ECOLOGICAL AND WATERSHED IMPLICATIONS OF THE MEGRAM FIRE

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ABSTRACT

The Megram fire burned 125,000 acres in 1999 in the same area where a 1996 major wind event led to high fuel accumulation. The effects of the fire on slope percent, slope position (upper, mid and lower slopes), vegetation type, seral stage, blowdown fuels and fuel treatments were analyzed and will be presented. Differences in fire severity based on these factors will be discussed along with the need for future treatments to reduce potential additional impacts to the watersheds. A comparison of burn severity will be made to other fires in the Siskiyou and Klamath Mountains to reflect differences in fire and suppression history.

Significant differences were determined within the Megram fire in burn severity by slope percent class, slope position, vegetation type, seral stage, and by fuel treatment. Of particular interest were the effects of logging and fuel treatment on fire behavior and burn severity. After the wind event and prior to the fire, some areas were salvage logged to remove large fuels. When the fire burned, these areas had been planned for or had undergone, follow-up treatments to reduce remaining fuels. These treatments ranged from no further treatment to almost complete removal of small diameter and fine fuels through under burning. The complete treatment resulted in significant reductions in high severity fire effects.

These results provide evidence that the practice of stand management in high fuel hazard areas, with specific fuel reduction goals, may prove to be valuable in reducing fire severity in forested environments. These results are particularly applicable to land managers in the Pacific Northwest where maintenance of late-seral and riparian habitat is a concern.

INTRODUCTION

This paper is an abbreviated version of one submitted earlier for publication in the proceedings of the “Fire Conference 2000: The First Congress on Fire Ecology, Prevention and Management”.

During the latter half of the 1990’s, two major disturbance events took place within the Megram area. In the winter of 1995-1996, high intensity windstorms swept the northeastern, higher elevation portion of the Six Rivers National Forest, shearing the tops and breaking the boles of numerous trees across approximately 12,000 hectares (30,000 acres). This occurred both within and outside the Trinity Alps Wilderness. The stands most affected by the windstorm were early and mid-mature white fir (*Abies concolor*) ranging in age from 80-130 years. These stands originated following catastrophic fires from around the middle of the 19th and turn of the 20th century. Old-growth stands or individual large remnant trees were not significantly affected by these wind events. Pockets of mature trees within old-growth stands were damaged. The result was a large increase in fuel loading estimated to be as much as 360 metric tons/acre. Following these events, fuel treatment projects were initiated at strategic locations, specifically along roads and ridges. The intent was to provide anchor points and safer areas for fire suppression activities should a fire occur.

The second major disturbance event occurred in August 1999. Lightning storms ignited the Megram and Fawn Fires, a part of the Big Bar Complex, in the Trinity Alps Wilderness on the Shasta-Trinity National Forest. These two fires burned together in September and crossed the boundary of the Six Rivers National Forest. During the first month of the fires, they consumed mostly ground fuels with occasional crown fires making runs in steep terrain and heavier fuels. Fire behavior was weather, fuel and topography dependent. Stable air masses produced inversions and reduced crowning, creating conditions conducive to surface and ground fires. On September 27th, and again on October 16th, low-pressure weather systems produced high northeast winds and pushed the fire west, further into the Six Rivers National Forest. The fire made major crown fire runs within the Horse Linto Creek, Tish Tang Creek and Mill Creek drainages. These wind-driven runs contributed the highest frequency of stand-replacing fire and passed through the areas treated in the blowdown fuel reduction projects. When controlled in November, the Fire had burned a total of 50,587 hectares on both National Forests (125,000 acres) (USDA 2000).

Historically, the high elevation area involved in these two events was subjected to the highest frequency of lightning on the Forest. Fire suppression during the last century successfully reduced the extent of both small and large fires (USDA 2000) and probably contributed to significant increases in biomass (Talbert 1996).

STUDY AREA

The Megram area is located in the Klamath Mountains of northwest California, on the Six Rivers National Forest, in Humboldt County. It includes 26,530 hectares (65,550 acres) in three watersheds, Horse Linto Creek, Mill Creek and Tish Tang Creek. Elevation ranges from 366 to 1920 meters (1200-6300 feet). Vegetation types include conifer and mixed conifer/hardwood forests with interspersed alder stringers and mountain meadows. The white fir and tanoak (*Lithocarpus densiflorus*) series were the dominant vegetation types covering 41% and 39% of the area respectively. White fir and red fir (*Abies magnifica var. shastensis*) dominated on upper elevation sites. The mid and lower slope positions throughout the area were dominated by Douglas-fir (*Pseudotsuga menziesii*) and tanoak.

The study area contained the full array of forest seral stages, including shrub/forb, pole, early-mature, mid-mature, late-mature, and old-growth (Jimerson et al. 1996, USDA 1999). It had the highest amount of late-mature, 17 percent, and old-growth, 29 percent, in the central portion of the forest. Together these two seral stages account for 46 percent late successional forest vegetation and were mainly found in the white fir and tanoak series. Early-mature and mid-mature stands made up 19 percent and 20 percent of the study area respectively and were also found primarily in the white fir and tanoak series. Early seral vegetation was included in the shrub/forb and pole seral stages. They accounted for 9 and 5 percent of the vegetation in the analysis area (USDA 2000).

The study area is made up of the following land allocations: late successional reserve (LSR) (78%), wilderness (21%) and general forest (1%) (USDA and USDI 1994). Each allocation has its own set of management direction, with wilderness being the most restrictive. Late successional reserves cover the largest extent of the study area and allow limited vegetation treatments. All treatments described in this paper occurred within LSR.

METHODS

High concentrations of blowdown related fuels were mapped in 1996 on the Six Rivers National Forest outside of the Trinity Alps Wilderness. Mapping of the blowdown consisted of walking the area and recording high concentrations of blowdown related fuels as polygons on aerial photos and project maps. These polygons were digitized on digital ortho-quads in ARC/INFO (ESRI 1991).

Following the wind events, areas outside of wilderness and identified roadless, with large amounts of blowdown on upper one-third slope and ridge top positions, were identified for fuel reduction projects. Treatment prescriptions were developed based on land allocation (Late Successional Reserve), and guidance found within the Six Rivers National Forest Land and Resource Management Plan, which incorporates the Record of Decision for the Northwest Forest Plan, Standards and Guidelines (USDA and USDI 1994). The prescriptions called for removal of blown down trees (tipped over) and snap top (broken topped) trees that had less than 20% live crown ratio remaining. Most trees in these stands had some portion of their tops broken off. Canopy closure was to be maintained above 60%, if present. Residual stand densities varied, depending on severity of wind damage, but stands generally maintained full stocking in terms of basal area and canopy closure. Canopy closure greater than 60% was desired based on requirements for northern spotted owl nesting and roosting habitat.

Fuel reduction treatments were planned for over 800 hectares and had been initiated on 641 hectares (1,583 acres). The treatments were designed to remove a significant portion of the large fuel component through salvage harvest and much of the smaller fuel through follow-up piling and burning. The post harvest follow-up treatments were in various stages of implementation when the fire occurred. These included:

1. no additional fuels treatment
2. slash was piled
3. slash was piled and burned
4. slash was piled, burned and the unit was understory burned.

Following the Megram Fire in 1999, burn severity was mapped in the same manner as the blowdown. The mapping was ground checked and updated in the summer of 2000. Burn severity was mapped in four categories: no burn (0% tree mortality), low burn (scattered individual dead trees, < 25% mortality), moderate burn (scattered or small groups of dead trees, 26%-70% mortality), and high burn (most trees killed, > 70% mortality).

RESULTS

The moderate fire severity category was identified as the most extensive. It accounted for the highest frequency of burn (10,779 hectares, 54%). It was followed by the high severity category (6,116 hectares, 31%), low severity (2,435 hectares, 12%), and no burn category (675 hectares, 3%).

Fire Severity by Slope Class

Fire severity was compared by 4 slope classes: < 20%, 20-34%, 35-65% and > 65%. No significant differences in fire severity were found between the 20-34% and 35-65% slope classes. These two classes were combined and fire severity was reanalyzed. Significant differences in fire severity were identified in the 3 remaining slope classes. The < 20% slope class had the highest frequency of no burn and low burn severity, 11% and 16% respectively. The combined 20-65% slope class had the highest frequency of high severity fire.

Fire Severity by Slope Position

Fire severity was examined on 3 slope positions; lower, middle, and upper 1/3 slopes. Significant differences were found in fire severity. For instance, lower 1/3 slope positions were characterized by moderate severity burn effects (63%) with a low frequency of high severity burn (20%). This is in contrast to the significantly higher frequency of high severity fire (40%) and significantly lower frequency of moderate severity burn (47%) in the upper 1/3 slope position. The middle 1/3 slope position showed the transition, in terms of burn severity, between upper and lower slope positions.

Fire Severity by Vegetation Series

The white fir series had the highest frequency of burned area (50 percent). It was followed by the tanoak series (24 percent), Douglas-fir series (9 percent), red fir series (9 percent) and a host of other vegetation types of lesser extent. These frequencies are somewhat reflective of the frequency of these series in the analysis area. When the series were analyzed independently, it is apparent that they differ significantly in frequency by fire severity category. For instance, the tanoak series had 66 percent of stands burned in the moderate severity burn category (26%-70% mortality), with only 16 percent in the high severity category (> 70 percent mortality). This contrasts with the white fir series, where 50 percent of stands burned in the moderate burn category and 36 percent in the high severity burn category. The red fir series shows even greater differences. It had 45 percent of stands burned in the moderate burn category and 44 percent in the high severity category. Red fir stands had significant infections of the parasite dwarf mistletoe (*Arceuthobium abietinum*) and cytospora canker (*Cytospora abietis*). This combination had caused both crown loss and high levels of mortality, which contributed to increased fuel loading.

Fire Severity by Seral Stage

Vegetation seral stages were differentially affected by fire. The highest frequency of affected hectares for all severities was in the old-growth seral stage (29 percent). In addition, 28 percent of the old-growth seral stage was affected by high severity fire. The high severity burn category normally had over 80 percent of the trees killed, which returned the seral stage to shrub/forb. This resulted in a significant loss of late seral habitat, one of the key features of the late successional reserve.

The highest frequency of high severity fire occurred in the early-mature seral stage. Here, due to the high degree of mortality, 39 percent of the early-mature seral stage was returned to the shrub/forb seral stage. The mid-mature and late-mature seral stages also suffered from high severity fire, with 30 percent and 26 percent of their extent being returned to the shrub/forb seral stage. These stands are very important, since they are the source of in-growth to the old-growth seral stage. In addition, the early seral stages, shrub/forb and pole showed high frequencies of stand replacing fire with 34% of their extent set back to time zero.

Fire Severity by Blowdown Category

In this analysis, the mapped blowdown polygons were compared to areas outside of the mapped blowdown polygons for differences in fire severity. High severity fire appeared to occur with significantly higher frequency in areas mapped with blowdown (46%) compared to areas without mapped blowdown (29%). In contrast, moderate severity fire appeared to occur with significantly higher frequency in areas without mapped blowdown (55% compared to 43%).

Fire Severity by Fuel Treatment

Outside of wilderness and roadless area, a variety of fuel reduction treatments were implemented following the 1995-96 windstorms. These treatments occurred in ridgetop and upper 1/3 slope positions within units identified as having high concentrations of blowdown-related fuels. Treatment units had the majority of blowdown generated large coarse woody debris removed through salvage harvest. In addition, most damaged trees with <20% live crown ratio were cut and removed. Background levels of snags and logs were maintained on all units. Removal of trees with <20% live crown ratio resulted in very small changes in overstory canopy closure because most of the wind damage resulted in sheared tops, rather than blown down trees. Stand treatments were designed to maintain at least 60% canopy closure where it existed after the blowdown event.

After harvesting, follow-up treatments to reduce fuels were at various stages of implementation prior to the fire. They included four treatments; no fuels treatment, slash was piled, slash was piled and burned, and slash was piled, burned and the unit was understory burned. Slash was defined as woody debris > 1 inch diameter and 3 feet long.

The analysis found significant differences in fire severity by treatment. The highest frequency of high severity fire occurred in stands with no follow up fuels treatment. Sixty-five percent of these stands suffered high severity fire. The background level for high severity fire in upper 1/3 slope positions was 39 percent. This indicates that large coarse woody debris removal without additional fuels treatment likely increases the risk of high severity fire.

Piling the slash resulted in a large reduction in high severity fire mortality (28%) compared to no treatment (65%). In comparison, burning the piled slash failed to significantly reduce high severity mortality (30%) when compared to piling without burning. When compared to the Fire in general, both treatments were below the overall frequency (39%) for high severity fire in upper 1/3 slope positions.

The most successful treatment in reducing high severity fire involved piling the slash, burning the piles, followed by understory burning. These treatments reduced high severity mortality to three percent of the area treated. An example comparison of this was two areas located immediately adjacent to one another on either side of a side-slope road. The stand below the road was untreated, including no large coarse woody debris removal. It was subjected to high severity mortality with over 90 percent of the trees killed. The treated stand above the road burned with low and moderate severity, where 10 to 25 percent mortality occurred.

DISCUSSION

The primary disturbance agents in the study area watersheds were fire, logging, flood, wind, insects and disease, cattle grazing, and recreation. Historically, fire has by far had the greatest effect in shaping the vegetation seral stages of the area (USDA 1999).

Fire Severity

In Megram, in addition to blowdown related fuels, fire severity was related to slope class, slope position, vegetation type, and seral stage. Gentle slopes and lower 1/3 slope positions were characterized by the dominance of the tanoak series and old-growth seral stage. Low to moderate burn severity was prevalent, while steeper slopes and upper 1/3 slope positions were characterized by high severity fire. At higher elevations, the white fir and red fir series were subjected to high severity fire. Mature stands (early and mid) located on upper 1/3 and ridgetop positions were more susceptible to stand replacing fire due to structural homogeneity. They normally have a thick fine fuel layer and dead limbs forming a ladder into the canopy. The potential for high severity fire in these stands places adjacent old-growth stands at higher risk, as evidenced by the loss of old-growth in white fir and red fir. The younger seral stages, shrub/forb and pole, also showed high frequencies of stand replacing fire as a result of their homogeneous stand structure.

