Subalpine Habitats

Climate Change Vulnerability, Adaptation Strategies, and Management Implications in Southern California National Forests

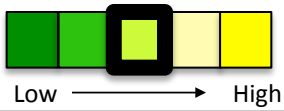
USFS/Photo by Joseph Torok

Habitat Description

Subalpine forests typically occur at elevations above 2,590 m, and make up a relatively small proportion of the available habitat types in southern California. These habitats are characterized by short growing seasons, cool temperatures, high wind, and extended periods of winter snowpack. Subalpine forests are strongly dominated by lodgepole pine (*Pinus contorta*) and limber pine (*P. flexilis*), and the forest understory is often sparse.

Habitat Vulnerability

Moderate Vulnerability



Sensitivity & Exposure

Subalpine forests are sensitive to increasing temperatures, and older trees are especially sensitive. In young trees, warming can improve growth, contributing to a shift toward dense stands that are more vulnerable to stand-replacing fire. Moisture is the primary limiting factor in these systems, and drought stress can prevent germination and severely limit growth. In subalpine habitats, climate and non-climate stressors such as drought, air pollution, and beetle outbreaks interact, increasing the likelihood of further stress or tree mortality.

Drivers of Subalpine Habitats

- Climate sensitivities: Air temperature, precipitation, snowpack depth, timing of snowmelt and runoff, drought
- Disturbance regimes: Wildfire, insects, disease
- Non-climate sensitivities: Recreation

Projected Climate and Climate-Driven Changes	Potential Impacts on Subalpine Habitats
Increasing temperatures *+2.5 to +9°C by 2100*	• Longer growing seasons and increased productivity • Increased mortality of large-diameter trees • Transition towards young forests with high stem density
Changes in precipitation, decreased soil moisture, & increased drought *Variable annual precipitation volume and timing; decreased soil moisture; longer, more severe droughts with drought years twice as likely to occur*	• Limited growth and germination, especially at dry sites or in species with higher sensitivity to water stress • Increased tree mortality, especially during drought years • Increased susceptibility to insect outbreaks and other stressors
Decreased snowpack depth & earlier timing of snowmelt/runoff *Up to 50% reduction in snowfall and 70% reduction in snowpack by 2100 (greatest loss in low elevations); snowmelt and peak runoff occurring 1-3 weeks earlier*	• Longer growing seasons limited by photoperiod requirements rather than snowmelt • Reduced soil moisture and longer summer dry periods • Increased dependency on spring precipitation events
Increased wildfire *Increased fire size, frequency, and severity*	• Increased recruitment of shade-intolerant species • Possible increased fire frequency in dense stands

Adaptive Capacity

Factors that enhance adaptive capacity:

+ Mostly intact due to inaccessibility of habitat
+ Many species are specialized and/or have unique interspecies relationships (e.g., limber pine and Clark's nutcracker)
+ Highly valued and provides variety of ecosystem services: water storage, recreation, aesthetic value

Factors that undermine adaptive capacity:

- Limited ability for range shifts due to lack of continuity among isolated mountaintop patches
- Interacting climate and non-climate stressors decrease both resistance and recovery
- Very slow growing vegetation with long recovery time after disturbance (100 years)
- Low species diversity

Adaptation Strategies for Subalpine Habitats

USFWS/Photo by Dave Menke

What kinds of adaptation options are there?

Enhance Resistance ➔ Prevent climate change from affecting a resource

Promote Resilience ➔ Help resources weather climate change impacts by avoiding the effects of or recovering from changes

Facilitate Transition ➔ Accommodate change and/or enable resources to adaptively respond to variable conditions

Increase Knowledge ➔ Gather information about climate impacts and/or management effectiveness in addressing climate change challenges

Engage Collaboration ➔ Coordinate efforts and capacity across landscapes and agencies

Adaptation Category	Adaptation Strategy	Specific Management Actions
Enhance Resistance	Prevent stand-replacing wildfire	• Increase fire permit restrictions for recreation users Implement prescribed burns to prevent severe wildfires
	Protect vulnerable plant and wildlife species in conifer and subalpine habitats	• Increase awareness of the need to incorporate bulldozer/ retardant avoidance around rare subalpine species during fires • Protect the area around rare, vulnerable, and/or endemic wildlife species from wildfire and post-fire impacts
Promote Resilience	Improve stand resilience to improve ecosystem structure and function	• Plant resilient species intermixed with current species to reduce outbreaks associated with monocultures and consider planting outside of post-burn areas
Facilitate Transition	Develop seed collections to increase genetic diversity	• Collect seed from trees in lower-elevation bands • Increase species and genetic diversity within seed collections
	Maintain biodiversity of shifting plant communities	• Facilitate migration of co-adapted species, focusing on species where one species within an association is limiting the migration of all • Use monitoring results to identify threatened populations and aid efforts to increase connectivity and genetic diversity
Increase Knowledge	Protect rare and sensitive plants in the southern California Sky Islands	• Monitor for species declines or an increase in invasive species • Learn more about fire return intervals in subalpine habitat and the effects and possible necessity of fire suppression
Engage Collaboration	Track the effects of climate change and monitor conditions by engaging multiple entities	• Implement a large-scale monitoring program designed to increase the identification, detection, and prediction of insect and disease outbreaks

*Actions presented are those evaluated as having higher effectiveness and/or feasibility.

Management Implications

This information can be used in a variety of ways:

- ✔ Forest Plan Revisions
- ✔ U.S. Forest Service Climate Change Performance Scorecard: Element 6 - "Assessing Vulnerability" and Element 7 - "Adaptation Actions"
- ✔ Bureau of Land Management Resource Management Plan Revisions

Resilient management requires implementing a variety of adaptation options

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Further information and citations can be found in source reports, *Climate Change Vulnerability Assessment for Focal Habitats of Southern California* and *Climate Change Adaptation Strategies for Focal Habitats of Southern California*, available online at the EcoAdapt Library: http://ecoadapt.org/library.