

# IX. FORESTRY

## Introduction

Forestlands and rangelands occupy over 80 percent of California's 100 million acres. Forests and woodlands, which cover about 31 million acres, have at least 10 percent tree canopy and include coniferous and hardwood habitats. About half of this area consists of timberland, land capable of growing 20 cubic feet of wood per acre annually. The most recent timber yield data shows that over 1.6 billion board feet of timber, valued at about \$474 million dollars, was harvested from private and public timberlands in 2007. Rangelands are native or naturalized grasslands, shrublands, deserts and open woodlands which have primarily been used for livestock grazing. They cover about 47 million acres of California's wildlands. For the purposes of this chapter, climate impact discussion and adaptation strategies focus mostly on ecosystems supporting tree cover, i.e., forests and oak woodlands (hardwood range). In addition to traditional economic uses of these working landscapes, California's forests and rangelands provide important environmental and economic benefits such as watershed protection, carbon sequestration and storage, biomass for energy production, recreation, and wildlife habitat for wildlife.

Climate change in California forests may affect tree survival and growth, forest composition, forest health and productivity, and will likely increase the intensity of ecosystem disturbances from wildfire, insects and pathogens. Population growth and land use change may create additional stresses that increase vulnerability to impacts from climate change. The interaction of these forces may reduce or change the range of ecosystem goods and services available for wildlife and watersheds, citizens, communities, and businesses.

## Future Climate Impacts to Forest and Rangeland Resources

### A. Increased Temperature and Extreme Events

Temperature rise affects plant species behavior, including seed production, seedling establishment, growth and vigor. It also reduces moisture availability for plants, threatens seedling and plant survival, increases the risk of wildfire, and is likely to enhance the survival and spread of insects and possibly pathogens. These effects could change the survival, distribution and composition of rangeland and forest habitats. A recent analysis of tree mortality information collected over the last five decades in the Western United States, including older established Sierran forests, determined that trees have been dying at a faster rate in recent decades as a result of increasing regional temperatures and climate change.<sup>1</sup>

With warmer temperatures, tree species in California may respond by migrating both northward and to higher altitudes.<sup>2</sup> Recent research concluded that upslope movement of pine forests and oak woodland conversions to grassland have already occurred due to climate change.<sup>3</sup> As the rate of climate change increases some tree species may not be able to adapt to changed conditions. Species with currently restricted ranges will probably be most vulnerable, while species with broader climate tolerances may be able to adapt more easily. Alpine forests and associated plant species are particularly vulnerable, because they have little room to expand. Ecologists also no longer assume that plant communities will migrate intact, so forest and range communities may change in species composition as they move.

The scenarios reviewed for the 2009 Scenarios Assessment show – inconclusively at this time – potential increases and decreases in forest productivity due to temperature and climate change.<sup>4</sup> Other researchers modeled interactions of temperature, wildfire, CO<sub>2</sub>, and other climate effects. The results have predicted declines in conifer forests, oak woodlands, savanna and chaparral, but increases in hardwood forests and grasslands.<sup>5</sup>

Other studies have predicted that in areas where water availability is adequate for growth, warmer average temperatures will potentially extend the growing season and allow forests to expand. A wetter climate model predicted that woody biomass would increase over the next century, while a drier climate model predicted a decrease in woody biomass.<sup>6</sup> A study modelling ponderosa pine plantation growth showed 9 to 28 percent increases in tree volume by the end of the century, primarily due to higher temperatures.<sup>7</sup> Ponderosa pine is an important commercial species, thus climate change could be economically beneficial in some areas.

Higher daily and seasonal temperatures will affect insect pest and disease life cycles and processes as winters become milder. Pests such as the mountain pine beetle have already expanded their range and have increased overall fecundity due to warmer average temperatures (Figures 18 and 19).<sup>8</sup> A 2 °F increase in annual average temperature allows mountain pine beetle to complete its life cycle in one year versus two.<sup>9</sup>

#### FORESTRY IMPACTS DUE TO WARMING

- Enhanced and/or Decreased Forest Productivity
- Tree Mortality
- Species Migration Barriers
- Invasive Species Increases
- Changes in Natural Community Structure
- Spread of Diseases & Insects
- Reduction in Ecosystem Goods and Services

**Figures 18 and 19:** Bark Beetle damage- forest mortality has increased in recent decades as tree-damaging pests expand their range with warmer temperatures



Many invasive plant, insect and disease species are successful at colonizing new areas precisely because they have a broad tolerance of physical conditions. As such, warmer average temperatures may make California rangelands and forests more hospitable for species that are new to the area. This could compound the loss of California's native species, increase costs for removal of invasive species, and potentially bring new species of commercial value to California's timberlands. Temperature rise also reduces moisture availability for vegetation. Warmer, shorter winters result in earlier snowmelt and spring runoff, which can mean longer dry periods in the summer months and reduced moisture for plant use. These factors have also been implicated in earlier and longer fire seasons.<sup>10</sup> Some models suggest that these snowpack losses are likely to occur more quickly in milder climates and at lower elevations; while slower losses are predicted at higher elevations.<sup>11</sup>

## B. Precipitation Changes and Extreme Events

Climate change may affect precipitation and hydrology, which are critical drivers in forest and range ecosystems, in several ways. Recent winters have been warmer and snowmelt has begun earlier.<sup>12</sup> In addition, a greater percentage of precipitation is already falling, and will continue to fall, in the form of rain rather than snow.<sup>13</sup> Less snowpack and the temporal changes in snowmelt and spring runoff can lead to longer dry periods in summer months, reducing available moisture for forest plants. Moisture deficits may, however, be somewhat offset by increases of atmospheric carbon dioxide which generally cause plants to increase their water use efficiency.<sup>14</sup> Earlier snowmelt will also affect wildlife behavior, and this could affect forests. For example, the early emergence of denning bears could result in greater localized tree damage, tree stress and lower forest health.

