	**I.** Enhance reproductive habitat to maintain or increase the total acres on the landscape and improve forest stand structure (Objectives 1A and 1B). Prioritize restoring degraded habitat and habitat in territories with decreased occupancy or lapse in reproductive activity. Strategically stagger timing and locations of treatments so as to not treat an entire territory at one time. **II.** Promote an upward trend in the quality, total amount, and connectivity of reproductive habitat by enhancing habitat with the potential to support reproduction near known territories as well as habitat between territories. Some habitats that can support elements conducive to reproduction with some management intervention include California Wildlife Habitat Relationships (CWHR) 4M, 4D, 5M, and 5D. **III.** Within late-seral forests, maintain and improve nesting and denning habitat elements, and overall vertical structural complexity. Promote the retention, growth, and recruitment of tall trees and recruitment of tall/large snags, especially in clumps (Strategy 1.A.v). Increase the presence of large downed wood in the understory, facilitate the development of tree cover in the uppermost canopy, retain trees with complex form and structure, and retain snags of different heights, sizes, and decay classes. **IV.** Where it can be safely applied and/or managed, prioritize the use of fire to restore habitat for species like California spotted owl. **V.** Create marten "dense cover areas" for marten as part of forest management actions consistent with Goal 1.
3B: Restore and maintain at least 780 acres of meadows.	**I.** Assess all areas currently identified as meadow to more accurately delineate extent and condition. Utilize associated stream environment zone conditions (e.g. soil type, soil moisture) to identify areas that are not currently meadow that could potentially be restored. **II.** Wherever possible, restoration actions should strive to expand meadow habitat based on suitable soil and hydrologic conditions. Maintain a variety of hydrogeomorphic meadow types on the landscape to provide multiple ecosystem benefits.

Objective	Strategy and Prioritization Guidelines
3B: *(continued)* Restore and maintain at least 780 acres of meadows.	**III.** Promote use of prescribed fire as either the primary or secondary restoration tool for vegetation management within meadows. Consider phasing large upland prescribed burns after downstream meadow restoration projects, to take advantage of enhanced floodplain connectivity to collect nutrients and sediment (Objective 2B). **IV.** Within the 780 acres identified, complete currently identified meadow restoration projects, such as Meeks and Antone Meadows. Focus subsequent meadow restoration activities based on the following criteria: **a.** To maintain a variety of meadow types (e.g. dry, mesic, wet); **b.** To support meadows identified as most resilient in the Landscape Resilience Assessment or in complementary assessments; **c.** When meadows are within the Wildland Urban Interface or would otherwise serve as a natural fuel break (Objective 2A); **d.** Presence of legacy impacts from past land management actions (e.g. grazing, water diversions, road and trail construction, introduction of invasive species); **e.** In areas historically occupied by or overlap with suitable habitat for a sensitive species like willow flycatcher, and/or overlap with suitable or designated critical habitat for species listed under the federal Endangered Species Act (Forest Service) and/or California Endangered Species Act (CA State); or **f.** When other assessment methodologies that suggest restoration work is needed. **V.** Align assessment and restoration work with the goals of the Sierra Meadows Strategy (Drew et al. 2016). **VI.** When removing conifers is identified as a restoration action for meadows, consider removing conifers greater than 30" DBH when needed to support restoration objectives. Removal can include causing mortality from fire or girdling to create snags, felling and removing or felling and leaving as course woody debris. When considering removal of large trees, managers should utilize the Duncan Dunning tree classification (Dunning, Duncan 1928) and prioritize retention of large trees that have old tree characteristics (Class 4, 5, and 7). When considering removal of trees 30" DBH or larger, managers should consult an interdisciplinary team during development of silvicultural prescriptions.

