REHABILITATION OF FIRE SUPPRESSION IMPACTS
ON THE
NORTH FORK FIRE
IN
YELLOWSTONE NATIONAL PARK[1]

by

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Abstract: The North Fork Fire, which totalled more than 400,000 acres, was one of the largest of the 1988 fires in Yellowstone National Park. Because this fire was human-caused, it was aggressively suppressed, resulting in the construction of approximately 30 miles of bulldozer firelines and 320 miles of hand firelines in backcountry areas. National Park Service (NPS) policy requires rehabilitation of land disturbances within parks. The potential for successful post-fire rehabilitation was significantly improved by the utilization of impact-reducing methods such as curvilinear fireline routing, implementation of techniques to minimize soil disturbance, and reclamation of disturbed topsoil and organic debris before winter. Rehabilitation techniques performed by a rubber-tired excavator at bulldozer sites included scarification, topsoil replacement, and large slash and boulder replacement. Soil raking, small slash replacement, and stump cutting on bulldozed firelines was completed by hand crews. Hand fireline rehabilitation included soil and slash replacement and stump cutting. Topsoil replacement has been found to be an effective method for revegetating disturbed areas in Yellowstone National Park. Gene pool integrity (species diversity/ representation/source) is maintained through the inherent seed source. Several years of soil and revegetation monitoring, including qualitative and quantitative analyses, are required to determine if the rehabilitation goals have been achieved. Site monitoring in 1989 and 1990 indicated that rehabilitated areas were typically revegetated with minimal erosion.

Introduction

The North Fork Fire perimeter (see Figure 1) encompassed remote areas of the park as well as developed areas. Because wildfire is part of the natural cycle, burned areas will recover naturally. Fire suppression disturbances were not part of the natural cycle and warranted rehabilitation. Mitigation

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[1]Excerpted from fire document prepared in 1990 and presented at the ASSMR meeting in Durango, Colorado, May 14-16, 1991.

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Proceedings America Society of Mining and Reclamation, 1991 pp 527-542
DOI: 10.21000/JASMR91020527
https://doi.org/10.21000/JASMR91010527

techniques for fire suppression disturbances were implemented during fireline construction and when other impacts were occurring. These techniques were designed to increase rehabilitation potential.

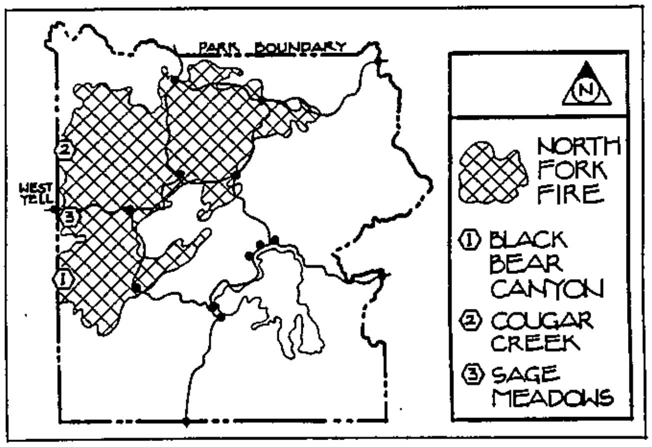

Figure 1. Map of Fire Perimeter and Rehabilitation Locations. (Ruchman)

Construction Techniques

The more significant fire suppression impacts can be grouped into the following categories.

Bulldozer Fireline Construction

Construction of bulldozer firelines was the most destructive suppression technique implemented on the North Fork Fire. This technique involved removal of all surface vegetation and root material with heavy excavating equipment. Figures 2 and 3 illustrate constructed bulldozer fireline. Several mitigating techniques were used to minimize the impact of these firelines. Utilizing curvilinear routes and avoiding timbered areas reduced visual impacts. Figure 2 illustrates a less intrusive, curvilinear bulldozer fireline, while Figure 3 is a high impact, linear line. By angling the bulldozer blade and reducing the depth of cut, only the necessary organic material was removed. This greatly benefitted rehabilitation work by localizing the removed organic material in windrows. Typically, bulldozer fireline construction results in a soil removal depth of 1 ft or more. Using this revised technique, soil was removed usually no deeper than 6 in. In either case, the medium for vegetative growth is removed, leaving mineral soils exposed. By conserving the upper organic layers, the original growth medium is not diluted with infertile soil and is better able to reestablish plant life once rehabilitation is completed. Additional clearing of vegetation adjacent to bulldozer lines was often performed to widen areas and reduce combustible materials. By feathering the edge of this corridor, the overall visual impact of the intrusion could be minimized.

