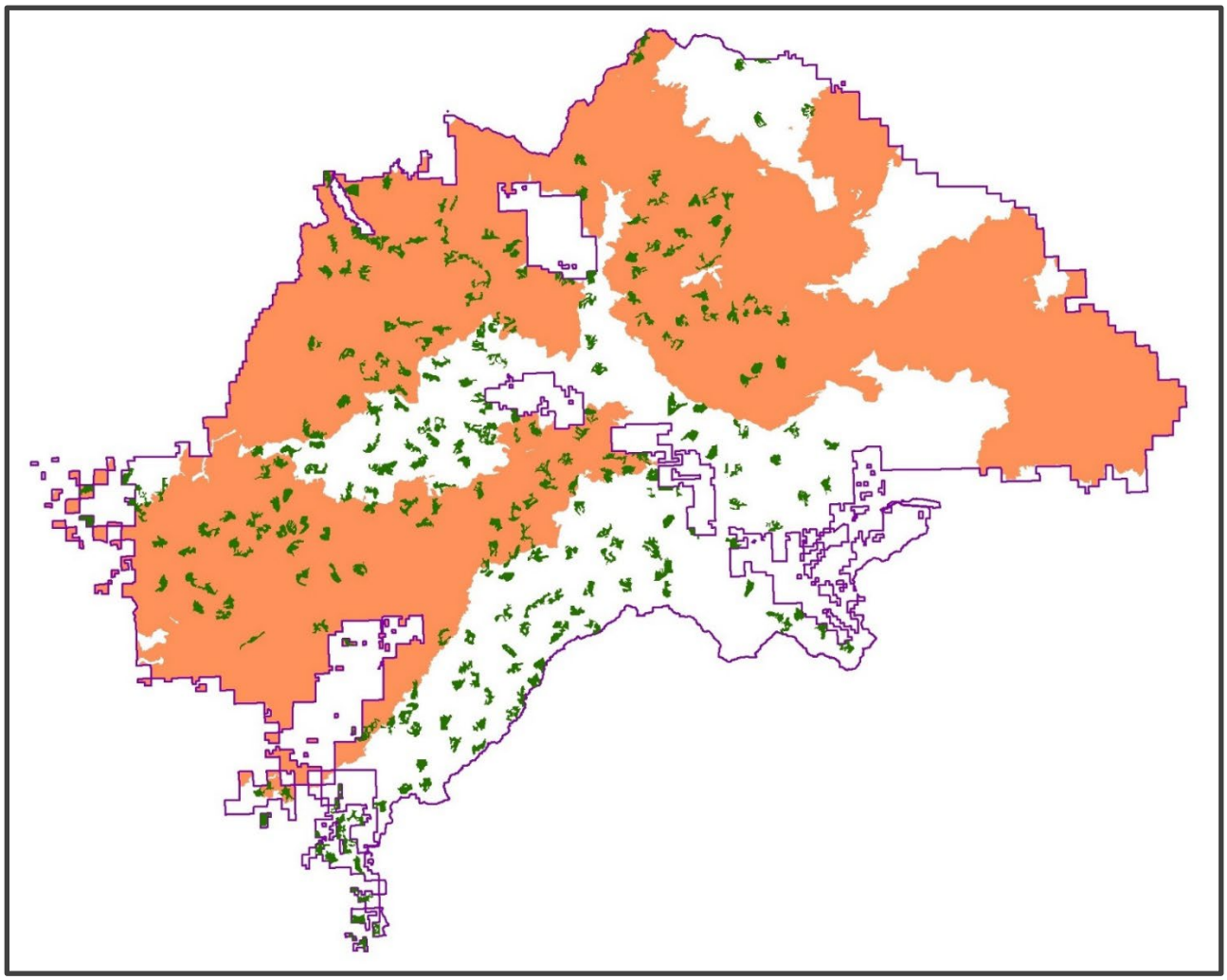
Forest Service
Region 5 Ecology Program
Sierra Cascade Province

Restoration Opportunities for California Spotted Owl on the Plumas National Forest



California spotted owl Protected Activity Centers (in green) on the Plumas National Forest, with areas within the perimeter of seven recent major fires (Dixie, Sugar, North, Sheep, Walker, Camp, Minerva) shown in orange.

December 15, 2022

Introduction

This analysis identifies restoration opportunities within California spotted owl land allocations on the Plumas National Forest through the process outlined in GTR-270 (Post-fire Restoration Framework for National Forests in California). It extends the analysis specific to the Dixie Fire (see "Postfire Restoration Opportunities for California Spotted Owl in the 2021 Dixie and Sugar Fires") to five additional major fires that have occurred on the Plumas NF since 2017 (North, Sheep, Walker, Camp, Minerva), and additionally includes opportunities within Protected Activity Centers (PACs) and Home Range Core Areas (HRCAs) in areas that have not burned in recent years. In general the restoration opportunities tier to those identified for conifer forest within the Dixie and Sugar Fires ("Post-fire Restoration Opportunities for Conifer Forest in the 2021 Dixie and Sugar Fires"), within the North, Sheep, Walker, Camp and Minerva fires ("Post-fire Restoration Opportunities for Conifer Forest, Plumas NF Fires 2017-2020") and from an all lands analysis that included unburned areas of the Plumas NF ("Identifying restoration opportunities in recently burned and unburned conifer forest across the Plumas National Forest "). This document, however, emphasizes management actions within PACs and HRCAs that are consistent with the California Spotted Owl Conservation Strategy, and utilizes the occupancy and departure modelling to suggest prioritization.

