Chapter 19: Integrating Chemical and Biological Control

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INTRODUCTION

Research and management efforts to establish an effective biological control program against HWA has received significant support by the U.S. Forest Service over the past 17 years. Other federal and state agencies, universities, and private entities have also contributed to this overall research and management effort. Although a number of HWA-specific predator species from Asia and western North America have been studied in quarantine, mass reared, and released, the work discussed here will focus on *Laricobius nigrinus* (Coleoptera: Derodontidae). This predator, from western North American hemlock forests, has become established throughout the mid-Atlantic region (Mausel et al. 2010). Also current studies by G. Davis (Ph.D student at Virginia Tech) show that the beetle does not disperse very far the year they are released and only about 300 m 5 years after release. Long-term impact studies of the predator are ongoing, but it is apparent that at many of the release locations where *L. nigrinus* has established, older mature trees have succumbed to HWA. The younger, more vigorous understory trees do not decline as quickly, and appear to sustain growing populations of *L. nigrinus*.

Imidacloprid has been the standard insecticide for application against HWA in urban and other settings where individual trees are highly valued. Merit 75WP and, more recently, Advance Tree and Shrub (Bayer) for homeowners have been used effectively in soil applications. Stem injections of various imidacloprid formulations have also found a niche for treating high value hemlocks. Recent formulation advances by Bayer have included CoreTect®, slow-release tablets placed under the organic layer around the root collar of trees. This recently registered product allows for a much easier application of imidacloprid and makes treatment of trees in remote areas more feasible.

Laricobius nigrinus susceptibility to imidacloprid was recently studied by Eisenback (2008). While acute toxicity was demonstrated in the laboratory from topical application and from feeding on poisoned prey (Eisenback et al. 2009), results were much less conclusive in the field. At sub-lethal dosage applications, predator mortality and fitness impacts from feeding on HWA settled on previously treated trees were minimal. Furthermore, HWA is extremely sensitive to imidacloprid (Cowles et al. 2006) and the presence of HWA on previously treated trees should indicate that imidacloprid concentrations in those branches are low or absent. A greater source of negative effects of imidacloprid on HWA predators was therefore predicted to be a result of reduced prey quality and density (Eisenback, 2008). Although imidacloprid exposure through feeding on adelgids on treated trees is possible, most HWA available to predators should be located on untreated trees or trees with little risk of exposing predators to toxicity.

Therefore, the new chemical technologies, the limited dispersal ability of the predator, and the predicted limited impact that systemically applied insecticides may have on predators in the field all lead toward the idea of developing a strategy that uses both chemical and biological tactics in the same stands. One integration scenario is to maintain the health of a select number of large hemlocks with insecticide applications, and at the same time release and allow the biological control agents to become established on understory trees, increase, and serve as long-term suppressers of HWA. We hypothesize that this integrated approach could save more hemlock trees over time in a given area than the use of either control treatment (biological or chemical) in isolation. If shown to be an improvement over current strategies, it can become the standard approach to area-wide IPM for HWA.

TESTING THE HYPOTHESIS

A study has been initiated at Kentucky Ridge State Forest, near Middlesboro, KY. Three blocks, each containing one replicate of four treatments, have been established (Fig. 1). The treatments are: 1. treat a cohort of co-dominant to dominant trees with imidacloprid; 2. release *L. nigrinus* on a cohort of understory hemlock trees; 3. combine insecticide and beetle release treatments as in 1 and 2; and 4. do nothing (control).

In plots assigned chemical-only and chemical plus predator treatments, 6 dominant or co-dominant eastern hemlock trees were chosen for chemical treatment. Chemical treatments consist of soil injection of imidacloprid (Merit 2F) applied with a Kiortz soil injector at a recommended rate of 0.2 ounces of product per inch dbh (0.5 g [AI] /cm dbh). Insecticide treatments were applied

