Sierra Nevada Regional Profile

September 2022

Product of the Science Advisory Panel
of the California Wildfire and Forest Resilience Task Force

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The State of California, the U.S. Forest Service and regional partners have a unified response to address the wildfire and climate crises. The primary goal of this response is to treat 1 million acres annually by 2025 across state and federal lands in California. The expected outcome is to reduce the risk of catastrophic wildfire and enhance community resilience that is also climate informed. To achieve this goal, we must increase our capacity to design and implement land management activities at ecologically meaningful scales that are also socially acceptable. This will require that state, federal, regional and local partners work across jurisdictional boundaries to develop regional plans and integrate federal and state priorities with local objectives, projects and strategies. The Regional Profiles have been designed to assist with this effort.

The Regional Profile series is a resource developed by the Science Advisory Panel of the California Wildfire and Forest Resilience Task Force (WFRTF) to summarize the social context and ecological condition related to community and ecosystem resilience to wildfire in each of the state's four diverse regions (see Fig. 1). The profiles are informed by the best available scientific information, as well as the experience and perspectives of diverse stakeholders from the region. The Regional Profile is a complement to the Regional Resource Kits (RRK), which are also developed for the WFRTF via an interagency collaboration. The RRKs provide core data and metrics for assessing current conditions of landscape resources, prioritizing treatments, and decision-making.

Both the Sierra Nevada Regional Profile and Sierra Nevada Regional Resource Kit leverage the Pillars of Resilience Framework, which was first developed for the Tahoe-Central Sierra Initiative through a collaborative process with stakeholders.

Figure 1. Boundaries of the four state regions, as delineated by the Task Force, and the boundaries of the seven subregions within the Sierra Nevada region shown in green, as delineated by the Sierra Nevada Conservancy.

The Framework is structured around ten desired outcomes, termed 'Pillars of Resilience', that reflect key social and ecological values, and each pillar is characterized by regionally-specific metrics intended to help assess current conditions. In this way, the Framework provides a common platform for tracking progress towards statewide goals while meeting regional-specific needs.

However, investing in actions that benefit one or more pillars may cause tradeoffs for other pillars. Additionally, needs and priorities for management likely vary at both the regional and sub-regional scales. To navigate this complexity, decision-makers must understand the priorities and values of local communities and stakeholders. For this reason, the Regional Profile includes stakeholder input that was gathered via an anonymous survey about priority areas of investment for achieving resilience, as well as more focused interviews with regional experts and leaders about key issues, barriers, and opportunities for increasing resilience to wildfire. To assess how community members' experiences and perspectives varied across the region, survey respondents were asked to identify with a geographical area based on the seven "subregion" boundaries which were created by the Sierra Nevada Conservancy (Fig. 1).

For the purposes of the stakeholder survey, we collapsed the ten Pillars of Resilience into seven categories: Healthy and resilient forests, Carbon storage, Water security, Biodiversity conservation, Air quality, Economically robust communities, and Resilient and fire-safe communities (see Fig. 2). The following sections provide an overview of how each of these seven categories are impacted by the interrelated crises of wildfire and climate change, as well as opportunities for increasing resilience. Each section also includes highlights from the 291 survey responses and the 30 interviews, and, finally, example assessments of current resource conditions to help land managers and decision-makers understand how data and metrics provided in the Regional Resource Kit can be applied to achieve desired outcomes.

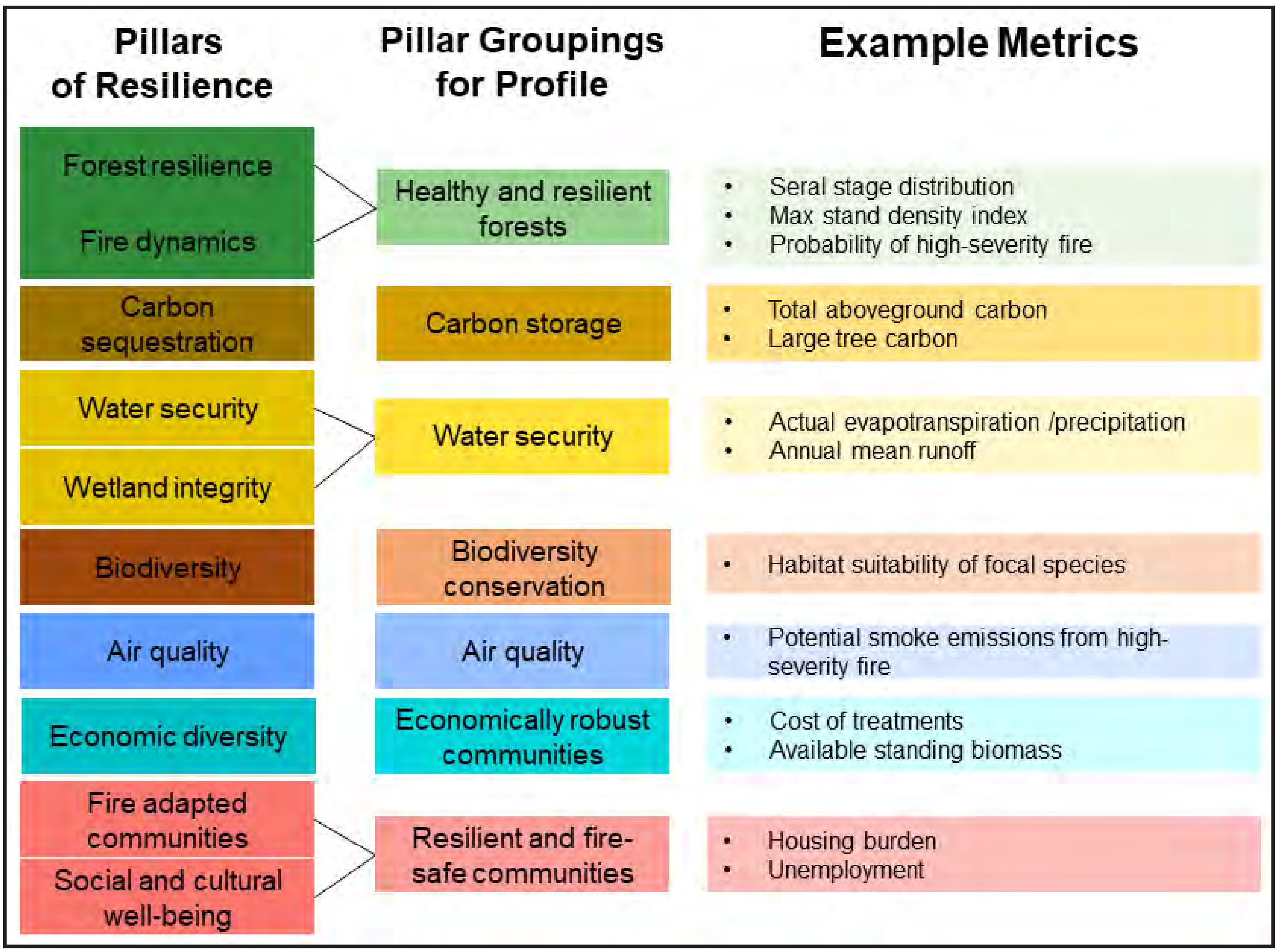


Figure 2. The original 10 pillars of resilience were collapsed into seven pillar groupings to gather stakeholder input via surveys and interviews. These seven groupings form the organizational basis for this document. Each pillar includes metrics for assessing current resource conditions. The metrics listed here are examples showcased in this profile, but additional metrics and data are provided in the Regional Resource Kit.

The Sierra Nevada Region

The Sierra Nevada Region includes the Sierra Nevada, Southern Cascades and Eastside or Inyo region. It is home to over 880,000 people across 23 counties, and encompasses one of the largest stretches of protected wilderness in the nation. The Region spans an extensive latitudinal gradient from Inyo and Kern counties in the south to the northeastern edge of California in Modoc county (Fig. 1). The federal government is the region's largest land owner (70% of the area), followed by private (27%). State and local governments, the Bureau of Indian Affairs, and non-profit organizations each own a much smaller proportion and are important partners in regional land management.

Like most of California, the Region is characterized by a Mediterranean climate, with hot-dry summers and cool-wet winters. Elevation is highest in the southern Sierra Nevada mountains, which leads to the southern Sierra being snowier than the northern. However, the effects of climate change are forcing very significant impacts across the region. The region is experiencing warmer and more extreme temperatures, declining snowpacks, and changes in streamflow timing. Furthermore, recent droughts have been more severe than historically experienced. These changes have important implications for the state, considering the Sierra snowpack is a critical water storage reservoir, typically providing 30% of the state's annual water supply.

The Sierra region is 90% natural and working lands. In general, oak woodlands and shrublands occur at lower elevations, rising to mixed conifer forests at middle elevations, and red fir and subalpine forests at higher elevations. On the east side we see drier montane desert environments supporting sagebrush and pinyon-juniper as the dominant vegetation types (see Fig. 4). Such variation in vegetation contributed to key differences in historical fire regimes and continues to drive important considerations for management and treatment planning today.

Today, human presence (communities, infrastructure, and recreation sites) tends to be concentrated in low to mid elevation mixed-conifer forests, which increases both the risk from fire and risk of accidental ignitions. In addition, historical land management practices and fire suppression created dense forest conditions that are particularly susceptible to the effects of current climate-driven stressors. The changing climate is impacting annual weather patterns and snowpack accumulation and retention. Consequently the vegetation types across the region are at increased risk to catastrophic fire and other climate mediated stressors like severe drought. Managing these forest and other vegetation types to a healthy condition will offer the greatest chance to be resilient to our future climate.

Stakeholder Input

Throughout the profile we will be sharing findings from stakeholder engagement in *'Stakeholder Input'* boxes like this one. This includes survey results, as well as key findings from interviews with forest management experts and others who interact with a broad variety of stakeholders in their work to increase ecosystem and community resilience to wildfire.

Survey results shown here and throughout the profile include all survey respondents. Additional survey results showing response for each subregion can be found in the Appendix.

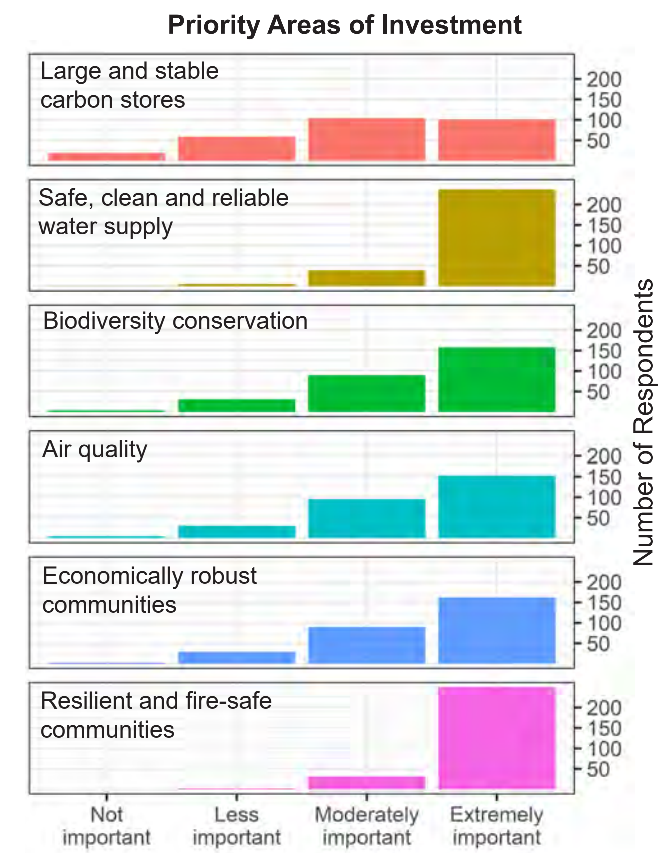


Figure 3. Sierra Nevada stakeholders provided input on the importance of investment across six pillar categories beyond 'Healthy and resilient forests.' 'Resilient and fire-safe communities' and 'Safe, clean and reliable water supply' emerged as the top-priority outcomes. However, all outcomes had a mean response ranging from moderately important to extremely important, which highlights the importance of considering all of these values when developing regional plans.

In the sections that follow we have used the framework from the Pillars of Resilience (see Fig. 2) to describe in detail the nature of each of: healthy and resilient forests, carbon storage, water security, biodiversity conservation, air quality, economically robust communities, and resilient and fire safe communities. The intent is to provide the reader with foundational background information related to each of those pillar categories, share findings from stakeholder surveys and interviews and describe in more detail the underlying make up of each pillar in terms of one to several select metrics being used to describe it.

Healthy and Resilient Forests

Healthy forest conditions result when the trees on the landscape are patchily distributed in terms of tree spacing and across size classes, sometimes referred to as forest heterogeneity by scientists. This results in a more open or park-like appearance to the forest, with fewer but larger trees that are generally not uniformly positioned on the landscape. In the low- to mid-elevation forests of the Sierra, this condition was maintained in part by fairly frequent low to moderate severity fires that burned every ~8-20 years. Historically, drier understories, lightning and cultural ignitions contributed to this fire regime in the lower elevation forests, whereas in higher elevation forests, snowpack and colder temperatures contributed to

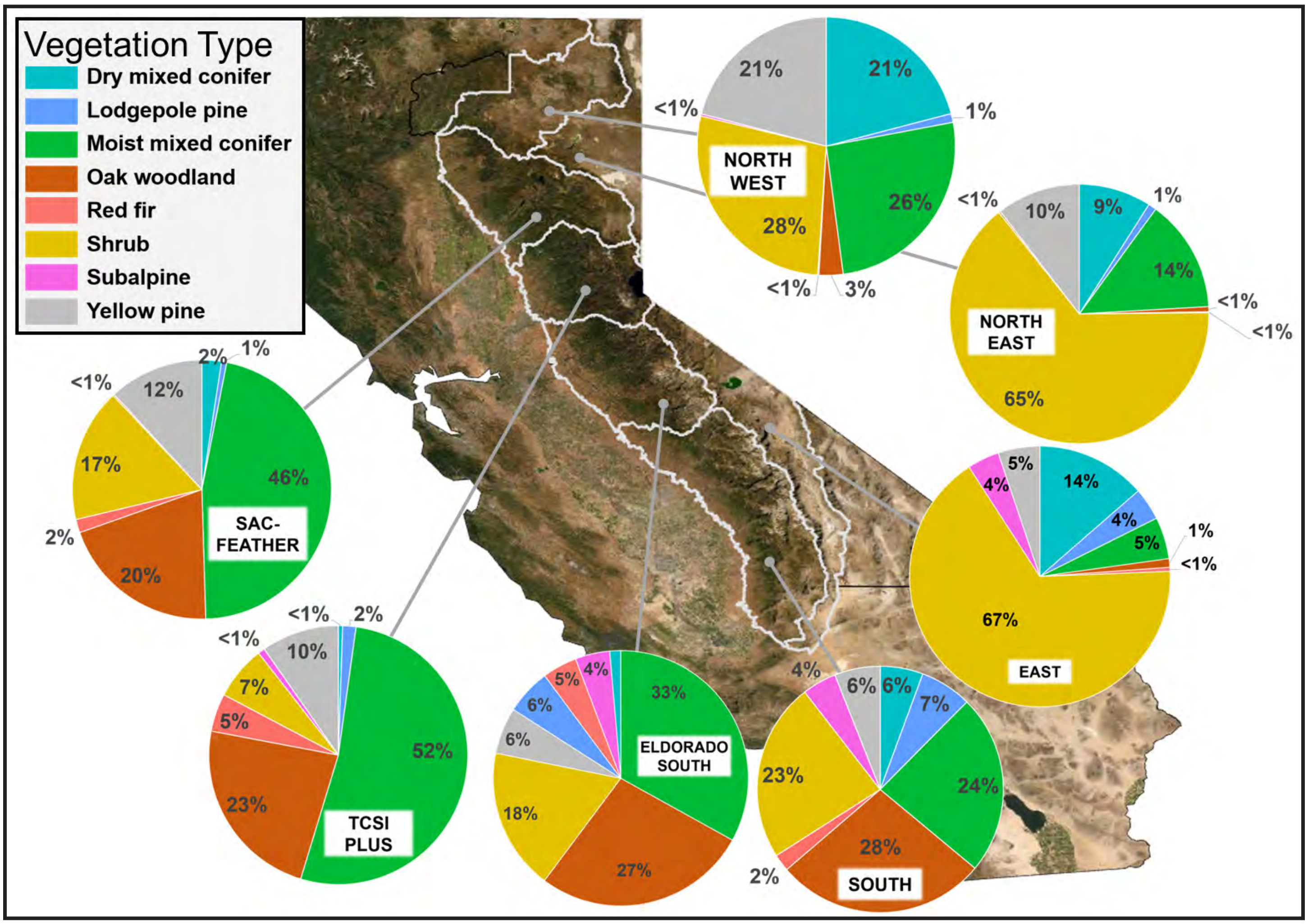


Figure 4. Distribution of vegetation cover types in the Sierra Nevada region per Sierra Nevada Conservancy subregions. Cover types were classified based on California Wildlife Habitat Relationship habitat types. Dry mixed conifer includes: eastside pine, juniper, montane hardwood-conifer, and pinyon-juniper habitats. Lodgepole pine includes: lodgepole pine, aspen, and mountain hemlock habitats. Moist mixed conifer includes: douglas fir, sierran mixed conifer, white fir, and redwood habitats. Oak woodland includes: blue oak woodland, blue oak-foothill pine, montane hardwood, and valley oak woodland habitats. Red fir includes: red fir, white fir, and lodgepole pine habitats. Shrub includes: alkali desert scrub, bitterbrush, alpine dwarf-shrub, chamise-redshank chaparral, desert scrub, desert wash, low sage, mixed chaparral, montane chaparral, and sagebrush. Non-forest or shrub habitats, including herbaceous, barren, and developed habitats were excluded.

an infrequent, but higher severity fire regime. This narrow fire return interval that low- to mid-elevation forests experienced allowed fires to remove smaller trees and other vegetation, thereby promoting the growth of larger and ultimately more resilient trees. Forests in the region historically had tree densities of ~50-80 trees/acre.

However, the 20th century fire suppression policy disrupted the natural and cultural fire regime resulting in denser forests and the build-up of surface fuels. This dynamic is more acute in the lower elevation forests as compared with higher elevation forests in the region. In fact much of the region's lower and mid-elevation forests have very high tree densities (300-400 trees/acre on average and as many as 700 trees/acre) with greater fuel loads compared to the higher elevation forests. Denser forests with high fuel loads are more prone to catastrophic fire and the effects of climate change. In particular, increased susceptibility to high severity fire is due in part to accumulated surface fuels, which can increase the chances of a crown fire occurring.

High tree densities have also led to increased competition for water which is especially acute during periods of drought. Although drought shaped California's ecosystems for millenia, recent droughts have been more severe and longer lasting. The hallmark of this trend was the 2012-2016 drought, which was California's most severe drought in over a millennium. During such a severe and extended drought, the trees in the forest become water stressed and are more susceptible to bark beetles. Several bark beetle species naturally occur in the region under normal conditions creating smaller patches of mortality that benefit forest structure diversity. However, under the recent drought conditions and poor forest health, pest populations surged and infestations moved quickly through dense stands with lots of host trees. This combination of drought and bark beetle outbreak ultimately led to ~129 million trees dying. The southern part of the Sierra Nevada experienced the highest drought stress and was especially vulnerable, resulting in over 26% tree mortality in the southern range between 2012 and 2017, whereas mortality in the northern range was 2%. Elevated tree mortality continued to occur in the region for several years after the drought.

