Rehabilitation and Recovery Following Wildfires: A Synthesis[1]

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Wildfires traditionally have been regarded as a threat to many of the multiple resources produced by forest lands. Timber, fish, recreation, and water are all important forest products that can be adversely affected by wildfires. The greatest threat, however, is to the long-term productivity of the land. Foresters are particularly aware of this threat because the production of their primary crop--trees--is such a long-term endeavor.

The importance of fire protection is demonstrated by the fact that about 40 percent of the USDA Forest Service budget in California is allocated to fire management. Once a wildfire does occur, wildland managers are obliged to take measures to minimize both short-term damage to resources and long-term reductions in productivity. Actions directed at reducing post-fire damage are typically termed rehabilitation, whereas actions directed at accelerating the return to pre-fire levels of productivity are classified as recovery.

The wildfires in summer 1987 were particularly dramatic in the western United States. Wildfires burned approximately 720,000 acres in California, or about 3.6 percent of the National Forests in California. Approximately 1.8 billion board feet of timber were damaged or placed at risk to disease and insects; this amount is roughly equivalent to the average annual cut on National Forest lands in California.

The extensive damage triggered rehabilitation and recovery efforts on an unprecedented scale. This session of the symposium provided an opportunity for land managers to compare post-fire treatments, and to conduct a preliminary evaluation of their effectiveness. Six of the papers were case studies from different National Forests, whereas the seventh paper (Taskey and others) was concerned with a specific technique--ryegrass seeding--in the central coast ranges of California.

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REHABILITATION AND RECOVERY

Taken together, the six case studies provide an excellent overview of the emergency rehabilitation techniques applied in the Sierra Nevada, northern California, and southwestern Oregon. The procedure followed on each National Forest was to: (1) assemble an interdisciplinary team; (2) collect basic information and field data; (3) identify needs for protecting life, property and resources; (4) establish objectives; and (5) recommend appropriate rehabilitation and recovery measures.

Rehabilitation and recovery measures can be classified as either slope treatments or channel treatments. Slope treatments, such as mulching, seeding, and contour felling, tend to focus on maintaining site productivity. Channel treatments are aimed at minimizing both on-site and downstream impacts. Typical techniques include the construction of check dams, stabilization of stream channels, and the replacement of burned-out woody debris.

A comparison of the papers shows that the balance between slope and channel measures differed in each National Forest, and that each Forest also tended to emphasize different techniques. This variation was due largely to the Forest managers' attempt to relate their rehabilitation and recovery measures to their specific environment and objectives. The final choice of treatments was determined by evaluating the compatibility of the treatments with other resource values, treatment costs, timber salvage goals, and a variety of institutional and political considerations.

Slope Treatments

Miles and others stated that slope treatments were intended to reduce surface erosion, disperse overland flow, prevent water concentration, and provide local sites for sediment storage. Similar objectives were cited in the other papers. Slope techniques common to most of the presentations included contour felling, seeding, and mulching. Other methods and their rationale were: the placement of lines of hay bales across the slope as an erosion barrier (Gross and others, Siskiyou National Forest); the removal of fire-killed trees in order to reduce the likelihood of small mass failures (Smith and Wright, Six Rivers National Forest); the removal of fire-killed trees to reduce the impact of concentrated raindrops falling from the dead limbs (Poff, Tahoe National Forest); planting in riparian areas and on potentially active landslides (Gross and others, Siskiyou National Forest); and deep soil ripping to break up a fire-induced hydrophobic layer (Poff, Tahoe National Forest).

Although each treatment has its merits, its effectiveness in a specific location depends on the physical and biological environment. For example, contoured hay bales and contour felling trapped only small amounts of sediment during the first rainy season (Miles and others; Gross and others). This should not be surprising because most forest soils have infiltration rates well in excess of expected rainfall intensities, and most runoff in forested areas is generated by subsurface stormflow (Pierce 1967; Dunne 1978). Only at the bottom of slopes or in swales is there sufficient topographic convergence to generate saturation overland flow or return flow, and it is these areas in which physical barriers might prove effective. Contour felling or contoured hay bales could also be helpful on compacted areas, such as roads and fire lines, or in areas with a fire-induced hydrophobic layer.

