Forest Harvest Can Increase Subsequent Forest Fire Severity

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Abstract

The USDA Forest Service is progressing from a land management strategy oriented around timber extraction towards one oriented around maintaining healthy forested lands. The healthy Forest Initiative promotes the idea of broadscale forest thinning and fuel treatments as an effective means for mitigating hazardous fuel conditions and, by extension, fire risk. Fuels mitigation is proactive while fire suppression is reactive and expensive. Costs associated with suppressing large wildfires, as occur in the western USA with annual regularity, are astronomical and routinely exceed fire suppression budgets. It is not difficult to demonstrate that treating forest fuels is more cost effective than suppressing forest fires on untreated lands. In addition, forest thinning is potentially profitable, or at least can recoup the cost of thinning, and may also produce safer conditions for those living in the wildland-urban interface zones. Thinning practices also facilitate wildland firefighting efforts for monitoring and controlling future fire incidents as well as for forest health management practices by state and federal forestry agencies. However, forest thinning and other fuel treatment strategies can take many different forms, some of which can do more harm than good when considered with other factors that influence wildfire behavior, such as weather and terrain. One example of this issue can be seen in Montana during the 2003 fires. At the Cooney Ridge fire complex, an extensively and homogeneously logged watershed burned severely and uniformly due to remaining ground slash (which had attained low fuel moisture after overstory removal) and severe fire weather (low relative humidity and strong upslope winds). This contrasted with a mosaic of burn severities in an adjacent watershed with higher fuel loads yet greater heterogeneity in fuel distribution at the stand and landscape levels. Harvesting timber does not translate simply into reducing fire risk. Given the stochastic nature of fire weather events, and the complex terrain of most forested landscapes in the western USA, applying a variety of forest thinning and fuel treatment operations towards the goal of maintaining a diverse forest habitat mosaic, also constitutes a sensible fire risk mitigation strategy.

Introduction

In recent decades, fires have burned an increasingly larger area in the western US. The many large fires experienced in the western US have been variously attributed to effective fire suppression that has allowed fuels to accumulate, to land use including logging that has removed larger trees but not always thinned the smaller tress that remain, and to climate change (Morgan and others 2003). In some drier forest types, such as the semi-arid ponderosa pine ecosystems, tree density far exceeds historical norms and these can fuel unusually intense fires (Covington and others 2000). Elsewhere, however, many forests, such as sub-alpine forests at high elevations, naturally contain abundant surface and canopy fuels. There, intense and severe fires were the historical norm. The increasing number of people living in and using forests and rangelands have greatly increased both the chances of fires starting and the degree to which fires threaten people and their property when wildfires do occur. Dense thickets of younger trees now abound, and human and ecological communities are increasingly vulnerable to destructive crown fires. A consensus has emerged that it is urgent to restore more natural conditions to these forests (Allen and others 2002). Large, severe fire events account for a majority of the total area burned over time (Strauss and others 1989), as well as threats to people and their property (Maciliwain 1994).

The US responded to increased cost and extent of western wildfires with the National Fire Plan (http://www.fireplan.gov/content/home/) in 2000 and more recently with The Healthy Forest Initiative (http://www.whitehouse.gov/infocus/healthyforests/). Both the National Fire Plan and the Healthy Forest Initiative seek to reduce fire hazard through active fuels management via logging and prescribed burning. Efforts are designed to complement continued fire suppression, assistance to local communities, and rehabilitation. Both efforts build on recent concern over declining forest health in the western US as a result of fire exclusion, land use change, and climate change. Past emphases in fire management have been on wildfire suppression and prescribed fire to reduce hazardous fuels following timber harvest and improve wildlife habitat. On the other hand, lightning fires have been allowed to burn in wilderness areas to restore natural process for over thirty years. It is only in the last five or six years that fire management has extensively used prescribed burning and mechanical fuel treatments to reduce hazardous fuel accumulations in non-wilderness areas (Long 2003). The degree to which mechanical treatments such as thinning will reduce the intensity and severity of subsequent fires is a subject of lively debate (Morrison and others 2000). Relatively few studies exist, and these mostly have focused on dry forests.

