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New York State Hemlock Initiative

# 2017 Annual Report



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# 2017 Annual Report

## New York State Hemlock Initiative



### Authors

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Mark Whitmore, Caroline Marschner, Nicholas Dietschler, Charlotte Malmborg, Samita Limbu, Isis Caetano, and Joshua Stone

### Mission

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The mission of the New York State Hemlock Initiative (NYSHI) is to coordinate state-wide efforts of land owners, state and federal agencies, government officials, and concerned citizens to conserve New York State's hemlock trees. Our research focuses on the management of hemlock woolly adelgid (HWA), a non-native invasive insect, using biological control. Additionally, our work involves public outreach to engage stakeholders and increase awareness of the threats posed by HWA and other invasive forest pests.

### Executive Summary

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2017 was a landmark year for the New York State Hemlock Initiative (NYSHI). Thanks to support from New York State's Department of Environment and Conservation (NYS DEC), the US Forest Service, and the US Department of Agriculture, the Initiative established New York's first biocontrol research facility for hemlock woolly adelgid (HWA), a non-native invasive insect species that threatens to functionally remove hemlocks from New York's forests. Our substantial growth included laboratory construction, increased personnel, and growing research, biocontrol research and development, and outreach programs. We continued to help coordinate the state and regional response to HWA, collaborated with NYS DEC for HWA mapping and management, worked with New York's Partnerships for Regional Invasive Species Management (PRISMs), supported new programs in Michigan and Nova Scotia, continued to participate in the national HWA program led by the USFS, conducted outreach to landowners and potential volunteers, and added new and expanded outreach tools and resources.

NYSHI's new HWA biocontrol research facility is housed in Morrison Hall on Cornell campus in Ithaca, NY, which was renovated to meet the the program's needs. Growth chambers, microscopes, cages, insect handling equipment and more were installed, and NYSHI's director Mark Whitmore hired two post-docs, a second field technician, two full-time laboratory technicians and a handful of student workers to provide expertise and staffing for the research laboratory. Exploration for HWA predators in the Pacific Northwest commenced in April and laboratory staff reared Silverflies (*Leucopis* species) to adulthood from April – June, then conducted experimental releases of these insects. In October

and November field collections of *Laricobius* beetles from the Pacific Northwest were used to establish a colony in the new laboratory, and the grand opening of the lab was held on November 17<sup>th</sup>.

## Looking forward

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In 2018, the NYSHI's programs will continue to mature. With our research program, we will refine our understanding of HWA and its biocontrols, moving us closer to implementing a viable biocontrol option for HWA. Goals in the laboratory include experimental manipulation of the HWA growth, and work to more fully understand development of *Leucopis spp.* and *Laricobius spp.* in order to maximize predator survival and develop efficient lab production. We will continue our exploration for predator sources in the Pacific Northwest, including British Columbia where more cold-tolerant biotypes may be found. Releases of predators and evaluation of their establishment will continue across New York State with a focus on hard-hit areas in the Southern Catskills. In our coordination role, we will continue to collaborate with New York's PRISMS, iMap, and hemlock conservation stakeholders to ensure that data collection and HWA management are consistent through the state. We will also continue to provide the best knowledge available to New York's public through presentations, citizen science programs, and train the trainer activities and tools.

# Capacity Building



2017 brought welcome changes to the NYSHI, as we expanded our staffing to include laboratory and additional field and outreach staff, construct the biological control research facility at Cornell, and greatly expand our public engagement and outreach materials.

## Outreach

In 2017 our capacity for outreach grew in leaps and bounds. In January we launched a new, expanded website with much more information than the previous version, and in the fall we added PRISM specific information along with several other new pages. Also in the fall we offered a subscription service for our website; our 23 subscribers receive our blog posts and are added to our contact database for other outreach. In August we hired Charlotte Malmborg as a full-time outreach technician, and she has been producing new outreach materials at a prodigious rate. We now have a Hemlock Initiative quarterly newsletter, the Hemlock Tribune, twice weekly Facebook postings to our 178 Facebook followers, and a matching set of new outreach materials. In December, we shot film for three short HWA related educational videos, which we will be completing in 2018.



Front page of our Winter 2017-2018 Newsletter, the Hemlock Tribune

## New Staff in 2017

**Tonya Bittner**, Post-doctoral associate (October 2017): Tonya's PhD dissertation (2000) combined individual ecology with molecular genetics to infer evolutionary processes in isolated populations of garter snakes. After teaching for several years and taking time to raise children, Tonya returned to research in 2014 and has produced several papers on invasive insects, including the *Sirex* woodwasp and gypsy moth, as part of the laboratory of Ann Hajek at Cornell. Tonya will work on the genetics of silver flies (*Leucopis spp.*) along with a collaborator from the US Forest Service, Nathan Havill.

**Marshall LeFebvre**, Field and Lab Technician (February 2017): Originally from Pittsburgh, PA, Marshall has lived in Ithaca since 2015. He has a degree in Conservation Ecology from California University of Pennsylvania and has worked in sustainable agriculture, exotic animal husbandry, and native landscape restoration. At NYSHI, Marshall conducts fieldwork, assists in the laboratory, and manages the NYSHI's student workers.

**Samita Limbu**, Post-doctoral associate (June 2017): Samita completed her undergraduate degree in Agriculture from Purbanchal University in Kathmandu, Nepal in 2010. For her graduate study, she joined Pennsylvania State University in Dr. Kelli Hoover's lab, earning her PhD in Entomology in Dec of 2016. One focus during her graduate research was

evaluation of a predatory lady beetle from China as a potential HWA biological control. At NYSHI she is developing laboratory protocols and training staff to rear predatory beetles in the laboratory, and her research focus is the assessment of *Leucopis* species as an HWA biocontrol.

**Charlotte Malmborg**, Outreach Technician (August 2017): Charlotte graduated from Lehigh University with a B.S. in Earth and Environmental Sciences. She previously worked with the Vermont Youth Conservation Corps in Vermont, Phipps Conservatory and Botanical Gardens in Pittsburgh, PA, and Kestrel Land Trust in Amherst, MA before joining the NYS Hemlock Initiative team. She currently focuses on science literacy and state-wide public outreach about hemlock conservation and biological control management efforts, and occasionally lends a hand in the field and lab.

