Forest Health Review

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American beech in Shenandoah National Park killed by beech bark disease (left), resulting in dense beech root-sprouting around each dead stem (right).

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Greetings

First, I would like to welcome Lori Chamberlin, our new forest health technician, who started in April 2014. Lori replaced Todd Edgerton, who left VDOF last January. She has a master's degree in entomology from the University of Kentucky, where she worked on biological control of the hemlock woolly adelgid. This year, she hit the ground running with a variety of field work related to southern pine beetle, emerald ash borer, fall cankerworm, beech bark disease, hemlock woolly adelgid and jumping oak gall, all of which will be covered in this issue of the *Forest Health Review*. Lori has also very quickly become proficient in GIS and is responsible for all the maps generated by the forest health program, as well as managing our ever-growing database of pest incidents.

This year we saw fall cankerworm still active but on the decline; an expanding number of emerald ash borer infestations; gypsy moth down but not out; southern pine beetle barely making its presence known; no change in the status of thousand cankers disease; an unusual outbreak of jumping oak gall wasp in northern Virginia, and another year of relatively mild weather. We also learned a whole lot more about the status of the invasive beech scale and beech bark disease in Virginia, some of which came as a surprise to me, which is why I made this the subject of my feature article. As a teaser, there is a silver lining to this story. I hope you find this issue of the *Forest Health Review* to be useful and informative.

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Beech Bark Disease in Virginia

Beech bark disease (BBD) results when an introduced insect, the beech scale (*Cryptococcus fagisuga*), feed on the sap of beech trees, creating cracks in the bark, which are colonized by the fungus *Nectria coccinea* var. *faginata* or *Nectria galligena*. Bark cankers associated with fungal colonization of the cambium can severely degrade or kill all size classes of American beech. The scale and associated Nectria fungus were accidentally introduced into Nova Scotia around 1890 and have been spreading south across the United States ever since. By the 1980s, beech bark disease was widespread in Pennsylvania and West Virginia, with isolated infestations in the mountains of Virginia and North Carolina.

Beech scale produce a white, waxy coating over their bodies as they feed on sap, in a similar manner as the hemlock woolly adelgid or white pine adelgid. Beech scale feed only on the bole and major branches of beech trees and, despite their very small size, heavy infestations can create a white coating or cast to the tree boles, similar to what one might see when pine adelgids are heavily infesting a white pine stand (see cover photo of the Spring 2006 issue of the *Forest Health Review*).

The pattern of BBD spread in space and time has been loosely described to follow three phases:

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1. The Advancing Front – Areas of mature beech forest that have been recently invaded by the beech scale, which are found sparsely and in low numbers but are gradually building over time.
2. The Killing Front – Beech scale have reached high populations, heavy colonization of beech trees by the Nectria fungus has occurred and significant beech mortality is under way.
3. The Aftermath Zone – Heavy mortality of mature trees (more than 8 inches) has occurred, with some residual big trees but many stands of small trees that mainly originate from root-sprouts. While large trees die more readily than small ones, small trees are often highly degraded due to the prevalence of beech scale and Nectria fungus.

Beech bark disease has devastated and degraded beech stands throughout the Northeast where the beech-birch-maple forest type is often dominant. So far, we have not observed widespread damage from BBD in Virginia, and I have often wondered why since it has been known in the Commonwealth and areas farther to the south for at least a couple of decades. For one, beech is a much smaller component of Virginia's forests, representing only 1.75 percent of forest volume and with very little beech-birch-maple dominant forest type around except at the very highest elevations. That said, there are numerous stands where beech is abundant or even dominant and yet very few of them seem afflicted with beech bark disease, except for very isolated patches at elevations above 2,000 feet where beech is generally much less common than oak-hickory.

So, where are these isolated infestations in Virginia to which I keep referring? Until this fall, there were only six known counties with beech scale, BBD or both, in isolated locations: three in the Appalachians on the George Washington National Forest (Bath, Highland and Rockbridge), and three in the Blue Ridge Mountains on land owned by Shenandoah National Park or The Wintergreen Foundation (Albemarle, Madison and Nelson). The known distribution of the beech scale / beech bark disease complex in Virginia has been expanded very recently with assistance from Bill Jones, a forest pathologist with the USDA Forest Service in Asheville, NC. After crisscrossing the Commonwealth this past October, Bill confirmed the scale and/or BBD in five additional counties (Grayson, Greene, Page, Rappahannock and Rockingham), bringing the total number of counties in Virginia to 11 (Figure 1). When I spent the day in Shenandoah National Park with Bill and Park biologists Rolf Gubler and Dale Meyerhoeffer, we found only scattered beech scale at the lower elevations on the east side of the Park near the Moorman's River and both scale and Nectria at elevations at or above 2,000 feet. At some of the higher elevation sites, beech was in severe