While the results of precipitation models vary, recent models lean toward predictions of a drier future for California.<sup>15</sup> Declines in precipitation and drier cycles will increase the risk of drought. The effects of a prolonged drought on forests will depend on the species present, their life stages, soil texture and depth, and the duration and severity of the drought.<sup>16</sup>

A lack of consistently available moisture can impact forest health, although some regions and forest types will be impacted more than others. For example, declines in precipitation may have significant impact on those inland forests that are drier as compared to coastal forests which receive moisture through coastal fog. Climate change may, however, also result in decreased fog regimes.<sup>17</sup>

In the short-term, forest trees will respond to increased drought by limiting growth and reducing water use. While adult trees, with their deeper root system and stored nutrients and carbohydrates, will be able to survive short-term droughts, new seedlings and saplings may be unable to establish. Under prolonged drought conditions trees and shrubs may weaken and become more susceptible to pests, disease and wildfires, and some plant communities may be more vulnerable to invasive species. Reforestation success may be improved by management practices that use more drought tolerant species or genotypes, by changes in stocking, and other silvicultural practices.

Climate change may result in other precipitation extremes. While total average annual rainfall may decrease only slightly, rainfall is predicted to occur in fewer, more intense precipitation events. More intense weather events may result in high runoff and flooding, which can cause soil erosion and landslides.

These events can impact watersheds, habitats, structures and public safety, integrity of road systems and other infrastructure and forest site productivity. Effects can be devastating when they follow wildfires that denude and destabilized slopes, as seen in “fire/flood” sequences in southern California.

### FORESTRY IMPACTS DUE TO PRECIPITATION CHANGES

- Longer Dry Periods and Moisture Deficits
- Potential for Increased Growth from CO<sub>2</sub>
- Competitive Species Interaction
- Increased Flooding & Runoff - Increases Erosion and Nutrient Loss
- Drought Conditions
  - Limits Seedling and Sapling Growth
  - Increase Wildfire Risk
  - Economic Losses

# Wildfires

## *Fire History and the Ecological role of fire in California*

Wildfires are an intrinsic part of California’s forest and rangeland ecosystems. Our native habitats have evolved with and adapted to periodic wildfire disturbance. Plants species have developed mechanisms or characteristics for resisting fire damage or for reproducing or re-establishing quickly after certain kinds of fire. Fire regimes differ by region and ecosystem due to differences in weather, topography, vegetation type and stand characteristics, which affect the timing, frequency, and behavior of wildfires. Plant communities may be well adapted to some fire regimes, but not to others. For example, species such as lodgepole, Coulter, knobcone and Bishop pines have cones that release seed in response to heat and fires; thus the vegetation is adapted to moderate to high severity fires, even though fire kills individual trees. Vegetation such as ponderosa pine forest and oak woodlands, on the other hand, evolved with and benefit from frequent but relatively low intensity understory fires that remove competing vegetation without damaging trees; seed dispersal is not dependent on fire, so large, high severity fires that result in extensive tree mortality can damage these types. The table below describes fire regimes for some California plant communities (adapted from Keeley et. al, 2009, Table 1, p25, incorporated with permission from the author)<sup>18</sup>.

Fire return interval (years)	Fire spread driven by	Fire intensity	Fire effects	Ecosystem examples
1-35	Surface and other low understory fuels	Heavy understory and fuel consumption	Low to moderate fuel overstory mortality	Ponderosa pine, pine oak savanna
1-35	Mostly surface fuels	Low to moderate	Aboveground biomass killed, most fuels consumed	Grassland, low scrub
35-100	Surface and canopy fuels	Mixed high and low	High understory mortality and fuel consumption, thinning of overstory	Western mixed-conifer forest
35-100	Mostly canopy fuels	High	Aboveground biomass killed, high fuel consumption	Chaparral, boreal forest, sagebrush
>200	Mostly canopy fuels	High	Aboveground biomass killed, high fuel consumption	Lodgepole pine forest, subalpine forest

Fire activity in California has undergone many changes over time. Prehistoric fire activity (before 1800) is estimated to have annually burned 1.8 million or more hectares (3.5 million acres) of California’s wildlands, excluding deserts<sup>19</sup>. European settlement brought livestock grazing and introduced nonnative annual grasses, both of which altered fire regimes. Gold rush settlement resulted in disturbances, ignitions and large fires in Sierran forests and woodlands. Fire suppression was instituted in the twentieth century, significantly reducing total acres burned in California wildlands and producing longer fire return intervals in many habitats.

Fire exclusion has resulted in white fir expansion downslope into ponderosa pine habitats, the expansion of juniper and pinyon stands in sage scrub communities on the east side of the Sierra and Cascades, and decreased giant Sequoia regeneration and encroachment into Sequoia groves by other conifer species<sup>20</sup>.

