TAHOE REGIONAL PLANNING AGENCY

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STAFF REPORT

Date: July 6, 2022

To: Threshold Update Initiative Stakeholder Working Group

From: TRPA Staff

Subject: Forest Health Threshold Standards

Summary:
Staff will provide an overview of the proposed forest health threshold standards. This item is presented for discussion and guidance from the working group.

Background:
The five proposed forest health standards incorporate 40 years of science and align the Region's goals with the latest science on landscape resilience and set the trajectory for a more resilient future. Resilience describes the ability of a system to retain its structure, composition, and functional integrity in response to stresses and disturbance. A resilient forest landscape means maintaining forests on the landscape in response to disturbances or stressors such as fire, drought, insects, and disease. The standards recognize the centrality of fire on the landscape and the importance of fire protection to maintain both public health and safety and the natural values of the Tahoe region.

The proposed standards draw heavily from the work of the Tahoe West Partnership and the Tahoe Fire and Fuels team. The presentation will provide an overview of the standards themselves and the engagement with the Tahoe Science Advisory Council to review and refine the standards.

At the July 13th meeting of the Threshold Update Initiative Stakeholders Working Group, staff will present an overview of the forest health threshold standards and an update on the process to refine the standards and the associated performance measures.

Contact Information:
For questions regarding this item, please contact Dan Segan, Principal Natural Resource Analyst, at dsegan@trpa.org, (775) 589-5233.

Attachments:
A. Forest Health Threshold Standards

Attachment A

Forest Health Threshold Standards

TAHOE REGIONAL PLANNING AGENCY

Threshold Update

FOREST HEALTH THRESHOLD STANDARDS

VERSION 1.1

JULY 6, 2022

CONTENTS

SUMMARY

The challenges we face in managing our forests are not different from those facing the rest of the western United States. Our forests are overstocked and generally of the same age class. The lack of stand and tree diversity and high tree densities means that our forests are more susceptible to the many disturbances (e.g., fire, drought, insect & disease) that threaten to reshape the landscape and impact ecosystem services provided by forests including wildlife habitat, clean water, scenic, and recreational opportunities.

The proposed standards incorporate the last 40 years of science on forest health and resiliency to modernize and formally express the region's shared goals for forest health. For the first time the standards recognize the centrality of fire on the landscape and the importance of fire protection to maintain both public health and safety and the natural values of the Tahoe region. Historically fire shaped the structure and pattern of Tahoe's forests, and incorporating it today is even more critical as climate change continues to exacerbate fire conditions creating megafires and threatening to extend the fire season to near year-round.

The proposed standards set the trajectory for a more resilient future. Resilience describes the ability of a system to retain its structure, composition, and functional integrity in response to stresses and disturbance (North et al. 2022). For TRPA and partners, a resilient forest landscape means maintaining forests on the landscape level in response to disturbances or stressors such as fire, drought, insects, and disease. Resilience should not be confused with resistance to the aforementioned stressors (North et al. 2022). Even if we meet all our goals, fire, drought, insects, and disease are natural processes that will continue to shape our forested landscapes, as they always have, but that the forested landscape will persist in spite of these stressors.

Managing for the resiliency of the forest is not a new concept, but the understanding of what makes a resilient forest has changed over the last forty years. When the current standards were adopted in 1982, the study recommending the standards wrote, "To enhance the stability of Tahoe's vegetation and to make it more resilient to unwanted changes, certain forest management practices need to be implemented to enhance the structural and species diversity of the forest communities (TRPA 1982a)."

BACKGROUND

TRPA operates under the authority of the states of California and Nevada and the federal government through the Bi-State Compact, which was ratified by Congress and signed by the President of the United States. The revised Bi-State Compact, signed nearly forty years ago, states “the waters of Lake Tahoe and other resources of the region are threatened with deterioration or degeneration, which endangers the natural beauty and economic productivity of the region (TRPA 1982)”. To safeguard the natural beauty and economic productivity of the region would persist for generations to come, the Bi-State Compact directs TRPA to establish “environmental threshold carrying capacities”, defined as "an environmental standard necessary to maintain a significant scenic, recreational, educational, scientific or natural value of the region or to maintain public health and safety within the region." The environmental threshold carrying capacities (threshold standards) establish goals for environmental quality and express the shared aspiration for environmental restoration of the Tahoe region. The compact mandates that the standards cover specific areas including standards for the preservation of vegetation in the Region.

The standards shape the goals and policies of the Regional Plan and guide billions of dollars of public and private investment in the basin through the Environmental Improvement Program. Most of the current threshold standards were adopted in 1982 based on science that is now over 35 years old. In addition, the cost of fully monitoring and reporting on status of all standards in the current threshold system has always been beyond the means of the agencies in the region. Numerous recommendations for modifying the system have been put forward, including over 90 recommendations in the 2011 Threshold Evaluation Report (TRPA 2012), and the standards have been repeatedly critiqued by partners, members of the threshold evaluation team, and external scientific peer reviewers (Hall et al. 2016). Prior attempts to review and revise the threshold standards, including the multi-year Pathway 2007 process, proposed but failed, to eventuate significant revisions to the standards.

The TRPA Governing Board identified the review and updating of the threshold standards and performance measures as a strategic initiative for the agency. TRPA is currently leading the process and incorporating new scientific information, to ensure that the standards that guide billions of dollars of public and private investment in the basin are representative, relevant, and scientifically rigorous. The goals of the initiative are:

- A representative, relevant, and scientifically rigorous set of threshold standards.
- Performance measures that are informative, cost-efficient, and support adaptive management towards threshold standard attainment.
- A robust and repeatable process for review of threshold standards in the future.

Threshold standards guide resource management goals and projects in the Tahoe Basin, where all Environmental Improvement Program (EIP) projects are implemented to attain and maintain the thresholds. In the 40 years since the original Vegetation Preservation thresholds were adopted, resource management objectives and forest health treatments have progressed with advances in our scientific understanding of the ecology of Sierra Nevada ecosystems. Forests are increasingly at risk to wildfire, drought, and insect-related mortality throughout the Sierra Nevada region, and these pressing concerns are reshaping forest management goals and objectives.

CURRENT THRESHOLD STANDARDS

The Bi-State Compact requires that TRPA adopt threshold standards in five areas, one of which is "vegetation preservation." Twenty standards were adopted for the preservation of regional vegetation in 1982, and the standards have been amended twice, most recently in 2001.

Twelve standards were adopted for the preservation of "common vegetation," in 1982 (TRPA 1982a). Common vegetation was described at the time, as the vegetation that was "readily viewed by the public (TRPA 1982a)." The rationale for the standards was, "Preservation of natural vegetation in the aforementioned diversity is necessary to protect the various scenic, recreational, and wildlife viewing opportunities in the basin while providing for the maintenance of such functional capabilities as water cleansing, soil conservation, air purification, and wildlife habitat (TRPA 1982a)."