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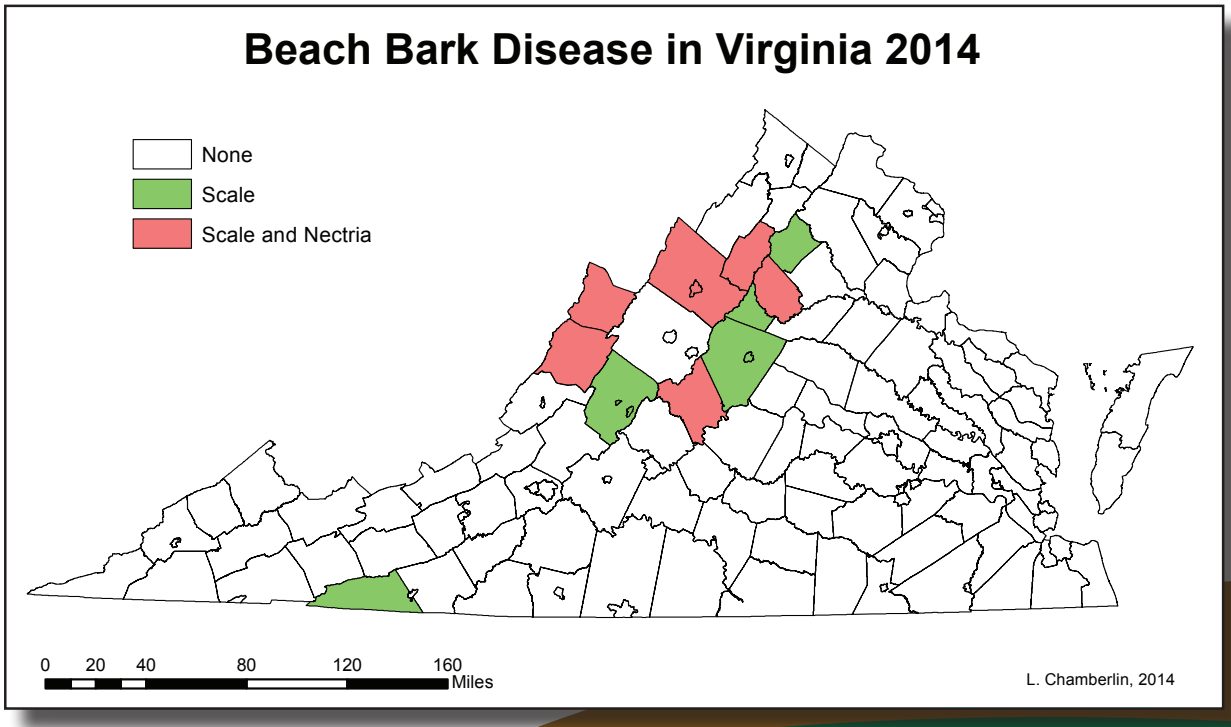
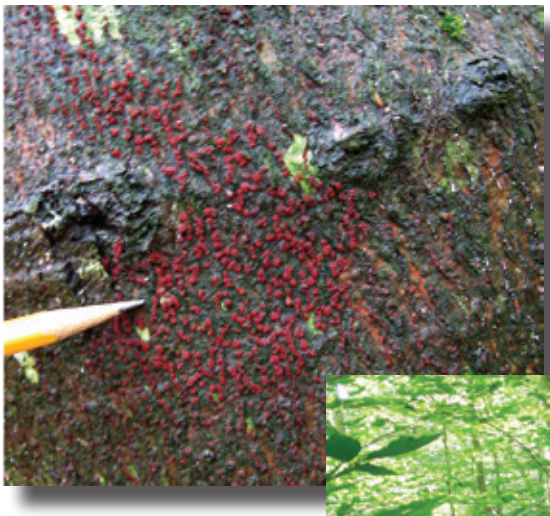


Figure 1

Bill Jones, forest pathologist with the USDA Forest Service, samples bark infected with Nectria fungus, the causal agent of beech bark disease (left). Sparse beech scale (white dots) on the bark surface of a diseased tree (right).



Circular red patches of fruiting bodies characterize areas of bark infected with Nectria fungus.

A mature beech tree killed by beech bark disease stimulates vigorous root sprouting around the main stem.

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decline with many large dead stems and extensive root-sprouting. These mini-forests of beech sprouts were quite thick in some places and difficult to walk though. Since most mature beech trees were dead or dying at these sites, beech scale were very light or minimal on most trees. Many beech stems had been dead for quite some time so that even the Nectria fungus was no longer visible and only severe bark cracking and fruiting from heart-rot fungi remained.

