Eastern White Pine Needle Damage Survey, 2011

In Maine, New Hampshire, and Vermont

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Abstract

White pine needle damage is a current concern in New England and eastern Canada where *Pinus strobus* is of great historic, ecological, and economic importance. State natural resource agencies received hundreds of calls from concerned citizens during 2010 when damage was particularly severe following a very wet spring. Foliar damage was attributed to a needle cast (*Canavirgella banfieldii*) and brown spot needle blight (*Mycosphaerella dearnessii,* anamorph *Lecanosticta acicola*). Both of these fungi cause similar symptoms, thus complicating diagnoses. In 2011, the USDA Forest Service coordinated a survey with Forest Health State Cooperators from Maine, New Hampshire, and Vermont to investigate the cause of the needle damage. Sixty trees from 13 sites with foliar damage the prior year were sampled from April to June by FH State Cooperators and then diagnosed at the USFS Northeastern Area Durham Field Office. The needles were found to be infected with *M. dearnessii* and *C. banfieldii*, and another needle cast causing pathogen, *Bifusella linearis*. At one location these three pathogens were all present and at another site more than one pathogen was found infecting the same tree. Long, dark hysterothecia fruiting bodies formed by *B. linearis* and *C. banfieldii*, along with browning of the distal parts of the needles, were present in samples collected in May. *Mycosphaerella dearnessii* was the most frequently observed and widely distributed pathogen, also the most consistently associated with chlorosis and defoliation in early July. White pine needle damage will likely remain a problem in years with wet springs which favors development of the fungi.

Introduction

During the summer 2010, white pine needle damage was observed frequently throughout New England generating much public concern. Symptoms consisted of yellow (Figure1A) and brown (Figure 1B) discoloration of one-year old needles (Figure 2A). Affected needles dropped causing tree crowns to look thin a year after initial infection (Figure 2B). Needles of both mature trees and regeneration were damaged.

White pine foliar damage has been attributed to frost and two foliar diseases, brown spot needle blight caused by the fungus *M. dearnessii* and Canavirgella needle cast caused by *C. banfieldii*. Diagnosing the damage agent is difficult because both fungi cause similar symptoms, although they can be differentiated by their fruiting bodies produced at different times in the growing season. The sexual fruiting structures of *C. banfieldii* are produced through the winter and are visible earlier in the spring, whereas *M. dearnessii* fruits in June (Merrill et al. 1996, Sinclair and Lyon 2005). Consequently, *C. banfieldii* fruiting bodies could be present in infected needles by April and fruiting bodies of both *C. banfieldii* and *M. dearnesii* could be present by June.

White pine foliar damage was mapped during 2010 aerial forest health detection surveys in New England. In Maine alone 60,116 acres were reported damaged (Figure 3). Because several fungi and frost were associated with the foliar damage, coding the damage consistently during the aerial surveys was challenging. There was a need to understand the extent of the damage that could be directly related to foliar pathogens. Consequently, the objective of this study was to determine the causal agent of the observed white pine needle damage.

Figure 1. Eastern white pines exhibiting symptoms of foliar damage: chlorosis (A), and necrosis (B).