Standard development was guided by two value statements (TRPA 1982a):

1) Provide for a wide mix and increased diversity of plant communities in the Tahoe Basin, including such unique ecosystems as wetlands, meadows and other riparian vegetation.
2) Conserve threatened endangered and sensitive plant species, and uncommon plant communities of the Lake Tahoe Basin.

They wrote that the "Implementation of the recommended threshold would provide for the retention of all the existing plant associations in the Basin while providing for opportunities to increase plant diversity and increase the total extent of wetland, meadow, and deciduous riparian vegetation. Improvement and or maintenance of existing conditions requires adherence to the Bailey system of allowable impervious coverage and use of the management practice to increase forest diversity. The attainability of the desired diversity conditions is a long-term goal; possibly requiring up to 20 years to achieve (TRPA 1982a)."

The expected implication of the threshold standards was described at the time of adoption as, "the visual, recreational, aquatic, wildlife, and other environmental resources will be enhanced as a consequence." The expected management implications at the time were described as, "allow management practices intended to increase the structural diversity of conifer forests (TRPA 1982a)."

LATE SERAL AND OLD GROWTH FOREST ECOSYSTEMS

When the threshold standards were first adopted in 1982, no standards were included specifically related to old growth forests (TRPA 1982b). Following the 1991 threshold evaluation, the Governing Board directed staff to develop standards for old growth forests and associated wildlife species. The Interagency Forest Health Consensus Group led the consultation process to develop threshold standards and associated regional plan and code updates to protect old growth forest. In May of 1997 the Governing Board adopted the following two standards within the Common Vegetation Category, for the protection of the old growth forest (TRPA 1997).

1) Provide for the promotion and perpetuation of the late successional/old growth forest. The goal is to increase late successional/old growth conditions across elevational ranges of the Lake Tahoe Basin forest cover types.
2) Individual trees greater than 30" diameter at breast height (DBH) shall also be favored for retention because of their late seral attributes.

The second standard, with reference to 30" DBH, was adopted at the time based on the latest research by the USFS that suggested that at smaller scales (i.e. forest stand), when trees reached 30" DBH (approximately 150-200 years) the forest began to exhibit old growth characteristics. Standards for the protection of Late Seral and Old Growth Forest Ecosystems were refined and adopted as a separate threshold category in 2001. The two old growth standards adopted in 1997 within the common vegetation threshold category, were removed in 2001, when three threshold standards were adopted in the Late Seral and Old Growth Forest Ecosystems category (TRPA 2001). At the time the standards were adopted, the majority of forested stands in the basin were estimated to be 100-120 years old, and estimated timeline for attainment was 50-60 years (2050 or 2060), based on a projected stand age for attainment of 150 years.

HISTORY OF TAHOE FOREST MANAGEMENT

Humans have occupied the Tahoe Region for at least 8,000 years (Elliot-Fisk et al. 1997), and the pattern and condition of its vegetation today reflect past and current human activities (Elliot-Fisk et al. 1997, Murphy and Knopp 2000, Taylor 2007). Prior to the early 1800s, the Washoe people occupied the Tahoe Region. Natural resource management by the Washoe over at least 1,300 years, in combination with natural processes, maintained a diversity of forest types (Murphy and Knopp 2000). Extensive logging activities to support the Comstock era mining boom began in 1859, and within 40 years approximately 60 percent of the Tahoe watershed had been clear-cut (Elliot-Fisk et al. 1997, Murphy and Knopp 2000). The remaining unlogged land was generally alpine, barren, or inaccessible (Murphy and Knopp 2000). As a result, most forest stands in Tahoe are less than 150 years old, with few examples of young and very old forest stands (Elliot-Fisk et al. 1997, Murphy and Knopp 2000). Livestock grazing also had pervasive effects on the Region's vegetation during and after the Comstock era. Sheep grazing was ubiquitous in the Region's forests and shrublands, and was so intensive that the understory was often denuded and browse species were extirpated from some areas (Elliot-Fisk et al. 1997, Murphy and Knopp 2000). Cattle were grazed in all of the Region's meadows and in subalpine areas (Elliot-Fisk et al. 1997, Murphy and Knopp 2000). A grazing allotment system was put in place in the 1930s, limiting livestock to specific areas. After the period of intensive logging, federal and state governments began acquiring lands in and around the Tahoe Region in 1899 and intensified acquisition in the 1930s; today the Forest Service manages 78 percent of the Region (Elliott-Fisk et al. 1996; USFS LTBMU 2015).

During most of the 20th century, forest management in the Tahoe Basin and throughout the western United States was primarily focused on fire suppression, which altered the natural fire regime and resulted in the densification of yellow pine and mixed conifer forests in the region (McKelvey et al. 1996, Elliot-Fisk et al. 1997, Taylor 2007, Beaty and Taylor 2008). Historically, fires occurred in the montane forests of the Tahoe Basin every 9-13 years (citation); these low-intensity fires worked to remove smaller trees and shrubs growing under the forest canopy, reducing future fire risk and providing ample sunlight for pine regeneration. The lack of fire in these forests has altered the vegetation composition, where pines are gradually being replaced by shade-tolerant species such as white fir (*Abies concolor*) that fill the understory with a dense continuous layer of trees that connect to the overstory (McKelvey et al. 1996, Elliot-Fisk et al. 1997, Taylor 2007). This change in composition and structure of the forest has increased the overall fire hazard and risk of Tahoe forests.

The long history of fire suppression, combined with periods of drought and insect-induced mortality, has resulted in stands with high concentrations of hazardous fuels (Murphy and Knopp 2000, Barbour et al. 2002, Beaty and Taylor 2008, Raumann and Cablk 2008). This condition has increased the threat of catastrophic wildfire and is typical of a forest where natural disturbance has been excluded. Since the 2007 Angora fire in South Lake Tahoe, land management agencies have collaboratively worked to increase pace and scale of fuel reduction treatments in conifer forests in the Region, especially in areas surrounding the wildland urban interface (e.g Marlow et al. 2007).

The 2007 Angora Fire marked a shift in forest management in the Tahoe Basin. After the fire, and the findings of the Bi-State Blue Ribbon Commission greater focus has been directed to coordinated fuels reduction and community protection from wildfire. The Bi-State Commission was created to identify recommendations regarding policy changes, education, funding, government structures, and environmental practices as they relate to wildland fuels management and community fire safety in the Tahoe Basin. The Tahoe Fire and Fuels Team (TFFT) was created in 2008 to implement the multi-jurisdictional fuel reduction and wildfire prevention strategy, which strives to collaboratively coordinate and implement cross-boundary forest health and wildfire reduction treatments. Today the TFFT includes representatives from 21 agencies and organizations and leads the prioritization of critical restoration work, identifies opportunities for regulatory and permit streamlining, and coordinates funding opportunities amongst partners.

