Forest & Shade Tree Insect & Disease Conditions for Maine

Summary 2018

Maine Forest Service

MAINE DEPARTMENT OF AGRICULTURE CONSERVATION & FORESTRY

Augusta, Maine

Forest Health & Monitoring
Summary Report No. 29

August 2019

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http://www.maine.gov/dacf/mfs/publications/condition_reports.html

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Forest Insect & Disease—Advice and Technical Assistance

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Phone: (207) 287-2431
http://maine.gov/dacf/mfs/forest_health/index htm

The Maine Forest Service/Forest Health and Monitoring (FH&M) program maintains a diagnostic laboratory staffed with forest entomologists and a forest pathologist. The staff can provide practical information on a wide variety of forest and shade tree problems for Maine residents. Our technical reference library and insect collection enables the staff to accurately identify most causal agents. Our website is a portal to information sheets and notices of current forest pest issues and other resources. Printed information sheets and brochures are available on many of the more common insect and disease problems. We can also provide you with a variety of other useful publications on topics related to forest insects and diseases.

Submitting Samples - Samples brought or sent in for diagnosis should be accompanied by as much information as possible including: host plant, type of damage (i.e., canker, defoliation, wilting, wood borer, etc.), date, location, and site description along with your name, mailing address and day-time telephone number or e-mail address. Forms are available on our website and in the Annual Summary Report for this purpose. Samples mailed to the laboratory should be accompanied by all necessary information and insects should be in crush-proof containers (such as mailing boxes or tubes). Live insects should be provided with adequate host material for food. Disease samples should be enclosed in paper bags. Mail containers for prompt shipment to ensure they will arrive at the Augusta laboratory or Old Town Office on a weekday.

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</table>

Forest & Shade Tree – Insect & Disease Conditions for Maine Reports
Sign Up Form

Sign up on-line at: www.maine.gov/dacf/mfs/publications/condition_reports.html (box at upper right)

The Maine Forest Service (MFS) Forest & Shade Tree Insect and Disease Conditions reports and Annual Summary Report provide information about what is impacting the health of Maine's forest and neighborhood trees. Updates are provided during the growing season and otherwise as conditions dictate. Additionally, our website is useful for special alerts and quarantine information. The MFS Insect and Disease Lab maintains hardcopy information sheets on a variety of pest problems that are also available on our website. Diagnostic services are provided as time and manpower permit. We are always interested in what you see affecting your trees – let us know!

E-Mail Address _____

You can cancel your subscription at using the unsubscribe link at the bottom of the mailings.

In an effort to conserve State resources, we are moving toward providing most material electronically. Although we will continue to offer the newsletter in hard copy if specifically requested, our default first option is now as an electronic publication.
**If you cannot or do not wish to receive the newsletter electronically please check here* ☐
**If you wish to receive electronic newsletter & paper Annual Summary check here* ☐

Name _____

Mailing Address_____

_____

Telephone_____ **Date (month/year)**_____/_____

Area of Interest (*only check one*):

- ☐ Academic Institution
- ☐ Arborist
- ☐ Christmas Tree Grower
- ☐ Forester
- ☐ Government Agency
- ☐ Landscaper
- ☐ Land Trust
- ☐ Library
- ☐ Logger
- ☐ Nursery/Greenhouse
- ☐ Woodland Owner
- ☐ Interested Individual
- ☐ Other _____

Comments:_____

Return your Completed Form To:

Insect & Disease Laboratory
168 Statehouse Station
Augusta, Maine 04333-0168

Phone (207) 287-2431
http://www.maine.gov/dacf/mfs/forest_health/index.htm

Scan to Sign up On-line

Or Contact Patti Roberts at: (207) 287-2431 or 168 SHS, Augusta, ME 04333-0168 for a paper subscription form.

MFS Forest Insect & Disease Diagnostic Request and Report Form

Sample provided - yes no Collection date _____

Please package disease samples in poly bags and insects in crush-proof containers.

Tree species affected _____

Township _____ County _____

Location in Township: (use area at right to construct map)

Property owner, address, and daytime phone number:

_____

_____

_____

_____

Location of affected plants:

- Forest or Woodlot ☐
- Yard or Landscape ☐
- Street or Driveway ☐
- Barnyard or Pasture ☐
- Tree Plantation ☐

Has the plant been recently transplanted? Yes No

Are there other plants of the same kind nearby? Yes No

Are they similarly affected? Yes No

Has the plant been recently fertilized? Yes No

Has the ground been disturbed? Yes No when/how?_____

Have weed killers been used in the vicinity? Yes No what?_____

Approximate size of trees: height _____ diameter _____ Number of trees checked _____

Damage Type: none _____ defoliation _____ wood borer _____ other _____

Damage Location: leaves _____ branches _____ trunk(s) _____ roots _____

Degree of damage: none ____ trace-light (<30%) _____ moderate (≥ 30-50%) _____ heavy-severe (>50%)

No. of trees affected: none _____ one _____ many _____ OR Number of acres _____

Describe problem and other additional information:_____

_____

_____

_____

Collector_____ Daytime Phone Number _____email:_____

P.O. Address _____

If we need further information to diagnose this sample who should we contact? _____

Daytime Phone Number _____ email:_____

Send sample to: Insect & Disease Laboratory, 168 State House Station, Augusta, ME 04333-0168
(or deliver in person to 201 Deering Building, 90 Blossom Lane) Tel. (207) 287-2431
e-mail: patti.roberts@maine.gov

Please send diseased herbaceous material to: Pest Management Office, Plant Disease Diagnostics Lab, 491 College Ave., Orono, ME 04473, http://extension.umaine.edu/ipm/

Acknowledgements

The information in this Annual Summary Report has been assembled and reviewed by Aaron Bergdahl, Allison Kanoti, Thomas Schmeelk and Colleen Teerling of the Maine Forest Service, Forest Health and Monitoring program. Many other individuals and organizations have contributed significantly to the information on forest health presented here, including the rest of the Forest Health and Monitoring Division.

The Forest Inventory and Analysis Unit of our Division provided invaluable assistance in a number of areas including: setting and retrieving traps for spruce budworm, surveying for browntail moth, peeling bolts at ash trap tree workshops and collecting data on hemlock impact plots, among other duties.

We extend our thanks to Greg Miller, Greg Lord, and Ken Laustsen, Maine Forest Service, for their assistance with mapping, computer, and statistical tasks. Our survey work was greatly enhanced by the efforts of Joe Bither, Amy Emery (Ouellette), Wayne Searles and Regina Smith. Patti Roberts does a wonderful job as the first contact for many of the public who reach out to our office; she also is vital in keeping us safe, acting as dispatch for folks in the field, and supplied.

We work closely with the DACF Division of Animal and Plant Health and appreciate the cooperation of Ann Gibbs, Division Director; Gary Fish, State Horticulturalist; and Karen Coluzzi, Pest Survey Coordinator, in particular. Their work in quarantines, survey and outreach dovetails with and enhances our work.

Our deepest thanks go to those who volunteer in survey and monitoring as well as other tasks. It would be much more difficult to continue winter moth research and parasite control work without Sharon Whitney. Thank you to Nancy Sferra of The Nature Conservancy and Tim Bickford with Maine Army National Guard who ran traps for the southern pine beetle survey this year. We thank David Bourque and Dana Michaud for their taxonomic contributions and additions to the insect collection. And thanks to the many other volunteers with MES who continue to work on sorting and organizing the insect collection, particularly current MES President and 2018 MFS retiree, Charlene Donahue.

Sincere thanks are also extended to many other administrative and field staff of the Maine Department of Agriculture, Conservation, and Forestry, and to our many contacts in the USDA Forest Service Northeastern Area – Forest Health and Protection, the USDA-APHIS, and to our other cooperators in the Northeastern States of the U.S. and Eastern Provinces of Canada.

Introduction

This annual summary report describes the efforts towards understanding and managing the health issues of importance to Maine's forest resources. Emphasis is placed primarily on insect and disease relationships of forest, shade, and ornamental trees. The myriad of biotic and abiotic agents capable of damaging trees can result in losses to wood production and quality, water quality values, recreational opportunities and enjoyment and, in some cases, impact human health. Conversely, the great majority of these agents are not simply beneficial, but critical to the productive functioning of forest ecosystems. Therefore, our understanding of the role insect and disease agents play in maintaining a healthy forest is as important as mitigating the damaging effects of the few native and invasive pest species capable of significant disruptions to forest sustainability.

The Forest Health and Monitoring Division has four primary mission responsibilities related to insect and disease conditions of our forest resources: 1) **monitoring and evaluating** the resource for overall health using both aerial and ground survey methods; monitoring is done for both specific agents of concern, and in cooperation with the statewide continuous forest inventory efforts of the Division's Forest Inventory and Analysis group; 2) **providing advice and assistance** on forest health issues to private and public landowners, foresters, industrial and commercial entities, and to the general public; 3) **conducting applied research and demonstration projects** to further the understanding and improve management of specific pests of concern and other forest health issues, and 4) **supervising and managing the forest pest-related quarantines** established by state regulations.

As this report will show, there has been a high level of Division activities conducted on several existing pest problems, along with significant efforts towards anticipating forest pests not yet present in the state. And, considering the pest management challenges of the coming seasons, the efforts outlined in this report will serve to strengthen our response towards more effectively managing our forest resources.

This product was made possible in part by funding from the U.S. Department of Agriculture. Forest health programs in the Maine Forest Service, Department of Agriculture Conservation and Forestry are supported and conducted in partnership with the USDA, the University of Maine, cooperating landowners, resource managers, and citizen volunteers. This institution is prohibited from discrimination on the basis of race, color, national origin, sex, age, or disability.

Personnel

Retirements

Charlene Donahue retired at the end of February after a more than 25-year career in the division (and that was preceded by 11 years working for the University of Maine, Maine DEP, and Cooperative Extension).

She came to work for the division in 1992, as a Biology Aide. Her primary responsibilities were the insect collection and developing records databases for our plethora of paper records in cardboard boxes. She was promoted to Entomologist I in 1994 and Entomologist II in 2006, assuming addition responsibilities for surveys and methods testing (along with continued curation of the insect collection and managing our records databases).

The survey and methods testing roles came to the fore in the past few years as we have dealt with browntail and winter moth. She was the division's liaison between MFS and the Maine State Museum – where she continues to hold an adjunct appointment.

Charlene remains heavily involved with Maine Entomological Society, and is a resource we continue to utilize.

Ken Laustsen retired the end of June after 19 years as the MFS's premier forest biometrician - a position he assumed as a second career after having worked for 24 years for Great Northern Paper Co.

Ken brought a critical mixture of scientific/analytical expertise and real-world understanding of forest survey to the job. As MFS (and specifically the FHM shop) assumed responsibility for conducting the annual state-wide forest inventory, it was Ken's role to turn the generated data into usable/understandable information for state agencies, industry and the public. He was largely responsible for the MFS's success in producing timely, relevant and unbiased reports on the status and trends of Maine's forest resource.

His contribution is perhaps best captured by comments made by Jim Contino, outgoing president of the Maine Forest Products Council when they presented him the "President's Award"

> "In recognition of his public service to the forest products industry as state biometrician, as well as his unique ability to make a complicated subject easily understood. His advocacy for better forestry communications went far beyond insuring that facts and figures were correct. He helped people evaluate the credibility and usefulness of information so that they could make better decisions."

Beyond that aspect of the job, he always had the time to help design surveys and analyze other situations, whether pest impacts or timber theft.

David Struble retired at the end of June 2018 after more than 40 years in various roles with what is now the Forest Health and Monitoring Division. Dave started out with the Maine Forest Service in 1973 in northern Maine at the height of the last spruce budworm outbreak; he also did a stint of field entomology in Southern Maine. He had been State Entomologist and Division Director since 1988. Dave has been a leader in both forest health and forest inventory nationwide and is widely recognized for his characteristic "strublisms" and more formally for his vision for the programs, while being a tireless advocate for Maine and the forests that identify the state. In retirement, Dave has continued to serve the state to advise and guide the transition during a period of rapid staff turnover.

New Employees

Thomas Schmeelk began working for the division in September, 2018. He most recently worked for the State of New York Forest Health Diagnostics Lab where he responded to client inquiries and worked on programs involving a variety of pests including Asian longhorn beetle, emerald ash borer, thousand cankers disease, southern pine beetle and Ips spp. Tom received a Master of Science Degree in Entomology from The University of Illinois, where he studied native longhorned beetle ecology. In his position with the Maine Forest Service, Tom will lead the browntail moth, winter moth, southern pine beetle and light trapping programs, among others**.**

In Memorium

John H. Chadwick (1919–2018) worked for the Maine Forest Service for 26 1/2 years, from 1954 to 1981. He was initially hired as Shade Tree Specialist. In this capacity he developed and administered Maine's embryonic Dutch Elm Disease response program, and was responsible for developing Maine's cohesive Shade Tree Program (which evolved into the current Urban & Community Forestry program). John was appointed State Entomologist in 1976 and served in that capacity, overseeing the various programs and major pest control projects, until his retirement.

Richard G. "Dick" Dearborn (1939–2018) worked as a forest entomologist for the Maine Forest Service for 37 years, retiring in 2003. Beyond serving as Maine's forest insect survey/taxonomic expert for all those years, Dick was also widely recognized and frequently consulted on a broad variety of entomologically related issues by associates throughout the region on both sides of the international border. Our taxonomic capacity was challenged after his departure and associated position loss.

One of Dick's legacies was to assemble and energize a critical mass of professional and amateur entomologists to create the Maine Entomological Society. The M.E.S and its members, as accessible sources of taxonomic expertise and survey support, have been critical to our ability to continue to provide services to our clientele in the face of downsizing and retirements.

Insect Conditions

Insects: Softwood Pests

Balsam Woolly Adelgid
Adelges piceae
Host(s): Balsam Fir (*Abies balsamea*)

Balsam woolly adelgid (BWA) is established in all Maine counties. BWA symptoms (and actual organism presence in the case of significant trunk-phase populations) are recorded from Forest Inventory and Analysis plots when encountered, but no special measurements were taken this year, nor were additional surveys conducted for this pest. Calls from the public and staff observations, particularly regarding trunk-phase populations, were down. Noticeable trunk phase, gout and/or related fir decline and mortality were observed or reported in Aroostook, Penobscot and Washington Counties.

Elongate Hemlock Scale
Fiorinia externa
Host(s): Primarily Fir (*Abie*s spp.) and Eastern Hemlock (*Tsuga canadensis*)

There were no new detections of elongate hemlock scale (EHS) in 2018. Elongate hemlock scale is known to be established in the forest in Kittery (York County) and has been found on planted trees in Cumberland County (Brunswick, Cape Elizabeth, Falmouth, Frye Island, Gorham, Portland, Scarborough, Yarmouth), Hancock County (Mount Desert, Sedgwick), Sagadahoc County (Topsham), and York County (Berwick, Kennebunk, Kennebunkport, Kittery, Ogunquit, Old Orchard Beach, Saco, Wells, York).

Planted trees that had been treated with pesticides in the past for EHS were resurveyed, and EHS was found re-established on many of them. In Gorham EHS was found to have spread from the originally infested trees into the surrounding forested area. This is the only site where this has been seen.

See Appendix A for more information.

Hemlock Woolly Adelgid
Adelges tsugae
Host(s): Eastern Hemlock (*Tsuga canadensis*)

There were no detections of hemlock woolly adelgid (HWA) in new towns in 2018. No new mortality was mapped (less aerial survey occurred in 2018 due to retirements), but hemlock decline, due at least in part to HWA damage, is apparent from the ground in several coastal communities in York, Cumberland, Sagadahoc, and Lincoln counties.

No new predators were released this year. No predator recovery surveys were undertaken this year, due to time spent on emerald ash borer survey efforts and very early, prolonged cold weather in the autumn.

See Appendix A for more information.

Pine Leaf Adelgid
Pineus pinifoliae
Host(s): Eastern White Pine (*Pinus strobus*), Red Spruce (*Picea rubens*), Black Spruce (*P. mariana*)

Crowns of eastern white pine are still thin in much of the impacted area previously mapped for pine leaf adelgid and evidence of previous shoot mortality remains on some trees, however, no new damage was mapped in 2017. Heavy populations of settled adults were noted in some sites in Piscataquis county that had been mapped for damage in 2015. This pest bears watching in 2019.

Pine Shoot Beetle
Tomicus piniperda
Host(s): Pines (*Pinus* spp.)

There is a State and Federal quarantine on pine shoot beetle and its host trees (pines) in all Maine counties except Aroostook and Washington. The Maine Forest Service and USDA-APHIS-PPQ trap to monitor for the spread of pine shoot beetle in unregulated counties. No pine shoot beetles were found in either Aroostook or Washington counties in 2018.

Red Pine Scale
Matsucoccus matsumurae

Host(s): Red Pine (*Pinus resinosa*)

Red pine scale was detected for the first time in Maine in 2014 in Mount Desert, Hancock County. To date, scale has only been detected off Mount Desert Island in one township (Lamoine, Hancock County), however it is an extremely cryptic insect and limited survey has been conducted by the Maine Forest Service.

Southern Pine Beetle
Dendroctonus frontalis
Hosts: Pitch Pine (*Pinus rigida*), Red Pine (*Pinus resinosa*)

Southern pine beetle has not been detected in Maine.

Southern pine beetle (SPB), *Dendroctonus frontalis,* is an aggressive bark beetle native to the southeastern U.S. It has been expanding its range north from southern states. It has now been found as far north as Massachusetts in monitoring traps but so far not in any hosts in MA. Long Island in NY has experienced severe mortality from SPB due to the unmanaged pitch pine barrens. The preferred hosts of SPB are "hard pines" like pitch pine (*Pinus rigida*) and red pine (*P. resinosa*). It has been known to attack eastern white pine (*P. strobus*) and Norway spruce (*Picea abies*) in areas with high infestations. With lures provided by the USDA Forest Service, traps were deployed to monitor for range expansion of this insect.