Data Sources

Data type	Data source	Description/Source
CSO PACs	NRIS Wildlife	Protected Activity Centers (PACs) on the Plumas NF, 11 November 2022.
CSO HRCAs	NRM NRIS Wildlife	Home Range Core Areas (HRCAs) on the Plumas NF, 11 November 2022.
Fire severity	Rapid Assessment of Vegetation Condition after Wildfire (RAVG) program; USDA Forest Service, Geospatial Technology and Applications Center (https://burnseverity.cr.usgs.gov/ravg/)	Reclassified the 7-class basal area mortality layer (rdnbr_ba7.tif) into a 5-class basal area mortality layer for 5 focal fires, as well as past fires (1997-2019); includes fire perimeter data
Departure from NRV	T:\FS\NFS\Plumas\Project\SO\PNF_AllLands_LandscapeAssessment\GIS\MasterData\GTR270_PNF_AllLands.gdb\Conifer_RestorationOpps_PNF	Departure from NRV for all lands on the Plumas NF, methodology described in "Identifying restoration opportunities in recently burned and unburned conifer forest across the Plumas National Forest"
Restoration Opportunities	T:\FS\NFS\Plumas\Project\SO\PNF_AllLands_LandscapeAssessment\GIS\MasterData\GTR270_PNF_AllLands.gdb\Conifer_RestorationOpps_PNF	Restoration opportunities across all lands on the Plumas NF, methodology described in in "Identifying restoration opportunities in recently burned and unburned conifer forest across the Plumas National Forest"
CSO suitable habitat	Existing vegetation; CALVEG, USDA Forest Service, Pacific Southwest Region. (https://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192)	Used California Wildlife Habitat Relationships (CWHR) in the Calveg layer to identify conifer vegetation types, size classes, and density classes considered suitable habitat for CSO.

Methodology

Occupancy: We utilized the same process detailed in "Postfire Restoration Opportunities for California Spotted Owl in the 2021 Dixie and Sugar Fires" to assess the probability of occupancy for each PAC that burned within the Dixie, Sugar, North, Sheep, Walker, Camp, and Minerva fires between 2017-2021. Many PACs had been redrawn where they occurred within high severity burn patches, and this analysis considered the redrawn PACs, not PACs as they occurred prior to focal fires. Probability of occupancy was not assessed outside of fire perimeters.

Departure and Opportunities: We intersected PAC and HRCA layers with layers from previous analyses that depict conifer stand departure from NRV and restoration opportunities within conifer forests across the Plumas NF. Stand departure from the Natural Range of Variation and restoration opportunities were assessed using data from analysis of restoration opportunities within conifer forest in the Dixie and Sugar Fires ("Post-fire Restoration Opportunities for Conifer Forest in the 2021 Dixie and Sugar Fires"), in the North, Sheep, Walker, Camp and Minerva fires ("Post-fire Restoration Opportunities for Conifer Forest, Plumas NF Fires 2017-2020") and from an all lands analysis that included unburned areas of the Plumas NF ("Identifying restoration opportunities in recently burned and unburned conifer forest across the Plumas National Forest "). See these documents for additional detail on how these metrics were detailed.

Remaining Potential Habitat: We defined potential habitat as conifer vegetation types of size class 4 or 5 and density class M or D (USDA FS 2019) extracted from CalVeg, and retained only areas that were unburned by recent fires, or burned at low to moderate severity. We used the PatchMorph tool to extract areas in patches greater than 300 acres that met those criteria.

PAC Scale

Probability of Post-fire Occupancy

We identified the probability that PACs would continue to be used by CSO after a fire based on patterns of fire severity according to the method described in "Postfire Restoration Opportunities for California Spotted Owl in the 2021 Dixie and Sugar Fires". Criteria used to classify the potential probability of occupancy are shown in **Table 1**.

Table 1. Criteria based on fire severity metrics to determine probability of CSO occupancy after fires.

PAC % High Severity	Territory % High Severity	PAC High Severity Patch Size	Territory High Severity Patch Size	Probability of Occupancy
<50% **and**	<50% **and**	<89 acres **or**	<250 acres	High
<50% **and**	<50% **and**	>89 **or**	>250	Moderate
>50% **or**	>50%	ANY	ANY	Low

Using these criteria we determined that most PACs on the PNF that have burned in the past five years (77%) had a high probability of being occupied by CSO after the fire (Table 2). This is likely because many PACs that were rendered unsuitable for CSO by fires have been removed from the PAC system. However, there are still some PACs remaining within the analysis area that may be unlikely to support CSO and had a low probability of occupancy based on fire effects (19% of PACs). However, these areas may still be a high priority for restoration actions, such as reforestation, that could

benefit CSO over longer time frames. Our analysis area included 97 PACs that were not within a fire perimeter and post-fire probability of occupancy is not relevant to these PACs.

Table 2. Number of PACs within each post-fire occupancy category.

