

Project Summary

Rocky Mountains Cooperative Ecosystem Studies Unit

Project Title: Phytostabilization of Abandoned Mine Sites on Public Lands-2005
Type of Project : Research
Funding Agency: Bureau of Land Management
Other Partners/Cooperators: Not Applicable
Effective Dates: May 13, 2003 through September 30, 2005
Funding Amount: \$23,575.00 FY03; \$5,000 FY04
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Project Abstract: The objective of conducting this phytostabilization study is to provide BLM managers and decisions makers with site-specific information and data relating to the implementation, costs, and effectiveness of phytostabilization technology so that it may be applied to other similar acid metalliferous mine tailing sites administered by BLM. In 2003, replicated experimental plots were constructed using soil amendments designed to ameliorate the plant inhibiting chemical characteristics of the tailings and to seed the experimental plots with appropriate native plants that can thrive in the newly created rootzone. In 2004 and 2005, vegetation performance of plants seeded into the amended or phytostabilized tailings was compared to results for plants seeded into tailings that were not amended, and plants seeded in an adjacent off-site, non-impacted area. Results of monitoring in 2005 are summarized below: 1. Canopy Cover: Analysis of variance indicated that the percent cover of perennial grasses growing on the treated tailings is significantly ($P < 0.05$) greater than percent canopy cover of perennial grasses growing on the untreated tailings. Canopy cover of vegetation on the treated tailings was not statistically distinct from perennial grasses growing on the off-site experimental plots. Percent canopy cover of perennial forbs growing on the treated tailings and the off-site control were also statistically equivalent. 2. Species Lists: A species list of all plants found within each of the twelve experimental plots was developed. Species are distinguished by whether they were part of the seed mix or naturally established within the plot. The detailed vegetation cover data were used to designate major species, those with mean cover percentages for the plot greater than 0.5%, and those that contribute little to the overall vegetation cover of the plot, but were present during the July survey. 3. Rooting Patterns: In treated plots, copious roots were visible to a depth of 8 to 10 inches, with fewer roots visible below. The maximum rooting depth was measured at 18 inches. Plant species were common yarrow, slender wheatgrass and western wheatgrass. The pH of the rooting media (treated tailings) was 7 to 8 using the Hellige triplex pH indicator solution. In untreated plots, maximum root depth was about 6 inches, with nearly all roots restricted to the upper 2 to 3 inches. The pH of the soil (tailings) profile was 4 to 4.5 4. Above-ground biomass: Analysis of variance indicated significant differences ($P < 0.05$) among the three treatments, with the treated tailings supporting the greatest above ground plant biomass, followed by the native range soils. The untreated tailings did support some plant growth, but significantly less than the treated tailings and the native range soils. Two grasses, western wheatgrass (<i>Agropyron smithii</i>) and slender wheatgrass (<i>Agropyron trachycaulum</i>) contributed most to the biomass on all plots and treatments. 5. Metal level in vegetation: Arsenic: Analysis of variance indicated that the mean arsenic level in grasses collected from the untreated tailings (2.60 mg/kg) was significantly greater than mean concentrations for grasses growing on treated tailings (1.09 mg/kg). Grasses growing on the native range soils revealed the least arsenic, with a mean of 0.36 mg/kg. For these statistical tests, any arsenic value reported at the detection limit were multiplied by 0.7, with the resulting value used to calculate mean concentrations. Cadmium: Mean concentration of cadmium in samples collected from the untreated tailing was 3.3 mg/kg, which was not statistically distinct from the mean cadmium concentration of grasses collected from the treated plots (0.70 mg/kg). A significantly lower mean concentration of cadmium was found in grasses growing on the native soils. The maximum tolerable dietary level of cadmium for cattle and horses is 0.50 mg/kg (NRC 1980). Of the eight individual grass samples (refer to Appendix D) from the treated tailings, one sample of Indian wheatgrass was found to have a cadmium concentration of 2.13 mg/kg, while the other samples had cadmium concentrations ranging from 0.21 to 0.80 mg/kg. The dietary level of cadmium for domesticated animals is based on human food

residue considerations (NRC 1980), and the need to avoid increases of cadmium in the US food supply. Higher residue levels (>0.50 mg/kg) for a short period of time would not be expected to be harmful to animal health or to human food use, particularly if the animals were slaughtered at a young age (NRC 1980).

Lead: Lead levels in vegetation samples were relatively low. Analysis of variance indicated that concentration of lead in grasses growing on the untreated tailings (mean of 1.8 mg/kg) was significantly elevated compared to mean levels in plants growing on the treated tailings or native range soils. All concentrations were less than the maximum tolerable dietary level for cattle and horses of 30 mg/kg. Normal concentrations of lead in mature leaf tissue range from 5 to 10 mg/kg (Kabata-Pendias and Pendias [1992]). All lead data were less than this range (refer to Appendix D). The lead concentrations in grasses growing on the Keating Tailings do not pose a threat to grazing animals.

Zinc: Mean zinc concentrations (Figure 4) were quite variable, and analysis of variance found that they were statistically distinct. The maximum dietary level for zinc for cattle and horses is 500 mg/kg; no sample concentration exceeded this value. The zinc concentrations in grasses growing on the Keating Tailings do not pose a threat to grazing animals.

Copper: Mean concentrations of copper in grass samples collected from the site (Figure 4) were significantly different across the three treatments. The grasses growing in native range soils had a mean copper level of 2.7 mg/kg. This level would be considered in the deficient range for this essential element. Mean levels of copper in grasses growing on treated and untreated tailings, 9.0 and 25.2 respectively, are statistically different ($P < 0.05$), but within the sufficient or normal range of 5 to 30 mg/kg provided by (Kabata-Pendias and Pendias [1992]). The National Research Council (1980) provided a maximum tolerable dietary level of copper for cattle and horses at 100 mg/kg. The copper concentrations in grasses growing on the Keating Tailings do not pose a threat to grazing animals.

Mercury: All of the mercury values were reported as < 0.1 mg/kg (refer to Appendix D). No interpretation of the data is appropriate.

Outcomes with completion dates (reports, publications, workshops, videos, etc.):

- 1) This project was presented at the National Meeting of the American Society of Mining and Reclamation in 2005.
- 2) 2005 report was submitted to BLM in October 2005

Keywords:

Phytostabilization, abandoned hard rock mines, reclamation, mine tailings, metal contamination