**Kate O'Connor**, Lab Technician (December 2017): Kate graduated in December 2016 from SUNY ESF with a BS in environmental biology. While in school, she worked for the Cazenovia Preservation Foundation and volunteered for NYSHI. Following graduation, she worked for NYS Parks as a forest health specialist, monitoring for invasive pests and pathogens throughout eastern New York. She joined NYSHI at Cornell as a laboratory technician for the Hemlock Initiative.

## Biocontrol Research Laboratory

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The laboratory facility consists of office and laboratory space, three walk-in coolers for the biocontrol insects and their food, four growth chambers for experiments, genetic equipment for *Leucopis* genetics work, microscopes that are critical to nearly every aspect of NYSHI's research, and a wide range of cages and environments for the various life phases of the *Laricobius* beetles. It also includes a greenhouse in Cornell's entomology quarantine facility, with custom-constructed cages for rearing *Leucopis* larvae to adults. The grand opening of the biocontrol research facility was on November 15<sup>th</sup> of 2017, and was attended NYS DEC Executive Deputy Commissioner Ken Lynch, NYS DEC Deputy Commissioner of Natural Resources Kathy Moser, State Assemblywoman Barbara Lifton, Dean Kathryn Boor of Cornell's College of Agriculture and Life Sciences, and professors, students and dedicated NYSHI volunteers.



Laricobius colony.  
Photo: Charlotte Malmborg, NYSHI

## Colony Establishment

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*Laricobius nigrinus* beetle  
Photo: Nicholas Dietschler, NYSHI

We are working with four species of predators for HWA biocontrol, *Laricobius nigrinus*, *Laricobius osakensis*, *Leucopis argenticollis* and *Leucopis piniperda*. Laboratory colonies of the *Laricobius* beetles are being established, and the colonies will be used to conduct research on the production and release of the species. In 2017 we wild-collected our founding *L. nigrinus* insects from the Pacific Northwest, and received our founding insects for *L. osakensis* from the laboratory at Virginia Technical Institute. Protocols for successful colony reproduction of the *Leucopis* fly species have not yet been established, so these are collected in spring from the Pacific Northwest as larvae, reared to adulthood in the quarantine facility at Cornell's Sarkaria Arthropod Research Laboratory, and then released in New York forests. In April of 2017, we wild-collected

over 4,400 *Leucopis* spp. from four sites in the Pacific Northwest for the development of laboratory rearing protocols; about 2000 of these were released in New York, and 300 were shared with other agencies for research purposes.

# Research Projects



Research projects investigated both HWA ecology and biocontrol rearing and release methods for HWA predators. These efforts were greatly expanded in 2017 with the purchase of high-powered stereo microscopes, growth chambers to conduct controlled experiments, and the addition of several personnel and student workers to provide increased capacity and expertise.

## Hemlock Woolly Adelgid Research

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We have several research projects ongoing at the biocontrol facility that inform our understanding of HWA's life cycle, response to weather extremes, spread across New York, and location of promising biocontrol release sites. Several of our HWA research projects are citizen science driven, including HWA surveys and HWA phenology. Please see our section on collaborations and outreach for the details on these programs.

### **Growing Degree Days and HWA Development**

Studies have shown that hemlock woolly adelgid (HWA) infestation is variable by year and by geographical location. HWA has been spreading more rapidly in the Southeast than the Northeast United States, and it is suggested that as temperature has a substantial impact on the developmental rate of HWA and contribute to the variability of its spread. Our laboratory is looking into effects of temperature on post-aestivation development of HWA. HWA from Taughannock Falls State Park were collected and placed in one of five temperature regimes; their development was tracked daily through the end of 2017. Already this study has revealed wide variability in HWA development even on a single twig. The data from this study will help us better track development and will refine our understanding of HWA's life cycle and its response to temperature. The experiment will conclude in late spring of 2018, and results will be in the 2018 annual report.



Hemlock woolly adelgid adult with eggs.  
Photo: Nicholas Dietschler, NYSHI

### **Winter Mortality and Supercooling**

2017 was the fourth year of winter mortality data collection for the Initiative, and the third year of supercooling data as part of the winter mortality program. Samples were collected biweekly each winter from November at three sites along a climate gradient, from the mild Ontario Lake plain to the Catskill Mountains. Samples were checked for HWA mortality over the course of the winter, and cumulative mortality calculated and compared against temperature data collected at each site. In addition, HWA were brought back to the lab from each site and tested to determine their



Hemlock woolly adelgid in Taughannock Falls State Park.  
Photo: Charlotte Malmberg, NYSHI

ability to survive low temperatures (“supercooling” points, the lowest temperature the insect could survive). Our data indicate that warm periods followed by a cold snap often increase mortality, and trends are emerging relating to site differences. We hope 2017 will help sharpen the emerging picture of HWA cold hardiness and winter mortality events which influence population buildups and predator population dynamics.

### Summer Mortality

This is the fourth year of a study of shade effects on HWA survivorship over the summer. The lab’s investment in high-powered stereo microscopes and increased staffing enabled

researchers to conduct this experiment with much higher accuracy, eliminating some of the uncertainties of previous years’ field data collection methods. In 2017, no impact of shade was found on HWA mortality during the summer. This may be a genuine lack of influence, or may be due to the mild temperatures and relatively high rainfall experienced in the summer of 2017. We will repeat this experiment in 2018 to build on the existing dataset and capture more weather variables to help understand the interactions between shade and summer weather on HWA mortality.



Hemlock woolly adelgid sistens before breaking aestivation.

### Cold Acclimatization & Reacclimatization

Our winter mortality experiment has shown high mortality in cold events following a period of warm weather, but the degree of mortality is not predictable. In December of 2017, we initiated a pilot study using growth chambers to look at HWA’s ability to acclimate to warm temperatures and subsequently reacclimatize to colder temperatures. The results from this pilot study will inform a full experiment in the winter of 2018-19.

