Forest and Shade Tree Insect and Disease Conditions

for Maine

Summary 2023

Maine Forest Service
MAINE DEPARTMENT OF AGRICULTURE CONSERVATION AND FORESTRY
Augusta, Maine
Forest Health and Monitoring
Summary Report No. 34

MAINE DEPARTMENT OF AGRICULTURE CONSERVATION & FORESTRY

Amanda E. Beal, Commissioner
Randy Charette, Deputy Commissioner
Nancy McBrady, Deputy Commissioner
18 Elkins Lane, Augusta, ME 04333
(207) 287-3200
maine.gov/dacf

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Forest Insect and Disease – Advice and Technical Assistance

Maine Department of Agriculture, Conservation and Forestry, Maine Forest Service
Insect and Disease Laboratory
Phone: (207) 287-2431
www.maine.gov/foresthealth

The Maine Forest Service, Forest Health and Monitoring (FHM) program maintains a diagnostic laboratory in Augusta, staffed with forest entomologists and a forest pathologist and a field office in Old Town where the State Entomologist, Resource Management Coordinator and additional forest entomologists are based. The staff can provide practical information on various forest and shade tree problems for Maine residents. Our technical knowledge, reference library and insect collection enable 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 provided for diagnosis should have as much information as possible including: host plant, type of damage (i.e., canker, defoliation, wilting, wood borer, etc.), date, location, and site/land use 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. Also on our website you can find our on-line report form for forest health concerns. Using this form, you can provide digital images which may eliminate the need to mail in samples.

Insect and Disease Laboratory, Augusta
168 State House Station
90 Blossom Lane, 201 Deering Building
Augusta, Maine 04333-0168
Phone: (207) 287-2431, foresthealth@maine.gov
Hours: Mon–Fri. 7:30 a.m.– 4:00 p.m.
(call ahead for availability)

Amy Emery, Office Associate
(207) 287-2431, Amy.L.Emery@maine.gov

Aaron Bergdahl, Forest Pathologist
(207) 287-3008, Aaron.Bergdahl@maine.gov

Michael Parisio, Forest Entomologist
(207) 287-7094, Michael.Parisio@maine.gov

Thomas Schmeelk, Forest Entomologist
(207) 287-3244, Thomas.Schmeelk@maine.gov

Colleen Teerling, Forest Entomologist
(207) 287-3096, Colleen.Teerling@maine.gov

Old Town Office
87 Airport Road
Old Town, Maine 04468

Allison Kanoti, Director, State Entomologist
(207) 827-1813, Allison.M.Kanoti@maine.gov

Jeff Harriman, Resource Management Coordinator
(207) 827-1812
Jeff.Harriman@maine.gov

Gabe LeMay, Forest Entomologist
(207) 827-1829
Gabriel.LeMay@maine.gov

Brittany Schappach, Forest Entomologist
(207) 287-3147
Brittany.Schappach@maine.gov

Field Staff
Joe Bither, Senior Entomology Technician, Stockholm,
Joe.Bither@maine.gov

Elicia Dionne, Senior Entomology Technician, Lagrange,
Elicia.Dionne@maine.gov

Wayne Searles, Senior Entomology Technician, New Gloucester, Wayne.Searles@maine.gov

Abby Karter, Entomology Technician, Albion,
Abby.Karter@maine.gov

Zoe Albion, Entomology Technician, Bangor,
Zoe.Albion@maine.gov

Forest and Shade Tree – Insect and 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 and 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 personnel resources permit. We are always interested in what you see affecting your trees – let us know!

E-Mail Address _____

You can cancel your subscription 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 option is now as an electronic publication.

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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 and Disease Laboratory
168 Statehouse Station
Augusta, Maine 04333-0168
Phone (207) 287-2431

www.maine.gov/foresthealth

Scan to sign up on-line

Email foresthealth@maine.gov or call (207) 287-2431 for a paper subscription form

MFS Forest Insect and Disease Diagnostic Request and Report Form

Sample provided? ☐ Yes ☐ No Collection date _____

Please package disease samples in plastic or paper 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 day-time 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 control products/herbicides 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 to light (<30%) _____ moderate (≥ 30% to 50%) _____ heavy to severe (>50%)

Number of trees affected: none _____ one _____ many _____ OR Number of acres _____

Describe problem and other additional information (if needed you can continue the description on back):

_____

_____

Collector_____ Day-time Phone Number _____email_____

P.O. Address _____

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

Day-time Phone Number _____ email_____

Send sample to: Insect and Disease Laboratory, 168 State House Station, Augusta, ME 04333-0168

(or deliver in person to 201 Deering Building, 90 Blossom Lane or 87 Airport Road Old Town, ME)
Tel. (207) 287-2431
e-mail: foresthealth@maine.gov

Please send diseased herbaceous material to: Pest Management Office, Plant Disease Diagnostics Lab, 17 Godfrey Drive Orono, ME 04473-3692, http://extension.umaine.edu/ipm/

Acknowledgements

The information in this Annual Summary Report has been assembled and reviewed by Aaron Bergdahl, Michael Parisio, Thomas Schmeelk, Colleen Teerling, Gabe LeMay, Brittany Schappach, Jeff Harriman, Amy Emery, and Allison Kanoti of the Maine Forest Service, Forest Health and Monitoring Division (MFS FHM). Many other individuals and organizations have contributed to the information on forest health presented here.

The Forest Inventory and Analysis Unit (FIA) of our Forest Health and Monitoring Division provided invaluable assistance in a number of areas, including survey for beech leaf disease and European larch canker, servicing spruce budworm pheromone traps and processing samples, surveying for browntail moth, felling and peeling ash trap trees, collecting data on hemlock woolly adelgid impact plots, and reporting various insect and disease occurrences.

We extend our thanks to MFS employees Greg Lord, and Jereme Frank for their assistance with computer and statistical tasks, respectively. Our survey work was greatly enhanced by the efforts of Joe Bither, Wayne Searles, Elicia Dionne, Zoe Albion and Abby Karter. Amy Emery is also thanked for her work in the office, being the first contact for many of the public who reach out to our office, managing day-to-day administrative tasks, and supporting staff in numerous other ways. We would like to recognize Jeff Harriman for his versatility in providing a wide range of support tasks enhancing personnel effectiveness and MFS FHM work environments.

We would like to acknowledge Maine Department of Agriculture, Conservation and Forestry (DACF), Division of Animal and Plant Health staff for their assistance with regulatory issues and appreciate their cooperative efforts towards our overall mission to protect Maine's forest resources through the use of forest pest quarantine rules and regulations.

Thanks are also extended to many other administrative and field staff of the DACF and to our many contacts in the United States Department of Agriculture (USDA) Forest Service (USFS), Northeastern Area – Forest Health and Protection, the USDA Animal and Plant Health Inspection Service, and to our other cooperators in the Northeastern States of the United States and Eastern Provinces of Canada. We also thank the Forest Ecosystem Monitoring Cooperative (FEMC) for their assistance with survey efforts in Maine and for help addressing priority issues. Thanks to Dr. Angela Mech of the UMaine SBW Lab and Dr. Neil Thompson and Regina Smith of University of Maine's Cooperative Forestry Research Unit (CFRU) for their partnership in Maine's statewide spruce budworm monitoring program. CFRU is also acknowledged for continued efforts towards improving the understanding of current forest health issues in Maine.

Our sincere thanks go to those who volunteer in survey and monitoring as well as other tasks. Sharon Whitney and Peter Darling both run daily traps for winter moth each holiday season. Thank you to Jon Bailey, Kelsie Daigle and Nancy Olmstead of The Nature Conservancy and Jesse Wheeler of Acadia National Park for running traps for the southern pine beetle (SPB) survey. Thanks also to Tim Bickford with the Maine Army National Guard for coordinating the SPB trap in Hollis. We also want to thank every one of the cooperators who maintain moth light traps throughout the summer, some of whom have participated in the annual survey for decades.

Cameron McIntire and Isabel Munck of USFS Durham office are acknowledged for their continued assistance with forest pathology issues in Maine, in particular beech leaf disease following its detection

in Maine in spring 2021 and the emerging issues related to chaga farming in Maine. We thank the members of the Maine Entomological Society for their ongoing interest in insects and contributions to our knowledge of them in Maine. We gratefully acknowledge all the landowners in Maine that allow us access to their properties for important activities in insect and disease survey and monitoring. We would like to acknowledge the support of Dr. Elkinton, Dr. Andersen and their lab at the University of Massachusetts in Amherst for rearing the *Cyzenis albicans* pupae and determining parasitism levels at release sites in Maine. Finally, special thanks go to the vigilant residents of Maine who keep extra eyes on our forest resources and alert us to issues impacting tree and forest health.

Introduction

This annual summary report describes the efforts made by the Maine Forest Service Forest Health and Monitoring and their many partners toward 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 negative impacts to wood production and quality, water quality, the enjoyment of recreational opportunities, and, in some cases, human health. The great majority of these biotic species are native to Maine and are elements of productive and balanced, functioning forest ecosystems. However, non-native-invasive species and changes to climate disturb this balance and bring into question some natural relationships that were previously understood. Therefore, our evolving 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) **administering 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.

Personnel Updates

In Memorium

We note with sadness the passing of long-time Forest Health and Monitoring employee **Grayln Smith** in February 2022. Grayln was hired as an insect ranger in 1975 and retired as a Senior Entomology Technician in 2010. His dedication to the job and cheerful demeanor were noted upon his retirement; he left quite a hole in our field staff. Catching up with Grayln after retirement always included stories of his granddaughter as she moved through school.

New Employees

Ronna Coleman was promoted to the Entomology Field and Mapping Supervisor position with the FHM Division in March of 2023. Ronna graduated from the University of Maine at Fort Kent with a degree in forestry. In 2001, she was hired as a Conservation Aide out of the Fort Kent area, later moving to Washington County, ME. In 2007, she left the program briefly to focus on other priorities and returned in 2013. She was promoted to an Entomology Technician position, where she was involved with many insect and disease surveys in addition to inventory work.

On the Forest Inventory Field Crew, **Sierra Williams** briefly filled in behind Ronna in Washington County. She moved on to other opportunities after a couple of months in the field. **Kelby Leary** was hired in July of 2023 as a Conservation Aide in acting capacity. Kelby has a Master of Forestry degree and a BS with a Minor in Forest Ecosystem Science. Kelby has also worked on numerous wildlife surveys and previously served as a summer intern for FHM. **Adam Raven** was hired in September of 2023 as a Conservation Aide in Northern Aroostook. Adam has a BS in Conservation Law Enforcement and an AS in Liberal Arts. He has worked as a Wilderness Guide and is an outdoor enthusiast. And **Brennan Gunster** was hired in October of 2023 as a Conservation Aide in the Augusta area. Brennan has his BS in Wildlife Ecology and has worked as an Invasive Species Technician and was part of an invasive aquatic field crew.

On the IDM team, we welcomed new entomology technician **Zoe Albion** to our team in July of 2023. Zoe works out of Bangor and received her BS in wildlife biology from the University of Vermont. She came to us most recently from the Field Museum in Chicago, IL. Zoe has extensive experience in managing insect collections and we welcome her organizational skills and taxonomic expertise.

We hosted two summer **student interns** in 2023: Johanna McGinley and Conor Boyan. Johanna worked out of the Insect and Disease Lab in Augusta and was enrolled at the University of Southern Maine, where she studied environmental policy and planning. Conor worked out of our Old Town office and was enrolled at University of Maine – Orono, where he studied wildlife ecology. Their enthusiasm for forest health was a welcomed addition, as well as the extra assistance these two provided during an especially busy time of year.

Employee Recognition

For the second year in a row, Maine Forest Service Director Patty Cormier along with division directors took time to recognize a staff person from each division for their contributions. **Joe Bither** was recognized for his diligent efforts, exceptional organizational skills, adaptability within his profession and invaluable support during the execution of the 2023 FIA survey. **FIA Field Staff and Leadership** were also recognized for their exceptional efforts in completing the 2023 inventory panel.

Insect Conditions

Insects: Softwood Pests

Arborvitae Leafminer Complex (*Argyresthia* spp., *Pulicalveria thujaella)*
Primary Host(s): Cedar (*Thuja occidentalis*)

There have been ongoing landscape-level issues with cedar-swamp forest types in northern Maine for years; however, typical background damage levels were elevated enough in some locations in 2023 to warrant additional mapping during aerial survey. While there is little doubt a combination of abiotic factors is leading to general cedar decline in many locations, arborvitae leafminer complex has also always been associated with these declining stands when ground survey has been performed to assess damage. Arborvitae leafminer complex is not believed to be the driving force behind stand decline at this point, but it may be a contributing cause to poor canopy condition of cedars in wide swaths in northern Maine, and there have been outbreaks of this pest in the past. This situation will be monitored more in the future, and some researchers at the University of Maine have taken special interest in this evolving situation.

Balsam Gall Midge (*Paradiplosis tumifex*)
Primary Host(s): Fir *(Abies spp.)*

Balsam gall midge reports in 2023 remain limited to a single public inquiry; however, we expect an increase in the near future based on the historical patterns of this pest in Maine. Significant populations were not observed by field staff, either. It remains early for balsam gall midge reports in 2024, and we may receive additional reports once Christmas tree and wreath making season is in full swing. Many Christmas tree growers are accustomed to this periodic pest, and those with treatment experience likely do not feel the need to call and report or request advice from MFS.

Balsam Woolly Adelgid (*Adelges piceae*)
Primary 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 (FIA) plots when encountered, but no special measurements were taken in 2023, nor were any additional surveys conducted for this pest. Aerial survey revealed no BWA damage in 2023 compared to roughly 80 acres of damage that was mapped via aerial survey in 2022. In Downeast Maine, recovery from previous damage was observed, perhaps aided by extremely cold temperatures in February and May and ample moisture throughout the growing season.

Given that BWA routinely shows up in balsam samples being screened for overwintering spruce budworm larvae by the University of Maine Spruce Budworm Lab, the lab is now going to keep track of this information to try to better understand distribution and population density on the landscape in northern Maine.

Brown Spruce Longhorned Beetle (*Tetropium fuscum*)
Primary Host(s): Spruce (*Picea* spp.)

The MFS surveyed for exotic *Tetropium* species as part of a larger USDA Plant Protection Act-funded exotic woodborer and bark beetle survey in 2023 at a total of ten sites in northern Maine (Aroostook County). Samples were collected bi-weekly throughout the trapping season for a total of 100 samples. There were no targets found in any of the samples collected. Detections of BSLB near the Maine border in Quebec and in Fredericton, NB, along with trap recoveries in Nova Scotia after years of not being recovered, has elevated our concerns about this pest. Despite 2024 not including funding for the Exotic Wood Borer and Bark Beetle program, we will continue the brown spruce longhorned beetle survey with a focus in new areas.

Coneworms (*Dioryctria* spp.)
Primary Host(s): Eastern white pine (*Pinus strobus*)

In response to a bumper crop of white pine cones across Maine in 2023, cone pests followed, with several reports of immature cones browning and dropping from trees during the late summer months. Reports spanned from Penobscot to York counties, but given the distribution of white pine in Maine, it is expected this issue was statewide. Coneworm populations may spike in areas where pines produced the biggest cone crops but are expected to return to endemic levels with the return of a typical cone crop.

Conifer Auger Beetle (*Sinoxylon unidentatum,* syn. *Sinoxylon conigerum*)
Primary Host(s): Polyphagous in Native Range, Solid Wood Packing Material

In early October 2023, Maine Forest Service was contacted by a warehouse in Augusta, ME when workers noticed wooden pallets carrying a shipment from Indonesia with obvious evidence of insect activity, including boring dust and several live beetles. Local partners with the DACF Horticulture Program who were available that day picked up the collected beetle specimens, which were then submitted to a USDA-APHIS-PPQ identifier and identified as conifer auger beetle.

This powder-post beetle is native to Indonesia, where the pallet wood was sourced, and has a wide host range. Unfortunately, it is frequently intercepted in the United States in solid wood packing material and has even managed to become established in some areas of the southern US. This particular incident was reported to be part of a much larger incident, where pallets containing this beetle were distributed to destinations in numerous other states. Based on what is known of this species, it is currently classified as a not actionable pest and interception of this insect does not prompt a regulatory response from USDA-APHIS-PPQ.

Upon discussing with the State Forester and other staff, it was decided that the most prudent action would be to limit further emergence of insects from these pallets into Maine's forested environment. With assistance from the recipient and the Forest Protection Division of MFS, over 100 pallets were collected from the warehouse. These were examined for treatment stamps and insect activity, then contained in heavy duty plastic bags until final disposal. These pallets were stamped as treated with methyl bromide, but apparently the treatment was not fully effective in this instance, allowing beetles to survive the long journey overseas.

Under normal circumstances, wood products like this are quickly incinerated to destroy all insect life. However, this shipment posed a problem, since open burning regulations prohibit burning of treated wood, and trash incinerators were loath to handle the material. With no good option for incineration, arrangements were made to have the pallets buried deep within the local landfill, an alternative disposal

method for this type of treated wood suggested by our colleagues at the Department of Environmental Protection. Forest Protection Division, with access to larger trucks and machinery for loading, assisted with transport of the material for burial.

Prior to disposal, pieces of pallets with the most abundant evidence of insect activities were separated and placed in rearing barrels where they will be monitored for additional insect emergence. There appeared to be at least four distinct types of insect galleries present on these pallets, which were constructed using several species of tropical wood.

Coniferous Fiorinia Scale (*Fiorinia japonica*)
Primary Host(s): Fir (*Abies* spp.), Spruce (*Picea* spp.), Pine (*Pinus* spp.), and Hemlock (*Tsuga* spp.)

A scale insect was observed on an exotic Swiss Stone pine (*Pinus cembra glauca*) planted in Boothbay (Lincoln County) in November 2022. Samples collected by the property manager and submitted to the diagnostic lab at UMass Amherst were identified as *Fiorinia japonica.* Maine DACF Horticulture Program sent additional samples to a USDA identifier, who confirmed the species ID. This was a new state record for Maine.

All trees with detection of this scale were promptly destroyed in 2022. No follow-up survey was performed in 2023.

An additional state record scale species was believed to have been recovered from the sample submitted. This scale is in the genus *Lepidosaphes* and was believed to be either *L. pallida* or *L. pini*. Neither has been previously confirmed in Maine. Confirmation of ID was never received by the Horticulture Program that submitted the samples.

Elongate Hemlock Scale (*Fiorinia externa*)
Primary Host(s): Fir (*Abie*s spp.), Eastern Hemlock (*Tsuga canadensis*), and other conifers

Elongate hemlock scale (EHS) is well-established in the forests of southern Kittery (York County). It has been found on planted trees in Cumberland, Hancock, Lincoln, Sagadahoc, and York Counties and has moved from planted trees to the surrounding forest in some of these locations. In many locations where it has only been found on planted trees, it is likely to have moved into the forest but has gone undetected due to the cryptic nature of EHS.

Two new infestations of EHS were found in late 2022, adding Lincoln County to the list. Fortunately, no new infestations were found in 2023.

Hemlock Borer *(Melanophila fulvoguttata)*
Primary Host(s): Eastern Hemlock (*Tsuga canadensis*)

Mortality from hemlock borer, in addition to other predisposing stressors, remains highly visible in southern Maine along major highway corridors. In these locations, harvesting activities to move the tree line further back from the road damaged the root systems of many hemlocks growing on ledges with shallow soils. This pest was not commonly reported in 2023, likely because much of the active damage areas were reported previously and the situation has resulted in mortality in many places. These standing dead trees are much less frequently reported than trees being actively fed on by woodpeckers searching for hemlock borer larvae.

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

After mild winters in recent years, Maine had extreme cold spells in January and February 2023. These led to very high mortality (98 percent or greater) in some, but not all, of our regular monitoring locations. Overall winter mortality ranged from 57.2 percent to 100 percent, averaging 83.6 percent over seven sites.

In 2022, HWA was detected in fifteen new towns, including new county-level detections in Kennebec County. In 2023, HWA was detected in six additional new towns: Durham in Androscoggin County, Bar Harbor in Hancock County, Pittston in Kennebec County, Islesboro and Lincolnville in Waldo County, and North Berwick in York County. These were the first detections in Androscoggin and Waldo County forests. Hemlock stands with a long history of infestation continue to decline and mortality is seen in some coastal areas of southern Maine.

The continuing decline of hemlocks in many coastal areas of Maine, coupled with an increased awareness of HWA by the public, has led to public demand for biological control. This has been fostered by increased education and outreach efforts by multiple land trusts and conservation districts, as well as by the continuing efforts of MFS. In 2022, seven organizations and individuals purchased 8,550 *Sasajiscymnus tsugae* and released them in nine locations. In 2023, this increased dramatically to 31 individuals and organizations who purchased 43,000 beetles and released them in 47 locations. This included beetles purchased and released at 23 sites by private landowners, at ten sites by cities and towns, at 11 sites by land trusts, and at three sites by other entities, including a state park and a school. At some sites, integrated chemical and biological control has been initiated; at others it is in the planning stages. Others plan to proceed with biological control only. MFS educates and advises on selecting suitable release sites and integrated pest management techniques and assists with releases as needed.

In September 2023, 1,000 'early emerging' *Laricobius osakensis* were released on Land and Garden Preserve property adjacent to Acadia National Park before HWA had emerged from aestivation. An additional 1,000 were released after aestivation had broken a few weeks later, at each of the two sites where they had been released in 2022: Camden Hills State Park (Knox County) and the Land and Garden Preserve (Hancock County). Also in late 2023, funding from the USDA Forest Service supported staff in a field collection trip to Maryland where, with the assistance of Maryland Department of Agriculture, staff collected approximately 600 *Laricobius nigrinus* which were released in Portland in Cumberland County.

Red Pine Scale (*Matsucoccus matsumurae*)
Primary Host(s): Red Pine (*Pinus resinosa*)

Red pine scale continues to affect areas of coastal Maine in Hancock and Washington counties. This year, aerial surveys detected approximately 253 acres of damage affecting stands of red pine bordering blueberry barrens in Columbia. Later confirmed on the ground, this new town detection was not unexpected given the proximity to the towns of Deblois, T18 MD BPP, Columbia Falls, and Cherryfield, in which red pine scale was detected in 2022. There is continued concern regarding the potential spread of red pine scale into the Machias River Corridor Public Lands, which contain several thousand acres of mature even-aged red pine. As a precaution, discolored trees north of the known infestations were sampled along Rt 9, though red pine scale was not detected. The Canadian Forest Service is also

concerned about the possibility of red pine scale expanding northward into the natural range of red pine. This fall, a CFS member met with MFS personnel to tour active red pine scale infestations in the Downeast region to gather photos and information useful in identifying the various life stages and symptoms of red pine scale.

Southern Pine Beetle (*Dendroctonus frontalis*)
Primary Host(s): Pitch Pine (*Pinus rigida*), Red Pine (*Pinus resinosa*), Jack Pine (*Pinus banksiana*), and other conifers

Southern pine beetle (SPB) was first detected in October 2021 in the Waterboro Pine Barrens. In response to that detection, we have adapted the timing of our monitoring program to better cover fall dispersal of SPB, whereas previous monitoring had focused on spring dispersal. Traps were operated from September 28 until mid-November with a lure change in mid-October, to capture a pulse in late October that we have observed over the past few years.

This year, 21 Lindgren funnel traps were deployed at 14 sites throughout the state, placed in key areas to monitor Maine's hard pine resources. A portion of these traps are run by our cooperators at The Nature Conservancy and the National Park Service. In addition to these monitoring traps, we are running a total of nine additional traps as part of a lure study conducted by researchers through the U.S. Forest Service. The purpose of this study is to develop an enhanced lure that is suited to early detection and response. We collected only one specimen of SPB during the October 16 collection at one of the experimental trap sites in Alfred, ME. This is a site where our federal cooperators have caught SPB previously in similarly low numbers in both 2021 and 2022. One thing to note is that we did have a cold snap in February 2023 where the temperature did get down to almost -20 F, which is lethal for SPB.

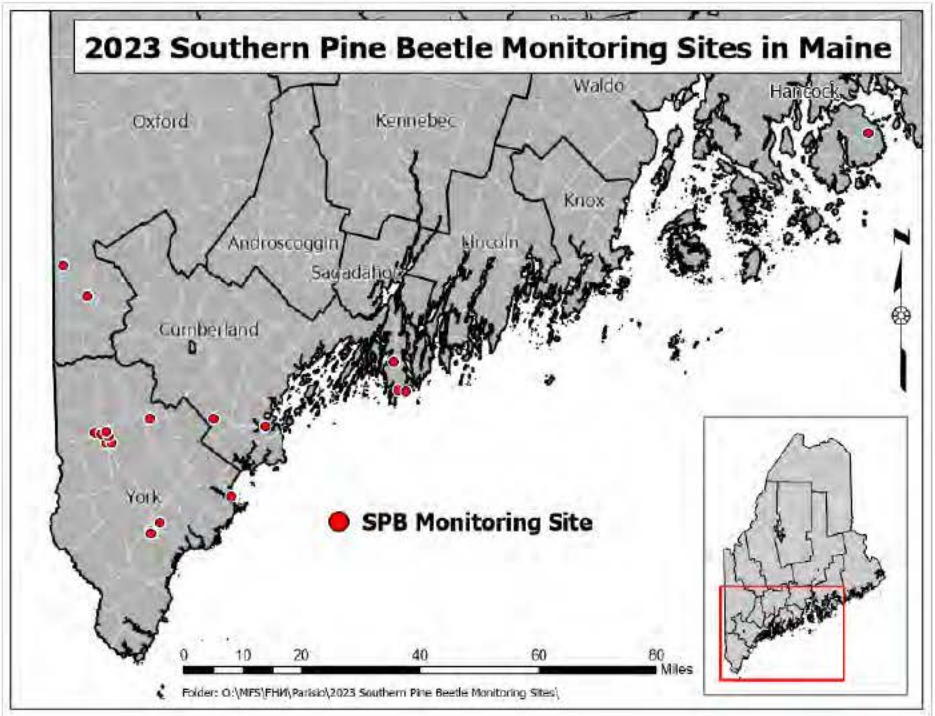


Figure 1: Locations of traps deployed for the detection of southern pine beetle in Maine.

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

The Maine Forest Service Division of Forest Health and Monitoring coordinates a network of roughly 350 SBW monitoring sites using pheromone lures in spruce-fir forests across Maine. After a mass migration event from Canada increased the average pheromone trap capture in 2019 to 67 moths per trap, these numbers decreased over the 2020 and 2021 monitoring seasons, falling to 36 and then 16, respectively. Trap capture remained constant in 2022 at 16 moths per trap. Trap capture continued to fall slightly in 2023, with a statewide average of 13 moths per trap. The Aroostook County average remains somewhat higher than the statewide average.

No defoliation damage from spruce budworm has been observed in Maine during aerial survey since 2021. Defoliation was also negligible across the 60 sites in Aroostook County monitored annually for defoliation using ground survey and the Fettes method.

The University of Maine Spruce Budworm Lab continues oversight of Maine's overwintering larval (L2) survey and branch samples from all over the state are currently being analyzed at the processing lab. Samples from all 58 sites submitted by MFS have now been processed, averaging just 0.4 larvae per branch and a maximum of 4.0 larvae per branch at one site. None reached the larval density threshold for treatment (average of seven larvae per branch sample).

Please see Appendix C for the full 2023 Annual Review and Outlook Report for spruce budworm.

Insects: Hardwood Pests

Anoplophora macularia
Primary Host(s): Maple (*Acer* spp.) and other hardwoods (complete host range of the insect has not been determined)

A fifth and final year of intensive ground survey was performed on August 9, 2023. The surveyors did not find any specimens or evidence of damage directly attributable to *Anoplophora macularia*; however, outreach materials were handed out to neighbors in the area to keep an eye out for any large beetles matching the description of *A. macularia*. During this survey, trees along the road near the presumed point of collection were observed from the ground. Trunks and branches were closely inspected for any signs of adult beetle activity, including egg-laying sites and emergence holes. These follow-up surveys were performed in response to a single pinned male specimen of *A. macularia* that was brought to the attention of the MFS in spring of 2019. The citizen reported he had collected the specimen on his property in North Berwick, Maine between 2014 and 2017.

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

Several reports confusing native longhorned beetles for Asian Longhorned Beetle (ALB) are received each year. All the public reports we received in 2023 were confirmed not to be ALB. Outreach efforts continue in conjunction with soil and water conservation district staff in Maine as part of a Plant Protection Act-funded initiative.

Browntail Moth (*Euproctis chrysorrhoea*)
Primary Host(s): Red Oak (*Quercus rubra*), Apples (*Malus spp.*), other Rosaceae spp., Deciduous Trees and Shrubs

Elevated populations of browntail moth (BTM) continue to be observed in different regions in Maine; most notably Cumberland, Knox, Penobscot, and Waldo counties. Aerial survey in late spring/early summer was hampered by one of the wettest seasons we've had on record, so much of the acreage reported in the table below comes from the second round of late summer aerial survey.

Table 1: Acres by county of defoliation by browntail moth in 2023

County	Browntail Moth Damaged Acres
Penobscot	18,972
Waldo	7,613
Hancock	6,470
Knox	6,100
Kennebec	2,151
Somerset	2,143
Oxford	1,529
Cumberland	1,285
Androscoggin	275
Lincoln	122
Sagadahoc	67
Grand Total	**46,727**

A more comprehensive report on browntail moth can be found in Appendix C.

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

Maine continues to actively survey for new emerald ash borer (EAB) infestations using multiple survey methods. Visual survey has once again proven to be one of the most powerful tools in the arsenal, revealing the most significant new EAB infestations detected in 2023. The Maine Forest Service manages biological control release and recovery efforts in the state. Looking ahead towards EAB management, MFS has recently acquired the tools necessary to perform trunk injections of pesticides to protect ash trees from EAB. Similar to some other states, MFS will initially be using these tools to protect the genetic diversity of forest ash and Maine's future ash seed source and will begin a pilot study at suitable sites beginning in 2024.

More details on EAB can be found in Appendix D.

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

This is the second year that significant forest tent caterpillar (FTC) activity was observed in Aroostook County, with damage again spanning from Hammond to Fort Kent. Defoliation of aspen was first

observed in early June, along with aggregations of FTC reported on roads. Though not as dramatic as the concentrated populations in 2018 that affected Blue Hill in Hancock County, caterpillar activity was certainly noticeable enough to be reported frequently by the public.

Aerial surveys, along with a lengthy ground survey, documented nearly twice the compared acres of damage when compared to the previous year: 30,584 acres, all within Aroostook County, vs 16,974 in 2022. Ground surveys were conducted in mid-July, when damaged aspen trees were beginning to refoliate, but the effects of FTC were still visible. There did not yet appear to be any obvious mortality among the affected trees. Recovery from early season defoliation by FTC has been aided by several seasons of regular or abundant rainfall in northern Maine, contrary to some of the drought stress conditions experienced further south in the state in prior years.

First observed in sizeable numbers in 2021, the FTC population in Aroostook County appears to be persisting. This is not abnormal, as FTC outbreaks are known to last up to five years at a time in Maine, though large populations often collapse sooner due to natural controls like pathogens. Weather conditions could also disrupt this population, as a late spring frost could kill large numbers of newly hatched caterpillars. However, based on the population levels observed this year and the year prior, we expect damage to persist in 2024. MFS will continue to document FTC activity in the area, with particular attention given to any trees which fail to refoliate following feeding damage.

Large Aspen Tortrix (*Choristoneura conflictana*)
Primary Host(s): Aspen (*Populus spp.*)

Large aspen tortrix was observed in northern Maine while assessing stands for defoliation from forest tent caterpillar. Large aspen tortrix was also reported in 2022 when a swarm of dead moths was reported in a Fort Kent gas station parking lot, drawn in by lights left on throughout the nighttime. They also oviposited characteristic green egg masses on the walls of the gas station building. Prior to these mentions, large aspen tortrix has not appeared in our conditions report since May 2012. This pest has more frequent outbreaks further north in Canada; however, a quick scan of forest health and newspaper headlines in Quebec and New Brunswick did not indicate abnormal amounts of large aspen tortrix activity in either 2022 or 2023.

