Status of Hemlocks, HWA and Biocontrol in Georgia: October 2015

HWA was found in the northeast corner of Georgia in 2002. No labs in Georgia – State, University or Federal – were working on HWA biology or any biocontrol aspects of this pest at this time. Federal money, State matching funds, and significant contributions from the private sector got the ball rolling in 2004 at Clemson, in 2005 at Young Harris College, in 2006 at the University of Georgia, and in 2008 at North Georgia University. During the ensuing twelve years, 95% of State, Federal, and private hemlock stands have been severely infested by HWA. Surviving hemlocks in the eastern-most third of the state are undergoing their third round of recovery and reinfestation. The most recent decline is much farther west in the Cohuttas. Hemlock resources near the Alabama/Tennessee borders are relatively healthy but make up less than 5% of hemlock stands. Mortality across the state is extreme. A very conservative estimate of dead trees from all categories of land ownership is 500,000 trees. I would not be surprised if the actual number is closer to 1 million dead hemlocks.

Georgia is on the front lines in this battle against HWA. We have a much longer growing season than many of our northern colleagues, and water is abundant, though annual droughts of varying severity are common. We are no stranger to longer term droughts (last one 2005 to 2009) which accelerate hemlock decline and mortality. Our hemlocks commonly support HWA densities nearing thirty HWA nymphs per cm of new growth. Trees remain relatively healthy even at HWA densities of ten to fifteen per cm of new growth, whereas hemlocks farther north exhibit decline symptoms (loss of new growth, needle loss, stagnation) at only five HWA per cm new growth. Pest populations can build to incredibly high numbers over large areas, and just as rapidly collapse leaving very sick and dying hemlocks in their wake. The University of Georgia, in conjunction with the aforementioned labs, has aggressively pursued biological control with three of the available predators (*Laricobius nigrinus, Scymnus sinuanodulus and Sasajiscymnus tsugae*), and a fourth predator discovered by Dr. Richard McDonald assisted by Dr. Michael Montgomery (ret). This fourth predator, *Scymnus coniferarum*, is from the Pacific Northwest where it has co-evolved with HWA and its predator guild for geologic time. At UGA we eliminated *Sasajiscymnus tsugae* early on for a number of good reasons including weak establishment at field sites and genetic stagnation in all lab colonies. We tested the other Asian lady beetle (*Scymnus sinuanodulus*) over four years, releasing several hundred thousand at multiple sites but never making a single field recovery. This predator was also dropped. This left us with *Laricobius nigrinus* and *Scymnus coniferarum* which work exceedingly well in concert in the Pacific Northwest to control HWA. We have every reason to believe that this combination of predators gives us our best chance at establishing biocontrol across north Georgia. *Laricobius* is already well established in a significant number of sites (175 total release sites), and we have field evidence supporting increased tree health with establishment of predators.

Ours was a very blue-collar operation in Georgia. We didn't look for any long-term research to occupy our time because hemlocks were dying right now by the thousands every week. We use what is available and try to apply our collective experience and common sense to address this monumental problem. We do survey work year-round assessing tree health, predator establishment, and predator efficacy on the fly. The past twelve years have shown us that as long as *Laricobius nigrinus* is actively feeding on HWA (October through early May in Georgia), HWA density is held to an acceptably low level which hemlocks tolerate well. Unfortunately, *Laricobius* drops to the soil and remains there during pupation and adult emergence from early May to mid-October. The second generation of HWA (Progrediens) is active until the end of June/mid-July, and there does not seem to be significant predation on this second generation of HWA. Consequently, HWA densities skyrocket, resulting in huge population increases when the entire system (trees/pests/predators) becomes active again in October. Our dire need in the deep South is for a second generation (late spring/summer) predator. Based on seven years of collecting in the Pacific Northwest by McDonald and Montgomery, *Scymnus coniferarum* may fill that hole very nicely. Georgia currently has dozens of sites which have received two Asian lady beetles and two native predators

[from the Pacific Northwest] in substantial numbers. Of our 175+ predator release sites, all of them have received at least one native and one foreign predator. Going forward, we will concentrate on the second generation native predator and release this in as many existing sites as possible. National Forest cooperators in Georgia fully support our efforts on their behalf and are excited regarding the possibility of a native predator solution for the HWA problem.

We will continue to seed new release sites with the native predators as they become available. New release sites will not be easy to locate now that all of the contiguous National Forest lands are infested with varying states of hemlock decline. Dumb luck has already yielded two new sites in the Hale Ridge Rd/Overflow Creek Rd. area in the Warwoman drainage. Additionally, we established one new site in the Davidson Creek drainage in 2014. Areas that might yield new release sites are in and around older beetle release sites and soil injection sites. As the soil injection sites near time for retreatment, HWA will begin to recolonize the hemlocks when the Imidacloprid titer drops below toxic levels. Predator beetles could be included on trees in these areas following several simple protocols (see below) which rely on either an adequate buffer zone of untreated hemlocks or a one-year time delay in releasing beetles on untreated trees within a soil-injected site. Isolated hemlock watersheds which have recovered from initial HWA infestation and are not experiencing significant HWA reinfestation pressure certainly exist on the National Forest. Our level of commitment will determine whether we find such sites in a timely fashion.