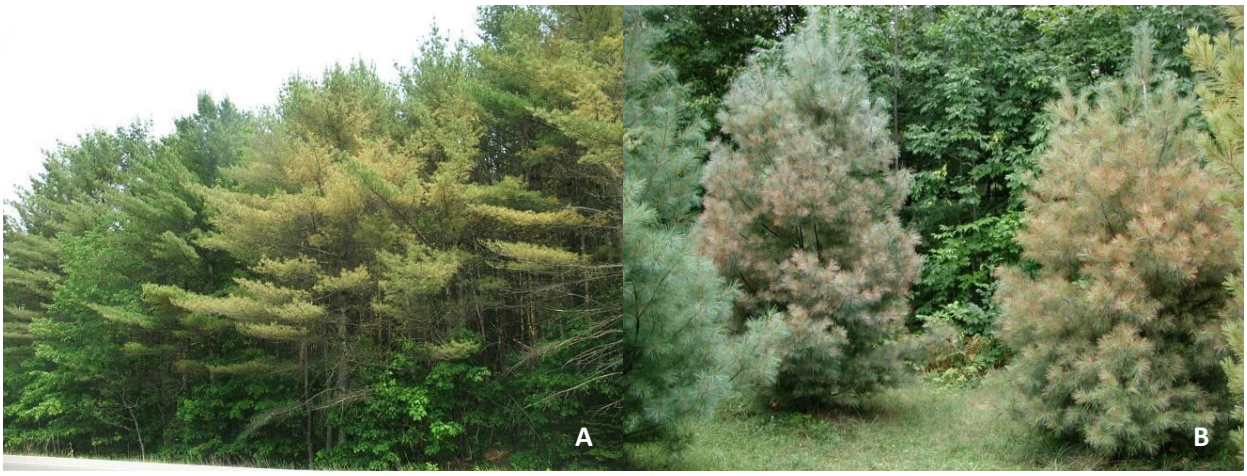
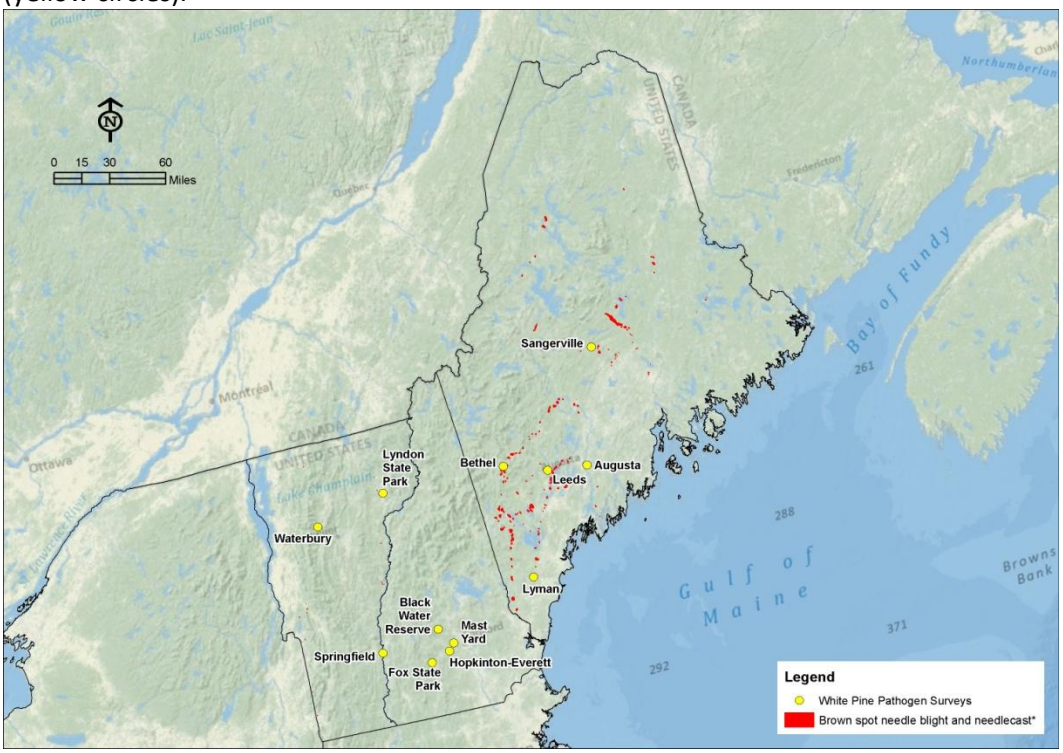


Figure 2. One-year-old needles of diseased white pines appeared chlorotic and necrotic in early summer (A), and then dropped by early July (B).

Figure 3. Map of white pine foliar damage detected during aerial detection surveys (red), and 13 sites sampled by State Forest Health Cooperators from Maine, New Hampshire, and Vermont during 2011 (yellow circles).



Methods

Forest Health State Cooperators from Maine, New Hampshire, and Vermont collected samples from at least three to five white pine stands per State that exhibited damage during 2010, along with stand information (Appendix A). Because the pathogens associated with the damage fruit at different times, stands were sampled between April 25 and May 2 and again during June 13 and 22, 2011. At each stand, samples were collected from at least three and up to five symptomatic trees. When available, samples were also collected from one healthy, control tree. Each sample consisted of a quart-size (1 L) bag full of branch tips.

Samples were sent to the Durham Field Office where they were processed for pathogen identification. All branch tips were visually examined for fungal fruiting structures. Disease incidence and severity were recorded. Twenty needles from one representative branch tip per tree were placed in a moist chamber, incubated at 25˚C for 24 to 72 hours, and then examined with the aid of dissecting and light microscopes. Moist chambers consisted of Petri plates with filter papers moistened with deionized water sealed with Parafilm.

Results

A total of 13 stands were sampled throughout northern New England (Figure 3). Most of these were natural stands located in wetland areas, but trees on dry steep slopes in one plantation in Vermont were also sampled (Table 1). Samples were taken from a total of 60 trees in all age classes. In May, 729 branch tips and 1,153 incubated needles were examined. Similarly, in June 384 branch tips and 901 incubated needles were examined.