Locust Leafminer (*Odontota dorsalis*)
Primary Host(s): Black Locust (*Robinia pseudoacacia*)

While locust leafminer is active almost every year in Maine, a few areas with high black locust density made damage from locust leafminer visible during aerial survey in 2023. One area was familiar from the air, since it had been extensively scouted earlier in the year for emerald ash borer, with the aerial surveyor remembering the abundance of black locust in this suburban area.

Oak Leafrolling Weevil (*Synolabus bipustulatus)*
Primary Host(s): Oaks (*Quercus* spp.)

A site being monitored in previous years at Holt Research Forest was not visited in 2023 due to a lack of indication from landowner that this insect is still active. This insect appeared in large populations following a winter harvest and caused substantial defoliation damage in the harvest block. The site indicated other evidence of armillaria root rot and presence of two-lined chestnut borer damage in

follow-up visits. In addition, this area experienced drought over a period of years, so some oak mortality is expected on this site due to this combination of multiple stressors.

Oak Twig Pruner (*Anelaphus parallelus*)
Primary Host(s): Oak (*Quercus* sp.), Hickory (*Carya* sp.), Elm (*Ulmus* sp.), Walnut (*Juglans* sp.) and several fruit trees

We received few reports concerning this insect in 2023 compared to numerous reports in 2022. The lifecycle of this species typically spans two years, so we expect to receive more reports again during the 2024 season based on historical reporting patterns.

Spongy Moth *(Lymantria dispar dispar)*
Primary Host(s): Oak (*Quercus* spp.), Birch (*Betula* spp.), Aspen (*Populus* spp.), Larch (*Larix* spp.), Pine (*Pinus* spp.), and many other hardwood and conifer species

Many areas in western Maine had experienced two to three seasons of spongy moth defoliation leading into 2023, with over 50 thousand acres of defoliation documented during aerial surveys in both 2021 and 2022. During this time, many areas where spongy moth defoliation occurred also experienced droughty conditions. When moisture regimes started to normalize again in 2022, evidence on the ground also indicated that spongy moth populations had reached levels where viral and fungal pathogens were primed to bring about a population crash, as is typical at the end of a spongy moth outbreak cycle.

A dramatic decrease in public reports in 2023 supports our observations that spongy moth populations have crashed in most of those areas affected in prior years. Unfortunately, these areas were not without defoliation in 2023, as a mid-May frost effectively killed emerging oak leaves across much of Maine, requiring the production of yet another set of leaves. In those areas where the spongy moth outbreak originated, this means as many as four consecutive years of defoliation, amidst a series of other abiotic stressors. This chain of events has proven too much for many oaks and substantial mortality is expected to have occurred or to ensue in the coming years.

As mentioned in the aerial survey section of this report, the timing of our spongy moth aerial survey flights prevented us from ascertaining the true situation at hand. Though 10,973 acres of damage was evident during aerial survey and mapped, the similar signatures of other simultaneous damage types mean there may be inaccuracies in the 2023 spongy moth data. Defoliated hardwood trees observed from the air may have been defoliated by remaining pockets of spongy moth caterpillars, defoliated by frost, or may have already succumbed to the dampening spongy moth outbreak. We are hopeful that a healthy canopy in 2024 will provide the contrast needed to accurately quantify the hardwood mortality resulting from this most recent spongy moth outbreak.

Spotted Lanternfly (*Lycorma delicatula*)
Primary Host(s): Nursery stock

Maine's spotted lanternfly (SLF) response is currently being led by the Maine Division of Plant and Animal Health – Horticulture Program as it is still considered a pest primarily of agricultural concern. Two interceptions of dead adult SLFs were reported to MFS by the Horticulture program: one aboard a cruise ship docking in Portland in late September 2023, from which numerous adults were recovered,

and the other in a supermarket in Augusta in October 2023. Additional live SLF were collected on the cruise ship after the initial report of the dead individual. We received public reports of SLF in Brunswick, Waldoboro, and Lewiston; however, we were able to confirm that these reported specimens were not SLF. We have semi-regular interceptions of SLF arriving from other states with populations, although there are still no documented established populations of SLF in Maine.

Survey is underway to better map the distribution of tree of heaven (*Ailanthus altissima*) in Maine, a heavily preferred host plant of SLF. Additionally, SLF has been included in the target list of pest species being surveyed for at five grape growing sites in five counties in southern Maine as part of a PPA-funded 'Small Fruit Pest Project' grant conducted by Maine's CAPS program.

Two-lined Chestnut Borer (*Agrilus bilineatus*)
Primary Host(s): Oaks (*Quercus* spp.)

In previous reports, two-lined chestnut borer (TLCB) was reported primarily in post-harvest conditions where an abundance of stressed oak hosts were readily available. While new areas with TLCB were not reported or observed in 2023, oak-dominated areas of Oxford County that have been heavily impacted by the recent spongy moth outbreak are of significant concern for the years to come. While we could not accurately assess oak mortality in 2023 due to aerial survey limitations, substantial mortality and decline are expected in the core affected areas. Many of these trees will be prime targets of TLCB attack, which could contribute to additional mortality post-spongy moth outbreak. We are working with large landowners to monitor the trajectory of oak mortality in Oxford County and future site visits may allow us to make observations about building TLCB populations in these areas.

Winter Moth (*Operophtera brumata*)
Primary Host(s): Oak (*Quercus* spp.), Maple (*Acer* spp.), Apples (*Malus* spp.) Ash (*Fraxinus* spp.), Birch (*Betula* spp.), and other trees and shrubs

Defoliation from winter moth caterpillars was prevalent in the Midcoast again in 2023 but was also found in other regions. We received reports of defoliation from the Boothbay Harbor region, Southport, Kittery and Mount Desert with the most severe defoliation occurring in West Bath, Phippsburg and the Bristol/ South Bristol peninsula. We attempted to document winter moth damage using roadside surveys this year due to the wet weather which impacted aerial survey. This ground survey was useful for documenting damage visible from the road, but the view from the air revealed the overall extent of these defoliated areas, allowing us to fill in the holes in our previous maps from the ground. Ground surveys confirmed severe defoliation in South Bristol, West Bath, and Phippsburg from winter moth as well. Overall, 4,186 acres of winter moth damage were documented in Midcoast Maine in 2023 using a combination of ground and aerial surveys.

On May 1, 2023, we released 447 *Cyzenis albicans* flies for biological control in South Bristol, Maine. This town was chosen due to its location on the coast, the abundance of severe defoliation, and the site's suitability. It is also the second release at this site to help boost the numbers of the prior release in 2022. We had excellent emergence rates this year, with mating observed as well.

Maine Forest Service staff, along with our colleagues at the Elkinton lab at UMass Amherst, engaged in our annual winter moth caterpillar collection on May 23 and 24 at previous biocontrol release sites, which included Boothbay Harbor, Bath, Cape Elizabeth, South Portland and two sites in Kittery. A

separate, smaller collection was made at our newer release sites on June 8 in East Boothbay and South Bristol to determine establishment of the parasitoid fly. Approximately 12,500 caterpillars were collected during these three days. After collection, the caterpillars were transferred to the Elkinton Lab at the University of Massachusetts to complete rearing and determine parasitism rates of the remaining viable pupae.

Overall, a total of 1,293 (an additional 30 were used by UMASS researchers for DNA work) *Cyzenis albicans* fly pupae were recovered from parasitized winter moth caterpillars in 2023 to be used as biocontrol for winter moth in Maine in 2024. These were placed inside an emergence cage in October 13, 2023 in West Bath and partially buried in the ground to overwinter until emergence in the spring of 2024.

In addition to acquiring biocontrol for future release sites, these collections show where the parasitoid has established successfully and what proportion of the winter moth population is being parasitized (see table below). MFS has been releasing *C. albicans* in Maine since 2013, generally working our way up the coast with each successful establishment of the fly.

Table 2: Percentage of parasitism at winter moth caterpillar collection sites in 2023.

Caterpillar Collection Site	Number of Live Pupae Assessed (WM + CY)	2023 Parasitism Rates
Bath	576	18%
Boothbay Harbor	280	6%
Cape Elizabeth	105	0%
East Boothbay (first recapture)	598	41%
Harpswell	533	2%
Kittery (Release Site)	551	34%
Kittery (Braveboat Harbor Rd)	1,179	23%
South Bristol (first recapture)	376	36%
South Portland	2,818	14%

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

Town	County	Release Dates	Number of *Cyzenis albicans* Released	Recovery Comments
Cape Elizabeth	Cumberland	1-May-2013	2,000	First recovery 2016; 27.4% parasitism in 2020
Harpswell	Cumberland	16 & 22-May-2014	1,200	Survival not good
Kittery	York	16 & 23-May-2014	1,200	First recovery 2016; 35.75% parasitism in 2021
Vinalhaven	Knox	21-May-2014	2,000	First recovery in 2018

Town	County	Release Dates	Number of *Cyzenis albicans* Released	Recovery Comments
Portland	Cumberland	15-May-2015	2,000	First recovery in 2018, 4.7% parasitism in 2020
Cape Elizabeth	Cumberland	15-May-2015	1,000	In 2021 parasitism rates at 10.95%
Harpswell	Cumberland	Cage set: 15-Nov-2016	2,000	First recovery 2020 0.85% parasitism in 2021
South Portland	Cumberland	Cage set: 29-Nov-2017	3,000	0.84% parasitism in 2021
Bath	Sagadahoc	21-May- 2019	500	Few flies emerged; cage was tampered with. 5.71% parasitism in 2021 (first recovery)
Boothbay Harbor	Lincoln	29-April-2020	500	Great emergence
East Boothbay Harbor	Lincoln	17-May-2021	150	Good emergence
South Bristol	Lincoln	5-May- 2022	329	Great emergence with breeding observed
South Bristol	Lincoln	1-May-2023	447	Great emergence, mating observed
West Bath	Sagadahoc	Cage set 13-Oct-2023	1293	To be released May 2024

Diseases and Other Injuries

Overview: MFS Forest Pathology travels the state of Maine, conducting site visits, providing technical assistance, and surveying forest diseases to gain a better understanding of the state's forest health conditions. Three presentations by the pathologist were given on various forest and shade tree pathology and forest health topics and contributions were made to a further seven presentations given by other forest health staff. In 2023, assistance was provided to approximately 437 landowners, homeowners, foresters, partners, and others. An additional 45 on-site visits occurred involving tree and forest disease diagnostic assistance. The staff pathologist wrote all pathology material in five issues of the *Forest and Shade Tree Insect and Disease Conditions for Maine* newsletters. The newsletter and this Annual Summary Report are coordinated by the staff forest pathologist and all pathology-related content provided in federal reports was written by the MFS forest pathologist.

Aerial survey of pathological forest health issues was limited in 2023. Survey of beech leaf disease (BLD) continues to expand to other parts of Maine using on-the-ground methods and reports from the public and natural resource professionals. The nine BLD long-term monitoring plots established in the state in 2021, in cooperation with the US Forest Service Pathologists in Durham, NH, were measured for a third time in 2023 (The York County plot was only in its second year of survey). Since the detection of BLD in

Maine, the staff forest pathologist has regularly participated in monthly National BLD Research Group meetings. MFS forest pathology also assisted with the logistical planning and facilitated landowner contacts for a USFS-led study on impacts of BLD infection on non-structural carbohydrates in beech. The MFS pathologist also served as a committee member for a University of Maine Master of Forestry student who did their final project on beech leaf disease and its impacts on wildlife.

Again in 2023, the pathology program assisted the US Forest Service in assessing white pine crowns in Bethel as part of a long-term white pine health project. Also in 2023, MFS cooperated with a Canadian researcher with Atlantic Forestry Centre Natural Resources Canada to collect butternut leaf and canker specimens as part of a genetic study. The Maine Forest Service's pathology program continues to participate in a national white pine health group and efforts within Maine to better understand eastern white pine health and management, although group activities were again minimal in 2023. MFS forest pathology also continued assisting graduate work in the University of Maine School of Forest Resources, Remote Sensing of Natural Resources. The current graduate students are working on using remote sensing data to assess eastern white pine health.

Winter survey for European larch canker yielded one new detection in a township outside of the quarantine area. Efforts to eradicate this disease in the outlying town of Brunswick were continued in cooperation with the Brunswick Country Club, where European larch canker is established.

The pathologist attended a limited number of in-person meetings and workshops in 2023 and participated in several virtual events. As in previous years, in 2023 the MFS forest pathologist also continued to represent Maine in the Forest Ecosystem Monitoring Cooperative and attended their annual meeting in December.

Finally, the MFS forest pathologist met with groups representing the farming of chaga (*Inonotus obliquus*) in Maine on four occasions and kept in contact and in good relations with the business in Maine pursuing chaga farming. Efforts are in process to develop common sense protocols for this new venture in Maine with potential forest health impacts. Also related to chaga, in late 2023, the early planning stages began for a cooperative experiment between MFS and the USFS Durham Field Office pathologists that will take place on the Massabesic Experimental Forest and or land owned by the University of Maine. The MFS pathologist will facilitate several aspects of this project throughout 2024.

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.), Sycamore (*Platanus occidentalis*)

The record rainfall during the growing season of 2023 created excellent conditions for anthracnose disease development. The weather allowed for high rates of initial infection and inoculum build-up as infections continued through mid-summer, a time when warmer and drier conditions prevail, limiting damage.

Ash Anthracnose (*Gnomoniella fraxini*) was observed causing severe premature defoliation in Boothbay Harbor (Lincoln County) and various levels of severity in other parts of Maine. The defoliation occurred in spring and trees were able to grow a new set of leaves. This disease was not reported by the public but was commonly seen on green and white ash by the MFS pathologist.

Beech Anthracnose (*Discula umbrinella*) was observed causing various severities of leaf lesions. Beech leaves damaged by the freeze event in mid-May were perhaps more susceptible to damage. Beech anthracnose damage was sometimes mistaken for symptoms of beech leaf disease (BLD). Beech anthracnose was seen co-occurring with BLD in areas where this disease was common.

Birch Anthracnose (*Discula betulina*) was observed on river birch in several areas of southern Maine and along the coast causing lesions and, in some cases, severe defoliation. Damage was reported in Cumberland, Hancock, Kennebec and Sagadahoc counties. Defoliation was also noted in several other areas, mostly on planted river birch.

Maple Anthracnose (potentially caused by *Aureobasidium apocryptum*, *Discula campestris* or *Colletotrichum gloeosporoides*) was very commonly seen in red and sugar maples and was also seen in striped maples. Severe defoliation of sugar maple in particular was reported in several of Maine's counties and was noticed impacting fall foliage color in many places. Lesser degrees of damage were seen in red, Norway, and striped maple. Variegated cultivars of Norway maples suffered heavy premature defoliation due to maple anthracnose. This was especially apparent on variegated Norway maples with portions of crowns that had reverted to unvariegated form. The variegated leaves were all shed from trees by August, while the unvariegated leaves stayed green and on the tree, with fewer lesions. This was observed in Androscoggin County and reported in York County.

Oak Anthracnose (*Discula quercina*) was observed throughout the state where oaks grow, causing various severities of leaf lesions and defoliation on multiple oak species. Oak leaves damaged by the freeze event in mid-May were perhaps more susceptible to damage. **Oak Leaf Blister** (*Taphrina caerulescens*) was recorded in one location in York County causing severe damage in white oak. This disease will be monitored in the coming years.

Sycamore Anthracnose (*Apiognomonia veneta*) was observed in the Augusta area (Kennebec County), causing moderate damage and defoliation. A severe infection accompanied by defoliation was also seen in York County. Sycamore trees are not common in Maine, but they are highly susceptible to this disease and full defoliation has been documented here when spring wet weather conditions favor disease development.

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

Armillaria root disease was seen in all Maine Counties in 2023, parasitizing stressed trees. This is no surprise as several species of Armillaria root disease fungus are thought to occur in Maine, and it understood that these fungi are present throughout the environment. The fungus appears to be a significant factor contributing to tree mortality, however the disease in Maine is only significant in combination with predisposing stressors in the form of primary insect or disease attack or environmental stressors. The Armillaria root disease complex remains a concern due to the unpredictable stressors that occur in Maine's forests each year. Current-year primary stressors were the unusually wet weather that led to summer flooding and root inundation in areas that are usually dry, the widespread freeze event in western Maine where oaks and beech (and several other species) lost their newly emerging leaves and defoliating insect pressure (primarily spongy moth and browntail moth feeding). Chronic stressors like beech bark disease, red pine tip and shoot blights and the white pine needle damage disease complex also represent opportunities for the opportunistic Armillaria to cause

more widespread mortality, although larger scale damage has not yet been documented. The compounded stress and decline of beech due to the newly established beech leaf disease complex (see **Beech Leaf Disease** section for distribution and more information) could lead to an increase in Armillaria root disease in Maine's beech resource. Armillaria fruiting was observed to be unusually prolific in fall of 2023, with large clusters of the fungus appearing at the base and on the lower stem of a variety of species. This was documented photographically by the staff pathologist.

Ash Rust *(Puccinia sparganioides)*
Host(s): Ashes (*Fraxinus* spp.)

Reports of a severe disorder affecting many ash trees in areas throughout Cherryfield and Columbia Falls (Washington County) in late June of 2022 prompted two 2023 visits by MFS staff to monitor development of this disease. The first visit in May was aimed at trying to find specific life stages of the ash rust fungus on its alternate host, cord grass (*Spartina* spp.), to predict disease development in ash later in summer. Several coastal tidewater areas were inspected and some rust symptoms were observed on grasses, but the identification of the rust on the cord grass and marsh grasses was not possible. It was too early to detect visible symptoms on the ash foliage at this time.

Like most of Maine in spring/early summer weather conditions were wet, which favored several species of fungal disease development. A June follow-up visit to areas impacted in 2022 revealed this was not the case for ash rust. While some orange rust pustules were seen in June on ash leaves and some lesions appeared to be in the process of forming, the damage was minimal compared to 2022. There are a few possible reasons for this. Perhaps because of the widespread and near total defoliation of ash trees in this area in 2022, the amount of rust fungus inoculum was not sufficient to re-infect alternate host marsh grasses in tidal areas as thoroughly as during the years prior to the 2022 outbreak. It is also possible that the leaf drop, in addition to dry weather during the spore dispersal period, led to decreased levels of infection. This is good news for the short-term health of ash trees in coastal Washington County. MFS will continue to monitor the area in 2024 for ash rust and impacts by secondary agents, like native ash boring beetles, that may become attracted to this stressed population of ash trees. This dynamic could potentially complicate early detection of emerald ash borer, which is not currently found in this area of Maine.

Bot Canker *(Diplodia corticola)*
Host(s): Oaks, primarily Northern Red Oak (*Quercus rubra*) in Maine.

Bot canker was occasionally observed in red oaks in Maine in 2023. Verifying all reports was impossible due to access to samples often occurring out of the reach of pole pruners. Bot canker symptoms were seen in Androscoggin, Kennebec, Knox, Lincoln, and York counties in 2023, and the disease was likely active elsewhere in the state where oaks grow. The numbers of reports could be down due to the masking of Bot canker symptoms from the mid-May freeze event that wilted oak leaves in many areas of Western, Central and Midcoast Maine. This also may be true for observed Kermes scale infestation, which is randomly encountered in Maine, and erroneously reported as Bot canker or oak wilt. False reports of Bot canker due to oak twig pruner (*Anelaphus paralellus*) damage did not occur this year due to a decrease in the occurrence of this pest compared to previous years. Typically, Bot canker tends to be associated with oaks growing on drought-prone soils and is reliably found causing damage on sandy soils in York County. As Bot canker incidence is thought to be associated with stress, the impact of record rainfall in 2023 causing prolonged inundation of soils in many areas of Maine may lead to an

increase in disease incidence next year. This is in contrast to drought events of previous years leading to stress and increased Bot canker symptom reports. The freeze event mentioned earlier in this section could also represent a stress that could increase the incidence of Bot canker next year and beyond.

While Bot canker is seldom a serious primary disease of oak, reports of symptoms are valuable from the perspective of early detection of oak wilt. We continue to get inquiries about oak branch flagging and wilting from the public, foresters and other natural resource professionals who are concerned about oak wilt. Although we have not yet found oak wilt in Maine, we annually feature the disease in our conditions reports, presentations, and other communications that reach a wide audience. Thus, we consider this increased awareness of oak disease symptoms as evidence of successful outreach efforts. Informal monitoring for Bot canker will continue in association with informal annual surveys for oak wilt disease.

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

Caliciopsis canker of white pine (*Caliciopsis pinea*) was commonly seen in 2023 during visits to white pine stands, especially on poor sites. Caliciopsis canker was seen affecting the health of codominant and suppressed white pine trees and seems to be responsible for mortality among white pine seedlings and saplings in the understory of infected stands. Caliciopsis canker is thought to be associated with overstocked stands and poor soils, but this relationship in Maine is only anecdotal. Drought stress from consecutive periods of drier-than-normal weather may favor further *Caliciopsis* disease development and impacts. Drought was not a significant stressor in 2023, but record rainfall throughout the range of white pine could have stressed white pine trees as water tables and levels rose, inundating roots. On drought-prone soils the wet weather could potentially have a positive effect on pine health and resilience to infection by *C. pinea*. The extent of the impact of the wet weather in 2023 will not be known for some time.

Chaga/Cinder Conk *(Inonotus obliquus*)
Host(s): Birches, primarily Yellow Birch (*Betula allegheniensis*) and less often on paper birch (*Betula papyrifera*) in Maine. Rarely found on American Beech (*Fagus grandifolia*) and Hophornbeam (*Ostrya virginiana*).

In 2023 the MFS pathologist met with groups interested in chaga production in Maine's forests. As far as we understand at the time of writing, the status of chaga production in Maine has simplified somewhat over the past year. It appears the international interest in Maine's chaga potential has, at least temporarily, dissipated. International importation of chaga-inoculated dowels also seems to have halted. The Livermore-based company that initiated efforts to cultivate chaga in Maine's forests has decided to work with a Maine producer of chaga-inoculated dowels in Portland, using a strain that is presumably native to Maine. The MFS pathologist has kept in contact with the Livermore-based company and continues to encourage them to develop best management practices for their operations in Maine. MFS remains concerned about the artificial augmentation of this tree pathogen's abundance in Maine's forests.

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

Eastern dwarf mistletoe is a parasitic plant frequently encountered in coastal areas of Maine where spruce is present. In 2023 requests for assistance related to this obligate parasite were down from previous years, although it continues to cause decline along Maine's coast and in island areas. Eastern dwarf mistletoe is less frequently encountered in areas of Maine further away from the coast, except for bog areas where high moisture levels are conducive to infection.

Fir Needle Blights and Fir Needle Casts *(Lirula nervata, L. mirabilis, Isthmiella faullii, Rhizosphaera pini)*

Host(s): Balsam Fir (*Abies balsamea*), Fraser Fir (*A. fraseri*)

Fir needle disease incidence appeared to be light, with only a few observations of fungi in the genera *Lirula* and *Rhizosphaera* causing mostly minor damage in Christmas tree plantings. One particular Christmas tree grower in Lincoln County has struggled to control *Lirula* and continues to have needle loss and branch dieback in the lower crown of his trees, despite application of preventative fungicide. This situation will be followed in 2024. The wet weather of the summer 2023 has made it difficult for growers with needle disease issues to apply preventative fungicide to break infection cycles. Cultural practices such as selecting suitable planting sites away from low areas, adequate tree spacing and vegetation control under crowns continue to be the primary methods for avoiding needle disease issues in fir plantings. *Isthmiella faullii* was not encountered or reported in 2023.

Fire Blight *(Erwinia amylovora)*

Host(s): Trees and shrubs in the Rosaceae family. Apple (*Malus* spp.), Pear (*Pyrus* spp.), Cherries (*Prunus* spp.), and Mountain-Ash (*Sorbus* spp.) account for most instances of fire blight in Maine.

Fire blight was observed and reported on several Rosaceous hosts throughout Maine in 2023 and is present at various levels throughout the state each year. Most fire blight infections occur earlier in the season via pollinators exposed to oozing bacterial fire blight cankers. As they visit flowers to forage nectar, they introduce the bacteria leading to blight symptoms. The other way fire blight spreads is via rainsplash, with the bacteria requiring a wound or natural opening to initiate infection. The freeze event in mid-May 2023 could have impacted fire blight in a couple ways. First, some varieties of apples had just begun flowering or blossoms were swelling and susceptible to freeze. The loss of blossoms could have had a negative effect on the fire blight bacteria's ability to spread via pollinators because of the lack of blossoms. On the other hand, freeze injury to susceptible tissues could have created entry points for infection a bit later in the season during the summer's frequent rain events. Overall, the number of reports and observations of fire blight was consistent with previous years, although reports were up in the northern regions of Maine.

One particular incidence of fire blight occurred in a municipal planting in Millinocket. It was strongly suspected that the trees supplied for this planting were already infected with fire blight prior to being delivered to the town. By the time of delivery, the trees had already flowered. The recently planted trees had numerous infected branch tips (strikes) where flowers would have been present. The characteristic dark staining of vascular tissues was observed and the typical shepherd's crook symptom was apparent. The town made the difficult decision to remove the trees and the supplier of the infected trees was non-cooperative and would not replace the trees with healthy stock.

Giant Tar Spot of Maple *(Rhytisma acerinum)*
Host(s): Norway Maple (*Acer platanoides*); occasionally other Maples (*Acer* spp.) are impacted by other *Rhytisma* spp.

Calls about tar spot of maple were surprisingly low in 2023. This may be related to the dry early summer of 2022 and a prolonged dry period before that in 2021, potentially disrupting the fungus's disease cycle. Tar spot of maple has been seen in the travels of the forest pathologist, albeit at lower levels. Perhaps the general poor appearance of foliage due to the wet summer of 2023 resulting in the proliferation of several hardwood foliar diseases masked the impacts of this conspicuous late-season tar spot disease of Norway maples. Norway maple continues to be considered an invasive tree species in Maine.

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

Hemlock shoot blight especially affects hemlock regeneration in forest habitats, typically closer to bodies of water. Once easily found in southern and southwestern areas of Maine, the MFS pathologist saw hemlock shoot blight only two times in 2023 (Oxford and Androscoggin counties). The very wet weather of 2023 has the potential to increase the occurrence of the causal fungus, and MFS staff will continue to look for this disease when working in hemlock during operations for other programs.

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

There were only a handful of reports of Phomopsis galls on oaks in 2023. As with many of the diseases presented in this summary, the number of reports does not necessarily reflect disease occurrence. Reports are typically received in spring before leaf-out and again when oaks lose their leaves in late fall/early winter when the unusual looking and often numerous galls are easily seen on the branches and the main stems of individual oak trees. Rarely a primary cause of oak tree mortality, trees with many galls may show branch dieback and are able to persist with the disease for many years.

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

Red pine blights caused by Diplodia tip blight (*Diplodia sapinea*) and Sirococcus shoot blight (*Sirococcus conigenus*) remain significant damaging agents to red pine in native and especially planted stands throughout Maine. The impacts of *D. pinea* and *S. conigenus* are clear and the diseases occur in high frequency throughout Maine's red pine resource; they often co-occur on sites. The diseases reduce growth and live crown ratios and are overall chronic stressors to red pine trees. Root diseases, such as Heterobasidion root disease (HRD, *Heterobasidion* spp.) and Armillaria root disease (*Armillaria* spp.), and heart rot fungi may also play a part in deteriorating red pine stand health. Efforts to better understand the distribution of HRD in Maine continue in formal and informal surveys. No formal survey was conducted in 2023.

Red Ring Rot of Eastern White Pine *(Porodaedalea pini* (formerly *Phellinus pini* and 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

Red ring rot was not reported in 2023, but this in no way means the disease is any less impactful in Maine. Because the decay conks are produced many years after infection and advanced decay, and the small velvet brown conks are somewhat cryptic in appearance, they often go unnoticed. This is why *P. pini* is more often seen by the MFS forest pathologist than it is reported by the public. Often, red ring rot is only noticed after a tree is harvested, or it structurally fails. The disease is still considered the most economically significant disease of mature white pine and other conifers because it causes the highest wood volume losses. The decay fungus *Porodaedalea pini* is generally seen in higher occurrence in over-mature trees due to the habit of the fungus to produce a fruiting body only after advanced decay. *P. pini* was a topic of discussion on a tree health evaluation visit to the Bowdoin Pines owned by Bowdoin University. This mature stand had some indications of *P. pini,* but no clear sign was detected during the tour of the stand.

***Rosellinia* spp.**
Host(s): Conifers

In late October 2023, the MFS pathologist was contacted by the University of Maine Plant Diagnostic Lab about unusual fungal growth on planted white spruce in a horticultural setting in Northeast Harbor (Hancock County). Thick white mycelial growth covering white spruce (*Picea glauca*) branches in the lower crown was causing heavy needle loss. The Diagnostic Lab had identified the fungus as a species from the genus *Rosellinia*, a group of fungal pests previously reported on hemlock growing along riverbanks in Georgia and also in tree nurseries in the western United States. Interestingly, similar reports had recently been made in Connecticut and weeks later in New Hampshire on Colorado blue spruce (*P. pungens*). Prior to these reports, the disease had not been reported anywhere in the northeast.

The location where *Rosellinia* spp. was collected was on a property undergoing major building and renovation. Many large trees had been brought onto the site to create a forest-like environment. The transplants ranged from 10 to 15 feet in height and had been in the ground for between 2 and 3 years. The worst infected trees were located in a lower area of the property, receiving little sunlight, and growing under an overstory of mature spruce in poor health with low live crown ratios. There was also a man-made circulating river winding through the area. The transplants had also been irrigated daily with water hitting their lower foliage. Additionally, the site is next to the ocean and fogs are often present for portions of the day and record rainfall was recorded throughout Maine during the 2023 growing season. Considering all of this, there was no shortage of moisture for disease development at this location, and *Rosellinia* spp. are known to thrive in moist environments. The site also, unsurprisingly, had spruce needle cast disease issues. Upon further discussion with the head gardener it was revealed that their landscaper had purchased at least some trees sourced from North Carolina. Since *Rosellinia* spp. have not been recorded causing damage to conifers in Maine before, and the fungi from that genus had been recorded causing disease in southern states (and western states), it was conjectured that the fungus came in on out-of-state nursery stock. Weeks later another report of *Rosellinia* spp. was confirmed at another residence in the same neighborhood. There the disease was impacting white spruce and Serbian spruce. Norway spruce growing in close proximity to heavily infected trees were not impacted. As there was no identification to species at this time, specific host information was not available and information about fungi impacting tree from this genus is very limited.

The general surrounding areas were surveyed for symptoms of *Rosellinia* spp. and an additional estate in Northeast Harbor that had also received several large transplants from the same supplier was inspected. No signs of the disease were found outside of the first two detections. Information was provided to the head gardener of the estate to share with her crew and the community of gardeners in the area. Hopefully this will reveal if more sites have been impacted by fungi in this genus. Informal survey for *Rosellinia* spp. will occur in connection with trips to this area of Maine and others in 2024.

Spruce Needle Casts *(Rhizosphaera kalkhoffii, Stigmina lautii)*
Host(s): White Spruce (*Picea glauca*) and Colorado Blue Spruce (*P. pungens*), Norway Spruce (*P. abies*) is typically more resistant, but is also affected.

Spruce needle cast diseases continue at moderate to high levels across the state, wherever hosts occur. The diseases have been especially damaging to ornamental plantings in suburban settings, in public parks, and along community streets. These instances are commonly reported to our office by the public. Severe damage to spruce trees by the spruce needle cast diseases has resulted in some mortality, but more often trees are removed because of reduced aesthetics or decreased function as privacy screens. Survey efforts to map the distribution of these diseases were minimal in 2023.