The addition of blowdown related fuels to areas that have had active/long-term fire suppression exacerbates the conditions described above. For example, unusually high concentrations of fuels in lower 1/3 slope positions may lead to greater incidence of stand-replacing fire.

Fire Severity Comparison

The Megram fire burned with higher severity when compared to the 1987 Silver and Longwood fires in southwest Oregon and the Thompson Ridge and Hayfork fires in northern California. For instance, the Silver fire showed 12% high severity fire and 33% moderate severity fire (Atzet et al. 1988), the Thompson Ridge fire showed similar effects, 14% high and 27% moderate severity fire (Taylor and Skinner 1998), and the Hayfork fire had approximately 7% high and 43% moderate severity fire (Weatherspoon and Skinner 1995). In comparison, Megram had 31% high and 54% moderate severity fire. Much of the Silver fire burned in wilderness where past fire suppression activities were limited. In addition, much of the area had burned previously in the 1930's (Atzet et al. 1988), which resulted in a more natural fuel profile. Thompson Ridge burned frequently between 1626 and 1992, which also contributed to a more natural fuel profile (Taylor and Skinner 1998). This contrasts with Megram, where aggressive fire suppression has taken place following World War II, resulting in stands that were denser and had a greater ladder fuel component (Talbert 1996). In fact, despite 284 recorded fires since 1911, the largest fire in the study area watersheds was only 185 hectares (460 acres) and only 7 fires were greater than 40 hectares (100 acres). Only 3 percent of the area has been affected by fire since 1911 (USDA 2000). In comparison, the Longwood fire had 27% high and 43% moderate severities. This area had a history of aggressive fire suppression similar to Megram, because of proximity to communities and private property. Neither the Silver, Thompson Ridge nor Longwood fires had recent major disturbance events that greatly increased fuel levels prior to the wildfires. The evidence suggests that the increased frequency of high severity fire in Megram is related to high surface winds during the fire, heavy fuel accumulations generated from the 1995-1996 wind event and aggressive fire suppression prior to the fire, resulting in increased biomass and ladder fuels. (USDA 2000).

Fuel Treatment

Both the treated and untreated areas were subjected to strong easterly winds. Since the wind pushed the fire through and beyond the treated stands, it appears that fire severity in these stands is directly related to the amount of fuel treatment. Sixty-five percent of untreated stands were subjected to stand replacing fire, while 3% of fully treated stands had stand replacing fire. Complete removal of surface fuels lead to low intensity surface fire, preventing crown fire or long duration ground fire from developing. Without full fuels treatment, surface fuels were still available to carry the fire, leading to a higher frequency of high severity fire. Approximately 30 percent of stands with partial treatments suffered stand-replacing fire.

Post Fire Situation

In much of the study area, the high severity fire resulted in crown fires, which killed most of the live trees without consuming the larger surface and blowdown created fuels. As the standing dead trees fall they will further contribute to higher fuel loads and, in combination with early seral vegetation, create a situation with high probability of stand-replacing fire in the future. Adjacent stands will also be put at higher risk due to this scenario. Evidence of this was gathered from the Hog and Yellow fires in the Salmon River drainage of the Klamath National Forest. The 1977 Hog fire burned under similar weather conditions and terrain as the Megram fire. The fire began under an inversion that led to a low intensity creeping fire. Once the inversion lifted high intensity fire became the norm, particularly in the upper 1/3 of the watershed. Post-fire efforts to reduce fire related fuels were carried out through salvage logging in parts of the area with the rest remaining untreated. In some areas concerns for decomposed granite (dg) soils lead the Forest Service to lop and scatter the standing dead material in an attempt to provide soil protection. In 1987 the Yellow fire burned in the same area as the Hog fire. In areas where the fuels were treated after 1977, the fire was of low-moderate intensity and controllable. In areas where the fuels were left behind curing for 10 years, in combination with invading brush, the fire burned out of control at high intensity. These high intensity burns resulted in much of the upper elevation slopes being left bare of vegetation cover. When the fall rains hit the area, it tended to mobilize the dg soils and move them down-slope in pulses, where they were eventually deposited in the anadromous fish baring streams at the base of the mountains.

MANAGEMENT IMPLICATIONS

One objective of the Pacific Northwest Forest Plan and the Six Rivers National Forest Land and Resource Management Plan is to maintain or enhance late seral habitat. The results of this analysis indicate that well planned and completely executed fuel treatments can influence fire behavior and the fate of forest stands during a wildfire. These treatments may include salvage logging, fuel cleanup and use of prescribed fire.

The survival of the treated stands during the wind driven events of the Megram Fire also show that, even in the face of extreme fire behavior, treated stands may slow the spread of the fire. The analysis also shows that incomplete, or partial treatments are less effective or ineffective. Large fuel removal alone, without the follow-up treatment of smaller diameter fuels, may not provide adequate fuels reduction to prevent a fire from becoming stand-replacing.

The loss of early and mature seral stages has implications to the amount of late-successional habitat in the future. The current situation points to the need for aggressive fuel treatments in much of the area. This is due to the many thousands of hectares of standing dead trees, combined with remaining blowdown related fuels, creating a high fire hazard. Once this is combined with developing early seral vegetation, the threat to remaining stands increases. Treating high fuel hazard stands reduces the threat to existing late-successional habitat and maintains future ingrowth. These treatments may actually accelerate development of late seral characteristics in younger stands. This may allow us to maintain desirable levels of late-successional habitat in LSR's.

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EFFECTS OF CLEARCUTS AND SITE PREPARATION ON FIRE SEVERITY, DILLON CREEK FIRE 1994

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ABSTRACT

Fire severity was compared in clearcuts and uncut stands following the Dillon Creek Fire of 1994. The extent to which fire severity in clearcuts affected adjacent stands was also investigated. Factors that may have influenced fire severity such as fuel treatment, fuel type, aspect, slope, and elevation were evaluated in order to explain possible differences among these stands.

The Dillon Creek Fire occurred in Douglas-fir/hardwood forests located in the Klamath National Forest of northwestern California. A geographical information system (GIS) was used to compile information from LANDSAT imagery, post-fire aerial photography, and ground observations. Kruskal-Wallis analysis of variance, chi-squared tests of independence, and descriptive statistics were used to evaluate the data.

Clearcuts were more severely impacted by fire than uncut stands. However, clearcuts that were broadcast burned following harvest experienced less severe wildfire than clearcuts that were not broadcast burned. Additionally, areas adjacent to clearcuts had more severe fire than uncut stands farther away. The greater fire severity associated with clearcuts was due to the relatively higher proportion of flammable fuel types such as grass, shrub, and mixed hardwood. The grass fuel type had the greatest proportion of locations with high and moderate fire severity followed by shrub, mixed hardwood, and woodland fuel types. Higher elevations and gentler slopes had greater fire severity than lower elevations and steeper slopes. There were higher fire severity levels on east, southeast, south, and southwest facing slopes.

INTRODUCTION

The Dillon Creek Fire

During the summer of 1994, the Dillon Creek watershed in the Klamath National Forest, Siskiyou County, California, experienced a large fire. Numerous lightning strikes ignited small fires in the eastern portion of the watershed during the afternoons of July 20 and 21. Fed by heavy fuel loads and strong winds, the fires quickly grew. Fire intensity varied, depending upon weather conditions and available fuel. The inaccessibility of the terrain made suppression efforts difficult. Many of the fires grew together developing into a large fire complex which extended over 11,000 hectares and burned until early November (USDA 1995).

The majority of the vegetation within the burn (approximately 76%) experienced low levels of damage where less than 30 percent of the canopy was killed. Throughout these low damage areas, small pockets of trees suffered mortality and much of the ground fuel was consumed (USDA 1995). Eighteen percent of the burned area suffered moderate fire severity (30-69% canopy kill). The majority of the overstory was injured and about half was killed. On sites with high fuel concentrations, most of the understory and ground fuel was either killed or completely consumed by the fire (USDA 1995). The remaining portion of the burned area (5%) suffered a high degree of vegetative damage. Seventy to 100 percent of the canopy was killed and most of the understory and ground fuels were consumed. All that remained throughout many of these patches were blackened snags and charred ground (USDA 1995).

Fire Ecology

Fire is the primary agent of disturbance in the Klamath region (Atzet and Martin 1992, Skinner 1995, USDA 1995) and plays a major role in ecosystem development and maintenance. It aids in the creation of a more diverse landscape and affects late successional stand development (USDA 1995, Taylor and Skinner 1998). Historically, Native Americans recognized the benefits of light burning to suppress insect populations, clear the ground of shrubs and woody debris for easier travel, improve wildlife habitat, encourage desired plant populations, and to decrease the risk of large severe fires (Atzet and Martin 1992, Agee 1993, USDA 1995, Rogers 1996, Martin 1997). Tribes in the Klamath region used fire to promote the growth of acorns, berries, and plants, such as beargrass and hazel, that provide fiber used in traditional basket construction (USDA 1995, Taylor and Skinner 1998). Settlers and prospectors set fires to drive game, rid the forest of pests, and expose rock outcrops (Atzet and Martin 1992, Taylor and Skinner 1998).

Prior to the 1900's fires tended to be extensive and burn for many weeks (Agee 1993, USDA 1995, Taylor and Skinner 1998). This pattern helped maintain the open stand structure as described by historical visitors in diary and newspaper accounts of their travels (Volland and Dell 1981). More recent lightning caused fires in the Klamath area, such as the Siege of '87 Fires, Big Bar Complex, and the Dillon Creek Fire, have burned over large areas, suggesting that fires spread easily in these Douglas-fir (*Pseudotsuga menziezii*) dominated forests (Taylor and Skinner 1998).

Foresters and land mangers continue to use fire today as a way to reduce fuel accumulation. It is a principal tool in site preparation of clearcuts (Heinselman 1981, Smith et al. 1997). In the Dillon Creek watershed, harvested sites were either broadcast burned or excess slash from clearcutting was collected into burn piles. Broadcast burning not only eliminates potential fuel but can also provide a high-quality seedbed essential to successful seedling establishment.

Lightning is another important source of fire ignition in the Dillon drainage (USDA 1995). Dry lightning storms occur throughout the summer but are most frequent during the late summer months when drought in the region gives rise to highly flammable conditions during the hottest time of the year (Agee 1993, USDA 1995).

Fire Regime

The pre-European settlement fire regime of the Dillon Creek watershed was frequent fires of low to moderate severity with sporadic pockets experiencing stand replacement events. The mean fire return intervals for the drainage were between seven and 28 years at lower elevations and from 21 to 61 years in mixed conifer stands at higher elevations. In early years of suppression, fires like these, though common, were contained quickly; they seldom escaped initial attack by fire fighting personnel (USDA 1995).

Forest management practices in this past century, specifically the policy of total fire exclusion, have led to a change in the fire regime of the Dillon Creek watershed. Fire suppression has lengthened the time between fire events initiating a new regime of hot ground fires with larger stand replacement events (USDA 1995). The Dillon Creek Watershed Analysis (USDA 1995) indicates that longer fire return intervals correlate to trends in increased fire severity levels. Similarly, Atzet and Martin (1992) found in a natural disturbance study of the Klamath province that as the age of a forest increased (ie. longer fire return interval), so did fire severity. Both findings suggest that an essential environmental process may have been altered through fire suppression, leading to a shift in the natural disturbance system.

Fire Suppression

A major ecological consequence of fire suppression is not only increased fuel loads (Taylor and Skinner 1998), but also the development of more continuous and homogeneous fuels. Skinner (1995) found that forest openings have become smaller and more fragmented in a study of the spatial characteristics of three watersheds, including Dillon Creek watershed, in the Klamath Mountains. Dense stands of suppressed timber become widespread. Less fire resistant species have invaded the forest understory and moved into forest openings, reducing the number of natural structural breaks that can control fire spread (USDA 1995, Stuart 1998). The increased biomass may also result in more severe burning conditions (Martin 1997).

By the 1940's, the results of the fire exclusion policy were evident in the Dillon Creek watershed. Increased fuel loads, species composition changes, and stand structure shifts warned of a serious transformation in the ecology of the forest. Since 1910 there have been at least seven fires involving over 40 hectares within the Dillon Creek watershed (USDA. 1995).

In addition to fire exclusion, timber harvesting has lead to ecological changes in forest structure that have increased fire hazard. Current management practices, specifically clearcutting in the Douglas-fir/hardwood forests of northwestern California, produce early successional stands, dominated by sprouting hardwoods and shrubs. On drier sites, hardwoods may dominate the location for a substantial length of time. Clearcuts that undergo repeated intense fires may remain completely dominated by early seral, disturbance-adapted species if there are no close sources of Douglas-fir seed (Thornburgh 1982). The Dillon Creek Watershed Analysis (USDA 1995) suggests that the burning characteristics of brush species more than likely influenced the fire. On sites once occupied by Douglas-fir forests, grasses and shrubs may, in effect, inhibit succession back to the initial vegetation type (Mayer and Laudenslayer 1988). These failed plantations or man-made brush fields may perpetuate themselves because they burn more readily than the original timber stand.

Study Objectives

The relationship between natural fire behavior and silvicultural treatment has not been the subject of intense research (Weatherspoon and Skinner 1995). Managers do not fully understand the effect of silvicultural activities on fire severity. Some studies have shown that The purpose of this study was to examine the relationship between silviculture and fire effects following the Dillon Creek Fire and to investigate factors that may account for variations in fire severity. The study addressed these objectives with the following hypotheses: 1) clearcuts result in higher fire severity than uncut stands, 2) there are differences in fire severity in clearcuts based on site preparation, 3) fire severity differs among fuel types, 4) locations closer to clearcuts burn with higher fire severity, and 5) topography, specifically aspect, slope, and elevation, influences fire severity.

