UNIVERSITY OF GEORGIA
Warnell School of Forestry & Natural Resources

Publication WSFNR-21-58A

June 2021

# Eastern White Pine Dieback in the Southern Appalachian Mountains

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## WHAT IS EASTERN WHITE PINE?

Eastern white pine *(Pinus strobus)* is the most widely distributed pine species in the eastern U.S. It is the only pine species native to the Southern Appalachian Mountain region that has five needles. Eastern white pine has a remarkable growth rate on a variety of soils and grows as tall or taller than most trees in the region. It can be found in many different forest types, providing important habitat for wildlife. Eastern white pine is used as a Christmas tree species, and its bark and resin are used for construction materials, extracts, and many other products.

## WHAT IS THE PROBLEM?

A new threat to eastern white pine has emerged. Symptoms include yellowing of needles, dying branches, and oozing resin. These symptoms, as well as death of seedlings and saplings, are associated with Caliciopsis canker, a disease caused by a pathogen well-known in the northeastern U.S. This pathogen is aided by a native but little-known insect, the eastern white pine bast scale, which creates feeding wounds that fungi use to infect trees. In the Southern Appalachians, the eastern white pine bast scale was first reported in Virginia and West Virginia in 2006-2007 and in Georgia in 2010. However, reports of Caliciopsis canker date back to the 1930s. This appears to be a newly described insect-pathogen complex, and symptoms are now present in the entire range of eastern white pine to varying degrees.

Young seedlings and saplings (<5" DBH) are most susceptible to mortality. Larger trees, poletimber (DBH = 5" - 12.5") and sawtimber (>12.5" DBH), are more resilient, but are still vulnerable to loss of needles, branches, and vigor. Caliciopsis canker and the bast scale are affecting eastern white pine regeneration and health of Southern Appalachian ecosystems.

**Figure 1:** *Eastern white pine tree with yellowing of needles, lower branch dieback, and canker growth on the trunk.*
Liz Moss (Center for Invasive Species and Ecosystem Health)

**Figure 2:** ***Eyelash-like fruiting bodies are a sign of the fungal pathogen, Caliciopsis pinea.*** Thomas D. Whitney

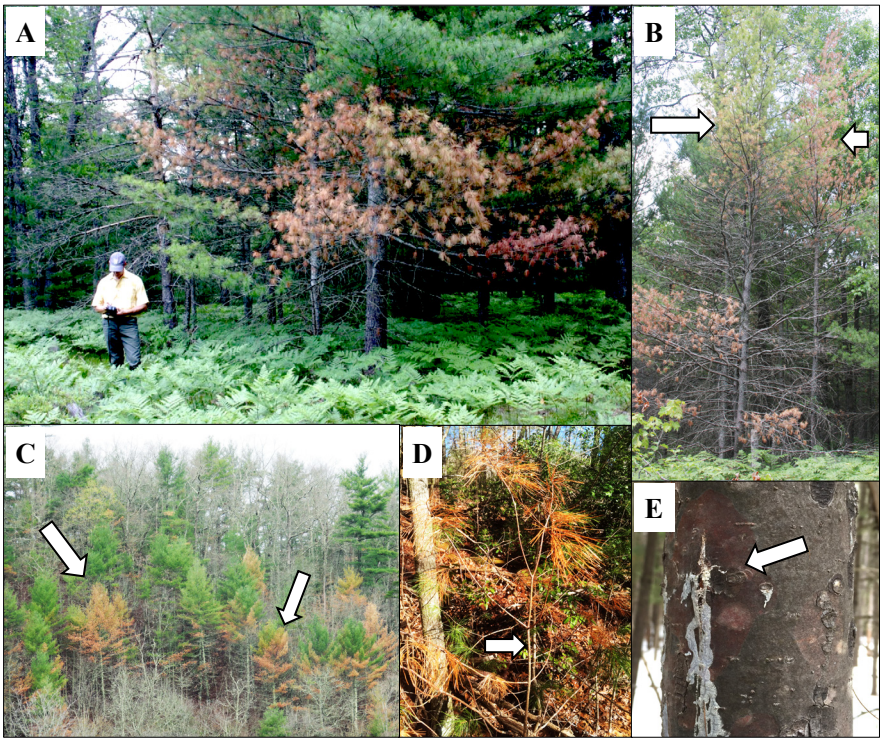


**Figure 3:** ***Symptoms of eastern white pine dieback include (a) bottom-up branch dieback that leads to (b) highly reduced crowns in poletimber and (c, d) mortality in small saplings. (e) Cankers and resin streaks often accompany these symptoms.*** (a, b) Joe O'Brien (USDA Forest Service, (c) Lori Chamberlain (Virginia Dept. Forestry), (d, e) Thomas D. Whitney

