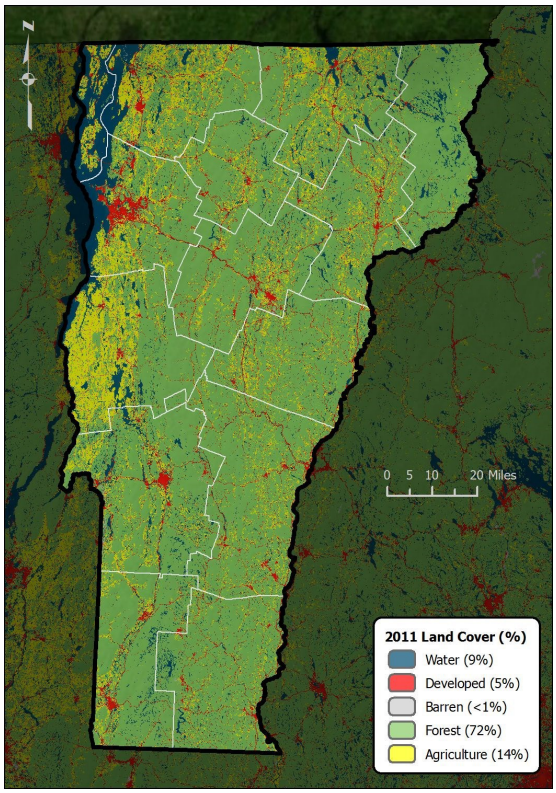
Forest Health VERMONT *highlights* 2015

These highlights summarize information from the annual report on Forest Insect and Disease Conditions in Vermont. In addition to an overview of the forest resource in Vermont, this summary provides forest health program highlights, separate sections on hardwood and softwood insects and diseases which are native or well-established in the state, a section on exotic forest pests which are not known to occur in the state or which are recent invaders, a summary of activities related to non-native invasive plants, and our results from monitoring forest health.

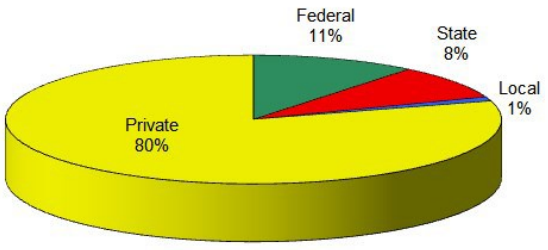
The complete annual report, as well as other Vermont forest health information, is posted on-line at http://fpr.vermont.gov/forest/forest_health. To receive a copy by mail, for assistance in identifying pests or diagnosing forest health problems, to request on-site evaluations or insect population sampling, to obtain defoliation maps, management recommendations, and other literature, or to participate in invasive pest citizen monitoring, contact us.



Forest Resource Summary

Forests cover about three-quarters of Vermont. Eighty percent of the State's forest land is privately owned with 11% under Federal management in the Green Mountain National Forest and 8% managed by the State of Vermont. Sugar and red maple, eastern hemlock, and white pine are the most common species by number and volume. More information on Vermont's forest inventory is at http://fpr.vermont.gov/forest/forest_business/forest_statistics/fia.

Forest Land Ownership in Vermont, 2012

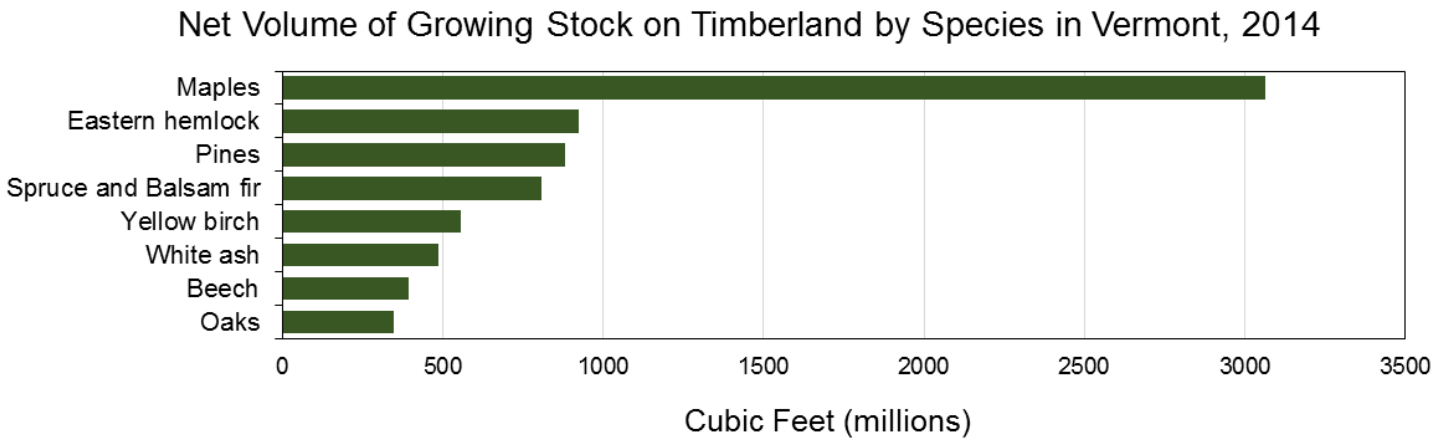


Land Cover Map: Jin, S.; Yang, L.; Danielson, P.; Homer, C.; Fry, J.; Xian, G. 2013. A comprehensive change detection method for updating the National Land Cover Database to circa 2011. Remote Sensing of Environment. 132: 159–175.

Forest Land Area by Ownership: Oswalt, Sonja N.; Smith, W. Brad; Miles, Patrick D.; Pugh, Scott A. 2014. Forest resources of the United States, 2012: a technical document supporting the Forest Service 2015 update of the RPA Assessment. Gen. Tech. Rep. WO–91. Washington, DC: U.S. Department of Agriculture, Forest Service, Washington Office. Table 2.