When Bill and I discussed the BBD issue at length, I learned something significant from him. It appears that most of Virginia's beech population consists of three strains or genetic varieties, two of which are resistant to beech scale and beech bark disease. The susceptible beech strain that is most similar to those found in the northeastern U.S. is generally only found at elevations above 1,500 feet, where beech is generally less abundant and typically only found in small pockets or as a scattered tree. A more resistant strain of beech is generally found in the Piedmont at elevations between 300 to 1,500 feet. This strain of beech may develop infestations of the scale, but does not seem to be colonized by the Nectria fungus. Finally, beech found in the Coastal Plain is the most resistant of all, appearing to avoid both the scale and fungus entirely. These ideas are based on years of ongoing research and observation but thus far have not been published. However, it does explain very well our observations of beech scale and BBD in the South. This may explain why, after decades since the of spread of beech scale/BBD into Virginia and North Carolina, we observe severe decline and mortality of beech only in small pockets (generally less than an acre) scattered throughout the Blue Ridge and Appalachians, but not in the Piedmont and Coastal Plain, where beech is more ubiquitous.

In mountainous regions, beech is more abundant at the base of mountains below 1,500 feet elevation in protected stream valleys or moist cove sites where the soil is richer and sites are generally wetter and more fertile. In some of the higher elevations between 3,000 and 5,000 feet, such as Wintergreen or the Grayson Highlands near Mount Rogers, beech can be an abundant component of beech-yellow birch-sugar maple forest types found more commonly in the Northeast states. Between these two extremes, between 1,500 and 3,000 feet, is where the majority of mountainous forest habitats in Virginia lie, where beech is relatively sparse compared to oak, hickory, pine and tulip poplar. Since BBD-susceptible trees are hypothesized to be present only around 1,500 feet or higher, we can perhaps expect this disease complex to be a scattered, isolated concern for Virginia, but not result in the widespread devastation to beech stands as seen farther north.

Weather

The winter of 2013/2014 was notable for having several "polar vortex" events. These were deep invasions of cold air that blanketed much of the South in brutally cold air for several days or more. The last polar vortex to impact Virginia in 2014 brought record single-digit temperatures during the second week of March. Following this shock to the system, 2014 was somewhat similar to last year in that we saw few extreme weather events once winter subsided. There were no significant tornadoes or hail storms, no hurricanes or tropical systems, no micro-bursts or derechos, no significant long-term drought or excessive flooding. The only exception was a report of widespread damage to trees from a strong storm in eastern Hanover County on June 19th. The downed and broken trees from this storm were reportedly scattered over 6,000 acres. Most places saw an adequate or close to average amount of rain for much of the growing season, with only a few short-term dry spells here and there. Another fairly wet spring softened the impact of early season defoliators, such as gypsy moth and fall cankerworm. Summer rains fell regularly enough in most places to avoid any significant drought, while temperatures were moderate to slightly above or below average, with an exceptionally cool and mild August. Things started to dry out slightly by fall, but by the end of October, most locations were only within a few inches of average annual rainfall for the year. Cool to unseasonably cold fall weather has already started to set in early. The first truly cold air hit the U.S. by mid-November this year.

Fall Cankerworm Outbreak in Eastern Virginia

The third year of an extensive fall cankerworm outbreak once again spanned a large area covering several counties in eastern Virginia (Figure 2). The worst-hit areas included King George, Caroline, Stafford and Spotsylvania counties while areas in and around the City of Richmond saw a sharp decline in overall defoliation. The Bull Run Mountains, spanning Prince William and Fauquier counties, also saw a second year of defoliation that increased in intensity from 2013. In total, eight counties and a total area spanning almost 57,000 acres were variably impacted with light to heavy defoliation. Approximately 16,000 acres were classified as having heavy, continuous defoliation and an additional 41,000 acres were classified as heavy but patchy. Overall, this is a significant decline in outbreak area compared to the previous two years

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and it looks like the cankerworm population may be on the decline. Typically by the third year of outbreak of a native defoliator, we expect natural enemy populations (insect predators and parasitoids) to catch up and more effectively regulate host numbers. It is thought that a parasitoid wasp that attacks the eggs is most effective at controlling cankerworm numbers.

As usual, most of the severely defoliated trees were oaks, while maple and beech also saw some moderate to heavy defoliation. Due to a relatively cool, wet spring, most trees refoliated very quickly and are expected to live through the event. Some trees may ultimately die, particularly those that have seen two to three successive years of heavy defoliation and already had other stressors with which to contend. An outbreak of this duration and magnitude is unprecedented as far as Virginia records go, particularly for this part of the state. Typically, cankerworm outbreaks occur in the mountains at higher elevations.

