Emergency Watershed Treatments on Burned Lands in Southwestern Oregon[1]

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ABSTRACT

Following extensive, natural wildfires on the Siskiyou National Forest in southwest Oregon during fall 1987, numerous rehabilitation measures were applied to severely burned public and private forest watersheds. Treatments were designed to prevent offsite degradation of water quality and fisheries, to minimize soil erosion and productivity losses, and to prevent offsite damage to life and property. Treatments were concentrated along stream channels and on steeply sloping lands prone to erosion and mass wasting. Treatments included aerial and hand sowing of grass and legume seed, 4,130 ha; fertilization, 2,750 ha; construction of check dams, 167 structures; construction of straw bale erosion barriers, 179 structures; spreading of straw mulch, 23 ha; planting shrubs and tree seedlings, 10 ha; and contour log structures, 70 ha. Success of treatments following a relatively mild winter ranged from filled check dams to untested straw bale erosion barriers and contour log structures.

Three large, natural wildfires occurred on the Siskiyou National Forest in September and October of 1987. These were some of the numerous wildfires ignited throughout northern California and southwestern Oregon by dry lightning storms on August 30th. The Galice Fire burned 8,500 ha; the Longwood Fire 4,000 ha; and the Silver Fire 39,000 ha. These fires burned mixed coniferous and hardwood forests in steep, rugged terrain of the northern part of the Klamath Mountains west and south of Grants Pass, Oregon. Precipitation for the year had been below normal, leaving soils and vegetation at near record low moisture levels. As a result, the fires burned at moderate and high intensities during clear weather, but slowed and burned at low and moderate intensities during periods of cloudy weather or climatic inversions.

Climate of the burned areas is Mediterranean and strongly influenced by the close proximity to the Pacific ocean. Warm and dry summers are followed by cool and wet winters. Winter precipitation, occurring as cyclonic storms, ranges from 150 to 330 cm, with about 90 percent falling between October and March. Rainfall rates range from 0.2 to 1.0 cm per hour, but often occur for extended periods. Summer precipitation is often non-existent, with droughts extending from June through October in many years.

Soils of the burned areas have developed from colluvium and residuum derived from metamorphosed sandstones, greenstones, slates, amphibolites, gabbros, and serpentinites. Soils on steep slopes are of the fine-loamy and loamy-skeletal families of mixed, mesic, Umbric Dystrochrepts. Soils on stable benches and ridge tops are of the fine-loamy, mixed, mesic family of Typic Haplohumults. In most steep areas the erosion hazard rating is moderate to severe, with annual potential erosion rates of 27 to 54 t/ha. For benches and ridges erosion rates are low to moderate, with annual potential rates ranging from 9 to 27 t/ha (Meyer and Amaranthus 1979).

Burn intensity varied considerably throughout each fire. Less than half the area of each fire was burned at high intensity, with the balance burned at moderate and low intensity. Numerous first- and second-order stream drainages burned at high intensity, killing all vegetation and stripping leaves and needles from all trees. About 30 Douglas-fir (Pseudotsuga menziesii Mirb., Franco) plantations, ranging from 5 to 25 years old, burned at high intensity. Long segments of steeply sloping land were stripped of all duff, litter, and woody residues, leaving exposed mineral soil. These burned-over forest watersheds presented many opportunities for emergency rehabilitation measures.

The objectives of this study are to describe emergency watershed treatments, to evaluate their effectiveness, and to emphasize areas where improvements can be made to the Emergency Burned Area Rehabilitation program. The treatments and evaluation apply specifically to the study area and care should be used in extending them to other regions.

METHODS

Emergency rehabilitation treatments and treatment maps were developed by a 7- to 12-person interdisciplinary team. Control dates for the fires happened to be well spaced, allowing the team to complete rehabilitation planning and implementation for each fire as it

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was contained and controlled. Throughout planning, the interdisciplinary team interacted with Ranger District personnel and community representatives to develop treatment measures for the most intensely burned areas.

Emergency treatments were constructed and applied using standard and readily available techniques (Frazier 1984; Lohrey 1981; McCammon and Maupin 1985). Checkdams of several types were constructed in first order streams following designs of Brock (1979), Heede (1977), and Sommer (1980). Straw bale erosion barriers followed designs used previously on the Siskiyou and other National Forests in California and Oregon. Application of straw mulch followed methods used by Kay (1978, 1983) and as applied in past years on this Forest. Contour log structures described by McCammon and Hughes (1980) and DeGraff (1982) were used. Cordone plantings of conifer seedlings, a local technique, were applied to a steep, eroding site. Aerial and manual application of grasses, legumes, and fertilizer followed procedures routinely used by the Forest.