Probability of Occupancy	# of PACs
Low	29
Moderate	6
High	120
Total	155

Departure of Conifer Forests within PACs:

We intersected the 252 PACs on the Plumas NF (81,665 acres) with measures of departure from NRV for conifer forests identified in the Dixie/Sugar, Plumas 5-Fire Analysis, and Plumas all lands vegetation analyses (**Table 3**). The methods used to determine departure are described in greater detail in the supporting documents for these analyses. Of the 81,665 acres within PACs on the PNF, 55,129 acres (68%) are considered highly departed from NRV with stand densities > 60% rSDI, and/or high departure from pre-settlement fire regime. An additional 18,195 acres (22%) are considered moderately departed, with rSDI between 35%-60% and fire regime departure, and 3,572 acres (4%) have low departure. Remaining acres (6%) were outside of analysis parameters, either pixels of non-conifer vegetation type, or within an area that was not analyzed for departure. While many PACs encompass a range of conditions, there are only four PACs where >50% of acres have low departure, and 52 PACs where >50% of acres are moderately departed.

Table 3. Acres of PACs in each category of departure from NRV for mixed conifer forests.

Departure from NRV	Acres	% PAC Acres
High	55,129	68%
Moderate	18,195	22%
Low	3,572	4%
outside analysis parameters	4,769	6%
Total	81,665	100%

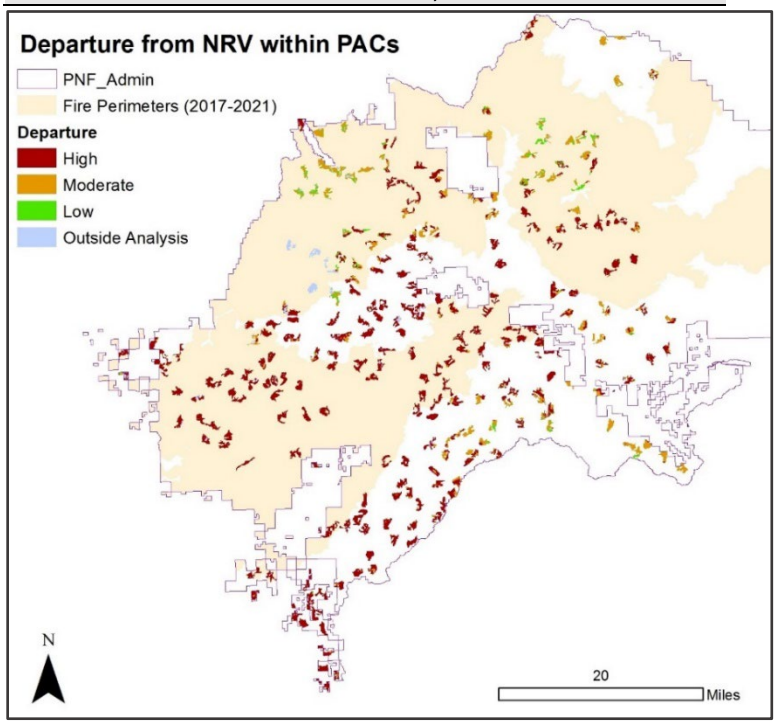


Figure 1. Spatial distribution of PACs across the Plumas National Forest attributed with levels of departure from NRV for mixed conifer forests.

PAC Restoration Opportunities:

We identified restoration opportunities within PACs based on metrics derived from previous analyses (see Methodology), which included an evaluation of high severity patch sizes (based on NRV for mixed conifer forests), the degree of departure from NRV prior to the fire, and whether they were within fire perimeters (**Table 4**). By intersecting CSO PACs with restoration opportunities for conifer forests, we sought to provide an integrated evaluation of opportunities for restoration actions that might benefit both resources.

Table 4. Restoration opportunities within PACs as indicated by forest conditions.

Condition	Acres	Opportunity
Large (>100 ac) high severity patch	3,321	Reforestation for long-term recovery of suitable habitat.
Small high severity patch (10-100 ac)	306	Evaluate for reforestation, reduce fuels to reduce risk of high severity reburn
High stand departure from NRV	51,087	Highest priority to improve resilience to future risk of high severity fire with fuels treatments, consider thinning treatments that promote health, vigor and recruitment of large trees.
Moderate stand departure from NRV	18,195	Moderate priority to improve resilience to future risk of high severity fire with fuels treatments, consider thinning treatments that promote health, vigor and recruitment of large trees.
Low stand departure from NRV	3,572	Maintain with prescribed fire applied at intervals as would have occurred under NRV.
Outside of analysis parameters	4,463	Evaluate on case-by-case basis
Total Acres	**81,665**	

These restoration opportunities are intended to promote the health and resilience of conifer forests. However, any restoration actions taken within PACs should also be designed to promote the specific habitat requirements for CSO. There is a suite of potential management actions that could both maintain and promote desired conditions for CSO habitat as well as restore those habitat areas where conditions were degraded. These actions include targeted and strategic fuels management designed to meet the dual objectives of conserving California spotted owl habitat and promoting resilience of Sierra Nevada forests by retaining large trees, reducing surface fuels and small tree densities, and promoting fire regimes within the natural range of variation for Sierra Nevada forests (USDA 2019). Specific management actions might include:

Prescribed burning and hand thinning. These treatments could both promote and restore desired conditions in CSO habitat areas.

