

Effects of Forest Biomass Harvesting on Soil Carbon and Forest Site Productivity

There has been considerable research on the effects of intensive forest harvesting (e.g., biomass harvesting or whole-tree harvesting) on soil carbon and site productivity. We've assembled some key scientific papers that are relevant to this issue. The first two references (Ayers et al. (2007) and Roberts et al. (2005)) discuss results from the Fall River long-term soil productivity project, which was established by University of Washington, Weyerhaeuser Company, and U.S. Forest Service scientists over 10 years ago. NCASI has provided support for the project since its establishment. The study was designed to look at the effects of varying harvest intensities, ranging from traditional bole-only removal to removal of all biomass and residues (even buried legacy wood), on site factors and tree growth. Five-year results show that even very intensive harvesting with residue removal (as well as a soil compaction treatment) had no significant effects on subsequent tree growth. The most significant factor affecting tree growth was whether competing vegetation was controlled. Ten-year measurements were recently conducted at Fall River and are consistent with these results but are not yet published.

The paper by Powers et al. summarizes 10-year results from the North American Long-Term Soil Productivity (LTSP) study, the most comprehensive study of intensive harvesting and biomass removal effects on soils and site productivity. This study is similar in design to Fall River and has shown similar results – intensive biomass removal that includes residues and even the forest floor has generally had little impact on tree growth at the sites. Reductions in soil carbon with residue removals do occur on some sites, however, and need to be monitored to gauge any long-term impacts. As with Fall River, the most significant factor affecting productivity was whether competing vegetation was controlled.

The study by Nave et al. (2010) is a statistical analysis of forest harvesting effects on soil carbon across a wide range of temperate forest sites. Although responses were variable, the analysis found no significant effects of harvesting on mineral soil carbon but did find significant losses of forest floor carbon. The forest floor effect in the analysis was heavily influenced by several studies in the Northeast, where forest floor accumulations were very high. The analysis also included a harvest intensity component to distinguish effects of whole-tree (i.e., biomass) and stem-only harvests and no significant effect of harvest intensity on soil carbon was found.

Also attached is an abstract from a paper by Page-Dumroese et al. (2010) that assesses effects of thinning and residue management on soil productivity in western U.S. forests. This paper contains some general residue management recommendations to protect site productivity.

Taken collectively, scientific evidence shows that many forest sites are quite resilient to harvest residue removals, even those that greatly exceed removals that would occur operationally. Responses across individual sites vary considerably, however, and sites with coarse-textured, infertile soils are often mentioned as more sensitive to biomass removals than other sites. Repeated, intensive residue removals over time do have the potential to deplete nutrients. Forest managers are more than capable of detecting and correcting nutrient deficiencies with fertilizers or other soil amendments over time if they do occur, however. It is important to note that intensive biomass harvesting for energy has been practiced in Scandinavian countries for many years and while they have found that nutrient losses or deficiencies can occur on some types of sites they often correct these losses with fertilizer or wood ash.