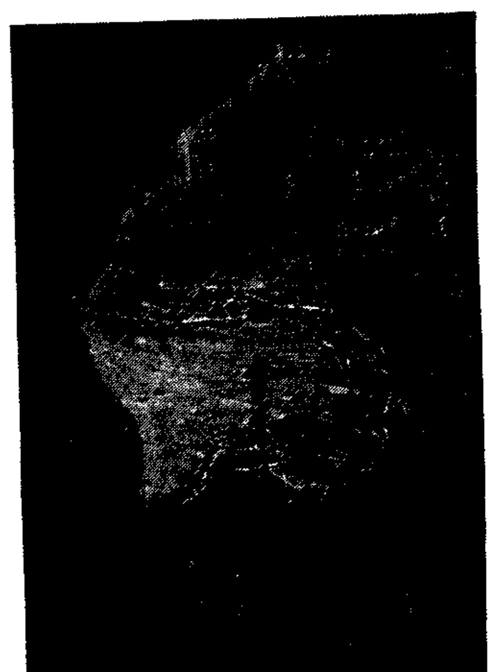

Figure 2. Aerial view of a less intrusive, curvilinear bulldozer fireline and safety zone. (Williams)

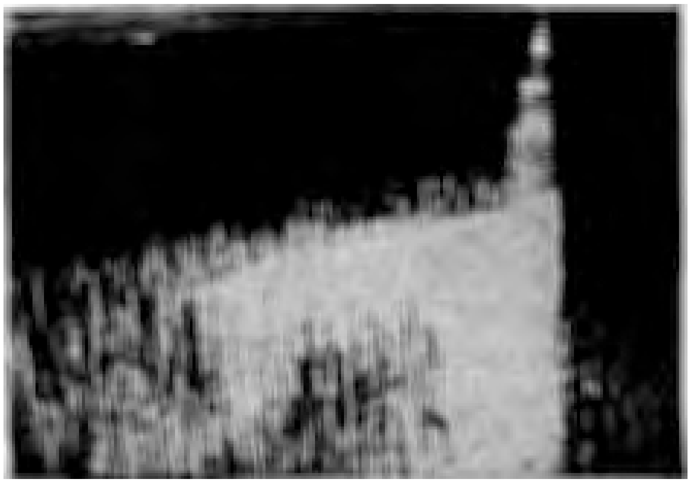

Figure 3. Aerial view of an intrusive, linear bulldozer fireline and safety zone. (Williams)

Following the construction of bulldozer lines, vehicles often used the 12-24 ft corridors for access, resulting in compaction. Bulldozer lines were located according to fire movement, frequently in remote areas. If left, they would become major intrusions in otherwise undisturbed areas and impede normal vegetation and drainage patterns.

Hand Fireline Construction

Fire crews, using hand tools including chainsaws, shovels, McClouds, and Pulaskies, constructed over 300 mi of hand fireline on the North Fork Fire. Using helicopter transport, these crews were able to reach even the most remote portions of Yellowstone National Park. Construction of hand fireline began with the removal of trees and shrubs by a chainsaw crew. The second step was removal of duff, sod, and organic soil layers with hand tools. This left a windrow of materials on one side away from the approaching flame. When completed, handlines were from 2-4 ft wide, with a wider, cleared corridor extending along fire perimeters. Figure 4 illustrates constructed hand fireline.

Several techniques were used to minimize the impacts of hand fireline construction. Defining and restricting the width of allowable fireline corridors, specifying curvilinear routes, following game trails, and flush cutting stumps reduced visual impacts. Building log or rock water bars during line construction (and providing a break so fire would not be carried) reduced erosion potential. By wind rowing topsoil and organic materials to one side of the fireline, rehabilitation was significantly improved.

Erratic fire behavior resulted in very irregular fireline location patterns. Frequent burn-over of constructed fireline meant that multiple, parallel lines were built as the fire moved. Without rehabilitation, these lines could obstruct drainage systems and would be potential locations for erosion and exotics invasion.

