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Dramatic needle browning and canopy dieback of eastern white pine (*Pinus strobus*) in southern New England

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During the spring of 2016, a dramatic decline of eastern white pine (*Pinus strobus*) has been observed throughout southern New England. Needles of mature trees become straw-colored to brown before they are prematurely shed from the canopy. In some cases, only a few main branches are symptomatic whereas on other trees, the entire canopy exhibits the symptoms (Fig. 1). One feature of the decline is that despite significant needle browning and premature shedding in the canopy, the current season's needles are elongating and appear healthy (Fig. 2).

FIGURE 1. EASTERN WHITE PINE ON THE UMASS CAMPUS WITH EXTENSIVE NEEDLE BROWNING AND PREMATURE SHEDDING THAT DEVELOPED IN SPRING OF 2016.

FIGURE 2. DEVELOPING CANDLES (BRANCHLETS) WITH CLUSTERS OF MALE CONES ARE ABUNDANT WHILE OLDER NEEDLES BECAME BROWN AND WERE PREMATURELY SHED.

Based on observations from arborists, landscapers and homeowners made to the UMass Plant Diagnostic Laboratory (UMPDL), white pine decline seems to be especially severe in southeastern New Hampshire, eastern Massachusetts and eastern Connecticut. The cause of this dramatic decline event is not entirely understood, as there are several interacting stresses that must accounted for. However, needle blight pathogens have been a primary issue affecting white pine since approximately 2010. Recent studies have identified several fungal pathogens are responsible for white pine needle blight in New England (Broders *et al.* 2015, Wyka and Broders 2016). Four needle blight fungi in particular have been identified as the principal pathogens associated with white pine needle blight in the region (Wyka *et al*. 2016) and include:

1. *Lecanosticta acicola* (formerly *Mycosphaerella dearnessii*)
2. *Lophophacidium dooksii* (formerly *Canavirgella banfieldii*)
3. *Bifusella linearis*
4. *Septorioides strobi*

Based on samples submitted to the UMPDL, three of these four pathogens have been regularly found on white pines with symptoms of needle blight (*Lophophacidium* has been uncommon to date). Evidence now suggests there is a strong link between climate change and the increase in damage from needle blight pathogens of white pine. Using regional weather data, Wyka *et al.* (2016) determined that an increase in precipitation during the months of May, June and July — the time period when white pine needles are elongating — is positively correlated with damage from needle blight pathogens. However, as is the case with many conifer needle pathogens, that effect has a one year delay. For example, above-average precipitation between May–July in 2016 would correlate to higher disease pressure in 2017.

Therefore, we must go back to the growing season of 2015 to better understand what factors might be influencing the damaged observed this year. During the spring of 2015, May was extremely dry with above-average temperatures and below-average precipitation was also recorded from July through September in the areas where white pine decline appears to be the most severe (Fig. 3). June, in contrast, was very wet and there were multiple rainstorms with accumulations >0.75″ (Fig. 4). Heavy rains promote sporulation and disperse significant volumes of needle blight pathogen spores through splashing and running water. Despite the above-average rainfall in June, the rest of the growing season was fairly dry and many trees may have entered the dormant period suffering from drought stress.