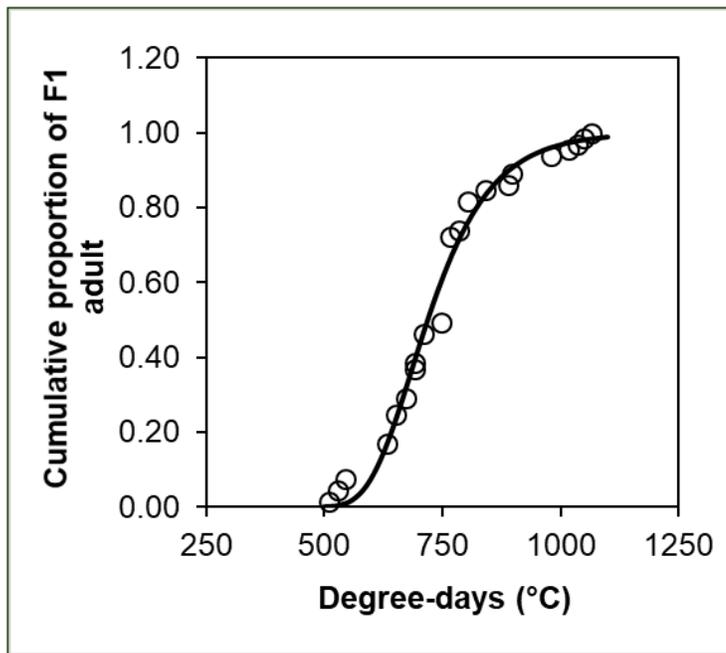
## HWA Biocontrol Research

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The core of NYSHI’s program is development and implementation of effective biocontrol options for HWA management in New York. Our biocontrol research facility enables us to look at questions that are fundamental to the success of biocontrol with the four species we are currently studying.

### Effects of Temperature on *Leucopis* spp. Development

The *Leucopis* species produce two generations per year, similar to the life cycle to HWA. Although *Leucopis* are the one of the most abundant predators of HWA in the Pacific Northwest, little is known about their life cycle, including how temperature influences the length of second generation maturation. This information is crucial both for recovery of the second generation at release sites and for any effort to establish a laboratory colony of *Leucopis*. In 2017 we conducted a pilot study to develop a model of *Leucopis* development for the second generation. Our result shows that



**Figure 1.** Cumulative proportion of *Leucopis* second-generation adult emergence over degree-days

after releasing the predator parent generation, we can expect 50% of their offspring to be adults after 975 growing degree-days ([https://en.wikipedia.org/wiki/Growing\\_degree-day](https://en.wikipedia.org/wiki/Growing_degree-day)). This will help us estimate timing of the second generation of *Leucopis* adult emergence, so we know when to check our *Leucopis* release sites for establishment. This will also help us develop rearing protocols for these flies. In 2018, we plan to expand this into a more rigorous study of *Leucopis* development at different temperatures, creating a stronger model of their temperature requirements for development and exploring the possibility of controlling the timing of *Leucopis* emergence. If this is possible, it will enable us to make sure the *Leucopis* reach adulthood when their food resources are at peak abundance.

### Effects of Temperature on *Leucopis* Longevity

The adult life stage of flies is short, and extending this period will increase the options for use of these HWA predators from the Pacific Northwest. Preliminary tests with *Leucopis spp.* collected in the rearing facility were conducted to verify the possibility of environmental temperature influence on the longevity on flies. One group of each sex was kept at 15°C and another at 20°C over a period of 10 days. Preliminary results suggest that females were not affected by the temperature regimes, but males had a higher percentage of individual survivorship for longer periods at 15°C. We will use the results of this pilot study to refine our rearing methods in 2018, and will expand the experiment to verify our finding.



Adult *Leucopis* silverfly



Silverfly cages at Cornell University's SARL Quarantine Facility

### *Leucopis spp.* Genetics

To date, we have outfitted the genetics lab to perform DNA extractions and PCR-based assays of *Leucopis spp.* and other organisms, and obtained 12 samples of *Leucopis* from sites in central New York and Ontario as well as the flies we collected from the Pacific Northwest. These and other samples from our collaborators will provide DNA for sequencing of each species (*L. argenticollis* and *L. piniperda*) and range (West vs. East). When we have these four sequences in hand, we will be able to find unique genetic markers that will allow us to identify which lineages are most successful in establishment/spread. Using these markers, we will also monitor for potential prey-switching, population mixing, and hybridization after release. The genetics lab should also be able to monitor for the presence of pathogens such as microsporidia in our laboratory colonies of predators.

# Biological Control Releases

## *Leucopis spp.* Spring 2017 Releases

The NYSHI partnered with CRSIP, NYC DEP, Finger Lakes Land Trust, TNC, and NYS DEC to locate appropriate biocontrol release sites for *Leucopis spp.* in the spring of 2017. The sites were surveyed for tree health, HWA infestation density, successful HWA egg laying, ecological significance, and practical release considerations. As *Leucopis spp.* adults emerged in the quarantine facility on campus, they were checked to make sure they were clean of other organisms, sexed, and packaged for release in sets of 5 males and 5 females (a subset had only 3 males, to see how many males are necessary for successful reproduction). These were released into mesh enclosures on HWA infested hemlock branches, so their reproduction could be monitored. We experimented with a range of release site characteristics, release densities of flies, and total numbers of flies released per site; this will provide preliminary data to frame future experiments on the best practices for *Leucopis spp.* release. NYSHI personnel returned within a month to remove the bags, and a subsample of the release branches were brought back to the lab to check for *Leucopis spp.* eggs and larvae. At two sites, bags were left intact and temperature loggers were added to track continued *Leucopis spp.* development in the field over the summer.



*Leucopis* release bags on hemlocks in the field.

A total of 1658 *Leucopis spp.* were released at nine sites in April and May of 2017. *Leucopis spp.* eggs and/or larvae were found at each site, with a total of 154 recovered from subsamples brought back to the lab. The distribution of eggs and larvae was patchy within the enclosures, making extrapolation to the total number of new *Leucopis spp.* difficult.

**Table 1.** *Leucopis spp.* release location information

Locations	Latitude	Longitude	Total bags	Total fly released
Buttermilk State Park (BM)	42.4154	-76.5201	3	30
Cayuga Nature Center (CNC)	42.5180	-76.5574	9	90
Denman Mt. Road (DM)	41.8613	-74.5530	7	48
Durand Eastman (DE)	43.2297	-77.5629	19	270
Myers Road (MR)	41.8344	-74.6363	49	540
Neversink Road (NS)	41.8221	-74.6690	13	130
Paddy Ln. (Pln)	41.8238	-74.6286	21	170
Taughannock Falls State Park (TF)	42.54294	-76.6025	14	140
TNC (TNC) Tanglewood Nature Center/Frenchman's Bluff	42.09799	-76.8740	24	240
<b>Total</b>			<b>159</b>	<b>1658</b>

In addition to the releases done by our lab, we sent 350 *Leucopis* to the Cary Institute in Millbrook, NY, and 300 to North Carolina for experimental release in collaboration with research being conducted by colleagues at the University of Vermont, Oregon State University, and the USFS Southern Research Station in Asheville, NC.

