Fiber Rolls as a Tool for Re-Vegetation of Oil-Brine Contaminated Watersheds

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Title: Fiber Rolls as a Tool for Re-Vegetation of Oil-Brine Contaminated Watersheds
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Project Amount: $70,740
Research Category: Brine Scar Remediation

Description:

Historic oil brine scars (sites that repeatedly received produced water) are extremely difficult to remediate because these sites possess degraded, highly saline soils, erosion damage, little or no plant cover and an altered microbial community. Ecosystem function is diminished as a result of these impacts.

We are evaluating the contribution of fiber rolls to restoration of a historic oil brine scar in south Arkansas. Four treatments (natural attenuation, standard soil reclamation techniques, fiber rolls, and soil reclamation with fiber rolls) have been applied to plots within the site. Fiber rolls are tubes formed with a geotextile material and filled with organic fiber, mycorrhizal fungal inoculum, bacterial inoculum (soil) and salt-tolerant plants. Consequently, fiber rolls may serve a variety of ecological functions including primary productivity, filtering of sediments and moisture and nutrient retention. Rolls also serve as a source vegetative growth, seeds, microbial spores, organic matter and nutrients.

Objective(s) of the Research Project:

Our primary objective is to examine the utility of fiber rolls as an effective, inexpensive, and easy-to-use remediation tool at oil brine spill sites. Established fiber rolls and adjacent brine affected plots will be examined to determine the:

1) Structural integrity and ability of fiber rolls to withstand periodic flooding/water flow,
2) Amount of sediment accretion behind fiber rolls,
3) Survival, extent and type of vegetative growth in fiber rolls, and
4) Type and extent of vegetation expansion from fiber rolls onto adjacent soils.

Soil reclamation as a result of treatments will also be assessed through measurements of electrical conductivity, sodium adsorption ratio, and cation exchange capacity.

Progress Summary/Accomplishments:

Field work has been completed. Statistical analysis of pre-and post-treatment soil samples (soil chemistry test results provided by the Agricultural Diagnostic Laboratory at the University of Arkansas) is underway.

Preliminary analysis suggests that soils in control sites changed significantly over the 9-month study period. Surface soils (0-6 cm in depth) in control plots demonstrated a decline in pH, sodium and iron concentration, along with an increase in copper and nitrogen (Figure 1.). Surface soils in plots treated with soil amendments demonstrated several significant differences in relation to the control plots. Soil pH, phosphorus, nitrogen (NO^3), and iron concentrations increased in treated plots while calcium, magnesium and chlorine levels declined.

Deep soil layers (6-12 cm in depth) in control plots also differed over the study period. Concentrations of copper and carbon were found to increase while electrical conductivity (EC) along with concentrations of manganese, calcium, magnesium, sodium and chlorine decreased (Figure 2.). Deep soils in plots treated with soil amendments demonstrated several significant differences in relation to the control plots. Phosphorus and iron levels appeared to increases in treated plots in relation to comparable soils in control plots (Figure 2.).

Several factors may complicate the evaluation of fiber rolls and soil amendments as remediation tools at this historic brine spill site.

(1) High variability in control site soil constituents over the short 9-month study period may be indicative of periodic recontamination of some portions of the study site. Runoff from the adjacent abandoned well site and from an unknown number of additional spill sites up-stream from the study site may occasionally flood the study site with new contaminates. Recontamination of the spill site from up stream sources may undermine reclamation efforts.

(2) Deer continue to heavily browse newly established forbs and shrubs trying to gain a foothold in treatment plots and fiber rolls. Few deterrents other than a deer-proof fence around the study site would be effective in reducing the level of herbivory.

(3) Lastly, soil layering appeared extreme and variable within the study site. Several distinctly different layers were visible within the upper 15 cm of soil. A dark oil-saturated soil layer, along with hardened layers of a light-colored clay-like material, and porous reddish sand layers were evident in some study site locations. Other locations within the study site displayed no distinct layering. We tried to minimize this variability by our soil sampling procedure. Surface soils were collected from 3 randomly selected locations within each plot, thoroughly mixed, before 3 sub-samples were taken from the mixture for analysis. The same procedure was undertaken for deep soil samples. Despite these precautions, high levels of variability between samples within the same plot or treatment area were observed. Thus, the variable and dynamic nature of this study site may complicate our analysis of the effectiveness of fiber rolls and soil amendments for the recovery of ecosystem processes.