SPB attacks healthy trees and uses pheromones to call in other beetles to help overcome the trees defenses. Often the most noticeable signs of a fresh attack are pitch tubes that resemble bits of popcorn on the trunk. SPB can overwinter in all life stages and can have multiple generations in a year. Generally, infestations start in a small area and then spread out as the population increases with many beetles attacking the same tree to weaken its defenses. Maine's coastal hard pine communities are most at risk from SPB attack.

The 2018 survey was conducted in ten pine stands, one each in Brownfield, Fryeburg, Phippsburg, Alfred, Eliot, Hollis, Kennebunk, Shapleigh, Waterboro and Wells. These are areas of southwestern Maine where primarily pitch pine (and one stand of red/white pine) are found. A 12-funnel Lindgren trap was set up in each location (

Table 1). Traps were deployed the first week of May and the trap catch collected every other week until the middle of June. This covers the primary long-distance dispersal season for SPB, the rest of the summer they only move short distances.

Table 1. Locations of southern pine beetle traps in 2018

Town	County	Location	Target Tree Species	Latitude	Longitude	Install Date	End Date
Brownfield	Oxford	Major Gregory Sanborn WMA	pitch pine	43.9746	-70.8900	5/1/2018	6/12/2018
Fryeburg	Oxford	Eastern Slopes Regional Airport	pitch pine	43.9884	-70.9490	5/1/2018	6/12/2018
Phippsburg	Sagadahoc	TNC Basin Preserve	pitch pine	43.7971	-69.8418	5/5/2017	8/2/2018
Alfred	York	USDA-FS Massabesic Experimental Forest	white and red pine	43.4493	-70.6803	5/2/2018	6/12/2018
Eliot	York	York Pond pitch pine bog	pitch pine	43.1903	-70.7565	5/2/2018	6/13/2018
Hollis	York	ME National Guard Training site	pitch pine	43.6769	-70.6573	5/1/2018	6/12/2018
Kennebunk	York	Kennebunk Plains WMA	pitch pine	43.4025	-70.6277	5/2/2018	6/13/2018
Shapleigh	York	Vernon Walker WMA	pitch pine	43.6164	-70.8524	5/1/2018	6/12/2018
Waterboro	York	TNC Waterboro Barrens	pitch pine	43.6193	-70.8247	5/1/2018	6/13/2018
Wells	York	TNC Wells Barrens Preserve	pitch pine	43.3778	-70.6456	5/4/2018	7/8/2019

Thank you to Nancy Sferra, The Nature Conservancy, and Tim Bickford, Maine Army National Guard for providing access to some of the survey sites and collecting samples throughout the season. Thanks go out to Regina Smith for sampling the other sites and to Amy Emery for pre-processing samples for identification.

Spruce Budworm
Choristoneura fumiferana
Host(s): Balsam Fir (*Abies balsamea*), White Spruce (*Picea glauca*), Red Spruce (*P. rubens*), Black Spruce (*P. mariana*), Eastern Hemlock (*Tsuga canadensis*)

Spruce budworm is a periodic major pest of fir and spruce in Maine. The Maine Forest Service has been monitoring this insect since the early part of the last century. Since 1992, the Maine Forest Service has been monitoring populations using pheromone traps and catches in a subset of about 80 sites had averaged well below five moths per trap. In 2011, the average moth capture across those sites crept over five moths per trap for the first time in almost two decades. The average continued to climb, and in 2014 and 2015 it was more than 20 moths per trap. 2016 trap catches were down dramatically compared to the previous years and registered at only 7.5 moths per trap across those long-term sites. In 2017 similar numbers were recorded. 2018's per trap average was more than double 2017. More information about spruce budworm in Maine can be found in **Error! Reference source not found.**Appendix B .

Insects: Hardwood Pests

Bare-Patched Oak Leafroller
Pseudexentera spoliana (cressoniana)
Host(s): Red Oak (*Quercus rubra*)

Defoliation continues to occur in Cherryfield (Washington County) and adjacent Hancock County. Ground surveys indicate there continues to be light to moderate damage to the foliage and scattered oak mortality.

Browntail Moth
Euproctis chrysorrhoea
Host(s): Northern Red Oak (*Quercus rubra*), Apple (*Malus spp.*) other Rosaceae family trees and shrubs, and other deciduous trees and shrubs

Originally introduced from Europe to Massachusetts in the 1890's, browntail moth (BTM) has been established in Maine since 1904. It is currently only known in North America in Maine and Cape Cod. Browntail moth is primarily a human health nuisance, causing skin rashes or breathing problems when people come into contact with or breathe in the barbed hairs that contain a toxin that is stable in the environment for one to three years. The severity of individuals' reactions to the hairs varies. It is a difficult insect to work with because of the health effects; little work has been done to rigorously study this insect in decades and we are working with researchers in the University to add to our understanding of this pest.

As predicted, browntail moth has continued to expand its range further inland. Mapping 2018 spring defoliation via aerial survey estimated more than 76,300 acres while the 2018 fall skeletonizing by early instar larvae was estimated around 126,050 acres (Figure 1). The 2018 spring defoliation was 22,000 more acres than the recorded in 2017. This means more people were impacted by the urticating hairs of the caterpillars. Areas most affected by defoliation still included much of Androscoggin and Sagadahoc Counties and coastal towns in Cumberland County. Looking towards 2019, more of Lincoln, Kennebec, northern Sagadahoc and Androscoggin Counties will likely see more intense populations. BTM has been found in 12 of Maine's 16 counties. In July, 205 moths were collected from light traps at 10 sites throughout the state. Although this number is lower than last year, it is to be noted that light trap operations have ceased at some locations that had captured high numbers of BTM the previous year. We are actively looking to replace operators in those areas left vacant.

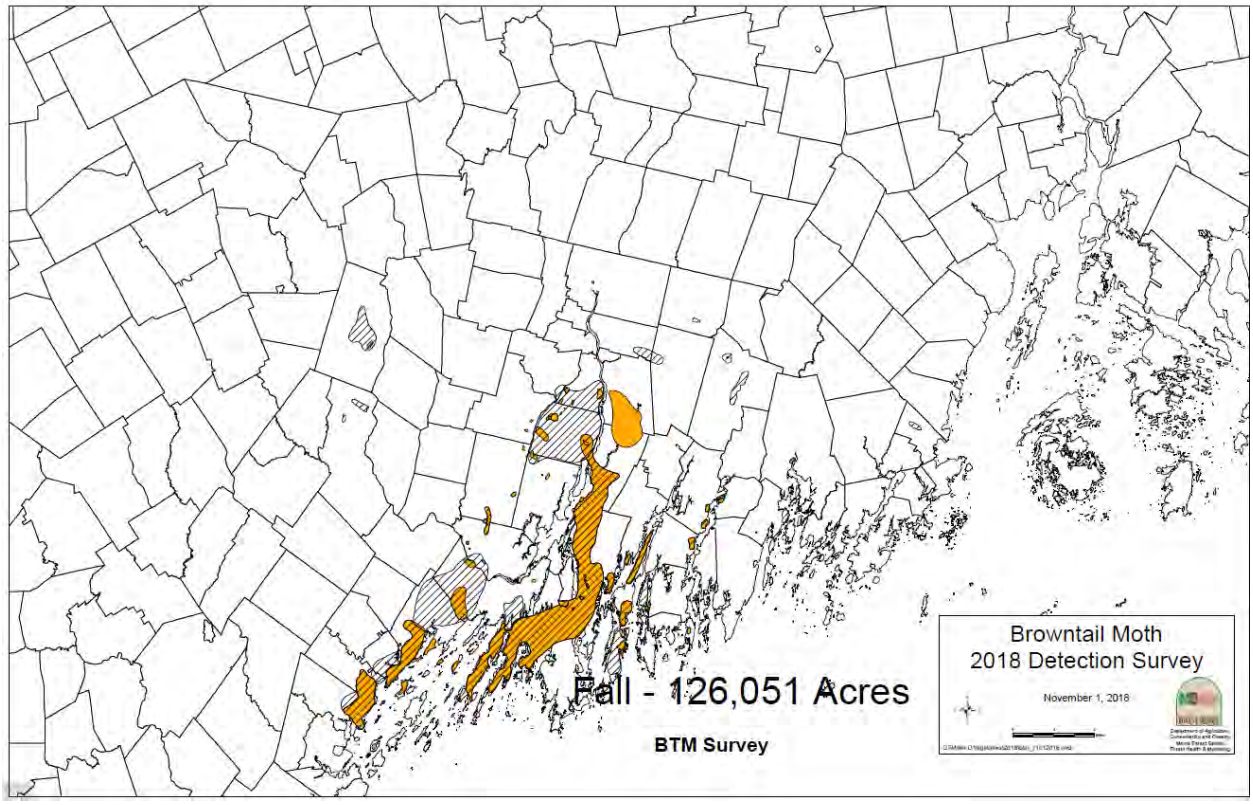

Figure 1. Browntail moth defoliation 2018 - Hatched area mapped in September (126,051 ac), shaded in June (76,125)

Once again, hundreds of calls came in from people affected by BTM rash or concerned about their trees. Over 1,000 people attended 20 BTM information sessions provided by the Maine Forest Service. Between April and September, 38 people used our online survey to report BTM. The Maine Forest Service provided technical advice to towns considering some type of control action and reached out to schools in all affected towns through collaboration with the risk management organization.

Despite the difficulties in working with an insect that causes health issues, there is work being done to develop new techniques for reducing the impact and understanding the ecology of the browntail moth. The Maine Forest Service has been supportive of the University of Maine's Dr. Ellie Groden and her graduate student, Karla Boyd. They have multiple experiments, one of which involves the degradation of winter webs (Figure 2) through the use of detergents. The hope is that they will be able to break down the hydrophobic silk on the webs in order to allow moisture and cold to infiltrate the webs to increase winter mortality. There are currently four field sites with four reps of four treatments (16 treated webs at each site) that include three commercially available detergents as well as a control. Orange guard, Turbo Spreader Sticker and Safer Soap are three of the treatments with water being sprayed as the control. Preliminary research using weather data from the past few decades indicates a positive correlation between warmer fall temperatures and increased BTM number the following year. The thought is that late summer larvae are able to feed longer and therefore grow more during the fall, increasing their overwintering success and subsequent spring defoliation.

Figure 2. Browntail moth winter web.

Dr. Groden has also continued her testing of biorational products for treating browntail moth. The lab tests yielded some encouraging results for pesticides with fewer non-target effects then more traditional products, however the field results were not as promising. None of the treatments looked good from the impact on feeding field treated foliage to larvae in the lab. These included Foray48(Bt), Mycotrol (Beauveria), and Azasol (Azardiractin). Preliminary findings support the need for two applications when using Bt, which is a problem cost-wise to many landowners and municipalities and can be difficult in Maine's coastal spring weather conditions. Most of the materials that were tested, which included those above plus Entrust (Spinosad), Confirm & Mimic (Tebufenozide), and Intreprid (Methoxyfenozide), did significantly better than the controls. They were sprayed at 1/2 rate in the lab and exposed the caterpillars for 24 hours only, so it is hard to know how the assays compared to field efficacy. Additionally, the University with MFS assistance continues to study the impacts of parasitoids, fungi and virus in the browntail moth populations. This is very difficult work as larvae and cocoons filled with toxic hairs need to be collected, reared and dissected.

We are hopeful for a wet spring, allowing the fungus that parasitizes BTM larvae, *Entomophaga aulicae*, to take hold in the most heavily infested areas and drop the population back to tolerable levels. Beyond hoping for disease-inducing weather, we continue to work with outside collaborators to find better solutions to this problem. In addition, we have fostered collaboration between University of Maine and SUNY Cortland faculty to explore the chemical ecology of BTM and reached out to Jim Slavicek from the USFS to look into possible collaboration with the University of Maine to continue his important work on the BTM baculovirus as well as performing field trials.

Emerald Ash Borer
Agrilus planipennis
Host(s): Ashes (*Fraxinus* spp.)

The year 2018 was a significant one for Maine with respect to emerald ash borer (EAB). Not only was this invasive wood-borer found in the far northern corner of Aroostook County in the spring, it was also found in southern York County in the fall. The towns of Madawaska, Frenchville and Grand Isle in Aroostook County and Acton, Lebanon, Berwick, and Shapleigh in York County were put under an Emergency Order to stop the movement of certain ash products and untreated hardwood firewood. A state quarantine drafted under the authority of the Horticulture Program replaced the order in early 2019.

Emerald ash borer attacks all species of ash (*Fraxinus* spp.) and threatens the survival of ash on our continent. Infested trees often exhibit crown dieback from the top down, epicormic (excessive) shoots, and bark splits. Serpentine larval feeding tunnels can be found etched into the inner bark and sapwood. Pupation occurs either in the sapwood or inner bark. Emerging adults create 1/8th inch wide "D" shaped exit holes. Woodpeckers often feed heavily on EAB larvae and pupae, especially during the fall, winter, and early spring. As they feed, they flick off the brown outer bark, exposing the blonde inner bark. This "blonding" is highly visible and is a good sign that EAB may be present. Many recent new infestations have been found because of woodpecker feeding.

See Appendix C for more information on EAB detections in Maine and 2018 and early 2019 emerald ash borer survey efforts.

Forest Tent Caterpillar
Malacosoma disstria
Host(s): Aspens (*Populus* spp.) and other hardwoods

In 2018 we received several reports on the same 138.5-acre patch of completely stripped oak trees in Blue Hill, Hancock County. This is about double the area defoliated in 2017 at the same location. It is on a 'main' road and spanned both sides of the road. A news story of caterpillars causing slippery road conditions on this short stretch of road gained national attention. Ground surveys in the area revealed large-branch mortality, likely due to a combination of at least two years of defoliation at this site as well as periods of drought conditions over the last several growing seasons. In addition to the reports in Blue Hill, there were also public reports in Boothbay Harbor and Bristol (Lincoln County) as well as Etna (Penobscot County).

Gypsy Moth
Lymantria dispar
Host(s): Apple (*Malus* spp.), Aspen (*Populus* spp.), Basswood (*Tilia americana*), Birch (*Betula* spp.), Larch (*Larix laricina*), Oak (*Quercus* spp.), and others (>300 trees and shrubs)

In 2018, defoliation by gypsy moth was reported in Sanford (York County). A follow up visit to the site confirmed the presence of a small patch of light defoliation. Maine Forest Service and USDA APHIS Deployed 531 traps in 2018 in the transition zone (area where reproducing populations of gypsy moth have not been detected). Of those, 511 were retrieved in good condition. Of the total, about 34% of the traps recovered no moths (were negative) and 85% recovered fewer than 10 moths. Egg mass scouting has been targeted to areas of where trap catches were highest. Population assessments are ongoing. To date, they show that in most of the generally infested area populations are low. However, there are indications that there may be pockets of defoliation next year in coastal Sagadahoc County and York County. Other pockets of defoliation not predicted by population assessments would not be surprising.

Table 2. Gypsy moth trap survey: Maine Forest Service and USDA APHIS 2018

County	Traps Set	Traps Intact	Negative Traps	Max Catch	Total Catch	Avg Catch
Aroostook	193	185	75	271	1102	5.96
Franklin	83	82	10	13	242	2.95
Oxford	18	18	0	12	71	3.94
Piscataquis	72	67	30	41	196	2.93
Somerset	165	159	60	150	482	3.03
TOTALS	**531**	**511**	**175**		**2093**	

Winter Moth
Operophtera brumata
Host(s): Oaks (*Quercus* spp.), Maples (*Acer* spp.), Apple (*Malus* spp.) Ashes (*Fraxinus* spp.), Birches (*Betula* spp.) and other trees and shrubs

The Maine Forest Service continued to survey for winter moth males using pheromone traps in December 2017-January 2018 to determine where winter moth populations were heaviest and to delineate the outer reaches of the infestation. Traps were deployed at 61 locations in towns along the coast and along a transect inland from known infested areas. The survey covered coastal portions of York, Cumberland, Sagadahoc, Lincoln, Knox, Waldo and parts of Hancock, Androscoggin and Kennebec counties. The largest trap catches were 11,503 in Harpswell (weighed), 10,350 in Kittery (weighed), 2880 in Bath (weighed), 1491 in Thomaston and 1163 in Cape Elizabeth.

The aerial surveys for winter moth in spring 2018 mapped 235 acres of defoliation; however, flights were limited in spring 2018 due to staff changeover and availability of aircraft. Once again, reports of moth observations were solicited from the public using a Survey Monkey form over 270 reports were received through this method and calls/emails to the office.

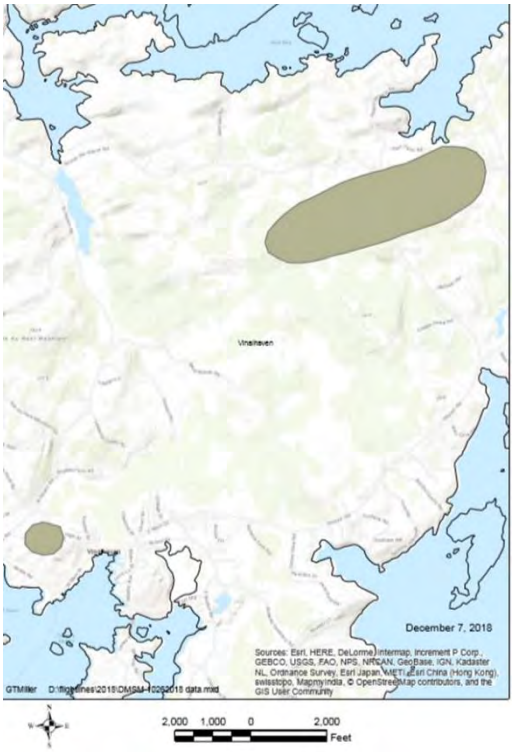

Figure 3. Winter moth defoliation in Vinalhaven detected through aerial survey.