Mechanical thinning and dead tree removal. These treatments may be appropriate in some areas to reduce the risk of high severity fire and allow for subsequent actions such as prescribed burning to restore natural fire regimes and desired conditions for CSO.

Reforestation. This management intervention may be warranted to restore desired conditions in areas with large patch sizes of high severity fire effects. Reforestation in these areas may consider planting preferred species by CSO, such as Douglas-fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), and red fir (*A. magnifica*). Hardwoods are also an important component of CSO habitat and these species should be protected and maintained during site preparation and other postfire management activities. Although reforested areas may not serve as CSO habitat in the short-term, they may provide habitat for CSO over longer time frames,

particularly when managed to promote desired conditions for CSO, such as through repeated prescribed burning.

Heterogeneity. Management approaches will be most effective at restoring desired conditions for CSO if they can be designed to promote and maintain heterogeneity. Creating a dynamic mosaic of tree clumps and openings of variable sizes, shapes, spatial configurations, and seral stages can enhance forest resilience to fire and other disturbances and protect existing stands of mature, multi-canopied forest preferred by CSO (Kane et al. 2013). Maintaining or restoring heterogeneity can also be accomplished by varying management approaches across different spatial scales. For example, actions that are taken within the territory or the home range may differ from those employed within the PAC because habitat elements that promote foraging are different from those associated with nesting and roosting. By considering spatial scale when implementing management actions, multiple restoration goals might be achieved, including promoting both structural and compositional heterogeneity across the landscape.

Monitoring and Adaptive Management. Monitoring is a critical component of any restoration strategy for CSO to test assumptions regarding postfire use. For example, monitoring in areas that we predicted would differ in occupancy could help refine our definitions and prioritization. In addition, potential habitat areas outside of existing PACs should be monitored to evaluate if this habitat is utilized by CSO in the future. In addition, the success of any management action taken will need to be evaluated through a well-maintained feedback loop between science and management in an adaptive management context.

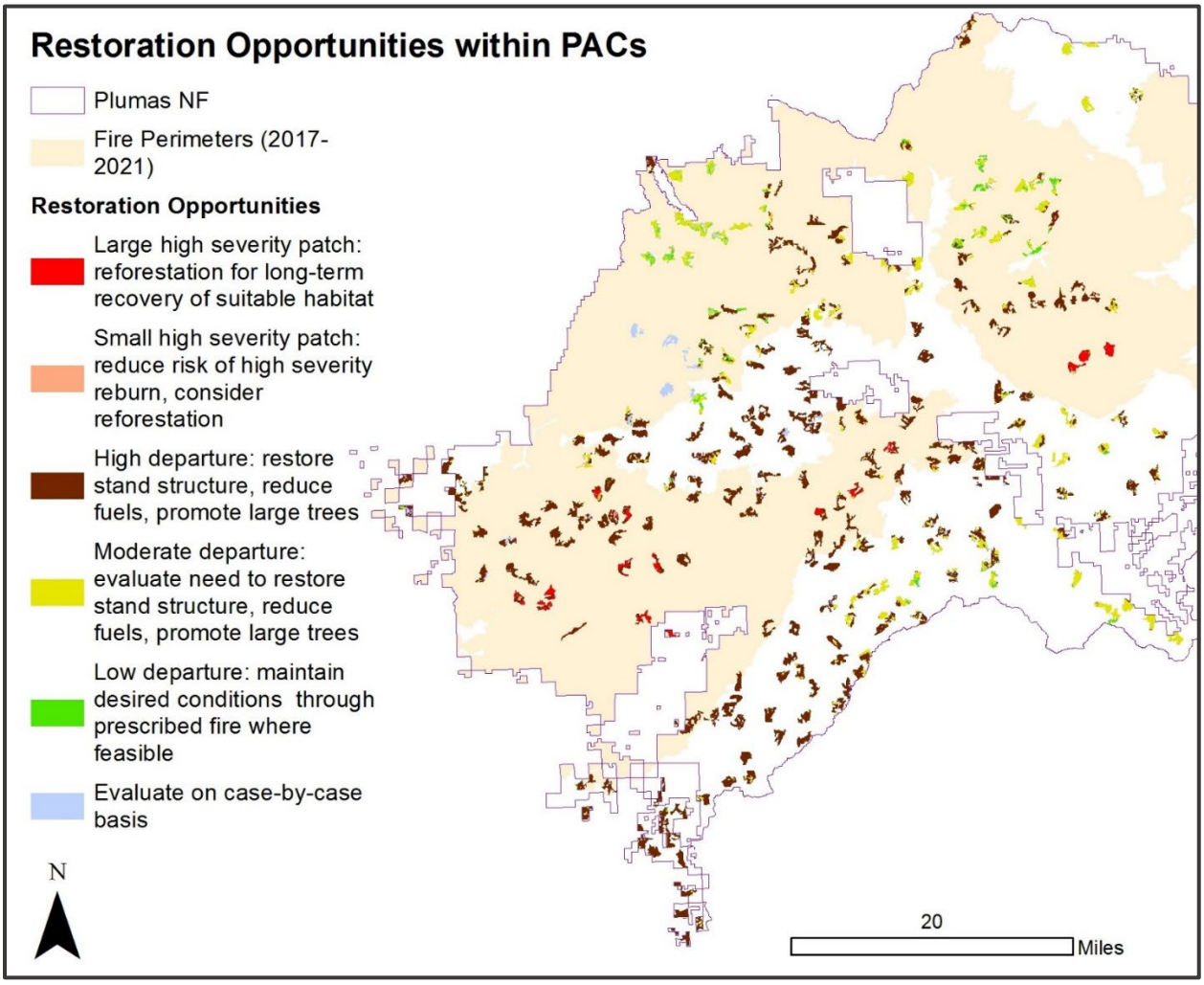


Figure 2. Restoration opportunities within CSO PACs on the PNF.