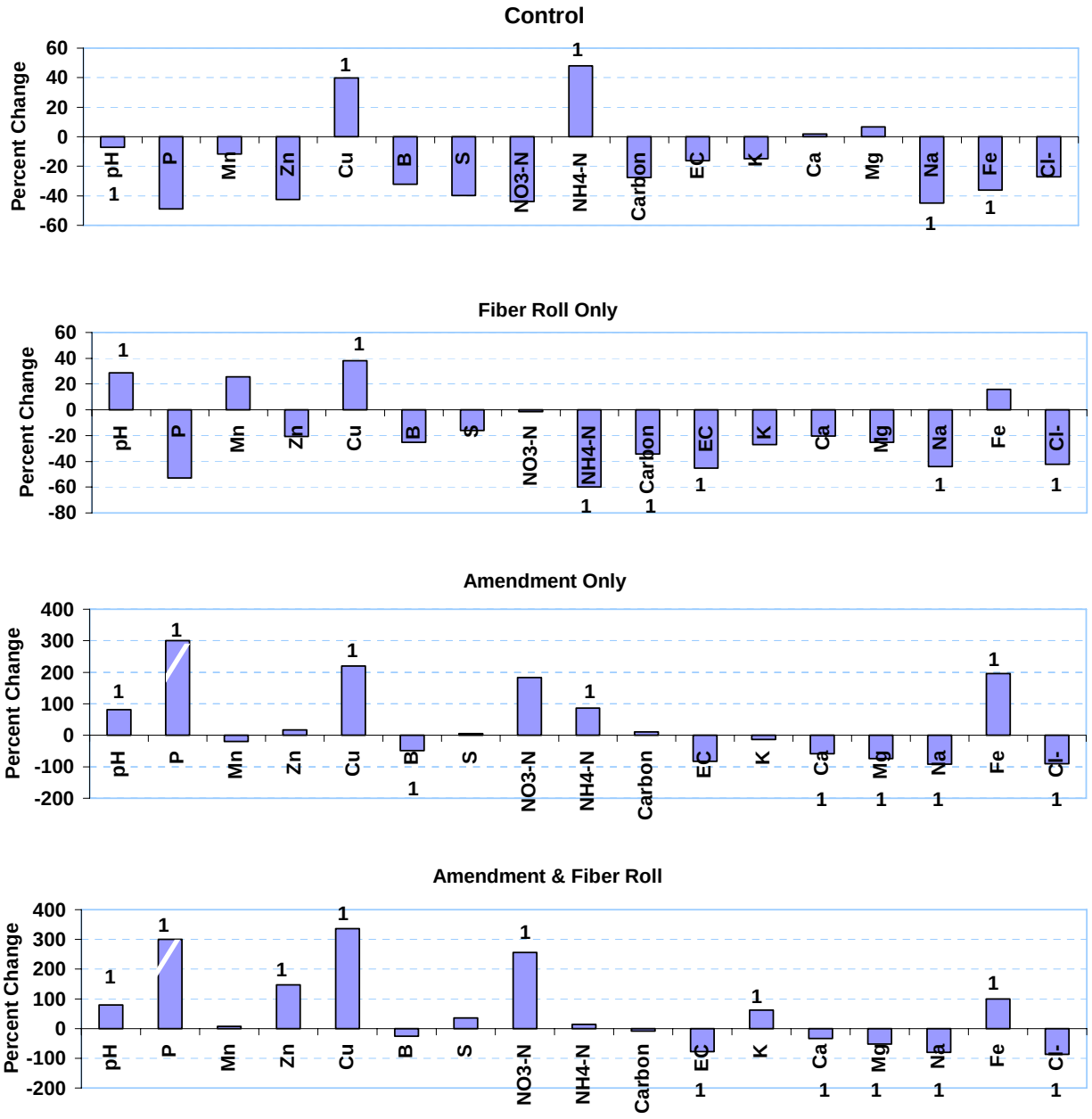

Figure 1. Percent change in surface soil values (between March, 2006 and December, 2006) by treatment. Symbol "1" indicates a significant difference ($P < 0.05$) between pre- and post-treatment values.

