



Southern California Pinyon-Juniper Woodland Habitats

Climate Change Vulnerability Assessment Summary

An Important Note About this Document: This document represents an initial evaluation of vulnerability for pinyon-juniper woodland habitats based on expert input and existing information. Specifically, the information presented below comprises habitat expert vulnerability assessment survey results and comments, peer-review comments and revisions, and relevant references from the literature. The aim of this document is to expand understanding of habitat vulnerability to changing climate conditions, and to provide a foundation for developing appropriate adaptation responses.



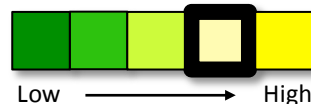
Habitat Description

In southern California, pinyon-juniper woodland habitats are typically found in mid- to high-elevation areas of the Mojave Desert, and in the San Jacinto and Santa Rosa Mountains (between 1,070 and 2,440 m).¹ They are typically located on slopes above desert or Joshua Tree forests,¹ where the climate is characterized by low precipitation, hot summers, and intense sunlight.²

Pinyon-juniper woodlands are characterized by an open overstory, and tree height is usually less than 15 m; the understory ranges from very dense to open and shrubs may reach heights up to 1.5 m.¹

Habitat Vulnerability

Moderate-High
Vulnerability



The relative vulnerability of pinyon-juniper woodland habitats in southern California was evaluated to be moderate-high by habitat experts due to moderate-high sensitivity to climate and non-climate stressors, high exposure to climate changes, and moderate adaptive capacity. Pinyon-juniper woodlands are sensitive to drought, primarily due to low seedling recruitment and growth rates that may prevent habitat regeneration; dry conditions have been linked to tree mortality and range contraction. Moisture-stressed trees are more vulnerable to insects and disease, and anthropogenic stressors such as pollution can exacerbate the impacts of climate stressors. Human activity may contribute to increased fire ignitions, and more frequent and/or severe wildfires may not allow stand regeneration, resulting in the loss of large areas of habitat. Pinyon-juniper woodlands are still relatively extensive in southern California. However, they are extremely slow to recover from disturbance, and habitat migration in response to climate change is limited by the slow growth of component species, as well as geographic and anthropogenic barriers. Pinyon pines (e.g., *Pinus monophylla*, *P. quadrifolia*) are less resilient to the effects of climate change and disturbances than juniper species (*Juniperus spp.*), which have longer-lived seeds, asynchronous seed production, and can establish in open areas without nurse plants. Pinyon-juniper woodlands are appreciated for their recreational and cultural

value, as well as for the ecosystem services they provide.

Sensitivity





Pinyon-juniper woodland habitats are sensitive to multiple climate drivers, including precipitation and drought. Historical data on pinyon-juniper woodlands demonstrate that climate plays an important role in their distribution,³⁻⁵ and the climate sensitivity of pinyon-juniper habitats is driven, in large part, by successful recruitment on a time scale that allows the community to sustain itself. Nurse plants, such as established junipers, may play a critical role in facilitating pinyon establishment by moderating harsh conditions (e.g., providing shade).⁶⁻⁸

Habitat sensitivity factors and impacts*

CLIMATIC DRIVERS		Moderate-High Sensitivity	High Confidence
<i>Precipitation</i>	<p>Pinyon-juniper expansion rates have been relatively low since 1950, which is likely due to increasingly arid conditions.^{9,10} Future changes in the amount and timing of precipitation may result in:</p> <ul style="list-style-type: none"> • Decreased seedling survival when summer precipitation is low • Tree mortality and habitat contraction during periods of low precipitation^{11,12} • Increased growth and habitat expansion when winter and spring precipitation are high^{3,10,13} 		
<i>Drought</i>	<p>Pinyon-juniper woodlands are very sensitive to periods of extreme drought, particularly when moisture deficits are combined with high temperatures.^{11,12} Increased drought may cause:</p> <ul style="list-style-type: none"> • Lowered reproductive and establishment success • Decreased growth for several decades following a drought event¹³ • Possible shift in composition towards juniper dominated stands, as pinyons are less likely to re-establish and are very slow-growing • Increased vulnerability to future drought events, as well as insect outbreaks and disease¹¹⁻¹³ • Tree mortality, large-scale woodland dieback, and/or range contraction¹¹⁻¹³ 		
DISTURBANCE REGIMES		Moderate-High Sensitivity	High Confidence
<i>Wildfire</i>	<p>Both pinyons and junipers have thin bark and low canopies, making them relatively intolerant of fire.^{12,14} Historically, fire intervals are measured in centuries, although variation in fire frequency does occur due to habitat heterogeneity.^{12,14} Future shifts in wildfire regimes may cause:</p> <ul style="list-style-type: none"> • Increased mortality from more frequent or more severe fires¹² • Loss of seeds and/or seedlings in summer fires, reducing regeneration⁶ 		

* Factors presented are those ranked highest by habitat experts. A full list of evaluated factors can be found in the Pinyon-Juniper Woodland Habitat Climate Change Vulnerability Assessment Synthesis.