Prioritization of PAC Restoration Opportunities

After determining the suite of restoration opportunities within PACs on the PNF, we then used the probability of occupancy by CSO to assign priorities for these restoration actions. Areas with the highest potential for occupancy and the greatest departure from NRV were given the highest priority for restoration actions such as thinning and fuels reduction and promotion of large tree health and vigor. Based on this assessment, 45% of PACs within the fire perimeters, and 39% outside of burned areas, would be a high priority for restoration (**Table 5**, **Figure 2**). However, areas with a low probability of occupancy and a high departure from NRV may be a priority for other kinds of restoration actions, such as reforestation, that could promote CSO habitat over longer time frames. Potential occupancy was not analyzed for unburned areas.

Table 5. Priority of restoration as determined by probability of occupancy by CSO and departure from NRV for mixed conifer forests.

	Probability of Occupancy	**Departure**	**Acres**	**% PAC Acres**	**Priority**
Within fire perimeter	High	Low	2,190	3%	Low
	High	Moderate	9,008	12%	**High**
	High	High	24,857	32%	**Highest**
	Moderate	Low	202	0%	Low
	Moderate	Moderate	191	0%	**High**
	Moderate	High	871	1%	**High**
	Low	Low	593	1%	Low
	Low	Moderate	1,012	1%	Low
	Low	High	6,915	9%	***Low****
Outside of fire perimeter	Not Analyzed	Low	588	1%	Low
	Not Analyzed	Moderate	7,984	10%	**High**
	Not Analyzed	High	22,629	29%	**Highest**
	Total		**77,038**	**100%**	

*Low priority for fuels/resilience treatments, but high priority for reforestation

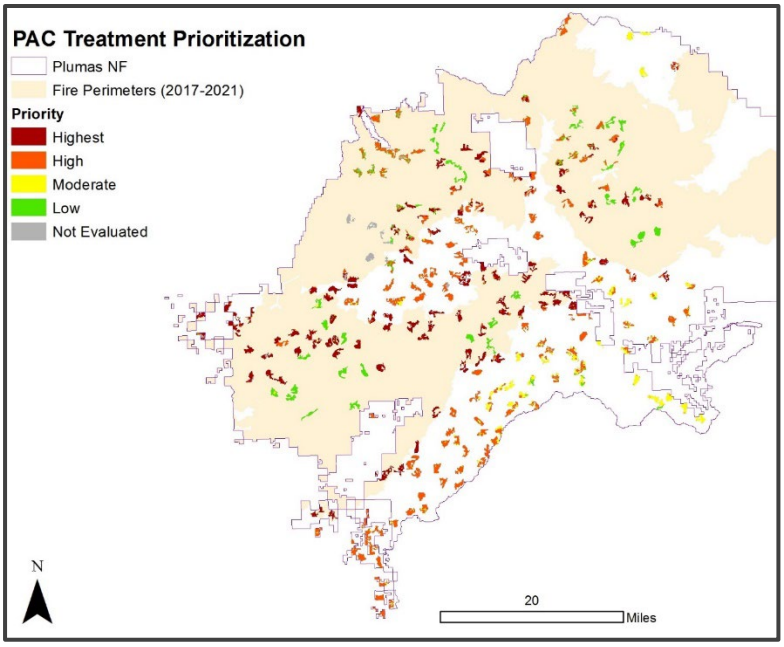


Figure 3. Prioritization of restoration opportunities within CSO PACs.

HRCA Scale

We intersected the 180,710 acres that are within HRCAs but outside of PACs with restoration opportunities identified in the Dixie/Sugar, Plumas 5-Fire Analysis, and Plumas All Lands vegetation analysis.

HRCA Departure:

Of the 180,710 acres within HRCA on the PNF, 111,763 acres (62%) are considered highly departed from NRV with stand densities > 60% rSDI, and/or high departure from pre-settlement fire regime. An additional 41,543 acres (23%) are considered moderately departed, with rSDI between 35%-60% and fire regime departure, and 12,553 acres (7%) have low departure. Remaining acres (7%) were outside of analysis parameters, either pixels of non-conifer vegetation type, or within an area that was not analyzed for departure. While many PACs encompass a range of conditions, there are only four HRCAs where >50% of acres have low departure, and 41 HRCAs where >50% of acres are moderately departed.

