

Maine: Forest Health Conditions Highlights in 2019

Report to the USDA Forest Service



December 2, 2019
Forest Resource Summary

With an estimated 17.6 million acres of forest land covering 89.1 percent of the land area, Maine boasts the highest percentage of forest cover of any state. Some 95.3 percent of the forest land is classified as timberland, meaning that it exceeds a minimum level of productivity and is not legislatively reserved from timber harvesting. An estimated 23.9 billion live trees ≥ 1 in DBH grow in the forests of Maine, amounting to a total above ground biomass of 713.8 million tons and a total net volume of 27.3 billion ft^3 when considering all trees ≥ 5 in DBH.

Maine's forest land area has changed little since 2012. An estimated 89.1 percent of the forest land is privately owned, 9.6 percent is publicly owned, and the remainder is owned by Native American tribes. The most common forest-type group is maple/beech/birch, representing 41.3 percent of Maine's forest land area, followed by the spruce/fir and white/red/jack pine cover types.

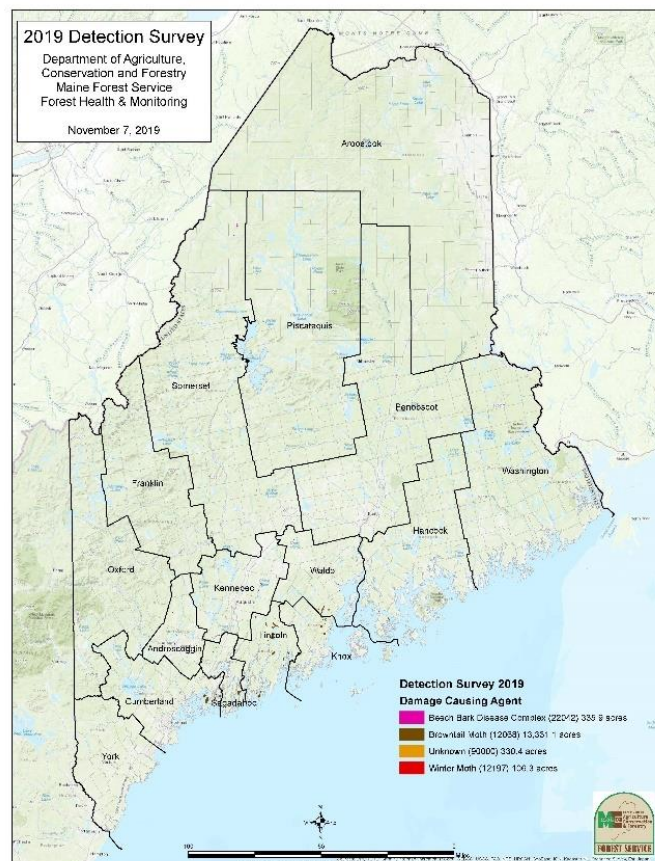
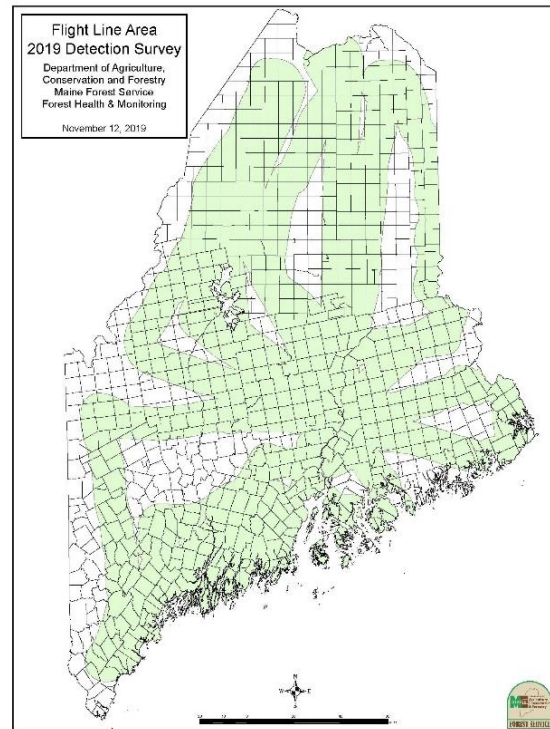
Maine's forests contain a wide variety of tree species and over 55 species were documented during 2017 sampling. In terms of volume, red spruce is the most common tree in Maine, followed by red maple and eastern white pine. Balsam fir, northern red oak, and eastern white pine have shown the most substantial increases in volume since 2012. In terms of number of trees, balsam fir is the most numerous species in Maine with 36.0 percent of the tree stems in the State. Other common species include red maple, red spruce, American beech, and paper birch.