Forest Health Programs in the Northeast

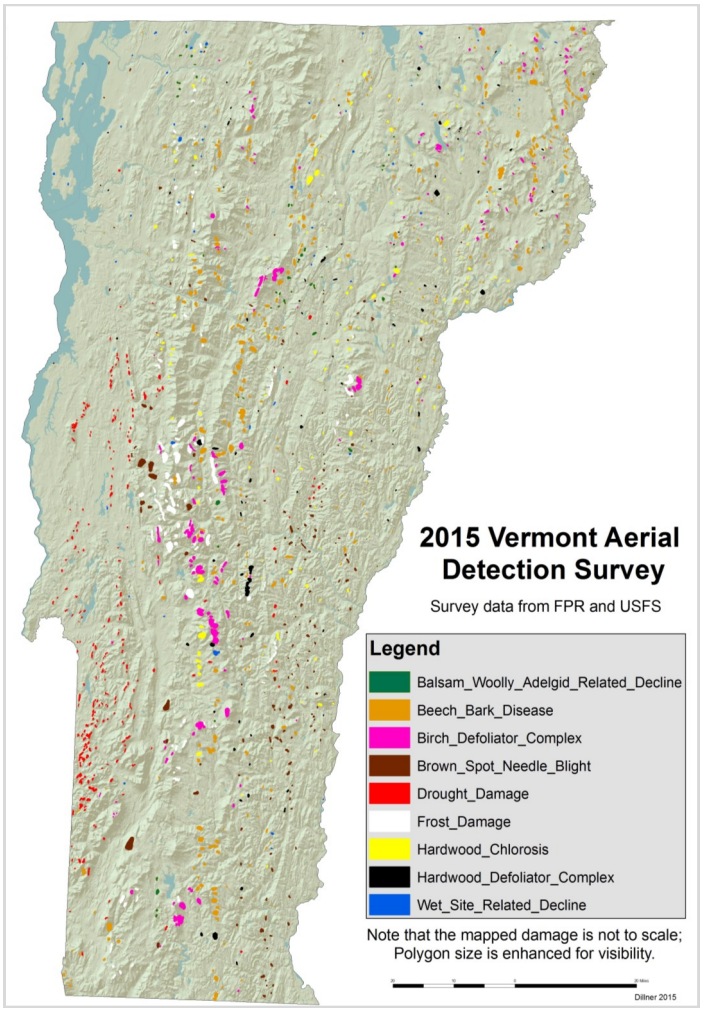
Vermont Department of Forests, Parks and Recreation (FPR) works in partnership with the US Forest Service to monitor forest conditions and trends in Vermont and respond to pest outbreaks to protect the forest resource.



Data presented are from Forest Inventory and Analysis (FIA) plots established by USDA – Forest Service. Estimates for Vermont totals were calculated using EVALIDator (v. 1.6.0.03) software (http://apps.fs.fed.us/Evalidator/evalidator.jsp), November 2015.

Forest Health Program Highlights

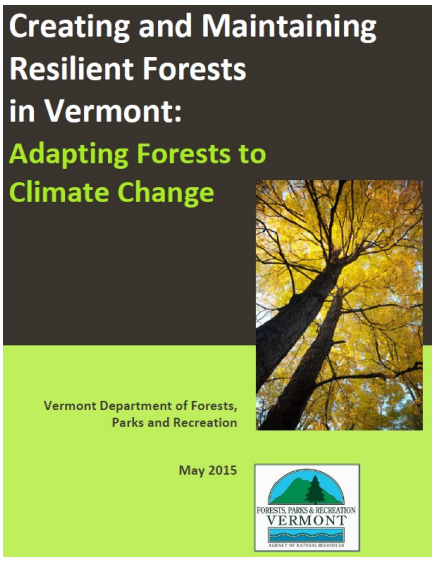
The Vermont Department of Forests, Parks and Recreation (FPR) conducts aerial and ground surveys to detect forest damage. In addition, long-term monitoring plots are inspected to evaluate forest health.



In 2015, 128,391 acres of forest damage were sketchmapped during statewide **Aerial Detection Surveys**. This represents less than 3% of Vermont's forestland, but an increase from 2014, when 38,235 acres were mapped. Beech bark disease and birch defoliation accounted for 28% and 20%, respectively, of the area mapped.

Forest adaptation to **Climate Change** remained a focus in 2015 with the publication of a guidebook for natural resource managers on preparing for climate disruptions, "Creating and Maintaining Resilient Forests in Vermont: Adapting Forests to Climate Change". This guidebook is online and content was offered and posted online through the Urban & Community Forestry Webinar Series and as part of the Vermont Forestry Outreach and Education Initiative, a webinar series on managing our changing forests.

This document on Adapting Forests to Climate Change provides strategies appropriate to current climate trends and modeled projections. Policy-level strategies are also included.



Invasive Pests and Plants are a key threat to forest health in the region. FPR and the Agency of Agriculture, Food and Markets (AAFM) collaborate with USDA agencies to survey and manage non-native forest pests, coordinate with University of Vermont (UVM) Extension on education and outreach, and work with The Nature Conservancy on invasive plant management efforts.

The website dedicated to invasives, **vtinvasives.org**, covers non-native plants and tree pests, and provides information on reporting suspects, spreading the word, and getting involved as a volunteer. With support from the Vermont Community Foundation, UVM Extension is upgrading this website, and welcomes suggestions on format or content.

The vtinvasives website, covering invasive pests and plants, is being upgraded.

A total of 166 volunteers have been trained as Forest Pest First Detectors (top).

In May, Firewood Awareness Week included displays at rest areas and tree tagging. (Photos: M. Klepack)

In 2015, nineteen new volunteers attended Vermont's **Forest Pest First Detector** Program training. This brings the statewide total of trained volunteers to 166, who assist the state effort to manage invasive forest pests by conducting public outreach and community preparedness activities, and assisting with initial screenings and other surveys.