	<ul style="list-style-type: none"> • Possible shift towards shrub- and grass-dominated habitats¹⁵ • Long-term loss in pinyon-juniper woodland¹⁵
<i>Insects</i>	<p>Because wildfire was historically infrequent, insects have been an important driver of stand dynamics in pinyon-juniper woodlands.¹² Warming temperatures could increase insect population success,¹⁶ and outbreaks could cause:</p> <ul style="list-style-type: none"> • Seed loss and extensive tree mortality,^{6,11-13} • Increased risk of outbreaks during periods of drought or when other stressors are present (e.g., air pollution)^{11-13,17}
NON-CLIMATE STRESSORS Moderate-High Sensitivity & Exposure  High Confidence 	
<i>Pollution</i>	<p>Even at relatively low levels, nitrogen deposition accelerates the growth of non-native grasses, which act as fine fuel and increase the risk of wildfire.¹⁸ Pollution also stresses vegetation, making pinyon and juniper trees more susceptible to mortality due to other causes (e.g., beetle outbreaks or drought).¹⁷</p>
<i>Fire suppression</i>	<p>Fire suppression could accelerate trends toward denser pinyon-juniper stands,⁷ potentially increasing fuel loading, drought vulnerability, and susceptibility to insect invasion. However, fuel management in areas where shrub cover is dense could help prevent stand loss from which recovery could take centuries.</p>

Exposure †



Under changing climate conditions, pinyon-juniper woodland habitats are likely to be exposed to increased air temperature, changes in precipitation, increased drought, increased wildfire, and decreased soil moisture. This habitat type has already responded to warming temperatures by shifting northward and towards higher elevations, although migration rates are slow (20-60 m per year).^{4,5} Optimal microsites, higher elevations, and more northern locations will likely act as refugia.^{5,10,19,20} Shifts in species composition toward juniper-dominated stands are likely,⁷ as pinyon species are expected to decline due to low regeneration rates.³ Overall, modeling studies project that the distribution of pinyon-juniper woodlands in California will decline and become more fragmented in the future.^{15,19}

Projected climate and climate-driven changes for Southern California

CLIMATIC DRIVERS	PROJECTED CHANGE
<i>Air temperature</i>	+2.5 to +9°C by 2100
<i>Precipitation & soil moisture</i>	Variable annual precipitation volume and timing, with wetter winters and drier summers; decreased soil moisture
<i>Drought</i>	Longer, more severe droughts with drought years twice as likely to occur
<i>Wildfire</i>	Increased fire size, frequency, and severity

† Relevant references for regional climate projections can be found in the Southern California Climate Overview (<http://ecoadapt.org/programs/adaptation-consultations/socal>).

Adaptive Capacity ‡

Moderate Adaptive Capacity



High Confidence





Pinyon-juniper woodland habitats were historically widespread across California; they expanded across the western U.S. beginning in the mid to late 1800s, and began to decline after 1950; however, patterns of expansion and contraction are variable and may be influenced by many factors.^{9,12} It can take up to 500 years for pinyon-juniper stands to recover from a major disturbance event, given their slow growth rate and limited seedling recruitment, and factors such as competition and stand density likely influence recovery following drought events.¹³

Habitat adaptive capacity factors and characteristics§

FACTORS	HABITAT CHARACTERISTICS
<p><i>Habitat extent, integrity, & continuity</i></p> <p>Moderate-High</p> <p>High Confidence</p>	<ul style="list-style-type: none"> + Woodlands dominated by different combinations of juniper and pinyon occur in almost every western state and represent some of the most extensive vegetation types in western North America¹² + Historically, pinyon-juniper woodlands were estimated to extend across 3.9 million acres in California, the majority of which occurred on national forest and publically owned lands²¹
<p><i>Landscape permeability</i></p> <p>Low-Moderate</p> <p>High Confidence</p>	<ul style="list-style-type: none"> + In areas of expansion, newly recruited trees are infilling existing woodlands, which may increase landscape permeability by wildlife¹⁰ +/- Pinyons and junipers are dependent on animals for dispersal (e.g., Clark’s nutcracker, rodents), and seeds can be dispersed over fairly long distances⁶ - Species movement/dispersal are limited by geologic features and grazing practices
<p><i>Resistance & recovery</i></p> <p>Low</p> <p>High Confidence</p>	<ul style="list-style-type: none"> - Previous injury or reduced growth from stressors such as drought, insects, and air pollution can decrease resistance to future events and climatic fluctuations¹³ - Competition and stand density significantly affect the ability to recover from disturbance¹³ - Pinyon-juniper woodlands have a very slow growth rate and limited seedling recruitment; full recovery from a disturbance event can take centuries - Pinyon pines have short-lived seeds, depend on nurse plants for

‡ Please note that the color scheme for adaptive capacity has been inverted, as those factors receiving a rank of “High” enhance adaptive capacity while those factors receiving a rank of “Low” undermine adaptive capacity.

§ Characteristics with a green plus sign contribute positively to habitat adaptive capacity, while characteristics with a red minus sign contribute negatively to habitat adaptive capacity.

FACTORS	HABITAT CHARACTERISTICS
	seedling survival, and are very slow-growing, making range shifts unlikely ^{5,6,8}
<p><i>Habitat diversity</i></p> <p>Moderate-High</p>  <p>High Confidence</p> 	<p>+ Moderate-high species diversity, with composition varying widely by location and climate</p> <p>+ Provides habitat for many southern California wildlife species, including numerous threatened/endangered species¹</p> <p>+ Moderate-high physical/topographic and moderate functional group diversity</p>
<p><i>Management potential</i></p> <p>Moderate</p>  <p>Moderate Confidence</p> 	<p>+ Moderate-high societal value: Valued for wildlife habitat, timber, aesthetics, livestock grazing, and cultural importance</p> <p>+ Pinyon-juniper woodlands provide a variety of ecosystem services: biodiversity, grazing, carbon sequestration, and timber</p> <p>- There is a low-moderate chance of alleviating climate impacts on pinyon-juniper woodlands; possibilities include managing stand density, grazing, and wildfire</p>

Recommended Citation

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This document is available online at the EcoAdapt website (<http://ecoadapt.org/programs/adaptation-consultations/socal>).

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