## WHAT ARE THE SIGNS AND SYMPTOMS?

The pathogen is easily recognized by the fruiting bodies protruding from bark lesions, which resemble black eyelashes (Figure 2). These fruiting bodies can be found throughout the year and are the easiest way to identify an infected tree. Caliciopsis canker produces wide-ranging symptoms, the severity of which increase with the number and size of cankers on the bark surface. Diseased tissue can expand to the point of girdling branches and trunks, especially where bark is thin and not furrowed, leading to branch dieback and mortality of young trees. The scale insect tends to colonize bark thin enough for their mouthparts to reach the cambium. Likewise, cankers most often develop on bark thinner than half an inch.

The first noticeable symptoms of the dieback are needle yellowing and whole branch flagging, most commonly in the lower canopy (Figure 3a). Branches will continue to die from the bottom up, eventually leading to mortality (Figure 3b). This disease progression is most common in poletimber. Younger seedlings and saplings (DBH <5") usually succumb to stem-girdling before all branches die (Figures 3c & 3d). Caliciopsis cankers often cause copious resin flow that leaves long streaks on the trunks of sawtimber (DBH >12.5") (Figure 3e).

## WHAT ARE THE POTENTIAL CAUSES OF EASTERN WHITE PINE DIEBACK?

Historically, landowners in the southern Appalachian Mountains have had to worry about white pine blister rust and white pine weevil. However, the current symptoms – needle yellowing, bottom-up branch dieback, and resin streaking – are likely due to two native organisms previously not known to be connected: a canker-forming pathogen *(Caliciopsis pinea)* and a sap-sucking insect (the eastern white pine bast scale).

### *Caliciopsis pinea*

*Caliciopsis pinea* is the fungal pathogen responsible for Caliciopsis canker. It primarily infects eastern white pine, but, in rare cases, is also known to colonize pitch pine, shortleaf pine, and Virginia pine in the eastern United States. Canker formation first requires spores of *Caliciopsis pinea* to penetrate the bark, usually through a wound created by mechanical damage or insect feeding. Fungal hyphae then grow into and kill the living plant tissue under the bark, resulting in the formation of a reddish-brown canker on the bark surface. The distinctive fruiting bodies will eventually emerge, produce more spores, and continue the cycle. Caliciopsis cankers can exist on the exterior and interior of the tree (Figures 4a & 4b). Cankers growing on the exterior bark surface are perennial and can expand to several inches in diameter. This expansion can girdle branches of large trees and the stems of small trees (Figure 4c). Interior cankers occur when the tree calluses over exterior cankers, which can decrease wood quality (Figure 4d).

