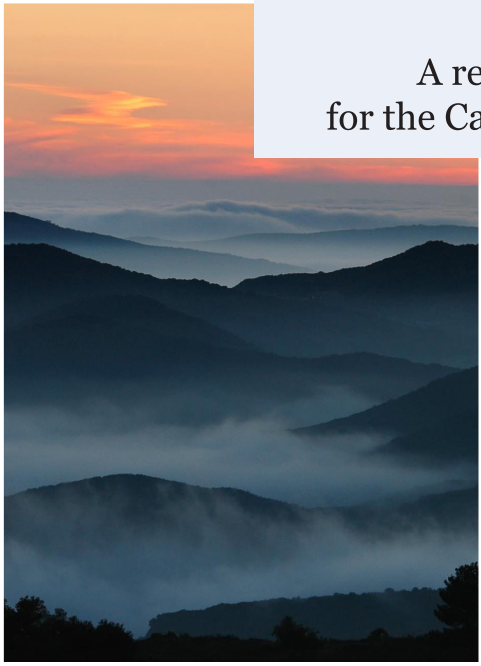
Southern California Regional Profile

February 2023

A report prepared by the Science Advisory Panel
for the California Wildfire and Forest Resilience Task Force



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California Wildfire and Forest Resilience Task Force's Science Advisory Panel
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Note: this updated version of the report was released in August 2023 to correct an error in survey data.

Cover photos:

Top: Antelope Valley California Poppy Reserve in northern Los Angeles county; Bruce Fingerhood. *Left:* Santa Monica Mountains National Recreation Area; National Park Service. *Center:* Montane forest in San Bernardino National Forest; Sergei Gussev. *Right:* Nonbreeding male Coastal California Gnatchatcher; U.S. Forest Service. *Bottom:* San Gorgonio Wilderness in eastern San Bernardino Mountains; Bureau of Land Management.

Contents

Southern California Regional Profile

The State of California, U.S. Forest Service, and regional partners are collaborating to respond to the wildfire and climate crises that have significantly impacted, and are projected to continue to impact, California's natural and human communities. The primary goal of this response is to identify the scale and types of management needed by 2025 to meet these interrelated crises and restore resilience to California's diverse ecosystems. The expected outcomes are 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 plan and implement socially acceptable land management activities at ecologically meaningful scales. This will require state, federal, regional and local partners working across jurisdictional boundaries to develop regional plans integrated with federal and state priorities as well as local objectives, projects and strategies. Regional Profiles, such as this report, have been developed as one of the resources to assist with this effort.

The Science Advisory Panel of the California Wildfire and Forest Resilience Task Force (WFRTF) developed the Regional Profile series in order to provide insight, both social and ecological, for community and ecosystem resilience to wildfire in each of the state's four diverse regions (see Fig. 1). The content of each Regional Profile is informed by the best available scientific information, as well as the experience and perspectives of diverse stakeholders from the region. Each Regional Profile also showcases products of the Regional Resource Kit (RRK), which provides publicly-available data and metrics for assessing current conditions of landscape resources. The RRK can be used for planning and prioritizing projects to achieve socio-ecological resilience. The RRK is another resource being developed for the WFRTF by an interagency collaboration to support state and regional planning efforts.

Figure 1. Boundaries of the four state regions, as delineated by the Task Force, and the boundaries of the eight counties within the Southern California region.

The Regional Profile and RRK build upon the Pillars of Resilience Framework, which resulted from a collaborative stakeholder process organized through the Tahoe-Central Sierra Initiative. 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 regionally-specific needs.

Actions that benefit one or more pillars may result in tradeoffs that impact other pillars. For example, fuel treatments that reduce wildfire hazard to communities ("Resilient and fire-safe communities") may negatively impact wildlife habitat ("Biodiversity conservation"). Additionally, management needs and priorities 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. Each Regional Profile includes stakeholder input 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 the primary county where they live or work (Fig. 1).

For the purposes of the Regional Profile stakeholder survey, we modified the ten Pillars of Resilience to eight categories: Healthy and resilient shrublands, Healthy and resilient forests, Resilient and fire-safe communities, Air quality, Water security, Biodiversity conservation, Carbon storage, and Economically robust communities (Fig. 2). The following sections provide a Southern California-specific overview of how each of these eight 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 159 survey responses and the 27 interviews, and, finally, example assessments of current resource conditions. Our intention is to provide foundational background information for the Southern California region; share findings that summarize stakeholder perspectives on the region's key issues; and describe select metrics being used to assess each pillar, 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.

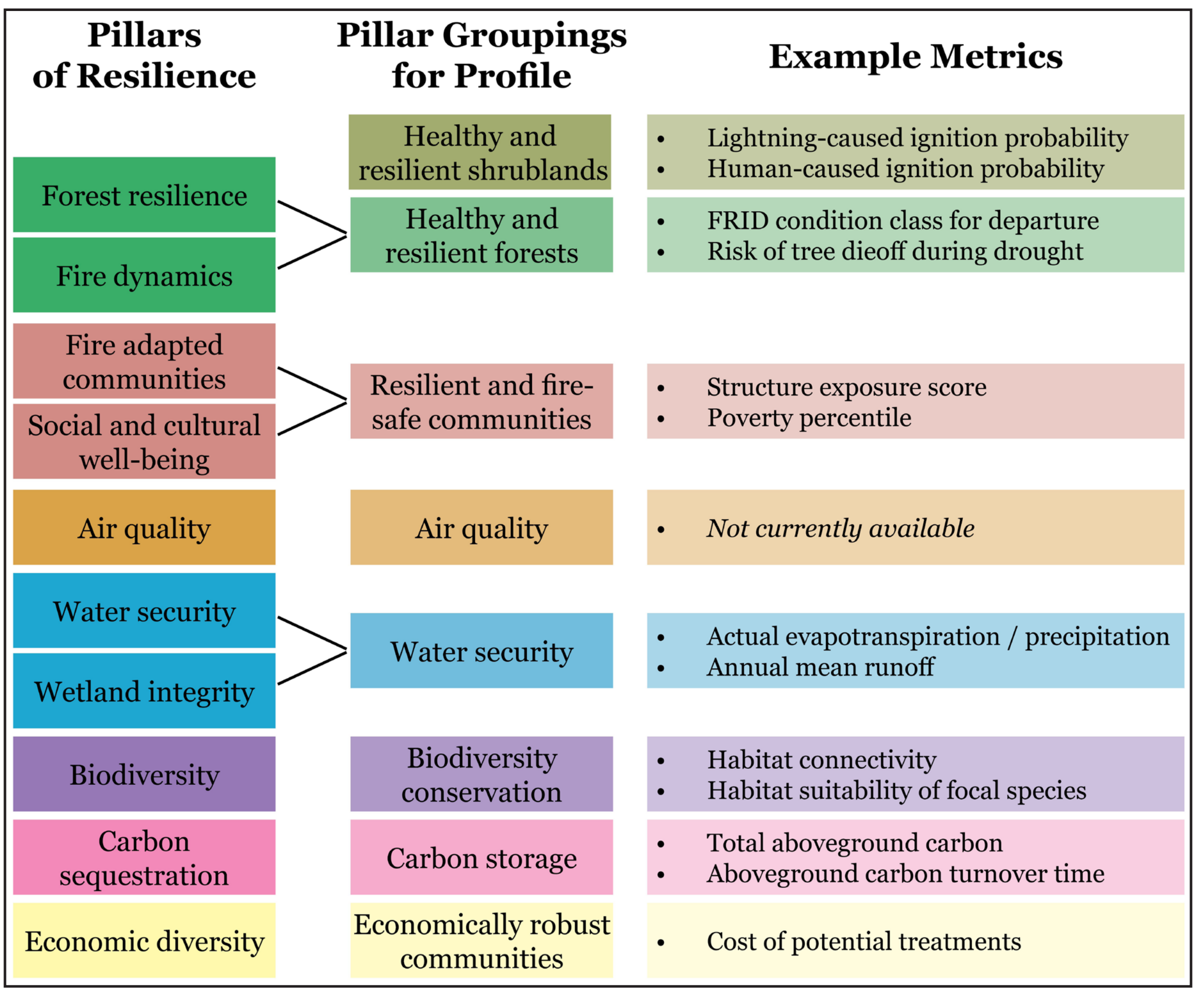

Figure 2. The original ten pillars of resilience were modified into eight pillar groupings to gather stakeholder input via surveys and interviews. These eight groupings form the organizational basis for this document. Each pillar includes metrics for assessing current resource conditions. The metrics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

The Southern California Region

The Southern California Region includes 8 counties: Los Angeles, Imperial, Orange, Riverside, San Bernardino, San Diego, Santa Barbara, and Ventura. It is home to over 25 million people, which is nearly 2/3 the population of California. The region is also notable for its ecological diversity, with habitat types ranging from shrublands on the coast to "sky island" forests on mountaintops to the Mojave Desert in the interior. Each habitat type requires different land management strategies to be resilient to climate change and other threats.

Like most of the state, Southern California has a Mediterranean climate, including hot-dry summers and cool-moist winters. However, this region has the highest year-to-year variability in annual precipitation of anywhere in the continental United States. This variability is expected to increase under climate change. Droughts are projected to become more frequent and intense, while extreme precipitation events also intensify. The recent atmospheric-river storms that closed 2022, one of California's driest years on record, with flooding and mudslides is a poignant example of these extremes.

Climate change also impacts wildfire resilience. Warmer and drier landscapes are at greater risk to wildfire, especially when ignitions occur during dry windy weather. The largest, and most catastrophic, wildfires in the Southern California region typically occur during the Santa Ana wind season. Santa Ana winds are a unique climatic feature of the Southern California region which occur during October to April, peaking in frequency and severity December to January. The winds originate from high-pressure regions over the Great Basin and Mojave Desert, and they blow gusts of hot, dry air to the Southern California coast. Wildfire ignitions that would normally be suppressed relatively easily can quickly grow out of control during high wind events. The longer dry season forecast under climate change makes it more likely that intense Santa Ana Wind events will occur before winter rains occur and when vegetation is still highly flammable.

Ignitions in Southern California are another critical component to the region's wildfire resilience. While California's natural fire regime is driven by lightning strikes, lightning events and Santa Ana winds rarely coincide seasonally. Instead, a recent study found that 100% of the fires that occurred during Santa Ana wind events from 1948-2018 were ignited by human activities. Primary ignition sources include powerline failures, arson, vehicles, campfires, and motorized equipment such as power tools. The 2017 Thomas Fire that burned more than 281,00 acres in Ventura

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.

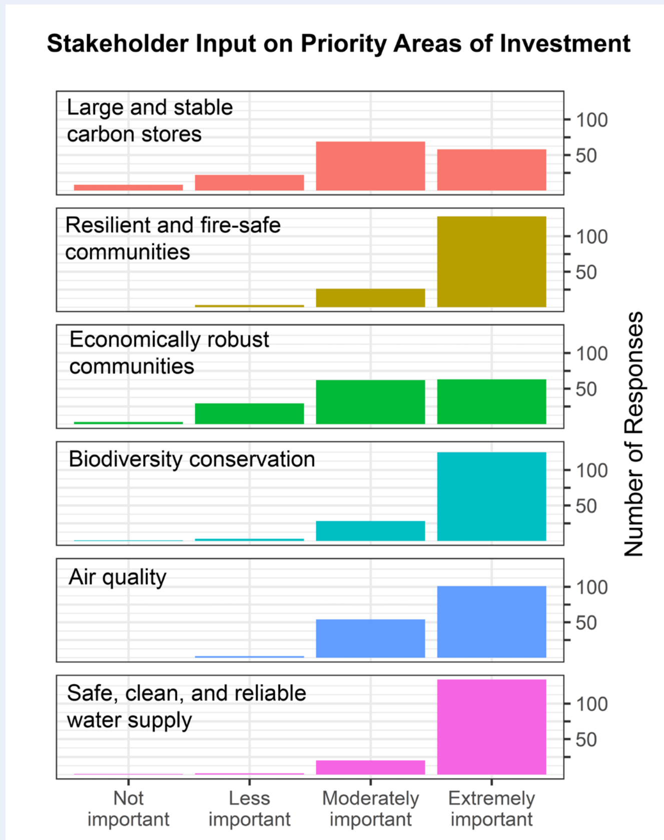

Figure 3. Southern California stakeholders provided input on the importance of investment across six pillar categories beyond 'Healthy and resilient forests' and 'Healthy and resilient shrublands.' 'Resilient and fire-safe communities,' 'Safe, clean, and reliable water supply' and 'Biodiversity conservation' 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.

and Santa Barbara Counties is believed to have been ignited by intense Santa Ana winds, which caused power lines to come into contact with each other, creating sparks. At the time, the Thomas Fire was the largest wildfire to have occurred in modern California history and remains one of the most costly, causing over $2.2 billion in damages and $230 million in suppression costs. High-intensity rain following the Thomas Fire compounded the damage by causing devastating debris flows to the town of Montecito.

Although the compounding danger of wildfire and climate change is daunting, one key strategy to addressing the threat in Southern California is reducing the number of wildfires that start. Ignitions – and consequently, area burned by wildfire – have primarily increased in Southern California as a result of population growth and increased development near wildland areas. 75% of buildings destroyed by wildfire in California are located in the wildland-urban interface.

In addition to reducing ignitions, there are a variety of strategies to increase resilience to wildfire that offer multiple co-benefits. Action can be taken at state, regional, community, and even household levels. However, many of these actions have tradeoffs. Understanding the costs and benefits associated with different actions can enable land managers and decision-makers to better reconcile these tradeoffs and achieve multiple goals across the region.

Healthy and Resilient Shrublands

Shrublands cover 31 percent of California, totaling roughly 33 million acres, and the largest and most contiguous patches of shrublands are found in the Southern California region. Wildfires in the Southern California region occur primarily in shrublands, because human presence is concentrated along low-elevation coastal areas where this is the dominant ecosystem. Even in Southern California's four national forests (the Angeles, Cleveland, Los Padres, and San Bernardino) 70% of the vegetation cover is chaparral; chaparral does not refer to a single plant but rather to a species-rich shrubland plant community. Another closely associated plant community is coastal sage scrub, which is considered one of the most endangered ecosystems in the United States. Whereas chaparral is dominated by woody evergreen shrub species, coastal sage scrub is dominated by semi-woody and semi-deciduous shrub species. Both ecosystems are highly adapted to drought. Both ecosystems are also adapted to fire, but currently fire in these ecosystems is occurring more frequently than these ecosystems are adapted for.

Since early Euro-American settlement of the region, there has been a misconception that chaparral represents degraded forest, leading to a lack of appreciation for its value as a native ecosystem. More recently, the inclusion of traditional ecological knowledge and additional research on these ecosystems have increased awareness of the important ecosystem services that chaparral provides and clarified misunderstandings about its natural history. Healthy chaparral communities provide numerous ecosystem services including reducing soil erosion, providing critical habitat for hundreds of rare and endangered species, and sequestering carbon into woody biomass. However, even as the value of chaparral is better understood, the ecosystem is increasingly imperiled.

Major threats to both chaparral and coastal sage scrub include past patterns of urban development, too frequent fire, increasing drought associated with climate change, invasion of non-native grasses, air

Southern California shrubland ecosystems include diverse plant communities. Two notable habitat types are mixed chaparral (shown top) and coastal sage scrub (bottom). Photo credit: California Chaparral Institute

Stakeholder Input

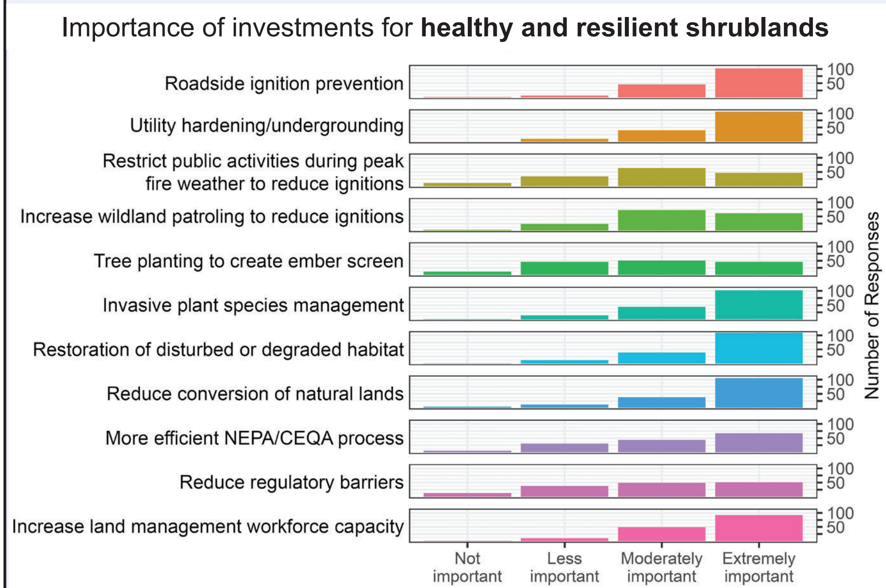

Figure 4. Survey respondents were asked how important the following potential areas of investment are for achieving healthy and resilient shrublands in their subregion. Top priority areas for investment (listed in order of mean rating) were utility hardening/undergrounding, restoring disturbed/degraded habitat, roadside ignition prevention, reducing natural land conversion to development, invasive plant species management, and increasing land management workforce capacity. Potential areas of investment that received a lower mean response than other options were tree planting to create ember screen, reducing regulatory barriers, and restricting public activities during peak fire weather to reduce ignitions.

Interview findings: When asked what the key issues were to achieving ecological resilience in shrubland ecosystems, there was widespread consensus among interviewees that preventing human-caused ignitions is key. Many interviewees also perceived that there was a lot of misunderstanding about how to treat shrubland ecosystems. Some interviewees related this to a long-standing lack of appreciation for the intrinsic value of shrubland ecosystems and the ecosystem services, such as carbon storage and habitat, that they provide. A major issue stemming from this misunderstanding is the misapplication of treatments that are recommended for managing forest ecosystems to shrublands. Applying prescribed fire, a treatment which can improve ecological resilience in forests, was considered to be especially detrimental to shrublands which are already unable to recover from too frequent fire. Many interviewees noted that some treatments, such as fuel breaks, which do not benefit the ecological health of shrublands are still important for clearing defensible space around human communities and should be applied strategically. Some interviewees observed that there has recently been more effort to introduce an ecological perspective into managing shrublands in the wildland-urban interface, such as focusing on thinning flammable plants and reducing ladder fuels instead of clearing all vegetation.

pollution, and unmanaged recreation. Unfortunately, many of these threats can interact and compound one another. For example, increased human-caused ignitions have severely increased the frequency of fire in shrubland ecosystems while drought-stress and encroachment of flammable annual grasses increase the risk of fire spreading and impair ecological recovery.

Prior to Euro-American settlement, most chaparral ecosystems experienced fire every 30 to 130 years. These fires were primarily set by ancestral land managers, not lightning. Today, due primarily to human-caused ignitions, many areas of Southern California are experiencing fire return intervals of 20 years or less. Multiple, short fire-return intervals of less than 15 years reduce the capacity of chaparral species to regenerate. Shrub species that regenerate exclusively from dormant, underground seed banks are especially susceptible because they do not have time for seedlings to grow to maturity and produce new seed stocks before the next fire occurs. Shrub species that have the ability to resprout, rather than relying on seed banks, generally have a high fire survival rate, but the resprouting process makes these species more vulnerable to water stress. Thus, these resprouting plants may survive fire only to later experience high mortality due to drought or to be outcompeted by invasive grasses that are better adapted to dry conditions and frequent disturbance. This is causing increasing vegetation type conversion from chaparral to nonnative annual grasslands. Furthermore, because grasses can be more flammable than woody fuels like chaparral, this conversion can lead to a positive feedback cycle of increasing fire ignitions and decreasing native shrub species.

Management of chaparral ecosystems has been controversial because many of the management actions that have been recommended for returning forest ecosystems to historic conditions and increasing wildfire resilience are detrimental or less effective when applied to shrublands. Whereas fuel treatments, including both mechanical treatments and prescribed burning, can increase forest ecosystem health, applying similar treatments in chaparral is generally harmful to the local ecosystem. However, management actions that may impair ecological resilience on the treatment site (e.g., strategic fuel breaks), may increase the ecological resilience of the larger landscape by reducing the risk of fire entering the neighboring undisturbed areas and human communities.

Implementing fuel breaks can provide critical access corridors for firefighters to reduce fire spread. However, both fuel breaks and fuel treatments are less effective against fires that occur during Santa Ana wind events when embers are carried over distances much greater than fuel breaks and land in dry vegetation. Also, fuel breaks can paradoxically increase wildfire hazard by facilitating off-road vehicle trespass, which is associated with increased human-caused ignitions, and increasing the invasion of flammable nonnative grasses in areas that were previously dominated by dense chaparral. Strategically placed and maintained fuel breaks, such as alongside communities, can nevertheless effectively reduce hazard from fires that are not driven by extreme weather events, reduce the risk that ignitions that start near communities become a wildland fire, and increase the safety of firefighters. Management actions that increase the ecological resilience of native chaparral can also reduce wildfire risk. Disturbed and degraded habitat that may exist along roadsides, unmaintained fuel breaks, and disused roads, create places for flammable non-native grasses to thrive and increase ignition risks. Restoring these areas with native plants or, where restoration is not possible, with less flammable surfaces (e.g., weed mats, decomposed granite, and concrete canvas) can restrict illegal access, increase fire resilience, and protect or improve ecosystem health. Additional ignition reduction actions include underground burial of power lines, restricting off-highway vehicle access, and building physical barriers along roads to prevent car sparks from igniting roadside vegetation. Other key actions that are being undertaken to help restore shrublands include reducing invasive plant species, planting native species, and protecting natural lands from development.

Current Conditions

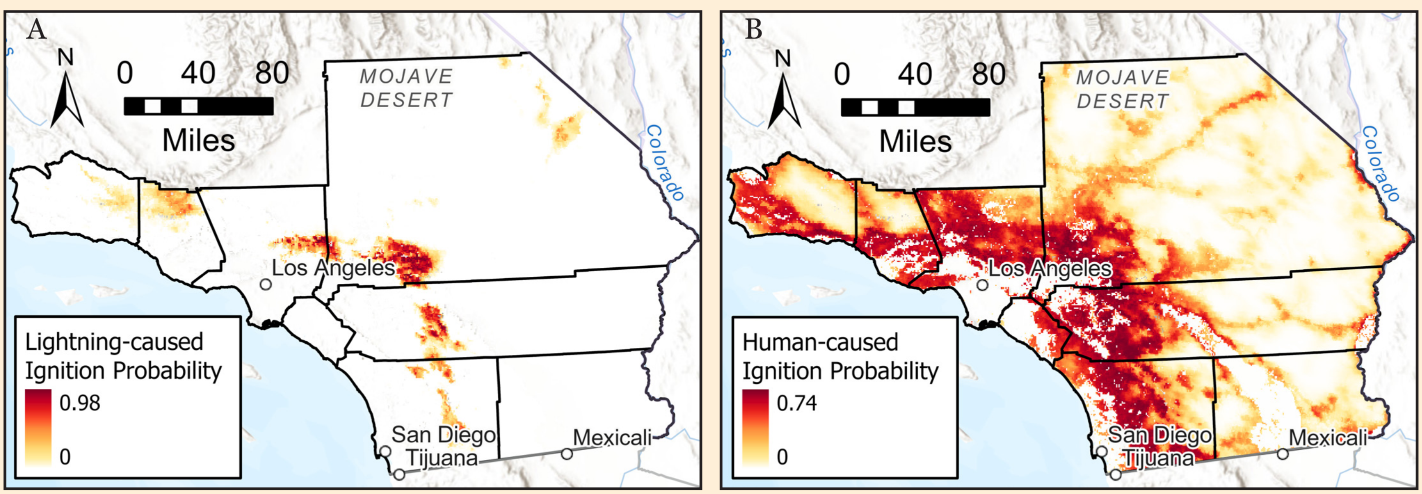

Figure 5. Shrublands are currently experiencing shorter fire return intervals due to increased human ignitions, and this is impacting the ability of shrublands to recover following fire. Understanding spatial patterns in ignition probability is important for assessing fire risk and prioritizing treatments across the region. The Regional Resource Kit ignition probability metrics reference a model that used recent (1992-2015) ignition records and environmental data, including human settlement, climate, fuels, and topographical variables, to predict lightning-caused (A) and human-caused ignition probability (B). In Southern California, wildfires ignited by lightning are most likely to occur in a relatively small geographic footprint, which aligns with montane forest landscapes. In contrast, human-caused ignitions are highly probable at lower-elevations nearby populated areas and along roads.

The San Bernadino National Forest has the tallest alpines mountains in Southern California and is one place where "sky islands" of montane forest habitat can be found at high-elevation. Photo credit: Sergei Gussev

Healthy and Resilient Forests

Although forested lands cover a smaller area of the Southern California region than in other parts of the state, forests provide vital ecosystem services, including protecting key watersheds, sequestering carbon and offering recreational opportunities. Similar to other parts of the state, forests and woodlands in the region are threatened by climate change, invasive species, development of natural lands, and increasingly large and severe wildfires. Threats and management priorities vary by forest type.

Montane forests

Montane forests in Southern California mostly occur within the four National Forests and are often referred to as "sky islands" because they are restricted to high-elevation mountain habitat. Similar to the Sierra Nevada region, montane forests are dominated by pine and fir species, and the natural fire regime of this habitat would have entailed frequent, low- to moderate-severity fires. Lightning-ignited fires generally occur from late-summer to fall in the western Transverse Range (Los Padres and Angeles National Forests), and in spring-early summer in the Southern Peninsular Range (Cleveland National Forest), with the San Bernardino mountains situated at an intermediate point along this gradient. Before Euro-American settlement, the mean fire return interval was 7-15 years, however, 20th century fire suppression policies caused these forests to burn less frequently. This is the opposite of what is occurring in ecosystems at lower elevations, where fire is igniting much more frequently than naturally occurred.

Suppression of the natural fire regime has resulted in denser forests dominated with smaller trees, more ladder fuels, and the build-up of surface fuels. Accumulated ladder and surface fuels increase the likelihood that fire will move into the forest canopy and burn with greater intensity. This causes more severe effects than the ecosystem would have naturally experienced. Drier conditions associated with climate change have also promoted high levels of tree mortality. This further facilitates higher intensity fires and inhibits the ability of forests to regenerate and recover following tree mortality and/or fire events. This is leading to many forested areas converting to shrublands. In fact, one study found from 1985 to 2021, 14% of montane forest cover was lost in Southern California. This is over twice the rate of tree cover loss experienced across the entire state (6.7%), suggesting that forests in Southern California are less capable of recovering from wildfire than in other regions.

Forest management treatments are being applied to help increase and restore natural forest ecosystem dynamics and resilience. Healthy forest conditions result when trees are patchily distributed in terms of tree spacing and across size classes. Management actions that reduce forest density, such as selective tree thinning and fuel treatments, can alleviate competition for water resources and encourage the growth of larger trees that are more resilient to fire and able to store more carbon. In some areas, such as Mount Laguna in the Cleveland National Forest, efforts are also being made to reintroduce low-intensity fire through prescribed burning in order to reduce fuels to mitigate the risk of larger, unmanaged wildfires occurring.

Riparian forests

Southern California riparian forests grow along stream and river corridors and are dominated by deciduous species, such as willows, sycamores, cottonwoods, alders, and live oaks. Historically, riparian forests functioned as natural fire breaks. However, the invasion of nonnative species, particularly arundo (giant cane) and tamarisk (salt cedar), has increased the presence of flammable, dry vegetation. This results in an increase of fire ignition risk and can fuel fire spread. Because arundo and tamarisk also recover quicker than native trees following fire, future wildfire risk can continue to increase after each fire as nonnative plants become more dominant in riparian forests. Human management of invasive plant species is essential for both protecting native riparian forest habitat and reducing wildfire hazard.

Oak woodlands

Oak woodlands are another ecologically and culturally important ecosystem of Southern California. This habitat is composed of a mosaic of grassland, shrubland, and woodland patches. For at least 3,000 years, ancestral land managers used fire to manage oak woodlands for resource benefits, such as improving acorn crops and stimulating the growth of plants used for weaving baskets. A historic fire regime of high-frequency, low-severity burning facilitated the growth of large, mature trees that were resilient to wildfire and also prevented shrub invasion. However, the 19th century displacement of Indigenous peoples and outlawing of cultural burning, followed by the 20th century policy of blanket fire suppression, disrupted the historic fire regime. Today, fuels have accumulated in oak woodland habitat and increased the risk of larger, more severe fires. Recently, there has been increased support for restoring cultural burning practices and further incorporating traditional ecological knowledge into land management.

Stakeholder Input

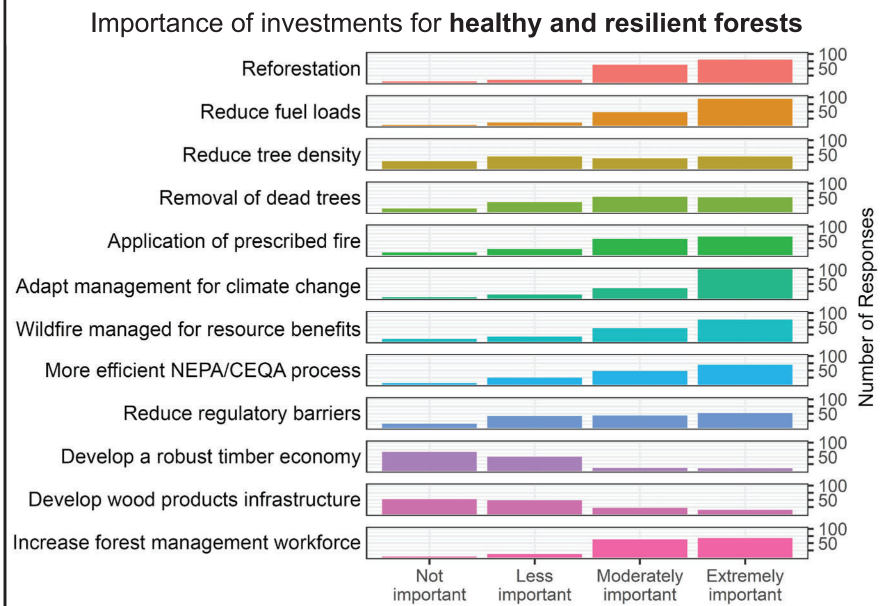

Figure 6. Survey respondents were asked how important the following potential areas of investment are for achieving healthy and resilient forests in their subregion. The actions that stakeholders rated as top priority areas of investment were reducing fuel loads, adapting management for climate change, reforestation, and increasing forest management workforce. Developing a robust timber economy and wood products infrastructure were perceived by stakeholders to be low priorities for the region.

Interview findings: When asked what the key issues were related to achieving resilience in forest ecosystems, many interviewees described protecting montane forest habitat as a high priority for management activities because this already rare habitat is being lost to disturbance and previously forested areas are converting to shrublands. Management practices being applied in montane forest habitat include thinning and, to a limited extent, applying prescribed fire to create a more natural forest structure and reduce the risk of a stand-replacing crown fire occurring. However, many interviewees expressed concern that Southern California forests have received much less research attention than Northern California forests. Instead, it has often been assumed that research findings and best management practices developed in Northern California can be applied to Southern California forests. Interviewees noted that more research was needed to understand the historic fire ecology of Southern California forests, how the forests are changing due to current disturbances, and what management actions are effective for increasing forest resilience.

Unfortunately, Southern California oak trees are experiencing significant mortality due to invasive pests. The Goldspotted Oak Borer (GSOB) is a small beetle that preys on drought-stricken oak trees. Affected species include coast live oaks, California black oaks and canyon live oaks. First discovered in San Diego County in 2004, it has since spread to Riverside, Orange, Los Angeles and San Bernardino Counties, and there is significant risk that it will continue to spread northward. Because GSOB is largely spread by the transportation of firewood, it is imperative that recreational users do not move firewood from the local area where they procured it. Management actions are currently focused on monitoring and limiting the spread of GSOB to new areas, protecting healthy trees, removing dead trees that can fuel wildfires, and reforesting.

Current Conditions

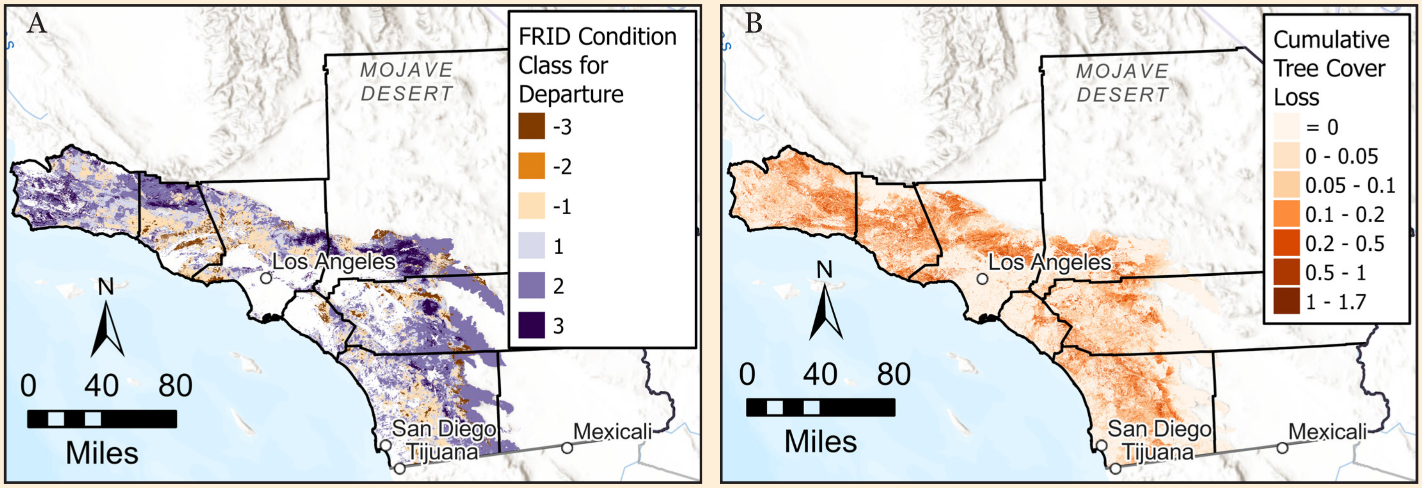

Figure 7. Forest health and resilience can be assessed by a variety of metrics, including those related to fire return interval departure (FRID) (A) and tree cover loss (B). The length of time between wildfires influences the benefits and negative impacts the fire has on ecosystem health and resilience. Fire return interval departure describes the difference between current and historical fire frequencies. This is important because areas that have vastly different fire frequencies may be at high risk of reduced resilience and, therefore, a priority for targeted management actions. FRID condition class categorizes the landscape into positive or negative values; positive values indicate fires are burning less frequently than historical regimes, while negative values indicate fires are burning more frequently than historical regimes. The higher the condition class value, the greater the departure from an area's historical fire return interval. Chaparral landscapes in the region, therefore, fall into negative condition classes, while forested landscapes have positive condition classes. The Regional Resource Kits also include data on cumulative loss of tree cover that has occurred over the past 30 years (1992-2021) due to fires, harvest/management, and other disturbances that cause tree dieoff. Tree cover is a continuous variable from 0 to 1. Cumulative loss can exceed 1 in cases where multiple disturbances occurred over the 30 year period.

Resilient and Fire-Safe Communities

Wildfire, along with high population density in the wildland-urban interface, poses serious risks to communities in Southern California. The preceding sections have largely focused on management actions that can be applied to public wildlands to increase resilience to regional wildfire and other disturbances. However, there is growing awareness that building community resilience to wildfire and protecting life and property on private lands, also requires proactive community planning, public education, and the active participation of Southern California's diverse population.

Many communities in Southern California are located within close proximity to large patches of natural lands; however, these developed areas typically have sparse or no wildland vegetation. This contrasts with other wildland-urban interface communities where houses and wildland vegetation directly intermingle. Fire is therefore less likely to spread directly to homes from nearby wildland vegetation and more likely to ignite from wind-carried embers, landscaping vegetation or neighboring buildings. This means that conventional activities and preventative measures that focus on wildland vegetation, such as fuel treatments, prescribed fire, and fuel breaks, are not sufficient to mitigate wildfire hazard.

There are however measures that homeowners can take to increase the resilience of their homes and other structures on their private property. This includes home-hardening techniques, such as building and re-roofing with less flammable materials, screening vent openings, and enclosing eaves. Plants that are known to be highly flammable should be removed from close proximity to homes and replaced with properly distanced, well-maintained fire-resistant species. Public engagement is needed to educate homeowners on the benefits of preparing homes for wildfire, recommended techniques, and available resources. Excellent resources for homeowners on home hardening are available on the CAL FIRE website.

Community vulnerability to wildfire is a function not only of exposure to wildfire hazard (e.g., proximity to a high fire risk area) but also sensitivity and adaptive capacity. Certain factors make individuals more vulnerable to wildfire and more in need of public assistance. Low-income, disadvantaged, and elderly individuals might not be able to afford fire mitigation services, such as home hardening techniques or vegetation treatments or have ready access to necessary information. They also might not be able to afford fire insurance or community firefighting resources, and have less capacity to rebuild or secure new housing after a disaster occurs. Renters are ineligible for much of the federal assistance available to homeowners for rebuilding after fire, and they are more likely to live in older buildings that are vulnerable to fire. Many fire-prone areas are often characterized by higher-income households because of the aesthetic value of wildland-urban interface areas, but this paradoxically means that low-income residents, or renters, within these same communities might be ineligible for financial resources and other types of assistance. Similarly, disadvantaged neighborhoods and other types of housing such as trailer parks or apartment buildings also can be found in these areas.

Other factors also contribute to individual and community vulnerability, including physical and cognitive disabilities, social or geographical isolation, and English-language proficiency. Emergency notifications, information on resources, and other critical announcements need to be translated and made accessible to diverse multilingual populations. Information delivery should 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 or conversely via different types of social media (e.g., Facebook, Instagram, or Whatsapp). Asking community-trusted representatives or intermediaries to share language-relevant information, and hosting public meetings in local areas can also be effective engagement strategies.