Oak defoliation from fall cankerworm on Bull Run Mountain in Prince William County

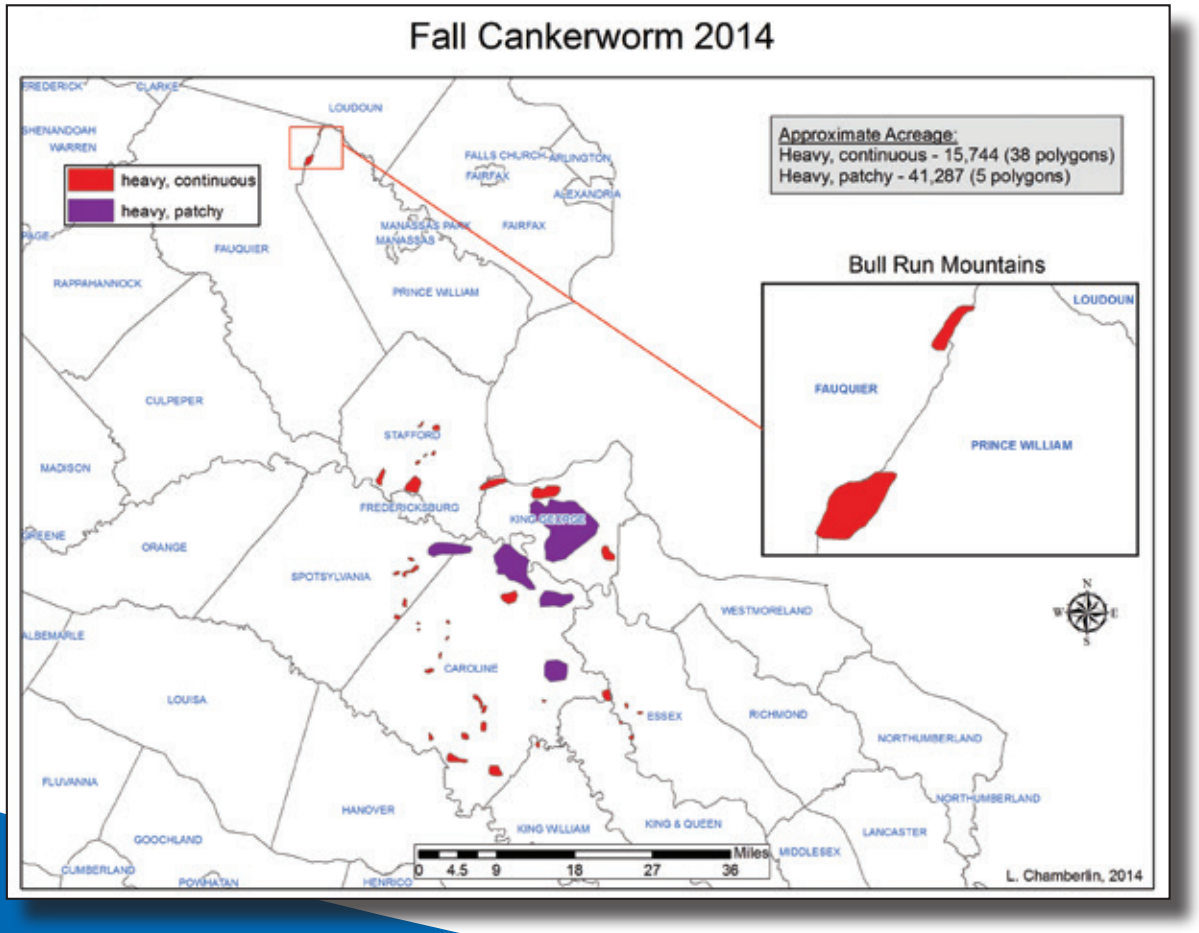

Figure 2

Jumping Oak Gall Wasp Outbreak in Northern Virginia

Beginning in June, homeowners in six Northern Virginia counties flooded the phone lines of Virginia Department of Forestry and Virginia Cooperative Extension offices expressing concern about defoliated white oak trees. The staff of the Northern Virginia (NOVA) work area, including Terry Lasher, Kyle Dingus, Blake Barnes and Joe Rossetti, conducted aerial and ground surveys and determined that, while this occurrence was fairly widespread, it was concentrated in and around the hills of western Fauquier County and adjacent Loudoun and Prince William counties (Figure 3). Portions of Culpeper, Orange and Rappahannock counties were also affected but were not included on the map.

The culprit was a very tiny insect known as a gall wasp. There are many species of gall wasps, particularly those that affect oak trees. These "wasps" do not sting and are rarely ever noticed by the public. However, this type of insect injects eggs into plant tissue, which forms a swelling or "gall" around the injection site. Inside a hollow space within the gall, the developing egg hatches into a larva and ultimately emerges from the gall as an adult wasp, repeating the cycle one or more times each year depending on the species. Each species of gall wasp specializes on a particular host and plant part, and each species produces a unique gall. Therefore, there are a wide variety of plant galls that differ in shape, size, color, texture and the part of the plant affected (leaves, twigs, buds, flowers, etc). While gall wasps are a normal component of every forest ecosystem, they are generally kept under control by other insects and are not typically abundant enough to cause serious damage to trees and shrubs. However, in rare instances, they can become so abundant that their galls can cause noticeable damage. Why certain species of gall makers undergo outbreaks and others do not is unclear.

