2022 Annual Forest Health Newsletter

NH Department of Natural & Cultural Resources
Division of Forests & Lands
Forest Health Program

Aerial Survey

Image 1: View from the aerial survey plane overlooking New Hampshire's Lakes Region (Bill Davidson, NH DNCR)

We mapped 58,680 acres of damage this year, which is the most damage mapped in the past decade. By far the largest damage causing agent was spongy moth, coming in at 52,532 acres of damage. The next most extensive damage causing agent was hemlock looper at 2,450 acres, followed by balsam woolly adelgid (1,826 acres), white pine needle damage (903 acres), and red pine scale (327 acres). Other damage causing agents present in 2022 were hemlock woolly adelgid (287 acres), sirococcus shoot blight on hemlock (277 acres) and logging damage (31 acres).

Aerial survey is a very useful tool for delineating and quantifying discrete damage events such as large-scale defoliation caused by spongy moth, or damage to an entire stand of trees such as what occurs during a red pine scale outbreak. Some types of damage, however, are either difficult to detect from the airplane or are difficult to accurately map. Examples of difficult to detect damage are hemlock looper, which caused extensive damage to understory hemlock throughout the southwest region of the state but was only mapped in the most severe instances where defoliation reached the upper canopy, and drought damage which manifests late in the summer, well after our aerial survey flights have concluded. Emerald ash borer is an example of damage that is difficult to map. This is because it effects a small percentage of trees across entire landscapes, making defining areas of damage a challenge. In 2022, ash trees killed by the emerald ash borer could be observed throughout the entirety of the state south of the Lakes Region but wasn't included on the damage map due to these challenges.

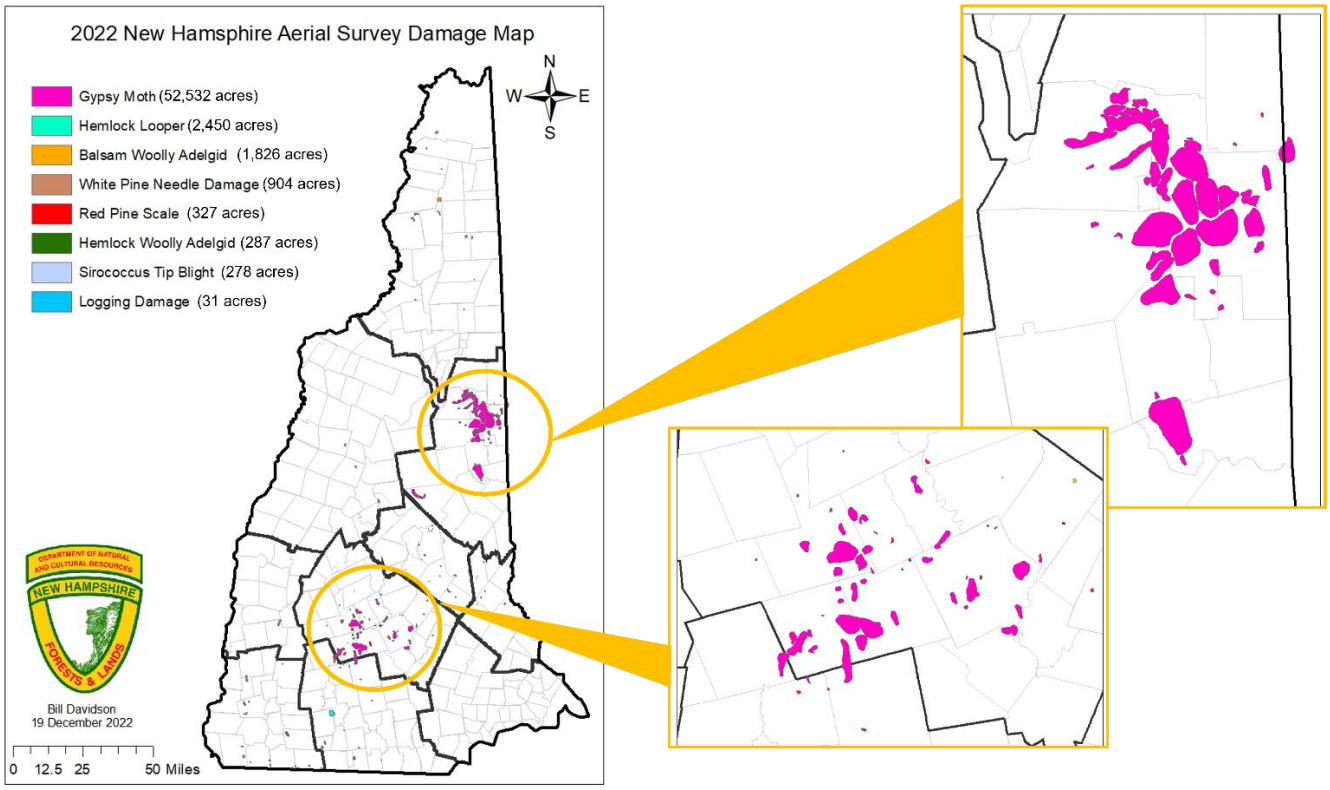
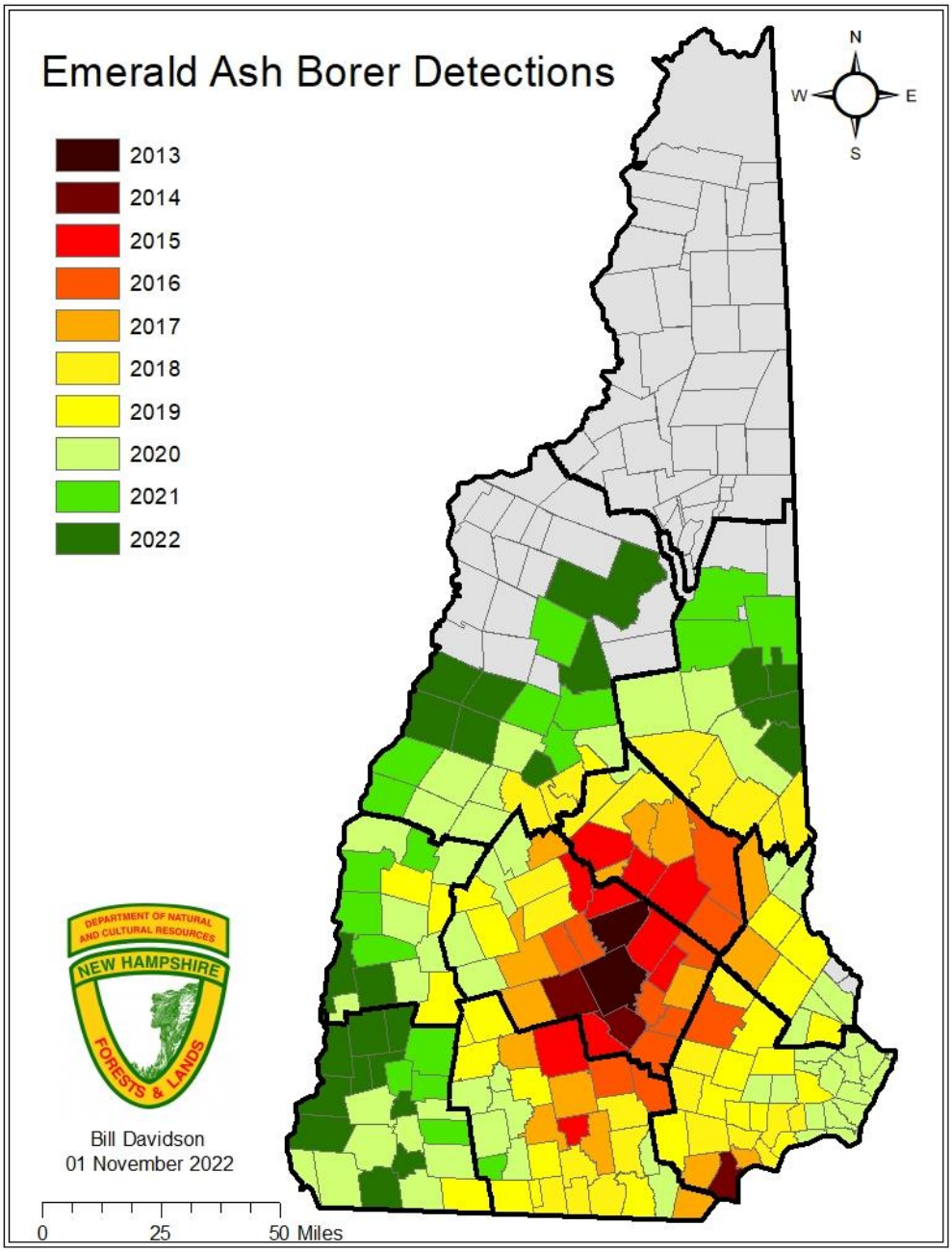