In the last decade, concerns over the impacts of climate change on forest health have risen to the forefront of resource management and decision-making across the states of California and Nevada. The extended drought and resulting widespread tree mortality in the middle of the last decade (Goulden & Bales 2019) has prompted a new push towards large-scale restoration efforts throughout the Region. With so many dead trees, heightened concerns about wildfire risk have elevated the urgency of the conversation and resource management agencies response to reduce the extreme hazard across the forested landscapes of the Sierra Nevada. The urgency of the forest health situation has pushed collaborative restoration planning, where land management agencies and stakeholders are coming together to tackle the forest health issues with a focus on large, landscape scale restoration.

In 2016, the Lake Tahoe West Restoration Partnership (Partnership) formed to begin planning and implementing landscape-scale forest restoration on the west shore of Lake Tahoe. The Partnership dedicated significant time and resources to reviewing the literature on forest resilience and developing goals for the region. The proposed standards presented here drawn heavily from that work, notably from the Landscape Resilience Assessment (Gross et al. 2017), the Landscape Restoration Strategy (LTW 2019), and the Lake Tahoe West Science Summary of Findings Report (LTW Science Team 2020).

OUTLOOK

Climate change is, and will likely continue to be, one of the greatest threats to attaining our collective goals and sustaining Tahoe's forests for future generations. Warming temperatures are already exacerbating catastrophic wildfires, and are forecast to significantly increase the area burned each year (LTW Science Team 2020). Climate change poses a threat to the integrity of the Region's vegetation communities and plant species. Warming temperatures and decreased snowpack due to less snow and more rain and earlier snowmelt are already occurring, and are predicted to continue for the Sierra Nevada (e.g. Hayhoe et al. 2004, Dettinger 2005, Safford et al. 2012). In the Lake Tahoe Region, these changes appear to be happening at an accelerated pace (Coats 2010). These changes are predicted to cause range shifts, re-sorting of species associations, extirpations, and extinctions in high elevation vegetation areas such as the Lake Tahoe Region (e.g. Seastedt et al. 2004, Loarie et al. 2008, Tomback and Achuff 2010). These changes have already begun and will likely affect both common and uncommon plant communities and species. For example, Jeffrey pine is widespread in montane elevations in the Region today, but populations are declining in low elevation areas, expanding in mid elevations, and slowly expanding in higher elevations (Gworek et al. 2007). Whitebark pine, a keystone high elevation conifer of western North America including the Sierra Nevada, has experienced widespread mortality due to the combined effects of warming and increased severity of pathogens such as native mountain pine beetle and non-native white pine blister rust (Tomback and Achuff 2010); hence its status as a candidate for federal listing as a threatened species. Many of the Region's high elevation species could be extirpated given the relatively low elevations of the area (e.g. Loarie et al.

2008). This includes the Freel Peak cushion plant community, and many of the Region's sensitive plant species. The Region's wetlands are also vulnerable, with a drier climate potentially leading to lower water tables which are critical for sustaining fens (e.g. Cooper et al. 1998), while earlier and more intensive snow melt and rain events may alter flow regimes and increase erosion.

Many of the proposed standards are rooted in the practice of looking at properly functioning systems to identify historical reference for goal articulation. The practice has dominated forest health restoration (Safford et al. 2012). As the climate continues to change, we may need to revisit the quantitative targets derived from reference conditions. In warmer world, with altered precipitation regimes, reference conditions maybe be more valuable as a guide to understanding process, rather than a tool for articulating specific targets for returning the forest to a state that is no longer feasible given the changes in processes driving forest dynamics (Safford et al. 2012).

FOREST COMPOSITION AND AGE

Seral stage is the term used in forest ecology and management to describe the age of a forest community. As implied by the term “stage” the concept incorporates the succession of communities on a forested landscape and the dynamic processes that shape those communities. Historically a diversity of seral stages were maintained on the landscape in the Sierra Nevada and the Tahoe region as a result of fire regimes of the region (Manley et al. 2020). Healthy and resilient Sierra forests contain a mix of seral stages (Manley et al. 2020). Different seral stages and compositions are also utilized by different species on the landscape and necessary to support biodiversity. The long history of fire suppression has resulting in stands across the Sierra with high concentrations of hazardous fuels (Murphy and Knopp 2000, Barbour et al. 2002, Beaty and Taylor 2008, Raumann and Cablk 2008). Composition refers to the relative canopy cover. Canopy cover is the “percentage “of forest floor covered by the vertical projection of the tree crowns (Jennings 1999; North 2012).” The canopy cover is a critical habitat determinate that influences understory microhabitat, and mediates light reaching the forest floor (North 2012).

CURRENT STANDARDS

Six standards currently relate to seral stage of the Region’s forest. Targets for Yellow Pine and Red Fir in stages other than mature are established by VP7 and VP8. Targets for total old growth forest, and old growth within different elevation zones are established by standards VP12-VP15.

PROPOSED STANDARD

Composition and Age – The range for dominant seral stage for forested areas of the region shall be as set forth in table 1

TABLE 1: TARGET SERAL STAGE DISTRIBUTION RANGES BY VEGETATION TYPE

Seral Stage	Yellow Pine	Mixed Conifer	Red Fir
Early Development Open <5” DBH & <40% Overstory Canopy	5-15%	5-20%	3-20%
Early Development Closed <5” DBH & >40% Overstory Canopy	0%	0%	0%
Mid Development Open 5”-19.9” DBH & <40% Overstory Canopy	8-25%	1-15%	0-15%
Mid Development Closed	0-10%	0-15%	12-30%

5"-19.9" DBH & >40% Overstory Canopy			
Late Development Open >20" DBH & <40% Overstory Canopy	29-50%	6-50%	2-15%
Late Development Closed >20" DBH & >40% Overstory Canopy	5-31%	7-79%	25-70%

Composition and stage are defined based on overstory tree diameter at breast height (DBH) and overstory tree canopy cover from above (% overstory canopy). The target ranges for the proposed standard are drawn from the work of the Tahoe West Partnership (Lydersen et al. 2013; USFS LTBMU 2015; Gross et al. 2017). The proposed standard improves on the current standards in multiple ways. First, the proposed standard utilizes the latest science to establish the desired range for each seral stage. Second the standard recognizes the difference between early and mid-seral stages, and establish targets for each (Swanson et al. 2011; DellaSala et al. 2014). Third the revised standards recognize the difference in function between open and closed canopy in each seral stage and establish individual targets for each. Open and closed canopy forest provide functionally different habitat which is not fungible across the landscape. Fourth, the standards establish targets for each seral stage for the three dominate forest types in the region.