In 2018, the total amount of foliage collected in the PNW will be increased, and PNW collection spread over three trips, one in late March, one in mid-April, and one in mid-May. Last year's release sites will be augmented with additional releases and monitored for establishment from last year's releases. This will enable us to collect preliminary data on site characteristics and release size and density to guide future releases and research.

### ***Laricobius nigrinus* 2017 Release**



In 2017 the focus for *Laricobius* species in New York was establishing our laboratory colony, in order to have stronger beetle resources for future releases. We conducted one release of 500 *Laricobius nigrinus* beetles on October 13<sup>th</sup> at Minnewaska State Park. Our first release of *Laricobius* beetles from our new colonies is scheduled for fall of 2018.

*Laricobius* release in Mianus River Gorge  
Photo: Nicholas Dietschler, NYSHI

# Coordination and Outreach



The NYSHI collaborates extensively throughout New York on hemlock conservation, and this emphasis on working with stakeholders throughout the state is integral to the success of our project. Over the last year we have increased our presence statewide, collaborating with new organizations and deepening our relationship with existing partners. These improved connections will allow us to combine statewide understanding of HWA spread and management with local knowledge of communities and hemlock resources to improve hemlock conservation in NY. We continue to develop these relationships through site visits, organizing field days, coordinating outreach programs and volunteer trainings, and working with stakeholders to identify their hemlock conservation goals while further advancing HWA biocontrol research.

## Collaborations

### NYS Department of Environmental Conservation

The NYSHI works closely with NYS DEC, exchanging survey data, assisting with surveys at high-priority early detection sites, working with state foresters to identify priority survey and biocontrol release sites, and bringing stakeholders together to exchange information and ideas. In 2017, NYSHI was deeply involved with coordination of the field response to the first HWA infestation found in the Adirondack Park, at Prospect Mountain in Warren County. Mark Whitmore was science advisor to the incident command structure for the response, and our staff contributed 104 person-hours to the intensive survey effort determining the extent of the infestation. We will continue to support survey efforts in Warren County, and applied for a CCE intern to conduct HWA surveys in Capital-Mohawk and Warren County for the summer of 2018.



A DEC-led HWA treatment taking place at Zoar Valley  
Photo: Mark Whitmore, NYSHI

### Partnerships for Regional Invasive Species Management



Mark Whitmore with FL-PRISM Coordinator Hilary Mosher  
Photo: Caroline Marschner, NYSHI

The PRISMs are the main drivers of invasive species work for each region of New York, and are primary stakeholders for NYSHI. The Hemlock Initiative sits on the steering committee and working groups of the Finger Lakes PRISM, and held a Finger Lakes hemlock prioritization meeting in February of 2017 to garner feedback on our prioritization efforts for the region. We have worked closely with APIPP PRISM in their prioritization and planning efforts around HWA, including partnering on grants to support remote sensing projects to identify hemlocks resources and monitor hemlock health. In the Catskills, we have assisted with CRISP's hemlock prioritization project; conducted surveys of hemlocks, biocontrol

release sites, and hedges; and worked with stakeholders including The Nature Conservancy, Catskill Mountainkeeper, NYS DEC, and NYC DEP to release *Leucopis* in the region. We collaborated with SLELO PRISM to provide speakers and outreach materials for their HWA monitoring trainings. In 2018, we plan to deepen our relationship with Capital-Mohawk PRISM through information sharing, survey planning and coordination of a CCE intern in summer of 2018.

### **NYS Department of Environmental Protection**

We are working with NYC DEP to identify potential biocontrol release sites and release HWA predators on NYC DEP property. In 2017 we released *Leucopis* at four sites on NYC DEP lands in the Neversink watershed and will be working with them to monitor those sites for establishment in 2018. NYC DEP has been working with NYSHI and other stakeholders in the region on hemlock prioritization.



Mark Whitmore with Bagley Wright from Catskill Mountainkeeper and Dan Snider from Catskill Regional Invasive Species Partnership  
Photo: Nicholas Dietschler, NYSHI

### **Land Conservation Programs**

We work closely with The Nature Conservancy, the Finger Lakes Land Trust, and the Cornell Botanic Gardens on hemlock conservation and biological control research. We assist with trainings and surveys, and each group has provided biocontrol release sites. In 2017, The Nature Conservancy hosted one of our nine *Leucopis* releases at the Tanglewood Nature Center in Elmira, NY.

### **New York iMap Invasives**

New York's iMap Invasives program run by NYS DEC has been an invaluable partner. They have been continuously supportive of our work, helpful with technical assistance, and have developed new functions within iMap to help volunteers and professional resource managers effectively track HWA infestations and management information. In 2017 they continued to support our work through intense planning to support HWA data needs, and technical assistance with data uploads and downloads. They have attended many of our meetings and workshops around the state, presented their area-based prioritization model, and in 2018 plan to build an app for HWA survey and management observations.

## **Outreach Program**

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The NYSHI's outreach program includes presentations on HWA, citizen science programs, train the trainer activities, and planning support for landowners, land managers and PRISMs. In 2017, our outreach to New York residents on HWA identification and management continued, and we established contact with new counties and landowners. Our network of volunteers grew, and our phenology monitoring project was launched in the fall. We continue to support hemlock conservation prioritization efforts in three PRISMs, and are developing materials to help landowners prioritize hemlock management projects on their properties. We participated in the annual HWA biological control conference and the U. S. Forest Service's HWA manager's meeting to share knowledge and coordinate research efforts with states from Georgia to Maine.

# Citizen Science Programs

## HWA Surveys

The director of NYSHI, Mark Whitmore, has been surveying for HWA in New York over the last 15 years. The 2017 season was notable for its significant increase in survey effort, both from our crew and volunteers and from the larger community.



Looking for HWA in the canopy.  
Photo: Nicholas Dietschler, NYSHI

NYSHI was able to increase our survey efforts thanks to increased staffing, a new work vehicle, and improved field equipment. The Initiative developed standardized forms for consistent data collection during site surveys, and consulted with landowners on stand management and hemlock conservation.