Table 1. Descriptive data for sites sampled in northern New England during the growing season of 2011.

State	Location	County	Ownership	Stand type	Site description	Latitude	Longitude
Maine	Augusta	Kennebec	Private	Natural	Wetland	44.2981	-69.75763
Maine	Bethel	Oxford	Private	Natural	Edge of water body	44.4619	-70.64176
Maine	Leeds	Androscoggin	Town Park	Natural	Edge of water body	44.341	-70.18728
Maine	Lyman	York	National Forest	Natural	Wetland	43.5699	-70.64176
Maine	Sangerville	Piscataquis	Town Park	Natural	Edge of water body	45.1702	-69.35963
New Hampshire	Black Water Reserve	Merrimack	State	Natural	Edge of water body	43.3725	-71.77912
New Hampshire	Clough State Park	Hillsboro	State	Natural	Edge of water body	43.0975	-71.65324
New Hampshire	Fox State Park	Hillsboro	State	Natural	Wetland	43.1314	-71.92971
New Hampshire	Hopkinton-Everett	Merrimack	State	Natural	Edge of water body	43.1857	-71.7186
New Hampshire	Mast Yard	Merrimack	State	Natural	Edge of water body	43.238	-71.6544
Vermont	Lyndon State Park	Caledonia	State	Plantation	Dry steep slope	44.4997	-71.98843
Vermont	Springfield	Windsor	Private	Natural	Windbreak	43.2981	-72.41734
Vermont	Waterbury	Washington	Private	Natural	Dry steep slope	44.372	-72.76921

Signs and symptoms of *C. banfieldii* and *M. dearnessii* were frequently observed. A third fungus, *Bifusella linearis*, was identified by Mary Inman, diagnostician for the Connecticut Agricultural Experiment Station. Both *B. linearis* and *C. banfieldii* produce long, dark fruiting bodies (Figure 4 and 5)(Merrill et al. 1996). The fruiting bodies of *B. linearis* are shiny and black (Figure 4B), whereas *C. banfieldii* fruiting bodies are grey and embedded in the needle (Figure 5B). These two fungi can be distinguished by the shape of their ascospores. *Bifusella linearis* ascospores are constricted in the middle (Figure 4C) (Horst and Westcott 2008), whereas *C. banfieldii* ascospores are not (Figure 5C) (Merrill et al. 1996). *Mycosphaerella dearnessii* produces smaller fruiting bodies (Figure 6B) and brown, banana-shaped spores (Figure 6C) (Jankovsky et al. 2009, Jurc and Jurc 2010). Several other fungi were found fruiting on needles (Appendix B), but these fungi were not associated with needle blight or needle cast symptoms and appeared to be secondary invaders.

Diagnostic *B. linearis* fruiting bodies were present in samples collected in April and June from the same five sites (Figure 7). Similarly, *C. banfieldii* fruiting bodies were observed in samples collected in April and June from the same three sites (Figure 8). Both these needle cast fungi produce sexual fruiting structures that take a year to develop. In contrast, *M. dearnessii* was only found fruiting on four sites in April; however by June it was fruiting in samples from ten sites (Figure 9). Unlike the needle cast fungi, *M. dearnessii* produces asexual fruiting structures that result in more than one disease cycle though the growing season.

Samples were disease free from only one site, Clough State Park, which is in New Hampshire (Figure 10). *Mycosphaerella dearnesii* was the most widely distributed fungus as it was present in most sites alone or co-occurring with the needle cast fungi. All three fungi were present in one tree at one site, Lyndon State Park in Vermont (Figure 10).

Figure 4. Necrotic needles (A) from Mast Yard, New Hampshire infected with *Bifusella linearis,* fruiting bodies (B) are shinny and black (x7.5) and the ascospores (C) are constricted in the middle (X400). Spores stained with methyl blue.

Figure 5. Needles (A) with chlorosis and necrosis from Sangerville, Maine infected with Canavirgella *banfieldii,* fruiting body (B) is embedded in the needle (x20) and ascospores (C) are not constricted in the middle (x200). Spores stained with methyl blue.

Figure 6. Sample (A) with defoliation and chlorosis from Waterbury, Vermont infected with *Mycosphaerella dearnessii* (anamorph *Lecanosticta acicola*), asexual fruiting body (B) (x35) and spores (C)(x200).

Figure 7. Location of sites with *Bifusella linearis*. Infected white pine samples were collected in April and June of 2011.

