Compatibility of Timber Salvage Operations with Watershed Values[1]

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Abstract: Timber salvage on the Indian Burn was carried out without compromising watershed values. In some cases watershed condition was actually improved by providing ground cover, by removing trees that were a source of erosive water droplets, and by breaking up hydrophobic soil layers. Negative impacts of timber salvage on watersheds were minimized by using an interdisciplinary team that identified issues, concerns, and opportunities early, defined specific objectives for each resource, had access to accurate site information, and developed management prescriptions in the context of whole watersheds and fire management areas.

Between August 30 and September 7, 1987, the Indian Fire burned 3,750 ha (9,300 ac) of highly productive timber land, killing over 283,000 m^3 (120 million bd ft) of timber. By May 1988, 245,000 m^3 (104 million bd ft) had been sold, and over 70 percent of this volume had been harvested (Svalberg 1988). This timely salvage captured high timber values without compromising watershed values. In some situations watershed conditions were actually enhanced, as compared to no salvage at all.

This paper presents information on how, and under what conditions, timber salvage can enhance watershed condition, and discusses critical steps in the environmental analysis process necessary to minimize damage to soils and watersheds.

LOCATION AND SITE CHARACTERISTICS

The Indian Fire is located approximately 120 km (75 mi) northeast of Sacramento, Calif., in the headwaters of the North Yuba River on the Tahoe National Forest (Fig. 1).

Elevations range from about 760 to 1600 m (2,500 to 5,200 ft), with most of the burned area between 1,200 and 1,500 m (4,000 and 5,000 ft). About half the area is rolling, well- dissected terrain with slope gradients under 35 percent; the other half is steep mountainsides and canyonsides. Precipitation ranges from 190 to 215 cm (75 to 85 in), about 20 percent as snow. Vegetation is mixed conifer forest to about 1,400 m (4,600 ft), and white and red fir forest at higher elevations. Timer volume before the burn ranged from 40 to 500 m^3/ha (7,000 to 85,000 bd ft/acre). Bedrock is dominantly a complex of metasedimentary rocks (slates and schists) at mid elevations, and volcanic mudflow (breccia and tuff) above 1,400 m (4,600 ft). A typical soil on the metasediments is the Jocal series, a fine-loamy, mixed, mesic Typic Haplohumult; a typical soil on the volcanics is the McCarthy series, a medial- skeletal, mesic Andic Xerumbrept (Hanes 1986).

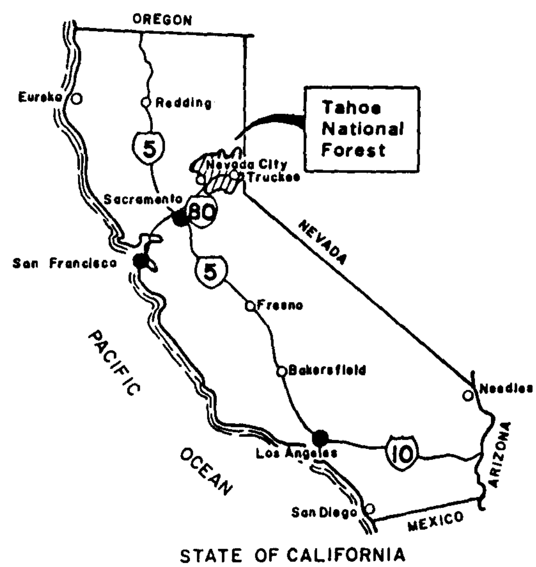

Figure 1--Location of Tahoe National Forest

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The central one-third of the fire area burned very intensely, in many places consuming all needles and fine stems in the crowns as well as all duff and litter on the ground. On another one-third, a very intense ground fire completely consumed all duff and litter, but did not consume the crowns. A very strongly hydrophobic layer--up to 38 cm (15 in) deep on the McCarthy series--developed where the burn was intense (Poff 1988).

BENEFITS OF SALVAGE LOGGING TO WATERSHEDS

Compared to no salvage at all, salvage logging can improve watershed condition by increasing ground cover, by removing a source of large, high-energy water droplets, and by breaking up hydrophobic soil layers. Salvage logging also has the potential to generate funds for watershed improvement work, and the potential to reduce the future risk of high-intensity fires by reducing fuel loading.