Tree mortality was most severe at low elevations and certain host species such as ponderosa pine and sugar pine were hit hardest. In some of the most impacted areas, 70% of trees were lost in a single year. The bark beetles also target larger trees which is particularly concerning because large trees (> 36" diameter at breast height) are already less abundant in the region than existed before pre-European settlement as a result of both denser forests and selective harvesting of large trees for timber. However, forest stands that had previously been treated by prescribed fire and mechanical thinning experienced lower mortality because fewer trees meant less competition for water resources. Additionally, research indicates that low-severity fire can spur sap production in the surviving trees for a decade or more, bolstering defenses against bark beetles. This suggests that forest treatments that reduce the probability of severe wildfire can also make forests more resilient to drought and bark beetle attacks.

Many of the dead trees standing on the landscape from the aforementioned large-scale tree mortality are believed to have contributed to the wildfires in the Sierra Nevada region in 2020. Over 1.1 million acres burned in the region in 2020, more than doubling the previous record set in 2018 (see Fig. 5). Most alarmingly, more than 80% of the acres burned were from only three fires and significant portions of those acres burned at high severity. This represents a significant departure from the historic fire regime of frequent but low-intensity, smaller fires. This regional record was broken again in 2021, when more than 1.5 million acres burned, including an 18-fold increase in the average amount of high-severity acres.

Larger and more continuous patches of high severity fire reduce natural tree regeneration. There have been cases of forested areas that experience a severe reburn transitioning to shrublands or a non-forest vegetation type. Climate change compounds this issue by shifting the existing ranges for different vegetation types. Shrublands and grasslands are projected to encroach into existing oak woodland and forest habitat. Oaks

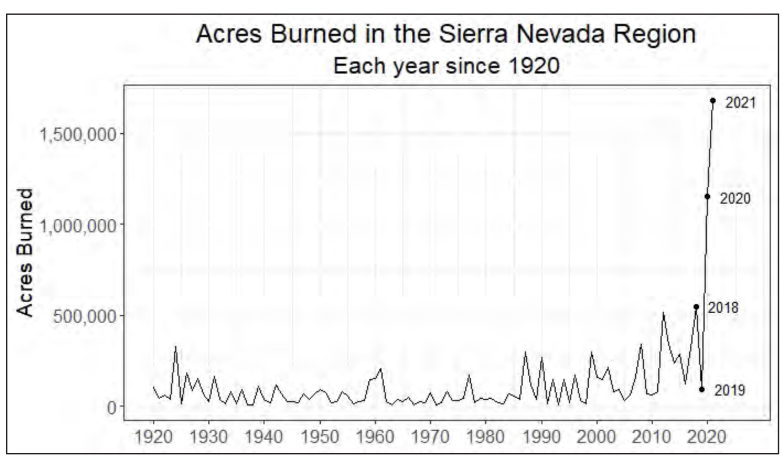


Figure 5. Acres burned by wildfire in the Sierra Nevada region from 1920 to 2021. Data provided by Sierra Nevada Conservancy.

may replace conifers in many low to mid-elevation areas, while conifers continue to move upslope to altitudes that were previously covered by snowpack, where existing soils can support them.

Climate change is here and its impacts have and will continue to be seen across the region for many years to come. As such we should expect some degree of change in terms of vegetation or forest coverage across the region. This necessitates that the decisions and actions made today consider the anticipated future conditions that are expected with climate change.

In summary, protecting communities while also enhancing ecosystem resilience to both fire and climate change may be achievable through a multi-pronged approach. This would include some combination of strategically placed fuel treatments to aid with community protection, investments to fireproofing structures and associated infrastructure, along with carefully designed vegetation management actions. To achieve this, selective tree thinning and fuels reduction activities would need to be accelerated and achieved at ecologically meaningful scales annually. This would also mean increasing the application of prescribed fire while also taking advantage, where prudent, of natural wildfire events especially where fires are burning at low intensities at strategic locations.

It is important for restoration of these frequent fire forests to achieve conditions where we can apply fire at low to moderate severity to burn and thus to reduce smaller trees, shrubs and other fuels. This will yield more heterogeneous forests with fewer and more widely spaced trees, lower the risk that surface fires will become crown fires, and reduce competition among trees during periods of drought and warming that is expected with climate change. This silvicultural strategy will also enable the recruitment of large, fire-resistant trees that are also important for many species of wildlife.

Stakeholder Input

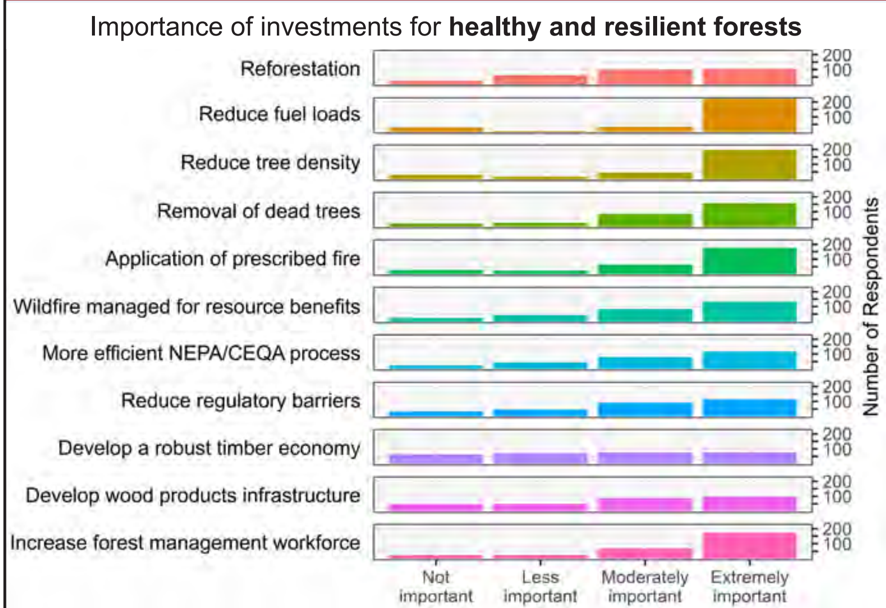


Figure 6. Survey respondents were asked how important the following potential areas of investment are for achieving healthy and resilient forests in their subregion. The actions that the highest number of stakeholders rated as 'extremely important' were reduce fuel loads and reduce tree density. Removal of dead trees, application of prescribed fire and increasing forest management workforce also had high average response. Developing a robust timber economy was generally perceived as less important than other options by respondents.

Interview findings: When asked what the key issues were related to achieving ecological resilience, interviewees emphasized that our current wildfire crisis should be recognized as a symptom of climate-driven drought and the legacy of historical forest practices, which converted landscape into dense forests and suppressed the natural disturbance regime. As a result, forest treatments are needed to reduce forest density and reduce fuels to restore a more natural disturbance regime. Some interviewees also highlighted the need to work on ecologically meaningful scales, which is currently limited by organizational and workforce capacity. Treatments also need to happen at a faster pace to keep up with increasing disturbance events. This includes faster response to addressing tree mortality, and the recent CAL FIRE initiative to work toward building Emergency Forest Restoration Teams could help to address that need. Regulatory compliance also was cited as a barrier that delays project implementation, and many interviewees mentioned that the NEPA/CEQA process needed to be more efficient so that delays in approving fuel treatment projects do not lead to more harm being done by catastrophic wildfire before treatment occurs.

Current Conditions

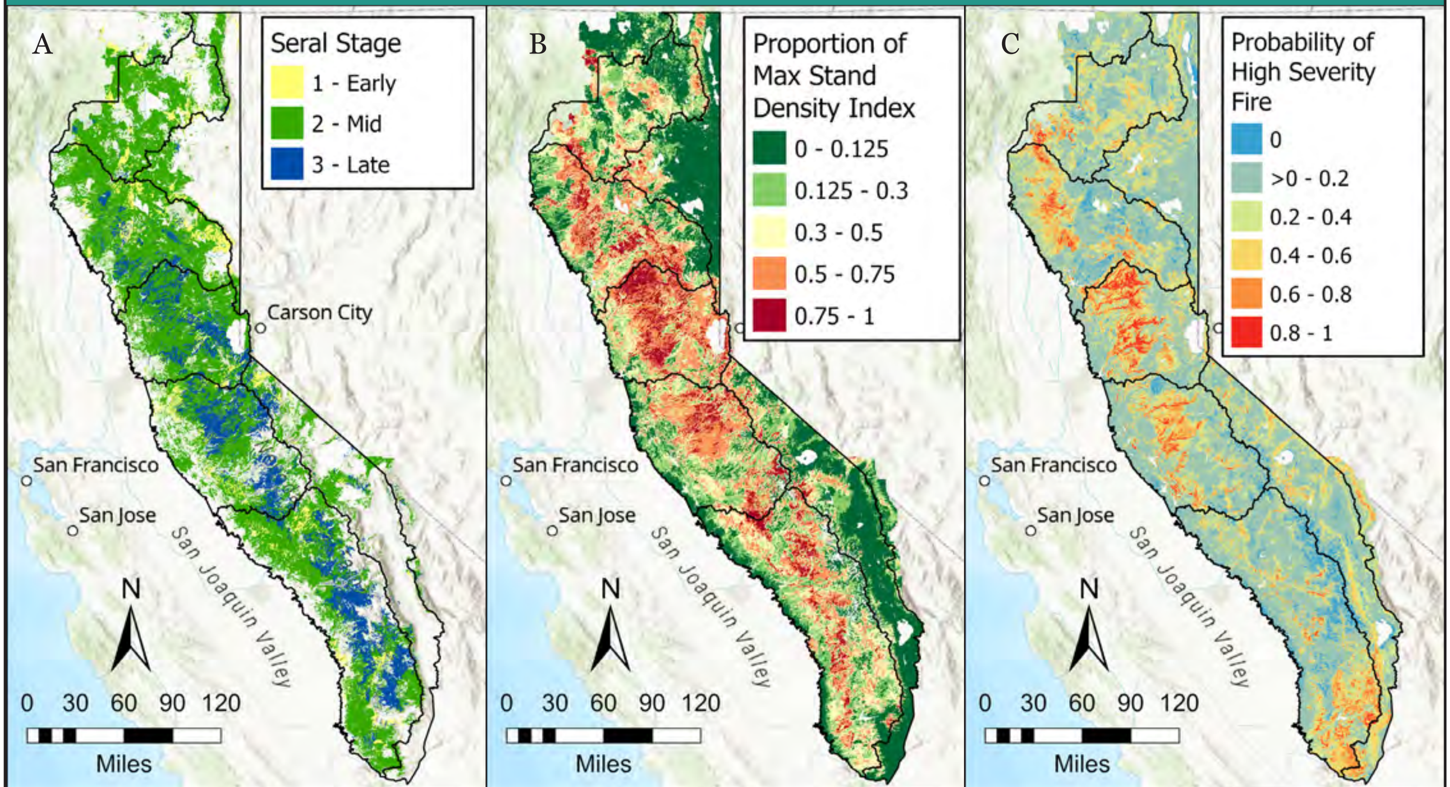


Figure 7. Healthy and resilient forests can be assessed using measurements of various forest structural characteristics, such as seral stage distribution (A), maximum stand density index (B), and estimated responses to disturbances, such as probability of high severity fire (C). A "sere" is a group of similarly aged trees co-occurring on the landscape. So the seral stage distribution refers to the arrangement of these different aged tree stands of trees across the landscape. The patterning of different seral stages is important because those patterns can impact how wildfire is carried and is expected to behave in a forest. In the Sierra Nevada region, nearly 20% of the landscape is in late seral stage, and approx. 9% is in early seral stage. Late seral stage forests are mature with relatively large trees that are important for carbon storage and other ecosystem services. The maximum stand density index (SDI) is the upper limit to the occupancy of a tree stand, at which point growth of the stand is only possible after the death of some individuals. SDI is a measure of the number of trees per unit area relative to the size class distribution of the stand. SDI values are important because it helps assess the degree of resilience of a forest which is often a critical objective of forest management. Probability of high severity fire is the likelihood of a fire with flame lengths exceeding 8-feet occurring on the landscape. It is important because management often seeks to reduce the extent and continuity of high-severity fires, which typically cause the most ecosystem damage and risk to life and property.

Carbon Storage

Managing California's natural lands for stable carbon storage and sequestration is essential to state efforts to achieve carbon neutrality and increase resilience to climate change. The Sierra Nevada region functions as a critical carbon stock by storing nearly half of the 2 billion metric tons of forest carbon stocks in California. Historically, within mixed-conifer forests in the Sierra most of the forest carbon was stored in a few very large trees. At that time, competition between trees was low and tree sequestration rates were high (see Healthy and Resilient Forests). Although fires occurred frequently they were generally of low to moderate severity which allowed emissions from fires to be quickly recaptured by the remaining live trees.

Today, much of the carbon of Sierra Nevada mixed-conifer forests is stored in smaller trees, which are increasingly vulnerable to fire and the effects of climate change. Carbon sequestration can be lost and emissions increased from multiple avenues as a result of these stressors and disturbances. The AB 1504 California Carbon Inventory for 2006-2015 reported that live trees in the Sierra Nevada region annually sequestered approximately 9.5 million metric tons of carbon dioxide equivalent (MMT CO_2e) which is equivalent to roughly the same amount of carbon dioxide that 2 million cars emit in a year. However, by 2017, tree mortality in the region had reduced this rate to 6.0 MMT CO2e. Not only is sequestration lost when trees die from drought, insect outbreaks, or fire but the decomposing trees also release carbon back into the atmosphere and become fuel for future fires. Depending on severity, wildfire plumes can also contribute significant greenhouse gas emissions. Finally, forest ecosystems are at risk of converting to grass and shrublands, especially after repeat high-severity fires, and these habitat types do not sequester as much carbon.

Fortunately, management action has the potential to reduce carbon emissions and increase carbon sequestration, and these same actions may also serve to protect important cultural and ecological resources. Thinning overly dense forests can trigger a return to similar historical processes, in which initial losses of carbon from lost or removed trees can be regained and stored more securely in the remaining large trees. Fuel treatments (including mechanical, Rx and managed wildfire) that remove small diameter trees, understory biomass, and reduce surface fuels can reduce the potential of crown fires, thereby protecting the carbon stored in live trees and promoting more stable annual sequestration. Carbon losses from mechanical treatments can also be further mitigated if the removed biomass is converted into durable wood products, which continue to store carbon. Residual biomass can also be converted into bioenergy, substituting for more carbon-intensive energy production. A recent study in the Sierra Nevada found that restoring montane meadows also increases carbon sequestration and ecosystem capacity for stable carbon storage in the soil.

Large trees like the legacy giant sequoia shown here sequester significant quantities of carbon from the atmosphere and store it in their biomass.
Photo credit: NPS/Kiel Maddox

Stakeholder Input

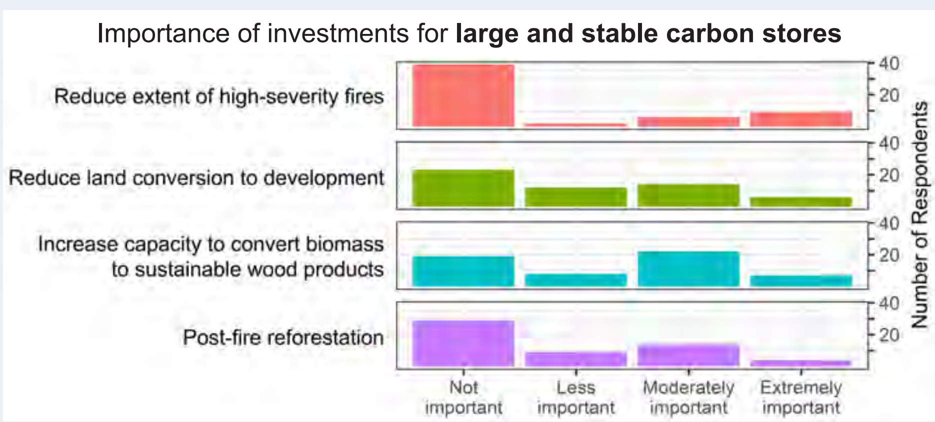


Figure 8. Survey respondents were asked how important the following potential areas of investment are for achieving large and stable carbon stores in their subregion. Although the mean response for 'Large and stable carbon stores' was still 'moderately important,' survey respondents scaled it as less of a priority than the other values (see Fig. 3) and rank many of the actions that might contribute to achieving large and stable carbon stores as less important than other potential areas of investment.

Given that maintaining forest carbon stocks is critical to achieving climate change mitigation goals, survey results suggest that investments in this social benefit may need to be driven at the state and regional rather than local levels. These results might also highlight a need for better public communication of how forest management for carbon storage can be applied to reduce greenhouse gas emissions and mitigate climate change.

Current Conditions

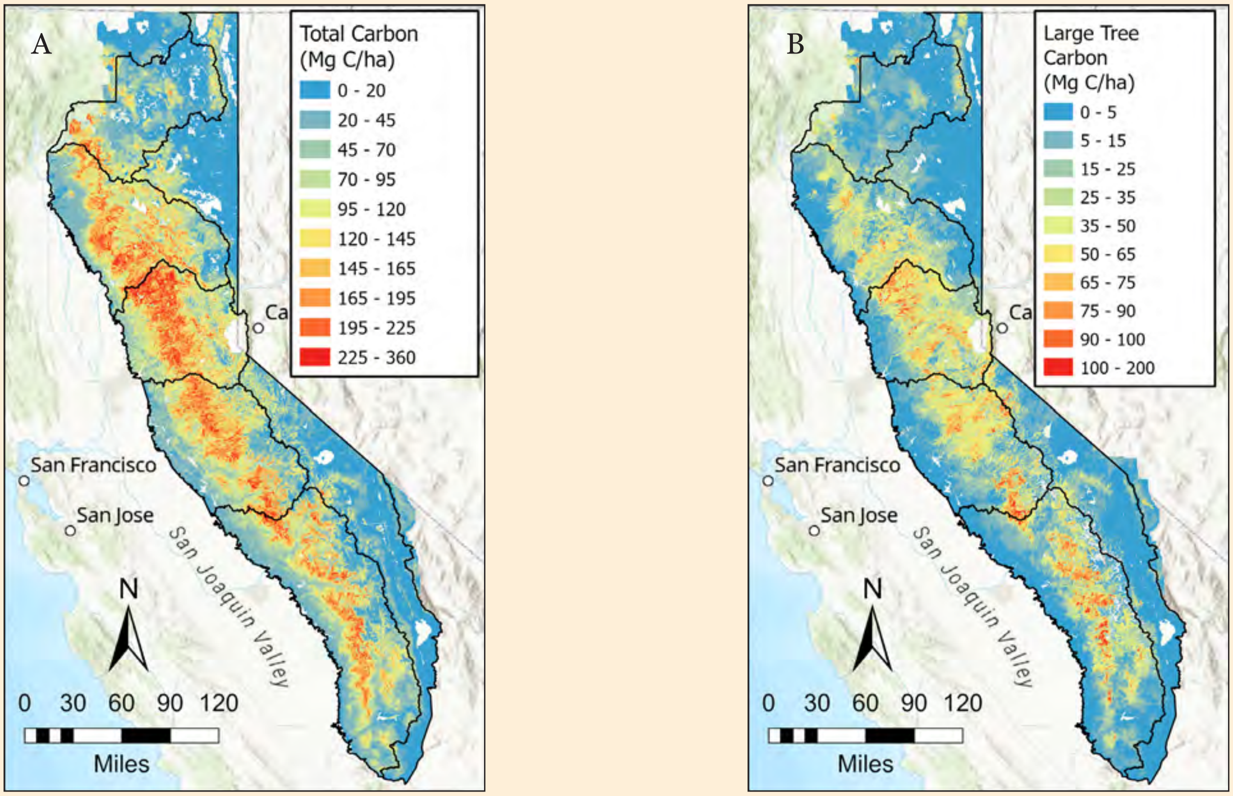


Figure 9. The regional resource kits rely on two metrics to assess carbon storage on the landscape: total aboveground carbon (A) and large tree carbon (B). The total aboveground carbon is the amount of carbon present in all live and dead trees, shrubs, herbaceous vegetation, and dead material on the ground. Total aboveground carbon is important because preserving carbon stored in natural systems is generally desirable for management goals and, therefore, understanding the magnitude of carbon stored on a landscape may help inform the location and type of treatment activities. Large tree carbon is a measure of carbon stability. It is the sum of the branches, stems, and foliage of trees greater than 30” in diameter. This is important because the carbon that’s stored in these larger trees is less likely to be released back into the atmosphere, unless a severe disturbance event occurs.

