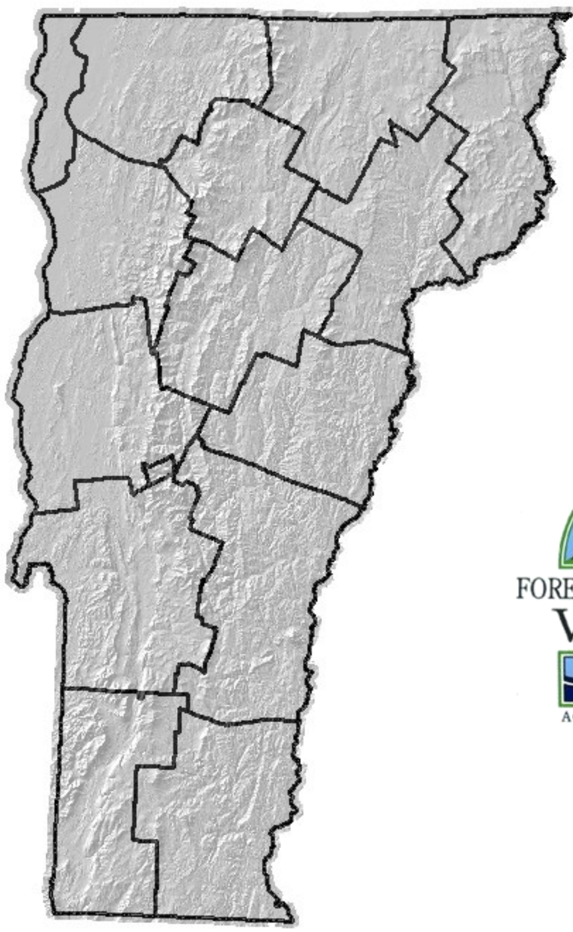
FOREST INSECT AND DISEASE CONDITIONS IN VERMONT 2015



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We gratefully acknowledge the financial and technical support provided by the USDA Forest Service, Northeastern Area State and Private Forestry that enables us to conduct the surveys and publish the results in this report. This document serves as the final report for fulfillment of the Cooperative Lands – Survey and Technical Assistance and Forest Health Monitoring programs.

FOREST INSECT AND DISEASE CONDITIONS IN VERMONT

CALENDAR YEAR 2015

PREPARED BY:

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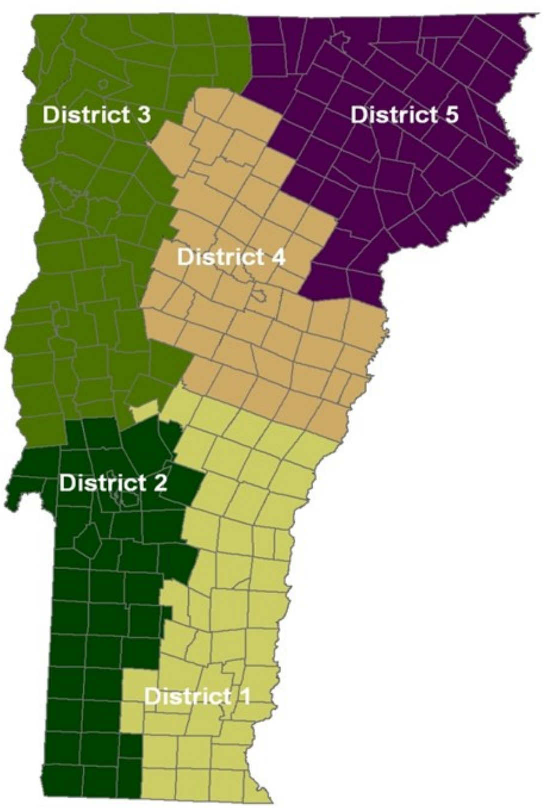

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INTRODUCTION

The report of Forest Insect and Disease Conditions in Vermont documents survey results and observations by Vermont Forestry Division staff in the calendar year. Activities were conducted in partnership with the US Forest Service, Vermont Agency of Agriculture, Food, and Markets, USDA-APHIS, the University of Vermont, the National Weather Service, cooperating landowners, resource managers, and citizen volunteers.

These reports have been produced annually since 1967. In prior years, observations were summarized in the Vermont Department of Forests and Parks Biennial Reports.

The year's most significant observations and activities are summarized at the front of the report in the stand-alone Forest Health Highlights. Details follow about weather and phenology, forest insects, forest diseases, animal damage, invasive plants, and trends in forest health.

Results are summarized from aerial surveys to detect forest damage. A statewide aerial survey to map late season defoliators and general forest conditions was flown between July 16th and September 24th. On June 17th, the US Forest Service conducted an additional aerial survey over the Green Mountain National Forest.

Ground data include tree health and pest population survey results. Additional data and metadata are available through the Vermont Monitoring Cooperative Database website or by request.
Also reported are insects and diseases of trees that were incidentally observed by our staff, the public and others. Except where indicated, the lack of an observation does not mean that the insect or disease was absent.

This report is available on-line at http://fpr.vermont.gov/forest/forest_health/current_health, or in hardcopy format. For additional information, including defoliation maps, management recommendations, and other literature, assistance in identifying pests, diagnosing forest health problems, on-site evaluations, and insect population sampling, or to participate in invasive pest citizen monitoring, contact Forest Resource Protection Personnel or your County Forester.

ACKNOWLEDGEMENTS

The **Forest Pest First Detector Program** is in its fourth year. In 2015, 19 new volunteers attended Vermont's Forest Pest First Detector Program training, bringing the statewide total of trained volunteers to 166. We thank the many continuing First Detectors, and welcome new volunteers:

Ruth Addante	Mark Dillenbeck	Peter Hausermann	Linda Miller	Sarah Sincerbeaux
John Akielaszek	PeggyAnn Duckless	Dan Healey	Sam Miller	Fred Skwirut
Gwen Allard	Gregory Duggan	Susan Hindinger	David Mitchell	Martin Smit
Alice Allen	Marilyn Dupre	Anne Holdridge	Carl Mohlenhoff	John Snell
Marie Ambusk	Elizabeth Eddy	Earl Holtz	Tim Moran	Dan Steinbauer
Ginger Anderson	Lauren Eno	Mary Houle	Fred Morgan	Brian Sullivan
Marnie Barry	Trevor Evans	Candice Huber	Veronica Norman	Jack Sumberg
Michelle Barth	Bob Everingham	Janet Kane	Tom Norton	Sally Thodal
Marvin Bicknell	Mike Fallis	Rick Kelley	Jesse Palmer	Dave Tilton
Jon Binhammer	Steven Farnham	Charlotte Kennedy	Charlie Parant	Jeremy Tinker
Corey Brink	Jim Faughnan	William Kennedy	Joe Parent	Ray Toolan
Paul Brown	Jordan Fletcher	Curtis Kile	Ken Parrot	Amalia Torres
Will Bunten	Frank Fomkin	Sara Kingsbury	Alexandra Pastor	Carol Truesdell
Pamela Burlingame	Jim Frohn	Rachel Klatzker	Nancy Patch	Rich Turner
Greg Campbell	Keith Gadapee	Chuck Kletecka	Roland Payne	Kurt Valenta
Andrew Cappello	Anastasia Gaszynski	Ali Kosiba	Shelby Perry	Pieter van Loon
Marcey Carver	Steve Gerard	Deb Lacroix	Lesley Porter	Ray Vezina
Mike Clough	Amanda Gervais	Rick LaDue	David Potter	Katherine Vose
VJ Comai	Seth Gillim	Craig Lambert	Annette Preiss	Thomas Warhol
Bill Conn	David Golubock	Teri Lamphere	Matt Probasco	Mike White
Gary Coryer	Gus Goodwin	Rory Lincoln	Michael Quinn	Jim White
Nilah Cote	Annette Goyne	Bob Little Tree	Brenda Raleigh	Patricia White
Lindsay Cotnoir	Barbara Graham	Pam Loranger	Doug Reaves	Betsy Whittaker
Zapata Courage	Ted Graham	Marie Louka	Andy Reed	Sarah Whittman
Barbara Curran	Michael Gray	Sue Lovering	Michael Rosenthal	Judy Wiger-Grohs
Mike Curran	Cynthia Greene	Jen Lyod Pain	Vincent Royce	Josh Wilcox
Brian Daigle	Scott Hance	Rhonda Mace	Daniel Ruddell	Ben Williams
Kathy Decker	Charlie Hancock	Jan McCoy	Ruth Ruttenberg	Mark Winer
F. Joshua Dein	James Harding	Polly McEwing	Gary Salmon	Jeff Young
Bob DeSiervo	Thomas Harris	Marianne McGee	Lucinda Sayre	Robert Zimmerman
Allaire Diamond	Bob Hartwell	Andy McLean	Diane Sedra	Anne Zolotas
Jaysen Dickenson	Jock Harvey	Bill Menning	Chris Simpson	

We are thankful to those who assisted us this year with **field surveys for emerald ash borer (EAB) and Asian longhorned beetle (ALB)** including: Alma Beals, Doug Burnham, Luke Curtis, Margaret and Patrick Daly, Scott, Noah and Grace Diedrich, Deborah Foote, Laura Gaudette, Annette Goyne, Kathleen Hacker, Mary Holland, Wally Jenkins, Bruce Jenson, Gabe Kellman, Bob Little Tree, Sarah Marcus, Kent McFarland, Susie Peters, Pieter van Loon, Joan Waltermire, Mary Lou Webster, Ben Williams and JudyYogman (**Cerceris wasp surveys for EAB**); Ashley Brisson, Trevor Evans, Sarah Kingsbury, Jen Lyod Pain and Lesley Porter (**ALB pheromone trapping efforts**); and Terri Armata, Drew Jones, Bob Little Tree, Joanel Lopez, Jennifer Loyd-Pain, Tim Marr, Lesley Porter, Solon Rhode, Vince Royce, Nancy Shay, Roland Smith, Dan Steinbauer, Shelly Stiles, Jim White, and Bob Williams (**EAB pheromone trap surveys and trap trees**).

Welcomed assistance with **hemlock woolly adelgid surveys** came from Alma Beals, Kathleen Hacker, Frankie Knibb, Ellen Allman, Lynn Morgan, Lori Miller, Lesley Porter, Irwin Kuperberg, Robert Trask, Robert and Barbara Wells, Mark Wright, and students and staff of Burr and Burton Academy's Mountain Campus.

Thank you to those who assisted the **Forest Biology Lab**, including Warren Kiel, who has continued to help us fill gaps in our insect collection Lepidoptera holdings, and Whitney Burgess and Levi Keszey, who helped in work with specimens and data entry. Taxonomic assistance came from Ross and Joyce Bell, Don Chandler, Rod Crawford, Charley Eiseman, Scott Griggs, Rick Hoebeke, Dan Jennings, Don Miller, Michael Sabourin and Dave Wagner.

Support in many program areas was provided by staff of the US Forest Service Forest Health Protection; the Vermont Agency of Agriculture, Food, and Markets; University of Vermont; USDA APHIS; the US Forest Service Northern Research Station; and VT State Parks, as well as many others in the VT Agency of Natural Resources.

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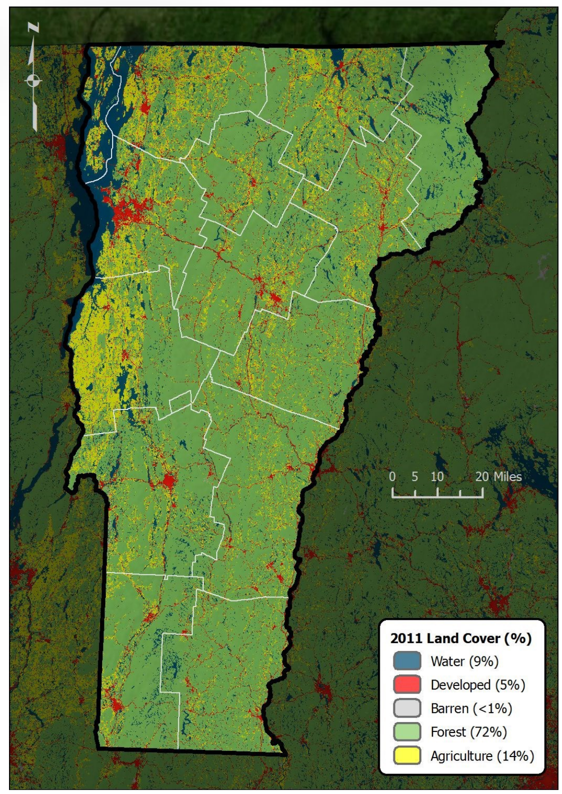
Forest Health highlights

VERMONT

2015



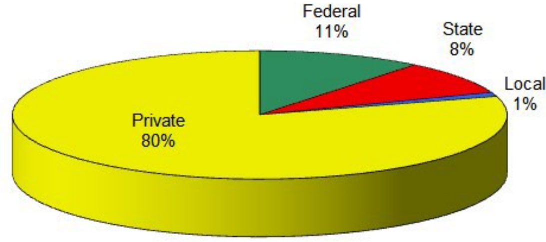
These highlights summarize information from the annual report on Forest Insect and Disease Conditions in Vermont. In addition to an overview of the forest resource in Vermont, this summary provides forest health program highlights, separate sections on hardwood and softwood insects and diseases which 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

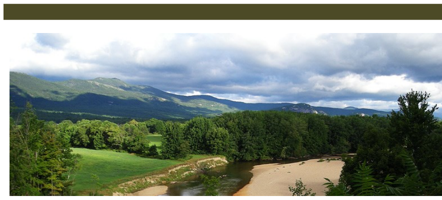
Forests cover about three-quarters of Vermont. Eighty percent of the State's forest land is privately owned with 11% under Federal management in the Green Mountain National Forest and 8% managed by the State of Vermont. Sugar and red maple, eastern hemlock, and white pine are the most common species 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



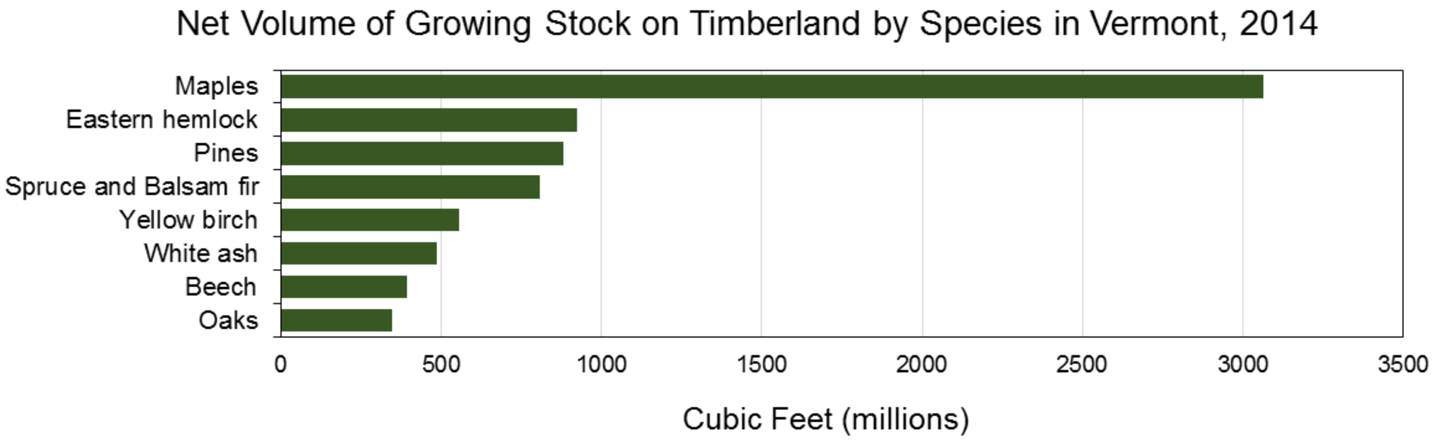
Land Cover Map: Jin, S.; Yang, L.; Danielson, P.; Homer, C.; Fry, J.; Xian, G. 2013. A comprehensive change detection method for updating the National Land Cover Database to circa 2011. Remote Sensing of Environment. 132: 159–175.

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

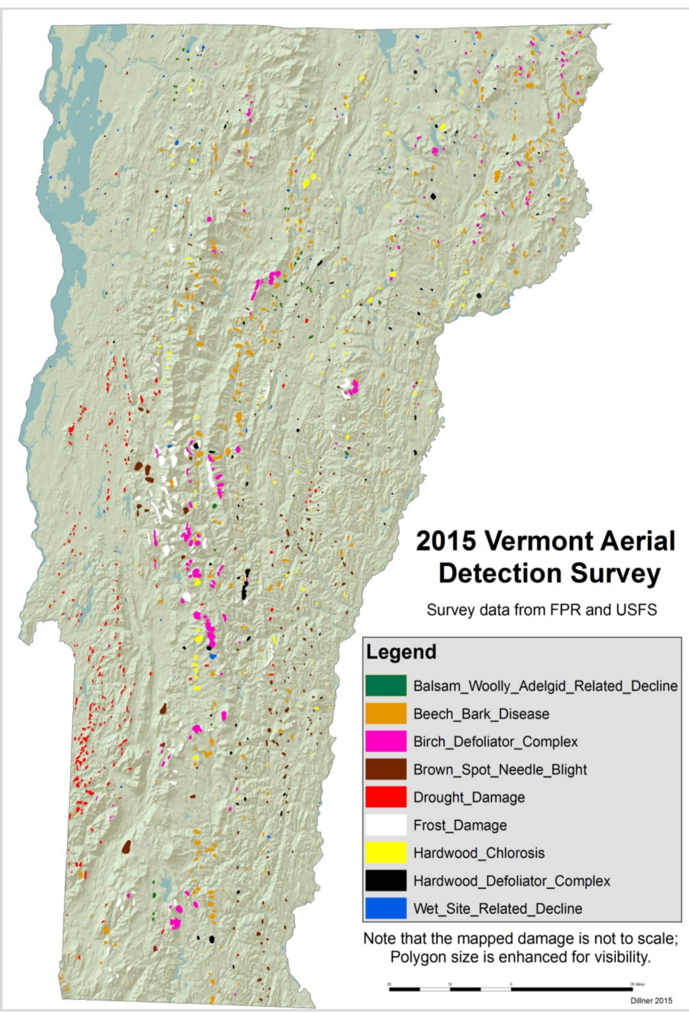
Vermont Department of Forests, Parks and Recreation (FPR) works in partnership with the US Forest Service to monitor forest conditions and trends in Vermont and respond to pest outbreaks to protect the forest resource.



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

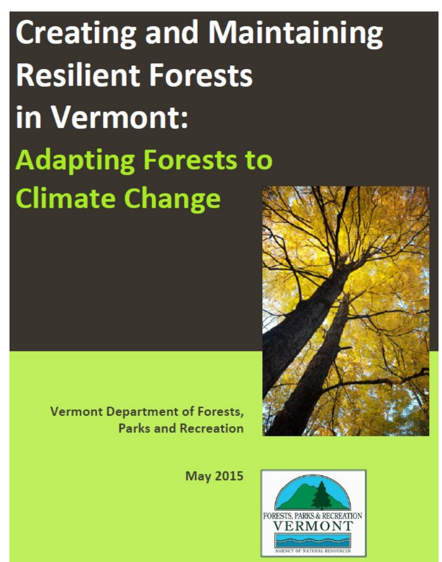
The Vermont Department of Forests, Parks and Recreation (FPR) conducts aerial and ground surveys to detect forest damage. In addition, long-term monitoring plots are inspected to evaluate forest health.



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.

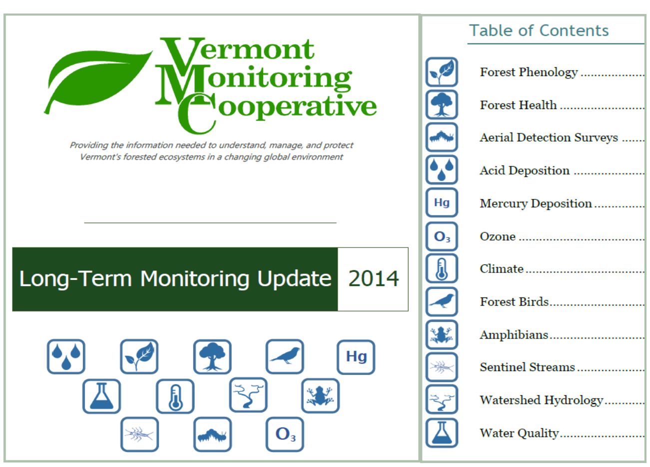
The rule is scheduled to go into effect on May 1, 2016. After that date, bringing untreated firewood (less than 4 feet long) into Vermont from out-of-state would not be allowed. Firewood could be brought into the state if treated to the highest USDA standard (160° F for at least 75 minutes) and accompanied 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 **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.