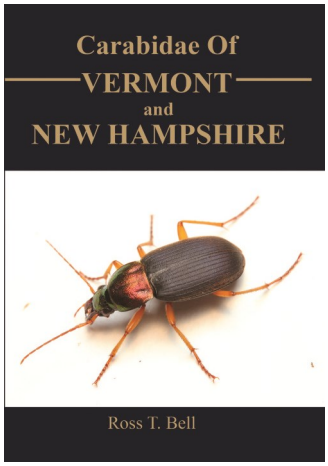
Proposed Rule Governing the Importation of Untreated Firewood into Vermont has been filed with the Secretary of State, and is posted for comment at http://fpr.vermont.gov/fpr.vermont.gov/forest/forest_health/health_management/firewood_quarantine. Two public hearings are scheduled for early January.

The rule is scheduled to go into effect on May 1, 2016. After that date, bringing untreated firewood (less than 4 feet long) into Vermont from out-of-state would not be allowed. Firewood could be brought into the state if treated to the highest USDA standard (160° F for at least 75 minutes) and accompanied by certification of treatment. By written request, FPR could grant a waiver if there is minimal threat to forest health and not restricted by other quarantines.

Firewood Awareness Week, a week-long campaign to raise awareness of the importance of buying and burning locally sourced firewood, was hosted in May by UVM Extension, FPR, AAFM, USDA APHIS, and the Green Mountain National Forest. The effort included tree tagging displays erected at 13 federal and state campgrounds, 14 rest areas, and 2 trailheads. The displays remained up through Labor Day Weekend and reached an estimated 400,000 people. A second Firewood Awareness Week is planned for the spring 2016, focusing on the new firewood rule.

At the **Forest Biology Laboratory**, we continue to provide invertebrate identifications, tree disease diagnoses and pest management recommendations, and support environmental education and outreach. Our invertebrate collection contains historical data that provide a unique inventory of Vermont's forest invertebrates, and how environmental changes, such as climate change, unusual weather and invasive species affect regional biodiversity and rare and endangered species. To that end, staff at our FPR lab, in cooperation with the Vermont Monitoring Cooperative, the Vermont Center for Ecostudies, the Vermont Entomological Society, and the Carnegie Museum of Natural History, helped publish the *Carabidae of Vermont and New Hampshire*, a book written by UVM emeritus Ross T. Bell. The book includes species accounts and summaries of the natural history of the 495 known species of ground beetles of our two states.

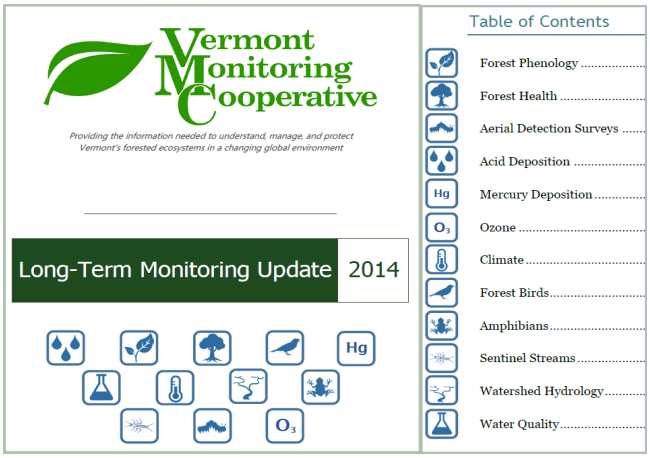
The Carabidae of Vermont and New Hampshire, by Ross Bell, includes species accounts and natural history of 495 species of ground beetles.



In a field trip led by the Forest Biology Lab, Middlebury schoolchildren learned about insects... and how to say "entomologist".

The **Vermont Monitoring Cooperative** (VMC) celebrated 25 years of forest ecosystem monitoring and research collaboration this year. In 2015, 41 forest health monitoring plots were sampled across Vermont. Nineteen were previous VMC plots and 22 were additions to the statewide system. Plots were added at sites where historical data were available from other plot network systems such as the North American Maple Project, Vermont Hardwood Health Survey, Forest Inventory and Analysis, and the Green Mountain National Forest's Long-term Ecological Monitoring Plots. This is a collaborative effort between UVM, FPR, and the US Forest Service.

The Vermont Monitoring Cooperative's Annual Report, summarizes key forest, wildlife, water, and air quality metrics, along with an analysis of the long-term patterns and trends in the data in order to provide a timely source of information on the current state of the region's forested ecosystems.



VMC's Annual Report summarizes trends in forest, wildlife, water, and air quality.

Due to concerns about **Forest Fragmentation,** the 2015 Vermont Forest Fragmentation Report was completed, providing an assessment of current and projected effects of fragmentation and recommendations for how to best protect the integrity of Vermont's forestland.

2015 Weather Influences on Forest Health

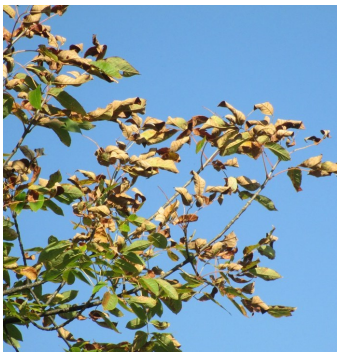
Once again, the year's weather was a major driver behind tree condition and the status of forest pests that predominated. The winter of 2014–2015 was colder than normal, with temperatures low enough to knock back populations of hemlock woolly adelgid and other cold-sensitive insects. Snow cover persisted throughout the winter.

Early spring was warm and dry, sparking multiple wildfires. A statewide burn ban was implemented for the first time since 2005, and southern Vermont was in moderate drought. After some "weather whiplash" with changing weather, most of the state recovered from drought conditions by the end of May.

Frost Damage to developing foliage of sugar and red maple was widespread following a freeze event on May 22nd. Damage was most severe on western slopes and at elevations between 1600—2400 ft. Some affected areas were noticeable throughout the summer as brown margins developed on old foliage, refoliation remained off-color, and crowns remained thin. Damage was mapped on 24,360 acres during aerial surveys.

Frost damage to maples remained visible through most of the growing season due to brown margins on old foliage (below left) and thin, off-color refoliation (below right).