Adapted from Butler, Brett J. 2018. Forests of Maine, 2017. Resource Update FS-160. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 3 p. <https://doi.org/10.2737/FS-RU-160>.

Aerial Survey

Aerial detection surveys were flown over approximately 16.5 million acres in Maine in 2019. Total acres of documented damage dropped dramatically from 144,980 acres in 2018 to just 14,104 acres in 2019. By far the biggest driver of this decrease was browntail moth. Two separate survey missions targeting browntail moth defoliation were flown in late spring and fall of 2018, yielding a total of 202,350 acres of damage. Of this, 76,300 acres were recorded during the active feeding period of large larvae in late spring, and the remaining 126,050 acres were recorded in the fall as young larvae skeletonize leaves prior to winter web construction (Note: Sum of acres for BTM flights is greater than annual total due to overlap in spring and fall BTM damage areas not counted towards annual total). Given difficulties with performing aerial survey as planned in 2019, such as weather and lack of airplane availability, we believe that the number of acres recorded for browntail moth in 2019 (13,331 acres) might be a substantial underestimate. Other notable aerial survey detections in 2019 include damage from beech bark disease complex and winter moth. We are pleased at the low number of winter moth acres recorded given the progress made with our winter moth biological control program.

(ABOVE) 2019 AERIAL SURVEY COVERAGE MAP FOR MAINE.
(BELOW) 2019 AERIAL SURVEY DAMAGE AREAS MAP FOR MAINE.



Insects

Anoplophora macularia

In spring 2019, a specimen of an unknown longhorned beetle was brought to the attention of the Maine Forest Service (MFS). The pinned specimen was in the collection of an amateur



ANOPLOPHORA MACULARIA SPECIMEN
REPORTED FROM NORTH BERWICK, ME.

collector and while displaying this collection at a public event, someone mentioned the striking resemblance of this specimen to Asian longhorned beetle (ALB). Upon learning that ALB was not yet known to be established in Maine, the collector contacted the State Survey Coordinator at the Maine Department of Agriculture, Conservation and Forestry (DACF) Horticulture Program.

Unfortunately, the specimen lacked standard collection data. However, the submitter reported that the specimen had been collected in North Berwick, Maine between two and five years ago.

After examination by USDA Animal and Plant Health Inspection Service (APHIS) and *Anoplophora* experts, the specimen was determined to be *Anoplophora macularia*, a close relative of ALB. There is very little information available about this species and to our knowledge it has never been previously intercepted in the United States. As a follow up, a multiagency team from DACF MFS and Horticulture and USDA APHIS and Forest Service performed intensive ground surveys and conducted a trapping program in nearby forested, nursery, and industrial areas. No additional specimens or damage directly attributable to *A. macularia* have been found to-date. We will continue our survey efforts for this species in the coming years to determine if there is an established population of wild beetles or whether this might be an isolated incident.

Browntail Moth (*Euproctis chrysorrhoea*)

As predicted by the high numbers of browntail moth (BTM) winter webs recorded from our winter web surveys during winter 2018-2019, some areas of the Midcoast and Downeast regions of Maine experienced severe defoliation from BTM during spring/summer 2019. Towards the end of June, several aerial survey flights were made to map defoliation in the Midcoast and Downeast regions of Maine and approximately 13,000 acres of defoliation damage were documented. Actual acreage of defoliation may have been significantly higher

because weather and aircraft availability prevented adequate coverage of the affected area during the most critical times.

Portions of Cumberland, Knox, Lincoln, and Waldo counties were particularly hard hit. Once our web surveys for winter 2019-2020 have been completed, we will have a better idea of which areas of Maine are likely to experience elevated population levels in 2020. So far, BTM hibernacula have been found in 12 of Maine's 16 counties. In other monitoring news, only five moths were collected from light traps at four sites throughout the state in July. Although this number seems extremely low, it should be noted that light trap operations have ceased at some locations that have captured high numbers of moths in previous years.



