

Abandoned Road Restoration Methods Tested at Grand Tetons National Park

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Every park, monument, and historic site within the National Park System has some disturbance that can be associated with either past or present anthropogenic activities. These disturbances alter both the structure and function of ecosystems and may result in landscape features that are aesthetically unacceptable. Disturbed areas also become ideal locations for establishment and spread of exotic plants and noxious weeds.

Restoration is the process of intentionally altering a site to establish a defined, indigenous, historic ecosystem. The goal is to emulate the structure, function, diversity, and dynamics of the specified ecosystem. Reclamation, on the other hand, has been defined historically as the process of returning disturbed land to a condition that approximates the original site conditions and is habitable by the same or similar plants and animals as existed on the site before disturbance.

Reclamation typically involves the restoration of certain processes or functions, but typically stops well short of restoration. It may however be viewed as an important step toward restoration. Restoration will be successful only if we (1) adequately understand how the disturbed system functions and what the limiting factors are, and (2) develop and apply the correct prescriptions. The restoration process is not simple and in most cases requires enough time to allow natural biological process, such as succession, to occur.

The NPS can use restoration techniques to treat disturbed sites so as to control erosion, remove exotic and noxious plant species, increase biodiversity of indigenous species, reestablish nutrient cycles, and improve aesthetic values. This report summarizes results from a research project designed to test the effectiveness of different restoration techniques on an abandoned road in Grand Teton NP. The specific objectives of this project were (1) to evaluate the effectiveness of various levels of site manipulation such as seeding, fertilizing, scarifying, topsoiling, and mulching, and (2) to compare the performance of seed from native species collected within the park to seed from native species obtained from commercial sources.

This research was part of a larger road construction project that included a seed collection and increase program in association with the Soil Conservation Service. Seed that was collected in Grand Teton was increased by the Environmental Plant Center in Meeker, CO, for restoration work in the park.



Test plot construction in the fall of 1988.

Abandoned road site at the north end of Timbered Island in Grand Teton NP. Seed in the area was collected to compare the effectiveness of indigenous seed vs. commercial seed.



The Study Site

The study was conducted within the disturbed tracks of an abandoned road at a 2,075 m elevation. Climate there is semiarid, with hot, dry summers and cool, wet winters. Average annual precipitation is 68 cm, with a mean annual temperature of 2.2 C. The soils of the area were formed on stream terraces and alluvial fans as well as glacial outwash materials from the Teton range. The soils are characterized as well drained, with moderate permeabilities.

The undisturbed community surrounding the study site can be classified as a low sagebrush/big sagebrush mosaic. The disturbed, abandoned road site consisted of highly compacted soils, low organic matter and nutrient levels, and absence of vegetation.

Methods

The study was begun in the fall of 1988. Over a four year period, 14 treatments were tested. A detailed description of them can be found in Cotts et al. (1991). Plant cover was measured by species during the growing seasons of 1989 through 1992. In addition, woody plant density was determined during the same time period and aboveground production was estimated, using a direct harvest method in 1992.

Infiltration and bulk density tests were conducted on scarified/non-scarified treatments and topsoiled/non-topsoiled treatments to assess the effect of soil scarifying and topsoiling on infiltration and bulk density. Aggregate stability analyses also were completed on the same treatments following the procedures of Kemper and Rosenau (1986) to understand the relationship between bulk density, infiltration, and aggregate size and stability of the treated and untreated soils on the site.

Results and Discussion

After four growing seasons we found that the topsoiled treatments supported the most plant cover and biomass, with 5 cm of topsoil providing more favorable results than 15 cm of topsoil (Fig. 1). Topsoil treatments that were seeded (to either indigenous or commercial seed) were dominated by perennial grasses, while non-seeded topsoil treatments were dominated by big sagebrush—the dominant species in the surrounding plant community.

Non-topsoil treatments had significantly less plant cover and biomass than topsoiled treatments, but those treatments that were seeded to the indigenous mixture showed good plant community development. Scarifying the original road substrate yielded better plant growth than non-scarifying, and mulching produced no differences in plant cover or production.

Infiltration and bulk density analyses were conducted to determine if compaction was a problem and if the selected treatments of scarifying and topsoiling improved the physical parameters of the road substrate. The undisturbed soil surrounding the road had the lowest bulk density, while the non-scarified road surface had the highest bulk density, confirming that the road had been compacted as a result of many years of vehicular activity.

It was expected the infiltration rates would be inversely correlated with bulk density; in other words, as bulk density increased, infiltration would decrease. The results of our testing showed that scarifying the road substrate reduced bulk density, but infiltration rates were not improved. Additional analyses of aggregate stability showed that the compacted soil from the road substrate had smaller and less stable aggregates than either the undisturbed soil or the topsoil used in the study.

We found that these less stable aggregates would disintegrate upon wetting, thus plugging macropores in the soil and reducing infiltration. It must therefore be recognized that although scarifying soil may reduce bulk

density and create more favorable seedbed characteristics, it may not improve infiltration if an aggregate stability problem exists. Aggregate stability will only improve with the addition of organic matter and after other soil building processes occur, such as soil microbial development.

Implications

Our research has shown that disturbances such as abandoned roads can be restored successfully with a variety of approaches that vary in the level of resource inputs and also in time required for complete restoration to occur. The applications of small amounts of topsoil (as little as 5 cm) in combination with seeding of indigenous seed will produce a plant community that will emulate the surrounding undisturbed community in as little as 15 years in environments similar to that at our Grand Teton study site.

