

Indirect effects of the hemlock woolly adelgid on oak seedling growth through effects on mycorrhizal richness and abundance

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Invasive, non-native phytophagous insects have led to widespread declines in many dominant tree species. The loss of these foundation species may lead to cascading effects on non-target plant species through indirect effects on the mycorrhizal fungal community. In this study, we examined the roles of ectomycorrhizal abundance and diversity on the response of a non-target species, Northern red oak (*Quercus rubra*), to the decline of eastern hemlock (*Tsuga canadensis*) following infestation by the hemlock woolly adelgid (HWA; *Adelges tsugae*), an invasive, non-native aphidlike insect. To address this issue, we grew red oak seedlings for one growing season in hemlock-dominated stands infested with the HWA and in adjacent oak-dominated stands. Soil cores indicated that ectomycorrhizal abundance and richness were significantly lower on hemlock trees in the infested hemlock stands compared to oak trees in the oak stands. Similarly, ectomycorrhizal abundance and richness were significantly lower on oak seedlings grown in the infested hemlock stands compared to oak seedlings grown in the oak stands. In addition, oak seedlings in the hemlock stands were significantly smaller than oak seedlings in the oak stands. Over 90% of the variation in oak seedling growth could be attributed to differences in ectomycorrhizal abundance and richness. These results indicate that reduced ectomycorrhizal abundance and richness in hemlock stands infested with the HWA negatively affect oak seedling growth in these stands. Further, these results suggest that the indirect effects of the HWA on the growth of replacement species through effects on ectomycorrhizal abundance and richness may negatively affect forest recovery following hemlock decline associated with HWA infestation.