A BROWNTAIL MOTH LARVA INFECTED WITH THE *ENTOMOPHAGA AULICAE* PATHOGEN.

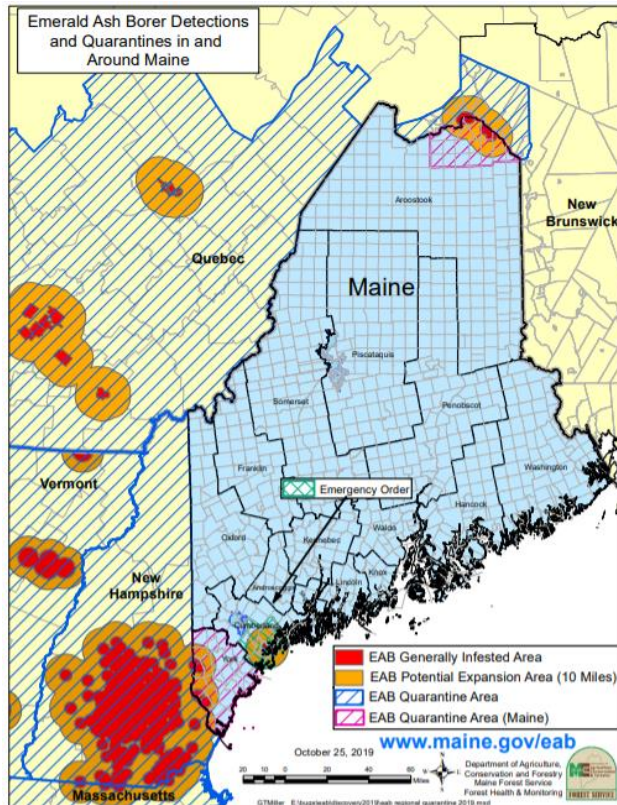
Once again, hundreds of phone calls came in from people affected by BTM rash or concerned about the health of their trees. Together with the Maine Center for Disease Control, we contracted with 211 this year to help better inform citizens about BTM. The 211-hotline fielded 1,056 calls, 97 texts, and 131 emails related to browntail moth. Additionally, MFS received over 500 direct inquiries regarding BTM. Over 1,000 people have attended 20 BTM information sessions provided by the Maine Forest Service as of November 2019. Between April and September, 153 people used our online survey to report BTM. The Maine Forest Service provided technical advice to towns considering some type of control action and reached out to schools in all affected towns through collaboration with the risk management organization.

We have some good news from the field. There were localized collapses of browntail moth in several areas due to the fungus *Entomophaga aulicae* and possibly other pathogens. These fungal outbreaks were brought on by the wet spring conditions we had this past spring/early summer. The Maine Forest Service collaborated with University of Maine to characterize these outbreaks and tease apart what species the pathogen community surrounding BTM is comprised of. During the project we monitored various BTM populations into late June/early July to assess incidence of disease. Localized population collapses occurred in parts of Cumberland County (Brunswick, Falmouth, Harpswell, Yarmouth), Knox County (Camden), Lincoln County (Bristol, Jefferson, Whitefield, Wiscasset) and Sagadahoc County (Arroswic,

Bowdoinham). Although we're not likely to see a statewide population collapse of browntail moth, at a minimum some areas will experience temporary relief from exposure to the caterpillars' hairs.

Emerald Ash Borer (*Agrilus planipennis*)

Emerald ash borer (EAB) was first found in Aroostook County (Madawaska, Frenchville, and Grand Isle), and York County (Acton, Berwick, and Lebanon), ME in 2018. In October 2019 it was



MAP DETAILING THE CURRENT AREAS OF MAINE REGULATED FOR EMERALD ASH BORER, FIND UPDATES AT WWW.MAINE.GOV/EAB.

detected in Cumberland County (Portland). The EAB-infested areas in Aroostook and York counties fall under the jurisdiction of state and federal EAB quarantines. The infested area in Cumberland County is under jurisdiction of a Maine Forest Service issued emergency order.