Burn Severity

Burn severity is broadly defined as the degree of ecosystem change induced by fire (Ryan and Noste 1985). Severe fires are those that result in great ecological changes (Rowe 1983, Ryan and Noste 1985, Moreno and Oeschel 1989, Schimmel and Granstrom 1996, De Bano and others 1998, Ryan 2002). Compared to low severity fires, vegetation recovery is slower, nutrient cycles are more altered, invasive species are more abundant, tree mortality is higher, and soil erosion is more likely to follow severe fires. Burn severity encompasses fire effects on both vegetation and surface soils (Ryan 2002, Ryan and Noste 1985, Key and Benson 2001).

Burn severity is usually mapped from remote sensing data, to assess ecological effects and the degree to which post-fire rehabilitation is needed to reduce soil erosion and speed vegetation recovery (Parsons and Orlemann 2002). The US Forest Service (USFS) and other land management agencies employ remote sensing tools in an effort to efficiently and effectively manage fire-adapted ecosystems. Fire perimeter data for this paper came from Incident Command Geographic Information Systems (GIS) during and immediately after the fire. Fire severity classes came from a Burned Area Reflectance Classification (BARC) map provided by the USFS Remote Sensing Applications Center (RSAC).

Cooney Ridge Fire

Cooney Ridge is one of several large wildfire events that occurred during the active 2003 fire season in western Montana (Fig. 1). A prolonged drought of four years preceded a very dry summer, and the weather in late August was hot, dry and windy. On August 8, 2003, lightning ignited a fire on Cooney Ridge, located approximately 18 miles east of Missoula, Montana (Fig. 2). Despite intensive suppression efforts (www.fs.fed.us/r1/fire/2003fires), the Cooney Ridge fire burned 8589 ha before it was contained on October 15, 2003. Many people who lived in small towns and scattered homes in nearby valleys feared that this fire would spread toward them. The fire threatened industrial power lines serving eastern Washington, northern Idaho and western Montana. A world-famous trout fishing stream, Rock Creek, directly to the east (and downwind) of the fire, was another resource fire fighters sought to protect.

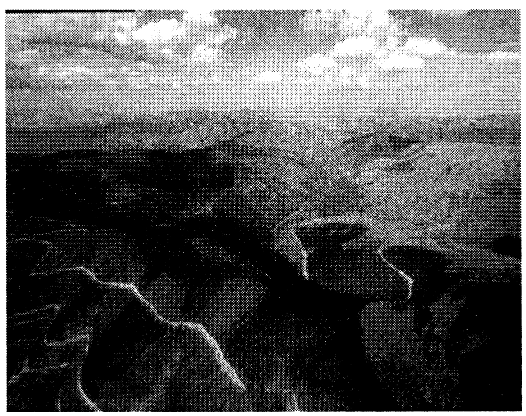

Figure 1 — Aerial Photo of the Cooney Ridge Fire.

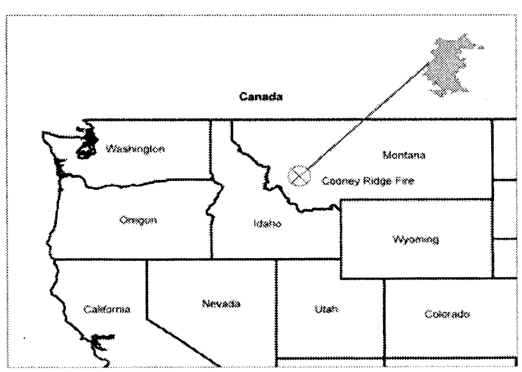

Figure 2—Location of the Cooney Ridge Fire.

The Cooney Ridge fire perimeter (Fig. 3) includes both public (54%) and private (46%) land. Most of the public land is managed by the USFS for multiple uses including timber extraction, recreation, and wildlife habitat, while only 177 ha (4%) is managed by the Montana Department of Fish and Game. Private land is mostly industrial forestland belonging to Plum Creek Timber Company, while only 48 ha (1%) is under other private ownership.