Objective	Strategy and Prioritization Guidelines
3C: Improve the habitat condition and promote climate refugia for native aquatic and terrestrial wildlife species.	**I.** This Objective includes a variety of management actions intended to improve habitats not covered by other Objectives and provide refugia in a changing climate. This is not a comprehensive list and new management actions may be identified. **II.** Strategically maintain the structural complexity of recently burned areas for species associated with these habitats. **III.** Assess the impacts of roads and trails on wildlife habitat quality in stream environment zones, and the impacts of roads and trails on spotted owl and goshawk habitat in Protected Activity Centers and marten habitat in known territories. **a.** Remove, re-route, and/or improve the condition of roads and trails that are degrading wildlife habitat elements in stream environment zones, such as reducing/degrading the water table, serving as a barrier to wildlife movement, and/or experiencing high levels of use beyond those tolerated by many nesting birds. **b.** Remove, re-route, or take other actions to limit human disturbance on roads and trails in and around potential nesting or denning locations. **IV.** Maintain and improve the connectivity of native riparian vegetation so that these areas may act as corridors which support unobstructed movement by wildlife species, especially terrestrial-based species, during dry, summer periods. **V.** Improve aquatic habitat to promote climate refugia for aquatic species. **a.** Evaluate streams where a deficit or conversely, an overabundance of vegetation is adversely affecting in-stream water temperature. Implement treatments, such as replanting different kinds of vegetation (e.g. graminoids, shrubs, hardwood trees, conifer trees) or strategically removing vegetation, to improve stream temperature conditions. **b.** Enhance stream microclimates by increasing stream bed heterogeneity (e.g. adding large woody debris), pool: riffle ratio, bank stability, and riparian vegetation. Allow for natural post-fire channel adjustments (e.g. landslides or debris flows) where such conditions do not threaten important public values, especially by mitigating road crossings (Objective 4A). **c.** Restore streams to ensure adequate water depth and stream flow that extends through the dry summer months, and especially during drought years (Objective 4B). **d.** Prioritize thinning where such treatments may increase the amount and duration of flow (e.g. extending into late summer) in reaches with marginal conditions (Objective 4C).

Objective	Strategy and Prioritization Guidelines
3C: *(continued)* Improve the habitat condition and promote climate refugia for native aquatic and terrestrial wildlife species.	**VI.** Remove non-native fish species from streams. Focus on removing non-native fish species that are known to have adverse effects on the life history of native fish species and their habitat (e.g. remove non-native fish from stream segments where Lahontan cutthroat trout reintroduction will take place). **VII.** Focus restoration actions in areas that would benefit multiple wildlife and aquatic species, and especially state and federally-listed species.
3D: Resize, replace, remove, and/or reconfigure 10 identified barriers to improve passage of native aquatic organisms.	**I.** Focus on barrier improvement in cases where improvement would provide the greatest length of creek access or would otherwise have the greatest ecological benefit to the creek and native species. **II.** Where new crossing structures are installed, or barriers will be replaced, select crossing structures that do not require regular maintenance to function properly. Retain natural substrate on the creek floor at the stream crossing location. **III.** In streams where Lahontan cutthroat trout restoration is a priority, work closely with the implementing agency to strategize the timing of barrier removal with fish removal (likely working in the direction from the headwaters towards the Lake). **IV.** Control/eradicate invasive aquatic species (e.g. plants and amphibians) before barriers are open to movement. Consider removing non-native and/or potentially hybridizing species before barriers are open to movement (Objective 3E). **V.** Coordinate with transportation partners and planning efforts, including the Highway 89 Recreation Corridor Management Plan, on bridge and infrastructure projects that may impact aquatic organism passage.