Recent catastrophic wildfires have also increased awareness of more widespread vulnerabilities or pinch points that need to be addressed to increase resiliency to wildfire and other natural disasters. During the 2018 Woolsey Fire in Ventura and Los Angeles Counties, 250,000 people were evacuated. Most people evacuated via their own personal vehicles, which led to heavy congestion along primary evacuation routes, such as the Pacific Coast Highway. Multiple agencies and jurisdictions were eventually able to coordinate to change all highway lanes to flow away from the fire, and some non-governmental organizations helped to transport people by partnering with private sharing economy companies, such as Lyft and Uber. Local and regional planning can proactively consider how to address evacuation challenges related to traffic congestion, assisting vulnerable individuals who do not own vehicles or otherwise do not have the ability to evacuate. Additionally, these recent incidents have demonstrated a need for better equipping public shelters with essential resources, such as American with Disabilities Act accessible facilities, medical supplies, and trained staff.

Stakeholder Input

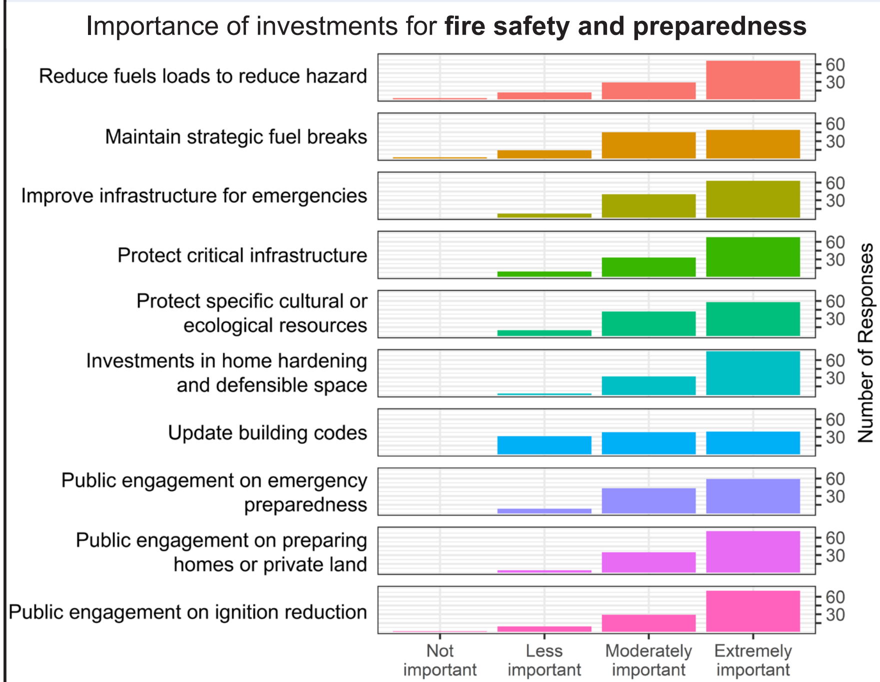

Figure 8. Survey respondents were asked to consider potential areas of investment related to fire safety and preparedness. Essentially all potential areas of investment were perceived as being 'moderately' to 'extremely important,' except for updating building codes. There was also less consensus on the importance of maintaining strategic fuel breaks and reducing fuels loads than other areas of investment.

Interview findings: There was broad consensus among interviewees that increasing community resilience to wildfire in Southern California requires the participation of the communities that live in the wildland-urban interface. Because vegetation treatments are less effective against wind driven fires, it is critical that homeowners implement home hardening and defensible space practices to protect their own house and other houses in their neighborhood. More public education is needed to increase public awareness of what actions community members can implement and to increase a sense of private homeowner responsibility. A few interviewees observed that many homeowners do not implement recommended actions not because of financial barriers but because they do not perceive it to be their responsibility or because of aesthetic values. Various programs exist to fund contract work for those who qualify as physically or financially unable to do it themselves or to provide free curbside chipping services, but access to homeowner assistance resources varies across the region. Also, several interviewees highlighted that many low-income and underinvested communities are not being reached by these programs, and a better understanding of where vulnerable communities exist is needed so that community engagement can prioritize targeting these areas.

Both public and private organizations have stepped up across the region to make Southern California communities more resilient and fire-safe. Fire Safe Councils help to engage private landowners, and some of these organizations have undertaken projects to protect high-risk lands and improve evacuation routes. Local Resource Conservation Districts, CAL FIRE, state conservancy agencies, and various non-governmental organizations also support and lead community efforts to increase wildfire resilience. However, in all cases, capacity varies across the region, and more attention and resources are needed to ensure that vulnerable communities are protected.

Stakeholder Input

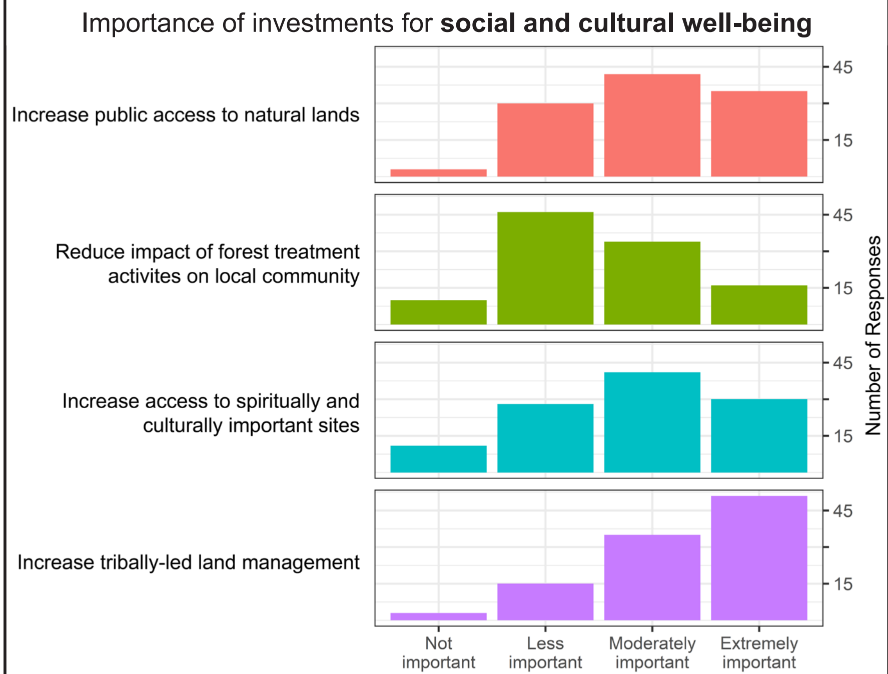

Figure 9. Survey respondents were also asked to consider investments focused specifically on social and cultural well-being. Increasing Tribally-led land management was perceived to be the highest priority based on both the number of stakeholders who rated it as 'extremely important' and mean response. Reducing impact of forest treatment activities on local communities was perceived to be less important in the Southern California region.

Interview findings: Increasing Tribally-led land management and learning from Indigenous knowledge of managing Southern California ecosystems was a theme that came up in several interviews. One interviewee noted that Southern California has the most diverse Tribes of anywhere in the continental United States, and there is enormous opportunity for Tribal involvement in wildfire resilience. Another interviewee noted Tribes could be empowered to take more management action by providing more opportunities and support for cultural burning experts to receive state or federal certification to conduct cultural burning.

Wildlands, such as the Los Penasquitos Canyon Reserve in San Diego, shown here, provide important social benefits in the form of recreation opportunities. Photo credit: Wayne S. Grazio

Current Conditions

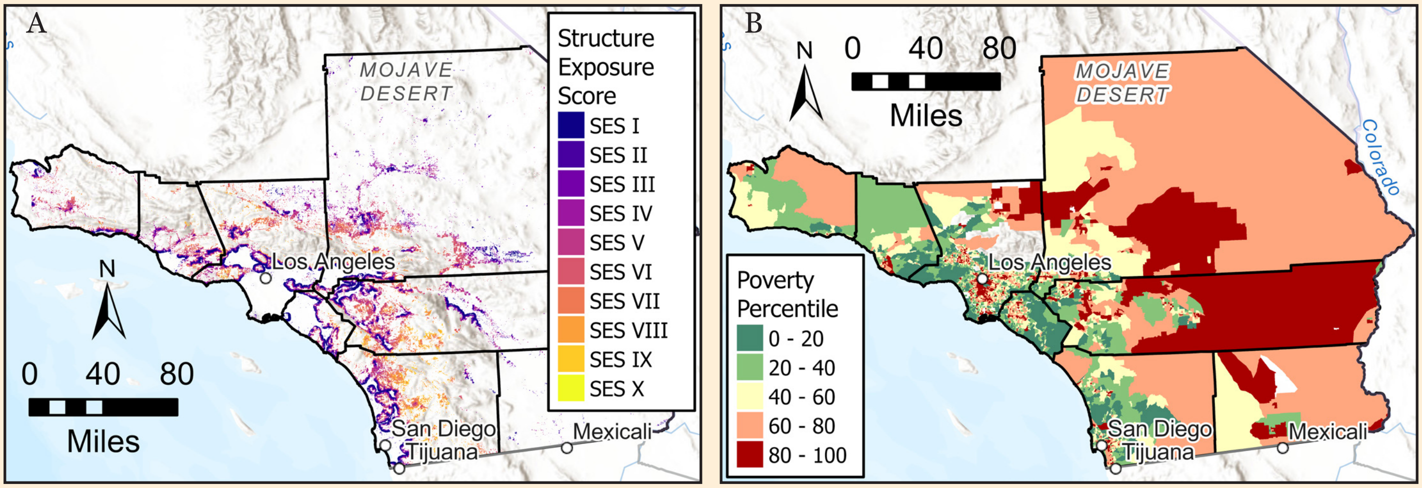

Figure 10. Community vulnerability is a function of exposure to risk, sensitivity, and adaptive capacity. Though by no means the only metrics for understanding community capacity or resilience, for the purposes of this profile, we consider structure exposure score and poverty percentile (B). Risk can be assessed by considering the degree of exposure to wildfires the structures within the community are predicted to experience. The Regional Resource Kits assessed the structure exposure score within Wildland Urban Interface (WUI) areas in the Southern California region. A structure exposure score reflects the likelihood of a wildfire reaching the location, as well as the potential intensity and ember load of such a fire. Higher scores indicate a location with higher exposure and wildfire hazard. The data use 10 classes of SES, where each class break is 1.5 times larger than the previous break. So, homes located within Class X are 1.5 times more exposed than those in Class IX, and so on. Poverty percentile is measured as percent of population living below two times the federal poverty level. Poverty percentile is considered to be a general metric 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. In mapping this metric, census tracts are represented by their percentile score in relation to other census tracts across California.

Air Quality

The Southern California region has some of the highest air pollution concentrations in the United States, and large wildfires are further aggravating baseline air quality issues. Hazardous air pollutants in wildfire smoke can exacerbate a range of respiratory and cardiovascular issues and even cause 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.

Smoke from wildfires can affect air quality thousands of miles from the fire. One study found that air quality in urban areas within 50-100 miles of a large wildfire was frequently 5-15 times worse than usual. In Southern California, Santa Ana winds can carry pollutants from fires burning inland to densely populated coastal areas. Population centers, such as Los Angeles, that already have poor air quality from vehicles and industrial activities can be especially vulnerable to temporary increases in fine particulate matter (PM2.5) and ozone levels.

One way in which the public health impacts of wildfire is studied is by examining rates of hospital admissions due to respiratory concerns, such as asthma. Significantly more respiratory-related hospitalizations occur during wildfire events and the highest increases occur in areas downwind of fire. One study of San Diego County found that when particulate matter

NOAA Malibu Coast Smoke Plume: Woolsey Fire smoke plume rises above California coast near Malibu, November 2018. Photo credit: U.S. Forest Service.

concentrations from wildfires were at their peak, people were 50% more likely to seek emergency healthcare than normally. The 2007 wildfires in Southern California are estimated to have caused over $3.4 million in healthcare costs for just the five counties that were studied. Research examining wildfire impacts across the entire state of California found that 2018 wildfires caused $210 million in medical expenses, and even more concerning, caused 3,652 air pollution-related deaths.

Research examining hospitalizations in Southern California found that PM2.5 from wildfire may be up to 10 times more harmful to human health than equal doses of PM2.5 from other emission sources. The temperature at which combustion occurs and the material that burns, including the type of vegetation, may affect the toxicity of the particles emitted, but more research is needed to understand these differences. In general, it has been found that fires that burn at lower intensity over smaller areas emit much less harmful pollutants than large, high-severity wildfires. Because of this, low-intensity prescribed fire is applied in some forested areas to reduce the risk of the higher air emissions that might result from an uncontrolled, potentially structure-damaging wildfire.

Certain populations may be especially at-risk to public health impacts of wildfires, 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). People that live in homes that lack air conditioning and/or proper sealing from outdoor air, or who live in areas that already experience poor air quality, such as near freeways or industrial facilities, are also particularly vulnerable. Initiatives that are being undertaken to alleviate public health impacts include: increasing public education on how to stay safe during hazardous air conditions, providing early notification of smoke events so that residents can prepare, and increasing access to public clean air spaces and personal protective equipment.

Stakeholder Input

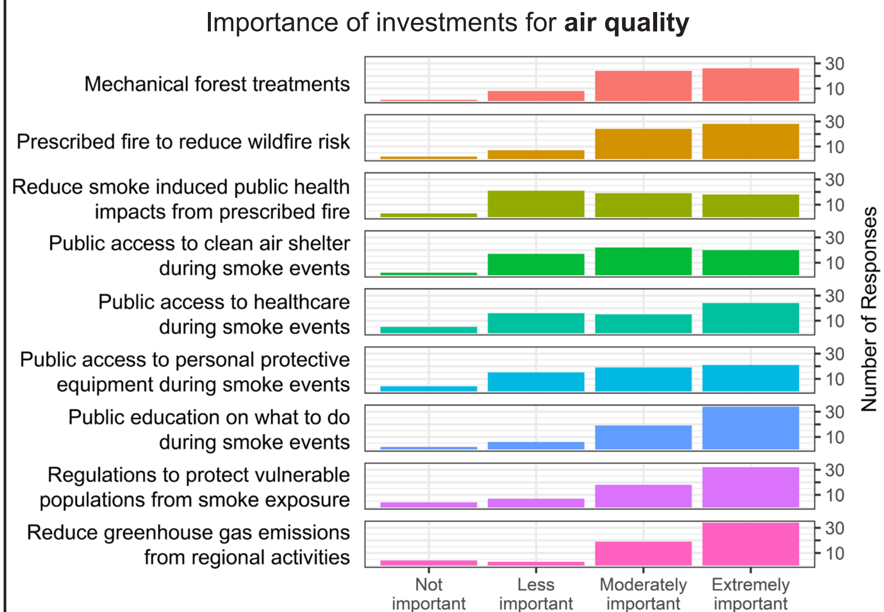

Figure 11. Most potential areas of investment for improving air quality received a mean rating of 'moderately important.' Top priorities based on mean response and the highest number of 'extremely important' ratings were public education on what to do during smoke events and reducing greenhouse gas emissions from regional activities. These were closely followed by regulations to protect vulnerable populations from smoke exposure, and fuel treatments that reduce the probability or scale of wildfire, whether mechanical or prescribed burning. Reducing public health impacts from prescribed fire was perceived to be slightly lower priority based on mean response.

Interview findings: Issues related to air quality were mentioned a couple of times during interviews. One interviewee identified smoke hazard exposure as a key issue and significant concern in the region, especially for people who work outside or who do not have access to air purifiers or other ways to protect themselves from air pollution. Another interviewee discussed how prescribed burning initiatives in their area were limited by Air Quality Management District (AQMD) restrictions. The interviewee noted that in recent years there were fewer days when it was permissible to burn because particulate matter concentrations, which were already high in nearby urban areas, increased with higher temperature. The interviewee observed a mismatch between where the AQMD evaluation was typically conducted in urban areas and where the prescribed burning activities were planned in more rural areas, and the interviewee recommended that AQMD evaluation to allow burning should be more localized and based on air quality conditions in the area that would be affected by the planned burning.

Soldiers from the California Army National Guard's 649th Engineer Company work to reroute water flow from the San Ysidro Creek inside the Randall Road Debris Basin, Jan. 13, 2023, in Montecito, California, as part of the state's storm response. The basin is in the same area where a deadly mudflow hit the town five years ago this week. Credit: U.S. Air National Guard photo by Staff Sgt. Crystal Housman

Water Security

Wildfire hazard and post-fire impacts are exacerbated by other regional concerns related to water security. California has recently experienced a series of severe multi-year droughts. Drought has caused extensive dieback of trees, shrubs, and grasses across Southern California. Because dead plants and moisture-stressed live plants are more flammable than healthy plants, drought makes it easier for fire to spread and for spot fires to ignite from wind-carried embers. Extensive chaparral dieback driven by 2011-2016 drought contributed to the massive sizes of the 2017 Thomas Fire and 2018 Woolsey Fire.

Wildfire also makes landscapes more vulnerable to extreme flooding, erosion, and debris flows. When vegetation cover is lost, the landscape is less stable, and hillslopes become more prone to landslides. Moderate and high intensity wildfire can also alter soil properties such as infiltration rates and hydrophobicity for up to 2-4 years after being burned, making the soil less permeable and further increasing runoff. Debris flows, or mudslides, are fast-moving landslides that generally occur after intense rain or rapid snowmelt. Burned areas denuded of vegetation are especially susceptible. Shortly following the 2017 Thomas Fire, heavy rain caused large debris flows uphill from the town of Montecito in Santa Barbara County. This resulted in 21 deaths and millions of dollars of damages. The risk of debris flows occurring on burned hillsides remains elevated for several years following fire, and the increase in extreme precipitation events forecast under climate changes makes it more likely that debris flows will be triggered.

In addition to the acute threat of debris flows, runoff and erosion following wildfire can also affect water quality by transporting ash, debris, and sediments into streams and reservoirs. Increased sedimentation reduces reservoir capacity, which impacts both water storage and flood control. Also, some of these sediments contain naturally occurring hazardous materials which may impact downstream ecosystems and enter community water supply. When structures and other artificial materials burn, different chemicals are released than when plants burn. Some of the pollutants that are eroded or leached can be especially harmful to human health and aquatic organisms, including mercury, lead, and other metals that are released by fire. A study of post-fire water quality in areas burned by the 2018 Woolsey Fire found that areas which experienced moderate and high soil burn severity had significantly larger pollutant levels for E. coli, nitrogen, phosphorous and total suspended solids. Elevated pollutant levels can be dangerous to human health. Excessive nutrients can also impact aquatic ecosystems by causing an overabundance of plants and algae to grow, which depletes oxygen supply in the water and can cause fish and other aquatic organisms to die.

Proactive management actions and investments can reduce the threat of damaging landslides and protect water quality. For instance, restoring vegetation in burned areas can reduce erosion. Upgrading and maintaining water infrastructure (e.g., larger culverts, debris dams) can better protect communities and water resources from potential flood damage and debris flow impacts. Maintaining sewer infrastructure and monitoring water quality can reduce the threat of pollutants entering community water supply.

Stakeholder Input

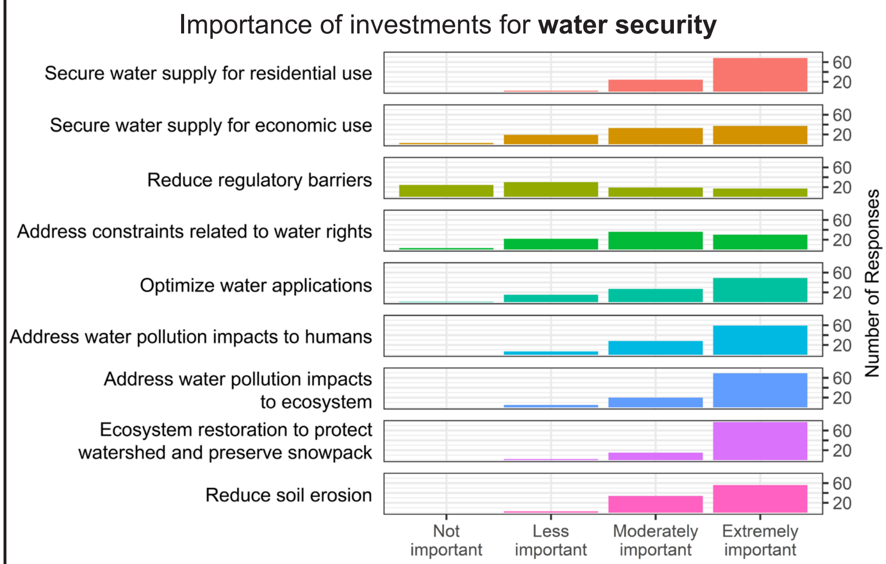

Figure 12. Survey respondents were asked how important the following potential areas of investment are for achieving water security in their subregion. Most investments were perceived as being at least 'moderately important,' except for reducing regulatory barriers. Investments that stakeholders perceived to be top priorities were ecosystem restoration to protect watershed and preserve snowpack, as well as secure water supply for residential use and addressing water pollution impacts to ecosystems.

Interview findings: Several interviewees noted how issues related to water security interact with other issues related to ecological and community resilience in the Southern California region. One concern is that massive floods and landslides can occur after fire, and increased soil erosion following fire also contributes to sedimentation in dams. Another interview noted that drought can increase the frequency and scale of wildfires because drought is more conducive to invasive species outcompeting native species, and drought also increases vegetation dieback. These effects in turn increase fuels on the landscape and contribute to larger fires. One interviewee highlighted the need for the public to understand how water and fire resilience are connected through forest ecosystem health. Water coming off of the Angeles National Forest provides 30% of the water for Los Angeles County; watershed health is thus extremely important for community water security.

Current Conditions

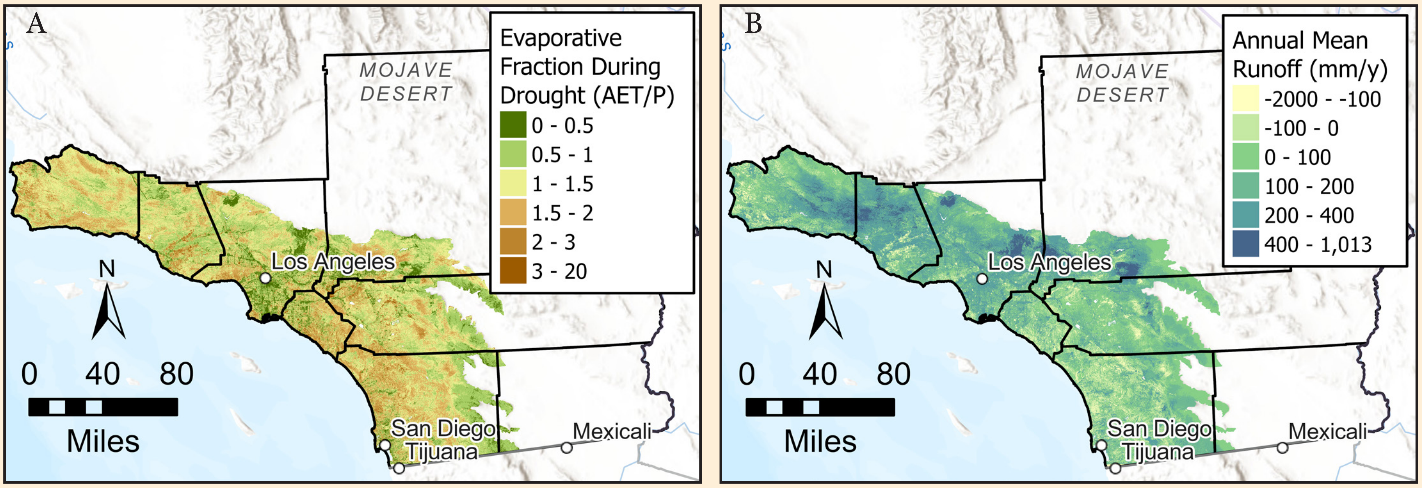

Figure 13. Water security can be assessed in terms of actual evapotranspiration/precipitation (AET Fraction) (A) and annual mean runoff (B). Actual evapotranspiration is the combined amount of water that evaporates from the land surface in addition to the water that is lost as vapor from plants. AET 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 > 1 indicate moisture stress driven by shortfalls in precipitation relative to plant needs. Values < 1 indicate no water stress. Both vegetation 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. Vegetation 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

The Southern California region supports an exceptionally high number of plant and animal species, many of which reside in threatened shrubland habitat. Approximately 200 imperiled plant and animal species can be found in San Diego County alone – more than any other county in the United States. For decades, urban development has caused the degradation, fragmentation, and loss of native habitat. It is estimated that 60-90% of coastal sage scrub habitat has been lost since the start of the 20th century, making it one of the most endangered ecosystems in the world. Although significant efforts have been made to protect and restore habitat, new threats are emerging, including changing fire regimes, invasive species, and climate change.

As previously discussed [see 'Healthy and Resilient Shrublands'], shorter fire return intervals driven by human ignitions has been found to be driving the conversion of native shrublands to annual grasslands with exotic species. Similar patterns of vegetation type conversion and loss of native biodiversity to invasive species are also happening in other Southern California ecosystems [see 'Healthy and Resilient Forests']. Riparian forests are being invaded by exotic species which increase wildfire hazard in these areas and also alter stream hydrology. This can make riparian habitat unsuitable for sensitive species, such as the federally endangered arroyo toad which depends on slow-moving streams for its breeding habitat.

The degradation and loss of native shrubland habitat also impacts many animal species. Chaparral provides important habitat to native birds, such as the California thrasher and wrentit. One endemic bird species, the federally threatened California gnatcatcher, depends heavily on coastal sage scrub for its survival. Although significant efforts have been made to protect critical habitat from urban development, climate change may make existing habitat unsuitable for climate-sensitive species that currently occupy it. It is projected that the climatic niches of many endangered plants in Southern California, including species associated with coastal sage scrub, will shift northward under climate change. 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.

To facilitate species persistence, efforts are being made to proactively protect areas that may provide suitable habitat in the future, including potential climate refugia. It may be necessary to transplant species to new suitable areas. Conservation planning that increases habitat connectivity, such as protecting stream corridors, removing fences, and building wildlife crossing over highways, can facilitate animal movement across the landscape. Increasing habitat connectivity can help species to shift their range to track climate change, and also establish important linkages between habitat areas that were separated by human development. This can be especially important for conserving species, such as mountain lions, that require large home ranges, and can help restore genetic diversity to populations that were isolated by habitat fragmentation.

Some management actions that support biodiversity conservation also increase the resilience of human communities. For example, reducing ignitions and removing highly flammable invasive species can restore native shrubland ecosystems while also reducing wildfire hazard to nearby human communities. Conserving wildlands in high wildfire hazard areas can reduce the likelihood of ignitions near sensitive habitat and concentrate residential development in areas where communities will be less at-risk of catastrophic wildfire.

Stakeholder Input

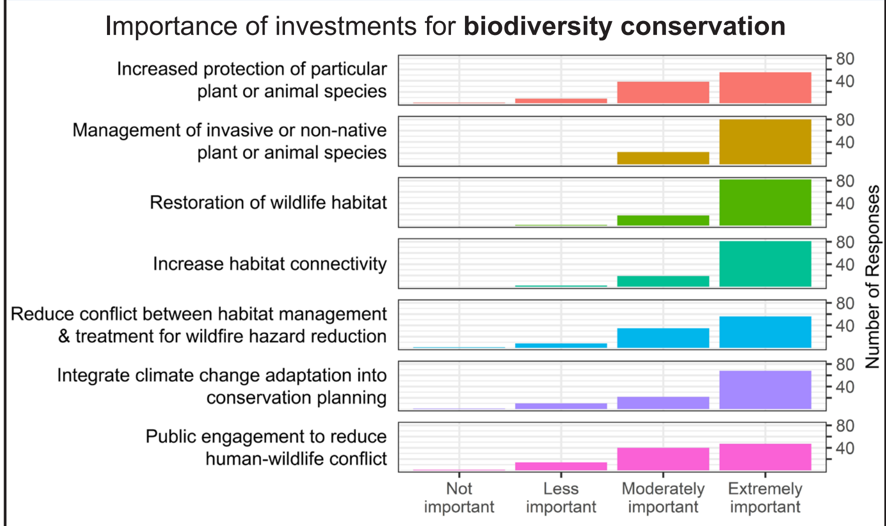

Figure 14. All potential areas of investment for achieving biodiversity conservation were considered on average to be at least 'moderately important.' Top priorities were managing non-native or invasive species, restoring wildlife habitat, and increasing habitat connectivity. These actions were not only on average rated higher, but also were rated as 'extremely important' by most respondents.

Interview findings: Interviewees discussed how the loss and degradation of native ecosystems, such as the conversion of shrublands to grasslands, are impacting biodiversity conservation in the region. Fortunately, some land management practices that increase ecological resilience to wildfire also have co-benefits for biodiversity conservation. For example, many plant and animal species benefit from invasive species treatments that reduce wildfire risk, and some land managers are integrating habitat-friendly fuel modifications, such as planting tree as ember screens or replacing invasive grasses along roadsides with cacti, which are less flammable and provide habitat for birds and other animals. 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. Balancing regulatory compliance with the need to increase pace and scale of treatments is considered to be especially challenging in the Southern California region because there are so many threatened and endangered species that need to be considered in project planning and assessment.

Many sensitive species, such as the threatened California gnatcatcher shown here, depend on shrubland habitat. Photo credit: Tony Morris

Current Conditions

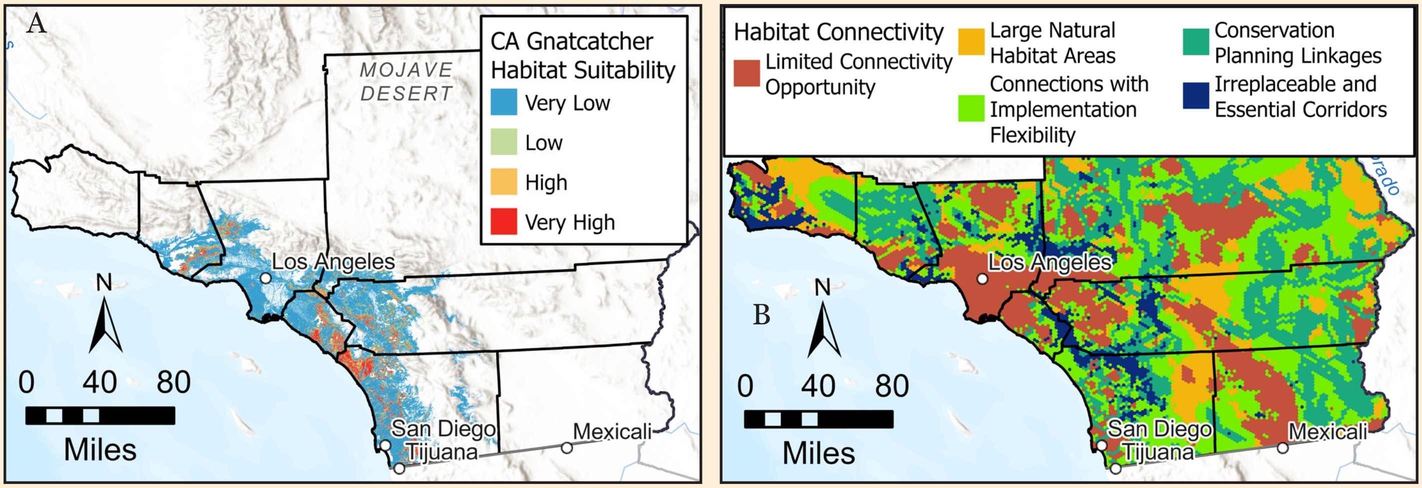

Figure 15. Biodiversity and metrics to inform its conservation can be measured in a variety of ways. The Regional Resource Kit assesses habitat suitability for several focal species of concern, including the coastal California gnatcatcher (A), as well as habitat connectivity for terrestrial species across the region (B). Habitat suitability for the gnatcatcher is measured by a combination of factors, such as land use, climate, topography and suitability of the area for California sagebrush. Orange county and northern San Diego county contain some of the densest concentrations of highly suitable habitat for the gnatcatcher. Habitat connectivity is another measure used to inform management for biodiversity goals. This metric summarizes, and ranks per unit area, the relative ability of a species to move across the landscape between patches of suitable habitat. Areas with high connectivity, such as the corridor within the Cleveland National Forest between Los Angeles and San Diego, are crucial to protect during management activities seeking to improve wildfire resilience.

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. Forests and shrublands store 85% of California's carbon stock. Climate change and wildfire are expected to cause forests and shrubland carbon stocks to decline over the next two decades. Losses of forest carbon stocks are already being observed in Southern California. The AB 1504 California Carbon Inventory for the 2019 reporting period found that Southern California was the only region where tree mortality was exceeding tree growth, resulting in an estimated net carbon reduction of the live tree pool equivalent to -0.8 ± 0.4 MMT CO2e per year.

Fortunately, management actions can lessen this loss by reducing carbon emissions and increasing carbon sequestration, and these same actions may also serve to protect important cultural and ecological resources. Treatments that focus on reducing the risk of high-severity, stand replacing wildfires can protect forest carbon stores. Thinning overly dense forests to densities more in line with historic conditions can simulate natural ecological processes, and lead to initial losses of carbon from lost trees being regained and stored more securely in the remaining large trees. Fuel treatments (including mechanical, Rx and managed wildfire) reduce surface fuels, shrubs and other understory biomass, and ladder fuels (small-diameter trees), reducing the potential of crown fires and thereby protecting the carbon stored in live trees and promoting more stable annual sequestration. Carbon losses from mechanical thinning 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. Halting the spread of disease or invasive pests, such as the goldspotted oak borer [see 'Healthy and Resilient Forests'] and maintaining native pest populations (e.g. mountain pine beetle) at background levels can also help protect carbon resources by preventing tree mortality. In areas where trees were lost to fire, beetle outbreaks, or other disturbances, proactive reforestation and invasive species management can protect forest habitat from converting to vegetation types that store less carbon and that may be more flammable.

Forests sequester and store a higher density of carbon than shrublands. Carbon makes up approximately 45-50% of plant biomass. The average biomass density of forests in California is 351 MT/hectare, and the average biomass density of shrublands is 55 MT/hectare, which is still considerably greater than grasslands (13 MT/hectare). The carbon turnover time of forest stands is generally density of forests in California is 351 MT/hectare, and the average biomass density of shrublands is 55 MT/hectare, which is still considerably greater than grasslands (13 MT/hectare). The carbon turnover time of forest stands is generally much longer because trees can live longer than shrubs. Given the extensive area that shrublands cover, especially in Southern California, protecting the carbon storage value of shrubland ecosystems is also important to regional and state carbon planning.

The amount of carbon stored in shrubland communities varies depending on vegetation type and age class. Aboveground biomass is on average highest in mixed-chaparral (average of 3461 g/m2), whereas in chaparral dominated by the commonly found species called chamise ('chamise chaparral') aboveground biomass is on average significantly lower (21114 g/m2). Coastal sage scrub typically contains less than half the aboveground biomass of mixed chaparral (1583 g/m2). For all of these plant communities, vegetation that experiences less moisture-stress tends to be more productive and thus sequester more carbon than drought-stressed plants. This means that Southern California shrublands may sequester less carbon if increased drought stress occurs under climate change, or may sequester more carbon if precipitation and water runoff increases in the future as some climate models project.

Older shrub stands, especially stands over 30 years old, generally have higher biomass than younger stands. However, mature stands are becoming rarer due to shorter fire return intervals [see 'Healthy and Resilient Shrublands' section]. Too-frequent fire is also driving the conversion of chaparral and coastal sage scrub ecosystems to grasslands, which contain only a fraction of the carbon. For this reason, reducing human ignitions, managing invasive species, and other management actions which reduce conversion of shrublands to grasslands benefit carbon storage objectives, while also reducing risks to communities and protecting critical habitat.

Stakeholder Input

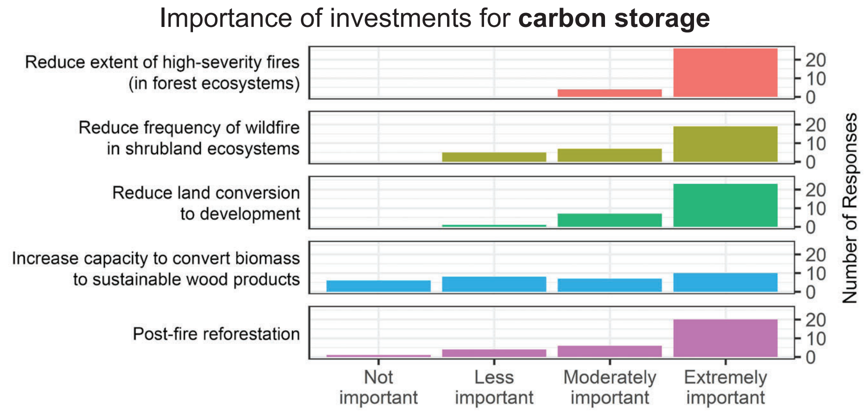

Figure 16. Survey respondents were asked how important the following potential areas of investment are for achieving large and stable carbon stores in their subregion. Most survey respondents rated reducing the extent of high-severity fires in forest ecosystems as extremely important for achieving this outcome. Reducing the conversion of natural land to development was also perceived to be a top priority by the majority of respondents. Reducing the frequency of wildfire in shrubland ecosystems and post-fire reforestation were on average rated as moderately important by respondents. There was less consensus among respondents on the importance of increasing capacity to convert biomass to sustainable wood products.

Interview findings: The topic of carbon storage came up in interviews primarily with regard to how regional carbon stores are being lost due to the conversion of natural lands to human development and because of vegetation treatments. One interviewee noted how vegetation treatments in Northern California forests can increase carbon storage by promoting larger trees which store more carbon and are more resilient to wildfire. However, the same approach does not apply to Southern California's chaparral ecosystems. Vegetation treatments reduce biomass and generally lead to carbon loss.