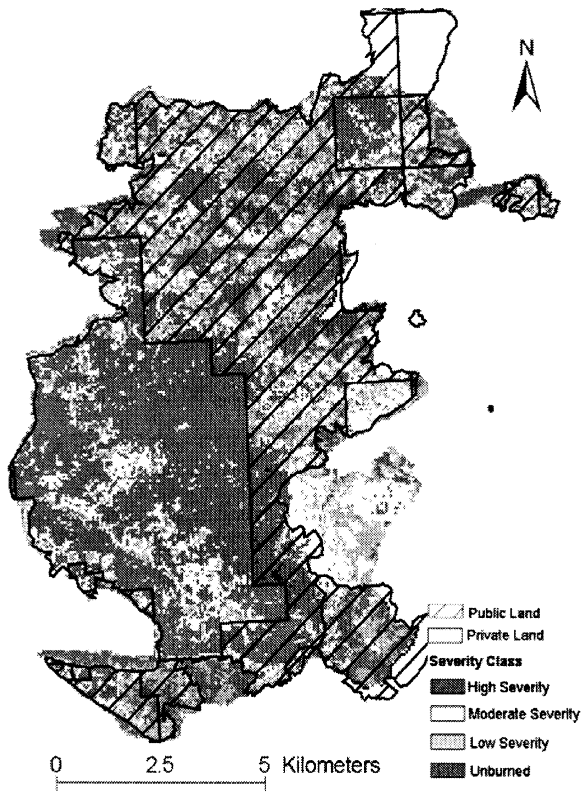

Fig. 3. Burned Area Remote Classification (BARC) Map

Results

Overall, 88% of the area within the final fire perimeter burned. More than 98% of private land burned, while 79% of public land burned. The areas that contain the most unburned vegetation are on the public lands portion (Table 1).

Table 1—*Area Burned on Public and Private Land in the 2003 Cooney Ridge Fire, Montana, USA.*

	Private		Public	
Class	Hectares	Percent (%)	Hectares	Percent (%)
Un-Burned	**83**	**2**	**984**	**21**
Burned	**3899**	**98**	**3622**	**79**
Low	*228*	*6*	*1347*	*29*
Moderate	*1704*	*43*	*1594*	*35*
High	*1967*	*49*	*681*	*15*
Total	**3982**	**100%**	**4607**	**100%**

Much more private land burned severely compared to public land (Fig. 4). Heavily logged areas and tree plantations have been known to burn more extensively than intact forests (Brown 2002). Much of the private land within the fire perimeter had been recently heavily logged for timber extraction, not for the purpose of fire hazard reduction

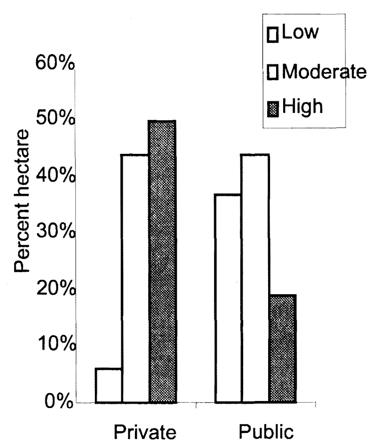

Figure 4—Proportional Area % burned in the Cooney Ridge Fire by ownership. Each column represents the burn severity classes illustrated in Fig. 3.

Daily fire perimeter maps showed that the largest fire expansion at the Cooney Ridge fire occurred between Aug 13 and Aug 17 (Fig. 5). The area burned during this time, and throughout the Cooney Ridge fire, was fairly evenly balanced between public and private lands (Fig. 6).