The dry spring prevented infection by many foliage diseases that have been widespread in recent years, and favored the survival of defoliating caterpillars. However, June and July were mostly cool and wet, with the wettest June on record for Montpelier. Fungal diseases did develop on birch, poplar, and other species whose indeterminate growth continued to produce susceptible young leaves after the weather turned wet. Wet conditions also led to **Sugar Maple Chlorosis** in some stands, and was mapped on 9,047 acres.



Dry conditions, except in the northeastern counties, caused leaf browning on shallow sites. Scorch developed on hardwoods (left) and ash defoliation (above right) was widespread.

Precipitation was below normal in August and September, with Southern Vermont reaching moderate drought and dry conditions outside the northeastern counties. **Drought Symptoms** were observed in some locations. "Scorch", or brown margins, developed on a variety of hardwoods, especially on shallow sites. Early leaf drop also occurred as trees tried to conserve moisture. Ash is a particularly drought-sensitive species, and by late summer, complete defoliation of white ash was common.

Scattered severe storms with hail, strong winds, and torrential rain damaged trees on July 19th, mostly in eastern/central Vermont, and on August 3rd and August 15th along the spine of the Green Mountains.

Late summer and early fall were warmer than normal, delaying the onset of foliage season. At our monitoring plots on Mount Mansfield, peak sugar maple color was more than a week later than average. However, foliage season, when it did occur, was spectacular, with brilliant foliage persisting well into October.

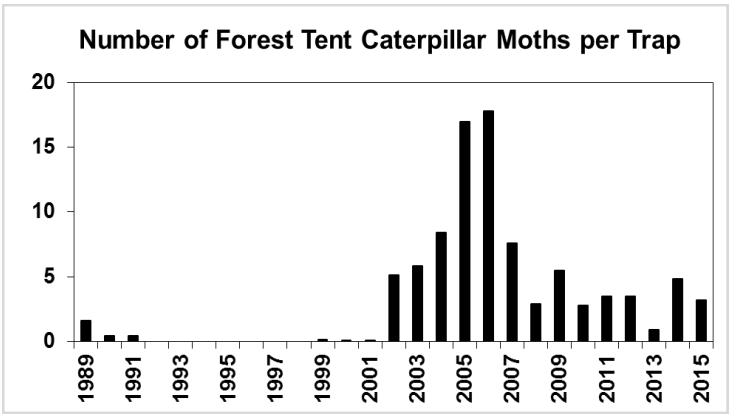
On Mount Mansfield, peak sugar maple color was more than a week later than average, but brilliant foliage persisted well into October. (Photo: R. Kelley)

Hardwood Insects and Diseases

Hardwood foliage symptoms from abiotic factors were common in 2015, but most hardwood insects and diseases remained at low levels. Maple defoliators were the most commonly observed, and may build in the future.

Forest tent caterpillars were common, but only light defoliation was observed. (Photo: W. Ciesla, Bugwood.org)

Most significantly, **Forest Tent Caterpillar** larvae, and some light defoliation, were seen throughout the state. Later in the season, moth catches in pheromone traps decreased from the previous year on a statewide basis, but counts were variable, and locally high, making it important to keep a lookout for forest tent caterpillar feeding in 2016. The most recent outbreak of this insect ended in 2006.



The average forest tent caterpillar moth catch decreased from 2014, but counts were variable and locally high.

Maple Trumpet Skeletonizer feeding was also seen throughout the state, and there was locally significant feeding by **Maple Leaf Cutter**. As late season defoliators, their impact on tree health is generally small. **Saddled Prominent** populations declined, and their feeding was rarely reported. The moth catch dropped from an average of nearly 12 per trap in 2014, to just over 1 per trap in 2015.

Dieback from **Beech Bark Disease** was mapped on 35,866 acres, an increase from the 14,479 acres mapped in 2014. Projects related to resistance to beech scale, the insect which initiates this disease, are being conducted at Green Mountain College and by the Green Mountain National Forest.

Due to the dry spring, fungal diseases that infect young foliage at that time remained low, including **Anthracnose** on maple, ash, and oak. However, foliage diseases did occur on species that continue to produce foliage later in the season. **Septoria on Birch** increased, and was a major cause of the 25,468 acres of birch defoliation that were mapped. Other common foliage diseases were seen in riparian areas on species with indeterminate growth. These included **Poplar Leaf Blight** on balsam poplar and cottonwoods and **Willow Blight**. Although foliage browning of these species is attributed to *Marssonina* and *Venturia*, respectively, the causal agents have not been confirmed.

Maple trumpet skeletonizer feeding (top left) was observed throughout the state. (Photo: C. Bassage). Septoria on birch (top right) was a major cause of an increase in the area of birch defoliation mapped in 2015. Leaf blights were common on poplar species, including cottonwoods in riparian areas (below).

Softwood Insects and Diseases

Reports of **Red Pine Mortality** increased substantially in 2015, focused on two areas of the state where this syndrome has been observed previously: north and central Orange County and east -central Rutland County. Similar observations have been made in Windsor, Bennington, and Caledonia Counties, and in other New England states.

Research is underway to determine the cause of red pine mortality in several "hot spots" in the state. Insects collected on dying red pine shoots from Mendon (top left) and Washington (lower left) were confirmed to be red pine scale. Lower right: Male cocoons and female ovisacs of red pine scale. (Photo: Allison Kanoti, Maine Forest Service, Bugwood.org)

A research project, led by a doctoral student at the University of New Hampshire with funding from the US Forest Service, is working to identify whether a primary pest or pathogen is responsible for this red pine mortality. During the research, the exotic insect, **Red Pine Scale**, was detected in Rutland and Orange Counties. The identification was confirmed by an entomologist at the Connecticut Agricultural Experiment Station. Red pine scale has been recently found in New Hampshire and Maine, but this is the first detection in Vermont.

Research is ongoing, so it is premature to say that red pine scale is the sole "cause" of this red pine mortality. Several shoot blight fungi are present and may play a role. Additionally, signs of red pine scale have not been found in some of the mortality areas under study, and the insect populations that were found this summer have been very low. Red pine scale is cold sensitive, which may help explain why it has been hard to detect.