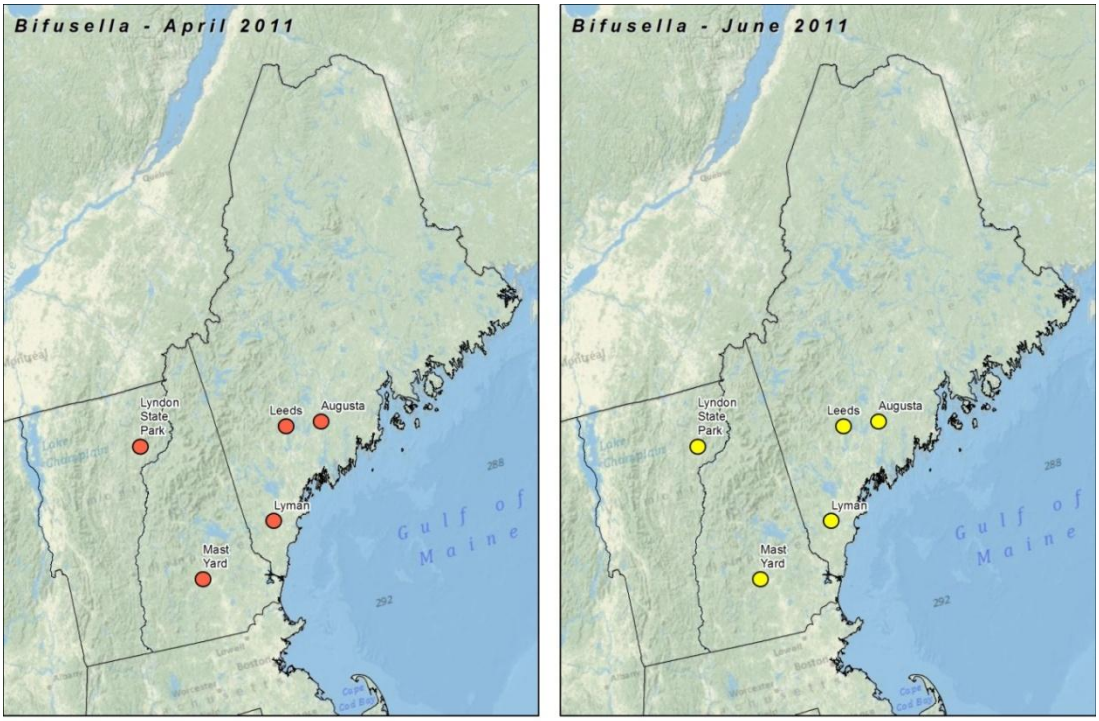


Figure 8. Location of sites with *Canavirgella banfieldii*. Infected white pine samples were collected in April and June of 2011.