CURRENT CONDITION

Current conditions of forested stand composition, age, density, and structure were assessed using Ecological Object Based Vegetation Mapping (EcObject) which is derived from aerial-based Light Detection and Ranging (LiDAR) data (2010). These data were updated to include landscape changes since 2010 (Conway 2017). The mapping and analysis presented here do not yet include updates to reflect the impact of the Caldor fire. The Lake Tahoe EcObject dataset represents a novel forest-wide existing vegetation dataset produced by the USFS Region 5 Remote Sensing Lab that incorporates LiDAR into several facets of the mapping process. It is created from a multi-resolution segmentation of LiDAR-derived tree approximate objects and a 1-m canopy height model, which were then aggregated by stand and tree-level ecologic relationships. The resulting segments were then populated with a collection of traditional and contemporary metrics at scales applicable to both project-level planning and large-landscape analysis. Different combinations of multi-dimensional datasets were used to estimate metrics and thus accuracies vary depending upon both the data used and workflows that were generated. Mean tree diameter and percent canopy cover values from each EcObject polygon were used to classify seral stage based on the ranges listed in table 1. Forest composition relative to the desired ranges for each forest type in the region is summarized in Table 2.

TABLE 2: CURRENT DISTRIBUTION OF SERAL STAGE BY FOREST TYPE IN THE TAHOE REGION.

Seral Stage	Yellow Pine Forest	Sierra Mixed Conifer	Red Fir Forest
Early Development Open	21%	14%	23%
Early Development Closed	4%	0%	0%
Mid Development Open	35%	52%	55%
Mid Development Closed	38%	32%	19%
Late Development Open	1%	1%	1%
Late Development Closed	2%	1%	1%

Table 3 provides a summary of landscape representation of each forest type by seral stage relative to the target range for that seral stage.

TABLE 3: SERAL STAGE SUMMARY RELATIVE TO DESIRED CONDITION

Seral Stage	Yellow Pine Forest	Sierra Mixed Conifer	Red Fir Forest
Early Development Open	Overrepresented	Within	Overrepresented
Early Development Closed	Overrepresented	Overrepresented	Overrepresented
Mid Development Open	Overrepresented	Overrepresented	Overrepresented
Mid Development Closed	Overrepresented	Overrepresented	Overrepresented
Late Development Open	Underrepresented	Underrepresented	Underrepresented
Late Development Closed	Underrepresented	Underrepresented	Underrepresented

The difference between the current landscape condition and the desired condition is summarized in Table 4. Table 4 expresses the difference in terms of the minimum number of acres of the forest type that would need to be added or removed to achieve the desired condition.

TABLE 4: MINIMUM ACREAGE THAT NEED TO BE ADDED OR REMOVED FROM THE CLASS TO BE WITHIN THE TARGET RANGE

Seral Stage	Yellow Pine Forest	Sierra Mixed Conifer	Red Fir Forest
Early Development Open	(1,556)	(10,376)	(1,002)
Early Development Closed	(917)	(80)	(54)
Mid Development Open	(2,512)	(26,211)	(12,616)
Mid Development Closed	(7,221)	(12,172)	(6,026)
Late Development Open	7,236	3,751	4,351
Late Development Closed	849	4,179	7,455

FIGURE 1: COMPOSITION AND AGE OF TAHOE'S FOREST

STAND DENSITY

Stand density refers to the number of trees in a given area of forest and is frequently expressed in trees per acre. The long history of fire suppression has resulted in stands in Tahoe and across the Sierra with densities far in excess of historic conditions and high concentrations of hazardous fuels (Murphy and Knopp 2000, Barbour et al. 2002, Beaty and Taylor 2008, Raumann and Cablk 2008). Higher stand densities are associated with stressed trees that are more susceptible to drought, insects, and disease. Elevated densities in in concert with an extended drought were implicated in the widespread tree mortality witnessed in the Sierra during the in the middle of the last decade (Goulden & Bales 2019). Forest health treatments to reduce density have been found to improve drought resistance, promote retention of larger trees on the landscape, and reduce overall tree mortality (LTW Science Team 2020; Low et al. 2021). Forest health treatments that reduce density have also been found to slow wildfire growth.

The LTBMU and the Tahoe West partnership identified stand density as a critical measure of landscape resilience and used to articulate desired conditions in the forest (USFS LTBMU 2015; Gross et al. 2017; LTW 2019). Recent work has suggested that even modern treatments may not be sufficiently aggressive to thinning forests and that to maintain forests on the landscape future treatments may need to reduce density even further (North et al. 2022). As the climate continues to change, target densities for each vegetation type may need to be adaptively managed to ensure that the target densities continue to reflect densities on the landscape remain resilient.

CURRENT STANDARD

No threshold standards relate to stand density.

PROPOSED STANDARD

Stand Density –The range for stand density for forested areas of the region shall be as set forth in the table below.

TABLE 5: TARGET DENSITIES BY VEGETATION TYPE

Vegetation Type	Target
Jeffery Pine Forest	<60

Sierra Mixed Conifer	<55
Red fir	<80
Subalpine	<140

The proposed standard is consistent with the ranges suggested by the LTBMU and the Tahoe West Partnership (USFS LTBMU 2015; Gross et al. 2017). The resilience targets for Tahoe West also included a target for Aspen standards, but data limitations have precluded quantification. If and/or when methods arise that can effectively quantify Aspen stand density at the regional scale, consideration should be given to adding a target for Aspen at that time.

CURRENT CONDITION

At present, just 30% of Tahoe's forests have densities within the range considered resilient (Table 6). Nearly half of the forested area with resilient densities is located in the sub-alpine zone of the region (Figure 2). To provide further segmentation for targeting treatments and planning, the Tahoe West Partnership identified three categories for stand density including in "resilient", "less resilient", and "least resilient" where densities were generally greater than twice those considered resilient (Gross et al. 2017). The analysis below follows that convention and segments all three classes (Table 6). Tree density region wide is depicted in figure 2.

TABLE 6: TOTAL ACRES AND PERCENT OF EACH FOREST TYPE WITHIN EACH DENSITY CLASS.