We believe, however, that less intensive approaches, such as soil scarification in com-

bination with seeding indigenous species, will result in successful restoration in a time frame of 20 to 25 years. Since indigenous seed performed better than native seed obtained commercially, we recommend that restoration projects use seed from sources known to be adapted to the climate and soil characteristics of the area to be restored.

With respect to economic considerations, the cost associated with adding 5 cm of topsoil and seeding indigenous plant materials would be approximately \$5,000/ha (\$2,100/ac). These costs are based on estimates associated with restoration work in the Grand Tetons and will vary depending on site conditions, sources of topsoil, and distance required to transport soil.

Restoration is a long-term process that is dependent upon natural physical and biological processes to bring it to completion. It is therefore critical that patience be seen as a necessary virtue for all resource managers

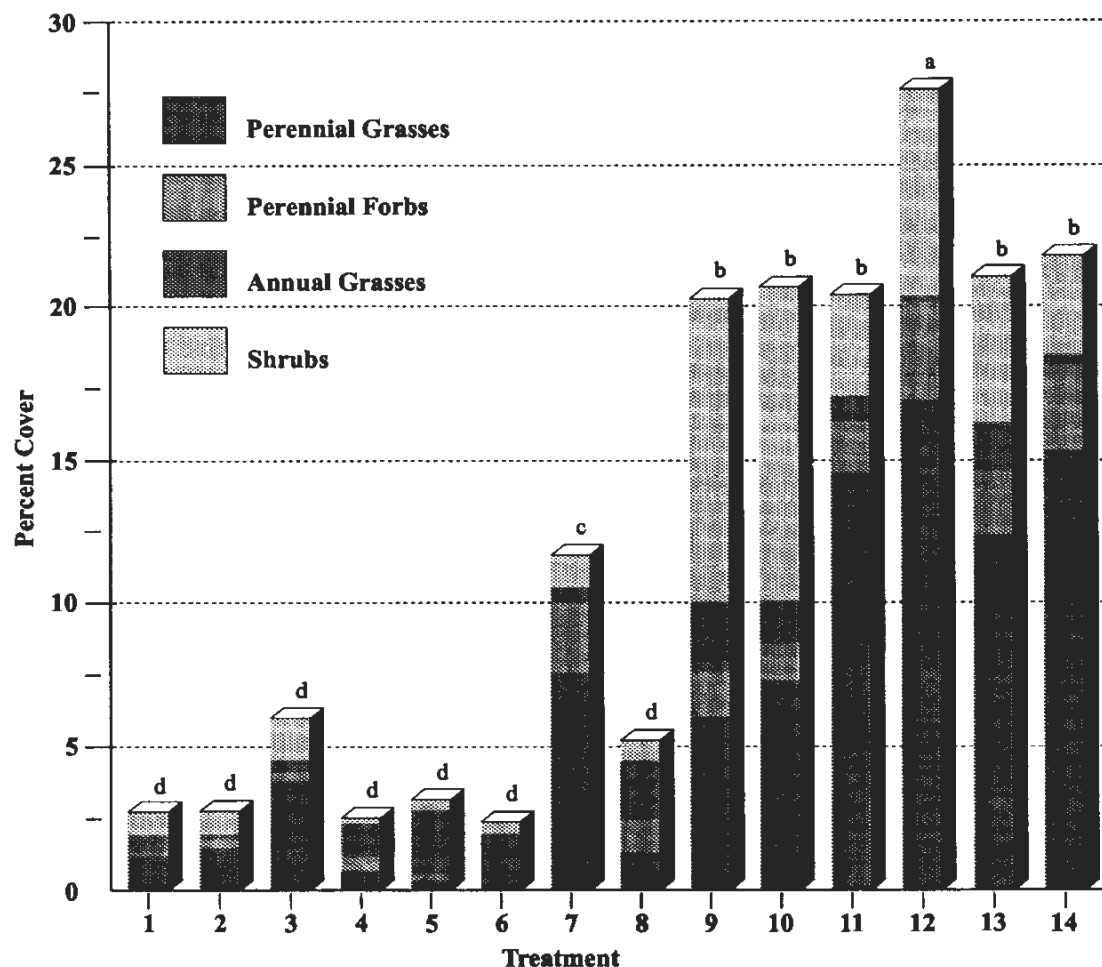
involved in such projects. Also, it should be understood that limited resource inputs can prove to be valuable approaches where the time frame for success is not a major restriction.

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Literature Cited

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Figure 1. Total plant cover in 1992, four years following initial treatment. Treatments with the same letter are not significantly different at $P < 0.05$.



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| 1. Control | 5. Scarify, No Seed | 9. 15 cm Topsoil and Scarify | 13. 15 cm Topsoil, Scarify, Commercial Seed |
| 2. Control and Mulch | 6. Scarify, Rock Raking | 10. 15 cm Topsoil, Scarify, Fertilize | 14. 15 cm Topsoil, Scarify, Indigenous Seed, Mulch |
| 3. Indigenous Seed | 7. Scarify, Indigenous Seed | 11. 15 cm Topsoil, Scarify, Indigenous Seed | |
| 4. Commercial Seed | 8. Scarify, Commercial Seed | 12. 5 cm Topsoil, Scarify, Indigenous Seed | |