Image 2: This stand of red pine in Gilmanton has been decimated by red pine scale. (Bill Davidson, NH DNCR)

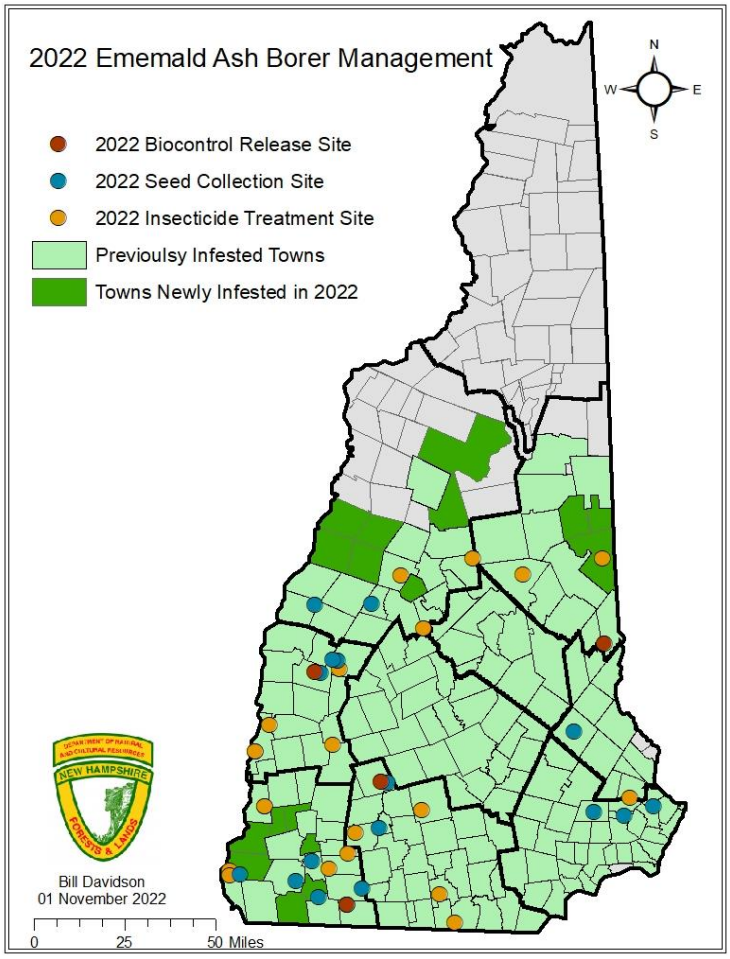
Image 3: Spongy moth defoliation of red oaks near Conway (Bill Davidson, NH DNCR)

Emerald Ash Borer

Emerald Ash Borer was detected in 23 new towns in 2022, with the majority of these detections located in the northern and western portions of the state. The infested area in New Hampshire now covers roughly 7,000 square miles spread across 194 towns, which represent about 70% of the total land area of the state and 80% of all towns. The last remaining portion of the state where the ash borer has not been found is the far northern portions of Grafton and Carroll counties along with the entirety of Coos County. The rate of spread of the core infestation has accelerated as the size of the infested area has expanded and expected that we will find EAB in these currently unimpacted areas in the near future.



Biological control continues to remain our best hope for long term management of emerald ash borer and in 2022 over 13,000 individual parasitic wasps of three different species were released across three locations. Since 2014, when the first deployments of the parasitic wasps were made in New Hampshire, over 300,000 individual wasps have been released at 25 locations spanning the entire extent of the infestation. Recent studies evaluating the efficacy of the introduced wasps' ability to attack emerald ash borer have spurred some semblance of hope for the future of ash in our forests. In these studies, researchers observed high rates of mortality inflicted on ash borer larvae by the introduced parasitic wasps along with evidence that these wasps are rapidly spreading throughout forests surrounding release locations. However, it is important to keep in mind that despite these encouraging findings, the biocontrol program will not save the mature ash currently present in our forests. As the initial wave of emerald ash borer moves through an area their population booms to enormous levels that rapidly overwhelm ash trees before natural enemies have a chance to respond. Once all of the mature ash in the forest have been killed off, an "Aftermath Forest" composed of ash seedlings and saplings that were too small to be killed off by the initial wave remains. It is in these Aftermath Forests where our hope for the parasitic wasps ultimately lies. When there are only small ash trees remaining, the ash borer numbers remain low, which will hopefully allow the wasps to keep the ash borer populations below the threshold necessary to kill trees. Even with a successful biocontrol program ash will not have the same prevalence as it did prior to the emerald ash borer invasion but may persist as a component of our forests into the future.



In addition to biological control, the NH Forest Health Program is also utilizing an Integrated Pest Management strategy to help conserve ash and jumpstart the recovery process in Aftermath Forests. To date, we have treated clusters of roughly a dozen ash trees at 80 sites throughout the infested area of the state with an insecticide with the goal of reaching 100 sites in the coming years. Pockets of treated trees will keep at least some large ash on the landscape, ensuring that in these areas we do not completely lose the ecosystem services provided by these trees. The pockets will also preserve regional genetic diversity within the state by allowing mature seed-bearing trees to bolster the seed bank in years to come, which will in turn jump start the recovery process in the Aftermath Forests. This process is designed to work synergistically with the biocontrol program so that seedlings descended from treated trees will develop under the protection of growing populations of parasitic wasps, hopefully allowing some of the young ash to persist to maturity. As an added measure to ensure regenerating forests have the greatest chance for success, we have collected ash seed from around the state with the goal of germinating this seed at the State Forest Nursery and then using the resulting seedlings to replant in forests that have been devastated by the ash borer.