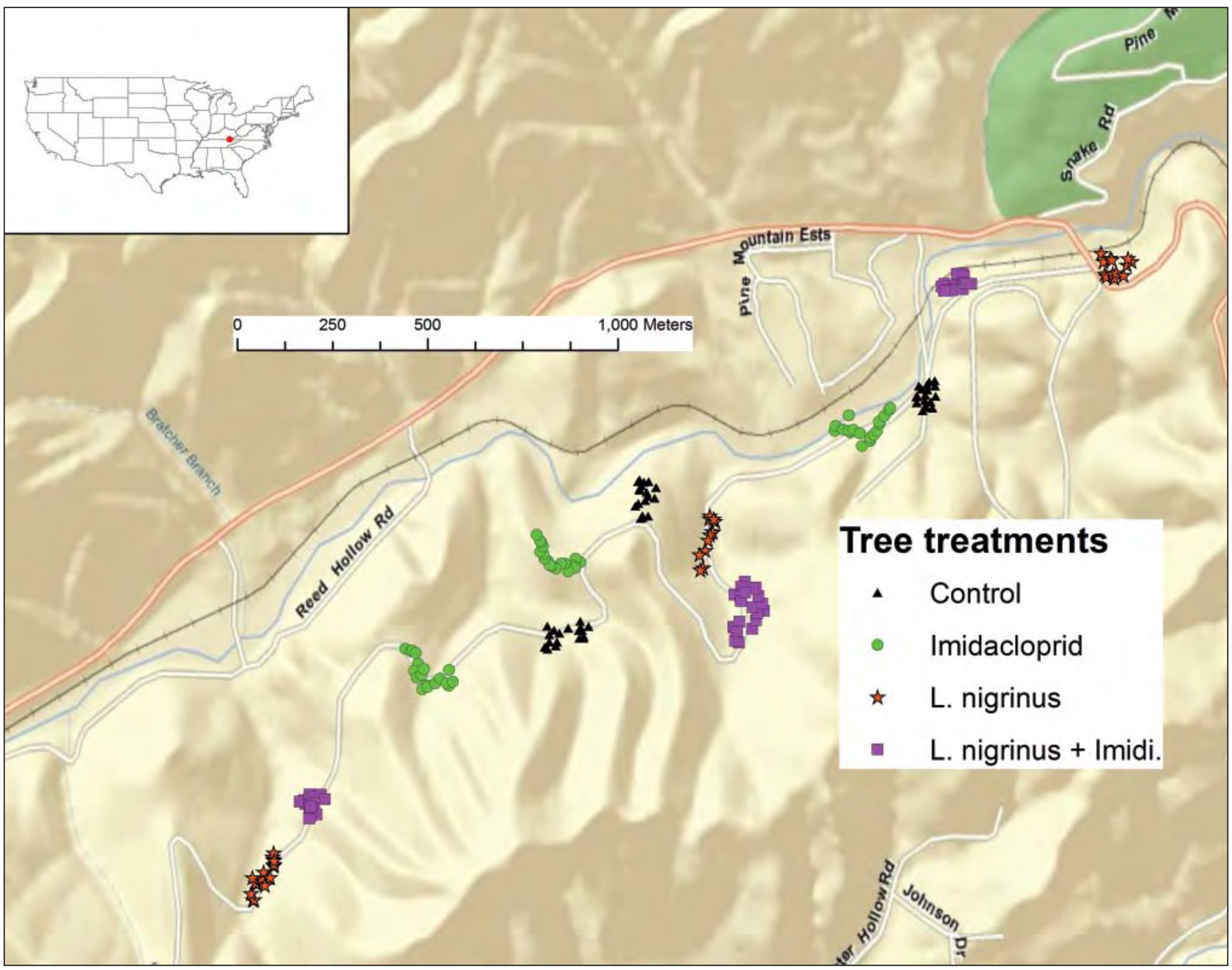

Figure 1. Chemical and biological control plots in Kentucky Ridge State Forest, KY.

in May 2010. In plots assigned beetle-only and beetle plus chemical treatments, 6 intermediate/suppressed trees were chosen as predator (*L. nigrinus*) release trees. A total of 125 lab reared *L. nigrinus* adults were released per tree (750 per plot) in October 2010. An additional 6 untreated trees within each plot were randomly selected for data collection to contrast with treated trees.

Tree health and HWA population measures were made for all chosen trees before treatment and will be assessed annually for 3 more years. Tree health measures include percent live crown ratio, foliage transparency, new growth, and tip dieback. HWA populations will be measured by randomly selecting 10 branches per tree. The terminal 30 cm will be examined and the number of HWA counted until ten HWA are found and the next branch will be examined. The total number of HWA found on the ten branches will be summed and this number will be recorded as an index of HWA density for that tree.

Sampling for adult predators every fall using beat-sheet methods and larvae every spring by clipping infested branches and rearing will be carried out to assess predator establishment. Predator exclusion sleeve-cage evaluations may also be carried out to determine if the impact from predation differs between predator only and predator plus chemical treatments.

Additional sites over a wide geographic range will be added to this study in an attempt to evaluate the proposed strategy along the active front of HWA movement. We will choose locations that normally would be chosen for HWA predator releases (i.e., stands with building HWA populations and none to minimal decline in tree health). In these situations, HWA populations are often sporadically present throughout the stands.

While this design will provide more answers over a longer time period, it is likely to yield measurable results within 3 years of application. We will be able to compare overall stand health for each treatment tested. We will also be able to compare predator establishment under the two predator treatment regimes to determine if presence of chemically-treated trees impacts predator success. Perhaps when this is done, we will be able to recommend a new coordinated integrated control treatment that can save a higher percentage of trees at any one location.

LITERATURE CITED

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