We do not yet know how widespread red pine scale is within the state. It is very likely that the insect occurs in some of the other stands where red pine shoot mortality is occurring. Like many scales, the insect spreads in the crawler stage by wind and as a hitchhiker, so spread is generally slow. Best management practices would be to take precautions to reduce human-caused spread. The State of New Hampshire recommends harvesting stands in winter when the insect is not capable of moving on its own, to chip tops so twigs and branches dry out more quickly, and to ensure equipment is free of plant material before leaving the site.

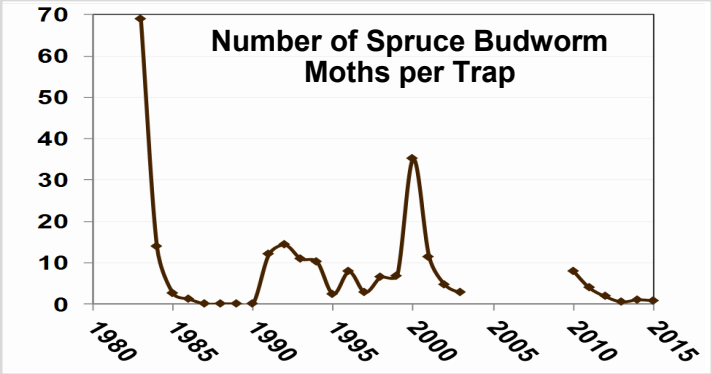
The white wool of balsam woolly adelgid (right) may be hard to find even where the insect has caused mortality (above). Balsam woolly adelgid is vulnerable to cold winters and doesn't survive on dead trees.

Balsam fir symptoms generated an unusually large number of diagnostic calls again this year. In addition, 2,263 acres of fir mortality were mapped from the air. A recent increase in **Balsam Woolly Adelgid** is responsible for some of the mortality. This insect is another exotic pest that is vulnerable to cold winters and does not survive on dead trees, so its populations have often collapsed by the time symptoms are observed.

Balsam Fir Branch Flagging, scattered in the lower crown, has also been observed throughout the state, as well as elsewhere in northern New England. No insects or diseases have been consistently associated with the symptoms, and the cause is unknown.

Balsam fir trees with scattered branch flagging (left) were seen in many locations, but the cause is unknown.

Below: The average number of spruce budworm moths in pheromone traps remains low. [Data from 1983-2015, with trapping suspended 2004-2009.]



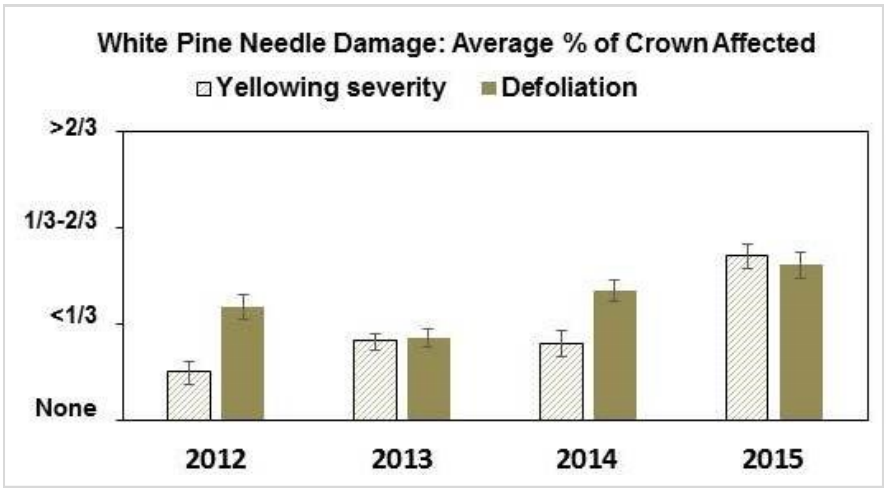
The area defoliated by **Spruce Budworm** increased again in Quebec, including south of the St Lawrence River, and populations have been building in Maine and New Brunswick. However, the moth trap catch in Vermont remains low.

Needle Diseases of White Pines continued to be widespread in the state and the region, with an increase in damage from 2014. In our monitoring plots, more yellow foliage was present than in 2014, and thin crowns were observed statewide due to early casting and consecutive years of disease. During aerial surveys, 11,488 acres were mapped. Because the damage is hard to detect in late summer, this acreage under-represents the total area affected.

The late spring symptoms on last year's needles are primarily attributed to the **Brown Spot Needle Blight** fungus. Infected needles dropped very quickly this year, and most were cast by the end of June. Browning that developed on current foliage of occasional trees and persisted into late summer is likely due to a disease now known as **Dooks' Needlecast** (after taxonomists determined that *Canavirgella banfieldii* and *Lophophacidium dooksii* are the same fungus).

The US Forest Service, in cooperation with UNH and affected states, continues to investigate this malady. Once the roles of needlecast fungi and weather are clarified, it will help in predicting the next year's damage. The major infection period for brown spot is June and July, so this year's wet conditions suggest damage will continue in 2016.

Needle diseases have been widespread since 2010, and the current epidemic has been building at least since 2005. The damage is most severe on 2nd and 3rd year needles in the lower crown where fungi have been thriving due to multiple wet springs. Because the upper foliage is mostly unaffected, trees without other health problems are expected to recover. In occasional stands, where stress factors such as wet site conditions, wind impact, or wounding are present, decline and mortality have been observed. Research has found that radial growth is reduced on diseased trees, and new foliage is stunted.



Severity of white pine needle yellowing and defoliation increased in monitoring plots (above). Last year's needles infected with brown spot needle blight (far left) were cast by the end of June. Browning of current needles persisted on some trees (left), probably caused by Dooks' Needlecast.

Hemlock Borer activity was observed on dead and dying trees in widely scattered locations. Some affected trees were predisposed to beetle attack by wind disturbance of their roots, by flooding, or drought. Increased hemlock borer activity is likely next year on ledgey sites stressed by late summer's dry conditions. Because of its shallow root system, hemlock is particularly susceptible.

Hemlock borer activity was observed on trees stressed by wind or flooding. Woodpecker activity exposes purple bark of infested trees.