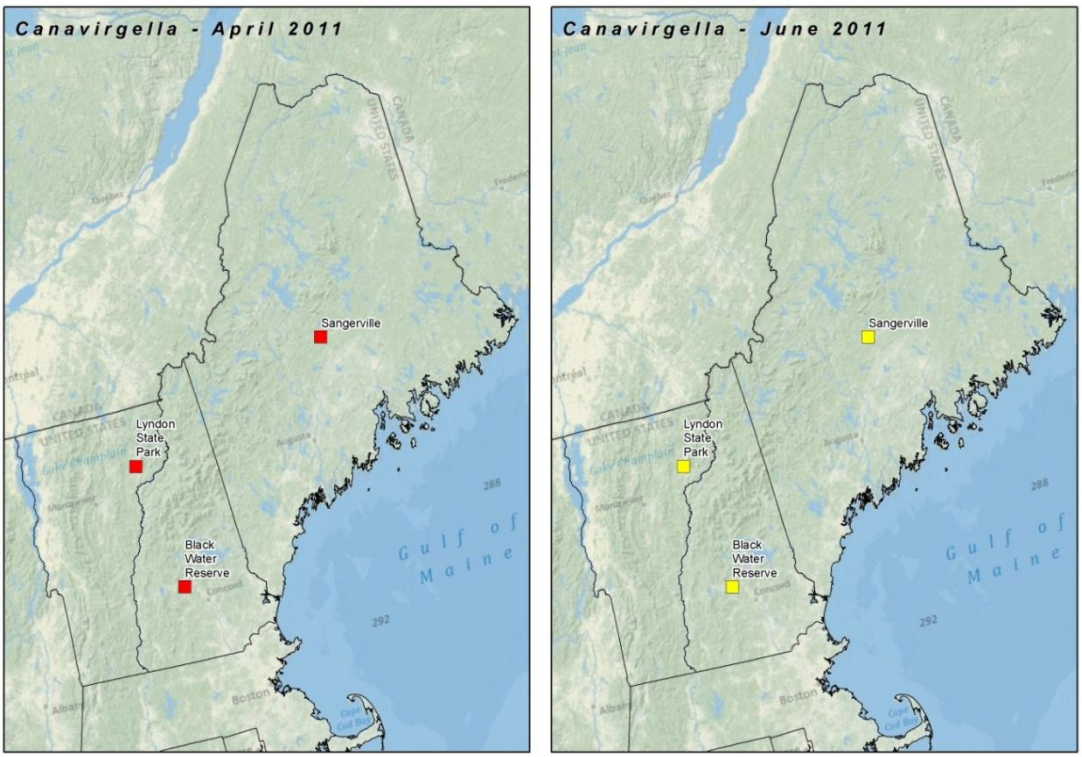


Figure 9. Location of sites with *Mycosphaerella dearnessii*. Infected white pine samples were collected in April and June of 2011.