White Pine Needle Diseases (*Mycosphaerella dearnessii (= Lecanosticta acicola), Lophophacidium dooksii*, *Bifusella linearis and Septorioides strobi))*
Host(s): Eastern White Pine (*Pinus strobus*)

Fungi of the WPND disease complex continued to impact white pine trees in 2023. This was surprising due to the very dry months of May and June in 2022, which should have disrupted the disease cycle, as those are the months when peak spore production for initial infection is believed to occur (these diseases take a full year to develop spore-producing structures for re-infecting pine). Noting this pattern again this year, it seems as if the WPND pathogens require fairly little moisture to complete their life cycles and cause severe premature needle loss in eastern white pine. The high moisture of the 2023 growing season may mean severe WPND damage in 2024. As Maine's white pines continue to be negatively impacted by WPND pathogens, especially in dense stands shown to be more conducive to needle disease development, we maintain our vigilance in surveying for secondary pests that could take advantage of this stressed and valuable resource. In such dense and impacted stands, management is encouraged but should be carefully considered with a forestry professional. Due to poor conditions for aerial survey this year, limited aerial survey for WPND impacts was carried out. Some areas were identified via ground survey. Ground survey of WPND may be increasingly valuable in the coming years using ArcGIS software products.

Diseases: Non-Native

Beech Leaf Disease *(Litylenchus crenatae mccannii)*
Host(s): American beech (*Fagus grandifolia)* and non-native and ornamental varieties of *Fagus* spp.

Since confirmation of beech leaf disease (BLD) in Lincolnville, ME (Waldo County) by MFS and USFS Durham Field Office forest pathology staff in late May 2021, more areas have been found, expanding the known extent of BLD's spread in Maine. As of December 2023, symptoms of the disease have been confirmed in 11 of Maine's 16 counties: Cumberland, Hancock, Kennebec, Knox, Lincoln, Penobscot, Piscataquis, Sagadahoc, Waldo, Washington and York counties (see table and map below). Survey for

BLD was carried out in all of Maine's counties in 2023. Further distribution of the disease is not known, but BLD is likely to found elsewhere in Maine and further survey efforts are planned for 2024.

BLD detection was communicated to the public through various forms of media and in monthly Maine Forest Service Conditions Report bulletins throughout the spring, summer, and fall. Ongoing public outreach has proved to be very effective as many reports of BLD have come from landowners, recreationists, foresters, and other natural resource professionals in the form of calls, texts and emails with pictures. Expanded training of cooperators has continued to lead to increased confirmed reports of BLD. BLD presentations were given in formal and informal settings outside of and within BLD-infested areas involving various interest groups ranging from land trust members to academics.

The nine established long-term monitoring plots in Cumberland, Hancock, Kennebec, Knox, Oxford, Penobscot, Waldo, and York counties were measured for a 3rd consecutive year (data has only been collected in the York County plot for two years). The plot in Acadia National Park marks the first time we have detected BLD on a plot where BLD has not been found in previous years. The USFS Durham Field Office is gratefully acknowledged for funding and assistance associated with these plots.

MFS forest pathology, in cooperation with Viles Arboretum in Augusta Maine and MFS Community Forestry, established a polyphosphite soil drench treatment trial in an area of the arboretum where BLD was found at trace levels in 2023. MFS will continue to work with partners to continue this trial and monitor results in 2024.

As more is learned about BLD through MFS pathology's participation in monthly BLD National Research Group meetings and learning from other resources, we will continue to share information and engage the public through various forms of outreach. We will also continue to ask for the public's help in identifying additional areas impacted by beech leaf disease. A Maine Forest Service BLD website was made in 2021 and has been maintained and updated in 2023 with the most recent information about BLD at local and national levels.

Table 4: List of counties where beech leaf disease has been confirmed and year of first detection.

County	Year of First Detection
Cumberland	2023
Hancock	2022
Kennebec	2023
Knox	2021
Lincoln	2021
Penobscot	2021
Piscataquis	2023
Sagadahoc	2023
Waldo	2021
Washington	2023
York	2022

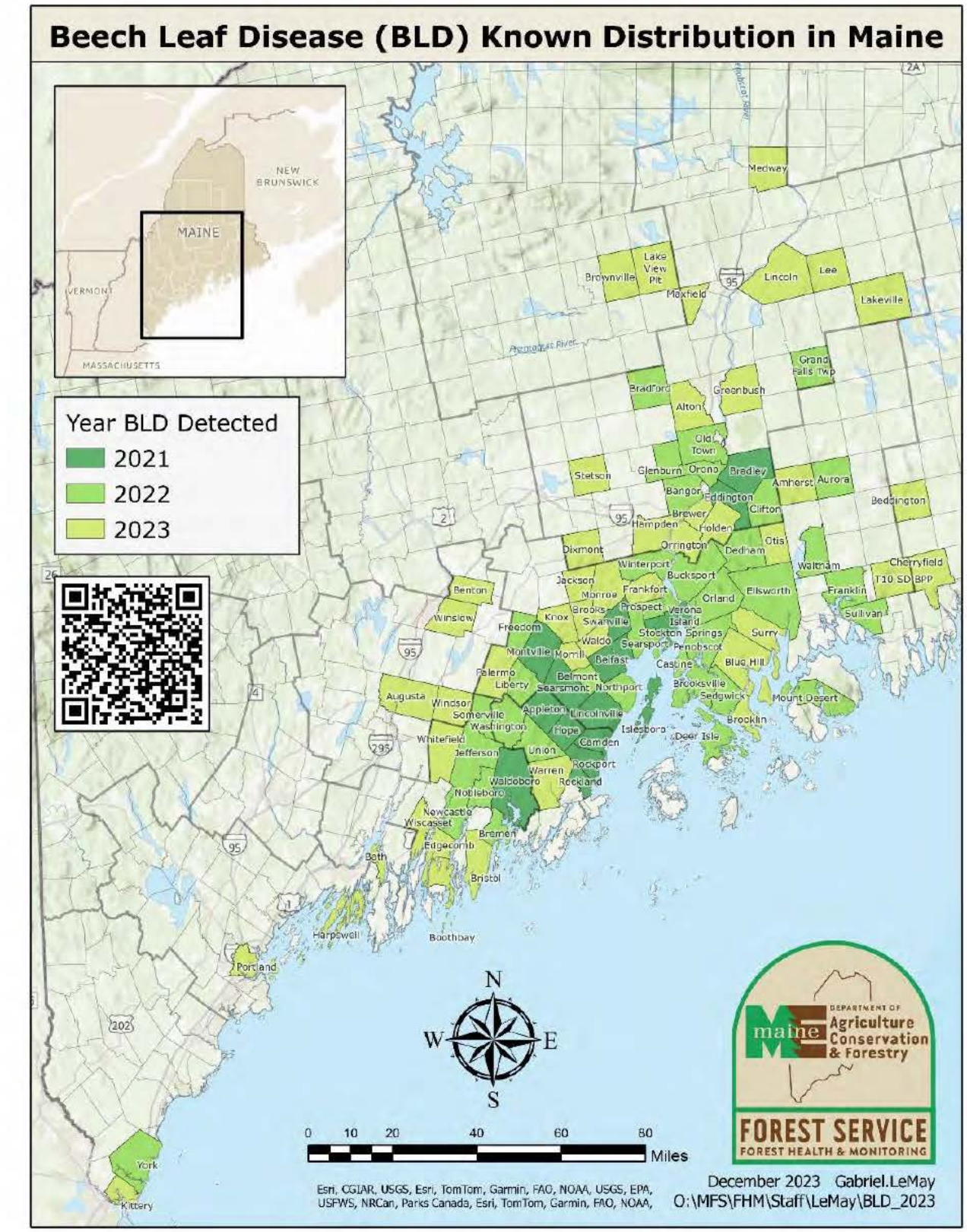


Figure 2: 2023 known town distribution of beech leaf disease in Maine.

Butternut canker (*Ophiognomonia clavigignenti-juglandacearum* (formerly *Sirococcus clavigignenti-juglandacearum*))
Host: Butternut (*Juglans cinerea*)

The health of butternut trees continues a steady decline across the state wherever they grow. It is highly unusual to find a non-hybrid, native butternut tree anywhere in Maine without symptoms and signs of the butternut canker fungus. Populations of butternut still persist on the landscape in Maine as confirmed by informal survey.

In summer 2023, the MFS forest pathologist received a request from a Canadian researcher with Atlantic Forestry Centre Natural Resources Canada to collect butternut canker-infected inner-bark tissues and leaf tissues for an investigation of genetic aspects of butternut trees and the butternut canker fungus. The request was approved, the protocol for sampling butternut trees in three different locations in Maine was carried out successfully and samples from three sites were submitted (Gardiner, Kennebec County; Starks, Somerset County; Houlton, Aroostook County). Butternut trees are not particularly common in Maine due to the specific site requirements of the species and decline and mortality due to butternut canker disease.

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

Dutch elm disease (DED) remains a prevalent disease of elms in Maine. MFS has received several reports from the public claiming DED is more prevalent this year than in previous years. This has not been supported by statewide field observations and it is suspected that the public reports have come from so-called DED 'hot-spots'. Unfortunately, Castine, Maine (Hancock County), home to a high amount of municipal elm trees, was one such area in 2023. The town proactively manages their elm population and receives regular technical support from MFS FHM and MFS Community Forestry. The reason for the DED increase in this area and other areas is not known. Perhaps the prolonged drought periods that occurred during the summers of 2021 and 2022 stressed elms and favored populations of the insect vectors of DED. Increased localized DED presence could also be due to the natural progression and movement of the disease on the landscape.

European Larch Canker (*Lachnellula willkommii)*
Host(s): Native and Non-native Larch (*Larix* spp.)

MFS has intensified winter survey for European larch canker (ELC) since 2022. Eastern larch is often found growing in wet areas, especially in bogs. While these areas are not accessible during the growing season, in late winter they are often frozen and MFS staff can access them on foot or snowshoes for closer examination of trees. Early fall survey to identify ELC based on flagging continues and provides us with potential areas for closer survey during winter. In December 2022 to late February 2023 MFS staff conducted ground surveys in several larch-rich areas outside of the current ELC quarantine area. This, again, yielded good results. In 2023, ELC was found in one new township, T34 MD BPP (Hancock County). Samples were collected during the survey and were submitted with assistance from APHIS in Hermon, ME. Fungal identifications were verified by a U.S. Department of Agriculture national fungal identifier located in Beltsville, MD. The new 2022 and 2023 ELC finds are depicted in the map below. The current quarantine boundaries are also seen in this map. Protocols for both the fall and winter surveys were updated in 2023. Staff and technicians continued to contribute to present and future ELC survey by

using technology to identify and record potential ELC detections and good larch sites for future survey. This has been facilitated by the use of the ESRI products QuickCapture and FieldMaps apps with customized surveys for ELC.

Cooperative efforts between the MFS and the Brunswick Country Club to eradicate ELC from this outlying area continued in 2023. The Club has prioritized removals based on our recommendations. Recommendations are based on surveys carried out each late winter that include a health evaluation of all *Larix* spp. trees on the course. Canker counts are made for each tree and reachable cankers are physically removed. This year we removed roughly 16 cankers, recommended removal of 13 trees based on disease presence and general health, and suggested pruning requiring a lift for four trees. A map was created by MFS and was given to golf course groundskeeping staff to aid in prioritizing tree pruning and removals. This cooperative effort will continue in spring 2024.

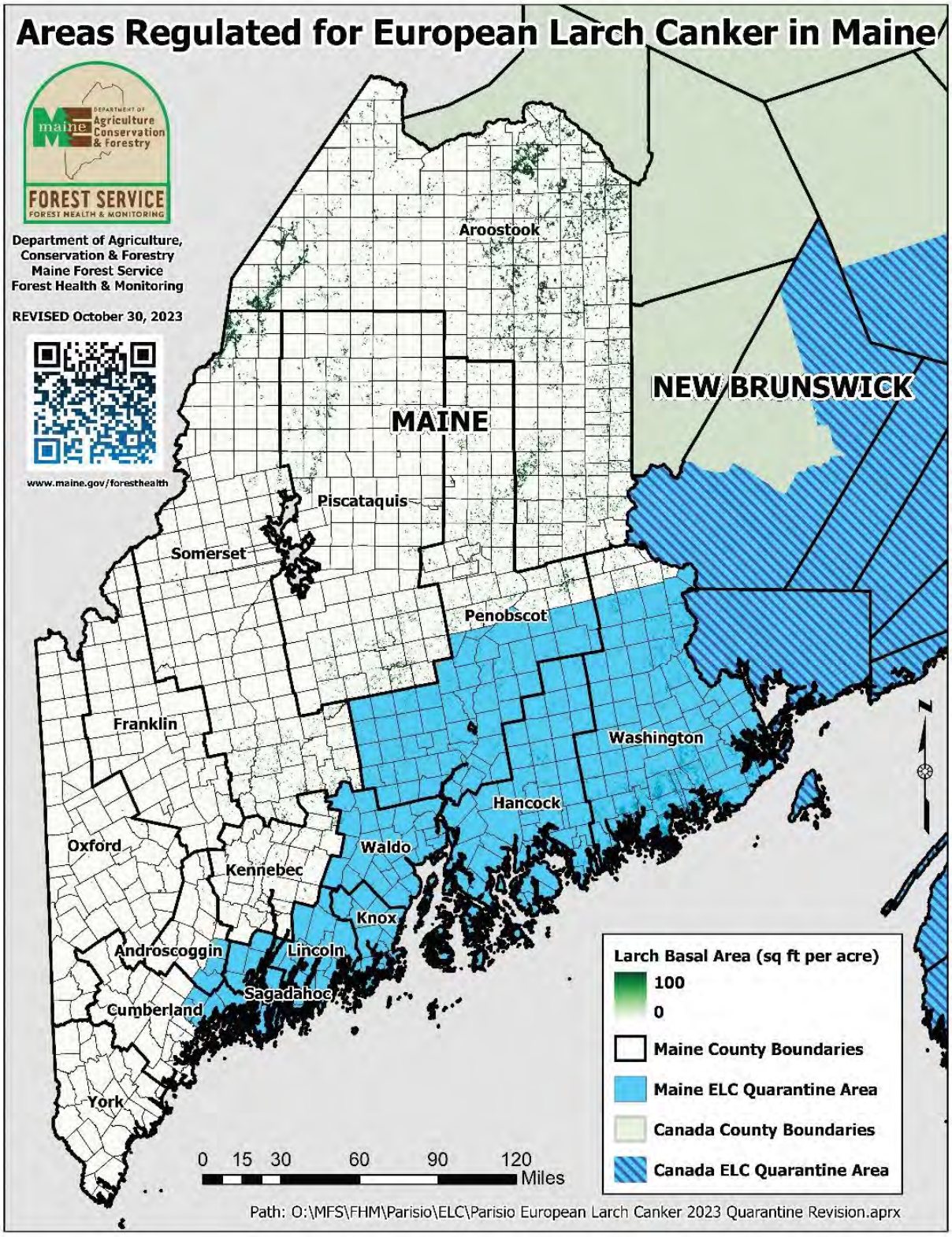


Figure 3: Current European larch canker (ELC) quarantine map showing eastern larch basal area, the current ELC regulatory area.

Oak Wilt (*Bretziella fagacearum)*
Host(s): Oak (*Quercus* spp.); Red Oak-group Oaks (highly susceptible), White Oak-group Oaks (moderately susceptible)

Oak wilt has not been found in Maine. Survey in 2023 was completed by general observation and investigating all reports of flagging/wilting oak branches from the public. Despite numerous reports of suspected oak wilt by the public associated with the mid-May freeze event and heavy oak anthracnose and other fungal oak leaf disorders due to the unusually wet summer, no suspicious cases of oak wilt were encountered requiring sample submissions for lab diagnosis. Instead these reports revealed occurrences of Bot canker (*Diplodia corticola*), mechanical/construction damage, limited oak twig pruner (*Anelaphus parallelus*) compared to previous years, high levels of oak anthracnose (*Apiognomonia errabunda*), a single report of oak leaf blister (*Taphrina caerulescens*) in York County, Kermes scale (*Allokermes* spp.) or oak Lecanium scale (*Parthenolecanium spp.*), spongy moth (*Lymantria dispar*) and browntail moth (*Euproctis chrysorrhoea*). Similar survey efforts toward early detection of oak wilt will continue to be prioritized in 2024.

White Pine Blister Rust *(Cronartium ribicola)*
Host(s): Eastern White Pine (*Pinus strobus*), Currants, Jostaberries, and Gooseberries (*Ribes* spp.)

White pine blister rust (WPBR) was seen impacting white pine regeneration in Androscoggin, Cumberland, Hancock, Kennebec, Knox and Waldo counties in 2023 and remains a threat, especially to white pine regeneration and sapling-sized trees throughout the white pine resource in Maine. White pine blister rust can typically be found wherever white pine and the rust's alternate hosts grow in Maine, which seems to characterize an increasingly large area of the state, as it has been many years since the cessation of State *Ribes* control programs. Plants in the genus *Ribes*, especially European black currant, are effective alternate hosts crucial to the disease cycle of WPBR. Due to the documented ability of the rust fungus to break the resistance in *Ribes* varieties marketed as resistant to the disease, existing regulations will continue to be enforced to protect Maine's valuable white pine resource. Examples of such enforcement include plant confiscation and seizure of plants at retail locations.

Abiotic/Weather Events

Unusually Wet Weather, Flooding
Host(s): All Species

Abnormally wet weather conditions throughout Maine in 2023 caused a variety of tree health issues. This is in stark contrast to the previous years, characterized by prolonged abnormally dry and drought conditions. Despite the contrast of these wet and dry weather extremes, some of the same symptoms and disorders were revealed. The wet weather did not represent 'recovery' from previous drought conditions as some have suggested, rather the excessive water compounded tree stress.

Many areas that are usually dry were inundated by the elevated water table. Other areas that typically experience spring flooding did not dry out. Trees species that are not tolerant of anoxic conditions in the root zone began to show signs of stress, such as leaf discoloration and early fall coloration, that may be predictors of further decline in future years. An additional layer of stress due to the wet weather was the higher occurrence of fungal leaf diseases. The effects of high moisture caused increases in disease levels in 2023, although the specific lifecycles of some fungal pathogens like the needle blights of conifers and the WPND complex may mean we will see the impact of the 2023 wet weather in early

summer 2024. This combination of stressful conditions may also predispose some trees to attack by insect and other fungal pests such as root disease.

Also related to the abnormally wet conditions in 2023, Maine experienced a total of 481 wildfires, burning a total of 315 acres. This is notably lower than the previous five-year average of 693 fires and 538 acres.

Herbicide Injury
Host(s): All Species

Reports of herbicide damage to trees in residential areas were steady in 2023 compared to previous years. Harm to non-target trees and shrubs due to improper application of broad-spectrum and selective herbicides used for vegetation control was seen in several cases, mostly in residential settings and rights of way. Instances of nefarious use of herbicide to kill trees continue to occur yearly in Maine and are referred to the Board of Pesticide Control. The MFS pathologist was consulted on two such cases in 2023.

December Wind Event
Host(s): All Species

A severe storm on December 18 brought powerful and destructive winds to much of Maine. Structurally weak trees snapped and trees with advanced root disease were windthrown, blocking roads and causing widespread power outages. The heavy rain associated with the storm softened the yet unfrozen soil causing uprooting of many healthy trees as well. The extent of damage to forest resources has not been estimated. Based on visual estimation, conifers seem to have been more heavily impacted than hardwoods.

Freeze Damage to Trees
Host(s): Deciduous Trees

A freeze event during the week of May 14 impacted trees throughout Maine, with reports ranging from Moscow (Somerset County) to the North, North Berwick (York County) to the south, east to western Hancock County and west to the New Hampshire border (Oxford County). Reports of severe damage were widespread in western Maine, while reports throughout the rest of the region were scattered and correlated with exposed areas and cold draws where cold air settled overnight. Conversations with forest health colleagues in neighboring New Hampshire indicated frost damage affected the entire southern half of their state as well. A total of 7,401 acres of frost damage was identified during Maine's aerial surveys, however ample time for re-leafing and canopy recovery prior to survey means acres of frost damage was much higher.

Symptoms ranged widely, from mild discoloration (mostly reddish coloration) to dead leaf tips and margins to full leaf wilting and death. Some trees were fully wilted, while others only suffered freeze damage at the tops or bottoms of trees. The species and individual trees affected were those at a particular early leaf maturation stage, which was highly susceptible to damage from the sub-freezing temperatures that dipped into the mid-to-upper 20s in some areas, persisting for several hours. In a survey of damage shortly after the freeze event, species that were observed to have sustained damage included apple (mostly blossoms), beech, black locust, poplar, red maple, red oak, shagbark hickory,

silver maple, striped maple, sumac, sycamore, and white oak. Damage to oak and beech was most frequently encountered.

Winter Injury
Host(s): Evergreen trees and shrubs, maples and other thin-barked species

Evergreens continue to be impacted by de-icing salts applied to roads in winter. As symptoms develop in late winter along many of Maine's roads, reports from the public become increasingly common. Salt damage symptoms were mostly reported along major roadways, and overall, the damage seemed to be similar to previous years.

Winter burn continues to be frequently encountered and reported in late winter to spring, especially among varieties of arborvitae planted in urban and horticultural settings. White pines were reported

Evidence of sunscald is seen and reported in various tree species with southern exposure each year in Maine. Impacted trees tend to be thin-barked trees such as white pine and maple species, specifically younger trees that have not yet developed thicker bark. Maples impacted by sunscald tend to become infected with the fungus causing Eutypella cankers, *Eutypella parasitica*, in the area of injury. This is especially seen in the urban setting with Norway maple trees (planted before the sale of Norway maple was prohibited in Maine).

Annually, snow load leads to branch breakage, especially in conifers, with white pine often most severely impacted. A wet and heavy snowfall in December led to branch breakage in many locations of Central Maine. The same storm led to birch tree deformation as the birches bent under the unusually heavy snow load.

Novel Annelids

Jumping worms (*Amynthas* spp.)

Jumping worms are a nonnative and invasive worm species that can potentially disrupt Maine's forests. They have been confirmed in 13 of 16 counties, with most populations occurring in southern and central Maine. Jumping worms rapidly decompose the leaf litter layer and change the texture of the soil into dry, loose castings (worm poop). Loose soil in a forest setting may cause soil erosion, exposed plant and tree roots, nutrient loss, and may cause plant and tree death, which may allow for invasive plant species to outcompete our native species. It is unknown how this species will affect our forests if it continues to spread.

In the fall of 2023, twenty-eight surveys were conducted in Penobscot, Piscataquis, Hancock, Aroostook, and Washington counties. Surveillance locations were chosen based on highest risk areas for possible introduction of jumping worms: hiking trails, boat launches, fishing areas, and transfer stations. Two new towns were added to the positive reports for jumping worms because of this surveillance study. Although concentrated in the southern and central region of the state, jumping worms are now considered to be widespread, with public reports in 2023 totaling over 300 and confirmed cases in over 80 new towns. The Maine DACF will establish long-term monitoring sites and continue monitoring this species in unconfirmed counties to understand their progression and impact on the state.

Other Division Activities

Forest Inventory and Analysis (FIA) - The Maine Forest Service-Forest Health and Monitoring Division works with the US Forest Service to implement an annualized Forest Inventory Survey, also known as Forest Inventory and Analysis (FIA). The Forest Inventory plots in Maine are broken into five panels corresponding to completion of the inventory on a five-year cycle. Each panel is distributed evenly throughout the state, the 2023 panel consisted of 642 plots.

The 2023 panel of measurements was completed 100 percent by the Maine Forest Service crews. Plot measurements for the 2023 panel started in December of 2022. Staff vacancies led to low weekly production until a complete complement of crews was hired and trained. More standard measurement production began in late July of 2023. Overall weekly production on average was 11.80 plots per week.

The measurement of 642 plots was completed by January 6, 2024. This was three to four weeks behind previous years, due to inclement weather and lack of personnel.

The US Forest Service conducts 100 percent of audits which assess the quality control and assurance of measurements taken by the Maine Forest Service crews. The Maine Forest Service crews are rated well above the required compliance score of 90 percent for the 2023 field season.

Along with completing the FIA panel each year, the Forest Inventory and Analysis crew members work on a Wood Utilization Program run by the US Forest Service. The Wood Utilization Program is to monitor timber product output and to get an understanding of how utilization of timber is being used. The 2023 Crew included: Supervisor Ronna Coleman, entomology technician; Elicia Dionne, Joe Bither and Jeff Harriman also assisted in plot completion

Exotic Woodborer and Bark Beetle Survey

Host(s): Spruces (*Picea* spp.), Pines (*Pinus* spp.), other conifers, and Oaks (*Quercus* spp.) and other hardwoods

The Maine Forest Service continued its participation in a Plant Protection Act Section 7721-funded pest detection survey for exotic woodborers and bark beetles for early interception of potentially destructive exotic pests. Pathways of potential spread for these insects could include industrial forest products such as logs, camp firewood, and solid wood packing material. This survey focuses primarily on spruce resources in northern Maine and pine and oak resources in the southern counties of Maine (Table 5). This year, four southern sites were replaced with new locations near wood processing facilities in the central region of the state. Depending on the target species, insects are trapped by using either funnel traps or cross vane traps baited with specific chemical attractants. Collected samples of certain target species are identified by MFS staff, while others are sent away to a taxonomic expert at the Carnegie Institute. *Agrilus biguttatus* is surveyed by purple prism traps and by monitoring colonies of *Cerceris fumipennis*, a predatory wasp that specifically hunts metallic wood boring beetles, and those beetle captures are screened by MFS staff. *Orchestes fagi* was surveyed by inspecting beech trees across the state for damage symptoms. This year, the only target species which was collected was *Dendroctonus frontalis*; all other samples were negative for targets. Details of the detection are covered in the southern pine beetle section of this report.

Table 5: Target species of the 2023 Exotic Wood Borer/Bark Beetle (EWBB) survey

Survey Target Scientific Name	Common Name
Tetropium castaneum	Black spruce beetle
Tetropium fuscum	Brown spruce longhorned beetle
Ips sexdentatus	Six-toothed bark beetle
Ips typographus	European spruce bark beetle
Monochamus alternatus	Japanese pine sawyer
Monochamus urussovii	Black fir sawyer
Hylobius abietus	Large pine weevil
Platypus quercivorus	Oak ambrosia beetle
Thrichoferus campestris	Velvet longhorned beetle
Megaplatypus mutatus	N/A
Agrilus biguttatus	Oak splendor beetle
Orchestes fagi	Beech leaf-mining weevil
Dendroctonus frontalis	Southern Pine Beetle

Partnership with the Forest Ecosystem Monitoring Cooperative

Cooperation between the MFS and the Forest Ecosystem Monitoring Cooperative (FEMC) continued in 2023. Maine has two state coordinators who attend monthly meetings, a yearly meeting, and participate in several other functions of the FEMC. Notable FEMC activities in 2023 included completion of FEMC inventory plots by MFS FIA crews and participation in grant review processes providing funding for ecosystem research by regional groups. The FEMC continues to provide support for regional efforts to increase understanding of threats to northern ecosystems, like Maine's forests.

Insect Collection

The Maine Forest Service Insect Collection contains over 73,000 specimens in the reference portion of the collection. Additionally, there are more than 5,000 ant specimens stored in alcohol, more than 60,000 spider records, and over 10,000 bark beetle and woodborer specimens. Most of the specimens are stored at the MFS Insect and Disease Lab located in the Deering building in Augusta.

Although we did not receive any requests for specimens this year from researchers, we did see the return of our syrphid and ichneumonid specimens that were out for identification. These identified specimens will be incorporated back into the main collection serving as valuable data points for future reference and research.

Over November 4-5, we were able to send two staff members to attend the annual Entomological Collections Network (ECN) meeting in National Harbor, MD. The Entomological Collections Network is a non-profit organization dedicated to the promotion of entomological science through the preservation, management, use and development of entomological collections and taxonomy. These staff members made many connections throughout the meeting and exchanged information which will facilitate incorporating new techniques into our reference collection. This includes a new more formalized loan process for specimen requests from researchers, which will be modeled after those of larger collections and developed in 2024.

Each year as part of the routine maintenance of the collection, each drawer of pinned insects undergoes a multistep freeze in order to kill any pests that may have made their way into the collection drawers, specifically dermestids, which are a family of beetles that feed on dry animal or plant material and can decimate an insect collection. During this freezing process the drawers were placed in clear garbage bags so that they would not be damaged by moisture from the freezer when going through a thaw cycle. This system, however, was not perfect and there were a couple of drawers that were slightly damaged. It was decided that the garbage bags would be replaced by 20-gallon Ziplock bags that encapsulate the drawers preventing any damage from this annual process.

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. Data collected in this program is important to help predict forest pest outbreaks and monitor invasive species. This program would not be possible without the help of the Maine Forest Service's citizen collaborators who take the time to operate light traps and submit all the different species they collect.

Eighteen traps were run in 2023 in locations from South Berwick to Big Twenty Township (Table 6). One new location in Jonesboro was added this year, while the Chester location was retired. The Rothamstead traps have a 150W light bulb inside a protective casing with an entrance for moths that leads to a collection container. Traps run for either 30 or 45 days depending on the trap location and flight season of the moths of interest. Trap operators collect the catch daily, arrange the specimens in padded boxes, and send it to MFS offices weekly where specimens are processed by FHM staff.

This year, staff were formally trained at moth identification workshop with a leading national lepidopteran expert. The group was instructed in taxonomy, ecology, and identification of Maine moth species, as well as various methods of collection, storage, and curation. The latter half of the workshop was dedicated to hands-on microscopy techniques and a demonstration of specimen preparation. New developments this year also include additional high-magnification microscopes used to distinguish subtle characters in lepidopteran identification.

A checklist of significant insect defoliators is used in sorting the moth catch material, with collection data for many of these species going back over 20 years' worth of trapping (Figure 3). One new target species was added this year; *Hypena opulenta* was involved in a biological control program conducted by other members of DACF. Pest populations of significance are reported in the appropriate section of this report. In addition to providing useful population data, a portion of the collected specimens are saved for use in outreach programs during the remainder of the year.

As part of previous efforts to make this longstanding dataset more accessible, this year the digitized results of the previous 76 years were organized, cleaned, and normalized for entry into computational programs for statistical analysis. Interpretation of data is still ongoing, though it is hoped that this will reveal previously undetected trends that can inform FHM operations in the future.

Table 6: 2023 light trap locations

Trap location	County	# nights	Start date	End date	Trap type
Allagash	AROOSTOOK	30	7/1/2023	7/31/2023	Rothamstead
Big Twenty Twp/Escourt	AROOSTOOK	30	7/1/2023	7/31/2023	Rothamstead
Clayton Lake- T11 R14	AROOSTOOK	30	7/1/2023	7/31/2023	Rothamstead
Garfield/Six mile checkpoint	AROOSTOOK	30	7/1/2023	7/31/2023	Rothamstead
Houlton	AROOSTOOK	30	7/1/2023	7/31/2023	Rothamstead
New Sweden	AROOSTOOK	30	7/1/2023	7/31/2023	Rothamstead
St. Pamphile	AROOSTOOK	30	7/1/2023	7/31/2023	Rothamstead
Cape Elizabeth	CUMBERLAND	45	6/16/2023	7/31/2023	Rothamstead
Rangeley	FRANKLIN	45	6/16/2023	7/31/2023	Rothamstead
Salem	FRANKLIN	30	6/16/2023	7/31/2023	Rothamstead
East Millinocket	PENOBSCOT	45	6/16/2023	7/31/2023	Rothamstead
Exeter	PENOBSCOT	45	6/16/2023	7/31/2023	Rothamstead
Monson	PISCATAQUIS	45	6/16/2023	7/31/2023	Rothamstead
Montville	WALDO	45	6/16/2023	7/31/2023	Rothamstead
Calais	WASHINGTON	45	6/16/2023	7/31/2023	BL-110V
Jonesboro	WASHINGTON	45	6/16/2023	7/31/2023	Rothamstead
Topsfield	WASHINGTON	45	6/16/2023	7/31/2023	Rothamstead
South Berwick	YORK	45	6/16/2023	7/31/2023	Rothamstead

Figure 4: A selected portion of target species collected via light traps over the past 20 years.