Current Conditions

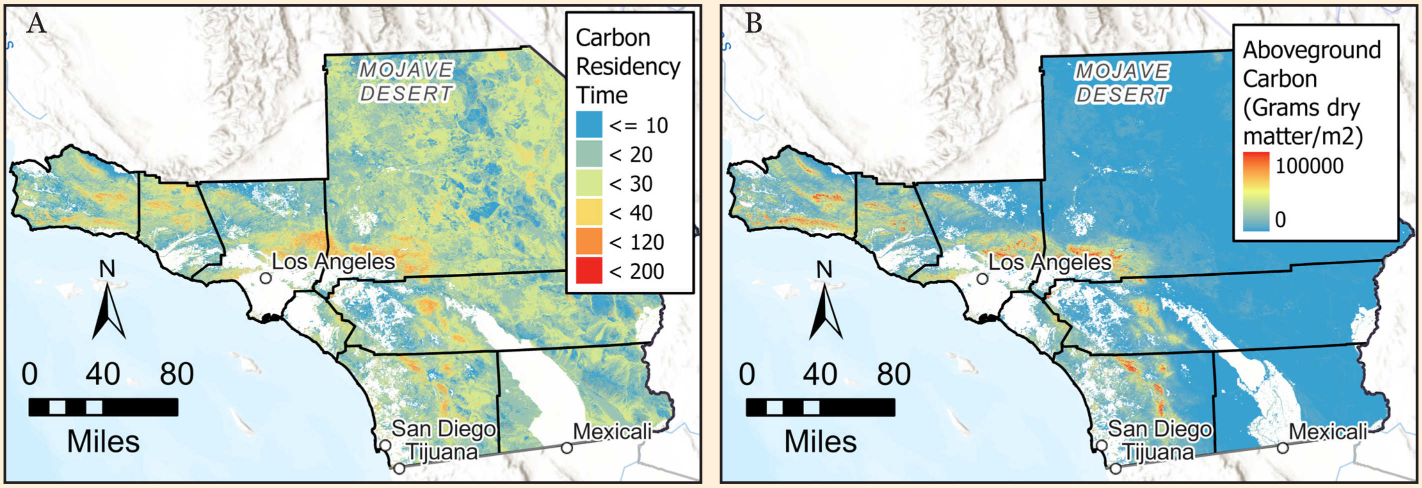

Figure 17. The Regional Resource Kit relies on two metrics to assess carbon storage on the landscape: total aboveground carbon (A) and average carbon turnover time (B). The total aboveground carbon is the amount of carbon present in all live and dead trees, shrubs, herbaceous vegetation, and dead material 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. Average carbon turnover time is a measure of carbon stability; it assesses the average lifetime of aboveground live and dead carbon in years. Locations with larger values have a longer turnover time and, therefore, more carbon in more stable pools, such as large trees or large coarse woody debris. In Southern California some of the locations with the longest carbon turnover time are, therefore, located in the montane forests. On the other hand, locations with smaller values have shorter turnover times and carbon pools that are more liable to change, such as live or dead leaves.

Economically Robust Communities

Wildfires pose significant economic impacts; in addition to the incalculable costs associated with lost human lives, wildfire destroys homes and businesses, impacts public health [see 'Air Quality' section], and damages roads and other infrastructure. Damage in Southern California can be especially costly relative to other areas because of high-population density and high real estate value. Wildfire also disrupts economic activities. For example, tourism is an important industry in Southern California. However, this industry is vulnerable to smoke events and other threats from wildfire, which can deter prospective visitors and critically shut down local business operations.

The economic impacts do not end once a wildfire is declared out. Debris flows following fire increase economic losses and recovery costs [see 'Water Security']. The Southern California region is at especially high risk of post-fire debris flows due to the combination of frequent fires stripping vegetation cover, steep topography, high population density, and high-intensity winter rainfall. In the case of the 2018 Montecito incident, debris flows caused Highway 101 to be shut down for nearly two weeks, disrupting business and transportation. In 2021, a section of Highway 1 just south of Big Sur was shut down for nearly 3 months due to post-fire debris flows. Incidents like these may be triggered more frequently in the future if extreme precipitation events increase under climate change.

Fire suppression costs have also escalated in response to the increasing scale and severity of wildfire. In 2020, fire suppression costs in California were nearly $2.1 billion. Because suppressing fire in ecosystems where it is a natural ecological process increases the probability of larger and higher severity wildfires occurring in the future, there is growing consensus that new investments are needed to increase ecological resilience before ignitions occur. This has motivated increasing the capacity for state and local fire departments to do fuels reduction work, in addition to the important work of protecting communities from dangerous fires.

Other public and private organizations are also contributing to proactive forest management to increase wildfire resilience. For example, the US Forest Service, which oversees management of the four national forests in Southern California, is investing about $2.42 billion from the 2021 Bipartisan Infrastructure bill into fuels-related projects across the country from 2022-2026. This includes a multi-year multi-million dollar investment into the Southern California Fireshed Risk Reduction Strategy that was announced Jan 2023. Working with partners and adjacent landowners, this Strategy will focus on ignition reduction projects, proactive vegetation management, and conservation. Fuel reduction work can be especially challenging in Southern California compared to regions that have forest product processing capacity because there are no treatments of vegetation in Southern California that generate revenue. This means that there is no way to recuperate the costs associated with thinning forests or removing biomass to increase forest ecosystem resilience. However, natural resource management protects valuable ecosystem services and is generally considered much less expensive than the costs that might otherwise result if large, high-intensity wildfires were to occur.

One of the greatest barriers to addressing wildfire resilience in California is workforce capacity. Capacity limitations exist at all levels of project development in Southern California, from personnel to help plan and do surveys to develop projects, to availability of crews to implement projects - limitations that will be compounded as pace and scale increases. Recently, there has been increased investment in fire resiliency projects that create new stewardship and economic opportunities, including for communities which were historically excluded or underrepresented in the natural resources management field. In 2022, the Fernandeño Tataviam Band of Mission Indians started the Tiüvac'a'ai Tribal Conservation Corps Program with funding from the Department of Conservation's Regional Forest and Fire Capacity program and support from other regional collaborators. This hands-on training program

Stakeholder Input

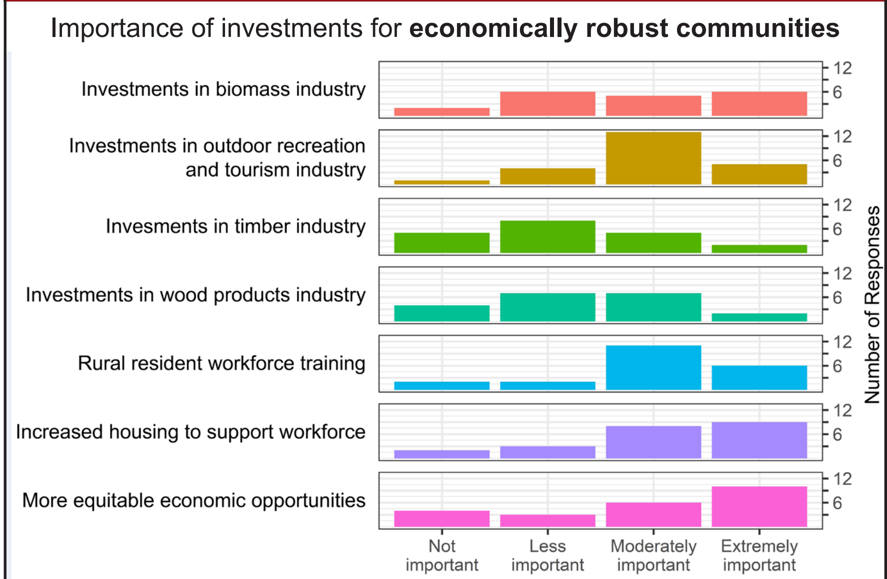

Figure 18. Most potential areas of investment for achieving economically robust communities were scaled as being on average 'moderately important.' However, investing in timber industry and wood products industry were on average perceived to be 'less important.' Investing in outdoor recreation and tourism and industry was the area of investment that had the most consensus from stakeholders on being 'moderately important' based on the spread of histogram values.

Interview findings: Many interviewees identified implementation capacity and organizational capacity as key barriers to increasing both ecological and community resilience to wildfire. Many organizations, including large federal and state agencies, are trying to pivot to increase the amount of vegetation treatment and other work being done to increase resilience to wildfire. CAL FIRE and US Forest Service have both created more year-round positions to increase capacity to do proactive fuel reduction treatments, but their workforces also must balance competing demands from fire suppression. Interviewees also observed that there is less funding available to increase organizational capacity to manage projects than there is to hire outside contractors or consultants. Several interviewees raised concerns about a mismatch between the type of work that gets funded and the priorities that need to be addressed to increase community resilience to wildfire. There is broad consensus in the Southern California region that funding is needed to reduce human-caused ignitions, increase public engagement, and make the built environment more fire resilient, such as providing homeowner assistance and incentives to do home hardening, but much less funding is available for these types of efforts than vegetation treatment. Also, vegetation treatments that maintain invasive grasses are often not seen as fuels reduction work, and even though they are critical to wildfire resilience, often do not qualify for funding. On the other hand, interviewees mentioned new programs, such as the Department of Conservation's Regional Forest and Fire Capacity program, as helpful for streamlining funding and enabling organizations to tailor projects to their local area.

will support Native youth in applying Traditional Ecological Knowledge to increase ecological resilience on ancestral lands while helping to complete US Forest Service priority projects. As an example of work being done in more urban environments, North East Trees, a non-profit organization in Los Angeles, is providing stewardship opportunities and job skills training for community members while working to restore native ecosystems and create more green spaces. These initiatives are just two examples of collaborative projects being done in the Southern California region to build economic and community resilience while reducing wildfire hazard.

Current Conditions

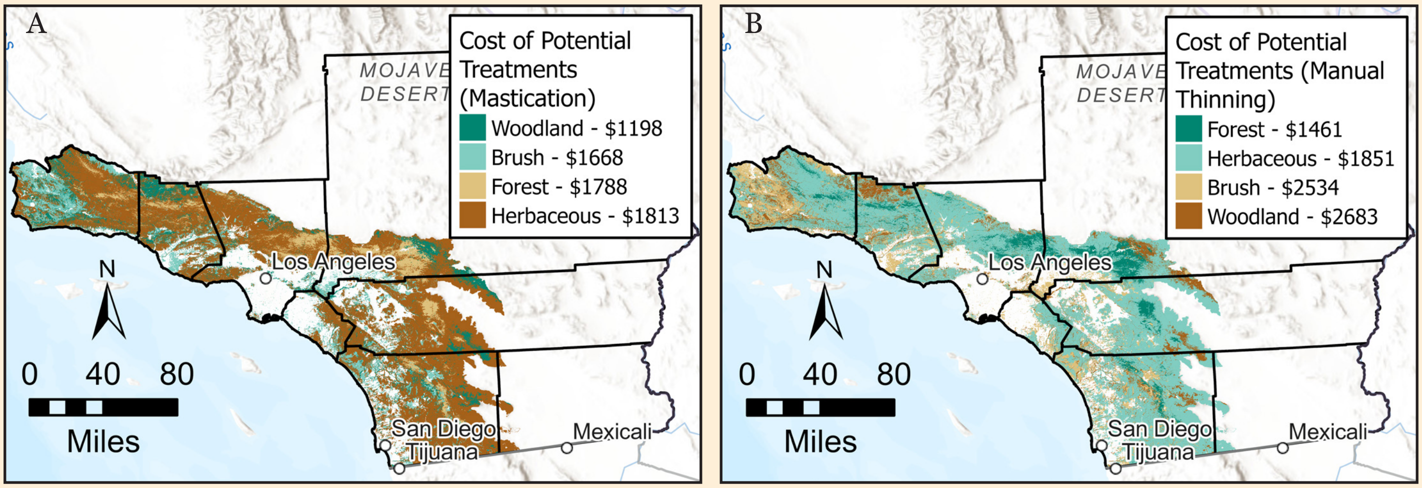

Figure 19. Vegetation treatments are one method to maintain or restore resilience on the landscape. The cost of treatments depends on the type of vegetation, required equipment, and the activities involved. The Regional Resource Kit assessed the cost of potential vegetation treatments by linking estimates of cost per acre for different treatment methods to the vegetation type per unit area. The maps shown here display estimated cost per acre from CAL FIRE for mastication (A) and manual thinning (B). Estimates for additional treatment types and from USFS can also be found in the Regional Resource Kit.

Concluding Recommendations from Interviews

When interviewing experts who work on Southern California 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 one size does not fit all for the state's solutions for fire resilience. The Southern California region encompasses distinct ecosystems and development pressures which lead to unique challenges and opportunities. This means that solutions that work in Northern California for addressing wildfire resilience do not always work in Southern California, especially in shrubland ecosystems. These nuances need to be voiced at the state policy level. At the same time, Southern California is ahead of the rest of the state in terms of experiencing frequent fire. The knowledge that the fire management and conservation communities have gained in Southern California could be shared to inform efforts in other regions.

2) Appreciate the diversity within the Southern California region. The region is incredibly diverse in terms of both ecosystems and human communities. Similar to how shrublands and forests must be managed differently, diverse approaches will be needed to increase community resilience to wildfire through public engagement and access to resources. More targeted efforts need to be made to reach the most vulnerable communities. Capacity also varies greatly across the region, with some counties having a long-standing history of doing conservation planning and fire management, while others are just getting started. Awareness of these differences is critical for tailoring projects to meet the needs of local areas more effectively.

3) Make novel collaborations part of the solution. Many interviewees emphasized the importance of regional collaboration, including a need for new partnerships with organizations that have not traditionally been involved in fire resilience planning, such as city planning departments, municipal governments, and the California Department of Transportation. Increasing wildfire resilience, especially in the Southern California region, requires a more holistic approach because wildfire is also connected to other challenges that the region is experiencing related to housing shortages, transportation, drought, and climate change. Considering these connections together can help inform smarter regional planning.

4) Recognize that all actions and investments have trade-offs. Management actions and areas of investment that benefit some objectives might be detrimental to others. Treating sensitive shrubland ecosystems to increase nearby community resilience to wildfire is a key example of this. However, one interviewee noted that acknowledging these trade-offs is helpful for allowing important conversations to happen and can facilitate conflicting values being better reconciled on a larger landscape scale.

List of Interview Participants

Stakeholder input was gathered during 27 individual, semi-structured interviews that focused on the key issues related to ecosystem and community resilience in the Southern California region, and the barriers, possible solutions, and recommendations for addressing these issues. Interviewees have extensive knowledge of and experience in both the ecological and social and cultural aspects of land management in the Southern California region.

Alexandra Syphard, Senior Research Ecologist, Conservation Biology Institute

Ana Rico, Community Ambassador, Community Environmental Council of Santa Barbara

Anna Olsen, Executive Director, Cachuma RCD

Anne-Marie Parkinson, Community Resilience Domain Lead, Santa Barbara County Fire Safe Council

Blair Crossman, Project Manager, San Gabriel and Lower Los Angeles Rivers and Mountains Conservancy

Brian Stark, Administrator, Conejo Open Space Conservation Agency

Carla D'Antonio, Professor, University of California, Santa Barbara

Chris Stubbs, Forest supervisor, USFS Los Padres National Forest

Danny Fry, Wildland Fire Management Coordinator, Natural Communities Coalition

Diane Travis, Fire Management Specialist, USFS Angeles National Forest

Gregg Bratcher, Division Chief, CAL FIRE Southern Region

Jeff Heys, Forest Resource Officer, USFS Cleveland National Forest,

Kat Selm, Stewardship Associate, The Nature Conservancy

Kris Preston, Ecologist, USGS Western Ecological Research Center

Luca Carmignani, Wildland-Urban Interface Fire Advisor, University of California Cooperative Extension

Matthew Bokach, District Ranger, USFS Angeles National Forest

Max Moritz, Wildfire Specialist, University of California Cooperative Extension

Megan Jennings, Co-Director, Institute for Ecological Monitoring & Management and Research Scientist at San Diego State University

Michael O'Connell, President and CEO, Irvine Ranch Conservancy

Richard Halsey, Director, California Chaparral Institute

Rob Hazard, Fire Marshall, Santa Barbara County

Rorie Skei, Chief Deputy Director, Santa Monica Mountains Conservancy

Sarah McCullough Hennessy, Associate Ecologist, US Forest Service, Southern Province

Scott Tangenberg, Forest Supervisor, Cleveland National Forest

Stan Hill, Forestry & Fire Prevention Project Manager, RCD of Greater San Diego County

Susie Kirschner, Conservation Programs Manager, Inland Empire RCD

Trish Smith, Regional Ecologist, The Nature Conservancy

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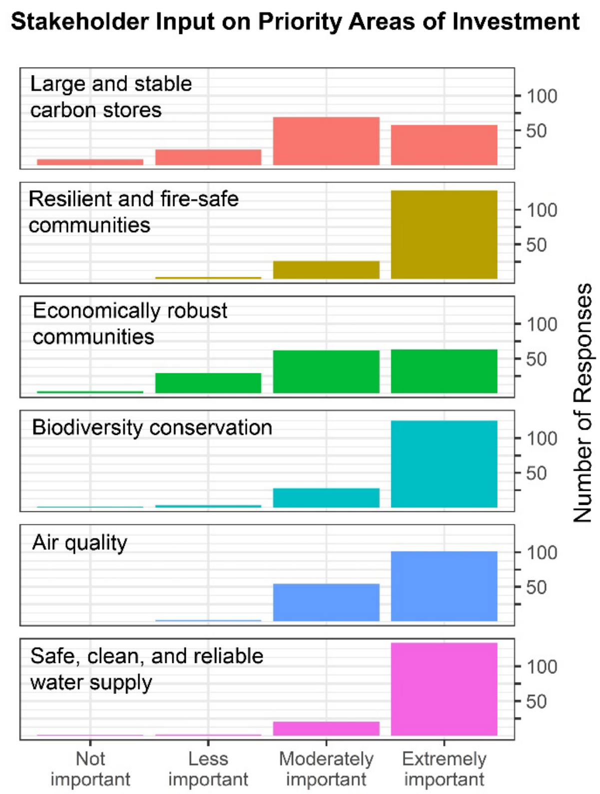
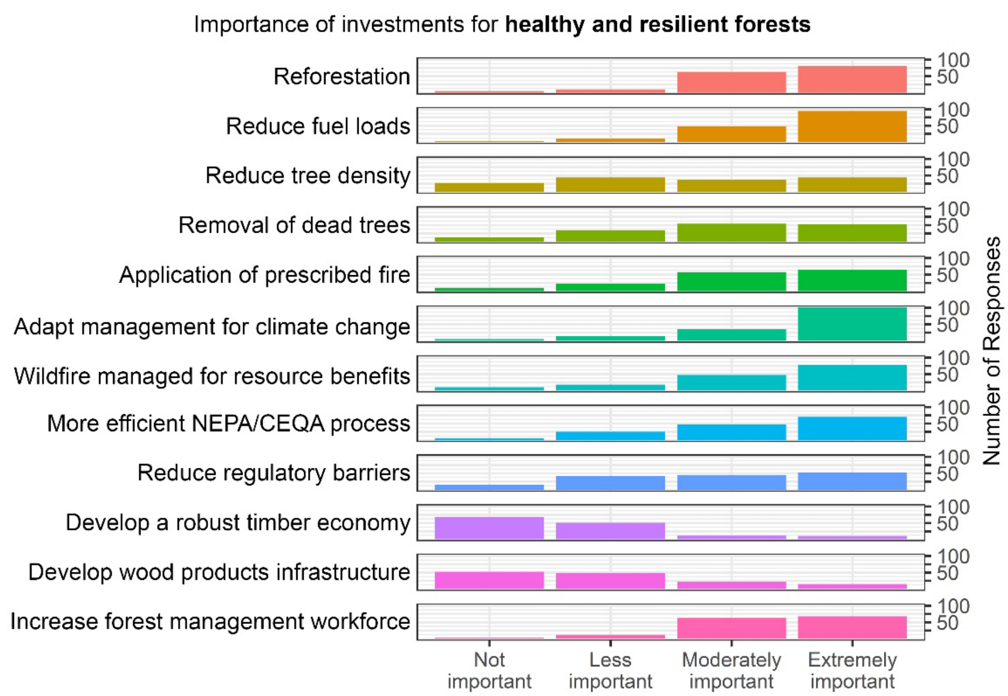
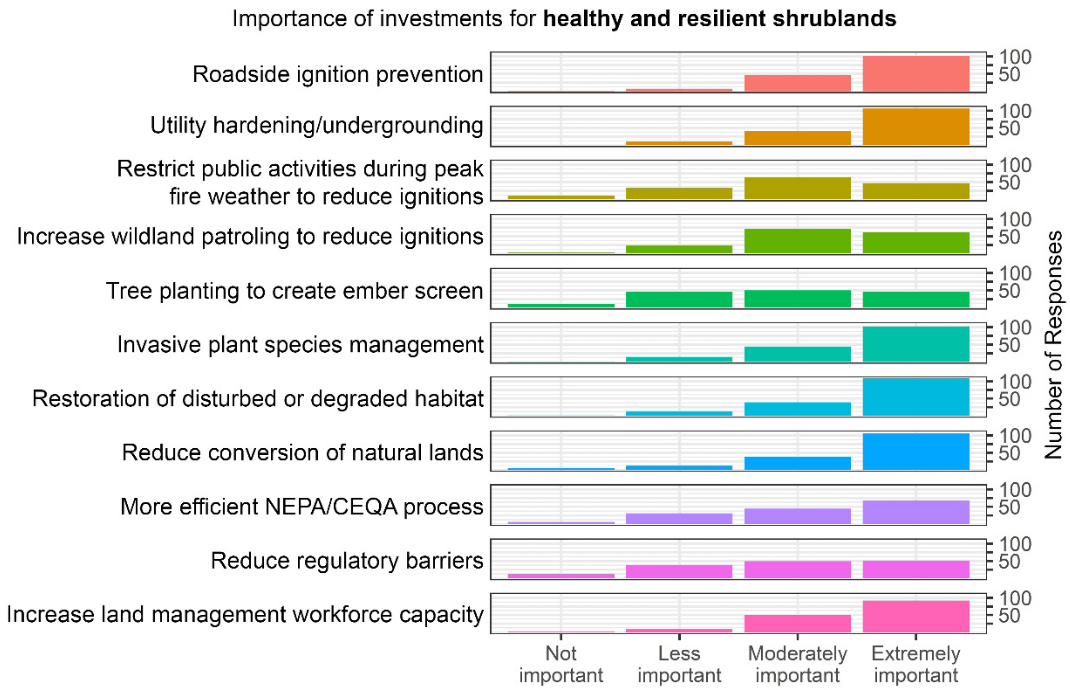
Southern California Survey Results

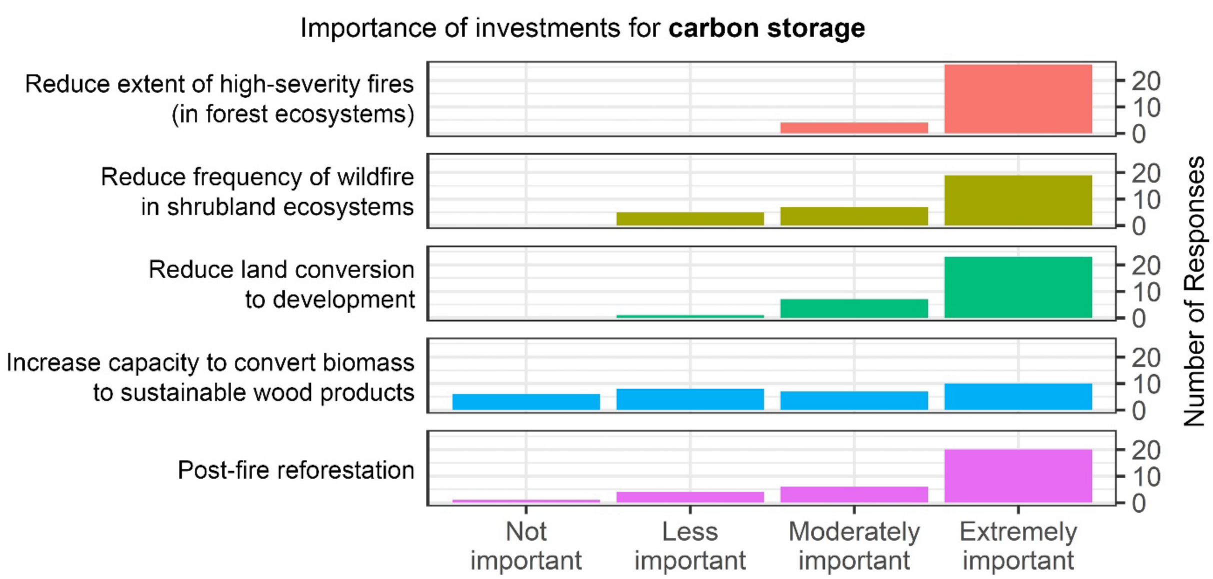
All Respondents





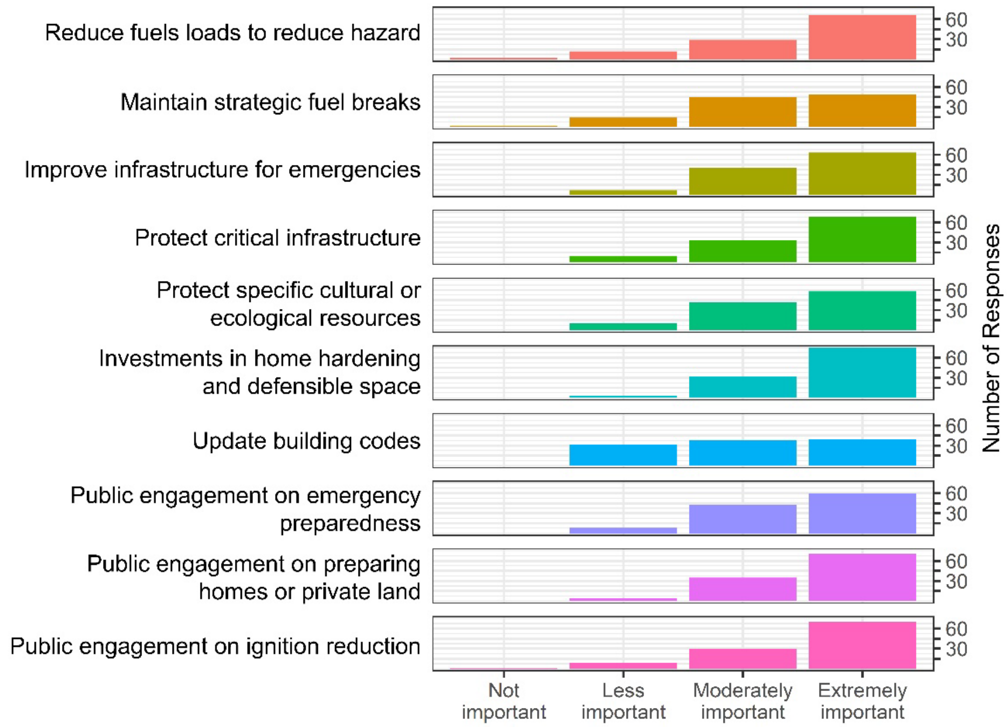


Importance of investments for **healthy and resilient shrublands**
Roadside ignition prevention
Utility hardening/undergrounding
Restrict public activities during peak fire weather to reduce ignitions
Increase wildland patroling to reduce ignitions
Tree planting to create ember screen
Invasive plant species management
Restoration of disturbed or degraded habitat
Reduce conversion of natural lands
More efficient NEPA/CEQA process
Reduce regulatory barriers
Increase land management workforce capacity
100
50
Number of Responses
Not important
Less important
Moderately important
Extremely important

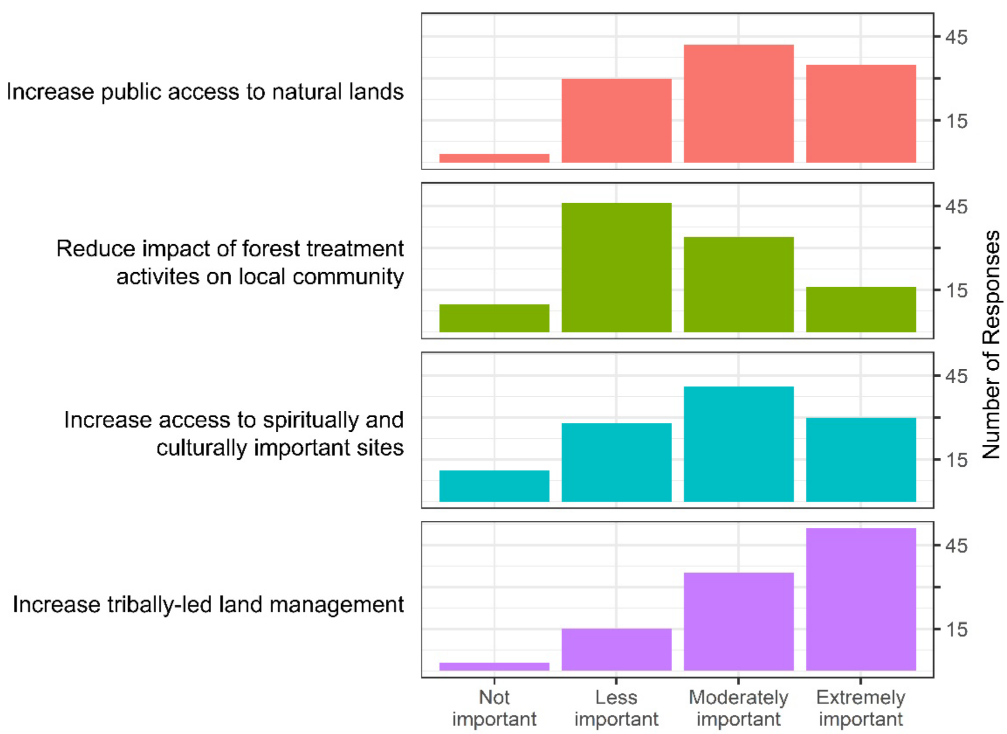


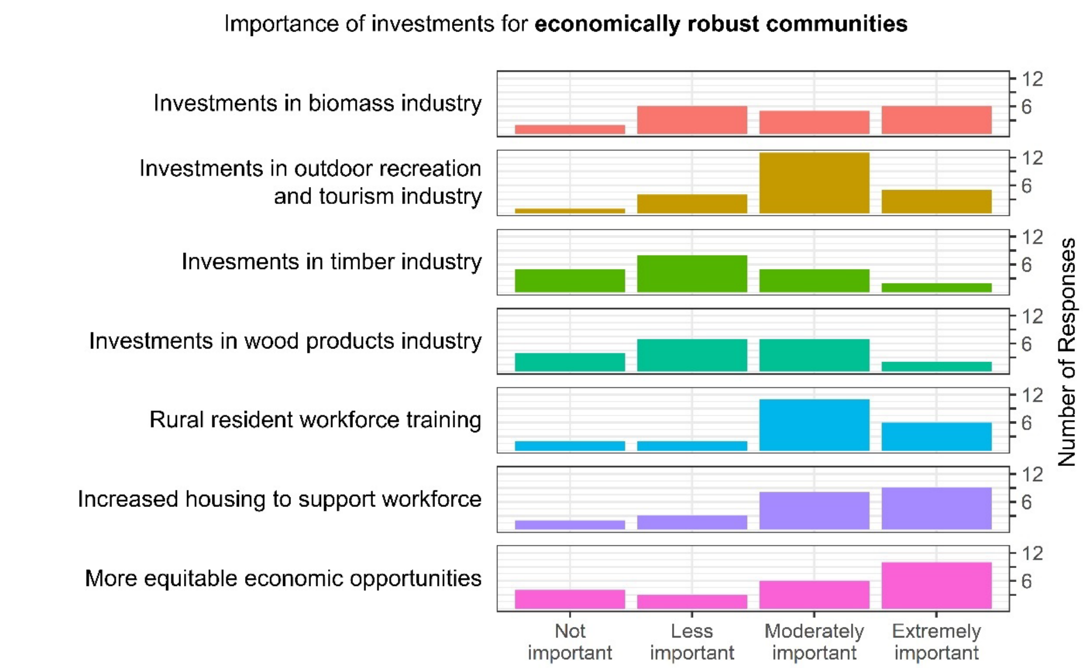
Importance of investments for **carbon storage**
Reduce extent of high-severity fires (in forest ecosystems)
Reduce frequency of wildfire in shrubland ecosystems
Reduce land conversion to development
Increase capacity to convert biomass to sustainable wood products
Post-fire reforestation
20
10
0
Number of Responses
Not important
Less important
Moderately important
Extremely important

Importance of investments for **resilient communities: fire safety and preparedness**

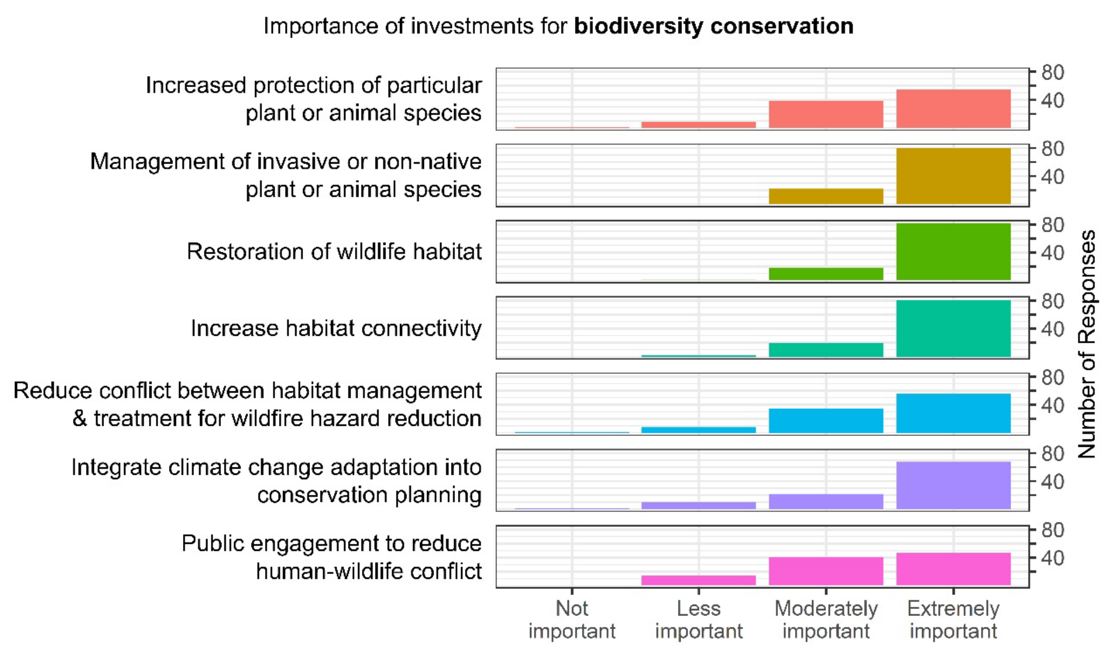


Importance of investments for **resilient communities: community well-being**



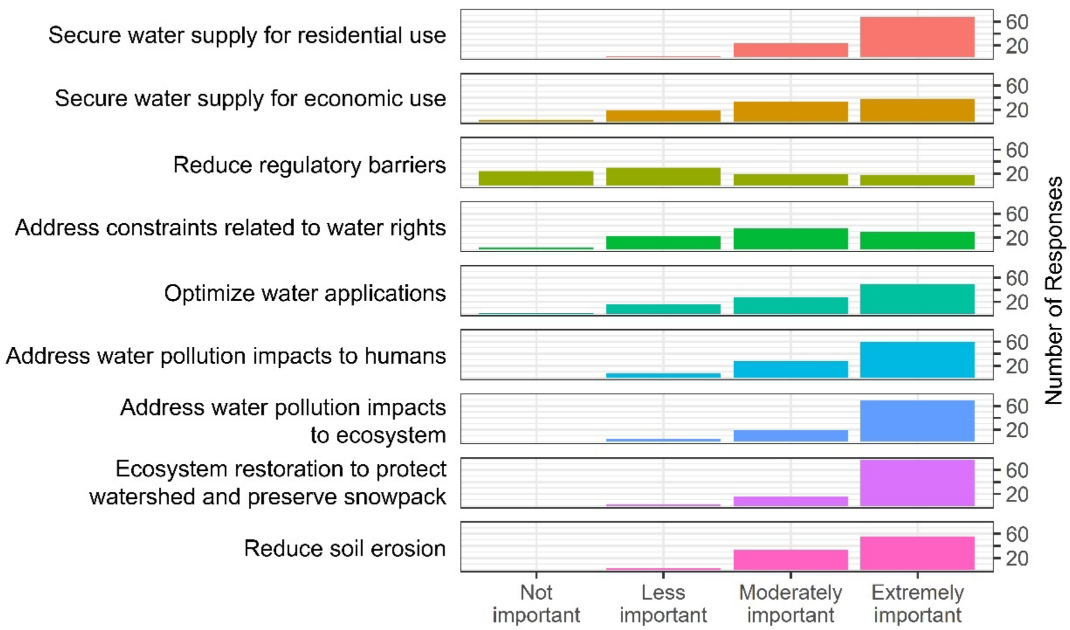


Importance of investments for **economically robust communities**
Investments in biomass industry
Investments in outdoor recreation and tourism industry
Invesments in timber industry
Investments in wood products industry
Rural resident workforce training
Increased housing to support workforce
More equitable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

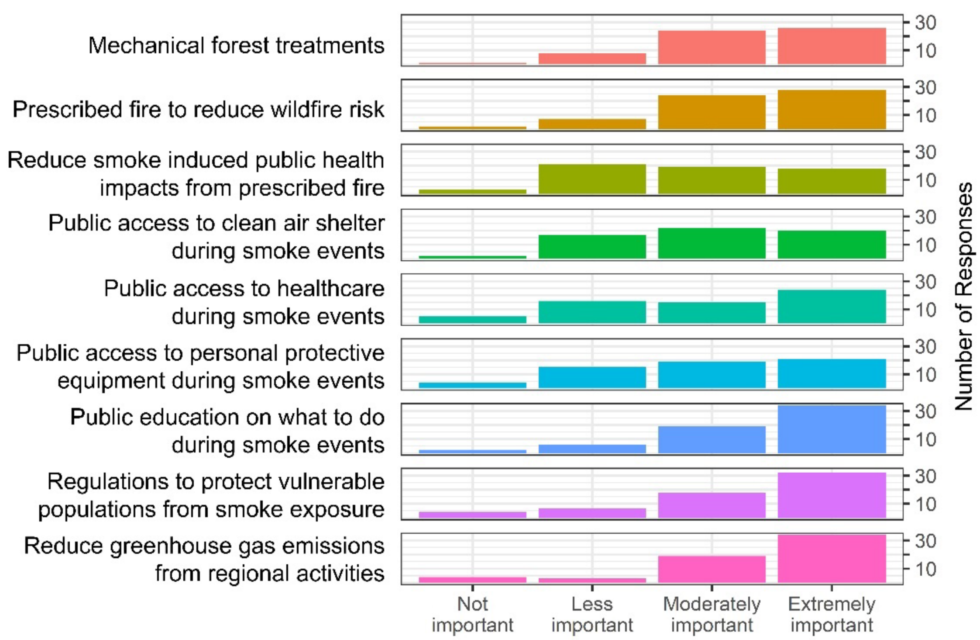


Importance of investments for **biodiversity conservation**
Increased protection of particular plant or animal species
Management of invasive or non-native plant or animal species
Restoration of wildlife habitat
Increase habitat connectivity
Reduce conflict between habitat management & treatment for wildfire hazard reduction
Integrate climate change adaptation into conservation planning
Public engagement to reduce human-wildlife conflict
80
40
Number of Responses
Not important
Less important
Moderately important
Extremely important