Water Security

The Sierra Nevada region is integral to California water security, supplying water to over 75% of Californians and generating about half of all hydroelectric power in the state. Much of this water is stored as snowpack, which functions as the state’s largest ‘natural’ water reservoir. Climate models indicate that average temperatures in the Sierra Nevada will warm by ~6-9^{o}F by 2100 and that a greater proportion of precipitation will fall as rain instead of snow. Consequently, Sierra Nevada snowpacks are expected to shrink by more than 60% across most of the range. Declining snowpacks and earlier snowmelts, coupled with warmer temperatures and increased evaporation throughout the year, will create greater competition for water resources among human applications, such as agricultural irrigation and hydropower production, as well as ecosystem needs, such as providing sufficient cold water for salmon and balancing salinity of delta ecosystems. These changes in water availability will also contribute to further drying of fuels and the corresponding elevated risk of severe wildfire, and shifts in streamflows and flooding. Increased potential for flooding threatens state water infrastructure, sensitive ecosystems and the public safety of downstream communities.

When high-severity wildfires burn vegetation and soil the landscape is much more prone to runoff and erosion which transports ash, debris, and sediments into streams. Some of the pollutants that are washed in can be especially harmful to human health and aquatic ecosystems including mercury, lead, and other metals that are released by fire. Increased sedimentation also reduces reservoir capacity, which impacts both water storage and flood control.

Proactive management actions and investments can reduce erosion, and protect and improve hydrological function and, ultimately, water security. For instance, meadow restoration can improve watershed functionality and increase groundwater storage; thinning forests can promote the health of the remaining trees by reducing competition for limited water resources; and upgrading and maintaining water infrastructure (e.g., larger culverts) can better protect communities and water resources from potential flood damage. The value proactive management offers has prompted some water agencies to become active partners in forest management projects, such as the French Meadows Forest Restoration Project. Investing in the health of the Sierra's watersheds both before and after disturbances occur has the potential to offer numerous ecological and societal co-benefits.

Stakeholder Input

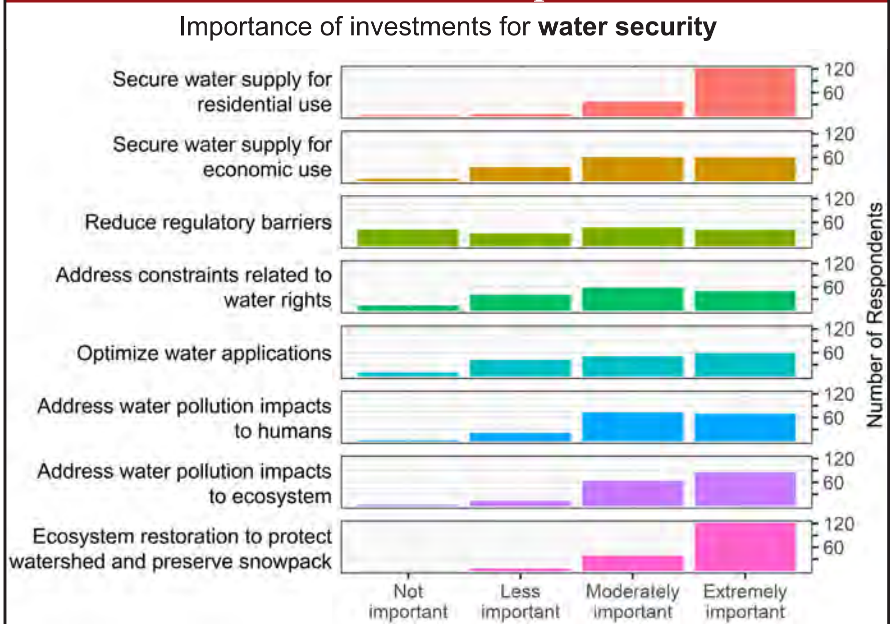


Figure 10. Survey respondents were asked how important the following potential areas of investment are for achieving water security in their subregion. Two actions were rated as 'extremely important' by the majority of responses: securing water supply for residential use and ecosytem restoration to protect the watershed and preserve snowpack. Addressing water pollution for both humans and the ecosystem were also perceived as highly important based on mean response. Reducing regulatory barriers was perceived as less important than other options.

Interview findings: Interviewees noted that water was one of the critical resources that the Sierra Nevada region supplies the rest of the state. Forest treatments need to prioritize key watersheds that are important to California water security. One interviewee noted that increasing recognition of the importance of regional water security could help mobilize resources and capacity to do work on a larger scale. Interviewees also noted local issues related to water security. Water infrastructure often takes too long to be rebuilt after fire, in part, because many communities do not have the budget or capacity to do the necessary work. An interviewee recommended that there needs to be more access to disaster recovery funding to address this.

This aerial view shows low water conditions at Folsom Dam in Sacramento County, when on this date, the storage was 309,573 reservoir acre-feet, which is 32 percent of the lake's total capacity. Photo taken October 28, 2021. Caption and photo credit: California Department of Water Resources/Andrew Innerarity

Current Conditions

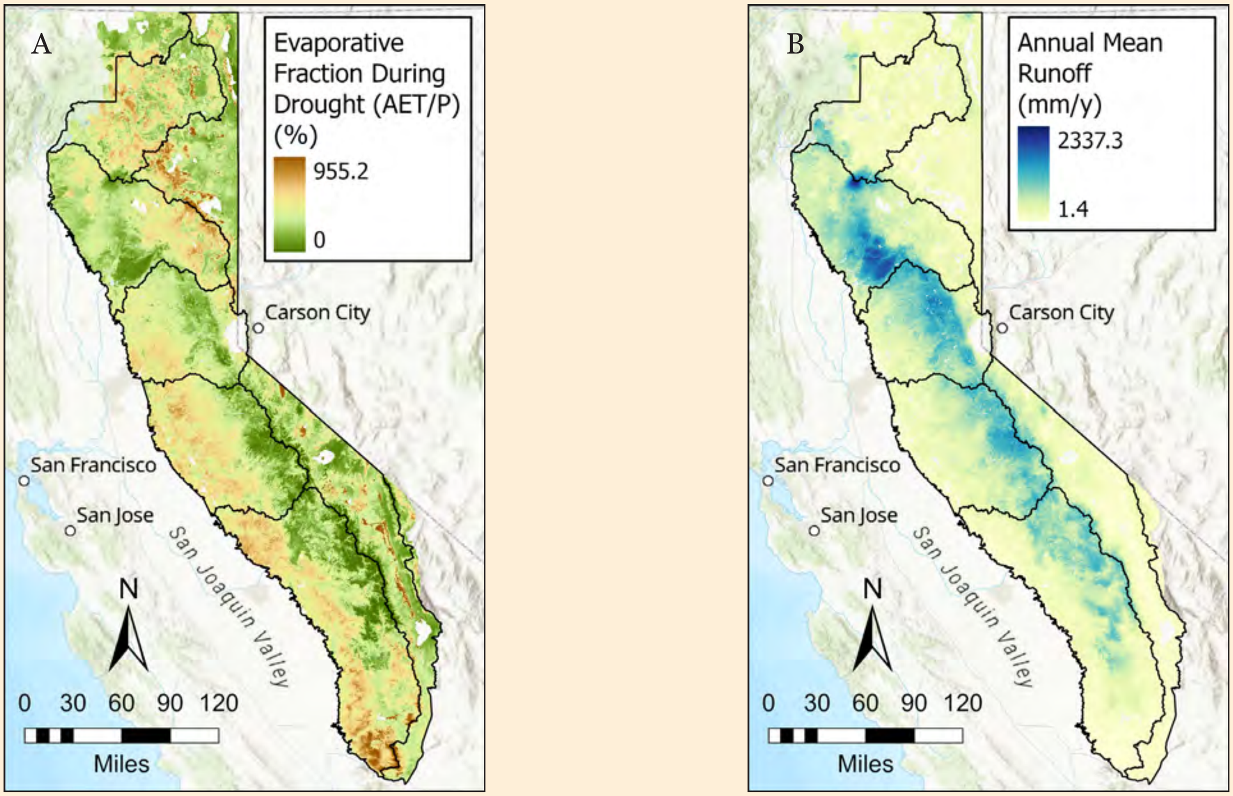


Figure 11. Water security can be assessed in terms of actual evapotranspiration/precipitation (AET Fraction) (A) and annual mean runoff (B). Actual evapotranspiration is the combined amount of water that evaporates from the land surface in addition to the water that is lost as vapor from plants. AET Fraction represents the percentage of water needed by plants that is met by precipitation during a severe 4-year drought. THis metric is important for water security because it estimates the moisture stress that would be experienced by the vegetation during drought. Values > 100% indicate moisture stress driven by shortfalls in precipitation relative to plant needs. Values < 100% indicate no water stress. Both forest management and disturbances like wildfire can affect AET Fraction by reducing the amount of vegetation at a site and thereby lowering the amount of water needed by plants. Annual mean runoff is the surplus water discharged from a location in the form of surface or groundwater flows. This metric is important for water security because it estimates the amount of surplus water for downstream use. Both forest management and disturbances like wildfire can affect runoff in part by changing the vegetation conditions at a site. For example, forest treatments that thin trees in moisture-stressed areas may increase runoff and provide more water availability downstream.

Biodiversity Conservation

Sixty percent of California's animal species reside in the Sierra Nevada region. The region ranks among the most biodiverse temperate forests in the world in terms of both the number of total species and the number of native and endemic species. Climate change threatens biodiversity globally and the Sierra Nevada is no exception. Warming temperatures and changes in precipitation may lead to habitat type conversions or otherwise make habitat unsuitable for climate-sensitive plant and animal species that currently occupy it. This will force species to shift their ranges, which is especially challenging for species which do not disperse well or do not have access to suitable habitat. Animal surveys conducted in Yosemite National Park and elsewhere in the Sierra Nevada indicate that many animal species have already shifted their range upslope compared to their historical distribution, and several high-elevation species have already experienced range contraction. Researchers projected that the ranges of approximately 60% of the 21 bird species that inhabit coniferous forests in the Sierra Nevada will experience substantial range reductions before the end of the 21st century.

Suitable habitat may eventually occur at higher elevations, but it takes decades for forests to develop mature habitat characteristics. This could affect several species of concern that rely on old-growth habitat, including the California spotted owl, Pacific fisher, American marten, and Northern goshawk. Large and severe wildfires further accelerate habitat loss. For example, scientific models predicted that, in

75 years under current wildfire trends, the cumulative amount of spotted owl nesting habitat burned by moderate to high severity fire would exceed the total existing habitat. Forest management to reduce habitat vulnerability to wildfire will be critical for the conservation of spotted owls and other threatened species.

In addition to forest treatments that reduce the probability of large and severe fires, efforts must be made to protect habitat which will remain or become suitable for sensitive species in the future. Protecting healthy habitat from development remains fundamental for species conservation. Newer strategies to conserve biodiversity include identifying and protecting areas that naturally function as 'climate refugia,' buffering species from the impacts of climate change. For example, it has been suggested that the southern Sierra Nevada may function as an important climate refugium for Pacific fishers. Forest management that facilitates the growth of taller trees and mature stand characteristics may increase the pace of habitat development for old-growth reliant species. It is also critical to protect land and riparian areas that facilitate animal movement across the landscape ('conservation corridors') in order to enable species to shift their range to track climate change. Aquatic ecosystems are also impacted by changes caused by wildfire, such as increased sedimentation and flooding, and may require habitat restoration post-fire or proactive treatment to protect species, including the endangered Yosemite toad.

Stakeholder Input

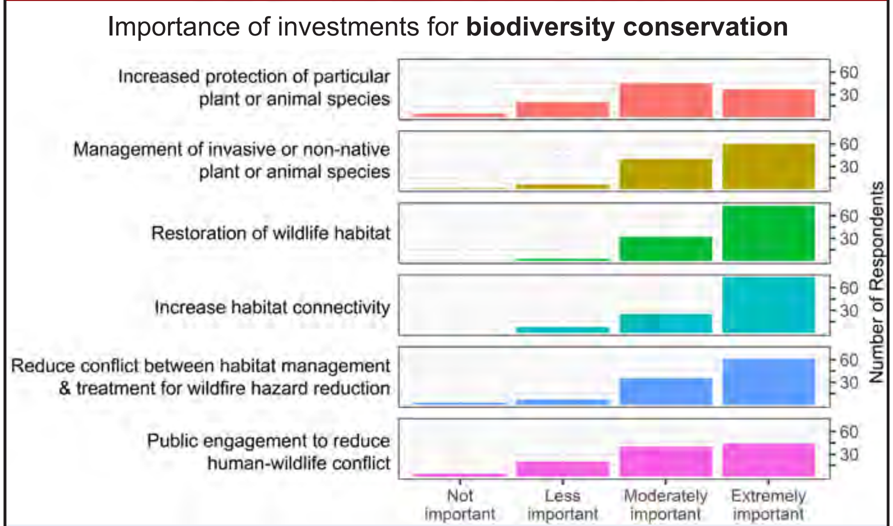


Figure 12. Survey respondents were asked how important the following potential areas of investment are for achieving biodiversity conservation in their subregion. The average rating of all actions was at least moderately important. Restoration of wildlife habitat and increase habitat connectivity had the highest numbers of "extremely important" ratings.

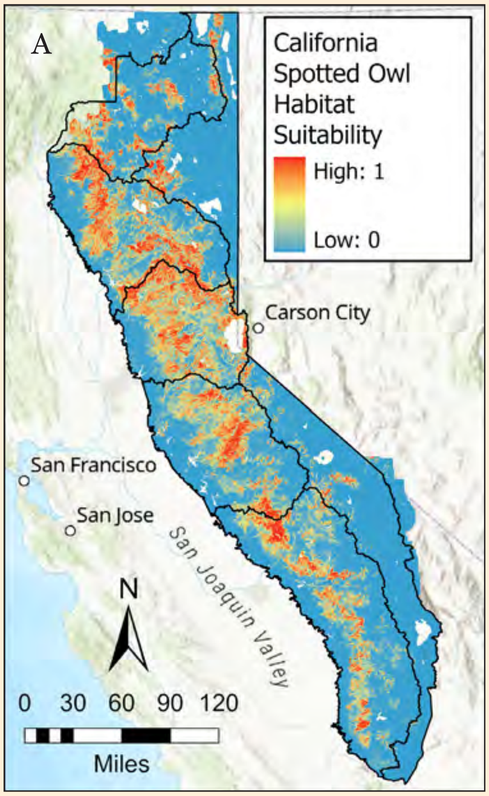
Interview findings: Issues related to biodiversity conservation also emerged in interview responses about increasing ecological resilience. One interviewee noted that efforts to increase resilience have prioritized human communities for obvious reasons, but we also need to find ways to identify, elevate and prioritize irreplaceable biodiversity resources. One barrier to doing this is understanding where critical habitat is on the landscape. Another interviewee noticed that in the last ten years, 30% of spotted owl protected activity centers (PACs) has been impacted by fire, and if we do not change forest management approaches then we will lose this habitat. Several interviewees highlighted that it is important that project planning continues to consider and mitigate threats to sensitive species, but the regulatory compliance process needs to be more efficient so that projects can be implemented before wildfire causes more harm than the proposed management.

Another emerging threat to biodiversity and ecosystem health under climate change is the increasing presence of invasive species. Some invasive species, such as cheatgrass and medusahead, can increase the intensity or severity of wildfire. Native species, such as bark beetles, have also emerged as novel threats under climate change (see Healthy and Resilient Forest section).

Actions that promote overall forest health, such as thinning overly-dense stands to increase forest resilience to drought, warmer conditions and insect outbreaks, will serve biodiversity conservation goals, as well. However, care must be taken that forest treatments to reduce wildfire hazard risk maintain key habitat elements, such as resting habitat, to mitigate the short-term impacts of actions that increase long-term landscape resilience. Treatments should also be timed to minimize disruption to important stages of sensitive species ecology, such as the season when young are born.

Pacific fisher is one example of a species of concern in the Sierra Nevada region that relies on old-growth forests. Photo credit: USFS Region 5

Current Conditions



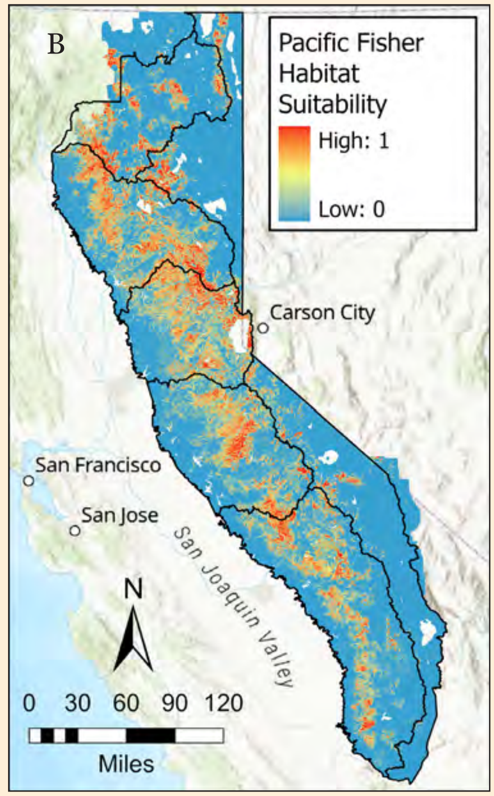


Figure 13. Biodiversity and metrics to inform its conservation can be measured in a variety of ways. Among other metrics, the Regional Resource Kit assesses habitat suitability for two focal species of concern: California spotted owls (A) and Pacific fisher (B). Habitat suitability of California spotted owls and Pacific fisher is measured by the likelihood of presence of each species based on a combination of suitable canopy cover, size class of trees, and vegetation type per unit area. Suitable foraging and nesting or denning habitat are included. The population of Pacific fisher in the southern Sierra is federally threatened and resides primarily on federally managed lands. The California spotted owl populations are in decline and considered warranted for listing under the ESA. It is important to consider habitat suitability during treatment planning to minimize negative impacts to these species or their habitat.

Air Quality

Smoke from wildfires can affect the air quality thousands of miles from the fire, presenting widespread risks to public health. The hazardous air pollutants in wildfire smoke may cause respiratory and cardiovascular illness and even premature death. Black carbon (soot) produced by wildfires may be especially unhealthy; in addition to cardiovascular and respiratory diseases, evidence has linked it to increased risk of cancer, and potentially, birth defects.

Certain populations may be especially vulnerable to these risks, including the elderly, children, outdoor workers, fire fighters, people with asthma or other pre-existing respiratory or cardiac conditions, as well as people who have limited access to health care services or who lack the socioeconomic resources to prepare and adapt to emergencies (e.g., by filtering air pollutants in their home or accessing a clean air shelter). Populations in areas that already experience poor air quality are also particularly vulnerable when they experience the compounded impacts of wildfire emissions. For example, communities and ecosystems in the southern Sierra Nevada are regularly exposed to high ozone levels and particulate-matter pollutants, with the highest pollutant levels observed on the western edge of the Sierra Nevada closest to the San Joaquin valley.

Poor air quality also has economic impacts unrelated to public health, especially in a region such as the Sierra Nevada which has an important tourism and outdoor recreation economy. Tourists may decide not to visit the region when air quality is poor and visibility of the landscape is reduced. Drops in visitation and recreation can have widespread and rippling consequences for the various businesses connected to these markets.