Appendix A
Hemlock Woolly Adelgid and Elongate Hemlock Scale in Maine 2023

Colleen Teerling, Forest Entomologist
Maine Forest Service, DACF
168 State House Station, Augusta, ME 04333

Hemlock woolly adelgid (HWA, *Adelges tsugae*) was first detected in Maine forests in August 2003. Currently, it is established in forests in towns from Kittery to Bar Harbor with an additional cluster of towns surrounding Sebago Lake. Most known infestations are close to the coast or other significant bodies of water. In 2023, HWA was detected in six new towns: Durham (Androscoggin County), Bar Harbor (Hancock County), Pittston (Kennebec County), Islesboro, Lincolnville (Waldo County) and North Berwick (York County). These were the first detections in Androscoggin and Waldo County forests. Due to recent detections of HWA in several new towns, the quarantine for HWA was expanded in 2023 (Figure 4).

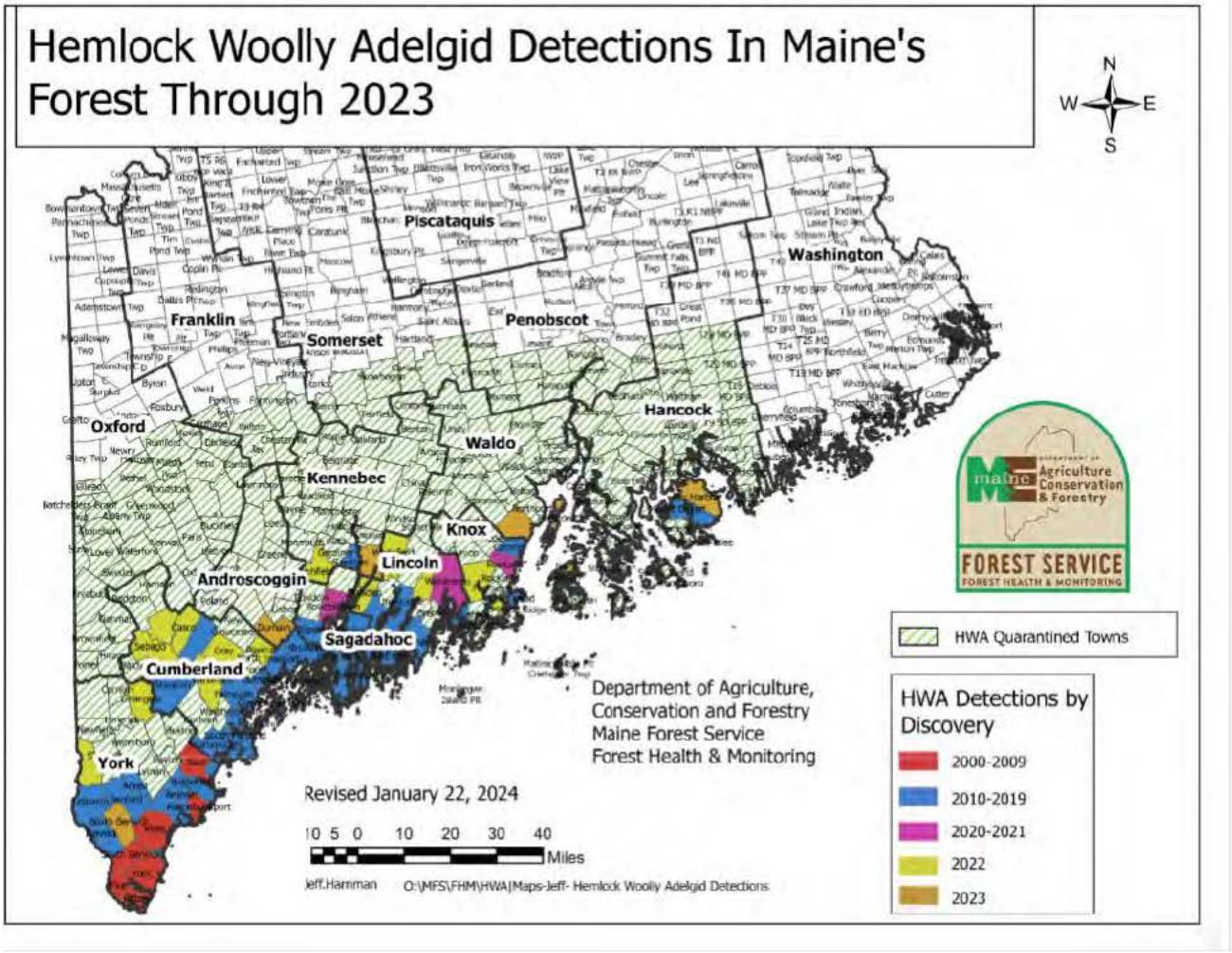


Figure 5: Hemlock woolly adelgid detections in Maine's forests and expanded quarantine zone.

Elongate hemlock scale (EHS, *Fiorinia externa*) is a slowly spreading invasive forest insect pest in Maine, first recognized in the state in 2009 on planted hemlocks. EHS was detected in the forest for the first time on Gerrish Island (Kittery, York County) in fall of 2010 and subsequently in mainland Kittery. This is the only area in Maine where EHS is known to be widely established in forested areas. In other areas, infestations on planted ornamental trees have been reported, scattered from Kittery to Mount Desert, and in many cases EHS has moved into the surrounding forest. However, even when it has not been detected in the forest around infested landscape trees, the cryptic nature of EHS suggests that it may be present at undetected levels. There were no infestations found in new towns in 2023 (Table 7).

Table 7: Known infestations of elongate hemlock scale in Maine 2023.

County	Town	EHS Status
Cumberland	Brunswick, Frye Island, Gorham, Falmouth	moved from planted trees, now established in forest
Cumberland	Cape Elizabeth, Casco, Freeport, Portland, Scarborough, Yarmouth	known on planted trees
Hancock	Mount Desert	moved from planted trees, now established in forest
Hancock	Sedgwick	known on planted trees
Lincoln	Boothbay, Damariscotta	known on planted trees
Sagadahoc	Bath, Topsham	known on planted trees
York	Kittery	established in forest
York	Berwick, Kennebunk, Kennebunkport, Ogunquit, Old Orchard Beach, Saco, Wells, York	known on planted trees

The bulk of the field work for these projects was conducted by Wayne Searles, Abby Karter, Zoe Albion, and Elicia Dionne, with assistance from James Canwell, Melanie Duffy (MFS-FIA) and others. A summary of 2023 activities related to these two pests follows.

An ongoing detection survey is conducted both in towns outside the HWA quarantine and inside the quarantine zone where HWA has not yet been found. In 2023, 71 sites were surveyed in 43 towns in eight counties (Figure 5). At most sites, at least 200 branches were inspected; (for 11 sites between 88-180 branches were examined) in hemlock stands in areas of high risk for HWA and EHS transmission. All surveys were negative for both HWA and EHS.

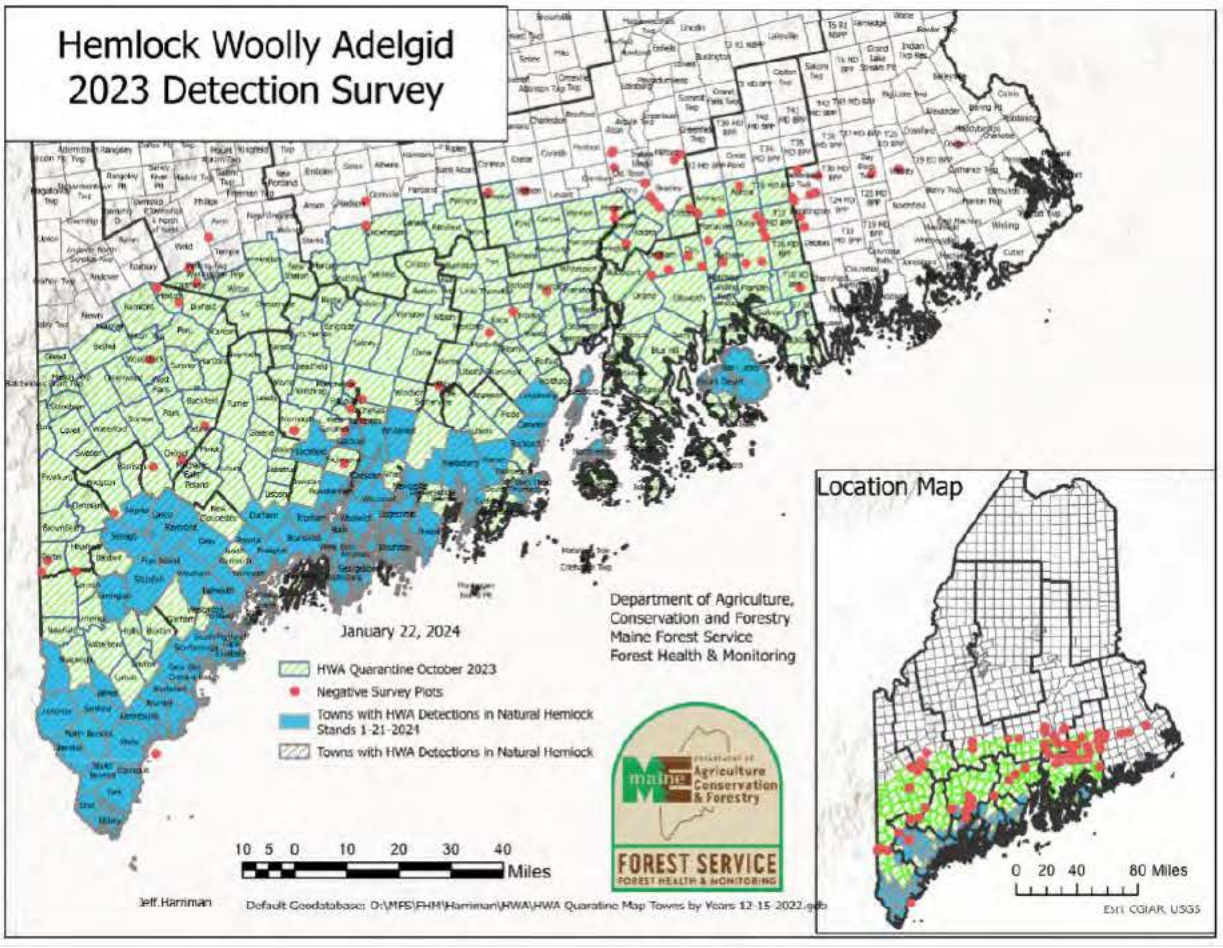


Figure 6: Detection survey for hemlock woolly adelgid and elongate hemlock scale, 2023.

Winter Mortality Survey

Maine Forest Service monitors winter mortality annually in six sites throughout the state. Adelgid-infested branches were collected from these sites in late winter, held in buckets of water in a cool room for one to two weeks to make it easier to differentiate between living and dead adelgids, and then mortality was measured under a dissecting microscope. After several recent years of mild winter temperatures, there were two extreme cold spells in early 2023. In addition, there was rapid fluctuation between above-freezing temperatures to extreme cold. This led to high adelgid mortality in several sites, although mortality was unexpectedly low in some sites. Because of the extreme weather, adelgid mortality was monitored at two additional sites in 2023. For the winter of 2022–23, mortality ranged from 57%-100% and averaged 84% (Table 8 and Figure 6).

Table 8: Hemlock woolly adelgid overwintering mortality (Winter 2022–2023)

County	Town	# HWA alive	# HWA dead	% mortality
Sagadahoc	Bath	86	115	57.21
Cumberland	Pownal	86	132	60.55
York	York	45	188	80.69
Cumberland	Cape Elizabeth	32	174	84.47
York	South Berwick	14	186	93.00
Cumberland	Standish	3	197	98.50
Cumberland	Freeport	1	204	99.51
Lincoln	Waldoboro	0	161	100.00
	total	**267**	**1467**	**83.60**

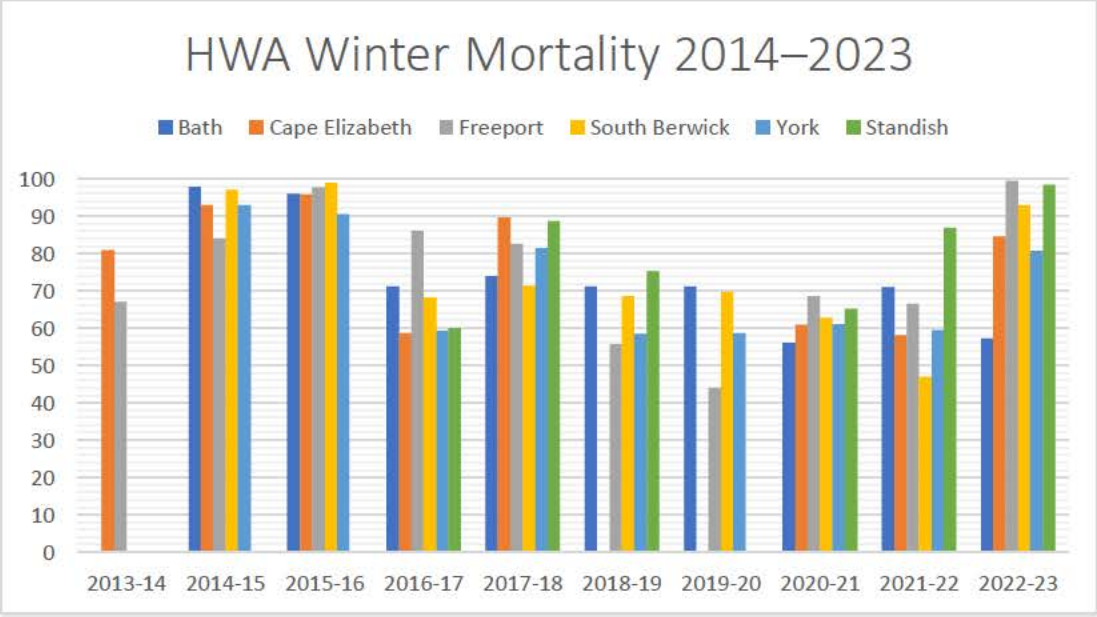


Figure 7: Overwintering mortality of hemlock woolly adelgid at monitoring sites in Maine 2014–2023.

Biological Control

Laricobius osakensis was released in the same two locations in 2023 as in the previous year. One thousand beetles were released in Camden Hills State Park (Knox County) and 1,000 were released on Land and Garden Preserve property on Mount Desert Island, on the border of Acadia National Park (Hancock County). In addition, 1,000 early emerging *L. osakensis* were released on the Land and Garden

Preserve in September before HWA emerged from aestivation. It is not known whether these would feed on aestivating nymphs and survive, but they were released as an alternative to euthanizing them.

In November, personnel from MFS traveled to Rocky Gap State Park in northwestern Maryland to collect *Laricobius nigrinus* with the assistance of the Maryland Department of Agriculture. Six hundred beetles were collected and released on Portland Water District land in Standish (Cumberland County).

Multiple individuals and organizations bought and released *Sasajiscymnus tsugae* in the spring of 2023, including state, city and town parks, schools, land trusts and conservations districts, and private individuals. A total of 43,000 beetles were bought by 31 organizations and individuals and were released at 41 sites in Cumberland County (Brunswick, Cape Elizabeth, Portland, Yarmouth), Knox County (Warren), Lincoln County (Bremen, Bristol, Edgecomb, Newcastle, Nobleboro, South Bristol, Waterboro), Sagadahoc County (Bath, West Bath), and York County (Old Orchard Beach, South Berwick). MFS educated and advised on the selection of suitable release sites and integrated pest management and assisted with releases as needed.

Since the initial detection of HWA in Maine's forests, MFS has facilitated the release of over 143,000 *S. tsugae* beetles, close to 6,000 *L. nigrinus* beetles and almost 11,000 *L. osakensis* (Table 9). These biocontrol release sites range along much of the known distribution of HWA (Figure 7).

Table 9: Release numbers of beetles in 2023

County	*Laricobius nigrinus*	*Laricobius osakensis*	*Sasajiscymnus tsugae*
Cumberland	600	1,950	37,003
Hancock		3,000	
Knox		2,000	
Lincoln		2,000	31,100
Sagadahoc			17,969
York	5,272	2,000	56,518
Totals	**5,872**	**10,950**	**143,290**

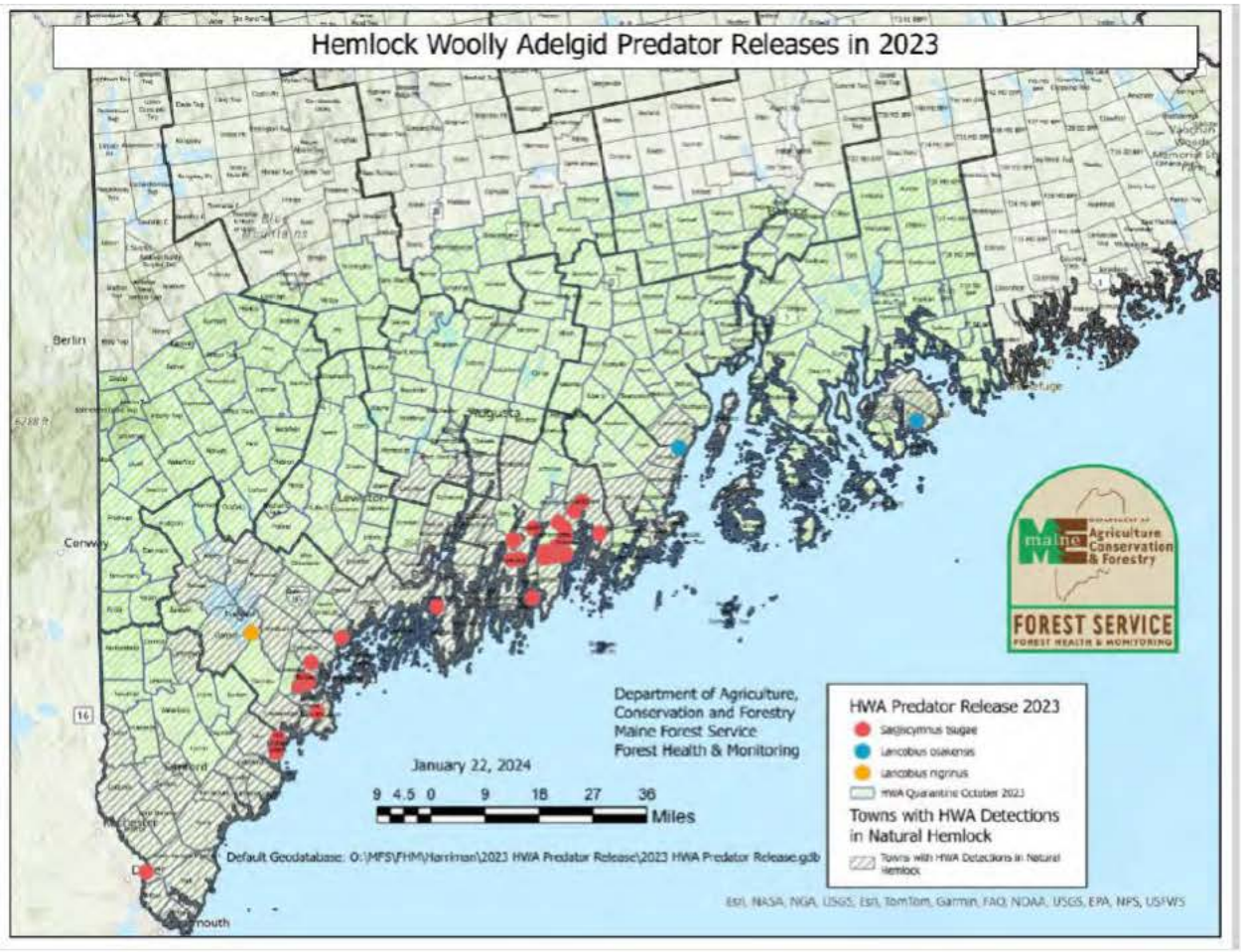


Figure 8: *Sasajiscymnus tsugae*, *Laricobius osakensis*, and *L. nigrinus* release sites in Maine 2023.

Sampling for recovery of HWA predators occurred in twelve locations in the autumn of 2023. Efforts were made to recover *L. osakensis* in Waldoboro (Lincoln) and in various sites in Raymond and Casco near the release site on Frye Island (Cumberland County). Survey for *L. nigrinus* occurred in South Berwick, York (York County). Survey for both *L. nigrinus* and *S. tsugae* were carried out at sites in Bath, West Bath (Sagadahoc County), Freeport, Harpswell (Cumberland County), Newcastle and Wiscasset (Lincoln County). No spring sampling was carried out. No predators were recovered.

Table 10: *Sasajiscymnus tsugae* recoveries in Maine (2005–2023)

Year	Kittery	York	Harpswell	Saco	West Bath	Freeport	Wiscasset	Bath	Woolwich
2004	Release								
2005	0								
2006	17								
2007	13	Release							
2008	18	1							
2009	28	0							

2010	55	1	Release	Release 1					
2011	37	0	3	0	Release 1	Release			
2012	0	0	2	0	0	0			
2013	0	0	0	0	0	0	Release		
2014	6	0	1	0	0	1	0	Release	
2015	0	0	0	0	0	0	0	0	Release
2016	26	0	5	0	0	1	5	0	0
2017	0	0	0	0	12	20	33	19	2
2019	0	-	-	-	0	0	0	0	-
2020	9	0	0	-	0	0	2	0	0
2021	4 (spring)	0 (spring)	0 (fall)	-	4 (fall)	3(fall)	3 (fall)	3 (fall)	0 (fall)
2022	0	0	-	-	-	2	5	1	0
2023	-	0	0	-	0	0	0	0	-

Appendix B
Spruce Budworm in Maine 2023

Michael Parisio – Forest Entomologist
Maine Forest Service – Forest Health and Monitoring
michael.parisio@maine.gov
www.sprucebudwormmaine.org and www.maine.gov/foresthealth

Introduction to Spruce Budworm in Maine

Spruce Budworm (SBW) is a native insect whose outbreaks cover vast regions and spread through massive dispersal flights as moths migrate from heavily impacted areas to new ones. In northeastern North America, SBW outbreaks tend to return on a 30–60-year interval and the last major SBW outbreak to directly affect Maine occurred during the 1970s-80s. Historic data tell us that Maine is due for another SBW outbreak and monitoring efforts illustrate that over roughly the last decade, SBW population levels appear to have left the endemic or "stable" phase experienced between outbreak events. During this period, pheromone trap and light trap catches have sometimes been well above numbers expected during the endemic phase, and millions of acres of defoliation in neighboring Canadian provinces continues to encroach on the Maine border. Large in-flights of moths from outbreak areas in Canada into northern Maine were well-documented in 2019. As we approach the five-year mark since this major influx of spruce budworm into Maine forests, monitoring data continue to show local fluctuations, indicating impacts from 2019 are likely still unfolding.

Statewide Spruce Budworm Pheromone Trapping Network (2014–2023)

The Maine Forest Service Division of Forest Health and Monitoring coordinates a network of roughly 350 SBW monitoring sites using pheromone lures (Distributions Solida Inc.) in spruce-fir forests across Maine. In 2019, pheromone trap captures peaked at an average of 67 moths per trap following a mass migration event from Canadian SBW outbreak areas. In the years following, the statewide average decreased to 36 in 2020, 16 in 2021, and remained at 16 moths per trap in 2022. In 2023, we observed another slight decrease, with the statewide average dropping to 13 moths per trap across 354 monitoring sites. This drop is primarily driven by the fact that 12 percent of sites statewide (43 sites) captured zero moths in 2023. The percentage of sites averaging more than 200 moths per trap also increased in 2023 but remained low at just one percent. The geographic locations of these sites in the higher bracket may be important since there appears to be some degree of concentration in far northwestern Aroostook County. This area warrants closer attention during the upcoming 2024 monitoring season. Across northern New England, SBW moth capture remained low at monitoring sites in neighboring New Hampshire and Vermont (*see SBW Map Appendix, Figure 15*).

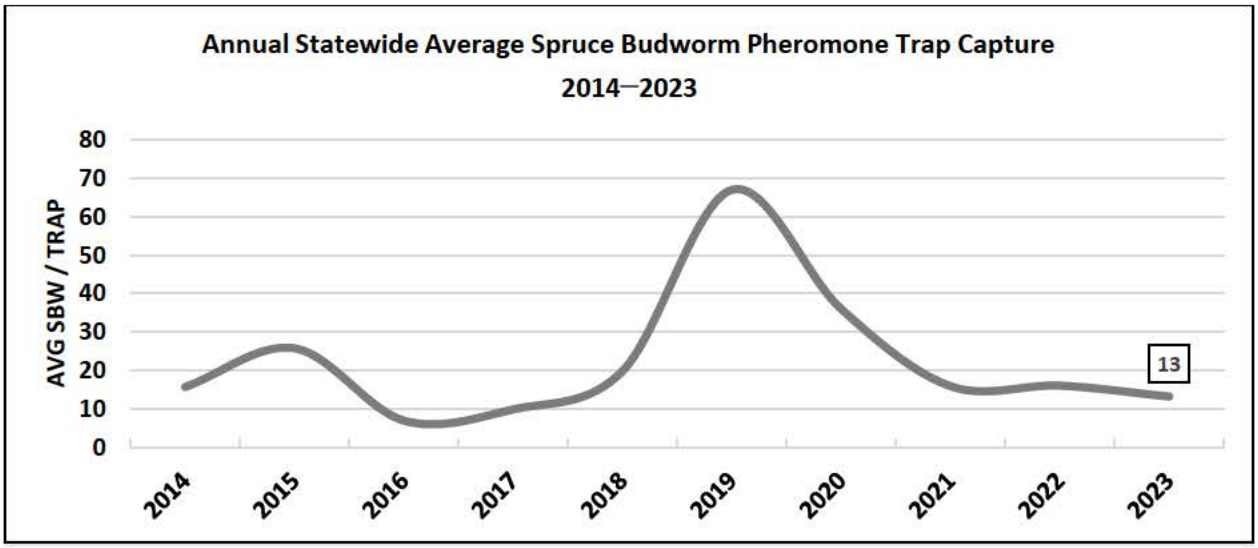
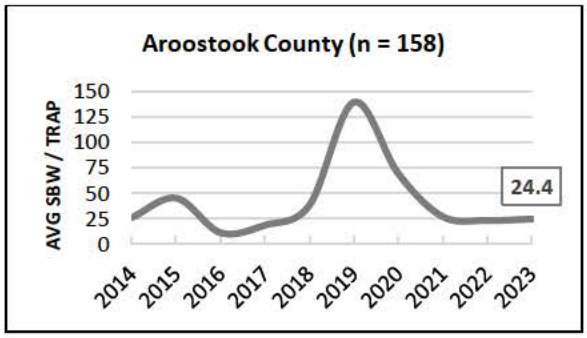
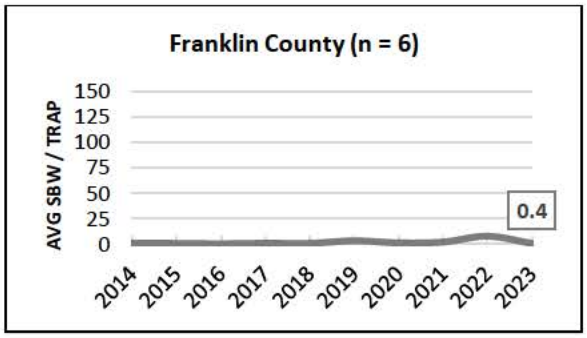


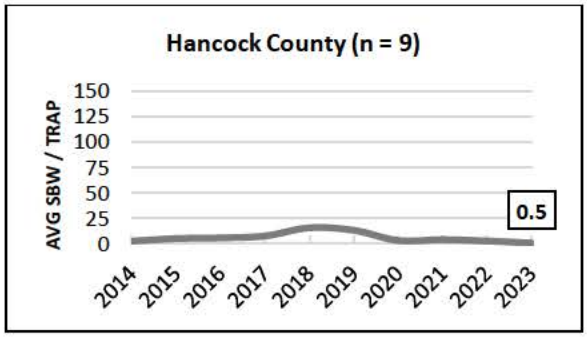
Figure 9: Annual statewide average spruce budworm pheromone trap capture 2014–2023.

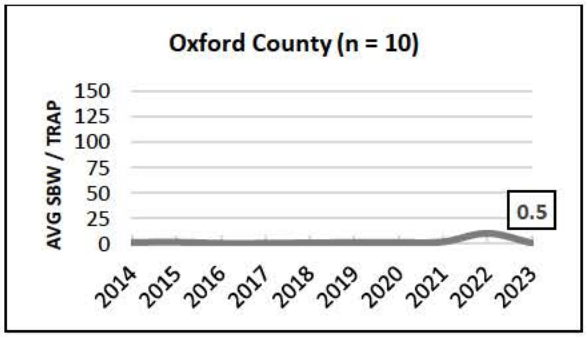
Following a peak in 2019, statewide average SBW capture has fallen or remained stable. A slight drop in 2023 marks another decrease in the annual statewide average from 16 in 2022 to 13 in 2023.

Annual County Average Spruce Budworm Pheromone Trap Capture
2014–2023









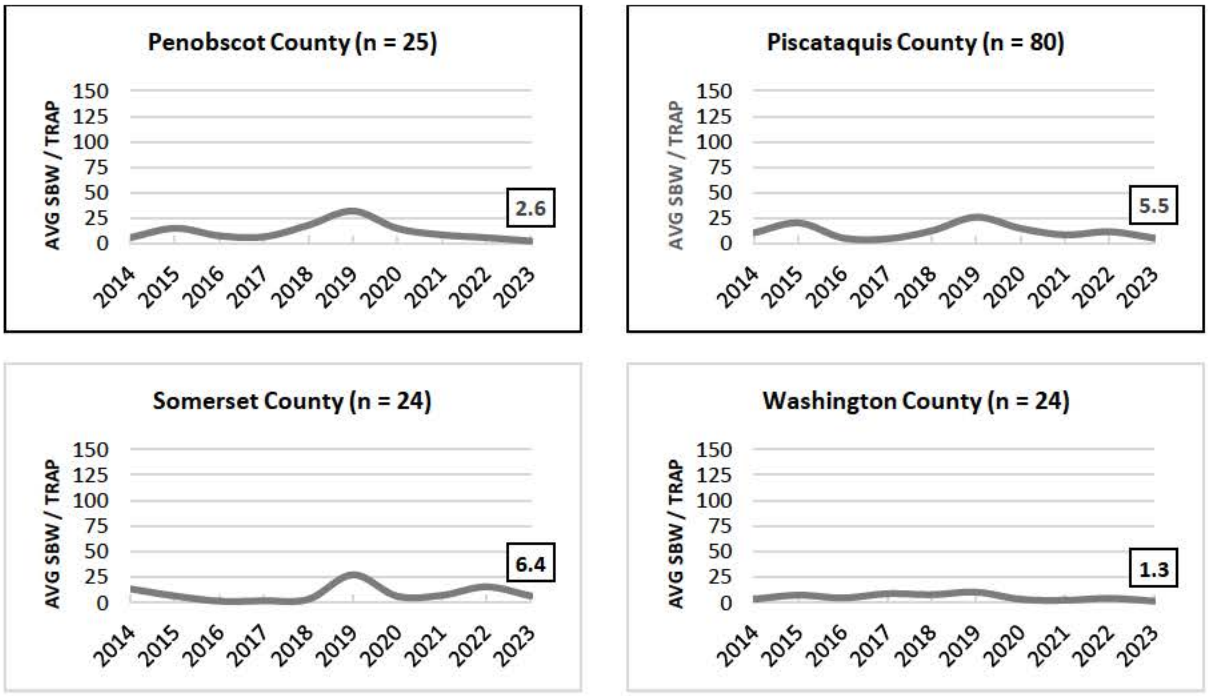


Figure 10: Annual county average spruce budworm pheromone trap capture 2014–2023

There was a slight increase in the average number of moths captured at sites located in Aroostook County, from 23 in 2022 to just over 24 in 2023, due to a concentration of sites with high averages in far northwestern Aroostook County in 2023. Averages in other counties remained low in 2023.