Departure from NRV	Acres	% HRCA Acres
High	111,763	62%
Moderate	41,543	23%
Low	12,553	7%
outside analysis parameters	14,851	8%
Total	180,710	100%

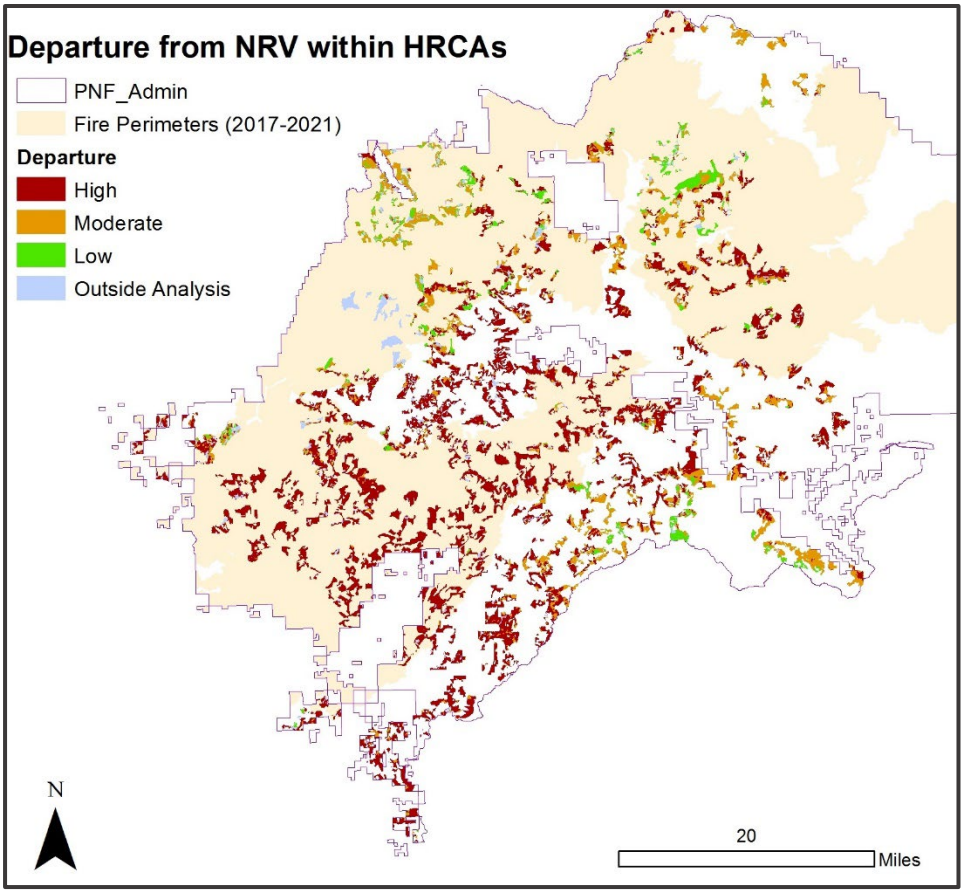


Figure 4. Departure from NRV within HRCAs.

HRCA Opportunities:

Opportunities within HRCAs varied by whether they are were high severity patches and the degree of departure from NRV.

Condition	Acres	Opportunity
Large (>100 ac) high severity patch	22,786	Reforestation for long-term recovery of resilient, late-seral habitat. High priority for fuels reduction to reduce risk of future high severity fire spreading into PACs. Edge hardening around these features.
Small high severity patch (10-100 ac)	1,569	Evaluate for reforestation where priority to re-establish mixed conifer forest. High priority for fuels treatments to reduce risk of future high severity fire spreading into PACs
High stand departure from NRV	90,763	Highest priority to improve future resilience to high severity fire with fuels treatments, promote forest health with density reduction treatments that promote health, vigor and recruitment of large trees.
Moderate stand departure from NRV	41,608	Moderate priority for fuels reduction to reduce risk of future high severity fire spread into PACs. Consider thinning treatments that promote health, vigor and recruitment of large trees.
Low stand departure from NRV	12,561	Maintain with prescribed fire applied at intervals as would have occurred under NRV.
Outside of analysis parameters	13,336	Evaluate on case-by-case basis
Total Acres	**182,624**	

