# Growth and Survival of Hemlock Woolly Adelgid on the Northern Frontier

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## ABSTRACT

The hemlock woolly adelgid, *Adelges tsugae* Annand, was originally introduced to the eastern U.S. in 1954 near Richmond, Virginia, from Osaka, a lowland region of Japan (Havill 2005). The insect reached Connecticut in 1985, and subsequently invaded Springfield, Massachusetts, in 1991. We are attempting to document the impacts of cold temperatures on the survival and fecundity of the adelgid at the northern edge of its range in southern New England. Further objectives are to determine how adelgid density affects overwintering survival, and if there are any Allee effects associated with overwintering mortality. Allee effects can be described as decreases in survival or fecundity as population densities decline to extremely low levels frequently resulting in extinctions of incipient populations. New infestations may arise from a single dispersing individual, and the resulting small populations face genetic bottlenecks, inbreeding depression, and the difficulty of individuals finding mates. While parthenogenesis excludes the adelgid from the latter challenge, there are several other reasons to expect Allee effects in newly colonized adelgid populations. These include the documented benefits of some hemipterans forming feeding aggregations, the possible weakening of tree defenses when adelgid are at higher densities, and increased protection from the environment when woolly masses are clumped and overlapping on branchlets.

In order to study the effects of overwintering temperature and adelgid density on survival and fecundity of the sistens generation, thirteen sites throughout Massachusetts and Connecticut were sampled between March and May, 2004. We found that adelgid mortality significantly increased with decreasing mean overwintering temperature P=0.050). The same trend is present using average minimum winter temperature, however the regression is not statistically significant (p=0.407). Fecundity also declined at lower minimum temperatures, a trend that was marginally significant (p=0.066). Overwintering mortality increases with density even at the lowest densities ($p<0.001$); thus there is no evidence for an Allee effect in overwintering mortality.

We are also collecting data on adelgid survival and fecundity at several sites for both the progrediens and sistens generations to see if we can explain the very slow rate of spread we have observed in Massachusetts over the past four years.