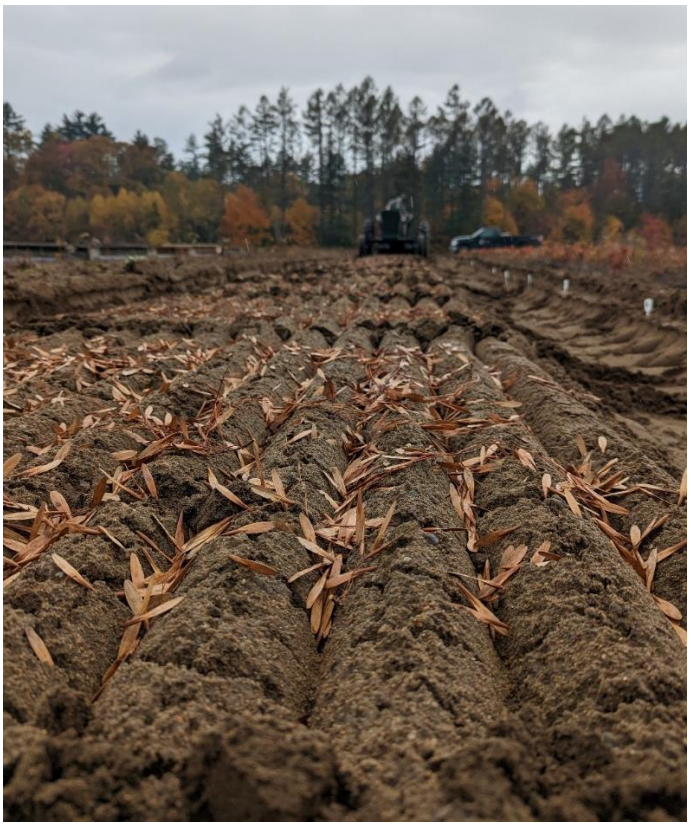
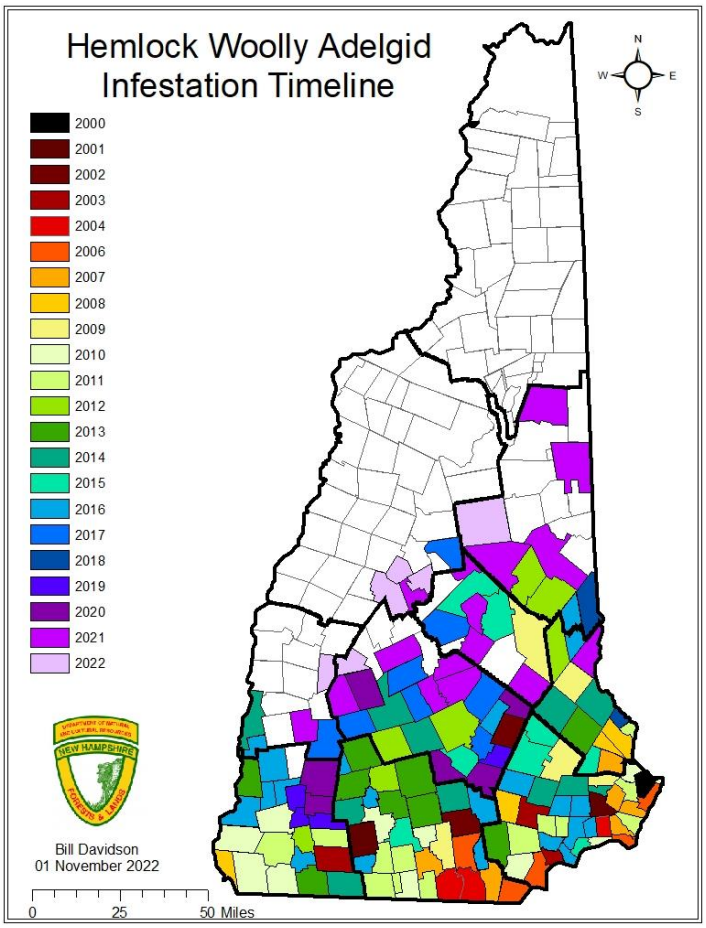


Image 4: Ash seeds being sewn at the State Forest Nursery in Boscawen (Bill Davidson, NH DNCR)

Hemlock Woolly Adelgid & Elongate Hemlock Scale

There was a noticeable increase in reports of HWA in 2022 but most infestations were in previously established regions. Only five towns were added to the list of infestations based on initial discoveries. The further north you go there is less hemlock forest and colder winter temperatures, so the annual northern spread has slowed.

Winter mortality in the HWA population at our monitoring sites has increased the last few winters. The coastal sites tend to be in the 50% mortality range and the inland sites tend to be higher than 80% mortality. These numbers above 80% are helpful but don't eradicate adelgid.



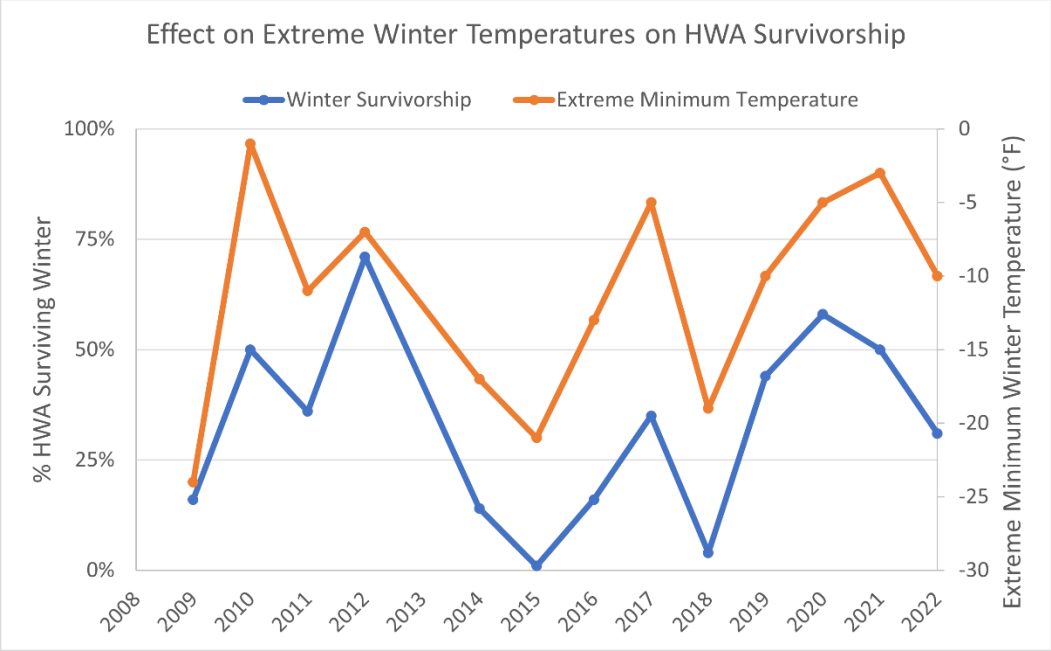


Chart 1: Note the correlation between extreme winter temperatures and survivorship of HWA. During winters when there is a very cold extreme minimum temperature (orange line) the number of surviving adelgids (blue line) plummets.

