THE RESPONSE OF RARE NATURAL COMMUNITIES AND SPECIAL-STATUS PLANTS TO FIRE IN MENDOCINO AND LAKE COUNTIES

Stillwater Sciences

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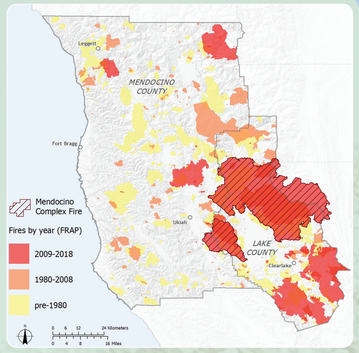
FIRE HISTORY

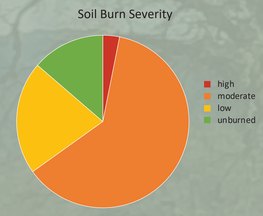
Mendocino and Lake counties cover >3,500 mi^2 and host dozens of rare natural communities and nearly 300 special-status plant species, 65% of which are endemic to California[3,4]. As in many California landscapes, these plants and communities are experiencing increased fire intensity at shortened intervals. Under warmer and windier forecasted climate change conditions, future fires will burn more intensely and spread faster; fire frequency and extent is predicted to double in Northern California's wildlands under a climate scenario with a doubling of pre-industrial levels of CO_2[8]. In Lake and Mendocino counties, over one million acres have burned since 1980 (one-third of the area), three-quarters of which burned in the last ten years[2,13].

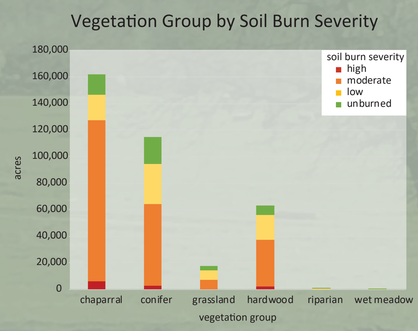


MENDOCINO COMPLEX FIRE

The Mendocino Complex fire covered 460,000 acres; 86% percent of which burned and over 60% of the area experienced moderate soil burn severity (pie chart)[13]:

- More chaparral acreage burned and at higher severity than any other vegetation type[14]
- Hardwood, oak woodlands, and associated grasslands made up much of the remaining burned area[14]
- Although only a fraction of the area is mapped as wet meadows, 86% of the meadows burned; wet meadows provide habitat for 28% of special-status plants[3,4,14]





FIRE TERMINOLOGY

Fire intensity: quantitative measurement of energy released per unit length of fire line[5]

Fire severity: qualitative measurement of the immediate effects on vegetation, soil, and litter that is contingent on the duration of fire and amount of heat produced[12]

Fire resistance: a plant's ability to resist burning[16]

Fire tolerance: a plant's relative ability to resprout, regrow, or reestablish from residual seed[16]

Fire return interval: how often fires occur over several fire cycles[5]

HARDWOODS & ASSOCIATED GRASSLANDS

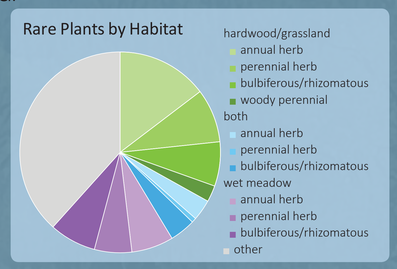
Oak woodlands, hardwoods, and associated grasslands support a rich diversity of plants and wildlife:

- Over 1 million acres of hardwoods and associated grasslands are documented within Lake and Mendocino counties[14] providing habitat for 110 special-status plants[4]
- Oaks and hardwoods are well adapted to fire:
  - Can go dormant for years if canopy burned, repairing over time and leafing out when healthy again[6]
  - Multiple species can re-sprout from stumps, burls, root crown, bole and/or lateral roots[5,15]