Forest Type	Resilient	Less Resilient	Least Resilient	Total Acres
Red Fir Forest	10,685 (34%)	20,871 (66%)	13 (0%)	31,568
Sub Alpine Forest	17,795 (94%)	N/A	1,122 (6%)	18,916
Sierra Mixed Conifer	11,839 (15%)	33,013 (43%)	32,630 (42%)	77,482
Yellow Pine Forest	3,987 (20%)	15,374 (77%)	685 (3%)	20,046
Total	44,306 (30%)	69,258 (47%)	34,449 (23%)	148,013

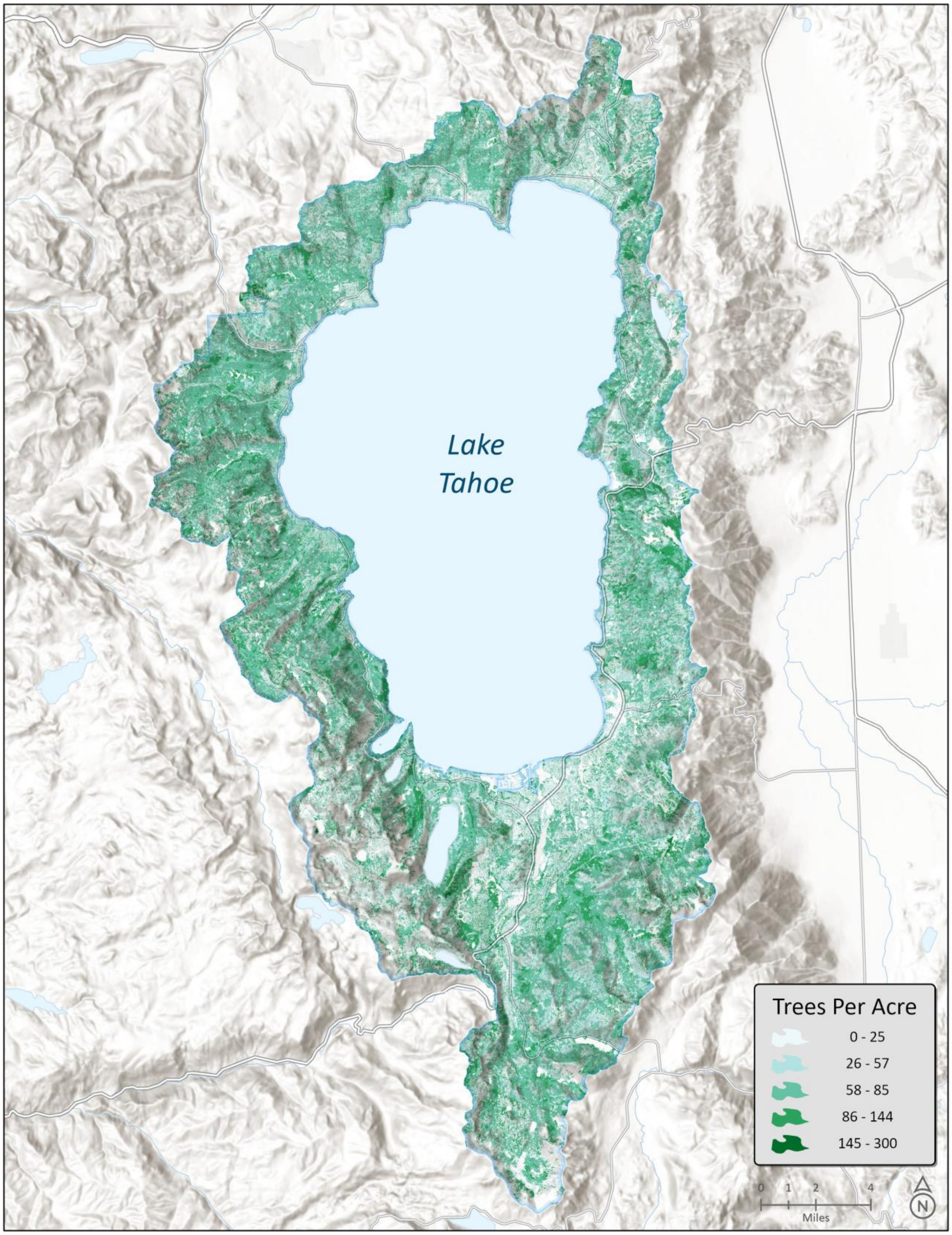

FIGURE 2: TREE DENSITY IN THE TAHOE REGION

STAND STRUCTURE

Stand structure here refers to the spatial pattern in which trees are found on the landscape. If they are close together in clumps or more dispersed across the landscape. The proposed stand structure standard is a measure of the horizontal heterogeneity of the forested landscape. A history of fire suppression on the landscape has resulted in a forest today that is far more homogenous than they were under natural fire regimes (Lydersen et al. 2013). The measure compliments the first proposed threshold standard regarding composition and age. Together the two, influence overall forest structure and response to disturbance, regeneration, snow retention (Gross et al. 2017; Safa et al. 2021). The structure of the forest is also determinant of habitat utilization for sensitive species (Eyes et al. 2017), and critical for provision of different habitat types across the landscape and the maintenance of regional biodiversity (Coppeto et al. 2006; Gross et al. 2017; Phillips et al. 2022). Restoring heterogeneity to the forested landscape has long been a goal of management in the region and a means to improve the resilience of the forest to natural and human disturbances (TFFT 2015). The proposed standard for structure also supports the proposed standards for wildfire, because the vision for a mosaic across the landscape is associated with moderating and limiting fire growth (USFS 2003).

CURRENT STANDARD

One standard, VP2, relates to forest structure in the region. The standard, reads “Increase plant and structural diversity of forest communities through appropriate management practices as measured by diversity indices of species richness, relative abundance, and pattern.” The standard articulates a desired goal that is similar to the proposed standard, but the current standard does not contain any specific or measurable criteria that would allow for objective assessment of attainment.

PROPOSED STANDARD

Stand Structure – The range for stand structure for forested areas of the region shall be as set forth in table 8.

TABLE 7: STAND STRUCTURE

Horizontal Heterogeneity Class	Lower % Range	Upper % Range
Individuals/Sparse[1]	1	7
Open (Gaps)	20	27
Stand initiation[2]	17	
Scattered clumps (2-4 trees, low cover)	13	36
Clump (medium 5-9 trees)	11	15
Dense clump (large, >10 trees)[3]	0.5	66
All clumps[4]	48	

The target ranges for the proposed standard are drawn from the work of the Tahoe West Partnership (Lydersen et al. 2013; USFS LTBMU 2015; Gross et al. 2017).

CURRENT CONDITION

Stand structure was evaluated using the EcObject dataset described above. The number of trees, tree count per acre, and percent canopy cover values were used to create the horizontal heterogeneity classes listed in the table 9. The most overrepresented classes in the region were the clumps, by both percent on the landscape and total acres. The analysis also suggests that forest openings are underrepresented on the landscape.