Similarly, the value of mulching and grass seeding on erosion will vary according to the site conditions. In areas from which the litter layer has been completely removed by fire or other types of disturbance, a mulch or grass layer can absorb much of the energy of falling raindrops. This will reduce rainsplash erosion, prevent the breakdown of soil aggregates, and inhibit surface sealing. Grass growth also can help capture nutrients released by the fire that otherwise might be lost through leaching.

The physical, on-site benefits of a mulch or grass cover are widely recognized. Ruby suggested that grass seeding also can have beneficial effects on the watershed scale. These include accelerated hydrologic recovery, mitigation of potential cumulative impacts, and reduction of the adverse effects of storm events. The efficacy of grass seeding in achieving these watershed-scale benefits is difficult to assess because runoff and sediment are derived from many sources in a watershed. A grass cover may be comparable to a forest cover in terms of protecting the soil surface from rainsplash and surface runoff, but it is not comparable in terms of slope stability or reducing soil moisture in the deeper soil layers. It is precisely because of these differences that the physical processes and treatment objectives must be identified before initiating a rehabilitation and recovery program. Otherwise we run the risk of applying inappropriate treatments.

As was the case with the other slope measures, the maximum benefit of seeding or mulching will be in areas where overland flow does occur. In these areas seeding or mulching can greatly reduce sediment yields and slow the velocity of overland flow. Because these areas have the greatest potential to deliver sediment directly to the stream channels, they should have the highest priority for treatment.

Roby's data from the Will Fire indicated that scattering slash is another means of providing ground cover in a burned area, and this was qualitatively supported by Poff and Miles and others. However, generation of the slash by salvage logging will increase soil disturbance, and this disadvantage must be carefully weighed against the benefits of an increase in ground cover. In general, we cannot base the decision to act on beneficial changes in a single process (for example, reduction of raindrop impact), but must consider all the effects of the proposed action.

Deep ripping is another disruptive treatment for which the pros and cons must be carefully weighed. Hydrophobic soils occur in both burned and unburned areas (DeBano 1969), but their hydrologic effects are quite different. In unburned areas hydrophobic layers can be quite deep, but they typically are discontinuous and do not generate much overland flow (Biswell 1974). On the other hand, fire-induced hydrophobic layers are shallow (less than 10 cm) and can be continuous enough to cause substantial surface runoff. Clearly the decision to treat and the design of effective treatments depend on our ability to assess the extent, strength, and persistence of hydrophobic layers following wildfires.

For some slope treatments the biological effects can be more significant than the intended effects on runoff and erosion. Taskey and others showed that grass seeding inhibited the regeneration and growth of native plant species. The seeding also led to an increase in the pocket gopher population, which caused erosion rates to be higher in the seeded plots. These types of results indicate that, in the face of uncertainty, more conservative (that is, less disruptive) treatments are preferred.

The stochastic element in land management must be recognized and considered. The winter following the 1987 wildfires, for example, was relatively mild, and this helped minimize adverse effects (Miles and others; Gross and others). The absence of a severe storm also means that the results of the monitoring may be biased. In years with more intense storms cross-slope barriers or other recovery measures could prove more effective than was indicated by the data from the first year after the 1987 fires.

Channel Treatments

The channel treatments had two basic objectives: (1) to provide channel stability by inhibiting lateral and vertical scour; and (2) to trap sediment that would otherwise be mobilized by the stream (Miles and others; Smith and Wright; Gross and others). The placement of structures in the channel was the most common means of achieving these objectives. These structures ranged from simple hay bale check dams to large woody debris. Other rehabilitation and recovery measures discussed in the papers included replanting riparian vegetation and bank stabilization.

The appropriate channel treatment was determined by the type of channel needing protection, the length of time protection was required, and the objective of the treatment. For short-term control in small channels hay bale or sandbag check dams were used (Miles and others; Gross and others). Their observed life-span of two to three years implies that a large portion of the trapped sediment will be remobilized after three or four years (Miles and others).

Where longer-term channel stabilization and sediment storage is desired, log-and-rock check dams or large organic debris is appropriate. Their larger scale means that failure after a couple of decades, or during a major runoff event, could release a large slug of sediment with a much greater potential for disruption. Thus the decision to install these larger structures implicitly assumes that the stream channel will have stabilized by the time failure occurs, and that the breakdown of one structure will not cause significant degradation or the failure of other structures downstream.