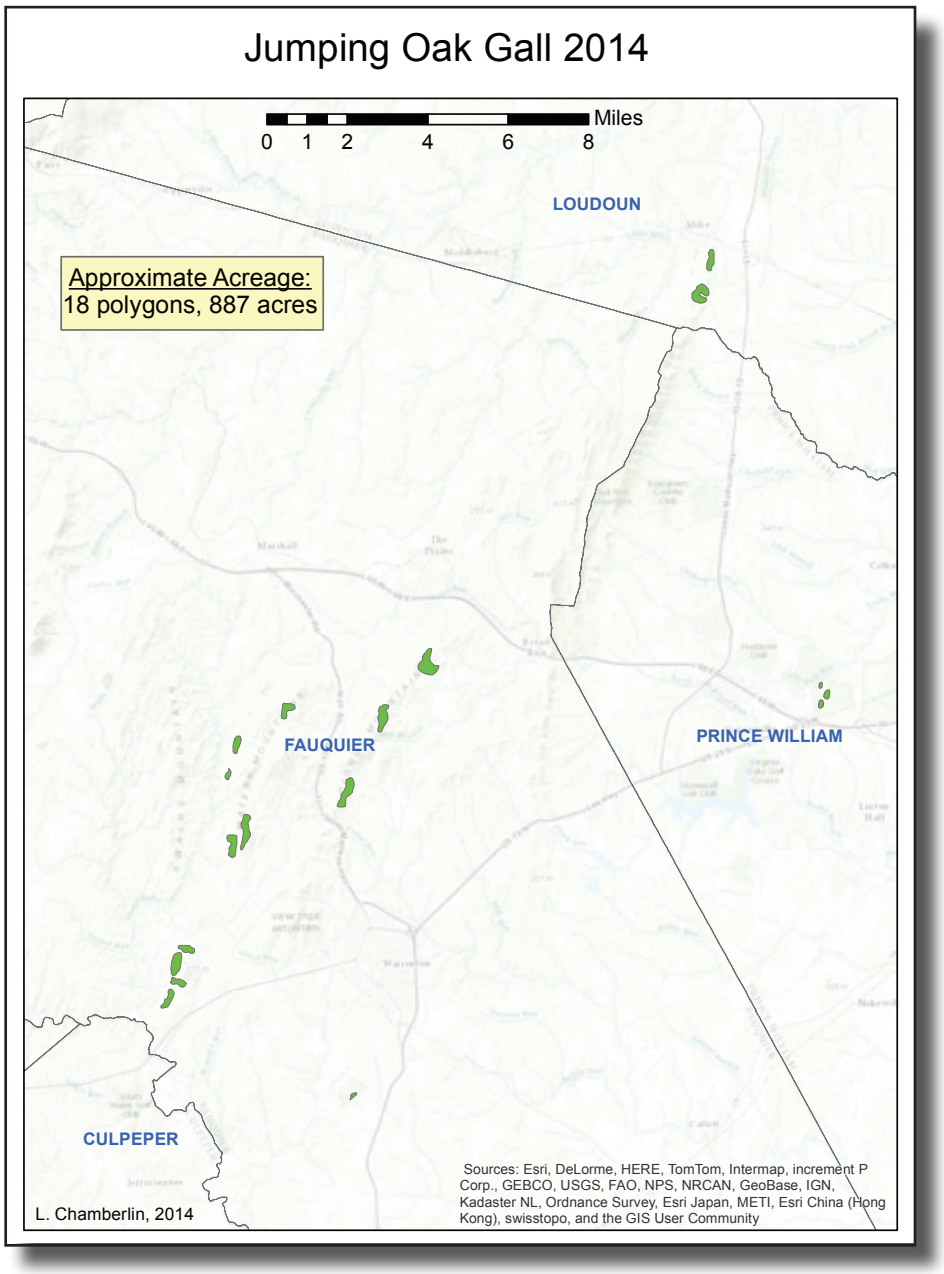

Figure 3

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Jumping Oak Gall Wasp Outbreak, continued

In this case, we were dealing with "jumping oak galls" – also known as "oak button galls" because of their button-like shape. These galls are quite small – about the size of a sesame seed – and are located on the underside of white oak leaves. They are orange in color and dislodge easily from the leaves when brushed lightly. Each gall leaves a "pock-mark" of dead cells at the point of attachment to the leaf. These dead spots on the leaves can sometimes be so abundant that they begin to run together, eventually enveloping and killing an entire leaf. Many trees have lost 50 percent or more of their foliage, and some trees have lost almost 100 percent.