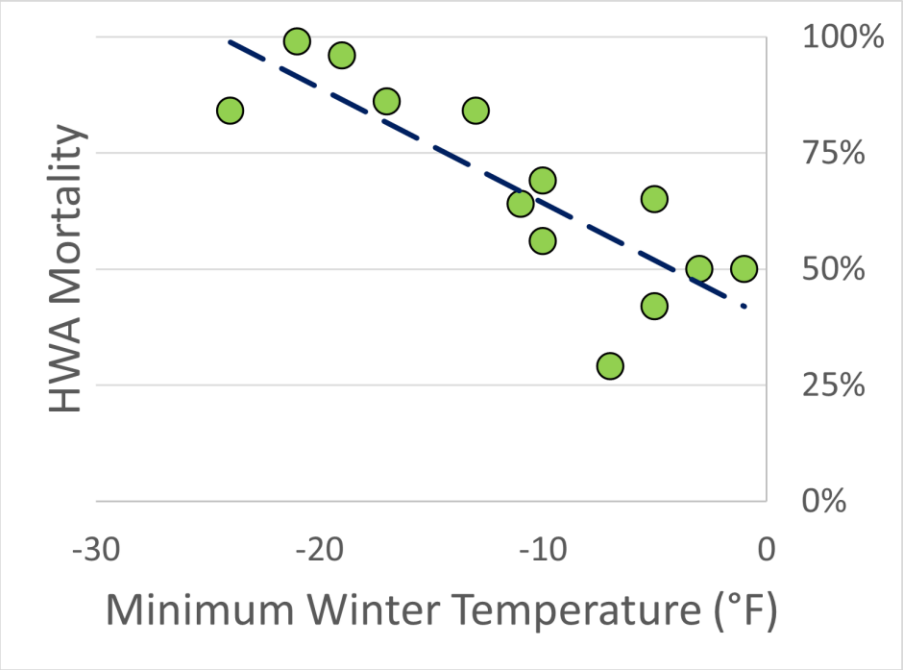


Chart 2: When we plot the extreme winter temperatures from the past 14 years from coldest to warmest, the correlation between winter temperatures and HWA mortality becomes even more apparent

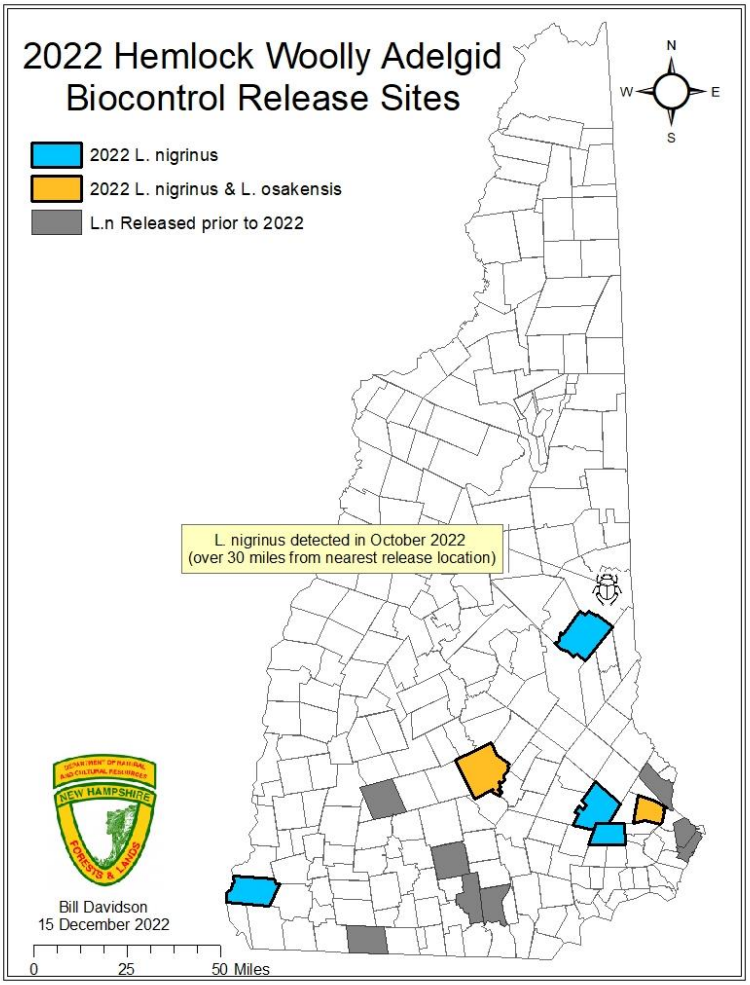
Pesticide use is common at sites throughout the Lakes Region and southern towns. Imidacloprid products are considered the best and safest chemicals to use on adelgid but where elongate hemlock scale is co-located you really need to use a product with dinotefuran in it. The scale insect feeds in the mesophyll of the needles while the adelgid feeds in the phloem of the twigs. Imidacloprid is not as water soluble as dinotefuran and doesn't perform as well traveling systemically out to the needles. Dinotefuran is also preferred because you can apply it to the bark of a tree rather than to the soil around a tree. Any time you can avoid pesticides in the soil it's best to do so.

Photo 5: Kyle Lombard of the NH Forest Health Program applies a dinotefuran treatment as a bark application to a hemlock tree infested with elongate hemlock scale and hemlock woolly adelgid. (Mary Tebow; UNH CE)