The larger community of HWA searchers also both grew and increased effort in 2017. More sites conducted independent trainings and surveys, existing iMap users entered more HWA points into iMap, and more organizations added both positive and negative HWA finds, into iMap. In 2017 the number of HWA points in iMap more than doubled with 675 new data points added to the 428 recorded from 1989 through 2016.

Over half of these points (233) were entered under the Hemlock Initiative project in iMap, by NYSHI staff, collaborators or volunteers. The HWA not detected option in iMap was also used heavily, with 1236 new points added in 2017, 123 through the Hemlock Initiative iMap project.

One of the most notable volunteer HWA finds in 2017 was at Plotters Kill State Park, where a volunteer team being trained to survey the park for HWA found it during their training. Plotters Kill has significant hemlock resources, and the DEC moved quickly to treat the infestation in November of 2017. The same volunteer group also assisted with the treatment effort.

In response to the first detection of HWA in the Adirondacks we participated in five public information events in the Lake George area with a total of 250 attendees.

In 2018 the Hemlock Initiative intends to increase our training efforts, and also provide more formal support for external groups training survey crews through presentation toolkits and outreach materials. We will also work with collaborators to find resources for increased paid survey effort in priority early detection areas.

## HWA Phenology

The goal of the NYS Hemlock Initiative's HWA Phenology Project is to support the HWA biological control program by providing a deeper understanding of hemlock woolly adelgid phenology. Observing and recording the date on which certain HWA life stages occur is important for the timely collection of food material for the biocontrol predator



**Top:** HWA showing clear signs of aestivation break including pinkish lines between body segments and wool accumulation.

**Bottom:** HWA, a few months following aestivation break, covered in wool and preparing to lay eggs.

Photos: Nicholas Dietschler, NYSHI

rearing facility, as well as timing biocontrol field releases and establishment surveys. The life stages that are most important to the success of the program are estivation break, egg laying, and the emergence of crawlers from egg masses. These are likely to vary with temperature and other site considerations across NY State. Tracking phenology with citizen scientists supports several of the HWA experiments discussed in the HWA research section.

Fall of 2017 marked the official launch of the phenology project. We produced phenology training materials for spring and fall phenology projects, and monitored spring egg laying at several sites. We held a series of eight trainings across the state in 2017, with a total of 83 participants trained. Sites ranged from a single motivated volunteer to staff and volunteers at nature preserves and existing phenology monitoring sites. Twelve sites reported phenology data in the fall of 2017, with NYSHI conducting surveys at another three.



*Laricobius* beetles feed on an infested hemlock twig.  
Photo: NYSHI

We also developed a collaboration with the USA National Phenology Network (USA NPN), an organization that tracks phenology for a wide range of species across the United States. We worked with the USA NPN to develop data collection protocols that met the needs of both the NYSHI and the USA NPN. In 2018 we plan to announce our official partnership with the USA NPN, and begin using their Nature's Notebook app to collect volunteer phenology data across the United States. This is significant for use not only in NY but also for collaborators in the eastern US and Canada to more fully understand HWA phenology and to monitor native HWA on the Pacific Northwest to enable efficient collection of predators.

## Hemlock Hedges

Hemlock hedges can make excellent locations for field insectaries, where biocontrol insects are released to reproduce and collections of their progeny are later made to release into priority areas. This is especially important for the *Laricobius* beetles, as laboratory rearing of these species is labor intensive. Hedges are useful because they have dense foliage within reach of researchers for collection, and can support dense HWA populations that in turn provide food for strong populations of biocontrol insects. In 2017 we added six new hedges to our list of potential field insectary sites, although we did not do any additional releases as our focus this year was on building up our laboratory colony. Hedge surveys were conducted by our partners at CRISP where *L. nigrinus* was released in the fall of 2016 to look for establishment. *L. nigrinus* was not confirmed at this hedge, which may indicate more time is needed for the populations to build to detectable levels, or may indicate a lack of establishment. Three hemlock hedges were successfully infested with HWA near Cornell University's Ithaca campus in the spring of 2017, with the hope of conducting hemlock hedge experiments in the future.

## Biocontrol Establishment Monitoring

Our biocontrol establishment monitoring was limited in 2017, due to the intense activity involved with the laboratory build-out. *Leucopis* larvae and eggs were found at all release sites, which provides evidence for successful establishment of *Leucopis*. These will be ready for establishment monitoring to determine overwinter survival



NYSHI Technician Nicholas Dietschler releases *Laricobius* beetles at Mianus River Gorge.

in 2018. Six of our *Laricobius* sites were surveyed in 2017; one of our dedicated volunteers monitored Hemlock-Canadice State Forest, CRISP monitored the 2016 hedge release in the Catskills, and NYSHI surveyed Texas Hollow State Forest and included limited *Laricobius* monitoring into our winter mortality sample processing from Durand-Eastman, Mine Kill State Park and Taughannock State Park. Establishment monitoring will be a priority activity for 2018.

### **Biocontrol Food Resource Location**

High quality food is essential for rearing predators and we were fortunate to locate ample HWA for our biocontrol facility. Our best connection was with Cotton-Hanlon Timber Management; they have many infested hemlock, good access to their lands through logging roads, and do not intend to treat for HWA. Monroe County also supplied excellent food resources from Webster Park. These two sites were sufficient for our needs in 2017, but we had many more offers from other land managers and private land owners. Sources of food material will be a driver of success for rearing of *Laricobius spp* in the lab; there will be an ongoing demand for recently infested, relatively healthy hemlock stands with high HWA populations.

## Outreach Events, Tools, and Publications

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In addition to the capacity building activities discussed above, the Hemlock Initiative had an active year of hosted events, presentations, outreach material development, media contacts, and publications. In 2017 the Hemlock Initiative hosted five events, presented at four scientific meetings, gave 43 presentations on HWA reaching 1,316 people. We renovated and expanded our website and Facebook page and instituted posting schedules for both platforms, produced 16 printable outreach materials, published a scientific article and two popular articles, and conducted 12 interviews with the media resulting in published articles.

### **Events hosted by NYSHI**

Feb 28, 2017: Finger Lakes Hemlock Prioritization Meeting, Ithaca, NY. Stakeholders met to receive NYSHI's update on our hemlock stand prioritization effort, and provided feedback and advice to improve the draft model. This was also an opportunity for stakeholder to compare notes on their hemlock management programs; feedback on the meeting suggested that this was a valuable component of the meeting. 12 attending.