STUDY AREA

The complex nature of the topographical features of the Klamath region and a historically frequent fire regime has resulted in a highly complex vegetative structure. Over 100 plant associations and at least 16 plant series have been identified (Atzet and Martin 1992). The vegetation of this region has also been altered by its long history of grazing, fire suppression, and logging such that the natural patterns of forest communities can often be difficult to distinguish (Sawyer et al. 1977). The zone includes forests with multiple aged cohorts and stands that commonly include all sizes of trees (Agee 1993).

Silvicultural activities in the watershed and surrounding landscape began in the 1950's (USDA 1995). Clearcutting first appeared on the southeastern and northeastern ridges of the watershed during the 1960's and continued until 1990. Sawtimber has been the most common product from these cuts (USDA 1995). Broadcast burning was a typical site preparation method, but about 25% of the clearcuts received no treatment at all. The harvesting activities occurred primarily in the Douglas-fir and Klamath mixed conifer vegetation types. Clearcuts were replanted primarily with Douglas-fir and ponderosa pine (*Pinus ponderosa*), but occasionally Port Orford-cedar (*Chamaecyparis lawsoniana*), incense-cedar (*Calocedrus decurrens*), and white fir (*Abies concolor*) were also included. Clearcuts generally contained smaller trees and a higher proportion of hardwoods, dense shrub, and dense grass habitat than did the study area outside the clearcuts.

METHODS

Sampling

Information gathered with Landsat satellite imagery, pre-and post-fire aerial photography, digital orthophoto quadrangles (DOQs), and ground observations was compiled using a geographical information system (GIS), ARC/INFO NT 7.2.1 (Environmental Systems Research Institute Inc. 1998). The Happy Camp and Ukonom Ranger Districts, Klamath National Forest and the Klamath Bioregional Assessment Study provided original data for the Dillon Creek watershed. Additional data was created from digital elevation models (DEM's). The compilation of data was reconfigured and amassed into a set of topographical and vegetative data significant to the analysis and study area and was statistically analyzed using NCSS 2000 (Hintze 1998).

The fire severity level was grouped into three categories based on the percentage of canopy kill: low (0-29%), moderate (30-69%), and high (70-100%). Klamath National Forest personnel distinguished the fire severity levels from aerial photography in early October 1994. In the case of trees, severity designations were made according to the percentage of upper and mid-story crown killed. For shrubs, the extent of kill in the canopy layer was measured and in grass habitat fire severity level was established based on the percentage of cover killed (USDA 1995).

Fuel models for the study area were derived from vegetation information provided by the Southern Oregon - Northern California (ORCA) Wildlife Habitat Map/Database Version 1.0a which is a modified version of the wildlife habitat relationship (WHR) classification system (Mayer and Laudenslayer 1988) based on computer classification of LANDSAT imagery (Fox et al. 1997). The five fuel models were based on physiognomic habitat type, WHR cover stage, and WHR size class. Fuel model descriptions (Table 1) loosely follow the standard 13 NFFL fuel model system developed by Rothermel (1983).

Table 1. Custom fuel model descriptions adapted from the NFFL fuel model system (Rothermel 1983).

Fuel Model	Description
Grass	Includes all grass habitat types. Fire spread by fine fuels.
Woodland	All tree type habitat less than 39% crown closure and greater than 15 cm. DBH. Fire carried by understory shrubs and grasses.
Shrub	All shrub type habitat and tree habitat less than 15 cm. DBH. Presence of highly flammable species and personal accounts of high intensity fires throughout these areas (USDA 1995). Fires in this fuel type have a fast rate of spread.
Mixed Conifer	Greater than 15 cm. DBH mixed conifer, mixed conifer-hardwood, and mixed hardwood-conifer with canopy closure greater than 40%. Usually slow moving ground fires with occasional torching out of trees.
Mixed Hardwood	Greater than 15 cm. DBH mixed hardwood and mixed oak with canopy closure greater than 40%. Fires move faster than previous model and flare up when reach pockets of high fuel concentration.

Clearcut polygons were digitized from the Bear Peak and Dillon Mountain USGS topographical quadrangles (7.5') with ARC/INFO. Fifty-one clearcut polygons were located within the Happy Camp and Ukonom Ranger Districts. Clearcuts ranged in size from 1 to 70 hectares with an average size of about 10 hectares. For purposes of this study, "clearcuts" included small patch clearcuts and some combined adjacent clearcuts, hence the extreme size variation. Adjacent clearcut stands were merged in the course of digitizing when the border between the stands was unclear. Merging only occurred when clearcuts were harvested within five years of each other, resulting in similar fuel types.

The distance between a sample point and its nearest clearcut was determined with the use of ARC/INFO. If a sample point was located inside a clearcut it was given a distance of zero. Albini (1979) stated that in large wildfires where there is sporadic torching of individual groups of trees, spotting distances might reach from two to three kilometers. It was assumed that beyond this distance, observations were most likely influenced by factors other than by fire in the nearest clearcut and so those located beyond 2500 meters (2.5 kilometers) were thrown out.

Thematic maps (or coverages) generated in the GIS showed fire severity level and forest stand activity (clearcut polygons). Site preparation method (broadcast burn or no treatment) was added as an attribute to the clearcut polygons. Stand activity information was obtained from the Region 5 Stand Record System (SRS) database provided by the Happy Camp and Ukonom Ranger Districts (USDA 1998). A digital elevational model (DEM) was used to generate aspect, slope, and elevation maps. The ORCAWildlife Habitat Map, which was displayed in a raster grid cell format (Fox et al. 1997), was converted into a polygon coverage and aggregated into five fuel model regions based on habitat characteristics presented in Table 1. Finally, over 20,000 random point coordinates were placed throughout the burn area to generate a point coverage map. These thematic maps were overlaid with the random point coverage to create a database where each point represented a single observation with attributes acquired from the thematic maps. Additionally, the distance in meters from each sample point to the nearest clearcut was added as an attribute. This database was imported into NCSS 2000 (Hintze 1998) for statistical analysis. The alpha level was 0.05 for all data analyses.

Data Analysis

To test the hypothesis that clearcuts resulted in higher fire severity than uncut stands, a two-way chi-squared test of independence was performed to discover if an association existed between fire severity and forest stand activity. The nature of the relationship between fire severity and stand activity was explained with the use of descriptive statistics.

Observations that occurred within clearcuts were further divided into two populations based on site preparation (broadcast burned and untreated) to test the hypothesis that there was an association between fire severity and site preparation. Again, a two-way chi-squared test of independence was used for the analysis.

The next analysis tested the hypothesis that fire severity was associated with fuel type. A two-way chi-squared test of independence was used in this instance. However, the fuel type variable had five classes, which made it difficult to explain the differences among fuel type classes based on inspection of descriptive statistics alone. Therefore, the data was subjected to unplanned tests of heterogeneity where the independence of selected subsets of data was evaluated. This process allowed us to see where significant differences in fuel type classes or groups of classes occurred. A simultaneous test procedure was used to test all possible subsets of data (Sokal and Rohlf 1981).

The subsequent analysis tested the hypothesis that locations closer to clearcuts burn with higher fire severity than do observations located farther away. Observations were grouped into three sample populations based on fire severity level. The dataset did not meet the assumptions of homoscedasticity (equal variances) and normality so a non-parametric Kruskal-Wallis analysis of variance on ranks (Kruskal-Wallis test) was used to compare the populations. NCSS 2000 has a pre-set limit to the total number of observations that can be used in a Kruskal-Wallis test (Hintze

1998) and so the total sample size including both populations was constrained to 1503 observations.

The Kruskal-Wallis test was also used to test the hypothesis that topography, specifically, aspect, slope, and elevation, influences fire severity. Observations were divided into three populations based on fire severity level. The variables measured were aspect, slope, and elevation. Three separate Kruskal-Wallis tests were performed using each topographic variable. Total sample size was 3801 observations for each analysis.

RESULTS

A significant association was found between fire severity and stand activity (clearcut vs. uncut) (P< 0.001). Fire severity level was higher in clearcuts than in uncut stands. Almost half (49%) of the locations inside clearcuts were of high and moderate fire severity while less than a quarter (22.9%) of the locations outside clearcuts were of high and moderate severity (Figure 1). Furthermore, an association was found between fire severity and site preparation method (P< 0.001). Fire severity level was lower in clearcut stands that were treated (broadcast burned) than in clearcut stands that had not been treated. In treated clearcut stands, over half of the observations (52%) were low severity. However, in the untreated clearcuts fire severity was low for about 40% of the observations, suggesting that broadcast burning reduced overall fire severity (Figure 2).

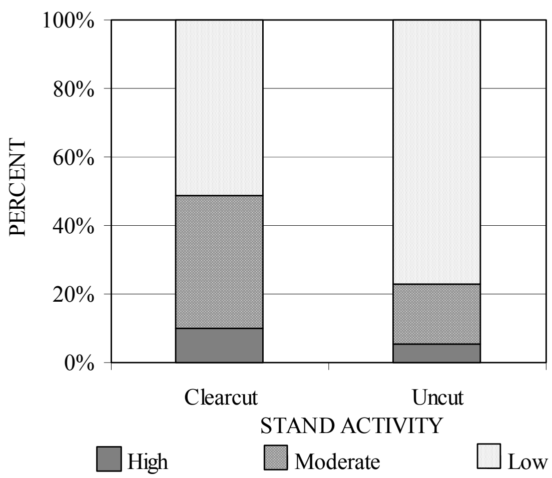

Figure 1. Distribution of fire severity levels in clearcut and uncut stands.

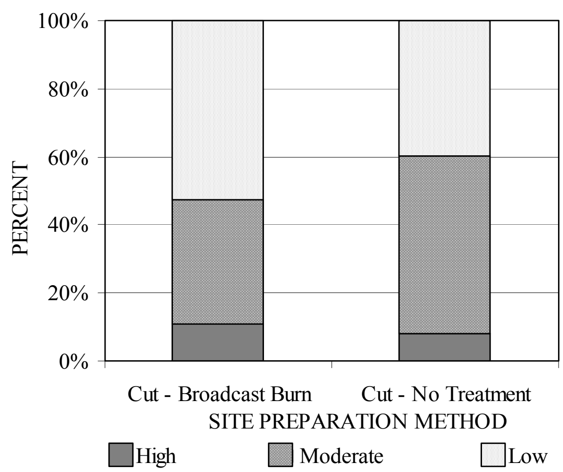

Figure 2. Distribution of fire severity levels in broadcast burned and untreated clearcuts.

Fire severity levels were also associated with fuel type (P<0.001). Three significantly different fuel type subsets were identified for the five different fuel types: grass, shrub-mixed hardwood-woodland, and mixed conifer. Figure 3 illustrates that grass had the highest percentage of high fire severity (25%), while mixed conifer had the least amount of high fire severity (6.1%). Shrub had the greatest amount of moderate fire severity (40.4%) and mixed conifer had the smallest amount (23.1%). Grass also had the highest level of high and moderate fire severity combined (57.5%). Shrub ranked second overall in percentage of high and moderate fire severity (49.2%) followed closely by mixed hardwood (47.3%) and then woodland (41.3%). Mixed conifer had the most low fire severity (70.8%)

Statistically significant differences (P< 0.002) among fire severity levels were found when the distances of sample points to their nearest clearcut were compared. The mean distance of locations with high fire severity level to the nearest clearcut was significantly less than the mean distance of locations with low fire severity level to the nearest clearcut. Locations closer to clearcuts showed higher fire severity levels than locations farther away (Figure 4).

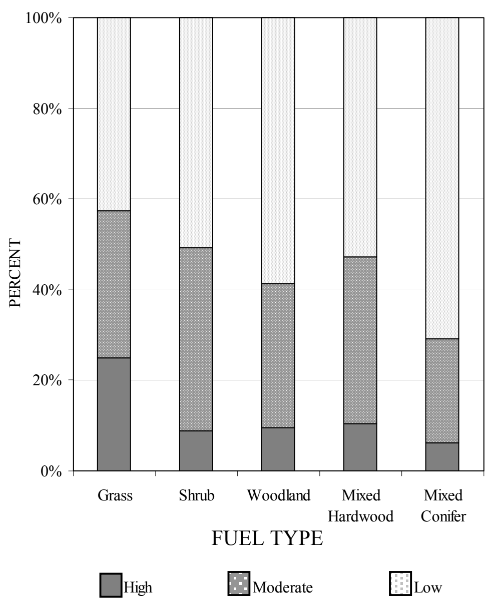

Figure 3. Distribution of fire severity levels among different fuel types.

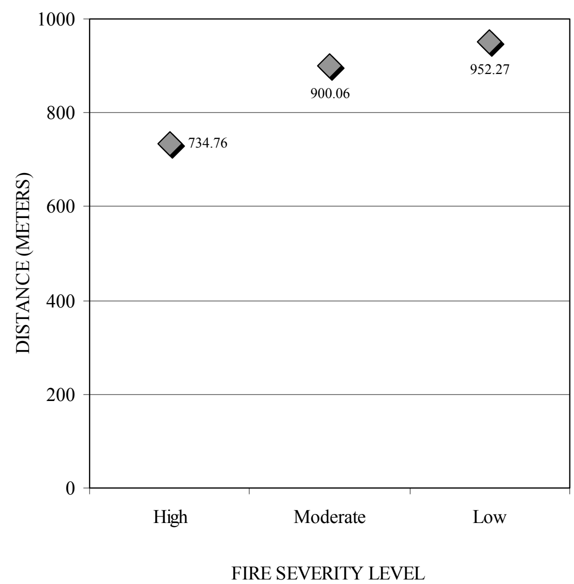

Figure 4. Average distance to nearest clearcut for different fire severity levels.