Clearly, reducing the risk of high-severity wildfires offers significant benefits to air quality. As a result interest in management actions that restore beneficial fire to the landscape such as managed wildfire, cultural burning, and prescribed burning has increased in recent years. Although beneficial, low-intensity fire can cause short-term negative impacts to air quality, its use can reduce the risk of uncontrolled and catastrophic wildfire. Fire that burns at lower intensity over smaller areas emit much less harmful pollutants than large, high-severity, wildfires. For example, the 2014 King Fire burned 97,717 acres and 50% of this burned at high severity, producing 2.3 million tons of greenhouse gas emissions which is equivalent to the annual emissions from about 500,000 vehicles.

Additionally, prescribed burn organizers and local air districts can collaborate to minimize air quality impacts by planning burns to occur during optimal weather conditions. They can also provide the public with advanced notice of planned burns. In contrast, catastrophic wildfire events not only ignite unpredictably, but they tend to occur in summer when ambient air quality is more degraded, compounding the impacts of the smoke on local and regional populations.

Expanding resources and public support for prescribed burning can also help facilitate indigenous communities' goals of restoring traditional burning, an important cultural practice which was outlawed by 19th century European settlers and throughout the extended history of 20th century policy of blanket fire suppression. Cultural burning can help to achieve additional land and resource restoration objectives beyond fuel reduction. For example, burning can encourage new growth of plants that provide important resources for humans and wildlife, as well as restore nutrients in the soil. Recognition of the additional benefits of cultural burning beyond the fuel reduction goals of prescribed burning has facilitated increased support for tribal leadership and the incorporation of traditional ecological knowledge into land management.

In 2021, California legislators took steps to increase prescribed burning capacity. This included expanding liability protections for authorized individuals who conduct a prescribed burn, provided that they adhere to permitted conditions. This law was also significant because it included liability protection for cultural fire practitioners, affirming the rights of Tribal communities to conduct cultural burns. Legislation also established a prescribed fire claims fund to address the insurance barrier which was keeping communities from being able to conduct prescribed

Stakeholder Input

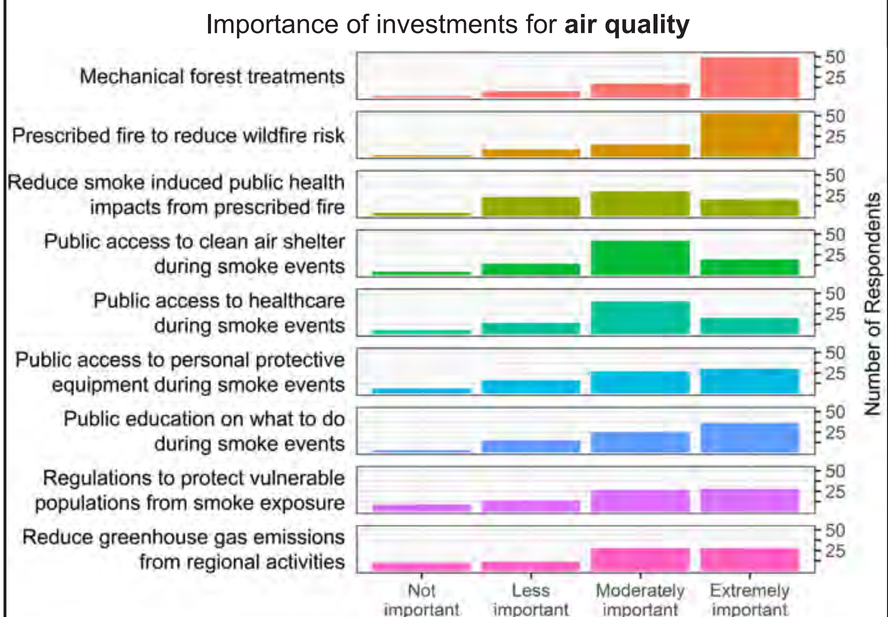


Figure 14. Fuel treatments that reduce the probability or scale of wildfire, whether mechanical or prescribed burning, were widely perceived by stakeholders to be the most important areas of investment. Many stakeholders perceived public access to clean air shelter and to health care during smoke events to be "moderately important." The spread of histogram values suggests that there was more variation in stakeholder perception of the importance of other potential actions, though mean survey response for all options was moderately important or higher.

Interview findings: Many interviewees discussed the need to significantly increase prescribed burning as part of forest health treatments and noted that there were many undeveloped areas where this could be done at low risk to communities, but perspectives varied regarding how feasible this was given social barriers. Participants observed that public and administrative support for prescribed burning varies across the region and increasing support would require changing both public perception and agency culture to make people more comfortable with managed fire and more tolerant of smoke. Cooperation between air quality districts and prescribed burners has been found to be effective for increasing prescribed fire treatments while reducing public impact of smoke. Recent legislation has also reduced some barriers to implementing both prescribed and cultural burning, but lack of trained workforce capacity continues to be a limiting factor. Building a prescribed fire training center to provide more training access to state and federal firefighting employees was one recommendation for increasing capacity.

and cultural burns. However, the narrow windows of suitable weather conditions, which can be further restricted by permitting decisions, create significant logistical challenges to completing prescribed fire treatments. Additional creativity, tolerance for risk, and investment in skilled workforce, will be necessary to leverage this management tool against wildfires that continue to burn without a permit, with devastating consequences.

Fires that burn at high-severity produce more air pollutants than less severe fire. 50% of the extent of the 2014 King Fire (shown here) burned at high-severity. Photo credit: CAL FIRE

Current Conditions

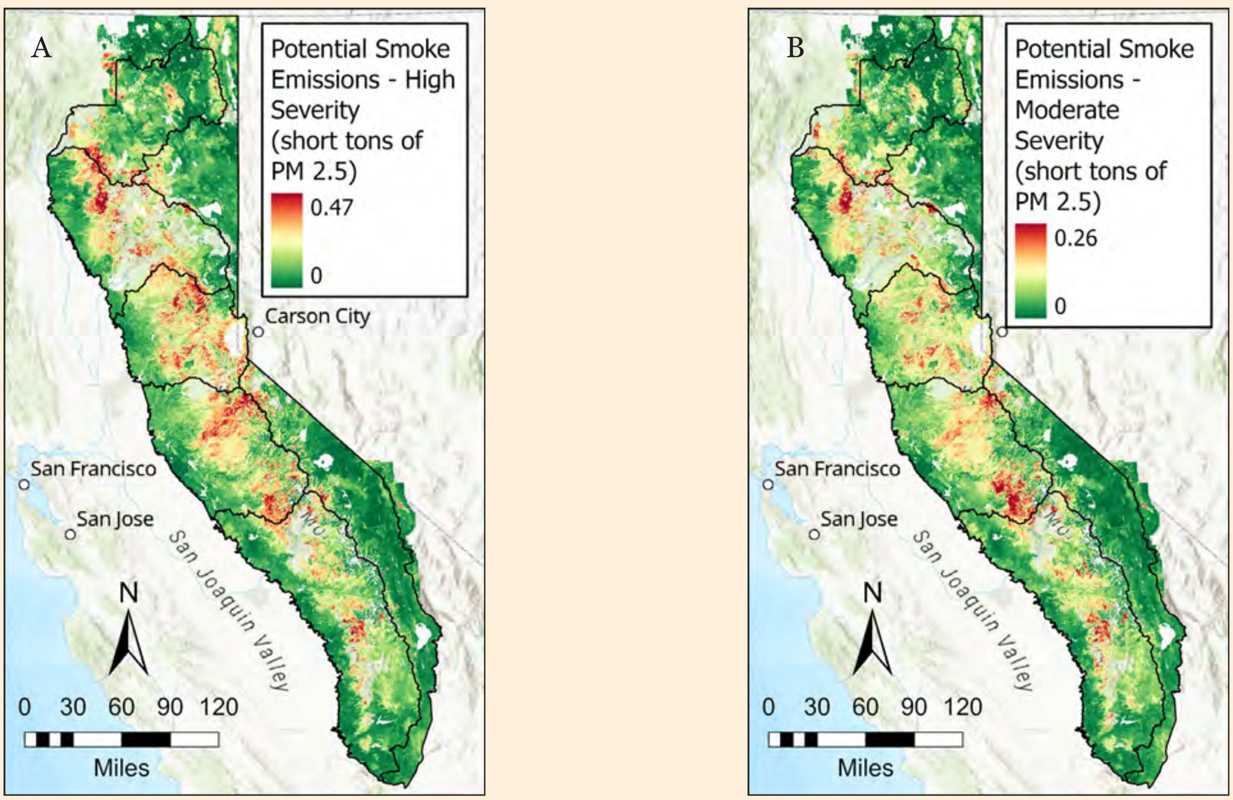


Figure 15. Air quality can be assessed by measuring the amount and concentration of pollutants from different sources; however, potential smoke emissions from wildfire is particularly relevant to natural lands management. This metric is measured as the amount of small (< 2.5 microns in width) particles in the air expected to be generated from high-severity fire (A) and moderate-severity fire (B). Because emissions of particulate matter from fire contribute to serious public health risks and negative environmental impacts, this metric is important for informing investments in reducing wildfire severity. Under high-severity fire, it is estimated that a 300-m area could emit as much as 0.47 tons of smoke emissions, whereas maximum emissions are estimated at 0.26 tons under moderate-severity fire. These assessments underscore the different impacts that high-severity versus moderate-severity fire can have on air quality and public health.

Capacity to implement forest management projects requires trained workforce capacity. Shown here members of a USFS crew prepare to do work as part of the Giant Sequoia Emergency Response. Photo credit: USFS Region 5

Economically Robust Communities

Over the past thirty years, California has lost much of its historical forest product processing capacity. Less than one-third of the number of wood products facilities that existed in the state prior to 1970 were still present in 2016. The remaining sawmills and biomass facilities do not have the capacity to meet the increased salvage demand created by large-scale fires or tree mortality events, such as the 2012 - 2016 drought and bark beetle outbreak in the southern Sierra, or the Dixie fire in the northern Sierra. The lack of adequate processing infrastructure and local markets for biomass residuals is severely limiting capacity to perform both proactive forest health treatments and post-fire restoration.

Meanwhile, tourism has emerged as the new economic backbone of many rural communities. Tourism is estimated to provide 12% of employment in the region, including over 202,000 jobs. In 2019, the tourism industry generated over $9.5 billion in taxable sales and provided tax revenues of nearly $9 million. However, this industry is increasingly susceptible to smoke events and other threats from wildfire, which can deter prospective visitors and critically shut down local business operations. For instance, the 2018 Ferguson fire, which burned in the Yosemite area, was estimated to have cost $45.1 million in spending loss and $1.1 million in potential tax revenues in Mariposa County, which does not even consider the direct costs of fire suppression, emergency response, damage and recovery. Suppression of the nearly 1 million acre Dixie Fire in 2021 was estimated to cost $630 million. Rebuilding the forest processing and products economy can bring important economic opportunities to rural communities, many of which suffer from high rates of unemployment. This will require greater governmental investment to support capacity building in areas which do not currently have sufficient local infrastructure or access to sustainable wood product markets. Stemming the loss of local capacity may also require additional policy incentives for public contracts to include local businesses and local workers, which are frequently outcompeted by large, out-of-state corporations.

One of the greatest barriers to rebuilding a robust forest management economy is lack of workforce capacity. Rural communities in the Sierra region have a higher cost of living than many other rural places in large part because of high housing costs. One-third of owner-occupied households and half of renter-occupied households in the Sierra Nevada region are considered housing-burdened. Lack of affordable housing makes it challenging for employers to attract and retain employees. Developing a permanent, local workforce requires access to year-round jobs with benefits and wages sufficient to support a family. Increasing access to professional development opportunities would also enable local workers to continue to advance in careers in the forestry sector, helping with retention and supporting demand for skilled workers.

Recently, there have been more efforts to include communities and demographic groups which have been historically underrepresented or excluded from the forestry industry. For example, the High Road Training Partnership is a partnership of Tribes, employers, and nonprofits that provides professional development and employment opportunities to build capacity in underserved and disadvantaged rural communities. Another notable example is the Inter-Tribal Stewardship Workforce Initiative, led by Tribal leaders and Tribal natural resource staff, which is working to develop tribal restoration workforces and advocate for Tribal and non-Tribal local contracts. These initiatives build community and economic resilience, and they also facilitate incorporating Traditional Ecological Knowledge and practices into forest restoration.

Stakeholder Input

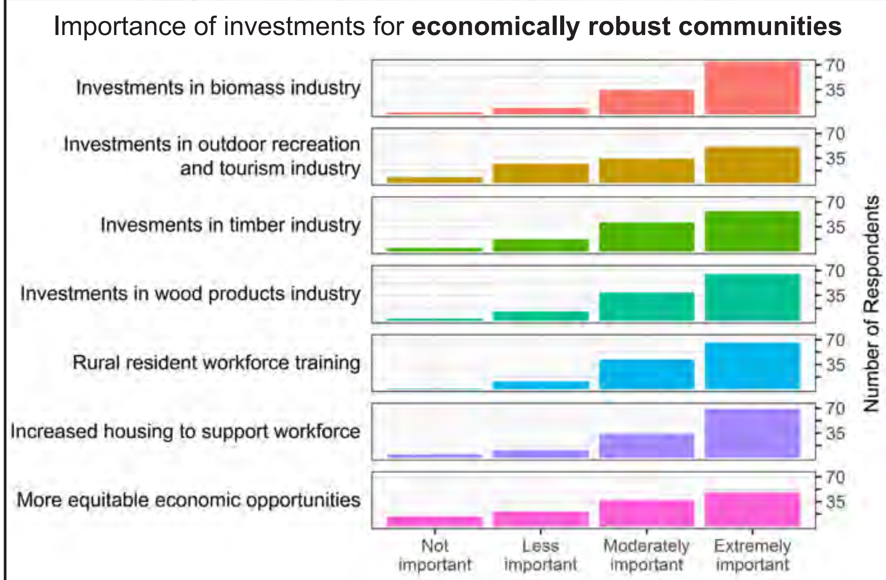


Figure 16. Survey respondents perceived investments in biomass to be the most important industry to invest in to achieve economically robust communities, though investments in timber industry and wood products industries were also generally considered to be at least moderately important. Rural resident workforce training and increased housing to support the workforce were also considered highly important by many respondents. Investments in outdoor recreation and tourism, as well as in more equitable economic opportunities, were still considered to be moderately important despite having a slightly lower average response and more spread than the other options.

Interview findings: When asked about the key issues related to community resilience to wildfire, many interviewees highlighted challenges stemming from how the forest management economy is structured and how this relates to workforce capacity and broader socioeconomic challenges in the region. One issue mentioned is that there are limited economic incentives to do fuel treatment work because there is no market for residual biomass. Building local biomass facilities and cogeneration plants would reduce the costs of forest treatment work and support local economies. Interviewees also highlighted that state and federal agencies rely on hiring private contractors and providing grants to external partners. As a result, because large public projects outcompete smaller projects, community-level organizations often have a harder time hiring contractors to do work. Increasing the internal capacity of agencies to conduct forest treatment work might alleviate this issue. This also points to the larger issue of workforce capacity limiting the pace and scale of forest management, and the need to provide new pathways into high-quality jobs in this sector. Numerous interviewees mentioned that lack of affordable housing makes it hard for both public and private organizations to fill available job opportunities. Many areas not only lack residents with technical expertise for forest management projects, but also skills like organizational leadership, grant writing, planning and public relations, which can limit local capacity to work toward resilience goals.

Current Conditions

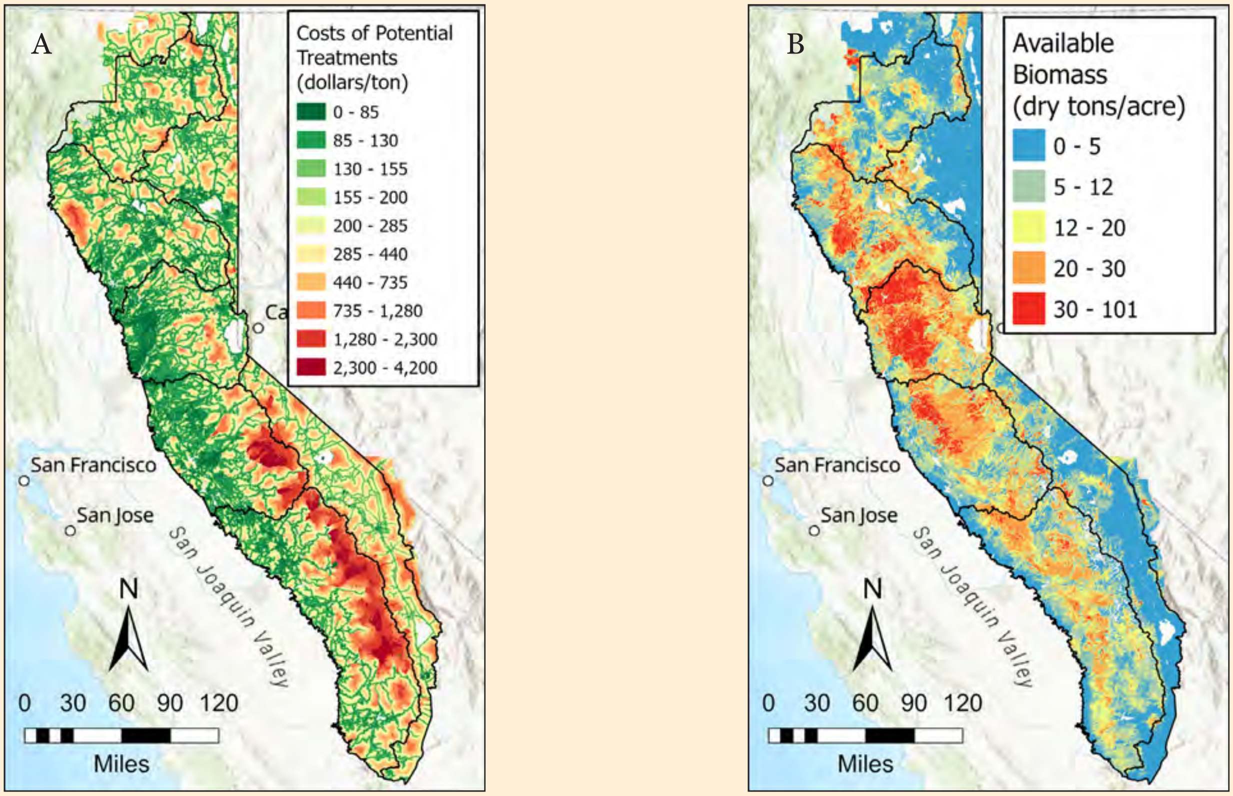


Figure 17. Assessing the economic robustness of communities is challenging and influenced by many elements. In the Sierra, creating environmentally sustainable forest management and wood product industries are crucial for robust rural economies. The cost of potential treatments (A) and available standing biomass (B) are relevant metrics for assessing the wood product sector's viability in an area. The cost of potential treatments is measured as the cost per acre to harvest biomass or sawlogs, remove material from the field and transport it to a processing facility. It is important because this cost affects the financial feasibility of thinning treatments as an economic opportunity for communities. The RRK assessments reflect the differing costs in conducting forest treatments across the region, which are largely related to where facilities exist to process biomass. For instance, costs for treatments tend to be higher in the southern and eastern parts of the region (as high as $627 per ton) compared to the central and northern regions (as low as $213/ton). Biomass is the total volume (tons per acre) of the crown branches and foliage and stem wood from all trees less than 10" in diameter. Total biomass is important because it represents the opportunity for utilizing biomass as a product of forest thinning.