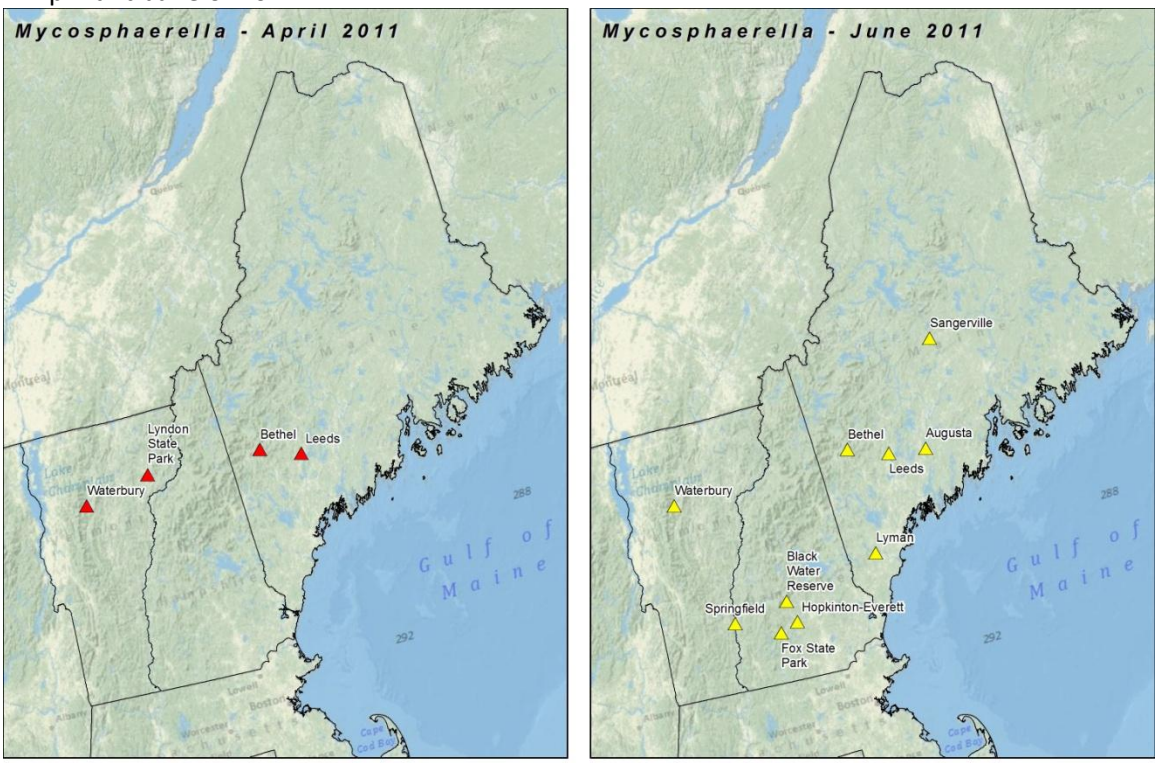
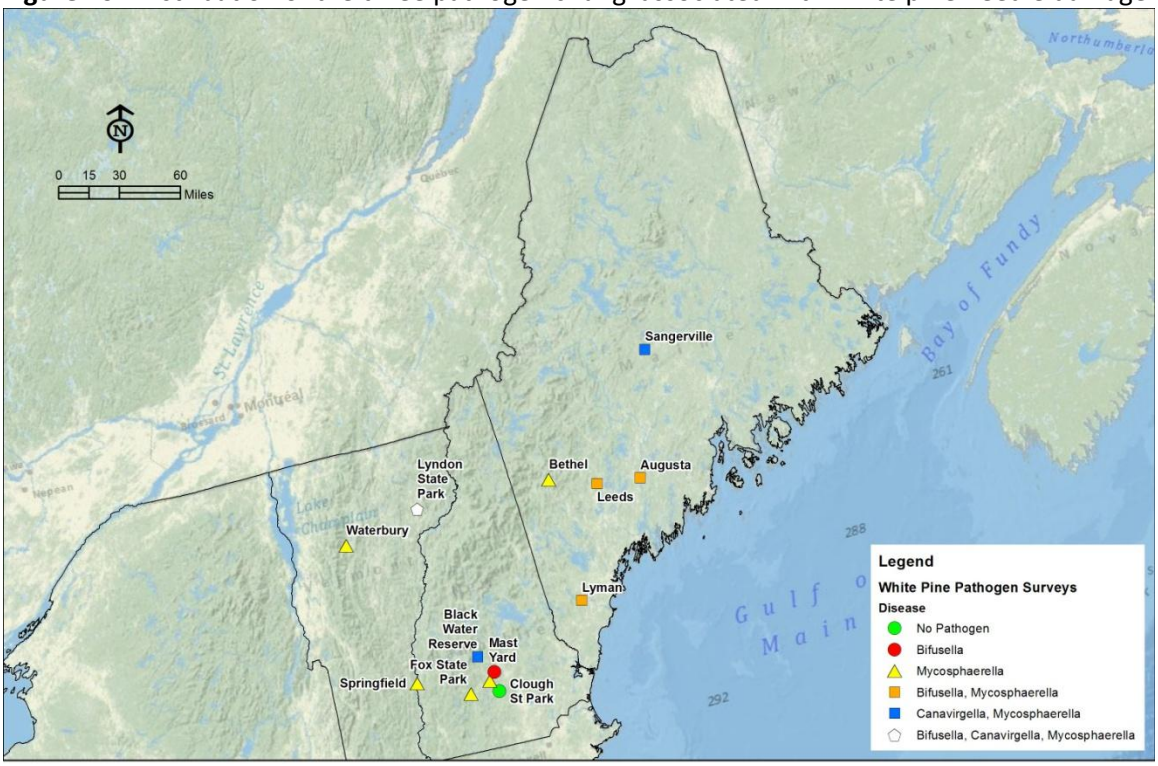
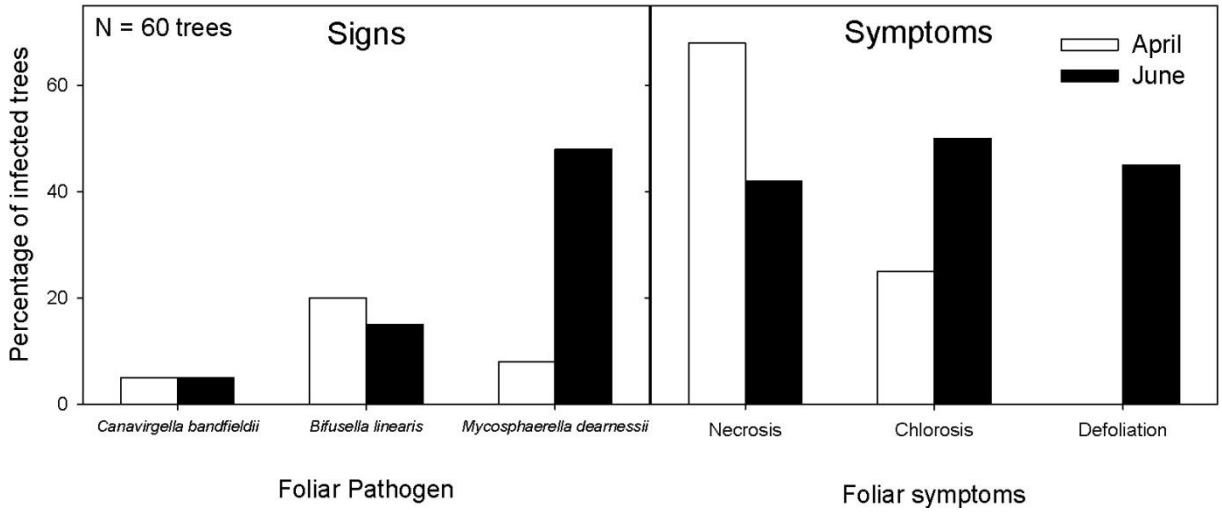


Figure 10. Distribution of the three pathogenic fungi associated with white pine needle damage.



In April, fruiting structures of all three fungi were found in less than 20% of the trees sampled (Figure11). By June, 48% of the trees yielded samples with signs of *M. dearnessii*. Between April and June the proportion of trees with symptoms of chlorosis and defoliation increased from 25% to 50% and 0% to 45%, respectively (Figure 11). In April 68% of the trees yielded samples with necrotic needles, although the necrosis was limited to less than one third of the needle. In contrast, the chlorosis of samples collected in June exceeded more than two thirds of the needle. It is possible that the proportion of necrotic needles decreased due to the needle drop in June.