Five hundred cocoons of the parasitic fly, *Cyzenis albicans*, from Massachusetts were set out in Bath (Sagadahoc County) in September 2018. They will remain caged in the ground until emerging naturally and being released in the spring. This is the seventh location in Maine to receive the parasitoids from the University of Massachusetts with funding from the USDA. Flies were recovered for the first time this year in Vinalhaven (Knox County), and Peaks Island (Cumberland County). Levels of parasitism at the Cape Elizabeth site were around 20 percent. At 20 percent parasitism, we expect to start seeing local reduction in winter moth numbers. Over the past years, parasites have been recovered from four of the seven release sites (two of which are too recent to monitor yet).

Table 3. Release and recovery of parasitic flies, *Cyzenis albicans*, in Maine

Town	County	Dates	Number of *Cyzenis albicans* Released	Comments
Harpswell	Cumberland	1-May-13	2000	Survival not good
Cape Elizabeth	Cumberland	1-May-13	2000	First recovery 2016
Kittery	York	16 & 23-May-14	1200	First recovery 2016
Harpswell	Cumberland	16 & 22-May-14	1200	
Vinalhaven	Knox	21-May-14	2000	First recovery in 2018
Portland	Cumberland	15-May-15	2000	First recovery in 2018
Cape Elizabeth	Cumberland	15-May-15	1000	In 2018 parasitism rates at 20%
Harpswell	Cumberland	15-Nov-16	2000	caged cocoons set out for release in spring 2017
South Portland	Cumberland	29-Nov-17	3000	caged cocoons set out for release in spring 2018
Bath	Sagadahoc	12-Sep-18	500	caged cocoons set out for release in spring 2019

A new, non-native winter moth cocoon parasitoid, *Cratichneumon culex* (Müller), was found last year in Maine. Maine Forest Service and retired MFS entomologist, Charlene Donahue, cooperated with Joe Elkinton and graduate student, Alexyss Langevin, from University of Massachusetts, in a study to investigate whether this generalist parasitoid was found in areas with low or no winter moth. Emergence traps were set out at 3 locations with high winter moth populations (all in Cape Elizabeth), and three traps were set out in areas with low or no winter moth (Cape Elizabeth, Lyman and Scarborough). Although *C. culex* was seen from all sites in Cape Elizabeth (including the low WM site) it was not recovered from winter moth at any sites.

Insects: Invasive Forest Insects Not Yet Detected in Maine

There have been no confirmed reports in Maine of Asian longhorned beetle (ALB) or brown spruce longhorned beetle (BSLB) These two insects (along with emerald ash borer) are woodboring beetles and are among dozens of species that can move in firewood and other untreated solid wood material. Because of this mode of transport and difficulty in detecting nascent populations of these insects, it is important to realize that we cannot say with certainty that these insects are not in Maine; only that they have not been found in Maine. Life history make brown spruce longhorned beetle more easily moved than Asian longhorned beetle, but firewood movement has been tied to spread of both of these insects. **They all serious threats to Maine's forest and our forest-dependent economy.**

If you suspect you have found these insects or their damage, please contact us as soon as possible: forestinfo@maine.gov; (207) 287-2431. Carefully note the location and take pictures if possible. Pictures can be sent to forestinfo@maine.gov. Do not move the damaged material unless you can do so safely—two layers of contractor-grade garbage bag tightly sealed will contain these pests short-term.

If you suspect you have found any of the insects, please collect a sample in a secure container (pill bottles, or other sealed plastic or glass containers work well). Store the sample in a cool location such as a refrigerator or freezer until you can contact our office for identification of the specimen.

If you use social media, you can follow news about these insects on Twitter (@MaineBugWatch) or Facebook (Maine Bug Watch).

Asian Longhorned Beetle
Anoplophora glabripennis
Host(s): Maples (*Acer* spp.) and other hardwoods

No Asian longhorned beetle detected to date in Maine. The MFS did not conduct any formal surveys in 2018.

Outreach efforts in conjunction with Maine Department of Agriculture, Conservation & Forestry, Plant Health program continued as part of their Farm Bill funded initiative.

Images of the beetle, its look-alikes and the damage it causes can be found at: www.albmaine.org.

Brown Spruce Longhorned Beetle
Tetropium fuscum
Host(s): Primarily Spruce (*Picea* spp.), occasionally Fir (*Abies* spp.), Pine (*Pinus* spp.), and Larch (*Larix* spp.)

No brown spruce longhorned beetle (BSLB) has been detected to date in Maine. Traps for this pest were set in Aroostook County by MFS and other locations around the state by USDA APHIS. BSLB is established throughout much of Nova Scotia. In addition, a reproducing population has been detected in Memramcook, NB. The province is carrying out activities to slow the spread of BSLB from that location. Through the Forest Health Working Team of the Northeast Fire Compact, MFS personnel assisted with surveys at the Memramcook site in April 2017.

Exotic Wood Borers and Bark Beetles of Spruce and Oak
Various
Host(s): Spruces (*Picea* spp.), Pine (*Pinus* spp.) and other conifers and Oak (*Quercus* spp.)

Maine Forest Service conducted a Cooperative Agricultural Survey Program funded trapping effort focused on early detection of potentially destructive exotic pests of spruce in Aroostook County and oak in southern Maine (

Table 1). Pathways of spread for these insects could include raw wood, camp firewood, and solid wood packing material. Funnel and Cross-Vane Panel Trap samples were screened by Carnegie Institute. Purple Prism Traps and *Cerceris fumipennis* captures were screened by MFS. None of the target beetles were found.

Table 4. Exotic wood borer and bark beetles of spruce and oak targets 2018

Survey Name	Survey Target Common Name	Survey Target Scientific Name	Method
Ips – 5 sites – Aroostook Co.	Six-toothed bark beetle	*Ips sexdentatus*	Funnel Trap
	European spruce bark beetle	*I. typographus*	Funnel Trap
	Mediterranean pine engraver	*Orthotomicus erosus*	Funnel Trap
BSLB – 5 sites – Aroostook Co.	Black spruce beetle	*Tetropium castaneum*	Cross-Vane Panel Trap
	Brown spruce longhorned beetle	*T. fuscum*	Cross-Vane Panel Trap
Oak – 6 sites – Southern Maine	Goldspotted oak-borer	*Agrilus auroguttatus*	Purple Prism Trap/Cerceris
	Oak splendor beetle	*A. biguttatus*	Purple Prism Trap/Cerceris
	Oak ambrosia beetle	*Platypus quercivorus*	Funnel Trap

Diseases and Other Injuries

Overview: The Forest Pathology program has completed numerous field visits and has travelled the state of Maine to better understand the state's current forest health conditions. The program was granted funding by the USDA Forest Service for a multi-state Evaluation and Monitoring (EM) effort aimed at enhanced monitoring of white pine needle disease and overall white pine health. The field work for this project was completed in June and July 2018. Also, in cooperation with the University of Maine, State of New Hampshire forest health professionals and the USDA Forest Service Durham Field Office forest pathologist, work was continued on a white pine management guide. The program is also active in a national white pine health group. Additionally, Federal funding for *New Emerging Pests* was also granted to the Maine Forest Service for efforts related to early detection of the oak wilt disease, a pathogen which has not yet been found in Maine.

Four presentations were given on various forest and shade tree pathology and forest health topics and contributions were made to several other presentations given by forest health staff. In 2018, approximately 136 tree disease clinic diagnoses were provided to landowners, homeowners, foresters, and others. An additional 41 on-site visits were documented involving tree and forest disease diagnostic assistance. Contributions were made to five issues of the *Forest and Shade Tree Insect and Disease Conditions for Maine* newsletter, which, in addition to this publication, is also coordinated by the staff pathologist. Work also continues on a beech management guide for Maine, in which the forest pathologist has been responsible for writing the content pertaining to the disease and evaluating resistance in beech trees. Other significant monitoring and evaluation work included a continuing survey of spruce needle diseases (*Rhizosphaera kalkhofii and Stigmina lautii)*, assistance to the USFS collecting Dutch elm disease isolates around Maine, white pine crown evaluations, locating butternut trees for potential study by Canadian researchers and a significant amount of time was devoted to further learning about the unique disease conditions in Maine.

Diseases and Injuries: Native

Anthracnose Diseases of Hardwoods
Various species, depending on the host species
Host(s): Ashes (*Fraxinus* spp.), Birches (*Betula* spp.), Maples (*Acer* spp.), Oaks (*Quercus* spp.)

Anthracnose diseases were rarely encountered in 2018. This was due to the lack of longer periods of moisture in summer needed for initial infections by monocyclic fungi and building of inoculum through cyclical infection by polycyclic fungi. In 2018, birch anthracnose, maple anthracnose, and oak anthracnose were seen on few occasions.

Armillaria Root Rot
***Armillaria* spp.**
Host(s): Trees, shrubs and several other plant species.

The *Armillaria* root rot fungus is present throughout the environment and several species are thought to occur in Maine. Samples were received and collected from various sources and from several areas of the state in 2018. *Armillaria* is typically only able to parasitize stressed trees, except for certain species of *Armillaria* that are sufficiently virulent to alone cause rapid decline and mortality. The *Armillaria* root rot disease complex is of concern due to the current widespread stress to pines, especially white pine that have suffered several years of heavy defoliation due to white pine needle diseases described later in this report. Further, the consecutive periods of drier-than-normal weather have led to drought stress in many parts of the state where white pines grow. The effects of drought have likely been more severe in pines growing in sandier soils. These areas, also impacted by white pine needle diseases, are particularly susceptible to secondary agents of decline, dieback and possibly mortality.

Caliciopsis Canker of White Pine
Caliciopsis pinea
Host(s): Eastern White Pine (*Pinus strobus*)

Caliciopsis canker is an ongoing problem in regions of Maine where white pine is abundant. Several sites where *Caliciopsis* canker was prevalent were observed in the central, west and southwest of the state in 2018. Presence of the disease is often indicated by numerous white streaks of pine pitch on the main stems of trees, however this is not always a clear indication of the disease since other agents (e.g., bark beetles, internal decay) can cause similar symptoms. *Caliciopsis* canker is thought to be associated with overstocked stands and poor soils, but quantitative data are not available. Drought stress from consecutive periods of drier-than-normal weather may favor further *Caliciopsis* disease development.

Cytospora Canker
***Cytospora* spp.**
Host(s): Balsam Fir (*Abies balsamea*), Concolor Fir (*A. concolor*), Spruces (*Picea* spp.), Aspens (*Populus* spp.)

Several species of *Cytospora* can cause cankers of branches and stems of both conifers and hardwoods. The disease is primarily a problem on ornamental off-site trees, and most commonly found in Maine on concolor firs and on white and Colorado blue spruces. In the forest setting, the disease is almost exclusively associated with highly stressed trees, and is commonly encountered on stressed trees in the genus *Populus*. In 2018, this disease was seldom seen via general observation and was not reported in the pest log.

Delphinella shoot blight
(*Delphinella abietis*)
Host(s): True Firs (*Abies* spp.)

Delphinella shoot blight is an occasional pest of firs in plantation settings in Maine. The disease has previously been recorded in several locations in northern areas of Maine and in 2018 was recorded in southern Penobscot County. Delphinella shoot blight is characterized by blighted tips of new growth. The damage at first glance can resemble that caused by late frost. Newly affected tips turn a reddish color and twist and turn irregularly (this symptom can also be mistaken for chemical injury). In time, numerous black fungal fruiting structures can be seen on the needles of the dry, blighted tips. These needles persist for a year or more and are the source of reinfection during prolonged periods of moisture the following spring. Management practices that encourage air flow in the vicinity of trees, thus enhancing needle drying (decreasing the period of needle wetness), may limit disease. Pruning of lower, infected branches reduces the source of reinfection (inoculum) and helps increase drying in the lower crown. Other cultural practices like maintaining proper spacing in Christmas tree plantations and controlling vegetation around trees is recommended where this disease is a problem. This disease has been described as cyclical in nature and with increasing reports. It appears that this disease may be on the rise in Maine.

Fire Blight
Erwinia amylovora
Host(s): Trees and shrubs in the Rosaceae family (apple, pear, mountain ash and others are most commonly seen infected by fire blight in Maine).

Fire blight was observed on several Rosaceous hosts in Kennebec County, widespread on mountain ash in Aroostook County and samples were received from a Knox County apple tree in 2018. This disease is likely present at various levels throughout Maine, mostly dependent on weather, since extended periods of plant tissue wetness are key drivers of the infection cycle of this bacterial plant disease. Injury to plants infected with fire blight, or plants

near other plants infected with fire blight just before (e.g. pruning), during (e.g. hail) or after moisture events can lead to very high levels of infection and severe damage.

Fir Needle Casts
Lirula nervata*, *L. mirabilis*, *Isthmiella faullii*, *Rhizosphaera pini
Host(s): Balsam Fir (*Abies balsamea*), Fraser Fir (*A. fraseri*)

Many Christmas tree plantations have been moderately to heavily affected by needle cast diseases in the past several years. In 2018, disease incidence appeared to be moderate with a handful of reports of *Lirula* and *Rhizosphaera* and a few samples processed at the lab. The forest pathologist and technicians visited several Christmas tree plantations in central and southern Maine in 2018. During these visits, low levels of needle cast diseases were observed. Needle diseases tend to occur in lower lying areas, whereas areas with better air circulation suffer less disease pressure. Further contributing to lower incidence of disease, some Christmas tree operations use fungicide (sometimes more than would actually be needed) to control these diseases.

Hemlock Shoot Blight
Sirococcus tsugae
Host: Eastern Hemlock (*Tsuga canadensis)*

Hemlock shoot blight is found throughout the state, wherever hemlocks are found, but is most prevalent in southern and southwestern areas of Maine. It has affected trees in ornamental settings, but is of more significance to hemlock regeneration in forest habitats. Hemlock shoot blight was not reported in Maine in 2018, but was seen in general survey by the forest pathologist and technicians in areas where hemlock grows.

Phomopsis spp. Galls
***Phomopsis* spp.**
Host(s): Oaks (*Quercus* spp.), occasionally other hardwoods

Several reports of *Phomopsis* galls on oaks are received annually, largely due to the unusual appearance and often the large numbers of the galls which develop on the branches and main stem of individual trees. The galls may be pea-sized up to softball-sized or sometimes larger. Some heavily infected tree crowns may have hundreds of galls, with subsequent branch dieback which can occasionally result in tree mortality. The galls are thought to be initiated by infection from a *Phomopsis* spp. fungus, but the subsequent growth of the gall continues for a number of years as woody host tissue. The disease is native, and is usually considered to be inconsequential in forest settings.

Red Pine Tip Blight
Diplodia pinea, Sirococcus conigenus
Host(s): Red Pine (*Pinus resinosa*), Scots Pine (*P. sylvestris*), and Austrian Pine (*P. nigra*)

Diplodia tip blight and *Sirococcus* shoot blight is widespread and moderately to severely damaging to exotic hard pines (Scots, Austrian, and Mugo pines) throughout the state. In particular, red pine plantations showing symptoms of tip blight and shoot blight are commonly infected with both *Diplodia pinea* and *Sirococcus conigenus*. This was confirmed at several large red pine plantations visited in 2018. General observations from Maine indicate that the relative rate of development of *Diplodia* infections in red pines is considerably slower than that of *Sirococcus* infections, but *Diplodia* seems to be found in a greater proportion of plantations. Taken together, these shoot and tip blights continue to pose a significant threat to red pine in native and plantation stands. Infection levels have remained high for the past several years due, in large part, to favorable wet weather conditions during springs and summers. A disease survey in of a proportion of red pine plantations in Maine is planned for 2019.

Red Rot of White Pine
***Phellinus pini* (including other related *Phellinus* species)**
Host(s): Eastern White Pine (*Pinus strobus*), also other Pines (*Pinus* spp.), Spruces (*Picea* spp.), Larches (*Larix* spp.), and several other conifers

Internal decay of pines and other conifers from *Phellinus pini* is often associated with over-mature trees, and with trees growing poorly in understory conditions or on poor sites. Red rot is often considered the most economically significant disease of mature white pine because it causes the highest wood volume losses. The pathogen is classed as a canker-rot. Some concern has been expressed recently that increased stresses on white pine health (see the ***Caliciopsis* Canker of White Pine** and **White Pine Needle Cast and Needle Blight** sections of this report) may result in an increase in losses over time from *Phellinus pini*, as well, although this relationship has not yet been examined in any detail. Data from the evaluation and monitoring project, 'Monitoring eastern white pine decline and its causes in New England and New York through enhanced survey methods', may provide further insight into the current frequency of this and other rot diseases affecting eastern white pine.

Eastern Spruce Dwarf Mistletoe
Arceuthobium pusillum
Host(s): White Spruce (*Picea glauca*), Black Spruce (*P. mariana*), Red Spruce (*P. rubens*), Balsam Fir (*Abies balsamea*)

In 2018, damage to white spruce, black spruce, red spruce and balsam fir by eastern dwarf mistletoe was frequently seen along coastal areas of Maine. The parasite is noticeably less common inland, but still occurs in certain areas and was commonly noted in informal survey in 2018.

Spruce Needle Casts
Rhizosphaera kalkhoffii; Stigmina lautii
Host(s): White Spruce (*Picea glauca*) and Colorado Blue Spruce (*P. pungens*)

Spruce needle cast diseases continued at moderate to high levels across the state, wherever the hosts occur. It has been especially damaging to ornamental plantings in suburban settings, in public parks, and along community streets. Severe damage to trees from the needle casts has resulted in some mortality, but more often the aesthetics of trees has been so affected as to warrant a considerable number of tree removals. A spruce needle cast disease survey continued in 2018.

Tar Leaf Spot
Rhytisma acerinum
Host(s): Norway Maple (*Acer platanoides*); occasionally other Maples (*Acer* spp.)