Results indicate that topography significantly affected fire severity level, but not always in the ways that were anticipated. Aspect differed significantly between fire severity levels (P<0.04). As expected, descriptive statistics showed that there were more observations of high and moderate severity than low severity on east, southeast, south, and southwest facing slopes. Alternatively, west, northwest, and northeast facing slopes had more observations of low fire severity, and north facing slopes had more observations of moderate and low fire severity (Figure 5). These results seem reasonable based on commonly recognized fire behavior principles and the findings of similar studies (Taylor and Skinner 1998).

The slope was statistically different among fire severity levels (P<0.001). However, contrary to what was expected, high fire severity was found on the least steep slopes, followed by moderate and low fire severity as slope increased (Figure 6). In contrast, we had reasoned that as slope increased, fire severity would also increase. One explanation for the disparity could be that clearcuts were located on less steep slopes, but were found in the first analysis to burn at high and moderate fire severity levels. The average slope of clearcuts was about 46 percent, which was the same as the average slope for high severity observation, also roughly 46 percent. This finding suggests that the fire severity on less steep slopes may have been tending towards high and moderate severity levels due to the presence of clearcuts.

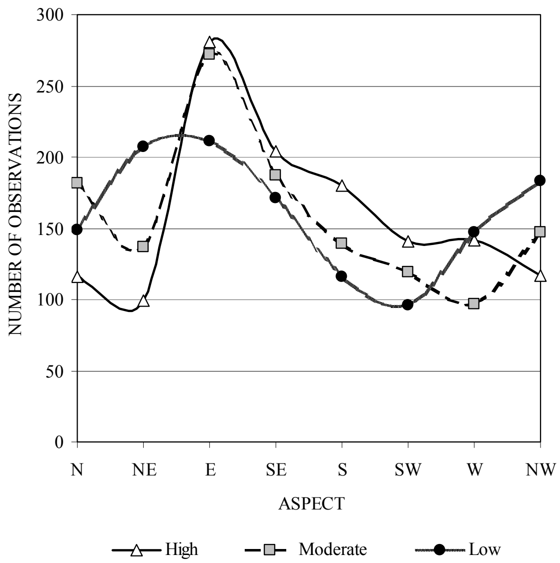

Figure 5. Number of observations for aspect by fire severity level.

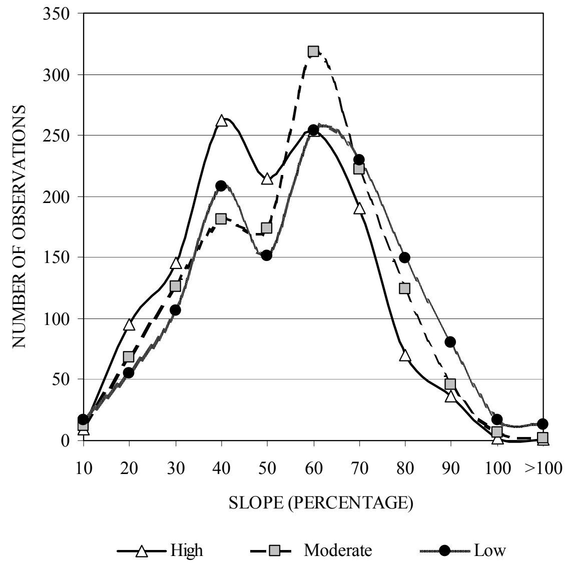

Figure 6. Number of observations for slope by fire severity level.

Results for elevation were also different from what was expected. While the elevation differed depending upon fire severity level ($P<0.001$), high fire severity had the highest mean elevation, moderate fire severity had an intermediate mean elevation, and low fire severity had the lowest mean elevation. Average elevation of clearcuts (1072 meters) however, was higher than the average elevations of moderate (1048 meters) and low (1022 meters) fire severity levels, indicating that the presence of clearcuts again may have influenced the outcome (Figure 7).

DISCUSSION

Results of this study indicate that fire severity levels are higher in clearcuts than uncut stands and that fire severity is inversely related to distance from a clearcut. Additionally, fuel types commonly found in clearcuts generated greater fire severity. The greater fire severity associated with clearcuts was due to the relatively higher proportion of flammable fuel types such as grass, shrub and hardwoods. This, in turn, may have influenced fire severity in neighboring stands. Thus, fuel characteristics have an impact on fire severity. Furthermore, the results suggest that the reduction of fuel loads through broadcast burning can mitigate severe fire damage.

Weatherspoon and Skinner (1995) described the relationship between the degree of damage in plantations and prior management activities in a study of the 1987 fires in the Hayfork Ranger District, Shasta Trinity National Forest. They found that fire damage to plantations was associated with the degree of fire damage in adjacent stands, grass and forb cover, elevation, and silvicultural activities, specifically site preparation methods. Similar to the results of this study, the degree of fire severity in plantations was found to be related to prior site treatment. Stands that were broadcast burned or machine piled suffered far less damage than units that were not treated (Weatherspoon and Skinner 1995).

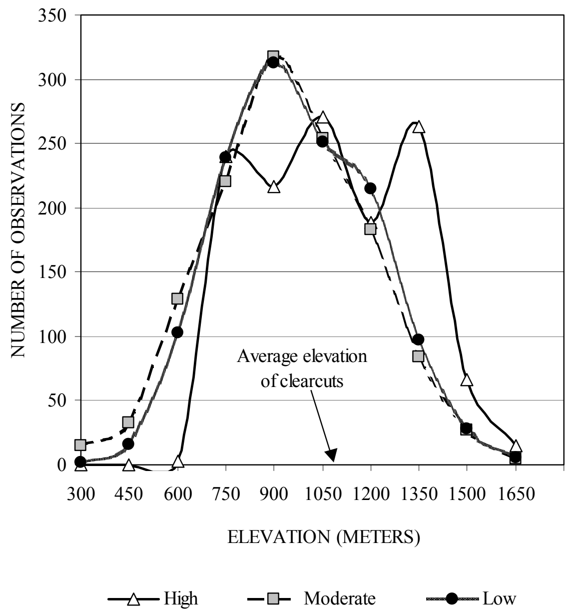

Figure 7. Number of observations for elevation by fire severity level.

Omi and Kalabokidis (1991) also realized the significance of fuel loading in a study of the North Fork Fire, one of the greater Yellowstone fires of 1988. They saw lower flammability in intensively managed areas than in adjacent fire suppressed mature stands. This phenomenon was attributed to the reduction of fuel on the managed units (Omi and Kalabokidis 1991).

Stand level climatic forces may also explain the increased fire severity found in clearcuts and adjacent stands. Countryman (1956) stated that many foresters have observed a difference in fire behavior between slash and uncut areas that may be due to climatic forces. Conversion of forests from closed mature stands to clearcuts causes changes in surface weather conditions resulting in a more dangerous fire climate with higher temperatures, lower humidity, and lower fuel moisture. He believed that this climatic shift was more important to understanding the effects that harvest activities have on fire intensities than simply the effects of increased slash fuel (Countryman 1956).

Another of Countryman's (1956) results may explain the tendency for increased fire severity levels in stands near clearcuts as was suggested by this research. He found fires in the open burn with greater energy and create strong convection columns, which loft burning embers into the neighboring forest (Countryman 1956). De Ronde et al. (1990) found that the edge of a plantation often experiences higher burn intensities than the interior because of the interactions of fuel type, fuel moisture, and wind. Fires create their own microclimate, which effectively spreads fire into surrounding forest.

CONCLUSION

In recent years, the ecosystem approach to forest management has become more prevalent and management guidelines have attempted to be more accommodating to natural patterns and processes. In order to create a more ecologically friendly clearcut, managers have designed harvesting practices to mimic natural disturbance patterns across a landscape with smaller, patchy clearcuts. Managers are also recognizing the role of other ecosystem components. Logs, snags, and other coarse woody debris are a long-term source of organic matter, provide habitat for many organisms, and influence geomorphic processes (Franklin et al. 1997). Consequently, many current harvest plans require more biological material be left on-site post-harvest (Agee 1993, Kohm and Franklin 1997). However, this study has shown that clearcuts, regardless of treatment, increase fire severity. Considering this trend towards more sustainable silvicultural activities, expanding our knowledge about silvicultural practices that decrease severe fire effects is crucial to achieving multiple forest management objectives (Weatherspoon and Skinner 1995, Kohm and Franklin 1997).

Graham et al. (1999) believe that the best way to decrease hazardous fuel build up is through site specific silvicultural treatments. Forest types and ages react differently to different systems. Thus, no single approach should be applied to all stands. However, a silvicultural system that manages for tree density and composition seems to be essential (Graham et al. 1999). This relationship between forest health and silviculture demonstrates the need for managers to focus on a landscape approach to ecosystem management (Weatherspoon and Skinner 1995). The possibility that extreme fire in clearcuts will have a destructive ecological impact not only within the clearcut but also in adjacent uncut stands, establishes the importance of widespread fuels management. How management activities affect forest stands, their immediate surroundings, and natural processes can determine the quality of the timberland and landscape overall.

Research on the effects of harvest activities on natural processes is a positive step towards the overall goal of better forest health. The need to balance the requirements of timber, recreation, wildlife, aesthetics, and other forest resources with increased risk of fire, suggests the need for more studies such as this into the realm of fire behavior and silvicultural associations.

ACKNOWLEDGEMENTS

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THE INFLUENCE OF FIRE SUPPRESSION ON VEGETATION, ENVIRONMENTAL QUALITY AND HUMAN HEALTH IN THE LOWER KLAMATH RIVER BASIN OF NORTHERN CALIFORNIA

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This paper examines the premise that fire suppression has significantly influenced the composition and density of forest vegetation throughout the forests of the Klamath River Basin. It draws from fire histories - both written and oral - fire risk assessment completed by the Forest

Service for the entire Basin, the considerable literature of fire studies conducted in the Basin during the past two decades, and what I like to call studies of the natural history of individual fire events which have been completed by the Klamath Forest Alliance and its allies. The paper offers the premise that fire suppression has not been equally effective across the landscapes of the Klamath River Basin. It offers the hypothesis and presents evidence that, in the more remote reaches of the steep and folded mountains of the lower Klamath Basin - the core Klamath Wildlands - fire suppression has not been effective and, as a result, vegetation and fire behavior are within the natural range of variability for these processes in this location. This suggests that the efficacy and impact on vegetation of fire suppression may be overestimated in other areas as well. It may be more valid scientifically to think of fire suppression effectiveness and consequent influences on vegetation as a continuum - from highly effective/deterministic influence on vegetation to ineffective/vegetation uninfluenced - rather than the current assumption that fire suppression/vegetation determination has been equally and highly effective across western forests.

Finally the paper turns from the impact of fire suppression on future vegetation composition and density to the impact of fire suppression activities themselves on Klamath Basin ecosystems – not only vegetation but also water quality, soil erosion, invasive species, stream sedimentation and fisheries. Evidence from the Hog Fire of 1977, the Yellow, Baldy and Glasgow Fires of 1987, the Dillon and Specimen fires of 1994 and the Big Bar Complex of 1999 will be examined to make the case that modern fire suppression activities IN THEMSELVES constitute a major degrading impact on the ecology and environmental quality of Klamath River Basin watersheds and one which is unnecessary and ineffective at putting large fires out. Ongoing studies by Anthony and Christine Ambrose of Citizens for Better Forestry of the Big Bar Complex will be used to make the case for a policy of minimum suppression or "loose herding" in Wilderness and other Backcountry areas.

FIRE AND LANDSCAPE DYNAMICS IN WATERSHEDS OF THE KLAMATH MOUNTAINS

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Despite the great ecological importance of riparian environments, little information is available concerning their past fire history. Thus, a great deal of uncertainty exists about the interactions of fire and riparian environments. With the Mediterranean climate and the general pattern of frequent fires in most vegetation types, it is logical to assume that fires regularly affected many riparian areas of the Klamath Basin in the past. Fire return intervals (FRIs) developed from fire scars on stumps for sites adjacent to perennial streams in riparian reserves were found to have been approximately double the FRIs from nearby upland forest sites. However, the ranges of FRIs were very similar. It appears that FRIs in riparian reserves may be more variable than in adjacent uplands and tend to be longer. Riparian areas may have helped to enhance the spatial and temporal diversity of landscapes by acting as occasional barriers to many low- and moderate-intensity fires.

FUELS TREATMENT ON PRIVATE LANDS: THE CASE OF LONG CANYON.

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It is commonly recognized that the expansion of homes into forested areas has created a potential for devastating loss of lives, dwellings, and forest resources. The East Fork Fire Management Plan was developed to address this potential in several settlements in the Covington mill area near Trinity Center in Trinity County. This community-based plan addresses fire safety and forest health opportunities for 300 rural residential parcels and adjacent forest land within the east fork of Stuart fork watershed. The planning process involved area residents, fire and forestry experts from CDF, USFS, Sierra Pacific Industries, and the private sector, and personnel from the Trinity county resource conservation district and the Trinity river conservation camp.

The plan contains recommendations that the community and individual landowners can follow to reduce the risk of losing their lives, homes and the landscape in which they desire to live. Recommendations to establish fuel breaks, reduce ladder fuels, and execute other management projects that reduce fire intensity will also help protect surrounding resource lands. It is anticipated that these projects will reduce the containment times of lower intensity fires and prevent them from moving into or out of settlements.

COMMUNITY-BASED WILDFIRE MANAGEMENT: INTEGRATING SOCIAL AND ECOLOGICAL OBJECTIVES ON PUBLIC LANDS

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ABSTRACT

A community-based approach to wildfire management in the U.S. has the potential to address persistent socioeconomic issues in forest communities while accomplishing fuels and fire management objectives in a cost-effective manner. In a community-based approach to managing fire, community expertise and labor is utilized in an ongoing set of integrated ecosystem management activities that reduces the threat of catastrophic fire. To realize the full benefits of this approach, capacity building at the community level will likely be needed in order for community-based businesses and groups to function as partners with government agencies. The case of a community-based approach to ecosystem management in northern California illustrates many of the components of community-based wildfire management as well as capacity-building needs and potential benefits. The emergency Congressional funding available for wildfire management in

2001 could be well invested in developing community-based approaches to wildfire management that yield environmental, social and economic profits.