Exotic Forest Pests

The **Hemlock Woolly Adelgid** (HWA) distribution map remained unchanged in 2015. Forty-nine sites were checked in 14 towns, with the help of 34 volunteers. HWA was not found in any new towns.

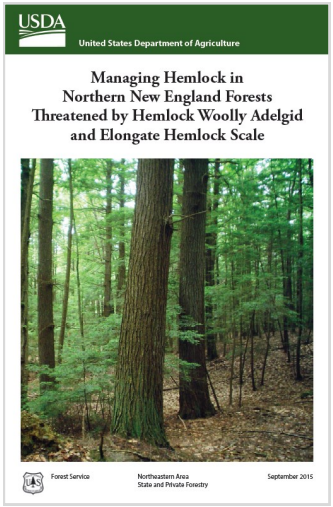
The winter of 2014-2015 was tough on hemlock woolly adelgid, killing an average of 99% of the "sistens", or winter generation. The previous winter had similar winter mortality rates. This helped to give hemlock trees a bit of a reprieve. However, populations rebounded quickly on infested sites.

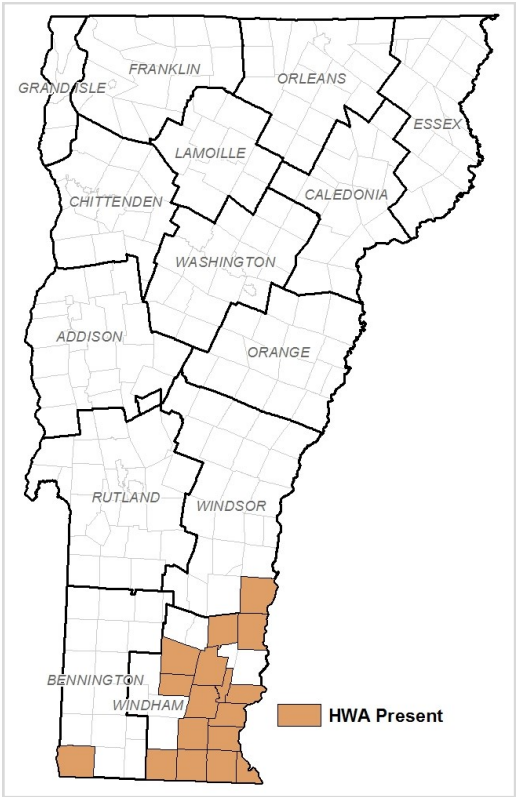
While these recent mortality rates have been high enough to temporarily stop the spread of HWA, trees are still threatened. Some stands of hemlock are in noticeable decline, with 83 acres mapped during aerial surveys, mostly on shallow sites. Compounding the situation are the spread of **Elongate Hemlock Scale** into southeastern Windham County, and the dry summer weather leaving the hemlock woolly adelgid infested area in drought conditions for a substantial period.

No predatory beetles, *Laricobius nigrinus,* were recovered during fall sampling of the three sites where they had been released, so the status of this introduction remains unknown. At UVM, research continues on potential biocontrols including silver flies and insect-killing fungi.

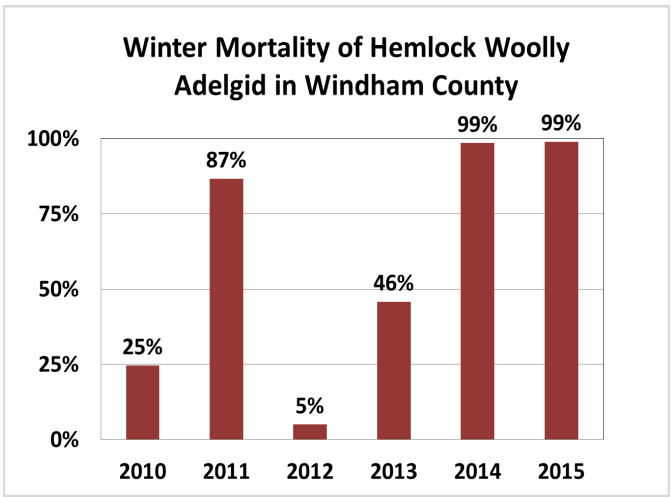
A 32 page pictorial guide "Managing Hemlock in Northern New England Forests Threatened by Hemlock Woolly Adelgid and Elongate Hemlock Scale", developed collaboratively by the three northern New England States and the US Forest Service, provides guidelines for managing threatened hemlock forests in the Northeast.

A publication with recommendations for managing threatened hemlock is available online.



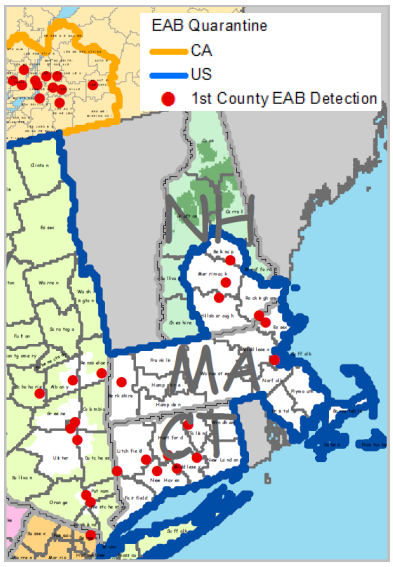


Hemlock woolly adelgid was not detected in any new towns in 2014. For the second year in a row, HWA populations rebounded quickly following heavy winter mortality. (Photo: L. Levine)



Emerald Ash Borer (EAB) is not known to occur in Vermont and was not detected by survey. However, new counties were found to be infested in New Hampshire and Connecticut in 2015.

In the northeastern US and in Canada, the regulated areas have expanded as well. As of November, the quarantine includes 4 counties in NH, and all of New York, Connecticut and Massachusetts. Anyone using hardwood firewood, ash sawlogs, or other ash products from infested states should be aware of current regulations. Information is available by contacting USDA APHIS, AAFM, or an FPR office below.