The vast majority of land area in Maine is still EAB-free and Maine is the last remaining state in New England that does not fall entirely under the jurisdiction of the federal EAB quarantine. In an effort to curtail the spread of this invasive forest pest, Maine continues to survey for the spread of existing populations and new establishments, enforce quarantine regulations, and perform biological control releases to aid in management efforts on the landscape wherever possible.

The use of girdled trap trees is a proven method for EAB detection and Maine uses a network of volunteers to assist in this survey effort. A total of 45 girdled trap trees deployed in the spring of 2018 were processed last fall, revealing no evidence of EAB beyond the known infested area at that time. This information was used to inform the first proposed quarantine boundaries, consisting of the entire county of York in southwestern Maine and 18 towns in northeastern Aroostook county in northern Maine.

In the spring of 2019, over 200 purple prism traps and several green funnel traps were placed throughout the state. They were inspected mid-season and when traps were removed in the fall, a single adult EAB was discovered on one of the prism traps placed high in the canopy of an urban ash tree by our cooperators in the City of Portland in Cumberland County. A Maine

Forest Service Emergency Order restricting the movement of ash products in thirteen towns in Cumberland County was immediately put into place on October 2019 and remains active.

Much like in 2018, a new set of ash trees were girdled in spring 2019 and were peeled in late fall. However results were much different in 2019. In York County, evidence of EAB was easily detected in peeled ash sections from the towns of Acton, Berwick, and Lebanon, where EAB was known to exist but difficult to find in the field. Infested bolts revealed EAB in three new towns in York County: Alfred, Kittery, and Limington. The number of positive sites and larval densities within trees came as a surprise, since infested trees showed no evidence of the woodpecker feeding we've come to rely on as a detection tool.



AN EMERALD ASH BORER GALLERY IS REVEALED WHILE PEELING GIRDLED TRAP TREES.

Fortunately, these new detections still fall within the area already subject to federal quarantine rules. This does suggest EAB is quickly becoming well-established within the

quarantine boundaries. Girdled trap trees from sites in Aroostook County surrounding the known infested area of Madawaska were all negative in 2019. There is one more tree peeling event scheduled in early December which will focus on girdled trap trees from outside the areas currently regulated for EAB.

Also in 2019, Maine's biological control campaign for EAB was launched. After suitable sites for parasitoid release were identified in Aroostook County, just under 20,000 parasitoids (*Tetrastichus planipennisi*, *Spathius gallinae* and *Oobius agrili*) were released at two sites throughout the summer. No suitable release sites were identified in York County in 2019, owing to the difficulty in locating forested areas within the urban interface large enough and in close enough proximity to known infested trees there. With the new information from girdled trap trees, we are optimistic about locating suitable biological control release sites for 2020 in York County. We expect to have biological controls efforts underway at both northern and southern infested zones in 2020.

Spruce Budworm (*Choristoneura fumiferana*)

Although many forest health activities are now aimed at combatting invasive forest pests, there's still one native forest pest that looms particularly large in the minds of those who rely on the northern forests of Maine for their livelihoods – spruce budworm (SBW). The MFS and partners have been closely monitoring this periodic major pest of fir and for decades using

methods such as light traps, pheromone traps, and branch sampling for overwintering second instar larvae (L2).

Adult SBW moths caught in light traps statewide climbed to 502 in 2019, compared to just 202 in 2018. As expected, the clear majority of moths were recovered from just four sites in Aroostook County (135 in Garfield, 127 in Crystal, 82 in St. Pamphile (T15 R15 WELS) and 27 in New Sweden). We would have also expected a large number of moths from our light trap in Big Twenty Township, however this trap was not operated in 2019. Interestingly, we also recovered several moths from light traps in places we would not usually expect to encounter SBW. Light traps are monitored daily, so we know that all these catches occurred within a few days of July 20th. Thanks to detailed flight models from the Canadian Forest Service and other partners, we were able to link these catches to a massive inflight of SBW moths that migrated south into Maine from the Canadian outbreak on this date.