Fire frequencies have increased, however, in Southern California chaparral and coastal scrub vegetation (Keeley et al., 2009). This is due to dramatic increases in human ignitions, coupled with the invasion of exotic annual grasses that act as “flashy” fuels. Scrub species are being replaced by even more annual grasses as a consequence of these shortened fire return intervals, resulting in complete vegetation type conversions in some areas and the loss of critical habitat values.

### ***Predicted Effects of Climate Change on Wildfire***

Increased wildfire has been identified as one of the most potentially significant climate change impacts to forested ecosystems. Climate change research predicts increased numbers and acres of wildfire. Wildfire occurrence statewide could increase from 57 percent to 169 percent by 2085 under the A2 (higher) emissions scenario and by more than 100 percent in most northern California forests<sup>21</sup>. Fire severity is also predicted to increase as a result of more frequent severe fire weather.<sup>22</sup>

The wildfire season already appears to be starting sooner, lasting longer, and increasing in intensity.<sup>23</sup> Burned wildland acreage has increased in the last several decades<sup>24</sup>. Over 48 million acres, or nearly half of the state, is at a high to extreme level of fire threat.<sup>25</sup>

Climate change will greatly influence the size, severity, duration, and frequency of fires. Rising temperatures will produce drier fuel conditions and increase moisture stress, likely impacting forest health and increasing susceptibility to pathogens and insects. These stressors, in turn, will further increase fire hazard. Fuel buildup from years of fire suppression and past management practices, in concert with changing climate, can contribute to increasing fire hazards, threatening life and property, air quality, watersheds and water quality, terrestrial and aquatic habitats, recreation and tourism, timber resources and other goods and services.

Increases in the frequency and intensity of wildfires will make forests more susceptible to vegetation conversions from trees to brush or grasslands.<sup>26</sup> In order for trees to reestablish after wildfires, patches of living trees must be left to provide seeds for the recruitment of new seedlings. As wildfires increase in size, they can result in “stand replacing” burns that are too big for natural regeneration. More frequent fires may also result in vegetation conversion by repeatedly killing regeneration.

Increased frequency of fires in southern California interior and coastal chaparral ecosystems will aggravate already damaged habitats, replacing brush species with annual grasses until there’s no brushy fuel left to burn. Vegetation conversions of chaparral and forest vegetation will impact biodiversity, habitats, watershed conditions, timber resources and other goods and services.

On rangelands, climate change induced wildfire increases are predicted to increase grassland acreage, while decreasing brush and oak woodlands.<sup>27</sup> Wildfires may increase invasion by annual and brush nonnative species, which are generally less palatable to livestock and wildlife than native grass and brush species. Annual grasses also increase fire risk and hazard by producing “flashy fuels” that ignite easily and carry fire quickly across the landscape.

Larger and more frequent wildfires will impact California’s economy by increasing fire suppression and emergency response costs, damages to homes and structures, interagency post-fire recovery costs, and damage to timber, water supplies, recreation use and tourism. The California Department of Forestry and Fire Protection (Cal/Fire) spent over \$500 million on fire suppression during fiscal year 2007/2008. As climate change continues these costs are expected to increase.

### ***Fire Management***

Management options for adapting to the threat of increased fires must address public health, public safety and ecosystem protection. Fire protection measures, including suppression, prevention and building codes, can reduce the occurrence, extent and damage of wildfires. Fuel reduction by manual, mechanical and prescribed burning can reduce the size and severity of wildfires. Vegetation and wildfire

management may be used to reestablish conditions that support historic or more ecologically beneficial and socially acceptable fire regimes. In significantly altered ecosystems and developed areas, this may take many steps and treatments.

In ecosystems where fuel loads have increased under fire suppression, such as northern California forests, proper fuel management, strategically placed, can effectively reduce hazard and risk and help restore vegetation conditions that are more resistant to wildfire damage. Fuel reduction also mitigates climate change by reducing GHG wildfire emissions and providing biomass for energy production as a fossil fuel alternative. Fuels management to restore more fire resistant forest conditions can be accomplished through prescribed fire, manual and mechanical treatments, or a combination of methods.

Over 200,000 acres of fuel management is conducted annually by federal and state agencies with natural resource protection responsibilities (i.e., US Forest Service, BLM (Bureau of Land Management), BIA (Bureau of Indian Affairs), NPS (National Park Service), NFW (National Fish and Wildlife Foundation), CAL FIRE, DPR (Department of Parks and Recreation)). The USFS conducts fuel management and forest health improvement on about 100,000 acres of their lands per year.<sup>28</sup> Prescribed fire is used on about 40 percent of the area and mechanical or other treatments on 60 percent. CAL FIRE has been treating about 16,500 acres per year on private lands (about 10,000 acres through prescribed burning and 6,500 with manual and mechanical treatments).<sup>29</sup> Federal grants are also been provided for community fire hazard reduction through the California Fire Safe Council. These efforts typically treat only a fraction of the area now at risk for high intensity fire.