RESULTS AND DISCUSSION

In-channel Structures and Riparian Plantings

Objectives of these measures were to reduce channel downcutting, to minimize bank erosion, and to provide temporary storage of sediments while streambank vegetation is reestablished.

Check Dams

To provide temporary grade control and storage of sediments, 167 check dams of four design types using straw bales, logs, rock cobbles and boulders, and sandbags were installed in intermittent streams. Steel fence posts, "rebar," and wood stakes were used to anchor the dams. Filter fabric and wire mesh were used to prevent water flow and erosion under all styles of check dams except the sand bags. All types of check dams worked well to store sediment and/or reduce channel erosion. The following observations were made:

-Straw bales placed against woven wire fence and wrapped in netting were effective dams in streams with few cobbles and boulders (fig. 1). Water sometimes undercut check dams that were not sealed on the steam channel.

-Log checks were highly effective and economical on sites where suitable size trees are available and where it is difficult and costly to import straw bales.

Figure 1--Straw bale check dam. Bales are wrapped in plastic netting, placed against woven wire fence, sealed at ground line, and staked.

-Rock cobbles and boulders with woven wire worked well in streams where rocks are abundant. Woven wire and anchors are the only materials that needed to be imported to the site.

-Sand bags were highly effective and worked best to prevent headward cutting of the stream channels in fine textured soils (fig. 2). Bags made of slow-to-degrade erosion cloth should be used to insure that the structures will last for several seasons.

Riparian plantings

-Close-spaced plantings of Douglas-fir and big-leaf maple (Acer macrophyllum Pursh.) seedlings were designed to provide bank stability and to prevent erosion for 9 ha of riparian areas. These plantings will provide much needed long-term erosion protection for stream banks.

Douglas-fir seedlings planted in the riparian area of several streams in early 1988 are growing well. Several thousand big-leaf maple seedlings will be planted along these and other streams in early 1989.

On-slope Measures

On-slope structures and measures were used to reduce surface erosion, disperse drainage, and prevent damage to the road system. These include the following:

Straw Bale Erosion Barriers

-The structures, 179 in all, were made of four to eight straw bales, placed end-to-end, on the contour, on steep, erosion-prone slopes. Bales were carried to project sites by helicopter. Designed to trap downslope movement of sediment on steep, exposed slopes, these dams intercepted soil on the more erodible fine-textured soils. On sites with high permeability, very little if any soil was intercepted.

Figure 2--Sand bag check dam. Rot-proof sand bags are filled on-site and keyed to gully bottom and walls.

Straw Mulch

-Straw was spread as a mulch, several inches thick, both in contour stripes and broad coverage on 23 ha of steep, erosion-prone slopes. The mulch provided the simplest and apparently the most cost effective erosion protection measure available to prevent rain drop impact and erosion on bare, exposed mineral soils of steep slopes. The mulch layer also provided a moist, shaded seedbed for germination of grasses and legumes. Partly decomposed the first winter and gone after one year, the straw is a short-term treatment that provides immediate protection.

Contour-log Structures

-Conifer logs, 15 to 30 cm in diameter, were felled on-site and placed on the contour on 70 ha of steep, erosion prone lands (fig. 3). Designed to intercept eroded soil on the steeper slopes, these log structures intercepted very little soil on most sites. The only effective structures were those on very steep slopes with fine textured soils, where the contour-log structures intercepted newly eroded soil and provided the desired erosion protection. While winter rains were light, we believe that infiltration was near 100 percent, with little surface runoff on most highly permeable soils. In addition, some log structures were placed on slopes of 20 to 40 percent where erosion is minimal.