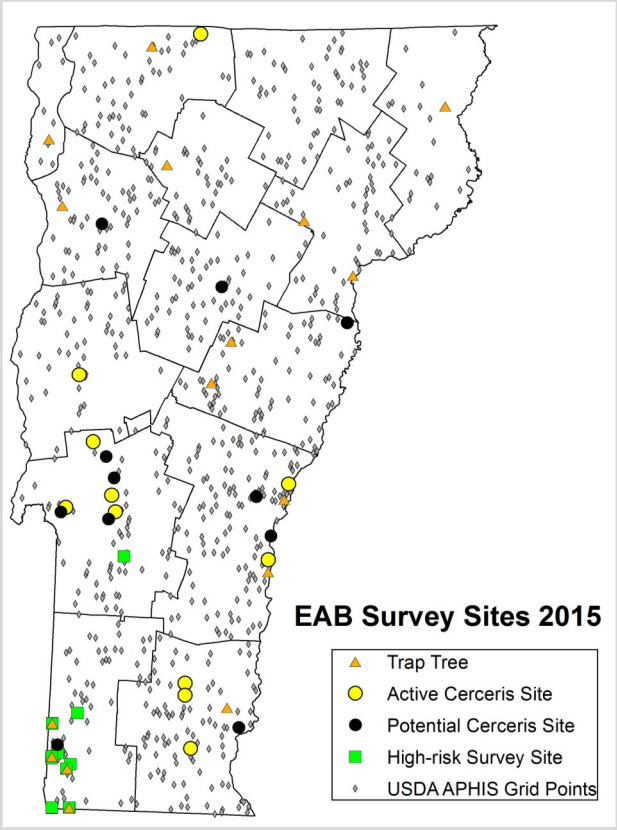
As of November 2015, four counties in New Hampshire, and all of New York, Connecticut and Massachusetts are included in the emerald ash borer quarantine area.

Map data from USDA APHIS, 11/2/15. For current information visit: www.aphis.usda.gov/plant_health/plant_pest_info/

An aggressive emerald ash borer detection effort continues in Vermont. New this year was an intensive survey to monitor for EAB in Bennington and Rutland counties, due to the close proximity of EAB detections in neighboring New York and Massachusetts. Working with individual volunteers, and volunteer organizations, 10 high risk sites were selected. In each site, both purple prism traps and green funnel traps were hung, for a total of 20 traps in the area. Trap trees were established at four of the sites. We will continue the survey next year in this location, and will also expand the effort to northwestern Vermont in order to target another high -risk area.

As part of ongoing efforts, USDA APHIS oversaw the deployment of 658 purple panel traps and 30 green funnel traps. In 2015, wasp watchers visited 55 Cerceris sites , including 15 new locations. Thirteen of the sites were active enough to warrant routine monitoring. Over 100 site visits were made, but no emerald ash borers were found amongst 659 beetles that were collected. We are also using girdled trap trees as a detection tool. In 2015, trap trees were girdled in ten counties in the spring, then harvested in November and peeled to look for signs of EAB.

In cooperation with UVM Extension, we continue to support Vermont towns in developing Community Preparedness Plans. Workshops were held in Newfane, Colchester, and Montpelier to inform community leaders about the need for and process of preparedness planning.



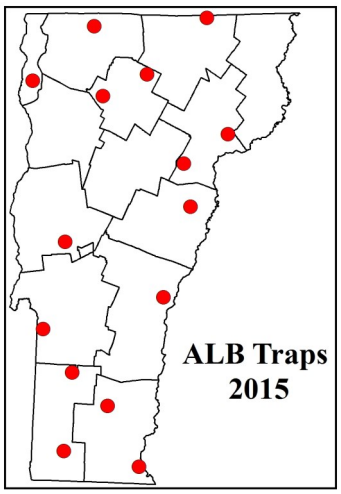
Emerald Ash Borer has not been detected in Vermont in spite of intensive surveys. In 2015, 10 high risk in southwestern Vermont were monitored with green and purple traps. USDA APHIS led the deployment of 688 additional traps in a statewide grid. Volunteers assisted with visiting 55 Cerceris sites (right) and with peeling 16 trap trees.

Asian Longhorned Beetle (ALB) is not known to occur in Vermont, and was not found in the panel traps deployed in 15 locations throughout Vermont. Traps were checked bi-weekly between July1st and September 23rd. We don't recommend any management adjustments in anticipation of this insect. However, early detection is especially important for Asian longhorned beetle; small populations in other states have been successfully eradicated.

Sirex Woodwasp has been trapped in six Vermont counties since 2007. In 2015, it was trapped again by AAFM in Chittenden County. No new observations of Sirex infesting trees were reported.

The **Common Pine Shoot Beetle** has been found in many Vermont counties since it was detected in 1999. By federal quarantine, pine material is free to move within Vermont and through most of the region. See Pine Shoot Beetle Quarantine Considerations for more information.

Other **Non-Native Insects and Diseases that Have Not Been Observed** in Vermont include winter moth, and the agents that cause oak wilt, thousand cankers disease, and sudden oak death.



Asian longhorned beetle is not known to occur in Vermont, and was not found in any of the 15 traps deployed in 2015.

Non-Native Invasive Plants

Invasive Plant Management efforts grew in 2015, with progress on mapping, control, outreach and education made possible through several grant-funded opportunities. A statewide invasive plant coordinator was hired within FPR, thanks to collaborative efforts between departments in the Agency of Natural Resources, The Nature Conservancy, and Jane's Trust. Over 18 workshops were hosted for a variety of stakeholders.

Department staff continue to provide outreach and information about invasive plants to the public and professionals, and are building the capacity to continue to identify and control invasive terrestrial plants on state lands across Vermont.

Efforts continue in Southwestern Vermont, combining invasive plant control with hands-on education and community service with creating and maintaining demonstration areas on state land to exhibit long-term management. This season, over 430 volunteers took part in these invasive education and management projects, contributing about 2,100 volunteer hours. The strike team known as the Habitat Restoration Crew controlled populations of invasive plants in State Parks and State Forests in this region.