What began as a small-scale MFS project with just a few dozen sites pheromone trap sites has ballooned in recent years to include a dedicated group of cooperators that now help monitor over 400 trap sites throughout the forests of the northern Maine. At present, about one third of all pheromone trap samples for 2019 have been processed in the entomology lab in Augusta. Based on this preliminary sample (133 sites), catches are averaging 49 moths per trap. Catches are highly variable however and range from zero to a maximum of 534 moths/trap. As expected, the highest catches have been found in northeastern Aroostook County, but many samples from that region remain to be counted. Overall, pheromone trap catches from more than 250 sites remain to be counted.



THE SORTED CONTENTS OF A SPRUCE BUDWORM PHEROMONE TRAP COLLECTED IN NORTHERN MAINE.

In response to defoliation in both Quebec and New Brunswick near the Maine border, an ongoing defoliation survey began in 2017 using the Fettes Method. Defoliation by all causes is captured using this approach. However, a trained observer can also recognize characteristics that point towards spruce budworm-related defoliation such as feeding on only the inside edges of two adjacent shoots (indicating the shoots may have been tied together during the growing season) and damage consistent with nipping of the twig at the bud end of the shoots. Using the Fettes protocol, defoliation is characterized as trace (0-5%), low (6-20%), moderate (21-50%), high (51-80%), or severe (81-100%).

Defoliation from all causes in 2017 was characterized as trace for all 30 sites evaluated. In 2018 the Cooperative Forest Research Unit (CFRU) incorporated the measure on all branch samples collected for L2 survey. Defoliation data was collected for 315 sites in 2018 and showed a marked increase in activity. Of these, 215 were characterized as trace, 67 as low, 31 as moderate, and two as high. No sites were characterized as severe. Samples from 2019 are currently being processed at University of Maine campuses in Fort Kent and Orono but results from 2019 are not yet available.

Our partners at The University of Maine Cooperative Forestry Research Unit have also headed up an L2 sample program in conjunction with the Canadian Forest Service since 2014. Branch samples (one branch from each of 3 trees per site) are taken during the fall and winter in areas where pheromone trap catches had been high or modeling has predicted at-risk stands. Winter 2019–2020 samples are still being collected and will then be sent to the Canadian Forest Service’s lab in Fredericton, NB for processing. In the winter 2018–2019 survey, only 26 overwintering larvae (L2) were detected from just 18 of 290 sites, with a maximum of 1.3 larvae per branch recovered. For reference, Atlantic Canada is in the midst of evaluating an Early Intervention Strategy to manage spruce budworm. If eight larvae/branch are detected, then further sampling is initiated to determine if treatment is justified. More on their program is available at www.healthyforestpartnership.ca.

The last time SBW was a problem in Maine was in the 1970’s and 1980’s and the effects of this outbreak were devastating. We know that outbreaks occur on roughly a 40-year cycle and SBW populations in Maine have now clearly left the “stable” phase on an upwards trajectory. This native defoliator of balsam fir and spruce has been defoliating trees in Quebec north of the Saint Lawrence Seaway for more than 10 years. Defoliation, which has spread to the south shore and into New Brunswick, currently covers more than 20 million acres. Maine has been spared so far, however, this might be changing rapidly in the upcoming years. More about spruce budworm in Maine can be found at www.sprucebudwormmaine.org.

Winter Moth (*Operophtera brumata*) The MFS continued survey for winter moth males using pheromone traps in December 2018 to determine where winter moth populations were heaviest and to delineate the outer boundaries of the core affected area. The survey covered coastal portions of York, Cumberland, Sagadahoc, Lincoln, Knox, Waldo counties and parts of Hancock, Androscoggin, and Kennebec counties. Traps were also deployed along a transect



WINTER MOTH LARVAE COLLECTED IN SOUTHERN MAINE TO BE REARED TO THE PUPAL STAGE AND EVALUATED FOR PARASITISM BY *CYZENIS ALBICANS*.

inland from known infested areas. These traps captured 5,005 winter moths in total. The towns with a notably high trap catch in 2019 included Kittery (2,311) and Eliot (888) in York County, Thomaston (560) in Knox County, and Cape Elizabeth (225) in Cumberland County. Despite apparently high recovery of moths, these trap catches are substantially down compared to 2018.