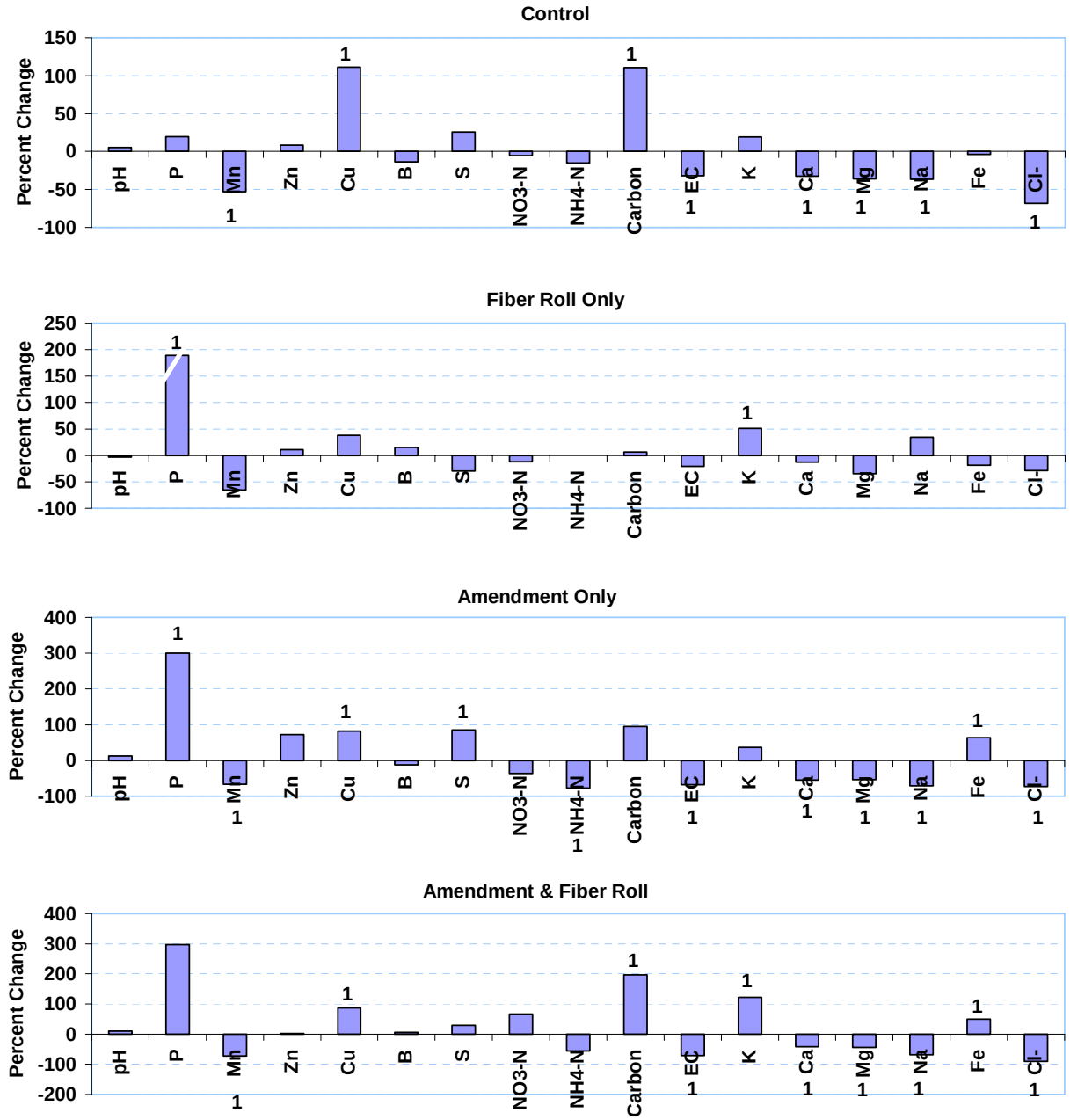

Figure 2. Percent change in deep soil values (between March, 2006 and December, 2006) by treatment. Symbol "1" indicates a significant difference ($P < 0.05$) between pre- and post-treatment values.

Publications/Presentations

Future Activities:

Completion of the final report is anticipated for June, 2007.