Importance of investments for **water security**

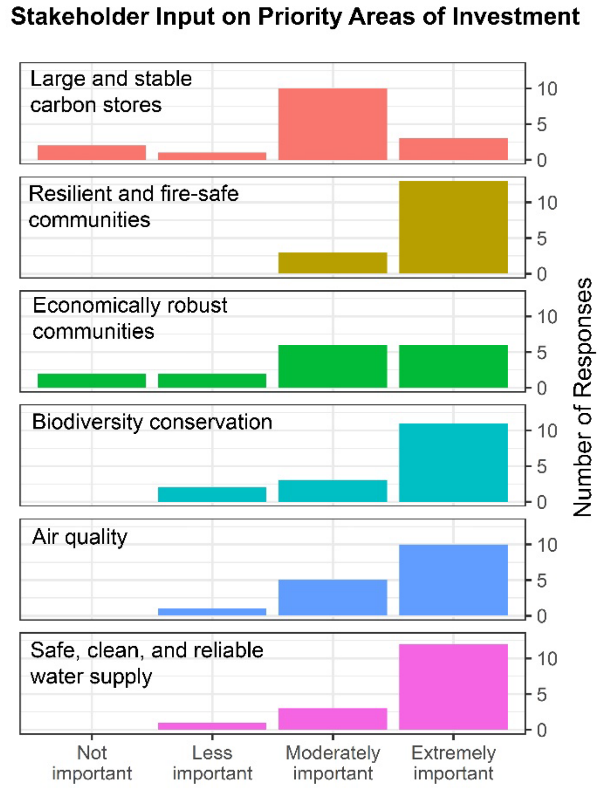


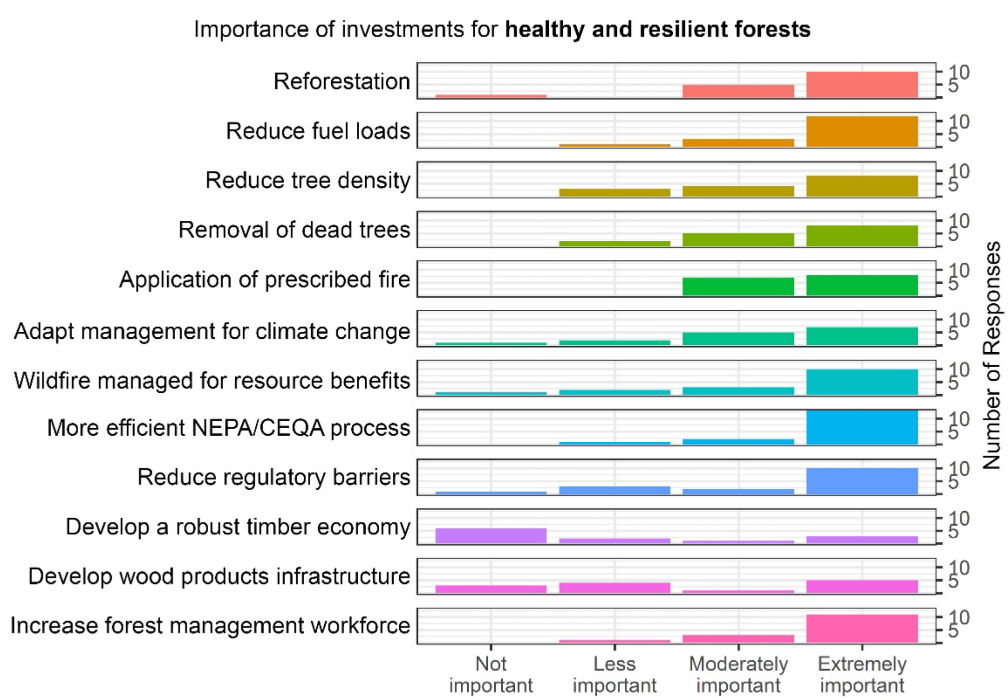
Importance of investments for **clean air**

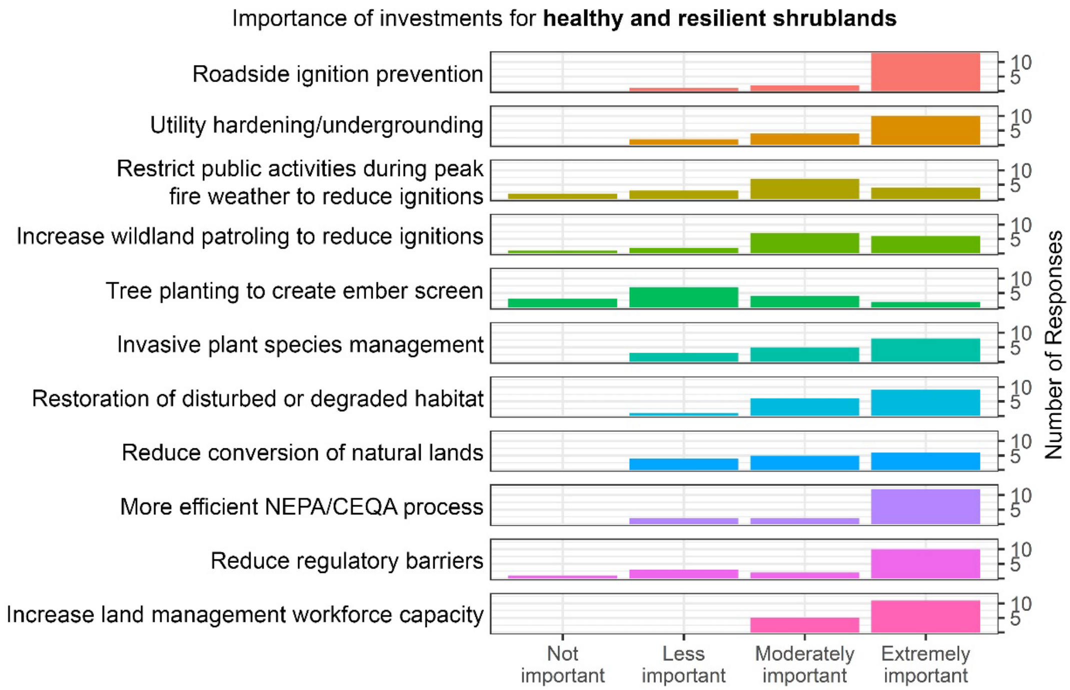


Southern California Survey Results

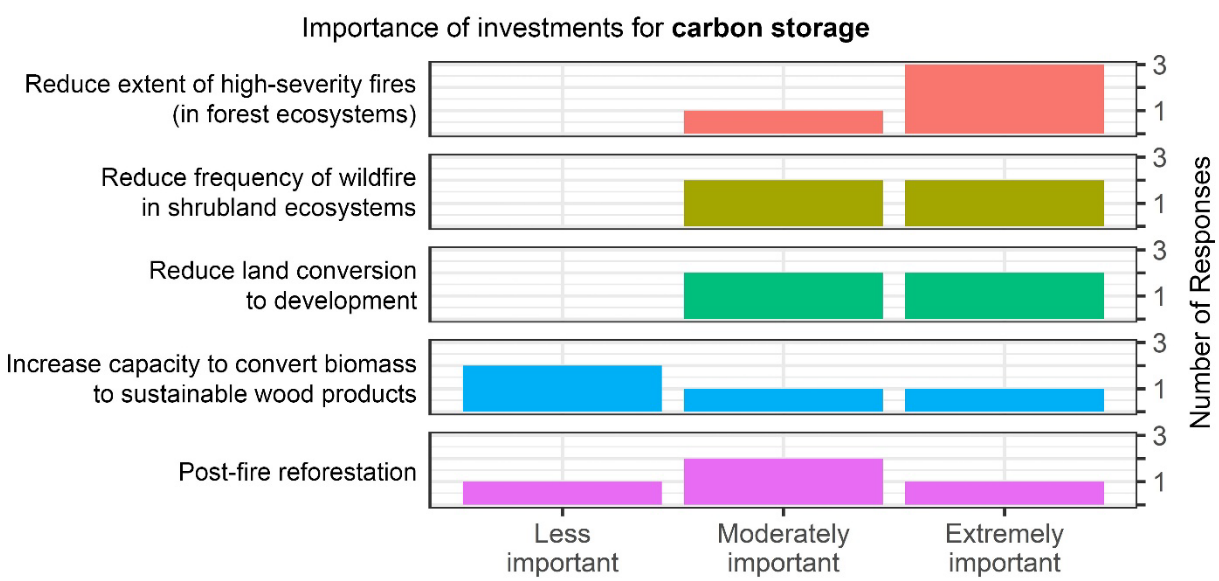
"Entire SoCal Region" Respondents



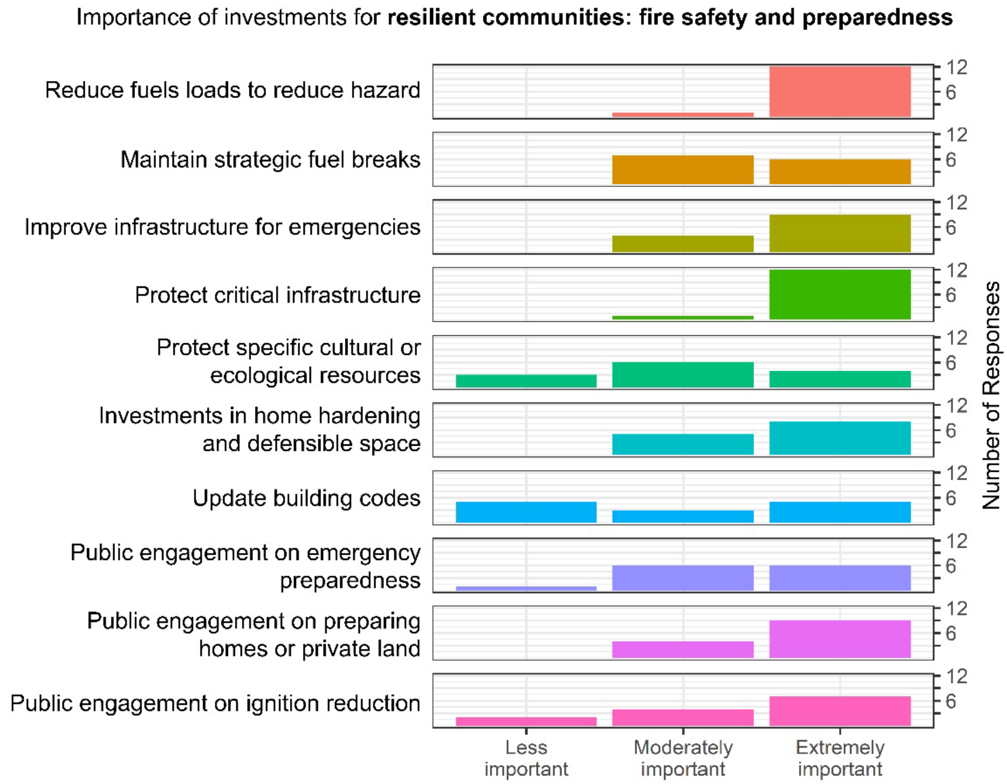




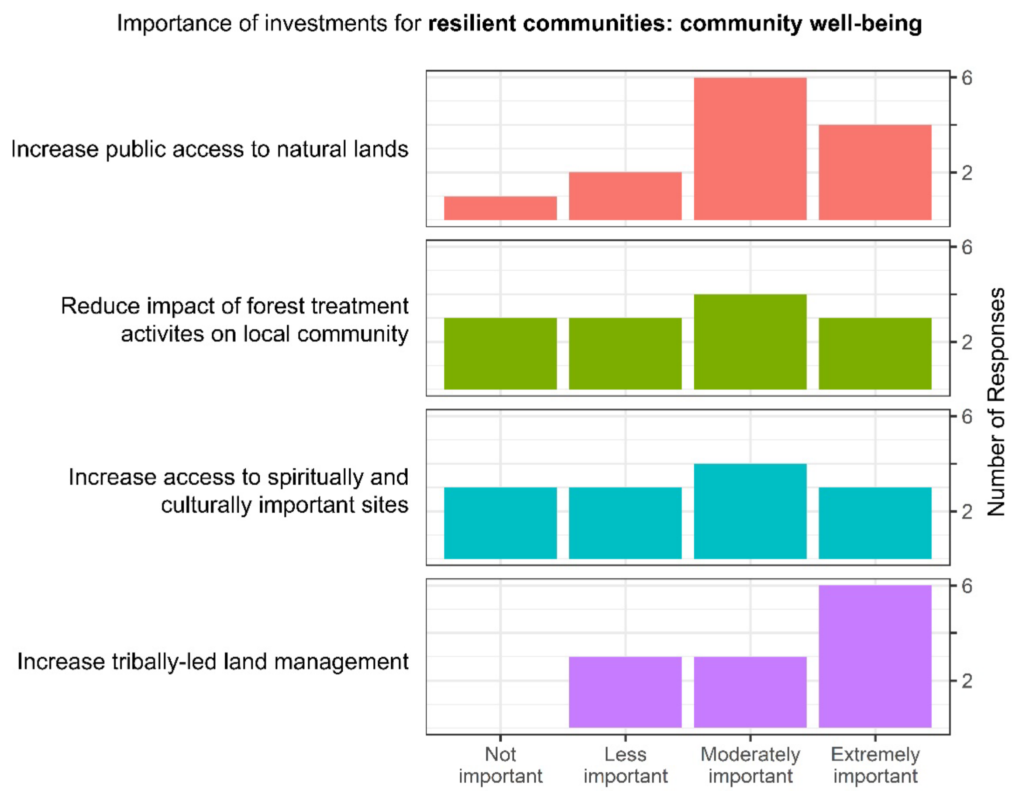
Importance of investments for **healthy and resilient shrublands**
Roadside ignition prevention
Utility hardening/undergrounding
Restrict public activities during peak fire weather to reduce ignitions
Increase wildland patroling to reduce ignitions
Tree planting to create ember screen
Invasive plant species management
Restoration of disturbed or degraded habitat
Reduce conversion of natural lands
More efficient NEPA/CEQA process
Reduce regulatory barriers
Increase land management workforce capacity
Not important
Less important
Moderately important
Extremely important
Number of Responses



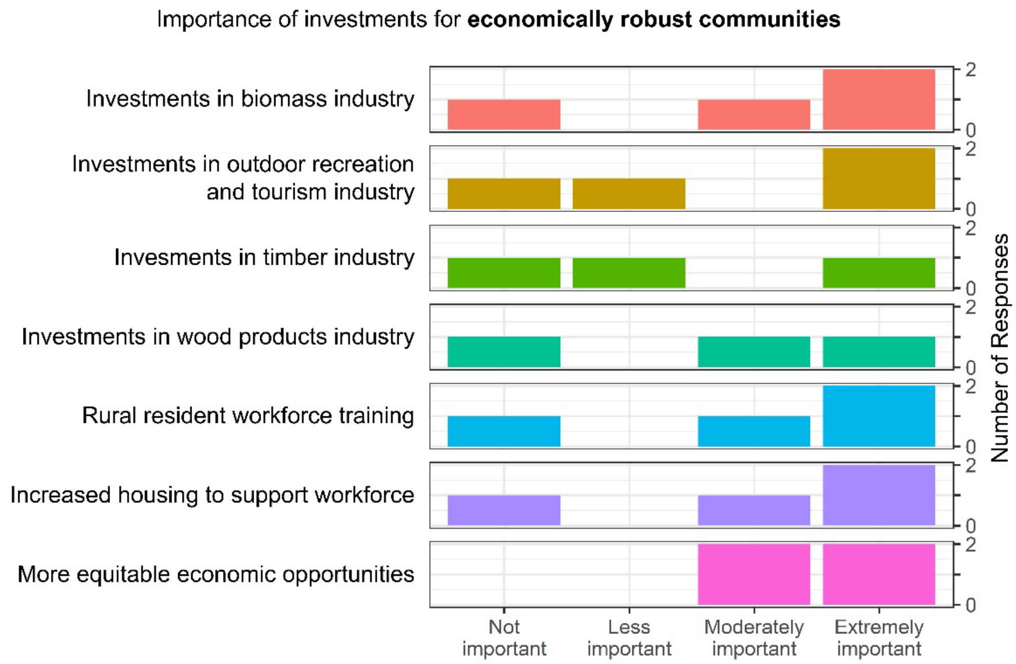
Importance of investments for **carbon storage**
Reduce extent of high-severity fires (in forest ecosystems)
Reduce frequency of wildfire in shrubland ecosystems
Reduce land conversion to development
Increase capacity to convert biomass to sustainable wood products
Post-fire reforestation
Less important
Moderately important
Extremely important
Number of Responses



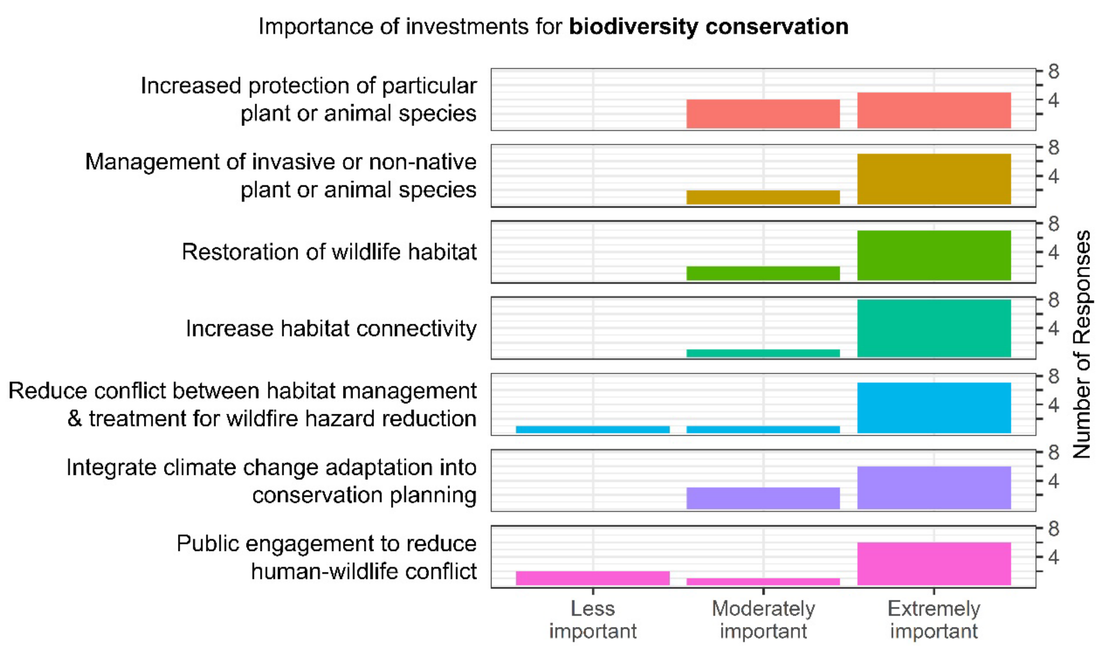
Importance of investments for **resilient communities: fire safety and preparedness**
Reduce fuels loads to reduce hazard
Maintain strategic fuel breaks
Improve infrastructure for emergencies
Protect critical infrastructure
Protect specific cultural or ecological resources
Investments in home hardening and defensible space
Update building codes
Public engagement on emergency preparedness
Public engagement on preparing homes or private land
Public engagement on ignition reduction
12
6
Number of Responses
Less important
Moderately important
Extremely important



Importance of investments for **resilient communities: community well-being**
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
6
2
Number of Responses
Not important
Less important
Moderately important
Extremely important

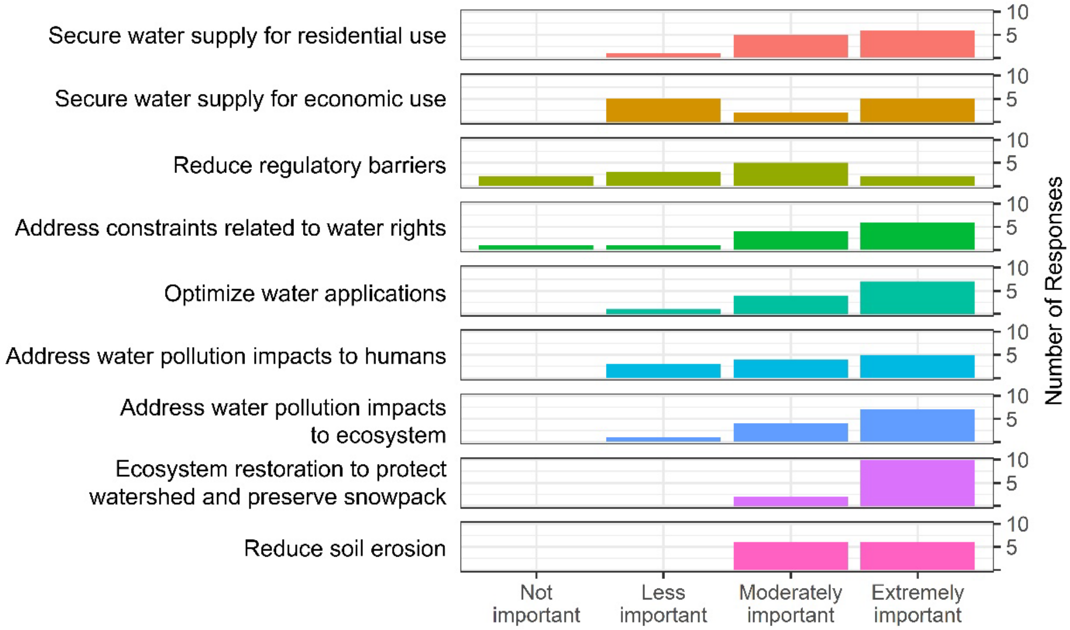


Importance of investments for economically robust communities
Investments in biomass industry
Investments in outdoor recreation and tourism industry
Invesments in timber industry
Investments in wood products industry
Rural resident workforce training
Increased housing to support workforce
More equitable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

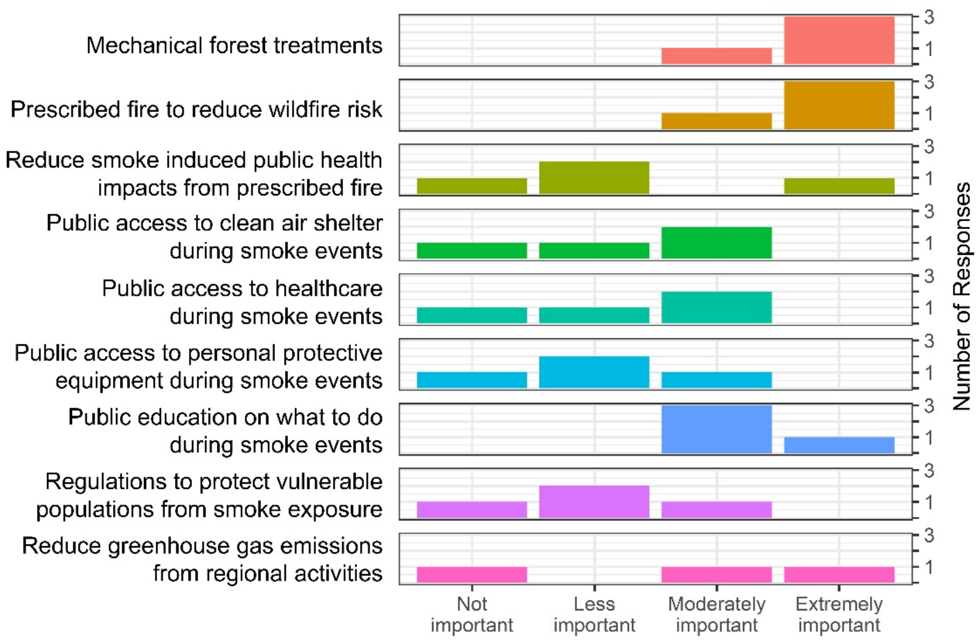


Importance of investments for biodiversity conservation
Increased protection of particular plant or animal species
Management of invasive or non-native plant or animal species
Restoration of wildlife habitat
Increase habitat connectivity
Reduce conflict between habitat management & treatment for wildfire hazard reduction
Integrate climate change adaptation into conservation planning
Public engagement to reduce human-wildlife conflict
Less important
Moderately important
Extremely important
Number of Responses

Importance of investments for **water security**

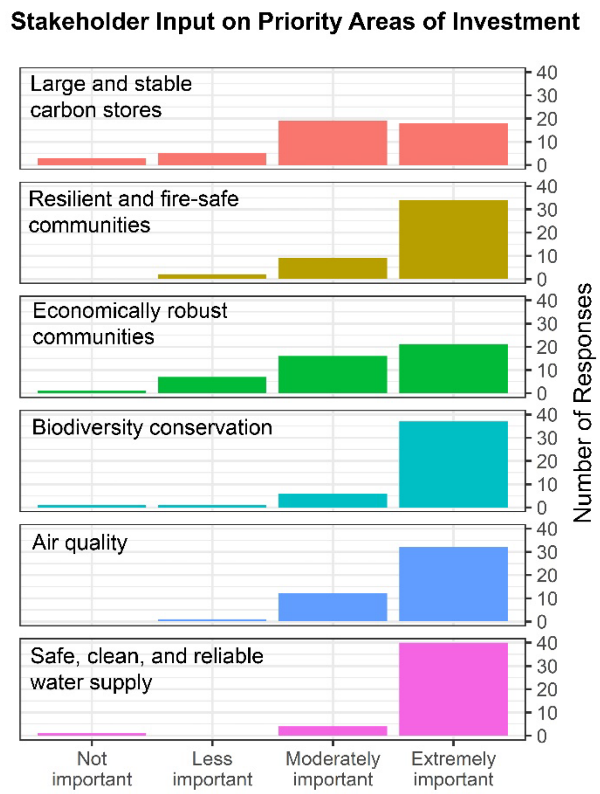


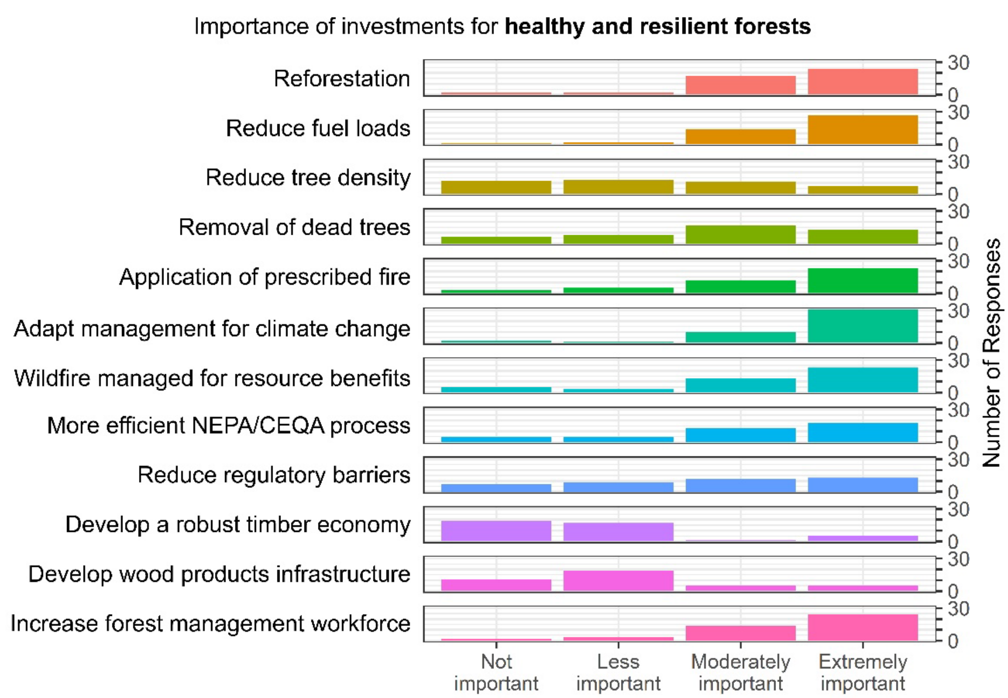
Importance of investments for **clean air**

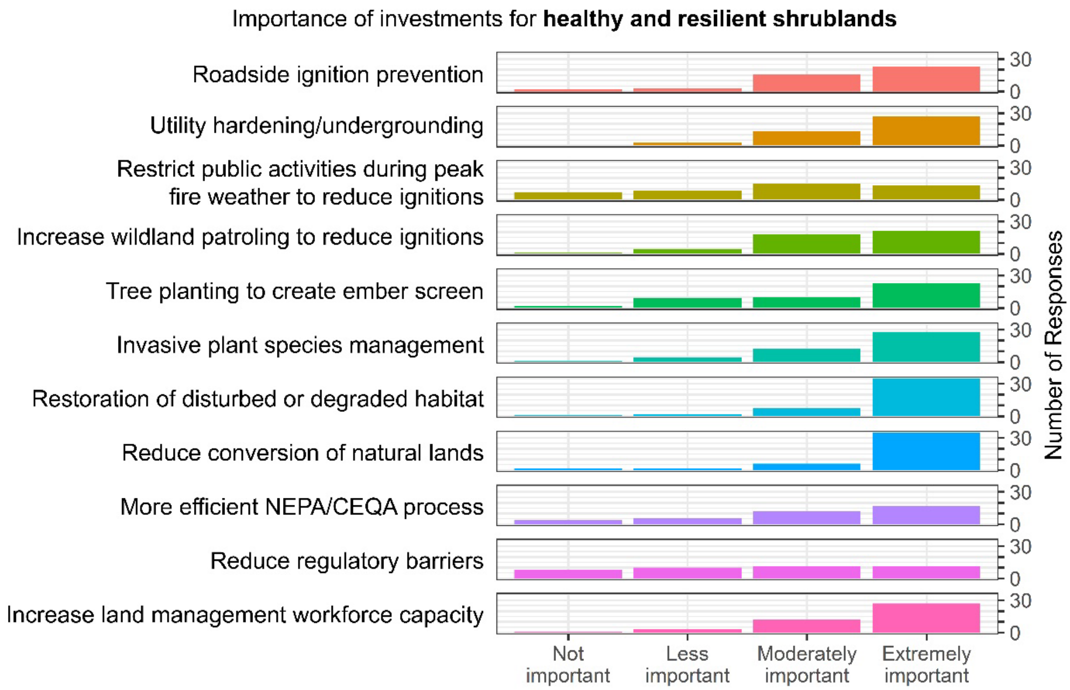


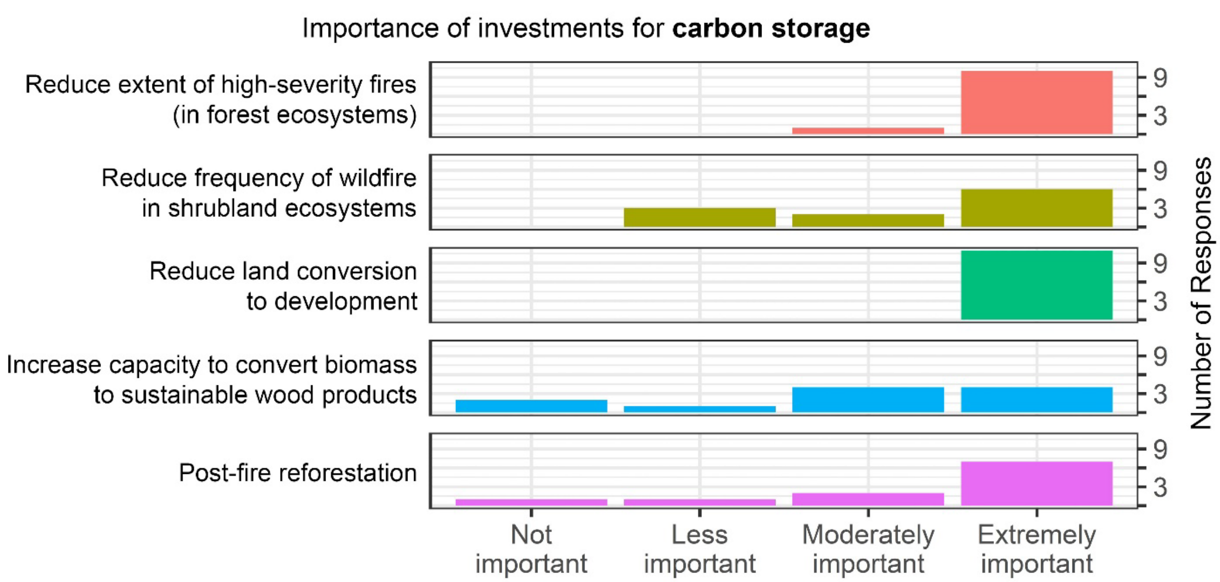
Southern California Survey Results

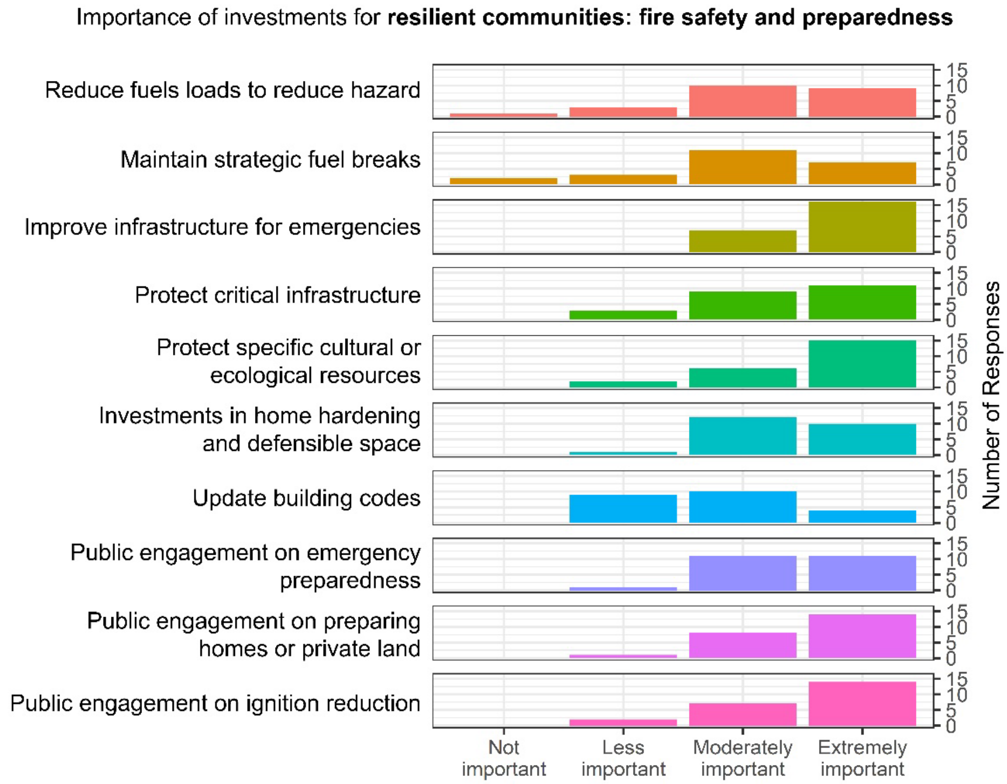
Los Angeles County Respondents

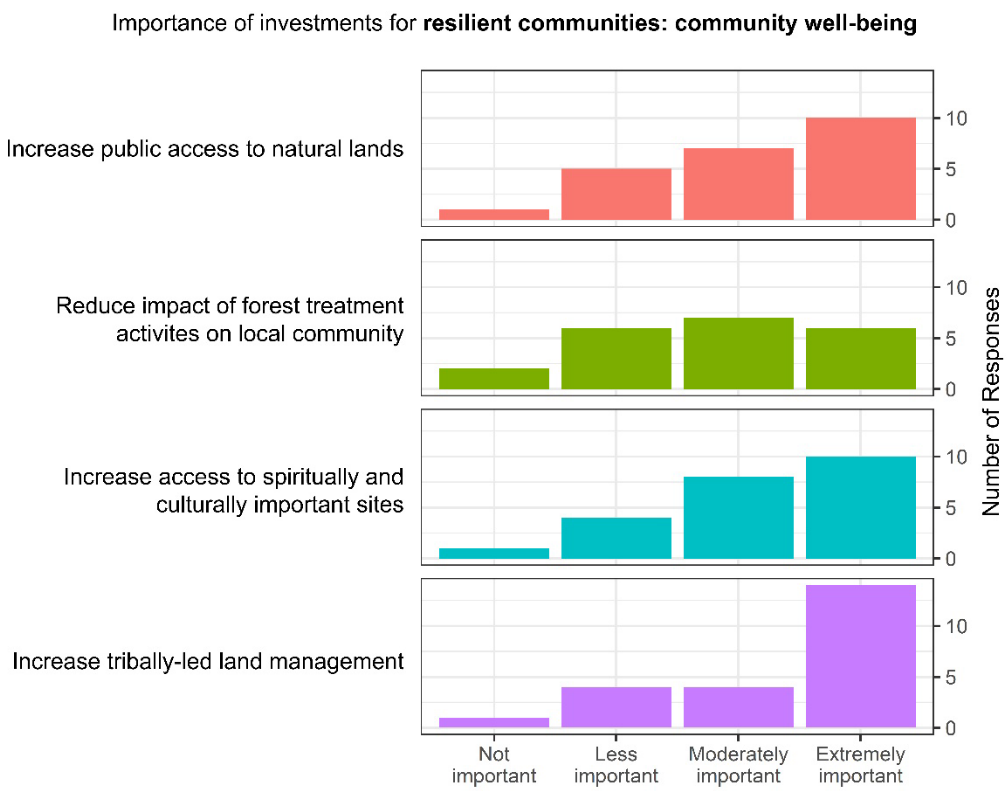


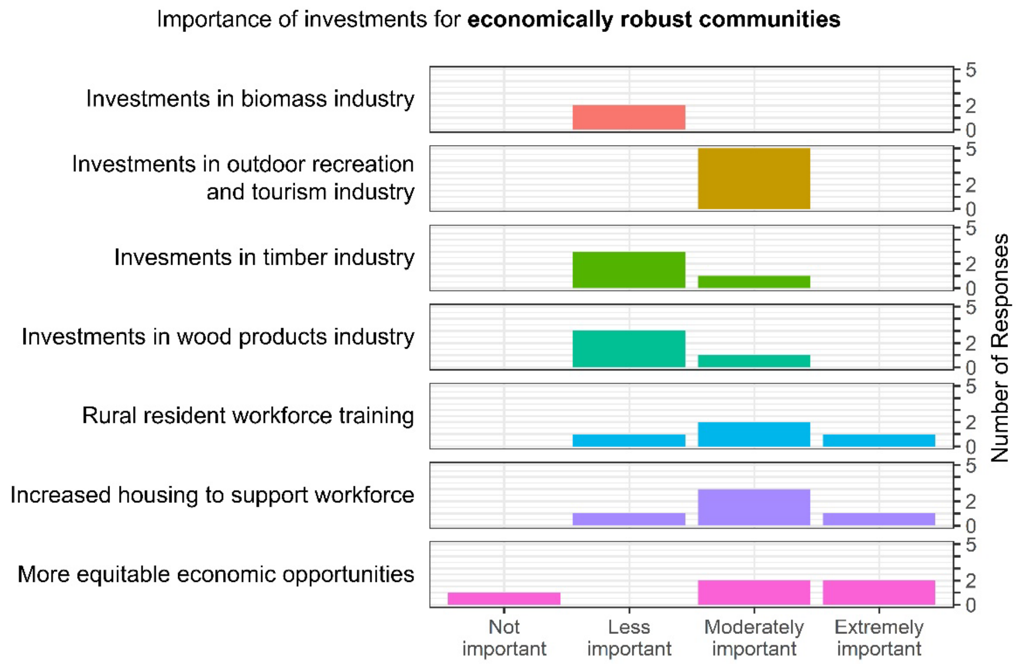


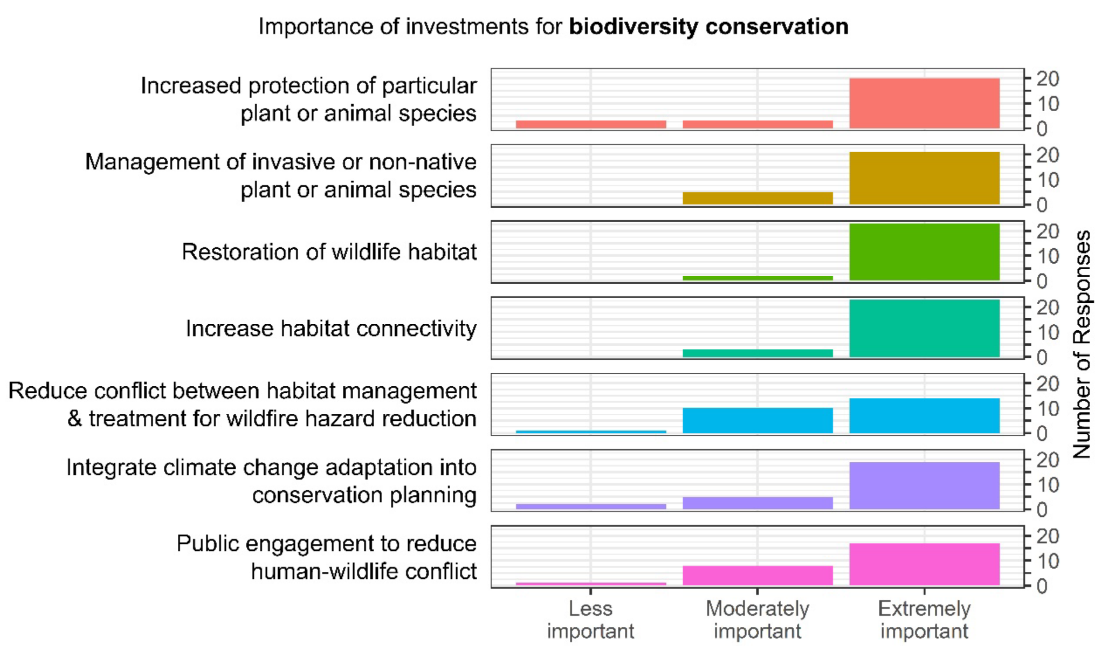

Importance of investments for **healthy and resilient shrublands**
Roadside ignition prevention
Utility hardening/undergrounding
Restrict public activities during peak fire weather to reduce ignitions
Increase wildland patroling to reduce ignitions
Tree planting to create ember screen
Invasive plant species management
Restoration of disturbed or degraded habitat
Reduce conversion of natural lands
More efficient NEPA/CEQA process
Reduce regulatory barriers
Increase land management workforce capacity
30
0
Number of Responses
Not important
Less important
Moderately important
Extremely important

