
DISPERSAL DYNAMICS AND PREY IMPACT OF *LARICOBIOUS NIGRINUS* IN THE EASTERN UNITED STATES

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ABSTRACT

Laricobius nigrinus Fender is one of the introduced predators being used in the on-going biological control program against hemlock woolly adelgid, HWA (*Adelges tsugae* Anand). Between 2007 and 2010 observations of *L. nigrinus* dispersal within a hemlock stand and predatory impact on HWA were made at several release locations in the eastern United States. In fall and winter of 2007/2008, 300 beetles were released at two locations in Pennsylvania and two in Virginia to observe dispersal during site colonization. In the spring, for two years following beetle release, samples were cut from three crown stratum (< 7 m, 7 – 15 m, and > 15 m), of three release trees, at the four sites. Ninety-eight percent of F₁ offspring at the Virginia release sites were recovered above the first 7 m of the crown. At the Pennsylvania sites F₁ vertical dispersal sampling was compromised by a collapse of HWA populations on the release trees. Yet, there was a trend of the parent beetles moving upward in the crown for oviposition. There was a positive correlation between HWA and *L. nigrinus* density (in 2008 $r = 0.49$ (12), $p = 0.0026$ and in 2009 $r = 0.23$ (13), $p = 0.0494$). Dispersal between trees was compared from only the lowest crown strata of release trees and infested hemlocks at 10, 30, 50, and 100 meters from the release trees. At least one individual of the F₁ generation dispersed to a non-release tree at all four colonization study sites. The maximum dispersal distance was 50 meters observed one year after release at both of the PA release sites. Dispersal observations at four established *L. nigrinus* release sites (Bear Run, Bald Eagle S.F., PA; Rothrock, Rothrock S.F., PA; Middle Creek, Pisgah N.F., NC; and Laurel Creek, Great Smoky Mountains N.P., TN) were made from 2007 through 2009 at varying distances (50, 100, 150, 200, 300, and 600+ m). A similar population shift was observed at all four sites, with increasing *L. nigrinus* frequency at further distances from the release each generation. Offspring of the F₅ generation were recovered at a maximum distance of nearly 400 meters from the release area. *These results support sampling for predator establishment near the release trees and then shifting long-term monitoring to the surrounding stand. Sampling techniques limited to the lower crown underestimate predator populations.*

The impact of *L. nigrinus* at the Middle Creek, NC and Rothrock, PA paired release and control sites were evaluated from 2007 through 2010. In 2010, two additional paired release and control sites were evaluated; Laurel Creek, Great Smoky Mountain N.P., TN and North Fork, Jefferson N.F., VA. Either 300 or 600 beetles were released at each site. Also evaluated in 2010, was a unique 10,700 *L. nigrinus* beetle release made from 2008 through 2010 at the base of Grandfather Mountain Biosphere Reserve, NC. Sev-

eral methods were used to assess predator impact on the prey and tree health. The first method compared before and after release measures of hemlock crown health (live crown ratio, transparency, and overall decline) and HWA density within a demarcated area of branches in the lower crown. The same measures were compared between the release and control sites with consideration for differences in initial HWA density and landscape factors. Results show tree health declined by varying degrees at both release and control sites. Similarities of initial parameters allowed comparison of two paired release and control sites. Both controls increased in number of dead tips and overall tree decline ratings were slightly greater than the release sites. A cage-exclusion experiment was attempted in 2009, yet was compromised by weather and human caused damage. The last method compared four years of observations in the eastern United States with the same parameters measured for two years at three locations in Seattle, WA, the predator's native environment. Measured impact parameters included predator density, prey density, prey survivorship, and HWA ovisac disturbance. Results show *L. nigrinus* densities reached the ranged observed in Seattle, WA at all release sites except North Fork, VA. HWA densities in the east fluctuated over several years. Most years HWA density and survival rates were greater than the range observed in WA. *Overall, the higher HWA densities and survival in the East indicate L. nigrinus release sizes of 600 or fewer adults, at initially low to moderately HWA infested hemlock stands, were not able to reduce HWA populations to a level tolerable by the hemlocks within seven years.*

Impact monitoring should continue. The described assessments were conducted at release sites intended to try to determine an optimal release strategy based on the number of predators available and the probability of establishment across many temperature gradients. Monitoring the long-term impact of large releases, such as at the Grandfather, NC site may lead to a more desirable reduction in HWA populations compared with smaller release sizes. Impact assessments were based upon measures of only release trees and primarily sampled from the lower crown. Results from dispersal observations indicate a better representation of *L. nigrinus* populations would be realized from samples taken from the upper crown and at increasing distances from the release area with increasing time. Parameter values varied greatly between years, demonstrating the need to sample for multiple years. Comparisons of parameters measured at releases made across the HWA infested range in the East with areas in the predators' native environment provide a meaningful comparison if the same sampling technique is applied with minimum subjectivity. *The results of this initial impact assessment provide data for discussion on how to design more effective HWA management strategies and to consider the complexity of the varied ecological systems hemlocks are part of.*