Based on the area of ecosystems that historically supported frequent low-severity fire regimes, the potential need for prescribed burning or other treatments that restore fire resistant ecosystem conditions may be estimated at over a million acres per year. While prescribed burning treatments can be less expensive to conduct, in many cases reintroduction of fire is not prudent until heavy understory and ladder fuel hazards have been treated through alternative means (e.g., mechanical treatments). Additional research, monitoring and information sharing on the effectiveness of all treatments to re-establish desired conditions for supporting wildland fire will also be very important.

Public health and safety concerns must also be taken into consideration. Air quality impacts, concerns about fire escapes and potential harm to people and property can also impact the feasibility and costs of using prescribed fire. (See the Biodiversity and Habitat chapter for more discussion of ecological concerns.)

## **C. Sea-Level Rise**

Sea-level rise poses minimal threats to forest stands. The convergence of sea-level rise and storm surges may, however, damage road systems in low lying forested areas right along the coast. This will impact residential access, timber management, recreation, and tourism uses of the landscape.

## **D. Risks for Forestry**

The changing risks faced by California's forestry sector have been qualitatively assessed and the projected consequences for California's forests and woodlands are characterized as follows:

- The most significant climate change risk facing California is associated with an increase in wildfire activity. Warmer weather, reduced snowpack and earlier snowmelt can be expected to increase fuel hazards and ignition risks. It can also increase plant moisture stress and insect populations, both of which impact forest health and reduce forest resilience to wildfires. An increase in wildfire intensity and extent will increase public safety risks, property damage, fire suppression and emergency response costs to government, watershed and water quality impacts, vegetation conversions and habitat fragmentation.

- Climate change may dramatically change forested and range landscapes, resulting in expansions of some forest and woodland types, contraction of others, and conversions to brush and grassland habitats. These will affect biodiversity and may impact habitat availability, quality and connectivity. It may also affect economic uses, such as timber harvest, though net interactions of growth, wildfire, lumber markets and other effects are hard to predict.
- Temperature rise may enhance and expand insect populations, resulting in increased mortality. This would impact timber resources and reduce habitat quality for some species. It also increases fuel hazards and the likelihood for more intense, stand replacing fires that impact timber resources, fragment habitats, threaten life and property and damage watersheds.
- Climate change may result in increased establishment of non-native species, particularly in rangelands where invasive species are already a problem. These species may be able to exploit temperature or precipitation changes, or to quickly occupy areas denuded by fire, insect mortality or other climate change effects on the vegetation.

## Forestry Adaptation Strategies

### Introduction

The state agency that participated in the Climate Adaptation Working Group (CAL FIRE) developed the following strategies and shall be responsible for and will spearhead strategy implementation for the state. Developing a successful comprehensive forestry adaptation strategy will, however, require working across agencies and with public and private landowners. Collaboration among federal and state resource protection agencies, landowning agencies, industry and non-industrial forest landowners, and other stakeholders is essential. The U.S. Forest Service, which owns over 13 million acres of forests and woodlands, will be an important partner in this effort.

Recent research has focused on the nature of successful adaptation strategies for minimizing the threats to forests resulting from climate change. Following the findings of some researchers, adaptation can be thought of in terms of three broad strategy constructs, from which a variety of specific actions can follow.<sup>30</sup> Resistance refers to either forestalling or protecting key areas from harm, and is generally considered a near-term strategy to highlight high-vulnerability/high-value resources and to target actions that defend those resources against change. An example would be a particularly sensitive habitat that fires are expected to destroy. The resistance adaptation would be to put in place fire prevention and hazard reduction projects to reduce the risk from future wildfires by making fire in the habitat area less likely.

Resilience strategies emphasize transforming currently vulnerable systems into less vulnerable ones, much like how preventative health care is designed to mitigate future medical problems. This is a more mid-term level approach that requires systematic understanding of how fires impact key assets, and how the fire environment can be modified to reduce damage. The classic example is treating high hazard mixed-conifer forests through fuel modifications to make future fires in low-severity systems low severity events, rather than the high severity events that might be expected under current fuel conditions. This approach has the added benefit of also being a climate change mitigation strategy in that it promotes carbon sequestration and limits CO<sub>2</sub> flux from future wildfires.

Finally, a Response strategy refers to pushing system effects in a beneficial way, and is typically viewed as a long-term strategy, in that ecological response is required to be conducted through successional time. As such, this strategy does not avoid change, it accommodates it.

Treatments in this strategy would try to mimic or expand on natural adaptive processes that allow natural systems to respond to changing environmental conditions as all systems have developed

over ecological time. Thus, treatments designed to improve dispersal, colonization, migration, etc. all can be viewed as promoting response. By encouraging gradual adaptation to a changing climate, the idea is to avoid rapid and often catastrophic conversions that might otherwise occur.

## **Adaptation Strategies and Actions**

### **Assessment and planning**

While forests inherently contain the ability to adapt to a changing climate, rapid climate change may result in significant disruptions of existing forest and range habitat structure and the goods and services we receive from them. Management actions, therefore, should enhance the resiliency of existing forests where possible, and facilitate the establishment of future stands that are more tolerant or able to exploit future climate conditions. Planning should include short and long term strategies, monitoring for unanticipated climate effects and for effectiveness of adaptation strategies, and flexibility to manage adaptively and make adjustments as we go.