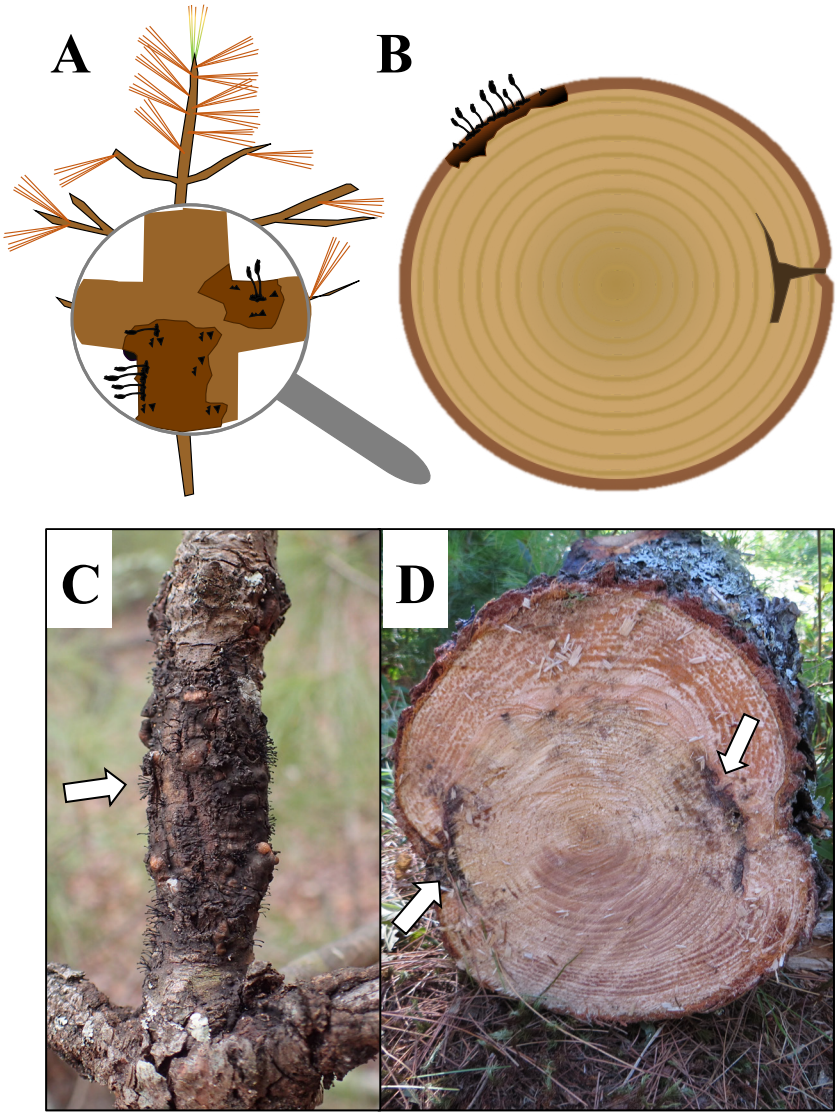


**Figure 4:** ***Exterior Caliciopsis cankers can cause girdling in young trees (a, c), but can also be calloused over and result in internal necrosis of the xylem (b, d), decreasing wood quality.*** (a, b) Ashley N. Schulz, (c) Thomas D. Whitney, (d) Kara Costanza (USDA Forest Service)

## EASTERN WHITE PINE BAST SCALE (*MATSUCOCCUS MACROCICATRICES*)

The eastern white pine bast scale is a tiny insect that feeds and reproduces exclusively on eastern white pine. It has four key stages in its one-year life cycle in the Southern Appalachians. The cyst stage of the insect (Figure 5a) settles on an eastern white pine tree and feeds on the tree with its stylet (5b). As it feeds, the insect cyst grows in size. Pre-adult males emerge (5c) and develop into a "pupa" (5d), and later transform into winged adults (5e). Females emerge from their cysts and remain wingless and soft bodied (5f). The wingless female and winged male mate (5g), and the female lays eggs in the summer (5h). The eggs hatch into the crawler stage (5i), which disperse and settle into the cyst stage, continuing the cycle. All life stages of the scale