Resilient and Fire-Safe Communities

The increasing frequency and scale of wildfires, along with continuing human development in the wildland-urban interface poses serious risks to communities in the Sierra Nevada. Recognizing this threat, a key goal of California's Wildfire and Forest Resilience Action Plan is to improve protection of these communities and support adaptation to living with fire; key actions include improving emergency preparedness and increasing assistance programs and partnerships to implement fuel reduction projects. Identifying the most at-risk communities, such as low-income populations and areas with high wildfire hazard potential, is integral to achieving this goal.

Many communities in the Sierra Nevada region contend with socio-economic challenges that limit local capacity to invest in wildfire resilience. These communities may lack the resources to update aging infrastructure, implement fuels reduction work without assistance, or respond to active emergencies. For instance, some areas don't have sufficient water storage, fire hydrants, or water pressure to fight fires. Additionally, though disadvantaged or underserved communities may be eligible for external financial support, they often lack the organizational capacity necessary to apply for grants. Programs like the Department of Conservation's Regional Forest and Fire Capacity program are targeting this need by investing in regional and local capacity to not only implement but plan, develop, and administer projects that strive to create fire adapted communities and landscapes.

Crucial vulnerabilities exist on a household level as well and are important for assessing community risk and local preparedness capacity. Low-income households may be less able to invest in emergency preparedness, including fire insurance, or have the capacity to recover from losses post-disaster. Seniors and individuals with reduced mobility, as well as households without access to personal vehicles, might have difficulty evacuating or accessing resources during emergencies. Many parts of the region do not have reliable internet coverage or cell reception, which may limit access to important public information, including public safety announcements. To address these vulnerabilities,information delivery can be tailored to how residents consume information. For example, low-income and technology-limited households may be better reached by direct mailings or print materials distributed at churches, community centers, and schools. Information can be translated into diverse languages to make announcements more accessible. Asking known points of contact, such as community leaders, to share information, and hosting public meetings in local areas can also be an effective engagement strategy, especially in geographically isolated or otherwise disadvantaged areas.

Various initiatives and programs are increasing awareness of the measures that Sierra Nevada residents can take to make their personal properties and communities more fire-adapted. Local fire safe councils are grassroots, community-led organizations that lead initiatives to increase community wildfire protection, such as hazardous-fuel-reduction projects, Community Wildfire Protection Planning, and

Stakeholder Input

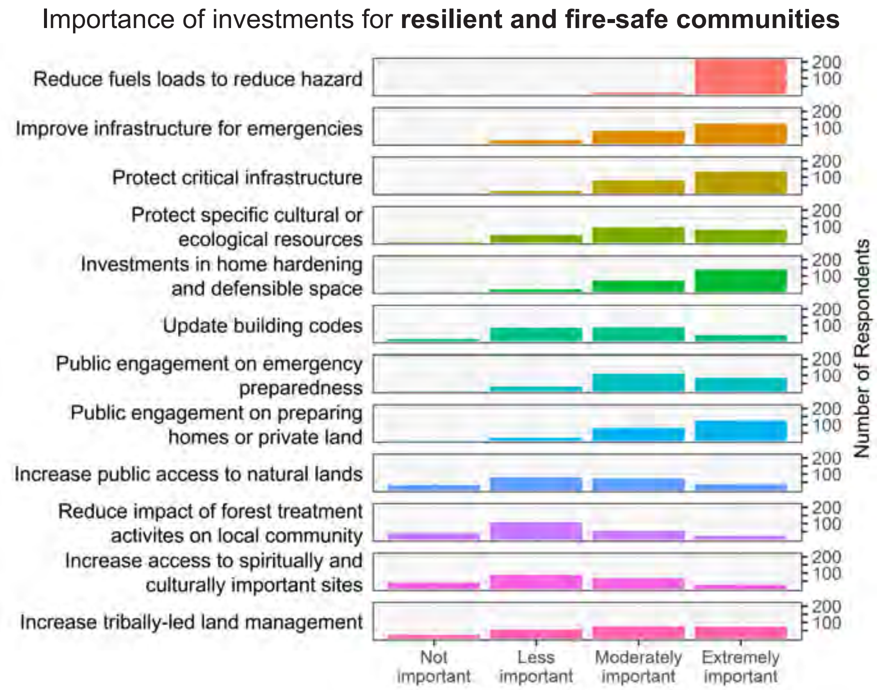


Figure 18. There is strong consensus from stakeholders that reducing fuel loads to reduce wildfire hazard is the most important area of investment for making communities more resilient and fire-safe. Other areas of investment that survey respondents scaled as the most important include improving emergency infrastructure and protecting critical critical infrastructure, as well as investing in home hardening and defensible space. Public engagement on emergency preparedness and on preparing private property to mitigate wildfire were also perceived as moderately to extremely important by most respondents.

Interview findings: Interviewees discussed various issues that impact community resilience to wildfire, most of which can be related to local capacity or the need for more public engagement. Many interviewees highlighted the need to reduce community wildfire hazard by treating fuels on private land. One barrier to addressing this is lack of private landowner awareness of what needs to be done to manage the landscape. This can be addressed through public education initiatives. Another issue is that fuel reduction work is more expensive than many nonindustrial private landowners can afford. Increasing financial support for private landowners, as well as access to technical expertise and cost-share programs, can make it more feasible for private landowners to contribute to making their communities more fire-adapted. Interviewees also noted that updating building standards and zoning can help to regulate housing development in high wildfire areas to reduce threats to communities. A variety of solutions were suggested to increase public safety, including improving egress routes and community emergency planning, making public emergency information easily accessible, increasing access to resilience centers and other resources to support communities during emergencies, as well as increasing and expediting support to communities after disaster occurs. One interviewee noted how enabling local communities to lead or be involved in restoration and response can empower communities and increase capacity to address issues across the region.

trainings for homeowners. Regional- and state-based organizations, such as University of California Cooperative Extension, also offer workshops and educational resources on topics such as how to create defensible space around private property and how to retrofit homes using fire-resistant construction materials. Prescribed Burn Associations are community-based organizations with a goal of helping California residents to live with fire by putting "good fire" back on the landscape.

Efforts to put "good fire" back on the landscape can be informed by Traditional Ecological Knowledge. This photo shows an interagency archeology and cultural fire workshop with tribal members near Mariposa, CA. Photo credit: CAL FIRE

Current Conditions

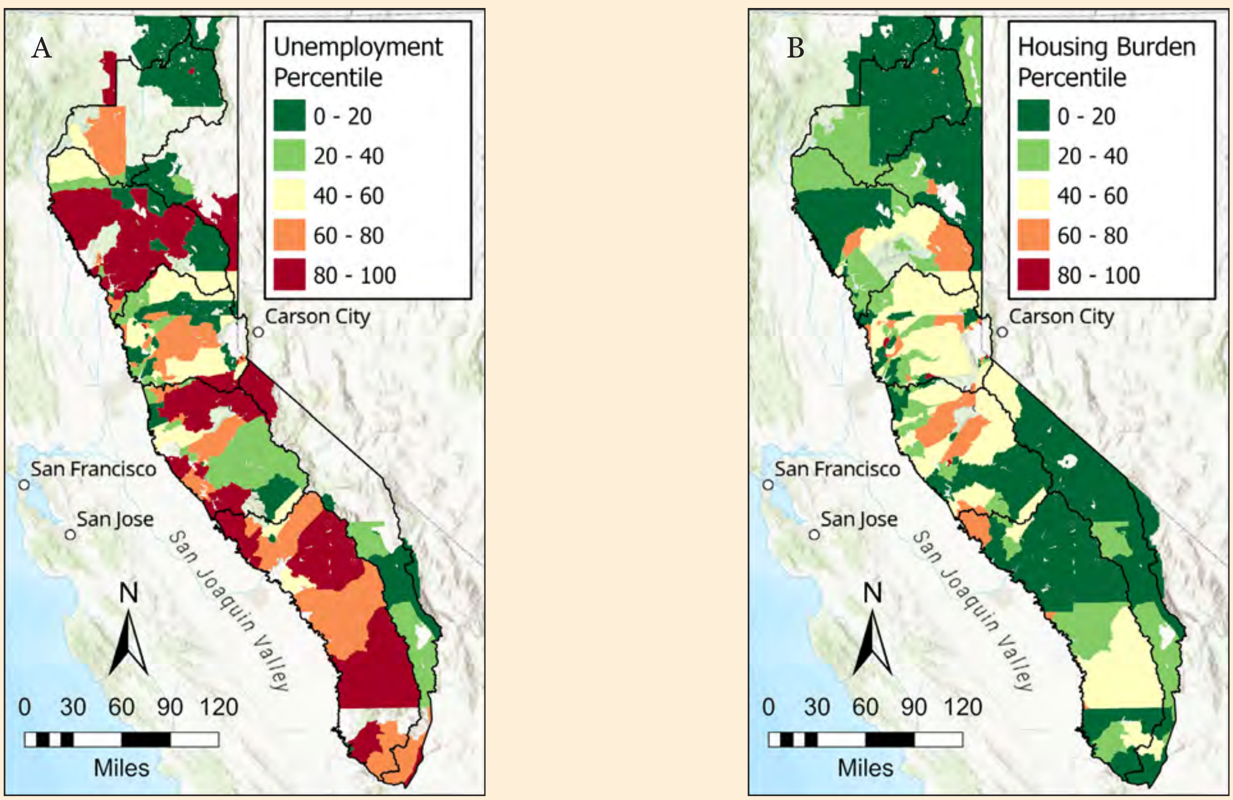


Figure 19. Resilient communities must be fire-adapted, as well as socially and culturally healthy. Though by no means the only metrics for understanding community capacity or resilience, for the purposes of this profile, we consider unemployment (A) and housing burden (B). Unemployment is measured as the percentage of the population over the age of 16 that does not have a job and is eligible for the labor force. Housing burden is the percent of households in a census tract that are both low-income (making less than 80% of the HUD Area Median Family Income) and pay more than 50% of their income to housing costs. Unemployment and housing burden percentages are considered to be general metrics of the socioeconomic well-being of a community and reflect community capacity to participate in measures that reduce the risk of wildfire hazard and to recover from disturbance.

Concluding Recommendations from Interviews

When interviewing experts who work on Sierra Nevada land management related to wildfire resilience, we asked participants if they had recommendations for increasing community and ecological resilience to wildfire. In addition to the findings already shared pertaining to specific pillars of resilience, some key big picture themes emerged from interviews. We conclude by highlighting a few of those recommendations.

1) Recognize that it is not possible to eliminate fire from a frequent fire landscape. California has a long legacy of fire suppression which has altered both the historical disturbance regime and humans' relationship with fire. Indigenous communities in the region used cultural burning to promote landscape health for thousands of years before this practice was suppressed. Interviewees discussed how we now need to find ways to get beneficial fire back on the landscape, including through prescribed burning and managed wildfire. As was also shared in interview findings of the 'Air Quality' and 'Resilient and Fire-Adapted Communities' sections, this is going to require increasing public tolerance for smoke, as well as additional efforts to prepare communities for living with fire.

2) Reducing wildfire hazard through active forest management requires a cultural change. Interviewees described how, in the past, forest management primarily focused on timber as an economically valuable resource. Now, as reflected in the Pillars of Resilience, forest management is being reframed to achieve multiple socio-ecological values that encourage both community and ecological resilience. Interviewees noted that effective communication will be key to increasing social acceptance of active forest management and to engaging the public as partners in this important work. This also requires changing how we measure and communicate the impacts of wildfires to help the public understand that sometimes fire burns in a way that is actually beneficial to the ecology of the landscape. It was suggested this could be done by shifting from "numbers of acres burned" to metrics that better measure the impacts of fire, such as structures burned, high-severity patches, and public health impacts.

3) Capacity needs to be increased to respond to the current pace and scale of threats. Interviewees frequently noted that forest treatments are not happening at a fast enough pace or a large enough scale to keep up with current wildfires. Many solutions that interviewees proposed to address this were already highlighted in the preceding Pillars sections (i.e., see 'Healthy Forests,' 'Water Security,' 'Biodiversity Conservation,' and 'Economically Robust Communities' sections). An additional suggestion that came up frequently in interviews was the need for longer-term and more stable funding to support collaborative forest restoration work. Organizations are competing for short-term grants, which make it hard to plan large projects. Making funding more secure would enable partners to coordinate efforts, hire permanent staff, and treat landscapes at ecologically meaningful scales. The capacity to plan projects on larger timescales was suggested to also be critical for encouraging investment in infrastructure and workforce development, opening the door for more partnerships with private industry and increasing local economic resilience.


PC: Chelsea Andreozzi

4) Increasing awareness of the value that the Sierra Nevada region provides can increase capacity to respond. Interviewees noted that the region provides many resources that are important to the state, including to many people that do not live in the region but drink water that falls as snow on Sierra Nevada mountains or visit the region for recreation. However, the burden for caring for these resources often rests on local residents. Increasing public awareness of the values that are threatened by climate change and wildfire can serve to mobilize greater support to address challenges, making the region and its resources more resilient.

List of Interview Participants

Stakeholder input was gathered during individual, semi-structured interviews that focused on the key issues related to ecosystem and community resilience in the Sierra Nevada, and the barriers, possible solutions, and recommendations for addressing these issues. All interviewees have extensive knowledge of and experience in both the ecological and social and cultural aspects of land management in the Sierra Nevada region. Of the 30 interviewees, 7 were US Forest Service employees, 7 were employees for the Sierra Nevada Conservancy, 6 were employees for UC Cooperative Extension, 6 were employees for environmental non-governmental organizations, and 4 were employees for Resource Conservation Districts.

Jared Dahl Aldern, Co-founder and Program Coordinator, Sierra-Sequoia Burn Cooperative

Teresa Benson, Forest Supervisor, USFS Sequoia National Forest

Tim Borden, Sequoia Restoration and Stewardship Manager, Save the Redwoods League

Deb Bumpus, Forest Supervisor, USFS Lassen National Forest

Lewis Campbell, Forestry Project Coordinator, Placer Resource Conservation District

Sarah Campe, Regional Scientist, Sierra Nevada Conservancy

Chris Dallas, Central Sierra Area Representative, Sierra Nevada Conservancy

Matt Driscoll, Eastern Sierra Area Representative, Sierra Nevada Conservancy

Michael Hall, District Manager, Feather River Resource Conservation District

Steve Haze, District Manager, Sierra Resource Conservation District

Kristy Hoffman, North Central Sierra Area Representative, Sierra Nevada Conservancy

Luke Hunt, Field Operations Manager, Sierra Nevada Conservancy

Eli Ilano, Forest Supervisor, USFS Tahoe National Forest

Susie Kocher, Forestry and Natural Resources Advisor for Central Sierra, UC Cooperative Extension

Jason Kuiken, Forest Supervisor, USFS Stanislaus National Forest

Fadzayi Mashiri, Mariposa County Director and Livestock and Natural Resources Advisor for Merced, UC Cooperative Extension

Paul Mason, Vice President of Policy and Initiatives, Pacific Forest Trust

Rebecca Ozeran, Livestock and Natural Resources Advisor for Madera, UC Cooperative Extension

Michael Pickard, South Central Sierra Area Representative, Sierra Nevada Conservancy

Allan Pietresanta, Board Chair, Sierra Business Council

Tuli Potts, Northern Sierra Area Representative, Sierra Nevada Conservancy

Kaeleigh Reynolds, Planning Technician for Climate & Energy, Sierra Business Council

Ricky Satomi, Forestry and Natural Resources Advisor for Sutter-Yuba, UC Cooperative Extension

Kristen Shive, Forest and Fuels Specialist, UC Cooperative Extension

Todd Sloat, District Manager, Fall River and Pit Resource Conservation Districts

Ryan Tompkins, Forestry and Natural Resources Advisor for Plumas Sierra, UC Cooperative Extension

Erick Walker, Forest Supervisor, USFS Lake Tahoe Basin Management Unit

Dana Walsh, Program Manager, USFS CA Landowner Assistance State and Private Forestry

Peter Wyrsch, Senior Project Associate, Blue Forest Conservation

Lesley Yen, Forest Supervisor, USFS Inyo National Forest

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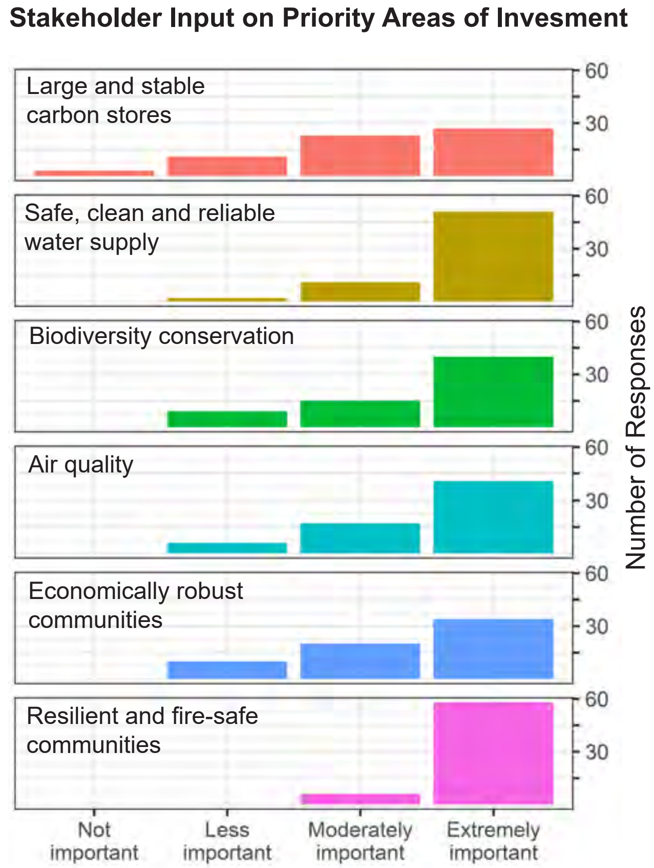
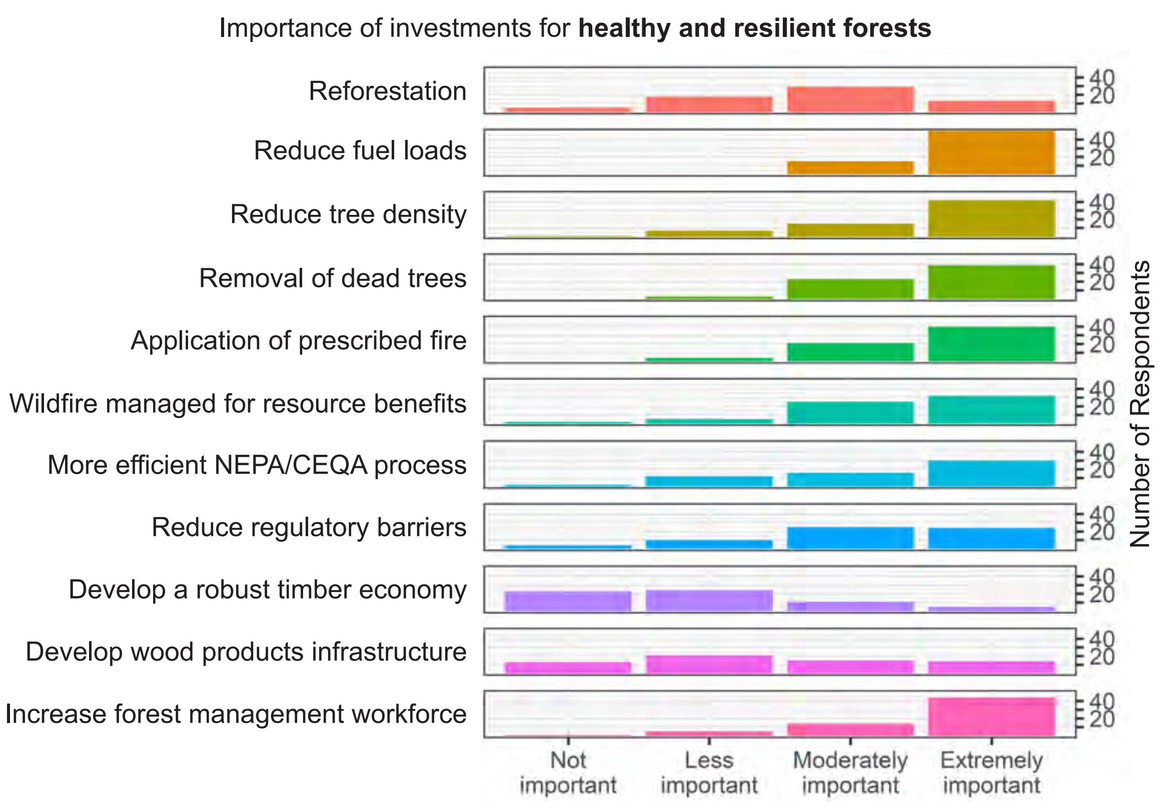
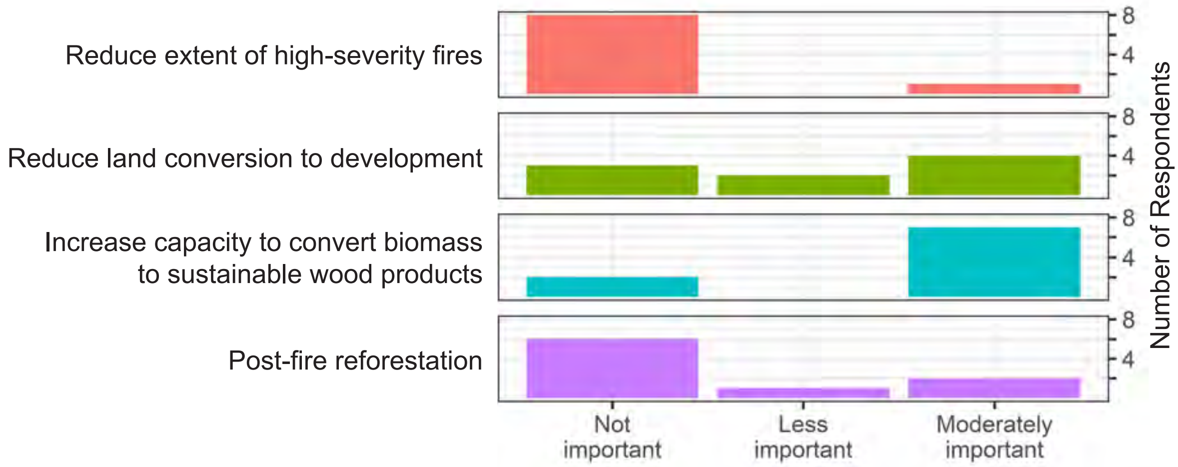
APPENDIX A: *Stakeholder survey responses by subregion*