Going forward: Georgia's HWA biocontrol project is a mature program well into its tenth year. We have demonstrated success in establishing one of the native predators (*Laricobius nigrinus*) in multiple sites across the state. We have high hopes for the second native predator (*Scymnus coniferarum*) and are into our fifth year releasing this predator. We have efficient protocols for site selection, hemlock health assessments, and predator establishment. Our most dire need is for funds to purchase wild caught, native predator beetles to continue this biocontrol effort.

Trial protocols for establishing native predatory beetles in and around soil injected areas.

As protection wanes in soil-injected areas due to loss of efficacy of the insecticide, hemlocks begin a reinfestation phase that is largely determined by surrounding HWA population pressure. During the time frame six to eight years post-treatment, we can select hemlocks to withhold from retreatment, allowing recolonization by HWA to serve as prey for our native predator beetles. Several ways to attempt this follow.

I. Retreat entire site with soil injection and search the perimeter for infested trees to release the native predators. Dozens of hemlocks with adequate numbers of HWA is preferable to just a few
II. Withhold a percentage of hemlocks in soil-injected area (20 to 30% at least) from retreatment and release predators. Timing can be manipulated, but injection in late spring followed by predator release in November/December might work well
III. If the surrounding forest is in good shape and *Laricobius* has been collected there, consider withdrawing the entire site from retreatment with insecticide and supplement with native predator releases, in particular *Scymnus coniferarum* (Scw).
IV. If new drainages with no current soil-injected sites are found and hemlocks are considered to be in reasonably good condition, treat new sites with insecticide on year 1, and then follow up with native predator releases in year 2 on select groups of untreated trees

Trees selected for recolonization by HWA should have ample foliage accessible from the ground or be on an edge of some opening. Continuity of untreated hemlocks might be important so trees in small groups are preferable to scattered single trees. All of these and most other treatment strategies require significant manual work in surveying and assessing hemlock and HWA condition on the ground in real time. There is no substitute.

Winter Mortality

Our recent flirtation with arctic conditions in the deep South resulted in a tremendous bump for our hemlocks. Below 2400' in elevation there was measurable winter mortality. Hemlock regrowth did occur, but HWA rebounded vigorously by the end of the Progrediens (second) generation, resulting in many areas in decline. Between 2400' and 2700' in elevation there was substantial HWA mortality, resulting in abundant foliage regrowth, but again the HWA had a strong resurgence in the second generation. HWA densities are not generally high enough to push sites into decline yet. Above 2700' moving into 3000' and above, HWA was in very low density and virtually impossible to find. Surveys at this elevation showed multiple growth flushes and no measurable recolonization by HWA. It is bound to be out there, but we could not find it. Good news indeed and we should hope for similar conditions this coming winter…briefly of course! These elevations are not gospel but are moderated by aspect (south/southwest facing slopes are warmer than North/northeastern facing slopes), steepness of the slope, and openness of the forest.

HWA predators and fire

Currently, avoid fire in beetle release areas. Additionally, give your predator release sites a one- to two-acre circular buffer zone in which no fire or soil treatment is used. When and if predators become established, they need adjacent areas for expansion. The area currently occupied by beetle release sites is minuscule compared to the total acreage to be burned, so this should not be an unreasonable parameter when preparing for prescribed burns. Bole and foliage scorch height defines the vertical kill zone for both HWA and predator larvae. Residency time of fire on the ground is also vitally important. Remember that predator larvae feeding on foliage above a fire can be directly killed where they feed, and most have a drop response to disturbance – not a good response with fire on the ground. All predator larvae at all heights end up on the ground where they pupate and aestivate (entomological equivalent to 'hanging out' for an extended time) at or near the soil/duff interface layer. Slow moving fire from late April to November has the potential to kill predator pupae where they lie in the soil. Concurrently, a real goer such as a head fire racing up a steep slope will have such tremendous foliage and bole scorch as to preclude anything surviving. Until studies are conducted to assess these potentially deadly scenarios, caution is certainly the side to be on. My recommendations are solely based on my 38 years of intermittent experience with prescribed fire, going back to my undergraduate days at UGA, and on one superb controlled study in longleaf pine at the Savannah River Plant conducted by an extremely capable post-doc in our lab. Google scholar "Brian T. Sullivan and SRP and longleaf pine mortality and prescribed burn" for a very enjoyable read.

This assessment of where we are with HWA, hemlocks, and predatory beetles is my take on the subject and most definitely still a work in progress!

Sincerely,
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