INTRODUCTION

During the fire season of 2000, 7.4 million acres of wildlands burned in the United States. Dramatic images of raging wildfires flashed across television screens nationwide. The cost of putting out the fires (suppression) exceeded $2 billion. The value of damages to natural resources, homes, and private property has not been totaled but was likely in the billions of dollars. The 2000 fires woke the policymakers in Washington DC to the "emergency" in the nation's forests. Congress approved $1.8 billion in FY2001 for a new National Fire Plan with a focus on "managing the impacts of wildfires on communities and the environment" (USDA/USDI 2000). Most of those appropriations are special, one-time emergency funds, and pressure is on the resource management agencies to show quick results. Treating wildfire exclusively as an "emergency," however, can exacerbate the socioeconomic problems faced by forest communities while failing to address the underlying reality of fire as an integral part of ecosystem processes.

While forest fire is generally viewed as a catastrophe requiring an emergency response, fire is actually a normal feature of many forest ecosystems. The 2000 fires occurred in areas where frequent fire has historically been a natural part of ecological processes. In recent years, however, fires have burned hotter over larger areas than in the past. The large fires of 2000 cannot be considered natural; they are the product of human intervention. More than five decades of effective fire suppression have resulted in an unprecedented build-up of small diameter fuels which contribute to the catastrophic nature of many present-day forest fires. Treating fire on an emergency basis will only perpetuate the problem when long-term investment is needed to address fire in a more comprehensive way.

A long-term approach to fuels and fire management requires landscape-level planning, diverse management activities in the field, and the development of technologies and markets for the products of fuels management. New public-private sector partnerships are needed to address the broad scope of tasks involved in managing wildfire in this way. Businesses, organizations, and individuals in forest communities can assist in fuels and fire management but may require investments in building their capacity to do so. Lessons applicable to capacity building for fire management can be learned from recent efforts to implement ecosystem management in the Pacific Northwest.

The special funding allocated to the National Fire Plan offers the opportunity to build the capacity to provide sustainable rural livelihoods in forest communities while reducing the threat of catastrophic fire for years to come. Local residents are particularly suited to assist in fire planning and management because they have knowledge of the area and transferable skills from years of living and working in the woods. Much of the work of managing public lands is currently contracted out to private firms. Surprisingly little of that work, however, is done by businesses located in small forest communities. Through a combination of local capacity-building and changes in agency policies, local communities will be able to do more of the long-term work involved in reducing the forest fuels and managing forest ecosystems. Moreover, value-added processing and marketing of the by-products of fuels management can not only create local jobs, but can also generate revenues for the government. When small diameter materials have some economic value, fuels can be treated over a larger area and the threat of big fires is reduced more quickly.

WHY A COMMUNITY-BASED APPROACH TO WILDFIRE?

Community-based approaches to managing wildfire have the potential to be more cost effective, better for the environment, and better for local communities then current approaches to fire for a number of reasons described below.

Forest communities are most affected by forest fires, in terms of loss of property, lives and livelihoods and therefore have an ongoing interest in participating in wildfire management. Members of forest communities often have local knowledge that can help in planning management activities as well as fighting fires. Many local residents have knowledge of fire history and weather patterns as well as knowledge of resources that can help fight fires, such as water sources, water trucks, access points, and backwoods roads. Residents can identify valuable natural resources, cultural sites and property that should be protected in firefighting efforts. Community-based planning efforts can integrate this local knowledge and agency expertise. Many times, local residents provide continuity and historical understanding that cannot be provided by agency experts who are mobile or frequently transferred.

Forest communities contribute to the labor and businesses that can make fuels treatments economically viable. If a fire-influenced ecosystem is managed in a consistent, comprehensive way, forest communities are well situated to provide ecosystem management workers who are cost effective because they need not travel long distances and pay for lodging and food on the road. Moreover, local businesses can potentially process and market the by-products of ecosystem management with minimal transportation costs for raw materials. Together, efficient labor and local processing can turn some costly service contracts into revenue-generating product sales. The management of fire-prone ecosystems provides an opportunity to develop long-term stewardship relationships between forest communities and the forest that surround them that can replace formerly extractive relationships.

Residents of forest communities are currently struggling with how to make a living. They are suffering the dual social and economic impacts of reduced timber harvesting and the shrinkage of local Forest Service staff. The reduction in timber harvest levels in the 1990s has hit timber-dependent forest communities particularly hard. Many of them have people and businesses with skills that could assist in fuels management. Such communities often need capacity-building efforts to strengthen them to the point that they can be effective partners. The community-based approach to wildfire management can address two needs simultaneously – the socioeconomic decline in forest communities and the need to manage for fire in a consistent ongoing basis.

The need to incorporate local communities into fire management efforts is an issue that has been addressed in Southeast Asia as well as the United States (e.g. Makarabhirom, Ganz and Onprom 2000). While the ecology and causes of ignition are different in these two areas, the value of involving local expertise and capacity for on-going management is similar.

EMERGENCY APPROACH TO FIRE MANAGEMENT VERSUS A COMMUNITY-BASED APPROACH

The National Fire Plan instructs federal agencies to "work directly with communities to ensure adequate protection" (USFS 2001). The Plan also notes nine operating principles including hazardous fuel reduction, collaborative stewardship, job creation, and applied research and technology transfer. It is not clear, however, how the agencies are supposed to achieve these multiple goals. A community-based approach to wildfire management builds on lessons learned from community forestry efforts and addresses each of these objectives.

Community forestry generally refers to institutional arrangements in which local communities have some share in decision-making and benefits and communities contribute labor and expertise related nearby forests to which they are culturally and/or economically connected. Community-based forestry in Trinity County and in federal forests elsewhere in the U.S. has come to mean: 1) community involvement in planning and decision-making through forums that encourage diverse local participation (i.e. that include protimber, proenvironment, and procommunity perspectives) (see Danks 2000), and 2) involvement of community members in the economic activities related to forest management. Local economic involvement in forest management includes contracts with local businesses and nonprofits for ecosystem management services, employment in local harvesting and processing of forest products, and direct employment with resource management agencies. Following on this conception of community forestry, a community-based approach to fire management involves communities as valuable participants in fire planning and prevention as well as economic opportunities related to the management of fire-prone ecosystems, processing of forest products, and fire readiness.

"Community" as used here refers to the residents of forest areas, who usually live in small, fairly isolated towns. Community does not refer to a local political unit as many forest communities in the West are unincorporated areas. Nor is community meant to exclude local residents who are government employees. Much of the expertise and organizational capacity that exists at the local level consists of residents who work at field offices of state and federal resource agencies. "Community-based" refers to both the local focus of attention and the relatively small scale of business operations and social interactions.

Table 1 contrasts the emergency approach that views wildfire as an accidental catastrophe and communities as helpless victims versus wildfire as a part of an ecosystem and communities as partners in managing a fire-influenced ecosystem. The text below it describes each box in greater detail. These approaches are presented as contrasting models for analytical purposes. Even with an active fuel treatment program, the capacity to respond to catastrophic fires will still be important to maintain. The challenge is to develop institutional arrangements that are able to meet both sets of needs.

Although ecologists and fire scientists understand the role of fire in the ecosystem, the institutional apparatus for fire management currently is organized to address fire as a catastrophe and has a strong focus on suppression. In contrast, a community-based approach to wildfire incorporates fire as part of ecosystem management. Planning and field activities integrate vegetation management with fuels reduction and fire fighting strategies. For example, vegetation treatments for enhancing old-growth characteristics (such as natural stand thinning from below or removal of invasive species) will be planned in a way that strategically breaks up fuels across the landscape and allows the introduction of prescribed fire. Shaded fuel breaks will be prioritized and laid out in a way that assists in fighting fires and mimics historical conditions to the extent possible.

Table 1. Contrasting Emergency and Community-Based Approaches to Wildfire.

Emergency Approach to Forest Fire	**Community-Based Approach to Wildfire Management**
Fire as a catastrophe	Fire as part of ecosystem
Focus on suppression	Focus on integrated vegetation (fuels) management and fire fighting strategies
Resources allocated on an emergency basis $$$$ suppression $ pre-suppression	Resources allocated on an on-going basis $ suppression $$$$ fuels management
Outside expertise	Local knowledge
Centralized capacity to respond	Decentralized capacity to manage
Mobile, specialized crews e.g. incident command teams hotshot smoke jumpers convict crews	Placed-based, multi-purpose, fire/fuels crews e.g. brush disposal crews ecosystem management technicians
Short-term, intense activity (capital intensive, high risk)	Long-term activities and objectives (good climate for private sector investment)
Communities as victims	Communities as partners

To date, resources have been allocated to fire management largely on an emergency basis. Large sums are allocated to suppression when necessary, and little funding is available for ongoing presuppression activities. In a community-based approach to fire management, the opposite would be true. Resources would be allocated on an ongoing basis with the bulk of the budget in fuels management. Over time, less money will be needed on average for suppression.

Planning for and fighting large wildfires relies largely on non-local expertise. These "outside" experts use generalized expectations of fire and weather behavior, published maps, and satellite images among other sources in developing fire plans and managing active fires. The knowledge of community residents and local agency personnel who have lived through the last fires, know the roads and ridges, and know local resources available to plan for and fight fires is often excluded by current practices. Community-based fire management would integrate local knowledge with outside expertise.

Wildfire resources have been used to develop a sophisticated and effective centralized capacity to respond to emergency. Fires are fought by mobile, specialized crews from the incident command teams that manage large fires down to the hotshot smoke jumpers on the front lines and the convict crews mopping up afterwards. Even landscape rehabilitation (e.g. Burned Area Emergency Rehabilitation) after a fire is considered an emergency due to the potential for erosion and is usually done by outside crews.

It is clearly necessary to have a system that can efficiently move a large number of people to the site of an emergency and have them function well together when the need arises. However if all fire resources were devoted to this model, little would be available to reduce the risk of large fires. In a community-based approach, resources would be invested in a decentralized capacity to manage forests in a way that reduces the probability of catastrophic fire. In this allocation of resources, emphasis would be on the development of place based, multipurpose fire/fuels crews. Such crews, whether they be private contractors or public employees, could work on diverse vegetation management projects that integrate fuels reduction throughout a long working season. These crews would also be trained and available to put out fires where necessary and to assist in prescribed burning. Their knowledge of the landscape and prior participation in local planning efforts should make them particularly effective in fighting fires locally. The ability to mobilize large crews when necessary should of course be retained. New ways to integrate local knowledge and workers in fighting large fires, however, should be explored.

When fire is considered an emergency, fire management activities are short-term and intense. When fire is dealt with as part of ecosystem management, fuels and fire management are long-term, ongoing activities. Long-term commitments provide a better climate for private sector investment. Under those conditions, community-based businesses can invest in the training and equipment needed to play supporting role as partners with federal agencies in managing fire on public and private lands.

Communities are viewed primarily as the victims of catastrophic fire. During a large fire, forest communities are invaded by fire camps, are victims of smoke, and experience the losses of homes, pets, timber, scenery and economic activities. Beyond clearing a "defensible space" around their homes, there are limited roles for community members in the emergency approach to fire management. To prioritize National Fire Plan funding, federal agencies sought to identify the communities “at risk," particularly those in the urban-wildland interface where high property values are of greatest concern (Federal Register 2001). Labeling communities as “at risk” gives limited recognition to the organizations and businesses in forest communities could help agencies in addressing wildfire. In a community-based approach, communities are viewed as partners with agencies in managing fire-prone ecosystems.

COMPONENTS OF COMMUNITY-BASED WILDFIRE MANAGEMENT : WHAT WOULD COMMUNITIES DO?

What parts of wildfire management are individuals businesses and organizations at the community level well suited to do? Community members are already carrying out key elements of wildfire management in the context of ecosystem management in fire-prone regions. Many of these activities are included in Table 2.

Table 2. Fire Management Activities in which Local Communities Can and Do Participate

On-Going Management of Fire and Fuels fire planning / mapping surveys – fuels, wildlife, erosion hazard, aquatic habitat, etc. environmental analyses fuels reduction in varied forms, for example: ground fuels management post-treatment burning prescribed fire fuel breaks, e.g. shaded fuel breaks density management fuels management in recreation areas (e.g. campgrounds) monitoring research
Complementary Value-Added Industry small diameter wood products primary and secondary processing (instead of just burning or chipping) e.g. poles, flooring value-added manufacturing e.g. furniture, fixtures non-timber forest products e.g. morel mushrooms, mullein marketing web design / internet marketing
Fighting Fires utilize local fire plans and knowledge utilize local personnel, businesses, and resources
Post-Fire Rehabilitation: erosion control of bare slopes rehabilitation of roads/fire lines used in fighting fires surveys / mapping environmental analyses replanting salvage monitoring

Not all communities are prepared to engage in all of the activities listed above. In some cases capacity must be built with the aid of public sector investment. The most important changes needed, however, are in public sector policies and practices. In particular, if federal land management agencies solicit ecosystem and fire management services in packages that are appropriately scaled and offered regularly, the private sector in forest communities can itself invest in building the needed capacity.

MODEL FOR DEVELOPING COMMUNITY-BASED APPROACH TO ECOSYSTEM MANAGEMENT

Lessons for what constitutes policies and practices that support a community-based approach to fire can be gleaned from recent experiences in the Pacific Northwest. In 1994, the Northwest Forest Plan, accompanied by the Economic Adjustment Initiative, transformed the land management regime and accompanying private sector businesses from an emphasis on timber production to ecosystem management in order to protect endangered old-growth species. These changes in land management objectives and practices were implemented with a special concern for the effect on timber-dependent communities. The efforts associated with the Northwest Forest Plan to increase the capacity in local communities to engage in ecosystem management provide insights into how the capacity for community-based wildfire management could be developed.

