California Forests and Climate Change: Enhancing Carbon Storage Through Forest Health

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Table of Contents

III. Forest Conditions in California

e. Co-Benefits

The Forest Carbon Plan presents a strategy for carbon storage and greenhouse gas emission reduction through storing carbon in living trees. Forested ecosystems however, are lot more than just carbon storage factories. Carbon storage is only one of the ecosystem services provided by healthy forests. Forests provide a range of benefits in addition to sequestering carbon. This section describes some of the ecosystem services that forests provide in addition to carbon, many of which are enhanced when forests are managed (e.g., harvesting, reforestation, prescribed fire) to remain in a healthy state.

We then go on to describe forest management actions that are appropriate for safeguarding and improving the total set of benefits, including carbon. Finally, we lead to recommendations for planning targets to maximize all benefits, including carbon storage and emission avoidance,.

Co-Benefits from California Forests

Employment and other economic opportunities:

Management actions that maintain healthy forests and reduce fuels provide an opportunity to also contribute to local economies. Spending on these activities contributes to job opportunities and earnings as well as the potential for local tax revenue collection on the goods and services purchased. Particularly important contributions result from activities that support the local forest products and biomass energy infrastructure and work force. Maintaining the economic sustainability of these local sectors is important to support the ability of land managers to undertake the management actions needed to improve forest health and reduce fuels.

Benefits to Water Resources:

Approximately 60 percent of California's water supply comes from forested watersheds. Healthy forested ecosystems can improve the quality and supply of these water resources. As described in the State Water Action Plan, investments in forest health help ensure that water is available downstream, rather than excessively taken up by small-diameter trees in overgrown forests. Investments in forest health can also reduce the impact of erosion and high sediment loads that typically occur due to large, high-severity fires like the Rim Fire or the King Fire. This sediment can reduce reservoir capacity and interfere with other critical infrastructure. Urban forests also provide benefits to water resources by absorbing runoff during storm events. This helps to retain water that might otherwise wash pollutants into waterways. Reforestation and thinning can improve watershed health and benefit water resources.

Reduced Risk of Large Wildfires:

California's forests are generally fire-dependent; they require periodic wildfires to clear out small-diameter trees and other woody biomass—thereby allowing the remaining trees to remain resilient to pests, natural wildfire, and other stressors. Practices that re-establish or mimic the

role of natural wildfires can help to reduce the risk of high-severity wildfires that are harder to control and release a greater amount of greenhouse gas emissions. The co-benefits of reducing large wildfires include:

Lessened risk to life, public safety, infrastructure:

Forest management that reduces high-severity wildfire can allow access for fire crews to protect property and infrastructure. Not only are homes and other structures at risk during wildfires, but critical infrastructure like transmission lines and roads also can be compromised.

Lessened cost of suppression:

Fuel reduction activities can lower the risk and cost of fire suppression activities by changing fire behavior and giving fire crews access to conduct suppression operations. Accordingly, the cost of fire suppression and the rehabilitation of burned areas can be substantially lower for forests that have been actively managed compared with areas that have not had active management. One study estimated that the cost of fire suppression and rehabilitation was about 60 percent lower in a scenario that included fuel reduction treatments prior to a wildfire compared with a scenario that did not include treatments.

Functional habitat and ecosystems:

Actions to create or restore forested ecosystems will help to maintain healthy habitats that support robust wildlife populations, including state and federally listed species, thereby preserving California's natural biodiversity. Active forest management can restore forests so that they are more representative of a native, fire-dependent ecosystem. In the absence of fire over the past 100 years, many of the state's forests have transitioned away from more natural species mixes and towards species that thrive in shady, dense conditions that are characteristic of a fire-suppressed landscape.

Forest management activities may help to create or protect certain areas of refuge ("refugia") for species under changing environmental conditions. Refugia can help support the persistence of species and habitats, even in new assemblages that may form in the future. Providing forested corridors and maintaining connectivity or linkages between habitat areas will help to facilitate the natural movement of species. This will become increasingly important as some species begin to adjust their geographic ranges to track shifting areas of climatic suitability in the future.