Vermont Monitoring Cooperative

Providing the information needed to understand, manage, and protect Vermont's forested ecosystems in a changing global environment

Long-Term Monitoring Update 2014

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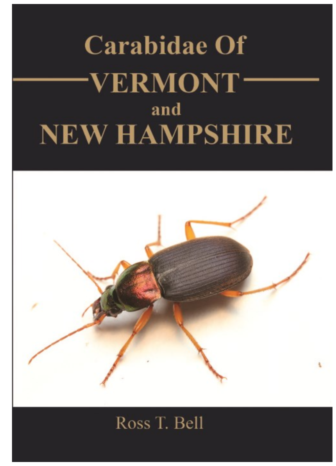
VMC's Annual Report summarizes trends in forest, wildlife, water, and air quality.

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".

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).

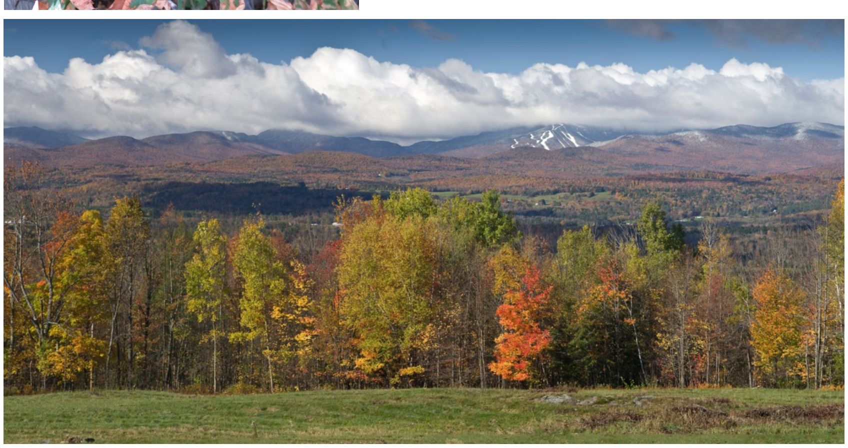
The dry spring prevented infection by many foliage diseases that have been widespread in recent years, and favored the survival of defoliating caterpillars. However, June and July were mostly cool and wet, with the wettest June on record for Montpelier. Fungal diseases did develop on birch, poplar, and 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.

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.

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.

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.



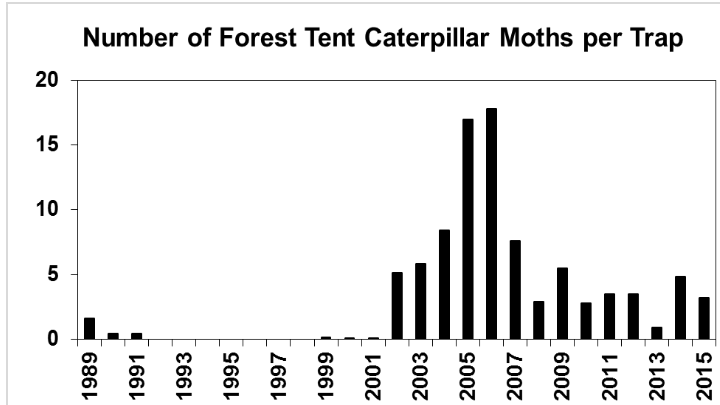
On Mount Mansfield, peak sugar maple color was more than a week later than average, but brilliant foliage persisted well into October. (Photo: R. Kelley)

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.

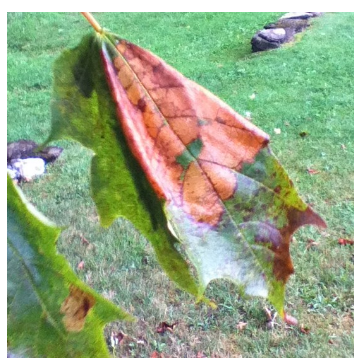


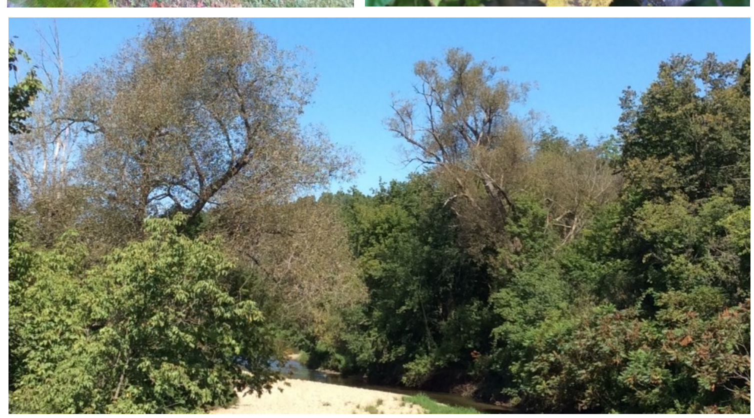
The average forest tent caterpillar moth catch decreased from 2014, but counts were variable and locally high.

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.

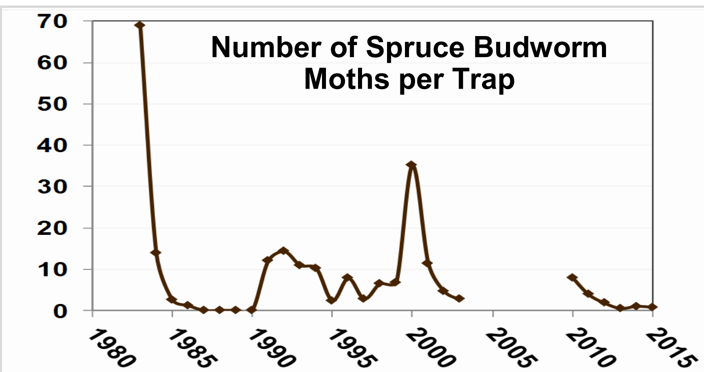
The white wool of balsam woolly adelgid (right) may be hard to find even where the insect has caused mortality (above). Balsam woolly adelgid is vulnerable to cold winters and doesn't survive on dead trees.

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.]



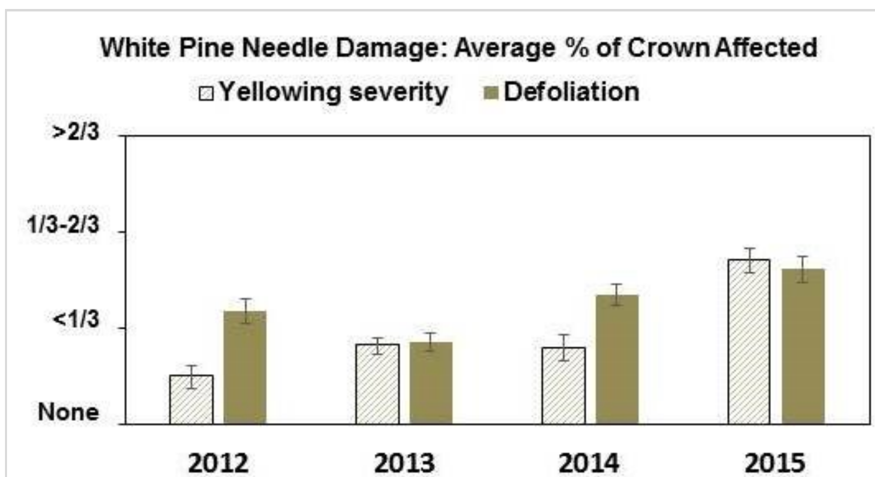
The area defoliated by **Spruce Budworm** increased again in Quebec, including south of the St Lawrence River, and populations have been building in Maine and New Brunswick. However, the moth trap catch in Vermont remains low.

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.

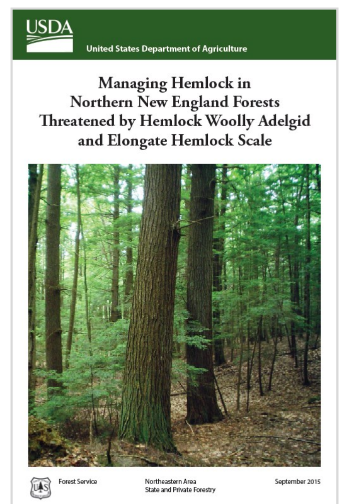
The winter of 2014-2015 was tough on hemlock woolly adelgid, killing an average of 99% of the "sistens", or winter generation. The previous winter had similar winter mortality rates. This helped to give hemlock trees a bit of a reprieve. However, populations rebounded quickly on infested sites.

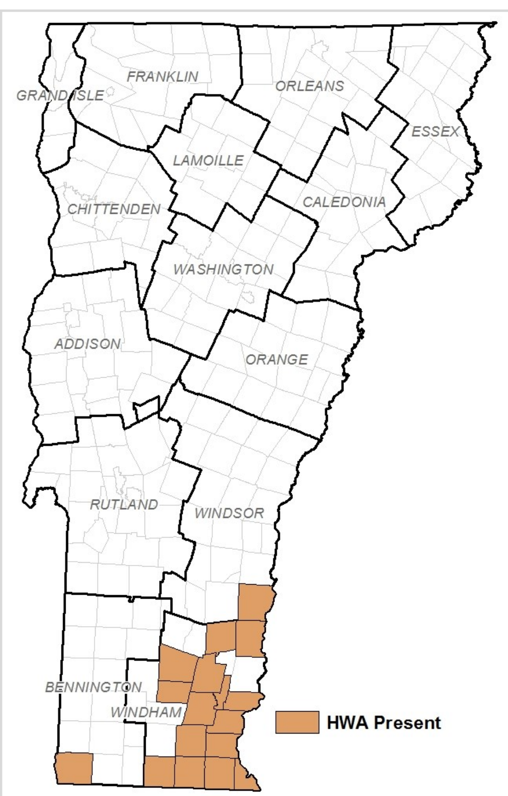
While these recent mortality rates have been high enough to temporarily stop the spread of HWA, trees are still threatened. Some stands of hemlock are in noticeable decline, with 83 acres mapped during aerial surveys, mostly on shallow sites. Compounding the situation are the spread of **Elongate Hemlock 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.

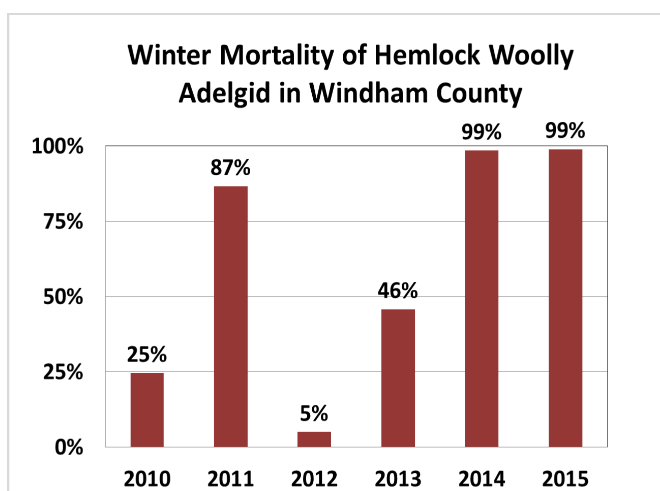
A 32 page pictorial guide "Managing Hemlock in Northern New England Forests Threatened by Hemlock Woolly Adelgid and Elongate Hemlock Scale", developed collaboratively by the three northern New England States and the US Forest Service, provides guidelines for managing threatened hemlock forests in the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

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



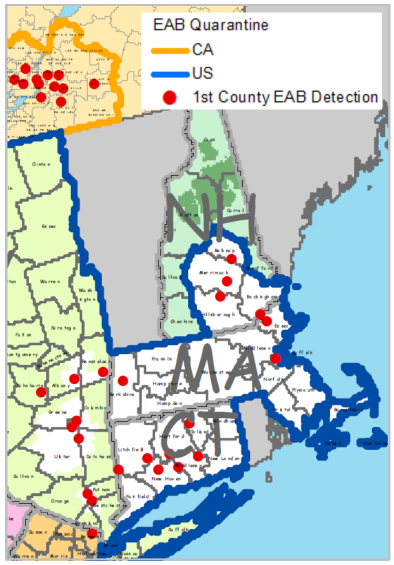


Hemlock woolly adelgid was not detected in any new towns in 2014. For the second year in a row, HWA populations rebounded quickly following heavy winter mortality. (Photo: L. Levine)



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.



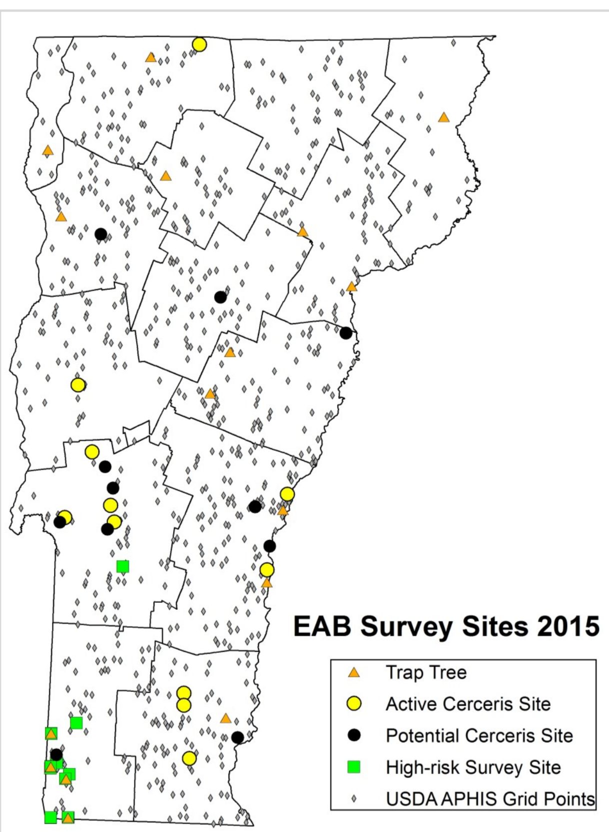
As of November 2015, four counties in New Hampshire, and all of New York, Connecticut and Massachusetts are included in the emerald ash borer quarantine area.

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.

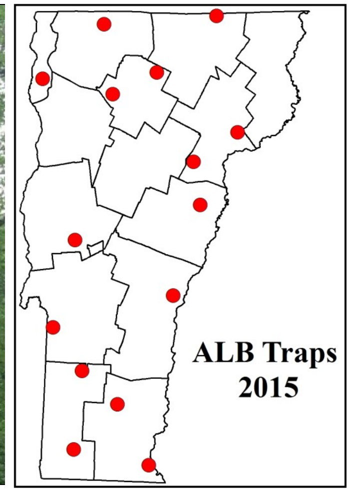
As part of ongoing efforts, USDA APHIS oversaw the deployment of 658 purple panel traps and 30 green funnel traps. In 2015, wasp watchers visited 55 Cerceris sites , including 15 new locations. Thirteen of the sites were active enough to warrant routine monitoring. Over 100 site visits were made, but 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.



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

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.

Non-Native Invasive Plants

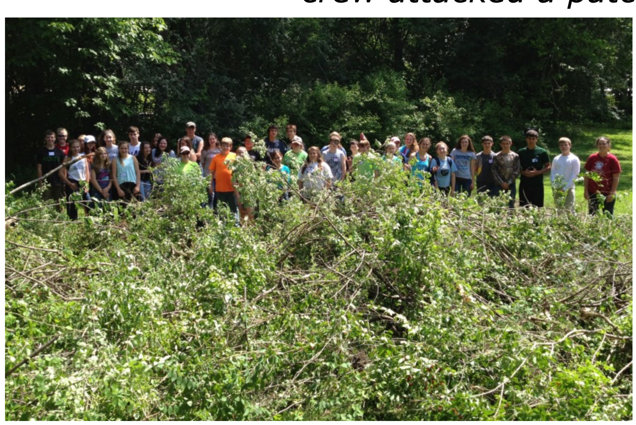
Invasive Plant Management efforts grew in 2015, with progress on mapping, control, outreach and education made possible through several grant-funded opportunities. A statewide invasive plant coordinator was hired within FPR, thanks to collaborative efforts between departments in the Agency of Natural 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.

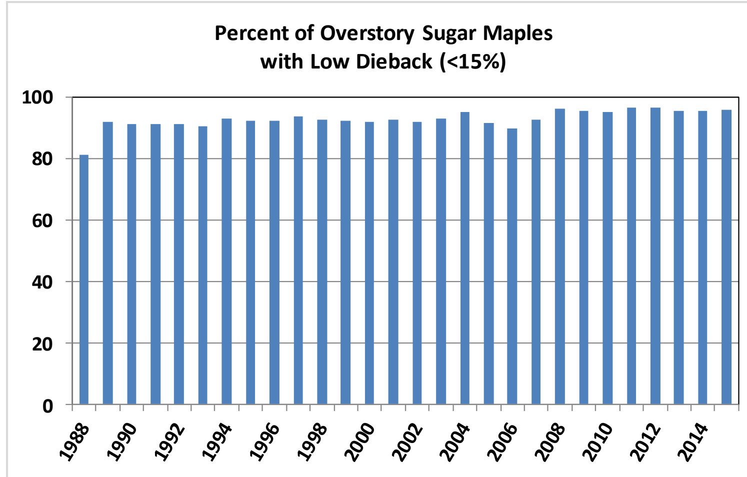
Efforts continue in Southwestern Vermont, combining invasive plant control with hands-on education and community service with creating and maintaining demonstration areas on state land to exhibit long-term management. This season, over 430 volunteers took part in these invasive education and management 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).

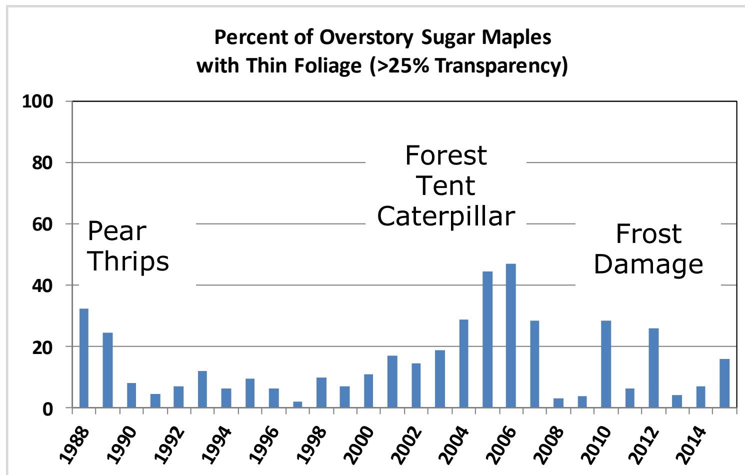


Monitoring Forest Health

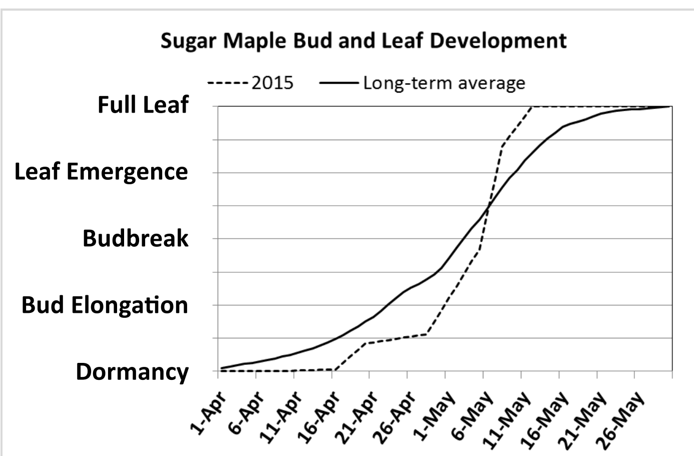


Vermont has continued to monitor sugar maple health in sugarbushes and in maple stands since 1988. In these **North American Maple Project** (NAMP) plots, over 95% of sugar maples were rated as having low dieback (less than 15%).

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
	Addison, Chittenden, Franklin & Grand Isle Counties......	Essex Junction (802) 879-6565
To contact Forest Resource Protection or County Foresters:	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/

Forest health programs in the Vermont Department of Forests, Parks, and Recreation are supported, in part, by the US Forest Service, State and Private Forestry, and conducted in partnership with the Vermont Agency of Agriculture, Food, and Markets, USDA-APHIS, the University of Vermont, cooperating landowners, resource managers, and citizen volunteers.

Where not otherwise noted, photo credits are VT Forests, Parks, and Recreation.

FIGURES AND TABLES

FIGURES

TABLES

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2015 Weather Summary

2015 was the year of extremes (or maybe a better term would be whacky). It was the coldest February on record in Montpelier and 3rd coldest in Burlington, but the warmest May, September and December as well as the 3rd warmest August and 2nd warmest November.

There was also an extreme swing in precipitation in 2015. January to May was drier than normal resulting in a moderate drought in southern Vermont and abnormally dry for the rest of the state, followed by the wettest June on record in Montpelier and on Mt. Mansfield and 3rd wettest in Burlington. It dried out again in October and November then Burlington ended the year with 6th wettest December on record.

In between, we had record rain events, late season frosts, heat waves, peak foliage in northern Vermont for Columbus Day weekend and a brown Christmas.

Winter 2014-2015

The winter of 2014-2015 included record cold temperatures and a substantial snowpack.