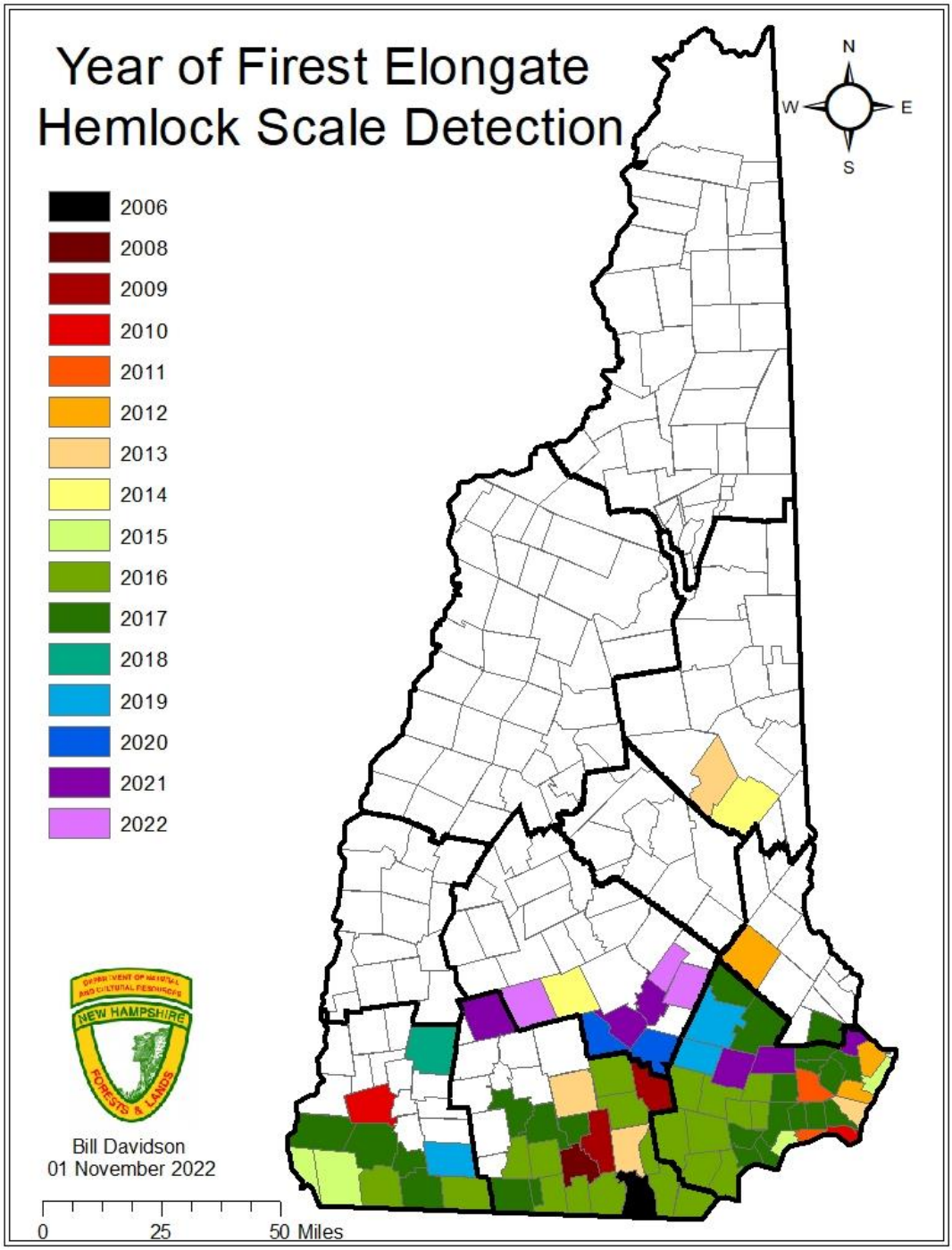
The biocontrol program had many successes in 2022. There were more than 5,000 Laricobius beetles imported and released at seven sites in southern NH. This record number was obtained from the Virginia Tech lab and from our own hand collections in Maryland. Also, for the first time we collected *Laricobius nigrinus* from the insectary on UNH Woodlands property and distributed it to a new location in Durham. This insectary has been under development for seven years with the intention of creating a local population of biocontrol that could be harvested and distributed regionally. Congratulations to Steve Eisenhaure and the UNH Woodlands staff for their patience, hard work and perseverance.

Photo 6: *Laricobius nigrinus* beetles being prepared for release in Durham (Steve Junkin; SPNHF)

A *Laricobius nigrinus* beetle was collected in Ossipee this year while cooperating with the University of Massachusetts on a project where we were attempting to collect *Laricobius rubidus*, a native Laricobius beetle in New Hampshire, for a genetic analysis they were working on. Unexpectedly we found the species *L. nigrinus*. The closest release site was more than 30 miles away at the time of capture, suggesting beetles released through the biocontrol program have established and are prevalent across large swaths of the state.



Elongate hemlock scale was detected in 3 new towns in 2022.


Year of Firest Elongate
Hemlock Scale Detection
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NEW HAMPSHIRE
FORESTS & LANDS
Bill Davidson
01 November 2022
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50 Miles

Eastern Hemlock Looper (Lambdina fiscellaria fiscellaria)

Hemlock looper is a native pest that outbreaks periodically and without warning. The last major outbreak before 2021 was from 1988 to 1991.

Image 7: Adult hemlock looper resting on a hemlock twig (Therese Arcand, Canadian Forest Service)

In 2022, 2,450 acres of defoliation was recorded during the aerial survey but due to the nature of defoliation in the understory it's likely there were many more acres defoliated. The 2,450 acreage was half of the 2021 total, but the geographic extent of reported damage was much larger in 2022. We had pockets of defoliation from New Ipswich to Plymouth and over to the Connecticut river.

Almost all the defoliated hemlock forests were completely killed. Some of the dominant overstory hemlock seems to be holding green needles but none of the intermediate hemlocks are surviving. Drought stress and years of hemlock woolly adelgid feeding have reduced the vigor of hemlock statewide. Treatments with pesticides are not feasible and there is no silviculture technique that would prevent further damage

Image 8: Understory of a hemlock forest defoliated by hemlock looper (Bill Davidson, NH DNCR)

If you're walking through a hemlock stand during a hemlock looper outbreak the tell-tale signs include hemlock saplings with virtually no foliage and the tree is tangled with silk left behind by the looper caterpillar as is drops or balloons to new trees.

Image 9: Understory hemlocks covered in silk from feeding looper caterpillars (W. Davidson; NH DNCR)

Spongy Moth

Spongy moth (*Lymantria dispar*), previously known as Gypsy moth, affected more area than any other forest pest in New Hampshire for the second consecutive year. We saw two distinct primary outbreak regions this year. The larger of the two was a roughly 35,000-acre contiguous block of defoliation concentrated around Conway and was similar in extent to damage in this region in 2021. The second primary outbreak, which was centered around Concord and Henniker, totaled about 15,000 acres and was more scattered than the larger northern outbreak. In addition to these two primary outbreaks, smaller pockets of spongy-moth-caused defoliation could be found across the state. The total acreage of spongy moth defoliation mapped in New Hampshire in 2022 was 52,532.

Image 10: Spongy moth defoliation of red oaks near Conway (Bill Davidson, NH DNCR)

This year's spongy moth outbreak generated more media interest and garnered more public attention than any forest health issue in recent years, mainly due to the striking visual appearance of defoliated forests. And while this pest can be a nuisance, raining down torrents of frass on lawns and playgrounds, it isn't time to panic for our oak forests just yet. Spongy moth caterpillars feed early in the summer, allowing defoliated oaks plenty of time to send out a new set of leaves before the end of the growing season. This process stresses the trees, but oaks can usually tolerate being completely defoliated for several years before succumbing to spongy moth. We expect to see some scattered dead trees in the most heavily damaged regions, but unless this current outbreak persists for several more years, we don't anticipate any mass oak mortality. However, in areas where spongy moth populations were the highest, once all the oak leaves had been eaten some of the caterpillars moved on to other tree species, including pine and hemlock. Coniferous trees do not have the same resiliency to defoliation as deciduous trees, and pines and hemlocks that were defoliated will likely will not survive.