Reduce Existing Stressors:

Certain forest management activities may serve to reduce existing stressors that pose additional threats and stress to native fish, wildlife, and plants. For example, forest management activities can include the direct removal of invasive species so that native species can thrive. Forest management can also ensure that trees are healthy enough to resist impacts from invasive

species, pests, diseases, and other stressors. Reducing existing stressors can create a healthier environment that is more resilient and adaptable to future change.

Resilience to future climatic conditions:

All forests will experience a variety of environmental changes due to climate change, such as shifts in temperature, water availability, and pests. Healthy forests are more likely to be able to resist these changes and recover from disturbances. For example, healthy trees may be able to successfully defend against pests. Restored forests also have gaps for tree seedlings to grow. Active management of forested areas can help maintain the ecological function and natural adaptive capacity of these lands.

Improved Air Quality:

Wildfires result in the emission of particulate matter, carbon monoxide, and other chemicals and compounds—all of which affect air quality at local and regional scales. These impacts can be particularly severe in the case of high-severity and uncontrolled wildfires. Healthy forests often require prescribed burning to achieve the ecological benefits of natural wildfire; however, prescribed burning can be timed and controlled to minimize air quality impacts. Greater amounts of forest treatment through these prescribed burns can lessen the risk of air quality impacts from unplanned wildfires. Urban forests may also play an important role by filtering air pollutants.

Historic and Cultural Resources:

There are many different kinds of cultural resources that occur in forested environments including a wide variety of prehistoric Native American archaeological sites and locations of historical events. One important benefit of modern forest management has been the protection of significant cultural resources that document human presence and use of forest lands in California and elsewhere. Logging and other activities associated with timber work can potentially damage or destroy fragile, non-renewable cultural resources. Because of this fact, both the state of California and the federal government require the development of detailed timber harvest plans (THPs) that include archaeological surveys to insure the location and identification of historic and prehistoric cultural resources, as well as specific protection measures or mitigations that are designed to preserve the important human record that is contained in such site locations. In California alone, professional foresters discover and record more than a thousand archaeological sites every year in the context of preparing timber harvesting plans. The great majority of these discoveries are fully protected from potential harm by logging and at the same time are documented and entered into a data base of information that can be queried by researchers or used for other purposes. These data are one of the benefits of forest sequestration of carbon because archaeological sites that have the potential to provide important information about the past are being preserved for study by future generations of scientists who will have technological tools and methods that are unavailable to us today.

Biomass Use and Bioenergy Development:

Converting biomass into electricity, liquid fuels and biogas is important as it provides a means of

disposing of significant volumes of biomass material that is otherwise: 1) open burned with no controls to reduce emission of particulates and greenhouse gases; 2) landfilled, and in the process, takes up precious space; 3) chipped and scattered in forests providing fuel to feed potential wildfires and causing off-gassing.

Biomass energy provides opportunities for rural development and job creation in economically depressed regions. The environmental services provided by biomass energy production are estimated to be in excess of 10 cents per kWh (Morris, 1999).

Forest materials—including biomass generated from forest management activities like thinning—can be used to generate electricity and heat and, wood products such as landscaping material. There is research testing the viability of biomass-sourced biofuels, liquid fuels, and biogas. This renewable source of energy can reduce the need for fossil fuels and can support rural economies. Given the alternative of open pile burning or broadcast burning biomass logging slash, bioenergy development burning wood in a controlled environment with efficient burners, is a GHG gain in and of itself. The state of Oregon recently declared its bioenergy sector carbon neutral.

Energy self-sufficiency in the form of relatively small, distributed bioenergy plants throughout the state, is one reason for biomass energy development. Extracting low-value biomass from the forest through thinning and fuel reduction projects promotes growth of higher-value, larger and more fire-resistant trees, that also tend to have more wildlife benefits.

Markets for biomass energy in California is complex. Old energy supply contracts with favorable prices are expiring, and in many cases are not renewed. SB 1122 guarantees a set price for biofuel for small energy plants, less than 3 KWh.