Sierra Nevada Survey Results
East Subregion

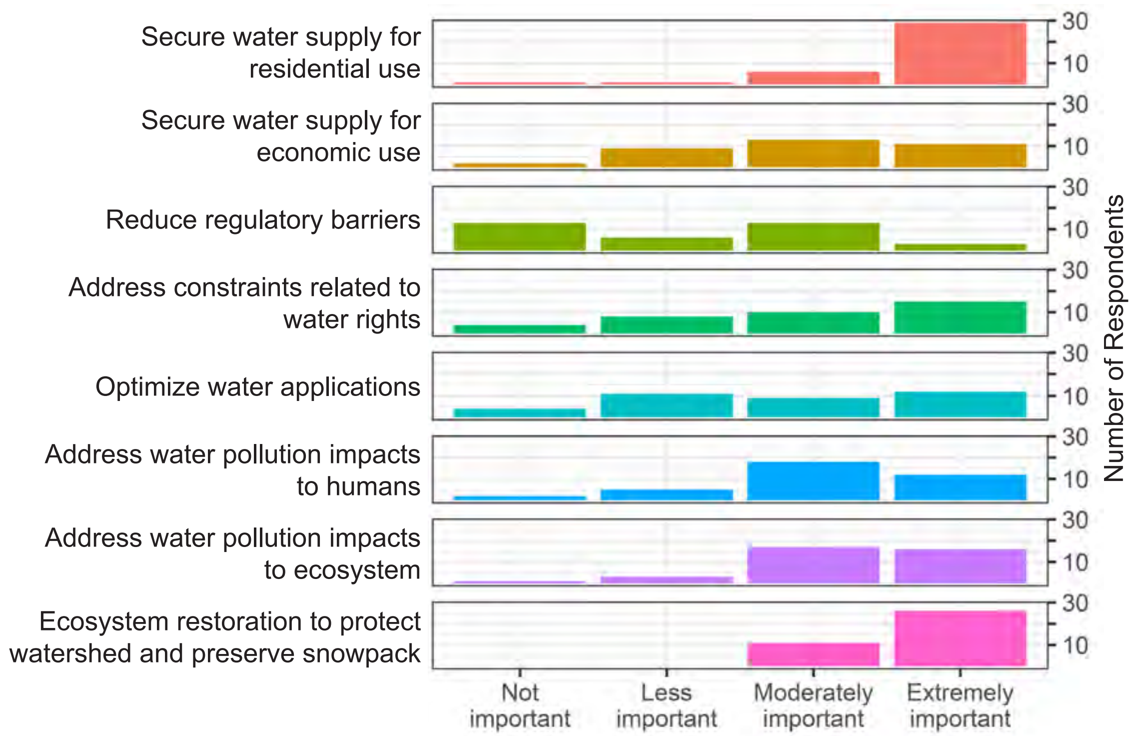


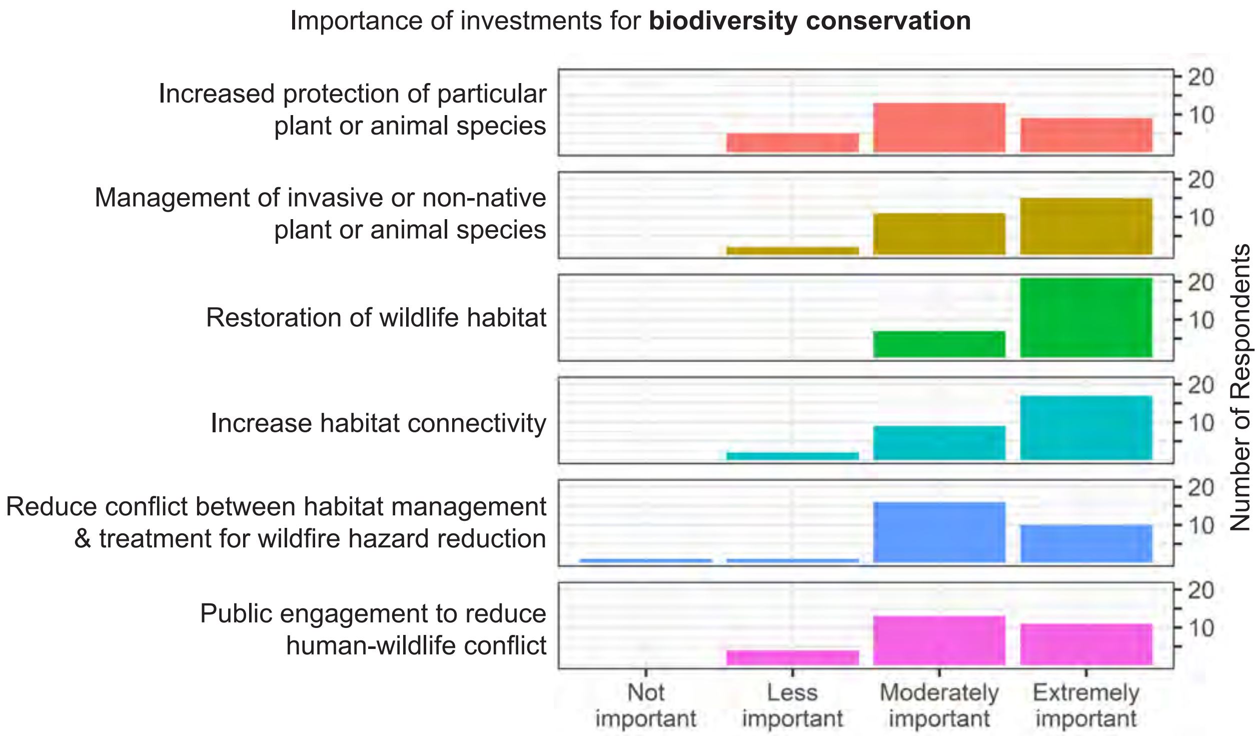


Importance of investments for **large and stable carbon stores**

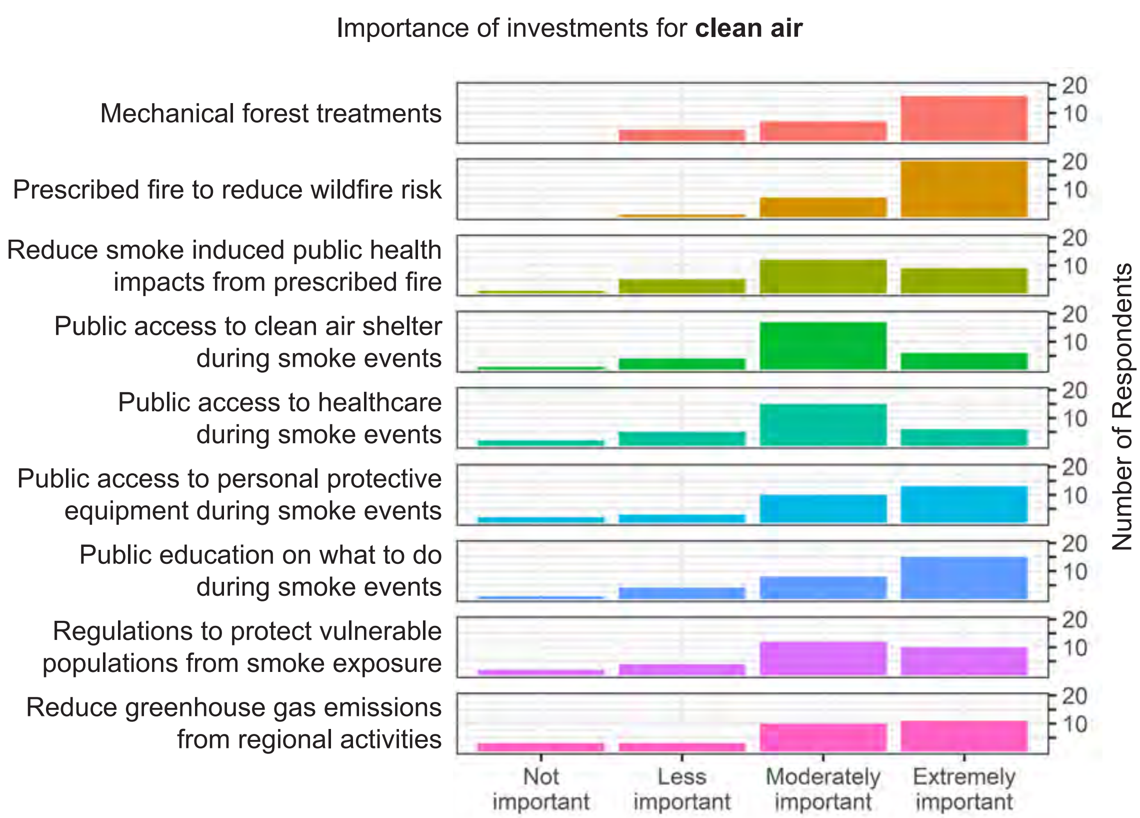


Importance of investments for **water security**

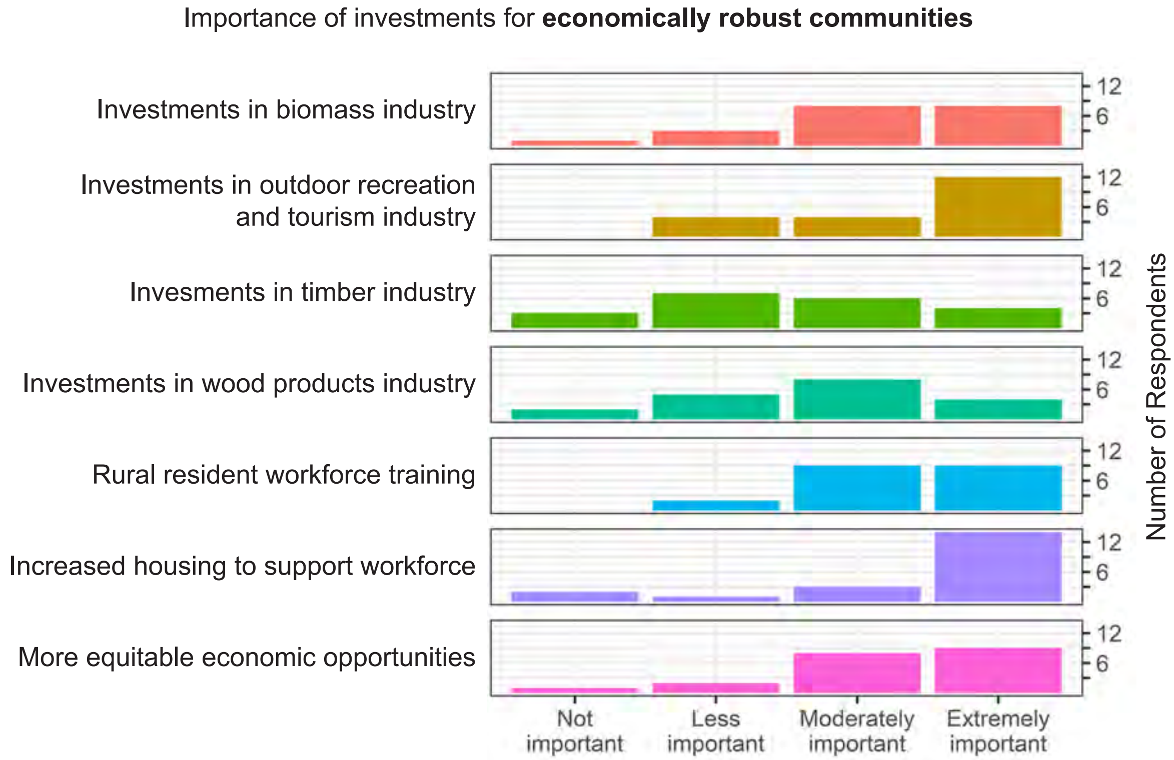


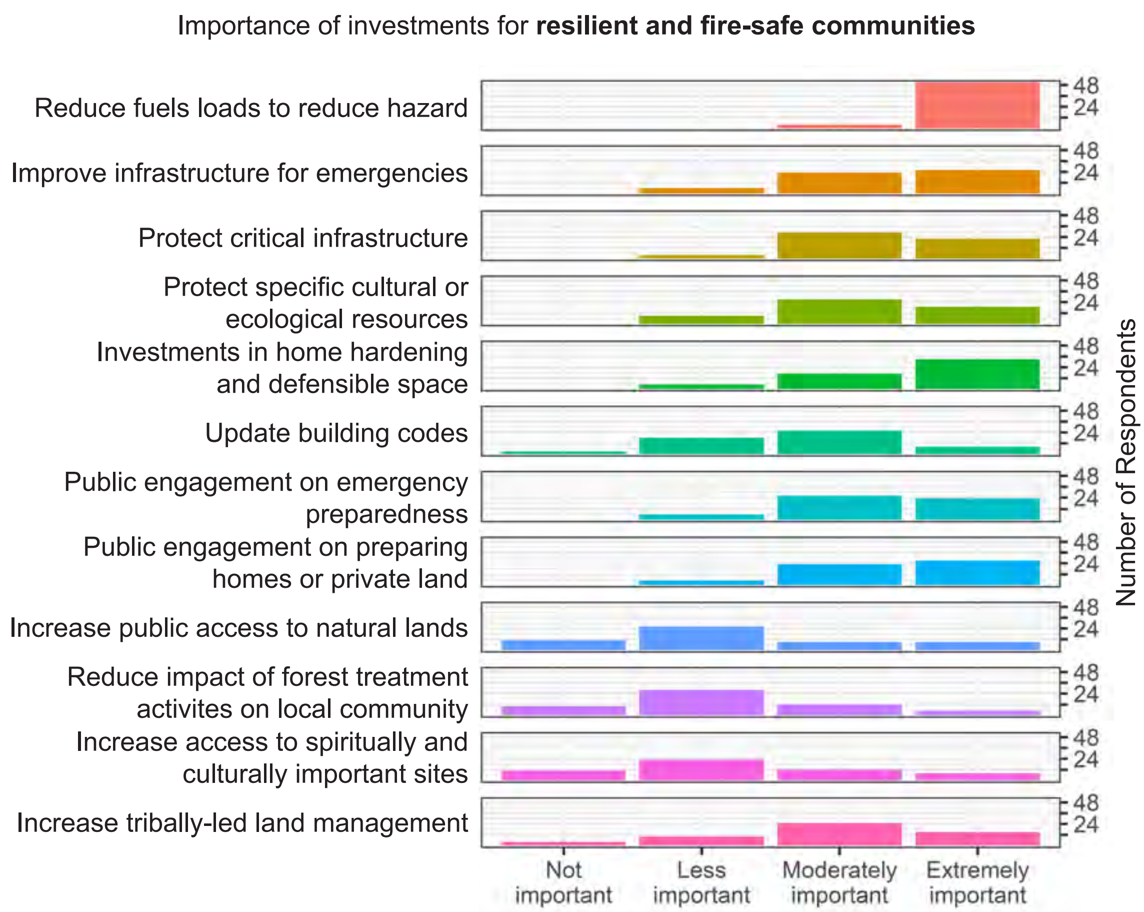


Importance of investments for **biodiversity conservation**
Increased protection of particular plant or animal species
Management of invasive or non-native plant or animal species
Restoration of wildlife habitat
Increase habitat connectivity
Reduce conflict between habitat management & treatment for wildfire hazard reduction
Public engagement to reduce human-wildlife conflict
Not important
Less important
Moderately important
Extremely important
Number of Respondents
10
20



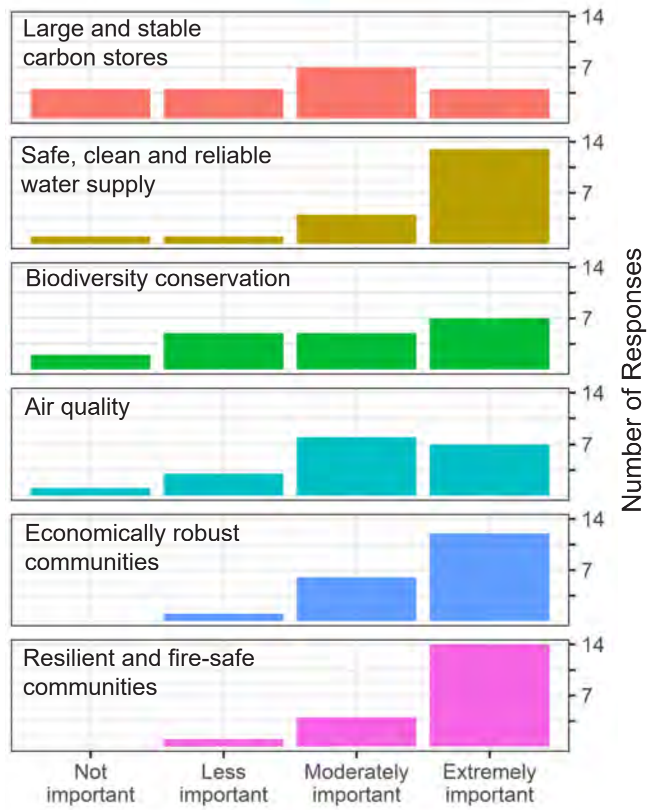
Importance of investments for **clean air**
Mechanical forest treatments
Prescribed fire to reduce wildfire risk
Reduce smoke induced public health impacts from prescribed fire
Public access to clean air shelter during smoke events
Public access to healthcare during smoke events
Public access to personal protective equipment during smoke events
Public education on what to do during smoke events
Regulations to protect vulnerable populations from smoke exposure
Reduce greenhouse gas emissions from regional activities
Not important
Less important
Moderately important
Extremely important
Number of Respondents
10
20