Objective	Strategy and Prioritization Guidelines
3E: Implement new and expand existing early detection rapid response programs for invasive species management.	**I.** Perform targeted searches and treatment with the goal of eradication of non-native invasive species that are not yet present in the Lake Tahoe Basin or are present, but are not widespread, per Early Detection Rapid Response (EDRR). **II.** For terrestrial plant species, the targeted EDRR list is the Lake Tahoe Weed Management Area's (LTWMA) Class One list. Treat all new Class One (LTWMA) detections and known populations within two years of detection and then treat annually until populations are eradicated. Treat Class One terrestrial invasive species in the most vulnerable habitats first (e.g. streams, meadows, and riparian areas). Surveys are recommended in the following areas and frequencies: **a.** 45 miles (100%) of state highways (surveyed annually); **b.** 40 miles (100%) of county roads, paved, and high use dirt roads and trails (surveyed every three years); **c.** 100% of facilities areas (surveyed every three years); **d.** 60 miles (100%) of high use trails (to be determined by manager) (every three years); **e.** 100% (at least two survey visits within five years of restoration) of recent restoration projects, or any projects that involve any soil disturbance: prescribed burning, wildland firefighting, stream restoration, etc. If the project is too large to survey exhaustively, focus on areas that received the most soil disturbance (staging areas, control lines, etc); and **f.** 100% of meadows and riparian corridors in Wildland Urban Interface (every five years). **III.** For aquatic species, the list of known invasive species within the Lake Tahoe Basin includes Eurasian watermilfoil, curlyleaf pondweed, bullfrogs, and warm water fish (Lake Tahoe Region Aquatic Invasive Species Management Plan). Prioritize control of aquatic invasive species in lagoons and streams with Lahontan cutthroat trout and/or lakes with current/historical occupancy by Sierra Nevada yellow-legged frog (Objective 3C). **IV.** Focus surveys in the following areas: **a.** 13 acres of lagoons, creek mouths, and streams downstream of Highway 89 (every two years). **b.** Monitor project locations that remove barriers (Objective 3D) to ensure there is no establishment or spread of non-native species.

Goal 4

Healthy creeks and floodplains provide clean water, complex habitat, and buffering from floods and droughts

Water: Quality, Supply, and Hydrologic Function - Properly functioning riparian ecosystems exist across the landscape. Water reliability, quantity, quality, and connectivity are buffered against precipitation variability and disturbance.

Objective	Strategy and Prioritization Guidelines
4A: Restore road and trail network including stream crossing structures (e.g. culverts, rock fords) to accommodate future increased stream flows and prevent erosion and water quality impacts.	**I.** Remove, re-route and/or improve the condition of roads and trails throughout the landscape consistent with Lake Tahoe Total Maximum Daily Load Pollutant Reduction Opportunity Report (2008) and wildlife goals (Objective 3C). Decommission roads where no longer needed, especially when the buffer between the road and a stream is less than 100 meters, on steep slopes, or where more erodible volcanic soils are present (Longxi, Lake Tahoe West Modeling Results; Elliot, Lake Tahoe West Modeling Results). Reduce hydrologic connectivity of the roads to watercourses and streams by reshaping and recontouring the road prism to reduce the amount of run off from the road surface. **II.** Increase the capacity of stream crossing structures to allow for increased flows of water, sediment, and debris, because of more rain-on-snow events and more wildfires expected with climate change. Focus stream crossing improvements in locations that are also a priority for aquatic organism passage (Objective 3E) and in meadow locations where failures are likely to contribute to meadow degradation. Improve crossings and road culverts while conducting road maintenance associated with thinning and biomass removal operations. **III.** Preemptively redesign road stream crossings that may be vulnerable to failure following wildfires (particularly due to undersized culverts), to avoid exacerbating channel incision or limiting transport of sediment and woody debris. Improve crossings and road culverts while conducting road maintenance associated with thinning and biomass removal operations. **IV.** Coordinate restoration of road and trail network with forestry thinning treatments and access needs for prescribed fire and fire control/suppression to maintain minimum necessary road network. Place thinning treatments around, and/or use low-impact treatments within, areas of naturally erosive soils to mitigate the potential for large and severe burns.