Figure 4. Constructed hand fireline. (Williams)

Explosive Fireline Construction

Explosive firelines were constructed utilizing detonation cord and a dynamite charge. A fireline of varying width was cleared depending on the type and strength of the charge. In areas where growing mediums were sensitive and developed slowly, explosive firelines were particularly detrimental. Because much of the organic material in the fireline was removed through the explosion, rehabilitation was very difficult. Figure 5 illustrates an explosive fireline.

Figure 5. Constructed explosive fire line. (Williams)

Helispot Construction

Creating backcountry landing zones for helicopters required removal of aboveground vegetation and loose organic material (see Figure 6). When removal of trees and shrubs was required, unnatural openings were created. To mitigate these disturbances, helispots were constructed using natural openings where possible. Meadows were favored because of safety concerns and the presence of vegetation that would recover from blowing. When helispots had to be constructed in forest vegetation, natural shapes were utilized. Irregular shapes mimicking natural openings were constructed by selectively removing larger trees while leaving small trees where possible. By noting the predominant wind direction, trees could be felled in a more natural pattern. Smaller natural openings that could be enlarged were used when available.

Figure 6. Constructed irregular helispot. (Williams)

Base Camps, Remote Camps, and Other Impacts

A variety of other impacts resulted during fire fighting efforts. These were minimized where possible through the use of pre-existing campgrounds and backcountry sites and the immediate removal of garbage.

Rehabilitation Techniques

Bulldozer Fireline Rehabilitation

An 880R series, rubber-tired excavator was used for rehabilitation of bulldozer firelines. Hand crews assisted the excavator in applying smaller organic debris, replacing soil along edges, and flush-cutting stumps. In areas too steep for the excavator to work, handcrews performed the rehabilitation work. However, the results of excavator rehabilitation were far superior and much faster. Effective rehabilitation of the 30 mi of bulldozer firelines would have been virtually impossible without this equipment. To prevent completed rehabilitation from being disturbed, work began at the most remote areas and proceeded toward the access roads.

Following are phases of the work:

1) Remove all trash, flagging, or debris.

2) Using the excavator bucket teeth (see Figure 7), mechanically rip and scarify the surface 6 in deep where compaction has occurred.

Figure 7. Illustration of scarification. (Williams)

3) Replace topsoil, duff, and seedbearing organic material over the scarified surface (see Figure 8). Replacement of this material is critical to revegetation and mixing of layers should be avoided.

4) Replace boulders, burying them to pre-disturbance levels. Replace downed trees and slash in a random manner covering the rehabilitated soil and extending outside of the fireline to feather the edge of the disturbance (see Figure 9). Keep downed trees in 1 piece (including the root ball) where possible. Using the excavator bucket, smash the ends of chainsaw cut logs to obscure the cut.

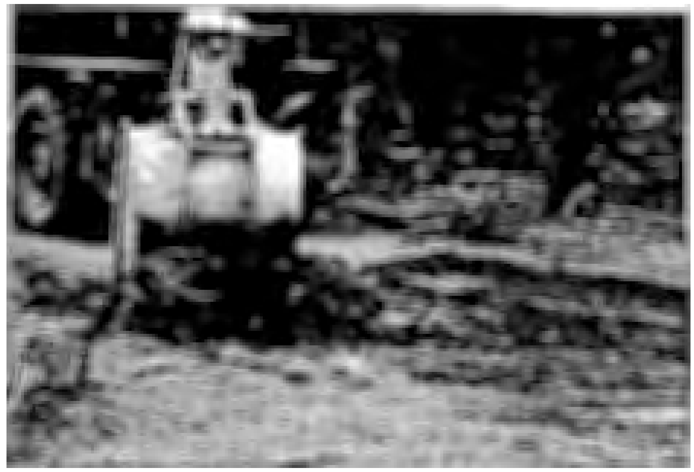

Figure 8. Illustration of topsoil replacement. (Williams)

Figure 9. Placement of snags on rehabilitated line. (Williams)

5) Construct water bars (log and/or rock) using either the excavator or the hand crew on slopes greater than 8%. Replace slash over surface (amount of slash replaced varied with existing undisturbed conditions). Flush-cut stumps and cover the cut with ash and organic debris.

6) Establish permanent photo points and transects for long-term site monitoring (see Figure 10).