TABLE 9: CURRENT STAND STRUCTURE

Horizontal Heterogeneity Class	Acres	Percent	Target (%)	Minimum Change	
				%	Acres
Individual/Sparse	12,539	7.3	7	-0.3	(503)
Open	17,688	10.6	20	+9.4	15,751
Stand Initiation	31,030	18.5	17	-1.5	(2,513)
Scattered Clump	63,157	37.7	36	-1.7	(2,849)
Clump	36,181	21.6	15	-6.6	(11,059)
Dense Clump	6,967	4.2	0.5	-3.7	(6,200)
All Clumps	106,305	62.1	48	-14.1	(23,626)

FIGURE 3: REGIONAL HORIZONTAL HETEROGENEITY

WILDLAND URBAN INTERFACE WILDFIRE PROTECTION

The Wildland Urban Interface (WUI) is the area where houses are adjacent to or intermingle with the wild, undeveloped landscape (Radeloff et al. 2005). Tahoe's WUI includes 117,954 acres adjacent to its communities, roughly half the total area of the region (TFFT 2015). In Tahoe, WUI is categorized as two zones: Defense Zone and WUI Threat Zone. The WUI Defense Zone is the area directly adjoining structures and evacuation routes, in total encompassing 69,158 acres (TFFT 2015). The defense zone extends for a least 0.25 miles from the edge of the community and is the highest priority for fuels reduction. The management goal for the defense zone is to reduce fuels so that flame lengths during extreme fire weather will burn at a length of 4-foot or less, enabling firefighters to engage the fire before it can reach the built environment (TFFT 2015). The WUI threat zone is an area adjacent to the WUI defense zone, where treatments are designed to reduce fuels in target areas where fires are known to start.

CURRENT STANDARD

No threshold standards relate to wildfire or wildfire protection for the region.

PROPOSED STANDARD

Predicted flame lengths are under 90th percentile fire weather conditions are less than four feet high across 90% of the wildland-urban interface defense zone.

While not part of the text of the proposed standard, the evaluation and management should consider the distribution of areas with predicted flame lengths over four feet to ensure they are generally-well distributed, do not exceed one acre per patch, and are not within 100 feet of structures or infrastructure.

CURRENT CONDITION

Wildfire risk vulnerability was modeled with the FSim-Wildfire Risk Simulation Software (FSim). FSim was developed by U.S. Forest Service researchers (Finney et al. 2011) and has been applied extensively in the western US to asses risk and assess the effectiveness of forest management (Ager et al. 2020).

FSim modeling uses current fuels, topography, historic weather, and historic fire occurrence data to estimate likelihood and intensity of wildfire across the landscape (Finney et al. 2011). We used the FSim modeling outputs created for the Northern Sierra Risk Assessment, which was completed by the USFS in 2018. The methods were identical to the Southern Sierra Risk Assessment, which was completed in 2016 (Thompson et al. 2016).

The modeling suggests there are 138,891 acres of the 205,503 acres of land that could burn at flame lengths greater than four feet. In the WUI Defense Zone, 44,668 acres of the 70,380 acres are at risk of burning at greater than four-foot flame lengths. Within the WUI Threat Zone 38,980 of the 46,078 acres are vulnerable (Table 10).

TABLE 10: FOREST MANAGEMENT ZONE BY AREA AT RISK OF GREATER THAN FOUR FOOT FLAME LENGTHS

Forest Management Zone	Total Area (acres)	Area where >4 ft Flames Possible (acres)	Area Vulnerable (%)
WUI Defense Zone	70,380	44,667	64%
WUI Threat Zone	46,078	38,980	85%
General Forest	64,390	43,927	68%
Wilderness	24,656	11,316	46%
Total	205,503	138,891	68%