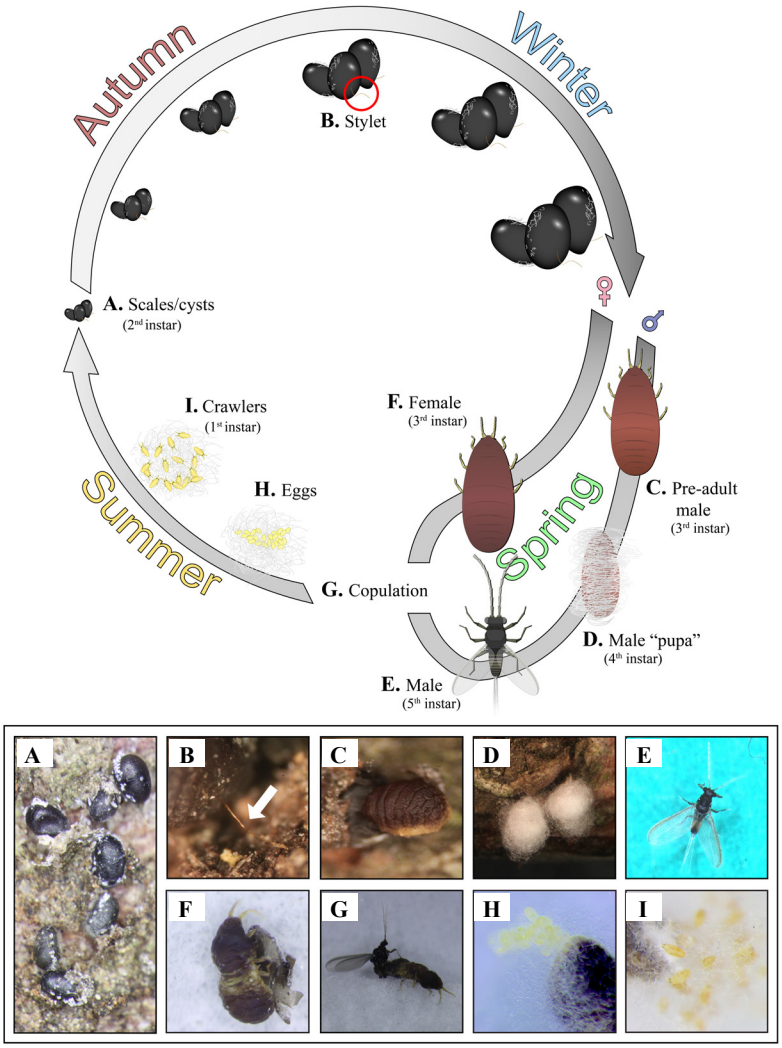


**Figure 5:** *In the Southern Appalachian Mountains, the eastern white pine bast scale has a one-year life cycle. Figure derived from Costanza et al. (2018). The photos (A-H) on the left refer to the (A-H) labels on the life cycle figure.* Thomas D. Whitney.

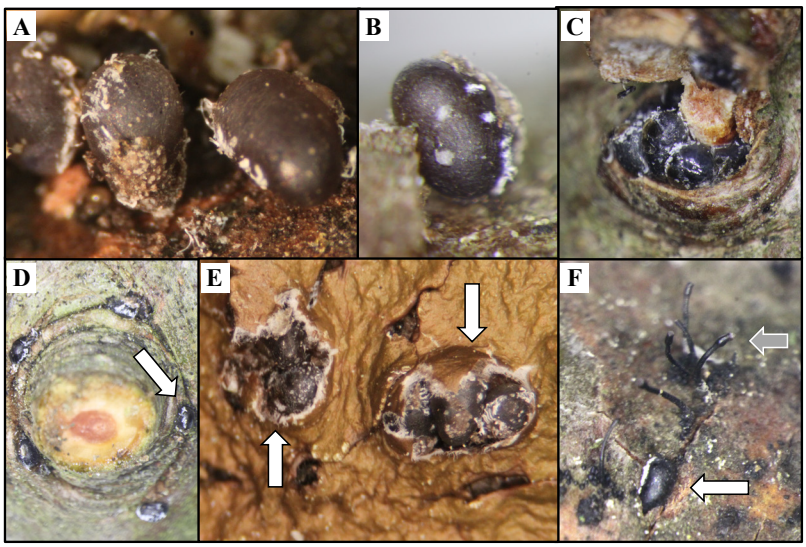


**Figure 6:** *The eastern white pine bast scale spends most of its life as a cyst, which resembles a little black pearl (a, b). It feeds on the tissues of white pine. They are difficult to locate but can be found in nodes (c), branch crotches (d), under lichen (e), and on the edge of cankers (f).* Thomas D. Whitney.

insect are difficult to see with the naked eye, so a hand lens and a pair of tweezers may be required to locate the insect. Scales are largest and easiest to find in early spring. The legless cysts, resembling little black pearls (Figures 6a & 6b), are the life stage of primary concern for eastern white pine dieback. They can be found embedded in nodes (Figure 6c), branch crotches (Figure 6d), under lichen (Figure 6e), and in the edge of cankers (Figure 6f). In these hidden locations, they use their long, spindly mouthparts like a straw to suck sap from vascular tissue underneath the bark. As the bast scale insects feed, the plant tissue around them starts to yellow in the area of feeding. When the young males and adult females emerge from the cysts, they leave behind a small feeding hole where their stylet was inserted in the tissue. Small trees that have many bast scale insects feeding at the same time are the most susceptible to damage.

## A LIKELY INSECT-PATHOGEN COMPLEX

The eastern white pine bast scale likely facilitates *Caliciopsis pinea* infection of eastern white pine trees. The severity of the symptoms increases as the number of both the scale insect and fungal pathogen on the tree increase. Spores likely use the deep feeding wounds left by the bast scales as an easier point of entry into the tree. The insect may further aid the pathogen by secreting saliva that hinders tree defenses, such as resin production. Research is underway to determine what has changed to allow the eastern white pine bast scale and Caliciopsis canker to work together to drive this bottom-up dieback that is prevalent on eastern white pine in the Southern Appalachians.