KEYWORDS

Laricobius nigrinus, dispersal, predator impact

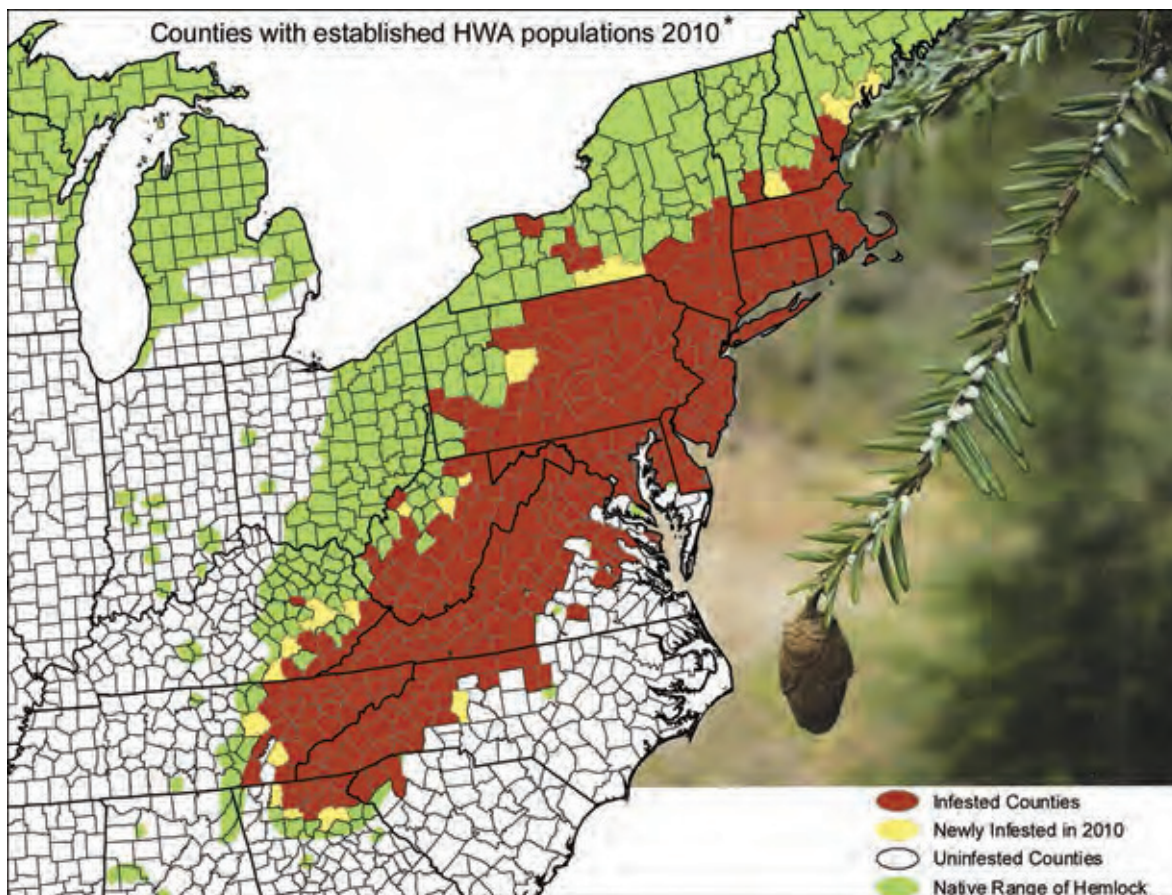
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TECHNOLOGY
TRANSFER

*Hemlock Woolly
Adelgid*

Fifth Symposium on Hemlock Woolly Adelgid in the Eastern United States

Asheville, North Carolina
August 17-19, 2010



*See inside cover.

Compiled by Brad Onken and Richard Reardon



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***Cover map:** Produced by USDA Forest Service, 2010. The map depicts counties with established populations of hemlock woolly adelgid (HWA) that have been confirmed by state forest-health officials. The coarse nature (scale) of the map does not provide information below the county level; highlighted counties are not necessarily entirely infested with HWA.

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Fifth Symposium on Hemlock Woolly Adelgid in the Eastern United States

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August 17-19, 2010

Renaissance Hotel
Asheville, North Carolina

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FOREWARD

This is the 5th HWA symposium; the first meeting was held in Charlottesville, Virginia in 1995. Over the past fifteen years we have seen HWA spread like wildfire in the south, invade six additional states, and cause extensive tree mortality throughout the mid-Atlantic and southern regions. Sounds rather hopeless and yet we remain optimistic, and here's why.

During the first seven years (1995-2002), there were but a handful of scientists, forest health specialists and resource managers working on the HWA research and management issue. Investigations into biological control were limited and in its infancy, there were no chemical control options for protecting hemlocks in a forest environment, no standardized sampling methods, impacts to hemlock forests remained scattered regionally and until the late 1990s, some forest health specialists were even skeptical that HWA was really that big of a threat to hemlocks! Our basic knowledge of HWA biology was limited as was the consistency of funding to support the needed research and methods development. In 2001, a formalized plan, *An Exotic Pest Threat to Eastern Hemlock: An Initiative for Management of Hemlock Woolly Adelgid* was put forward and more stable levels of funding were made available annually by the USDA Forest Service beginning in 2003. This was the beginning of the HWA Initiative and the accelerated effort to research and develop management solutions. An effort that now involves 24 universities, seven institutions in China and Japan, 20 state agencies, four federal agencies and nine private institutions.

In the last eight years we have seen several effective systemic insecticides become labeled for forest applications resulting in tens of thousands of hemlocks treated and protected annually. Standardized survey methods have been developed, and thanks to investigative DNA technology, we now know that all HWA are NOT created equal and that the origin of HWA found in the East is southern Japan. We now have six institutions rearing HWA predators and we are seeing predators becoming established in many areas from Maine to North Carolina. The cold tolerant *Laricobius nigrinus* found in the interior west has been recently released is now becoming established in areas where the coastal strain of this beetle was difficult to establish. With all this, we also have approval to begin rearing and releasing the newly discovered beetle predator from Japan, *Laricobius osakensis* which has proven to be very promising.

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