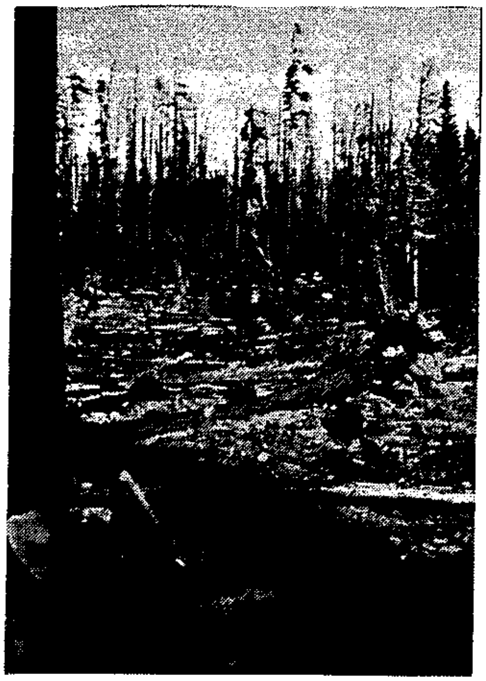

Figure 10. Illustration of permanent photo point markers. (Eggers)

Hand Fireline Rehabilitation

The basic techniques in rehabilitating hand firelines are similar to bulldozer work but on a smaller scale. No heavy equipment was used. The specific steps were performed in a different sequence to better accommodate a hand crew. Stumps were flush-cut, and water bars were installed before soil was replaced. Hand firelines resulted in less locally severe impacts, but covered much longer distances. Approximately 320 mi of hand firelines were rehabilitated on the North Fork Fire.

Explosive Fireline Rehabilitation

Successful rehabilitation of explosive firelines was difficult because organic materials removed upon detonation were nearly impossible to recover. Surfaces and edges of lines were hand raked to incorporate seed sources into the area. Firelines were covered with loose, shrubby material to create microclimates that provide shade and shelter for regrowth.

Helispot and Camp Rehabilitation

Helispots and camps were located in remote backcountry areas and were rehabilitated to the original characteristics of the surrounding land. All human-related attractants were mitigated. Disturbed areas were cleared of debris such as garbage and flagging. Compacted areas were raked, and topsoil was replaced. Deadfall snags and slash were placed randomly, similar to ground litter in the surrounding areas. All stumps were flush-cut.

Results of Rehabilitation

Results of Bulldozer Rehabilitation

Typical treatments outlined earlier resulted in slope stabilization and revegetation. Figures 11 and 12 illustrate examples of a steep site before and after rehabilitation. Figures 13 and 14 illustrate a more level area. Figures 15 and 16 illustrate examples of aerial photographs before rehabilitation and after the first growing season.

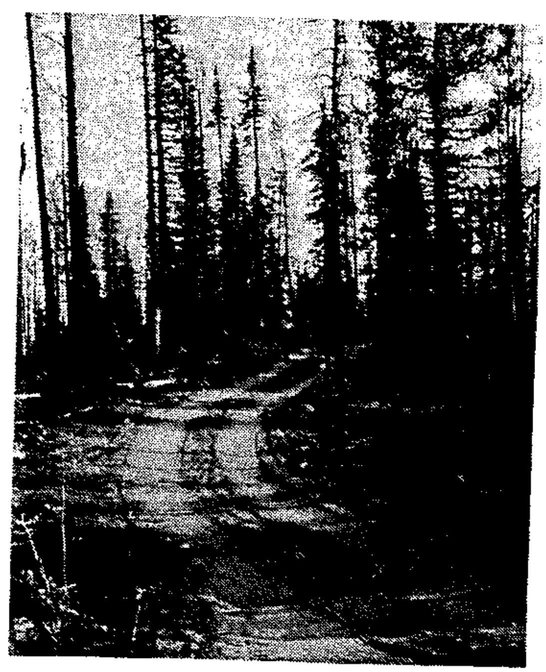

Figure 11. Bulldozer fireline prior to rehabilitation. (Bundros)