NOTE: (n = 2023 number of sites)

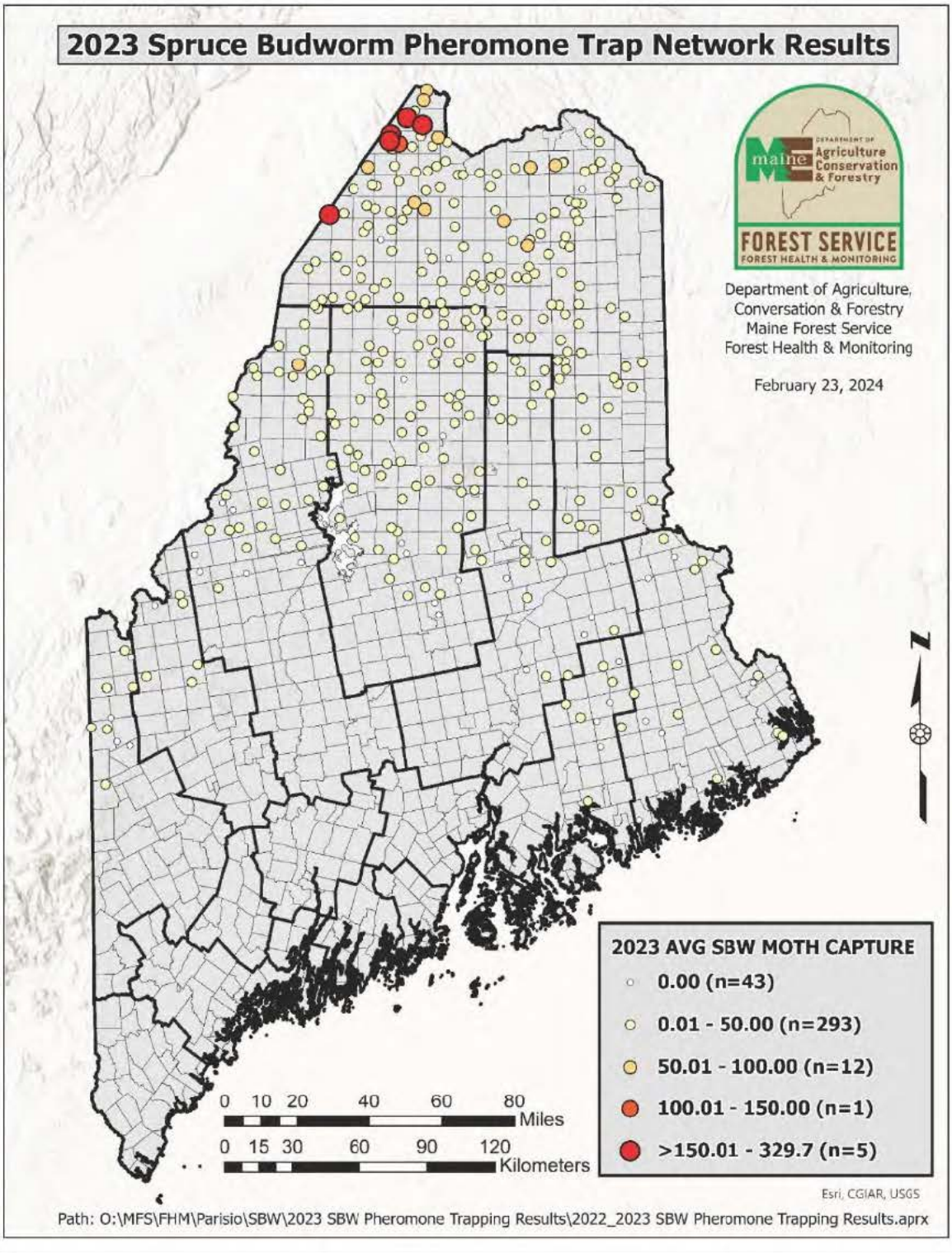


Figure 10: Statewide spruce budworm pheromone trap captures.

Statewide pheromone trap captures were mostly low in 2023, with elevated numbers evident at just a few locations in far northwestern Aroostook County that showed greater SBW activity.

Spruce Budworm Long-term Pheromone Trap Monitoring Sites (1993–2023)

A subset of long-term pheromone trap sites has been monitored since the early 1990s and revealed the first significant increase in SBW populations since the last major SBW outbreak in Maine during the 1970s and 1980s. From 1992 to 2012, the average number of SBW captured was below 10. This average rose to 18 in 2013, 22 in 2014, and 23 in 2015, resulting in the expansion of the pheromone trap network to its current size of around 350 sites statewide. Average capture fell to seven moths per trap in 2016 and 2017, then rose to 15 in 2018. In 2019, the average capture rose dramatically to 55, again influenced by the mass migration events from Canada. The average capture fell again to 30 in 2020 and 12 in 2021, followed by a slight increase to 15 in 2022. Samples from several long-term sites in Washington County that traditionally return low numbers of moths were unable to be used this season, meaning that the long-term site average might be artificially higher with these sites absent in the 2022 data. In 2023, the average at long-term sites rose to just under 18. This is undoubtedly influenced by the long-term site operated by MFS in T15 R15 WELS, which had the highest average of any site statewide at just under 330 moths per trap. Without this outlier site factored in, the average is in line with the statewide average for all sites in 2023 at around 13 moths per trap.

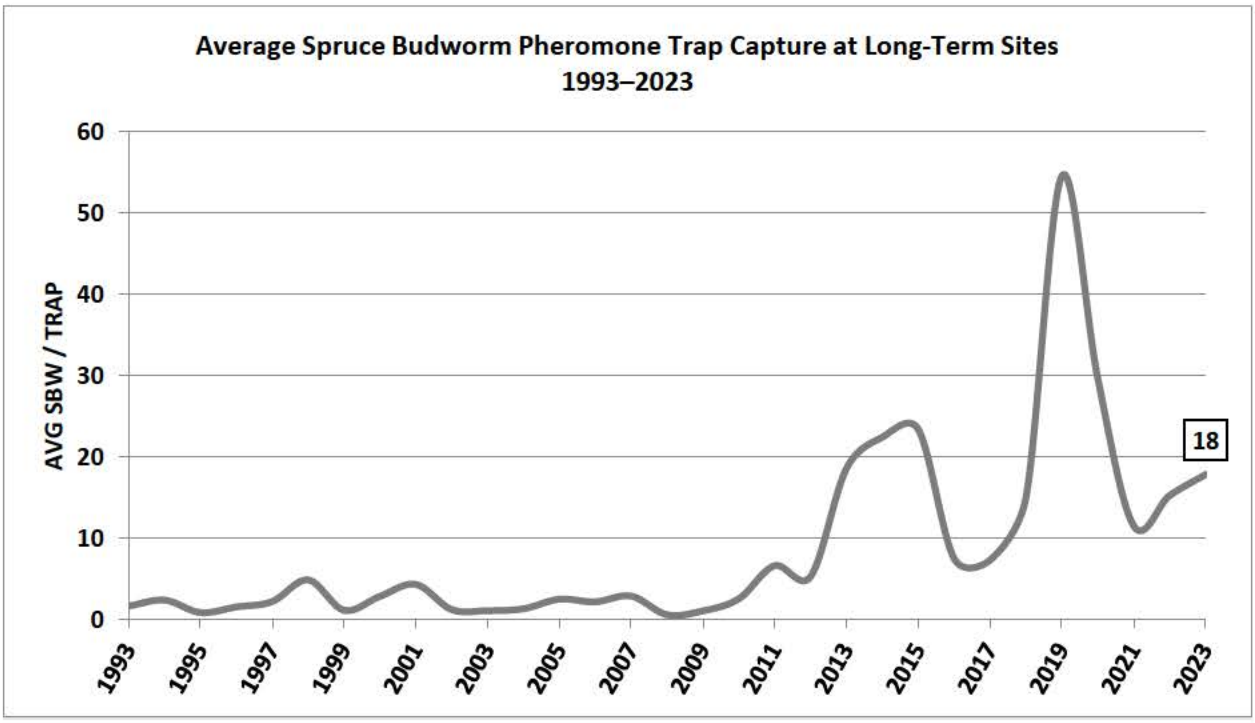


Figure 11: Average spruce budworm pheromone trap capture at long-term sites 1993–2023.

Despite a slight increase in 2022 and again in 2023, average trap captures at Maine's long-term pheromone monitoring sites remain substantially lower than 2019 levels. The increase in 2023 owes largely to a single outlier site in T15 R15 WELS, while most other long-term monitoring sites remained stable at low numbers. Given the relatively short lifespan of fir, suitability at many of these sites is continually decreasing over time. Now over 30 years since these sites were established, attention must be given to relocating many of them to younger and more suitable stands in order to collect more reliable SBW data in the future.

Automated Pheromone Traps in Aroostook County (2021–2022)

Natural Resources Canada provided Maine with two automated spruce budworm traps in 2021 to broaden the network of traps operating throughout Quebec and the maritime provinces. These traps provided daily information on flight phenology and were located in Aroostook County in New Canada and Stockholm. In 2021, the first adult moths in Maine were recorded on the night of June 21. In 2022, the first adult moths in Maine were recorded on the night of June 28. Unfortunately, the cellular data requirements of these automated traps have now rendered them obsolete and were no longer able to be operated beyond 2022.

Spruce Budworm in Maine's Light Trapping Network (2014–2023)

Light trapping has been used in Maine since the 1940s to monitor forest defoliators and remains a valuable tool for monitoring SBW moths. Similar to the pheromone trapping network, the light trap network saw a dramatic increase in moth catch in 2019, with 507 SBW moths captured statewide. This was immediately followed by a substantial decrease in capture to 107 moths in 2020 and again in 2021 with just nine moths recorded statewide. Statewide light captures rose slightly in 2022 to 19 moths with all moths recovered from just three sites, located in Estcourt Station, Millinocket, and Rangeley. Similarly, the apparent large increase in 2023 to 60 moths is caused by moths captured at a single site near Saint Pamphile. The MFS pheromone trap near this light trap site also had the highest trap capture in Maine in 2023 (average ~330 moths per trap). Given these two pieces of information, this area bears closer inspection when traps are installed for the 2024 monitoring season.

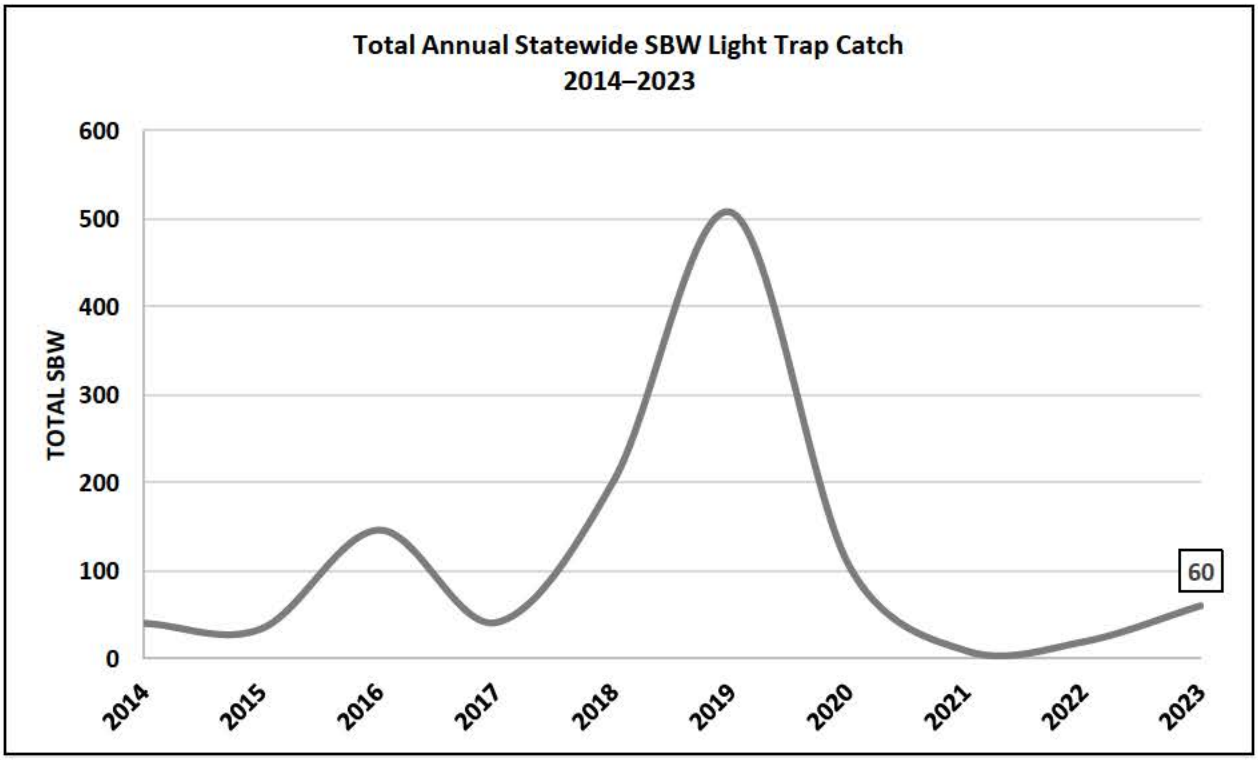


Figure 12: Total annual statewide spruce budworm light trap catch.

Despite a second consecutive year of an increase in the number of SBW moths recovered in light traps statewide, the overall number remains relatively low when compared to 2018 through 2020. The vast majority of SBW captured by light traps were captured at a single site in northwest Aroostook County, where other pheromone trap capture data have also shown a potentially higher local population.

Overwintering Larval Monitoring Statewide Sampling Sites (2019–2023)

Spruce budworm overwinters as larvae and branch samples collected from spruce-fir forests across Maine are now analyzed at the University of Maine Spruce Budworm lab for the presence of overwintering SBW larvae. An average of seven larvae per branch is the recommended management threshold set forth by the SBW Early Intervention Strategy (EIS) guidelines employed in Atlantic Canada (https://healthyforestpartnership.ca/what-we-do/targeting-and-treating/). Sites exceeding the threshold are identified as potential "hot spots" and may undergo additional sampling.

Following the events of 2019, the statewide overwintering larval survey recovered an increased number of larvae with 309 larvae collected from 328 sites statewide in 2020 versus 70 larvae recovered from 317 sites statewide in 2019. The larvae collected in 2020 were distributed among 99 sampling sites versus just 29 sites in 2019, indicating a more widespread distribution than the season before. In 2020, a single site in Cross Lake Township exceeded the EIS threshold with 7.66 larvae per branch. Samples were analyzed from 292 sites in 2021, indicating two sites achieved an average greater than seven larvae per branch. Following treatment in 2020, the Cross Lake Township site had a reduced average of 0.67 larvae per branch when resampled in 2021.

Both hot spots revealed during the 2021 overwintering larval survey were in Aroostook County. One was located on the border of T17 R13 WELS and T17 R14 WELS and the second was located near the shared corner of the four towns of Sinclair Twp, Van Buren Cove Twp, Madawaska Lake Twp, and Stockholm. These hot spots received aerial treatments in 2022, described in the EIS section below.

Following a quiet 2022 season, the L2 survey identified several areas of concern in 2023. Many of the sites with high L2 populations were in townships with high moth captures and near areas with active SBW defoliation in adjacent Quebec. Branch sampling was performed at a series of additional sites to determine the boundaries of these potential hot spots and develop treatment blocks in preparation for the 2024 aerial application season. Due to the need for immediate resampling of high priority areas, results of the overall statewide L2 survey are still pending and will be made available by the University of Maine Spruce Budworm Lab.

Overwintering Larval Monitoring – MFS Sampling Sites (2021–2023)

The Maine Forest Service submits branch samples from multiple ownerships each year. Samples were submitted from 46 sites in 2021, averaging 0.5 larvae per branch with a maximum of 4.3 larvae per branch. Samples were submitted from 65 sites in 2022, again averaging 0.5 larvae per branch and with a maximum of 4.7 larvae per branch. In 2023, MFS submitted branch samples from 58 sites and maintained a low average of 0.4 larvae per branch across all sites, with a maximum of 4.0 larvae per branch at any one site.

In addition to sites sampled annually by MFS, increased capacity at the SBW Lab allowed MFS to sample 22 additional sites identified by UMaine Cooperative Forestry Research Unit as areas of interest. This additional sampling proved beneficial, as it led to the identification of a site with an average of 9.33

larvae per branch. This could represent a potential hot-spot and is above the typical EIS management threshold of seven larvae per branch.

Results from other cooperators in the 2023 statewide overwintering larval survey are currently being compiled and will be made available by the University of Maine Spruce Budworm Lab.

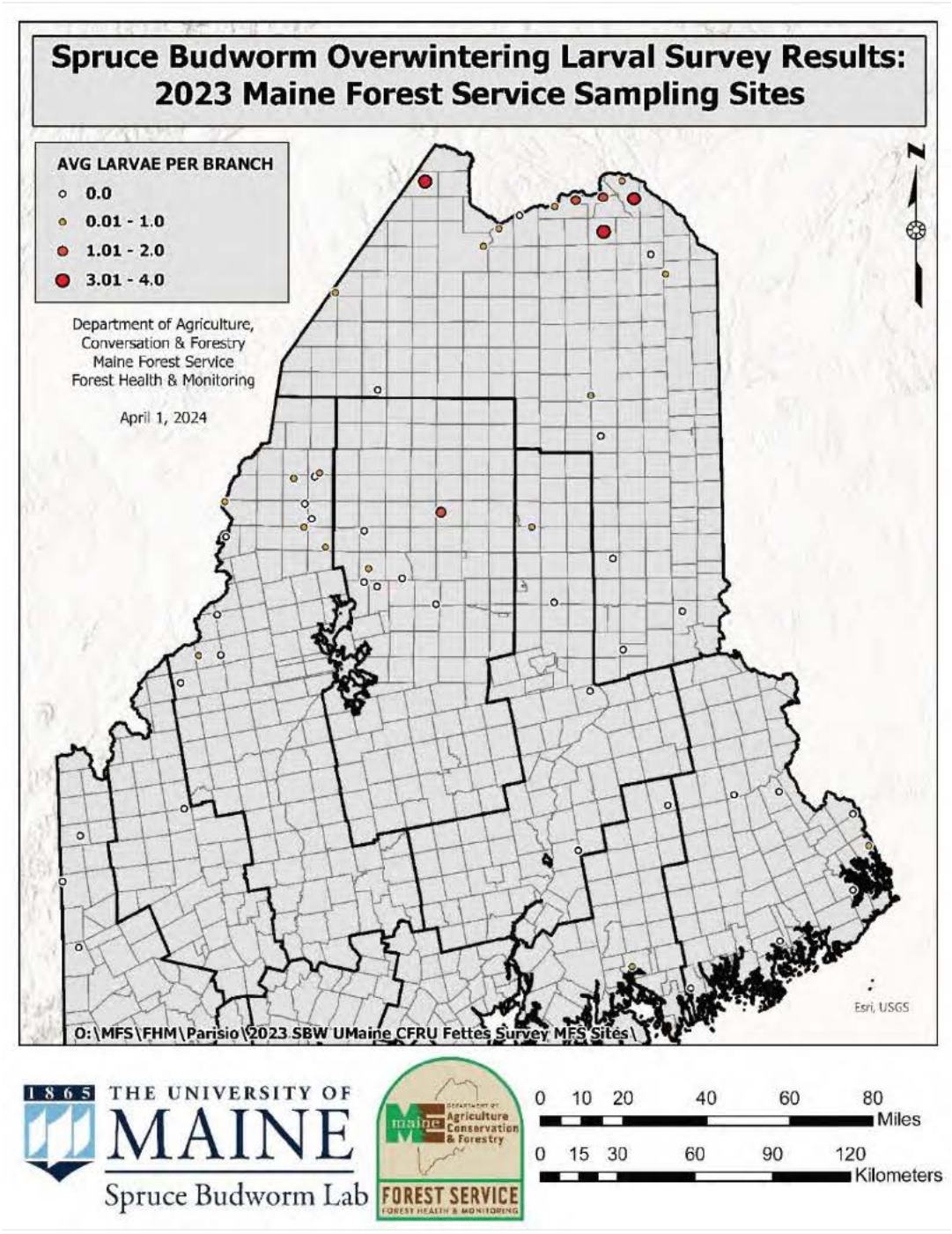


Figure 13: Spruce budworm overwintering larval survey results: 2023 Maine Forest Service sites.

Overwintering larval levels have remained comparable at the subset of statewide sites monitored by the Maine Forest Service from 2021 to 2023. The maximum average number of larvae recovered at any one site decreased from 4.67 in 2022 to 4.0 in 2023. No Maine Forest Service sampled sites reached a recommended management threshold of an average of seven larvae per branch.

Early Intervention Strategy (EIS) Treatments in Maine (2021–2023)

No aerial treatments for SBW were performed in Maine in 2023.

Prior to this, results of the 2020 overwintering larval survey identified a single site in Cross Lake that exceeded the recommended management threshold of seven larvae per branch set forth by the SBW Early Intervention Strategy (EIS) guidelines being employed in Atlantic Canada (https://healthyforestpartnership.ca/what-we-do/targeting-and-treating/). Supplemental survey in the surrounding forest resulted in a 5,000 acre spray block that was treated by a private landowner in 2021 with an aerial application of Foray 76B (a formulation of *Bacillus thuringiensis kurstaki*). This was the first aerial treatment of SBW in Maine since the last major outbreak of the 1970s and 1980s.

Similarly, results of the 2021 overwintering larval survey identified two locations that exceeded the seven larvae per branch management threshold, resulting in treatment of roughly 2,000 acres in 2022. One spray block was located on the border of T17 R13 WELS and T17 R14 WELS and comprised roughly 500 acres. A second larger spray block comprised of roughly 1,500 acres and included portions of Sinclair Twp, Van Buren Cove Twp, Madawaska Lake Twp, and Stockholm. Both spray blocks were treated by a private landowner with aerial applications of Foray 76B.

Statewide Defoliation Survey (2022–2023)

Prior to being analyzed for overwintering larvae, all branch samples collected undergo defoliation assessment by University of Maine Spruce Budworm Lab staff to document missing needles from current-year growth. Results of the 2023 statewide defoliation survey are currently being compiled and will be made available by the University of Maine Spruce Budworm Lab.

Aerial Defoliation Survey (2021–2023)

The Maine Forest Service performs an annual aerial survey for insect and disease issues affecting Maine's forests. 2021 marked the first time where light SBW defoliation was visible during our annual aerial survey effort and roughly 850 acres of damage was mapped. This low level of defoliation did not progress in 2022, and defoliation was no longer visible in 2022 in those areas mapped in 2021. No new areas of SBW damage were mapped anywhere in the state in 2022 nor 2023. Areas in far northwestern Aroostook County will be prioritized for aerial survey coverage for possible SBW defoliation in 2024.

Aroostook County Ground Defoliation Survey (2020–2023)

Ground surveys using the Fettes Method for SBW defoliation have been conducted at 60 sites in Aroostook County since 2020. Compared to 2021, defoliation levels decreased at 43 of 60 sites in 2022 with an average decrease of 4.26 percent. At the 17 sites where defoliation increased, the average increase was 0.5 percent. Maximum defoliation at any site in 2022 was just below 10 percent. In 2023, defoliation levels again decreased at 43 of 60 sites, with an average decrease of 1.38 percent. Defoliation levels remained the same at 2 of 60 sites. At the fifteen sites where defoliation levels

increased, the average increase was 0.94 percent. Maximum defoliation at any site in 2023 is now just below six percent.

Due to the lack of active defoliation on the landscape, MFS is considering relocating some sites to higher priority areas during the 2024 monitoring season. These survey sites are established however, and the survey can be resumed as is in upcoming seasons should there prove a need.

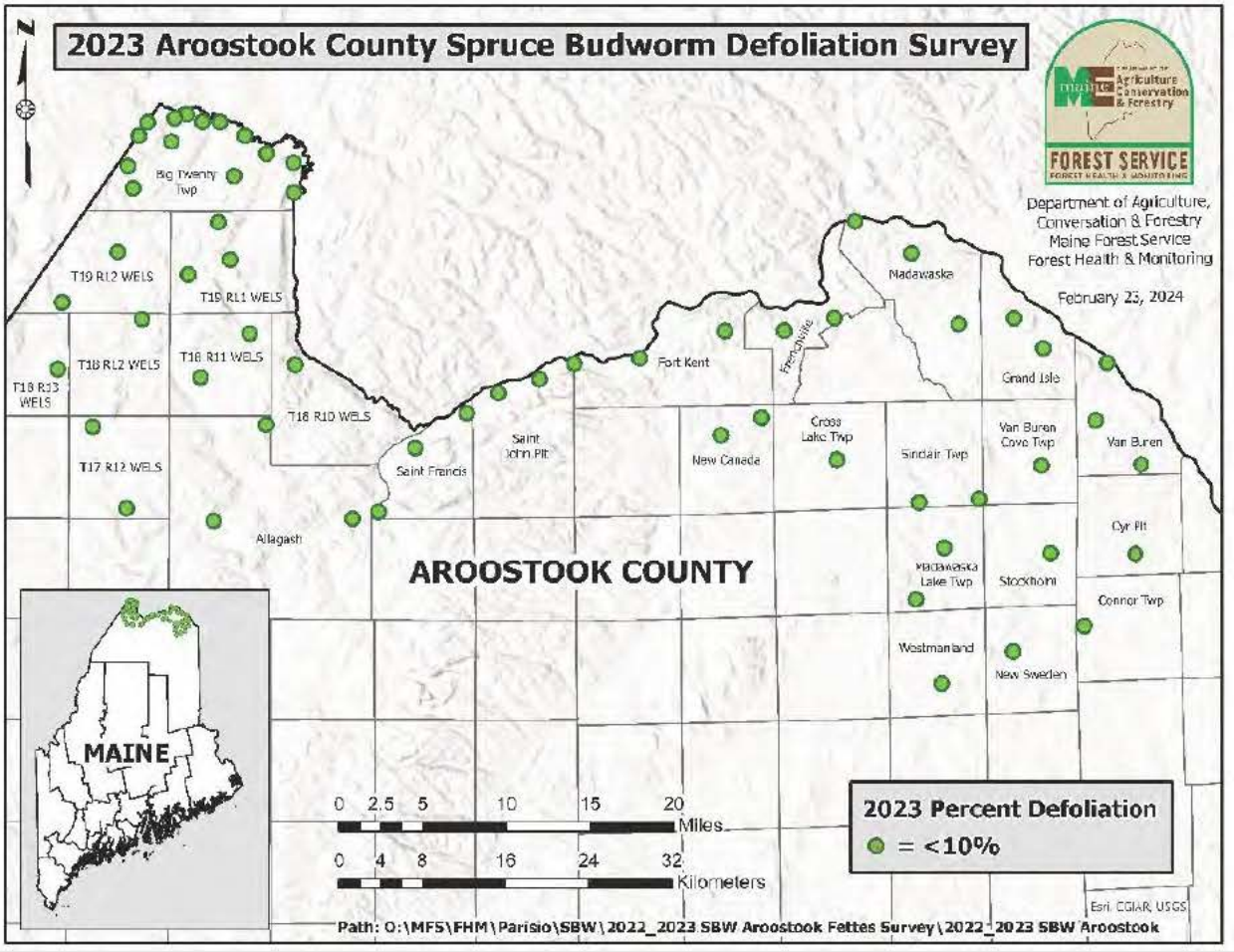


Figure 14: 2023 Aroostook County spruce budworm defoliation survey.

Following the events of 2019, defoliation ratings at many MFS defoliation survey sites scored higher than ten percent in both 2020 and 2021. These defoliation levels dropped precipitously in 2022, with all sites scoring below ten percent. In 2023, all sites scored below six percent defoliation.

Spruce Budworm Task Force Report Update (2023)

In late 2021, the Maine Spruce Budworm Task Force held a workshop to revisit and provide progress reports on recommendations that were made in the original 2016 SBW Task Force Report. Each of the seven task teams, representing different areas of research and expertise, were asked to provide updates on their work as well as prioritize future needs regarding the potential for a spruce budworm outbreak. This updated report provides a number of links for those interested in newly published research related

to spruce budworm, media stories and educational materials, mapping tools, and more. The updated 2023 executive summary can be viewed or downloaded at sprucebudwormmaine.org.

2024 Spruce Budworm Outlook

The spruce budworm outlook in Maine continues to look favorable following another consecutive season of stable and falling trap captures. The combined value of the multiple monitoring techniques used throughout Maine is evident in 2023 as it has helped to identify potential areas of concern in 2024. The areas of far northwestern Aroostook County were not covered during the 2023 aerial survey flights, but MFS will make sure to prioritize these areas during aerial survey in northern Maine in 2024. Similarly, the L2 monitoring component of the monitoring network has identified areas that will potentially require aerial treatments in 2024.

In Canada, areas of Quebec due north of Maine that pose the greatest threat from moth migration appeared less active in 2023. SBW populations in Quebec are now concentrated in three main areas: in eastern Quebec near the Ontario border, in central Quebec north of the St. Lawrence River, and in eastern Quebec at the tip of the Gaspe Peninsula. Despite the locations to the east and north of Maine, there was no evidence of any major moth migration from Quebec to Maine in 2023. Although not a major area of damage, it appears there still is some SBW activity across the Canadian border opposite the areas where moth captures were high in Maine (*see SBW Map Appendix, Figure 16*).

In New Brunswick, a few interesting SBW observations were made in the "panhandle" that borders northern Maine (*see SBW Map Appendix, Figure 17*). First, there were two standout pheromone trap monitoring sites. One of these was rated as moderate (average 201–300 moths per trap) and the other as high (average 301–400 moths per trap). Second, an L2 monitoring site in the same general area was also rated as high (average 20.6–40.5 larvae per branch) (*see SBW Map Appendix, Figure 18*). Of the three branches sampled at this site, two had no larvae, whereas the third branch was responsible for producing all the larvae recovered at the site, likely a sample with one or more egg masses deposited directly on the branch. In response to these initial findings, extensive follow-up surveys indicated these population levels were not representative of the surrounding areas, making it the possible result of a small in-flight from Quebec.

Similar to the New Brunswick panhandle, perhaps the small concentration of high moth captures in far northwestern Aroostook County could be the result of a small in-flight of moths from Quebec in 2023, simply not captured in flight-models or by radar equipment. Indeed, the annual report released by Quebec indicates a few small pockets of moderate and severe SBW defoliation due west of these Maine monitoring sites across the border. The Maine Forest Service continues to appreciate insight like this and for the open lines of communication with our SBW colleagues to the north. We will continue to pay close attention to our neighboring Provinces and States and exchange this valuable information each season.

Acknowledgments

The Maine Forest Service gratefully acknowledges the large team of cooperators, the University of Maine Spruce Budworm Lab, the University of Maine Cooperative Forestry Research Unit, and the hard work of all field staff on the ground that make this monitoring program possible.