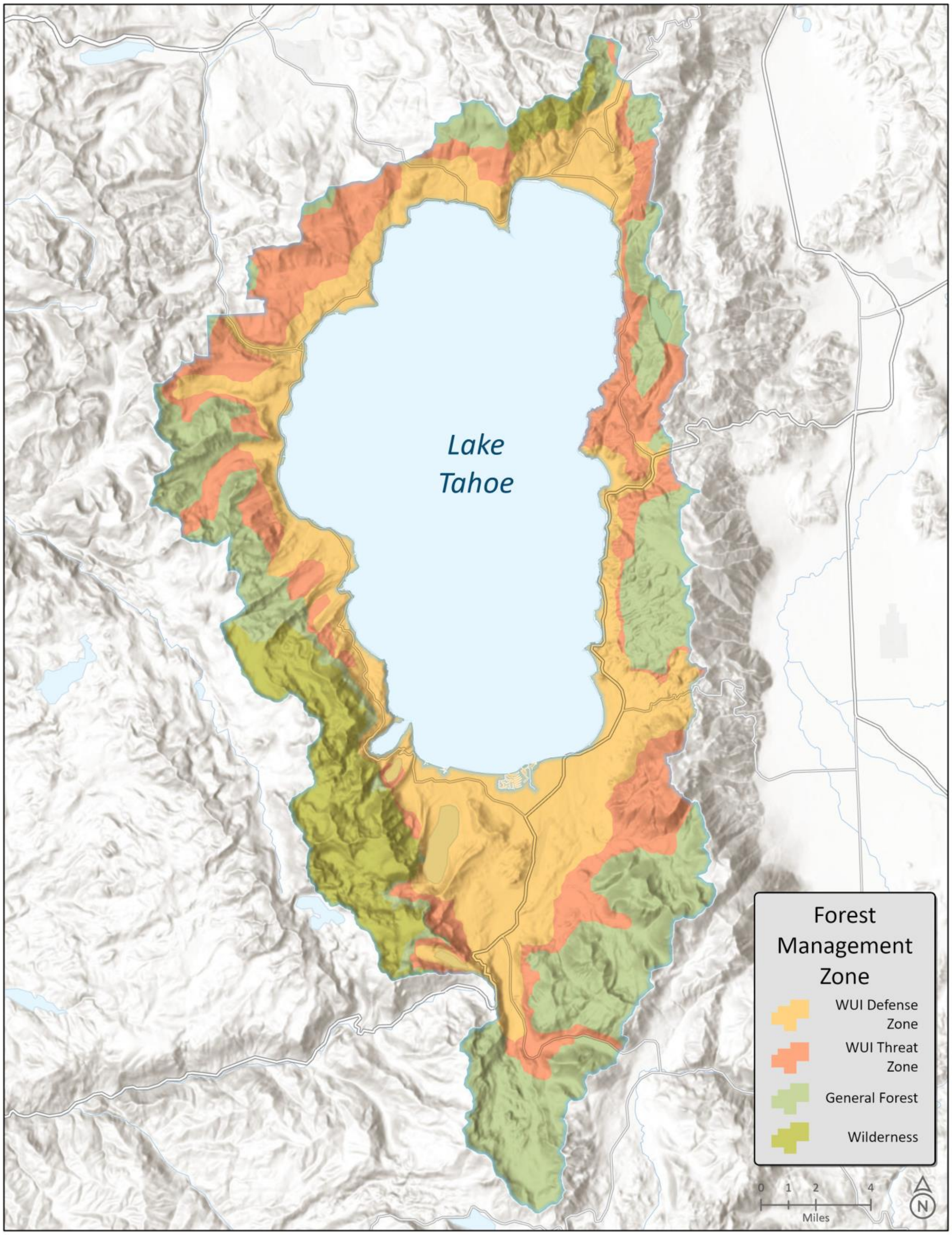

FIGURE 4: FOREST MANAGEMENT ZONES IN LAKE TAHOE

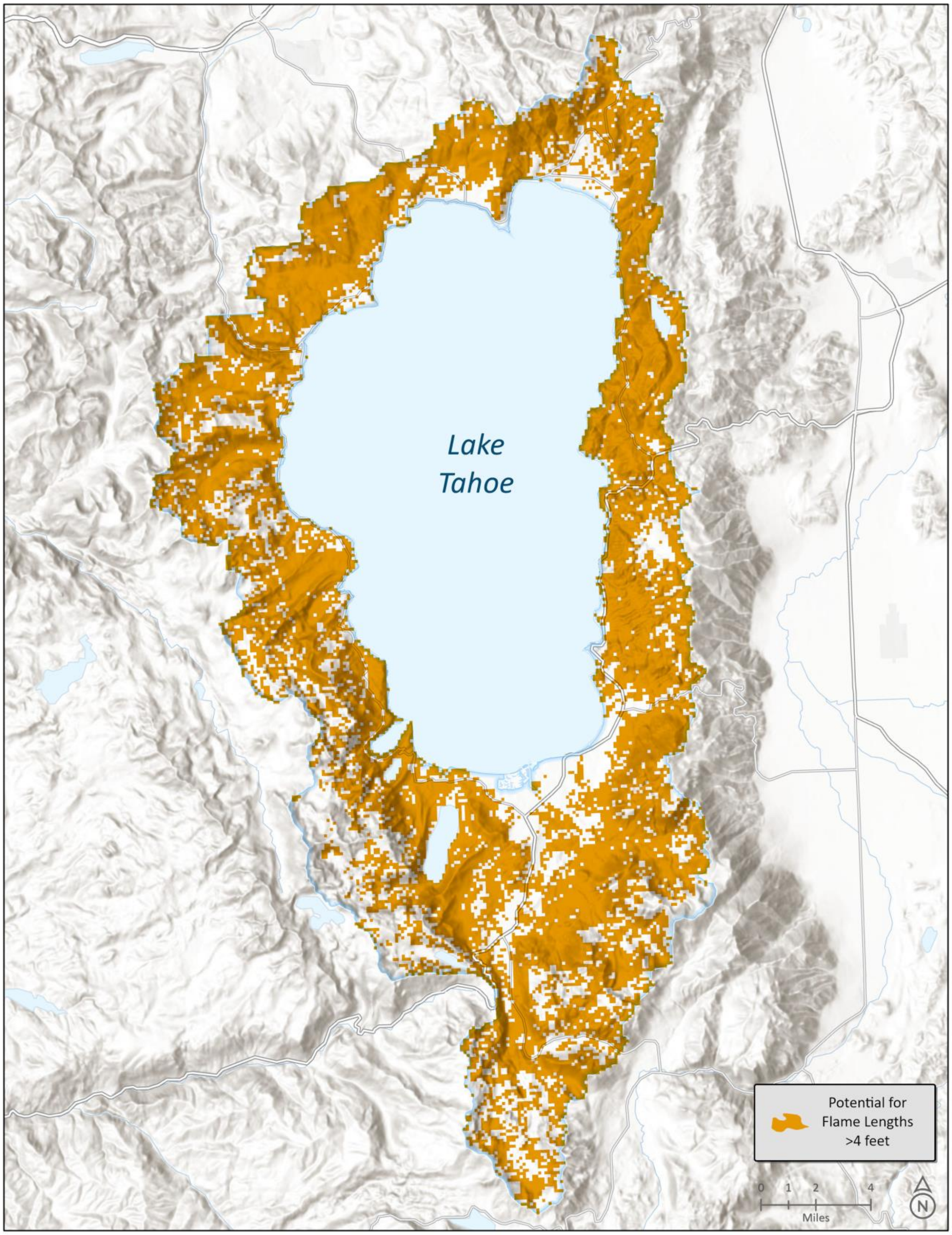

FIGURE 5: AREA WITHIN TAHOE WITH PREDICTED FLAME LENGTH GREATER THAN FOUR FEET.

LANDSCAPE FIRE DYNAMICS

Fire is a natural disturbance that has shaped the forests of the Sierra for millennia. Pre-settlement, Tahoe's forests burned frequently but at relatively low intensity (Safford & Schmidt 2007; TFFT 2015). Regionally fire return interval was between 5-128 years, but in the lower elevation portions of the Region, the fire return interval was shorter, generally less than 20 years (TFFT 2015). Years of wildfire suppression have led to higher fuel loads on the landscape and increased frequency of high severity fires across the Sierra (Miller et al. 2009). The lack of low severity burns has been implicated in large scale tree mortality across the Sierra (Stephens et al. 2018), lack of forest diversity (McKelvey et al. 1996, Elliot-Fisk et al. 1997, Taylor 2007), and increased the likelihood of high severity fries. High severity fire often burns hotter, decimating soils and vegetation with complete combustion. High severity fire is often more difficult to control and provides little opportunity to first responders to manage the fire appropriately and direct it away from communities and critical infrastructure.

Fire severity patch size identifies areas on the landscape that are more prone to large patches of high severity fire and associated high tree mortality. Large patches of high severity fire remove mid- and late-seral forest characteristics which degrades the resilience of these ecosystems and the value of wildlife habitat, and places such ecosystems on uncharacteristic trajectories (e.g. transitioning from a forest to a shrub ecosystem). Forest heath treatments have been found to help moderate high severity fire and promote resilience (Lydersen et al. 2017).

CURRENT STANDARD

No threshold standards relate to wildfire or wildfire protection for the region.

PROPOSED STANDARD

Limit high severity patch size to no more than 40 acres.

CURRENT CONDITION

The Tahoe West Partnership defined large patch high severity fire as any area greater than 40 acres with the potential to burn at greater than six-foot flame lengths (Gross et al. 2017). We used the FSim modeling described above to identify areas that met this criterion. The FSim raster output had a pixel size of approximately eight-acres, so high severity patches were identified as areas with a probability of flame lengths over six feet occurring across five pixels or more.