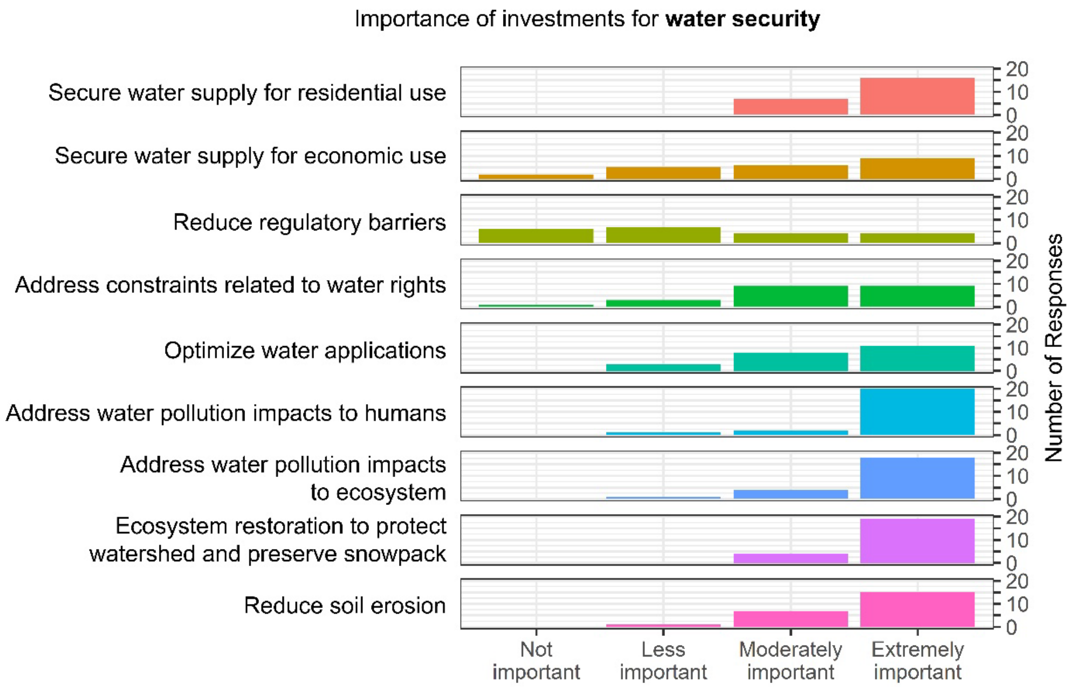

Importance of investments for **carbon storage**
Reduce extent of high-severity fires (in forest ecosystems)
Reduce frequency of wildfire in shrubland ecosystems
Reduce land conversion to development
Increase capacity to convert biomass to sustainable wood products
Post-fire reforestation
9
3
Number of Responses
Not important
Less important
Moderately important
Extremely important


Importance of investments for **resilient communities: fire safety and preparedness**
Reduce fuels loads to reduce hazard
Maintain strategic fuel breaks
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
Public engagement on ignition reduction
Not important
Less important
Moderately important
Extremely important
Number of Responses
0
5
10
15

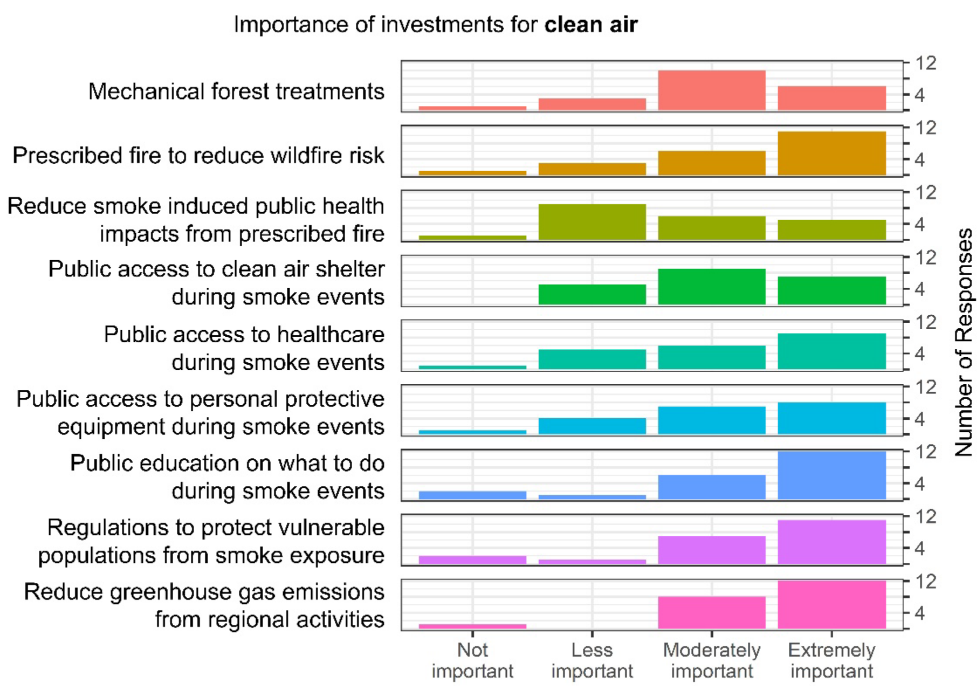

Importance of investments for **resilient communities: community well-being**
Increase public access to natural lands
Reduce impact of forest treatment activites on local community
Increase access to spiritually and culturally important sites
Increase tribally-led land management
Not important
Less important
Moderately important
Extremely important
Number of Responses
0
5
10


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
Not important
Less important
Moderately important
Extremely important
Number of Responses
0
2
5


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
Integrate climate change adaptation into conservation planning
Public engagement to reduce human-wildlife conflict
Less important
Moderately important
Extremely important
Number of Responses
0
10
20



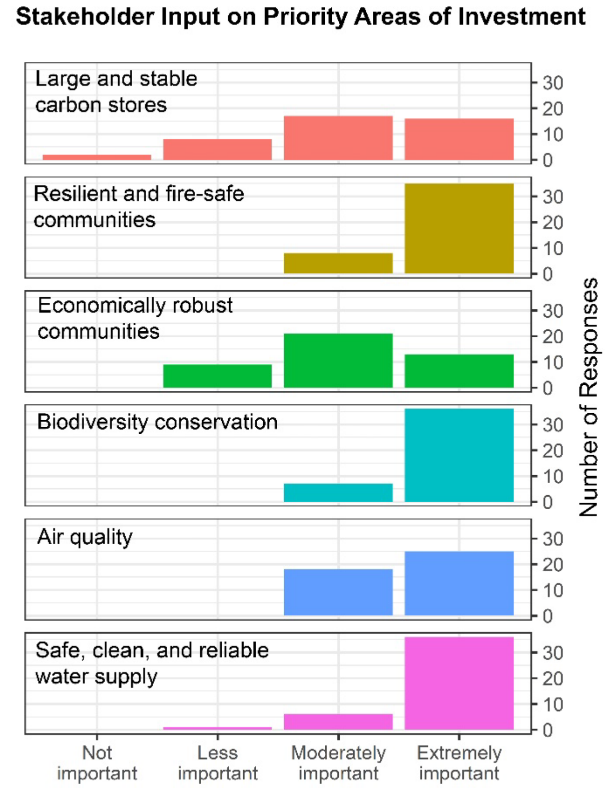
Importance of investments for **water security**
Secure water supply for residential use
Secure water supply for economic use
Reduce regulatory barriers
Address constraints related to water rights
Optimize water applications
Address water pollution impacts to humans
Address water pollution impacts to ecosystem
Ecosystem restoration to protect watershed and preserve snowpack
Reduce soil erosion
Not important
Less important
Moderately important
Extremely important
Number of Responses
0
10
20

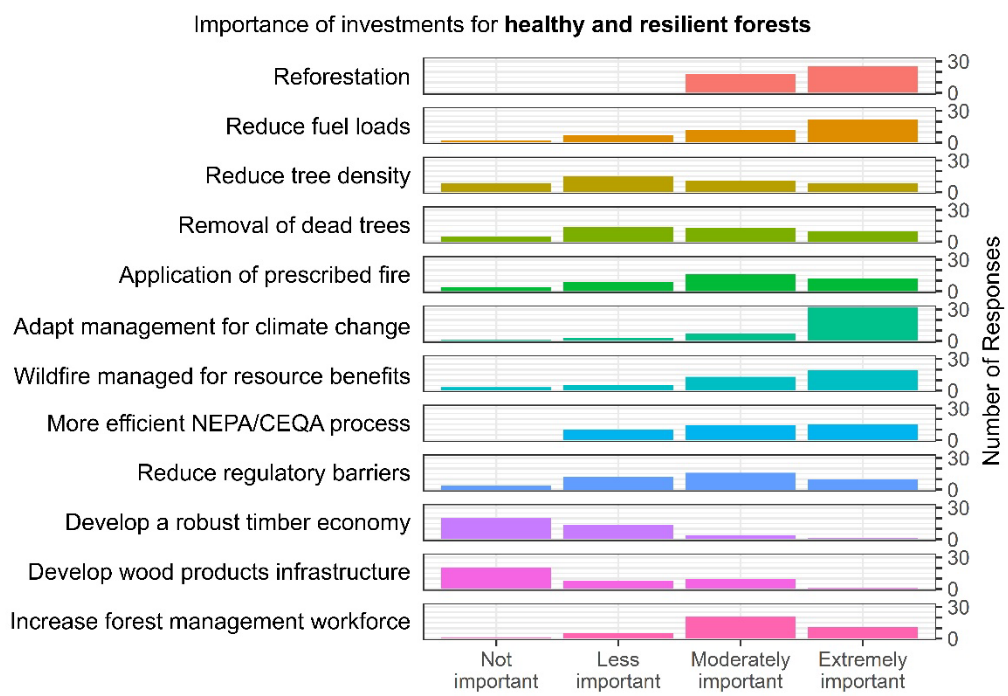


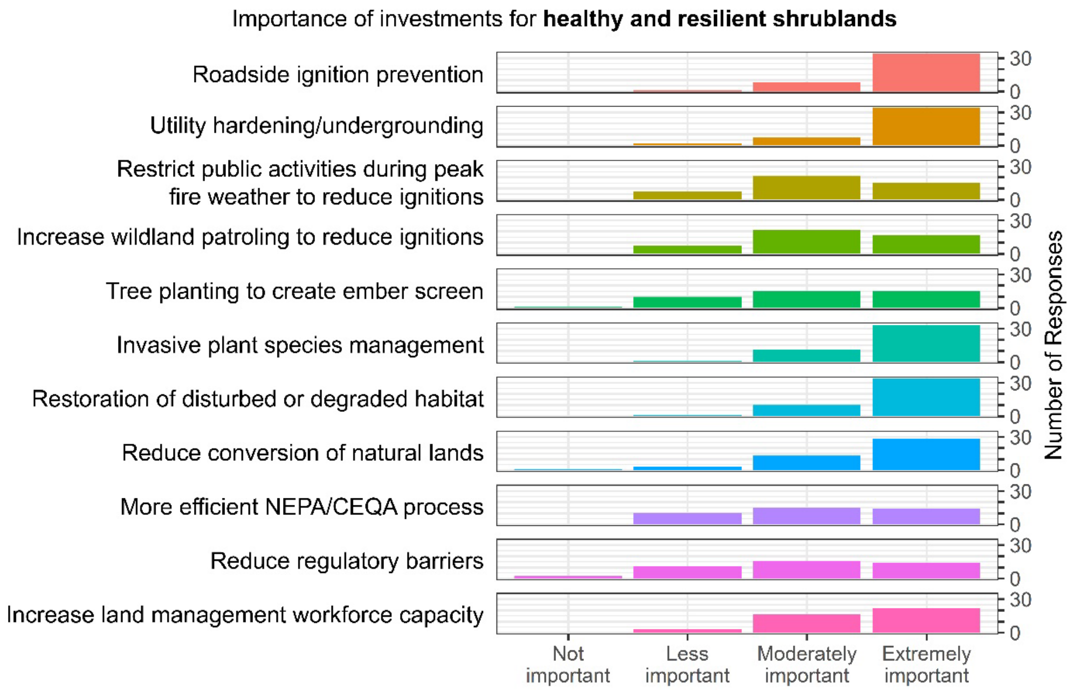
Importance of investments for **clean air**
Mechanical forest treatments
Prescribed fire to reduce wildfire risk
Reduce smoke induced public health impacts from prescribed fire
Public access to clean air shelter during smoke events
Public access to healthcare during smoke events
Public access to personal 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 Responses
4
12

Southern California Survey Results

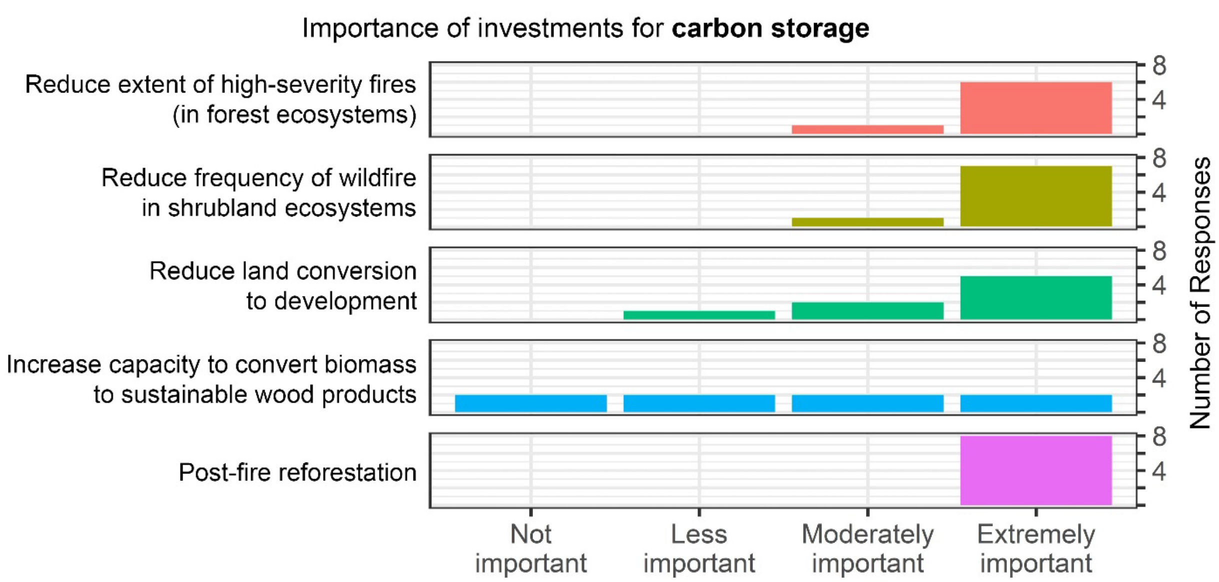
Orange County Respondents



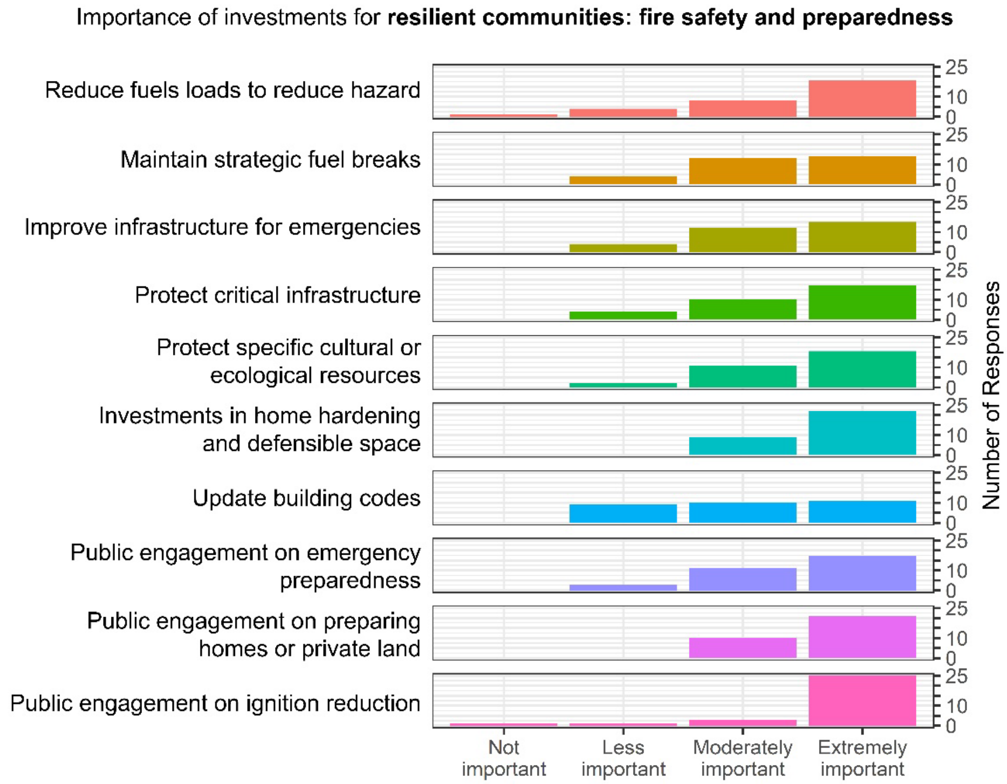




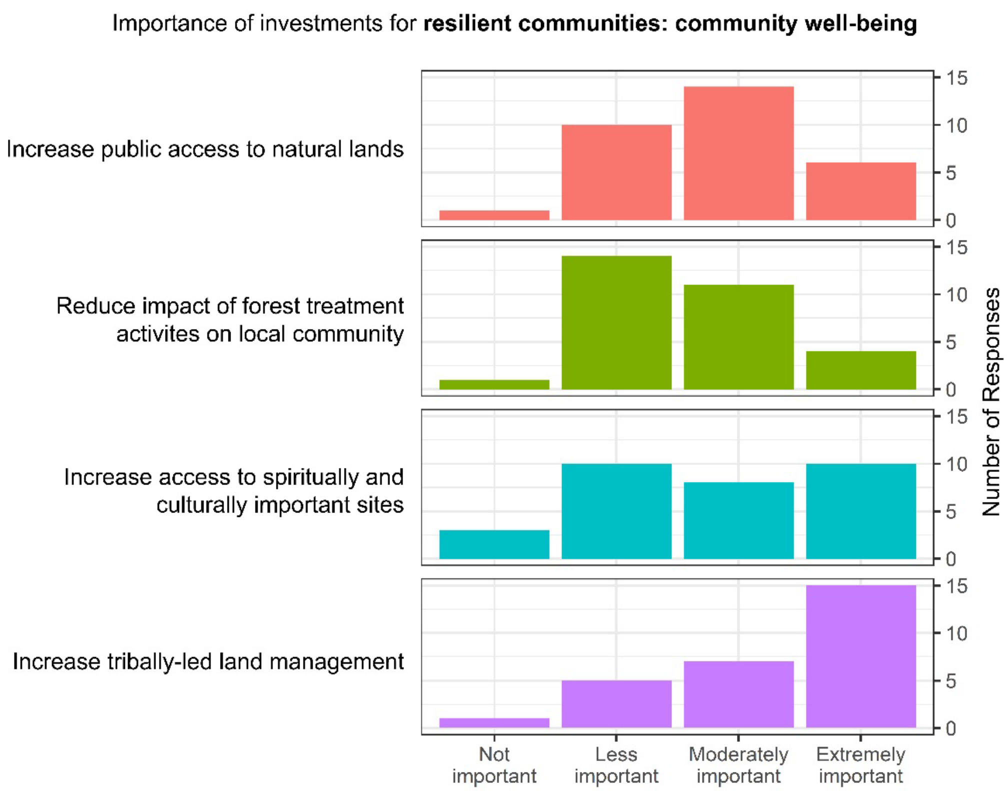
Importance of investments for **healthy and resilient shrublands**
Roadside ignition prevention
Utility hardening/undergrounding
Restrict public activities during peak fire weather to reduce ignitions
Increase wildland patroling to reduce ignitions
Tree planting to create ember screen
Invasive plant species management
Restoration of disturbed or degraded habitat
Reduce conversion of natural lands
More efficient NEPA/CEQA process
Reduce regulatory barriers
Increase land management workforce capacity
30
0
Number of Responses
Not important
Less important
Moderately important
Extremely important



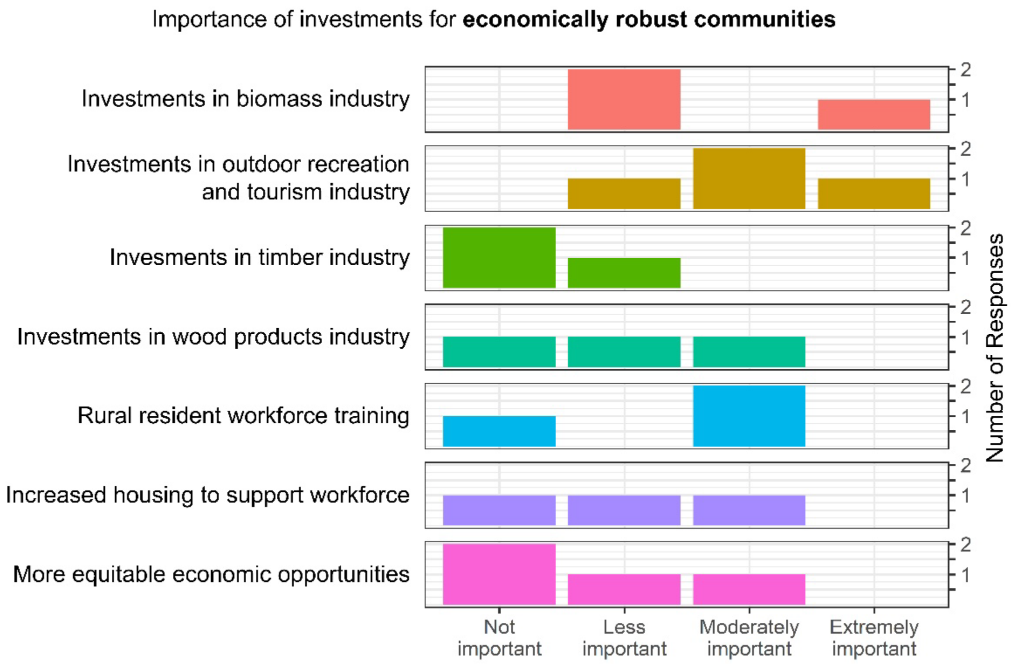
Importance of investments for **carbon storage**
Reduce extent of high-severity fires (in forest ecosystems)
Reduce frequency of wildfire in shrubland ecosystems
Reduce land conversion to development
Increase capacity to convert biomass to sustainable wood products
Post-fire reforestation
8
4
Number of Responses
Not important
Less important
Moderately important
Extremely important

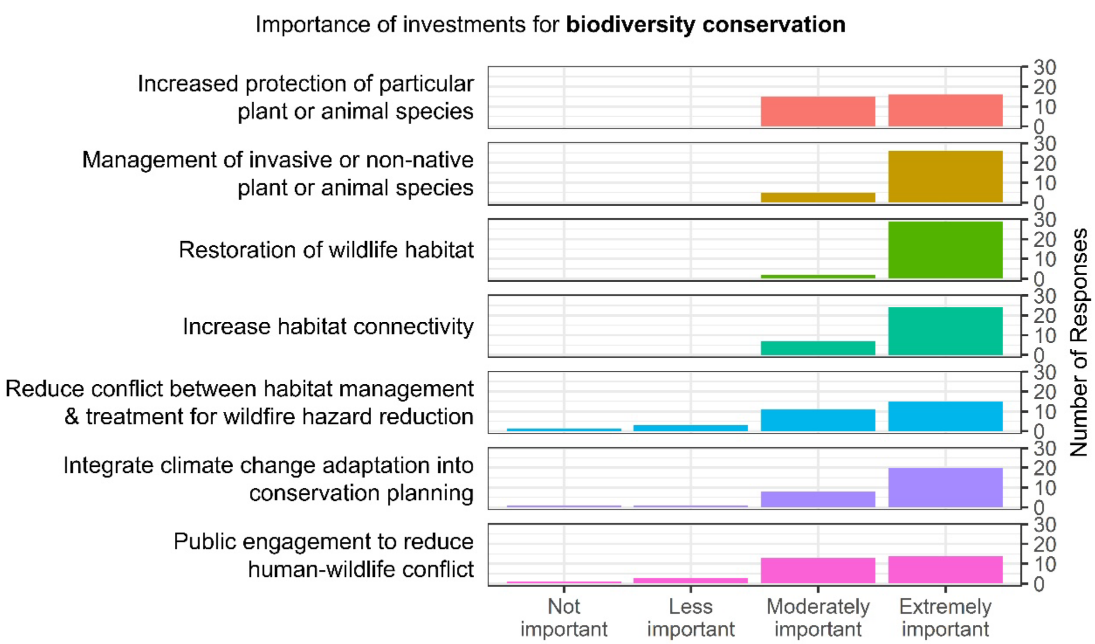


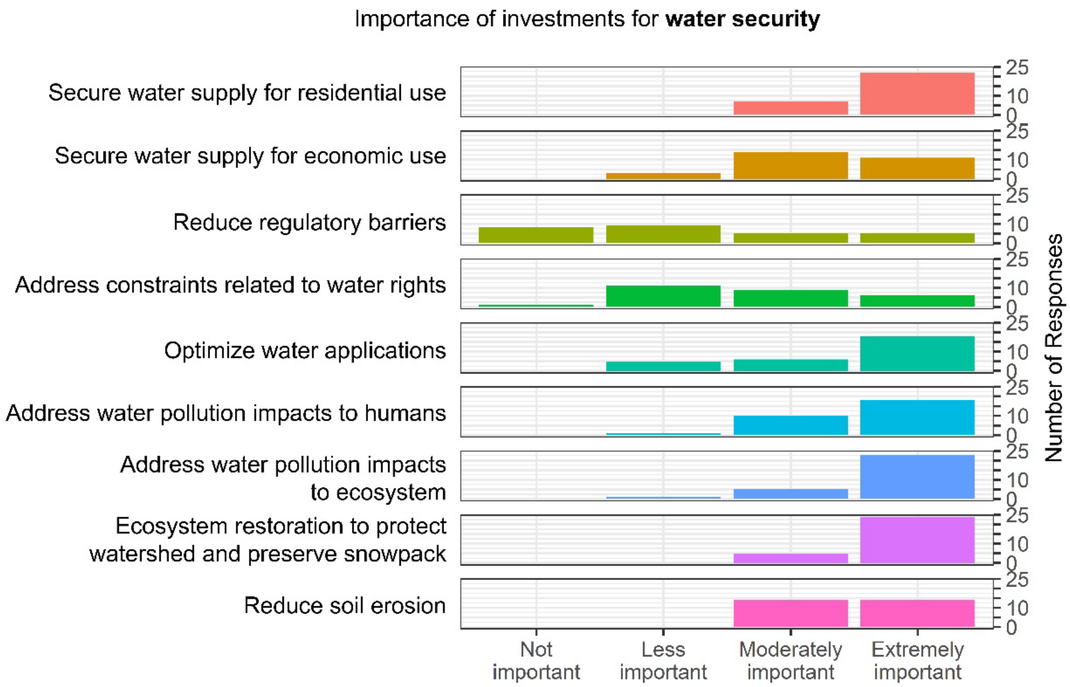
Importance of investments for **resilient communities: fire safety and preparedness**
Reduce fuels loads to reduce hazard
Maintain strategic fuel breaks
Improve infrastructure for emergencies
Protect critical infrastructure
Protect specific cultural or ecological resources
Investments in home hardening and defensible space
Update building codes
Public engagement on emergency preparedness
Public engagement on preparing homes or private land
Public engagement on ignition reduction
Not important
Less important
Moderately important
Extremely important
Number of Responses
0
10
25

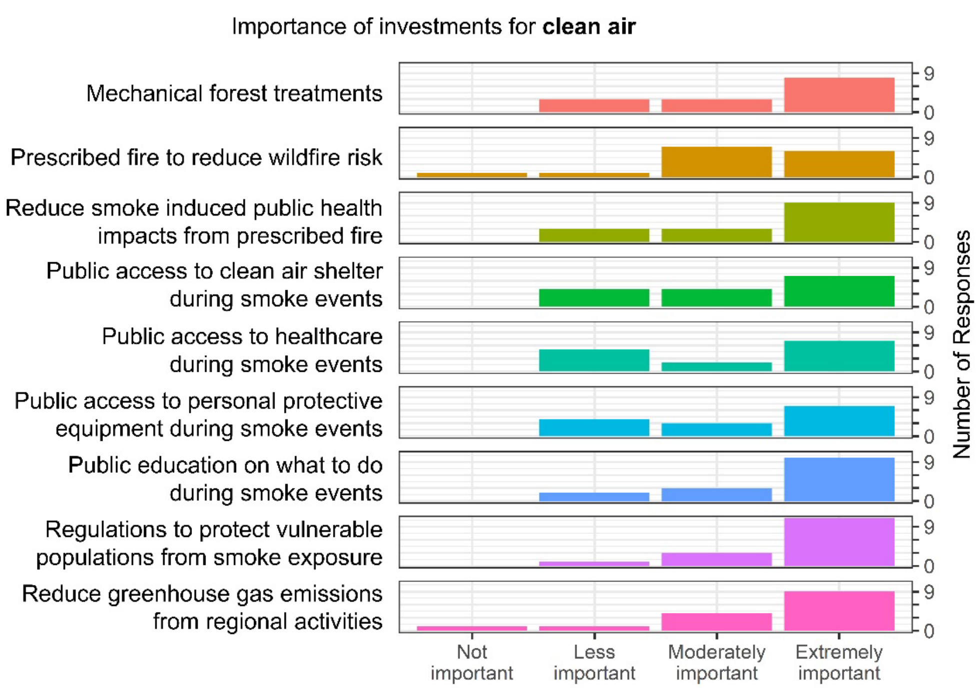


Importance of investments for **resilient communities: community well-being**
Increase public access to natural lands
Reduce impact of forest treatment activites on local community
Increase access to spiritually and culturally important sites
Increase tribally-led land management
Not important
Less important
Moderately important
Extremely important
Number of Responses
0
5
10
15


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
Not important
Less important
Moderately important
Extremely important
Number of Responses

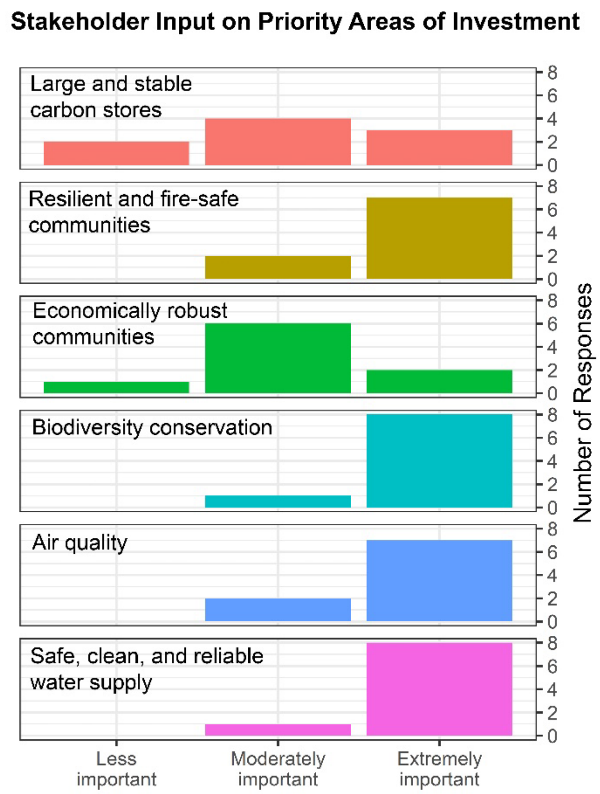

Importance of investments for biodiversity conservation
Increased protection of particular plant or animal species
Management of invasive or non-native plant or animal species
Restoration of wildlife habitat
Increase habitat connectivity
Reduce conflict between habitat management & treatment for wildfire hazard reduction
Integrate climate change adaptation into conservation planning
Public engagement to reduce human-wildlife conflict
Not important
Less important
Moderately important
Extremely important
Number of Responses