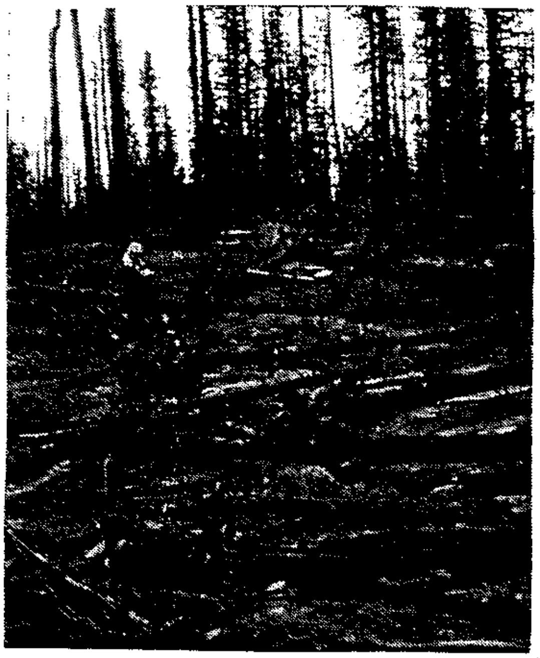

Figure 12. Bulldozer fireline following rehabilitation. (Bundros)

Figure 14. Bulldozer fireline following rehabilitation. (Eggers)

Figure 13. Bulldozer fireline prior to rehabilitation. (Bundros)

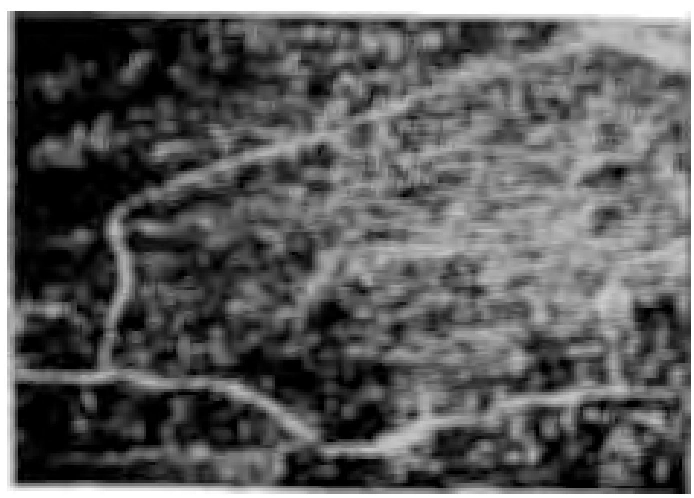

Figure 15. Aerial view of bulldozer fireline prior to rehabilitation. (Williams)

Figure 16. Aerial view of bulldozer fireline following rehabilitation. (Williams)

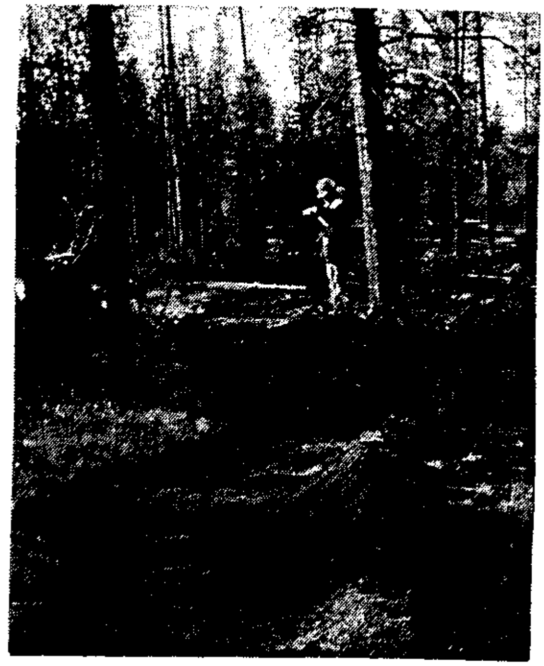

Figure 17. Hand fireline prior to rehabilitation. (Bundros)

Results of Hand Fireline Rehabilitation

Hand fireline rehabilitation proceeded in a progression similar to bulldozer fireline. Flush-cutting stumps and water bar construction were performed as the first steps when possible. Performing these early minimized the disturbance of replaced topsoil. Topsoil replacement was completed by crews using hand tools. In most cases, some scarification of the compacted subsoil layer occurred as the topsoil was being reapplied. Sod, duff, and organic debris were returned to near original positions. Mixing was avoided. Following topsoil replacement, slash was scattered over the surface to protect the disturbed area from wind and water erosion. This also enhanced the microclimatic conditions. Figures 17 and 18 illustrate examples.