Objective	Strategy and Prioritization Guidelines
4A: *(continued)* Restore road and trail network including stream crossing structures (e.g. culverts, rock fords) to accommodate future increased stream flows and prevent erosion and water quality impacts.	**V.** Utilize data provided by volunteer groups (e.g. Tahoe Rim Trail Association, Tahoe Area Mountain Biking Association, and California Off-Road Vehicle Association) on the condition of all road and trail networks. When possible, organize volunteer events to assess and restore eroding features. **VI.** Where possible, assist jurisdictions with completing regional storm water projects to intercept and slow surface run-off and improve water quality.
4B: Restore currently identified stream reaches and enhance up to 9 miles of stream channel to improve function, reduce excessive bed and bank erosion, and meet Total Maximum Daily Load recommendations.	**I.** Assess all stream reaches on a recurring basis to determine if the desired conditions are maintained and find new issues as they arise. Focus initial restoration efforts on known restoration needs on Ward, Blackwood, Burton, Polaris, and Meeks Creeks. Utilize findings of further assessments and the Lake Tahoe Total Maximum Daily Load Pollutant Reduction Opportunity Report (2008). **II.** Perform restoration treatments based on following criteria: **a.** Presence of excessive bank slumps or un-vegetated/unstable banks; **b.** Excessive bed and bank erosion (incision and gully formation); **c.** Chronic sediment overloading/aggradation; **d.** Watersheds with a high percentage of naturally erosive soils; or **e.** Increased channel capacity that causes infrequent out of bank events (>2 year recurrence). **III.** Restoration actions should increase in-stream complexity (Objective 3C), support appropriate hydrogeomorphic functions, and aim to reconnect the channel with its active floodplain where possible to remain resilient to changes in rain and snow patterns and associated drought forecasted with climate change. **IV.** Address watersheds holistically to improve overall hydrologic function. Completing restoration of the upstream hydrologic conditions and inputs (i.e. problematic roads or legacy issues such as old railroad lines; Objective 4A), may allow degraded stream channels to recover on their own. **V.** Consider phasing large upland prescribed burns after downstream channel restoration projects, to take advantage of enhanced floodplain connectivity to collect nutrients and sediment (Objective 2B).

Objective	Strategy and Prioritization Guidelines
4C: Complete upland thinning treatments to increase snowpack retention, groundwater recharge, and resultant late-summer water availability.	**I.** Treat upland areas, especially above meadows, to promote increased water yield. Remove trees up to 60 feet tall, in relatively dense stands, particularly at lower elevations, to reduce the amount of snow intercepted by trees and increase the amount and retention of snowpack (Objective 1A, Harpold LTW modeling results). Consider using prescribed fire where feasible to treat stands with these conditions (Objective 2B). **II.** The greatest benefit to water yield can be achieved via thinning the watershed above a meadow, where it is initially greater than 25% forest cover (Albano, publication in progress). **III.** Create openings of less than 1.25 acres or with diameters roughly less than twice the average tree height surrounded by forest cover to create optimal conditions for snowpack retention (Kitteradge 1953 and Stevens 2017 in North et al. 2018; Objective 1C).
4D: Treat around areas with highly erosive soils to reduce fire risk, and conduct thinning where necessary with special considerations.	**I.** Complete upland thinning treatments to reduce fire risk (Objectives 1A, 2A, 2B, and 2C), as moderate to high-severity fires can generate larger hillslope sediment yields especially on naturally erosive soils (Dobre/Bindl Lake Tahoe West modeling results). **II.** Where needed, complete restoration projects on stream channels, floodplains, and meadows prior to landscape scale application of prescribed fire and natural wildfire to capture potential increased sediment loads resulting from those treatments. **III.** Utilize all standard Best Management Practices when completing upland thinning treatments to prevent, or capture and treat, storm water and erosion runoff from all landings, roads, and trails.

Goal 5

Human communities live safely with fire and enjoy and steward the landscape

Community - Recreational, residential, and tribal cultural communities are integrated into restoration efforts. Society lives safely with wildfire and is accepting of both fire as a natural process and as a management tool. The landscape provides accessible diverse year-round recreation opportunities while protecting sensitive resources.