March 7, 2017: NYS Hemlock Conservation Meeting, Ithaca, NY. Stakeholders from across the state met to discuss actions taken to date, ways to move forward across the state, and the ideal role for the NYSHI. 15 attending.

October 11, 2017: New York HWA Manager's meeting, Albany Pine Bush Preserve, Albany, NY. HWA managers and stakeholders from around the state met to hear updates from NYSHI and DEC on hemlock conservation and HWA management activities in 2017, and to discuss plans for the upcoming field season. 25 attending.

November 13, 2017: Biocontrol Laboratory opening gala at Cornell University; 50+ in attendance.

November 17, 2017: Biocontrol laboratory ribbon cutting ceremony. 30+ in attendance. Press coverage in 22 news outlets.



Students from Hobart & William Smith Colleges survey for HWA on a Finger Lakes Land Trust property near Cayuga Lake

Photo: Charlotte Malmberg, NYSHI

## Educational Materials

- Hemlock Woolly Adelgid Poster, printed and distributed by Cornell Cooperative Extension
- 8 PRISM-specific HWA info/reporting pages
- Hemlock and HWA ID Field Guide/Protocol
- Fall and Spring Phenology Field Protocols
- 4 Citizen Science volunteer position description information pages for website
- Children's coloring pages of HWA and biocontrol insects

## Publications

2017. Motley, K., N.P. Havill, A.L. Arsenault-Benoit, A.E. Mayfield, D.S. Ott, D. Ross, M.C. Whitmore, K.F. Wallin. Feeding by *Leucopis argenticollis* and *Leucopis piniperda* (Diptera: Chamaemyiidae) from the western USA on *Adelges tsugae* (Hemiptera: Adelgidae) in the eastern USA. *Bulletin of Entomological Research*. 107 (5), 699-704.

2017. Whitmore, Mark. An update on invasive adelgids in New York. *Branching Out*, August edition.

2017. Whitmore, M., & Malmberg, C. (2017, November). Hemlock Woolly Adelgid in New York State. *The New York Forest Owner*, 55(6), 16-17.

## Presentations at Scientific Meetings

9 January 2017. M. C. Whitmore and B. Thompson. Surveying for predators of Hemlock Woolly Adelgid in Washington State. USDA Annual Interagency Research Forum on Invasive Species, Annapolis, MD.

3 March 2017. Kimberly F. Wallin, Tav Aronowitz, Arielle L. Arsenault-Benoit, Stephen Gaimari, Nathan P. Havill, Albert E. Mayfield, Kyle Motley, Darrell W. Ross, and Mark C. Whitmore. *Adelges tsugae*—where are we now? University of Quebec-Montreal. Montreal, Quebec, Canada.

2 August 2017. Mayfield, A., S. Brantley, C. Brown, C. Brownie, C. Coots, J. Elkinton, J. Grant, A. Galloway, J. Hanula, N. Havill, A. Heminger, G. Hodge, K. Hoover, R. Jetton, S. Joseph, C. Jubb, T. Keyser, J. Lombardo, T. McAvoy, C. Miniati, K. Motley, B. Mudder, A. Neidermeier, B. Reynolds, D. Ross, J. Rhea, S. Salom, A. Tait, K. Wallin, M. Whitmore, W. Whittier, G. Wiggins, D. Zietlow. 2017. Hemlock woolly adelgid research: update from the Southern Research Station. 3rd Annual Hemlock Woolly Adelgid Program Managers Meeting, Chattanooga, TN.

7 November 2017. Ross, D.W., K.F. Wallin, N.P. Havill, A.E. Mayfield, M.C. Whitmore, A.C. Rose, S.D. Gaimari. Current Status of Silver Flies as Biocontrol Agents of Hemlock Woolly Adelgid in the Eastern US. Entomological Society of America Annual Meeting, Denver, CO.

## Media Contacts

23 January 2017. Interview with Roger Gilson of Columbia Greene Media about Hemlock Woolly Adelgid. An article was published in the The Daily Mail, Catskill , NY and the Register-Star, Columbia County, NY.

17 April 2017. Skaneateles Conservation Area hike teaches people how to spot hemlock woolly adelgid. Jonathan Monfiletto. Auburn Citizen and WOCJournal.com, Auburn, NY.

26 July 2017. Hemlock Woolly Adelgid discovered in Adirondack Park. Pete DeMola. Sun Community News, Plattsburg, NY.

14 September 2017. Emerald Ash Borer response to Associated Press article on ash trees becoming extinct. Matt Weinstein at the Ithaca Journal/Binghamton Press, NY. Front page article.

29 September 2017. Hemlock Woolly Adelgid in the Adirondacks. Anthony Hall. Lake George Mirror, Lake George, NY. Article and Editorial.

12 October 2017. Interview on Hemlock Woolly Adelgid and climate change. Veronica Volk at the Great Lakes News, Rochester, NY.

14 November 2017. Office interview with Caitlin Whyte from WXXI, Rochester for a piece on Hemlock Woolly Adelgid in her radio show, Great Lakes Today.

17 November 2017. Hemlock Woolly Adelgid and the Cornell Lab Project. Nick Reynolds. The Ithaca Times, Ithaca, NY. Article.

22 November 2017. Hemlock Woolly Adelgid and the Cornell Lab Project. Paul Post. The Saratogian, Saratoga Springs, NY. Article.

22 November 2017. Hemlock Woolly Adelgid and the Cornell Lab Project. Brian Nearing. The Post Standard, Albany, NY. Article.

12 December 2017. Hemlock Woolly Adelgid in Nova Scotia. Zack Metcalf, independent journalist. Article in the Atlantic Forestry Review, January 2018.

18 December 2017. Hemlock Woolly Adelgid, Balsam Woolly Adelgid and the Cornell Lab Project. Follow-up article. Paul Post. The Saratogian, Saratoga Springs, NY. Article.

## Presentations

January 7, 2017, Jessi Lyons. HWA identification and reporting training at Ellis Hollow. 8 attendees.

January 25, 2017, Jessi Lyons. HWA identification and reporting training for the Canandaigua Lake Watershed Association. 21 attendees.

January 26, 2017, Jessi Lyons. HWA identification and reporting training For the Morrisville Forestry Class. 13 attendees.

January 27, 2017, Jessi Lyons. HWA identification and reporting training at the Finger Lakes National Forest. 1 attendee.