Figure 18. Hand fireline following rehabilitation. (Ruchman)

Results of Explosive Fireline Rehabilitation

It was difficult to rehabilitate explosive firelines. These sites were stabilized in a condition that would promote regrowth. Scattered slash, which enhanced microclimatic conditions and captured wind blown seed appeared somewhat atypical for general litter conditions. After the first or second growing seasons, this material should blend better.

Results of Helispots and Remote Camps Rehabilitation

Rehabilitation work at these disturbed areas was performed on a site-specific basis. Garbage removal and raking were often all that was necessary since the initial construction mitigated disturbance.

Case Studies

The Black Bear Canyon, Cougar Creek, and Sage Meadows areas on the North Fork Fire were sites of major disturbances from bulldozer firelines construction. These sites were designated as case study areas because of the severity of disturbance and the need to closely monitor the effectiveness of bulldozer firelines rehabilitation. Permanent photo point locations and 50-meter transects were established to monitor results. A series of photographs, taken over time, have been generated for each established point. Fifty-meter transects of disturbed/unrehabilitated, disturbed/rehabilitated, and undisturbed/control have been established along lines for each case study site. Data has been collected at 1-meter intervals to determine species type, density, and distribution. This data will provide quantitative information on the rehabilitation work. (A publication on this data is in progress.)

The Black Bear Canyon area represents a forested, high-elevation plateau environment with soils dominated by obsidian sand. The Cougar Creek area represents a forested, riparian environment with alluvial soils. The Sage Meadows area represents a mixed forest/grassland environment with alluvial and volcanic soils.

Case Study 1: Black Bear Canyon

The Black Bear Canyon area near the west boundary had approximately 10 mi of bulldozer firelines. Much of the firelines was on steep, highly erodible terrain. Soils in this area were dominated by obsidian sand (black, volcanic glass) making revegetation difficult. Thirteen photo points were installed in the area. The photo points included (see Figures 19-22) are representative of the site.

Figure 19. Black Bear Canyon Photo Point prior to rehabilitation, 9/88. (Bundros)

Figure 20. Black Bear Canyon Photo Point following rehabilitation, 10/88 (Eggers)

Figure 21. Black Bear Canyon Photo Point at approximate maximum snow depth (over 20 ft), 3/89. (Eggers)

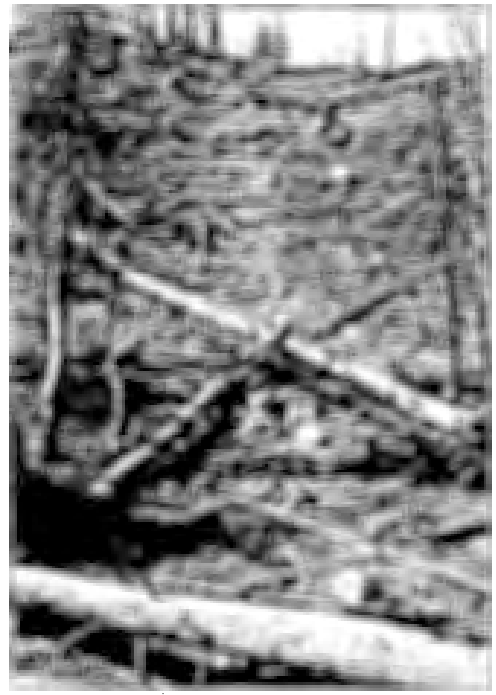

Figure 22. Black Bear Canyon Photo Point in 8/90. (Ruchman)

Case Study 2: Cougar Creek

Cougar Creek, north of West Yellowstone, Montana, was the location of approximately 7 mi of bulldozer firelines. These firelines were located on a stream terrace between the Cougar Creek and Duck Creek floodplains. Terrain at this site was generally level and sloping towards the river. Vegetation was mostly lodgepole pine forest with intermixed grassy meadows. Being adjacent to an active floodplain, the soils were mostly alluvial. Three photo points were installed at this site. The one illustrated in Figures 23 through 26, is representative of the site.