Various views of defoliation due to the jumping oak gall wasp on white oaks in Fauquier County, VA. (Aerial photo by Terry Lasher, VDOF senior area forester, Northern Virginia)

Outbreaks of this particular gall wasp are not very common, but they have occurred before in the NOVA area. Typically, gall outbreaks are short-term in nature, and gall wasp populations soon crash on their own after a year or two. While the current defoliation was concerning and sudden to many folks, the good news is that most trees recover without too much long-term damage. While defoliation can be a significant stressor, a tree that is otherwise healthy will normally start to produce new leaves and survive, even when defoliation is near 100 percent.

Gypsy Moth

Ground and aerial surveys located 18 small gypsy moth infestations totaling 36 acres across six counties in the Piedmont and near the I-95 corridor between Richmond and Fredericksburg. Some of these locations were also hard hit by fall cankerworm over the last few years. Some oaks that were defoliated heavily never leafed out properly and are likely declining and dying from various factors, including defoliation events, site-related stresses, past drought and old age. The next dry spring may lead to increasing gypsy moth defoliation in many locales. However, this makes the fifth consecutive year of virtually no detectable defoliation due to gypsy moth in the mountains

Gypsy Moth, continued

or on federal (National Forest or National Park) lands. For the fifth year in a row, a cool, wet May augmented *Entomophaga maimaiga* populations, which may be helping to prevent a major resurgence of gypsy moth populations across the Commonwealth.

Gypsy moth infestation in a Hanover County neighborhood near I-95

Oak Decline Following a Defoliation Event

Regardless of the culprit, trees that experience severe defoliation for two or more years in a row are more likely to succumb, especially when exposed to other stressors. Many oaks across Virginia, especially older ones, often suffer from decline. Oak decline is a complex condition that can be due to multiple factors acting in concert. These factors include site-related stressors, such as poor soil and mechanical damage to the roots or tree bole from mowing or other equipment, or from recent construction and soil disturbance. Areas that have experienced severe drought over the past 10 years also see elevated rates of oak decline; even if we aren't experiencing drought conditions right now, drought impacts can often be seen years later after root disease sets in and slowly weakens trees. Weakened trees become more vulnerable to insects and diseases, which contribute to further decline.

Most people don't notice tree decline because the initial symptoms can be subtle and occur internally or below-ground. Trees can appear to die "suddenly" when they reach a critical point, but, in most cases, they were rotting from the inside for many years. Homeowners should not panic, though, if their trees look bad during the summer months due to brown leaves or defoliation. If the tree is otherwise healthy, it can withstand a lot of defoliation before any long-term health impacts set in. Even if an oak tree looks bad for the rest of the year, it's best to wait until the following spring to see if it leafs out normally. This usually indicates the tree is doing fine.

Thousand Cankers Disease / Walnut Twig Beetle

A more recent threat to Virginia's forests is thousand cankers disease (TCD) of black walnut. This disease is caused by a fungus spread by the walnut twig beetle (WTB), which bores into and feeds within walnut twigs. Each beetle hole becomes infected with fungus, which causes a small canker in the twig. After hundreds or thousands of beetle entry points, many small cankers are present and end up girdling small twigs, then major branches, and pretty soon the whole tree is killed. This process can take 10 to 20 years depending on the initial health and size of the tree when first attacked.

Beginning in June 2011, positive identification of the fungus and the associated walnut twig beetle occurred for five counties and two municipalities: these include the counties of Henrico, Chesterfield, Hanover, Goochland and Powhatan and the cities of Richmond and Colonial Heights. With the deployment, by VDACS, of walnut twig beetle pheromone traps across the Commonwealth, new TCD infestations were discovered in northern Prince William and Fairfax counties in Northern Virginia in 2012. This now makes two major metropolitan areas in Virginia where WTB/TCD appear to be pretty widespread. Surveys by VDACS continued in 2013 and resulted in the counties of New Kent, King William and King and Queen added to the quarantine. WTBs were caught in the far southeast corner of Louisa County (Piedmont county adjacent to the quarantined Goochland County) last summer, but no disease or cankers were found in this county as of yet. Louisa County could be quarantined in the near future if continued monitoring reveals TCD there. No new WTB or TCD counties were added to the quarantine in 2014.

Southern Pine Beetle

The southern pine beetle has been relatively quiet during the last 12 years. Numbers remain extremely low in most places based on the spring trapping survey results and relatively few reports, and there has been a decrease in activity since last year. In total, six spots amounting to 56 acres of dead loblolly pine across four counties were detected.

Industrial loblolly pine plantations in the Central Piedmont, Buckingham County

In general, the southern pine resource in central and southeast Virginia remains healthy and productive. Federal funds from the USDA Forest Service Forest Health Protection support our (Southern Pine Beetle Prevention) cost-share program with landowners and loggers for thinning of pine stands. To date, Virginia has thinned about 45,000 acres of loblolly pine since 2004 out of approximately 130,000 acres of two- to 10-year-old stands estimated to be overstocked. Overstocked pine stands are more vulnerable to bark beetle outbreaks and thinning is the best method of reducing this threat.