Importance of investments for economically robust communities
Investments in biomass industry
Investments in outdoor recreation and tourism industry
Invesments in timber industry
Investments in wood products industry
Rural resident workforce training
Increased housing to support workforce
More equitable economic opportunities
12
6
Number of Respondents
Not important
Less important
Moderately important
Extremely important

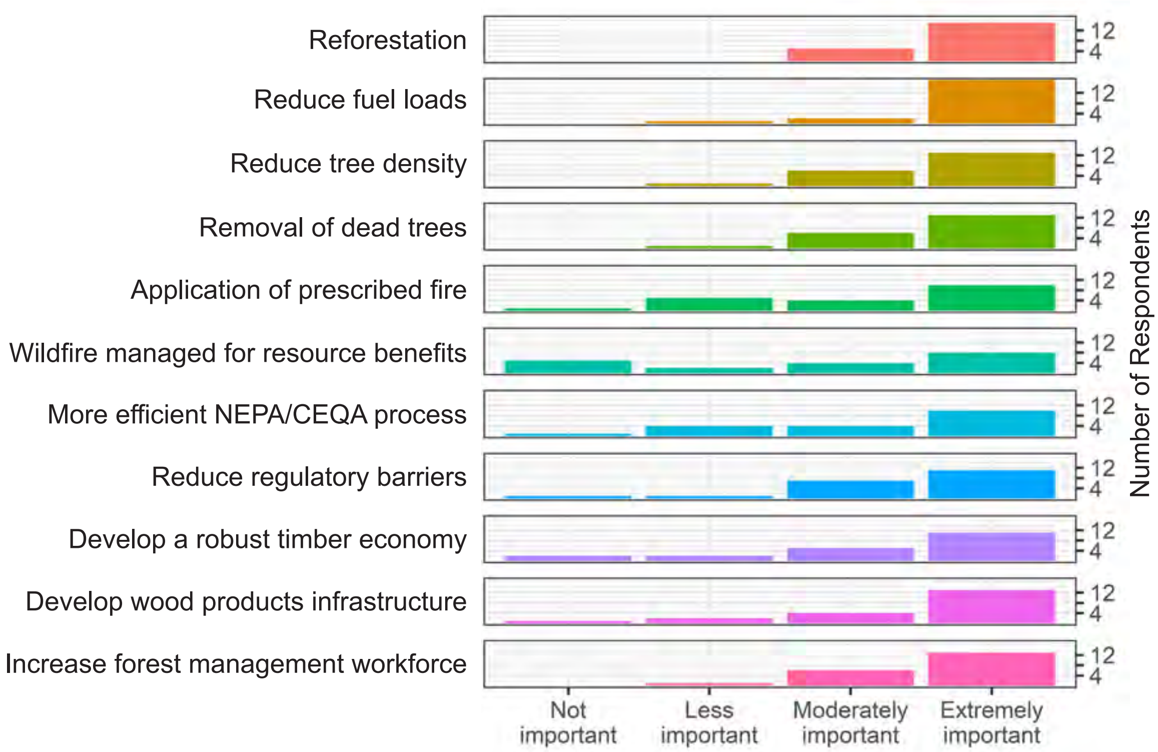

Importance of investments for resilient and fire-safe communities
Reduce fuels loads to reduce hazard
Improve infrastructure for emergencies
Protect critical infrastructure
Protect specific cultural or ecological resources
Investments in home hardening and defensible space
Update building codes
Public engagement on emergency preparedness
Public engagement on preparing homes or private land
Increase public access to natural lands
Reduce impact of forest treatment activites on local community
Increase access to spiritually and culturally important sites
Increase tribally-led land management
48
24
Number of Respondents
Not important
Less important
Moderately important
Extremely important

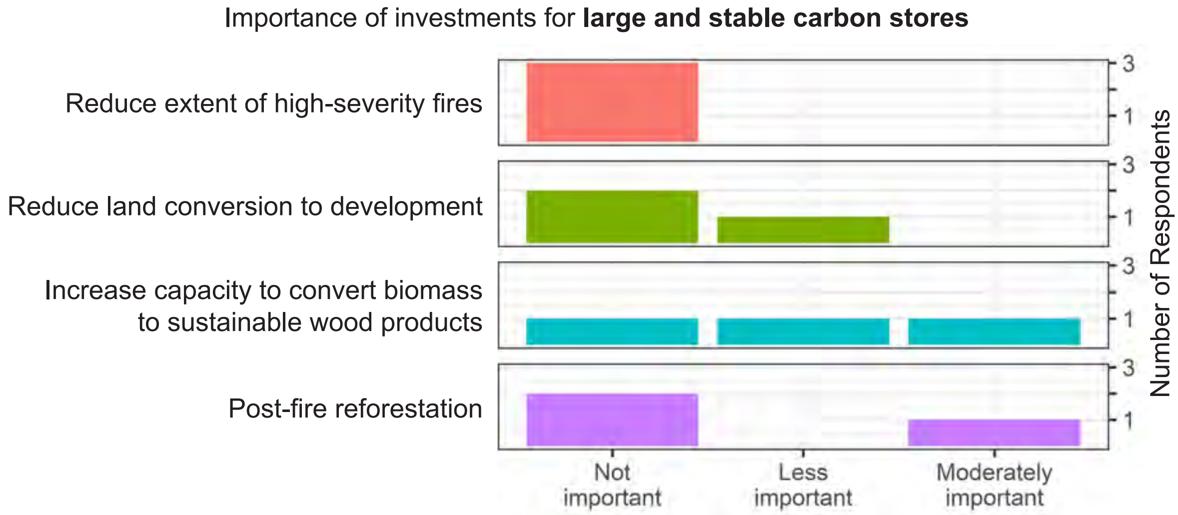
Sierra Nevada Survey Results
North East Subregion

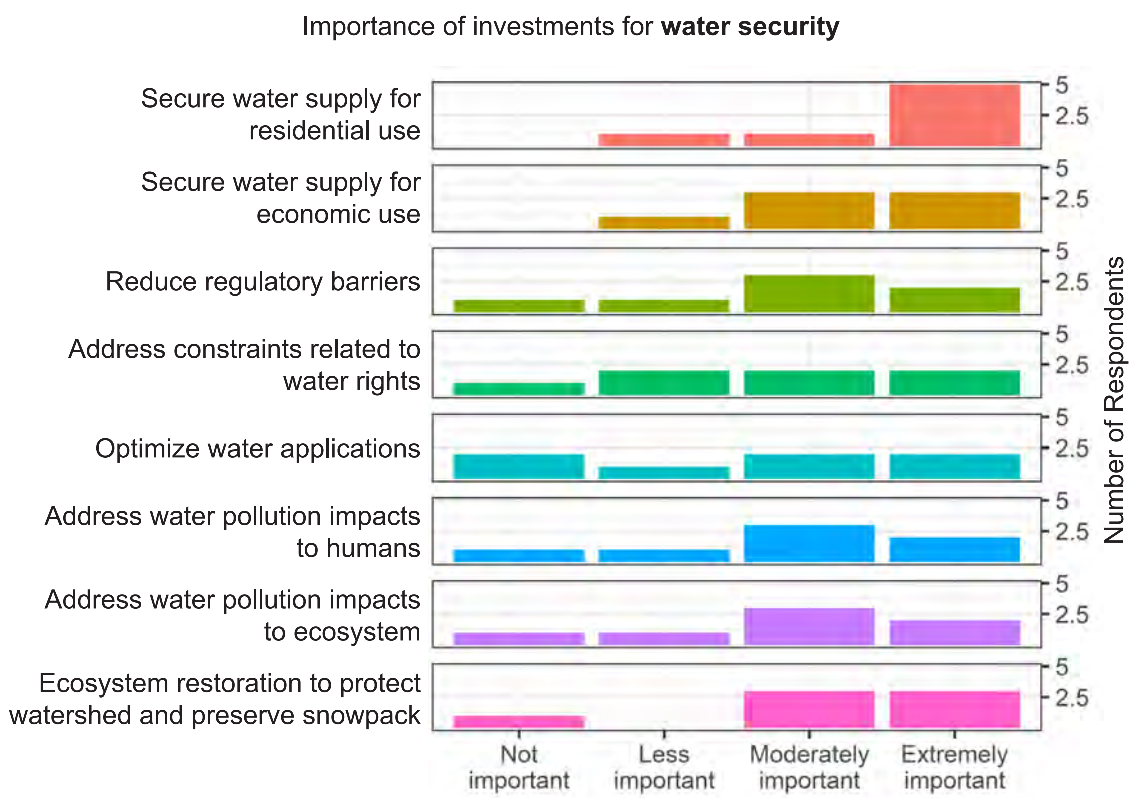
Stakeholder Input on Priority Areas of Invesment



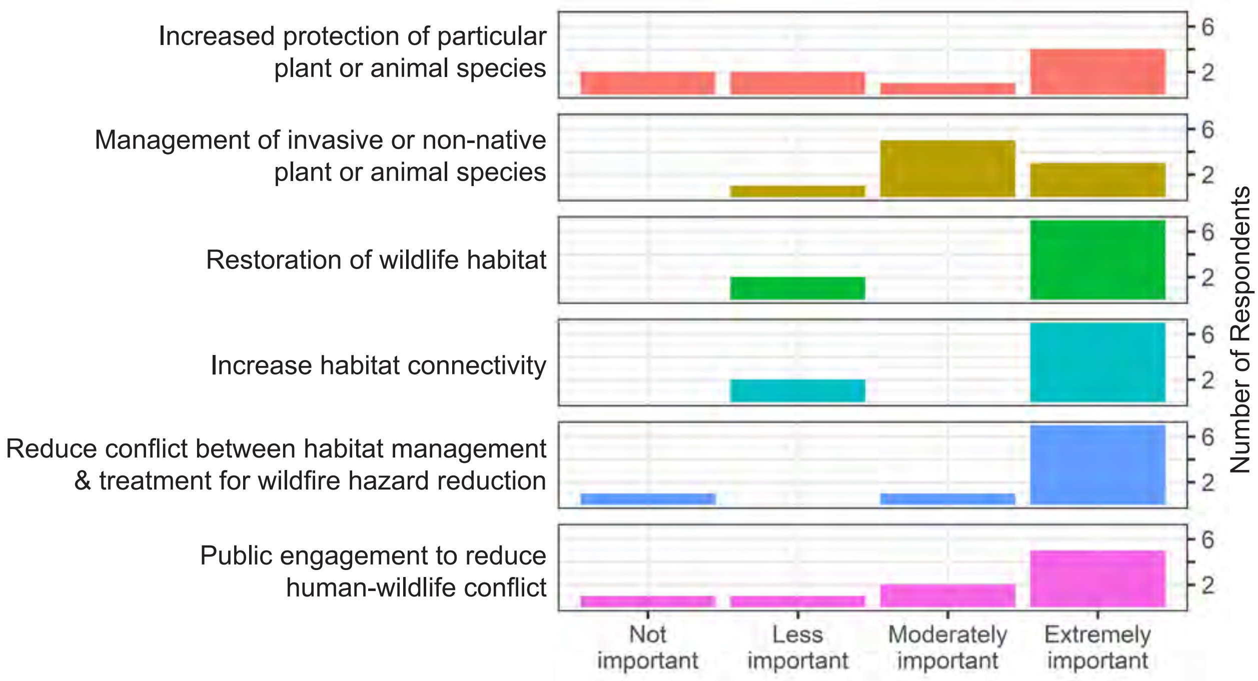
Importance of investments for **healthy and resilient forests**



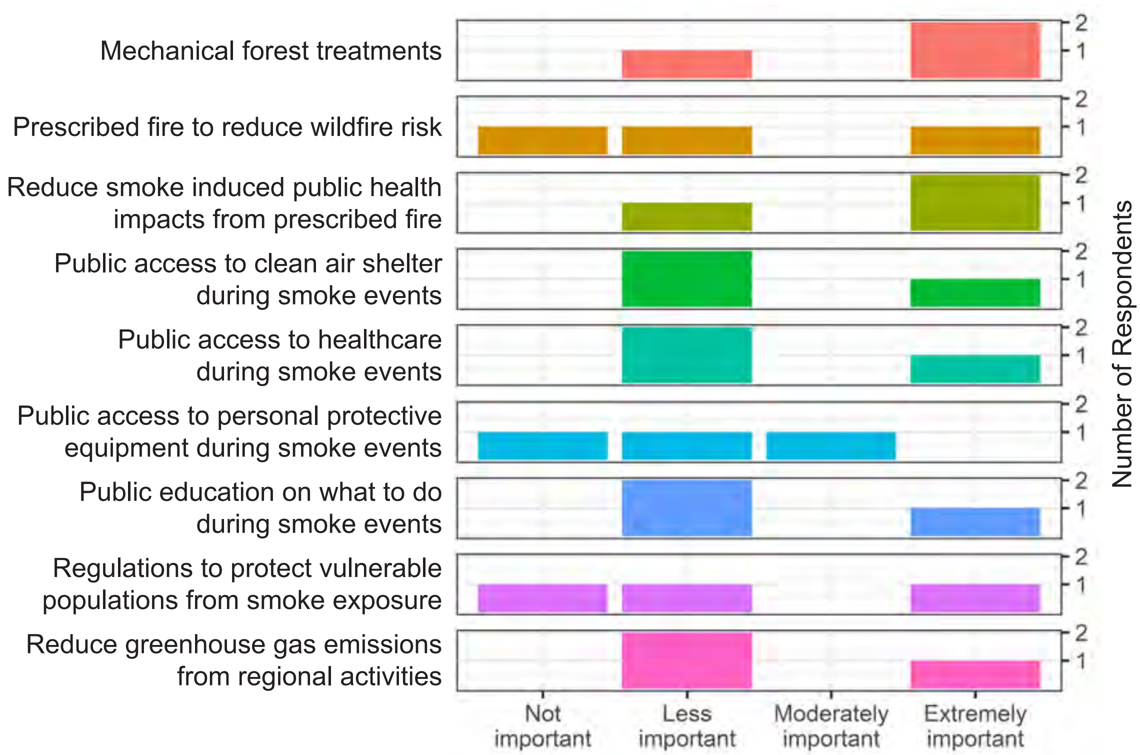

Importance of investments for **large and stable carbon stores**
Reduce extent of high-severity fires
Reduce land conversion to development
Increase capacity to convert biomass to sustainable wood products
Post-fire reforestation
Not important
Less important
Moderately important
Number of Respondents
3
1


Importance of investments for **water security**
Secure water supply for residential use
Secure water supply for economic use
Reduce regulatory barriers
Address constraints related to water rights
Optimize water applications
Address water pollution impacts to humans
Address water pollution impacts to ecosystem
Ecosystem restoration to protect watershed and preserve snowpack
Not important
Less important
Moderately important
Extremely important
Number of Respondents
5
2.5

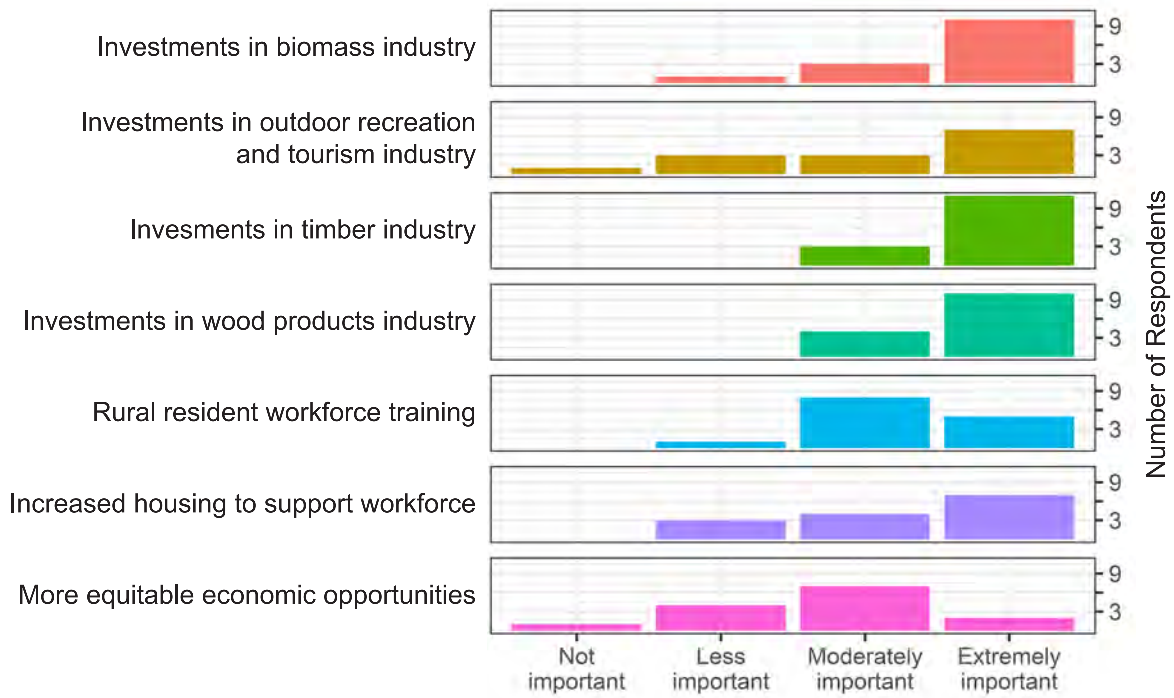
Importance of investments for **biodiversity conservation**



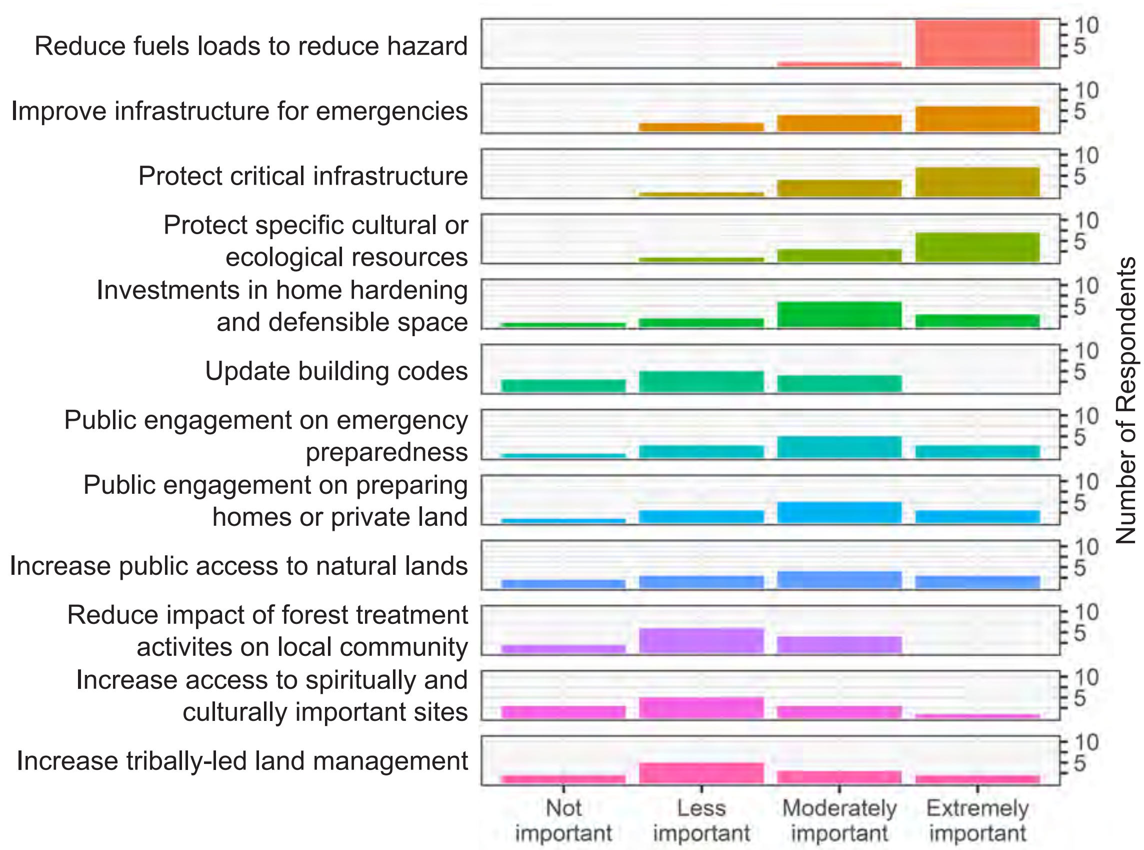
Importance of investments for **clean air**