Incidence of tar leaf spot diseases was significant but considerably less prevalent in 2018 than 2017. This is likely due to the drier spring in 2018. The disease is very common in Maine wherever Norway maples are planted as ornamentals and where they have naturalized, especially in urban and suburban communities.

Verticillium Wilt
***Verticillium* spp.**
Host(s): Maples (*Acer* spp.) and many other hardwoods

In 2018, trees potentially affected by *Verticillium* wilt were seen in horticultural settings from the road, however these cases were not confirmed. This disease is not commonly encountered, and although the disease has a wide host range, it is most commonly associated with maples in Maine.

White Pine Needle Cast and Needle Blight
Mycosphaerella dearnessii (= Lecanosticta acicola), Lophophacidium dooksii* (= *Canavirgella banfieldii*), and *Bifusella linearis
Host(s): Eastern White Pine (*Pinus strobus*)

The white pine needle diseases (WPND) complex that has been impacting white pine trees, for what is believed to be 10 consecutive years, has continued to result in extensive pre-mature needle shedding typically in late May through early July wherever white pines grow across the state. Needle losses resulted in a moderate number of disease clinic requests for assistance. The diseases remain widespread, but most severe throughout central, western, and southern Maine. Due to the mostly consistent disease level over the past years, the implications of this chronic stress and mortality remain a concern. The multi-state evaluation and monitoring project, 'Monitoring eastern white pine decline and its causes in New England and New York through enhanced survey methods' funded by the US Forest Service was completed in 2018. It is hoped that the data from this survey will shed light on the current state of white pine trees in Maine, with particular respect to the occurrence and severity of WPNDs. Continued monitoring of this situation will be prioritized for early detection of any emerging insect or disease agents that could serve as further factors leading to white pine decline and mortality.

Diseases: Non-Native

Butternut canker
Ophiognomonia clavigignenti-juglandacearum = Sirococcus clavigignenti-juglandacearum
Host: Butternut (*Juglans cineria*)

The health of butternut trees continues a steady decline across the state wherever butternut trees grow. Informal survey of the disease continues, while plans are underway in Maine for a more formal survey based on a regional 2010 USFS-funded survey.

Dutch Elm Disease
Ophiostoma ulmi; O. novo-ulmi
Hosts: Elms (*Ulmus* spp.)

Dutch elm disease (DED) reports were common in Maine wherever American elm trees grow. Overall, the level of disease is judged to be at moderate levels in younger elms in mixed forest and roadside stands. Landowner requests for assistance have been up slightly from previous years, but the anecdotal information from field staff and land managers has indicated that, from a statewide perspective, DED levels are about normal this year. Some land owners and technicians reported that it seemed that the period of DED symptomology was extended in 2018. The potential reasons for this are unclear.

Oak Dieback
***Diplodia corticola* (=*Botyrosphaeria corticola*)**
Hosts: Oak (*Quercus* spp.)

In 2018 symptoms of oak dieback were rarely observed in southern parts of Maine. This may be due to the unusually dry growing conditions in the middle of the summer over the past few years. Conversely, as this disease is generally considered to be a secondary agent, affecting trees initially weakened or damaged by some other cause, there is some concern that the drought could increase disease incidence when precipitation increases in future growing seasons.

White Pine Blister Rust
Cronartium ribicola
Host(s): Eastern White Pine (*Pinus strobus*)

White pine blister rust remains a significant threat, especially to white pine regeneration and sapling-sized trees and stands throughout Maine's white pine resource. This disease was seen having a significant impact on white pine regeneration in Kennebec and Lincoln counties in 2018, although white pine blister rust can typically be found wherever white pine is grown in Maine. As plants in the genus *Ribes* are increasingly encountered, the incidence of white pine blister rust may continue to increase.

Abiotic/Weather Events

Drought
Host(s): all species

The weather conditions during June – August were unusually dry and represented drought conditions in much of Maine. Drought was again especially severe in coastal and island areas. This is the third consecutive year that prolonged drought has impacted tree resources over large sections of Maine. It is feared these conditions will lead to an increase in stress-related diseases and subsequent dieback, decline and even mortality.

Herbicide Injury
Host(s): all species

Reports of herbicide damage to trees in residential areas were up in 2018 compared to 2017. Harm to non-target trees and shrubs due to improper application of broad-spectrum herbicide and broadleaf weed control products was seen in these cases.

Division Activities

Northeast Forest Fire Protection Compact - Forest Health Working Team
State forest pest managers in the northeast have been looking for a way to maximize shrinking resources across the region. In 2011, Maine and the ten partner jurisdictions contained within the Northeast Forest Fire Protection Compact (NEFPC) established a Forest Health Working Team to provide resource sharing and mutual assistance for forest health related situations. Initial seed money was provided by member jurisdictions for survey and response to pest problems requiring resources beyond what each entity could do on its own. A USDA grant in 2014 then funded a pilot/demonstration of a resource-sharing project linked to increased survey capacity for the Worcester Massachusetts Asian longhorned beetle infestation. Personnel from Maine, the other New England states and New York were activated for duty in Worcester.

There were six mobilizations associated with the NFFPC Forest Health Working Team in 2014 and 2015, none in 2016 and two in 2017. In April 2017, crews from ME, NH and VT mobilized to NB to survey for brown spruce longhorned beetle. Travel funds for this mobilization were paid by voluntary dues submitted by working team member jurisdictions. In July 2017, a training for recognition and management of oak wilt and emerald ash borer was held in Pittsburgh, PA. Crews from within and outside of the compact participated in the training.

Mobilization efforts are a definite success from Maine's "sending jurisdiction" perspective: response was expedited and finance and logistical matters were facilitated through the Compact's oversight. More importantly, we were able to provide survey and response training to MFS staff so that we are better prepared to address emerging threats before they arrive in Maine. We also now have a way to call for assistance when Maine has a pest problem requiring additional resources. In these times of shrinking resources, this initiative is proving to be extremely beneficial.

The Maine Forest Service has promoted a suggestion that the USFS release some of the funds currently targeted for other projects and reallocate them to maintain a standing pool of funding to underwrite survey mobilizations under the NEFPC forest health working team. We also believe that, where all states in the northeast area are members of analogous mutual aid Compacts, this approach would be beneficial for the entirety of the region. This effort resulted in funds awarded to the compact for Asian longhorned beetle in September of 2017.

Aerial Survey

Aerial survey flights were flown from June into November in 2018 for both delineating forest pest problems and overflights detecting potential damage and stress situations. Damage by the following damage agents was mapped: bare-patched oak leafroller (*Pseudexentera spoliana*), browntail moth (*Euproctis chrysorrhoea*), hemlock woolly adelgid (*Adelges tsugae*) winter moth (*Operophtera brumata*), drought, logging damage, shoot blights, and white pine needle damage. Trees along the margins of ponds, beaver flowages, heaths, etc., are in poor health across the entire state due to fluctuating water levels in recent years. Birch at high elevations is in poor condition overall. Beech in northwestern parts of the state, where beech bark disease is killing trees on the hardwood ridges, is also noticeable.

We continue to balance the need to survey the forest with the cost of flights. The survey flights were made from MFS aircraft. In addition, trained, unaccompanied MFS pilots conduct initial aerial reconnaissance in sections of the state where no new detectable stress events are anticipated. This effort is incorporated into fire detection and other MFS routine flight activities. If they see anything unusual in the forest they give a call to the Entomology Lab. We also solicit ancillary ad hoc reports from outside cooperators. These efforts augment our internal capacity and provide a cost-effective initial detection tool for triggering targeted survey and evaluation.

We have been using digital aerial sketch mapping (DASM) since 2007 and find it an improvement over using paper maps and a pencil. However, like any other electronic device, it is always wise to bring a mechanical backup. The computers and software are supplied through a grant with the USDA Forest Service who also help troubleshoot problems both in the air and in interpreting the data. Greg Miller, MFS Geographic Information Systems Coordinator, handles the data and produces maps from the surveys.

Firewood and Invasive Insects Awareness Campaign

Maine Forest Service continues to partner with the DACF Division of Animal and Plant Health on invasive insect outreach – in particular, hemlock woolly adelgid, winter moth, browntail moth and emerald ash borer. In 2018, the Maine Association of Conservation Districts contracted with DACF Division of Plant and Animal Health to do outreach on invasive insects. This was funded by a Farm Bill cooperative agreement with USDA-APHIS.

The "*Leave Your Firewood at Home*" and/or "*Be on the Lookout for Invasive Insects*" messages were promoted at fairs, festivals, camper shows, outdoor shows, various industry shows, and other gatherings. Multiple training sessions were run for right-of-way arborists, as these are some of the folks "on the frontline" when it comes to looking at trees.

The firewood message was promoted in several ads in various camping magazines and newspaper supplements. The goal of these ads was to reach out-of-state campers before they left home with their firewood. Cooperators serving the camping/outdoor recreation public also help promote the message.

The effort to educate the public about firewood is a broad program across the Northeast with funding from both USDA Forest Service and USDA-APHIS. These agencies have also put their time and effort into the outreach effort along with states and private groups. The Nature Conservancy's "*Don't Move Firewood*" campaign has also been instrumental in spreading the word through their internet presence, videos and PSA's.

DACF Plant Health Division has partnered with Firewood Scout to showcase local sources of firewood within the state. More information can be found at: www.firewoodscout.org/s/ME.

Insect Collection

The Maine Forest Service Insect Collection contains over 73,000 specimens in the reference portion of the collection. Additionally, there are now more than 5,000 ant specimens stored in alcohol, more than 60,000 spider records, and in excess of 10,000 bark beetle and woodborer specimens. Most of the specimens are stored at the MFS Entomology Lab, we also have computerized records of all this material. This year the collection will be moving to the Deering building with us and will be given its own separate room. Some of the collection like the Brower moth collection, exotic insects, extra mosquitos and Schmitt boxes will find a new home at the Maine State Museum Annex. This will make more room for collections expansions. In addition to the move, we will be working on switching the collection database to a more modern system.

Light Trap Survey

The Maine Forest Service has been monitoring forest insect pest populations with an array of light traps across the State for over 70 years. Twenty-one traps were run in 2018 in locations from South Berwick to Ashland to Topsfield (Table 5). Rothamstead light traps are used in most locations with blacklight (BL) traps at the remaining sites. The Rothamstead trap has a 150W light bulb inside a protective casing with an entry for moths. The moths fall down a funnel into a can where they die. Blacklight traps have metal fins that the moths hit as they fly toward the light and then fall into a collecting can. One light trap runs on batteries as there is no power at Frost Pond. Trap operators collect the catch daily and send it in weekly to be processed. Traps run for either 30 or 45 days depending on the location and flight season of the moths of interest. The results are used in predicting forest pest outbreaks. A heartfelt thank you goes out to the trap operators each year. Although it is not difficult to operate a trap and they are minimally compensated for it, attention to detail and daily attendance is required and very much appreciated.

Table 5. 2018 light trap locations

Trap Location	County	Start Date	End Date	No. Nights	Trap
Turner	Androscoggin	6/16/2018	7/31/2018	45	Rothamstead
Allagash	Aroostook	7/1/2018	7/31/2018	30	Rothamstead
Ashland	Aroostook	7/1/2018	7/31/2018	30	Rothamstead
Big Twenty Twp	Aroostook	7/1/2018	7/31/2018	30	Rothamstead
Clayton Lake Twp	Aroostook	7/1/2018	7/31/2018	30	Rothamstead
Crystal	Aroostook	7/1/2018	7/31/2018	30	Rothamstead
New Sweden	Aroostook	7/1/2018	7/31/2018	30	Rothamstead
T15 R15 WELS	Aroostook	7/1/2018	7/31/2018	30	Rothamstead
Cape Elizabeth	Cumberland	6/16/2018	7/31/2018	45	Rothamstead
Rangeley	Franklin	6/16/2018	7/31/2018	45	Rothamstead
Salem Twp	Franklin	7/1/2018	7/31/2018	30	Rothamstead
Exeter	Penobscot	6/16/2018	7/31/2018	45	Rothamstead
Millinocket	Penobscot	6/16/2018	7/31/2018	45	Rothamstead
Bowerbank	Piscataquis	6/16/2018	7/31/2018	45	Rothamstead
Monson	Piscataquis	6/16/2018	7/31/2018	45	Rothamstead
T3 R11 WELS	Piscataquis	6/16/2018	7/31/2018	45	BL-Battery
Big Six Twp	Somerset	7/1/2018	7/31/2018	30	Rothamstead
Jackman	Somerset	6/16/2018	7/31/2018	45	Rothamstead
Calais	Washington	6/16/2018	7/31/2018	45	BL-110V
Topsfield	Washington	6/16/2018	7/31/2018	45	Rothamstead
South Berwick	York	6/16/2018	7/31/2018	45	Rothamstead

A checklist of significant insect defoliators is used in sorting the moth catch material. Trap catch records for some of these insects are available for over 30 years' worth of trapping. Other insects that are trapped and occur in unusual numbers or have not been seen before are noted in the light trap records. A portion of the moth catch is saved for use in outreach programs during the remainder of the year. Pest populations of significance are reported in the appropriate section of this report. These traps are also used to monitor for invasive species coming into the State.

Public Assistance
Public assistance from the Forest Insect and Disease Program takes many forms. We speak at workshops and field days to a broad range of audiences, write articles for our own and other publications, speak with television, newspaper and radio journalists, answer questions at trade shows and other venues, and answer the many questions that come in by phone calls, e-mails and walk-in visitors.

We continued to publish the Conditions Reports during the 2018 growing season. Our use of web-based vehicles continued to increase our readership with now over 2100 people choosing to use the electronic format (an increase of ~400 over 2016 subscriptions). We also continue to offer these products in the traditional paper format (approx. 64 subscribers for the paper format). Both these formats continue to be popular with clientele.

Quarantine Administration
The unit administers state quarantines on European larch canker, gypsy moth, hemlock woolly adelgid, pine shoot beetle and white pine blister rust. Parallel federal quarantines exist for European larch canker, gypsy moth and pine shoot beetle. Each quarantine lists regulated articles and areas. Compliance agreements, usually held by receivers, allow controlled movement of regulated articles out of the regulated area for the European larch canker, gypsy moth, hemlock woolly adelgid and pine shoot beetle quarantines. **Questions about forestry-related quarantines and moving regulated material and requests for compliance agreements can be directed to Allison Kanoti, e-mail: allison m kanoti@maine.gov; phone: (207) 827-1813; Maine Forest Service, PO Box 415, Old Town, ME 04468-0415.**

Maine Forest Service
DEPARTMENT OF AGRICULTURE, CONSERVATION & FORESTRY
INSECT & DISEASE MANAGEMENT PUBLICATIONS
Technical Report Series

No. **Title**

1. LaBonte, G.A. The Saddled Prominent Outbreak of 1970-1971 and Its Damages. March, 1978. 20 pp.
2. Dearborn, R.G., H. Trial, Jr., D. Struble and M. Devine. The Saddled Prominent Complex in Maine with Special Consideration of Eastern Maine Conditions. March, 1978. 20 pp.
3. Maine Forest Service, Entomology Division. Spruce Budworm in Maine: 1977. March, 1978. 80 pp.
4. Devine, M.E., H. Trial, Jr. and N.M. Kotchian. Assessment of Spruce Budworm Damage in the Moosehorn National Wildlife Refuge. August, 1978. 32 pp.
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6. Morrison, T.A. and J.B. Dimond. Field Trials for Control of Spruce Budworm in Maine: A History and Bibliography. September, 1978. 13 pp.
7. Bradbury, R. Spruce Budworm Parasitic Survey in Maine with Special Reference to the 1978 Season. December, 1978. **Unpublished**.
8. Trial, Jr., H. and A. Thurston. Spruce Budworm in Maine: 1978. December, 1978. 109 pp.
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22. Dearborn, R.G., R. Bradbury and G. Russell. The Forest Insect Survey of Maine -Order Hymenoptera. May, 1983. 101 pp.
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35. Bradbury, R.L. Efficacy Trials of Foray 48B Against Early Larval Instars of the Browntail Moth, *Euproctis chrysorrhoea* (L.). May, 1995. 7 pp.

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41. Foss, K.A. Variations in Ground Beetle (Coleoptera: Carabidae) Populations Across Ecological Habitats for the Stetson Brook Watershed in Lewiston, Maine. October 2001. 2- pp. + i-ii.

42. Foss, K.A and R.G. Dearborn. Preliminary Faunistic Survey of Mosquito Species (Diptera: Culicidae) with a Focus on Population Densities and Potential Breeding sites in Greater Portland, Maine. November 2001. 35 pp.
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Appendices

Appendix A
2018 Hemlock Woolly Adelgid and Elongate Hemlock Scale Report

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Hemlock woolly adelgid (HWA, *Adelges tsugae*) was first detected in Maine forests in August 2003. Currently, the pest is found in the forest in towns from Kittery to Camden with an additional cluster of HWA in the area of Sebago Lake (Figure 4). Most known infestations are close to the coast or other significant water. Hemlock decline, due at least in part to HWA damage, is apparent in several coastal communities.