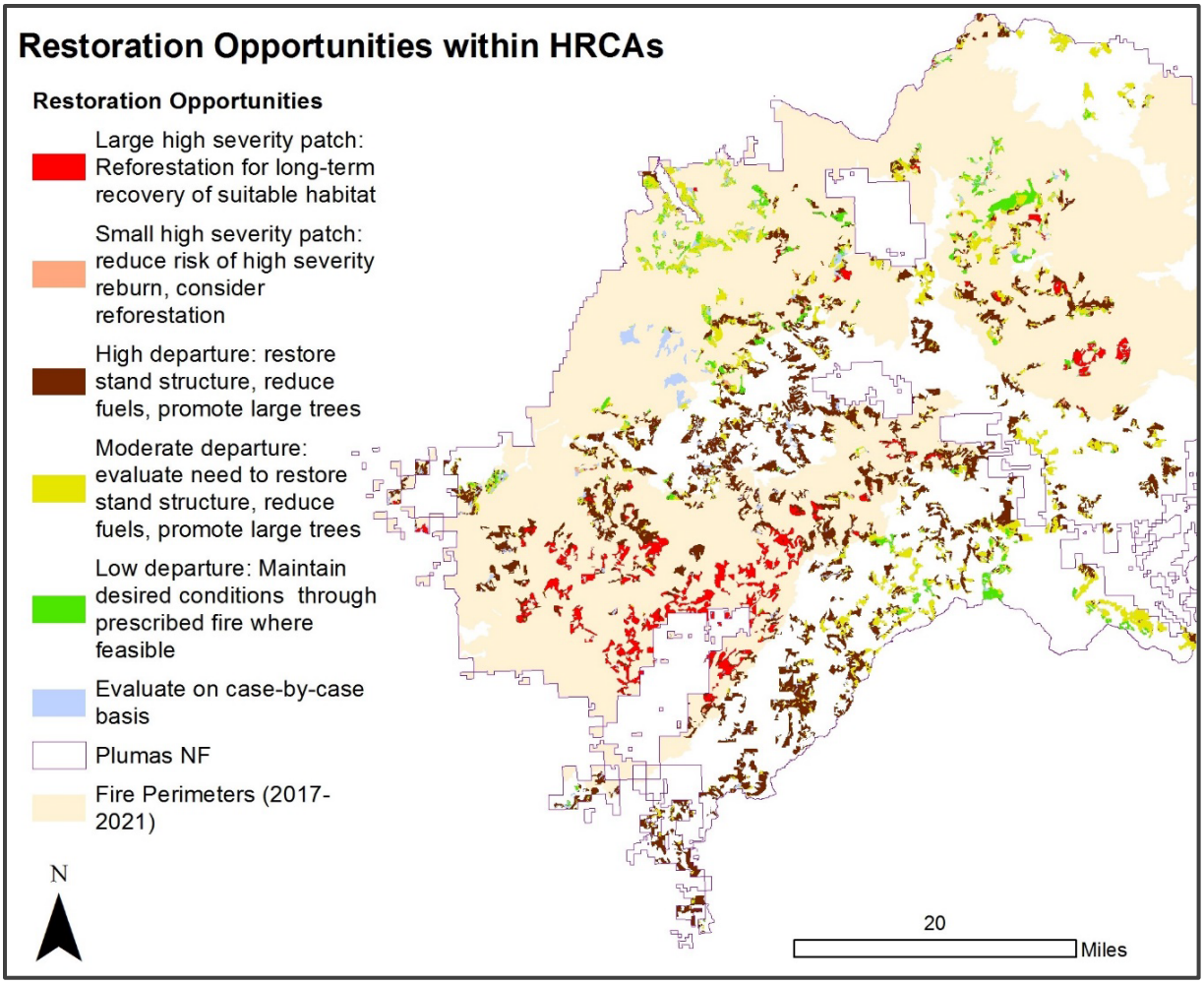


Figure 5. Restoration opportunities within HRCAs on the Plumas NF.

CWHR Analysis of Remaining Potential Habitat:

We conducted a geospatial analysis to determine where contiguous patches of CSO habitat (existing and potential) occurred on the landscape prior to and after recent fires. Habitat was defined as conifer vegetation types in Size Class 4 or 5, and Density Class M or D, using the CalVeg vegetation dataset. Criteria for inclusion post-fire were as follows:

1. Pre-fire CalVeg polygons of conifer forest types
2. Size Classes 4 or 5; Density Classes M or D
3. Outside of recent fire perimeters, or did not burn at high severity (<75% basal area mortality)
4. Within contiguous patches of at least 300 acres

We identified a total of 431,557 acres that met these criteria prior to recent fires. Post-fire, much of this habitat was either lost to high severity fire, or fragmented by high severity fire into smaller patches. In all, 241,776 acres met these criteria post-fire, which represents a loss of 43% of habitat on the Plumas NF since 2017. Of remaining habitat, 109,052 acres are classified as Size Class 5. This layer shows the extent to which recent fires have reduced the amount of remaining suitable habitat on the Plumas NF, and can be used to prioritize the protection and restoration of remaining habitat at the landscape scale, particularly where there may be late seral habitat in Size Class 5. These acres include areas both within and outside of currently designated PACs and HRCAs.

CWHR Size Class	Range	Pre-fire Acres	Post-fire Acres	% Loss
4	11” – 24” dbh	234,503	132,725	43%
5	24” dbh	191,068	109,052	43%
Total		**425,572**	**241,776**	**43%**