CAL FIRE will continue to refine its understanding of wildland vulnerability to climate change. The Fire and Resource Assessment Program (FRAP) is updating a chapter on climate change in its Forest and Rangeland Resources Assessment. The climate change chapter will incorporate information on Fire Hazard Severity Zone mapping, recent revisions to CAL FIRE's Vegetation Management Program EIR, and climate research conducted by FRAP personnel. The assessment, which will be finished in 2010, will inform climate policy development, strategic planning, and implementation of the AB 32 Scoping Plan's Sustainable Forests target by the Board of Forestry and Fire Protection (BOF).

In order to meet the threat of increasing wildfires, CAL FIRE will focus adaptation activities on pre-fire management and fire suppression. It will work with the BOF to revise the State Fire Plan by January 2010. The plan will consider policies and programs for defensible space (fuels treatments and fire safe development standards), land use planning (timberland conversions, development projects, and fire protection responsibility), ignition resistant building standards, fire suppression deployment based on hazard/risk rating, and restoration and rehabilitation. By 2009, CAL FIRE will also have made recommendations for Very High Fire Hazard Severity Zone classification of over 200 cities in Local Responsibility Areas, which can be used to implement adaptation activities for increasing fuel reduction and improving structural resistance to wildfire. CAL FIRE will also encourage local entities to reduce fire risks and hazards and to enhance disaster readiness planning for escape routes and evacuation.

### **Fire Hazard Reduction and Fire Suppression**

CAL FIRE has several programs that support vegetation management and fuel hazard reduction activities (mechanical treatments and prescribed burning). These can be used to increase forest health and resilience to climate impacts. Although state funding for the Proposition 40 Sierra Nevada Fuels Reduction Program expires this year, CAL FIRE is anticipating a \$13.5 million-dollar, one-time federal fuels management grant and is actively pursuing other potential funding sources.

In recent years, both state and federal fuel reduction priorities have focused on the wildland urban interface (WUI), the area where at-risk forests and rangelands meet structure and human development. The WUI's proximity to communities makes mechanical treatments often more acceptable than prescribed fire, due to concerns about fire escape, life and property damage, and smoke impacts. In 2001, federal agencies and the Western Governors' Association approved "A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment," a 10-year strategy to improve fire suppression, prevention, fuels reduction and recovery, and to restore fire adapted ecosystems through collaboration among states, federal agencies and stakeholders. The plan includes the use of prescribed fire, mechanical treatments and wildland fire use, and seeks to reduce barriers to treatments through policies and incentives.<sup>31</sup>

Biomass utilization can help offset the cost of vegetation management and fuels reduction activities to reduce fire risk and create healthier, more resilient forests. In addition to promoting healthy forests and defensible communities, biomass utilization of these materials reduces landfill waste, provides net air quality benefits over open slash burning, and contributes to economic and job development. Sustainable biomass utilization for energy production will reduce GHG emissions because emissions are carbon neutral. CAL FIRE will work with the California Energy Commission, the Air Resources Board, stakeholder organizations and the research community to develop definitions, practices and policies that ensure forest biomass utilization is sustainable and to enhance its use for environmental benefits. CAL FIRE is developing a plan for a small demonstration biomass-to-electricity plant in Mendocino County which will be completed by December 2010. It is also working with the California Biomass Collaborative (CBC) and the California Energy Commission to inventory available forest biomass and to evaluate the potential for "Biomass Management Zones" (report due December 2009).

Ignition resistant building construction is also critical to reducing fire hazard and risk to life and property in wildland-urban interface (WUI) fires. These conflagrations, though not necessarily large (e.g., 1991 Oakland Tunnel Fire, at 1,600 acres), can overwhelm fire suppression and result in 80 to 90 percent destruction of ignited buildings. The State Fire Marshal has begun a revision of the California Building Code Chapter 7A, "Materials and Construction Methods for Exterior Wildfire Exposure" to develop more comprehensive hazard mitigation measures. The revision will be completed January 2010.

CAL FIRE has already increased fire suppression readiness to meet changing climate conditions. A year round fire season was established and staffed in southern California, and recommendations from the Governor's Blue Ribbon Commission are being implemented to replace aging fire engines and to provide a higher level of firefighter safety. Emerging remote sensing technologies are being tested on major fires to provide real time planning tools to incident commanders and fire managers, and new air tanker platforms, including the DC-10, are being evaluated for large and remote fires. Recent Governor Executive Orders have also provided increased staffing, additional aircraft availability and other support for periods of critical fuel and weather conditions.

## **Reforestation, Urban Forestry and Forestland Conservation**

Adaptive approaches to forest regeneration can increase resilience in the short and long-term by adjusting silvicultural practices to establish forests that are more tolerant of future climate conditions. This includes planting genetically appropriate species that will be better adapted to changed climate conditions than the genotypes currently on site. CAL FIRE's L.A. Moran Reforestation Center seedbank catalogues and stores approximately 42,000 pounds of primarily native conifer seeds which are available for replanting forest stands after fires, insect or disease outbreaks, or other catastrophic events. Its greenhouse facilities have capacity for up to 400,000 container seedlings per year, but have gone unused for seven years due to inadequate funding. CAL FIRE's Magalia Reforestation Center has the capacity to produce up to 2.5 million bare-root seedlings and 40-50,000 container seedlings per year. These facilities could be brought back on line relatively quickly and inexpensively if funds for operating and staffing were provided.