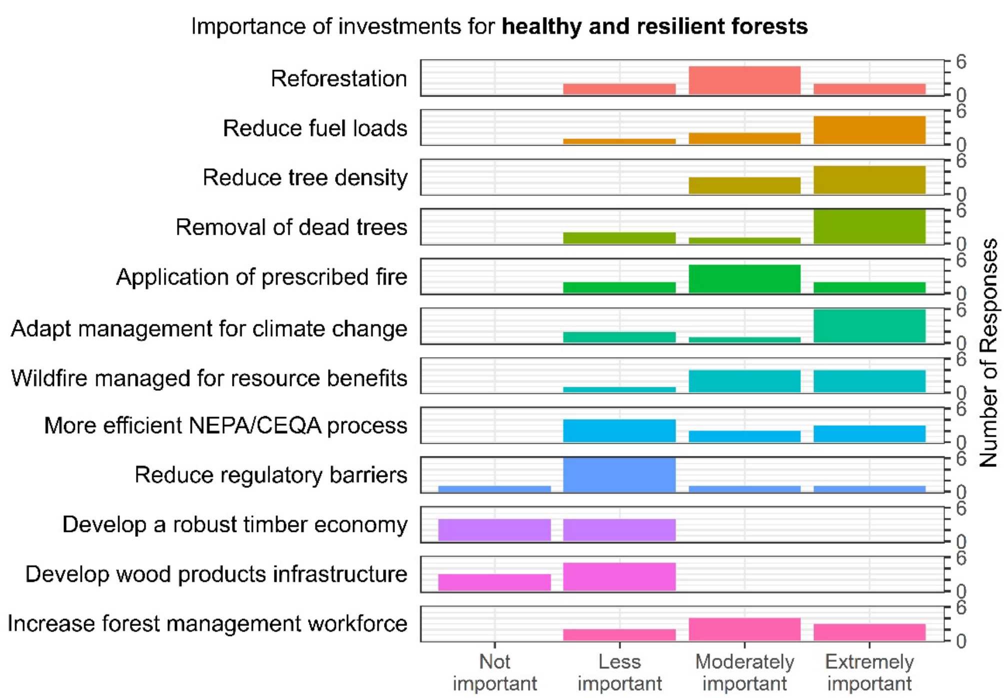

Importance of investments for water security
Secure water supply for residential use
Secure water supply for economic use
Reduce regulatory barriers
Address constraints related to water rights
Optimize water applications
Address water pollution impacts to humans
Address water pollution impacts to ecosystem
Ecosystem restoration to protect watershed and preserve snowpack
Reduce soil erosion
0
10
25
Number of Responses
Not important
Less important
Moderately important
Extremely important

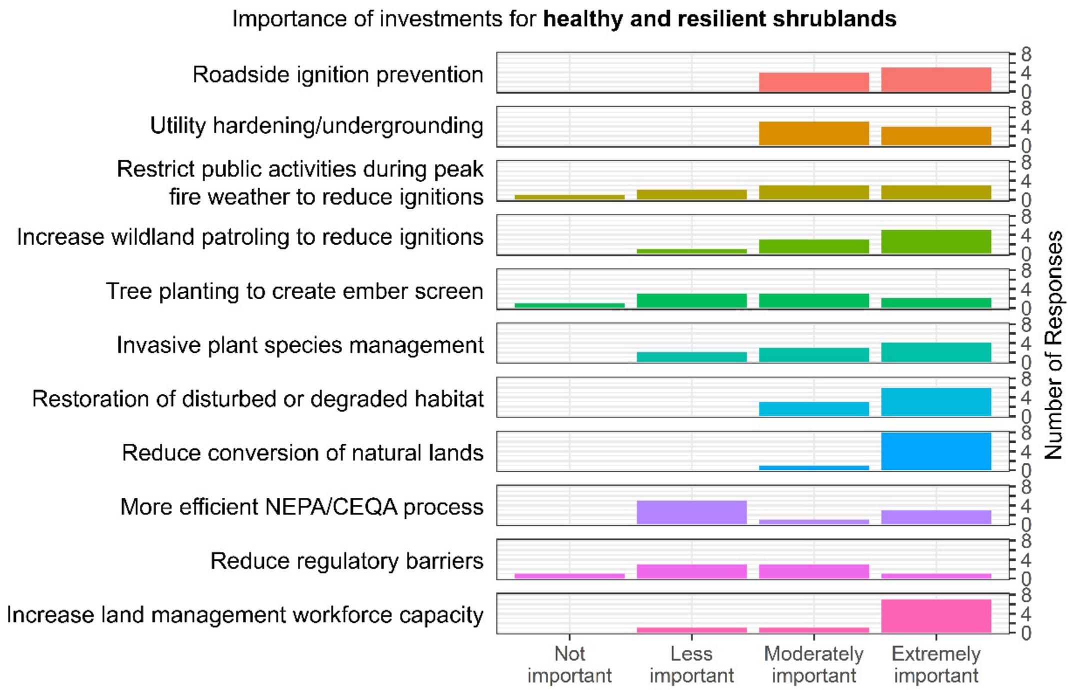

Importance of investments for clean air
Mechanical forest treatments
Prescribed fire to reduce wildfire risk
Reduce smoke induced public health impacts from prescribed fire
Public access to clean air shelter during smoke events
Public access to healthcare during smoke events
Public access to personal 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
0
9
Number of Responses
Not important
Less important
Moderately important
Extremely important

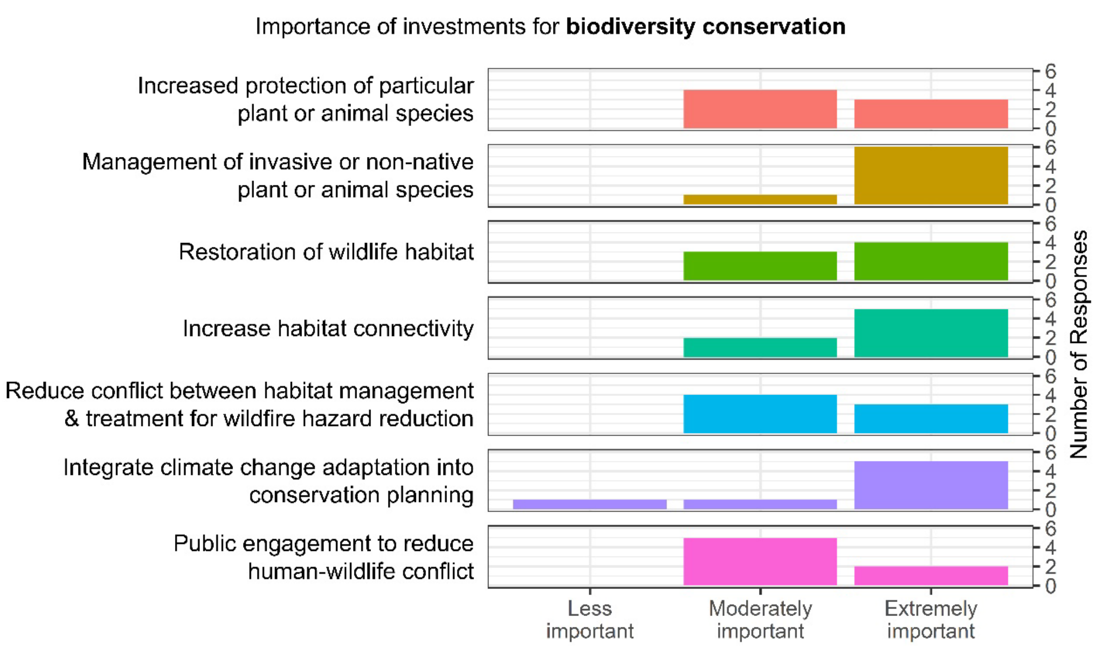
Southern California Survey Results

Riverside County Respondents

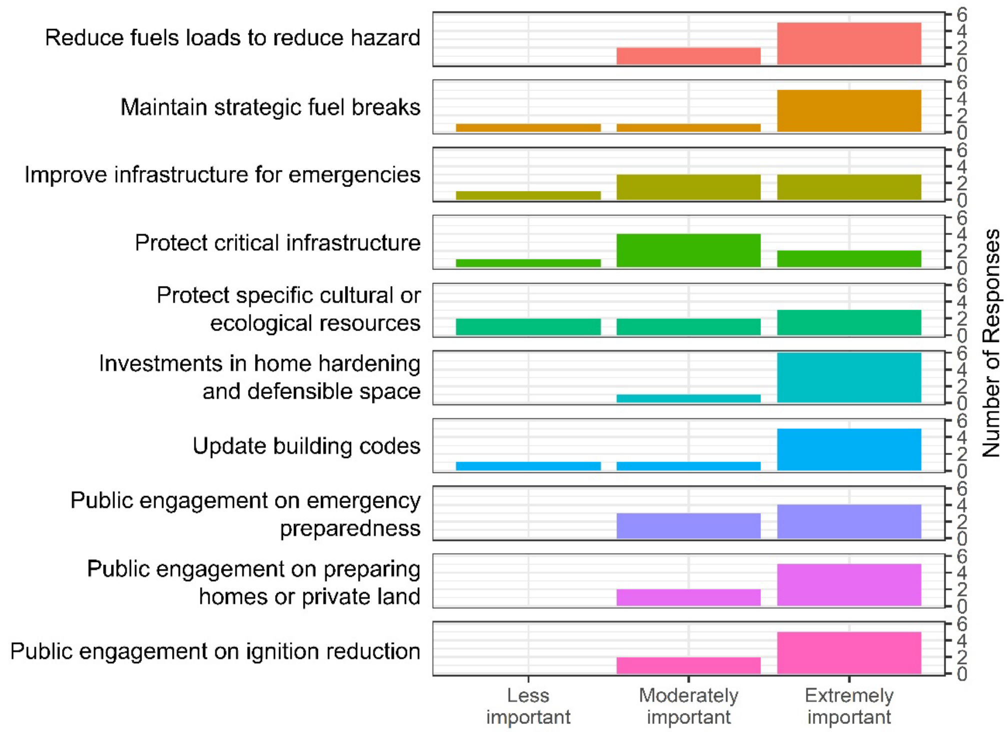




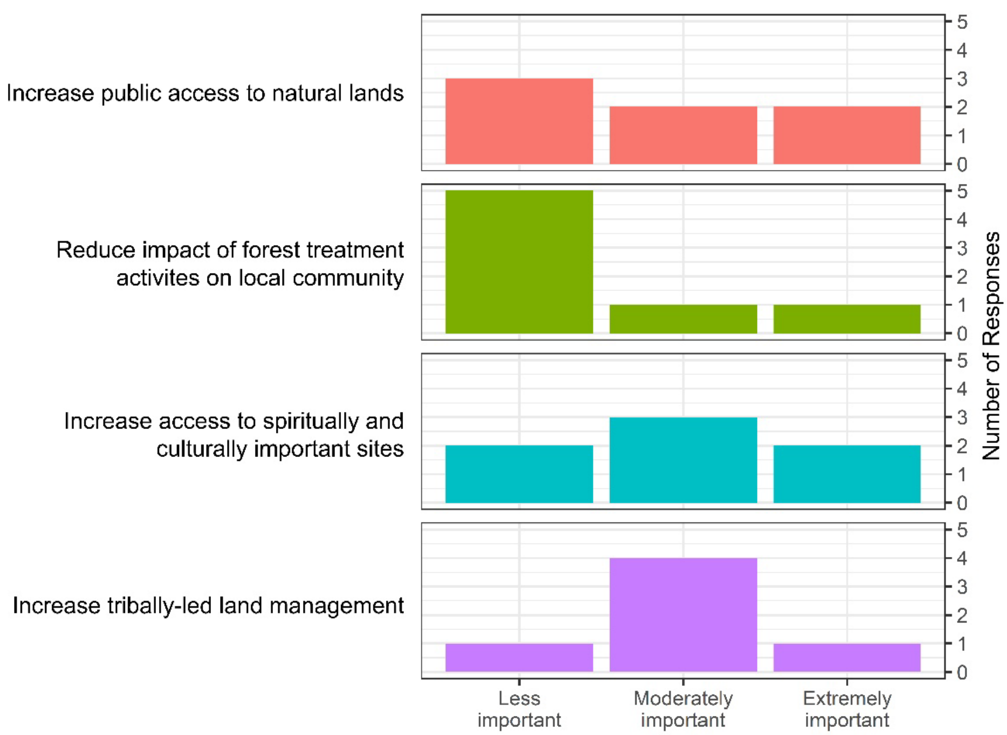

Importance of investments for **healthy and resilient shrublands**
Roadside ignition prevention
Utility hardening/undergrounding
Restrict public activities during peak fire weather to reduce ignitions
Increase wildland patroling to reduce ignitions
Tree planting to create ember screen
Invasive plant species management
Restoration of disturbed or degraded habitat
Reduce conversion of natural lands
More efficient NEPA/CEQA process
Reduce regulatory barriers
Increase land management workforce capacity
Not important
Less important
Moderately important
Extremely important
Number of Responses
0
4
8

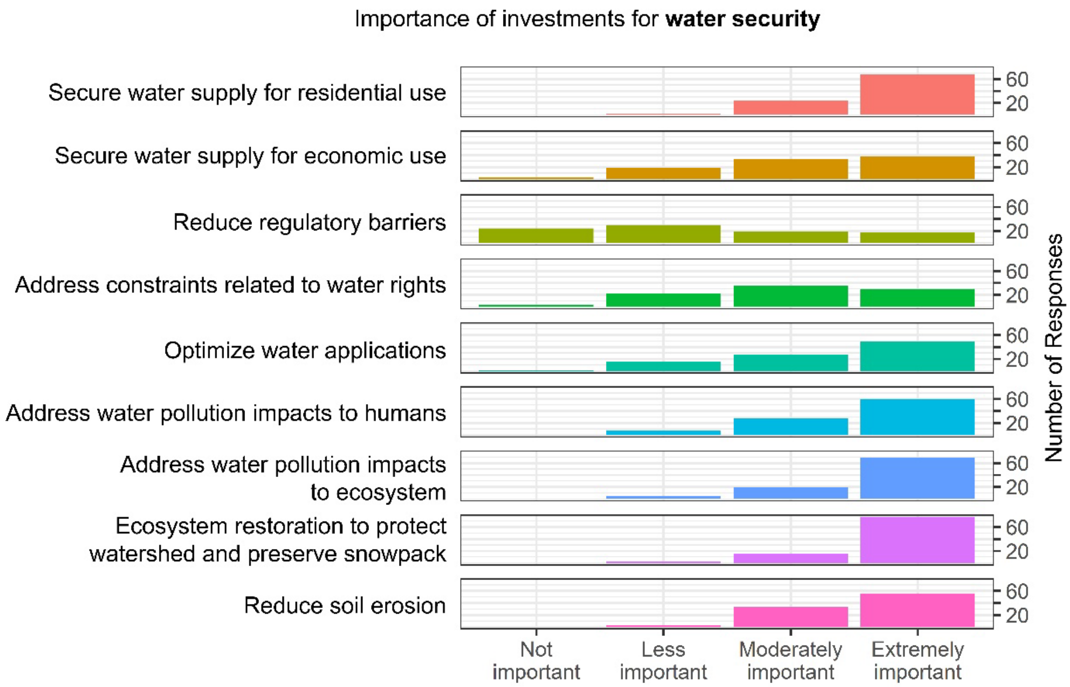

Importance of investments for **biodiversity conservation**
Increased protection of particular plant or animal species
Management of invasive or non-native plant or animal species
Restoration of wildlife habitat
Increase habitat connectivity
Reduce conflict between habitat management & treatment for wildfire hazard reduction
Integrate climate change adaptation into conservation planning
Public engagement to reduce human-wildlife conflict
Less important
Moderately important
Extremely important
Number of Responses
0
2
4
6

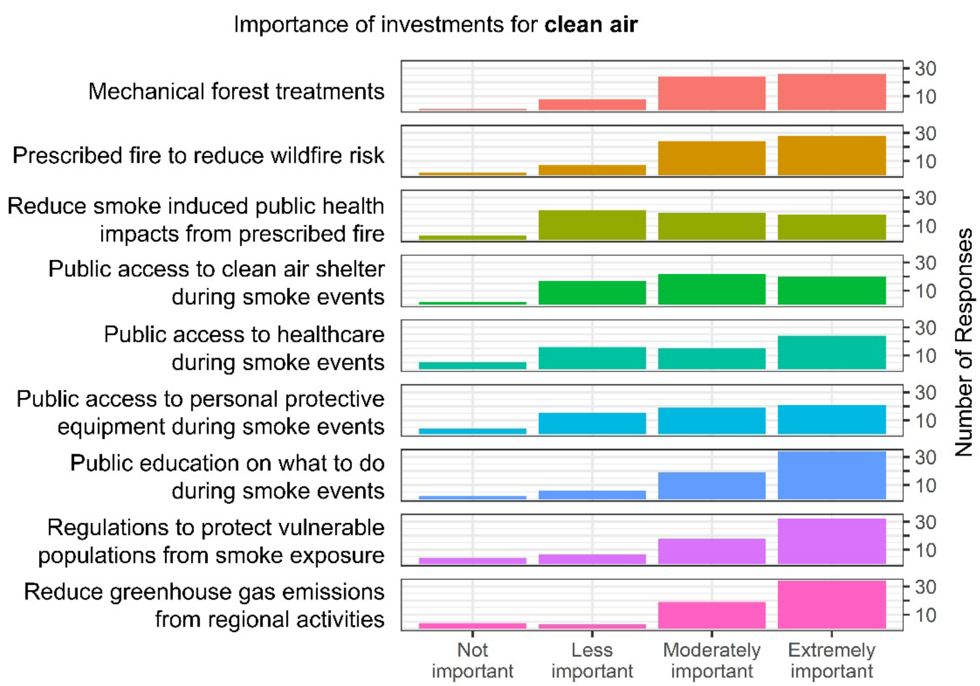
Importance of investments for **resilient communities: fire safety and preparedness**



Importance of investments for **resilient communities: community well-being**

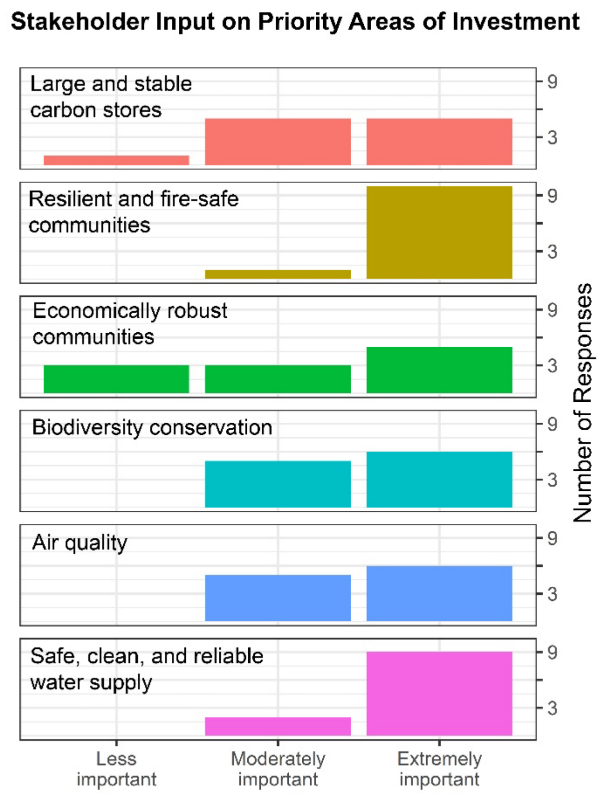


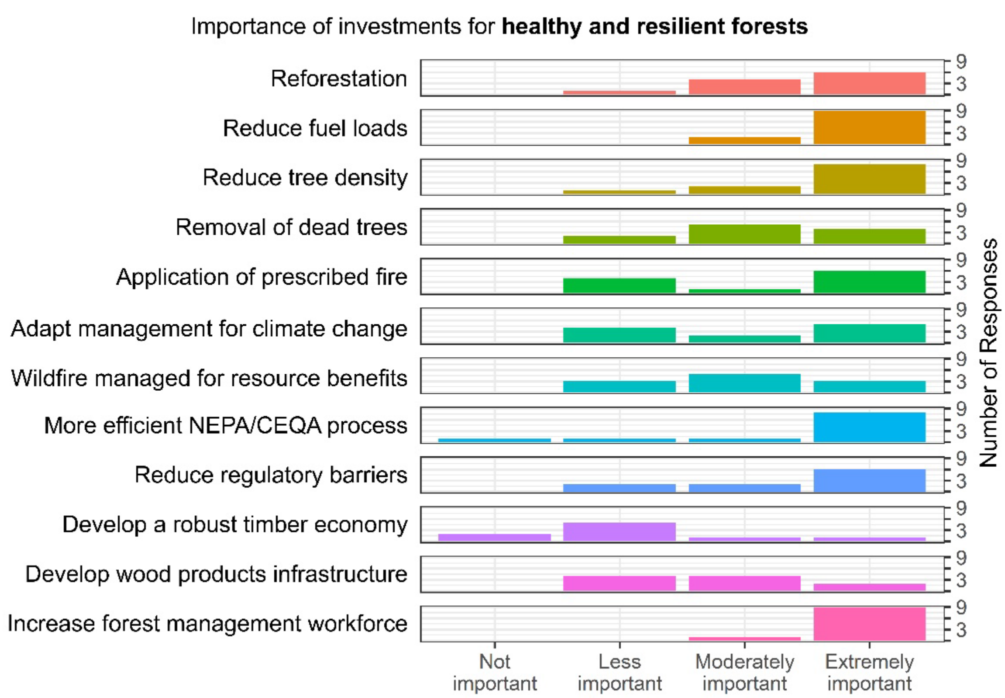

Importance of investments for water security
Secure water supply for residential use
Secure water supply for economic use
Reduce regulatory barriers
Address constraints related to water rights
Optimize water applications
Address water pollution impacts to humans
Address water pollution impacts to ecosystem
Ecosystem restoration to protect watershed and preserve snowpack
Reduce soil erosion
60
20
Number of Responses
Not important
Less important
Moderately important
Extremely important

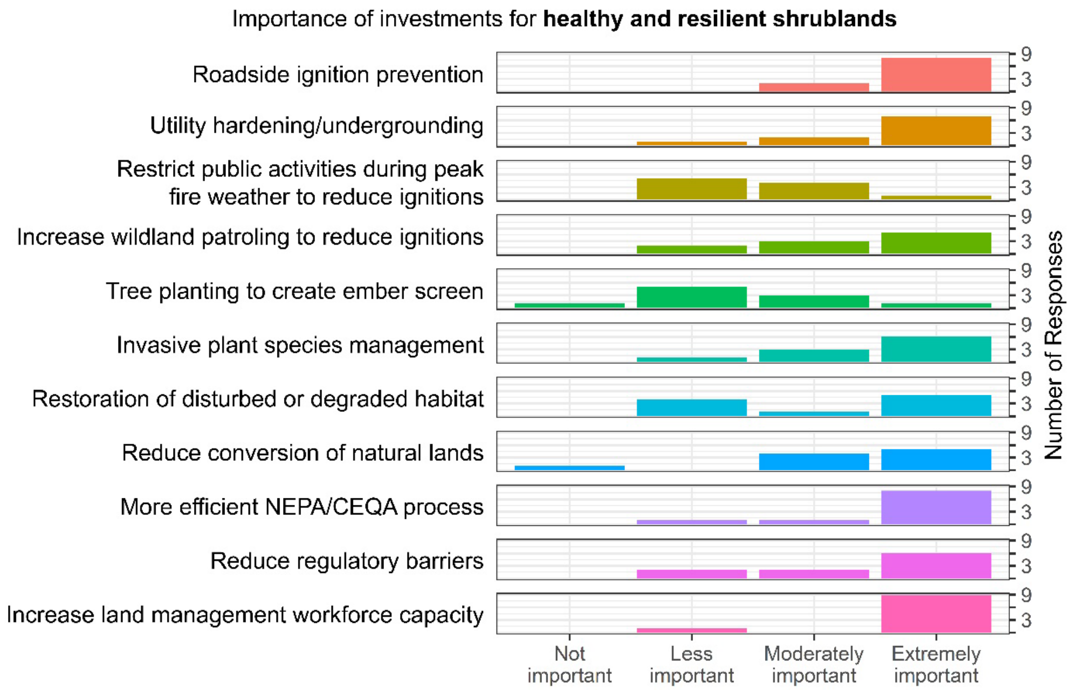

Importance of investments for clean air
Mechanical forest treatments
Prescribed fire to reduce wildfire risk
Reduce smoke induced public health impacts from prescribed fire
Public access to clean air shelter during smoke events
Public access to healthcare during smoke events
Public access to personal 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
30
10
Number of Responses
Not important
Less important
Moderately important
Extremely important

Southern California Survey Results

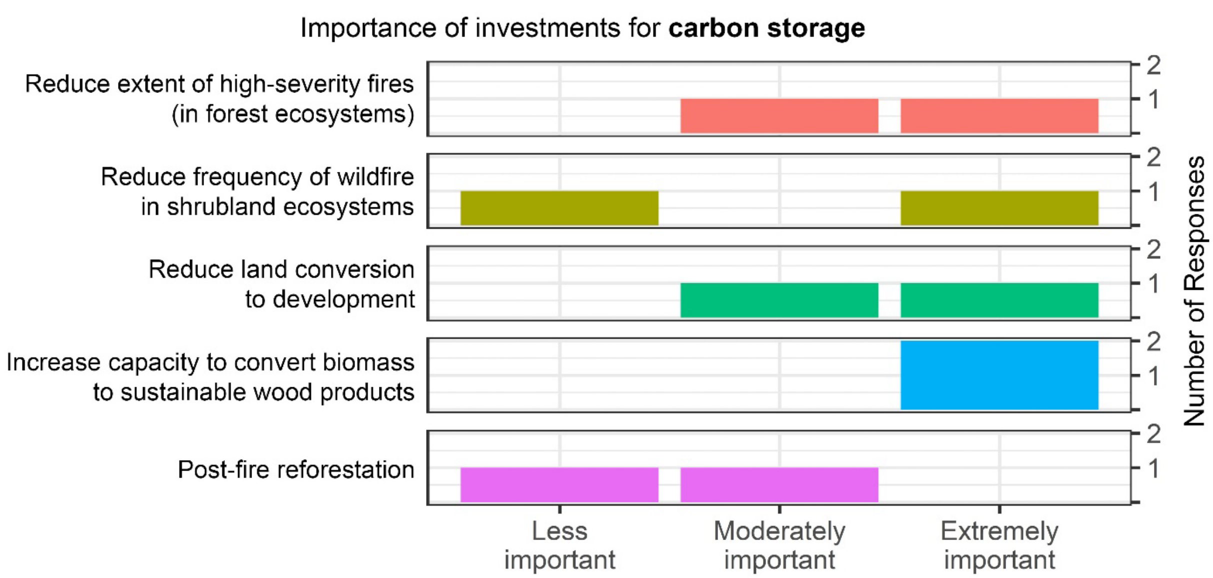
San Bernardino County Respondents



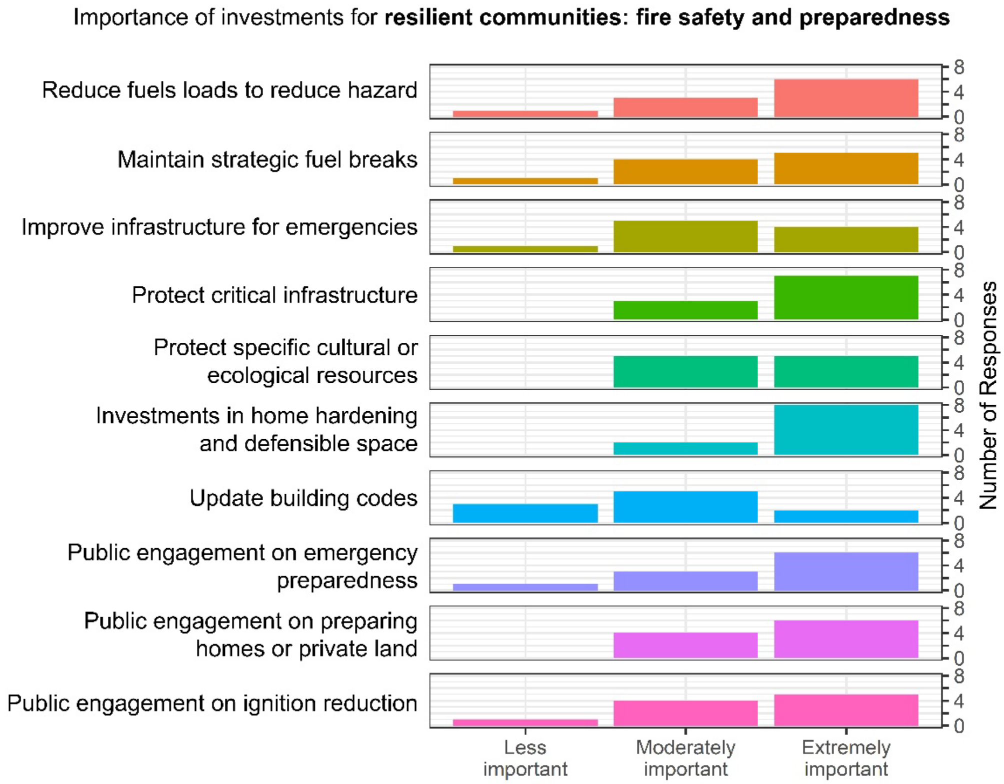


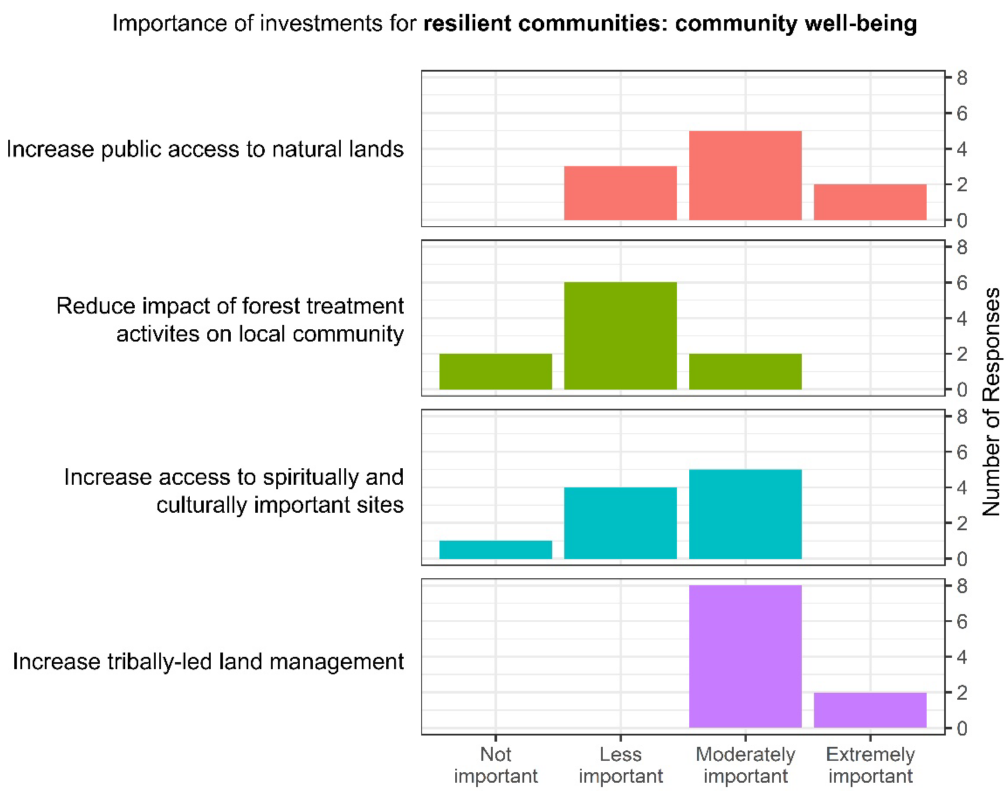


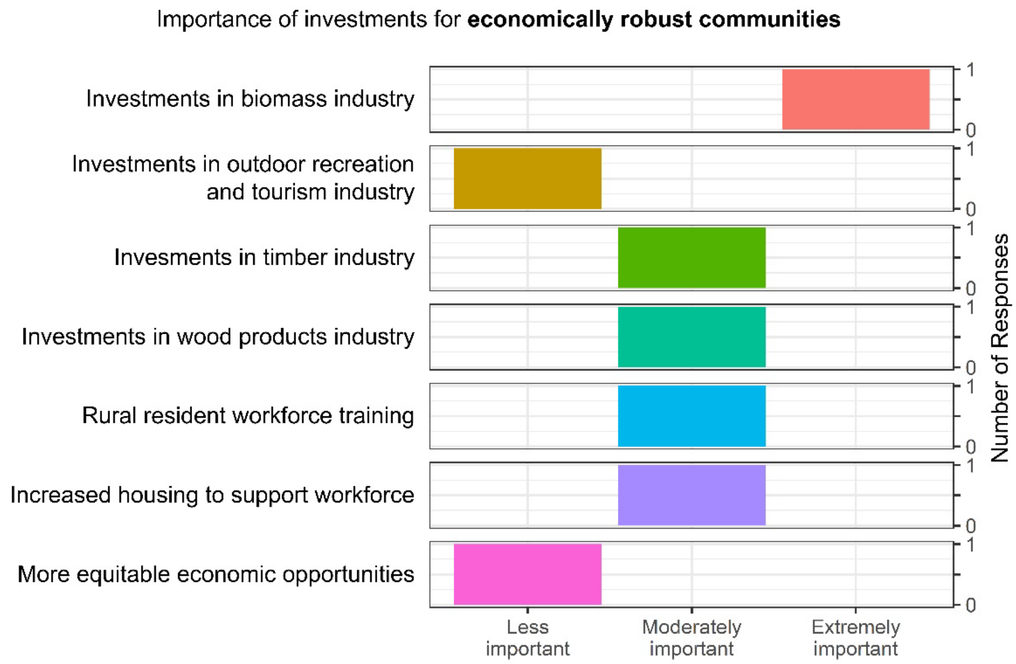
Importance of investments for **healthy and resilient shrublands**
Roadside ignition prevention
Utility hardening/undergrounding
Restrict public activities during peak fire weather to reduce ignitions
Increase wildland patroling to reduce ignitions
Tree planting to create ember screen
Invasive plant species management
Restoration of disturbed or degraded habitat
Reduce conversion of natural lands
More efficient NEPA/CEQA process
Reduce regulatory barriers
Increase land management workforce capacity
9
3
Number of Responses
Not important
Less important
Moderately important
Extremely important

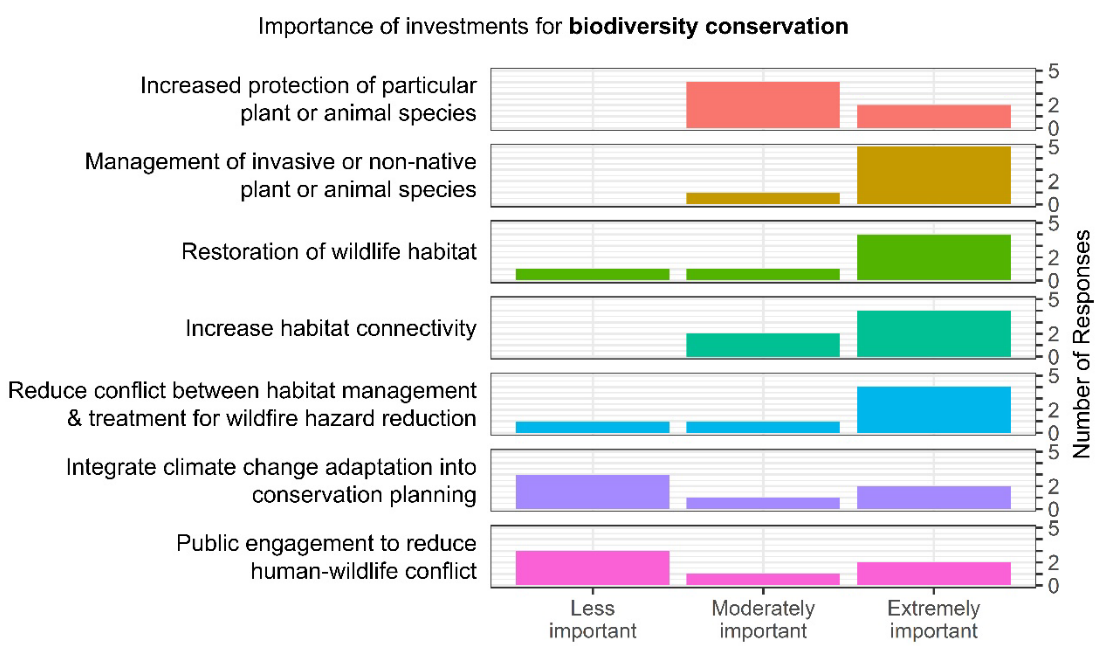


Importance of investments for **carbon storage**
Reduce extent of high-severity fires (in forest ecosystems)
Reduce frequency of wildfire in shrubland ecosystems
Reduce land conversion to development
Increase capacity to convert biomass to sustainable wood products
Post-fire reforestation
2
1
Number of Responses
Less important
Moderately important
Extremely important

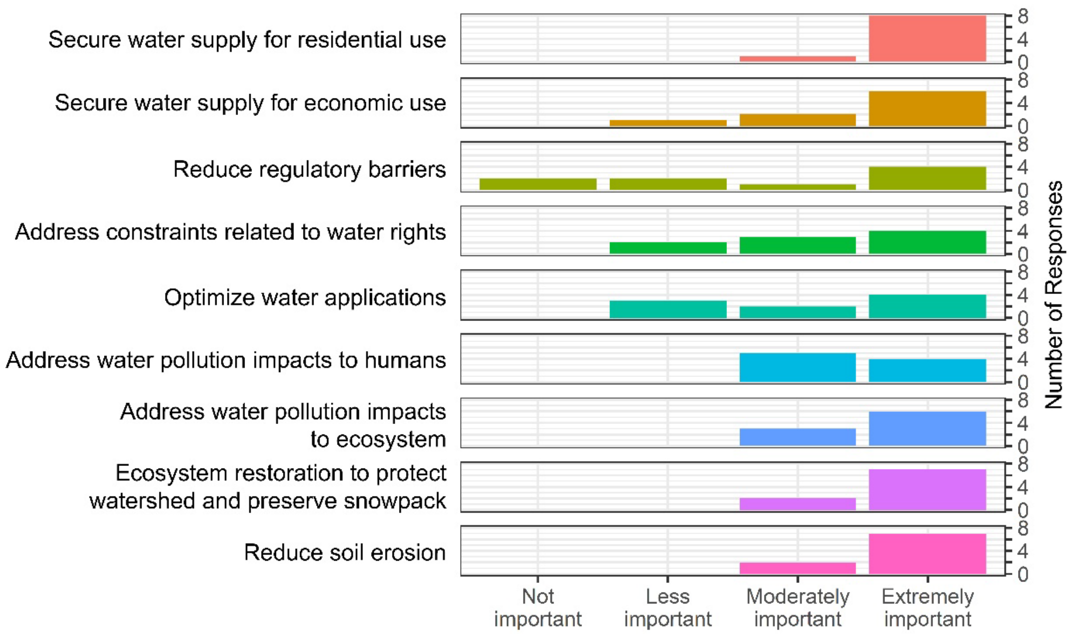

Importance of investments for **resilient communities: fire safety and preparedness**
Reduce fuels loads to reduce hazard
Maintain strategic fuel breaks
Improve infrastructure for emergencies
Protect critical infrastructure
Protect specific cultural or ecological resources
Investments in home hardening and defensible space
Update building codes
Public engagement on emergency preparedness
Public engagement on preparing homes or private land
Public engagement on ignition reduction
Less important
Moderately important
Extremely important
Number of Responses
0
4
8