Figure 23. Cougar Creek Photo Point prior to rehabilitation, 9/88. (Bundros)

Figure 24. Cougar Creek Photo Point following rehabilitation, 10/88. (Eggers)

Figure 25. Cougar Creek Photo Point at maximum snow depth (<4 ft), 3/89. (Eggers)

Figure 26. Cougar Creek Photo Point in 7/90. (Ruchman)

Case Study 3: Sage Meadows

Located near the old Madison River Overlook, east of West Yellowstone, Montana, approximately 12 mi of bulldozer fire-lines were constructed here. On rolling, foothill terrain, this area contained a mixture of lodgepole pine forest and grass/sagebrush meadows. This site is above the Madison River floodplain and contains soils mostly of volcanic origin. Two photo points were installed in this area. The photo point illustrated in Figures 27 through 30, is representative of the site.

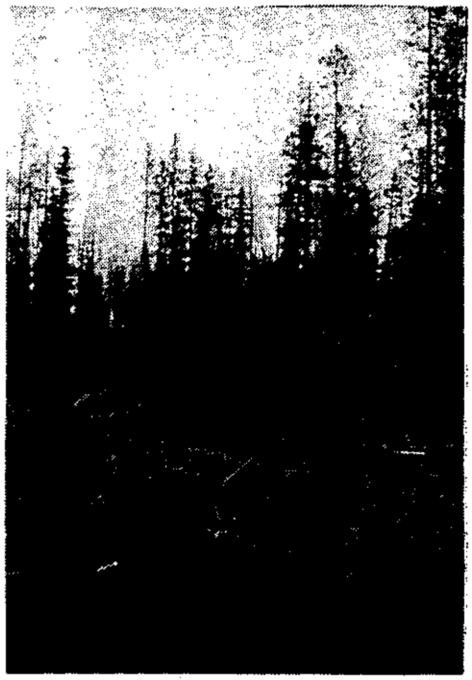

Figure 27. Sage Meadows Photo Point prior to rehabilitation, 9/88. (Bundros)

Figure 28. Sage Meadows Photo Point following rehabilitation, 10/88. (Eggers)

Figure 29. Sage Meadows Photo Point at approximate maximum snow depth (4 ft), 3/89. (Eggers)

Figure 30. Sage Meadow Photo Point in, 8/90. (Ruchman)

Conclusions

The rehabilitation project for mitigation of fire-suppression impacts on the

North Fork Fire was unprecedented in the history of the National Park Service. Never before has a situation occurred requiring such large-scale fire-suppression within a national park. Through rehabilitation performed in 1988 and 1989, a majority of fire suppression disturbances have been mitigated.

By implementing an impact reduction strategy with on-site advisors during firelines construction, the potential for successful rehabilitation was increased. This is a key point to consider in planning during any kind of disturbance. Visual and physical impacts caused by soil and vegetation disturbance can be more easily mitigated with appropriate rehabilitation planning. However, in forested areas where substantial tree removal is involved, rehabilitation of visual impacts can be difficult even with adequate planning. In the case of bulldozer firelines rehabilitation, success was increased in areas with curvilinear firelines construction, controlled soil-removal depth, and immediate replacement of soil layers compared to areas where these techniques were not used.

Though many of the techniques utilized in this rehabilitation project involved basic, soil management and landscape architecture principles, the organization and attention to detail made a significant difference in the degree of success. The extra attention given to soil reconstruction has enhanced the speed of revegetation. Utilizing seed inherent in the soil, rather than supplemental seed, protected the existing gene pool in the location of the disturbance. This led to a species composition in rehabilitated areas nearly identical to adjacent undisturbed areas. Because soil development is minimal in most areas of Yellowstone Park, protecting the organic matter accumulation is of utmost importance. In an environment as harsh as Yellowstone, prevention of soil degradation is a critical component in preserving the natural landscape.

Monitoring of photo points will continue twice a year for qualitative results of the rehabilitation work. In 1990, 50-meter transects were established to provide quantitative information. Species type, density, and distribution were collected in 1-meter increments along disturbed/unrehabilitated, disturbed/rehabilitated, and undisturbed/control transects established for each case study site. A publication of this information is in progress.

Acknowledgements

North Fork Fire rehabilitation involved a team working together to achieve common goals, including personnel from the National Park Service, United States Forest Service, private contract crews, Student Conservation Association, Youth Conservation Corps, and others.

Project Supervisor: Eleanor Williams (Yellowstone National Park)

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