Spruce Budworm Monitoring Program Cooperators:

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

SBW Map Appendix

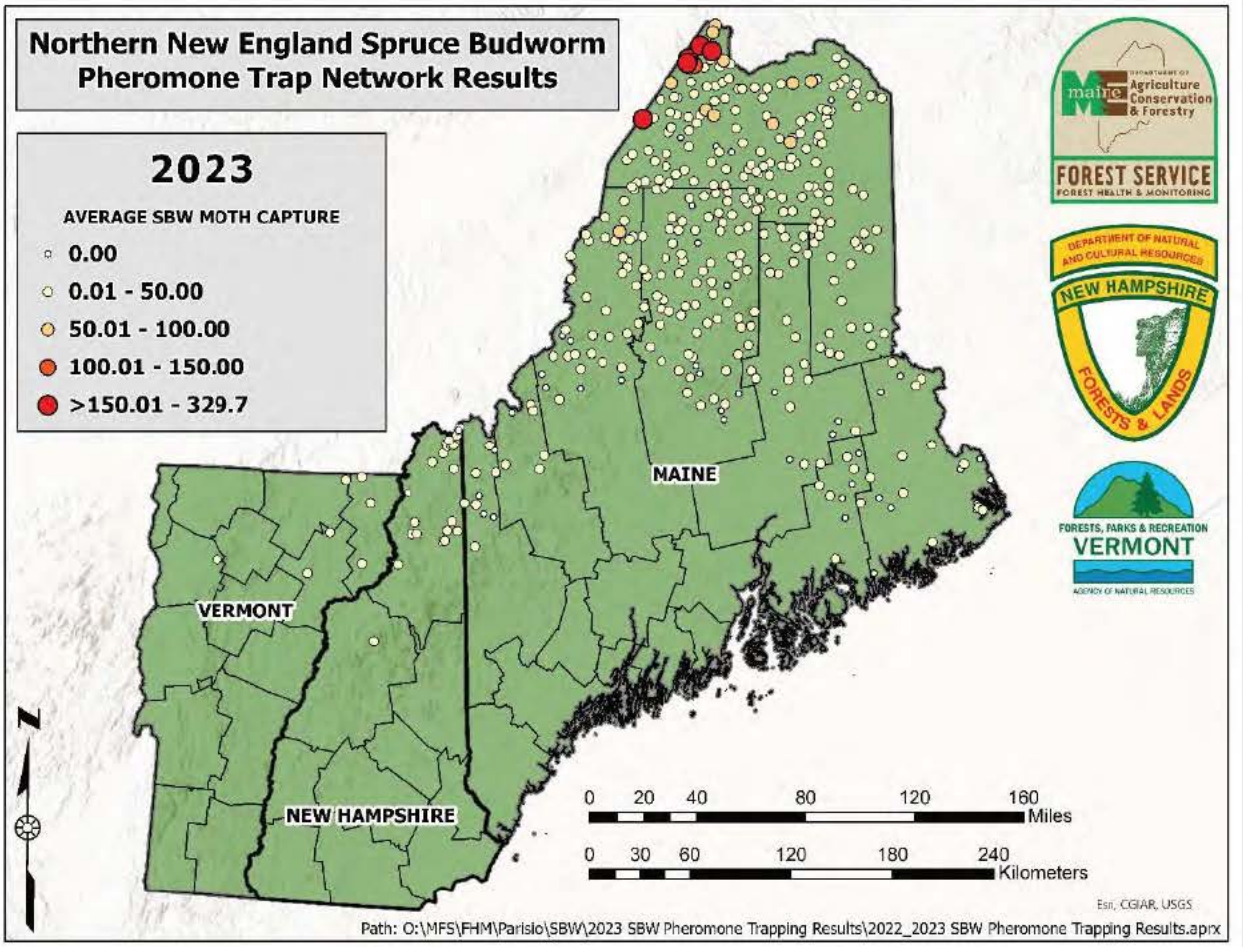


Figure 15: 2023 Northern New England spruce budworm pheromone trap network results.

All traps in New Hampshire and Vermont captured an average of less than 50 moths per trap in 2023.

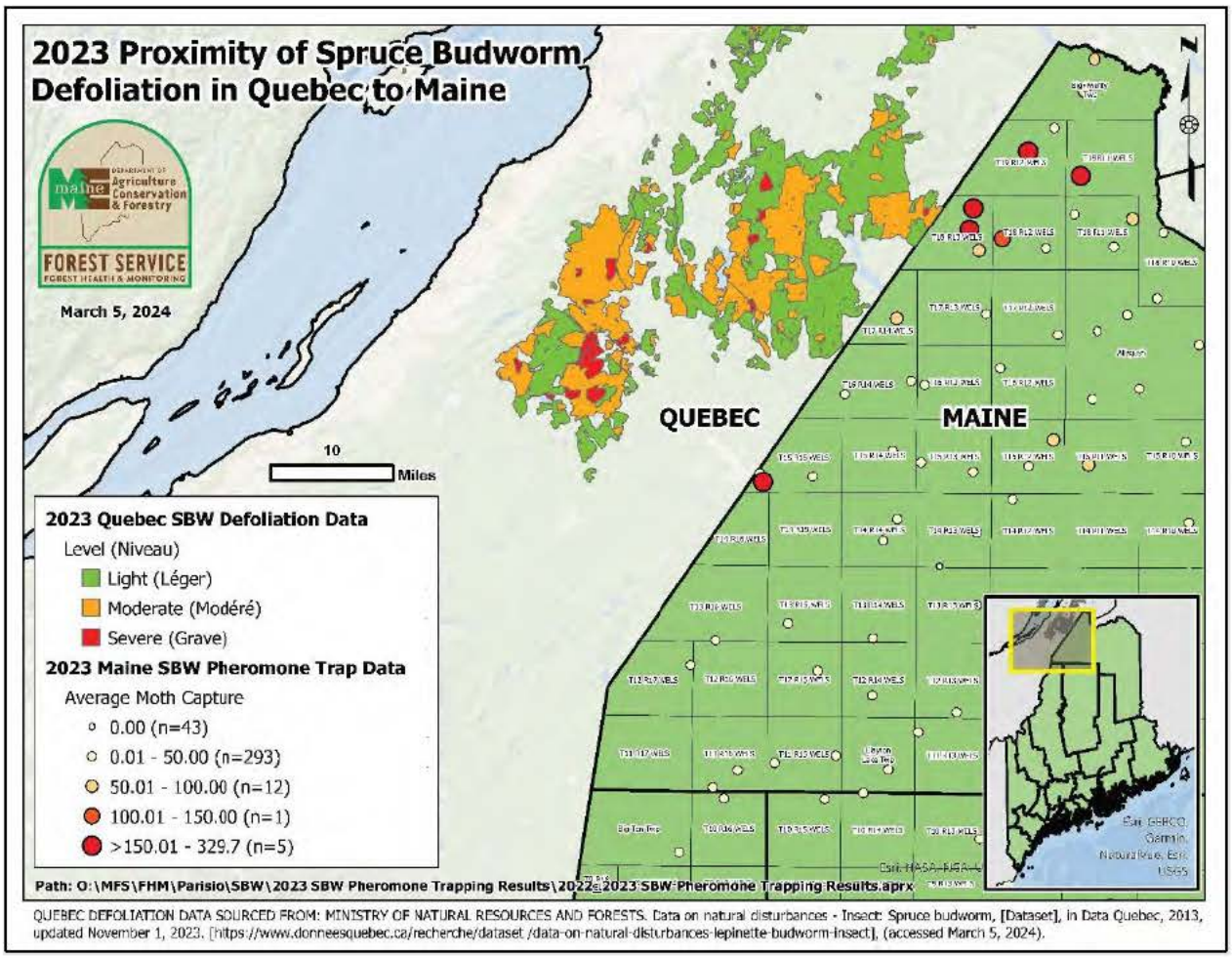


Figure 16: Proximity of spruce budworm defoliation in Quebec to Maine.

Areas of spruce budworm defoliation in the Province of Quebec adjacent to areas in far northwestern Aroostook County in Maine with high average spruce budworm pheromone trap captures in 2023. Several L2 monitoring sites located in these areas also had higher than average larval populations in 2023.

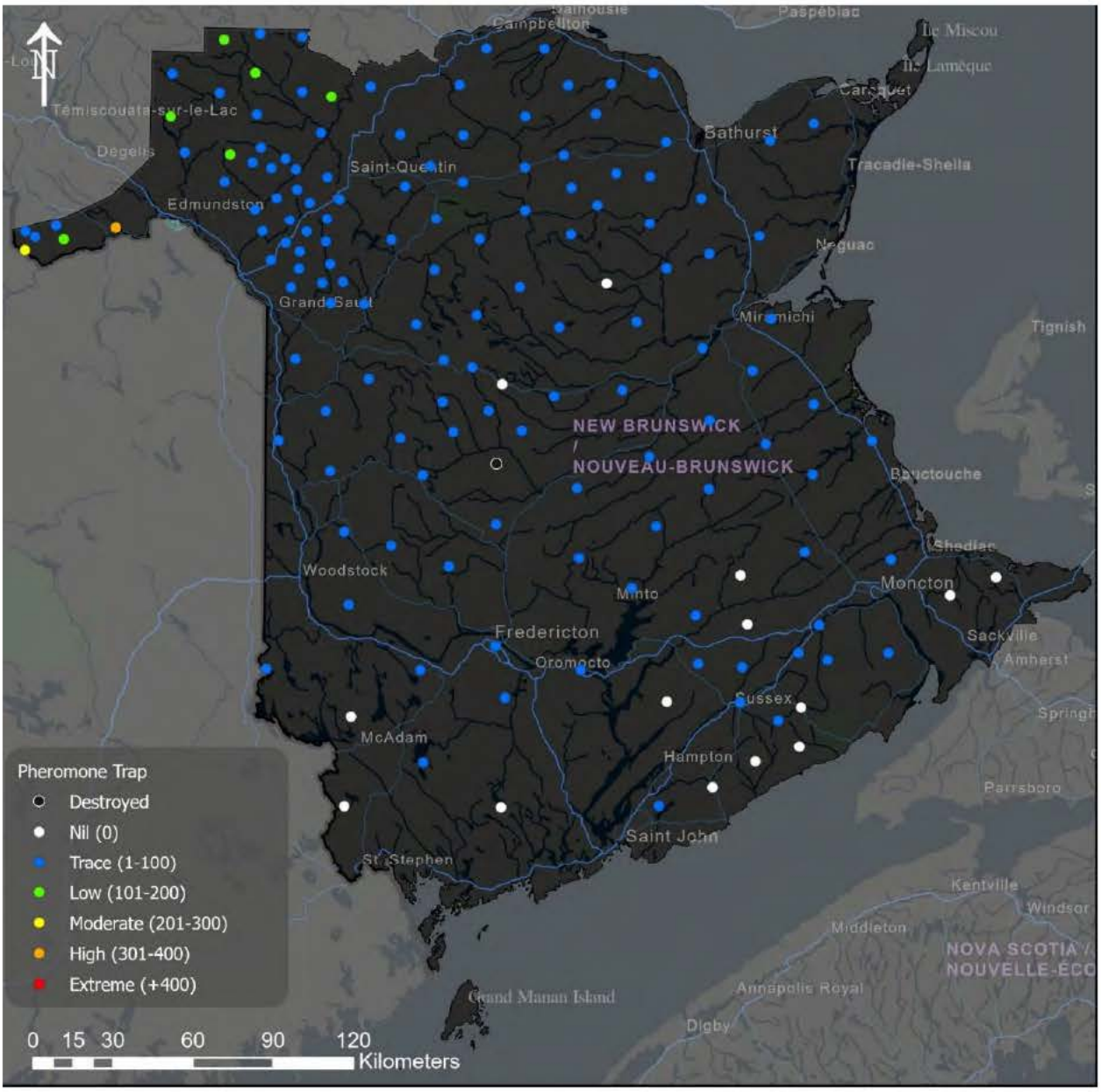


Figure 17: 2023 Spruce budworm pheromone trap monitoring results for New Brunswick.

Note the results for the panhandle over Maine, where one trap captured between 201–300 moths and one trap captured between 301–400 moths. Source: New Brunswick 2024 Pest Report

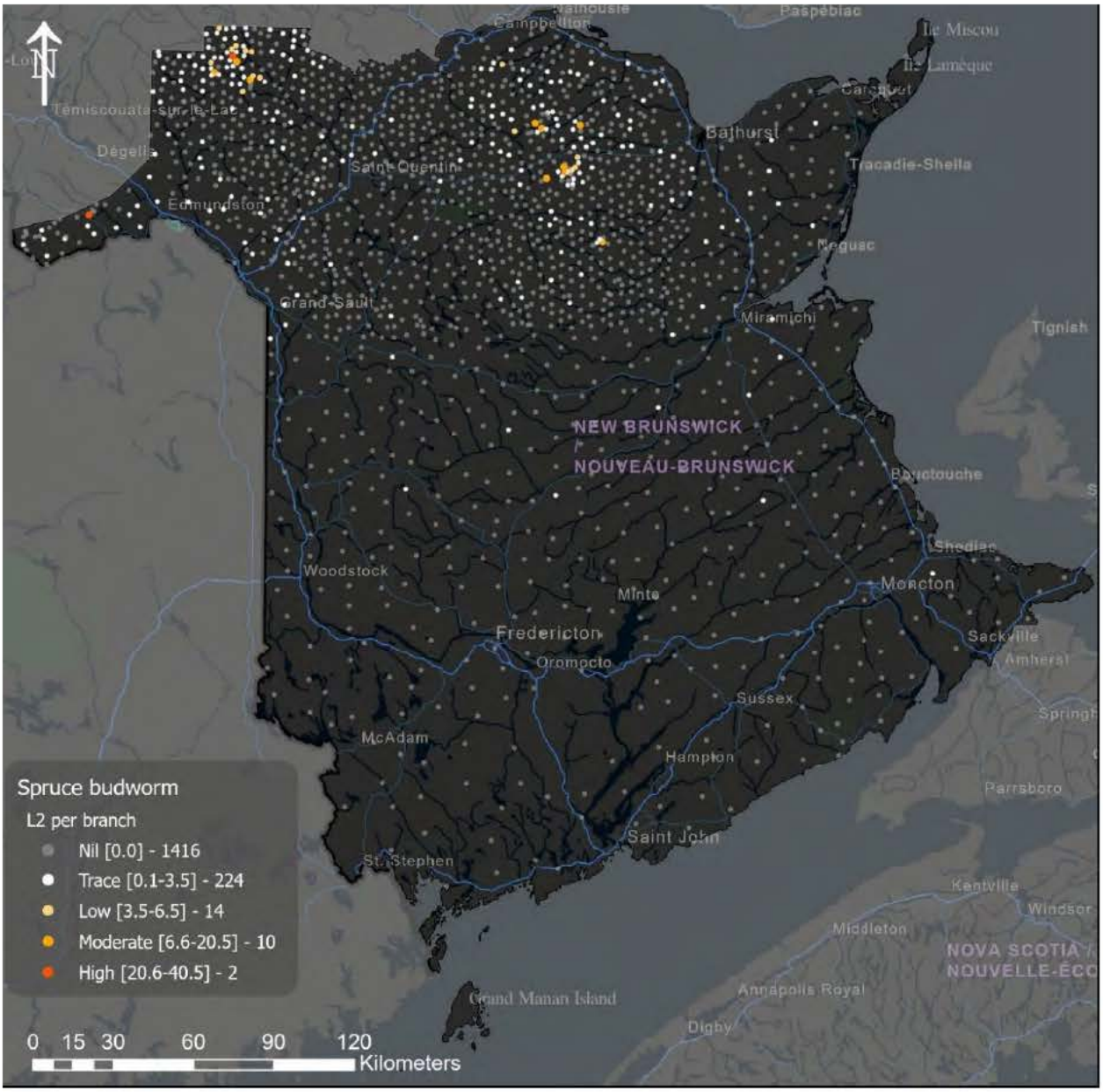


Figure 18: 2023 Overwintering larvae survey results for the province of New Brunswick.

Again, note the result for one site in the panhandle over Maine, rated as high, indicating an average of 20.6 to 40.5 larvae per branch. Source: New Brunswick 2024 Pest Report

Appendix C
Browntail Moth in Maine 2022

Tom Schmeelk, Forest Entomologist
Maine Forest Service, DACF
168 State House Station, Augusta, ME 04333

Originally introduced from Europe to Massachusetts in the 1890s, browntail moth (BTM) has been established in Maine since 1904. In North America, sizeable populations are currently only known to exist in Maine and on Cape Cod, MA. BTM is primarily a human health nuisance, causing skin rashes or breathing problems when people come into contact with or inhale airborne hairs. The caterpillars' barbed hairs contain a toxin that is stable in the environment for one to three years. The severity of individuals' reactions to these toxic hairs varies. It is a difficult insect to work with because of its health effects; more work has been done to study this insect in past years, and MFS has been working with researchers in the northeast to add to the understanding of this pest.

Elevated populations of browntail moth continue to be observed in different regions in Maine, most notably Cumberland, Hancock, Knox, Penobscot, and Waldo counties. Aerial survey in late spring and early summer was hampered by one of the wettest seasons on record. When we were finally able to perform aerial survey, southern Penobscot County was heavily impacted, where browntail moth has continued to expand recently. The survey results were compounded by a very late freeze event in mid-May, which caused damage that looked similar to BTM defoliation in oaks over a wide swath of Maine. The lateness of the aerial survey also meant that many of the BTM-damaged trees had recovered, aided by prolific moisture which helped the trees re-foliate. While some damage was visible, the true extent of areas affected by BTM was masked by this recovery. A total of 47,727 acres of BTM damage were mapped during aerial survey, with the vast majority of damage mapped during our second round of aerial survey to capture skeletonization damage from newly emerged larvae in late summer.

This year, we continued our network of monitoring sites to observe larval development over the course of the season and monitor locations for evidence of the pathogens affecting BTM caterpillars. Many of these monitoring sites have changed location from previous years to best capture trends and developmental differences in the browntail population throughout affected areas of Maine. The ten monitoring sites for 2023 were in Bangor, Belfast, Brunswick, Dresden, Ellsworth, Garland, Lincoln, Skowhegan, Turner, and Unity. Weekly developmental updates from these monitoring sites were shared regularly with the public and other stakeholders using the Maine Forest Service BTM website as well as our BTM news bulletin.

Although we saw pathogen-related mortality, it was not as widespread as anticipated. Perhaps all the rain was too much of a good thing, and it is possible these pathogens need rainless periods in order to sporulate and spread. We responded to a request from the manager of Eagle Island State Historic Site and confirmed high mortality of browntail caterpillars from the fungus *Entomophaga aulicae.* However, on the mainland in Harpswell we did not see the same mortality. As caterpillar development concluded for the season in late June, we confirmed viral and fungal pathogens at some of our monitoring sites. Many of the deceased caterpillars observed had died right before pupation either in or just outside the pupal packet. We are not ruling out larger-scale impacts; as we saw a couple of years ago, the young caterpillars that hatched in August can also succumb to pathogen activity. A clearer picture of the impacts of fungal and viral pathogens on the BTM population this past spring and summer will come to light once we begin our winter web surveys in January 2024.

Looking back at the season, we received our first confirmed report of BTM caterpillars emerging from their winter webs beginning the week of April 16. We received the first report of a browntail moth adult on July 7 in Penobscot County, with other confirmed sightings in Turner and Skowhegan later that same day. A month later, we observed the first browntail moth egg masses hatching the week of August 7. As the young caterpillars feed, they graze on the outer surface of the leaf without consuming the entire leaf. This damage is called skeletonization and causes the leaf to die and turn a distinctive copper color. When we perform our aerial BTM surveys in the late summer, we use this damage to help identify where BTM populations are most severe. We started to witness skeletonization damage on the ground during the week of August 28. Staff noted this damage on the I-95 corridor in southern Penobscot County, southern Somerset County, northern Kennebec County, and northern Sagadahoc County, with damage visible in other parts of the infested area.

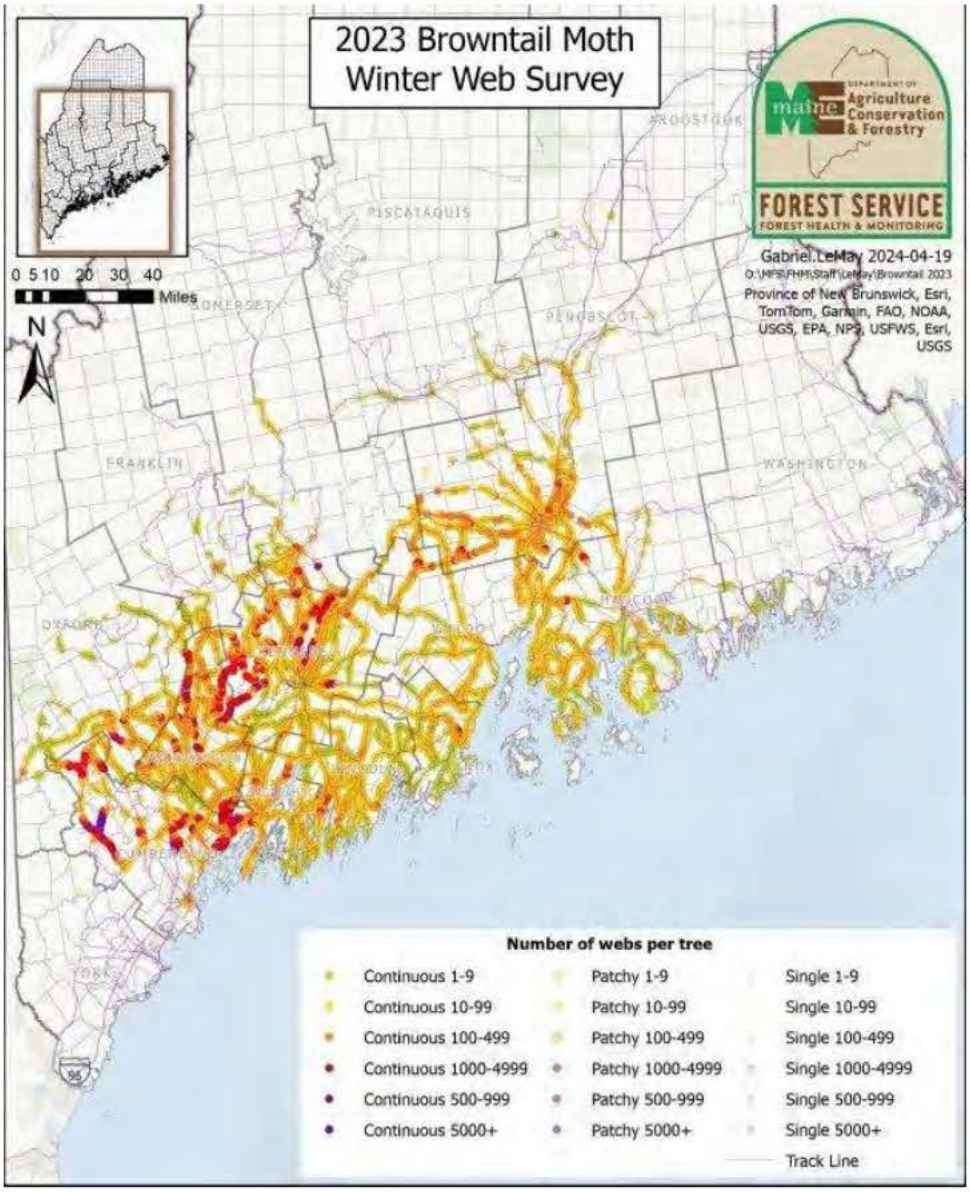


Figure 19: Data points from the 2023 winter web survey.

Appendix D
Emerald Ash Borer in Maine 2023

Michael Parisio & Colleen Teerling, Forest Entomologists
Maine Forest Service, DACF
168 State House Station, Augusta, ME 04333

Emerald ash borer (EAB) continued to spread in Maine in 2023, with several new notable locations that required revisions to Maine's emerald ash borer quarantine regulations. In an effort to maintain accurate quarantine boundaries for emerald ash borer, we continue to survey for this pest using a variety of methods across the state. Additionally, we rely heavily on visual observations and reports submitted to us by the public and the tree care professional community to aid our mapping and knowledge of emerald ash borer's distribution in the state. Presented here is a summary of monitoring and management activities and regulatory updates for emerald ash borer during 2023.

Purple Prism and Green Funnel Trap Survey

In 2023, MFS operated 197 purple prism traps (PPT) statewide. The PPT program requires traps to be visited three times each season: once to set up the trap, once during the summer months when EAB is active to check the traps, and one final time when traps are removed for the season. In an interesting side project, we calculated that this survey requires at least 6,000 miles of driving between all three visits. This means visual inspection of roadside ash trees for woodpecker damage has occurred along many miles of Maine roads. No EAB were found on any of the traps operated by MFS in 2023. A PPT used by a cooperator for a research project did recover EAB in Frenchville in northern Maine in 2023, however Frenchville is known to be long infested with EAB; it was first discovered in 2018.

Due to changes in regulatory areas and funding in 2023, green funnel traps were not operated in southern Maine in 2023. Green funnel traps were operated at five sites in northern Maine in 2023; however, none of these produced any EAB beetles.

Girdled Trap Tree Survey

Girdled trap trees also remain a core part of Maine's EAB detection network. A total of 48 trees were girdled in 2023, with roughly half in southern and central Maine and the remainder in northern Maine. Most of the trees are intended to serve as detection tools for monitoring the spread of EAB, but some are used to evaluate sites for biological control releases. Five trees have proven positive for emerald ash borer. Two were in northern Maine in Grand Isle, an already known infested town, and Cyr Plantation, a new town record. The three other positive trees were located in central Maine and were established to evaluate sites for biological control. Based on these results, new EAB biological control release sites have been proposed for Newport (Penobscot County) and Lewiston (Androscoggin County) in 2024.

Biosurveillance

Biosurveillance with the hunting wasp, *Cerceris fumipennis*, was employed to monitor for EAB. Thirty-one surveys were conducted at eleven sites in the towns of Poland (Androscoggin County), Freeport (Cumberland County), Farmington (Franklin County), Dedham (Hancock County), China, Farmingdale, Winslow (Kennebec County), Boothbay, Wiscasset (Lincoln County), and Veazie (Penobscot County).

These sites were outside of the generally infested areas of the state. Two hundred and eighty-two buprestids were collected, and no EAB were found among them.

Biological Control

In 2023, all three species of parasitoids, *Tetrastichus planipennisi*, *Spathius galinae*, and *Oobius agrili*, were released at five sites in Maine: Portland, Bridgton (Cumberland County), Waterville (Kennebec County), Frenchville and Fort Kent (Aroostook County) (Figure 20). Approximately 7,880 *Tetrastichus planipennisi,* a larval parasitoid, 5,105 *Spathius galinae*, also a larval parasitoid, and 5,200 *Oobius agrili*, an egg parasitoid, were released among all sites in 2023. We appreciate the efforts of cooperators who assisted with releases at the three sites in southern Maine.

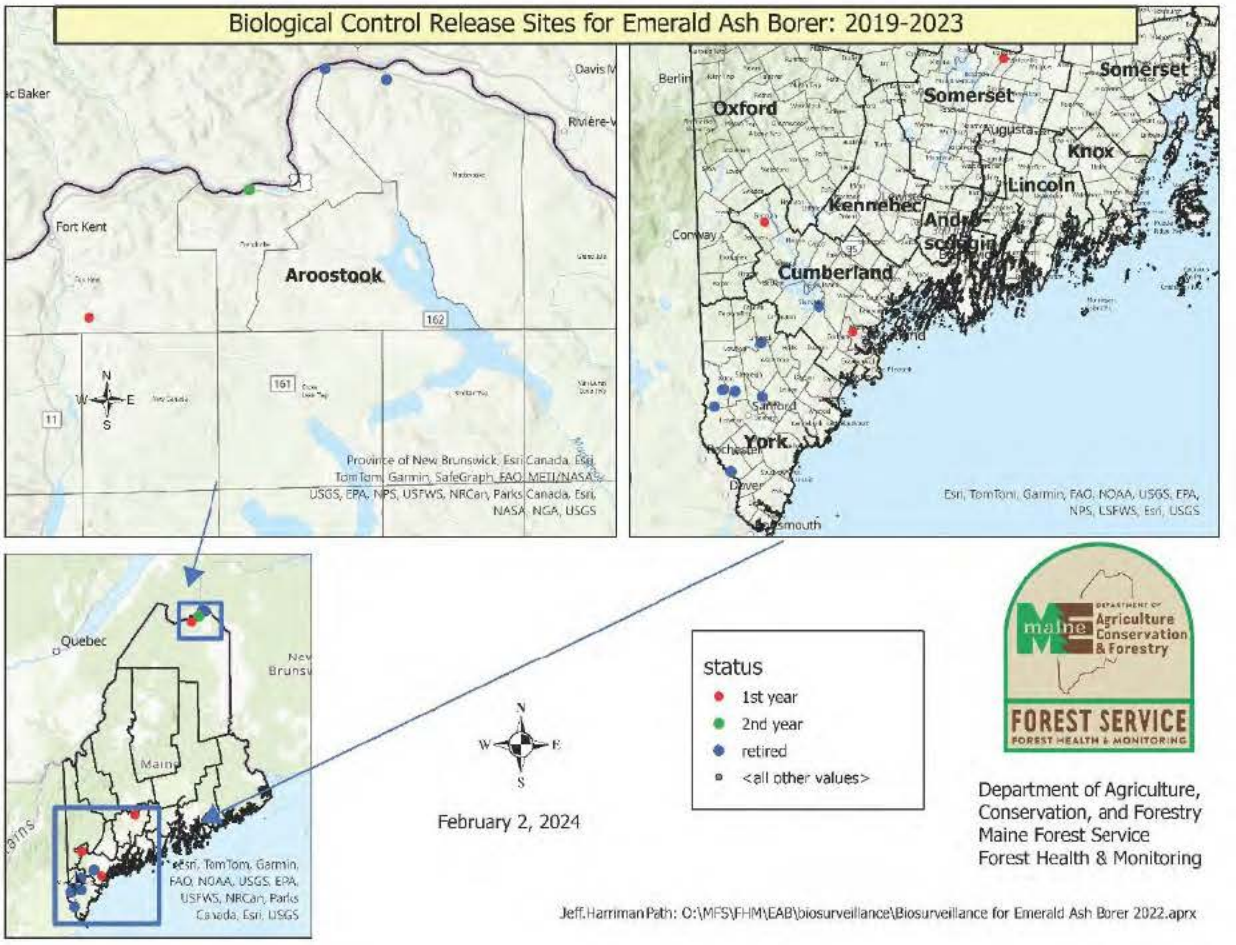


Figure 20: Release sites for biological control of emerald ash borer 2019–2023.

Although EAB parasitoid recovery has taken place in northern Maine, 2023 was the first year for recovery efforts at southern release sites. Four small ash trees were felled at each of the six retired release sites in York County and the one in Cumberland County. The lower boles and large branches of each tree were peeled to look for larval parasitoids. The smaller upper branches were placed in rearing barrels held in Durham, NH, at the US Forest Service facility to monitor for adult emergence. No signs of parasitoids were seen on the peeled trees. The upper branches remain in rearing chambers until 2024.

From August to September, yellow pan traps were deployed at each of five sites: Alfred (two sites), Limerick, South Berwick (York County) and Gorham (Cumberland County). Samples were collected every two weeks and will be processed to search for adult parasitoids of all three species. We appreciate the assistance from cooperators in collecting samples at three of the more remote sites.

To date, only one female *Tetrastichus planipennisi* has been recovered in Maine from a 2021 yellow pan trap sample from Aroostook County.

County and Town Detection Summary

New locations with EAB infestations were reported in the following towns in 2023. Many of the towns listed are in infested areas and have likely been infested prior to Maine Forest Service receiving an official report in 2023.

Table 11: Towns with 2023 first or subsequent reports of emerald ash borer.

County (Year First Detection)	Town (Year First Detection)	Initial Detection Method	Detection Method in 2023
Androscoggin (2022)	Lewiston (2022)	Visual Survey	Visual Survey & Girdled Trap Tree
Aroostook (2018)	Cyr Plantation (2023)	Girdled Trap Tree	Girdled Trap Tree
Aroostook (2018)	Grand Isle (2018)	Purple Prism Trap	Girdled Trap Tree
Cumberland (2019)	Brunswick (2023)	Arborist Report	Arborist Report
Cumberland (2019)	North Yarmouth (2023)	Public Report	Public Report
Cumberland (2019)	Portland (2019)	Purple Prism Trap	Public Report
Cumberland (2019)	South Portland (2021)	Visual Survey	Public Report
Kennebec (2022)	Oakland (2022)	Visual Survey	Visual Survey
Kennebec (2022)	Waterville (2022)	Visual Survey	Visual Survey
Oxford (2021)	Andover (2023)	Visual Survey	Visual Survey
Oxford (2021)	Woodstock (2023)	Visual Survey	Visual Survey
Penobscot (2023)	Corinna (2023)	Visual Survey	Visual Survey
Penobscot (2023)	Newport (2023)	Arborist Report	Arborist Report
York (2018)	Eliot (2023)	Public Report	Public Report
York (2018)	Lebanon (2018)	Purple Prism Trap	Public Report
York (2018)	Limerick (2022)	Visual Survey	Public Report

York (2018)	Sanford (2023)	Public Report	Public Report
York (2018)	Wells (2023)	Public Report	Public Report
York (2018)	West Newfield (2023)	Public Report	Public Report

Quarantine Revision

Several notable detections of EAB occurred beyond the boundaries of the previously regulated areas in 2023. The first of these new detections was reported in March by a tree care professional and was located in the Newport and Corinna area. This marked the first detection of EAB in Penobscot County and a sample was submitted for entry into the USDA APHIS PPQ ARM database. Almost immediately after this discovery, a Maine Forest Service employee reported two additional suspicious locations in Oxford County, Andover, and Woodstock, which were confirmed positive for EAB shortly after. Though not outside of a regulated area, EAB was also detected in Brunswick in August of 2023, a notable inroad into the Midcoast area. After several information gathering sessions and a long public comment period, Maine's EAB quarantine revision was finalized on November 26, 2023. In December 2023, EAB was also detected in Hermon (Penobscot County), which falls within the latest revised regulated area.