February 4, 2017, Jessi Lyons. HWA identification and reporting training at Baltimore Woods. 14 attendees.



Mark Whitmore speaks to a group of land professionals and volunteers at Letchworth State Park  
Photo: Charlotte Malmberg, NYSHI

February 23, 2017, Mark Whitmore. Viewing of "HWA: Loss of an Ecosystem: film and discussion. 26 attendees.

February 23, 2017, Jessi Lyons. HWA identification and reporting training at Wells College.

February 27, 2017, Mark Whitmore. HWA phenology project training at Harlemville, NY. 12 attendees.

February 27, 2017, Mark Whitmore. HWA phenology project training at Green Chimneys Education Center in Carmel, NY. 23 attendees.

February 28, 2017, Jessi Lyons. HWA identification and reporting training for the Irondequoit Conservation Board.

March 2, 2017, Mark Whitmore. Emerald Ash Borer, Hemlock Woolly Adelgid, and other invasive forest insect pests in New York. Southern Tier Nursery and Landscape Association. Owego, NY. 78 attendees.

March 4, 2017, Mark Whitmore. Update on Emerald Ash Borer, Hemlock Woolly Adelgid, and other emerging forest pests. Cornell Cooperative Extension of Allegany County Rural Landowners Workshop. Yorkshire, NY. 30 attendees.

April 8, 2017, Mark Whitmore. Hemlock and Balsam Woolly Adelgid Biology, Detection, and Management, sponsored by Warren County CCE, the Adirondack Mountain Club, and APPIP PRISM. Warrensburg, NY. 35 attendees.

April 14, 2017, Mark Whitmore. Emerald Ash Borer and Hemlock Woolly Adelgid Biology, Detection, and Management, volunteer training program sponsored by Onondaga County CCE. Skaneateles, NY. 30 attendees.

April 27, 2017, Mark Whitmore. The Hemlock Woolly Adelgid; Loss of an Ecosystem" movie and panel discussion, sponsored by the Atlantic Chapter of the Sierra Club at the Linda Theater. Albany, NY. 25 attendees.

April 22, 2017, Mark Whitmore. HWA informational talk at the Mianus River Gorge manager's meeting. 5 attendees.

May 9, 2017. Management options for HWA in the Plotters Kill Preserve, meeting with county and state stakeholders. Schenectady, NY. 12 attendees.

May 10, 2017, Mark Whitmore. HWA management in New York, telephone presentation for the Canadian HWA technical advisory committee. 10 attendees.

10 June, 2017, Marshall Lefebvre. HWA Biology and Identification, Honeoye Valley Association Annual Symposium. 100 attendees.

6 July, 2017. Little bug, big problems: saving our hemlock forests. SUNY ESF Huntington Lecture Series, Newcomb, NY. 30 participants, 1.5 hours.

July 7, 2017, Mark Whitmore. What is the Hemlock Woolly Adelgid and what can we do to save the hemlocks? Schroon and Paradox Lakes Associations annual meeting, Schroon Lake, NY. 120 attendees.

July 13 2017, Mark Whitmore. The NYS Hemlock Initiative. New York State Invasive Species Conference, Siena College, Loudonville, NY. 90 attendees.

August 15, 2017, Caroline Marschner. HWA identification and reporting for CCE Erie's Forest Pest Training. Buffalo, NY. 20 attendees.

September 6, 2017, Nicholas Dietschler. HWA phenology training at the Community Greenway Colaborative. 2 attendees.

September 6, 2017, Nicholas Dietschler. HWA phenology training at the Minnewaska State Park. 5 attendees.

September 7, 2017, Nicholas Dietschler. HWA phenology training at The Nature Conservancy's Tanglewood Nature Center. 6 attendees.

September 9, 2017, Mark Whitmore. Hemlock Woolly Adelgid detection and management. Meeting of volunteers sponsored by the Adirondack Mountain Club and the Adirondack PRISM. Lake George, NY. 35 attendees.

September 11, 2017, Mark Whitmore. Updates on Emerald Ash Borer and Hemlock Woolly Adelgid. NYS Fish & Wildlife Management Board. White Eagle Convention Center, Hamilton, NY. 20 attendees.

September 11, 2017, Nicholas Dietschler. HWA phenology training at the NY Botanical Garden. 7 attendees.

September 13, 2017, Nicholas Dietschler. HWA phenology training at the Mianus River Gorge. 5 attendees.

September 14, 2017, Nicholas Dietschler. HWA phenology training at Green Chimneys. Putnam Lake, NY. 9 attendees.

September 28, 2017, Nicholas Dietschler. HWA phenology training at the Five Rivers Environmental Education Center. Delmar, NY. 12 attendees.

September 28, 2017, Mark Whitmore. What we can do to manage the Hemlock Woolly Adelgid. NYC DEP Ashokan Watershed Council meeting, Shokan, NY. 28 attendees.

September 28, 2018, Mark Whitmore. The threat posed by the Hemlock Woolly Adelgid in the Adirondacks. Lake George Park Commission annual meeting, Lake George, NY. 20 attendees.

September 29, 2018, Mark Whitmore. The threat posed by the Hemlock Woolly Adelgid in the Adirondacks. Town of Hague Community Meeting, Hague, NY. 45 attendees.

September 29, 2017, Nicholas Dietschler. HWA phenology training at the Catskill Interpretive Center. Mt. Tremper, NY. 2 attendees.

October 20, 2017, Mark Whitmore. Hemlock Woolly Adelgid management. Black Locust Conference organized by CCE Schuyler County, Big Flats, NY. 60 attendees.

October 28, 2017, Caroline Marschner. HWA identification and reporting for the Trout Unlimited annual meeting. Pulaski, NY. 36 attendees.

November 8, 2017, Caroline Marschner. Invasive Species, with HWA identification and reporting embedded. Geneva, NY. 32 attendees.

November 15, 2017, Caroline Marschner. NYSHI Update at the NY CCE Agricultural In-Service's Invasive Species track. Ithaca, NY, 50 attendees.

November 15, 2018, Mark Whitmore. The impact of Hemlock Woolly Adelgid to the streams of the Catskills. Annual meeting of Trout Unlimited Ashokan Chapter, Boiceville, NY. 25 attendees.

November 16, 2017, Mark Whitmore. The impact and management of the Hemlock Woolly Adelgid in NY. Lunch speaker at the Annual Environment Conference of the NYS Business Council, Saratoga, NY. 135 attendees.