Rare Natural Community[5]	Fire resistance[16]	Fire tolerance[16]	Fire intensity[5]	Fire severity[5]	Fire adaptations[5,15]
Aesculus californica Woodland Alliance	No	Medium	Low to Moderate	Low to Moderate	Lacks leaves during much of fire season; resprouts from the root crown
Arbutus menziesii Forest Alliance	No	Medium	Moderate to High	Low to High	Resprouts from dormant buds on the burl
Bromus carinatus - Elymus glaucus Herbaceous Alliance	No	None - High	Moderate	Moderate	Resprouts from the root crown, stolons or tillers; dense leaf bases; self-pollination
Danthonia californica Herbaceous Alliance	Yes	High	Moderate to High	Moderate to High	Unknown
Festuca idahoensis Herbaceous Alliance	No	Medium	Low	Low to High	Re-establishes from seed in low-intensity fires
Leymus cinereus - Leymus triticoides Herbaceous Alliance	No	High	Moderate to High	Low to High	Fire resistant (course foilage); resprouts from surviving root crowns and rhizomes
Quercus garryana Woodland Alliance	Yes	Low	Low	Low	Thick bark; resprouts from bole, root crown, and lateral roots
Umbellularia californica Forest Alliance	No	Medium	Low to High	Moderate to High	Resprouts from bole and root crown

SPECIAL-STATUS PLANTS

Of the 266 special-status plant species with the potential to occur within the two counties, 164 species can be found in hardwood forest/grassland or wet meadow habitats[3,4] (see chart to the right). Fire effects depend on the timing of fire in relation to species seed release timing and species-specific physical and morphological traits[10]. We found fire resistance or tolerance information on less than 5% of potential special-status plant species[7]. However, species response to fire can be explored by considering a range of fire adaptations available by plant life form.



ANNUAL HERBS

- Rely on seed persistence and/or colonization post-fire[12]
- Fire may reduce competition from invasive plants or create openings for seedling establishment

Hesperolinon adenophyllum

PERENNIAL HERBS

- May have new growth post-fire depending on location of buds, presence of insulating tissue, and potential for soil protection[10,11]
- Particularly sensitive to early season fires[11]

Astragalus rattanii var. *rattanii*

BULBIFEROUS/RHIZOMATOUS

- Perennial graminoids may resprout if decadent material protects buds from heat damage, or buried buds/ meristems are located deeper below soil surface[10]
- Bulbs and rhizomes are insulated from fire by soil, contain stored energy, and may resprout after top-kill by fire[10,15]

Calystegia collina subsp. *tridactylosa*

WOODY PERENNIALS

- May be protected by thick bark or ability to regenerate from aerial buds[10] located or underground structures[10,13]

Arctostaphylos manzanita subsp. *elegans*

WET MEADOWS

Meadows are biodiversity hotspots, recharge groundwater, moderate sediment discharge, and serve as local carbon reservoirs[9]:

- 400+ acres of meadows are documented within Lake and Mendocino counties[14], providing habitat for nearly 80 special-status plants[4]
- Fires reduce forest cover in the contributing area, which reduces evapotranspiration and can increase downslope water availability; in some areas, this has increased extent of both dry and wet meadows in the burned watershed[1]
- Controlled fire has been used by Native Americans and restoration practitioners to limit forest encroachment and promote favored meadow species[7,10]

Rare Natural Community[5]	Fire resistance[16]	Fire tolerance[16]	Fire adaptations[5,15]
Camassia quamash Herbaceous Alliance	No	Medium	Resprouts from bulbs
Carex (*aquatilis, lenticularis*) Herbaceous Alliance	Yes/No	Low/High	Resprouts from rhizomatous buds
Carex luzulina Provisional Herbaceous Alliance	No	High	Unknown
Hordeum brachyantherum Herbaceous Alliance	No	High	Unknown
Mimulus (*guttatus*) Herbaceous Alliance	No	Medium	Unknown

PREDICTIONS

Potentially fire resistant and/or tolerant plant groups:

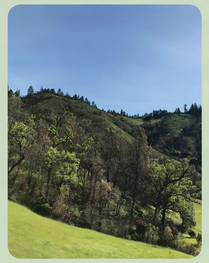
- Geophytes/rhizomatous (e.g., *Carex comosa*, *Cypripedium californicum*)
- R-strategists (e.g., *Lasthenia burkei*)
- Seeds with long dormancy and/or thick seed coats (e.g., *Calycadenia micrantha*, *Limnanthes bakeri*, *Plagiobothrys lithocaryus*)

Potential vulnerable to increased fire intensity and earlier season fires:

- Perennial grasses (e.g., *Danthonia californica*)
- Annual forbs with few seeds
- Annual forbs with small seeds, thin coats, and/or short longevity
- Annual forbs with patchy distribution and/or short dispersal distances (e.g., *Delphinium uliginosum*)

WHAT NEXT?