Importance of investments for **resilient communities: community well-being**
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
Not important
Less important
Moderately important
Extremely important
Number of Responses
0
2
4
6
8

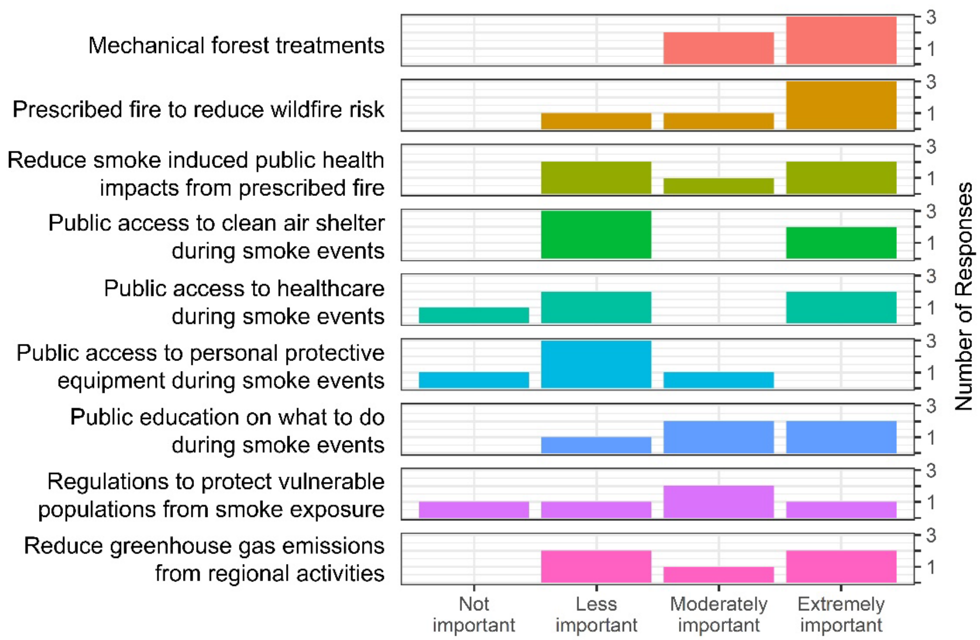

Importance of investments for economically robust communities
Investments in biomass industry
Investments in outdoor recreation and tourism industry
Invesments in timber industry
Investments in wood products industry
Rural resident workforce training
Increased housing to support workforce
More equitable economic opportunities
Less important
Moderately important
Extremely important
Number of Responses


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
Integrate climate change adaptation into conservation planning
Public engagement to reduce human-wildlife conflict
Less important
Moderately important
Extremely important
Number of Responses

Importance of investments for **water security**

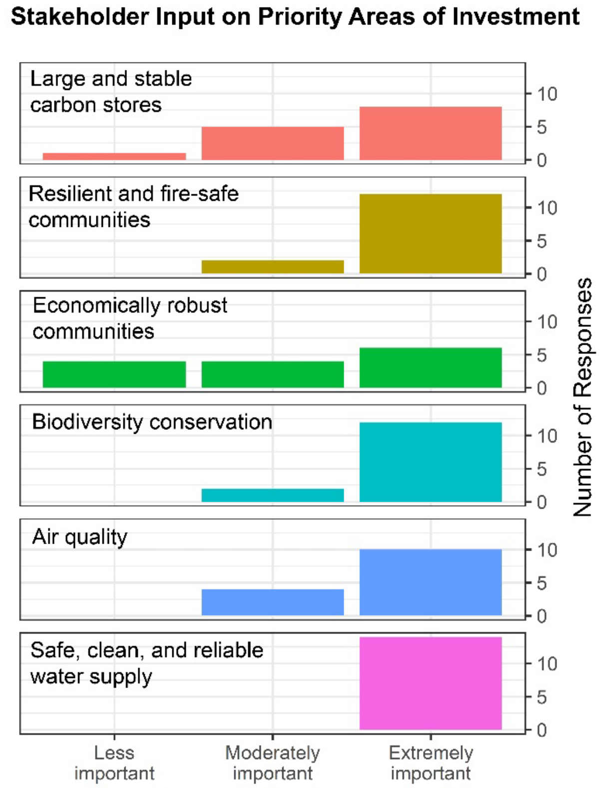


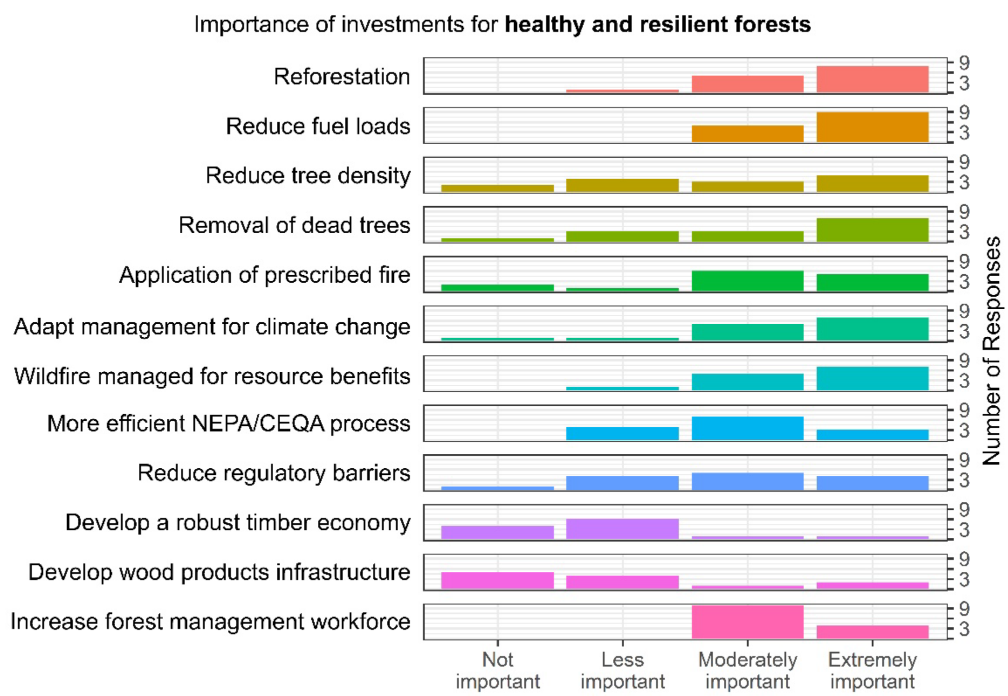
Importance of investments for **clean air**

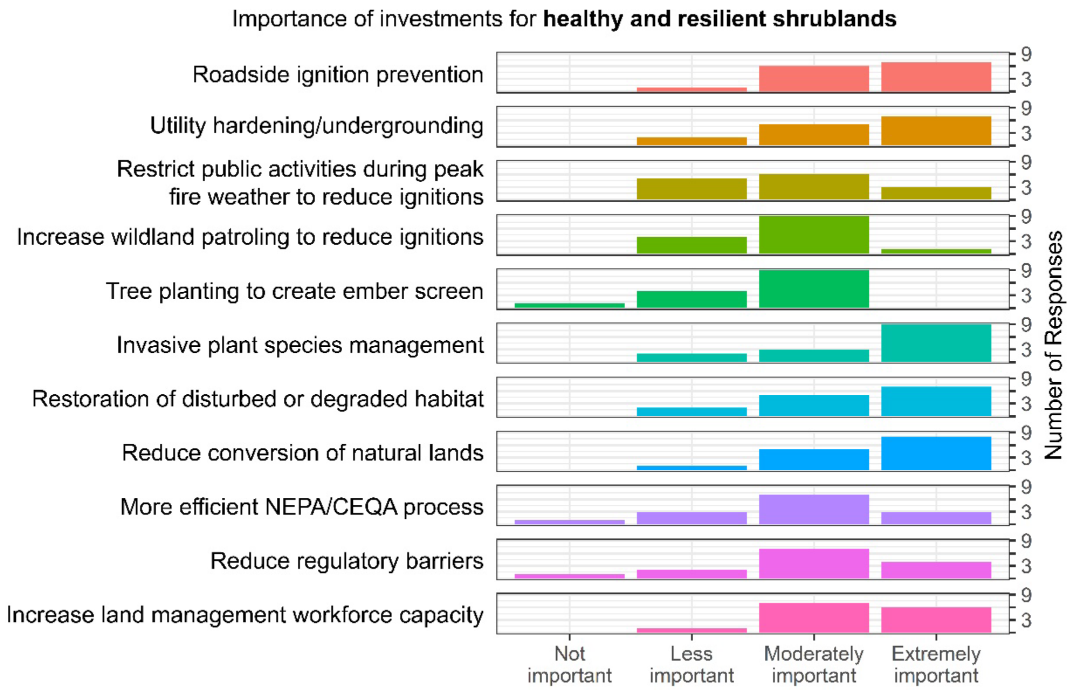


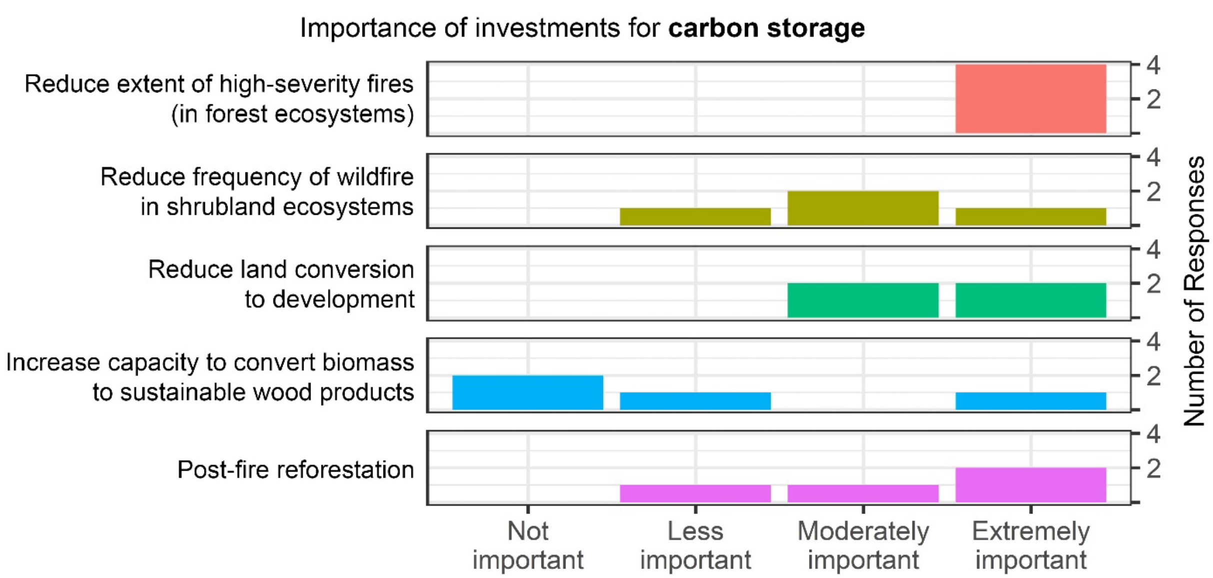
Southern California Survey Results

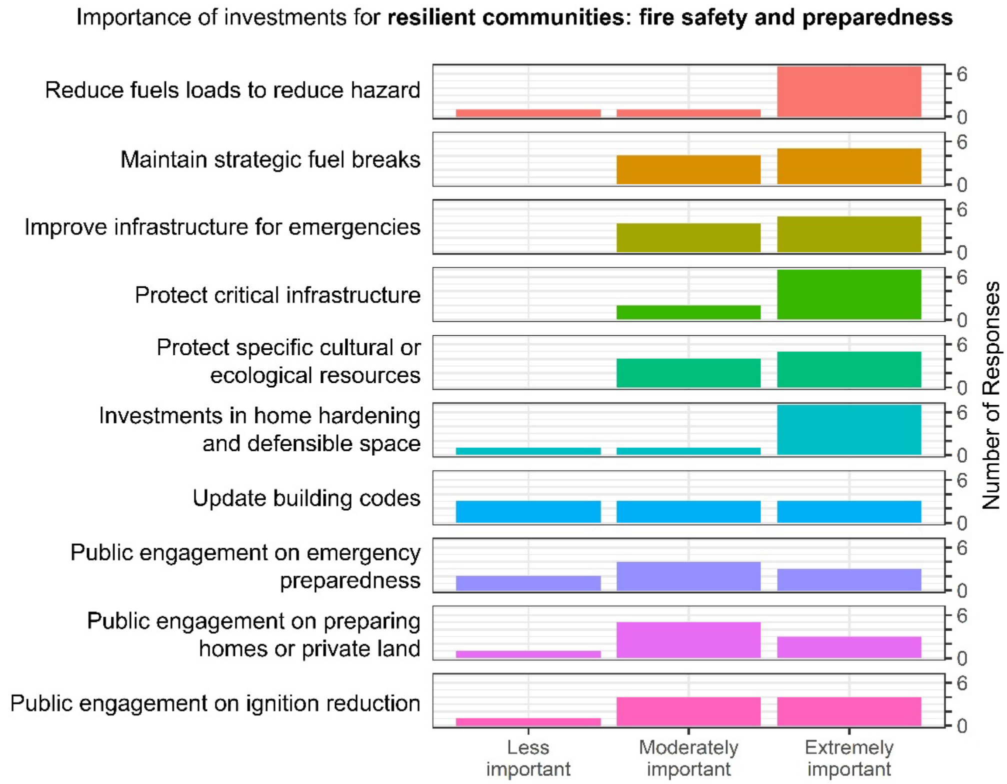
San Diego County Respondents

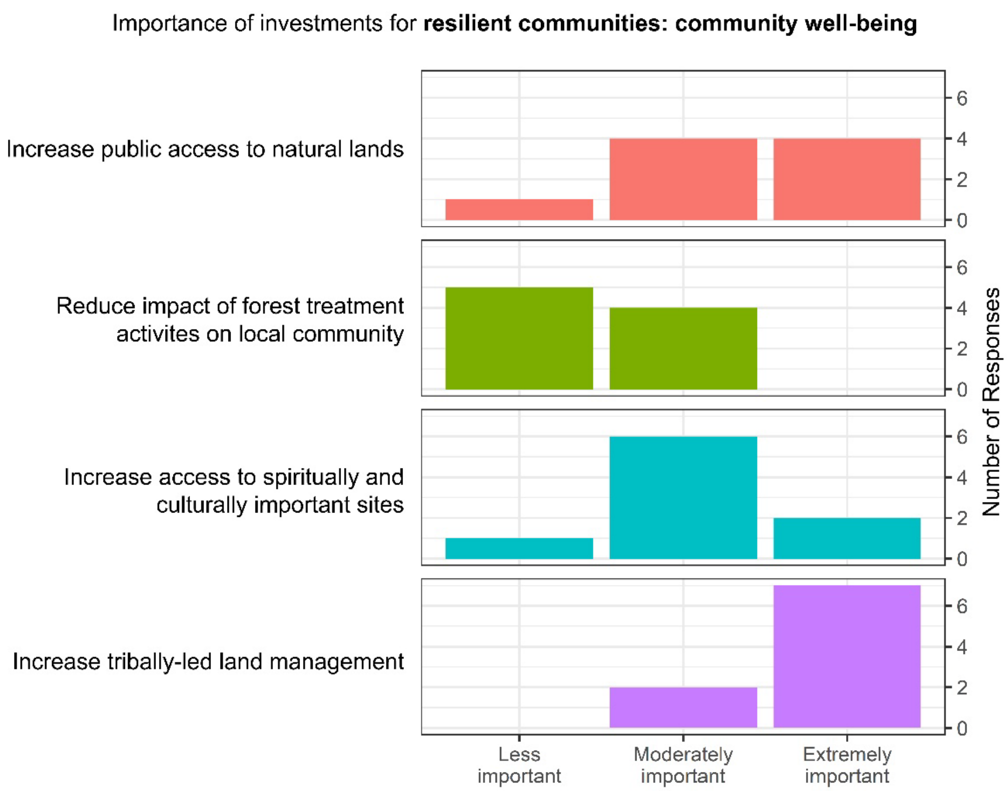


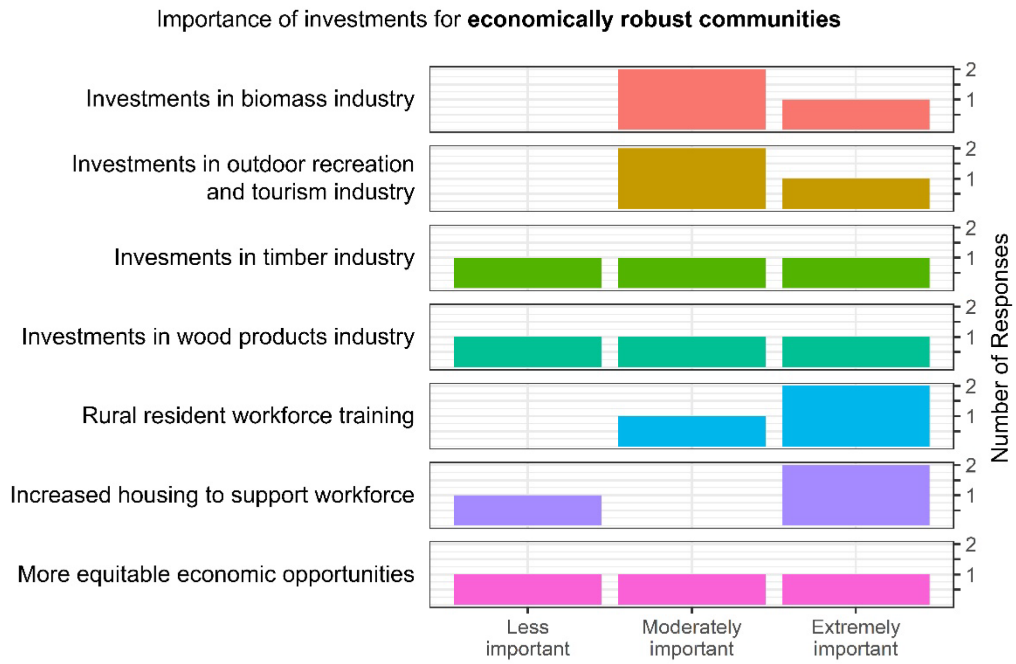


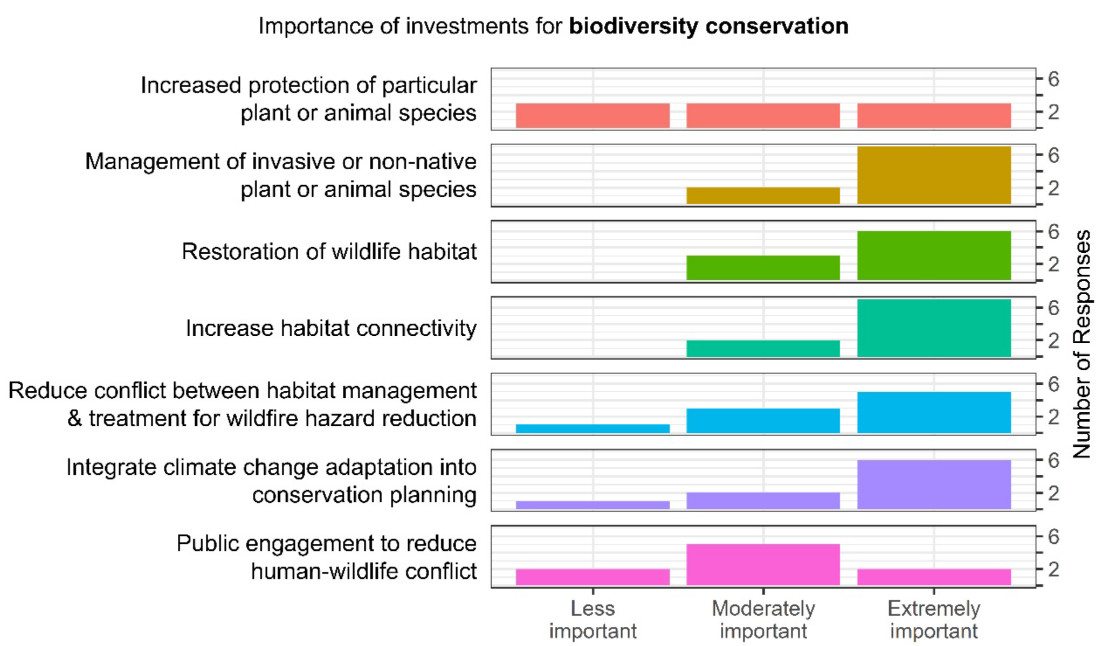

Importance of investments for healthy and resilient shrublands
Roadside ignition prevention
Utility hardening/undergrounding
Restrict public activities during peak fire weather to reduce ignitions
Increase wildland patroling to reduce ignitions
Tree planting to create ember screen
Invasive plant species management
Restoration of disturbed or degraded habitat
Reduce conversion of natural lands
More efficient NEPA/CEQA process
Reduce regulatory barriers
Increase land management workforce capacity
Not important
Less important
Moderately important
Extremely important
Number of Responses
9
3

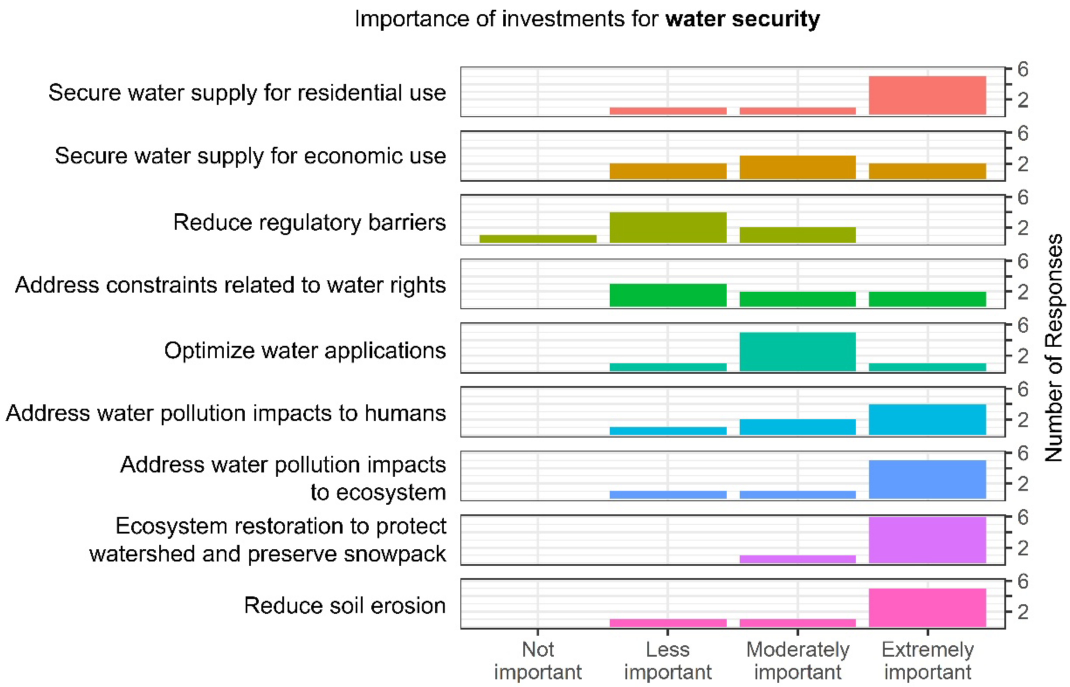

Importance of investments for carbon storage
Reduce extent of high-severity fires (in forest ecosystems)
Reduce frequency of wildfire in shrubland ecosystems
Reduce land conversion to development
Increase capacity to convert biomass to sustainable wood products
Post-fire reforestation
Not important
Less important
Moderately important
Extremely important
Number of Responses
4
2

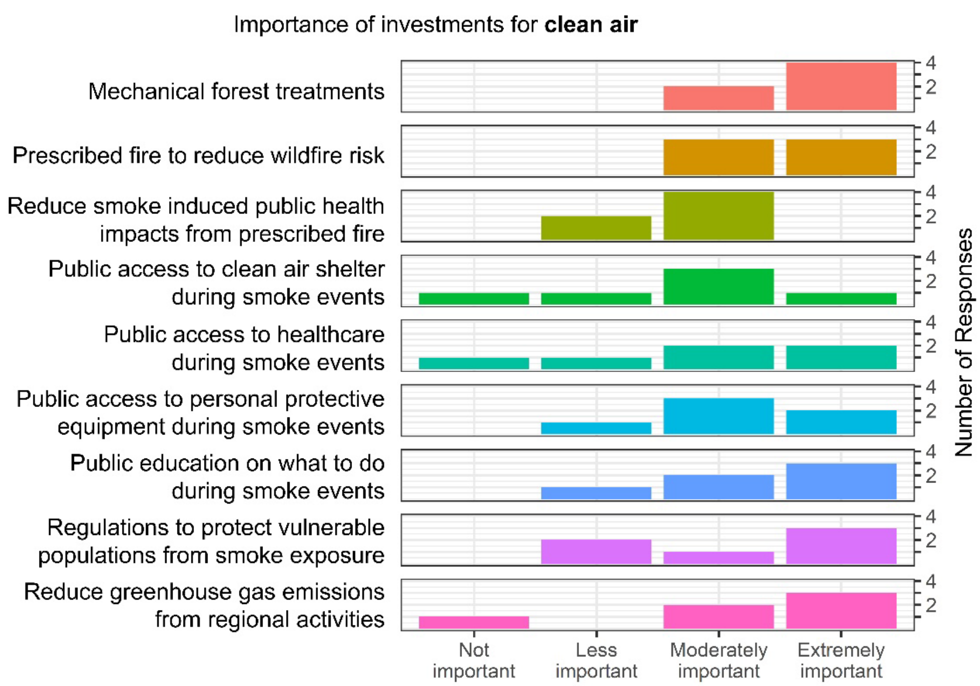

Importance of investments for **resilient communities: fire safety and preparedness**
Reduce fuels loads to reduce hazard
Maintain strategic fuel breaks
Improve infrastructure for emergencies
Protect critical infrastructure
Protect specific cultural or ecological resources
Investments in home hardening and defensible space
Update building codes
Public engagement on emergency preparedness
Public engagement on preparing homes or private land
Public engagement on ignition reduction
Less important
Moderately important
Extremely important
Number of Responses
0
6


Importance of investments for **resilient communities: community well-being**
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
Less important
Moderately important
Extremely important
Number of Responses
0
2
4
6


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
Less important
Moderately important
Extremely important
Number of Responses
1
2

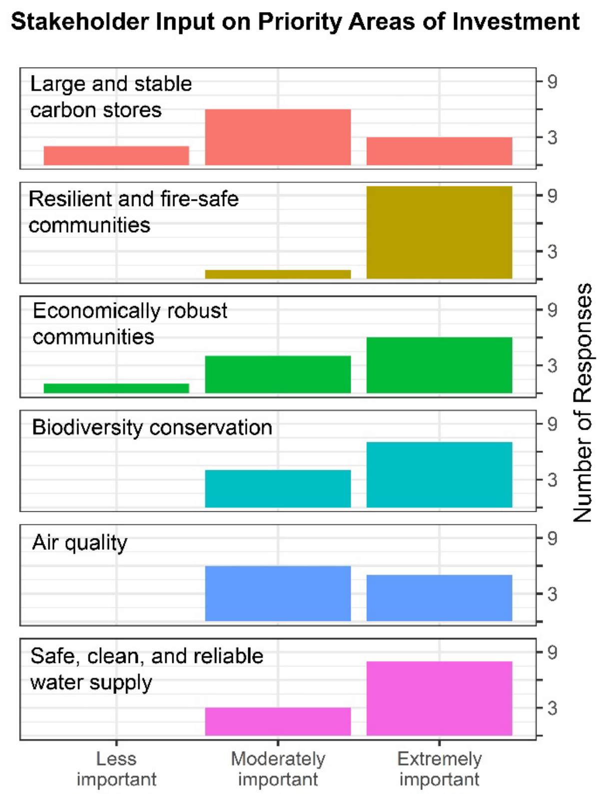

Importance of investments for **biodiversity conservation**
Increased protection of particular plant or animal species
Management of invasive or non-native plant or animal species
Restoration of wildlife habitat
Increase habitat connectivity
Reduce conflict between habitat management & treatment for wildfire hazard reduction
Integrate climate change adaptation into conservation planning
Public engagement to reduce human-wildlife conflict
Less important
Moderately important
Extremely important
Number of Responses
2
6

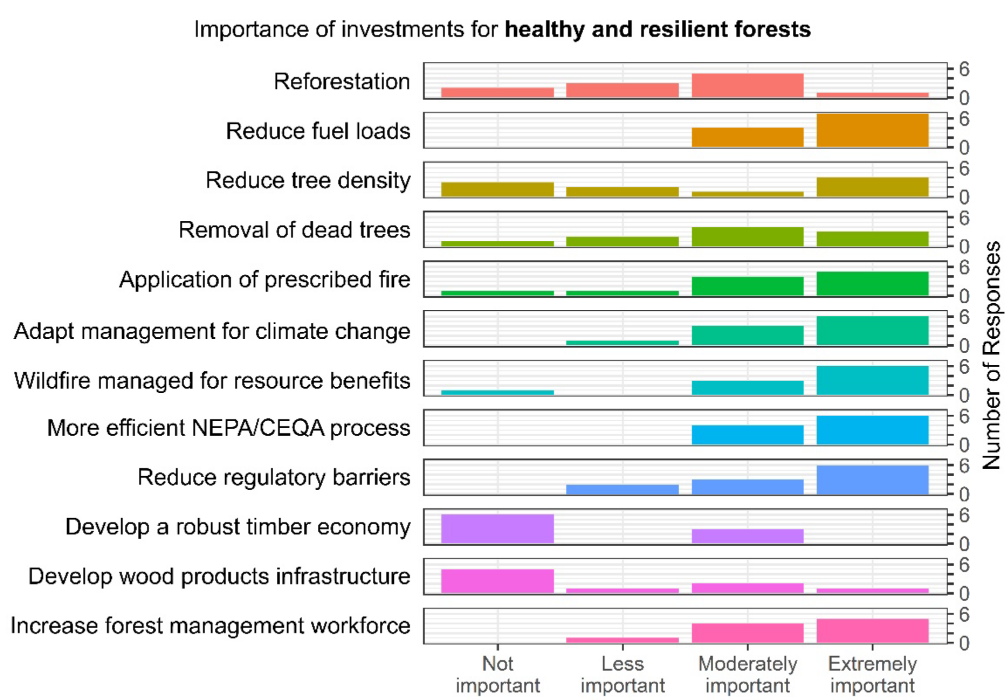

Importance of investments for **water security**
Secure water supply for residential use
Secure water supply for economic use
Reduce regulatory barriers
Address constraints related to water rights
Optimize water applications
Address water pollution impacts to humans
Address water pollution impacts to ecosystem
Ecosystem restoration to protect watershed and preserve snowpack
Reduce soil erosion
Not important
Less important
Moderately important
Extremely important
Number of Responses
6
2

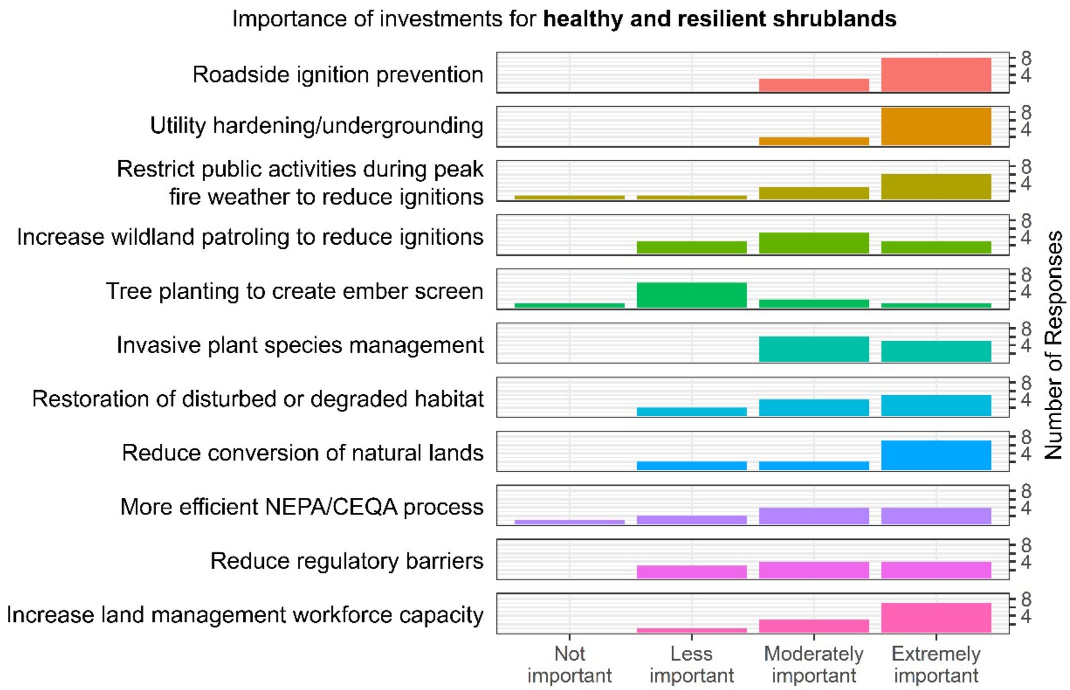

Importance of investments for **clean air**
Mechanical forest treatments
Prescribed fire to reduce wildfire risk
Reduce smoke induced public health impacts from prescribed fire
Public access to clean air shelter during smoke events
Public access to healthcare during smoke events
Public access to personal 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 Responses
4
2

Southern California Survey Results

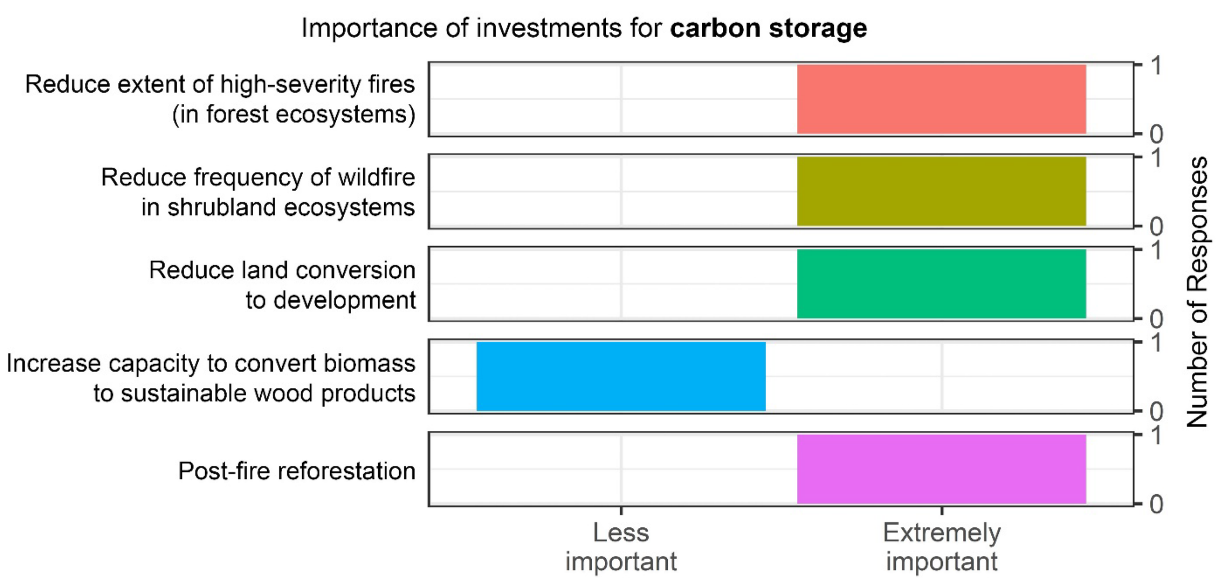
Santa Barbara County Respondents





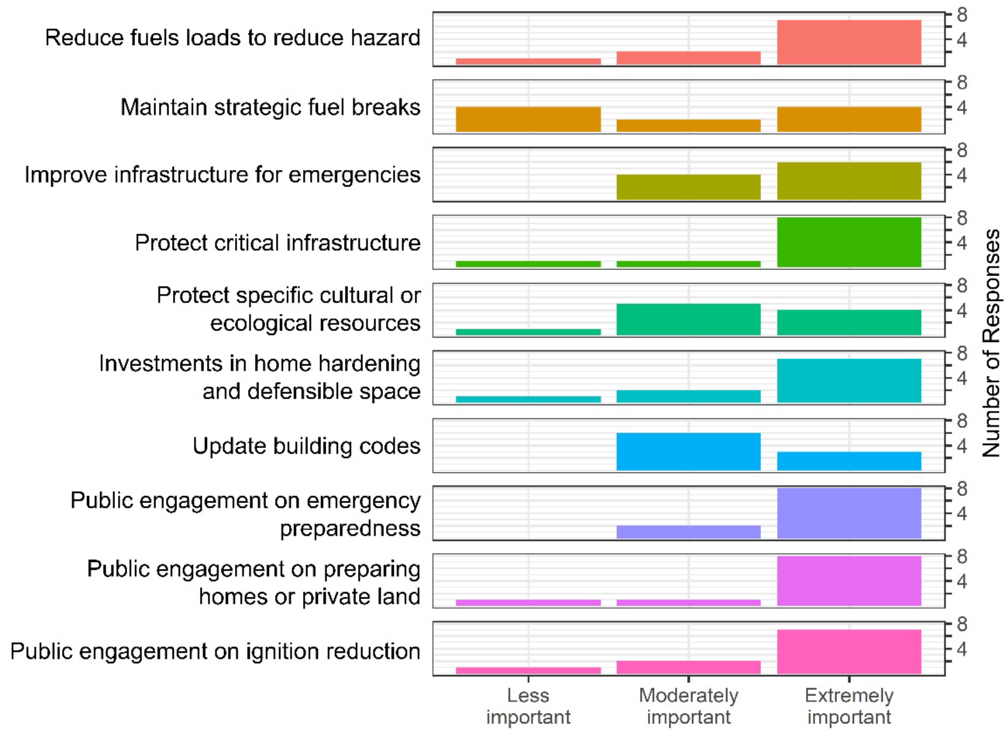


Importance of investments for **healthy and resilient shrublands**
Roadside ignition prevention
Utility hardening/undergrounding
Restrict public activities during peak fire weather to reduce ignitions
Increase wildland patroling to reduce ignitions
Tree planting to create ember screen
Invasive plant species management
Restoration of disturbed or degraded habitat
Reduce conversion of natural lands
More efficient NEPA/CEQA process
Reduce regulatory barriers
Increase land management workforce capacity
Not important
Less important
Moderately important
Extremely important
8
4
Number of Responses