On December 9 to 11, 2014, a well-publicized Nor'easter arrived in Vermont and brought snow, sleet, freezing rain and rain to the region. This slow moving storm caused slippery roads and accidents, downed trees laden with heavy wet snow and extensive power-outages (see Forest Insect & Disease Conditions in Vermont, 2014 page 22 for more details).

Temps below freezing and little to no wind kept the snow in place for days, snapping trees and bringing down power lines. Ten counties qualified for FEMA federal assistance: Addison, Chittenden, Essex, Franklin, Lamoille, Orange, Orleans, Rutland, Washington, and Windsor.

Above normal temps brought rain by Christmas week which nearly wiped out the snowpack. Most of the state did enjoy a white Christmas however minimally. On December 22nd, 87% of the Northeast had snow on the ground. One week later, only 36% remained, a loss of more than half of the snowpack in a week.

In early January, snow accumulated across most of the state only to be erased by rain and freezing rain leaving the spine of the Greens and points west with only a trace to 4 inches. Eastern Vermont managed to hold most of the snow with 4 inches in the valleys to nearly 20 inches in higher elevations.

A long, long cold spell settled in by mid-month along with significant snow storms in early February. Vermont's share of these snow events was near normal compared to the mega-dumping in other parts of New England, with Maine and Massachusetts the hardest hit.

February was the 3rd coldest on record in Burlington. In Montpelier, all days in February were colder than normal, temperatures never went above freezing. Lake Champlain froze over by February 12 for the second year in a row which is quite unusual. A series of light and very dry snowstorms that didn't accumulate all that much, fell along with the cold temps, also unusual when snowstorms occur with temps at or near zero.

Sugaring season was a short one, with a late start due to record cold temps early on and then a quick warm up in about a 3-week time frame for warmer sugarbushes. Although not a record setting year for many, Vermont still managed to have a very productive season, keeping Vermont the number one maple producer in the US.

Spring, 2015

Despite the deep mountain snow, spring flooding was minimal with no heavy spring rains to accelerate snow melt. In fact, it was drier than normal and by the end of March all of Vermont except the NEK was classified as abnormally dry by the US Drought Monitor.

By early April, the valleys quickly dried out and some early fire activity was reported. The National Weather Service in Burlington, VT and Albany, NY issued a red flag warning on April 15th for the Champlain and southern Connecticut River valleys. After a short period of showery weather at the end of April, a drying trend began in early May, and as fire danger climbed, the stage was set for a sharp increase in fire activity.

High fire danger on May 2-3 sparked multiple reports of wildfires. A statewide red flag warning was issued by the NWS offices in Burlington and Albany on May 4. Multiple wildfires were reported including the largest the state has seen since the early 1990's. This 137-acre fire in Norwich was started by a downed powerline. Six acres of that fire were still visible from the air in late August and was mapped during the aerial survey (see Fire Damage, page 83).

A statewide burn ban was implemented on May 5, the first since 2005. Fire activity decreased significantly with the ban in place despite continuing high fire danger. Rain finally arrived in northern Vermont on Mother's Day, May 10. Over the next couple of days, enough rain had fallen to dampen fuels and accelerate greening. The burn ban was lifted for all of Vermont except Bennington and Windham counties on May 12. Another red flag warning was issued for Bennington and Windham counties only on May 13. The ban was allowed to expire for Bennington and Windham counties on May 19 when greening minimized fire danger despite continuing abnormally dry conditions.

This dry pattern continued statewide through May with the southern 4 counties elevated to a moderate drought on May 19th. A soaking rain began early on May 31 and ended on June 2 with lingering showers. Rainfall amounts varied with just over an inch in southern Vermont to nearly 4 inches in the central part of the state, eliminating the abnormally dry conditions in northern Vermont. The lesser amounts of rain in southern Vermont kept drought conditions in place.

In addition to being dry, May ended as the warmest on record in Burlington and the second warmest in Montpelier and on Mt. Mansfield. On the flip side, May 22, saw a widespread frost that caused light damage to ash, maple, and beech at higher elevations, and to some understory trees elsewhere. Japanese knotweed browning due to frost was also reported.

June ended as the wettest on record for Montpelier with nearly 11 inches of rain, 2.6 inches more than the previous record. Mt. Mansfield was also the wettest with 15.5 inches. Only 10 days were rain free for most of the state with frequent daily rainfall amounts between 1 and 2.5 inches. Rainfall amounts from ½ to 1 inch were common. All this rain resulted in a rise in Lake Champlain to the 98.46 foot lake level at the King Street Ferry Dock, the 5th highest ever observed for June 30.

The NWS issued frequent watches/warnings/hazardous weather statements during the month for heavy rain, severe storms with lightning, hail, wind and rain, flash flooding and flooding but despite the potential, only minor flooding, power outages and localized downed trees were reported.

Summer, 2015

The wet trend continued into July with a frequent threat of severe weather. However, these storms were generally scattered in nature, with some areas not hit at all and other areas hit more than once. With the widespread rain in June and the scattered rain in July, spring drought/abnormally dry conditions that were in place for much of the state were substantially reduced. On July 7, only western Bennington County remained abnormally dry. The following week, all dry conditions were lifted.

July 19th was memorable for many Vermonters as scattered severe storms with heavy rain, hail, strong winds, and torrential rain caused localized flash flooding in eastern/central Vermont. Plainfield and Barre Town were the hardest hit with washed out roads and damage to bridges. Downed trees and powerlines were also reported during this storm.

Summer temperatures averaged about normal with June on the cooler side, July nearly normal and August on the warm side. July had some wild temperature swings when July 16th dropped to the 40's and low 50's with even some upper 30's in the coldest parts of the state. A stretch of hot and humid weather from July 27 to 30 resulted in at least one official heat wave occurring at the Danby fire weather station. A heat wave is 3 consecutive days of temps at 90^0 or above.

The heat continued into August giving Burlington its fourth warmest August on record since 1884. The Queen City hit 90 degrees four days in a row (August 17-20), but left firm the 1944 record of eight days at 90 or above. A record temperature of 87 degrees was set at Montpelier on August 19, breaking the old high of 85 set in 1971.

Precipitation was below normal, statewide, for the month of August. According to the Palmer Drought Severity Index (which measures the duration and intensity of long-term drought inducing patterns), southern Vermont was categorized in moderate drought as of August 29; the US Drought Monitor showed Bennington, Windham and part of Rutland counties back to abnormally dry as of August 4. Severe thunderstorms developed along the spine of the Green Mountains on August 3rd and August 15th. In some areas, large hail, high winds, downed trees, and power outages resulted. Temperatures remain well above normal and dry conditions persisted into September.

Fall, 2015

Fall color was slow to get started, delayed by about two weeks. Columbus Day weekend saw peak foliage in northern and higher elevation locations where leaves rarely last until the end of September. Once the leaves turned, beautiful color and pleasant weather attracted many leaf-peepers. With no major rain or wind events, the leaves stayed on the trees for an extended season. It would be into November before oaks in the Champlain valley and southern Vermont shed their leaves while beech and larch provided some good color elsewhere in the state.

Early September saw plenty of sunshine with temperatures 4 to 9 degrees above normal, reaching the upper 80's and low 90's. Numerous records were broken or tied including the warmest September on record in Burlington. Scattered frost occurred in late September and early October in the coldest pockets but it was well into October before the first widespread frost. Precipitation was also in short supply and below normal in much of the state in September. A widespread soaking occurred from September 11th to 14th, but resulted in varying amounts. For example, less than an inch was recorded at the Essex fire weather station and over 3 inches at the Woodford station. In October, precipitation and temperatures were below normal statewide and the higher elevations received a dusting of snow mid-month.

The long autumn continued through November with warm, dry days. Temperatures in the 70's on the 5th and 6th broke records in Montpelier, St. Johnsbury and the top of Mt. Mansfield. The first snow of the season, just a dusting to 8" on Mt. Mansfield, fell on November 14th across much of the state, however most of it was gone the next day.

By the time November ended, Vermonter's were starting to wonder where winter was but December got warmer instead of colder! Temperatures averaged 9 to 15^0 above normal for the month setting several records. The most notable were the numerous records shattered on Christmas Eve, December 24 including:

- Burlington high max temperature of 68^0, old record was 51^0 set in 1957.
- Montpelier high max temperature of 66^0, old record was 53^0 set in 1957.
- Mount Mansfield high max temperature of 51^0, old record was 47^0 set in 1957.
- Burlington high of 68^0 was also the record warmest December temperature. The old record was 67^0 set on 12/7/1998 and also on 12/5/1941.
- The Montpelier high of 66^0 was the 2nd warmest December temperature. The warmest was 67^0 set on 12/6/2001 and 12/7/1998.
- St. Johnsbury high min temperature of 42^0, old record was 36^0 set in 2006.
- Mt. Mansfield high min temperature of 36^0, old record was 33^0 set in 2003.
- Burlington high min temperature of 43^0, old record was 40^0 set in 1931.
- Montpelier high min temperature of 37^0 tied the old record set in 1979.

December 2015 ended as the warmest on record in Burlington, Montpelier and St. Johnsbury.

Other December oddities included: frequent inversions, freezing fog, brilliant sunsets, rainbows, blooming flowers, sailboats on Lake Champlain, haying in Addison county and lawn mowing on Christmas day in Cabot! December 25 was also the first time ever with no snow at the stake on the top of Mt. Mansfield on Christmas since records started in 1954.

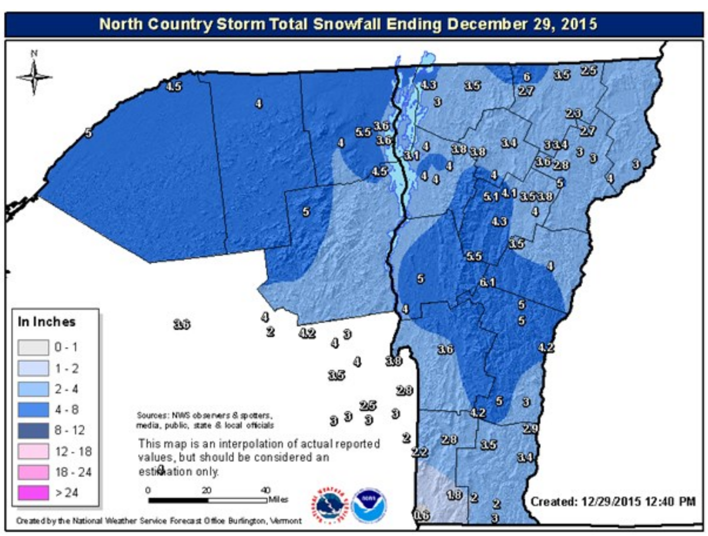
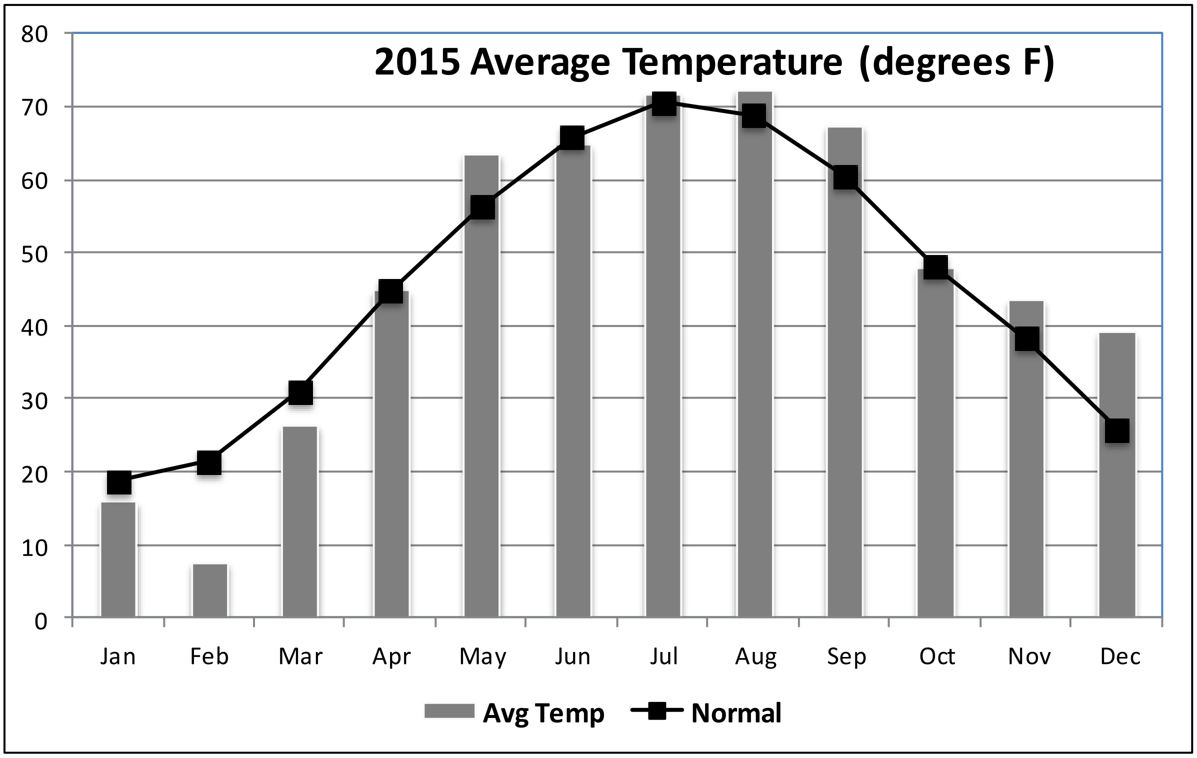


Figure 1. Total snowfall map from storm ending December 29, 2015.

In fact, the only snow east of the Rockies for Christmas was in extreme northern Maine. The first real statewide lingering snowfall (at least into the new year) occurred on December 29 with the maximum amount of 6 inches in the mountains of central Vermont. This storm caused as much drama as a normal 8 to 12 inch storm would have caused.

Figures 2-11 and Tables 1-4 *provide details on 2015 temperatures, precipitation and phenological observations.*



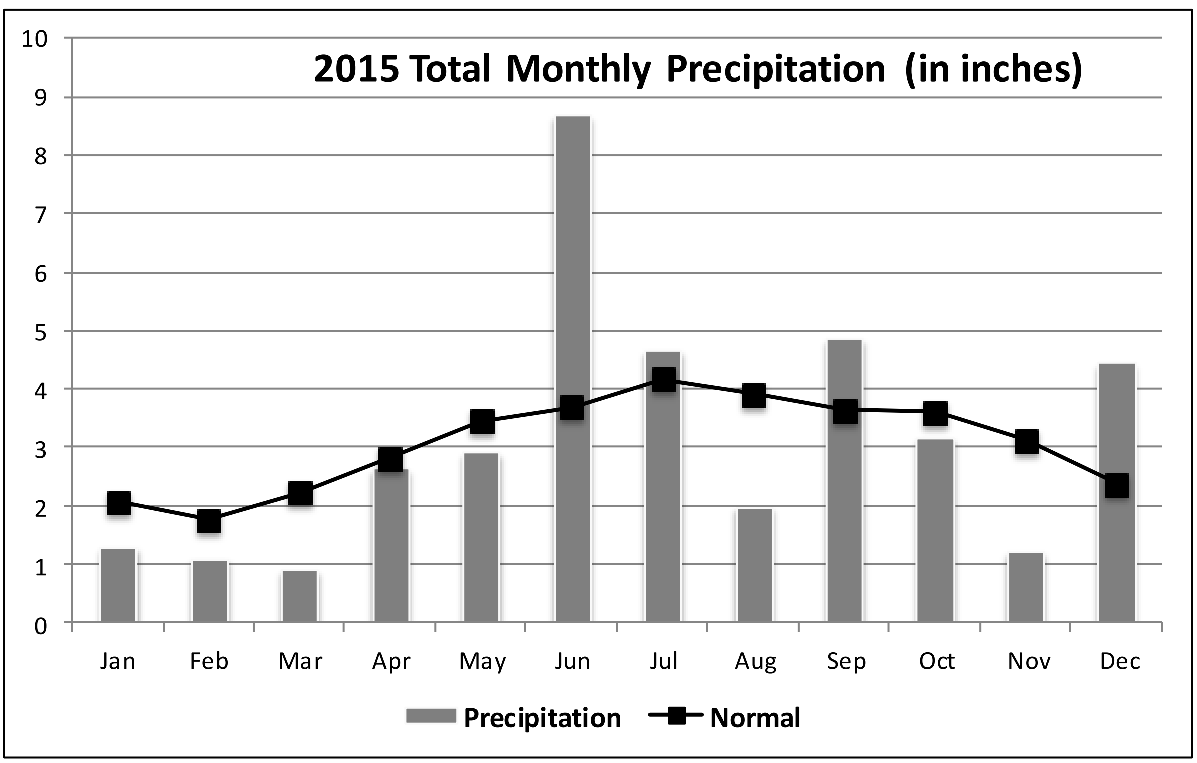


Figure 2. Monthly average temperature and total monthly precipitation in 2015, compared to normal for Burlington, Vermont. (Normals are for years 1981-2010.) *Source: National Weather Service, Burlington.*

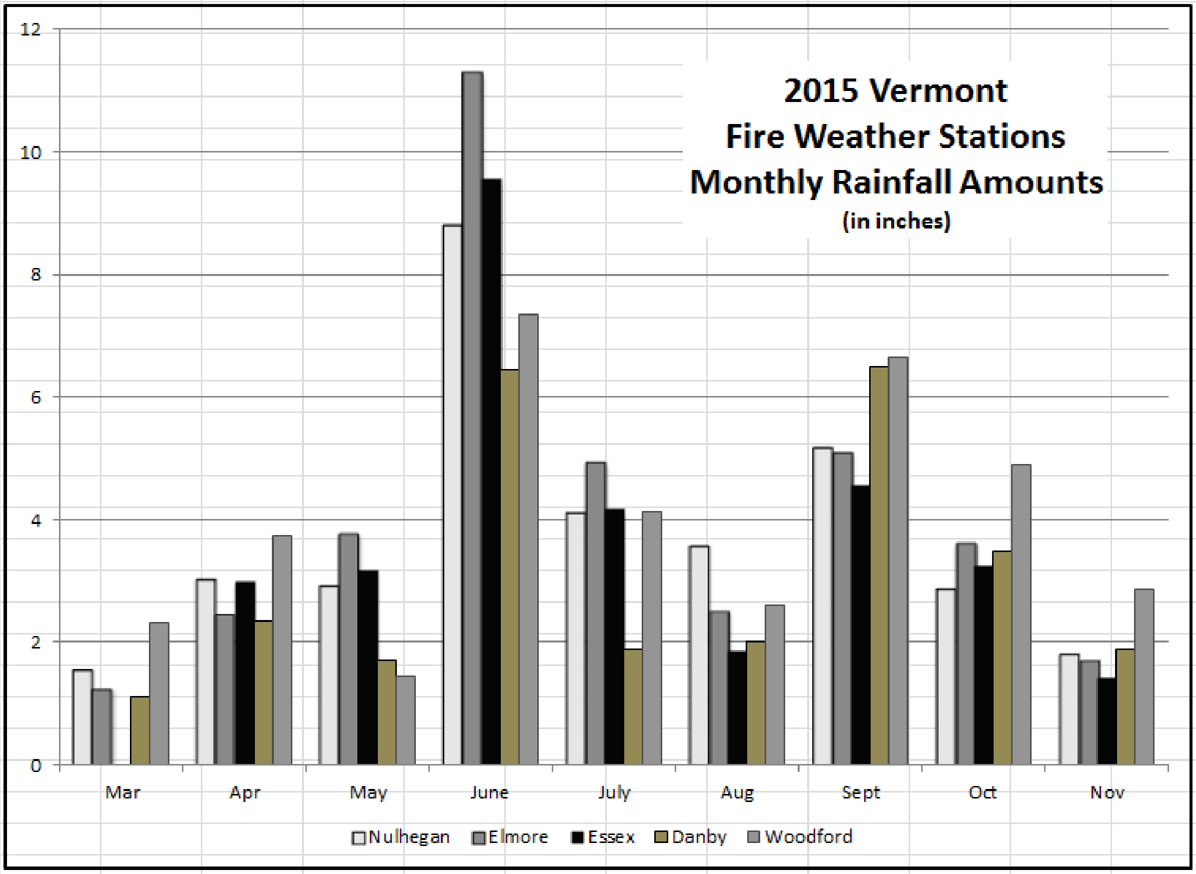


Figure 3. Monthly rainfall amounts (in inches) at Vermont fire weather observation stations through fire season, March-November, 2015.