Urban forestry has a significant role in adaptation to rising temperature and precipitation runoff events. Increased street tree cover provides shade relief to pedestrians and other residents, absorbs pollutants including ozone and CO<sub>2</sub> which may increase with climate change, and reduces stormwater pollution and flooding. A ten percent increase in vegetation cover can reduce ambient temperatures by 1 to 2 degrees. Urban forests also provide significant co-benefits, reducing habitat fragmentation and mitigating GHG emissions through sequestration and by reducing energy use for buildings. CAL FIRE urban forestry activities, funded through state bonds authorized under Propositions 40 and 84, help plant trees and support local agencies and non-profits in planning, implementing and monitoring urban forestry programs. CAL FIRE helped develop urban forestry carbon protocols to provide incentives for increased urban forest development, and will continue to work with local and federal agencies, private and non-profit sector to expand and enhance urban forests.

Development pressures on forestlands are increasing due to declining profitability from timber management and demand for rural subdivisions and vineyards. Forestland conversion fragments forested ecosystems, reducing forest health and capacity for carbon sequestration, degrading and eliminating wildlife habitat and isolating populations of forest species, increasing wildfire risk, and complicating wildland fire suppression efforts. CAL FIRE is proposing revisions to the CEQA guidelines to incorporate more protection for forestland and will work with the Board of Forestry and Fire Protection over the next 18 months to improve review and permitting for forest, timberland and Timberland Production Zone (TPZ) conversions.

## Strategies and Actions

The following list of strategies and actions by the Department of Fire and Forestry (CAL FIRE) elaborates on the discussion above and identifies additional activities for addressing climate adaptation. The strategies include both near term actions - those recommendations that have been identified, proposed, initiated, or can be completed by 2010. The long term actions identified include those recommendations that will require additional collaborative efforts with multiple state agencies, as well as sustainable funding and long-term state support.

### ***Strategy 1: Incorporate Existing Climate Information into Policy Development and Program Planning.***

#### **Near-Term Actions:**

- a. **Comprehensive Program Integration** – Integrate climate risk information into existing CAL FIRE program planning to address forest and range adaptation. CAL FIRE program managers should identify key climate effects or uncertainties that may affect implementation of a broad range of programs including: Forestry Assistance, State Forests, Forest Practices Regulations, Fire Protection, Fire Prevention, Unit Fire Plans, and Capital Outlay.
- b. **Identify and Engage Stakeholders** – CAL FIRE will fully engage Forest Sector and cross-sector stakeholders in identifying key impact and adaptation concerns and questions as they relate to agency responsibilities and services. [e.g., U.S. Forest Service (USFS), Bureau of Land Management (BLM), National Park Service, National Marine Fisheries Service, U.S. Fish and Wildlife Service, State Department of Fish and Game (DFG), State Parks, regional air boards, regional water quality boards and other state agencies, local governments, private landowners, community groups and Non-Government Organizations (NGO)].
- c. **Forest and Rangeland Resource Assessment** – CAL FIRE is required by statute to periodically assess the condition and availability of the state’s forest and rangeland natural resources. The update will expand upon the previous climate change chapter to inform the Board of Forestry and Fire Protection’s (BOF) climate policy, strategic plan and climate change actions. The draft plan will be developed, reviewed by the public, and considered for BOF approval by the end of 2009, and finalized in 2010.
- d. **Timber harvest planning under the Forest Practices Act** - Provide guidance for project proponents and CAL FIRE staff to address climate impacts and adaptation actions within existing maximum sustained timber yield production plans required by the California Forest Practices Act.

#### **Long-Term Actions:**

- e. **Build Institutional Capacity** - Update policies and CAL FIRE Handbook and activity guidelines.

## ***Strategy 2: Improve Institutional Capacity for Data Development and Analysis, Assess Climate Effects and Forest Vulnerabilities, and Recommend Strategic and Tactical Responses.***

### **Near-Term Actions:**

- a. **Vulnerability & Risk Assessment** – CAL FIRE will conduct strategic risk analyses and vulnerability assessments to identify and prioritize planning and tactical actions to address adaptation needs. Included in this is the deliberate development of quantitative risk modeling of fire impacts on key assets and resources in a spatially explicit framework. A major portion of this work involves projecting future fire probabilities and future vegetation/fuel conditions across the state.
- b. **Policy Actions** – Begin to develop policy, management and funding recommendations for actions by Board of Forestry and Fire Protection, CAL FIRE, other agencies (including USFS) and private sector to increase resilience of forest lands and resources.

### **Long-Term Actions:**

- c. **Improve Data and Modeling Capabilities** – Fill major data gaps for strategic planning and assessment by CAL FIRE and other programs.
- d. **Improve Scientific Knowledge Base** – CAL FIRE programs, such as the Fire and Resource Assessment Program, will work with Scripps, UC, USFS, Energy Commission and others to refine climate models for CAL FIRE Fire Protection and Resource Management Programs. CAL FIRE's Demonstration State Forest Program will also work with the USFS Pacific Southwest Research Station, the University of California and other landowners to establish research reserves, studies and demonstrations across geographic and elevation gradients that inform climate change forest management and protection needs.