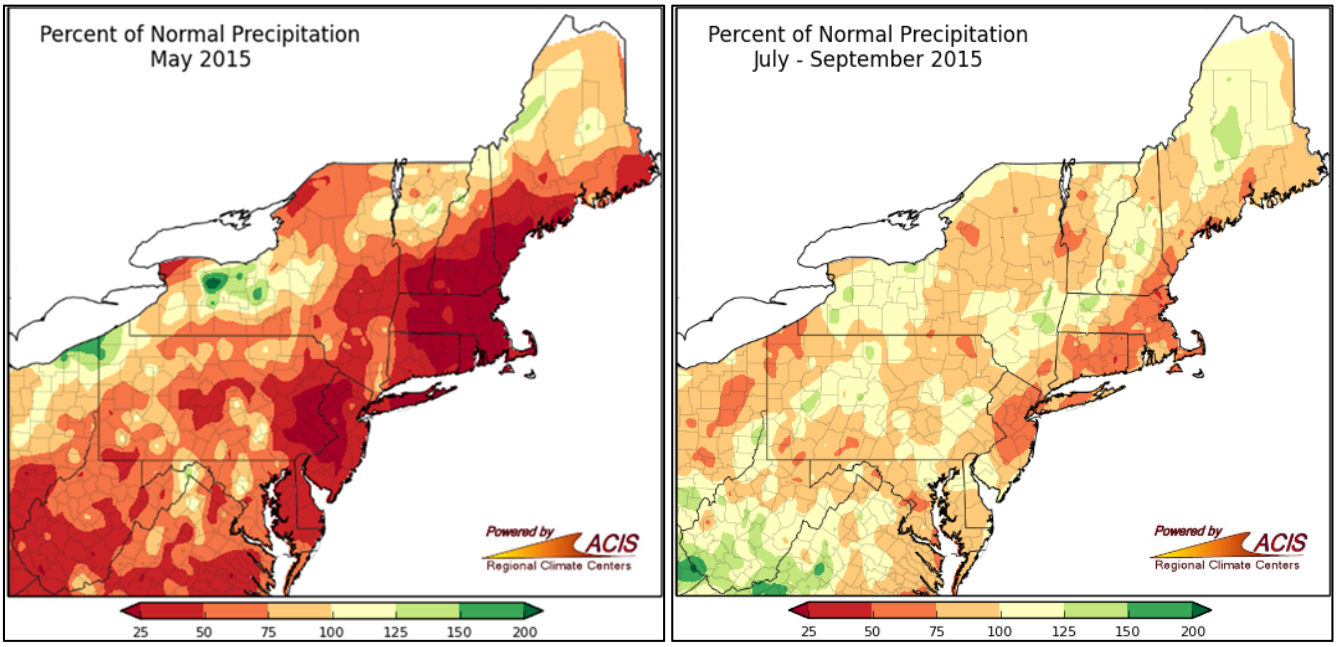

FIGURE 3. BELOW-AVERAGE PRECIPITATION DURING MAY (LEFT) AND FROM JULY THROUGH SEPTEMBER (RIGHT) IN 2015.

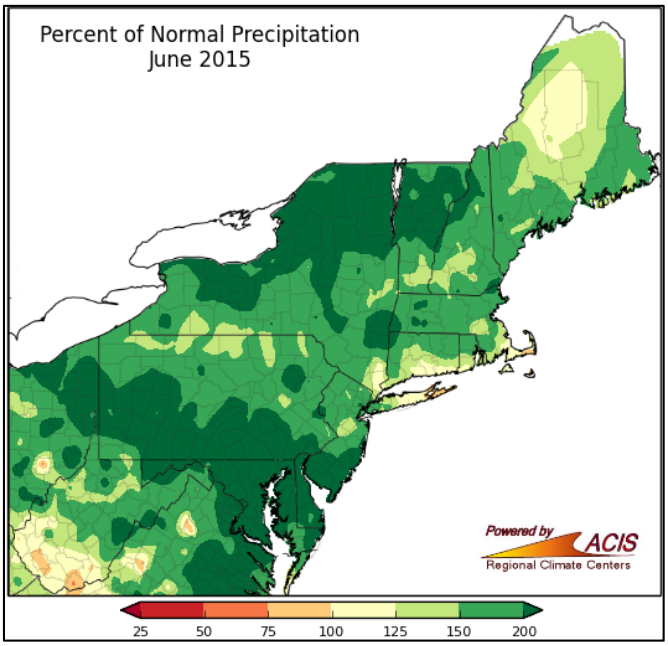

FIGURE 4. ABOVE-AVERAGE PRECIPITATION DURING JUNE OF 2015.

Beginning in July of 2015, the UMPDL began to receive white pine samples with an uncharacteristic symptom: blighted tips on current season's needles. Symptoms of infection from needle blight fungi typically develop on older needles while the current season's needles appear green and healthy. The condition was reported from West Virginia to Maine but affected trees were scattered on the landscape and in many cases were directly adjacent to healthy trees. On a majority of the samples, an unknown fungal pathogen was present that was later identified as *Septorioides strobi*. While this species was only recently described it has been found to be associated with white pine needle blight throughout northeastern North America (Wyka and Broders 2016, Wyka *et al.* 2016). Most often, needle tips were straw-colored to brown while the base of the needle remained green and healthy. Needle lesions, spore masses and colorless, asexual spores are shown below (Figs. 5 & 6).