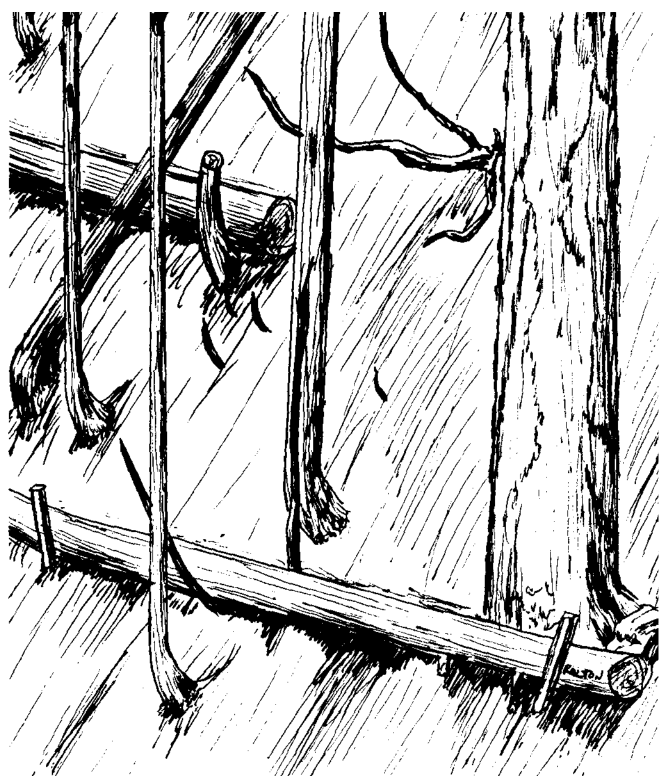

Figure 3--Contour-log structure. Bole of small diameter Douglas-fir tree is placed on slope, anchored with stakes, and sealed at ground line.

Cordones

-Douglas-fir 2/0 seedlings were planted in "cordone" style on a 90 percent slope of a pre-fire landslide (fig. 4). This slide posed renewed erosion activity following the Longwood Fire. We expect the cordones will provide an excellent, long-term ground cover on these highly erodible soils.

Figure 4--Douglas-fir 2/0 seedling cordones planted on a steeply sloping landslide.

Aerial Application of Seed and Fertilizer

-Annual ryegrass, (Lolium multiflorum) and vetch (Vicia sativa) were aerially applied at a rate of 45 kg/ha to 4,130 ha of erodible, severely burned areas. Fertilizer, high in nitrogen and phosphorus (16-20-0-15), was aerially applied at a rate of 280 kg/ha to 2,750 ha of the sown areas.

Following one winter, population and growth of annual ryegrass and vetch are excellent and have provided surface erosion protection. The effect of grasses and legumes on species composition and vegetative structure on native plants of southwest Oregon, however, is poorly understood. Possible benefits, in addition to erosion control, include some shrub control and reduced vegetative competition for conifers. Negative aspects may include competition for space and moisture with native herbs and shrubs, with possible effects on the long-term abundance and composition of some native species. Work in chaparral ecosystems of California by Barro and Conard (1987) suggests that competition for both space and moisture are increased where grasses are planted.

Hand Application of Seed and Fertilizer

-Grasses and legumes were applied manually to 95 ha of erodible, severely burned riparian areas. In addition to annual ryegrass and vetch, the seed mix included orchardgrass (Dactylis glomerata), perennial ryegrass (Lolium perenne), and white clover (Trifolium repens). Population and growth of grasses and legumes in riparian areas is excellent and appears to meet the objectives of soil stabilization and erosion control for stream banks. Erosion protection and wildlife forage benefits are high for these sensitive areas.

Emergency road maintenance and post-fire storm patrols

-Following the fires, road maintenance for 70 km of roads included cleanout of ditches and culverts, replacement of several culverts, and installation of water bars. Storm patrols were activated for the first few storms of the year to maintain road drainage and to prevent accelerated road damage. This maintenance was highly effective and prevented any loss of road facilities.

CONCLUSIONS

Emergency burn rehabilitation relies on the Watershed Management group for leadership. Treatments, however, affect fish, wildlife, plant communities, fuels, range, timber, cultural resources, facilities, and communities.

Development of rehabilitation objectives requires a broad interdisciplinary team that may include community representatives and other agency personnel. The values at stake dictate that we include a spectrum of affected resource specialists.

Monitoring of emergency rehabilitation has a poor track record, and should be given a high priority. At present little documentation of treatment successes and failures has been made, with little data available for treatments applied to earlier fires.

The need to design structures in anticipation of a 25-year storm led to a comprehensive array of treatments. This points out the need for, and use of, accurate field data and past work to choose the best measures.

Selection of treatments and sites is a critical step for emergency rehabilitation projects. Without reliable data our interdisciplinary team tended to over-rate or under-rate most post-fire processes. Our experience indicates a need for a better understanding of the land, its resources, and natural recovery of forest ecosystems.

The projects point out the need to evaluate the ecological implications of domestic grasses and legumes on forest ecosystems. Effects of grasses and legumes on space and moisture needed by native species have not been documented for the plant communities of these fires.