Community-Based Ecosystem Management in Trinity County

Trinity County, CA is described below because it is a place within the Northwest Forest Plan area that exemplifies conditions in vulnerable forest communities in the U.S.. It is also a good example of the promise and challenges of agency-community partnerships to manage wildfire. In Trinity County, community-based organizations have worked with the Forest Service and other government agencies on a number of components of community-based fire management. These activities range from community-based fire planning to value added processing of the products of fuels management. This case shows the value of private sector involvement in fire/ecosystem management and the kind of capacity building needed in poor forest communities to achieve that goal. In addition, Trinity County was the site of several major fires in recent years. In 1999 the town of Lewiston lost 23 homes in an escaped prescribed fire and later that summer the Megram fire grew into a complex that burned 125,040 acres. Residents still talk of the "87 fires" when fires burned 91,000 acres adjacent to towns and smoke blocked the sun for weeks in the late summer of 1987. This fire history has created common ground among residents and agency personnel who experienced these traumatic fires and understand the need for fuels and fire management.

Trinity is a mountainous, rural county of approximately two million acres (810,000 hectares) and 13,000 people in northern California. There are about 18 communities within the County and their populations range from 30 to 3200. Most communities are fairly isolated with large tracts of forest land between them. The only local government is the Trinity County Board of Supervisors. There are no incorporated towns, no mayors, no town councils and no traffic lights. The rugged topography ranges from 600 to 10,000 feet in elevation and the predominant vegetation is mixed conifer forests and oak woodlands. The average fire return interval differs throughout the County with various studies reporting a range from three to twenty years (USFS 2000, Taylor and Skinner 1998).

The timber and recreation industries are the core sectors of the economy, making Trinity County one of the most forest dependent areas in the Pacific Northwest.1 More than 30 percent of employment in Trinity County was in the timber industry in the late 1980s (Greber 1994). Other than local commercial and support services (e.g. stores, schools, government services), there is relatively little economic activity, public or private, that is not directly related to the National Forests-related activities include logging, lumber mills, recreation, watershed management, fire management, tourism and reforestation. Local residents are economically connected to the forest not only through employment but also through some subsistence uses. Seventy percent of the homes in Trinity County are heated with wood (USDC Bureau of the Census 1993). Hunting and fishing are not only popular forms of recreation, but they also supplement the diet of many local residents. This close relationship with the surrounding forest means that many community members have a good knowledge of the terrain and experience in working in the woods that can increase the value of their participation in ecosystem and wildfire management.

Unfortunately, like many forest communities throughout the United States, Trinity County has relatively high poverty (19 percent) and high unemployment. For more than a decade, the annual unemployment rate in Trinity County has been about twice that of the state of California. Employment is highly seasonal in Trinity County, with the highest unemployment occurring during the winter months (Figure 1). Forest dependence, on both timber and recreation, contribute to this strong seasonality. These data suggest that the communities in Trinity County are in need of more livelihood options. There are many people with woods and wood products experience who are underemployed and could contribute to wildfire management.

The size and regularity of forest contracts makes a difference to small community-based forest-related businesses. There are three main ways that community members are employed directly in the management of national forests in Trinity County: as loggers, and their workers, who bid competitively to buy timber; and as contractors, and their workers, who bid competitively for paid contracts to do various tasks in the woods (e.g. treeplanting, surveys, rehabilitation, precommercial thinning), and as direct employees of the U.S. Forest Service. Trinity County businesses, however, received only seven percent of timber sales and field service contracts on the Trinity National Forest from 1991 to1996 (McDermott and Danks 1998). Analysis revealed that Trinity County businesses were most likely to win timber sales and contracts when they were packaged in small jobs (which require small crews and small amounts of capital) and were offered consistently year-to-year.

Unfortunately for forest communities, most timber sales and service contracts are packaged as large jobs with relatively short time frames which require large crews to complete the jobs on time. Despite the appearance of an open competitive market, this packaging constitutes a bias against forest communities where businesses are small and capital is limited. An emergency approach to fire management, with a focus on large-scale, short-term intense activities, will likely intensify the bias against local livelihoods. An ongoing program of fuels management, which seeks to incrementally treat fuels and restore ecosystem functions, can better offer opportunities to provide and package work in ways that are accessible to businesses in forest communities.

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[1] Normally the community--not the county--is the appropriate unit to analyze forest dependence in the U.S. even though more data are available at the county levels. However, the absence of significant agricultural, industrial (other than timber) or urban sectors in Trinity County makes it more like a forest dependent community than an economically diverse California county.

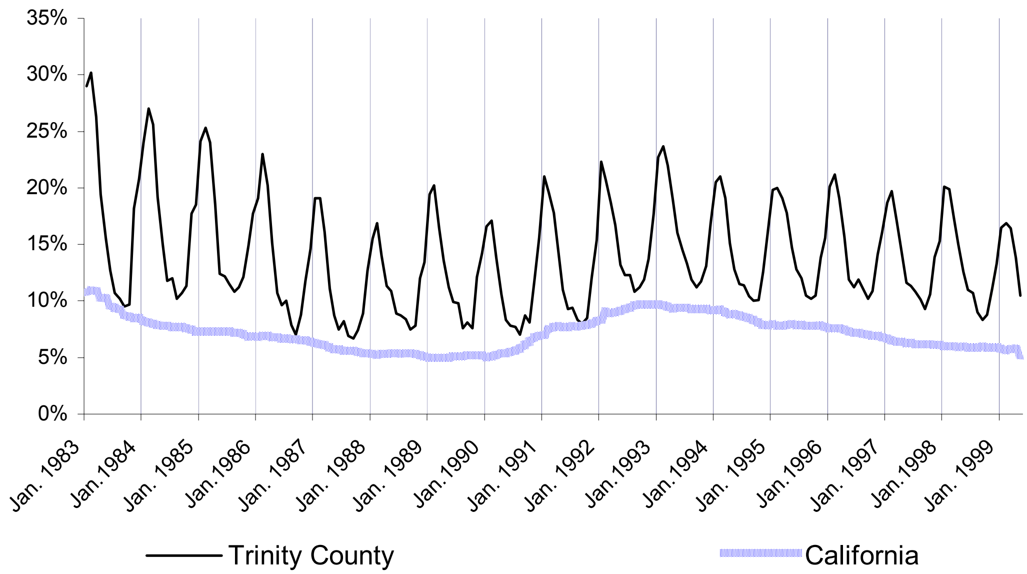

Figure 1. Monthly Unemployment Rates for Trinity County and California, 1983-1999

The highly seasonal unemployment, high poverty rates, and the strong historical dependence on timber extraction go hand-in-hand. There are many capable woods workers in the communities of Trinity County, but the lack of steady work has led to a precarious situation for families. Contracting practices that favor large businesses and require workers to travel long distances for short periods of time exacerbates the problem. While workers are away, they cannot participate in community and family life. They cannot help their children with homework, go to church, coach Little League, lead a scout troop, or serve on a community development committee.

Like the National Fire Plan, the Northwest Forest Plan included broad policy directives to work with communities in implementing ecosystem management. When the Northwest Forest Plan was announced, it was hoped that residents of forest communities could secure long season work year after year, doing the diverse tasks needed to steward national forests. Although the plan was criticized by the timber industry and environmentalists, Trinity County embraced the opportunity to implement ecosystem management in a way that would finally benefit forest communities. The Watershed Research and Training Center, located in the center of Trinity County, took the lead in capacity building efforts to enable forest communities to contribute to the ongoing sustainable management of nearby national forests.

The Watershed Center, in partnership with federal and local agencies, led a comprehensive set of programs to help prepare its community to engage in the new set of field, office and factory tasks involved in managing forest ecosystems for diverse benefits. The tasks of ecosystem management include a combination of field and information-based activities, such as data collection, data entry, mapping, surveys, inventory, planning, monitoring and research; designing, constructing, and maintaining trails, campsites and other recreational areas; marking, thinning, yarding, pruning and burning in dense natural stands and plantations; rehabilitating, closing and removing roads; and restoring streams and wildlife habitat.

The capacity-building efforts conducted by the Watershed Center and its partners to prepare people for this kind of work included: 1) an ecosystem management training program to diversify the skills of displaced timber workers and other unemployed residents, 2) advanced contractor training to bolster specialized field and business skills, 3) stewardship contracting program to help agencies design longterm contracts for ecologically beneficial forest work that was at a scale appropriate for local businesses, 4) a small diameter program to pilot harvesting and processing technologies that required limited capital and were ecologically appropriate, 5) assistance in developing private sector value-added processing and marketing of the products of ecosystem management. These efforts were enabled by the federal policies that encouraged agencies to work with communities and funding available to public agencies and the private sector to help forest communities adjust to changes in land management activities.

These capacity-building programs had multiple benefits. Forest communities had more and more diverse economic opportunities. Government agencies who could accomplish work more cost-effectively because community partners contribute pieces, like small diameter processing and marketing, that lowered government costs. The environment benefited because the forest finally received treatments that promoted healthier conditions and reduced the threat of a large, damaging fires.

The capacity-building efforts for ecosystem management in Trinity County are much the same as those needed for community-based wildfire management because fire is a main ecological force in the Trinity's forests and many of the ecosystem management activities, especially small diameter thinnings, fuelbreaks and prescribed fire, are essential parts of wildfire management. In addition, the mapping, inventorying, monitoring and other information-based field work of land management and planning are also necessary for wildfire management. Therefore, efforts to integrate wildfire management into ecosystem management and to develop capacity for a community-based approach to wildfire have already been piloted in Trinity County.

In additional to building capacity for implementing ecosystem management, local community-based organizations in Trinity County have collaborated on innovative community-based fire planning. This fire planning process used a participatory mapping approach to combine the knowledge of local residents and agency experts on fire hazards, fire-fighting resources, and special areas in need of protection (Everett, Sheen, and Doyas 2000). These data provide a foundation for the design and prioritization of wildfire management activities in the County.

Trinity County's ecosystem management activities demonstrate the potential benefits of a community-based approach to wildfire management. A community-based approach can help provide economic opportunity in small communities while accomplishing management activities. Involving the private sector in developing and implementing value-added processing and innovative stewardship contracting means some fuel treatments can be done because more cost-effectively. Reducing the costs of management not only saves taxpayers' money, it also helps the environment because more areas can be treated within the same limited budget. Achieving these benefits required both capacity-building efforts (which were conducted as joint public-private efforts) and changes in government policies to remove barriers to community participation.

POLICY IN TRANSITION – AN OPENING FOR CHANGE

The new National Forest Plan prioritizes: fire-fighting, rehabilitation and restoration, hazardous fuel reduction, community assistance, and planning and analysis. The vast majority of the funding is still directed to the catastrophic model of fire, i.e. on firefighting readiness, suppression, and rehabilitation of burned areas. The National Fire Plan also represents a transition reflected by its focus on fuel reduction and communities. The need to retain fire suppression capabilities while building fire management capacity is not contradictory. These dual needs are so broad in scope that they require a public-private sector partnership, in particular, an agency-community partnership.

The way in which the National Fire Plan is implemented will have great impact on forest communities. If lawmakers and agencies only address fire as a catastrophic emergency, they will never invest in creating the institutional arrangements needed to reduce the severity of fire. With substantial new funding, an attentive Congress, and a new Administration to implement the Fire Plan, there is an unprecedented opportunity to invest in a new way of addressing fire that benefits both the environment and local communities.

CONCLUSION

A short-term, emergency approach to wildfire addresses neither the underlying ecological problem nor persistent socioeconomic problems of forest communities. A community-based approach to wildfire management offers the opportunity to achieve multiple goals. Communities can play a bigger role than that of "victim". Community members can provide knowledge to create better fire plans and knowledgeable labor to implement those plans. The private sector can be contracted do much of the data gathering, project implementation and support work needed to manage fire as part of the ecosystem on federal lands. Community-based businesses can develop markets for by-products of fuels treatments that can make fuels management economically viable. For businesses and organizations in small forest communities to engage in these activities, the federal agencies need to consider scale and consistency of work opportunities. In addition, capacity-building can enhance individual skills and assist in the development of viable, local industries related to wildfire management. The policies and capacity-building efforts associated with the Northwest Forest Plan can provide examples of how the 2001 funding for the National Forest Plan can integrate social and ecological objectives on federal forest lands.

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COMMUNITY PARTICIPATION IN FIRE MANAGEMENT PLANNING-A CASE EXAMPLE FROM TRINITY COUNTY, CA

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ABSTRACT

The ecological, social and economic costs associated with wildfires are escalating in California. One still underutilized opportunity in efforts to address these complex problems is systematic involvement of rural community residents. They are often first responders in case of wildfire, they hold valuable local knowledge of place, fire history and fuel loading, and on a very personal level, they have the most to gain from participating in community level education, coordination, fuels reduction and other fire management efforts.

Wildfires are a recurring phenomenon in rural Trinity County in Northern California, but the intensity and scale of fires in 1987 and 1999 have catalyzed community organizations and state and federal resource management agencies into a systematic landscape level fire management planning and coordination effort lead by the Trinity County Fire Safe Council. In 1999/2000 the Fire Safe Council, using GIS technology and working through local Volunteer Fire Departments, initiated a participatory information gathering process with community members. They have worked to identify values at risk and site specific recommendations for pre-fire implementation activities such as fuels treatments, as well as capturing local knowledge of pertinent factors for emergency response. The experience gained may be of interest to other communities involved in landscape scale fire management planning.