The greatest potential for benefits to watershed conditions exists where fire has consumed needles and small twigs in tree crowns as well as the duff and litter. In this situation, not only is ground cover lacking, but the potential for its replenishment by needlecast is also lacking. An often underestimated impact under these conditions is caused by the stems of standing dead trees, which allow rainfall to coalesce into large, highly erosive droplets that accelerate erosion around the bases of dead trees. This phenomenon has been observed by Miles (1987) on the Shasta-Trinity National Forest, and the physical processes involved have been described by Herwitz (1987). The importance of drop size on erosivity is discussed by Hudson (1971). Salvage logging thus not only increases ground cover by the addition of slash, it also removes the source of large water droplets causing accelerated erosion.

Where strongly hydrophobic soil layers have developed, ground disturbance caused by yarding operations can break up the continuity of the hydrophobic soils and improve infiltration. However, this apparently occurs only if logging disturbance is deep enough to penetrate the full depth of the hydrophobic soil layer. Observations on the Indian Burn also suggest this benefit may not be achieved where the hydrophobic layer is very thick (Poff 1988).

Where high volumes of timber have been killed, producing excessive fuel loading, a long-term benefit of salvage logging is to reduce the risk of an intense fire in the future.

Another often overlooked benefit of salvage logging is the generation of funds for watershed improvement projects. When timber is sold, some of the receipts are returned to the sale area for post-salvage resource improvement projects. Timely salvage means less deterioration and higher value; if higher value brings a higher price, the potential for funds to do resource improvement work is likely to be higher.

CRITICAL STEPS IN INTERDISCIPLINARY APPROACH

One reason for the successful salvage on the Indian Burn, including watershed protection treatments, was the interdisciplinary process used to prepare the environmental analysis. Key steps in this process were (1) early development of watershed issues, concerns, and opportunities, (2) defining specific objectives for each resource, (3) accurate assessment of on-site conditions, and (4) looking at whole watersheds and fire management areas.

The first critical step was the development of issues, concerns, and opportunities (ICOs) by the Emergency Burn Rehabilitation Team even before the fire was controlled. This early identification of ICOs legitimized the special needs of all resources, including the importance of timely salvage to capture the high timber values.

The second critical step was to define minimum objectives for each resource in specific terms. This set the stage for developing strategies and treatments that would benefit all resources and would provide a basis for trade-offs. For example: the watershed specialist defined the need for ground cover to minimize erosion, but the fuels specialist identified the need to remove woody material to reduce fuel loading; however, when specific objectives were examined, there was no conflict. The preferred ground cover to maintain watershed values had been defined as litter and small woody material close to or in contact with the soil; the greatest fuel hazards had been defined as woody material larger than 8 cm (3 in) in diameter, in a continuous bed, and with a fuel ladder above the ground.

The third critical step was to develop an accurate assessment of on-site conditions. The burn was subdivided into 10 timber sale areas, with a team assigned to each. These field teams provided detailed information on on-site conditions to the interdisciplinary team (IDT). In addition, each stream was traversed by a hydrologist or hydrologic technician who prescribed specific treatments for individual stream reaches. This detailed information was invaluable to the IDT when developing management prescriptions.

The last critical step was to look at whole watersheds and fire management areas to assess risks. This broader perspective encouraged development of combination treatments. For example: on some cable clearcuts fuels were treated only on the upper slopes, leaving slash for erosion control on the lower slopes. On other harvest units, heavy fuels were removed only along ridgetops to create fuel breaks. Similarly, risks to water quality and soil productivity on each harvest unit were examined in the context of a whole watershed. This allowed ranking harvest units on the basis of need for ground cover, and made tradeoffs easier with other resources.

PRESCRIBED TREATMENTS

The following treatments were developed for specific harvest units in order to meet the need to treat fuels, to provide ground cover, to remove trees contributing to raindrop erosion, and to break up the continuity of hydrophobic soils:

Intentional Disturbance of Hydrophobic Soils--Where hydrophobic layers were thin, generally less than 5 to 10 cm (2 to 4 in), tractors were intentionally not restricted to a designated skidding pattern, but were encouraged to disturb as much surface soil as possible.

Protection of Streamside Management Zones (SMZs)--Variable width SMZs were prescribed and posted on the ground for each individual stream reach. No tractors were allowed in SMZs; on cable units logs were fully suspended across stream reaches. Trees salvaged from SMZs were directionally felled and end-lined.

YSM and YUM Specifications to Reduce the Need for Broadcast Burning--Woody material generally larger than 8 cm (3 in) in diameter was removed during yarding by specifications in the sale contracts to yard submerchantable material (YSM), or to yard unmerchantable material (YUM), to avoid the need for broadcast burning.