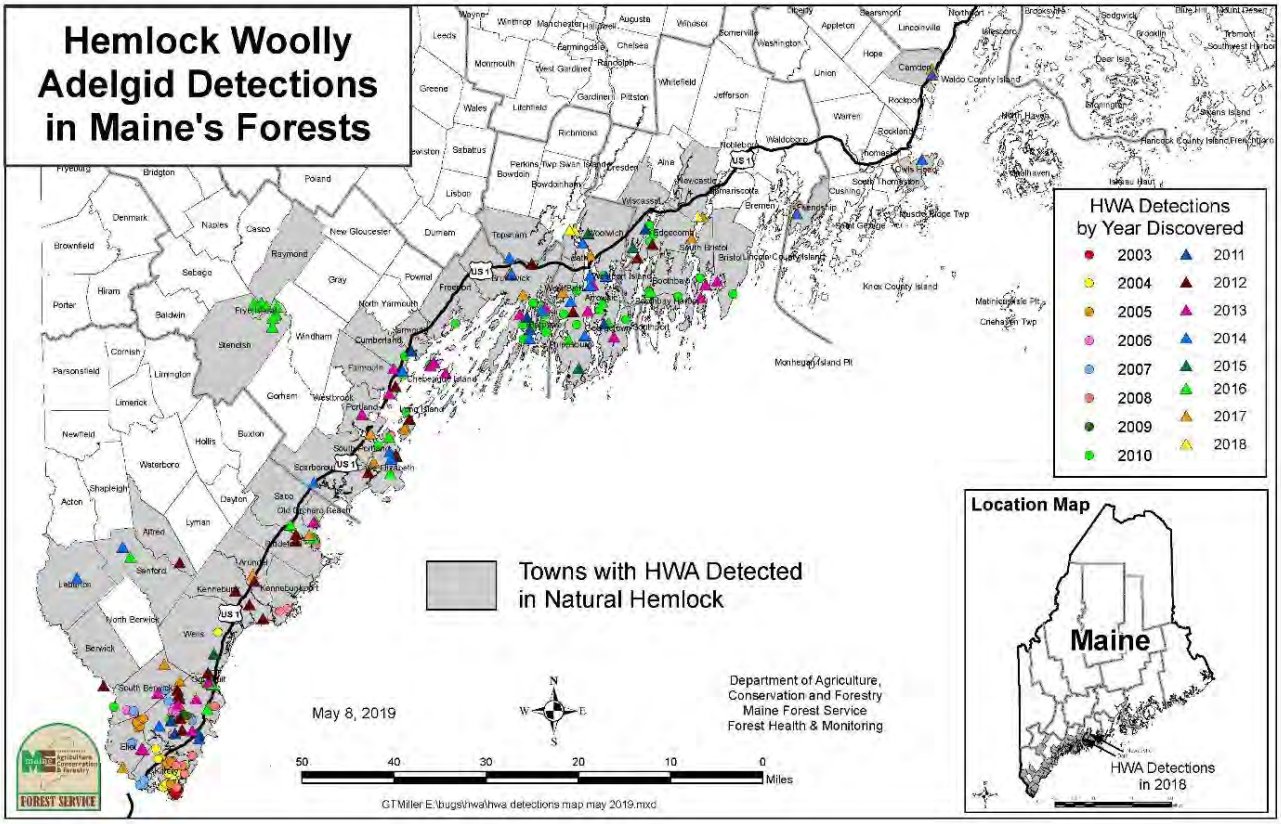

Figure 4. Hemlock woolly adelgid detections in Maine's forests

Elongate hemlock scale (EHS) (*Fiorinia externa*) is an emerging invasive forest insect problem in Maine. It was first recognized in the state in 2009, and MFS has had spray programs to contain individual sites of infestation on planted trees since then. EHS was detected in the forest for the first time on Gerrish Island (Kittery, York County) in fall of 2010. All subsequent forest detections have also been in Kittery, although it may have moved into the forest at undetected levels in other areas. Detections on ornamental trees have been reported, scattered from Kittery to Mount Desert (Figure 5). There were no new detections of EHS in 2018.

The beetle, *Cybocephalus nipponicus*, a generalist scale predator, was discovered feeding on EHS at multiple sites on Gerrish Island in Kittery, York County. Its identity was confirmed in Jan 2018. There are reports of this predator being released in Massachusetts decades ago for control of San Jose scale on *Euonymus.* It appears that it has naturally followed populations of EHS. In Pennsylvania, *C. nipponicus* has been released as a control measure for EHS, and may have contributed to the decline of EHS populations there.

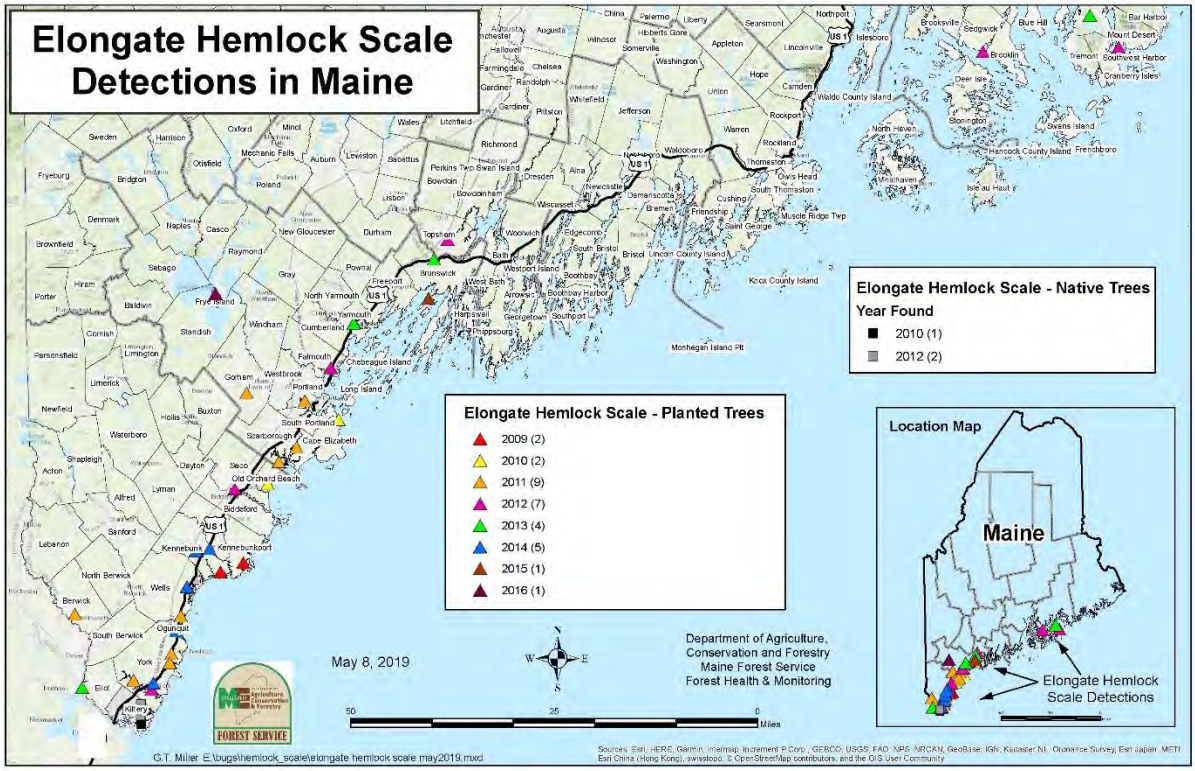

Figure 5. Locations of forest and planted tree detections of elongate hemlock scale in Maine

The bulk of the field work for these projects was conducted by Wayne Searles and Regina Smith. We had additional assistance from Greg Bjork (MFS-FIA), Amy Emery, Melanie Duffy (MFS-FIA), and others. A summary of 2018 activities related to these two pests follows.

There is an ongoing detection survey both in towns outside the HWA quarantine, and towns or areas inside the quarantine zone where HWA has not yet been found (Table 6). Different towns are surveyed each year.

Table 6. 2018 Maine Forest Service hemlock woolly adelgid detection survey by county and town

County	Town	# Sites	All Sites with >200 Branches	Town HWA Detection Status	Town in HWA quarantine?
Chelsea	Kennebec	5	Y	absent	N
Gardiner	Kennebec	4	Y	absent	N
Hallowell	Kennebec	1	Y	absent	N
Randolph	Kennebec	2	Y	absent	N
W. Gardiner	Kennebec	3	Y	absent	N
Dresden	Lincoln	1	Y	absent	Y
Newcastle	Lincoln	2	Y	present	Y
Bath	Sagadahoc	1	Y	present	Y
Bowdoin	Sagadahoc	2	Y	absent	Y
Bowdoinham	Sagadahoc	5	Y	absent	Y
Richmond	Sagadahoc	1	Y	absent	Y
Woolwich	Sagadahoc	1	Y	present	Y

Permanent Sampling Plots

Hemlock monitoring plots were established in Maine to assess hemlock crown health and presence of three stressors (HWA, EHS and hemlock tip blight (*Sirococcus tsugae*). Five sites were established in 2011, one in 2015 in Hallowell, outside the infested area of Maine, and one in 2016 in an uninfested area of Frye Island, Maine's most inland HWA infestation. Crown indicators and damage agent information was collected on each of the plots during December 2018 revisits. Field assistance was provided by the MFS forest inventory unit. Data from these sites and similar locations in Vermont and New Hampshire will be analyzed by David Orwig of Harvard Forest. Crown classification measures follow those established for USDA Forest Service, Forest Inventory and Analysis plots. Infestation status (infested or not) of individual trees was based on what observers could see from the ground.

Winter Mortality Survey

Winter mortality data has been collected for several years for a project in cooperation with Virginia Tech's Tom McAvoy (Figure 6). Adelgid infested branches are collected from five sites for observation under a dissecting scope in early March. Sistens and progrediens density counts were conducted at three sites and results were submitted to our cooperator. In 2018, mortality ranged from 71–90% across the five sites, and averaged 81% (Table 7). In comparison, mortality over the mild winter of 2011–2012 was less than 18% across five sites.

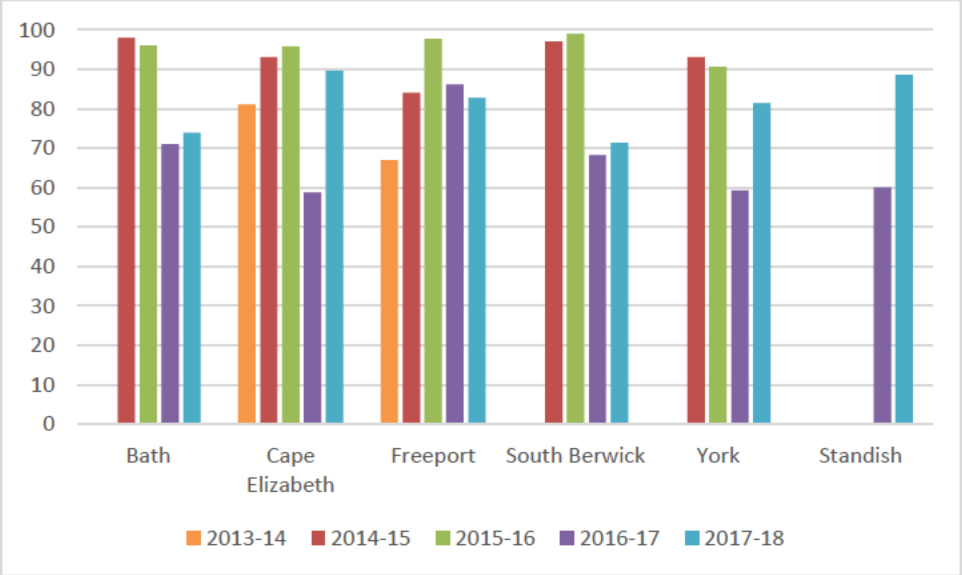

Figure 6. Overwintering mortality of hemlock woolly adelgid in Maine 2014–2018

Table 7. Hemlock woolly adelgid overwintering mortality (Winter 2018)

County	Town	Date Collected	Date Counted	# HWA dead	# HWA alive	% mortality
York	York	4/2/2018	4/4/2018	496	113	81.4
York	South Berwick	4/2/2018	4/4/2018	372	149	71.4
Cumberland	Cape Elizabeth	4/2/2018	4/4/2018	448	52	89.6
Cumberland	Freeport	4/3/2018	4/3/2018	379	79	82.7
Cumberland	Standish	4/5/2018	4/5/2018	451	58	88.6
Sagadahoc	Bath	4/3/2018	4/3/2018	334	118	73.9
			totals	**2480**	**569**	**81.3**

Appendix B
Spruce Budworm in Maine 2018

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May 8, 2019

The Maine Forest Service (MFS) and its cooperators are closely watching spruce budworm in Maine to monitor and prepare for another epidemic of this native defoliator. Over the last several years, Spruce budworm populations in Maine have left the "stable" phase and appear to be building. Pheromone and light trap catches have been up above zero for a number of years, defoliation in Quebec has increased year after year, defoliation has been mapped in New Brunswick. This is an insect whose epidemics cover vast regions and flights of moths from heavily infested areas can migrate to new areas. That there will be another outbreak in Maine, soon, is undeniable. When, where, how severe, and what the specific impacts and reactions may be remain to be seen.

The Maine Forest Service, cooperators within and outside the state, and Canadian provinces are working together to monitor and predict the growth of the spruce budworm population and its potential impact on the region's forests. Monitoring takes place using pheromone traps, light traps, overwintering larval samples and ground and aerial surveys.

The most sensitive method of monitoring budworm is pheromone traps. Permanent pheromone trap locations were established in the early 1990's across the northern half of the State and have been run yearly for the past twenty years. In the past, that network had run about 80 sites set up by the Maine Forest Service, J.D. Irving Ltd, Penobscot Nation Department of Natural Resources and the USDA Forest Service. Since 2014, the pheromone trap monitoring program has been significantly expanded, with more than twenty land owners and managers participating in setting and retrieving traps at more than 400 sites (Figure 7).

Spruce budworm pheromone survey cooperators 2018

American Forest Management	Maine Bureau of Public Lands
Appalachian Mountain Club	Maine Forest Service
Baskahegan Company	Passamaquoddy Tribal Forestry Department
Baxter State Park	Penobscot Indian Nation
Forest Society of Maine	Prentiss & Carlisle
Hilton Timberlands, LLC	Rangeley Lakes Heritage Trust
Houlton Band of Maliseet Indians	Seven Islands Land Company
J.M. Huber Corporation	The Nature Conservancy
J. D. Irving Ltd.	USDA Forest Service
Katahdin Forest Management, LLC	Wagner Forest Management, Ltd.
LandVest	Weyerhaeuser

Cooperators were asked to place traps approximately one per township or every six miles in stands that were 25 acres or larger and at least 50% pole-sized or larger spruce/fir. These could be mature or pole sized stands, uncut or lightly cut spruce-fir dominated and could be pre-commercially thinned or shelterwood stands. Cooperators chose the sites based on where they had monitored in the past, with new sites established due to previous or planned management, change in access or other reasons.

The trapping method follows standardized protocol used by both Canadians and Americans since 1986. http://phero net/iobc/montpellier/sanders html.

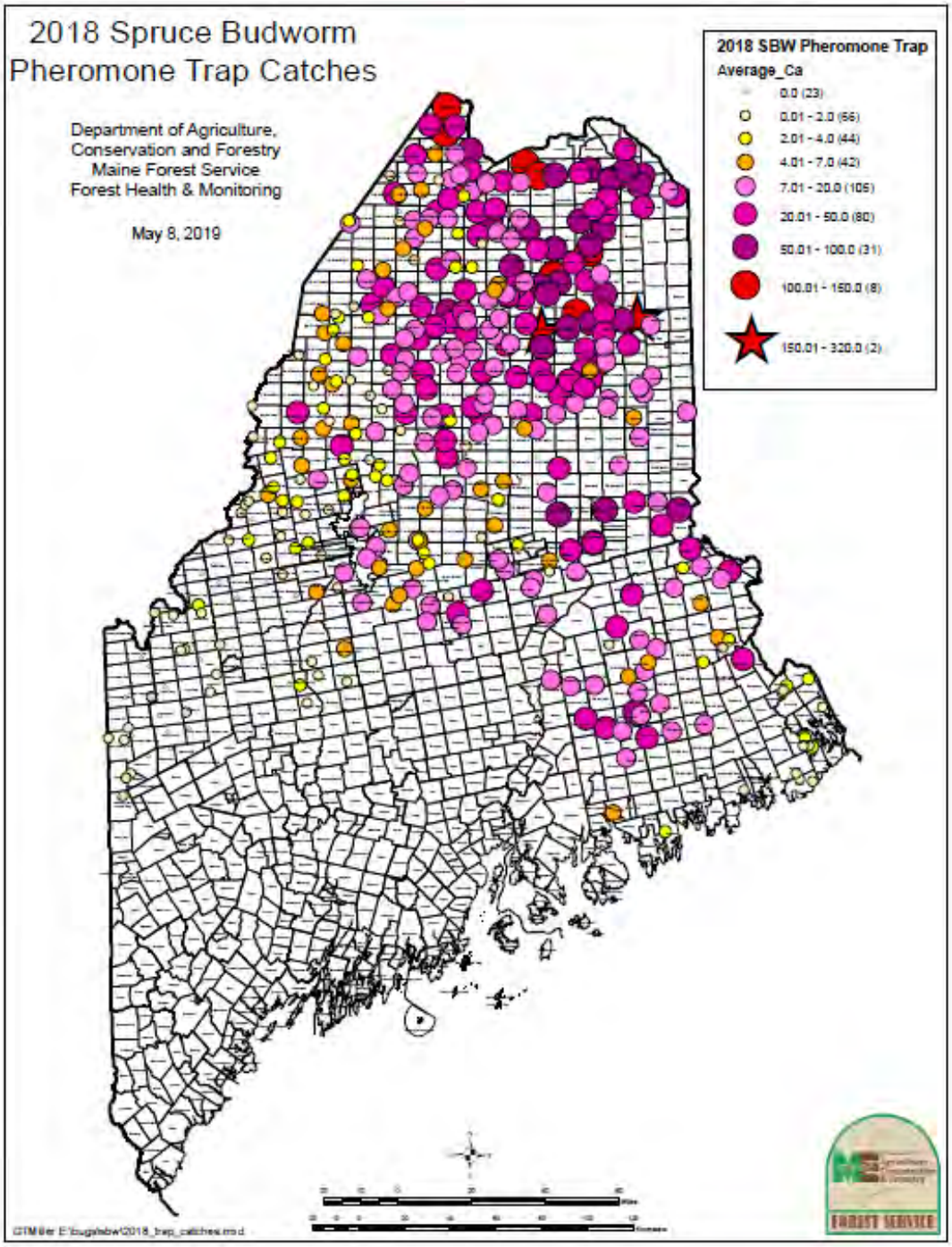


Figure 7. 2018 distribution of spruce budworm pheromone traps and trap catches across Maine

Each site had a three-trap cluster with traps arranged in a triangle with approximately 130 feet between traps. Instructions were to place traps away from the road and at an average elevation for the area. Cooperators were asked to deploy traps during the first three weeks of June and retrieve them after mid-August. Joe Bither, our technician in Stockholm, managed the logistics of getting supplies to and samples from cooperators this year. The catch was processed by division technicians from across the state in Stockholm, Old Town and Augusta.