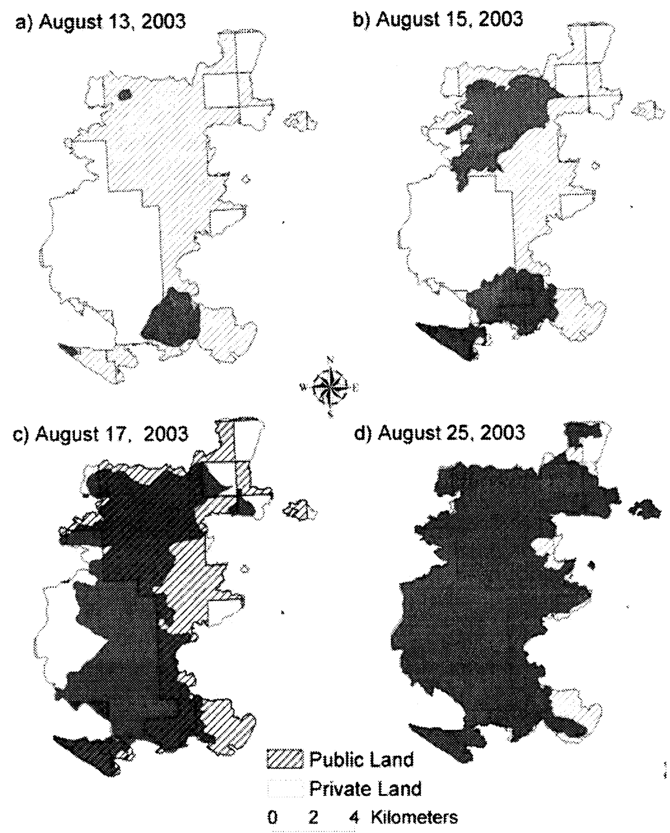

Fig. 5. Cooney Rige Fire Progression by date.

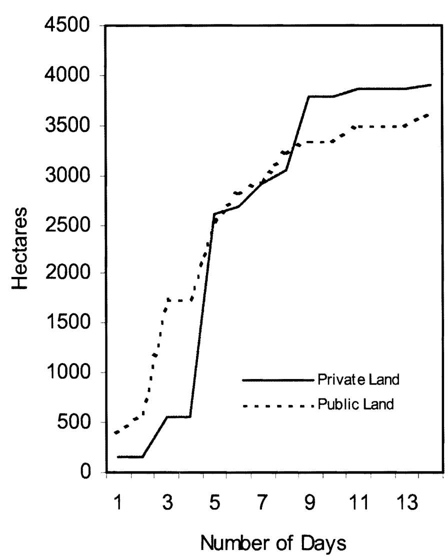

Fig. 6. Number of hectares burned per day of the Cooney Ridge Fire between the dates of August 13 to August 26, 2003.

Discussion

Private lands in this area were recently harvested with large clear cuts. Remaining vegetation and slash debris burned in the Cooney Ridge Fire. A much lower proportion of the public land had been recently harvested. Cut patches on the private land were much smaller, reflecting restrictions on the size of clear cuts and other harvesting units on public lands. The USFS manages federal lands for multiple uses besides timber production: wildlife habitat, recreation, and protecting water quality. As timber supply from federal lands has fallen over the last three decades, harvesting rates on private timberlands have increased to meet demand.

Pollet and Omi (2002) mention that fire severity refers to fire effects on the ecosystem and is directly related to post-fire vegetation survival. Their findings indicate that fuel treatments do mitigate fire severity. Fuel treatments provide a window of opportunity for effective fire suppression and protecting high-value areas. They go on to state that topography and weather may play more important roles than fuels in governing fire behavior. Of course, topography and weather cannot realistically be manipulated to reduce fire severity.

Hot, dry and windy weather made fire suppression efforts difficult, despite the many roads providing access for fire fighting crews. Daily fire perimeter maps showed that the largest blowup at the Cooney Ridge fire occurred between Aug 13 and Aug 17 (Fig. 5). The area burned during this time, and throughout the Cooney Ridge fire, was fairly evenly balanced between public and private lands (Fig. 6). Although local weather conditions may have differed slightly when public and private lands burned, these similar fire progression trajectories suggest more similarity than difference.

The Healthy Forest Initiative promotes the idea of broadscale forest thinning and fuel treatments as an effective means for mitigating hazardous fuel conditions. This is based on the sensible assumption that treating forest fuels is more cost effective than suppressing forest fires on untreated lands. In addition, forest thinning is potentially profitable, or at least can recoup the cost of thinning, and may also produce safer conditions for those living in the wildland-urban interface zones. However, as the Cooney Ridge fire suggests, timber harvesting does not always reduce the intensity or severity of subsequent fires. At Cooney Ridge, much of the extensively and homogeneously logged private lands burned with uniform high severity (Figs. 3-4, Table 1). Presumably, this is due to residual fuel, which had dried to very low fuel moisture.

