

ASSESSING ASSUMPTIONS ABOUT ADELGID ATTRIBUTES: LANDSCAPE PATTERNS OF AN INVASIVE INSECT

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ABSTRACT

The hemlock woolly adelgid (HWA) (*Adelges tsugae*) is a small aphid like insect native to Asia and eastern North America. In 1951, this insect was detected on ornamental hemlocks in Richmond, VA, and in the 1980s spread outward into natural stands of eastern and Carolina hemlock (*Tsuga canadensis* and *T. caroliniana*). Infestation by the HWA results in increased rates of tree mortality, and populations of HWA are known to be in at least 17 states in the eastern United States. At the present time, control of the insect is limited to individual-tree applications of insecticides, and although biological control efforts are underway, landscape-scale control of this insect is driven by its ecological tolerances. One of the major factors that may limit the ultimate spread of the HWA is winter temperature. Previous laboratory work has shown that this insect has a limited tolerance for low temperatures. Using recent surveys of *A. tsugae* mortality across the latitudinal gradient occupied by the adelgid in the eastern United States, we show that there is a significant positive correlation between minimum winter temperatures and winter survival at the landscape

scale; the strength of this relationship, however, varies through time. In spring 2004, minimum temperatures explained nearly 50 percent of the tree-level variance, but only 7 percent of the variance in 2003. Previous studies have suggested adelgid survival may be density dependent, a pattern that may complicate the detection of environment-insect interactions. Although these data do show a statistically significant relationship between these two variables, the relative contribution of the current year's density to changes in survivorship is small, suggesting other, as yet unidentified, factors play a major role in reducing populations of HWA. Using landscape estimates of minimum winter temperature based on more than 1,200 weather stations, we also show three methods of estimating landscape-level adelgid survival rates as a means to estimate the potential maximum geographic range of this invasive species. All three methods suggest that much of the distribution of *T. canadensis* in the United States, and likely all of *T. caroliniana*, fall within areas in which climate will not impose critical limits on populations of *A. tsugae*.