The traps used were high capacity re-usable Multipher traps capable of monitoring spruce budworm moth populations over a wide range of densities. Using the lure provided, catches will range from 0–20 at low population densities to over l000 at high densities. The SBW lure was made by ISCA Technologies and distributed by Solida. This is a change from 2014-2017 when the lure was manufactured by Synergy. The change was made to align with the product used by Quebec and New Brunswick. The insecticide used in the traps is a 1" x 4" strip (10% DDVP) brand Vaportape II.

The expanded spruce budworm pheromone survey shows spruce budworm is widespread but still at low numbers across the trapping range (Figure 7 and Figure 8). Trapping effort was heaviest in the northern third of the state, light across the middle of the state, with no trapping in the south where budworm is not expected to have a direct impact (Figure 7). Average county-wide catches in 2018 were at least double in Aroostook, Hancock, Penobscot and Piscataquis Counties and as a whole vs. 2017. They approached values last seen in 2015. Captures were relatively stable in Franklin, Oxford, Somerset and Washington Counties. As in previous years, the majority of sites (84 percent) captured trace to 50 moths/trap (Figure 9). About two percent of the sites (10) had a per trap average of more than 100 moths.

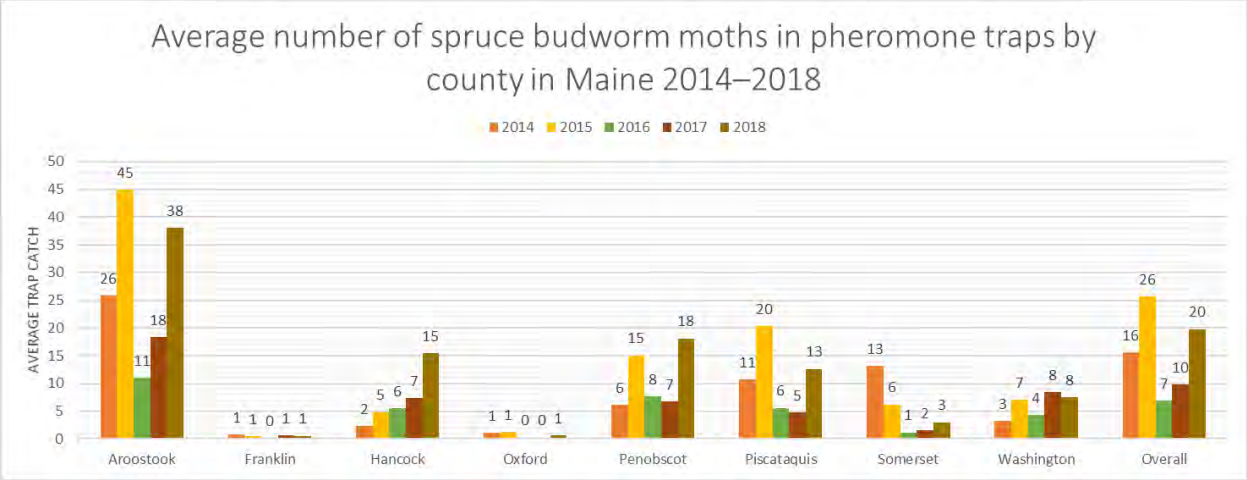


Figure 8. Average number of spruce budworm moths in pheromone traps by county in Maine 2014–2018

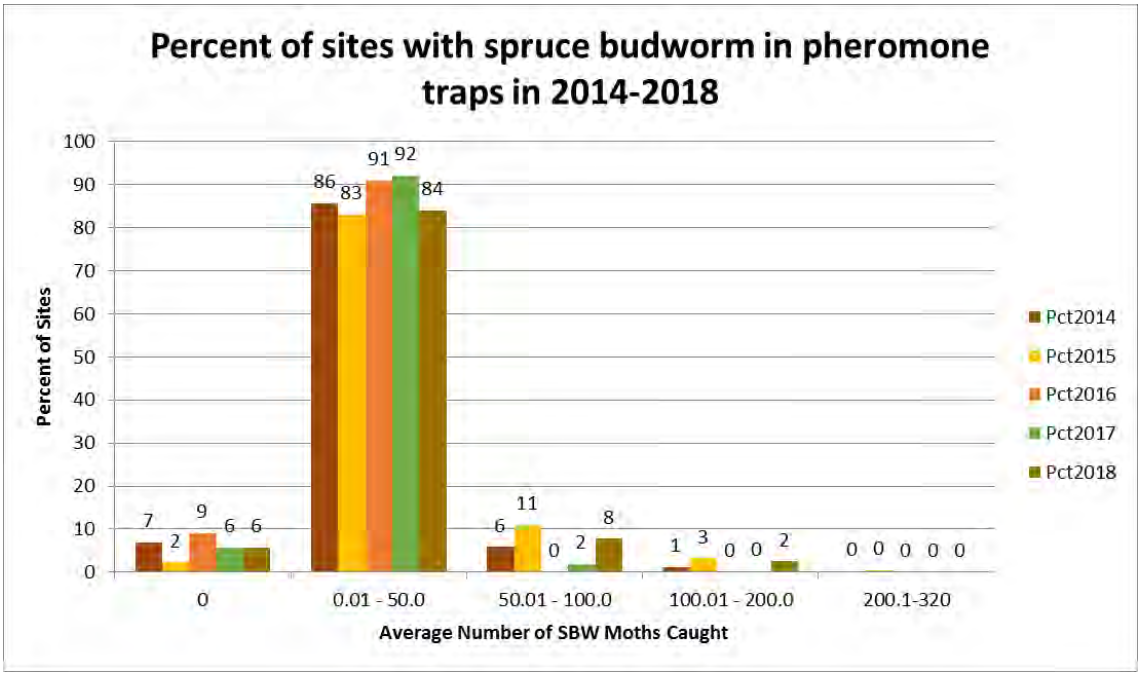


Figure 9. Percent of sites with spruce budworm in pheromone traps by catch 2014–2018

As noted earlier, the Maine Forest Service has monitored collections at a set of longer term pheromone trap sites for the past 25 years. During that time, the average number of moths/trap stayed well below 10 until 2013 when the number jumped to 18 (Figure 10). In 2014 and 2015 it was above 20 moths/trap. In 2016, average catches declined to seven moths/trap, where they stayed in 2017. 2018 saw a return to double digit averages across these long term sites, with a rise to 15 moths per trap.

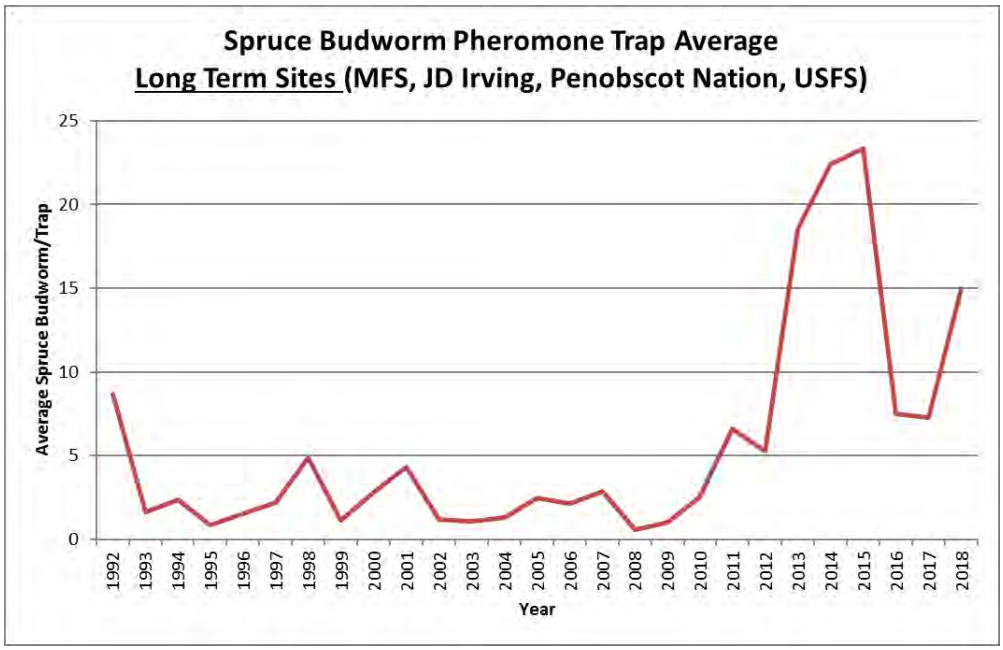


Figure 10. Spruce budworm pheromone trap average catch long term sites only (Maine Forest Service, J.D. Irving Ltd., Penobscot Nation DNR, USDA Forest Service)

Light traps have been used in Maine for more than seven decades to monitor spruce budworm populations and other forest defoliators and continue to be used today. In 2018, 21 traps were run by Maine residents in their backyards. Budworm moth counts from light traps were up (Figure 11), however two new sites were added in Northern Maine. Twelve sites in the network caught a total of 202 spruce budworm moths (Table 8). In the 10 years before 2013 there were fewer than 10 spruce budworm moths caught in all the light traps combined. Therefore, the past years are a significant increase. At such low numbers, apparently wide fluctuations are not surprising.

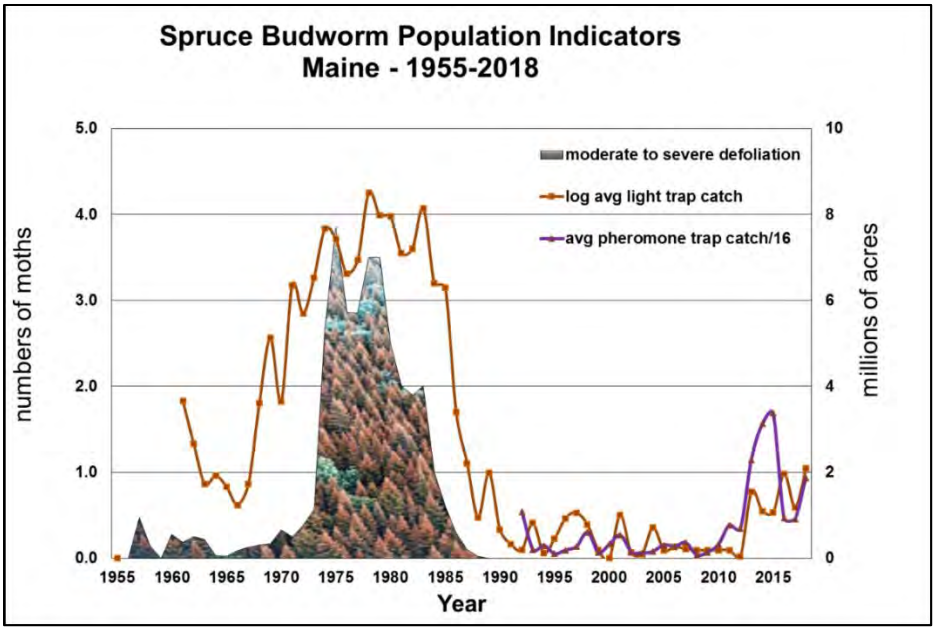


Figure 11. Composite graph of spruce budworm population indicators: defoliation, light trap and pheromone trap data 1955–2018

Table 8. Spruce budworm caught in light traps in 2015 through 2018

Town	County	SBW 2015	SBW 2016	SBW 2017	SBW 2018
Allagash	Aroostook	**3**	**25**	n/a	**23**
Ashland	Aroostook	0	**3**	0	**29**
Big Twenty Twp	Aroostook	n/a	n/a	n/a	**54**
Bowerbank	Piscataquis	**1**	0	0	**2**
Calais	Washington	**2**	0	**6**	**2**
Cape Elizabeth	Cumberland	0	0	0	**1**
Clayton Lake Twp	Aroostook	**n/a**	**n/a**	**n/a**	**10**
Crystal	Aroostook	**5**	**53**	**7**	**42**
Exeter	Penobscot	**0**	**0**	0	**2**
Millinocket	Penobscot	**1**	**1**	0	0
Mount Desert	Hancock	n/a	**4**	n/a	0
New Sweden	Aroostook	**2**	**3**	0	**12**
Rangeley	Franklin	**1**	0	0	0
Topsfield	Washington	0	**44**	**18**	**22**
T3 R11 Wells	Aroostook	**17**	**13**	0	0
T15 R15 WELS	Aroostook	**2**	0	**10**	**3**
Total number of moths		**34**	**118**	**28**	**202**

Volunteers in Maine committed to collecting moths on a weekly or better basis at Maine sites. These sample locations were included in the Healthy Forest Partnership's Budworm Tracker Program. This project is managed by the Healthy Forest Partnership. Results can be requested at www.budwormtracker.ca.

The University of Maine Cooperative Forestry Research Unit (CFRU) continues to head up an "L2" sample program in conjunction with the Canadian Forest Service as part of the Healthy Forest Partnership. The L2 project goals are to assemble a broadly distributed long-term time series of budworm population monitoring data to: (1) enhance opportunities for management planning by identifying incipient local populations as early as possible and (2) add to a database that can be linked with vegetation data and information about natural enemies in the future to fill important knowledge gaps about how landscape conditions influence local outbreak dynamics. CFRU members have approved funding for support of this survey through 2019.

Since 2014, spruce budworm host branch samples have been collected during the fall and winters in areas where pheromone trap catches had been high, modeling predicted at-risk stands, or previous samples had been collected. One 30-inch-long branch is cut from the mid-crown of each of three trees at each sample site. Samples are sent to Canada for processing at the Canadian Forest Service lab in Fredericton. The data can be viewed on the healthy forest partnership research map at: http://www.healthyforestpartnership.ca/en/research/what-where-and-when/. 2017 samples from Maine yielded a total of 32 larvae across 13 sites. No larvae were recovered at 242 of the 255 sites sampled (Table 9). Data from branches collected in fall 2018 are being compiled by CFRU.

Table 9. Overwintering larvae recovered during L2 surveys in Maine 2014-2017

Year	Town	County	Site ID	L2/ 30 inch Branch
2014-2015 (N sites = 100, 6.0 percent positive)	Saint Francis	Aroostook	IRV-STF-59	1.0
	T12 R12 WELS	Aroostook	OT-1212	0.3
	T14 R13 WELS	Aroostook	OT-1413	0.3
	T14 R7 WELS	Aroostook	IRV-147	1.0
	T14 R8 WELS	Aroostook	IRV-148-15	0.3
	Westmanland	Aroostook	IRV-WES-30	0.7
2015-2016 (N sites = 241, 5.8 percent positive)	Allagash	Aroostook	IRV-ALL-32	0.3
	Dyer Brook	Aroostook	IRV-DRB	0.7
	Perham	Aroostook	IRV-PER	0.3
	Portage Lake	Aroostook	IRV-POL	0.3
	T12 R9 WELS	Aroostook	IRV-129-12	5
	T13 R11 WELS	Aroostook	IRV-1311	0.3
	T13 R7 WELS	Aroostook	IRV-137	0.3
	T15 R11 WELS	Aroostook	IRV-1511	0.3
	T15 R15 WELS	Aroostook	MFS-1515	0.3
	T16 R4 WELS	Aroostook	IRV-164	0.7
	T17 R5 WELS	Aroostook	IRV-175	0.3
	T18 R10 WELS	Aroostook	OT-1810	0.3
	T5 R20 WELS	Somerset	MFS-520	1.3
	T6 R8 WELS	Penobscot	MFS-68	0.3

(**Table 9** continued)

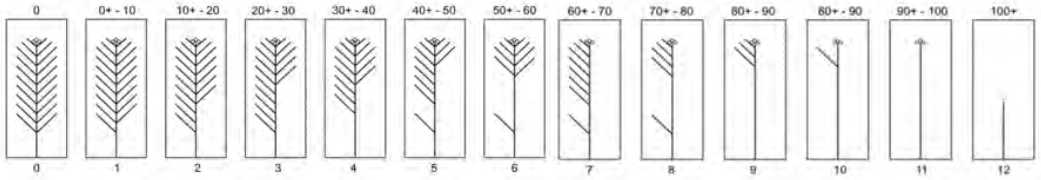
Year	Town	County	Site ID	L2/ 30 inch Branch
2016-2017 (N sites = 219, 4.1 percent positive)	Lower Cupsuptic Twp	Oxford	SI-LCT	0.3
	New Canada	Aroostook	MFS-VOS	1
	New Canada	Aroostook	MFS-VOS2	0.3
	Portage Lake	Aroostook	IRV-POL	0.3
	Princeton	Washington	MFS-PRI	0.3
	T15 R12 WELS	Aroostook	IRV-1512	0.3
	T17 R5 WELS	Aroostook	IRV-175	0.3
	Topsfield	Washington	MFS-ltTOP	0.3
	Wallagrass	Aroostook	IRV-WAL	0.3
2017-2018 (N sites = 255, 5.1 percent positive)	Connor Twp	Aroostook	MFS-CON	0.3
	Cross Lake Twp	Aroostook	MFS-175	1.3
	Cross Lake Twp	Aroostook	MFS-175-ALT	0.3
	Fort Kent	Aroostook	MFS-FTK	0.7
	Fort Kent	Aroostook	MFS-FTK-2	2.3
	Hamlin	Aroostook	IRV-HML-48	0.3
	Madawaska	Aroostook	MFS-MAD	1
	Saint John Plt	Aroostook	MFS-SAJ	0.7
	T11 R8 WELS	Aroostook	SI-118	0.3
	T17 R4 WELS	Aroostook	IRV-174-56	0.3
	T9 R9 WELS	Aroostook	SI-99	0.3
	TC R2 WELS	Aroostook	IRV-TC2-05	2.3
	Wallagrass	Aroostook	IRV-WAL	0.3

Both ground and aerial surveys were conducted in 2018, looking specifically for spruce budworm in northern Maine where damage would first appear. This year defoliation was assessed by CFRU student employees on all L2 sites. The Fettes Method was used to quantify defoliation on current-year growth. This method provides a systematic approach to measuring defoliation. It was employed during the last budworm outbreak in Maine, and is currently in use in Quebec. CFRU staff received training on implementing the method in a September 2018 demonstration at the University (with the coordinator at U Maine Fort Kent attending via video conference. The Fettes Method captures defoliation from all causes and can be used to estimate both current-year defoliation and cumulative defoliation. Results will be available from the CFRU. A brief introduction to the Fettes Method is provided in this document: http://www.sampforestpest.ento.vt.edu/defoliating/spruce-budworm/pdf/montgomery-etal1982-sbw.pdf. A sample data sheet is shown in Figure .