Aerial survey for winter moth damage in spring 2019 mapped 106.3 acres of defoliation, with the heaviest defoliation occurring in Boothbay Harbor. Again, this low acreage mapped partially reflects the fact that survey flights were limited in spring 2019 due to weather and availability of aircraft. On the ground, reports of moth observations were solicited from the public using a Survey Monkey form; 49 reports were received through this method in addition to over 100 calls/emails to the office.

On the biological control front, five hundred cocoons of the parasitic fly, *Cyzenis albicans*, were set out in Boothbay Harbor (Lincoln County) in October 2019. They will remain in in the soil beneath protective cages until emerging naturally and dispersing in the spring. This is the eighth location in Maine to receive the parasitoids from the University of Massachusetts (UMASS) with funding from the USDA. Preliminary data provided by UMASS from collections of winter moth caterpillars in Maine this spring indicate the following levels of parasitism at previous release sites: 27.4 percent at Two Lights State Park (Cumberland County), 16.3 percent at Fort McClary State Park (York County) and 4.7 percent at a site in South Portland (Cumberland County). The early results from the South Portland site are very promising considering the release occurred just two years prior.

Diseases

White Pine Health

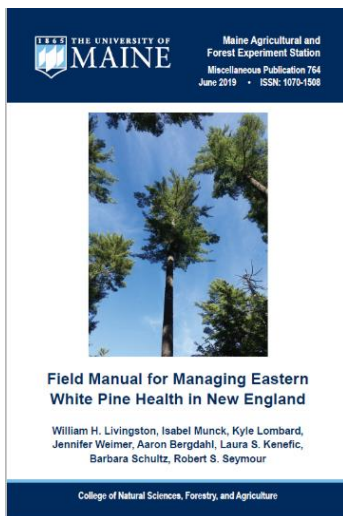
The white pine needle diseases (WPND) complex (*Mycosphaerella dearnessii* (= *Lecanosticta acicola*), *Lophophacidium dooksii* (= *Canavirgella banfieldii*), and *Bifusella linearis*) has been impacting white pine trees for what is believed to be 10 consecutive years. Each year, WPND has continued to result in extensive pre-mature needle shedding, typically in late May through

early July, wherever white pines grow in Maine. The needle diseases remained widespread in 2019, but were most severe throughout central, western, and southern Maine. The high prevalence of WPND is driven by prolonged periods of high moisture in the spring when the diseases spread. The unusually wet spring weather that had prevailed over the past decade has resulted in high defoliation of white pines, representing a chronic stress to the trees. This stress can lead to further tree health issues and in some cases even mortality.



(LEFT) A HEALTHY WHITE PINE TREE WITH A FULL CROWN; (MIDDLE) A TREE WITH ORANGE NEEDLES INFECTED WITH WPND THAT WILL BE SHED PREMATURELY IN EARLY SUMMER; (RIGHT) THE VIEW FROM THE UNDERSTORY OF A WHITE PINE FOREST SEVERELY IMPACTED BY WPND SHOWING THIN AND SMALL CROWNS.

The frequency of a seemingly stress-related canker-causing fungal pathogen, *Caliciopsis* canker of white pine (*Caliciopsis pinea*), has been on the rise in past years and was commonly seen in 2019. During visits to white pine stands in this field season, *Caliciopsis* canker was seen affecting the health of codominant white pine trees and seems to be responsible for mortality among white pine seedlings and saplings in the understory of affected stands. Similarly, the *Armillaria* root rot disease (*Armillaria* spp.) attacks stressed trees and is of concern given the widespread stress to white pine due to several years of severe WPND in Maine. *Armillaria* root rot was seen in several areas in Maine in 2019 parasitizing stressed white pine trees. The fungus appears to be a significant factor causing tree mortality in compromised trees of several species.



This series of interrelated disease problems impacting Maine’s white pine resource led to the completion of a regional effort to create a publication related to white pine health. The manual, titled, ‘Field Manual for Managing Eastern White Pine Health in New England’ (pictured here), was produced by cooperators from the Maine Forest Service, University of Maine, USDA Forest Service Northern Research Station and Northeastern Area State and Private Forestry, New Hampshire Division of Forests and Lands and Vermont Department of Forests, Parks and Recreation. The guide provides readers guidance for identifying and evaluating important health problems of eastern white pine in New England and helps land managers justify forest management practices.