## ***Strategy 3 - Actions to Address Climate Vulnerabilities (Sector Preparedness Action Plan)***

### **Near-Term Actions:**

- a. **Management of Forest and Range Lands for Resilience** – In cooperation with federal, state and local agencies, CAL FIRE plans to reduce the vulnerability of forests to disturbances from climate change impacts. Specific actions include:
  - i. **Expand Landowner Assistance and Technology Transfer** – CAL FIRE's Forest Improvement Program will work with the US Forest Service, University of California Extension, Resource Conservation Districts (RCDs), Natural Resource Conservation Service and others to prevent and minimize catastrophic wildfire and restore fire resistant conditions in fire adapted vegetation types through mechanical and prescribed fire treatments, and to assist with post-fire recovery.
  - ii. **Review Regulatory Framework** – The Board of Forestry and CAL FIRE's Forest Practices, Fire Protection and State Fire Marshal programs will review and consider the need for regulatory and related improvements, incentives for private investments, and revisions to CAL FIRE Handbook.
  - iii. **Support Urban Forestry** – Funded through Propositions 40 and 84, CAL FIRE's Urban Forestry Program will continue to assist local entities with tree planting and urban forest management. This will help protect and expand urban forests that serve to buffer the impacts of local wildland forests, and provide sequestration, watershed, water quality and habitat co-benefits.

- b. **Department Established as “Trustee” Agency in CEQA** – CAL FIRE will work with Board of Forestry to consider establishment of CAL FIRE as a Trustee agency in CEQA will provide assurance that new projects and development provide mitigation that is consistent with adaptation goals, including fire safety and forestland conservation and maintenance.

**Long-Term Actions:**

- c. **Reduce Fire Risk, Hazards and Emissions** – CAL FIRE will work with state agencies such as Fish and Game, Parks and Recreation, Sierra Nevada Conservancy, Tahoe Conservancy and Dept. of Water Resources, with landowners and local government, and with federal agencies, including USFS and others, to identify high value and high risk natural resource areas (e.g., habitats and corridors, watersheds, parks, timberlands) and to increase fuels management and restore fire resistant forest conditions where appropriate through mechanical and prescribed fire fuel treatments.
- d. **Support Restoration Activities** – CFIP and Nurseries will work with state agencies such as DFG and DPR, USFS, landowners, and others to develop technical assistance and guidance materials.
- e. **Seedbank and Nursery Support** – CAL FIRE will work with the USFS and private sector to improve long-term seedbanks and nurseries in order to secure genetically appropriate varieties for future plantings and to preserve genetic legacies.
- f. **Rangeland Adaptation** – CAL FIRE will cooperate with the Board of Forestry and Fire Protection and its Range Management Advisory Committee, state agencies, the University, and the private sector to promote research on carbon cycling benefits and rangeland management climate benefits.
- g. **Promote Adaptation in Land Use, Public Safety and Economic Infrastructure** – Promote an active response by communities and other institutions to improve land use planning and implementation to reduce conversion and wildfire risks. Specific actions needed include:
  - i. **Determine Regional Readiness to Respond to Disasters** – CAL FIRE’s Fire Protection Program should work with governmental agencies and others to examine the climate impacts resulting from more frequent extreme natural events such as floods and wildfire and the ability of regional or statewide resources to respond.
  - ii. **Improve Local Land Use Planning Support** – CAL FIRE’s Fire Protection Program and State Fire Marshal (SFM) will work with local agencies and groups to decrease risk and hazards and increase public safety options, including revision of California Building Code Chapter 7A, “Materials and Construction Methods for Exterior Wildfire Exposure” to develop more comprehensive hazard mitigation measures.
  - iii. **Factor Climate Change into Planning for Fire Protection Services** – CAL FIRE will encourage other state agencies, cities, counties, special districts and community-based non-profits such as Fire Safe Councils to develop local fire management plans that explicitly evaluate climate change impacts as part of the planning process. Fire management plans should identify risks, vulnerabilities, and preventative measures to cope with climate change.
  - iv. **Minimize Impacts of Development** – CAL FIRE will work with other agencies to incorporate adaptation concerns into environmental review and permitting (e.g., timberland conversion, County General Plans, subdivision development review and individual development projects for forest impacts, wildfire hazard mitigation and structural fire resistance).
  - v. **Improve Utilization of Forest Carbon Stocks** –CAL FIRE and Board of Forestry and Fire Protection will work with state agencies, industry, the Legislature and others to

ensure adequate infrastructure for biomass utilization and traditional wood products. CAL FIRE will also work with the California Energy Commission, the Air Resources Board, federal agencies, stakeholder organizations and academia to develop definitions, practices and policies that ensure that forest biomass utilization is sustainable.

- vi. **Improve Opportunities for Rangeland Management Adaptation** – CAL FIRE will cooperate with the Board of Forestry and Fire Protection, the Range Management Advisory Committee, and the Dept. of Food and Agriculture to support private sector efforts to identify economic opportunities for climate adaptation, including invasive weed control, fire hazard reduction, watershed restoration and livestock management.
  - vii. **Post-Fire Vegetation Management** - The Department will strengthen efforts following large damaging fires to guide and invest in vegetation management to change conditions under which the next fire will burn, including encouraging the establishment of new populations of native species that may be favored by climate change. Smaller investments of resources are needed to manage vegetation following a fire than when applied to dense pre-fire vegetation.
- h. **Identify Investment Options and Other Strategies to Address Climate Adaptation** – The state, CAL FIRE and the Board of Forestry and Fire Protection will initiate efforts to build public support for long term investments in public and private forestlands and develop a robust set of options to address adaptation needs for the protection of forest and range land resources.