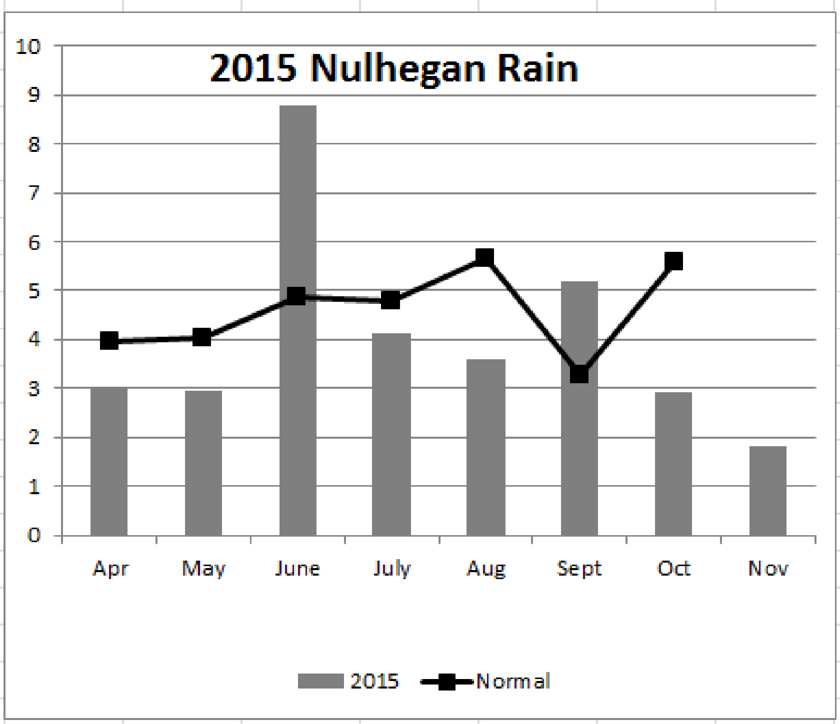


Figure 4. Monthly rainfall amounts (in inches) at the Nulhegan fire weather observation station in Brunswick, Vermont compared to normal through fire season, April-October, 2015. Normal is based on 13 years of data.

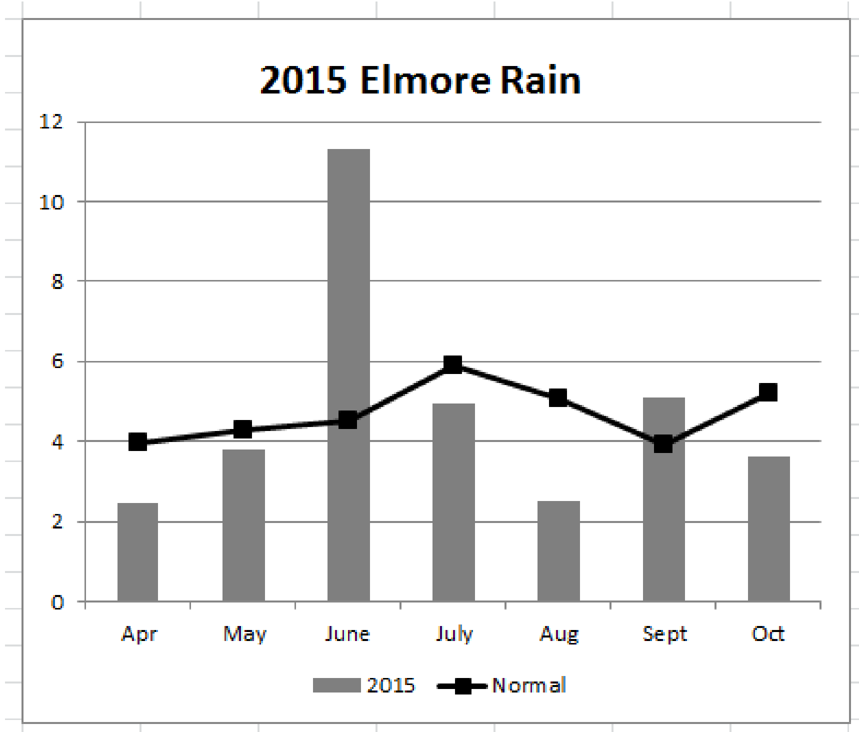


Figure 5. Monthly rainfall amounts (in inches) at the fire weather observation station in Elmore, Vermont compared to normal through fire season, April-October, 2015. Normal is based on 21 years of data.

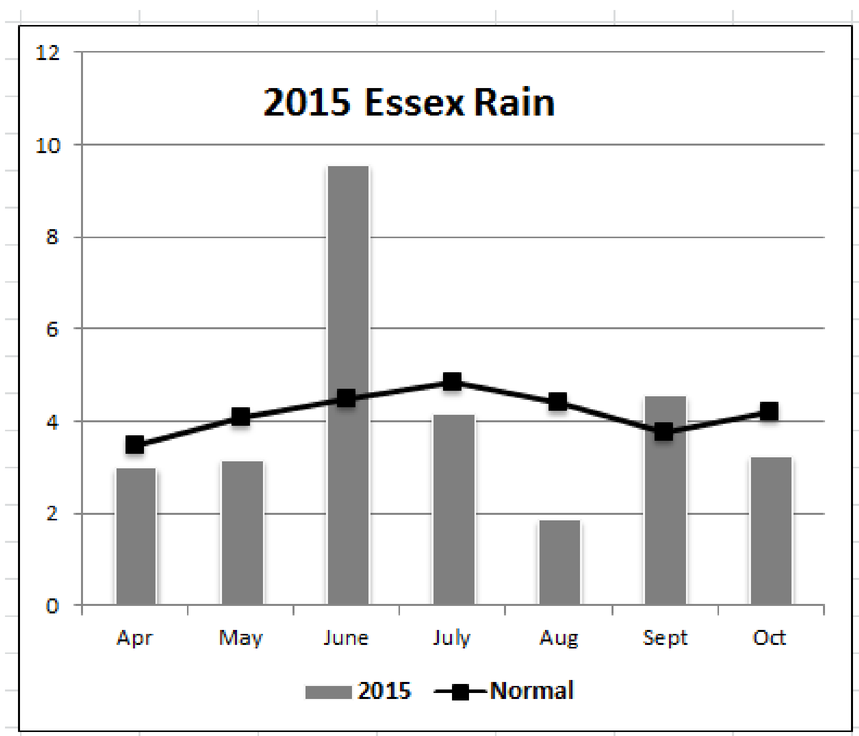


Figure 6. Monthly rainfall amounts (in inches) at the fire weather observation station in Essex, Vermont compared to normal through fire season, April-October, 2015. Normal is based on 22 years of data.

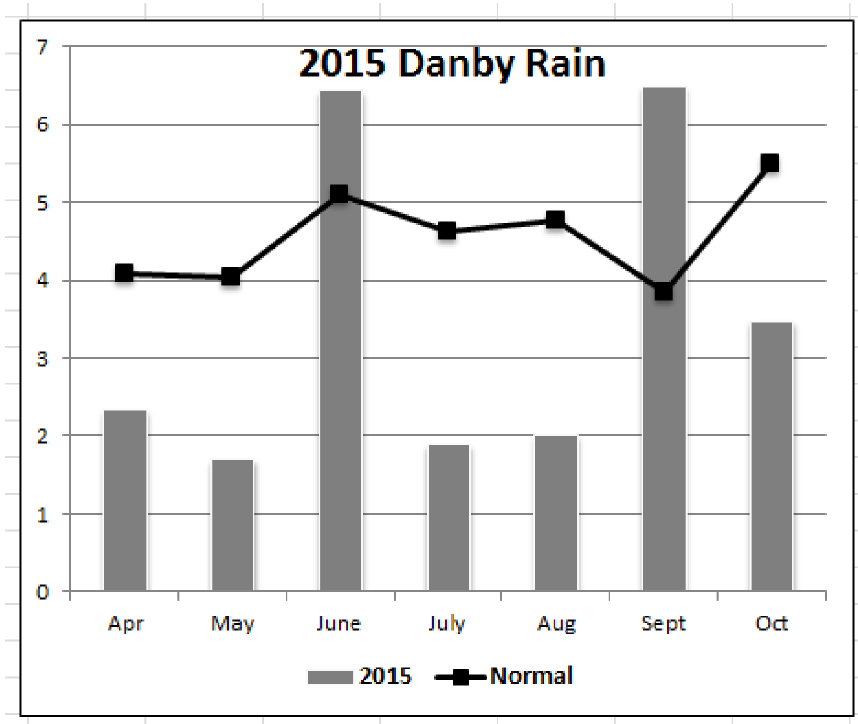


Figure 7. Monthly rainfall amounts (in inches) at the fire weather observation station in Danby, Vermont compared to normal through fire season, April-October, 2015. Normal is based on 18 years of data.

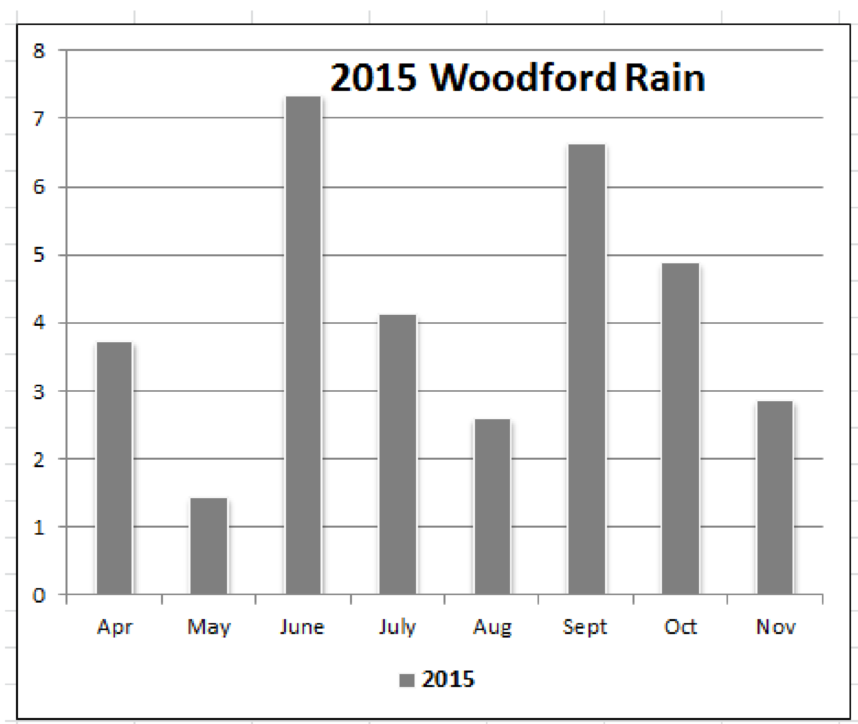


Figure 8. Monthly rainfall amounts (in inches) at the new fire weather observation station in Woodford, Vermont through fire season, April-October, 2015.

Spring Bud Break and Leaf Out at Mount Mansfield and throughout Vermont

As part of ongoing research with the Vermont Monitoring Cooperative, sugar maple trees at the Proctor Maple Research Center in Underhill were monitored in spring for the timing of bud break and leaf out. Sugar maple leaf bud expansion was slower than normal in 2015. Bud break on May 6th was nearly 3 days later than the long-term average. Full leaf out was 5 days earlier than the long-term average (Figures 9 & 10).

A broader selection of species was monitored for vegetative bud development throughout the spring in Vermont (Table 1). Trees that were monitored will be incorporated into annual phenology measures in order to evaluate the influence of climate on sensitive and valuable species in the state.

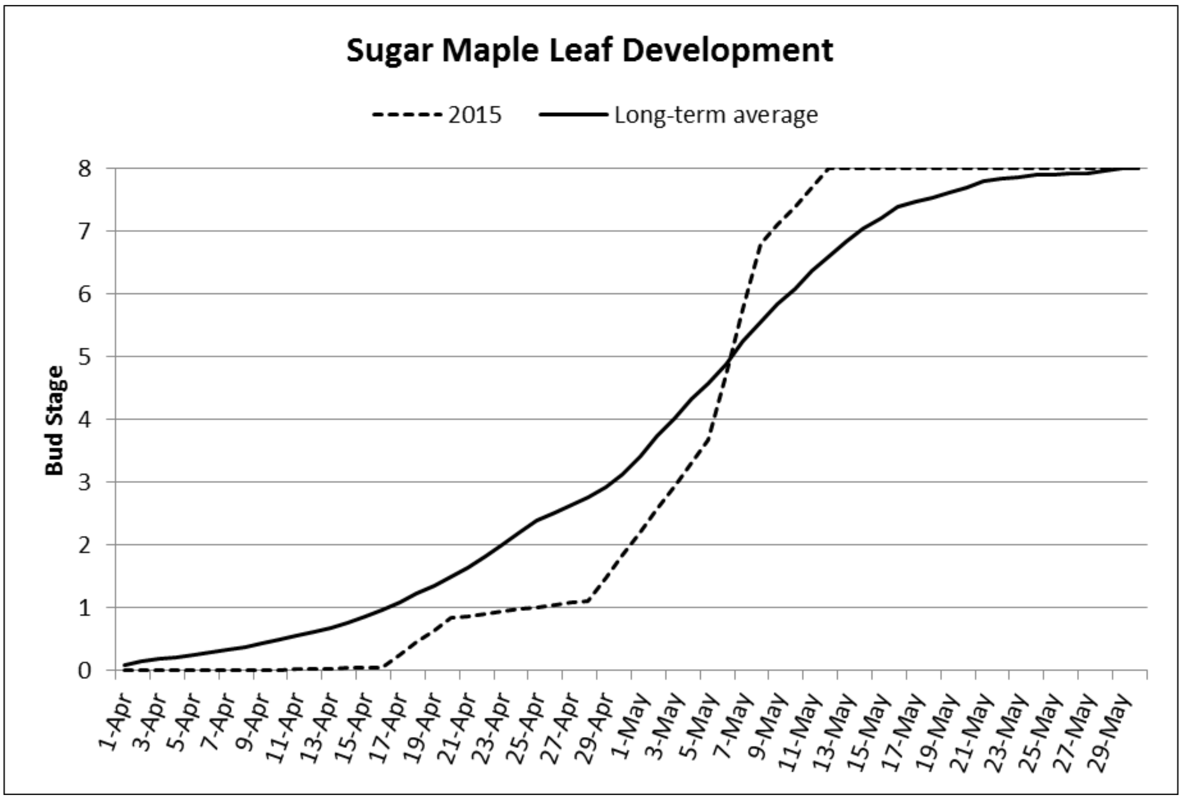


Figure 9. Sugar maple bud break and leaf out at Proctor Maple Research Center, Underhill, Vermont. Note: bud stage 4 = bud break.

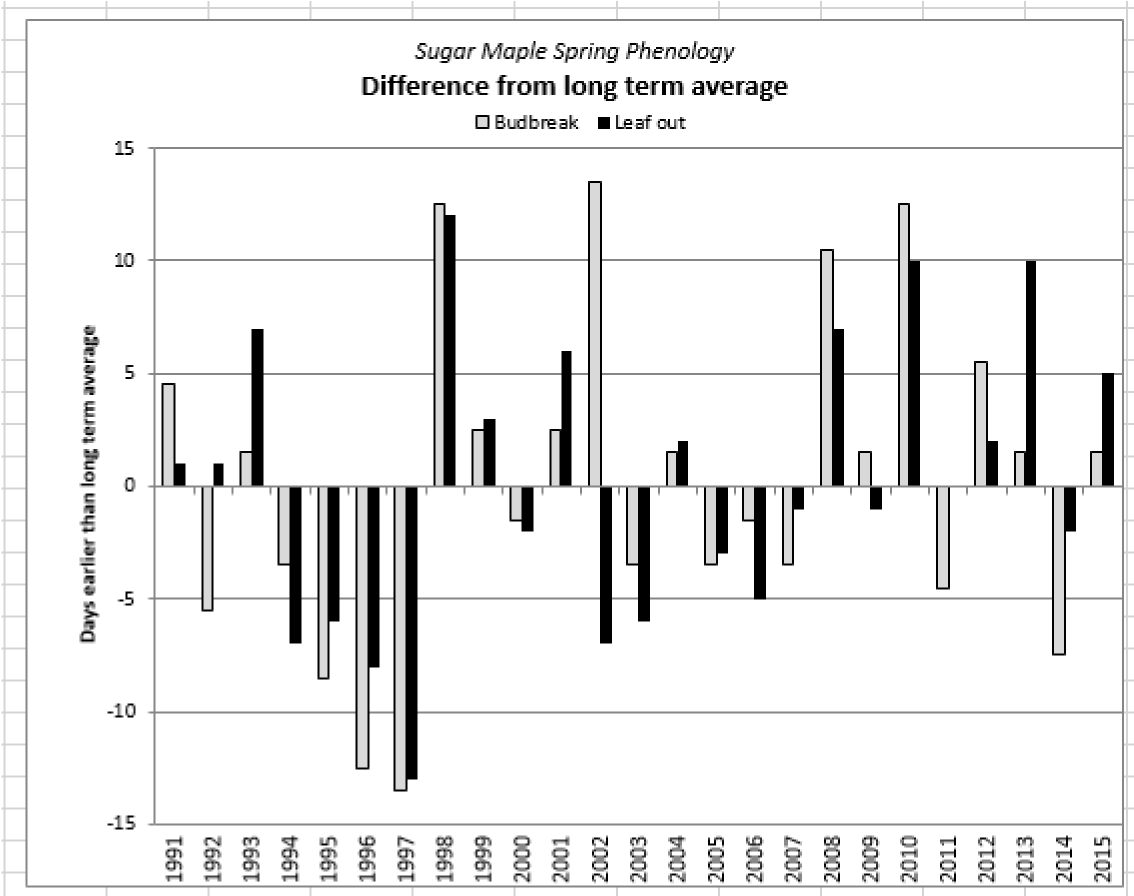


Figure 10. The timing of sugar maple bud break and leaf out compared to the long-term (24 year) average of trees monitored at the Proctor Maple Research Center, Underhill, Vermont.

Table 1. Dates of vegetative bud development for species at five locations throughout Vermont. Measures of red maple in Jericho were delayed, resulting in the lack of data for bud swell.

Species	Location	Bud swell	Bud break	Leaf-out
Sugar maple	Underhill	4/25	5/6	5/12
Red maple	Jericho		5/9	5/26
Red maple	Essex	4/20	5/5	5/18
White ash	Jericho	5/5	5/9	6/4
American beech	Jericho	4/28	5/7	5/18
Yellow birch	Jericho	4/28	5/7	5/18
Balsam fir	Lincoln	5/5	5/16	6/5
Red spruce	Lincoln	5/26	6/9	6/15
Eastern hemlock	Springfield	5/11	5/17	6/13

Fall Color Monitoring at Mount Mansfield

Trees at three elevations in Underhill at the base of Mount Mansfield were monitored for the timing of peak fall color and leaf drop (Figure 11). Field data recorded included percent of tree expressing fall color, as well as portion of crown where leaves have fallen. These two measures are integrated to yield an "estimated color" percentage, which helps to indicate when a given tree has the most foliage with the most color present in the fall. Sugar maple trees at the Proctor Maple Research Center (1400 feet) were later than the long-term average (1991-2015) for both timing of color and progression of leaf drop (Tables 2 and 3). With the exception of female red maple trees at low elevation, all species experienced later peak color than the long-term average.

Figure 11. Timing of fall color (Figure 11a-f) and leaf drop were monitored at three elevations on Mount Mansfield in 2015: 1400 feet at the Proctor Maple Research Center, and 2200 and 2600 feet near Underhill State Park. Five species are monitored: sugar maple, red maple (male and female trees), white ash, paper birch and yellow birch.

Figure 11a.

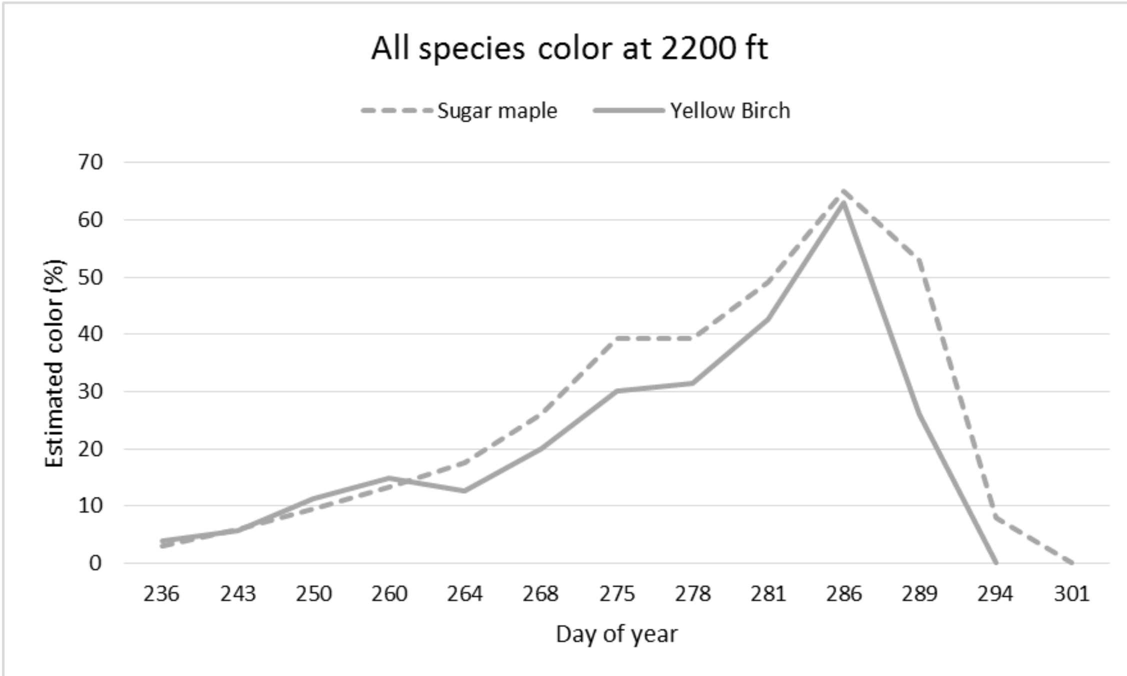


Figure 11b.