Long-term supply contracts from both private and federal lands are essential to guarantee the long term viability of bioenergy plants through a sustainable supply of wood.

Removing excess biomass for bioenergy will in most cases reduce wildfire risks through removing potential fuels. Long term supply contracts can ensure that harvest levels are sustainable. If too many bioenergy plants are built they may not be sustainable in the long run. Biomass removal guidelines are important to balance supply and demand to ensure that bioenergy plants can operate sustainably.

Research is needed on possible environmental trade-offs involved in removing small trees and forest waste. These materials are known to maintain site productivity when they decompose, and provide biodiversity. They are important habitat elements in their own right and widespread removal can conceivably have negative consequences. Studies to date suggest that the productivity of most sites is largely resilient to removal of forest waste and small trees. On the other hand, wide-spread application of such harvests on a large scale have not occurred yet. This indicates the need for new research and identification of best management practices for planning and execution of biomass removal.

Given ambiguous current federal policy on biomass issues, it is even more important for California to develop clear policies that will foster development of biomass markets. Biomass production may be a niche for National Forests which are constrained by environmental

concerns from harvesting trees, to thin out forests and support a resources-based industry in local communities. Biomass harvesting may provide a new product source on private lands that may be restricted from reaching their full financial potential due to environmental regulations.

Reduction of Energy Demand:

Strategically planting trees in urban areas can provide shade and cooling benefits from evapotranspiration (the process of absorbing water through roots and releasing it through leaves as water vapor). These effects can reduce the energy demand of nearby buildings; one study estimated that planting 50 million trees to shade east- and west- facing walls could reduce peak energy demand by 4.5% over 15 years.

Recreational Opportunities and Tourism Revenue:

Management actions that maintain a healthy forest and reduce fuels ensure a suitable environment for recreational activities and also facilitate a more resilient landscape. This more resilient landscape is less susceptible to events such as catastrophic fire and vegetation mortality that can interrupt and eliminate the recreational opportunities that provide value to the quality of peoples' lives.

Recreation is also an important source of economic activity in many forest communities so sustainability of those benefits is important to the socioeconomic structure of communities. These economic contributions, resulting from visitor spending, include service based jobs and earnings as well as sales and lodging tax revenues that are critical in supporting local public services.

Threats to Co-Benefits:

Co-benefits associated with forests and forest management are often a mixture of benefits accruing naturally (clean water and air) and those resulting from management actions (healthy forests, biomass energy). Threats can include wildfire, drought, pest and disease outbreaks, forest management practices, land conversion, habitat loss, and on a smaller scale, wind storms and landslides. Management actions are often taken in part to counter these threats.

Forest Management:

Managed forests can store more carbon than unmanaged forests. Despite the fact that logging removes trees from the forest, forest management, including timber production, thinning and fuel reduction, is an important tool to increase forest carbon, and avoid fire related emissions to ensure that forests in California remain sinks and not sources of carbon. Forest management, primarily through thinning, can prevent overstocked stands, which increase the risk of pest and disease attacks and wildfire. Wood products from harvested trees store carbon for the life of the product, and create a new carbon pool in addition to the carbon stored in living trees.

Managed forests in the Unites States generally remain carbon sinks. California's forests are somewhat unique however, due to their exposure to wildfire. There is evidence to suggest that by virtue of the wildfire regimes in the state, many California forests are close to the boundary

between a source and a sink, and particularly active wildfire seasons can push many California forests from being a sink into being a source of greenhouse gas emissions. Forest management is therefore an indispensable tool for maintaining California forests as carbon sinks.

Unmanaged forests in theory can provide a higher total yield of carbon than managed stands, but in most areas of California outside the coast redwood region, unmanaged forests are prone to carbon losses from wildfires. Given the ongoing drought and in some areas, decades of accumulated fuels, a no management option in a lot of cases is likely to lead to a future of intense, uncontrolled wildfire emissions and resulting conversion of forest land to brush and chaparral types with much lower carbon storage capacity. In unmanaged forests with no stocking control, non-fire mortality is likely to be higher than in managed stands, as trees compete for a limited pool of water, sunlight and soil nutrients. An important part of forest management is reducing mortality and harvesting trees that are likely to die in the near future, capturing the carbon that would have been emitted and storing it in wood products.