The only area of major southern pine beetle activity across Virginia during the last few years is on the island of Chincoteague on the Eastern Shore. This location has many mature loblolly pines growing on difficult soils, exposed to salt spray and saltwater intrusion and in environments such as campgrounds and developed areas that receive a lot of vehicle traffic, soil disturbance and compaction. There are also sites where loblolly is grown in traditional plantation culture and as part of natural forested areas, such as on nearby Chincoteague National Wildlife Refuge. The infestation has been festering and growing for at least three years and threatens most of the mature pines on the island.

Hemlock Woolly Adelgid

Significant hemlock decline continues in many areas due to the hemlock woolly adelgid (HWA), although trees in some areas that have supported infestations for many years are still hanging on. The adelgid continues to spread and has more-or-less permeated the entire range of hemlock within Virginia, minus a few pockets here and there. Based on annual plot surveys conducted by Virginia Tech entomologists from Professor Scott Salom's lab, hemlock mortality levels average about 27 percent in the southwest portion of the Commonwealth from Bath and Rockbridge counties southwest to Lee County. This is a five percent increase from last year's mortality estimate.

I recently visited the Limberlost Trail, which is near Big Meadows along the Skyline Drive in Shenandoah National Park. This trail was once well known for its magnificent stand of old-growth hemlocks. Sadly, it was one of the first major casualties of the HWA advance through Virginia. The trees in this stand also died quite quickly, most within five

Dead hemlocks (left) along the Limberlost Trail, Shenandoah National Park, with vigorous sprouting of sweet birch underneath (right).

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Hemlock Woolly Adelgid, continued

years during the 1990s. This caught Park officials off guard, and, although some remaining hemlock trees persist due to systemic insecticide treatments over the last couple of decades, most were not treated in time. Even though I had never seen these hemlocks in their full glory (I arrived in Virginia in 2005 when most here were long gone), it is not hard to imagine what it might have looked like based on the number of standing dead trees, fallen logs and gigantic stumps that remain on site. With the sudden increase in light levels on the forest floor, nature is filling in the gaps with a vigorous sprouting of sweet birch that are almost too thick to walk through. There is even a fair number of red spruce seedlings in the understory. Red spruce does well only at elevations above 3,000 feet or so in Virginia. Nothing will replace what was lost, but nature's capacity to regenerate itself is nonetheless inspiring.

Emerald Ash Borer (EAB)

The emerald ash borer (EAB) was first found to be established in Fairfax County, Virginia, in 2008 and has since been found in 23 counties, including six new counties this year (Alleghany, Bath, Bedford, Fauquier, Page and Shenandoah) (Figure 4) . 2012 was a breakout year for EAB in Virginia, with 13 additional counties added for a total of 17. Most of these new finds were due to the widespread APHIS trapping survey, but several new infestations were also discovered separately killing thousands of trees, especially in Southside Virginia. In 2013, no new counties were added to the list, but new infestations were discovered in and around the extensive area of infestation in Southside Virginia along with four new counties in adjacent North Carolina. In addition, Shenandoah National Park reported its first positive EAB on its northern end based on its own trapping effort. This year, many new areas of infestation were discovered and reported. Although some trapping on federal lands owned by the USDA Forest Service and National Park Service is still being done, widespread trapping efforts by APHIS ended in Virginia after 2012 due to budget cuts. Therefore, most new EAB discoveries occur after infested trees that are declining or dying become more apparent. In most cases, these infestations are at least three to five years old when found. This trend of finding new infestations will accelerate with each passing year.