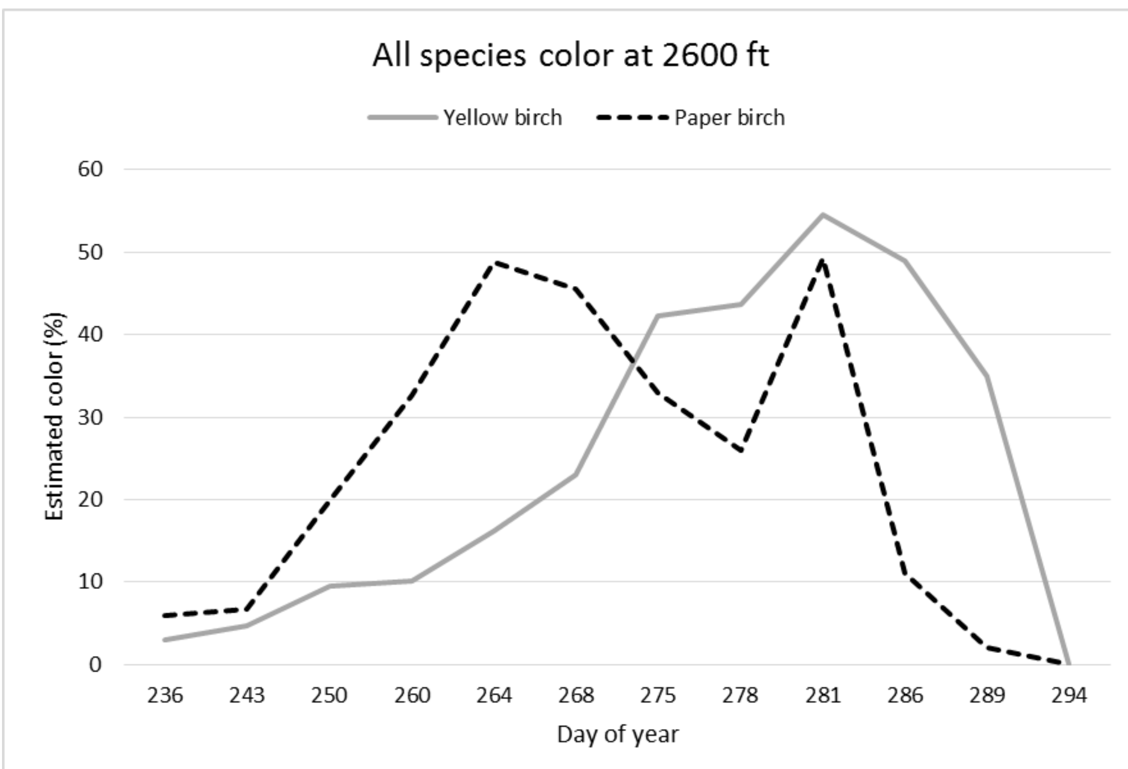


Figure 11c.

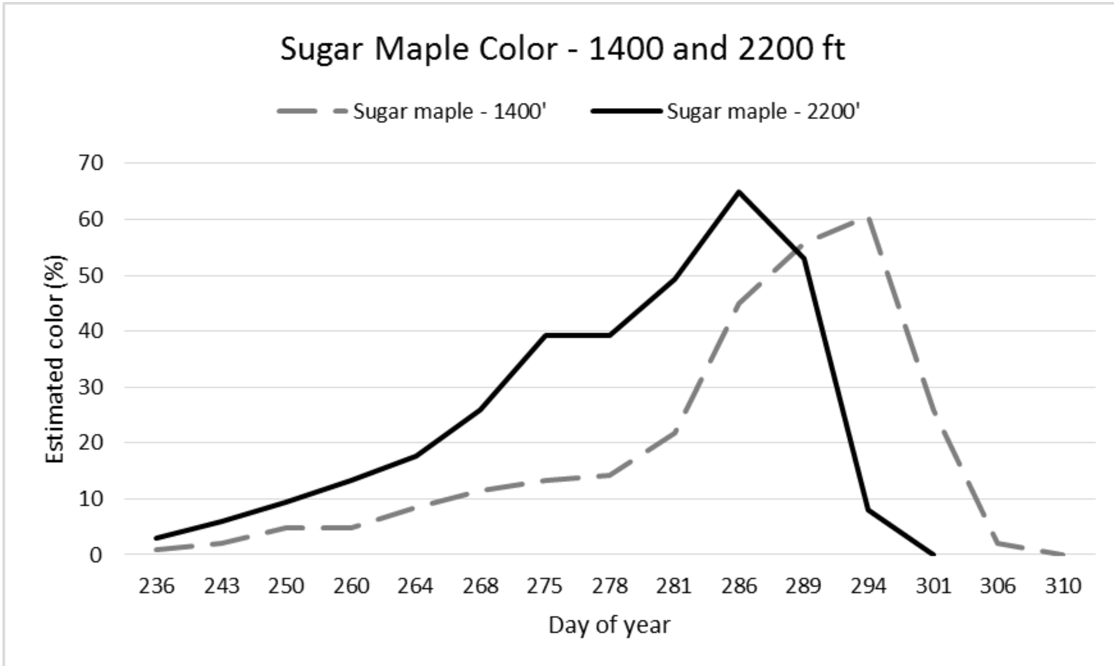


Figure 11d.

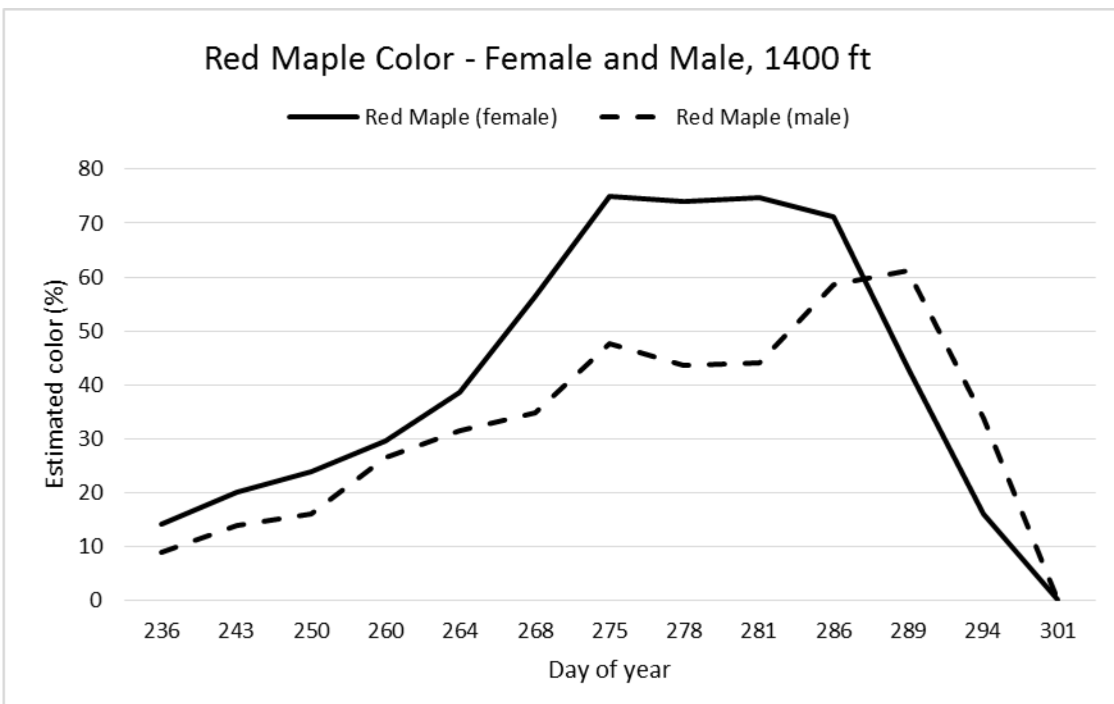


Figure 11e.

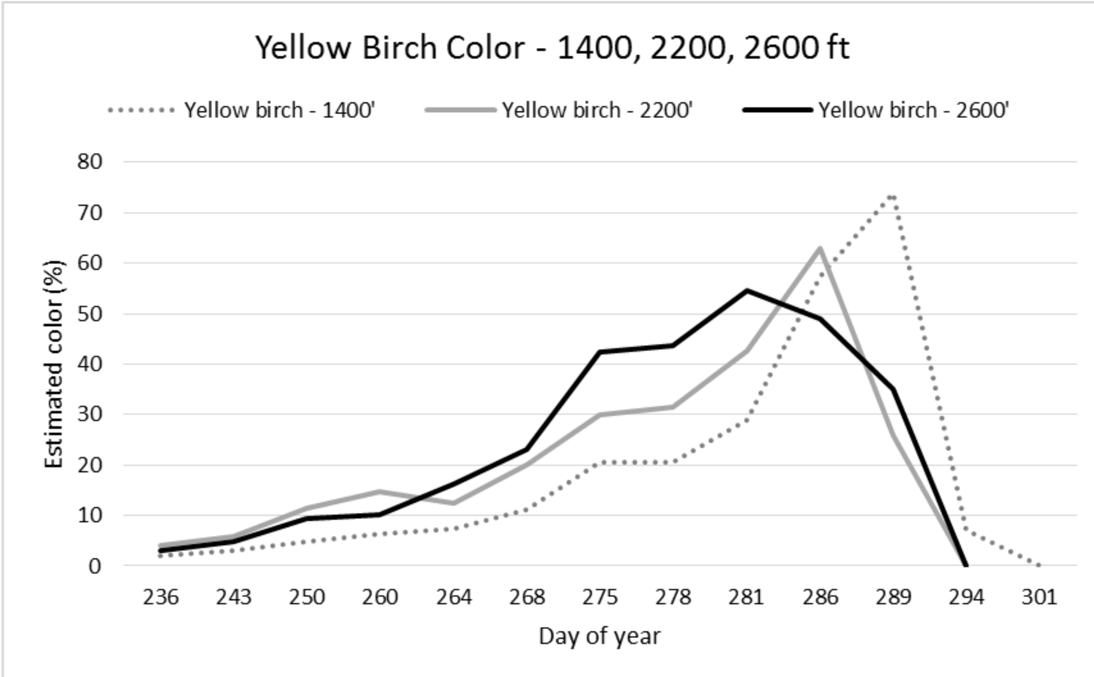


Figure 11f.

Table 2. Estimates of peak color based on percent color and percent of foliage present. Length of long-term averages differ by species, with trees at 2600 ft having a 16-year record, red maple and white ash a 20-year record, sugar maple at 1400 ft a 25-year record, and all other trees a 24-year record. Color was considered "peak" when the highest integrated value of color and leaf presence occurred.

Peak Color		
	Long-term average (Day of year)	2015 data (Day of year)
Elevation 1400'		
Red maple (Female)	281	281
Red maple (Male)	285	289
Sugar maple	286	294
Yellow birch	285	289
White ash	279	286
Elevation 2200'		
Sugar maple	277	286
Yellow birch	273	286
Elevation 2600'		
Yellow birch	274	281
Paper birch	269	281

Table 3. Progression of leaf drop for trees at 3 elevations on Mt. Mansfield. Day of year when either 50% of foliage had dropped or more than 95% of foliage had dropped are included for both this year and the long-term average. In general, many species began losing leaves later in 2015 than the average, as can be seen in the "50% leaf drop" data (especially paper birch, which lagged the average by 11 days). However, full leaf drop was relatively similar to the average.

Leaf Drop				
	50% leaf drop		> 95% leaf drop	
	Long-term average (Day of year)	2015 data (Day of year)	Long-term average (Day of year)	2015 data (Day of year)
Elevation 1400'				
Red maple (Female)	288	289	299	299
Red maple (Male)	290	291	300	300
Sugar maple	290	298	302	306
Yellow birch	288	291	298	296
White ash	284	288	296	294
Elevation 2200'				
Sugar maple	281	290	294	297
Yellow birch	279	287	291	293
Elevation 2600'				
Yellow birch	278	286	289	294
Paper birch	272	283	286	288

Table 4. Average dates of sugar maple bud break, end of growing season (leaf drop) and length of the growing season 1991-2015 at the Proctor Maple Research Center in Underhill.

Year	Date of Bud break	Date of End of Growing Season	Length of growing season (days)
1991	4/28	10/15	171
1992	5/7	10/13	159
1993	5/4	10/18	167
1994	5/6	10/14	161
1995	5/13	10/19	159
1996	5/14	10/22	161
1997	5/16	10/14	151
1998	4/17	10/15	181
1999	5/5	10/19	167
2000	5/9	10/17	161
2001	5/4	10/15	164
2002	4/18	11/5	201
2003	5/9	10/28	172
2004	5/4	10/27	175
2005	5/2	10/27	178
2006	5/2	10/16	167
2007	5/7	10/22	168
2008	4/22	10/15	175
2009	4/30	10/29	182
2010	4/22	10/26	187
2011	5/7	10/19	163
2012	4/16	10/16	186
2013	5/3	10/15	165
2014	5/12	10/20	161
2015	5/6	10/30	177
Long-term Average (1991-2015)	**5/4**	**10/20**	**170**

FOREST INSECTS

HARDWOOD DEFOLIATORS

Birch Defoliation was mapped on 25,468 acres during aerial surveys in 2015. This accounted for 20% of all areas mapped with forest damage this year. A selection of mapped polygons was ground-checked by Vermont Forest Resource Protection staff based on access and distribution across the state. Results showed a **Birch Defoliator Complex**, consisting of birch leafmining sawflies (e.g., *Fenusa pusilla, Messa nana,* and others), birch skeletonizers (*Bucculatrix canadensisella*), and birch leaf fungus (*Septoria*). Birch leaf fungus increased from 2014 due to wet conditions in late spring and early summer. Dry conditions later in the season caused more noticeable browning of leaves that had been damaged by insects or fungi. The mapped area is an increase from 2014 but a decrease from 2013, when 5,334 and 98,329 acres, respectively, were affected. (Also see Foliar Diseases.)

Table 5. Mapped acres of birch defoliator complex in 2015.

County	Acres
Addison	1,404
Bennington	1,479
Caledonia	1,183
Essex	1,575
Franklin	318
Lamoille	1,114
Orange	2,319
Orleans	684
Rutland	8,485
Washington	2,087
Windham	2,188
Windsor	2,632
Total	25,468

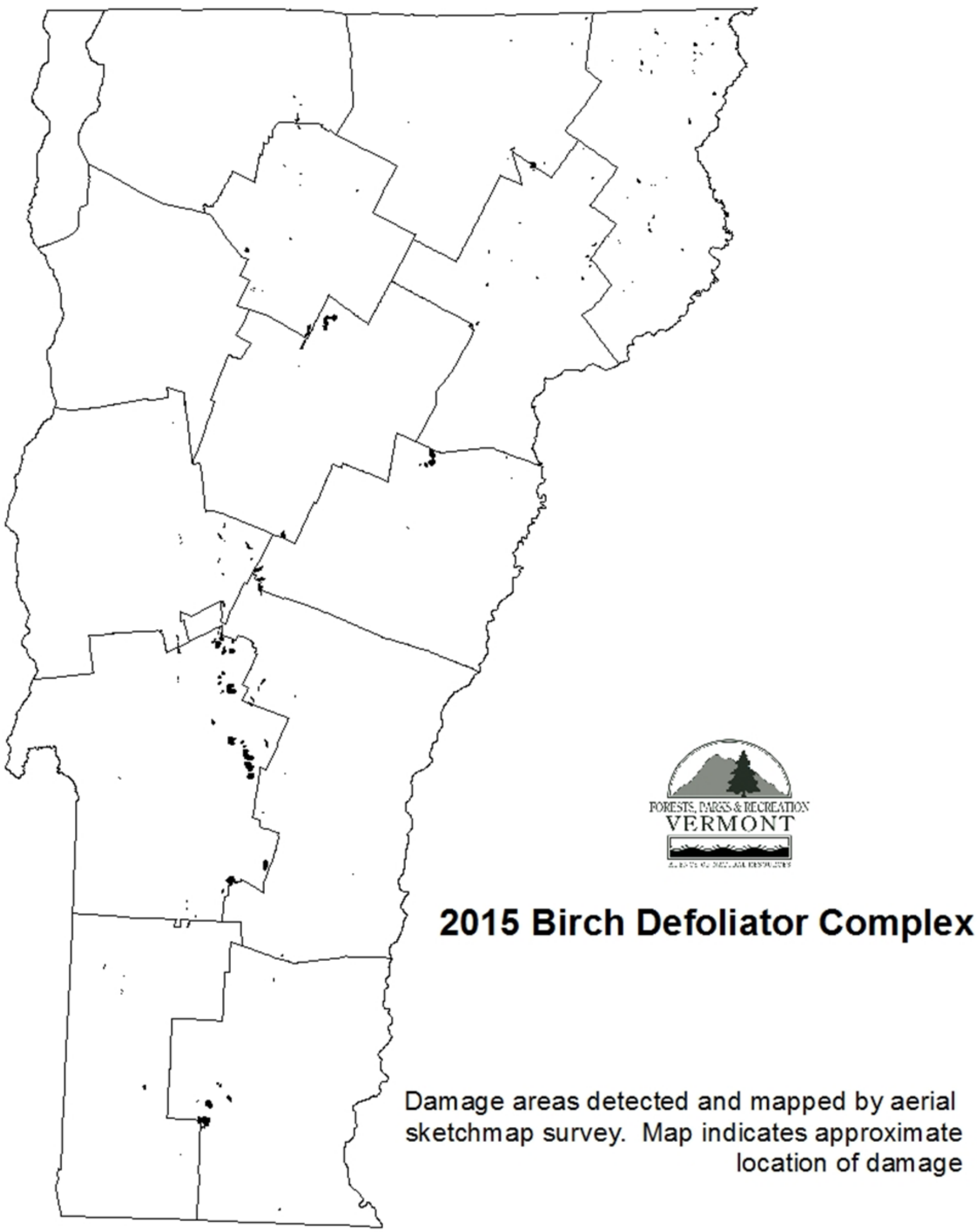


Figure 12. Birch damage caused by a complex of birch defoliators mapped in 2015. Mapped area includes 25,468 acres.

Observations of **Forest Tent Caterpillar**, *Malacosoma disstria*, were common, but only widely scattered light defoliation was observed. Moth catches in pheromone traps decreased from 2014 on a statewide basis, but counts were variable, and locally high (Table 6 and Figure 13). The most recent outbreak of this insect ended in 2006.

Table 6. Average number of forest tent caterpillar moths caught in pheromone traps, 2002-2015. Three multi-pher pheromone traps baited with PheroTech forest tent caterpillar lures were deployed at each survey location in 2015. The VMC 3800 site in Stowe was not trapped in 2015; the Dillner Farm in Montgomery was added.

