Thinning Western Dry Forests as an Adaptation to Climate Change

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Compiled as background for the National Academies study on Adapting to the Impacts of Climate Change and other studies on this topic.

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The problem and solution

Many western forests are susceptible to insect outbreaks and catastrophic wildfires. The legacy of past management practices, along with warming temperatures and widespread drought, are increasing these risks to forest health. Yet management practices do exist that could increase the resiliency of western forests to global warming and drought, even while increasing their ability to store carbon that would otherwise convert to airborne greenhouse gases.

Management setting

Past management practices—including logging of large trees, grazing, and suppression of naturally occurring fires—have allowed an overabundance of small-diameter trees to survive in western dry forests such as ponderosa pine.

These small trees now crowd many forest stands, competing for limited water and acting as "fuel ladders" to carry flames into the treetops. This leads to more stress during drought years. In a 2003 outbreak of bark beetles in Arizona, even the large trees, which were generally resistant to attacks during the 1950s drought, succumbed to beetle infestations during the larger-scale 2003 episode.

Similarly, overly dense forest stands are more susceptible to devastating crown fires, as the 2002 Rodeo-Chediski fire in northern Arizona illustrated. That wildfire burned about 468,000 acres to varying degrees, including stand-replacing crown fires.

The U.S. Forest Service considers about 21 million acres of ponderosa pine forest in the U.S. (including Alaska) at risk of bark beetle infestation because of overcrowded, high-density conditions, according to its 2002 publication. Ongoing global warming puts these same forests at higher risk of drought stress and catastrophic wildfires as well as beetle infestation.

Climate change impacts

Hotter temperatures have already been linked to an observed increase in bark beetle damage during the early 2000s outbreak compared to an outbreak during the 1950s drought, as David Breshears and colleagues documented in 2005. Higher evaporation

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rates come with higher temperatures, adding stress to forest systems by reducing soil moisture.

What's more, higher than normal spring and summer temperatures—and the earlier snowmelt that results—have been connected to the documented increase in the number of large western wildfires (i.e., greater than 1,000 acres) in recent years. Analyzing data from the U.S. Forest Service and other federal agencies for 1970-2004, Anthony Westerling and colleagues (2006) found a four-fold increase in the number of large western forest fires in the second half of the record compared to the first half, with big fire years correlated with higher spring and summer temperatures.

Thus, warming temperatures alone make it more challenging for western forests to remain healthy. Temperatures in the U.S. West are projected to rise faster than other parts of the country, with average annual temperatures projected to increase by about 7 degrees Fahrenheit in the U.S. Southwest by the end of this century, according to model projections reported by the Intergovernmental Panel on Climate Change (2007). In addition, the ensemble of models indicates that aridity in the southwest quadrant of the U.S. will likely increase due to the projected temperature increase and a possible decrease in precipitation (Seager et al., 2007).

Management to prevent wildfires

Arizona's Rodeo-Chediski fire did less damage in stands that had been "thinned" of its smaller-diameter trees, as Barbara Strom and Peter Fulé documented in a 2007 paper. The fire tended to drop to the ground in these thinned areas, so fewer trees died. The thinned areas were also less likely to convert to oak-manzanita scrub, the authors found. Thus, clearing some of the small-diameter trees out of forests can reduce the risk of stand-replacing crown fires.

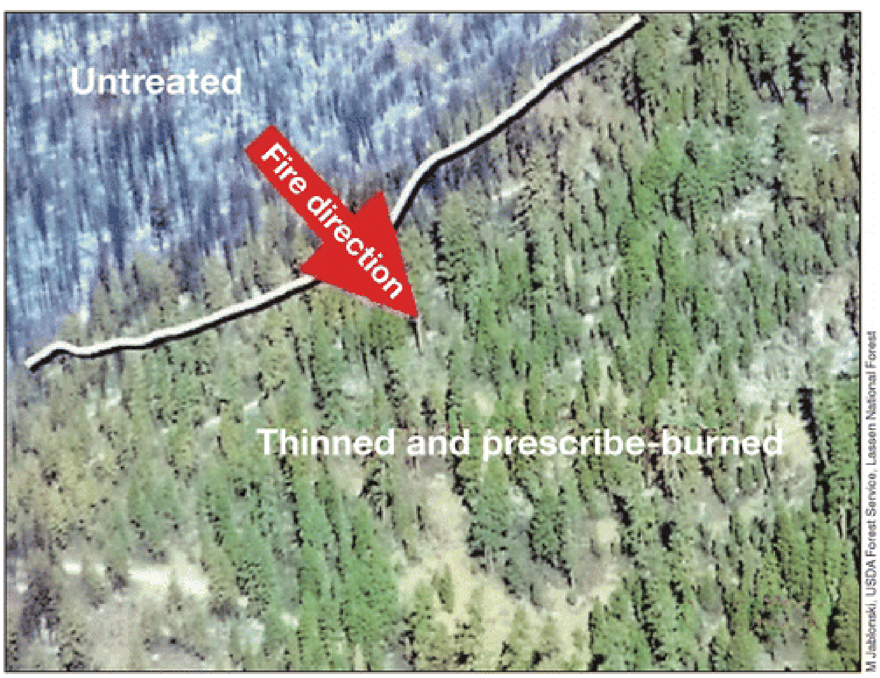

Figure 1. Stand conditions following the 2002 Cone fire at the Blacks Mountain Experimental Forest in California's Lassen National Forest. The white line approximates the border between

the treated and untreated areas prior to the wildfire. The area in the upper left was left untreated and the remaining area was thinned and prescribe-burned prior to the Cone fire.
Studies in Arizona's White Mountains, California's Lassen National Forest, and many others described in a 2008 paper by Matthew Hurteau and colleagues make a strong case for the restorative value of thinning treatments in ponderosa pine and other western dry forests. Hurteau and his colleagues analyzed data involving four major western wildfires from 2002 (including the Rodeo-Chediski) and found that:

- Of the 1.25 million acres that burned in these four fires, nearly a quarter of a million (227,000) acres underwent a high-severity burn.
- The high-severity burn area alone released emissions equivalent to about 4.2 to 6.1 million metric tons of carbon dioxide.
- Thinning these same forests beforehand could have reduced these emissions by more than 90 percent, to an estimated 70,000 to 300,000 tons of carbon dioxide equivalent.
- The thinning treatments would have removed woody materials amounting to about 3.9 million metric tons of carbon dioxide if burned or decomposed.
- The fate of the carbon contained within the woody material would depend on how it was handled. Conversion into furniture or other long-lived products would extend its lifetime, while burning in the field would release most of the stored carbon as carbon dioxide. Alternatively, burning to generate usable energy would replace, or offset, emissions from fossil fuels.

Obstacles to forest-thinning treatments

Collaborative groups managing forests, such as Arizona's White Mountains Natural Resources Working Group, are welcoming the opportunity to thin ponderosa forests to make them more resistant to wildfire and climate change (Lenart 2006). In the aftermath of the Rodeo-Chediski fire, which destroyed 465 homes in the White Mountains area, the local working group has made thinning areas near residences a major priority.

One potential obstacle, resistance from environmental non-governmental groups, appears surmountable in the context of collaborative management. The White Mountains working group, for example, included members from several local environmental NGOs. Their involvement in management decision-making had the effect of avoiding potential lawsuits, members agreed.

The cost of thinning treatments arguably remains the biggest barrier to its large-scale implementation as a means of making western dry forests more resistant to wildfire and climate change. Treatments in Arizona's White Mountains area were expected to range from $380 to $600 an acre over the course of a decade. In their analysis of nine western forests, R.D. Fight and R.J. Barbour found thinning treatments costs through the mid-2000s ranged from $140 to $450 an acre.

Because thinning treatments have the effect of reducing the risk of crown fires and thus impart the benefit of keeping more carbon in the forest over the scale of decades, they theoretically could be eligible for support in a carbon market.

However, a major obstacle arises in carbon market mechanisms, namely the Kyoto Protocol and the California Climate Action Registry, relating to how carbon is tallied.

Hurteau and colleagues (2008) identify this unrealistic approach to calculating carbon baseline and storage:

- Current carbon market mechanisms count a removal of woody biomass during thinning treatments as a *reduction* in carbon storage from the baseline. The material is assumed to undergo complete and immediate combustion or decay, a situation that does not always reflect reality.

- Meanwhile, if the same forest loses some biomass to a fire, the baseline is simply *reset*, as if no carbon loss had occurred. This is the case even though, ironically, more of the material is likely to undergo immediate combustion than in the thinning treatment scenario.

Benefits to changing policy to reflect the science

Clearly, a more realistic appraisal of the value of thinning treatments in maintaining carbon in the forest could help promote such treatments, and perhaps help secure funding to support them. Other possible benefits include:

- Treatments could reduce the need to spend so many federal dollars fighting and recovering from uncontrollable blazes. The Rodeo-Chediski fire, for example, cost an estimated $640 an acre in firefighting personnel and equipment alone—more than it would have cost to thin the forest so that a fire would have been likely to spread through it safely.

- Thinning treatments could create jobs, perhaps for some of the same people who rely on firefighting income. Such jobs would be safer and more consistent throughout the year. Doing such work would also reduce the risk of having a shortage of firefighting resources during fire season because of large-scale, runaway wildfires.

- Policy that reflects actual carbon storage rather than a fictional accounting of baseline tallies might win over more environmental NGOs to support the concept of acknowledging forest carbon storage potential in carbon markets. Currently many environmental NGOs are opposed to this mechanism.

- Thinning projects could be strategically located to create fire breaks, thus further reducing the risk of large uncontrollable wildfires while creating a mosaic of conditions within forest stands.

- Creating a mosaic of conditions within the forest could promote the retention of snow in western mountains. Will Veatch and colleagues (2009) found open areas shaded by tall trees contained the most moisture stored in snow at the beginning of the growing season. Thus, trees can help preserve the snow that in turn influences how early the fire season begins.

Risks of new policy to incentivize widespread thinning

Widespread thinning operations are not without potential downsides. Notable among these are the potential for soil disturbance associated with movement of personnel and machinery that promotes invasive species.

In addition, thinning is not a permanent solution. Thinning treatments would need to be repeated at appropriate intervals to deal with regeneration, unless surface fires were allowed to burn through the understory more frequently to prevent the return of densely packed small-diameter trees.

The importance of diversity

Treatment implementation would need to be planned with a landscape perspective. In addition to strategically locating treatments on the landscape to reduce fire spread, treatments should be placed to provide core habitat and habitat connectivity to meet the needs of species that require open forest canopy and species that require more densely forested areas.

Creating a diverse mosaic of forest habitats would also promote the retention of mountain snow longer in the season, especially where tall trees shade open areas (Veatch et al., 2009).

Involving local collaborative management groups with diverse members in the planning process would help ensure that other values—including species diversity, snowpack and watershed protection, and job creation—are considered along with carbon storage and resistance to future wildfires. Such groups could also provide guidance in reducing risks such as soil disturbance, and perhaps even be involved in monitoring efforts to identify and control invasive species.

Conclusion

With proper oversight, thinning treatments could make many western dry forests better able to withstand the high temperatures, drought and wildfires that are likely to become more extreme as climate continues to change. Immediate benefits would also accrue, including improvements in forest health, job creation and a lower risk of catastrophic wildfire in forests and nearby residential areas.

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