KEYWORDS: community mapping, collaborative planning, fire management planning, landscape planning, public participation, GIS

INTRODUCTION

Fire is a function of temperature, wind and fuels. Since people cannot control climate, reducing fuel loading through pre-fire treatments is the most promising area in which people may influence wildland fire behavior. (Agee, 1993; Weatherspoon and Skinner, 1996) Pre-fire treatments also can significantly benefit suppression efforts once a fire starts. (Agee et al., 2000). One of the underlying challenges of applying pre-fire treatments to the landscape is bringing together the land managers, often a mix of private owners and public agencies with different mandates, along with affected communities to decide which treatments to apply and where. The scale of the Summer, 2000 fires across the United States has focused national attention and is bringing new investment in fire management with an increasing emphasis in pre-fire treatment while maintaining fire suppression capabilities. As managers rush to implement programs, one important source of information, expertise and ground level support that could be drawn upon more than in the past are local communities, the people who live in the fire zone.

In November, 2000, the Trinity County Fire Safe Council in Northern California completed the first phase in an ongoing effort to work collaboratively with government agency and local citizen members to develop and implement a landscape scale fire management plan. In this paper we briefly report on the TFSC and the current status of this process.

COMMUNITY INVOLVEMENT IN FIRE MANAGEMENT PLANNING ACROSS JURISDICTIONS

Local citizens are not normally involved in fire suppression planning or pre-fire decision-making processes. When a large wildfire burns, enormous emergency costs, often in the tens of millions of dollars are incurred for suppression. A large proportion of California wildlands are federally held public lands. On these lands, firefighting agencies go into a para-military attack mode. When a fire reaches a certain size and rate of spread or goes beyond local capacity for suppression, national strike teams are brought in from outside the area. They take over the "command central" of the fire suppression activities. While local line officers, *e.g*. U.S. Forest Service District Rangers are still in charge, in effect the "superior expertise" of the strike teams takes over. As rapid decisions are made regarding back-burning, bulldozing and other suppression activities, local citizens' knowledge, expertise and opinion is not typically factored into decisions. Yet, if site-specific information known to local residents (*e.g*. about weak bridges, narrow roads, locked gates and water sources on private land) were readily available, some fires might not escalate and resources could potentially be saved. Volunteer Fire Departments (VFDs) are first responders in emergencies including fire in many rural areas. Many VFDs are inadequately staffed, most have wish-lists of basic equipment for emergency response. It is in the interest of land managers and the public at large to have well staffed and supported VFDs and to maintain good communications with them. In operational terms, local site-specific knowledge and experience with the terrain, past fire behavior and locations for emergency fire lines, all could save lives, time and money in emergency situations.

Instead when a wildfire erupts under the current system, some local residents may gain short-term employment as fire fighters, or work as support activities staff providing food and facilities for large fire base-camps. Like a telescoped version of the historic timber and mining industries, suppression of catastrophic fire is yet another rapid boom and bust economic cycle for forest dependent communities – quick high earnings during and immediately after the fire, with years of lost forest resources to follow. Most would prefer to avoid the cycle and many agree with fire managers who advocate pre-fire vegetation treatments.

Here again, the potential value of citizen involvement in pre-fire management has not been fully recognized. Fire is oblivious to property and jurisdictional boundaries. It is up to private landowners to carry out fuels reduction around their homes and on forest parcels neighboring public lands. If they don't, the risk to public resources is increased. Industrial forestland owners carry out a range of fuels management and fire planning activities, sometimes, but not always in coordination with neighboring land management agencies. When a fire starts, whether on public or private land it can quickly travel to other ownerships.

THE CALIFORNIA FIRE SAFE COUNCIL

In recognition of the need for coordination among a range of agencies, industries and communities to increase fire safety for communities, the California Fire Safe Council (CFSC) was formed in 1993. It meets quarterly and now has 50 members at the state level including such groups as State and Federal Resource and Emergency Response Agencies, the League of California Cities Fire Chiefs, the American Red Cross, Insurance and Realty Companies, Environmental Organizations and Utility Companies. The CFSC develops and distributes educational materials, evaluates legislation and policies pertaining to fire safety and supports over 60 local Fire Safe Councils that have emerged in communities around the state. The growing recognition of the institutional structure supporting community involvement in local fire management facilitates efforts to formalize cooperation at the local level among agencies and between agencies and communities, e.g. with Memoranda of Understanding on the types of joint activities that may be undertaken. However, while they share the common goal of improving fire safety, the community based Fire Safe Councils emerge from locally perceived needs for cooperation and vary in their structure, memberships and activities depending on their local circumstances.

THE TRINITY COUNTY FIRE SAFE COUNCIL, CALIFORNIA

Trinity County is a rural county extending over two million mountainous acres (Figure 1). Fewer than 13,000 people live here. Over 75% of the land is managed by the federal government, primarily in the Shasta-Trinity and Six Rivers National Forests. The vegetation is predominantly mixed conifer forest and oak woodland (Sawyer and Keeler-Wolf, 1995) with fire as the dominant disturbance regime.

In the county, fear of catastrophic fire that could repeat or be worse than the 1987 and 1999 conflagrations is growing. In mid 1998, the Trinity County Board of Supervisors' Natural Resources Advisory Council appointed a sub-committee to address the issue of fire. This initiated the Trinity County Fire Safe Council (FSC) that has met on average monthly since. The FSC includes representatives from local Volunteer Fire Departments (VFD), non-governmental organizations (NGO's), the county, state and federal land and fire management agencies, and other community members. All have signed a Memorandum of Understanding (MOU) to cooperate on fire management planning (MOU, 1998).

The FSC has embarked on a landscape analysis and strategic planning process for fire management in the county. The first steps taken in 1999 and 2000 were to build local involvement and interest in fire management planning by seeking to systematically capture local knowledge about fire and to glean residents' and fire management specialists' recommendations for pre-fire treatments. The research objective involved was to develop and implement a method to capture local and regional expertise in fire management as effectively and efficiently for the local participants as possible. Participatory research and community mapping methods were adapted to achieve this goal. (Brokensha et al., 1980; Elwood and Leitner, 1998; Harris and Weiner, 1998; Obermeyer, 1998; Sieber, 1997) Two local NGO's, the Trinity County Resource Conservation District and the Watershed Research and Training Center, provided the team that led the effort. These FSC members, including the authors of this paper, found funding support from the USFS Pacific Southwest Research Station and the California Water Resources Control Board.

COMMUNITY MAPPING AND PARTICIPATORY RESEARCH

The FSC team proceeded to work with community members in four steps: 1) to gather and develop a geographic information system (GIS) populated with all available spatial data for the county that were pertinent to fire; 2) to identify local knowledge and map data relevant for emergency response; 3) to work with local residents and professional experts to design a process for gathering community recommendations about fire management; 4) to implement that process including: gathering residents' perception of Values at Risk; collating their recommendations for pre-fire treatments to protect these values; and helping participants systematically prioritize among proposed activities.

1. Developing the GIS:

Data layers pertinent to fire management including e.g. topography, roads, hydrography, vegetation and past fire starts, were collated from a range of sources including the U.S. Forest Service, the Bureau of Land Management, the California Department of Forestry and Fire Protection and other data keepers. There had been no previous effort on this scale to integrate data sets for the county. Once these data had been compiled useful base maps for information gathering with community members and for future fire management modeling could be generated (See papers by P.Towle and K.Sheen in these proceedings).

2. Identifying local knowledge and mapping emergency response data:

From November 1999 on a series of 13 widely publicized community meetings were held in VFD halls throughout the county. The purpose of these meetings was to discuss the Fire Safe process with community members and raise the local level of awareness about issues of fire management ranging from needs of local VFDs to county, state and federal efforts. Further, the team hoped to identify local expertise in fire management that could be called upon to participate in later phases of the process and to gather site specific information not yet contained in existing GIS based map layers. In order to ensure comparability between meetings, the basic format for all meetings was the same, with two or more members of the FSC team participating in each.

At each meeting members of the FSC team presented an overview of the Fire Safe effort and then proceeded to gather participants around maps of the local terrain developed from the GIS. A computer with the GIS database was brought to each meeting so that existing information in addition to data on the maps could be accessed on request. Participants added missing information by marking reference points on the maps and explaining issues of concern which were written down. These data, of particular interest for local emergency response, included locating water sources, weak bridges, road maintenance needs, locked gates and similar information. After each meeting the FSC team entered the new data into the GIS database and maps reflecting the new input were sent back to meeting participants to verify that the new information was accurately reflected. Updated paper maps were left with VFD in each participating community so that new information might be added and included database updates on a regular basis. The GIS was shared with local land management agencies and emergency respondents e.g. VFDs. The number of community participants in these meetings was variable.

3. Working with local residents and professional experts to design a process for gathering community recommendations about fire management:

A two-day planning meeting involving representatives of agencies and groups participating in the Fire Safe Council was held in April, 2000 to develop an appropriate process for gathering community input across the county. The FSC team hoped that by bringing together locally and regionally recognized experts to contribute their ideas to the process, we would establish a credible process for all concerned.

At the meeting it was decided that in addition to the GIS and local emergency response data already gathered in previous meetings, the most important input from residents would be to identify and prioritize among key Values at Risk from wildfire in their local areas, and to make recommendations for protecting these values. Values at Risk identified by residents for example species habitat, prime recreation sites and so forth[2]. Recommendations might include identifying places in which to treat vegetation to reduce fire risk and hazard. However, even where the turn out

[2] Note this process varies somewhat from the approach taken by CDF in the California Fire Plan where Values at Risk are pre-identified and ranked by CDF staff and community meetings are held to evaluate these proposals (CDF, 1996: p 24).

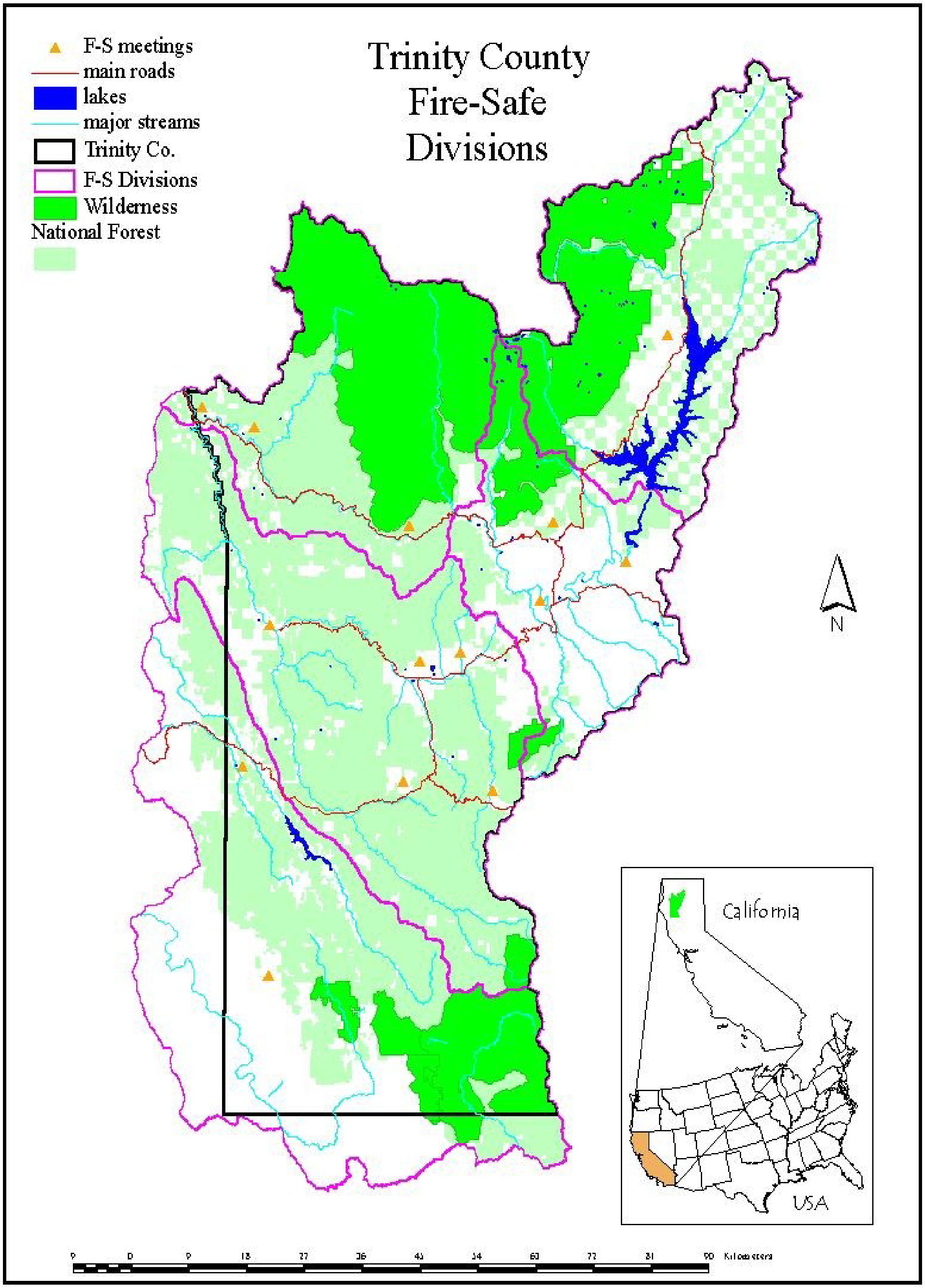

Figure 1: Map of Trinity County in California

was not large, it included a high proportion of VFD members and others with an active interest in fire management issues.

In order to make the best use of localized knowledge and staffing capability for meeting purposes, the county was divided into five parts. Evening and daytime meetings to maximize local attendance were to be held in central locations in each of these five areas, and discussion was to focus on the specific area in question.

4. Community Meetings to identify Values at Risk and to identify and prioritize pre-fire treatments:

As decided in the planning meeting, an evening and a day time community mapping meeting was held in each of the five areas of Trinity County in May 2000. Publicity to encourage broad participation was crucial. Everyone who had attended the earlier community meeting or who had been identified in the April meeting was sent a written invitation to attend and many people were also contacted directly by phone. In addition, the meetings were publicized in the local newspaper and several press releases about the fire planning process were published.

