An experimental approach to assess the ecological sustainability of woody biomass harvests

Chris Moorman and Steve Grodsky, Dept. of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC
Presented by Ben Wigley, National Council for Air and Stream Improvement, Inc., Clemson, SC

Introduction: By 2030, forest and agricultural biomass could account for 20% of global renewable energy, and the Southeast is expected to contribute substantial feedstock from its forests. Yet, harvesting wood from forests (i.e., woody biomass) for forest bioenergy is likely to influence the amount of downed wood left on the ground after timber harvest. And, this downed wood provides important food and cover for a variety of wildlife, including frogs and toads, lizards, small mammals, birds, and insects. Our goal was to inform strategies to minimize ecological impacts of woody biomass harvest for forest bioenergy production. In turn, results of our study should help guide policy development related to biomass harvesting guidelines (BHGs) designed to mitigate ecological impacts of woody biomass harvests.

Objectives: Specific objectives of our project were: 1) to empirically assess the efficacy of BHGs by quantifying amphibian, arthropod, bird, mouse, reptile, and shrew responses to manipulations of spatial distribution and volume of residual woody biomass; and 2) to determine the mechanisms responsible for key wildlife responses to woody biomass harvests.

Study Design: We designed a randomized complete block study on 8 sites (i.e., replicate clearcuts): four in Beaufort County, North Carolina (NC); three in Glynn County, Georgia (GA); and one in Chatham County, GA. All study sites were in intensively managed loblolly pine (*Pinus taeda*) plantations in the Coastal Plain Physiographic Region. Clearcut harvests with treatment implementations were completed in 2010-2011. We divided sites into the following six randomly-assigned woody biomass harvest treatments (Fig. 1): 1) Clearcut harvest with no biomass harvest (NOBIOHARV); 2) Clearcut with 30% woody biomass retention clustered (30CLUS); 3) Clearcut with 30% woody biomass retention dispersed (30DISP); 4) Clearcut with 15% woody biomass retention clustered (15CLUS); 5) Clearcut with 15% woody biomass retention dispersed (15DISP); and 6) Clearcut with no BHGs (NOBHG).

Methods: We monitored wildlife in treatments from 2011 – 2014 in NC and GA. We used drift fence arrays to capture amphibians, reptiles, and shrews, and surveyed breeding and winter birds using spot-mapping and a modified version of spot mapping, respectively. Our experimental unit for all vertebrate wildlife analyses was the woody biomass removal treatments replicated across clearcuts in each state. To capture surface-active invertebrates, we used pitfall traps situated in arrays (4 traps/array) amongst the following three sub-treatments within each large-scale treatment in NC: 1) hardwood pile; 2) pine pile; and 3) no pile. We followed the same design in GA, but differences in site-preparation between states led to the establishment of only two sub-treatments: 1) windrow; and 2) no windrow. We used a multi-scale approach for our invertebrate analysis, with both individual pitfall traps and pitfall trap arrays as experimental units.

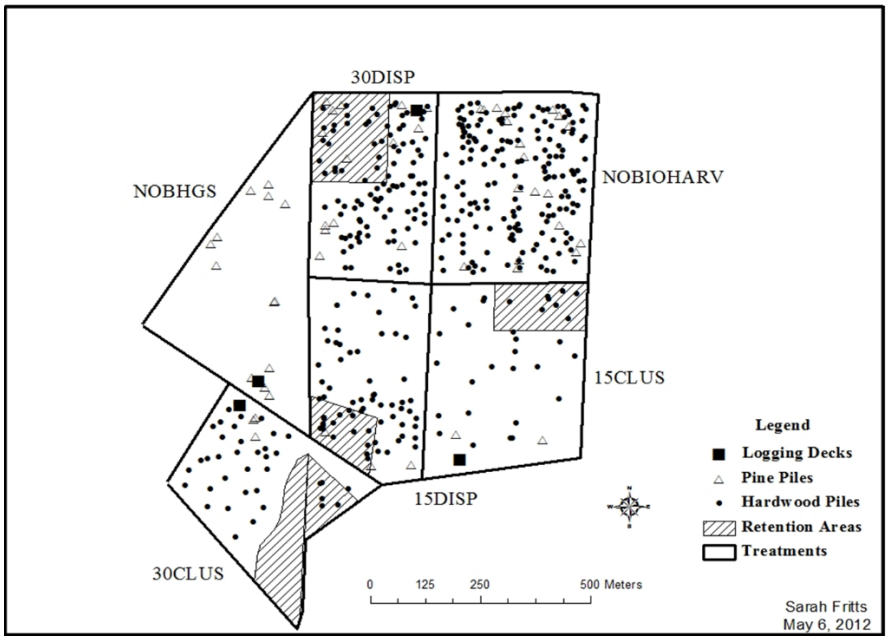

Figure 1. Distribution of harvest residues in six woody biomass removal treatments, Beaufort County, North Carolina. Treatment implementation followed our experimental design (Fritts et al. 2014).

Wildlife response: We found a lack of community, taxanomic guild, or individual species responses by reptiles and amphibians to woody biomass removal treatments, suggesting the addition of woody biomass harvests does not impact herptofauna use of pine plantations in the Coastal Plain of the southeastern United States. Shrews were associated more with vegetation than downed wood; hence, woody biomass harvests likely have little influence on shrew abundance or diversity in young pine plantations. Similarly, wintering birds were not affected by the biomass harvest treatments and instead increased in number as the vegetation returned following the harvests. Breeding birds showed similar responses as winter birds, although a few species (e.g., mourning dove) showed greater use of areas closer to residual debris piles even though overall abundance did not differ among treatments. Preliminarily (invertebrate analyses on-going), some surface-active invertebrates responded positively to downed wood retention at micro- and macro-scales, including centipedes, camel and field crickets, fungus-associated flies, pill bugs, and woodroaches.

Our large-scale, experimental study adds to a growing body of research suggesting wildlife in the southeastern United States may have a weaker relationship with downed woody debris than in other regions where downed woody debris volumes in forests are greater. Many wildlife species we detected were obligates of early-successional plant communities and are tolerant of the environmental conditions present following clearcut harvests. Some of these species have adaptive behaviors for disturbed areas with low volumes of downed woody debris, including burrowing, using cover other than downed woody debris, and not relying on downed woody debris as an important foraging substrate. Further, clearcut harvesting is a substantial disturbance event and likely drove changes in animal populations, regardless of the volume of woody biomass retained as downed woody debris. Harvest inefficiencies prevented complete harvest of logging residues, and considerable volumes of woody biomass were retained in NOBHG treatment units in North Carolina. In fact, post-harvest debris volumes in all treatment

units exceeded by at least three-fold recommendations by the Forest Guild for Piedmont and Coastal Plain physiographic regions of the southeastern United States.

Future work: We will further investigate invertebrate response to harvest residue removal with finer taxonomic resolution, including ant, carabid and dung beetle genera and species. We also will address the question of whether the findings of our large-scale experiment in the southeastern Coastal Plain translate to other regions and community types. Currently, we are conducting a project to examine relationships between wildlife abundance and residual logging debris following timber harvests in the mountains of western NC.