Check dams appear to be a very effective means of preventing downcutting and providing temporary storage of sediments. We are uncertain, however, about the duration of sediment storage. Will that trapped sediment move downstream annually, or is it lodged, only to be moved only by the 10- or 25-year storm?

Routing of sediment is another area of uncertainty. While Amaranthus' work of 1989 shows considerable local, onsite erosion, the transport of sediment to the stream has not been well defined. Observation indicates that some eroded soil may reach the channel, while some appears to lodge at slope breaks. Are streambanks the primary source of sediment trapped by check dams; or does it come from the interfluves? What portion of interfluve erosion reaches the stream?

Aerial application rates of seed and fertilizer need to be carefully evaluated for the rehabilitation objectives. Stocking density in most areas was higher than needed to provide erosion protection. In this study, aerial application of seed beat the first rains. Success might have been measureably reduced if operations had been several weeks later. Consideration should be given to sowing grasses and legumes in strips to break fuel continuity of the dried grass.

Hand-applied seed and fertilizer in riparian areas appears to be one of the most effective and easily controlled methods of erosion protection. Wildlife forage and habitat is an added benefit in these out-of-the-way areas that generally provide wildlife food, cover, and travel routes. In future projects, application of seed would be considered for greater coverage of riparian areas.

Straw mulch, spread area-wide or in contour strips, is a simple and effective treatment for all soil types, especially for fine-textured soils that have low infiltration rates. Straw does, however, have a short life in this maritime climate.

Emergency road patrol measures, first used for emergency rehabilitation in December, 1987, proved to be an economical and efficient means of carefully monitoring roads and making small repairs before serious damage occurred.

REFERENCES

Amaranthus, Michael P. Surface erosion in intensely burned clearcut and adjacent forest with and without grass seeding and fertilizing in southwest Oregon. 1989 (These proceedings).

Barro, Susan C.; Conard, Susan G. 1987. Use of ryegrass seeding as an emergency revegetation measure in chaparral ecosystems. Gen. Tech. Report PSW-102. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 12 p.

Brock, Terry. 1979. Erosion control in mountain meadows of the Sequoia National Forest. In: Proceedings of the Earth Science Symposium II, February 1979. Redding, CA: California Region, Forest Service, U.S. Department of Agriculture; 165-170.

DeGraff, Jerome V. 1982. Final evaluation of felled trees as a sediment retaining measure, Rock Creek Burn, Kings River RD. Fresno, CA: In-service report. Sierra National Forest, Forest Service, U.S. Department of Agriculture; 9 p.

Frazier, James, W. 1984. The Granite Burn; the fire and the years following; a watershed history, 1974-1984. Presented at the Water Resource Management Conference, September, 1984. Sonora, CA: California Region, Forest Service, U.S. Department of Agriculture; 11 P.

Heede, Burchard, H. 1977. Gully control structures and systems. In: Guidelines for watershed management; FAD Conservation Guide, No. 1. Rome, Italy: Food and Agricultural Organization of the United Nations; 181-219.

Kay, Burgess L. 1978. Mulches for erosion control and plant establishment on disturbed sites. Agronomy Progress Report No. 87. Davis, CA: Agricultural Experiment Station, University of California; 19 p.

Kay, Burgess L. 1983. Straw as an erosion control mulch. Agronomy Progress Report No. 140. Davis, CA: Agricultural Experiment Station, University of California; 11 p.

Lohrey, Michael, L. 1981. Planning gully control and restoration; In-service report. Lakeview, OR: Fremont National Forest, Pacific Northwest Region, Forest Service, U.S. Department of Agriculture; 20 p.

McCammon, Bruce; Hughes, Dallas. 1980. Fire rehabilitation of the Bend municipal watershed. In: Proceedings of the 1980 Watershed Management Symposium, volume 1; 1980 July 21-23; Boise, ID. New York: American Society of Civil Engineers; 225-230.

McCammon, Bruce; Maupin, John. 1985. Fire rehabilitation; Paper No. 7. In: Protecting the forest; Fire management in the Pacific Northwest. Portland, OR: Pacific Northwest Region, Forest Service, U.S. Department of Agriculture; 3 p.

Meyer, LeRoy C. and Amaranthus, Micheal P. 1979. Siskiyou National Forest soil resource inventory. Siskiyou National Forest, Pacific Northwest Region, Forest Service, U.S. Department of Agriculture; 258 p.

Sommer, Christopher. n.d. Soil erosion control structures: Construction and maintenance manual. In-service report. Bishop, CA: Inyo National Forest, Pacific Southwest Region, Forest Service, U.S. Department of Agriculture; 41 p.