In total there are 74,354 acres in the region at risk of high severity fire with a patch size greater than 40 acres. The lower elevations along the east and north sides of the Tahoe Basin have the potential to burn large areas at high severity, while the potential for large patches of high severity fire on the West shore is concentrated in the canyons and drainages (Figure 6). On the south shore most of the potential for large patches of high severity fire is within the WUI. During the Caldor Fire, 4,930 acres of the 9,930 acres that burned in the Tahoe Basin, burned at high severity in large contiguous areas. These observed high severity patches from the Caldor Fire, align with where FSim predicted large high severity fire. Future wildfire modeling efforts will account for the change in forest fuels created by the Caldor Fire and other disturbances.

Vegetation burn severity during the Caldor Fire showed 4,930 of the 9,930 acres that burned in the Tahoe Basin burned at high severity in large contiguous areas. These observed high severity patches from the Caldor Fire align with where FSim predicted large high severity fire. Future wildfire modeling efforts will account for the change in forest fuels created by the Caldor Fire and other disturbances.

FIGURE 6: POTENTIAL FOR HIGH SEVERITY PATCH SIZE IN EXCESS OF 40 ACRES

APPENDIX I –THRESHOLD STANDARDS FOR COMMON VEGETATION (CURRENTLY ADOPTED)

COMMON VEGETATION

MANAGEMENT STANDARDS

VP1) A non-degradation standard shall apply to native deciduous trees, wetlands, and meadows to preserve plant communities and significant wildlife habitat, while providing for opportunities to increase the acreage of such riparian associations to be consistent with the SEZ threshold.

VP2) Increase plant and structural diversity of forest communities through appropriate management practices as measured by diversity indices of species richness, relative abundance, and pattern.

VP3) Maintain the existing species richness of the Basin by providing for the perpetuation of the following plant associations:
Yellow Pine Forest: Jeffrey pine, White fir, Incense cedar, Sugar pine.
Red Fir Forest: Red fir, Jeffrey pine, Lodgepole pine, Western white pine, Mountain hemlock, Western juniper.
Subalpine Forest: Whitebark pine, Mountain hemlock, Mountain mahogany.
Shrub Association: Greenleaf and Pinemat manzanita, Tobacco brush, Sierra chinquapin, Huckleberry oak, Mountain whitethorn.
Sagebrush Scrub Vegetation: Basin sagebrush, Bitterbrush, Douglas chaenactis.
Deciduous Riparian: Quaking aspen, Mountain alder, Black cotton-wood, Willow.
Meadow Associations (Wet and Dry Meadow): Mountain squirrel tail, Alpine gentian, Whorled penstemon, Asters, Fescues, Mountain brome, Corn lilies, Mountain bentgrass, Hairgrass, Marsh marigold, Elephant heads, Tinker's penney, Mountain Timothy, Sedges, Rushes, Buttercups.
Wetland Associations (Marsh Vegetation): Pond lilies, Buckbean, Mare's tail, Pondweed, Common bladderwort, Bottle sedge, Common spikerush.
Cushion Plant Association (Alpine Scrub): Alpine phlox, Dwarf ragwort, Draba.

VP4) Relative Abundance - Of the total amount of undisturbed vegetation in the Tahoe Basin: Maintain at least four percent meadow and wetland vegetation.

VP5) Relative Abundance - Of the total amount of undisturbed vegetation in the Tahoe Basin: Maintain at least four percent deciduous riparian vegetation.

VP6) Relative Abundance - Of the total amount of undisturbed vegetation in the Tahoe Basin: Maintain no more than 25 percent dominant shrub association vegetation.

VP7) Relative Abundance - Of the total amount of undisturbed vegetation in the Tahoe Basin: Maintain 15-25 percent of the Yellow Pine Forest in seral stages other than mature.

VP8) Relative Abundance - Of the total amount of undisturbed vegetation in the Tahoe Basin: Maintain 15-25 percent of the Red Fir Forest in seral stages other than mature.

VP9) Pattern - Provide for the proper juxtaposition of vegetation communities and age classes by;
1. Limiting acreage size of new forest openings to no more than eight acres

VP10) Pattern –Provide for the proper juxtaposition of vegetation communities and age classes by; 2. Adjacent openings shall not be of the same relative age class or successional stage to avoid uniformity in stand composition and age.

VP11) Native vegetation shall be maintained at a maximum level to be consistent with the limits defined in the Land-Capability Classification of the Lake Tahoe Basin, California-Nevada, A Guide For Planning, Bailey, 1974[1], for allowable impervious cover and permanent site disturbance.

LATE SERAL AND OLD GROWTH FOREST ECOSYSTEMS[2]

NUMERICAL STANDARDS

VP13) Attain and maintain a minimum percentage of 55 percent by area of forested lands within the Tahoe Region in a late seral or old growth condition, and distributed across elevation zones. Standards VP 14, VP15, and VP16 must be attained to achieve this threshold.

VP14) 61 percent of the Subalpine zone (greater than 8,500 feet elevation) must be in a late seral or old growth condition. The Subalpine zone will contribute 5 percent (7,600 acres) of forested lands towards VP13.

VP15) 60 percent of the Upper Montane zone (between 7,000 and 8,500 feet elevation) must be in a late seral or old growth condition. The Upper Montane zone will contribute 30 percent (45,900 acres) of forested lands towards VP13.

VP16) 48 percent of the Montane zone (lower than 7,000 feet elevation) must be in a late seral or old growth condition; the Montane zone will contribute 20 percent (30,600 acres) of forested lands towards VP13.

UNCOMMON PLANT COMMUNITIES

NUMERICAL STANDARDS

VP17-VP18) Provide for the non-degradation of the natural qualities of any plant community that is uncommon to the Basin or of exceptional scientific, ecological, or scenic value. This threshold shall apply but not be limited to:

VP17) The deep-water plants of Lake Tahoe.

VP18) The Freel Peak Cushion Plant community.

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[1] See attachment B

[2] For standards VP13 - VP16: Forested lands within TRPA designated urban areas are excluded in the calculation for threshold attainment. Areas of the montane zone within 1,250 feet of urban areas may be included in the calculation for threshold attainment if the area is actively being managed for late seral and old growth conditions and has been mapped by TRPA. A maximum value of 40 percent of the lands within 1,250 feet of urban areas may be included in the calculation.

SENSITIVE PLANTS

NUMERICAL STANDARDS

Maintain a minimum number of population sites for each of five sensitive plant species.

VP19) Maintain a minimum of 2 Lewisia pygmaea longipetala population sites.
VP20) Maintain a minimum of 2 Draba asterophora v. macrocarpa population sites.
VP21) Maintain a minimum of 5 Draba asterophora v. asterophora macrocarpa population sites.
VP22) Maintain a minimum of 26 Rorippa subumbellata population sites.
VP23) Maintain a minimum of 7 Arabis rigidissima v. demote population sites.

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