Figure 11. Frequency of foliar disease signs and symptoms on infected trees.



Conclusions

At one site all three pathogenic fungi were present and multiple pathogens were found on the same tree at another location. *Mycosphaerella dearnesii* was the most frequently observed, widely distributed pathogen, and most constantly associated with chlorosis and defoliation in late June. It is likely that wet spring weather, favorable to disease development, during several consecutive years has led to an outbreak of foliar diseases. Trees in a variety of sites across northern New England were affected. Thus, the observed foliar damage is probably not site related.

Prior to this outbreak, damage caused by Canavirgella needle blight was reported on less than 0.1% of eastern white pines (Merrill et al. 1996). Similarly, although brown spot needle blight is common on 2 and 3 needle pines, it typically is not associated with white pine. In addition, Bifusella needle cast is rarely reported in northeastern North America; however, this disease may have been misdiagnosed or overlooked in the past. The consequence of repeated defoliations by these pathogens is unknown. These fungi are expected to continue to cause damage in years following unusually wet springs. Thinning damaged trees during these conditions is not recommended as these trees are already stressed by repeated defoliations.

A publication was created and several research projects were supplemented as a result of this survey. The Pest Alert (NA-PR-01-11, revised April 2012) was published to help Forest Health State Cooperators respond to the large volume of calls from concerned citizens (Munck et al. 2011).

Collaborative research projects to further investigate the damage caused by these fungi have been initiated with Kirk Broders, professor in the Department of Biological Sciences at the University of New Hampshire. Samples from the survey were sent to the following scientists for fungal genetic research projects:

- Marion Kessler, Department of Forest Protection, Unit of Phytopathology and Biochemistry, Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW), Vienna, Austria.
- Josef Janousek, Mendel University in Brno, Faculty of Forestry and Wood Technology (424), Zemedelska 3, Brno 613 00, Czech Republic
- Gaston Laflamme, Natural Resources Canada , Canadian Forest Service, Laurentian Forestry Centre, P.O. Box 10380, Stn. Sainte-Foy, 1055 P.S. Str., Québec, QC, Canada, G1V 4C7.

Photo credits

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Figures 2 A and B, Maine Forest Service

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Manuscript editing: Margaret Miller-Weeks and Kevin Dodds

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Appendix A. Survey form completed by Forest Health State Cooperators at each collection site.

Eastern White Pine Needle Damage Sampling Protocol 2011

To determine causal agent extensive damage to eastern white pine foliage during the summer of 2010 we are asking State partners in Maine, New Hampshire, and Vermont to collect samples from the same 5 affected stands at least twice in 2011 (April 25-29 and June 6-10). If disease incidence is high during the summer of 2011, then stands will be revisited in the fall of 2011. This sheet provides collection instructions and information to be filled out at each stand.

Your Name:	Date:
Your address:	Phone Number: Email:
Location where collected (state, county, township, range, section, and GPS coordinates if possible)	
Ownership (circle answer): National Forest State Private	
Stand type (circle answer): Plantation Natural Other:_____	
Extent of damage (approximate acres or number of trees affected):	
Site description (circle all that apply): 1) edge of waterbody 2)wet area 3)dry, steep slope 4) Other:	

Tree #	Tree size (SE=seedling, SAP=sapling, P=pole, M=mature, circle one)	Condition (D=disease, H=Healthy)	Part of crown affected (Circle all that apply)	Proportion of total crown affected (circle one)
Tree 1	SE SAP P M		Bottom Middle Top	0 1/3 1/3-2/3 >2/3
Tree 2	SE SAP P M		Bottom Middle Top	0 1/3 1/3-2/3 >2/3
Tree 3	SE SAP P M		Bottom Middle Top	0 1/3 1/3-2/3 >2/3
Tree 4	SE SAP P M		Bottom Middle Top	0 1/3 1/3-2/3 >2/3
Tree 5	SE SAP P M		Bottom Middle Top	0 1/3 1/3-2/3 >2/3

