THE EFFECTS OF HWA OUTBREAKS ON ECOSYSTEM LEVEL CHANGES IN SOUTHERN NEW ENGLAND

Sultana Jefts and David Orwig

Harvard Forest, Harvard University,
P.O. Box 68, Petersham, MA 01366

ABSTRACT

The continued spread of the introduced hemlock woolly adelgid (HWA), *Adelges tsugae*, has lead to widespread decline and mortality of eastern hemlock (*Tsuga canadensis*) and initiated intensive hemlock logging. This pest alters the structural and vegetative composition of hemlock forests by transforming them into largely hardwood-dominated forests. Less well understood are the impacts that HWA has on local trophic interactions and how this pest may alter many ecosystem processes. We provide evidence from several studies (Stadler et al. 2005, Orwig et al. and Jefts et al., unpublished data) that highlight the important role that HWA plays in altering stand microenvironment, soil nitrogen (N) availability, soil mycorrhizal associations, litter quality, litter microbiology, and canopy throughfall chemistry. In addition, we compare microenvironmental conditions and nutrient availability associated with HWA infestation and with hemlock logging, one of the primary management responses to HWA outbreaks.

Results from these studies suggest that persistent HWA feeding leads to direct crown deterioration and initiates subtle but important changes in canopy characteristics that have cascading effects on a variety of ecosystem processes. Forests infested with HWA commonly have significantly higher soil temperatures (by 1 - 2 ^{o}F) and mineral soil moisture content and lower organic soil moisture content (decreases up to 40%) than uninfested forests. In addition, infested forests typically have higher soil N availability (171 and 92 µg N/g resin in infested vs. uninfested forests) due to several different mechanisms, including: 1) induced microenvironmental changes that favor decomposition due to deteriorating crowns, 2) reduced uptake as trees decline, and 3) enhanced N content of litter, and canopy throughfall. Furthermore, infested forests have significantly lower root ectomycorrhizal (ECM) colonization than uninfested forests (up to 30% less ECM coverage), suggesting that soil N is no longer limiting, and trees are not allocating as much resources to below-ground production—which may in turn also affect changes in soil nutrient availability and cycling. HWA-infested foliage exhibited significantly higher foliar N content (1.9–2.8% infested vs. 1.5–1.9% control) and abundances of bacteria, yeasts, and filamentous fungi than uninfested foliage. Throughfall precipitation collected under infested hemlock branches contained significantly higher concentrations of nitrate, total N, and dissolved organic N than that collected under uninfested branches.

Hemlock logging led to higher soil temperatures and greater available soil N than infested or uninfested forests. Although N availability is highly variable, intensive cutting of hemlock in response to HWA may lead to ecosystem level impacts that are higher in magnitude than the insect itself, further increasing N losses from these systems. Results indicate that introduced pests and selective tree decline can rapidly and dramatically alter ecosystem processes such as energy flow and ion fluxes, even prior to the onset of extensive tree mortality.

KEYWORDS

Ecosystem processes, nutrient cycling, throughfall chemistry, hemlock cutting.

ACKNOWLEDGMENTS

We would like to thank Dr. Bernhard Stadler, Richard Cobb, Matt Waterhouse, Tawanna Childs, Leann Barnes, and Laura Barbash for field assistance and technical support. Heidi Lux provided critical comments on earlier versions of this presentation. This work was financially supported by the National Science Foundation (Grant # DEB-0236897) and the Harvard Forest Long-Term Ecological Research Program.

REFERENCE

Stadler, B., T. Müller, D. Orwig, and R. Cobb. 2005. Hemlock woolly adelgid in New England forests: canopy impacts transforming ecosystem processes and landscapes. *Ecosystems* (in press).