Site	Year													
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Castleton	----	----	----	17	17.3	8	1	4.7	1	1.7	0.3	2.3	1.7	1.7
Fairfield (NAMP 29)	----	1.3	1.7	----	4.3	4.7	4	10.3	2.0	6	4	1.7	3.3	1.3
Huntington (NAMP 027)	9.2	6.7	10	15.7	16	6.3	4.3	4.3	2.7	6.3	6	1.7	2.7	0.0
Killington/Sherburne (Gifford Woods)	6.9	9.7	20	15.3	21	17.3	7.3	8	2.7	0	1.0	0.7	6.0	5.3
Manchester (new site in 2008)	----	----	----	----	----	----	0	5.7	3	1	0.7	0.3	1.3	10.3
Rochester (Rochester Mountain)	5.0	4.7	9	4.7	29	10.3	0.7	----	0.3	0	0	0	3.5	2.3
Roxbury (Roxbury State Forest)	16	14.7	13.3	7.3	22	22.7	8.0	2.7	7.0	2	1.5	1.7	6.3	5.7
SB 2200 (Stevensville Brook)	3.8	11.7	18.3	23.3	35.3	6.3	5.7	10	2.7	6.3	8	0.3	5.3	2.7
Underhill (VMC 1400)	3.6	3	0.3	7.3	9.3	2.7	1.3	8.3	5.7	8.3	7.7	0.3	5.7	0.7
Underhill (VMC 2200)	3	7	6.3	11.7	6.3	4.7	1.3	4.3	2	2.7	4.7	0.3	2.5	1.3
Stowe (VMC 3800)	1	2.7	10.3	26	5.7	5	1.3	1.7	0.7	2	2	1.3	1.7	----
Waterbury (Cotton Brook)	2	0.7	1.3	41	22.3	0.3	1	5	3.3	4.3	7	0.3	9.3	5.7
Waterville (Codding Hollow/Locke)	0	2	1.3	17.7	24.7	2.7	2.3	1.3	3.0	4.3	3	1	12.5	3.3
Dillner Farm Montgomery (new site in 2015)	----	----	----	----	----	----	----	----	----	----	----	----	----	1.0
Average	**5.1**	**5.8**	**8.3**	**17**	**17.8**	**7.6**	**2.9**	**5.5**	**2.8**	**3.5**	**3.5**	**0.9**	**4.8**	**3.2**

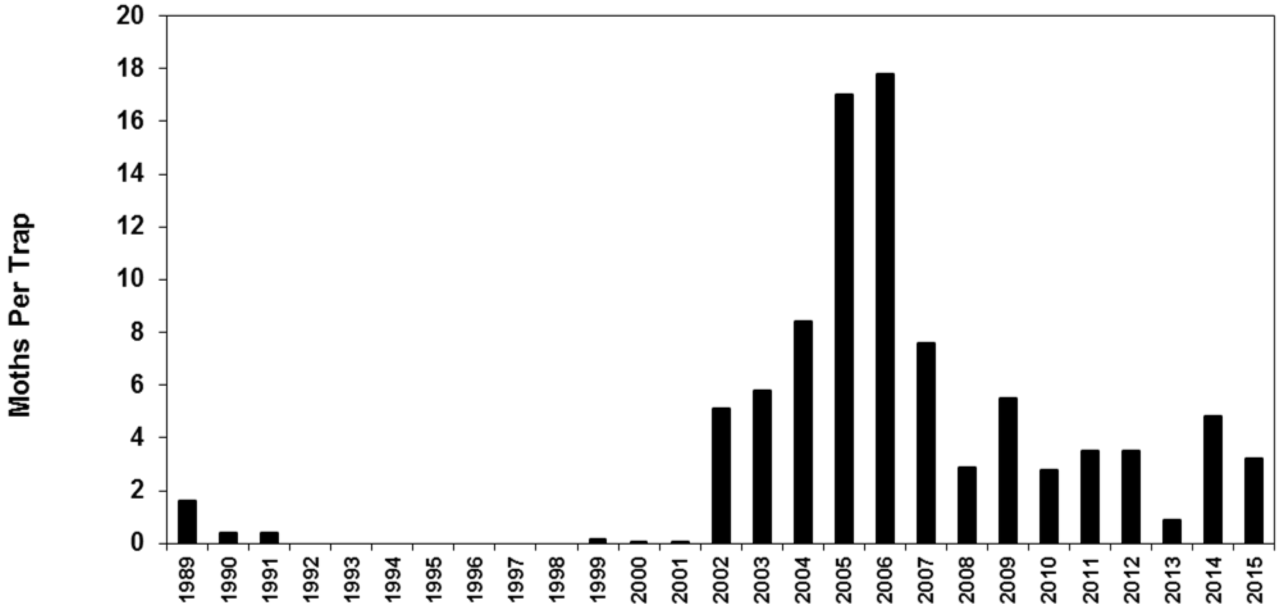


Figure 13. Average number of forest tent caterpillar moths caught in pheromone traps 1989-2015. Three multi-pher pheromone traps per site, with PheroTech forest tent caterpillar lures, were used in 2015.

Gypsy Moth, *Lymantria dispar*, were credited with light defoliation in North American Maple Project (NAMP) plots in Lincoln, Wilmington and Sheldon, and scattered reports of occasional caterpillars or single egg masses were received from elsewhere. For the fourth year in a row, no egg masses were observed in focal area monitoring plots (Table 7 and Figure 14).

Table 7. Number of gypsy moth egg masses per 1/25th acre from focal area monitoring plots, 2003-2015. Average of two 15-meter diameter burlap-banded plots per location in 2015.

Site	Town	Year												
		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Arrowhead	Milton	1.5	2.5	0	0	0	2.5	0	0	0.5	0	0	0	0
Brigham Hill	Essex	2.5	2	1.5	0	0	0	0	0	0	0	0	0	0
Ft. Dummer	Guilford	0	——	0	0	0	0	0	0	0.5	0	0	0	0
Minard's Pond	Rockingham	0.5	2	0	0	0	0	0.5	0	0	0	0	0	0
Mount Anthony	Bennington	1.5	0	0	0	0	0	0	0	0	0	0	0	0
Perch Pond	Benson	0	0	0.5	1	0	0.5	0	0.5	0	0	0	0	0
Rocky Pond	Rutland	0	0	0.5	3	3	0.5	0	0	0	0	0	0	0
Sandbar	Colchester	3	1.5	0	0	0	2.5	0.5	0	0	0	0	0	0
Tate Hill	Sandgate	0	30	18	3	0	1.5	0.5	0	0	0	0	0	0
Average		**1**	**4.4**	**2.3**	**0.8**	**.3**	**.8**	**.2**	**0.06**	**0.11**	**0**	**0**	**0**	**0**

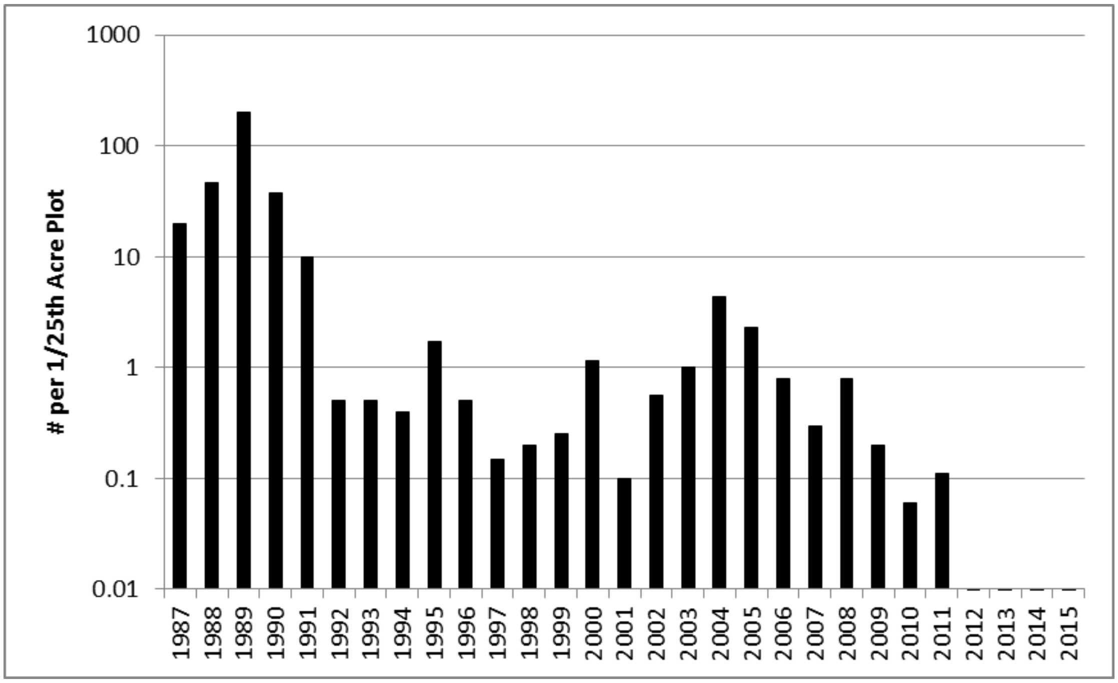


Figure 14. Number of gypsy moth egg masses per 1/25th acre from focal area monitoring plots, 1987-2015. 2015 data reflect the average egg mass counts from ten locations, with two 15-meter diameter burlap-banded plots per location. No egg masses were found in any plots in 2015.

Hardwood Defoliation, mapped on over 6,000 acres during annual aerial surveys, was attributed to a "Hardwood Defoliator Complex." Ground checking of some of these hardwood stands showed a combination of leaf fungi, insect defoliators and abiotic damage. Among the fungal defoliators, an unusually common amount of Septoria leafspot on maple contributed to the damage. Defoliation in some areas of was attributed to frost and maple trumpet skeletonizer on maples.

Table 8. Mapped acres of hardwood defoliator complex.

County	Acres
Addison	892
Bennington	808
Caledonia	60
Essex	177
Franklin	102
Lamoille	14
Orange	528
Orleans	313
Rutland	314
Washington	280
Windham	868
Windsor	1,668
Total	**6,024**

Saddled prominent, *Heterocampa guttivitta*, populations declined, and their feeding was rarely reported. The moth catch dropped from an average of 13 per trap in 2014, to just over one per trap in 2015.

In 19 of the 20 survey sites, the average per trap catch was less than two; the highest average catch, at a sugarbush in Sheldon, was six (Table 9 and Figure 15).

As in 2014, sets of three traps were deployed at each site. The Vermont Forest Resource Protection staff placed traps in 15 locations (3 sites per district) and the US Forest Service (USFS) worked in five sites in the Green Mountain National Forest. Traps were deployed between May 11 and18 and retrieved between July 23 and August 3.

Table 9. Sites, listed by county, where saddled prominent pheromone traps were deployed in 2015. Data include location, town, county, coordinates, and average number of moths per site for 2014 and 2015. (NT– not trapped)

Location	Town	County	Lat	Long	Ave # SP moths/trap 2014	Ave # SP moths/ trap 2015
Gale/Orvis (USFS)	Lincoln	Addison	44.15115	-72.95627	4.3	1
Hagelberg (NAMP 40)	Arlington	Bennington	43.06350	-73.17630	21.3	0.7
Sprague	Searsburg	Bennington	42.87463	-72.91520	12	0
Willoughby S.F.	Sutton	Caledonia	44.71037	-72.0399	10.3	0.3
Groton S.F.	Peacham	Caledonia	44.31163	-72.2888	3.3	0
Honey Hollow	Bolton	Chittenden	44.34702	-72.91	31	1.7
VMC 1400-PMRC	Underhill	Chittenden	44.52405	-72.8651	10	1.3
Reed (NAMP 8)	Sheldon	Franklin	44.86471	-72.87340	NT	6
Smith (NAMP 37)	Vershire	Orange	43.96919	72.34424	13	1
Butterfield (NAMP 39)	Topsham	Orange	44.17331	72.29451	11.7	1.7
Ward	Vershire	Orange	43.9859	72.37471	NT	1.7
Bartley/NAMP 6	Derby	Orleans	44.96356	-72.1717	6	NT
Shelton/NAMP 9	Glover	Orleans	44.70073	-72.2098	26	0.3
Spring Lake Ranch (NAMP 16)	Shrewsbury	Rutland	43.48305	-72.9099	20	2
Smokey House (NAMP 17)	Danby	Rutland	43.35054	-73.0602	47.3	1.3
Griffith (USFS)	Mt. Tabor	Rutland	43.34283	-72.97840	4.7	1.7
Ascutney	Weath- ersfield	Windsor	43.42785	-72.4655	1.3	0
Camp Plymouth SP	Ludlow	Windsor	43.47553	-72.6943	5.7	0.3
Begin (USFS)	Stockbridge	Windsor	43.78549	-72.78468	6.7	1
Harrington (USFS)	Pomfret	Windsor	43.70859	-72.44882	6.7	2
Downer SF	Sharon	Windsor	43.78901	-72.38104	NT	0.3
Average					13.4	1.2

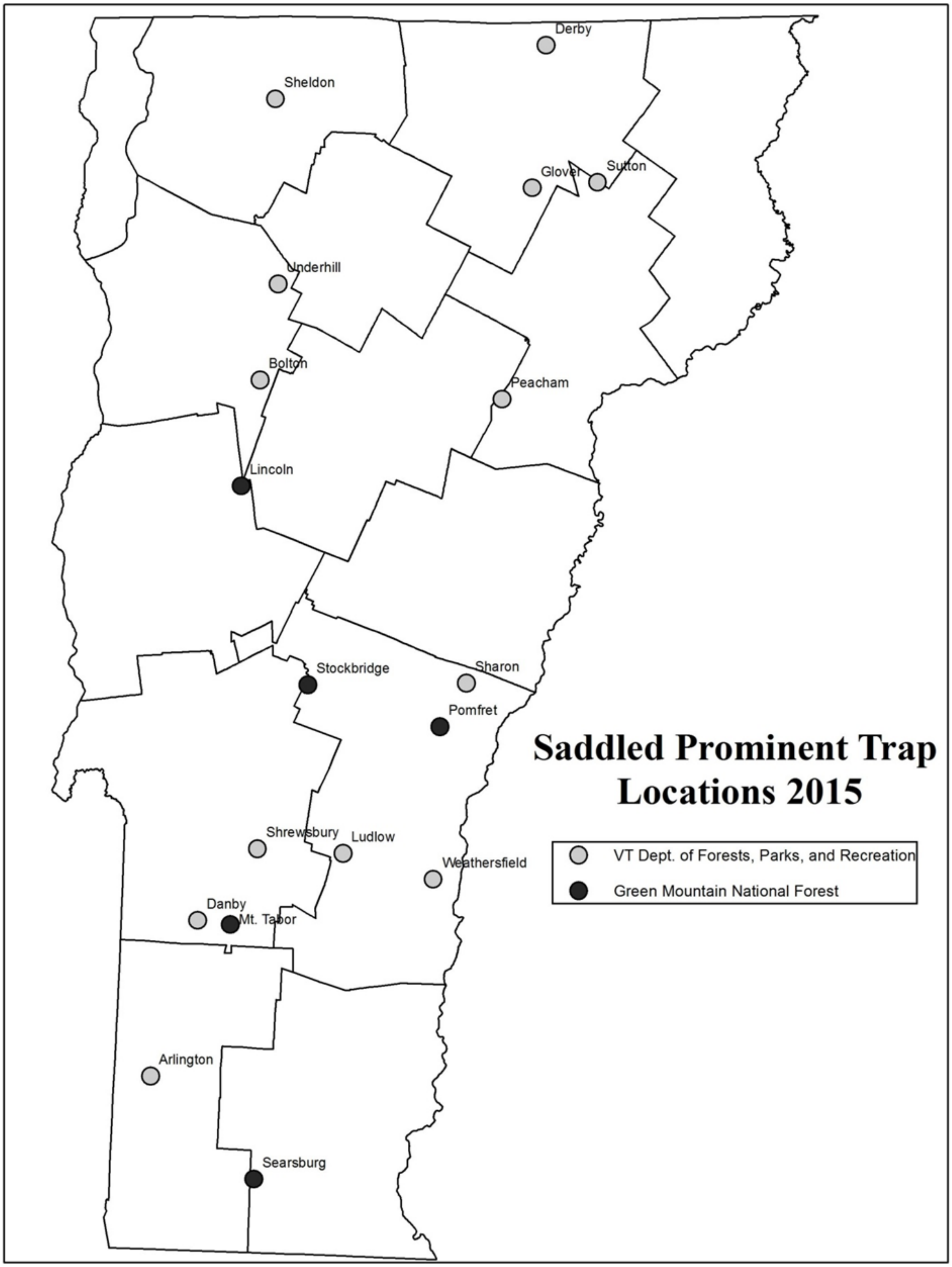


Figure 15. Location of saddled prominent pheromone traps set in Vermont in 2015 by Vermont Forest Resource Protection staff and the USFS.

OTHER HARDWOOD DEFOLIATORS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Apple and Thorn Skeletonizer	*Choreutis pariana*	Serviceberry	Lamoille County	Heavy defoliation observed.
Birch Leafminer	*Lyonetia prunifoliella*	Birch	District 2	Noticeable mining but less than in 2014.
Birch Skeletonizer	*Bucculatrix canadensisella*	Birch	Chittenden, Dover	Scattered occurences. Also see narrative under Birch Defoliation.
Bruce Spanworm	*Operophtera bruceata*	Sugar maple, aspen, beech and other hardwoods	Statewide	Very few moths noticed during flight period.
Cherry Scallop Shell Moth	*Hydria prunivorata*	Black cherry	Scattered	Caterpillars and defolation were not reported, but moth specimens were recovered from FTC pheromone traps.
Dogwood Sawfly	*Macremphytus tarsatus*	Dogwood	Huntington, Hyde Park, Burlington	Noted on ornamentals.
Eastern Tent Caterpillar	*Malacosoma americanum*	Cherry and apple	Throughout	Noticeable, but only light damage. Increase in observations in Franklin County and southern VT.
Elm Sawfly	*Cimbex americana*	Elm, maple, birch, willow and basswood	Jamaica, Essex	Individual larvae observed; no damage noted.
Fall Webworm	*Hyphantria cunea*	Hardwoods	Throughout	Common along roadsides but only scattered damage reported.
Forest Tent Caterpillar	*Malacosoma disstria*			See narrative.
Gypsy Moth	*Lymantria dispar*			See narrative.
Hickory Tussock Moth	*Lophocampa caryae*	Various hardwoods	Scattered	Though not uncommon, fewer casual observations of larvae.

OTHER HARDWOOD DEFOLIATORS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Imported Willow Leaf Beetle	*Plagiodera versicolora*	Willow	Lamoille, Orange and Addison Counties	Skeletonizing observed ranging from light to heavy on defoliated willows.
Japanese Beetle	*Popillia japonica*	Many	Statewide	Scattered to heavy. Beetles observed feeding on Japanese knotweed in some locations.
Locust Leafminer	*Odontata dorsalis*	Black locust	Windsor and Orange Counties	Damage in southeastern Windham County remains relatively lighter than previous years. Moderate to heavy damage was mapped for 20 acres in Orange County during aerial surveys.
Maple Leaf Cutter	*Paraclemensia acerifoliella*	Maples	Statewide	Light feeding observed throughout the state with noticeable defoliation in sugarbushes in Westminster and Marlboro.
Maple Trumpet Skeletonizer	*Epinotia aceriella*	Sugar maple	Statewide	Unusually common, with noticeable damage in the lower crowns of sugar maple statewide. In some locations, leaves throughout the tree were affected, causing browning/off color during early foliage season.
Maple Webworm	*Tetralopha asperatella*	Sugar maple	Northern Vermont	Very light.
Oak Trumpet Skeletonizer	*Catastega timidella*	Red oak	Fairlee	On ornamental.
Pear Sawfly	*Caliroa cerasi*	Red oak	Montpelier	On ornamental.

OTHER HARDWOOD DEFOLIATORS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Red-headed Flea Beetle	*Systena frontalis*	Hydrangea	Dorset	Observed on nursery stock. Considered a new pest in our state.
Red-humped Caterpillar	*Schizura concinna*	Blueberry and apple	Montgomery, Shrewsbury	Larvae feed on wide range of woody plants from many different families.
Saddled Prominent	*Heterocampa guttivata*	Sugar maple		See narrative.
Satin Moth	*Leucoma salicis*	Poplar	Orange and Chittenden Counties	Isolated locations with heavy defoliation were observed in Burlington and Randolph.
Spiny Oak Sawfly	*Periclista sp.*	Oak	Ferrisburgh	
Variable Oakleaf Caterpillar	*Lochmaeus manteo*	Apple	Danville, Springfield	Minor feeding.
Viburnum Leaf Beetle	*Pyrrhalta viburni*	Viburnum	Scattered	On occasional ornamentals.
White-marked Tussock Moth	*Orgyia leucostigma*	Various	Scattered	Less obvious than usual.
Winter Moth	*Operophtera brumata*	Hardwoods		Not known to occur in Vermont.

Hardwood defoliators not reported in 2015 include Birch Leaf Folder, *Ancylis discigerana* ; European Snout Beetle, *Phyllobius oblongus* ; Green-striped Mapleworm, *Dryocampa rubicunda* ; Mountain Ash Sawfly, *Pristiphora geniculata* ; Rose Chafer, *Macrodactylus subspinosa* ; Uglynest Caterpillar, *Archips cerasivorana* .

SOFTWOOD DEFOLIATORS

Spruce Budworm, *Choristoneura fumiferana*, defoliation in Quebec continued to increase, but the moth trap catch in Vermont remains low.

Traps were deployed in Caledonia, Chittenden, Essex and Orleans Counties in 2010 - 2015. The traps in Norton and Walden showed very slight increases; Holland and Underhill numbers dropped and counts in Burke were identical to those of 2014. (Table 10 and Figures 16-17). We do not anticipate defoliation by the spruce budworm in 2016.

Table 10. Average number of spruce budworm moths caught in pheromone traps, 1991-2015. Trapping had been discontinued 2004-2009. There were 3 traps per location, one location per town in 2015.