December 19, 2017, Caroline Marscher. HWA identification and reporting for the Ithaca Rotary Club. Ithaca, NY. 10 attendees.

December 12, 2017, Mark Whitmore. Hemlock Woolly Adelgid management in the eastern United States. Featured speaker at a Special Conference organized by Parks Canada. Kedjimakujik National Park, Nova Scotia, Canada, 50 attendees.



HWA on a twig fallen from a hemlock canopy  
 Photo: Charlotte Malmborg, NYSHI

## Outreach Going Forward

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In 2018, we plan to continue outreach and coordination efforts at the PRISM, state, and regional levels. We will grow our *Laricobius* colonies and begin release experiments with our locally reared insects. We will organize volunteer efforts for *Leucopis spp.* and *Laricobius* releases in the fall and spring field seasons. Additionally, we will add to our hemlock hedge database, increase our prioritization efforts by improving our hemlock data with additional surveying and volunteer data. We will also officially partner with the National Phenology Network to share phenology information on HWA publically, and continue to recruit volunteers for our citizen science programs. Effort is being put into increasing phenology collaboration throughout the east and west coast using USA NPN as the platform.

## Acknowledgements

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### **Special thanks to**

The New York State Department of Environmental Conservation, Invasive Species Coordination Unit for their support, guidance, and partnership.

Our PRISM partners for their tireless work and partnership on hemlock conservation around the state.

Dr. Marc Goebel of Cornell University for his collaboration on hemlock research.

The Finger Lakes National Forest for their support and collaboration.

The National Forest Service for their support, cooperation, and hemlock conservation efforts from Maine to Georgia.

The Adirondack Mountain Club for their continuing collaborations in volunteer training, survey work and education.

The administrative staff of the Department of Natural Resources at Cornell University for their technical, administrative, and fiscal expertise.

# Appendix



## DEC Contract Points & Deliverables

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### Contract Points

The contract contains a two-part plan for this phase of the NYSHI:

- 1) Train volunteers and professionals to assist the NYSHI project.  
We held eight workshops providing information to professionals and trained 543 individuals in HWA ID.
- 2) Research methods of HWA predator production, release, establishment, and efficacy at the Cornell HWA Biocontrol Research Laboratory.  
We conducted this research and used it to set our priorities and protocols for our laboratory work.

### Train volunteers and professionals to assist the NYSHI project:

Activities to be covered include:

- Develop educational materials and a website for outreach and training.
  - New website constructed and refined
  - Webpage for training published
  - Powerpoint for training published on website
  - Facebook page revitalized
    - Regular postings
    - 178 followers
- Detection of HWA infestations.
  - 233 positive HWA detections entered in our iMap project by staff, professional partners and volunteers; 675 entered in 2017 overall, more than any previous year
  - 120 negative HWA points entered in our iMap project by staff, professional partners and volunteers; 1235 entered overall in 2017
- Reporting HWA development over the growing season, or phenology, to assist in determining when and where predators can be effectively released.
  - 12 volunteer sites reporting HWA phenology data in 2017; data indicated change from 2016 and provides the first year of data to establish trends across the state
  - 3 sites of full HWA phenology recorded by NYSHI staff
- Assist in the evaluation of predator establishment.
  - All 2017 *Leucopis* release sites monitored for first-generation establishment
  - Six pre-2017 *Laricobius* release sites monitored for establishment
- Location of abundant HWA populations for use in the Biocontrol lab for growing predators.

- Abundant HWA-infested foliage collected from Cotton-Hanlin and Highland Park; more sites identified for use in future years
- Assist in the evaluation of insecticide treatment efficacy.
  - Worked with Finger Lakes Land Trust and Mianus River Gorge to develop treatment efficacy protocols and data collection tools

**Research methods of HWA predator production, release, establishment, and efficacy at the Cornell HWA Biocontrol**

Research Laboratory:

A number of tasks will be required to continue our work on HWA predators:

- Collection of Silverflies (*Leucopis argenticollis*, and *Leucopis piniperda*) in the Pacific Northwest (PNW) for use in stocking lab colonies and for wild release.
  - Over 4,400 silverflies collected for protocol development and wild release; 2,008 flies released in New York across ten sites; see Table 1 (1,658 by NYSHI, 350 by the Cary Institute)
- Genetic analysis of *Leucopis* spp. collected in the PNW and in NY to establish accurate taxonomic relationships.
  - Samples of local and PNW *L. argenticollis* and *L. piniperda* collected for genetic analyses; sample results will be returned in April 2018
- Investigate temperature and daylight in the lab for optimal *Laricobius nigrinus* development, survival, and synchrony with HWA.
- Investigate different pupation mediums for optimum *Laricobius* survival.
- Investigate methods of establishing a lab colony of *Leucopis* spp.
  - We investigated existing literature and spoke with the rearing facilities in Virginia and North Carolina, and these three items have already been determined. See Salom, S M, L T Kok, A B Lamb, C Jubb. 2012. Laboratory rearing of *Laricobius nigrinus* (Coleoptera: Derodontidae): a predator of the hemlock woolly adelgid (Hemiptera: Adelgidae). *Psyche*, (2012)9p. We focused our efforts on better understanding of HWA life cycles in New York and the variability within those populations, which is critical data for biocontrol releases.
- Conduct experiments to establish prey consumption rates for *Laricobius* and *Leucopis*.
  - *Laricobius* prey consumption rates have already been determined; see Zilahi-Balogh, G M G, S M Salom and L T Kok. 2003. Development and reproductive biology of *Laricobius nigrinus*, a potential biological control agent of *Adelges tsugae*. *BioControl* (48)293-306.

**Project Outputs/Deliverables**

Output #	Task/Product/Deliverable Description	Duration/Frequency/Due Date
1	Educational materials developed. Powerpoint presentations for training and pamphlets for reference	Complete; more in 2018
2	Number of infestations reported by volunteers and HWA trained personnel at various organizations	111
3	Number of volunteers trained to report on HWA phenology	83

4	Effort by volunteers to evaluate predator establishment	Pending in 2018
5	Number of insecticide efficacy evaluations made	2 partnerships developed
6	Number of Silverflies collected in the Pacific Northwest	4,400
7	Number of <i>Laricobius</i> beetles collected in Pacific Northwest	2,600
8	Results of the various experiments planned in the lab for the predators	See report above