No defoliation was detected during aerial survey. Feeding needs to be approaching a moderate level of damage before it is visible from the air. All population measures indicate that numbers are too low everywhere in Maine to expect that level of feeding yet.

Spruce budworm populations in Maine have left the "stable" phase and appear to be building. Outbreaks occur on a roughly 40-year cycle in response to maturing forest stands and reduced pressure from parasites; the last time budworm was a problem in Maine was in the 1970's and 80's. This native defoliator of balsam fir and spruce has been defoliating trees in Quebec north of the Saint Lawrence Seaway for more than 10 years and has now been mapped within 10 miles of our northwestern boundary. Defoliation, which has spread to the south shore and into New Brunswick, currently covers more than 20 million acres. Current population levels in the state will allow more time to prepare before trees begin to experience growth-loss from budworm feeding.

SBW Defoliation--Fettes Method, CURRENT YEAR: Examine 20 tips per mid-canopy branch and rate using graphic, multipy N*Value, Sum products and divide by Total number of tips to get percent defoliation by branch or site. Try to do 3 branches from 3 trees at each site.



Lat: _____ **Long:** _____ **Date:** _____ **Operator:** _____

Township: **No. Branches:** **Species:**

Tally													**TOTALS:**
N tips													**N:**
(Value)	0	5	15	25	35	45	55	65	75	85	95	100	100	
Product														**Σ:**

OWNER INFO (Optional) **Branch Defoliation (Σ/N):** _____

Figure 12. Sample Fettes Method annual defoliation data sheet - Data were generally collected on hand-held tablets using DoForms, however paper data sheets were made available (Excel file available upon request).

Overall, this project goes very well, considering the number of cooperators. However, each year, there are issues with data completeness and sometimes sample quality, which can affect our ability to use the data cooperators have put effort into collecting. We are open to suggestions from cooperators in improving directions and making sample collection easier.

Updates to this report will be posted to www.sprucebudwormmaine.org as well as www.maineforestservice.gov.

Acknowledgements:

Cooperators are such a big part of the success of this program. A big thank you goes out to all the folks who paid attention to details of the trap protocol and worked to get the traps out and samples back in for processing. A lot of effort goes into the trap network, from people in the woods to those in the office who manage data from multiple surveyors. We appreciate their efforts and the support of the Spruce Budworm Task Force members.

Thanks to the MFS field staff that helped with the surveys this year. A special thanks to Joe Bither, our Sr. Entomology Technician in Stockholm, who stepped up to coordinate supply distribution and be the MFS point person for the more than 20 cooperators. His assistance was invaluable in a year with more than one significant retirement and a raging browntail moth infestation in the southern part of the state. Patti Roberts was instrumental in procuring supplies for the survey and keeping us all on task. Special recognition to Amy Emery who sorted through most of the light trap samples. Many staff from both insect and disease management and forest inventory and monitoring pitched in to wash traps and count trap catches—putting to a test the axioms “misery loves company” and “many hands make light work.”

Appendix C
Emerald Ash Borer in Maine

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2018 was an eventful year in New England with respect to emerald ash borer (EAB). EAB was found in Vermont in February. It was then found in the Canadian province of New Brunswick, right on the border with Maine, adjacent to the town of Madawaska in Aroostook County. EAB was then immediately found in Maine in northeastern Aroostook County. In July, it was discovered in Rhode Island. In September, it was found in two towns in York County in southwestern Maine. By the end of the calendar year 2018, all New England states other than Maine were completely regulated for emerald ash borer (EAB), with statewide quarantines. In Maine, the towns of Frenchville, Grand Isle and Madawaska (Aroostook Co.) and Acton, Berwick, Lebanon and Shapleigh were under an emergency order to prevent the movement of regulated ash products before the quarantine was put in place (see Figure 15) which was replaced by a partial state quarantine in early 2019.

Aroostook County. In May 2018, EAB was found in Edmundston, NB, within 1600 feet of the Saint John River (international border). It was subsequently found in Madawaska along the river by visual inspection. Felling and peeling of trees to look for larval activity revealed that EAB was established in brown ash (*Fraxinus nigra*) along the river for about half a mile and extended up tributaries for at least a quarter of a mile. After EAB was found in Madawaska, ME, along the St. John River, the Maine Forest Service (MFS) deployed approximately 100 purple prism traps in the towns surrounding the initial find. EAB were found on four traps within two miles of the original find, in Madawaska and the neighboring town of Frenchville. In addition, a single EAB was found on each of two traps in the town of Grand Isle, approximately 11 and 15 miles distant. Branch samples and whole trees near the positive traps in Grand Isle were peeled, but no EAB have yet been found in any tree in that town. Canadian visual and green trap surveys discovered additional infested trees around the initial find in Edmundston, across the river from Madawaska and Frenchville, and a single EAB was found on a trap in Ste. Anne de Madawaska, NB, just across the river from Grand Isle.

Twenty-nine ash trees in Madawaska and surrounding towns were girdled in June by MFS and volunteers. These were peeled in November 2018. All trees were negative for EAB except for a single tree within half a mile of the original find. Girdled trap trees in other parts of the state were processed in early 2019.

York County. In southern York County, a single EAB was found in each of Acton and Lebanon on USDA APHIS-contractor managed traps. Although MFS followed up with branch samples and whole tree dissections, no sign of EAB was found in trees in those towns in 2018.

As of March 2019, EAB has been found in three towns in northern Aroostook County (Frenchville, Grand Isle, and Madawaska), and in three towns in southern York County (Acton, Berwick and Lebanon). The county of York and 18 towns in Northeastern Aroostook County are under quarantine for EAB (see Figure 16, 17).

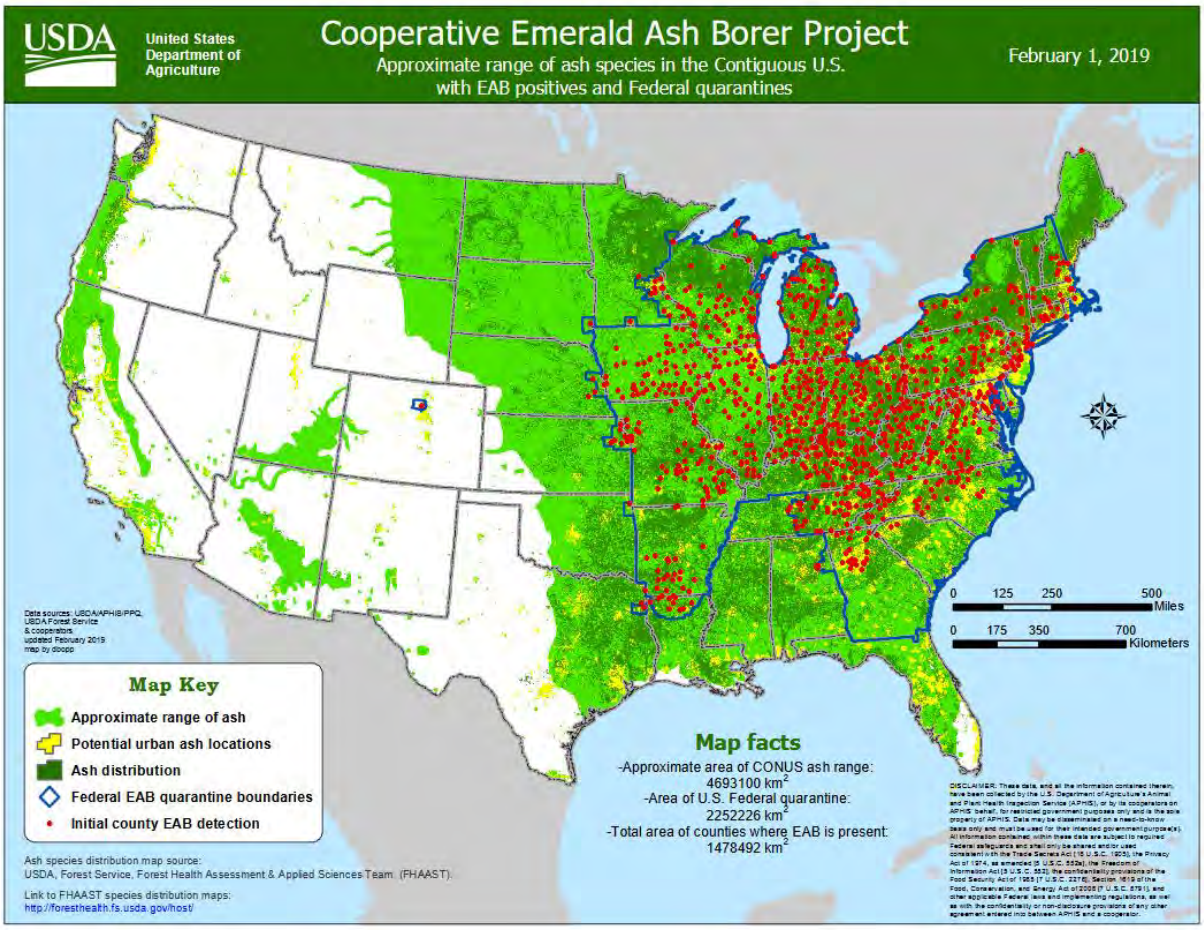

Figure 13. Range of ash and initial county detection of emerald ash borer in the United States of America.

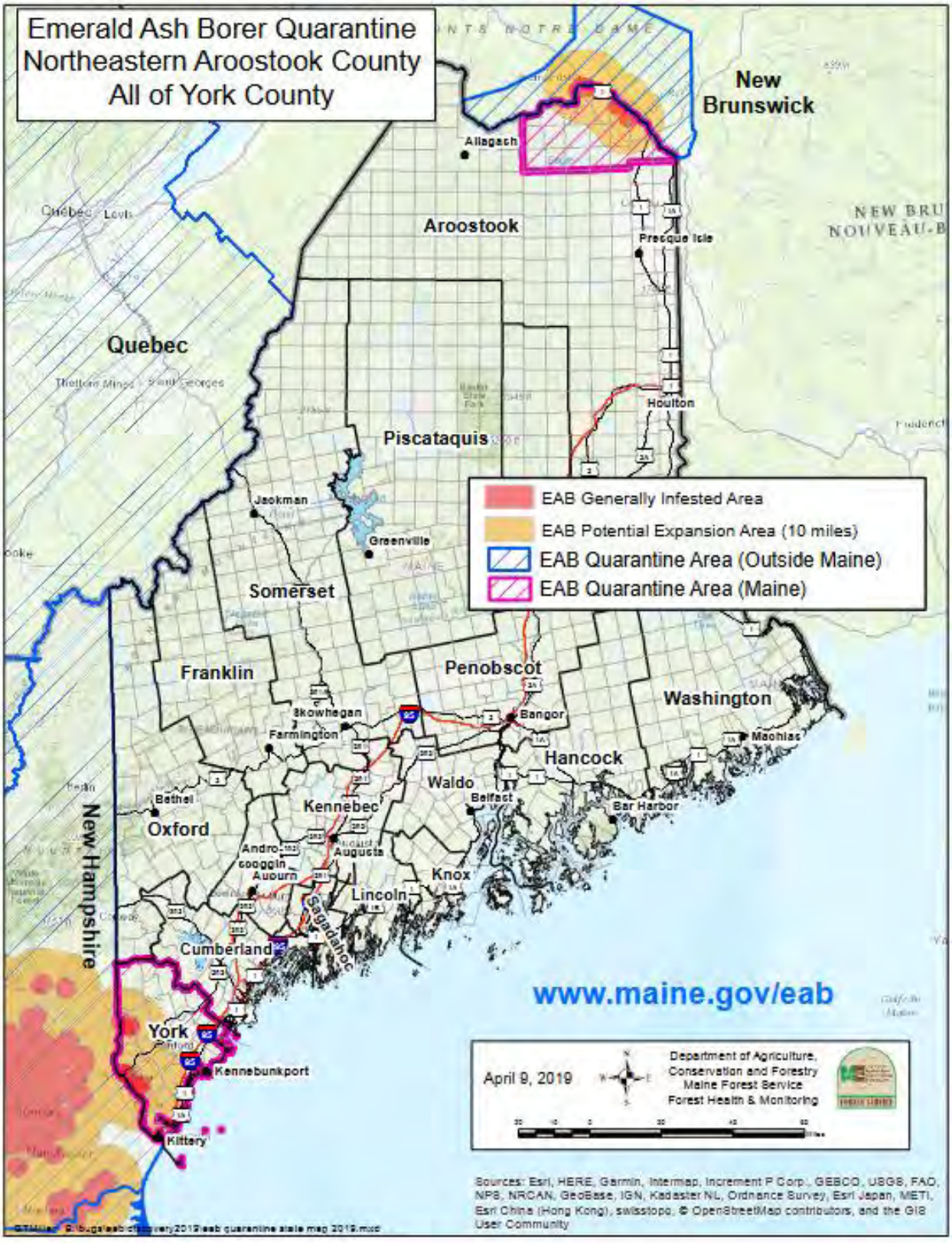

Figure 14. Emerald ash borer regulated areas in Maine and surrounding states and provinces.

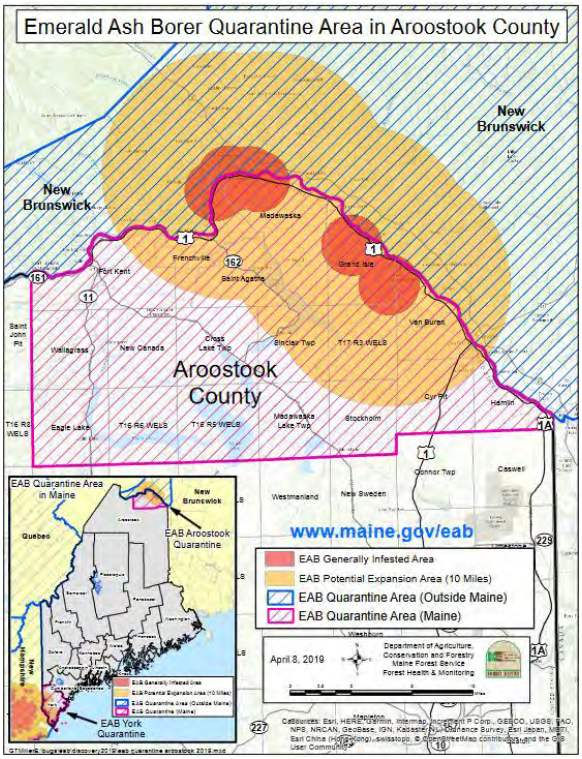

Figure 16. Aroostook County emerald ash borer detections and quarantine.

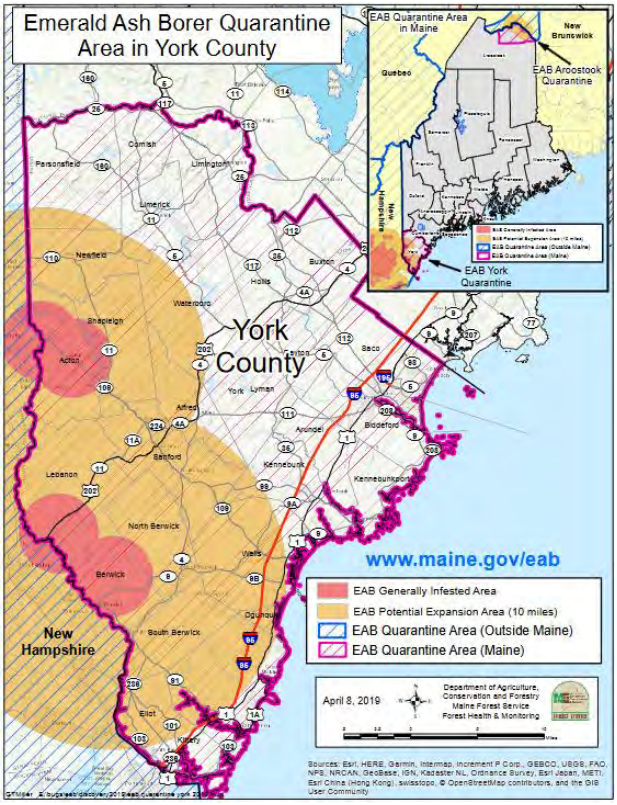

Figure 16. York County emerald ash borer detections and quarantine.

Visual Survey

Within days of the announcement of EAB being found in New Brunswick, Canada, EAB was found by visual survey in a small area along the floodplain. Felling and peeling of trees established that EAB was established in black ash along the floodplain for about half a mile and extended up tributaries for at least a quarter of a mile.