The Mapping for Healthy Forests effort continues to focus on Northwestern Vermont. This citizen science project trains volunteers to assess and prioritize treatment areas for invasive plant management. All of this information is stored on the iNaturalist website and accessible through this link: https://www.inaturalist.org/projects/mapping-for-healthy-forests-vermont.

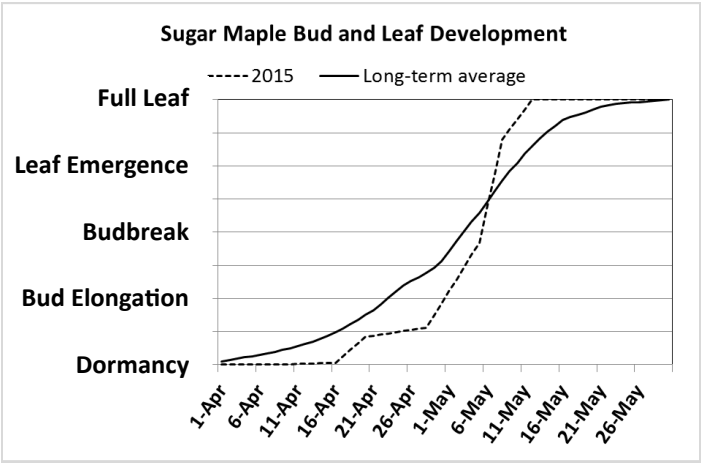
In southwestern Vermont, 430 volunteers and a habitat restoration crew were involved with invasive plant control. Students from Fair Haven High School made a dent in the invasives at Bomoseen State Park (left). In Shrewsbury, volunteers and the crew attacked a patch of goutweed (right).

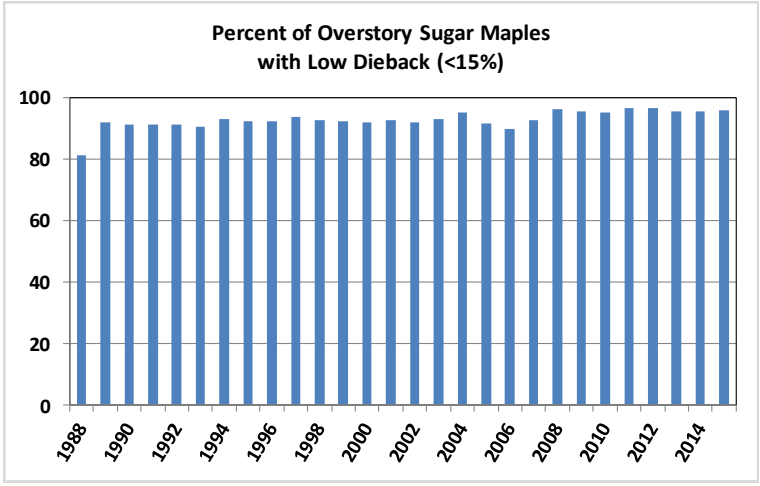
Monitoring Forest Health

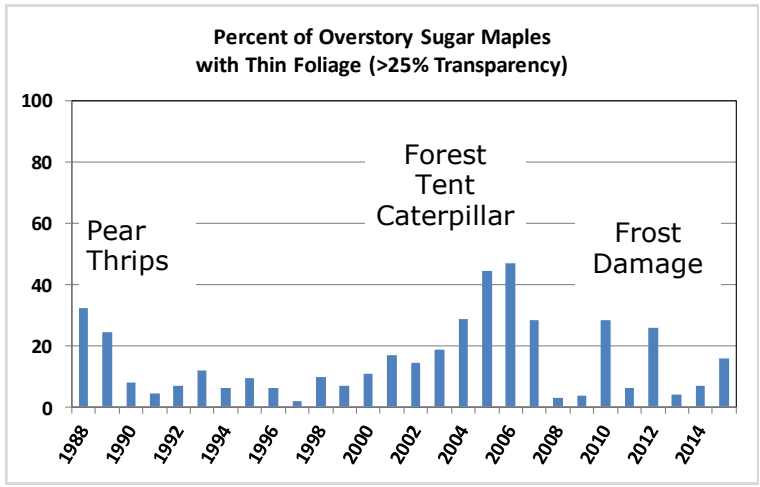
Vermont has continued to monitor sugar maple health in sugarbushes and in maple stands since 1988. In these **North American Maple Project** (NAMP) plots, over 95% of sugar maples were rated as having low dieback (less than 15%).

The frequency of thin foliage increased from 2014 with over 15% of overstory maples having greater than 25% foliage transparency. Foliage transparency is sensitive to current stress factors. In 2015, most of this was due to frost damage, which was observed on 20% of the NAMP plots. Other recent spikes in transparency were also due to frost injury. In previous years, pear thrips and forest tent caterpillar defoliation were responsible.

Sugar maple trees in Underhill were monitored for the timing of budbreak and leaf-out as part of the **Vermont Monitoring Cooperative.** Sugar maple leaf bud expansion was slower than normal in 2015. Budbreak on May 6th was nearly 3 days later than the long-term average, but full leaf-out was 5 days earlier than average.







Over 95% of sugar maples were rated as having low dieback (<15%) in North American Maple Project plots (above). Thin foliage was mostly due to frost.

In spring phenology monitoring plots, sugar maple budbreak was slightly later than average (left).

For more information, contact the Forest Biology Laboratory at 802-879-5687.	Windsor & Windham Counties.....	Springfield (802) 885-8845
	Bennington & Rutland Counties.....	Rutland (802) 786-0060
To contact Forest Resource Protection or County Foresters:	Addison, Chittenden, Franklin & Grand Isle Counties.....	Essex Junction (802) 879-6565
	Lamoille, Orange & Washington Counties	Barre (802) 476-0170
	Caledonia, Orleans & Essex Counties.....	St. Johnsbury (802) 751-0110

Forest Health Protection
US Forest Service
Northeastern Area State and Private Forestry
271 Mast Rd.
Durham, NH 03824
603–868–7708
http://www.na.fs.fed.us

Vermont Department of Forests, Parks, and Recreation
1 National Life Drive, Davis 2
Montpelier, VT 05620-3801
802-828-1531
http://fpr.vermont.gov/

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