County and Town	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2010	2011	2012	2013	2014	2015
Essex - Norton	3	10.7	5.7	2.3	1	1	1.3	26	34.7	29.7	17.7	1.3	2	5.3	1	1.3	0.7	0	0.3
Orleans - Holland	3.3	11	2.3	1.3	0	1.7	1.3	5	4.7	29.3	5	5.7	3.7	6	8.0	1	0.7	1.7	1.3
Caledonia - Walden	17.7	17.7	13	14.3	3	6.3	2	4.3	5	85	16.7	9.7	3.7	6.7	1	0.7	0	0.3	1.0
Essex - Lewis	2.0	2.7	0.67	2	0	0.67	0	8	4.3	14	6.7	1.3	1.7	5.7	0.3	0	0	0	0.0
Chittenden - Underhill	31.7	29	16	53	11.7	30.3	3.7	6	13.3	24.7	11.3	14.7	3.7	19	11.3	8	1.3	3.7	1.7
Caledonia - Burke	3.5	2.3	6	3	0	2	3.7	7.3	6	30	15	3	1.7	4	1.7	0	0.3	0.3	0.3
Average	10.2	12.2	7.3	12.7	2.6	7.0	2.0	9.4	11.3	35.5	12.1	6.0	2.8	7.8	3.9	1.8	0.5	1.0	0.8

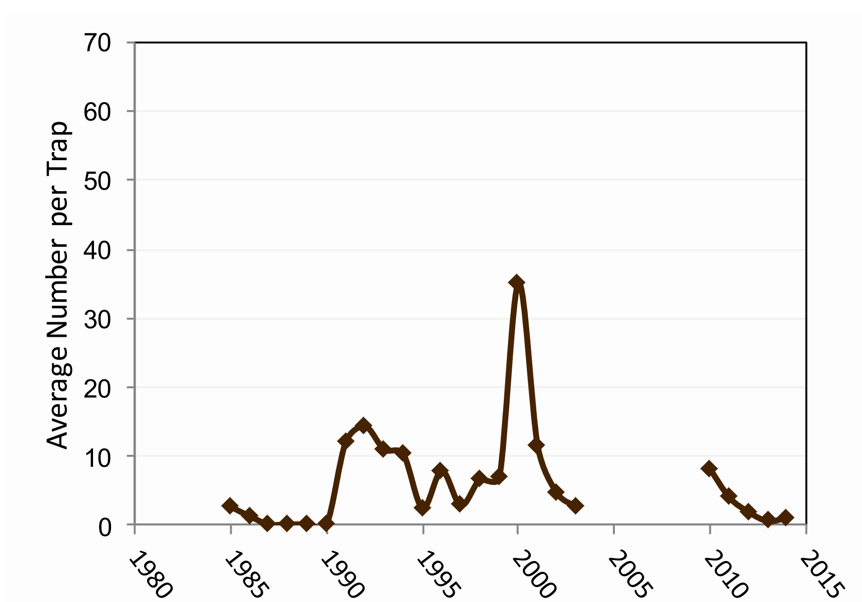
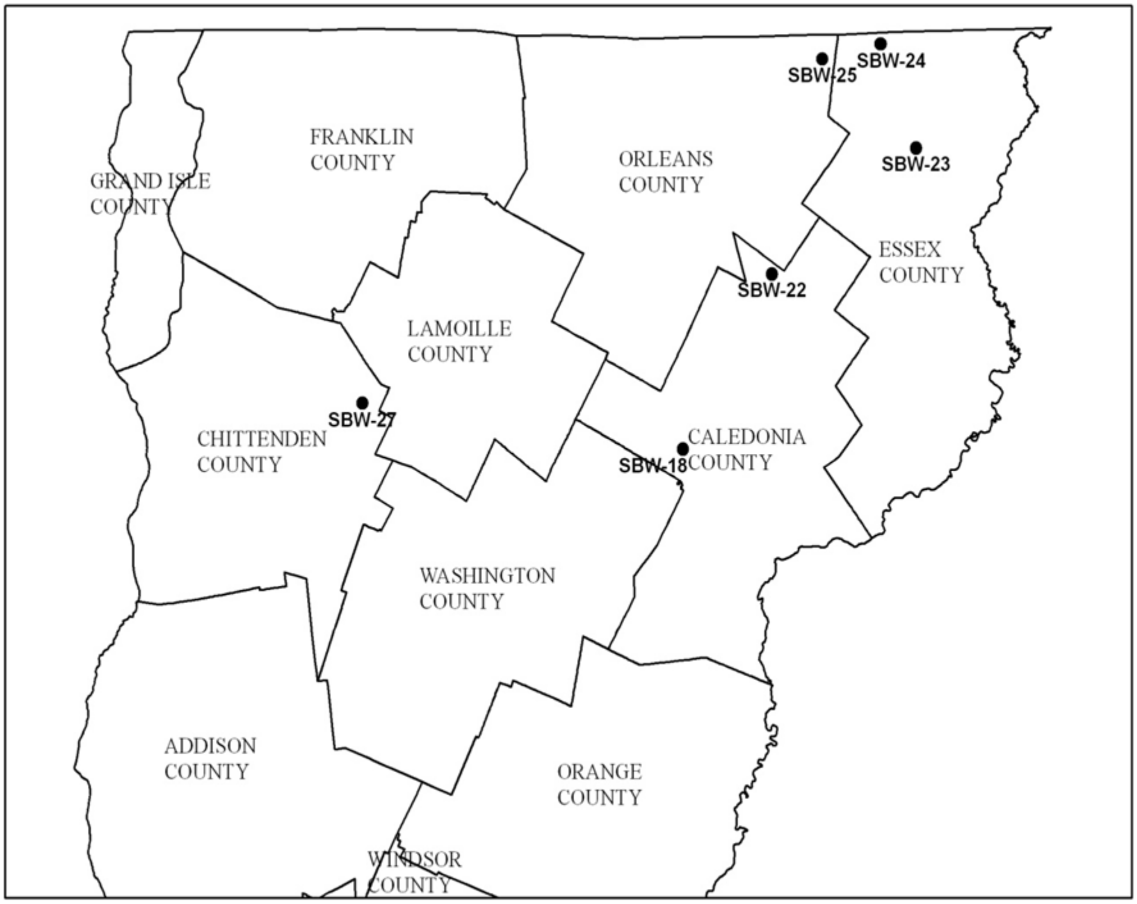


Figure 16. Average number of spruce budworm moths caught in pheromone traps 1983-2015. Trapping was discontinued, 2004-2009. Average of six locations in 2015.

Spruce Budworm Trap Locations



Trap #	Trap Location	Town	Latitude	Longitude
SBW-18	Steam Mill Brook WMA	Walden	44.48385	-72.25364
SBW-22	Willoughby S.F.	Burke	44.69555	-72.03616
SBW-23	Tin Shack/Silvio Conte	Lewis	44.85915	-71.74222
SBW-24	Black Turn Brook S. F.	Norton	44.99521	-71.81300
SBW-25	Holland Pond WMA	Holland	44.97610	-71.93103
SBW-27	VMC 1400	Underhill	44.52570	-72.86477

Figure 17. Locations of spruce budworm pheromone traps in 2015. Coordinates are NAD83.

OTHER SOFTWOOD DEFOLIATORS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Eastern Spruce Budworm	*Choristoneura fumiferana*	Balsam fir and spruce	Statewide	See narrative.
Fall Hemlock Looper	*Lambdina fiscellaria*	Hemlock	Brookline	Insignificant.
Spruce Needleminer	*Taniva albolineana*	Ornamental Spruce	Springfield	Light damage.
Webspinning Sawflies	Family Pamphiliidae	Ornamental Spruce	Burlington	Light damage.
Yellow-headed Spruce Sawfly	*Pikonema alaskensis*	Blue Spruce	Brownington	Quickly devoured ornamental spruce.

Softwood defoliators not reported in 2015 included Arborvitae Leaf Miner, *Argyresthia thuiella* , European Pine Sawfly, *Neodiprion sertifer,* Larch Casebearer, *Coleophora laricella* , Introduced Pine Sawfly, *Diprion similis,* White Pine Sawfly, *Neodiprion pinetum* .

SAPSUCKING INSECTS, MIDGES, AND MITES

Balsam Woolly Adelgid, *Adelges piceae***,** is thought to be responsible for much of the 2,263 acres of fir mortality that were mapped from the air, including higher elevations of the southern Green Mountains, and upland trees in central and northern Vermont. The insect was confirmed in several of the mortality areas by ground-checking. While it was not found in other areas, balsam woolly adelgid is vulnerable to cold winters and does not survive on dead trees, so its populations have often died out by the time mortality was observed.

Active adelgid populations were observed in Bethel, Calais, Hartford, Middlesex, Montpelier, Peacham, Springfield, and Wilmington. In Springfield, very heavy populations were observed on street trees that were not showing significant damage. Gouting of regeneration was noted in Peacham, but mostly the stem phase was observed.

Table 11. Mapped acres of balsam woolly adelgid related decline.

County	Acres
Caledonia	125
Chittenden	24
Essex	15
Franklin	346
Lamoille	250
Orange	129
Orleans	99
Rutland	66
Washington	623
Windham	341
Windsor	246
Total	2,263

Elongate Hemlock Scale (EHS), *Fiorinia externa*, was first detected in 2014 in Brattleboro and Guilford in conjunction with hemlock woolly adelgid. The Brattleboro site involved urban trees near a parking lot, while the Guilford site was a forest stand. EHS was not known to be established in Vermont prior to 2014, though it had been detected in a planted landscape in Charlotte, Vermont. This insect, in association with hemlock woolly adelgid, continues to compromise the health of hemlocks in southern Vermont.

The **Hemlock Woolly Adelgid (HWA),** *Adelges tsugae*, distribution map remained unchanged in 2015. Although 49 sites were surveyed in 14 towns, HWA was not found in any new towns. To date, three counties (17 towns) are positive for HWA: Windham (15 towns including Brattleboro, Brookline, Dummerston, Grafton, Guilford, Halifax, Jamaica, Marlboro, Newfane, Putney, Rockingham, Townshend, Vernon, Wardsboro, and Whitingham), Bennington (town of Pownal) and Windsor (town of Springfield) (Figure 18). In 2015, 34 volunteers, using a modified Costa protocol, contributed at least 127 hours to the HWA survey effort.

Figure 18. Towns known to have hemlock woolly adelgid-infested trees in 2015.

The winter of 2014-2015 was tough on hemlock woolly adelgid; 97 to 99 percent of the sisten, or winter, generation died (Table 12 and Fig. 19). The previous winter had similar winter mortality rates. This helped to give hemlock trees a bit of a reprieve. But, while these recent mortality rates have been high enough to temporarily stop the spread of HWA, the trees are still threatened.

Table 12. Assessment of hemlock woolly adelgid winter mortality over the winter of 2014-2015. Data include location of study site, date hemlock wooly adelgid was collected, number of dead and live adelgids, and percent mortality. (Winter mortality and sisten density data are shared with a cooperative, multi-state group and are kept at Virginia Tech.)

Site	Date	#HWA alive	# HWA dead	% mortality
Vernon	12/18/15	8	982	99.19
Brattleboro	12/18/15	6	1205	99.50
Townshend	12/19/15	40	1540	97.47
Jamaica	12/19/15	6	1005	99.41

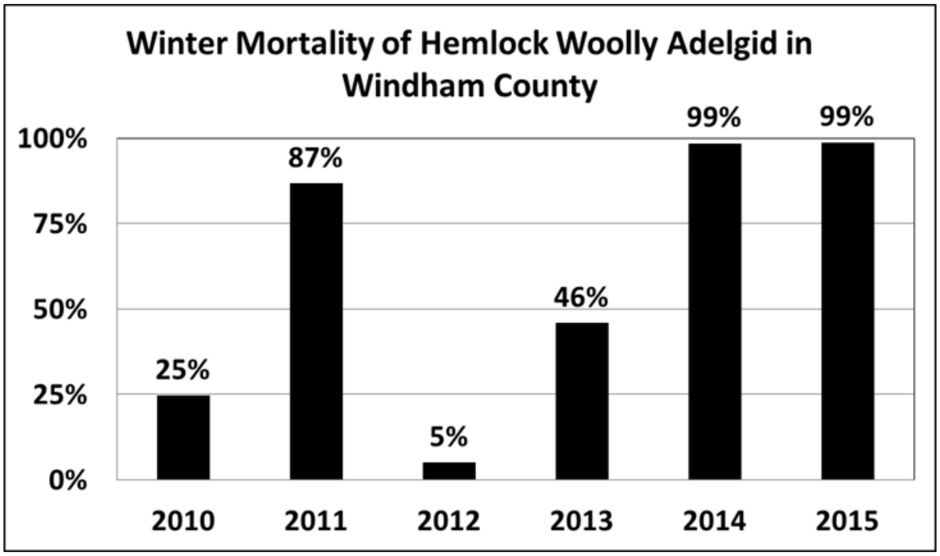


Figure 19. Overwintering mortality of hemlock woolly adelgid in Windham County 2010 - 2015.

Another stress on hemlock trees has been our summer weather. The HWA-infested area has been in drought conditions for a substantial period. Because of its shallow root system, hemlock is susceptible to drought. Some stands of hemlock, particularly on ledgy, shallow sites, are in noticeable decline, with 83 acres mapped during aerial surveys. Compounding the situation is the presence of elongate hemlock scale, *Fiorinia externa,* (EHS) in southern Windham County. EHS is another invasive forest pest, often found in conjunction with HWA.

Study sites in Vernon, Pownal and Brattleboro were surveyed in November 2015 for *Laricobius nigrinus*, a HWA predator previously released in Vermont. No beetles were recovered from any of the sites. Monitoring activities will be conducted earlier (end of October or November) in the 2015-2016 season.

In future work, FPR and UVM plan to work together in establishing field study sites in the spring of 2016 to help determine if predatory silver flies in the family *Chamaemyiidae* are an appropriate biocontrol for the Northeast.

Five impact plots were established to monitor the effects of HWA infestation. These will complement similar plots elsewhere in New England, and help clarify the risk to trees as the insect spreads north. The plots are located in the Roaring Brook Wildlife Management Area in the towns of Guilford and Vernon, Fort Dummer State Park in Brattleboro, Townshend State Park in Townshend, Black Mountain Reserve in Dummerston (The Nature Conservancy) and Atherton Meadows Wildlife Management Area in Whitingham. Data from these sites will add to the understanding of forest impacts of HWA, and will be analyzed along with information collected in Maine and New Hampshire. All measurements and crown assessments have been completed and field data collected to date are being transferred to an electronic database.

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. Other resources are available on the Vermont Forestry Division website, vtforest.com, and at the Vermont Invasives website, vtinvasives.org.

Pear Thrips, *Taeniothrips inconsequens*, caused no detectable damage in 2015. At our long-term monitoring site at Proctor Maple Research Center in Underhill, the first thrips were present on yellow sticky traps during the week of April 10th. The highest numbers were present the week of April 24th, averaging just over 22 insects per trap. Total thrips counts for the year were the lowest (181 thrips captured) in recent record (Table 13).

Table 13. Total pear thrips counts on yellow sticky traps at Proctor Maple Research Center in Underhill, Vermont, from 2010-2015. Sticky traps are deployed in sets of four. Traps are evaluated and replaced each week and monitored throughout pear thrips emergence.

2010		2011		2012		2013		2014		2015	
Sampling Dates	Number of Thrips	Sampling Dates	Number of Thrips	Sampling Dates	Number of Thrips	Sampling Dates	Number of Thrips	Sampling Dates	Number of Thrips	Sampling Dates	Number of Thrips
				3/19 – 3/26	121						
4/2 – 4/7	408	4/6 – 4/12	0	3/26 – 4/2	6	3/29 - 4/5	0	4/1 – 4/10	0		
4/7 – 4/15	100	4/12 – 4/21	2	4/2 – 4/9	7	4/5 - 4/15	0	4/10 – 4/18	2	4/10-4/16	3
4/15 – 4/23	102	4/21 – 4/29	191	4/9 – 4/16	84	4/15- 4/22	23	4/18 – 4/25	60	4/16-4/24	5
4/23 – 5/3	175	4/29 – 5/6	10	4/16 – 4/23	23	4/22 - 4/30	125	4/25 – 5/2	88	4/24-5/4	90
5/3 – 5/11	151	5/6 – 5/13	9	4/23 – 4/30	8	4/30 - 5/7	18	5/2 – 5/9	38	5/4-5/12	51
5/11 – 5/18	43	5/13 – 5/20	16	4/30 – 5/7	53	5/7 - 5/13	27	5/9 – 5/16	29	5/12-5/20	18
5/18 – 5/24	36	5/20 – 5/27	15	5/7 – 5/14	65	5/13 - 5/20	11	5/16 – 5/23	65	5/20-5/26	7
5/24 – 6/1	4	5/27 – 6/2	5	5/14 – 5/21	25	5/20 - 5/28	1	5/23 – 5/30	16	5/26-6/1	5
6/1 – 6/7	2			5/21 – 5/30	16	5/28 - 6/3	0	5/30 – 6/6	6	6/1-6/6	2
				5/30 – 6/4	1					6/6-6/12	0
	1,021		248		409		205		304		181

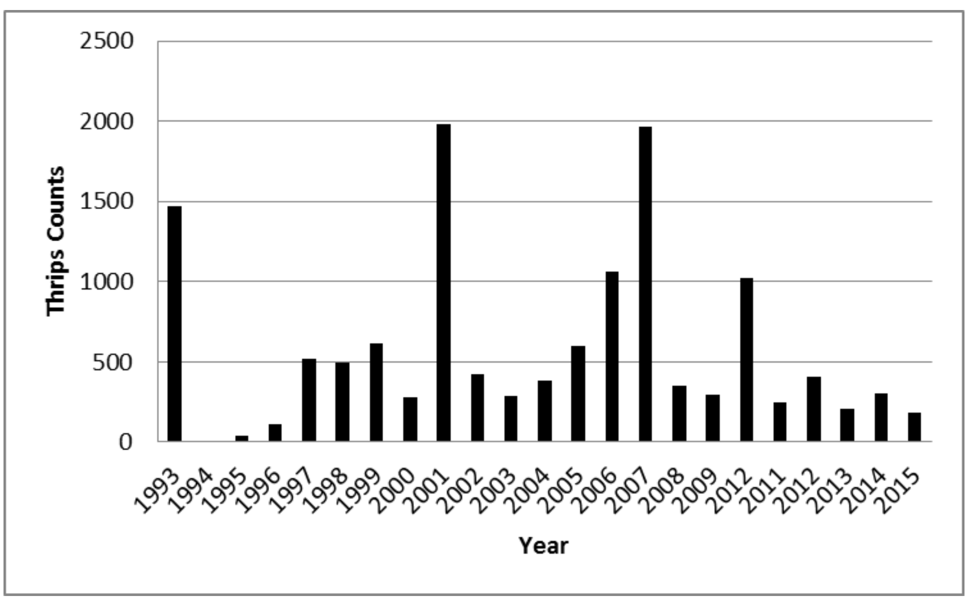


Figure 20. Total number of thrips collected at Proctor Maple Research Center in Underhill, VT on sets of four sticky traps, 1993-2015.

Red Pine Scale, *Matsucoccus resinosae*, was detected in Rutland and Orange Counties in 2015. The insect has been recently found in New Hampshire and Maine, but this is the first detection in Vermont. The identification was confirmed by Dr. Gail Ridge, a taxonomist at the Connecticut Agricultural Experiment Station.

The scale was discovered by Michael Simmons, a doctoral student at the University of New Hampshire who is hoping to determine if a primary pest or pathogen is responsible for red pine mortality observed in north and central Orange County and east-central Rutland County. Dead and dying red pines have also been observed in Windsor, Bennington, and Caledonia Counties in Vermont and in other New England states.

It is too early to attribute red pine mortality to a primary agent such as red pine scale. 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.

OTHER SAPSUCKING INSECTS, MIDGES, AND MITES

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Ash Flowergall Mite	*Aceria fraxiniflora*	Ash	Springfield	Light, scattered damage.
Balsam Twig Aphid	*Mindarus abietinus*	Balsam fir	Widely scattered	
Balsam Gall Midge	*Paradiplosis tumifex*	Balsam fir	Scattered	Very light despite building populations in some plantations last year.
Balsam Woolly Adelgid	*Adelges piceae*	Balsam fir and Fraser fir	Statewide	Light, scattered reports.
Beech Scale	*Cryptococcus fagisuga*	Beech	Statewide	See Beech Bark Disease narrative.
Birch Aphid	*Betulaphis quadrituberculata*	Birch	Springfield	This is an inconspicuous leaf-feeding aphid on birches in North America and Europe, now recorded on paper birch. (Tentative identification.)
Boxelder Bug	*Leptocoris trivittatus*	Boxelder	Scattered	Several reports of large numbers around boxelder trees and in and around homes; no damage to trees reported.
Brown Marmorated Stink Bug	*Halyomorpha halys*	Wide variety of hosts, including apples	Records exist for Bennington, Chittenden, Lamoille, Washington, Windham and Windsor Counties. (now reported from at least 38 states.)	UVM Extension recommends closely monitoring agricultural crops including tree fruits and grapes as this emerging new pest can can cause significant damage throughout the growing season.
Elongate Hemlock Scale	*Fiorinia externa*	Ornamentals	Brattleboro, Guilford	See narrative.
Gouty Vein Midge	*Dasineura communis*	Sugar maple	Georgia	Reported by concerned landowner.