Red Pine Decline

Infection of red pines by *Sirococcus* shoot blight (*Sirococcus conigenus*) and *Diplodia* tip blight (*Diplodia sapinea*) has become increasingly common throughout Maine and other New England states over the past decade.

Many red pine plantations were established in Maine and northern New England after harvesting spruce and fir stands damaged by the spruce budworm during the 1970's and 1980's. These plantations are now showing a high susceptibility to injury and mortality from *Sirococcus* shoot blight. The disease is also found in native red pine stands.

Infection potential is largely driven by conducive weather conditions of cool, wet springs and summers; conditions which have been common in most of the Northeast for the past decade. The favorable weather conditions and the concentration of suitable host material, especially in plantations, can result in a rapid build-up of the diseases and infection potential. Growth reduction results from chronic infection and in some cases tree mortality can occur after several years of high disease incidence and severity. Spread within an infected plantation can develop rapidly.

Red pine shoot and tip blights remained a significant threat to red pine in native and especially planted stands throughout Maine in 2019. In response to questions by industry and the general public about the health of red pine, a survey of red pine stands was initiated in 2019, with over 20 plantings and 500 trees evaluated. *Diplodia* tip blight was recorded at nearly all sites, while *Sirococcus* shoot blight was present at fewer sites. Most often, the diseases were found in combination, and in several cases represented serious stand health impacts. Heavy infection levels were observed in red pine plantings in Androscoggin, Aroostook, Cumberland, Kennebec, Lincoln, Oxford, Penobscot, Sagadahoc, Somerset, and York counties. The survey is planned to continue in 2020 to better understand the distribution and severity of disease impacting red pine resources.



(ABOVE) A HEALTHY RED PINE STAND WITH TREES HAVING FULL LIVING CROWNS AND (BELOW) A RED PINE STAND IMPACTED BY DIPLODIA TIP BLIGHT AND SIROCOCCUS SHOOT BLIGHT DISEASES SHOWING MANY DEAD BRANCHES IN THE LOWER PORTIONS OF THE CROWN.

Oak Wilt (*Bretziella fagacearum*)

Oak wilt is not currently found in Maine but is found in the Northeast in New York State. Oak wilt primarily kills red oaks and can do so quickly. White oaks are also affected but compared to red oak, their decline and mortality is measured in years instead of months. Oak wilt disease presents a significant threat to Maine's oak resource should it be transported here.

To better prepare Maine for detecting and eventually managing oak wilt disease, two professionals from the Maine Forest Service Insect and Disease Lab attended a three-day oak wilt workshop hosted by the USDA Forest Service (USFS) in Minnesota and Wisconsin. Attendance was made possible by a USFS grant to the Forest Health Working Team of the Northeastern Forest Fire Protection Compact.



(LEFT) AN OAK SAPLING IN MINNESOTA INFECTED WITH OAK WILT SHOWING LEAF SYMPTOMS TYPICAL OF THE OAK WILT DISEASE (RIGHT) A MATURE OAK TREE KILLED WITHIN A MONTH OF THE FIRST ONSET OF OAK WILT SYMPTOMS. NEXT TO THE TREE IS A VIBRATORY PLOW THAT SEVERS ROOT CONNECTIONS BETWEEN NEIGHBORING OAK TREES TO PREVENT UNDERGROUND SPREAD OF THE DISEASE.

The intensive field session included demonstrations of identification of oak wilt in the field, proper sample collection for lab identification, and multiple management techniques. This was highly instructive, and lessons learned at the workshop were shared within the Maine Forest Service and with other agencies in the state.

Various survey efforts aimed at early detection began in 2019 with visual surveys of urban forests in Cumberland, Kennebec, and Waldo counties. Survey efforts will continue in 2020 as part of an emerging pest grant from the USFS. The Maine Forest Service's efforts to educate the public and industries about oak wilt will continue in 2020 and beyond.

This summary was produced for USDA Forest Service reporting. Information about forest health conditions in Maine is also provided in the Maine Forest Service, Forest Health and Monitoring Division's Insect and Disease Conditions Updates and Annual Summary Report. Subscription information is available here: https://www.maine.gov/dacf/mfs/publications/condition_reports.html.

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