Fuel Reduction:

Fuel reduction projects typically consist of a thinning from below to reduce ladder fuels and overall tree density, and distribute the remaining carbon in the stand on fewer, larger trees, better able to withstand wildfire. Harvested material can be utilized for wood products or chips for bioenergy plants. When strategically placed on the landscape in high fire threat areas, fuel reduction projects can have a beneficial effect of reducing greenhouse gas emissions through avoided wildfire emissions. Fuel reduction projects do not affect the probability of fire starts, but they reduce the intensity and rate of spread of fires, and give firefighters a chance to contain the fire at a smaller size.

Vegetation Management:

Prescribed burning projects focus on the use of prescribed fire and other mechanical methods to reduce wildland fire fuel hazards. The use of prescribed fire mimics natural processes, restores fire to its historic role in wildland ecosystems, and provides significant fire hazard reduction benefits that enhance public and firefighter safety. CAL FIRE's VMP program allows private landowners to enter into a contract with CAL FIRE to use prescribed fire to accomplish a combination of fire protection and resource management goals.

Timber Harvesting:

Regular timber harvest activities conducted by landowners to meet revenue goals typically will also thin stands sufficiently to have a beneficial effect on reducing wildfire intensity. All else equal, managed stands can also compete with unmanaged stands purely on carbon yield merits, when the carbon stored in harvested wood products are counted. Age and density related mortality normally become sources of biomass and carbon loss in unmanaged stands.

Conclusions and Policy Recommendations:

Polices and management practices aimed narrowly at maximizing carbon alone are likely to be

sub-optimal in the long run. Such management practices will result in forest structures that are less resilient and more susceptible to wide-spread destruction by wildfire. Instead, a focus on overall forest health will better diversify management practices and is likely to sequester and maintain more carbon over time.

Given the certainty of an uncertain future environment, it is prudent to deploy as wide a range of management strategies as possible to maintain options for any future management situation that may materialize.

Allow wildfire to play a role in California's forests. Through a combination of fire suppression, fire prevention and forest management, aim for less extreme fire regimes that will reduce the number of intense, stand-replacing fires and associated type conversion to non-forest ecosystems.

Co-benefits can provide potentially useful "tie-breakers" for decision-making on carbon sequestration strategies. Different management strategies may not produce significantly different carbon storage levels, but managing forests with a general focus on overall forest health, including an annual sustained yield of timber, fiber or energy from the forest, will generate the largest overall benefits. Such an emphasis on forest health may be the best way to ensure that carbon storage, along with all associated co-benefits and environmental services are protected.

Given the prevalence of wildfire in California forests, a sustainable forest management strategy aimed at maintaining overall forest health and increasing forest carbon stocks, while producing an annual sustained yield of timber, fiber or energy from the forest, will generate the largest long-term benefit.

Table 1. Acres of Priority Areas by Ownership Group.

	Federal Ownership	Private Ownership	State Ownership
1. Population Growth & Development			
2. Risk Reduction on Forestlands			
3. Restoring Impacted Timberlands			
4. Preventing Wildfire Threats to Maintain Ecosystem Health			
5. Restoring Wildfire to Impacted Areas to Maintain Ecosystem Health			
6. Preventing Wildfire Threats for Community Safety			
7. Forest Pest Impacted Areas to Maintain Ecosystem Health			
8. Restoring Forest Pest Impacted Communities for Public Safety			
9. Water Supply			
10. Water Quality			
11. Urban Tree Planting for Energy Conservation and Air Quality			
12. Urban Tree Maintenance for Energy Conservation and Air Quality			
13. Community Planning to Reduce Wildfire Risks			
14. Biomass Energy for Ecosystem Health			
15. Wildfire Threat to Areas Protected for Wildlife Habitat			
16. Conserving Green Infrastructure			
17. Managing Green Infrastructure			
18. Forest Carbon – Threats from Wildfire, Insects and Disease			
19. Forest Carbon – Threats from Development			
Total			