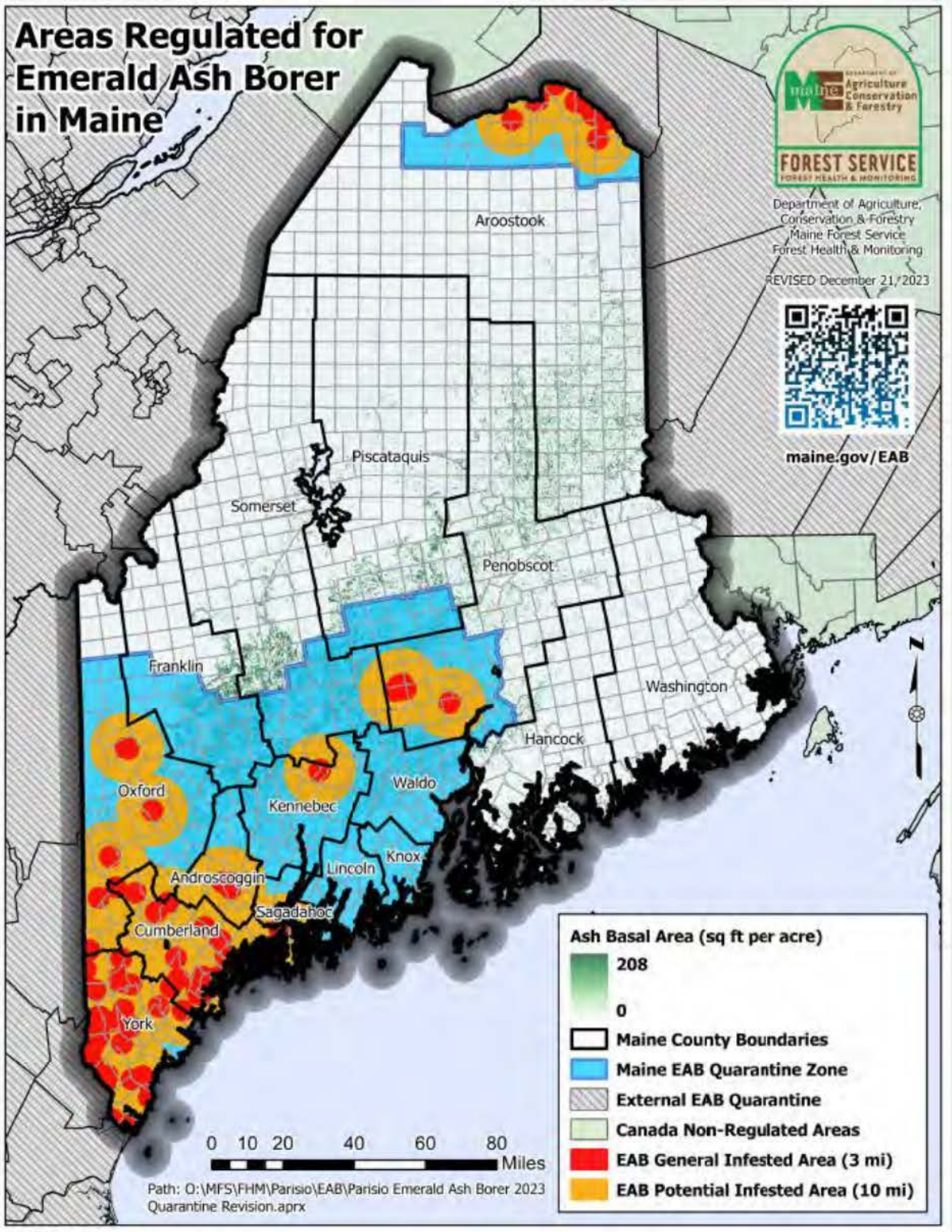


Figure 21: Map depicting extents of 2023 expansion of Maine's emerald ash borer quarantine area.

Appendix E
Aerial Survey Maps 2023

Insect and Disease Laboratory
Maine Forest Service, DACF
168 State House Station, Augusta, ME 04333

The maps in this appendix show forest damage polygons recorded during aerial survey flights in 2023. Some maps also include ground survey data; it is indicated on the map when this occurs. These are not meant to provide a comprehensive estimate of damage to Maine's forests. It is impossible to survey the entirety of Maine's forest resources, and surveys are targeted broadly to regions and known problem areas. Some forest damages are not easily detected through this method, and acres damaged are underrepresented for those, in some cases significantly. In areas with a lot of forest damage or when tracking damage from a specific agent, it can be difficult for surveyors to map all damage polygons. While many areas are confirmed through ground-truthing, providing precise acreages and verifying all pest impacts is impossible.

Several challenges were seen in the 2023 aerial survey season. It proved impossible to time a flight to pick up damage from the late spring frost. Frost damage complicated mapping of damage by browntail moth, spongy moth and others. Weather and wildfire smoke limited good flying days, and the typical challenges of competing priorities also impacted survey opportunities.

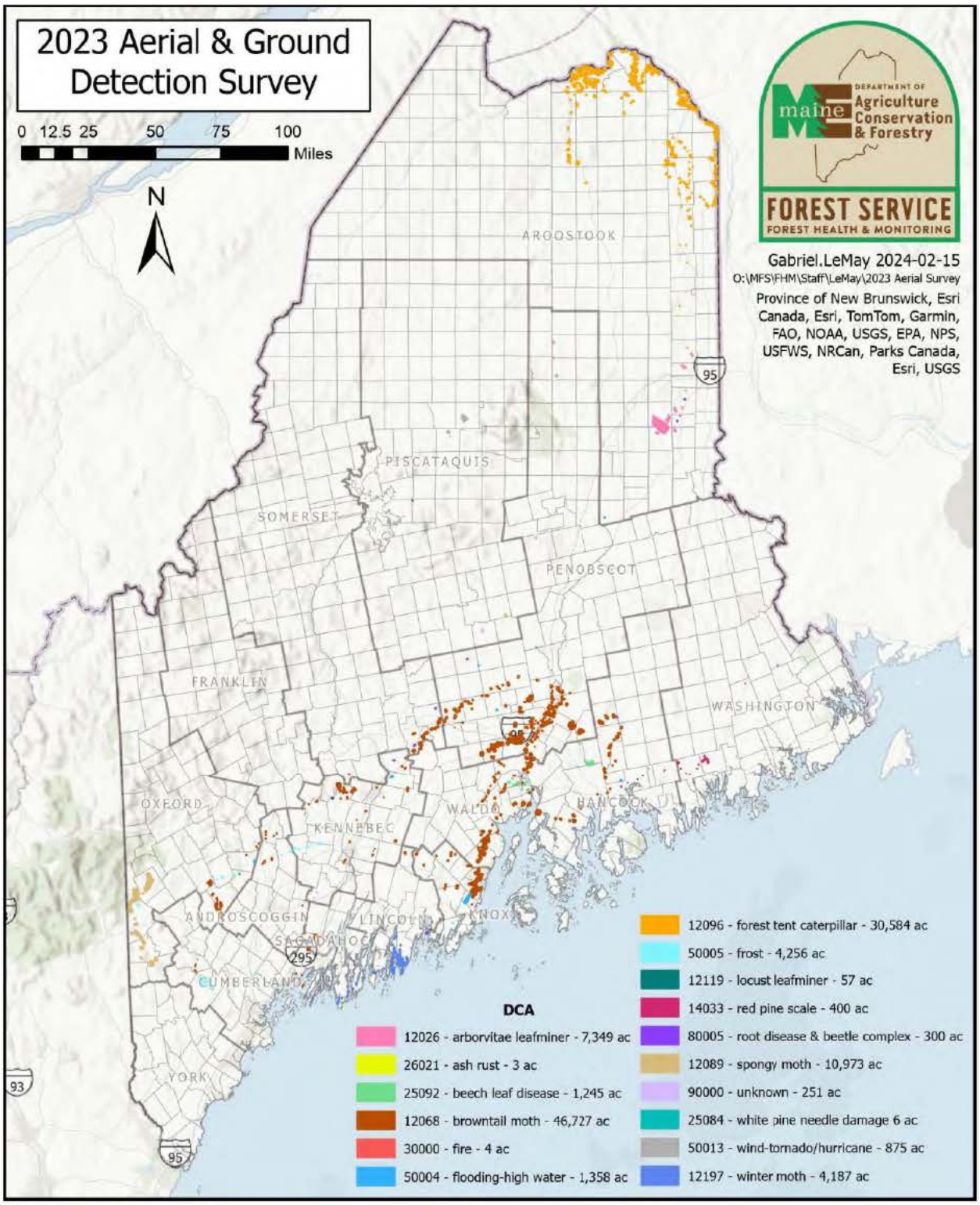


Figure 22: Ground and aerial survey map of all damage noted.

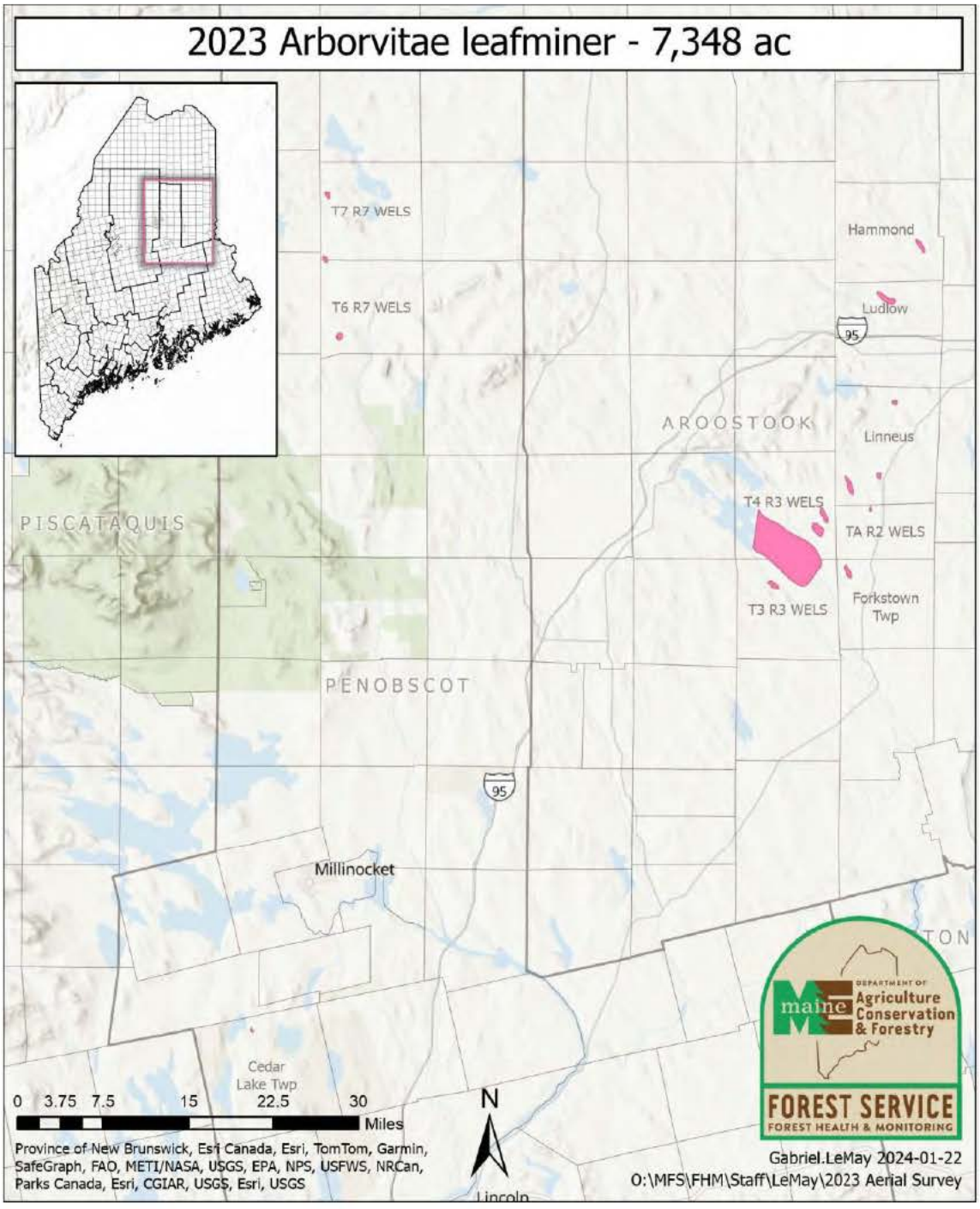


Figure 23: Aerial survey map of damage caused by arborvitae leafminer.

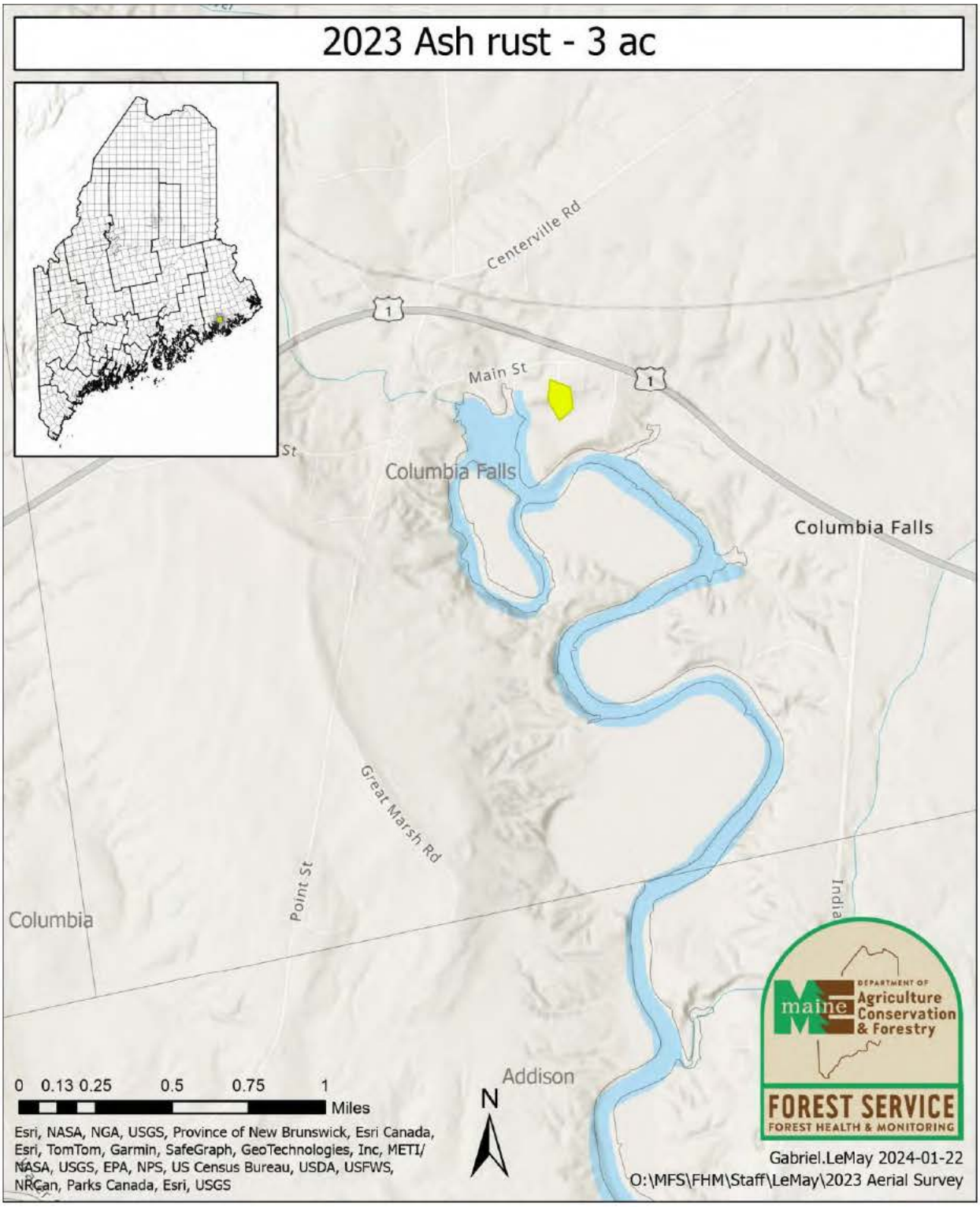


Figure 24: Aerial survey map of damage caused by ash rust.

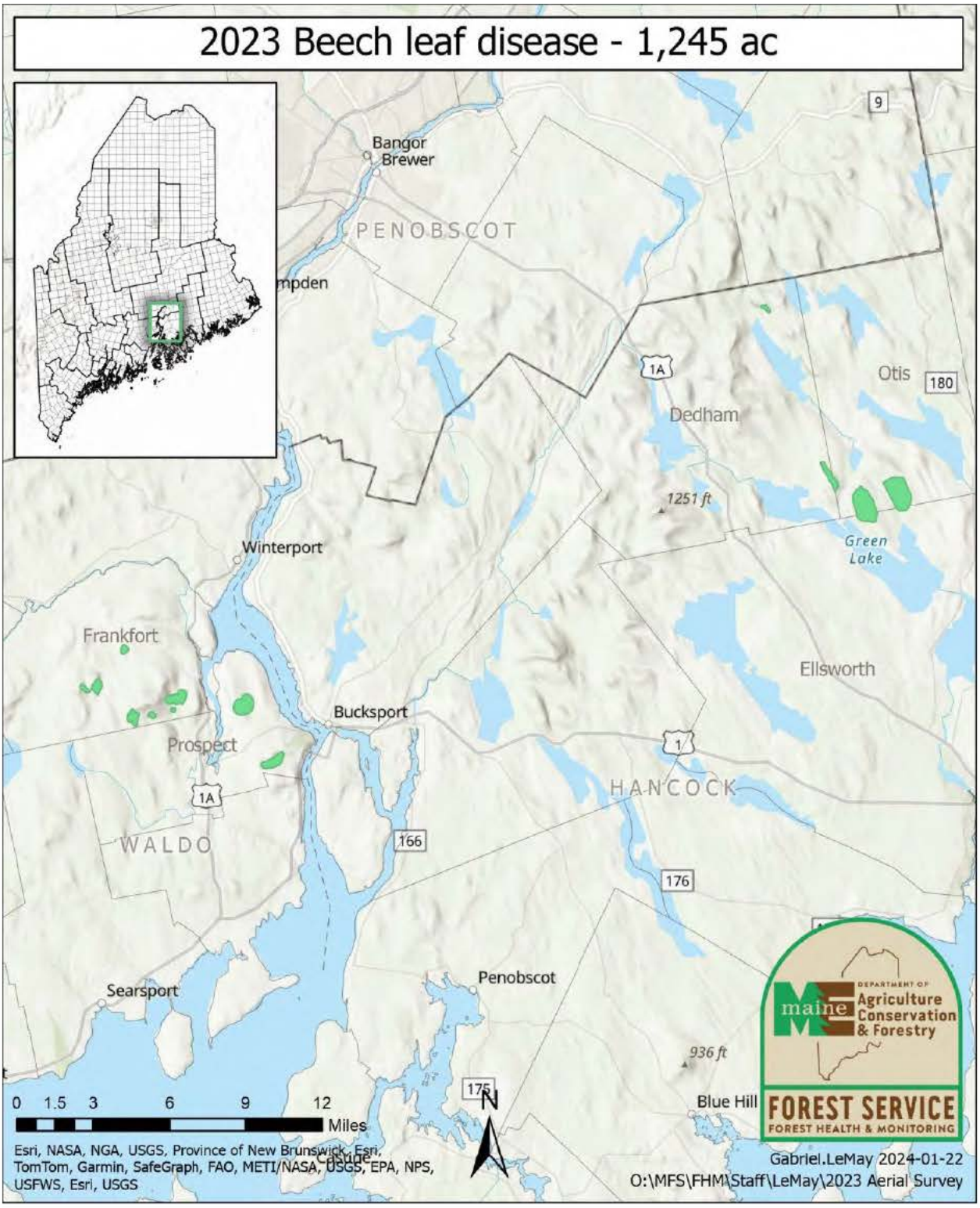


Figure 25: Aerial survey map of damage caused by beech leaf disease.

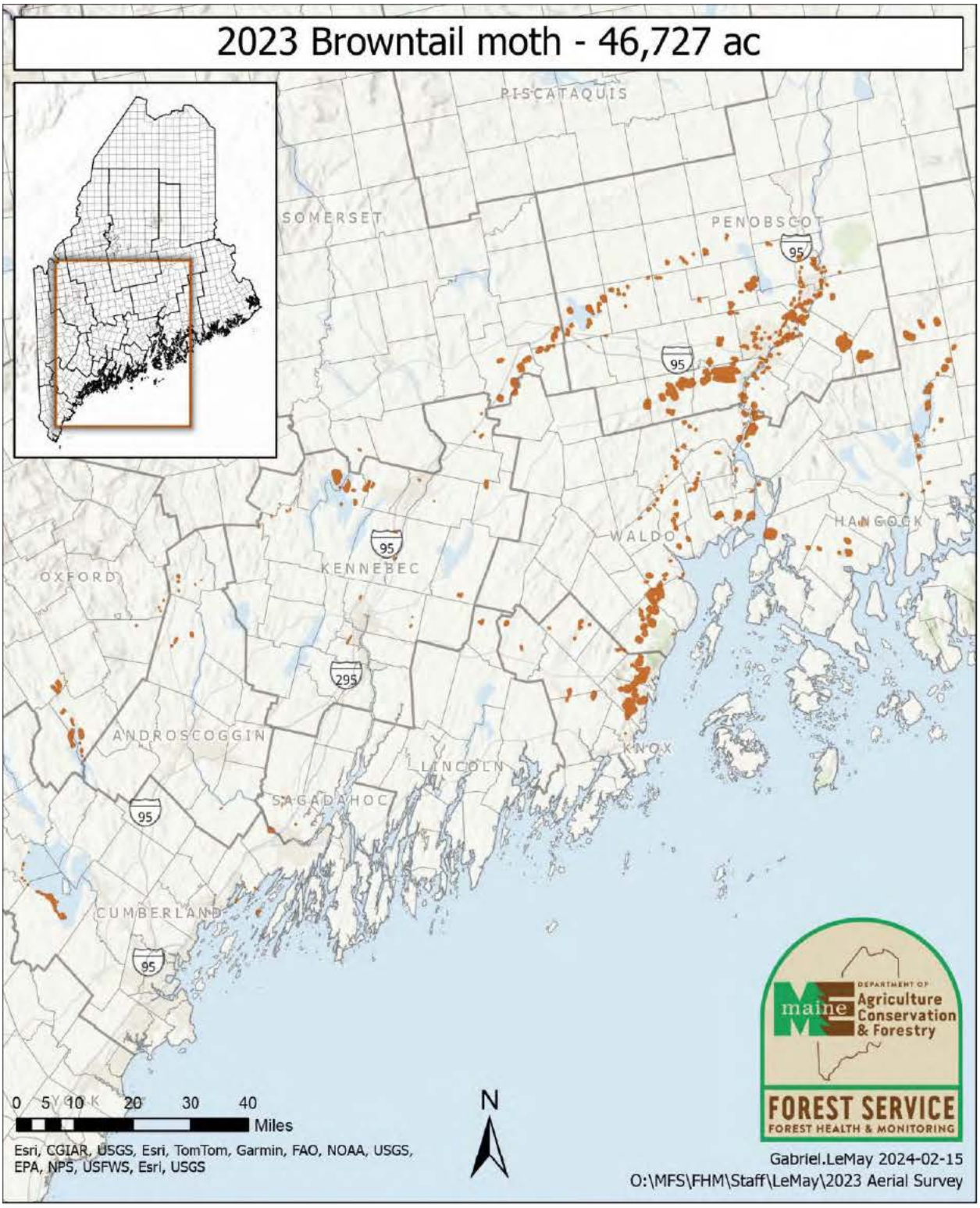


Figure 26: Aerial survey map of damage caused by browntail moth.

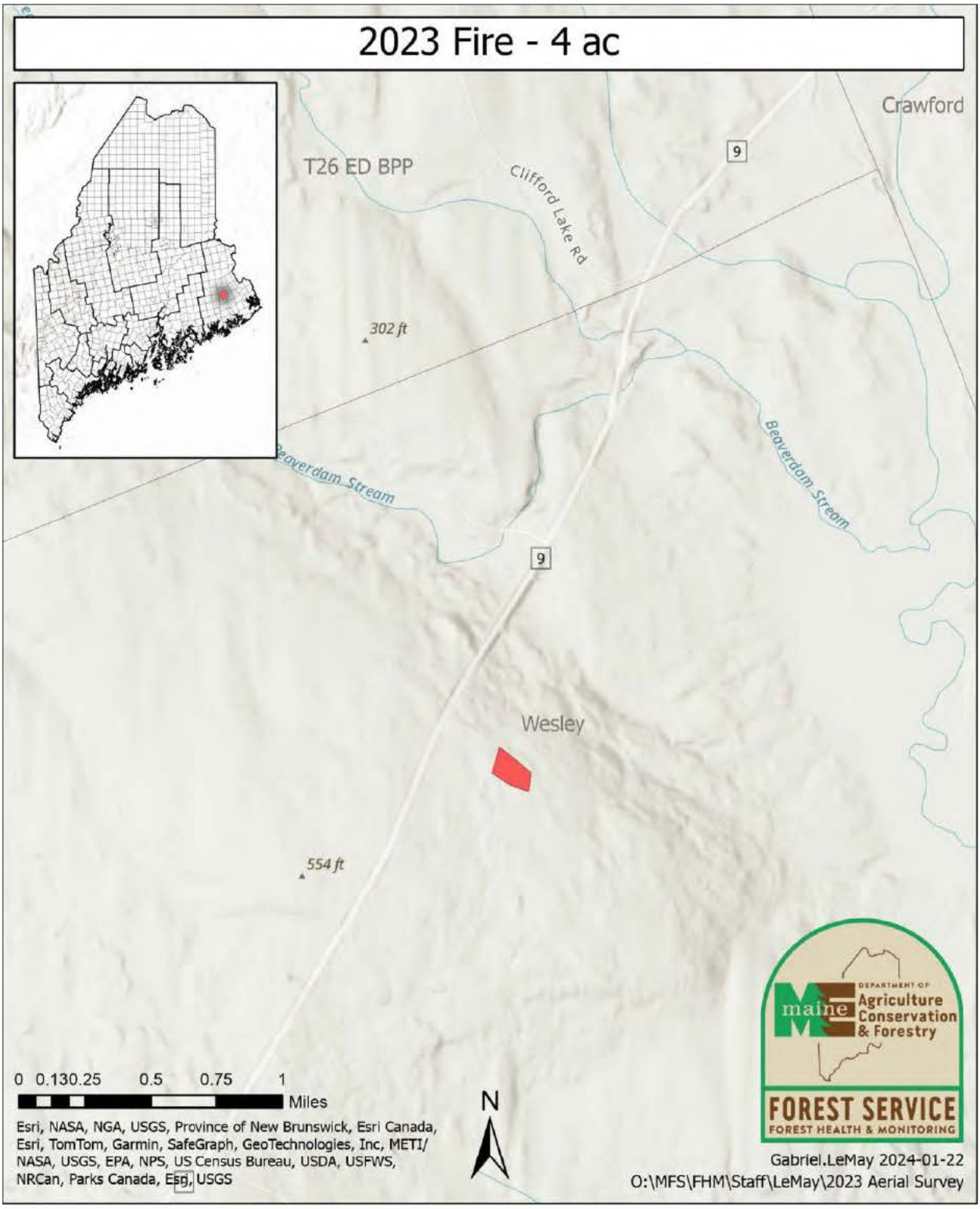


Figure 27: Aerial survey map of damage caused by fire.

Figure 28: Aerial survey map of damage caused by flooding and high water.

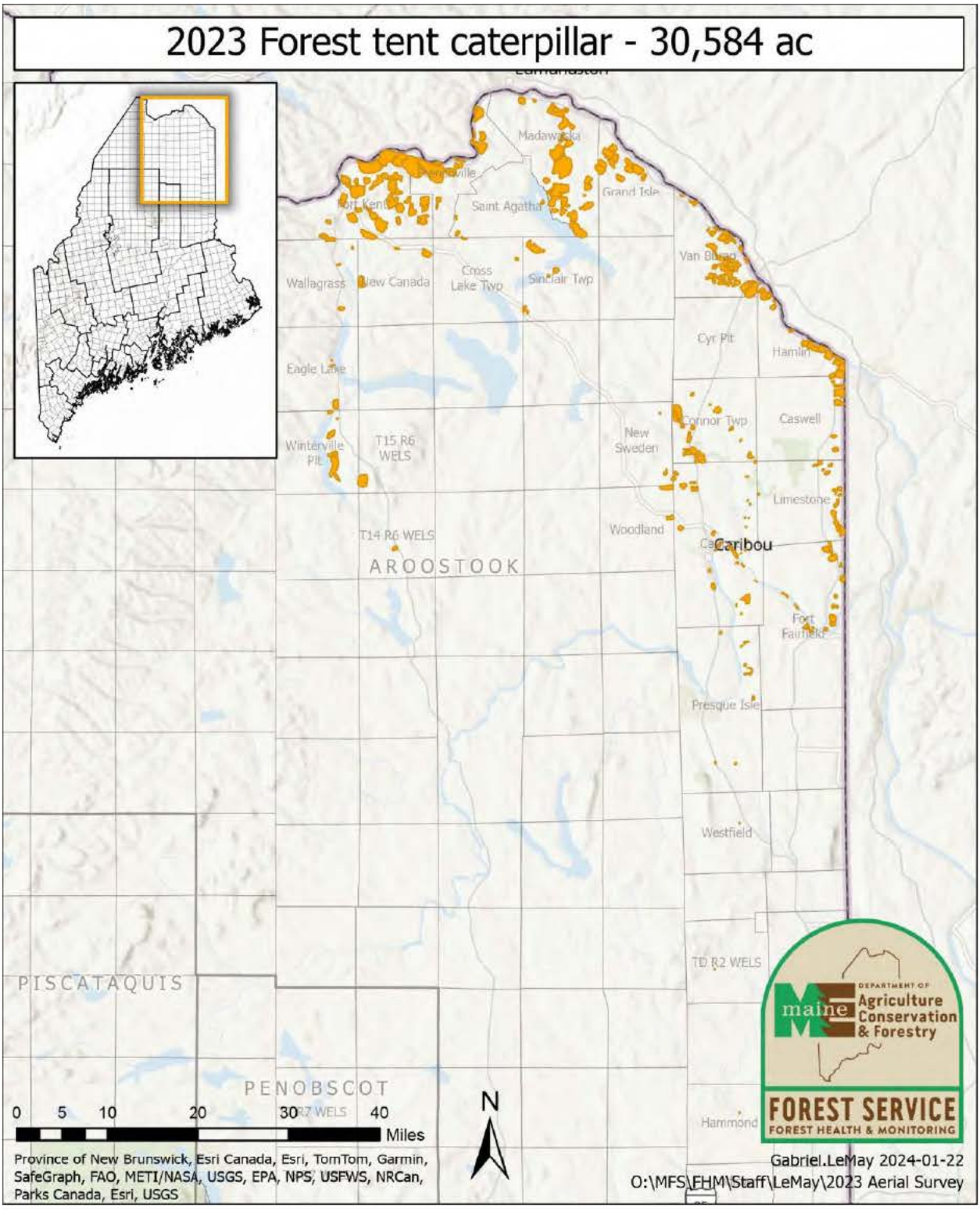


Figure 29: Aerial survey map of damage caused by forest tent caterpillar.