At the meetings people gathered around maps of their part of the county to discuss ideas in a lively give and take. As in the Emergency Response meetings described above, initial input on Values at Risk was captured on maps and in notes taken during the meetings as well as through on-location editing in the GIS system. In each case there were several community members, often life-long residents, who were immediately able to contribute ideas. The FSC team typically would sit down the following day with a smaller group of participants (often retired firemen, USFS staff or VFD members) to review and consolidate the data gathered earlier.

Once participants had identified which Values were at Risk from fire and where they were located, they next were asked to make recommendations for landscape vegetation treatments to protect values at risk. Recommendations might include, for example, fuels reduction work (thinning the forest from below, ladder fuels reduction, controlled burning) or shaded fuel break construction.

Finally, participants worked together to identify which projects should have highest priority. In an approach adapted from similar participatory prioritization methodologies (e.g. Margoluis and Salafsky, 1998), categories with which to evaluate proposals were defined and then ranked using a matrix approach. At each meeting, several categories with which to evaluate the importance or relative priority of proposed activities were presented and modified if participants desired (Table 1). Each category was discussed and defined in detail at the outset in each area meeting to ensure that all participants had a similar understanding of the valuation process. The resulting "scores" in the matrix were treated as indicating relative values among proposals. In order to avoid a false sense of quantitative valuation, all categories were weighted equally. The resulting prioritization matrices for each meeting were presented with a detailed description of the process applied and CD ROMs with the GIS data sets in a draft final report to the Fire Safe Council in January 2001 (Trinity County Fire Safe Council, 1999).

RESULTS

Thirteen Community meetings were held at VFD Halls to capture emergency response data. Maps were created for each meeting and returned to participants for correction. They are now ready for further ground truthing and distribution. In addition, five community workshops were held involving over 200 people including a range of regional and local agency experts. At these meetings Values at Risk were identified and recommendations were made for pre-fire treatments to protect these values. In all 116 projects were proposed and prioritized.

A number of additional recommendations emerged from the community involvement process. Federal land managers were strongly encouraged to coordinate across jurisdictional lines on fire and road management policy. Trinity County was encouraged to identify community safety zones and escape routes in case of catastrophic fire and to keep water tenders and other equipment locally available. Strong support for VFDs was advocated. All fire managers were encouraged to take a landscape scale view of fire hazard and to coordinate treatments accordingly while identifying and focusing attention on critically important habitat for wildlife and on protecting old growth forests. They should pursue the joint outcomes of protecting key values from catastrophic fire, while allowing for reintroduction of low intensity fire, and providing an ongoing source of employment to the county workforce to carry out the fuels reduction work (Trinity County Fire Safe Council, 1999).

Figure 2: Participants Gather Around Maps at the North Lake Meeting, May 16, 2000
(Photo by C. Fall).

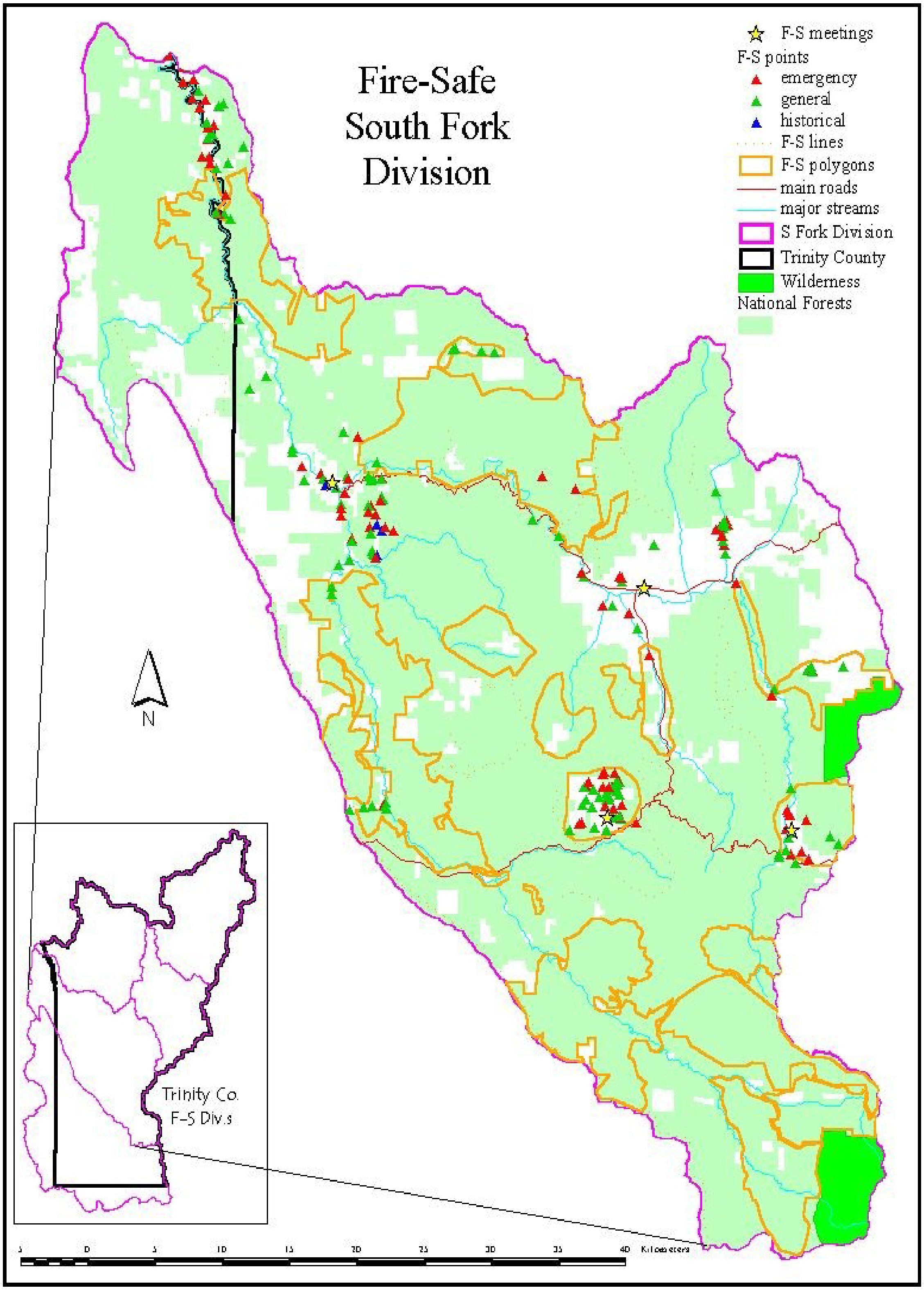

Figure 3: Pre-Fire Treatment Recommendations Captured for the South Fork Area.

Table 1: Categories Used by Participants to Rank Recommended Projects
(High, Medium or Low)

Community – areas most highly valued by community members

- ***High value e.g*. a community, a housing development or a grouping of several residences, a telecommunications translator, a community water supply, key travel corridors;**
- ***Low value* – no residences or infrastructure issues**
- **Public Safety** – a * was added to highlight urgent projects

Fuel Hazard – areas with high fuel loading, flammable vegetation

- ***High hazard* - dense, flammable vegetation e.g. thickets of second growth, untreated plantations, brush fields**
- *Low hazard* - open ground, areas previously thinned, no ladder fuels

Fire Risk – areas with a high likelihood of fire starting

- ***High risk* - high slope position and southwest aspect, past history of lightening strikes or high concentrations of human activity e.g. hunting camps.**
- *Low risk* - low slope position, little human activity, little past history of lightening strikes or fire

Ecological Value –a measure of known ecological concerns in the landscape

- *High value* - known habitat of threatened, endangered species or species for which U.S.F.S. survey and manage protocols apply[1]; notable stands of old growth vegetation, known nesting habitats of rare species
- *Low value* did not indicate lack of ecological value but rather no outstanding concerns for the particular area in question

Economic Value – a measure of known economic value of area resources

- *High value* - areas with private property values, power lines and/or plantations or other investments/resources at risk
- *Low Value* – no particular infrastructure or resource value

Readiness – ability of landowners and managers to respond quickly

- *High value* - ability of both private landowners and the U.S.F.S. to act immediately with community buy in on public or private land
- *Low value* - significant administrative work needed (e.g. NEPA) before activities could take place,

Cost of Project – referred to overall economic cost of doing the work

- *High cost* - due to inaccessible or steep terrain or large scale project
- *Low cost* - clearing defensible space around a residence, some types of controlled burn

Recreation Value / Viewshed

- *High value* - scenic highway designation; high recreational use area
- *Low value* – no particular value noted

Land Allocation – U.S.F.S. land allocations were included in the matrix to give a quick view of likely treatment opportunities and constraints on public lands as defined in the Northwest Forest Plan to protect the Northern Spotted Owl (e.g. Late Succession Reserve, Adaptive Management Area, Wilderness, Matrix).

CONCLUSION

The recommendations have already provided a basis for Trinity County NGOs and VFDs seeking funding support for carrying out more fuels reduction work. A number of recommended projects are being implemented in 2001 (Baldwin, 2000). Further, there have been coordinated planning meetings between FSC members and the U.S. Forest Service. Other Fire Safe Council efforts are emerging in surrounding counties. The report has been distributed widely and has been a topic of discussion at national fire plan development meetings. The Trinity County FSC is currently involved in developing an overarching strategic plan for fire management in which the community recommendations will play a significant guiding role. Clearly there are many avenues for community involvement in fire management planning and implementation.

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REHABILITATION AND MONITORING OF THE LOWDEN FIRE IN THE TRINITY RIVER WATERSHED

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This paper will discuss the physical and biological rehabilitation efforts undertaken to restore the Lowden Fire adjacent to the Trinity River immediately downstream of the Lewiston dam. The paper will describe the circumstances surrounding the prescribed burn that turned into a wildfire in early July 1999; the immediate effects of the catastrophic fire; the sensitivity of the landscape underlain with decomposed granitic soils; the short-term efforts undertaken to protect public safety and the water quality of the receiving waters; and the efforts to restore the landscape in sub-basins of the Trinity River using techniques developed in the adjacent watershed of Grass Valley Creek. The status of the restoration efforts will be discussed and current monitoring data will be provided. Particular attention will be placed on the importance of public outreach and community involvement in achieving the short-term and long-range goals of the rehabilitation program and the significance of catastrophic fire on the overall restoration of the Trinity River.

FOLLOWING A MAJOR WILDFIRE--FUEL TREATMENT OPPORTUNITIES

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The Megram Fire burned over 50,585 ha (125,000 ac) on two National Forests (Six Rivers National Forest and Shasta-Trinity National Forest) in northwestern California during the summer and fall of 1999. Within a period of 73 days this fire burned through parts of the Trinity Alps Wilderness, a Late Successional Reserve, a Roadless Area, a Research Natural Area, an Indian Reservation, various Riparian Reserves, several plantations, along with general Forest land.

Adjacent community structures were not directly impacted, but smoke impacts were severe enough for both a state and federal state of emergency to be declared. The resulting tree mortality varied across the landscape from minor damage in previously treated shaded fuelbreaks to complete mortality in areas that had extensive blowdown related fuels from a windstorm that occurred over the winter of 1995-96. In several areas complete mortality stretches for miles across the landscape.

Now that the smoke has cleared, both short-term and long-term fuel treatment needs must be addressed. In the short-term, residual fuel from fireline construction and hazard trees along roads

present the greatest fuel and safety hazard. In the long-term, the standing dead component presents the greatest fuels hazard, especially when interspersed with a tremendous ingrowth of shrubs, grasses, hardwood sprouts, and conifer regeneration over the next 3-12 years. Opportunities for fuel treatments abound, but questions of priorities, environmental and political conflicts, cooperative ventures, research possibilities, and implementation restrictions and mitigations can make the process a daunting task.

This paper presents a process that moves us from existing guidance documents (i.e., the Land and Resource Management Plan, a Late Successional Reserve Assessment, and a Watershed Analysis) to potential landscape-level fuel treatment projects that can be further evaluated in environmental documents. By focusing on burn patterns across the landscape, the line officer's priority of community protection, and vegetative recovery patterns over time, a strategic, long-term fuel treatment program was developed for this area. As the infrastructure of building block treatments are created, the process will allow for "connecting the dots" on a landscape scale over an extended time frame.

COMMUNITY PLANNING REGARDING FIRE ON THE SALMON RIVER

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The Salmon River is a 751 square Mile watershed located in the California portion of the Klamath River Basin. Private property accounts for only 1.3% of the Basin, with the publicly owned majority being under U. S. Forest Service management.

Since approximately 1911, the Forest Service has actively suppressed most fires occurring in the Basin. The suppression activities, along with resource management activities have created a landscape conducive to catastrophic wildfires capable of denuding large areas of our forested landscape.

The Salmon River Restoration Council (SRRC) has been involved in fire planning since 1994 when we started our Jobs in the Woods Program (JITW). The JITW Program is funded by the U. S. Fish and Wildlife Service and accomplishes fuels reduction activities on private properties in the Salmon River. The SRRC has also been working with the Forest Service to develop a basin-wide fire management strategy that will identify and prioritize areas where fuels reduction activities should occur.

The Salmon River Fire Safe Council (FSC) held its first meeting in December 2000. The mission of the FSC is to ".. help plan, monitor and implement the reinstatement of natural fire regimes in the Salmon River Ecosystem in a manner that protects life, property, improves forest health, and enhances the resources valued by its stakeholders." The FSC will be used for cooperative fire planning in the Salmon River Basin.

FIRE ON THE SALMON RIVER
(POSTER)

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Since approximately 1911, the Forest Service has actively suppressed most fires occurring in the Basin. The suppression activities, along with resource management activities have created a landscape conducive to catastrophic wildfires capable of denuding large areas of our forested landscape.

The Salmon River area has experienced numerous wildfires since 1911. These fires have burned 44% of the Basin, while over 30% of the Salmon has burned since the mid 70s. Fire planning and fuels reduction activities need to be increased in order to begin reintroducing fire to its natural role in the Salmon River watershed.