- Additional literature review to identify priority vulnerable species and vegetation communities by life history strategies
- Conduct post-fire surveys focusing on the response of selected species and communities
- Map distribution of vulnerable populations in relation to dispersal distances
- Greenhouse experiments with different seed types and fire/heat/smoke treatments



REFERENCES

[1]Boisrame', G., S. Thompson, B. Collins, and S. Stephens. 2016. Managed Wildfire Effects on Forest Resilience and Water in the Sierra Nevada. Ecosystems 20: 717-732.
[2]California Department of Forestry and Fire Protection (CalFire). 2015. Fire Resource Assessment Program: Fire Perimeters. http://frap.fire.ca.gov/data/frapgisdata-sw-fireperimeters_download
[3]California Department of Fish and Wildlife (CDFW). 2018. California Natural Diversity Database. RareFind5. Electronic database, Natural Heritage Division, California Department of Fish and Game, Sacramento, California. http://www.dfg.ca.gov/biogeodata/cnddb/rarefind.asp
[4]California Native Plant Society (CNPS). 2018a. Inventory of Rare and Endangered Plants of California (online edition, v8-03 0.39). California Native Plant Society, Sacramento, California. http://www.rareplants.cnps.org/
[5]CNPS. 2018b. A Manual of California Vegetation, Online Edition. California Native Plant Society, Sacramento, CA. http://www.cnps.org/cnps/vegetation/
[6]CNPS. 2018c. Fire Recovery Guide. California Native Plant Society.
[7]DeBano, L.F., D.G. Neary, and P.F/ Folliott. 2005. Soil physical properties. Pages 29–51 in: D.G. Neary, K.C. Ryan, and L.F. DeBano, editors. Wildfire Fire in Ecosystems: Effect of Fire on Soil and Water. USDA Forest Service General Technical Report RMRS-GTR-42-VOL. 4. Rocky Mountain Research Station, Fort Collins, Colorado, USA.
[8]Fried, J. S., M.S. Torn and E. Mills. 2004. The Impact of Climate Change On Wildfire Severity: A Regional Forecast for Northern California. Climatic Change 64: 169. https://doi.org/10.1023/B:CLIM.0000024667.89579.ed
[9]Merrill, A.G., N.L. Jurjavcic. 2018. Mountain Meadows: Emerald Oases of the Sierra Nevada. Fremontia Vol. 46, No. 2. California Native Plant Society.
[10]Merrill, A.G., A.E. Thode, A.M. Weill, J. Fites-Kaufman, A.F. Bradley, and T.J. Moody. 2018. Fire and Plant Interactions. Pages 103–122 in: J.W. Van Wagtendonk, N.G. Sugihara, S.L. Stephens, A.E. Thode, K.E. Shaffer, and J. Fites-Kaufman. Fire in California's Ecosystems. Second Edition, revised. Oakland: University of California Press.
[11]Reiner, J.R. 2007. Fire in California Grasslands. Chapter 18 in California Grasslands Ecology and Management. Ed by M.R. Stromberg, J.D. Corbin, C.M. D'Antonio. UC Press, Berkeley, CA.
[12]Robichaud, P.R., J.L. Beyers, and D.G. Neary. 2000. Evaluating the effectiveness of post-fire rehabilitation treatments. USDA Forest Service General Technical Report RMRS-GTR-63.
[13]USDA Forest Service, Geospatial Technology and Applications Center, BAER Imagery Support Program. 2018. Soil Burn Severity Dataset for the MENDOCINO COMPLEX Fire occurring on the Mendocino Unit National Forest, Salt Lake City, Utah, USA https://fsapps.nwcg.gov/afm/baer/download.php
[14]USDA Forest Service. 2018a. CALVEG Zone 1: North Coast – Mid, North Coast – West and Central Valley vegetation maps, using the Regional Dominant classification. http://www.fs.usda.gov/detail/r5/landmanagement/resourcemanagement/?cid=stelprdb5347192.
[15]USDA Forest Service. 2018b. Fire Effects Information System (FEIS) Syntheses about fire ecology and fire regimes in the United States https://www.feis-crs.org/feis/faces/index.xhtml
[16]USDA Natural Resources Conservation Science. 2018. The PLANTS Database http://plants.usda.gov National Plant Data Team, Greensboro, NC 27401-4901 USA.
[17]Wright, H.A. A.W. Bailey, and W. Arthur. 1982. Fire Ecology: United States and Southern Canada. John Wiley and Sons, New York, New York, USA.