**Near-Term Actions:**

- i. **Explore Cross Agency and Sector Synergies** – The state, through the Climate Action Team and the California Natural Resources Agency should promote coordination among state planning processes, grant and assistance programs, and management activities on climate actions with high co-benefits. CAL FIRE will collaborate with other agencies on their adaptation strategies and with programs that increase forest resilience (e.g., with ARB to explore funding opportunities from cap and trade markets for activities with both mitigation and adaptation benefits; with WCB on Prop 84 forest conservation; with DWR, DFG, and the California Department of Conservation (DOC) to implement upper watershed protection and riparian reforestation; with DFG to identify, protect and improve the resilience of critical habitats at wildfire risk; with Energy Commission and others on Renewable Portfolio Standard (RPS) implementation to increase funding for fuels reduction; with OPR on CEQA and land use planning tools; with the Department of Public Health and ARB to address fire and smoke issues; with DOC and Dept of Food and Agriculture to consider rangeland issues; with local governments, CalTrans and others to consider development effects on fire risks; working with Strategic Growth Council on urban greening; and with Sierra Nevada Conservancy Prop 84 fuels reduction and forest restoration).
- ii. **Demonstration Project** – CAL FIRE will develop a biomass-to-electricity plant at Mendocino County Conservation Camp to demonstrate the value of small power plants. Planning and funding commitments will be completed by December 2010.
- iii. **Maintain Current Wood Product Utilization Capacity** – The Board of Forestry and Fire Protection and CAL FIRE will work with other agencies and the private sector as appropriate to encourage policies and strategies that help maintain utilization infrastructure (sawmills, pulp mills, veneer plants, etc.) and that encourage modernization of existing facilities or development of new facilities.
- iv. **Provide Regulatory Certainty** – The Board of Forestry and Fire Protection and CAL FIRE will consider the need for additional incentives, or the removal of disincentives, to encourage landowners to actively manage their lands for adaptation, e.g., cap and trade markets, protocols and RPS implementation.

**Long-Term Actions:**

- v. **Adequately Fund Programs** – Consider development of stable funding sources such as carbon fees, Carbon Trust, and public goods charges.
- vi. **Encourage Market Development** – The Board of Forestry and Fire Protection is collaborating with the U.S. Forest Service to encourage investment in bio-energy facilities. The Board will consider the role of biomass utilization in the California Fire Plan revision by January, 2010.

**Strategy 4 - Implement Priority Research Agenda**

CAL FIRE will work with California Energy Commission's PIER Program (Climate Action Team), Air Resources Board, University of California and other research entities to identify and fill knowledge gaps related to climate adaptation and evaluate the most effective strategies. Potential research options include:

**Long-Term Actions:**

- a. **Fill research gaps, including, but not restricted to, the following topics:**
  - i. Urban Forests and Climate Change: Comprehensive Cost and Benefit Analysis
  - ii. Predictive Tree Biomass Model Evaluation and Improvement
  - iii. Wildfire GHG Emission Analysis: Standardized Estimation Methodologies
  - iv. Life-Cycle Characterization of Forest Carbon Pools and Wood Products in California
  - v. Forest Landowner Profile Development: Current and Projected Forest Conditions and Landowner Participation in Programs and Markets
  - vi. Improved Forest Research and Management Tools: Climate Smart Forest Projections and Risk Assessments for Pests and Fire
  - vii. Forest Bioenergy and Biofuel GHG Profile Characterization
  - viii. Climate Change and Forests Research and Monitoring Infrastructure Development: Joint Strategic Planning
  - ix. Quantification of managed fire versus wild fire GHG emissions in California forests.
  - x. Risk and prevention analysis of catastrophic tree mortality in California forests and woodlands from parasitic and exotic insects and disease.
  - xi. A comprehensive monitoring and adaptive management program to quantify the effects on climate change and the effectiveness of adaptation strategies.
  - xii. Improved analysis of timberland conversion trends and effects.
  - xiii. Economic analysis of cross sector effects of investments, e.g. looking at feed-in tariff for biomass based electricity on the cost of fire suppression.

## ***Strategy 5 - Implement Forest Health Monitoring in an Adaptive Management Context***

Monitoring programs for detecting climate change, effects on vegetation and management results are needed to support adaptation planning and management. CAL FIRE will work with the California Natural Resources Agency and others to determine and implement key monitoring needs, including forest health trends, land use and management change, and effectiveness of adaptation actions.

### **Long Term Actions:**

- a. **Define Indicators** – Development of ecosystem and other climate related indicators that show or measure trends.
- b. **Establish Monitoring Criteria** – Establish a network of long term monitoring plots that are implemented across both longitudinal and elevation gradients to detect climate change impacts
- c. **Continue and Expand Pest Detection** – Support existing programs that can provide early detection of insects, disease, and drought in forest and range lands.
- d. **Establish Adaptive Management Criteria** – Identify feedback process to inform and, as necessary, adjust policy, strategies, and regulatory approaches.
- e. **Monitor Changes in Land Use** – Acres of growth and loss of forest cover as well as resulting carbon stock effects.
- f. **Interagency Cooperation** – Collaborate with other state agencies to leverage limited monitoring resources.