Image 11: An oak tree in Henniker sends out a second flush of leaves after being defoliated by spongy moth caterpillars. By early August the oaks in the area had full canopies of new leaves. (W. Davidson; NH DNCR)

On a positive note, there are indications that the populations in the largest outbreak regions is on the decline. We have seen evidence that some of the most important factors in controlling spongy moth populations, the fungus *Entomophaga maimaiga* and the Nuclear Polyhedrosis Virus, have taken hold, resulting in dying caterpillars and lower numbers of new egg masses than were observed in previous years. Only time will tell how effective these pathogens have been, but the hope is that we are seeing the beginning of the end of this current outbreak.

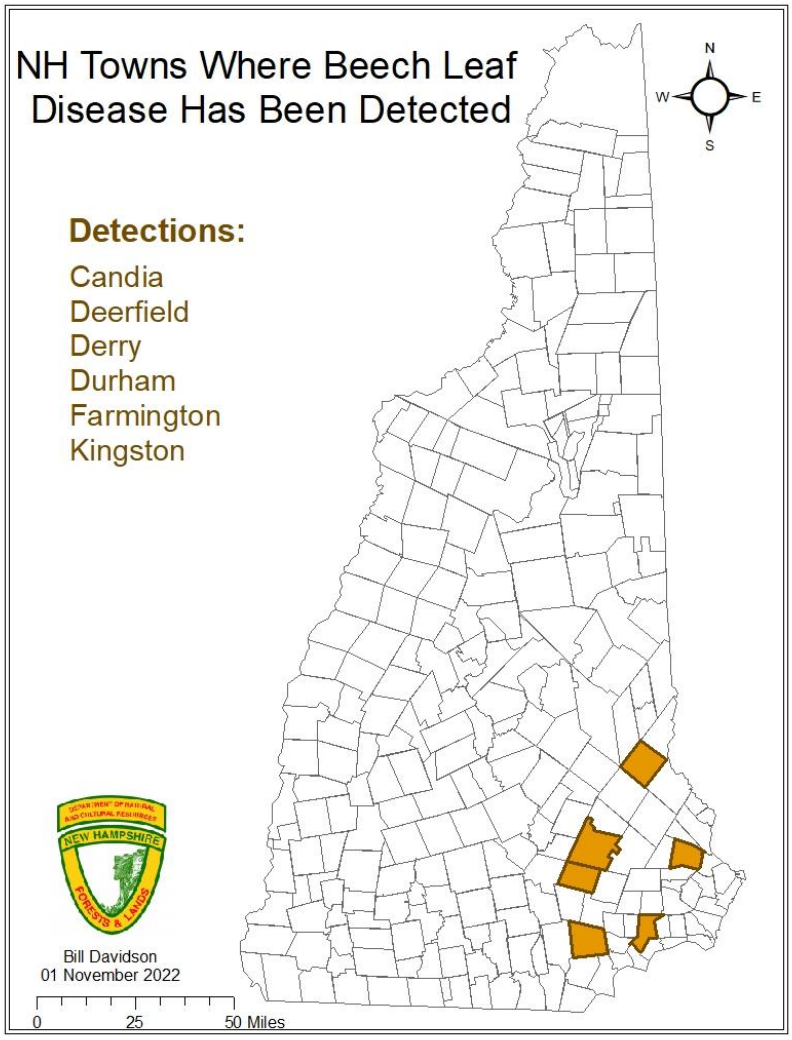
Image 12: A white pine in Conway, NH that has been defoliated by spongy moth caterpillars. (W. Davidson; NH DNCR)

Beech Leaf Disease

Confirmed cases of beech leaf disease were discovered in six NH towns in 2022.

The first signs of beech leaf disease in North America were found along the St. Lawrence Seaway in Ohio in 2012. After several years of research, the damage causing agent was identified as a nematode, *Litylenchus crenatae mccannii*. The origin is likely Asia where many similar nematodes are found.

Plant nematodes are microscopic worm-like organisms that feed within plant cells. They pierce the cell, inject enzymes, and then suck in the partially digested matter. This feeding process is what causes plant damage. Specific to this nematode in beech, the feeding takes place in the buds before elongation. When elongation occurs in the spring, bands of damaged tissue are evident. After several years of population build-up, the beech tree foliage becomes severely damaged and tree vigor declines. In North Central states it seems that understory beech is experiencing mortality in less than five years and the large dominant beech survive 5-10 years.



Images 13 & 14: Nematode damage in beech expresses itself in a unique pattern of banding on newly flushed leaves. (W. Davidson; NH DNCR)

Image 15: Mites and anthracnose damage are common on beech in New Hampshire, and it can look similar to beech leaf disease. When comparing the different symptoms, it's important to identify the banding in foliage infested by nematodes and the lack of banding related to mites or anthracnose. In this photo the beech leaf disease is on the right and a combination of mite and anthracnose damage is on the left. (Bill Davidson, NH DNCR)

Image 16: A low temperature scanning electron microscope (LT-SEM) of a mature female nematode, *Litylenchus crenatae*, found in the leaves of beech trees (USDA Agricultural Research Station, Electron and Confocal Microscopy Unit; colorization by Joe Mowery D4260-1)

Red Pine Scale

The prevalence of red pine scale has been on the rise in recent years and 2022 was no exception. 327 acres of red pine mortality was mapped during aerial surveys and this pest was detected in Sullivan County in September 2022, bringing the total of known infested counties to seven.