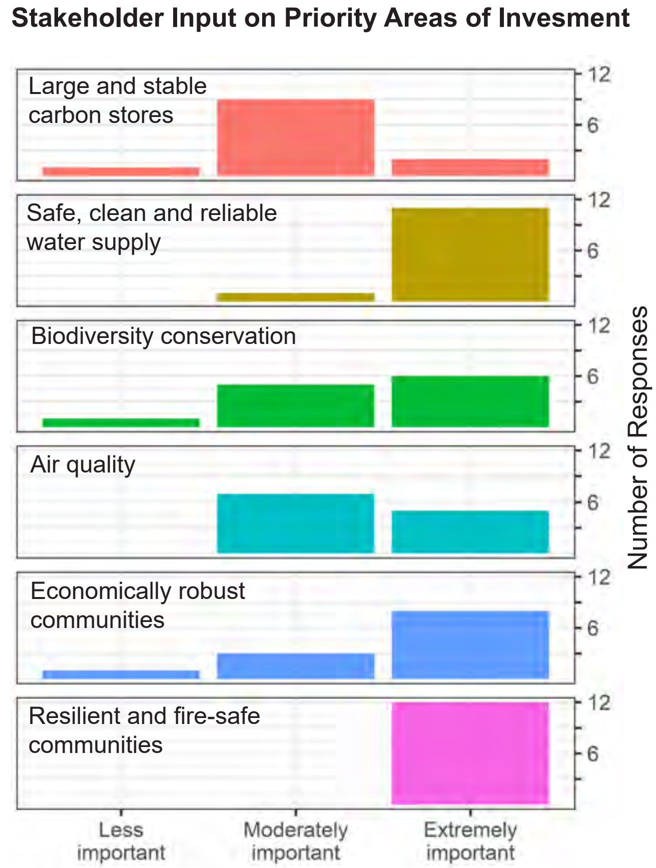
Importance of investments for **economically robust communities**

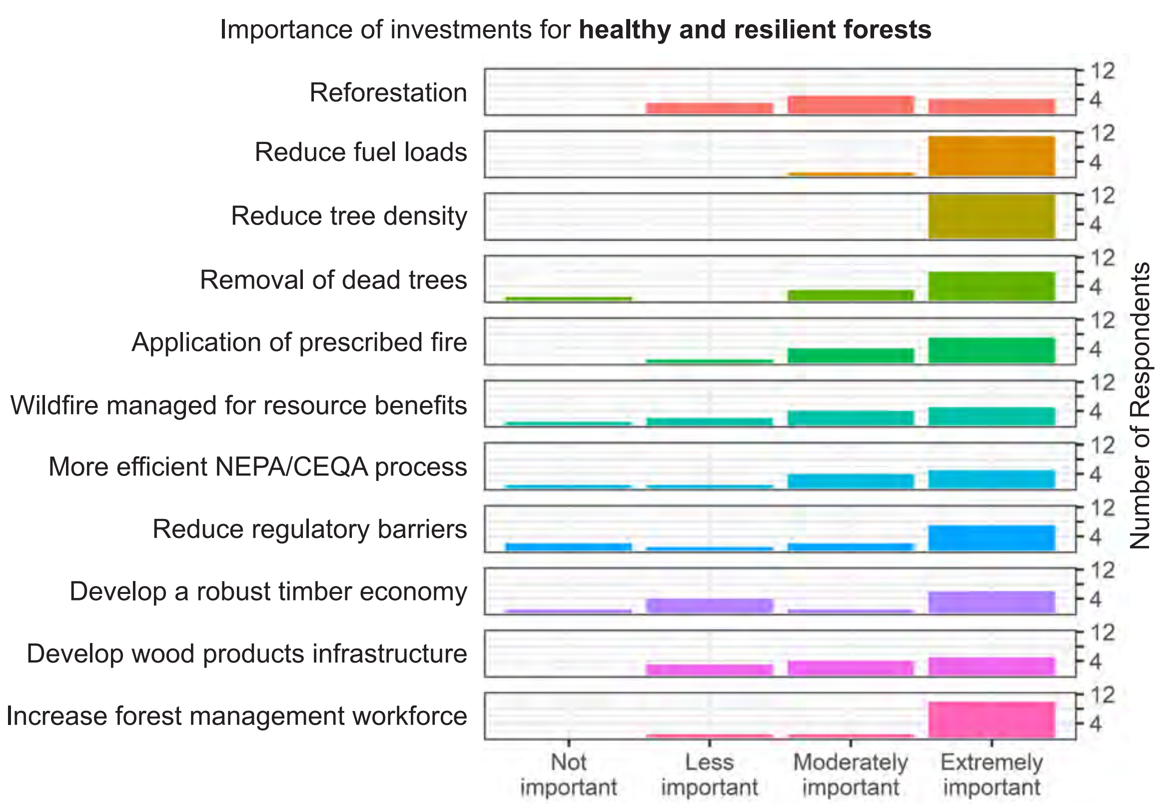


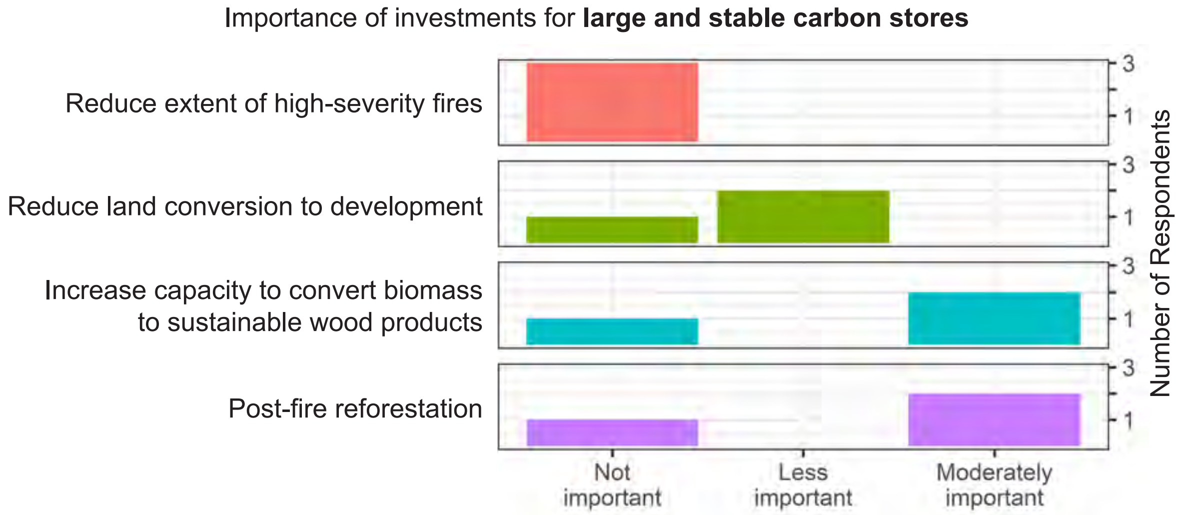
Importance of investments for **resilient and fire-safe communities**

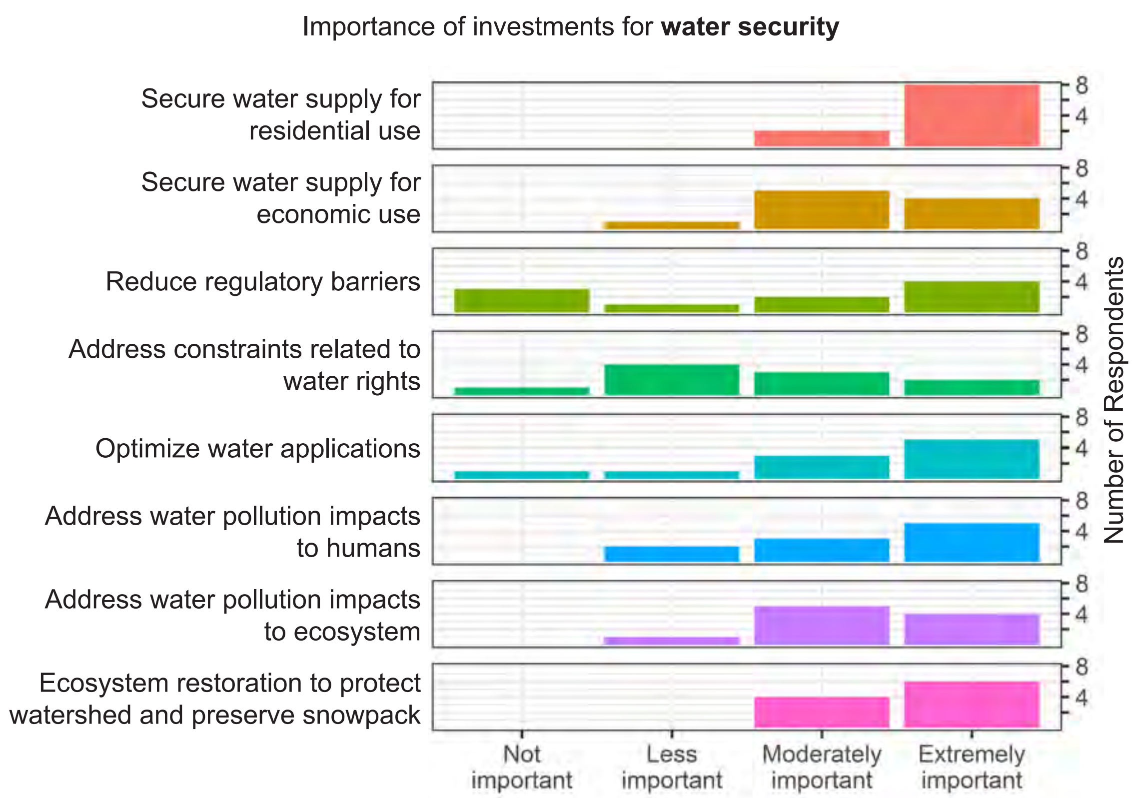


Sierra Nevada Survey Results
North West Subregion

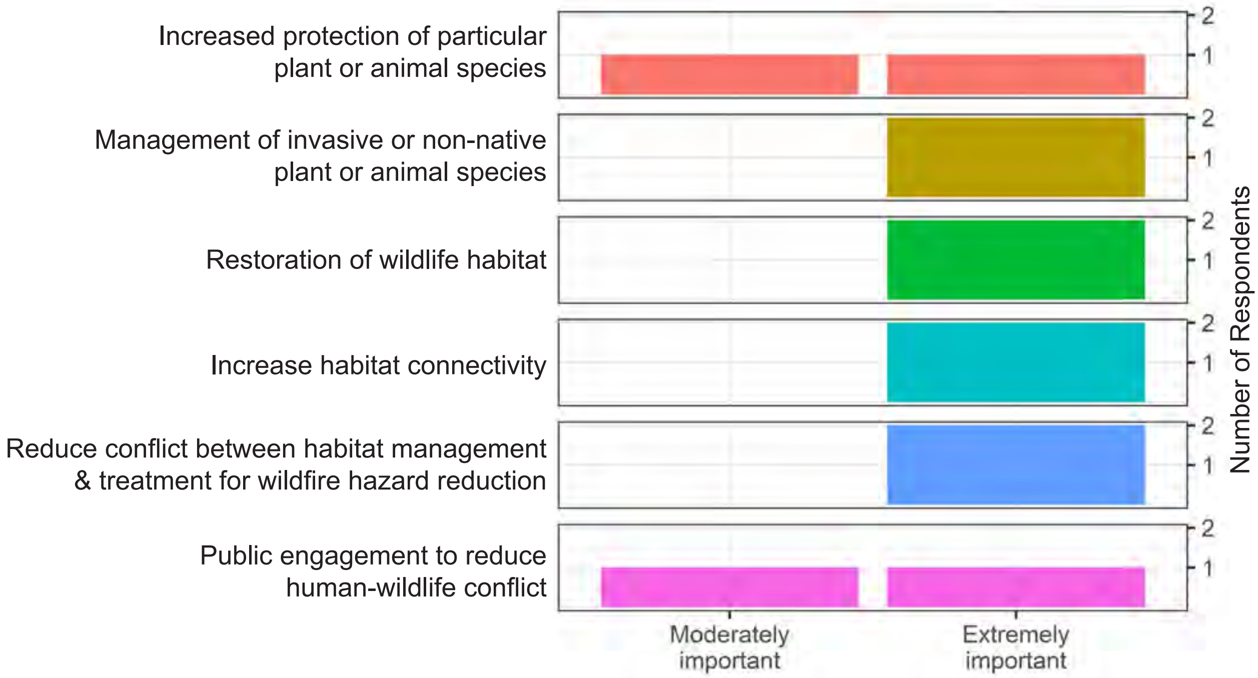




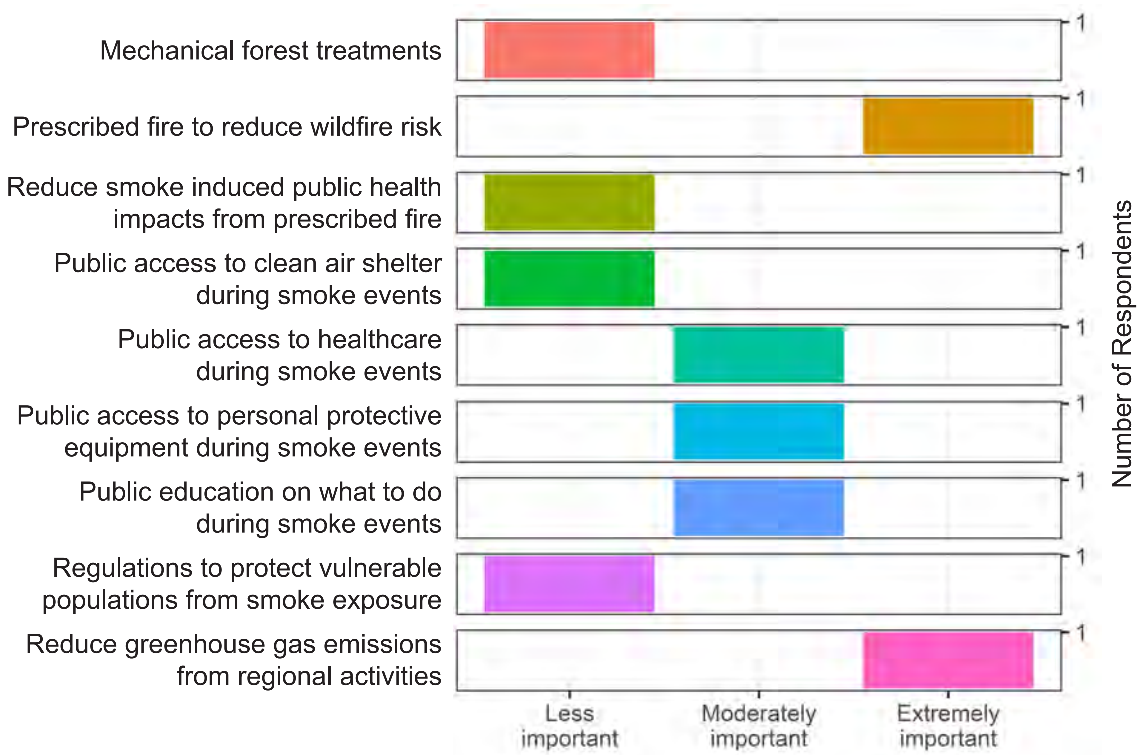

Importance of investments for **large and stable carbon stores**
Reduce extent of high-severity fires
Reduce land conversion to development
Increase capacity to convert biomass to sustainable wood products
Post-fire reforestation
Not important
Less important
Moderately important
Number of Respondents
1
3


Importance of investments for **water security**
Secure water supply for residential use
Secure water supply for economic use
Reduce regulatory barriers
Address constraints related to water rights
Optimize water applications
Address water pollution impacts to humans
Address water pollution impacts to ecosystem
Ecosystem restoration to protect watershed and preserve snowpack
Not important
Less important
Moderately important
Extremely important
Number of Respondents
4
8

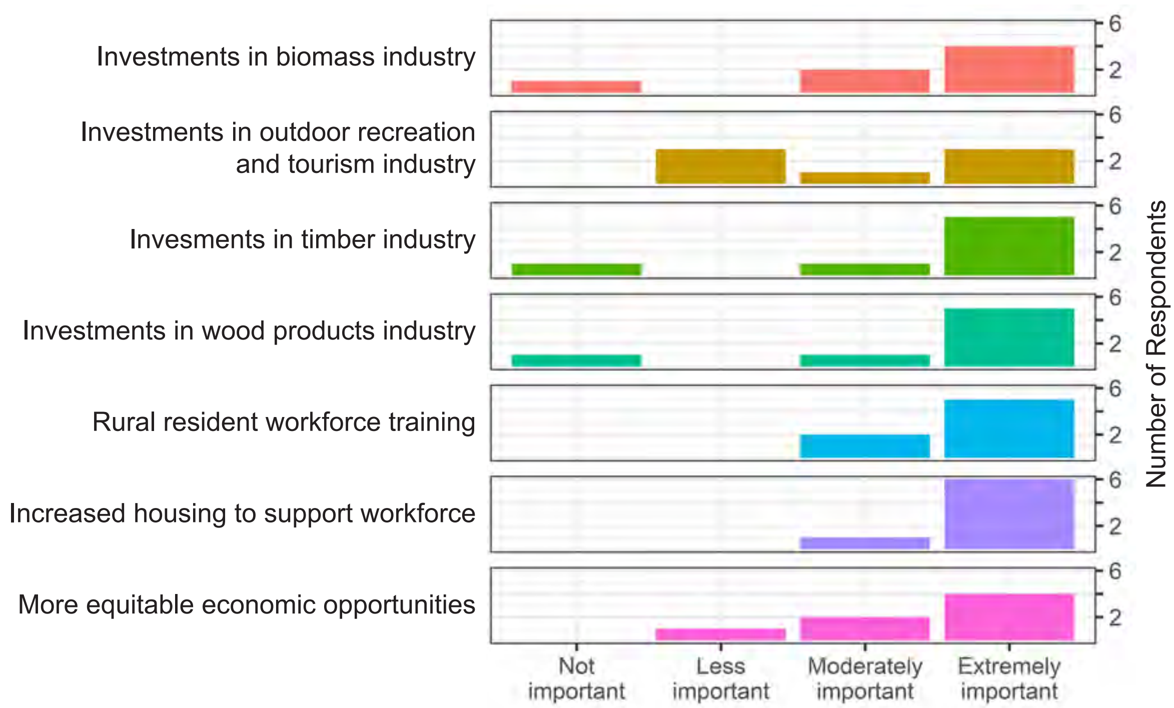
Importance of investments for **biodiversity conservation**



Importance of investments for **clean air**



Importance of investments for **economically robust communities**



Importance of investments for **resilient and fire-safe communities**