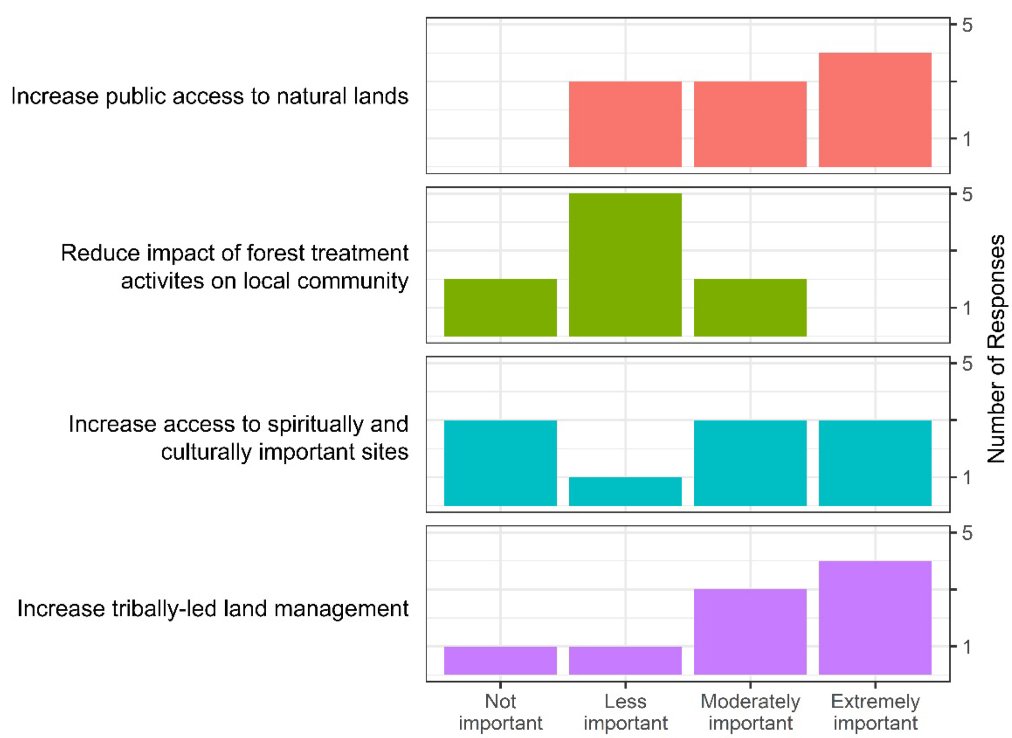


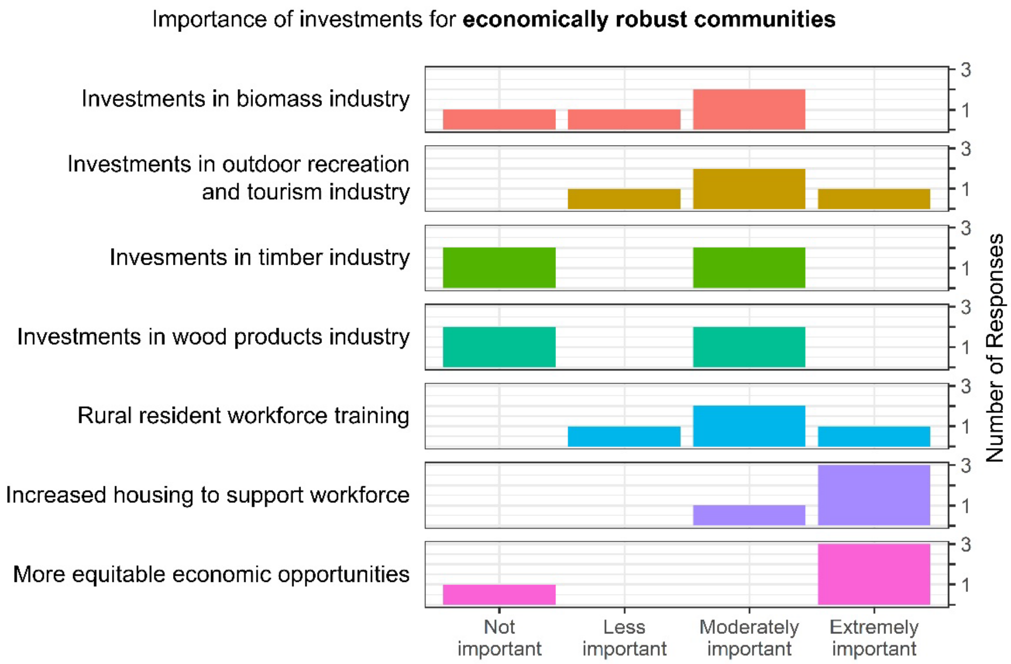
Importance of investments for **carbon storage**
Reduce extent of high-severity fires (in forest ecosystems)
Reduce frequency of wildfire in shrubland ecosystems
Reduce land conversion to development
Increase capacity to convert biomass to sustainable wood products
Post-fire reforestation
Less important
Extremely important
1
0
Number of Responses

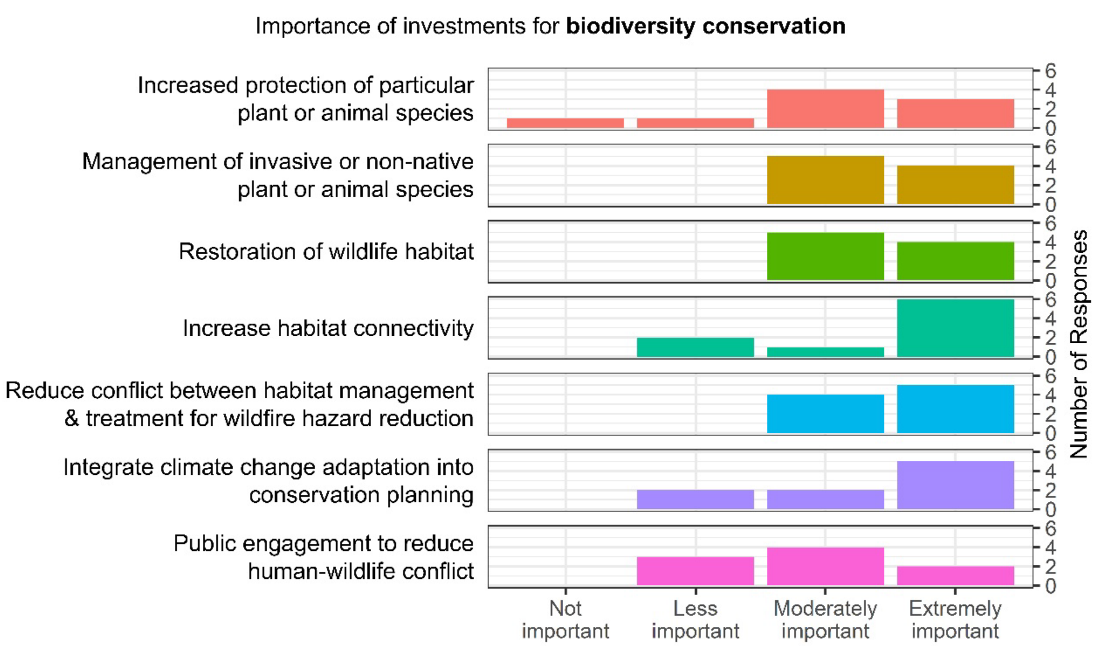
Importance of investments for **resilient communities: fire safety and preparedness**

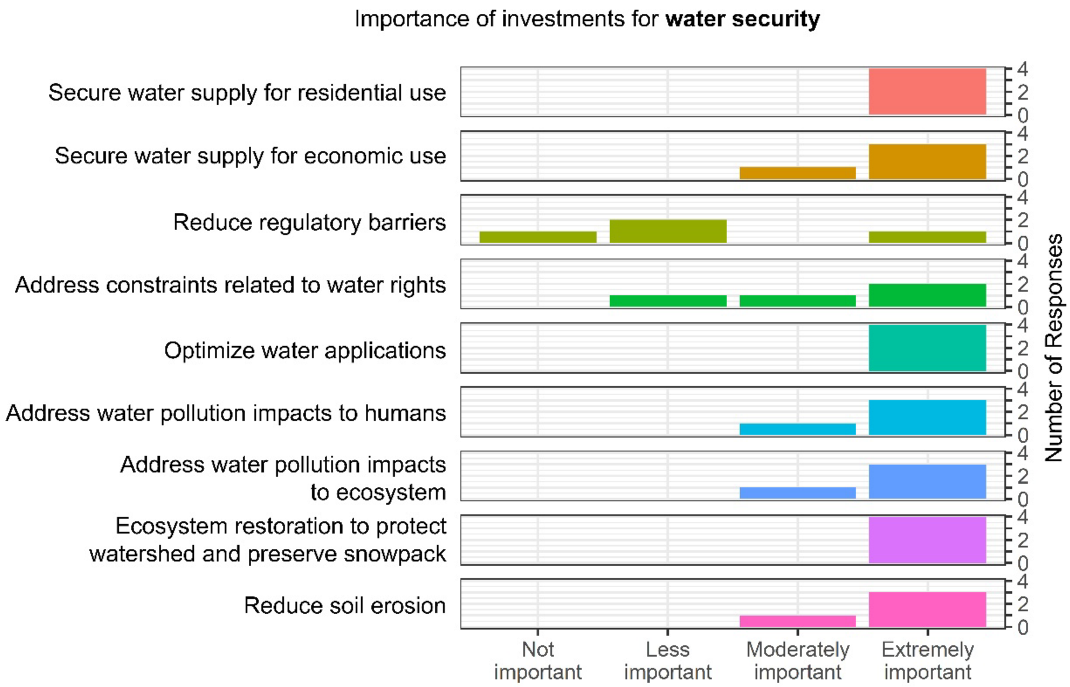


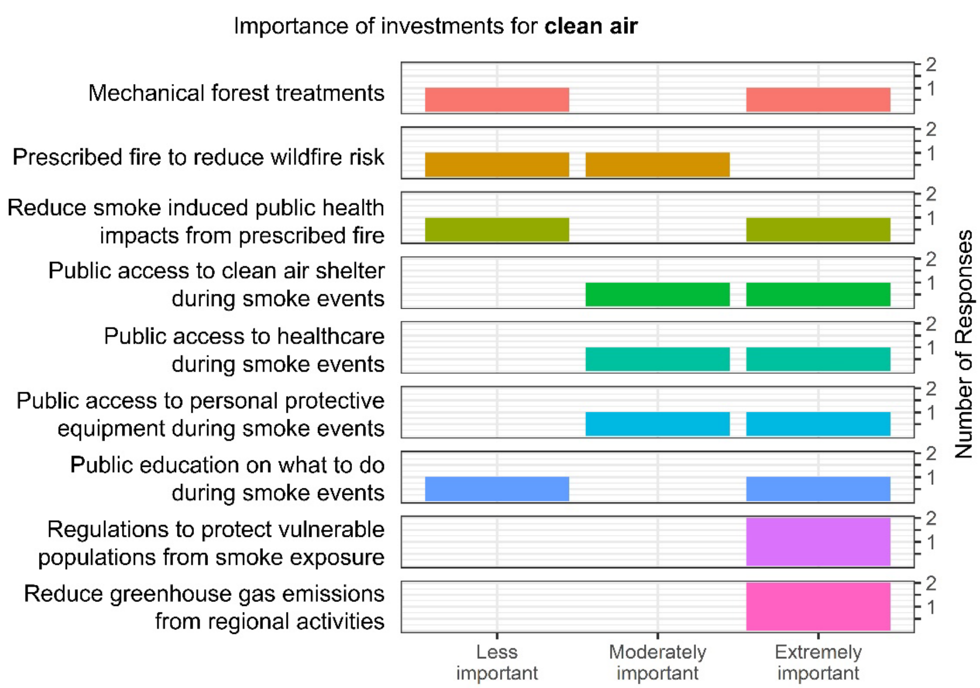
Importance of investments for **resilient communities: community well-being**




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
Not important
Less important
Moderately important
Extremely important
Number of Responses
3
1

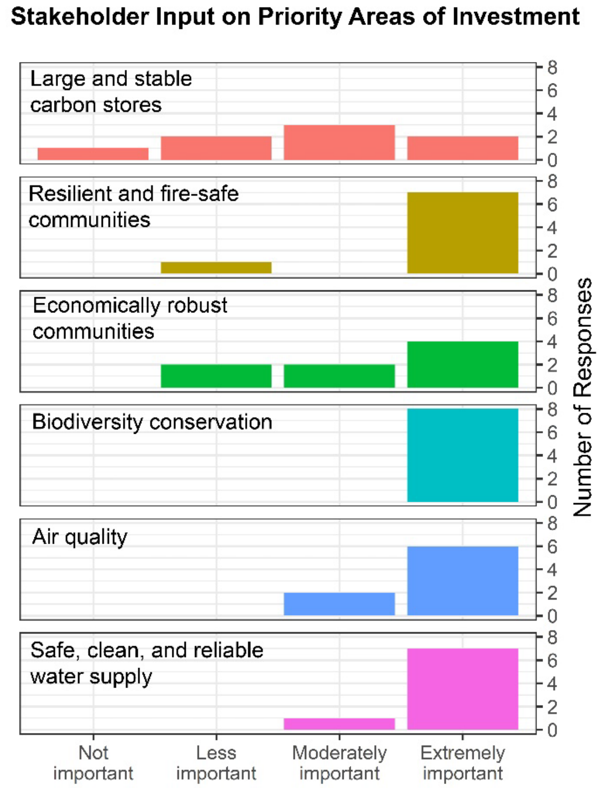

Importance of investments for biodiversity conservation
Increased protection of particular plant or animal species
Management of invasive or non-native plant or animal species
Restoration of wildlife habitat
Increase habitat connectivity
Reduce conflict between habitat management & treatment for wildfire hazard reduction
Integrate climate change adaptation into conservation planning
Public engagement to reduce human-wildlife conflict
Not important
Less important
Moderately important
Extremely important
Number of Responses
6
4
2
0

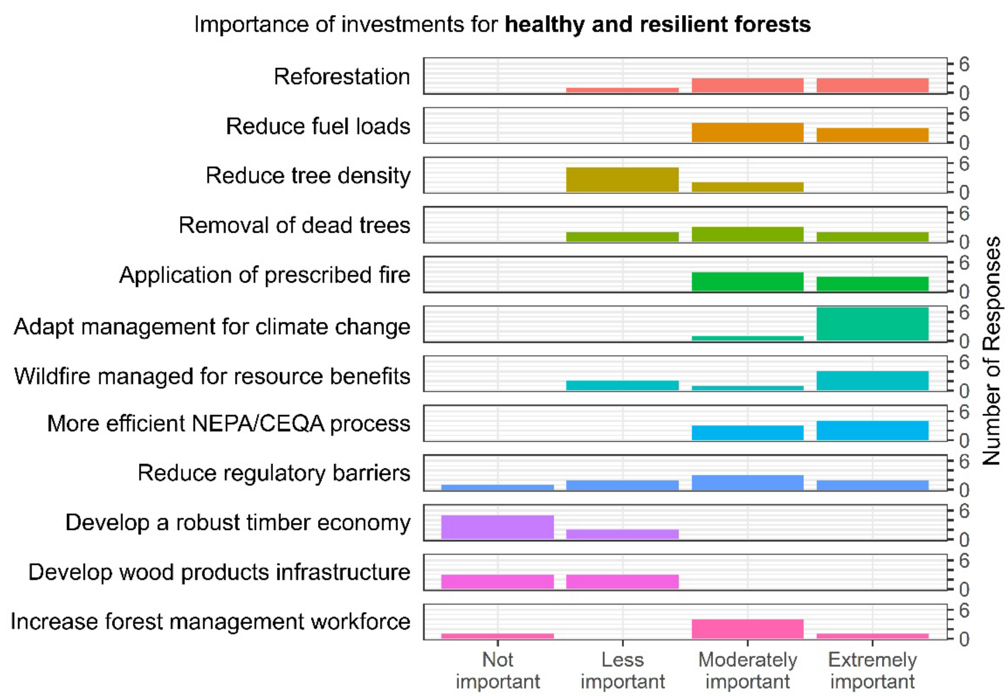

Importance of investments for **water security**
Secure water supply for residential use
Secure water supply for economic use
Reduce regulatory barriers
Address constraints related to water rights
Optimize water applications
Address water pollution impacts to humans
Address water pollution impacts to ecosystem
Ecosystem restoration to protect watershed and preserve snowpack
Reduce soil erosion
Not important
Less important
Moderately important
Extremely important
Number of Responses
0
2
4

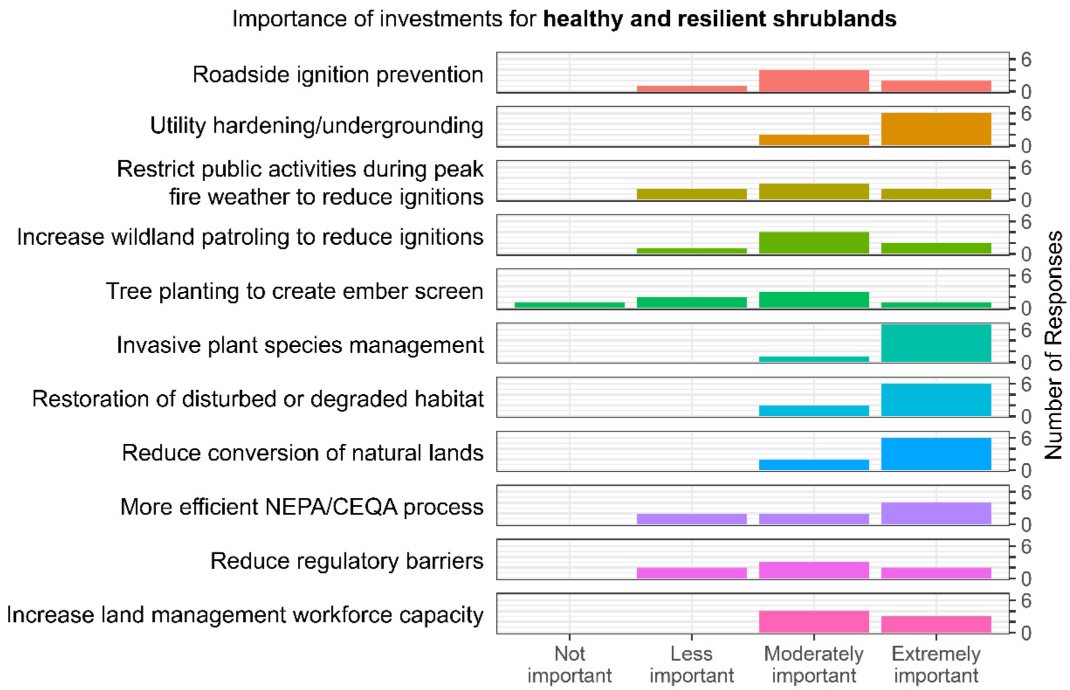

Importance of investments for **clean air**
Mechanical forest treatments
Prescribed fire to reduce wildfire risk
Reduce smoke induced public health impacts from prescribed fire
Public access to clean air shelter during smoke events
Public access to healthcare during smoke events
Public access to personal 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
Less important
Moderately important
Extremely important
Number of Responses
1
2

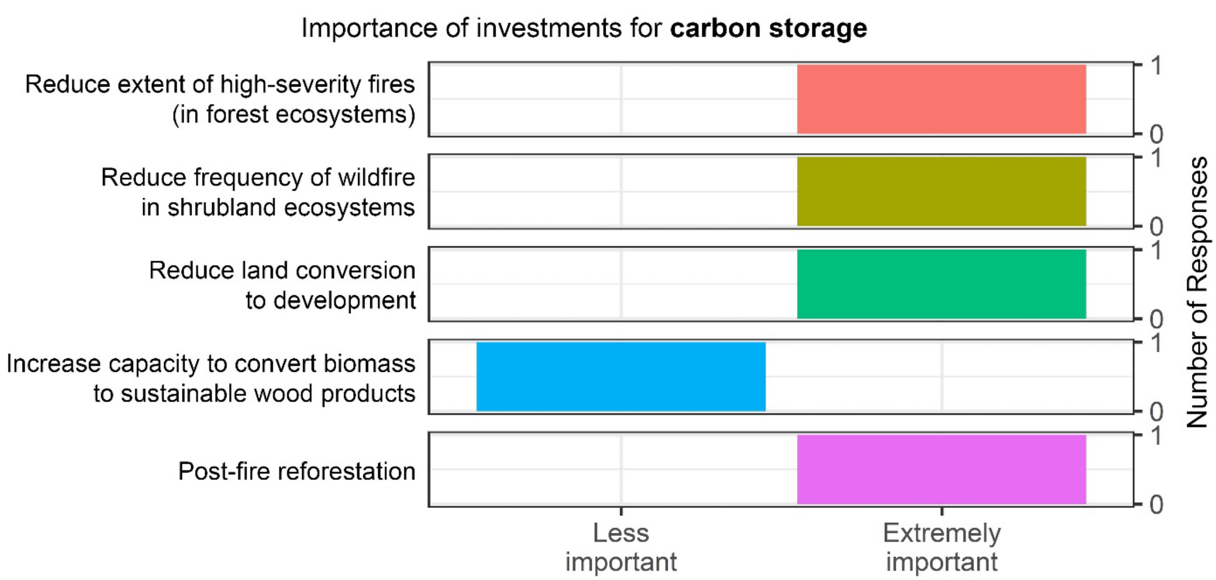
Southern California Survey Results

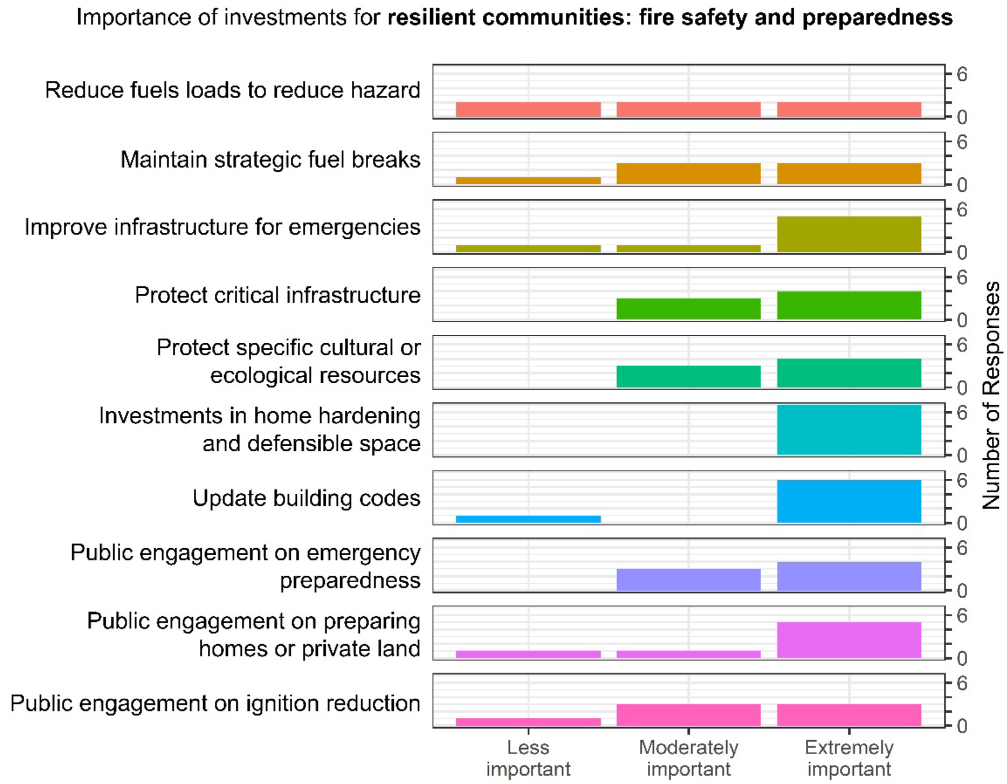
Ventura County Respondents



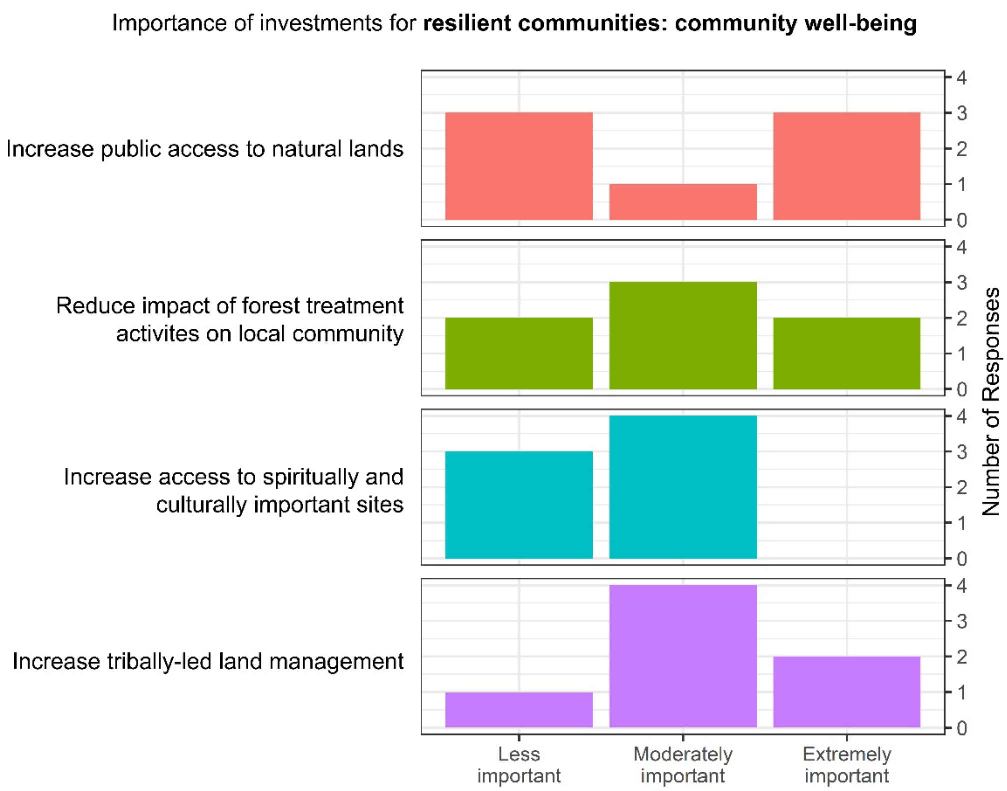



Importance of investments for **healthy and resilient shrublands**
Roadside ignition prevention
Utility hardening/undergrounding
Restrict public activities during peak fire weather to reduce ignitions
Increase wildland patroling to reduce ignitions
Tree planting to create ember screen
Invasive plant species management
Restoration of disturbed or degraded habitat
Reduce conversion of natural lands
More efficient NEPA/CEQA process
Reduce regulatory barriers
Increase land management workforce capacity
Not important
Less important
Moderately important
Extremely important
Number of Responses
6
0

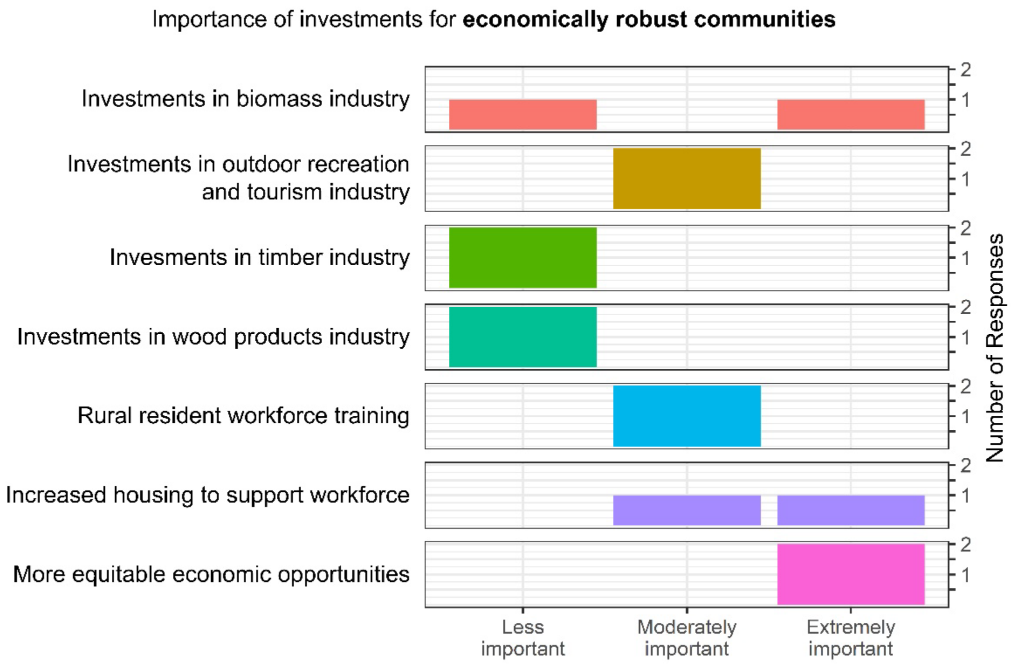

Importance of investments for **carbon storage**
Reduce extent of high-severity fires (in forest ecosystems)
Reduce frequency of wildfire in shrubland ecosystems
Reduce land conversion to development
Increase capacity to convert biomass to sustainable wood products
Post-fire reforestation
Less important
Extremely important
Number of Responses
1
0

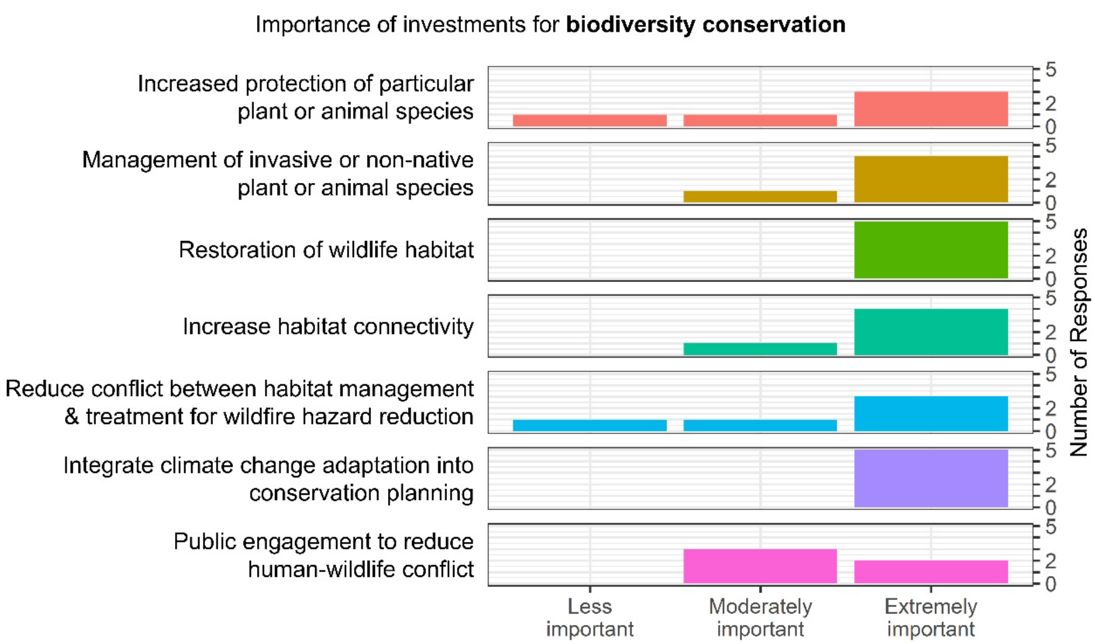


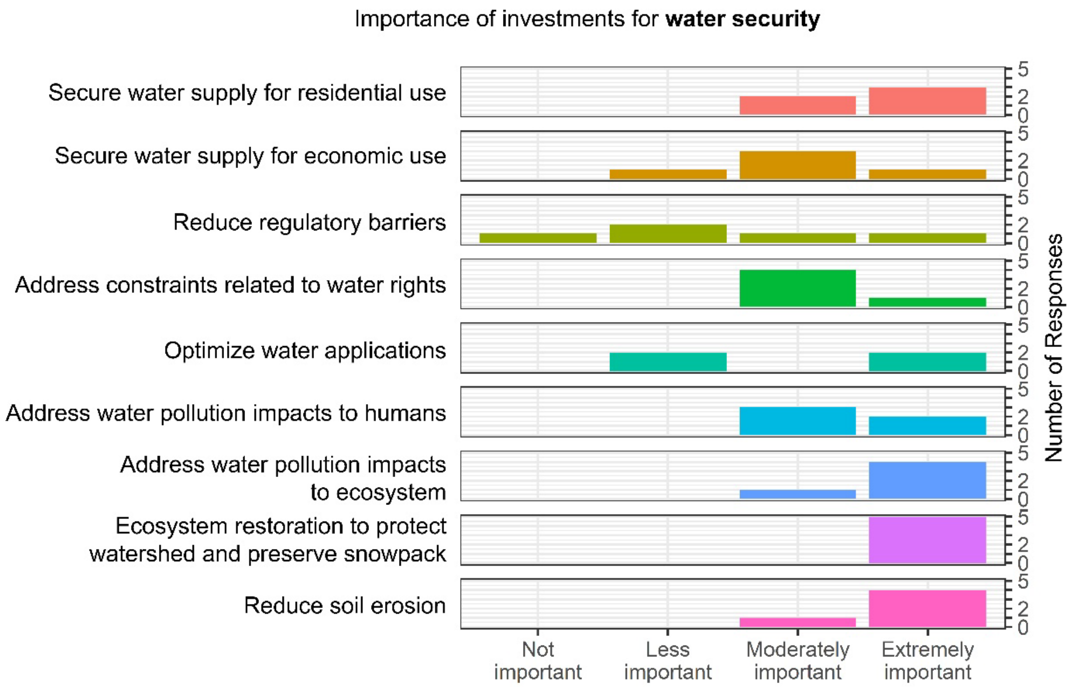
Importance of investments for **resilient communities: fire safety and preparedness**
Reduce fuels loads to reduce hazard
Maintain strategic fuel breaks
Improve infrastructure for emergencies
Protect critical infrastructure
Protect specific cultural or ecological resources
Investments in home hardening and defensible space
Update building codes
Public engagement on emergency preparedness
Public engagement on preparing homes or private land
Public engagement on ignition reduction
Less important
Moderately important
Extremely important
Number of Responses
0
6

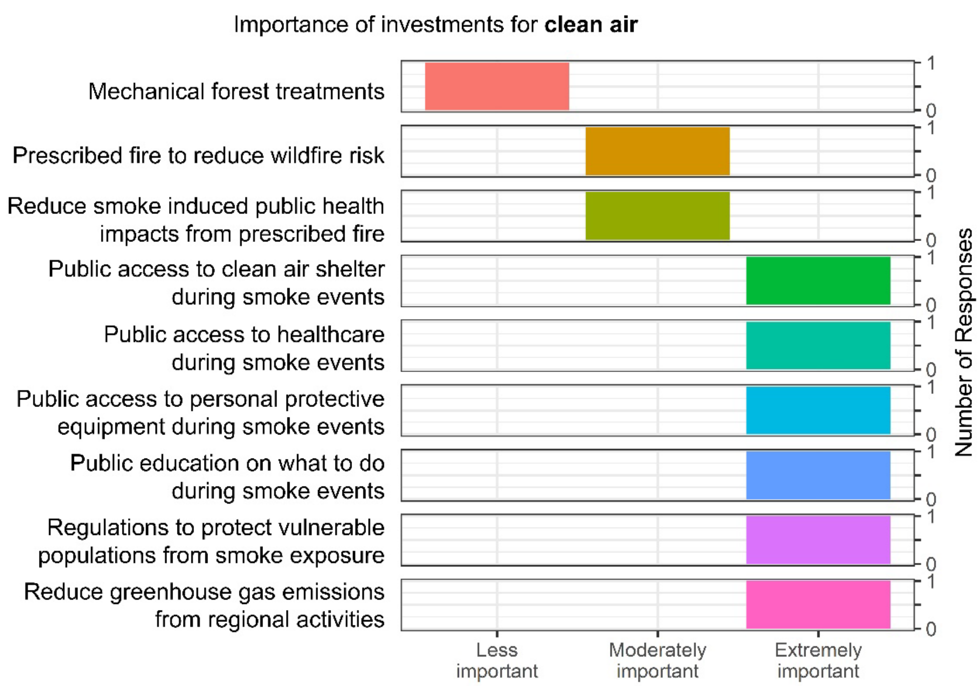


Importance of investments for **resilient communities: community well-being**
Increase public access to natural lands
Reduce impact of forest treatment activites on local community
Increase access to spiritually and culturally important sites
Increase tribally-led land management
Less important
Moderately important
Extremely important
Number of Responses
0
1
2
3
4


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
2
1
Number of Responses
Less important
Moderately important
Extremely important


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
Integrate climate change adaptation into conservation planning
Public engagement to reduce human-wildlife conflict
5
2
0
Number of Responses
Less important
Moderately important
Extremely important


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
Reduce soil erosion
Not important
Less important
Moderately important
Extremely important
Number of Responses
5
2
0


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
Less important
Moderately important
Extremely important
Number of Responses
1
0