Objective	Strategy and Prioritization Guidelines
5A: Within the Wildland Urban Interface Defense Zone, complete 100% (5,000 acres) of initial entry fuels reduction treatments within the first 5 years and maintain fuels conditions to meet fire behavior objectives.	**I.** Complete work concurrent with treatments described in Objective 1A. Promote using prescribed fire as a follow-up to thinning treatments in the Defense Zone (Objective 2B). **II.** Prioritize thinning treatments in stands where biomass extraction is possible (Objective 6A). **III.** Although multiple objectives can be achieved in the Wildland Urban Interface, fire and fuels objectives should generally increase in priority with increasing proximity to communities while restoration of structure, composition, and wildlife habitat should generally increase in priority with increasing distance from communities. **IV.** Ensure forest treatments are completed along evacuation routes to assist emergency preparedness.
5B: Achieve compliance with fire clearing requirements for habitable structures.	**I.** Work with Tahoe Fire and Fuels Team and the Fire Adapted Communities program to identify properties needing defensible space work and provide assistance services that increases residents' ability to comply with Public Resource Code 4291. **II.** Coordinate across land ownerships within and near residential areas to reduce fuels, create defensible space, and provide stewardship opportunities on vacant lots adjoining residential parcels.

Objective	Strategy and Prioritization Guidelines
5C: Increase actions to mitigate smoke impacts to downwind communities and vulnerable populations.	**I.** Coordinate with Tahoe Fire and Fuels Team to support efforts to enhance advance warning system and improve smoke forecasting. **II.** Facilitate communication between CAL FIRE and all agencies completing prescribed fire or pile burning to increase communication with the public about potential smoke impacts. **III.** Minimize daily emissions above harmful levels from wildfire events through restoration of natural fire regimes (Objective 2C). **IV.** Emphasize restoration projects that help restore a natural fire regime (return interval and severities) and remove biomass from forests to mitigate future smoke impacts from within-Basin wildfires.
5D: Increase actions to improve public awareness of the benefits of prescribed fire as a means to reduce the risk of high-severity wildfire.	**I.** Ensure that local businesses and communities understand the importance of fuels reduction, the types of treatments utilized and the tools available, along with their relative value. Communicate this through blogs, brochures, television ads, and other media outlets. **II.** Promote the use of prescribed burning and natural wildfire as management tools and distribute educational materials that promote an understanding of the difference in emissions between controlled burns and high-severity fire (Objectives 2B and 2C). Increase public acceptance of fire and possible smoke impacts so that prescribed burning is a more widely accepted management tool through presentations, public workshops, and other communications. **III.** Incorporate signage at high-use recreation sites to take the opportunity to educate about the benefits of prescribed fire. Include communication about the benefits of prescribed fire with existing public outreach efforts (e.g. Take Care, League Stewardship days, Tahoe Fire and Fuels Team/ Fire Public Information Team [FirePIT], Fire Festival).
5E: Continue engaging with the Washoe Tribe and tribal members in stewardship of the area, including the application of tribal traditional knowledge and practices.	**I.** Promote low-intensity fire to foster culturally important species, restore meadows and other areas of exceptional cultural value, and mitigate threats to culturally important resources from high-intensity fire, through increased use of intentional burning guided by tribal traditional knowledge and cultural practices. **II.** Create and/or involve crews that include tribal members and/or otherwise directly engage the Washoe Tribe in stewardship activities.

Objective	Strategy and Prioritization Guidelines
5F: Support and maintain existing recreation access, opportunities, and experience. Where opportunities exist, incorporate actions into project design to enhance high-quality, equitable recreation experiences while protecting natural resources.	**I.** Where opportunities exist, work with the Sustainable Recreation Working Group to identify opportunities to plan and implement restoration projects in ways that promote high quality recreation experiences, protect natural resources, and anticipate future recreation needs and demands. **II.** Anticipate recreation impacts from project implementation, and provide outreach and public notice to user groups. Where there are potential conflicts between recreation and natural resource protection, engage recreation stakeholders to find solutions. **III.** Maintain and ensure equitable access to recreation amenities within the forest. Maintain or enhance access to public lands for a wide spectrum of recreation users and skill levels.
5G: Communicate proactively and effectively with residents, businesses, the public, and other stakeholders about restoration activities	**I.** Seek feedback and input from key constituencies during project planning and implementation to anticipate and mitigate impacts and to identify opportunities to enhance stewardship and access for recreation and other uses. **II.** Develop communication materials that target specific constituencies – for example, homeowners, recreation groups, and conservation advocates – and provide information about Lake Tahoe West restoration activities relevant to them. **III.** Provide local businesses with information about restoration activities and the Lake Tahoe West effort so that they can help to educate visitors to the west shore. **IV.** Use multiple avenues for communication such as direct outreach, social media, videos, public events, brochures, and trailhead signage.