## WHAT ARE THE BEST WAYS TO MANAGE EASTERN WHITE PINE DIEBACK?

Forest managers in the southeastern United States are just beginning to evaluate how to best manage Caliciopsis canker and the bast scale. In New England, where eastern white pine is a major timber species, this disease may be best managed through thinning. Active management is not as prevalent in the Southern Appalachians, so action may only be warranted once the disease kills more larger diameter trees. At this time, seedlings and saplings are the most impacted by the bast scale and Caliciopsis canker development. Stands of eastern white pine displaying symptoms of bottom-up dieback and signs of Caliciopsis canker may benefit from mechanical thinning or other strategies. Symptom severity and the incidence of Caliciopsis cankers increases with stand density, so thinning may help. This treatment would reduce density and increase sunlight, creating subpar conditions for both the bast scale and spread of the disease. There is no current guidance on chemical control. Spray insecticides will not likely be effective, because the scale is generally buried in the bark crevices. Systemic insecticides, which are applied into the trunk or soil may be a better option for the bast scale control.

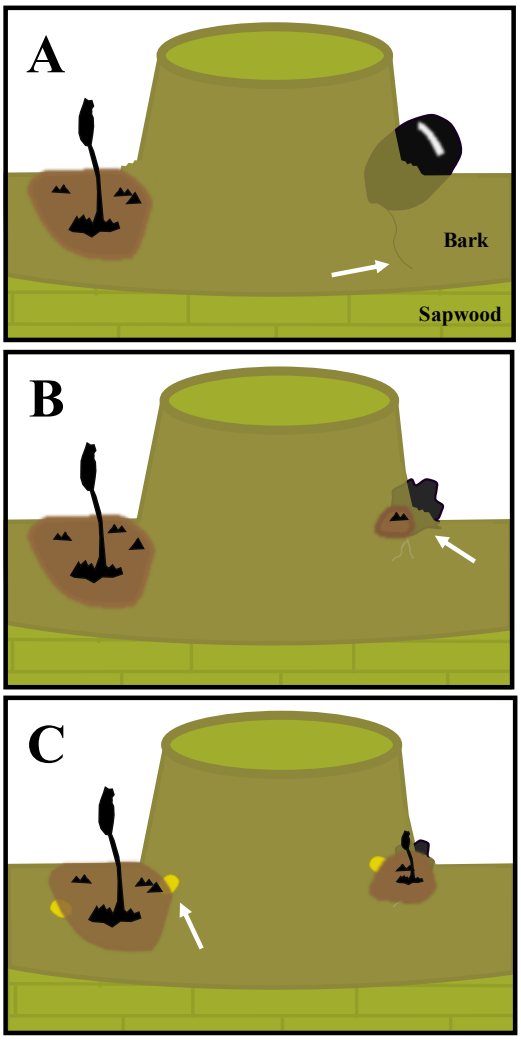


**Figure 7:** *The hypothesized mechanism of Caliciopsis pinea infection first requires localized damage to the bark from bast scale feeding (a). Spores use the feeding wound as an entry point into the cambium, and a canker begins to develop (b). First instar, yellow bast scales disperse, settle along the edges of cankers, and create new feeding wounds, perpetuating the cycle (c).* Ashley N. Schulz.

## WHAT TO DO IF YOU SUSPECT EASTERN WHITE PINE DIEBACK

Are your eastern white pine trees suddenly producing excessive resin on the trunk or branches? Is the foliage yellowing and dying from the bottom-up? If so, you might have eastern white pine dieback. Here is what to do next:

1. Look for the black, eyelash-like fruiting bodies of *Caliciopsis pinea* on the trunk and branches.
2. See if you can locate the eastern white pine bast scale. Click here for a helpful tri-fold brochure.
3. Contact your state forestry service or the USDA Forest Service and notify them of the symptoms you are seeing:

**Georgia Forestry Commission**
5645 Riggins Mill Road
Dry Branch, GA 31020
Phone: (478) 751-3500
*http://www.gfc.state.ga.us/*

**Kentucky Division of Forestry**
300 Sower Blvd.
Frankfort, KY 40601
Phone: contact your local division field office
*https://eec.ky.gov/Natural-Resources/Forestry/Pages/default.aspx*