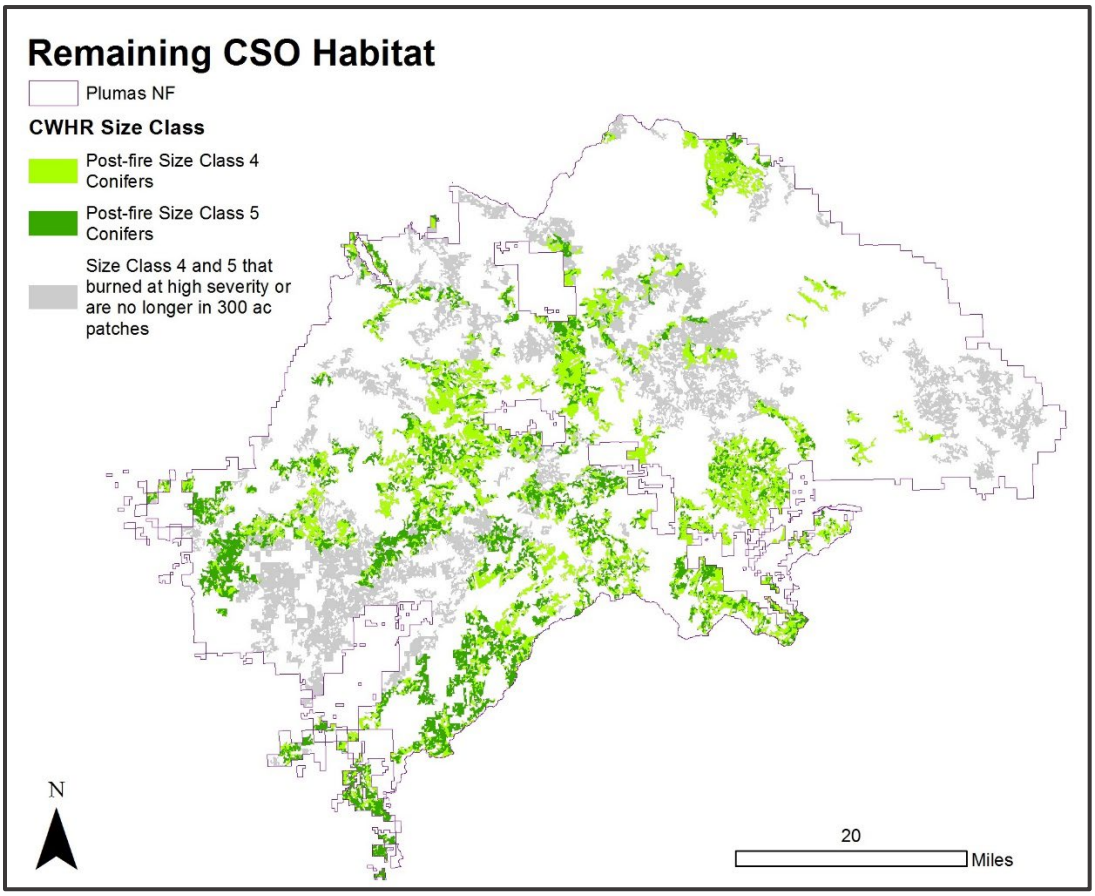


Figure 6. Areas of conifer forest classified as 4M, 4D, 5M or 5D in contiguous patches >300 acres post-fire and pre-fire.

Appendix I: Guide to geospatial data

Geospatial data are found in **GTR270_PNF_AllLands.gdb**. This geodatabase can be found at T:\FS\NFS\Plumas\Project\SO\PNF_AllLands_LandscapeAssessment\GIS\MasterData

GTR270_PNF_Admin.gdb

a_Opportunities

PNF_CSO_PAC_Opportunities

Restoration opportunities within California Spotted Owl Protected Activity Centers (PACs), PNF layer from November 2022.

PNF_CSO_HRCA_Opportunities

Restoration opportunities within California Spotted Owl Home Range Core Areas (HRCAs), PNF layer from November 2022.

i_Wildlife

CSO_Probability_Occupancy

Post-fire probability of occupancy for each PAC on the PNF, assessed with

CWHR_45DM_300acPatches

Areas within patches that are at least 300 contiguous acres of CWHR 4M, 4D, 5M or 5D size and density classes that are unburned or burned at low to moderate severity in the 7 focal fires.

Guide to Attributes:

PNF_CSO_PAC_Opportunities & **PNF_CSO_HRCA_Opportunities**

LOCAL_ID	Local identifier for each activity center (e.g. PLU0024) – 1:many, as there are often multiple opportunities within each PAC or HRCA
AREA_AC	Polygon area
Perc_Fire	Percentage of the WHOLE PAC or HRCA that is within perimeter of focal fires
Occupancy	Predicted post-fire occupancy for PACs within fire perimeter
Condition	Captures whether in high severity patches, and departure from NRV whether inside or outside of focal fires
Departure	Low, Moderate, or High Departure from NRV (not analyzed for non-conifer veg types, or within high severity patches)
CSO_Opp	Restoration opportunity – see body of document for details
Priority	Prioritization for restoration treatment – see body of document for details

CSO_Probability_Occupancy

LOCAL_ID	Local identifier for each PAC (e.g. PLU0024) – 1:many, as there are often multiple opportunities within each PAC or HRCA
T_High	Proportion of territory that burned with >75% basal area mortality
T_PS	Largest patch of high severity in the territory (acres with >75% basal area mortality)
P_High	Proportion of PAC that burned with >75% basal area mortality
P_PS	Largest patch of high severity in the PAC (acres with >75% basal area mortality)
Occupancy	Predicted post-fire occupancy
BurnStatus	Whether PAC burned or unburned

CWHR_45DM_300acPatches (Pre and Post-fire)

Acres	polygon acres
Acre_Cat	indicates this polygon is part of a patch of at least 300 contiguous acres for all pys
CWHR_TYPE	vegetation type (all are conifer vegetation types found on the PNF)
CWHR_SIZE	CWHR Size Class (4 or 5 only)
CWHR_DENSI	CWHR Density Class (M or D only)
CWHR_SZDN	Concatenation of CWHR size and density classes