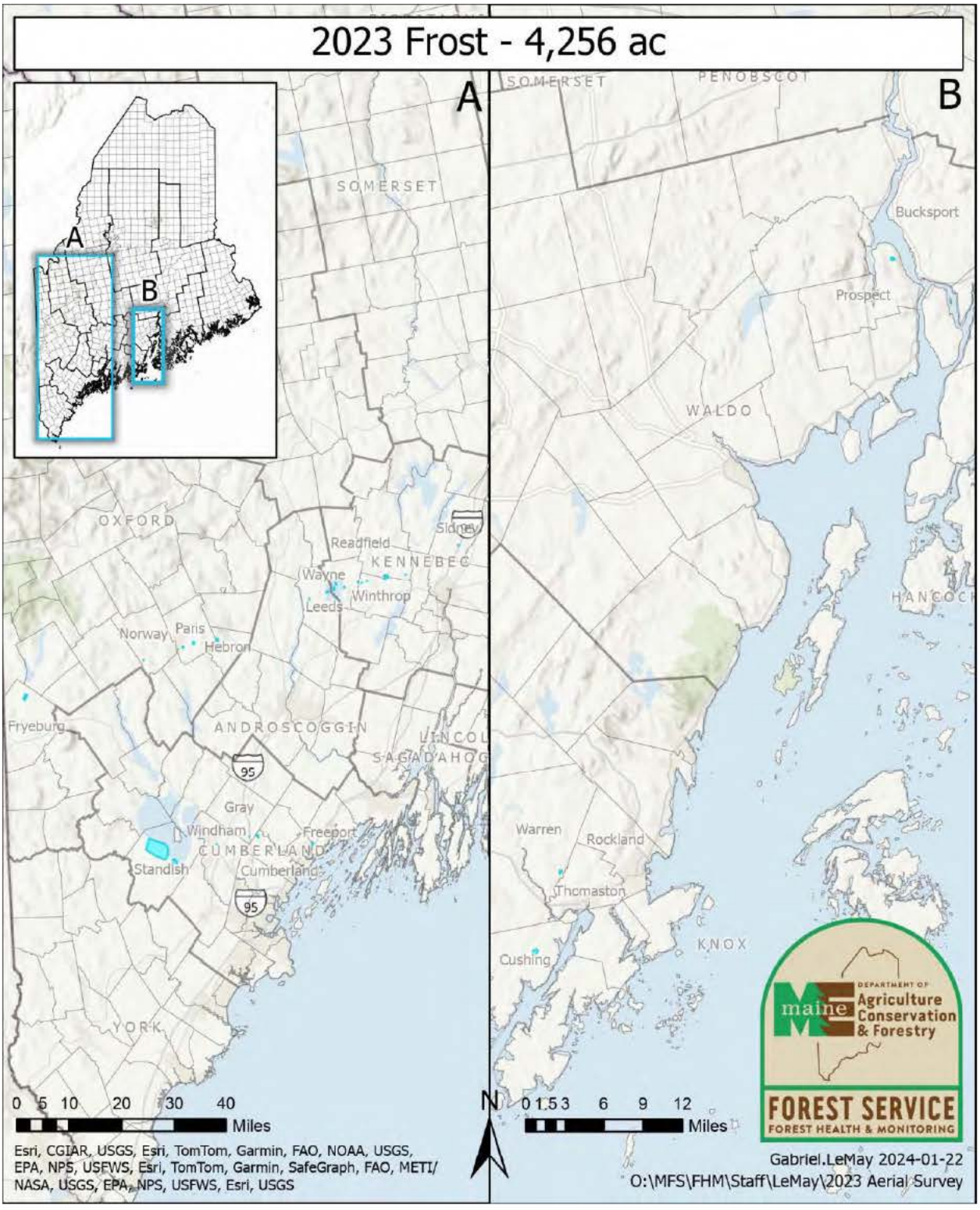


Figure 30: Aerial survey map of damage caused by frost.

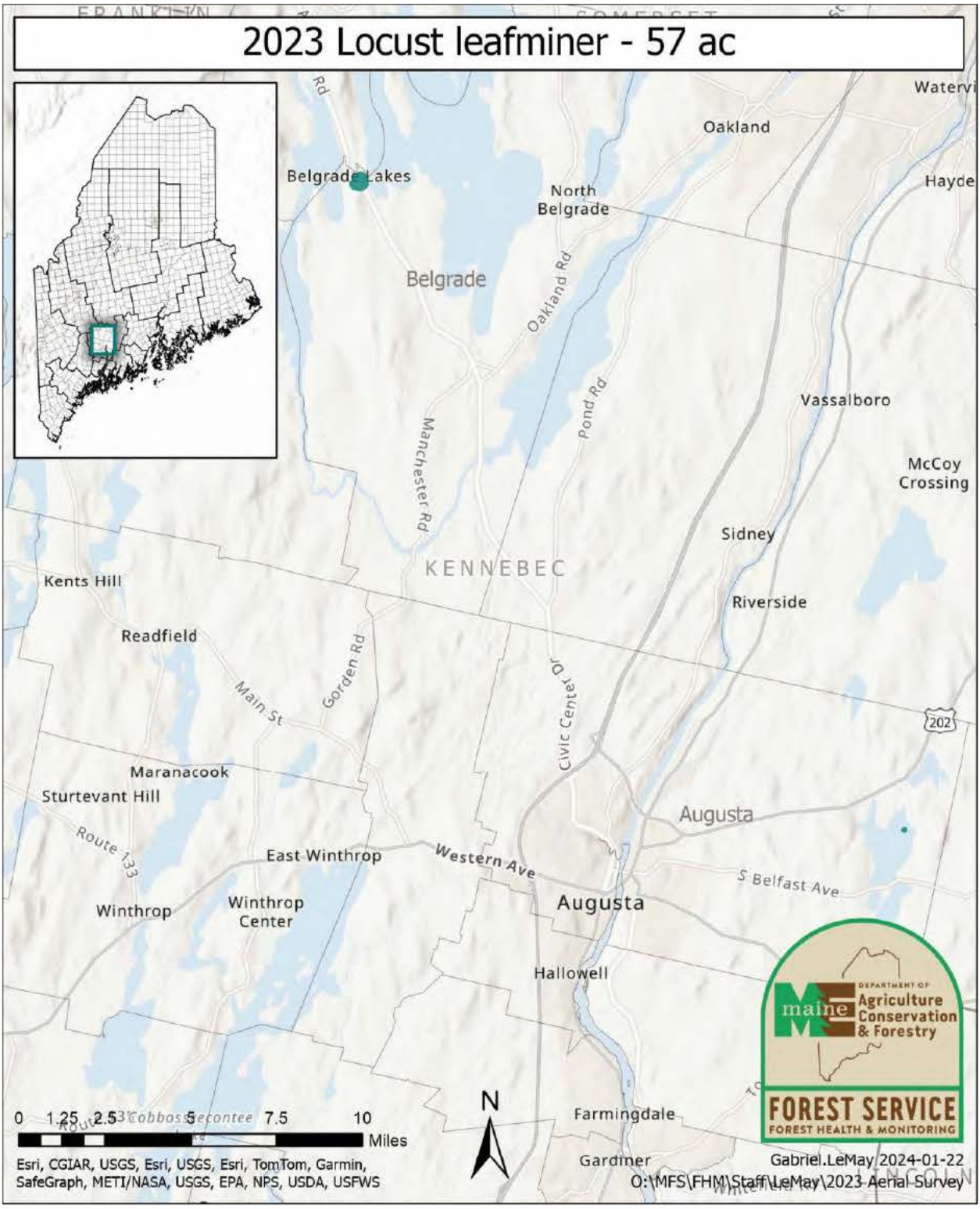


Figure 31: Aerial survey map of damage caused by locust leafminer.

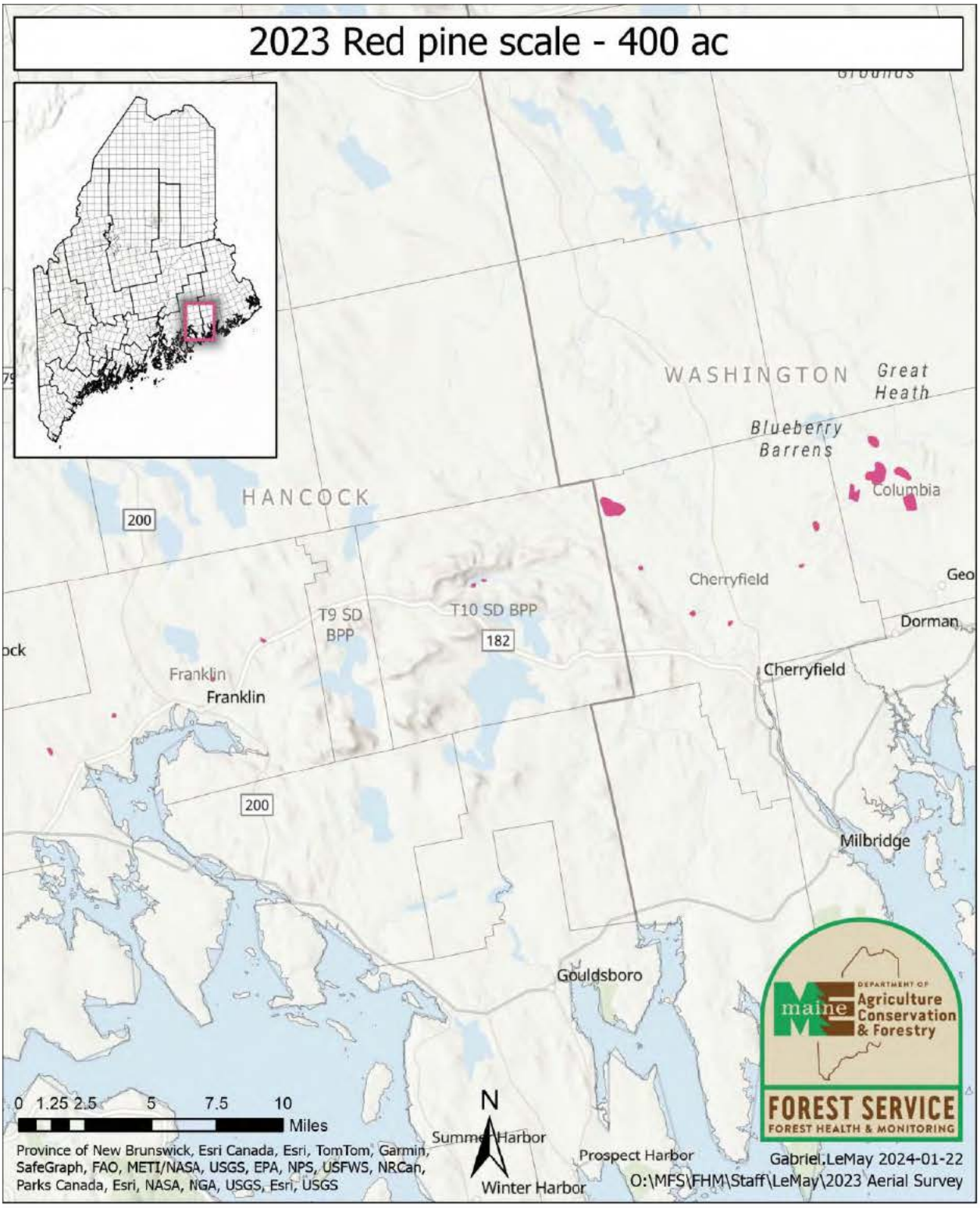


Figure 32: Aerial survey map of damage caused by red pine scale.

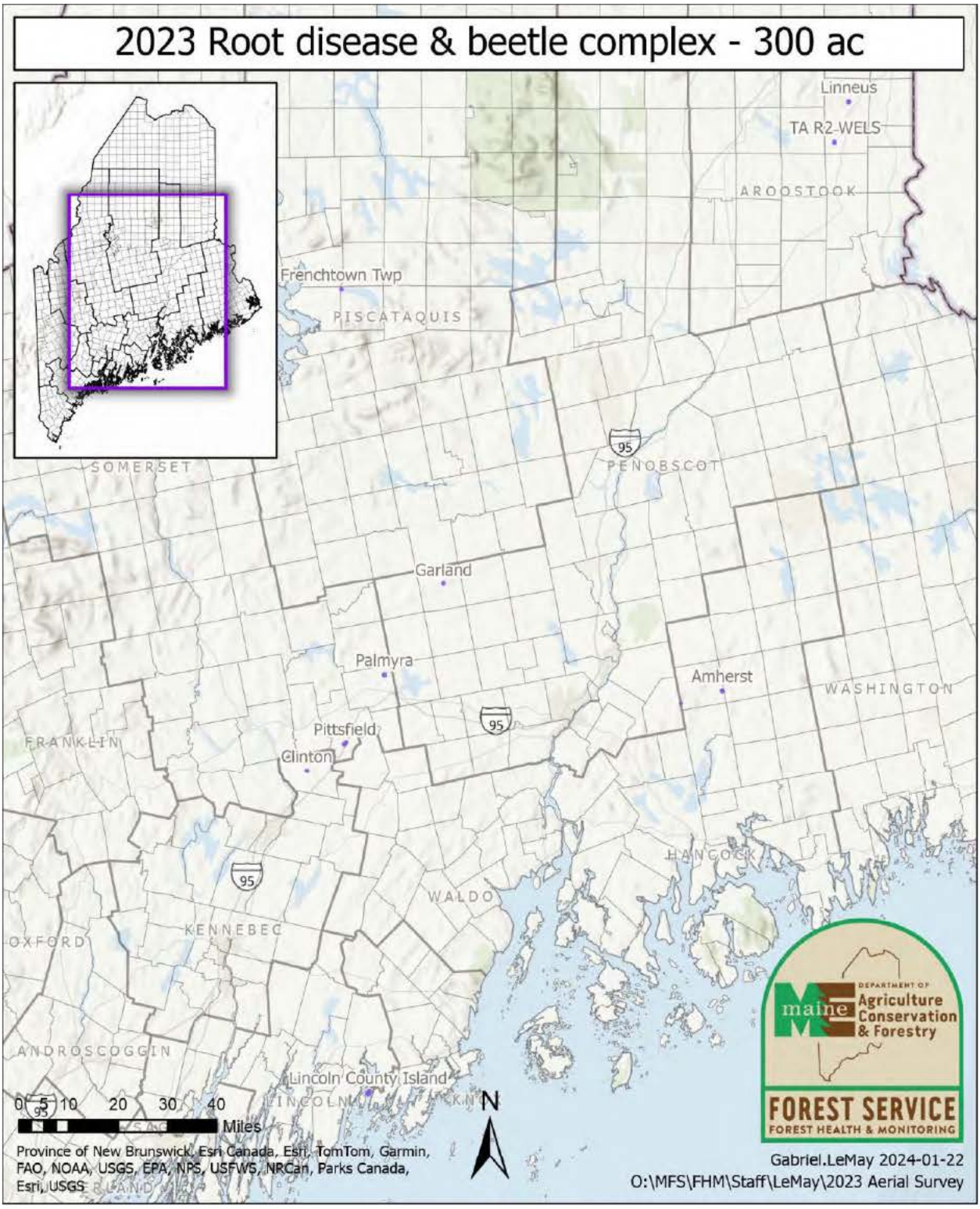


Figure 33: Aerial survey map of damage caused by root disease and beetle complex.

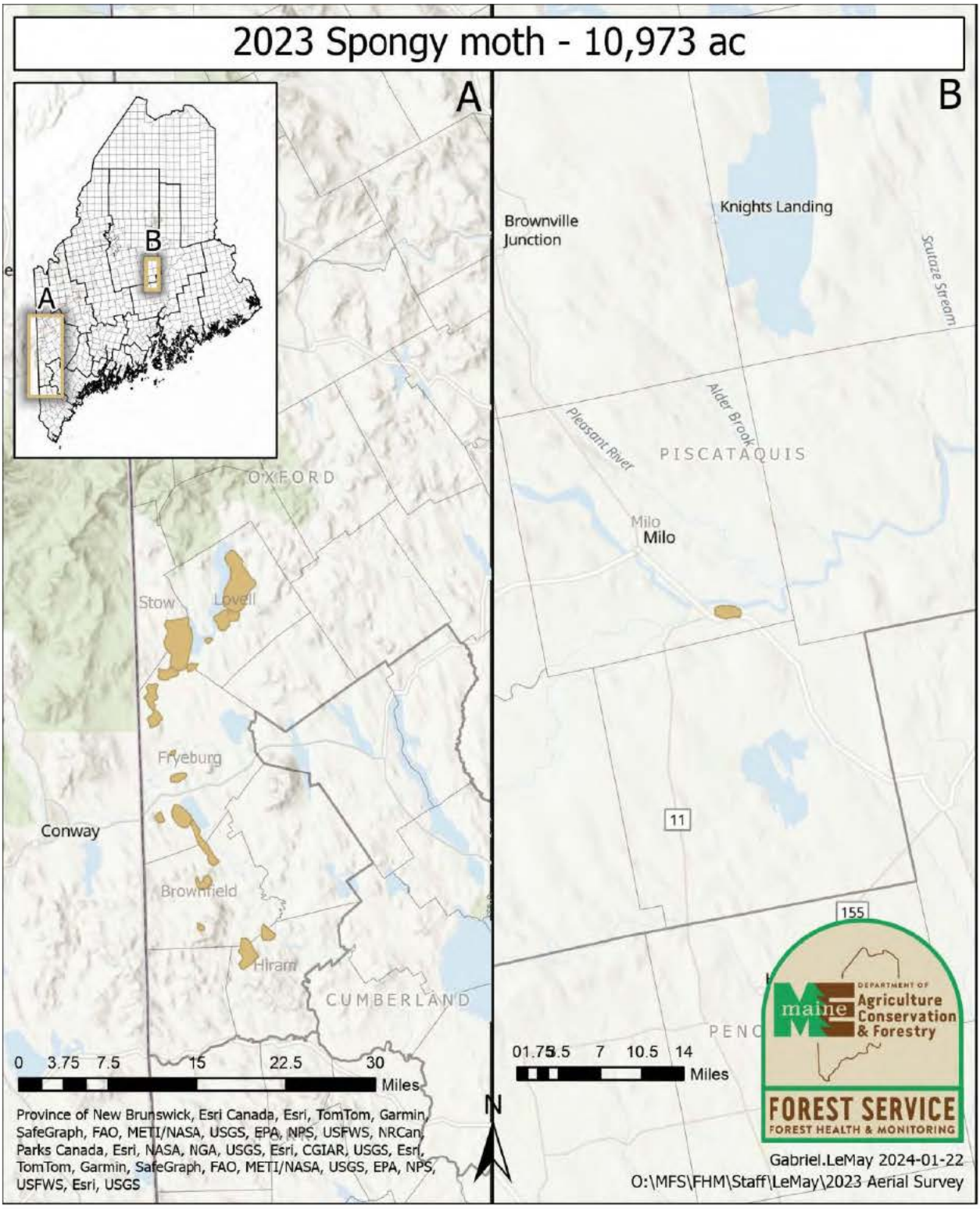


Figure 34: Aerial survey map of damage caused by spongy moth.

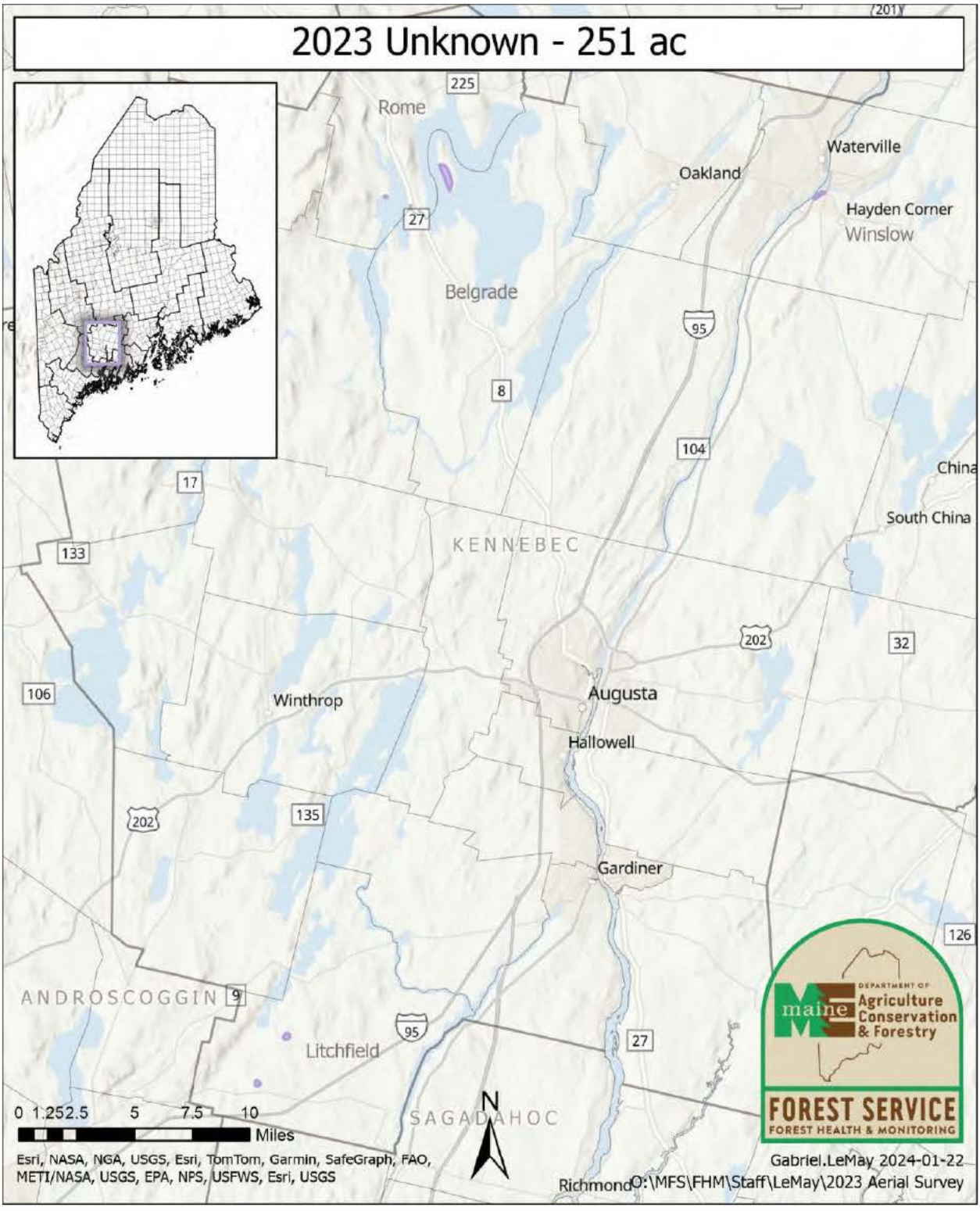


Figure 35: Aerial survey map of damage caused by an unknown source.

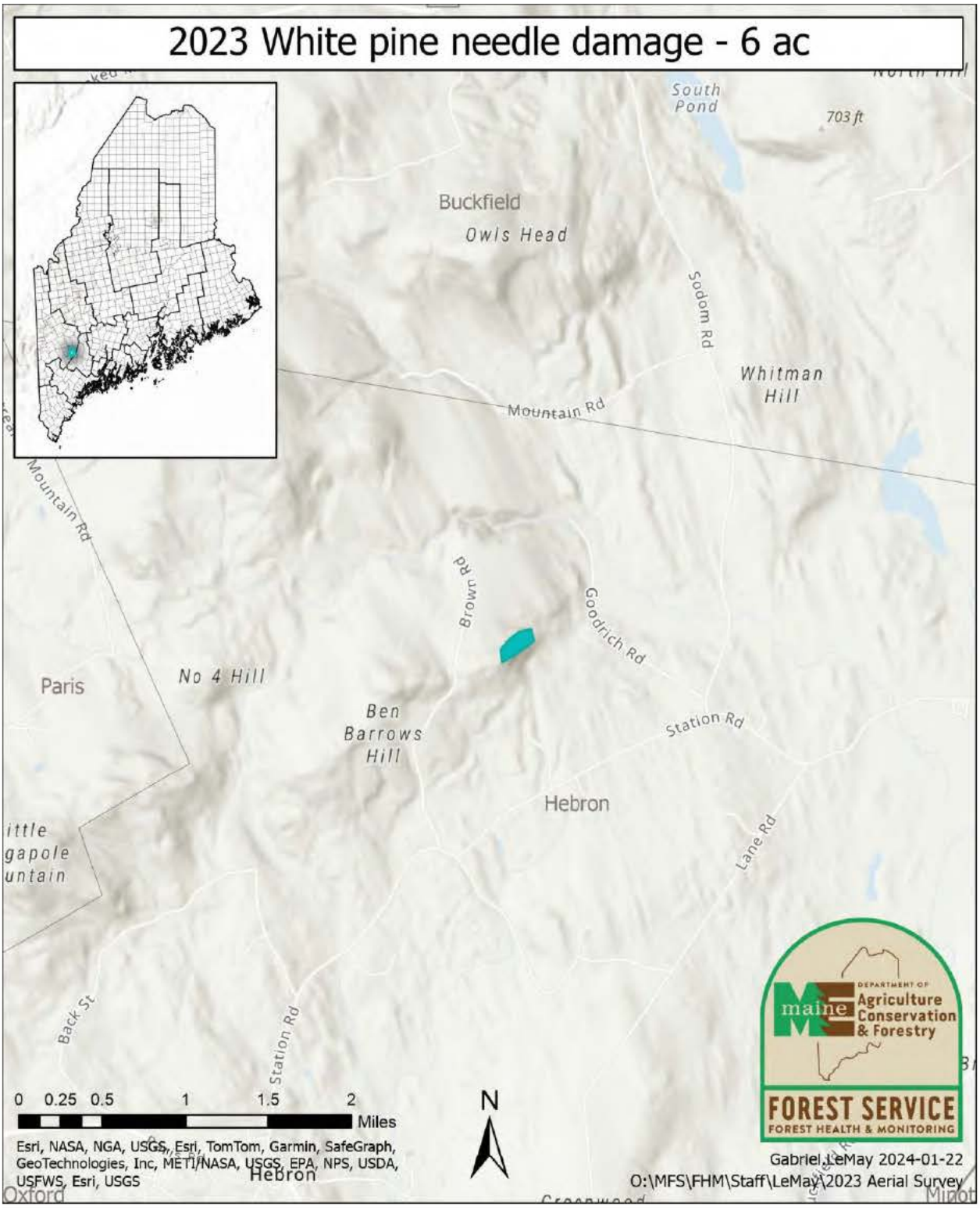


Figure 36: Aerial survey map of damage caused by white pine needle damage.

Figure 37: Aerial survey map of damage caused by wind, tornado, and hurricane events.

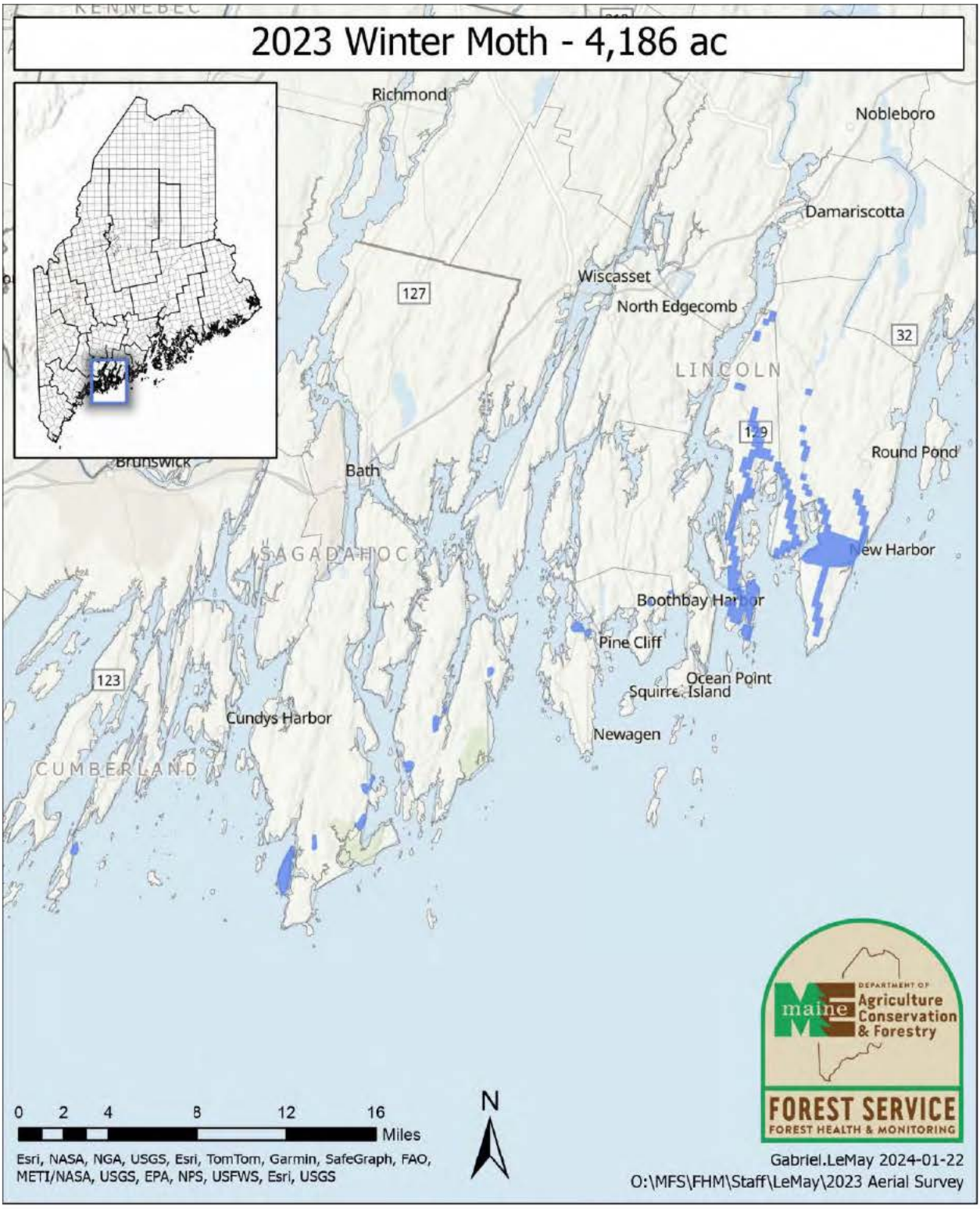


Figure 38: Aerial survey map of damage caused by winter moth.

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List of Abbreviations

ALB: Asian longhorned beetle
APHIS: Animal and Plant Health Inspection Service
BLD: Beech leaf disease
EAB: Emerald ash borer
BWA: Balsam woolly adelgid
DACF: Department of Agriculture, Conservation, and Forestry
DED: Dutch elm disease

EHS: Elongate hemlock scale
EIS: Early intervention strategy
ELC: European larch canker
EWBB: Exotic woodborers and bark beetles
FHM: Forest Health and Monitoring
FIA: Forest Inventory Analysis
HWA: Hemlock woolly adelgid
L2: Refers to second instar spruce budworm larvae
MFS: Maine Forest Service
SBW: Spruce budworm
SLF: Spotted lanternfly
SPB: Southern pine beetle
TNC: The Nature Conservancy
USDA: United States Department of Agriculture
USDA-APHIS-PPQ: US Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine
WMA: Wildlife Management Area
WPBR: White pine blister rust
WPND: White pine needle diseases