In general, these types of structural treatments were considered successful. The few failures observed were due to the usual problems associated with the technique, namely a failure to adequately protect the structure against piping or undercutting.

CONSENSUS AND CONFLICT

The 1987 wildfires in California and southern Oregon were unprecedented in scale. The efforts of forest managers to reduce adverse effects were guided by the resource concerns in the individual areas and their knowledge of runoff and erosion processes. Differences in values, perceptions, sites and resources all contributed to the variation in approaches reported in this session.

Despite these differences, the authors agreed on several issues that have important implications for future rehabilitation and recovery efforts, and for current Forest Service research and management. First, there is no substitute for reliable baseline data. First-hand knowledge of site conditions is essential to the proper selection of treatment measures. Second, the interdisciplinary team approach is essential to developing rehabilitation and recovery plans that respond to the objectives of all the various constituencies. Third, post-fire resource management objectives must be identified as early as possible. Specification of the timber salvage objective, for example, was necessary to reduce post-fire management conflicts and maximize emergency treatment funds. Fourth, the effectiveness of the emergency treatments is highly dependent on their timing. The treatments should be applied as soon as possible after the fire is controlled and be in place before the first winter storms. Finally, the authors agreed that more effort should be devoted to evaluating the treatment measures discussed in the papers. Cooperation between researchers and the National Forest System is not only desirable, but is probably essential.

The primary controversy was whether grass seeding was an effective treatment for burned areas. Miles and others found that the effect of seeding can be highly variable. Roby's report on the 1979 Williams Creek burn indicated little or no differences between seeded and unseeded areas in terms of ground cover and sediment yield. His data showed that, in forested watersheds at higher elevations, seeding with grass does not provide cover any more expeditiously than the natural revegetation processes. Taskey and others concluded that seeding of annual ryegrass can be ineffective or even harmful. A recent review by Barro and Conard (1987), although focussing on chaparral ecosystems, emphasized the variability and uncertainty associated with seeding ryegrass after wildfires. This range of opinions and results means that the controversy will persist until more definitive data are available. Until then, the decision to seed will depend on factors such as the willingness to take risks, compatibility of grass growth with other resources, site conditions, the time of year, and the sociopolitical need to take demonstrative action.

FUTURE DIRECTIONS

Obviously, post-fire rehabilitation and recovery require considerable thought and planning before action can be initiated. No "canned" set of methods and techniques can be applied once the wildfire is extinguished.

In view of the current uncertainty about the value of different treatments, rigorous monitoring and evaluation studies are the next logical step. Miles and others have taken the lead in attempting to quantify the costs and benefits of the different treatments. Their efforts on the Shasta-Trinity National Forest must be supported by:

(1) Standardizing the methods for measurement and evaluation. Any comparison of treatments must use the same methodology.

(2) Specifying the time scale for measuring and calculating benefits. In general, the time scale should be consistent with the expected life-span of the treatment. A corollary to this is that treatments should be selected according to the desired length of effectiveness. In some cases the timing of sediment delivery may be more important than the absolute amount, and this must be taken into account when selecting and evaluating treatments.

(3) Evaluating all the effects of a given treatment.

(4) Recognizing that treatment effectiveness is not necessarily the same as achieving the treatment goal. An example cited by Taskey and others was that the percent increase in ground cover due to seeding (the objective) cannot be used to assess the reduction in sediment yield (the goal).

Several times during the conference it was suggested that there was little one could do after a fire except get out of the way. While this is an overstatement, the point is that we cannot completely negate the adverse effects of a wildfire, and that much of the rehabilitation and recovery is accomplished by the natural stabilization processes. Nevertheless the public demands, and our responsibility as land managers requires, that we make all feasible efforts to reduce adverse on-site and downstream effects. As resource demands continue to escalate, land managers will be increasingly required to explain and justify their efforts. We must begin now to develop the information and data necessary to make the best choices. The recent wildfires have given us the opportunity to do so, and the development of guidelines for the future should be one of the enduring legacies of the 1987 fire season.

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