Lop and Scatter Slash--Specifications to lop and scatter slash after logging were made to reduce height of fuel ladders and to get the slash in contact with the soil for erosion protection.

Biomass Harvesting of Submerchantable Material--As an alternative to tractor piling or broadcast burning, rubber-tired logging equipment was used to harvest submerchantable material, which was yarded to a chipper. Specifications were to leave on-site all material smaller than 8 cm (3 in) in diameter.

Special Specifications for Tractor Piling--Ground cover and large woody material specifications were developed for tractor piling logging slash to prepare sites for planting.

Over-the-Snow Logging--Over-the-snow logging was specified to reduce soil compaction during winter logging operations.

The following summary indicates the wide range of post-sale site preparation treatments prescribed for the Indian Burn:

Treatment:	Area (ha)	(ac)
Treat brush	726	1,800
Hand cut brush	72	180
Tractor pile	481	1,200
Broadcast burn	48	120
Lop and scatter	1,418	3,500
Spot burn	36	90
Hand pile slash	73	180
YSM	158	390
YUM	56	140

The amount of area in the last four treatments is significant. These four treatments are alternatives to broadcast burning that were prescribed for watershed protection. The area of alternative treatments is almost seven times the area prescribed for broadcast burning.

RESULTS

The intentional disturbance of surface soils to break up hydrophobic layers appeared effective on the Jocal soils, where the hydrophobic layers were less than 5 to 10 cm (2 to 4 in) thick. Where these soils had been intentionally disturbed, they were no longer hydrophobic in August 1988; on adjacent undisturbed control plots soils were still hydrophobic and showed no sign of recovery. On McCarthy soils, where hydrophobic layers were thicker than 15 cm (6 in), the hydrophobic layers were not effectively disturbed by either the rubber-tired logging equipment or by tractors, and soils were just as hydrophobic as on adjacent undisturbed control plots. This was partly because disturbance was not deep enough and partly because the disturbance merely remixed the hydrophobic soils (Poff 1988).

The harvest of excess fuels in SMZs was effective. The directional felling and end-lining caused very little ground disturbance. However, where fires had consumed the crowns only and where there was no needlecast, directional felling placed fine branches and tops outside the SMZs, resulting in loss of desirable ground cover in the SMZ.

Biomass harvesting with rubber-tired logging equipment increased ground cover from 16 percent before salvage logging to 54 percent after biomass harvest. However, this increase in cover is still inadequate to protect the site because of the thick, strongly hydrophobic soil layers. Strict conformance to the specifications developed for biomass harvesting would have produced much more cover, but it was difficult to get the contractor to leave all the fine woody material on-site because this required an extra crew person to limb tops and branches.

The special specifications for tractor piling were effective. Ground cover was 35 percent before logging, 77 percent after logging but before site preparation, and 69 percent after site preparation.

On the units where special YSM or YUM specifications were used to reduce fuel loading, effective ground cover ranged from about 75 to 90 percent.

Over-the-snow logging was successful in avoiding soil compaction. However, where YSM specifications were used with cable logging over snow, results were unacceptable because much of the material was lost in the snow. On one unit it was necessary to follow up with tractor piling to reduce fuels to acceptable levels.

NEED FOR FURTHER STUDY

The strongly hydrophobic soils have persisted much longer than anticipated (Poff 1988). They have undergone one year of seasonal changes, including 80 cm (30 in) of precipitation. How long they will persist is unknown. This is a serious problem because reforestation cannot begin until the rooting zone is moist, and soil erosion will remain high until infiltration returns to normal.

The treatments prescribed have added ground cover. Long-term monitoring is needed to evaluate how effective this cover will be in controlling soil erosion.

Resprouting shrubs are common in parts of the Indian Burn. The effect of treatments to control brush reinvasion could have long-term impacts on watershed condition.

CONCLUSIONS

Salvage harvesting of fire-killed timber can improve watershed conditions (as compared to no salvage) where fire has consumed both ground cover and tree crowns. Improvements are accomplished by adding effective ground cover and by removing the source of large water droplets that can cause erosion around the base of dead trees.

Salvage harvest of fire-killed timber can improve watershed condition where hydrophobic soils have developed, if logging equipment can disturb the hydrophobic layers to a sufficient depth.

Interdisciplinary solutions of potential conflicts among resources can be resolved if (1) critical issues, concerns, and opportunities are identified early in the planning process, (2) specific resource objectives are defined, (3) accurate on-site information is available, and (4) management prescriptions and mitigation measures are made in the context of whole watersheds and fire management areas.

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