**North Carolina Forest Service**
512 North Salisbury Street
Raleigh, NC 27604
Phone: (919) 857-4801
*https://www.ncforestservice.gov/*

**South Carolina Forestry Commission**
5500 Broad River Road
Columbia, SC 29212
Phone: (803) 896-8800
*https://www.state.sc.us/forest/*

**Tennessee Division of Forestry**
Ellington Ag Center - Bruer Bldg.,
406 Hogan Rd., Nashville, TN 37220
Phone: (615) 837-5520
*https://www.tn.gov/agriculture/forests.html*

**Virginia Department of Forestry**
900 Natural Resources Drive
Charlottesville, VA 22903
Phone: (434) 977-6555
*http://www.dof.virginia.gov/*

**West Virginia Division of Forestry**
7 Players Club Drive
Charleston, WV 25311
Phone: (304) 558-2788
*http://www.wvforestry.com/*

**USDA Forest Service - Forest Health Protection**
Southern Region (Region 8)
1720 Peachtree Road, NW
Atlanta, GA 30309
Phone: (404) 347-4177
*https://www.fs.usda.gov/main/r8/forest-grasslandhealth*

## WANT MORE INFORMATION?

For more information on eastern white pine dieback, Caliciopsis canker, and the eastern white pine bast scale, please see the following links and articles below:

Costanza, K. K. L., Whitney, T. D., McIntire, C. D., Livingston, W. H., and Gandhi, K. J. K. 2018. A synthesis of emerging health issues of eastern white pine (Pinus strobus) in eastern North America. Forest Ecology and Management, 423, 3-17. *https://doi.org/10.1016/j.foreco.2018.02.049*

Livingston, W.H., Munck, I., Lombard, K., Weimer, J., Bergdahl, A., Kenefic, L.S., Schultz, B., and Seymour, R.S. 2019. MP764: Field Manual for Managing Eastern White Pine Health in New England. Maine Agricultural and Forest Experiment Station Miscellaneous Publications. *https://digitalcommons.library.umaine.edu/aes_miscpubs/24*

Mech, A.M, Asaro, C., Cram, M.M., Coyle, D.R., Gullan, P.J., Cook, L.G., and Gandhi, K.J.K. 2013. Matsucoccus macrocicatrices (Hemiptera: Matsucoccidae): First report, distribution, and association with symptomatic eastern white pine in the southeastern United States. Journal of Economic Entomology 106: 2391–2398. *https://doi.org/10.1603/EC13251*

Schulz, A.N., Mech, A.M., Asaro, C., Coyle, D.R., Cram, M.M., Lucardi, R.D., and Gandhi, K.J.K. 2018. Assessment of abiotic and biotic factors associated with eastern white pine (Pinus strobus L.) dieback in the southern Appalachian Mountains. Forest Ecology and Management 423: 59-69. *https://doi.org/10.1016/j.foreco.2018.02.021*

Schulz, A.N., Mech, A.M., Cram, M.M., Asaro, C., Coyle, D.R., Lucardi, R.D., Lucas, S., and Gandhi, K.J.K. 2018. Association of Caliciopsis pinea Peck and Matsucoccus macrocicatrices Richards with eastern white pine (Pinus strobus L.) seedling dieback. Forest Ecology and Management 423: 70-83. *https://doi.org/10.1016/j.foreco.2018.03.013*

Whitney, T.D., Cram, M.M., Barnes, B.F., Yao, J., Lucardi, R.D., and Gandhi, K.J.K. 2018. Tree-level distribution of a novel insect-pathogen complex and its potential contribution to eastern white pine dieback. Forest Ecology and Management 423: 49-58. *https://doi.org/10.1016/j.foreco.2018.02.002*

Whitney, T.D., Gandhi, K.J.K., and Lucardi, R.D. 2019. Native or non-native? Historical biogeography of an emergent forest pest, Matsucoccus macrocicatrices. Journal of Biogeography 46(12): 2860-2874. *https://doi.org/10.1111/jbi.13702*

## SUGGESTED CITATION:

Whitney, T. D., A. N. Schulz, C. Asaro, M. M. Cram, R. D. Lucardi, E. P. McCarty, and K. J. K. Gandhi. 2021. Eastern White Pine Dieback in the Southern Appalachian Mountains. University of Georgia Warnell School Outreach Publication WSFNR-21-58A. 7 pages.