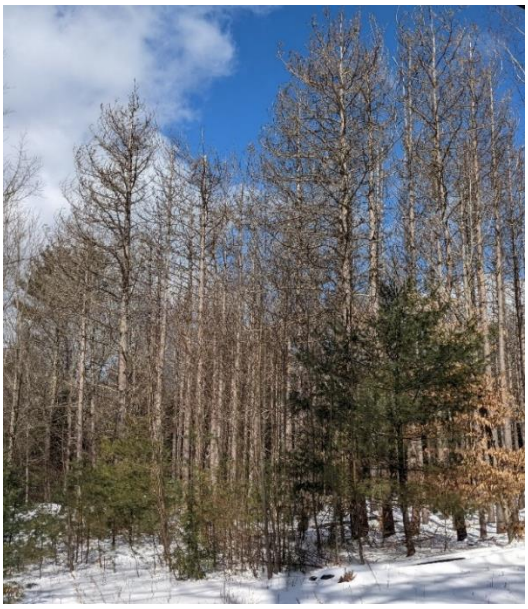
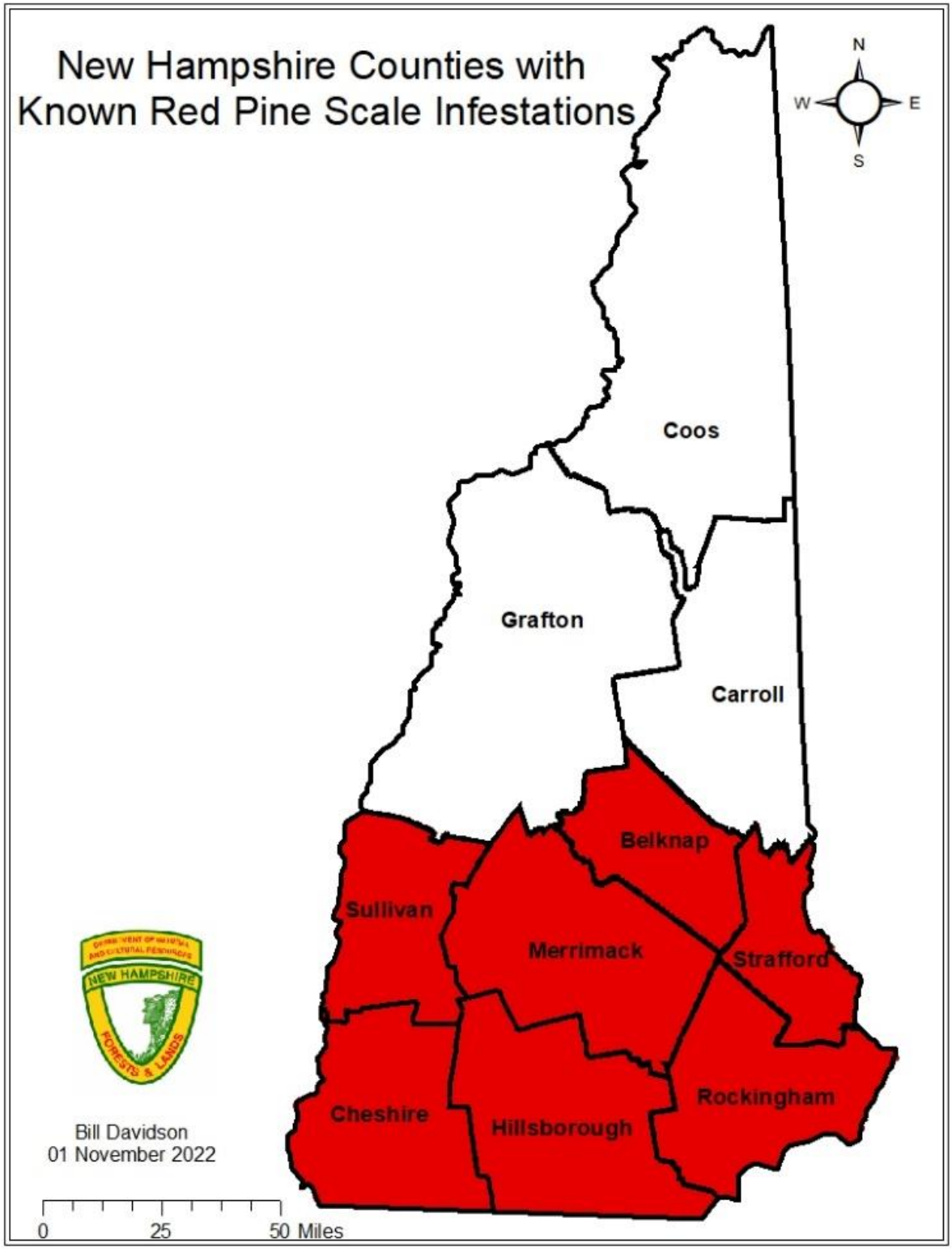


Image 17: This stand of red pines in Deerfield has been killed by red pine scale (W. Davidson; NH DNCR)


New Hampshire Counties with
Known Red Pine Scale Infestations
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Coos
Grafton
Carroll
Belknap
Sullivan
Merrimack
Strafford
Cheshire
Hillsborough
Rockingham
NEW HAMPSHIRE
FORESTS & LANDS
Bill Davidson
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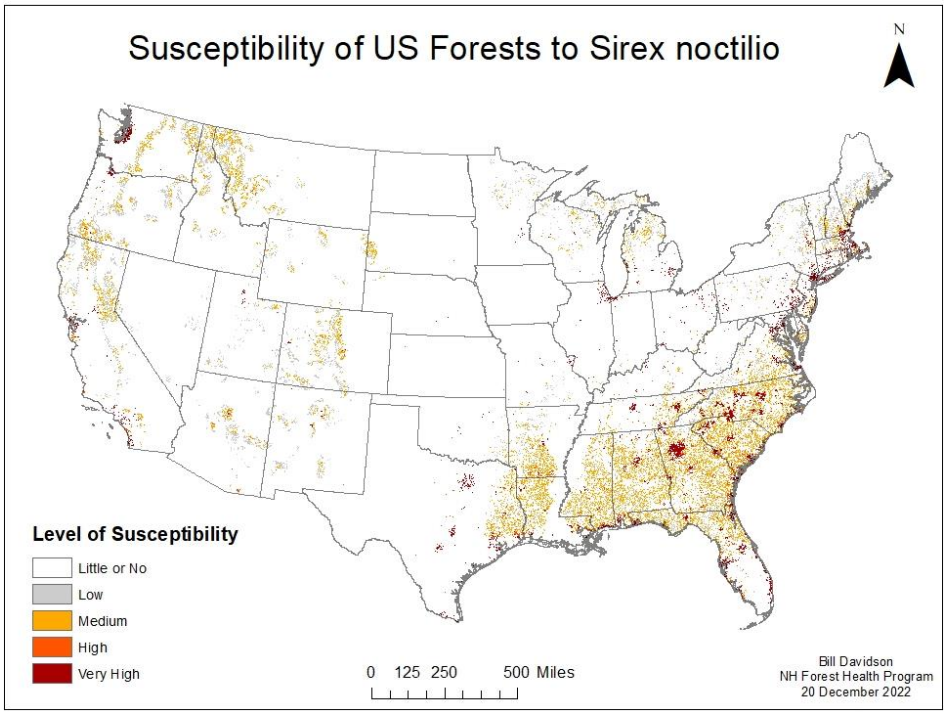
Sirex Woodwasp (*Sirex noctilio*)

The New Hampshire Department of Agriculture, Markets and Food captured another Sirex woodwasp in their forest pest trapping program in 2022. This interception occurred in Henniker, which adds Merrimack County to Grafton, Hillsborough, Cheshire, and Rockingham as counties with Sirex woodwasp detections. To date in New Hampshire, we don't know of any pine stands infested with this invasive pest as all detections have from pheromone trap collections as opposed to being found in trees. This wood wasp is native to Europe and North Africa and its preferred hosts are two needled and three needled pines. In New Hampshire that would be Scots pine, Jack pine, red pine, and pitch pine.