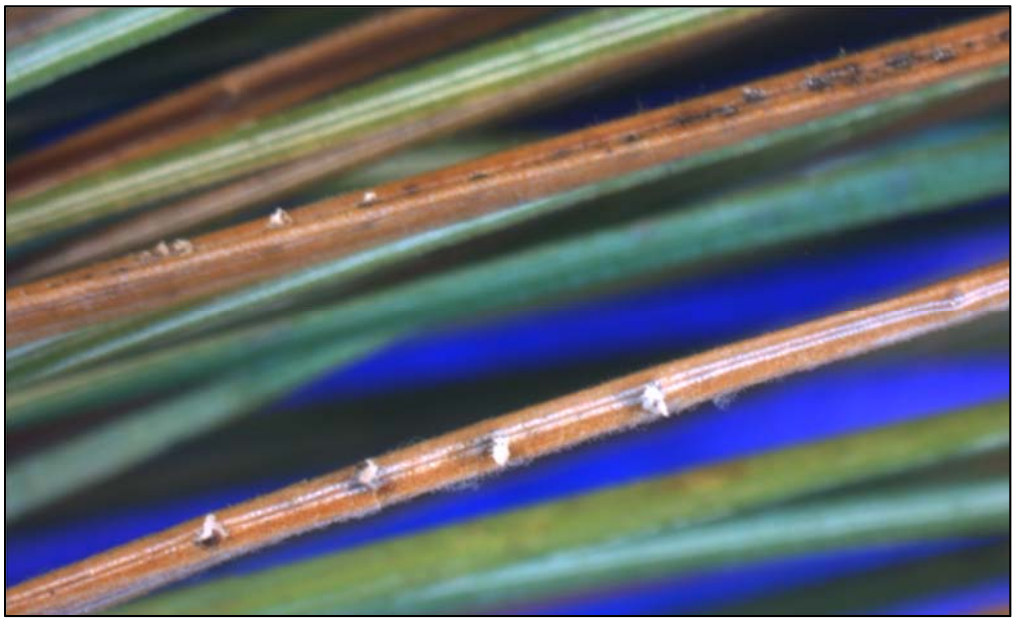

FIGURE 5: BLACK-COLORED, CIRCULAR LESIONS EXTRUDING CLEAR MASSES OF SPORES ON BLIGHTED NEEDLE TIPS.

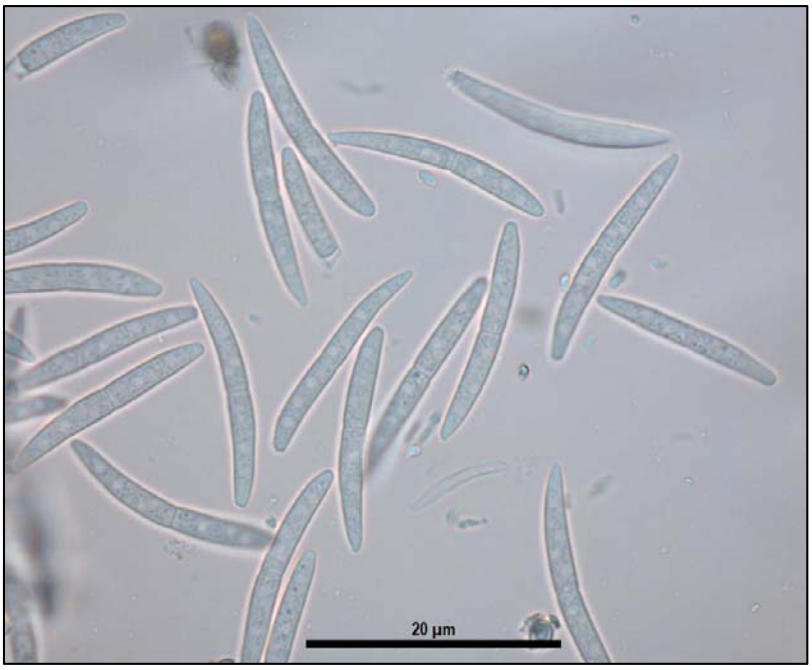

FIGURE 6: ASEXUAL SPORES PRODUCED BY *Septorioides strobi*.

As we entered the last months of the 2015 calendar year, temperatures throughout the region were above-average, especially in December (Fig. 7). These warm, late season temperatures may have adversely affected the ability of white pines to acclimate for cold winter temperatures. Drought stress is also known to reduce winter hardiness. Once temperatures became more seasonable in January and February, cold injury may have been inflicted. However, the effect of warm, late season temperatures is speculative and may not be a current factor in white pine decline.