Purple Prism Trap Survey

In 2018, ASDA-APHIS contracted with the private company, Delta-21, to hang 411 purple prism traps to monitor for EAB in southwestern Maine, within 100 miles of known infestation in New Hampshire. In addition, DACF deployed just under 200 additional traps in other areas of the state. After EAB was found in Madawaska, the Maine Forest Service deployed approximately 100 of these traps in towns surrounding the initial find. EAB were found on 4 traps within 2 miles of the original find, in Madawaska and the neighboring town of Frenchville. In addition, a single EAB was found on each of two traps in the town of Grand Isle, approximately 11 and 15 miles distant. In Canadian green trap surveys, a single EAB was found on a trap in Ste. Anne de Madawaska, NB, just across the river from Grand Isle.

In southern York County, a single EAB was found on A Delta-21-managed trap in Acton and Lebanon (See Figure 18).

Girdled Trap Tree Survey

In the spring of 2017, 22 ash trees throughout the state of Maine were girdled as trap trees for EAB. These trees were felled and peeled in the late winter/early spring of 2018. All proved to be negative for EAB (see Figure 19).

In the spring of 2018, 54 ash trees were girdled. Thirty-two of these were in Aroostook County, in Madawaska and nearby towns. The rest were located elsewhere throughout the state. In November 2018, the trees in Aroostook County were felled and peeled. All proved to be negative with the exception of one located less than half a mile from known infested trees. In the early spring of 2019, all the rest of the trees (except for 7 that were snowbound) were peeled. All these proved negative for EAB (see Figure 20).

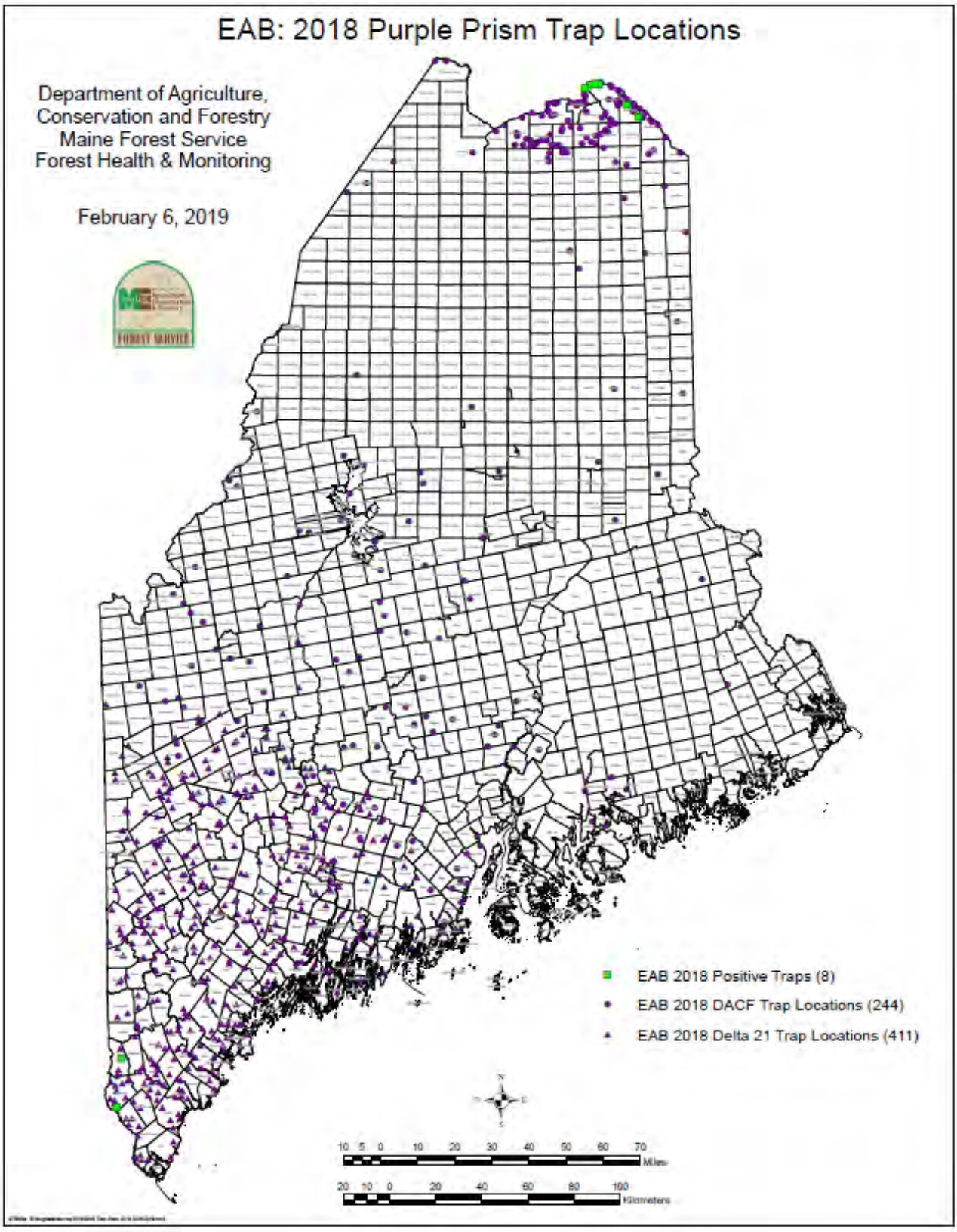

Figure 17. Maine purple prism trap survey 2018.

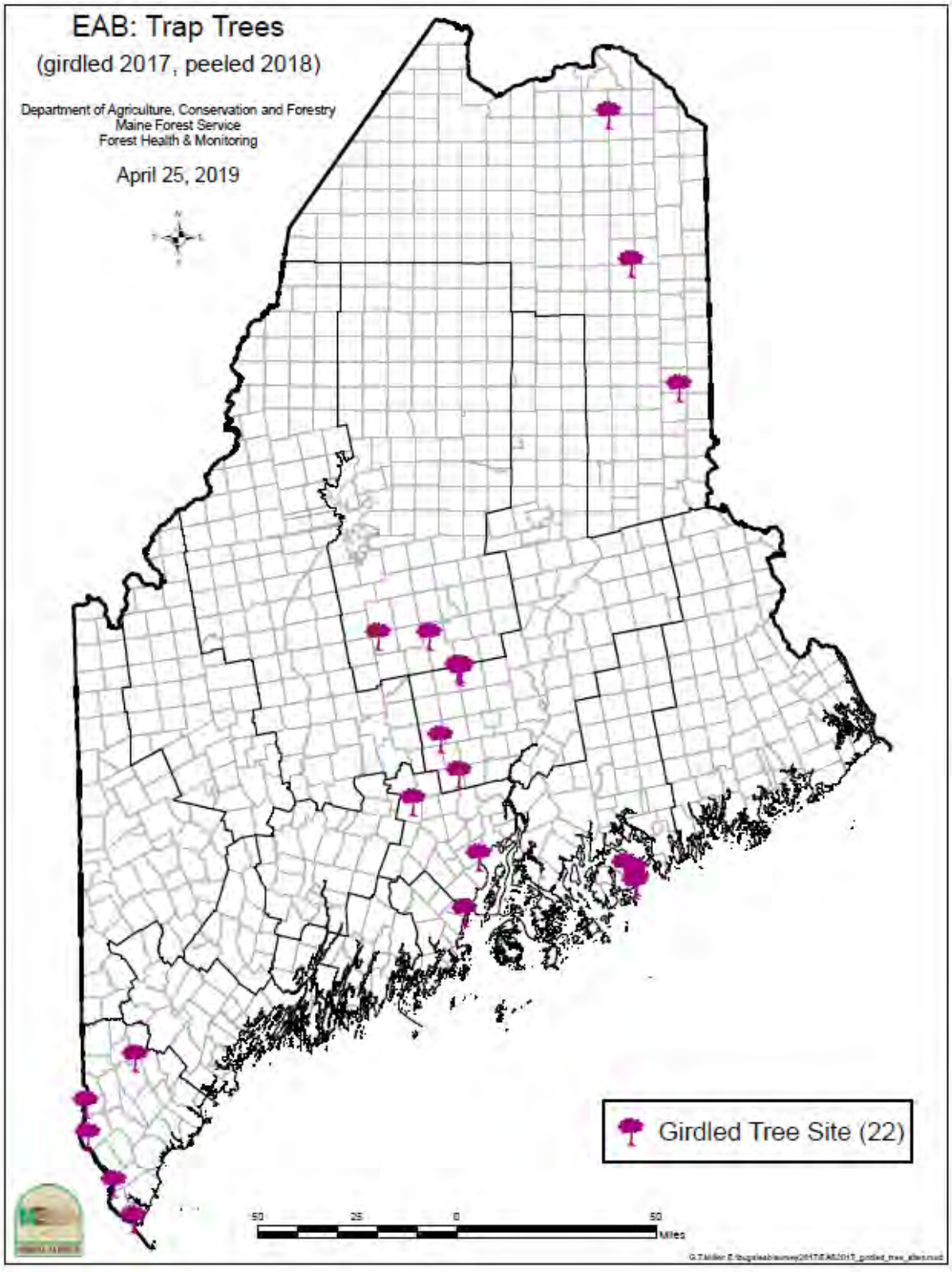

Figure 18. Girdled trap trees girdled in 2017, peeled in 2018.

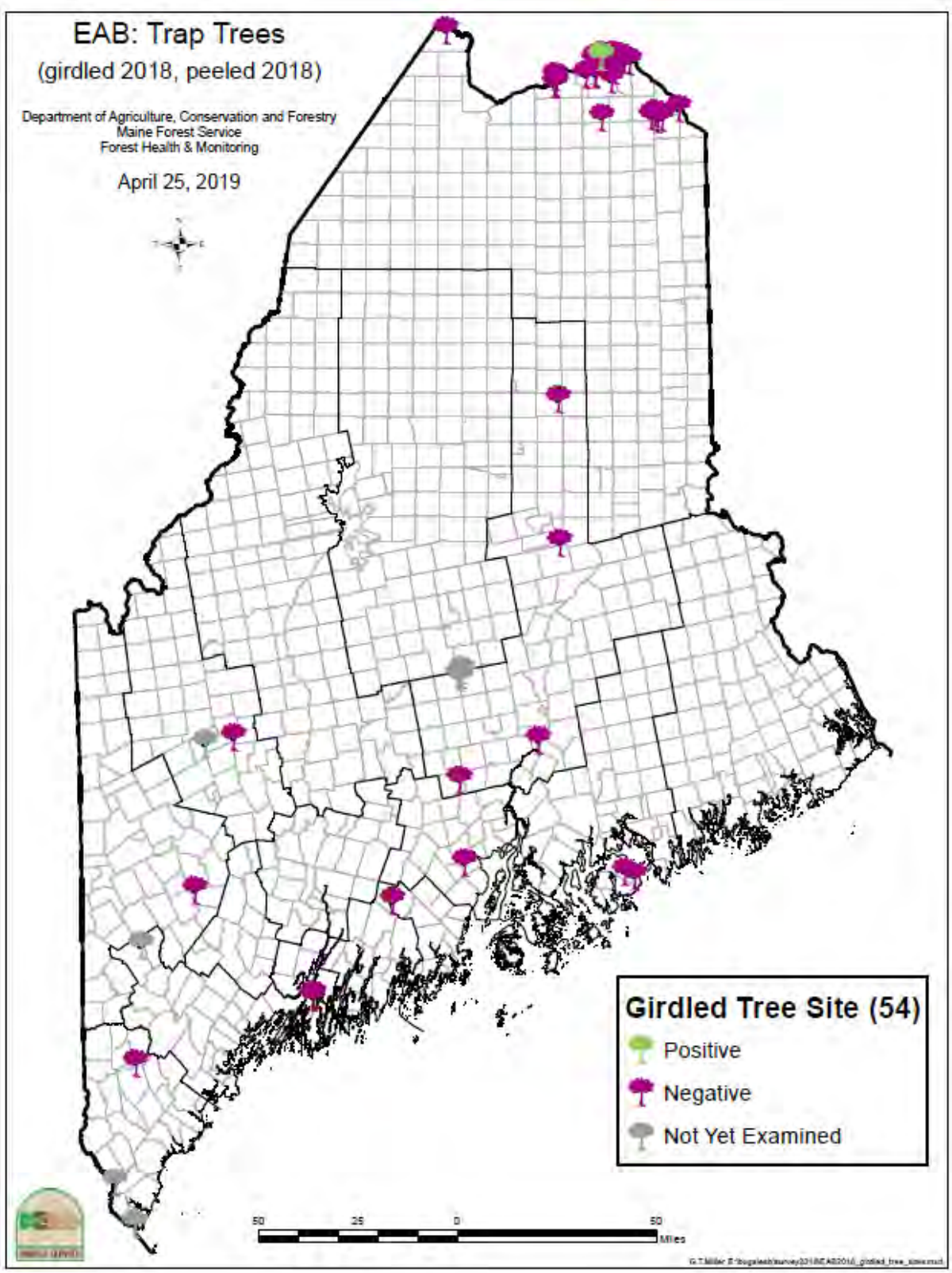

Figure 19. Girdled trap trees girdled and peeled in 2018.

Branch Sampling
After finding a single EAB on each of two traps in Grand Isle (Aroostook Co), whole trees and branch samples near each tree were peeled. However, no tree has yet been found in this town with any sign of EAB.

After finding a single EAB on each of two traps in southern York County, whole trees and branch samples in the vicinity of each tree were peeled, again, finding no sign of EAB. In February 2019, Maine Forest Service had the assistance of Central Maine Power. A team with a bucket truck collected 46 mid-crown branches from the sunniest aspect of 21 roadside trees in the towns of Acton, Lebanon, and Berwick. Three to four feet at the basal end of these branches were peeled. The branches were generally at least 2 inches in diameter. A single first-year larva (L2-3) was found in a single branch in both Acton and Berwick.

Biosurveillance
Biosurveillance with the hunting wasp, *Cerceris fumipennis*, was also employed to monitor for EAB. Biosurveillance efforts were concentrated in southern and western Maine, as *C. fumipennis* does not appear to live in the eastern and northern part of the state. In 2018, biosurveillance was carried out at 37 sites and buprestids were collected at 25 of these sites. This effort generated 304 beetles collected; none were EAB (see Figure 21).

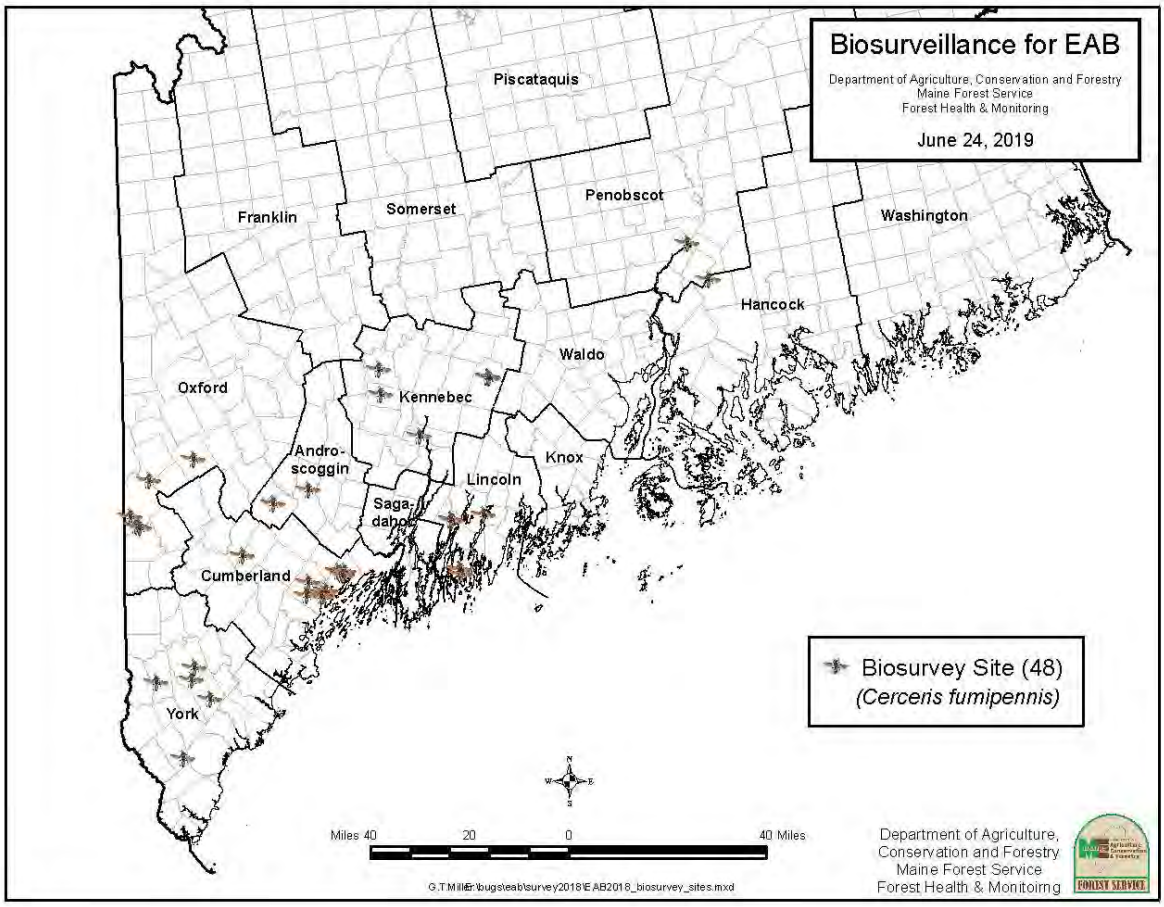

Figure 20. Biosurveillance for emerald ash borer with *Cerceris fumipennis* 2018.

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