Image 18: Adult *Sirex noctilio* (Steven Valley, Oregon Department of Agriculture, Bugwood.org)

Several USDA Agencies developed a risk map in 2006 which showed low risk of potential damage to the pine resources of NH, but many southern states have much more susceptible pine forests and may regulate the import of any green logs from New England. Sirex woodwasp prefers hard pine stands in poor condition due to lack of management practices so the best defense against creating an outbreak is to keep pine stands at healthy stocking levels.

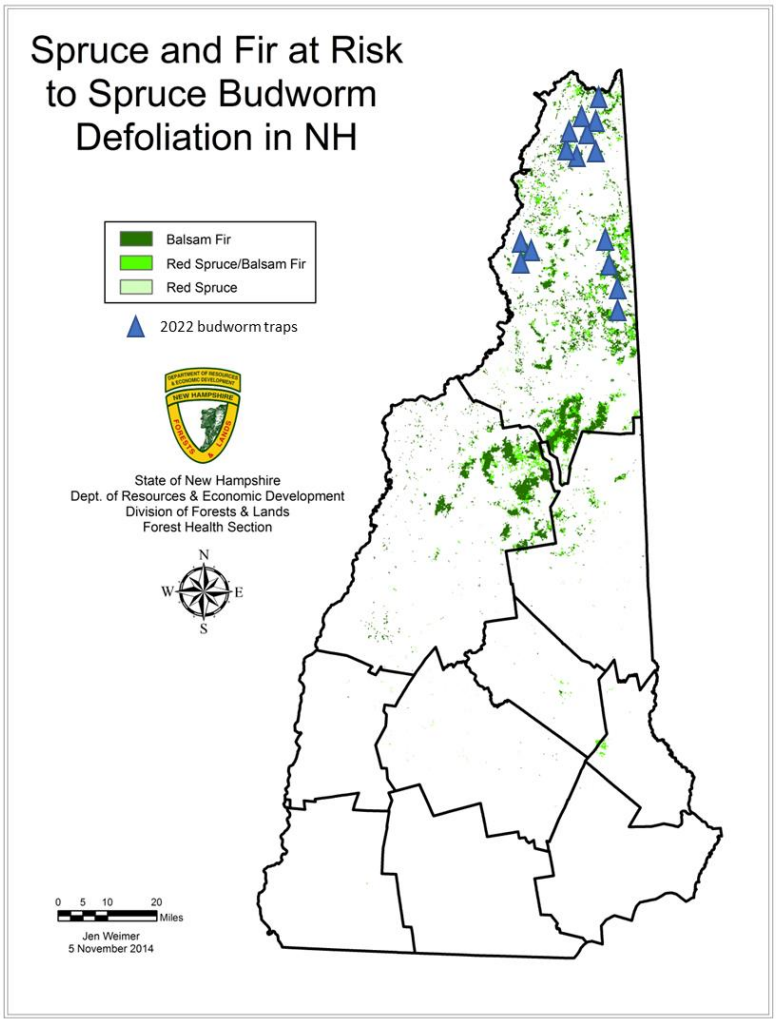


Data provided by: Forest Health Technology Team (FHTET) USDA Forest Service Steering Committee: Marla Downing, Daniel M. Borchert, APHIS PPQ, Donald A. Duerr, USFS R8, Dennis A. Haugen, USFS NA, Frank H. Koch, USFS SRS, Frank J. Krist Jr., USFS FHTET, Frank J. Sapio, USFS FHTET, Bill D. Smith, USFS SRS, Borys M. Tkacz, USFS FHP, Michael F. Tuffly, ERIA Consultants, LLC.

Spruce Budworm

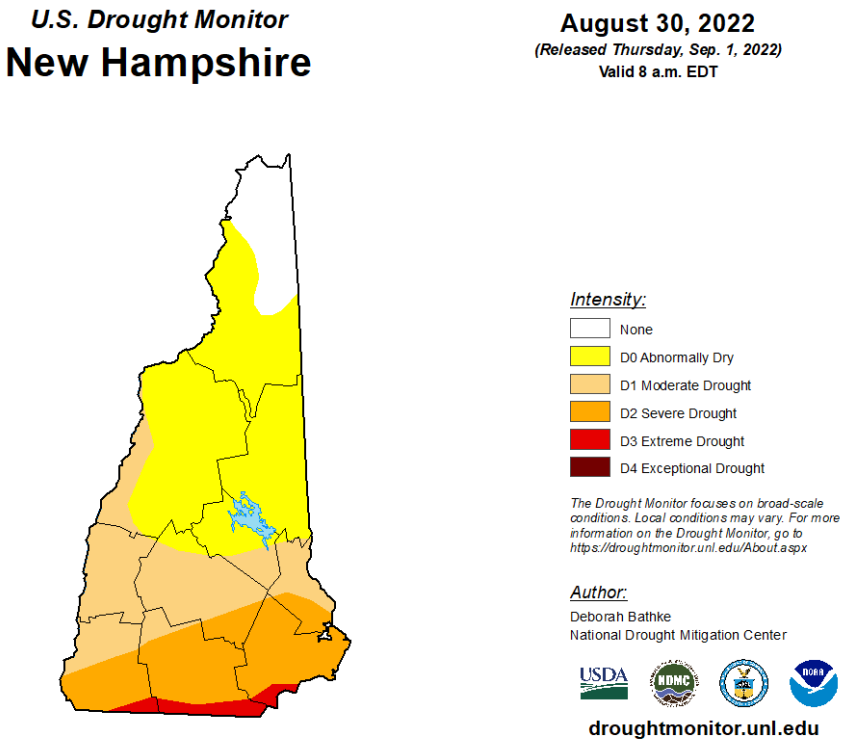
No defoliation from spruce budworm was observed in 2022 but the outbreak in Quebec has continued since 2014. Several million acres have been defoliated north of New Hampshire and Maine.

In NH we've seen annual moth catches in pheremone traps increase after 2014 but stay significantly below the threshold for expected light defoliation. After seven years of outbreak in Canada it seems likely it will not be spreading south into New Hampshire.



Drought

Most of New Hampshire experienced an abnormally dry summer which peaked at the end of August, by which time over 90% of the state was experiencing abnormally dry conditions, about a quarter of the state was in severe drought, and the very southern reaches of the state were in extreme drought. By the end of summer, effects on the health of forests in the driest areas were becoming apparent as some trees, especially those on thin or sandy soils, had their leaves either drop prematurely or turn brown. A return to normal precipitation during the fall moths has since alleviated drought conditions throughout most of the state.



The U.S. Drought Monitor is jointly produced by the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. Map courtesy of NDMC.

Images 19 & 20: Trees turning brown prematurely in due to drought. (W. Davidson; NH DNCR)

Office Notes

The NH Forest Health Program office and lab is located at the Caroline A. Fox Research and Demonstration Forest in Hillsborough NH. Our staff monitors forest pest populations on all state and private lands and provides technical assistance for a wide variety of pest mitigation projects. You can help by contacting us if you observe any forest damage. Photos can be uploaded at NHBugs.org or you can contact us directly.

Forest Health Program Contacts

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