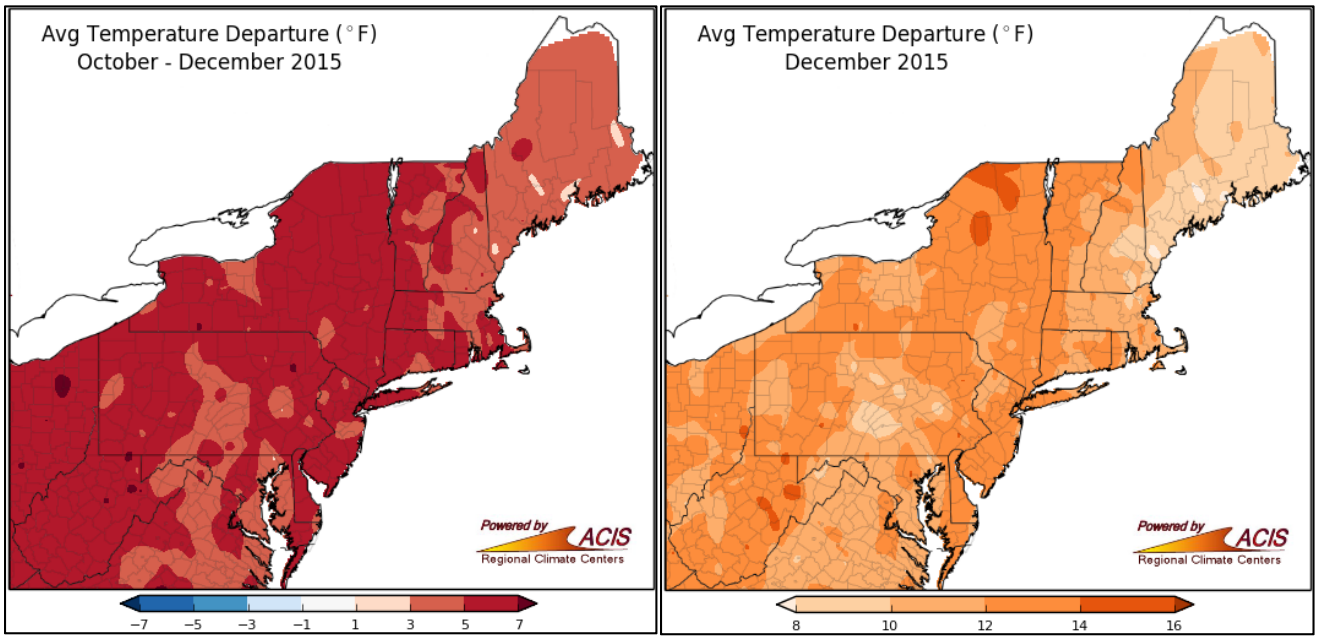

FIGURE 7: ABOVE-AVERAGE TEMPERATURES FROM OCTOBER THROUGH DECEMBER (LEFT) THAT WERE PARTICULARLY PRONOUNCED IN THE MONTH OF DECEMBER ALONE (RIGHT).

To summarize, the current decline of eastern white pine is not fully understood and will take many more months to better understand. However, the following factors should be considered in the decline:

1. Multiple needle blight pathogens that may or may not co-occur on the same tree.
2. Increased precipitation in the months of May, June and July that would promote needle blight infections on developing white pine needles.
3. Environmental stress such as drought.
4. Branch cankering? Cankering by the fungal pathogen *Caliciopsis* has emerged as a significant threat to forest white pines (see Munck *et al.* 2015) but may not be as important in landscape settings.

Literature Cited:

1. Broders *et al.*, 2015. Characterization of fungal pathogens associated with white pine needle damage (WPND) in northeastern North America. Forests 6:4088–4104.
2. Munck *et al.*, 2015. Extent and severity of Caliciopsis canker in New England, USA: an emerging disease of eastern white pine (*Pinus strobus* L.). Forests 6:4360–4373.
3. Wyka and Broders, 2016. The new family Septorioideaceae, within the Botryosphaeriales and *Septorioides strobi* as a new species associated with needle defoliation of *Pinus strobus* in the United States. Fungal Biology (*In press*).
4. Wyka *et al.*, 2016. Emergence of White Pine Needle Damage (WPND) in the northeastern U.S. is associated with changes in pathogen pressure in response to climate change. Global Change Biology (*In press*).