Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Mitigating Soil Degradation in Log Landings

A Pollinator Habitat in Log Landings Project Fact Sheet

Background

Log landings (places where loggers stack, sort, and load timber into trucks) result in soil compaction and the removal of vegetation. Although using dedicated landing sites and skid trails during timber harvests limits heavy machine traffic to specific areas of the forest and minimizes soil and vegetation disturbance, these practices can result in severe soil compaction on the small areas used, which can in turn lead to erosion of unprotected soils and provide opportunities for invasive plant species to gain a foothold. The result can lead to poor quality habitat for local wildlife, including pollinators.

Figure 1.—Landing #15 of the Mark Twain National Forest before treatment (left) and one year after treatment (right). (photograph by Will Rumpf)

The Pollinator Habitat in Log Landings (PHiLL) project aims to mitigate soil compaction in log landings so that these sites can host high quality pollinator habitat between timber harvests. Fifteen landings across the Hoosier National Forest in Indiana, the Shawnee National Forest in Illinois, and the Mark Twain National Forest in Missouri were selected to test the effectiveness of subsoiling and biochar applications as soil remediation strategies. Pretreatment site data showed significant soil compaction across all landings when compared to undisturbed forest. In the Hoosier and Shawnee forests, soil bulk densities exceeded the 1.4 g/cm^3 threshold for compaction at which plant root growth is restricted. On rocky sites in Southern Missouri, up to 34 percent of the soil volume is rock fragments. Here, the coarse fragments (CF) protected the soil from some of the compaction, suggesting that CFs redistribute the compressive forces of heavy machinery and reducing the impact on the soil.

Key Takeaways

- Removing timber harvest residue allows for plant growth and reduces bulk density.
- Applying biochar combined with subsoil ripping shows promise in mitigating compaction in the upper layers of soil.
- Amending soil with biochar can augment soils and improve their ability to support native vegetation and pollinator habitat.

Management Implications

- Clearing debris from the surfaces of log landings helps mineral soil to rebound and allows native seeds in the soil to germinate and grow.
- Using rocky sites as landings can mitigate the effects of heavy machinery on soils.
- Converting timber harvest residues to biochar and applying biochar to log landings may improve soil health and productivity.

The Research Study

Experimental treatments included (1) applying softwood biochar at 10 tons per acre, (2) subsoiling at widths of 2.5 feet and depths of 20 inches using a skid steer, (3) applying a combination of the two, and (4) control plots where nothing was done. Each plot had areas that were seeded with a native pollinator seed mix and unseeded test areas. Biochar was applied with an industrial self-propelled broadcaster. Seeds were spread by hand and overlaid with straw. Skid steers were used to remove residue layers (e.g., woodchips and bark) on landings where residue was thick enough to prevent plant growth. Soil sampling was conducted at a random location in each subplot. A beveled ring with a known volume was pushed into the side of a hand dug hole at three depth intervals: 0 to 10 cm from the surface of mineral soil, 10 to 20 cm, and 20 to 30 cm. To determine the effectiveness of the treatments, the following measurements were collected from the soil samples:

- Bulk density to estimate degree of compaction
- POXC (permanganate oxidizable carbon) for estimates of active carbon stocks
- PMC (potentially mineralizable carbon) for estimates of carbon available to microbial communities
- Soil pH for assessing acidity/alkalinity
- Total carbon and nitrogen
- CEC (cation exchange capacity) for estimating nutrient holding ability of soil
- Bray-1 P to measure the amount of phosphorous (necessary nutrient for plants) in the soil

Preliminary bulk density results show a significant decrease in compaction across all landings and treatments in the top 10 cm of soil, meaning that the soil surface has rebounded from the original compaction over time.

At depths of more than 10 cm, soils remained compacted, meaning that treatments were less effective in deeper soils. The Shawnee National Forest was the only forest that had statistically significant differences between treatments; there, the combination of applying biochar and ripping led to less compacted soils at depths greater than 10 cm. The presence of CFs, while potentially helpful during the time of soil compaction, seemed to interfere with the incorporation of biochar and the effectiveness

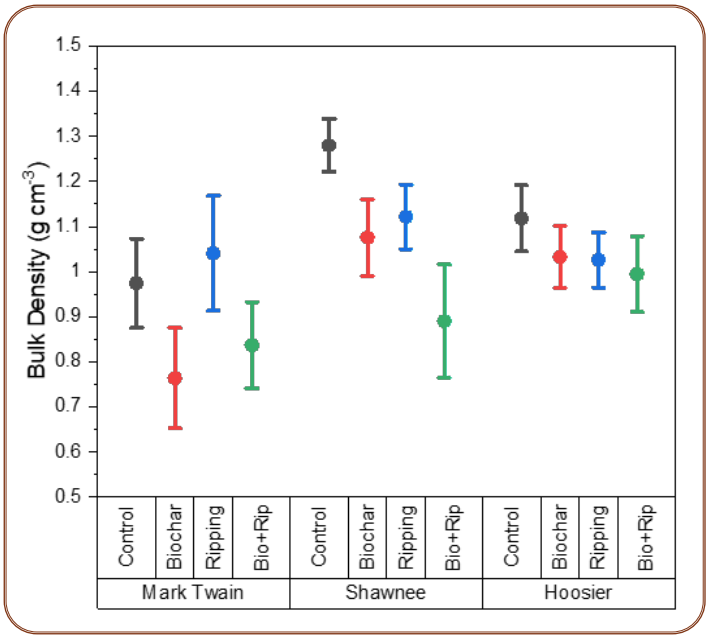

Figure 2.—Post treatment bulk density for all forests was below the 1.4 g/cm3 threshold for compaction at the 0 to 10 cm depth range. Pretreatment data saw Shawnee National Forest and Hoosier National Forest above the 1.4 g/cm3 for all depths, and Mark Twain National Forest as significantly higher than surrounding undisturbed forest.

of treatments. Other notable preliminary results include a slight increase in plant available phosphorous and total carbon stocks on sites with biochar amendment.

By demonstrating the effectiveness of subsoiling and biochar applications as soil remediation strategies, this study provides guidance for managing log landings as pollinator habitat. By prioritizing soil restoration, forest managers can help to prevent erosion and the spread of invasive species while providing high-quality habitat for pollinators and other wildlife. *By Will Rumpf.*

More Information

- This work was done in partnership with the University of Missouri. Will Rumpf is an MS student under the direction of Dr. Morgan Davis, School of Natural Resources.
- This research study will result in a General Technical Report (GTR) synthesis of the project outcomes and a management guide including best management practices (BMPs) for establishing ephemeral pollinator habitat in log landings. GTR expected in 2024.
- Please visit the PHiLL website at webpage: https://www.fs.usda.gov/research/nrs/projects/phill