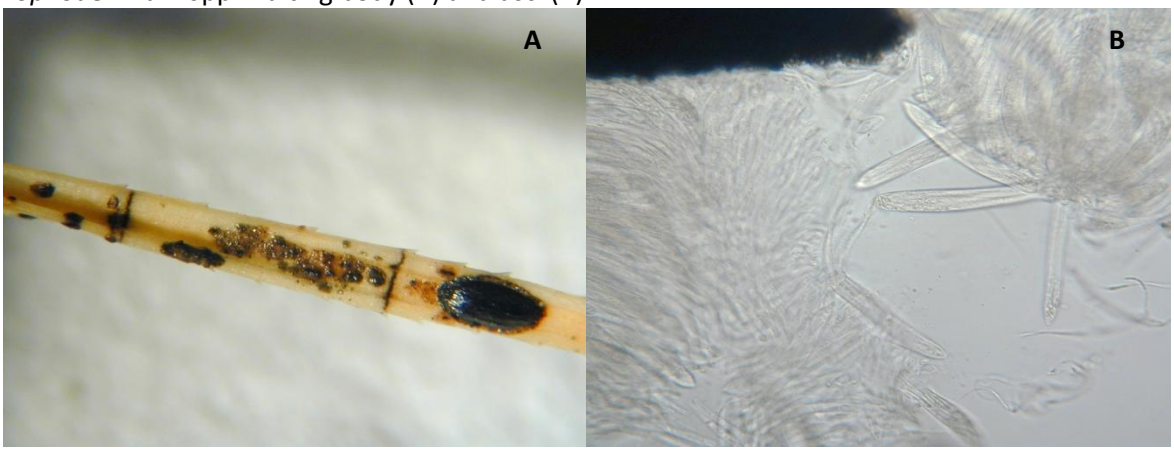
HOW TO COLLECT SAMPLES:

1. Identify 4 symptomatic (preferably 2 understory and 2 overstory) and one healthy, control tree. If it is not possible to collect foliage from overstory trees, collect foliage from 3 symptomatic trees total. If a healthy tree cannot be found in the stand, then collect foliage from a nearby healthy tree with a green crown.
2. Collect branch tips with symptomatic needles (include current growth and up to 3-year old needles if present) from several locations on the tree. Do not remove needles from fine twigs. Place all samples collected from each tree in a separate one quart size plastic bag.
3. Keep samples dry inside the bag. Do not add water and if necessary add a dry paper towel to absorb moisture.
4. Label sample bag with date, tree#, location (state, county, stand #), tree size, diseased/control (healthy).
5. Keep samples cool (keep on ice during transportation from the field and refrigerate if they cannot be mailed right away).
6. If possible, please take pictures of the site and symptomatic trees and e-mail to address below.
7. Collect samples from the same stands in April and June. If possible collect sample from the same tree. Please note if sample was taken from the same tree or from a different tree on the sample bag or datasheet.
8. Mail completed form with sample as soon as possible to address below.

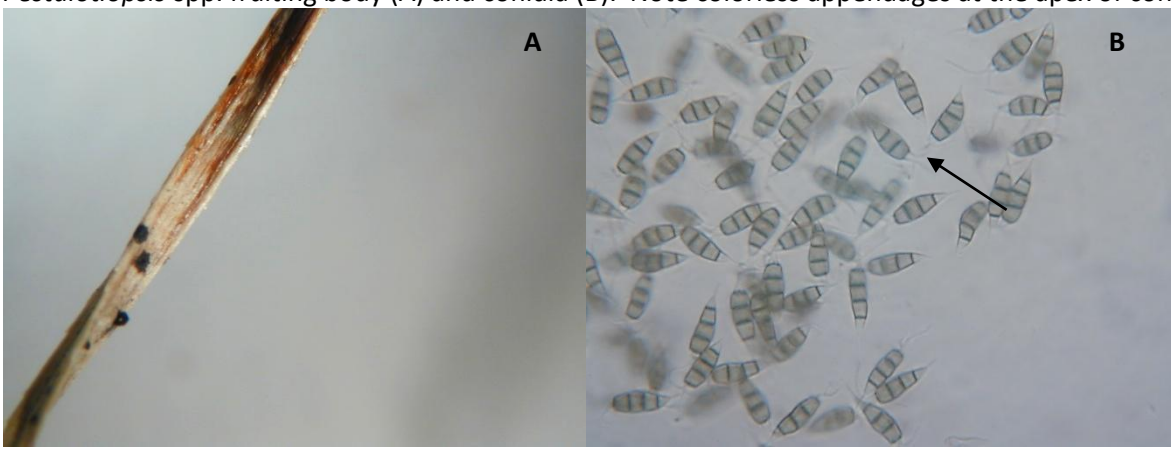
Isabel Munck, USDA Forest Service, 271 Mast Road, Durham, NH 03824, E-mail: imunck@fs.fed.us

Appendix B. Other pathogenic and saprophytic fungi observed fruiting on white pine samples.

*Lophodermium s*pp. fruiting body (A) and asci (B).



Pestalotiopsis spp. fruiting body (A) and conidia (B). Note colorless appendages at the apex of conidia.



Hendersonia pinicola (?) (Funk 1985, page 51) fruiting bodies (A) and conidia (B).