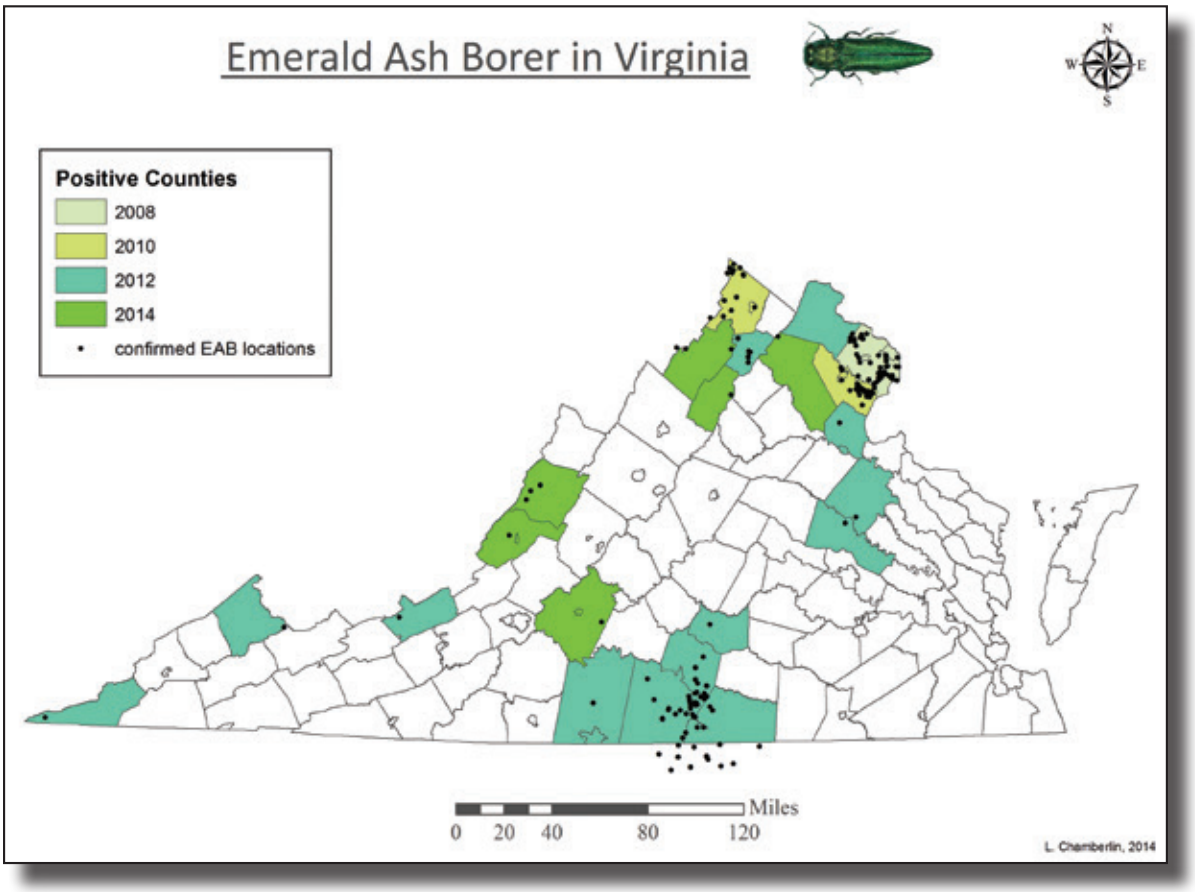

Figure 4

Odds and Ends

Towards the end of the season, numerous reports of defoliation by elm leaf beetle surfaced between Roanoke and the Shenandoah Valley, as well as areas just east of the Blue Ridge. More than 100 acres were reported to have been impacted. Generally, late season defoliators like the elm leaf beetle are not a huge concern because it's late enough in the year that trees won't need to expend valuable energy to put out a new crop of leaves. On the other hand, when trees leaf out following defoliation by early season defoliators (cankerworms and gypsy moth), they expend a great deal of energy to make new leaves, which can weaken them later on and make them more vulnerable to other stressors. However, trees defoliated early make this physiological gamble because they still have a long growing season to go – too long to be without leaves and thus not be able to build up more carbon reserves through photosynthesis. Late in the season, however, and trees have already built up a good reserve of stored energy through photosynthesis, so any lost leaf tissue doesn't really need to be replaced until the following spring. When it gets tricky is mid-season defoliation (late June/July); which physiological strategy a tree takes is less certain and depends on tree species, tree health, environmental conditions and many other variables.

This year, there were scattered reports of damage to young pine plantations by voles on hundreds of acres in Amelia and Charles City counties, and pales weevil on dozens of acres in Henry County. Why do I mention these two very different pests in the same sentence? For one, both attack young pine seedlings by feeding on bark and cambium of very young pine seedlings and saplings, which can easily result in girdling and death of the pines. Damage is typically sparse but can occasionally be catastrophic, requiring replanting. Like most things, these two pests are probably way underreported. Reinspection surveys after planting need to be rigorous, frequent and detailed enough across the state for any conclusions to be drawn about whether these problems are widespread or localized and what the underlying issue might be. Rarely do people have time to collect the data that are really needed for a proper evaluation of the problem (or lack thereof) on a state-wide basis. Sometimes plantations that end up understocked due to seedling mortality are discovered a year or more after the damage occurred, making it difficult, if not impossible, to determine the culprit. We do see vole problems in pine plantations spike from time to time; often the most damage occurs in late winter when food sources are scarce and snow cover provides the voles protection from predators so that they can attack the base of the pines unmolested (see the April 2006 issue of the Forest Health Review for a detailed review of the vole problem). Pales weevils are typically controlled by treating seedlings with insecticide in the nursery before planting, although this treatment can be overcome if weevil populations are locally very high. But as to whether plantations with VDOF treated seedlings in Henry County have more pales weevil problems than anywhere else or, vole problems might be worse in Amelia and Charles City counties than anywhere else, I cannot possibly say without more information.

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