Goal 6

Restoration is efficient, collaborative, and supports a strong economy

Economics and Capacity - Work takes place across jurisdictions and the treatment of multiple resources in the same entry increases project efficiency. Restoration under Lake Tahoe West creates regional economic benefits for multiple industries and local employment opportunities.

Objective	Strategy and Prioritization Guidelines
6A: Harvest forest products sustainably and utilize them to minimize carbon emissions through long-term carbon storage, bioenergy, or other products.	**I.** Maintain an ecologically sustainable supply of biomass to support regional facilities (Objectives 1A, 1B, 5A, and 6B). **II.** Utilize products to allow for carbon storage in long-lived durable wood products or for bioenergy production. **III.** Continue to engage regionally with the Tahoe Central Sierra Initiative and other initiatives to develop opportunities for a restorative wood industry, including biomass facilities, a strategy for consistent and sustainable biomass supply, and maximizing the use of biomass generated from restoration for ecological and economic benefit.
6B: Increase consistent business opportunities that provide regional economic growth and additional benefits to vulnerable populations.	**I.** Create consistent work for forestry and environmental restoration contractors, with local training and employment opportunities (Goals 1 and 2). **II.** Develop fire management capacity to safely utilize prescribed burning and wildfire from natural ignitions on the landscape (Objectives 2B and 2C). **III.** Support existing businesses, recreation, and regional property values through landscape restoration.
6C: Increase the number of projects that incorporate multi-benefit restoration objectives across multiple ecosystem types and land jurisdictions.	**I.** Aim to complete comprehensive restoration projects that span across jurisdictions, ownerships, and ecosystem types. **II.** Work collaboratively with partners, land owners, and permitting agencies to seek efficiencies in environmental review, permitting, and project implementation. **III.** Complete upland forest removal treatments concurrent with adjacent SEZ restoration projects where it increases project efficiencies and will improve the resilience of both systems. **IV.** Between agencies, utilize partnership opportunities such as Joint Powers agreements and Good Neighbor Authority to share resources, allow work on one another's property, and improve efficiency (Objective 6C).

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Photo: Anthony Cupaiuolo

Letter of Support

December 2, 2019

The Lake Tahoe West Restoration Partnership was formed in 2016 to restore and maintain the resilience of the forests, watersheds, recreational opportunities, and communities on Lake Tahoe's western shore. A multi-agency Executive Team provides oversight of the Lake Tahoe West Restoration Partnership.

National, state, regional, and local leaders recognize and support the mutual benefit to all jurisdictions, working collaboratively, to sustain resilient landscapes and communities in the Lake Tahoe Basin.

The undersigned chief executives resolve to support the Lake Tahoe West Landscape Restoration Strategy with partners in the Lake Tahoe Basin.

Jeff Marsolais, Forest Supervisor
Forest Service, Lake Tahoe Basin
Management Unit

Chief Mike Schwartz, Fire Chief,
North Tahoe Fire Protection District

Patrick Wright, Executive Director
California Tahoe Conservancy

Joanne Marchetta, Executive Director,
Tahoe Regional Planning Agency

Matt Green, Acting District Superintendent,
California State Parks, Sierra District

Patty Kouyoumdjian, Executive Director,
Lahontan Regional Water Quality
Control Board

Lake Tahoe West

Landscape Restoration Strategy