ENVIRONMENTAL AND ECONOMIC RESEARCH AND DEVELOPMENT PROGRAM

Impacts of Harvesting Forest Residues for Bioenergy on Nutrient Cycling and Community Assemblages in Northern Hardwood Forests, Wisconsin

Executive Summary
September 2012

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This report was funded through the Environmental and Economic Research and Development Program of Wisconsin's Focus on Energy.

Executive Summary

Background

The most readily available source of woody biomass to the logger is through whole-tree harvesting that removes what has been traditionally left as slash (i.e., fine woody debris - FWD). This material has potential to be used as energy feedstock. However, a critical element of managing for biodiversity is maintaining woody debris on the forest floor. Woody biomass is important for nutrient cycling, providing seed beds, and creating habitat structure for wildlife. Researchers recognize the link between biodiversity and ecosystem functioning, but this relationship is not well understood. A change in species may have cascading effects across trophic levels, and cause shifts in the size, distribution, and vertical zonation of vegetation over large areas. Our goal was to investigate the impact of FWD removal on nutrient availability and above and belowground community assemblages on rich soils under regenerating northern hardwood stands in Wisconsin. Land managers are concerned with removing FWD in this system because of the existing lack of large woody debris and structural diversity (e.g., understory shrubs). In addition, exploiting slash for bioenergy purposes will compete with ot her ecological services Wisconsin forests provide.

Research Objective

We manipulated the amount of fine woody debris removed after timber harvest within the Chequamegon-Nicolet National Forest to compare soil carbon:nitrogen availability and community change [i.e., the abundance and diversity of plants (forbs, shrub, tree regeneration), beetles (Coleoptera), and amphibian assemblages) across 4 forest residue removal treatments: (1) 0% tipwood removed (100% retention; current practice), (2) 65% tipwood removed (intermediate retention; amount based on Minnesota biomass harvesting guidelines), (3) 100% tipwood removed (tipwood from every tree harvested removed from site; some tipwood remained on site due to incidental breakage during skidding), and (4) no-cut control

Methods

Fine woody debris removal was applied winter 2009-2010 across nine treatment blocks within a second-growth northern hardwood forest. We used a randomized complete block experimental design; each FWD removal treatment was randomly assigned to a >8 ha section of each block. Treatment sites ranged from 8.5 – 17.4 ha. Within each treatment site, we established a 100 x 100 m (10,000 m^2) plot near the center to ensure sufficient spacing and independence of replicates, and to minimize edge effects from the surrounding forest and other treatment areas. Within each plot, four transects spaced 33.3 m apart were run the length of the plot. We used time constrained searches along each transect to sample the amphibian assemblage. Pitfall traps spaced 25 m along each transect were used to sample the beetle assemblage (Coleoptera). Plant community and fine woody debris amounts were measured in 1 m^2 quadrats placed every 10 m along each transect. Soil samples were collected at 25 m intervals along each transect to a depth of > 20 cm. Measurements were taken May – August, 2009 (pre-treatment), 2010 91-year post-harvest), and 2011 (2-years post-harvest)

Results and Conclusions

In general, there were few short-term qualitative changes in species composition at the plot-level across fine woody debris removal treatments for all species groups. While forb and fern species richness did not change, fewer shrub species were found immediately post-harvest compared to pre-harvest and 2-years post-harvest. Tree regeneration was similar across treatments. Changes in the plant community appeared to be the result of the harvest rather than changes in FWD amounts.

There were changes in abundance across treatments for amphibians and beetles. For amphibian species, we found more individuals in the 100% removal treatment, but by 2-years post-harvest, 2 of the 4 species showed no differences among treatments (American toad and spring peepers). These results may be due to our collecting method because retained slash piles were difficult to search, or an interaction with the functional changes associated with uneven-aged harvest practices (i.e., more direct sunlight to forest floor for open canopy over slash piles). Abundances for all beetles (Coleoptera) were reduced at the plot-level, and by 2-years post-harvest, abundances were reduced by half for the more abundant species. The reduced numbers of almost all beetles, and no qualitative changes in species composition is consistent with trends found in other soil arthropod studies investigating slash removal.

For soils, levels of carbon, nitrogen, pH, and C:N ratio did not consistently decrease when greater volumes of FWD were removed; changes in pre- and post-harvest levels did not occur in the upper mineral soil layers but were significantly more prominent in the deeper depths. While not investigated in the current study, one explanation for the differences and changes in the lower soil layers may be impacts from earthworm invasions that are known to disrupt C, N, and C:N levels and ultimately the balance of forest floor ecosystems.

This study represents the short-term responses of multiple trophic levels to forest residue removal. Future studies will be required to determine the long-term impacts of removing this material from nutrient rich northern hardwood second-growth forests. These studies will be able to build on our current baseline information to evaluate long term impacts of biomass removal.

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