The western United States is a fire environment (Morgan and others 2003). Fires will occur in the future, and some will occur when weather conditions are very dry, hot and windy. Given this ecological reality, the stochastic nature of fire weather events and the complex terrain of most forested landscapes in the western USA, applying a variety of forest thinning and fuel treatment operations towards the goal of maintaining a diverse forest habitat mosaic constitutes a sensible fire hazard mitigation strategy. An understanding of where fires are more likely to be severe would help to strategically locate and design fuel management treatments where they will be most effective. Such an understanding would also be helpful in fire suppression, fire mitigation and post-fire rehabilitation decisions.

Several challenges exist for fuels management. First, there is no single prescription that will be appropriate to all the conditions possible in diverse ecosystems. Second, thinning has very different economic and ecological effects depending on whether large trees are removed or remain behind. Third, the effects of logging include roads and sometimes, the damage to residual trees. Lastly, the costs of treatments must include long-term maintenance and monitoring. If practical alternatives to prescribed fire for reducing hazardous fuels can be found, resource managers will have a wider choice of methods to reduce risk of damaging wildfires at the urban interface (Brose and Wade, 2002).

In extreme years, especially after prolonged drought (Swetnam and Betancourt 1990, 1998), extensive areas burn across the western US. Such years account for the majority of the area burned (Strauss and others 1989) and the greatest threats to people and property (Maciliwain 1994). Thus fuels management through logging or other means will be less effective when weather conditions are extreme. Pollet and Omi (2002) suggest that funding for fuels management be directed towards the urban interface, tree plantations, critical watersheds, and habitat for threatened and endangered species.

Conclusion

One the clearest lessons from history is that fires have always occurred, and that they will continue to occur despite our efforts to detect and suppress them (Morgan, 2003). In many forest ecosystems biomass production exceeds decomposition; this accumulated biomass fuels fires when lightning or people ignite fires in hot, dry, windy conditions. Fire and other disturbances have played important ecological roles in these ecosystems, thus complicating management decisions.

More research is needed to understand the relationship between ownership practices and severity. At the Cooney Ridge fire, patches of unburned vegetation and low severity remained after the fire, while much more of the private land burned uniformly with high severity. These results indicate that more diversified public lands management helped produce a much more diverse fire mosaic, thus better protecting this forested landscape. By comparison most private forested land burned with moderate to high severity, under likely similar weather conditions as on the public land.

Our results show that, perhaps counter intuitively, heavy harvest can increase subsequent fire severity. Costs associated with wildfire suppression far outweigh the costs of fuel treatment. Given the damages in both dollar and acreage, it would seem to be in the best interest of timber companies to implement thinning treatments and/or prescribed burning programs, rather than clear cutting. While there is much to be learned about the current status of forested ecosystems on the national Forest Lands, and about efficacy of thinning and prescribed fire to make these forests more sustainable, it appears clear that action must be taken to reverse trends of degradation. Since 1) thinning is a form of logging, and 2) prescribed fire can produce excessive smoke, runs the risk of escape, and appears to contradict decades of misinformation about the evils of forest fire, both techniques will be controversial among some portions of the public. Every effort should be made to apply these tools in manners that reduce the possibility of unintended consequences (Brown, 2002).

Cooney Ridge is not unique. Extensive amounts of untreated logging slash contributed to the devasting fires during the late 1800s and 1900s in inland Pacific Northwest forests (Graham and others 1999). Logging doesn't always result in severe fires; it depends on which trees are harvested and the fuels left behind (Graham et al 1997, Pollet and Omi 2002.) Logging at Cooney Ridge was not designed to reduce hazard, and clearly it did not. Carefully designed harvesting practices, including those that retain smaller trees and/or thin dense stands, can reduce fire hazard (Pollet and Omi 2002, Graham et al 1999). Logging geared only towards large tree removal, since it does not manage surface fuels, will increase fire hazard and subsequent fire severity (Morgan and others 2003).

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