OTHER SAPSUCKING INSECTS, MIDGES, AND MITES

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Hemlock Woolly Adelgid	*Adelges tsugae*	Hemlock	Windham, Bennington and Windsor	See narrative.
Lacebugs	Family Tingidae	Hardwoods	Statewide	Common, but only very light damage reported
Lecanium Scale	*Lecanium* or *Parthenolecanium*	Hophornbeam and maple	Bolton	Scales observed on twigs but no damage was noted.
Magnolia Scale	*Neolecanium cornuparvum*	Magnolia	Norwich	Reported by concerned landowner.
Pear Thrips	*Taeniothrips inconsequens*	Hardwoods	Statewide	See narrative.
Pine Bark Adelgid	*Pineus strobi*	White pine	Burlington	Heavy population on ornamental.
Spruce Gall Adelgids	*Adelges spp.*	Spruce	Scattered	Commonly observed on red spruce regeneration; Cooley and eastern spruce gall adelgids observed on ornamentals in scattered locations.
Spruce Spider Mite	*Oligonychus ununguis*	Fraser Fir	Bennington County	Increasing populations noted.
Woolly Alder Aphid	*Paraprociphilus tessellatus*	Alder and Silver maple	Burlington, Starksboro	Flying adults reported as a novelty.

Sapsucking Insects, Midges and Mites that were not reported in 2015 include Beech Blight Aphid, *Grylloprociphilus imbricator* ; Cinara Aphid, *Cinara* sp.; Conifer Root Aphid, *Prociphilus americanus* ; Cottony Maple Scale, *Pulvinaria innumerabilis;* Oystershell Scale, *Lepidospaphes ulmi* ; Pine Leaf Adelgid, *Pineus pinifoliae* ; Pine Needle Scale, *Chionapsis pinifoliae* ; Pine Spittlebug, *Aphrophora parallela;* Spotted Poplar Aphid, *Aphis maculatae.*

BUD AND SHOOT INSECTS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Common Pine Shoot Beetle	*Tomicus piniperda*	Pines	Throughout	Found in many Vermont counties since it was first detected in Vermont in 1999, including again this year during a trapping survey in Chittenden County. By federal quarantine, pine material is free to move within Vermont and through most of the region.
Pine Gall Weevil	*Podapion gallicola*	Red pine	Orange, Rutland, and Windsor Counties	Commonly observed in red pine decline areas.
White Pine Weevil	*Pissodes strobi*	White pine and Colorado blue spruce	Throughout	Common at low levels.

Bud and Shoot Insects not reported in 2015 included Balsam Shootboring Sawfly, *Pleroneura brunneicornis*; Eastern Pine Shoot Borer, *Eucosma gloriola*; Maple Petiole Borer, *Caulocampus acericaulis;* Oak Twig Pruner, *Elaphidionoides parallelus.*

ROOT INSECTS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Broadnecked and Tilehorned Root Borers	*Prionus sp.*	Various	Scattered	Though larvae feed on and destroy the roots, observations usually involve appearance of the adult beetles.
Japanese Beetle	*Popillia japonica*	Many	Throughout	Populations much reduced throughout state in 2015.
June Beetle	*Phyllophaga* spp.	Many	Scattered	Few reports received in 2015.

Root Insects not reported in 2015 included Conifer Root Aphid, *Prociphilus americanus* ; Conifer Swift Moth, *Korsheltellus gracillis* .

BARK AND WOOD INSECTS

Asian Longhorned Beetle (ALB), *Anoplophora glabripennis*, is not known to occur in Vermont and 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. We continue to discourage the movement of firewood and other wood products that may be routes of entry for ALB. (See Firewood section below.)

For the third year, we deployed flight intercept/pheromone traps in Vermont for detection of ALB (Table 14, Figure 21). No ALB were collected. Lures used in the 15 traps were comprised of a combination of six different pheromones and volatiles. Locations selected for survey work included state and private campgrounds throughout the state that were potentially at high risk based on the chance that infested firewood might have been in the area. Traps were deployed in late June and checked bi-weekly between July 1st and September 23rd. Volunteers helped service many of these traps, and we were grateful for their assistance.

Table 14. Location of Asian Longhorned Beetle traps deployed in Vermont in 2015. Data include county, town, location, tree species, coordinates, dates of deployment and number of trap checks.

County	Town	Location	Tree Species	Latitude	Longitude	Date Out	Date In	Number of Trap Checks
Addison	Salisbury	Branbury State Park	Red Maple	43.905468	-73.063188	7-Jul-15	23-Sep-15	6
Bennington	Dorset	Emerald Lake State Park	Sugar Maple	43.26999	-72.011120	10-Jul-15	25-Sep-15	6
Bennington	Woodford	Woodford State Park	Sugar Maple	42.88771	-73.063250	10-Jul-15	25-Sep-15	6
Caledonia	Groton	Nature Center	Norway maple	44.285801	-72.264964	7-Jul-15	22-Sep-15	5
Caledonia	St. Johnsbury	Moose River Campground	Sugar Maple	44.428512	-71.964724	6-Jul-15	22-Sep-15	5
Franklin	Franklin	Lake Carmi State Park	Red Maple	44.95403	-72.875690	6-Jul-15	25-Sep-15	6
Grand Isle	Grand Isle	Grand Isle State Park	Sugar Maple	44.68682	-73.291660	6-Jul-15	25-Sep-15	7
Lamoille	Cambridge	Brewster River Campground	Sugar Maple	44.614079	-72.812353	1-Jul-15	23-Sep-15	7
Lamoille	Eden	Lake Eden campground	Sugar Maple	44.720123	-72.513871	30-Jun-15	23-Sep-15	7
Orange	Topsham	Thompson Campground	Sugar Maple	44.076552	-72.218887	30-Jun-15	23-Sep-15	7
Orleans	Derby Line	Derby Line Welcome Center	Sugar Maple	44.99443	-72.103350	6-Jul-15	22-Sep-15	5
Rutland	Poultney	Lake St. Catherine State Park	Sugar Maple	43.48074	-73.206940	10-Jul-15	28-Sep-15	6
Windham	Guilford	I-91 Visitor Center	Sugar Maple	42.81285	-72.566120	17-Jun-15	16-Sep-15	6
Windham	Jamaica	Jamaica State Park	Sugar Maple	43.10871	-72.774620	17-Jun-15	16-Sep-15	6
Windsor	Hartford	Quechee SP	Red Maple	43.63591	-72.403740	18-Jun-15	16-Sep-15	6

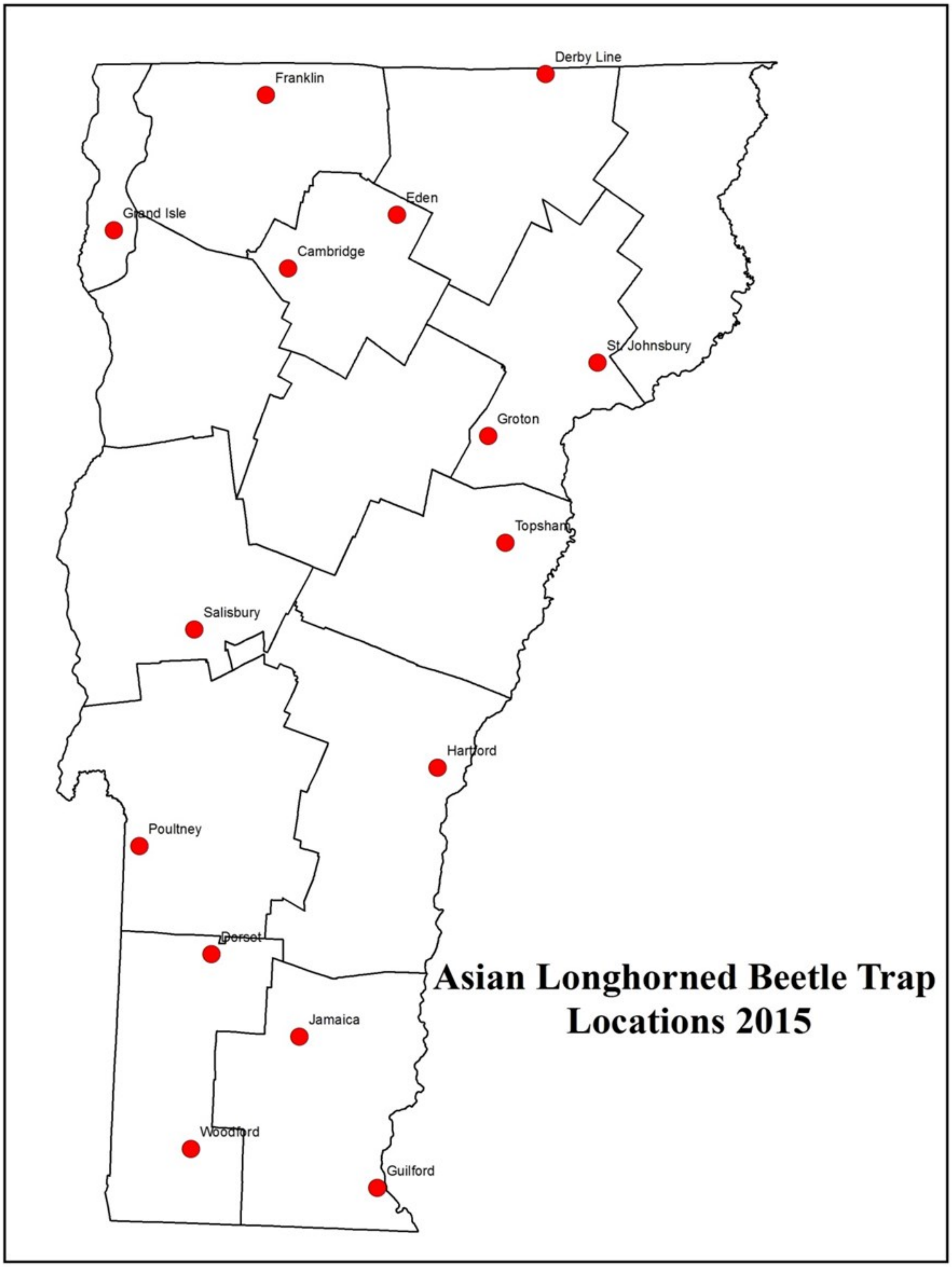


Figure 21. Asian Longhorned Beetle trap locations in 2015. There was a single trap at each location.

Emerald Ash Borer (EAB), *Agrilus planipennis*, is not known to occur in Vermont and was not detected by survey in spite of an aggressive emerald ash borer detection effort. 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, and the presence of known areas of dead ash. Working with individual volunteers, and volunteer organizations, 10 high risk sites were selected (Figure 22). In each site, a single purple prism traps and green funnel trap were hung, for a total of 20 traps in the area. Trap trees were established at four of the sites. We will continue to survey next year in this location, and will also expand an intensive survey effort to northwestern Vermont in order to target another high-risk area.

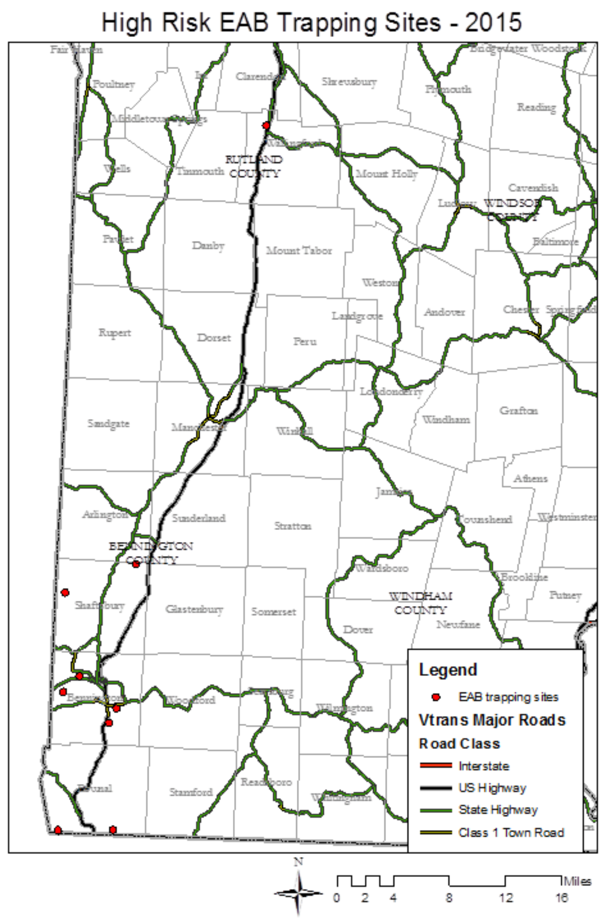


Figure 22. Trapping locations for intensive EAB survey in southwestern Vermont. A total of 10 sites were included with 2 traps at each location deployed. The site indicated in southwest Pownal had two sites present with a total of 4 traps represented by this data point. A subset of these sites will be used in 2016 to continue our intensive monitoring efforts for EAB.

In addition to trap trees that were part of the intensive EAB survey effort in Bennington and Rutland counties, we selected and girdled ash trees from additional high risk areas for a total of 16 trees in 10 counties (Table 15). Fifteen trees were white ash and one was a brown ash. All trees were girdled between May 4 and June 10, 2015. As in past years, ash trees 4-10 inches in diameter were girdled with a pruning saw to make two parallel cuts, 8-12 inches apart. A drawknife was used to remove the bark between these cuts.

The trees were cut shortly before the peeling dates of November 17 and 18. The peeling was conducted by staff members from Forests, Parks and Recreation and the Department of Agriculture, assisted by five volunteers from First Detectors and AmeriCorps. No evidence of the emerald ash borer was discovered in any of the peeled tree bolts.

Table 15. Locations of girdled trap trees used to survey for emerald ash borer in 2015. Data include district, site, county, coordinates and tree identification number.

EAB Trap Tree Locations - 2015						
District	**Site**	**County**	**Latitude**	**Longitude**	**Observer**	**Tree**
1	I-91 ROW WRJ	Windsor	43.64416	72.33855	Esden	15-1-1
1	Ascutney SP	Windsor	43.43426	72.40405	Esden	15-1-2
1	Fort Dummer SP	Windham	43.04084	72.56665	Esden	15-1-3
1	One World Cons. Ctr.	Bennington	42.86145	73.19718	Esden	15-1-4
2	The Dome Trailhead - USFS	Bennington	42.74962	73.18754	Lund	15-2-1
2	Solon Rhode Property	Bennington	42.99377	73.25758	Lund	15-2-2
2	Whipstock Hill	Bennington	42.89632	73.25805	Lund	15-2-3
3	Grand Isle SP	Grand Isle	44.68645	73.29239	Dillner	15-3-1
3	Lake Carmi SP	Franklin	44.95753	72.87491	Dillner	15-3-2
3	North Beach Campground	Chittenden	44.49390	73.23581	Dillner	15-3-3
4	I-89 Rest Area Randolph	Orange	43.98240	72.62966	Lackey	15-4-1
4	Brewster River Campground	Lamoille	44.61403	72.81247	Lackey	15-4-2
4	Limehurst Campground	Orange	44.10213	72.55040	Lackey	15-4-3
5	Barnet Fire House	Caledonia	44.29299	72.05942	Greaves	15-5-1
5	Silvio Conte US F&W	Essex	44.78165	71.68051	Greaves	15-5-2
5	54 Greaves Road	Caledonia	44.45292	72.25665	Greaves	15-5-3

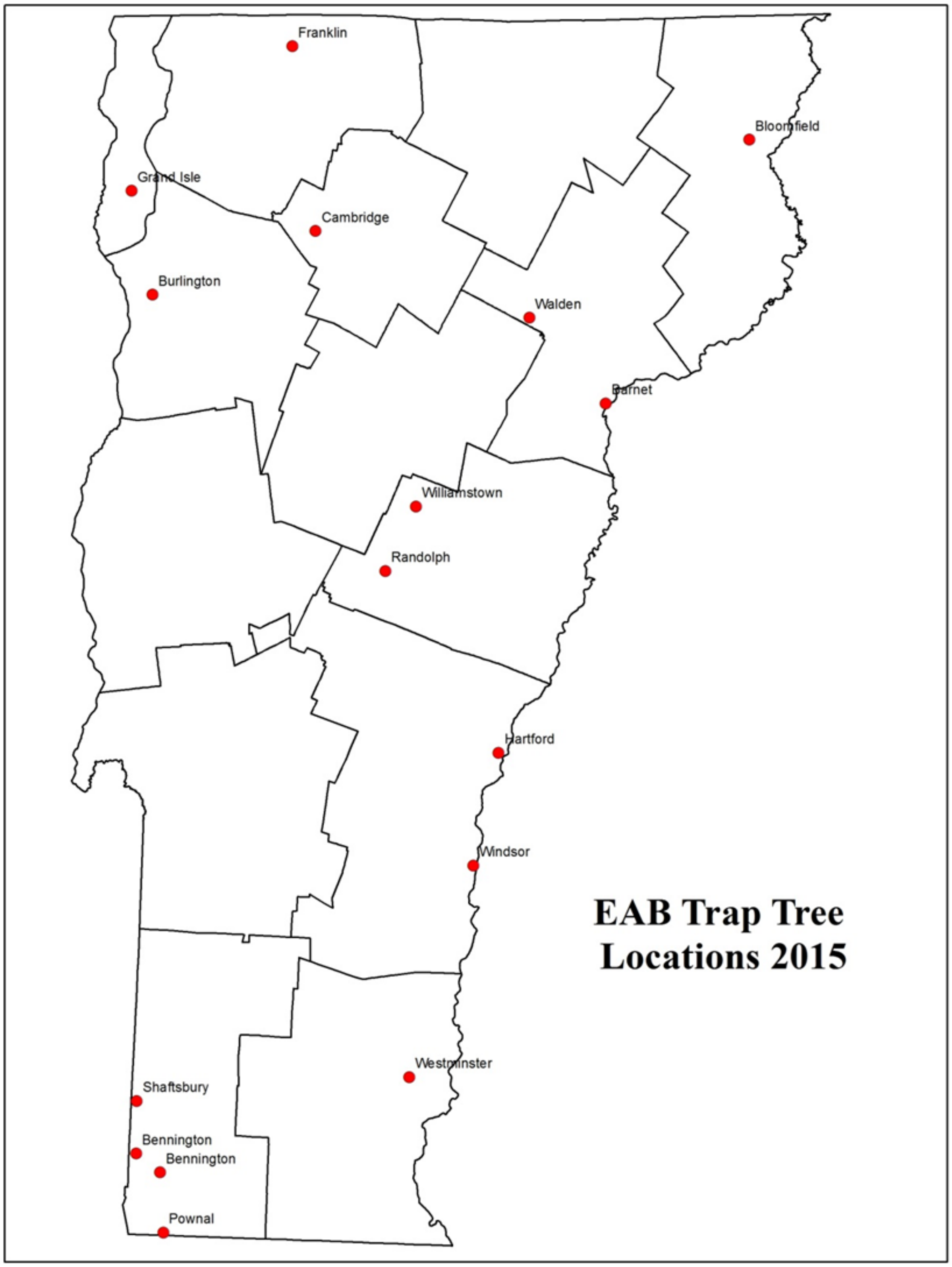


Figure 23. Location of girdled ash trap trees in 2015.

In 2015, wasp watchers visited 55 Cerceris fumipennis nest sites, including 15 new locations (Table 16, Figure 25). While wasp behavior in some sites was similar to what we've observed in previous years, activity started late in many locations and was disappointingly slow and nearly non-existent in others. Heavy rain in the early part of the season, followed by episodic "hopscotch" deluges, interrupted the wasps' foraging. Thirteen of the sites were active enough to warrant routine monitoring, 11 had only limited wasp activity, and no nest holes were found at 31 of the sites visited. Over 100 site visits were made over the course of the flight season, but no emerald ash borers were found amongst 659 buprestids collected.

Highlights of the 2015 Cerceris season included locating our first two nest sites in Addison County, both in the Middlebury area. In notable catches, wasp watchers at two other sites collected wasps that were carrying mating pairs of beetles. In both cases, the beetles in tow turned out to be *Chrysobothris azurea*, a tiny, showy species of buprestid. Our Brandon volunteers captured a wasp that was carrying a tiny Chrysomelid beetle in the genus *Neochlamisus*. These beetles are taken infrequently by *Cerceris*; this was only the second time we have found one in Vermont.

Figure 24. Mating sets of the buprestid *Chrysobothris azurea* (left) were collected at two *Cerceris* sites. At a third site, a *Cerceris* wasp returned to her nest with a Chrysomelid beetle in the genus *Neochlamisus* (right). *Photos*: Joshua P. Basham and Graham Montgomery.

Table 16. Vermont sites where *Cerceris fumipennis* nests were found in 2015. Data include county, town, site, coordinates, and numbers of buprestid beetles collected at each site.

County	Town	Site	Latitude	Longitude	Number of Buprestids
Addison	Middlebury	Middlebury Union HS	44.003689	-73.162169	19
Franklin	Richford	Richford Playground	44.993795	-72.677627	63
Orange	East Thetford	Cedar Circle Farm and Education Ctr.	43.806317	-72.186173	9
Orange	Wells River	Blue Mountain Union High School	44.155746	-72.083988	1
Rutland	Brandon	Estabrook Field	43.810583	-73.103448	43
Rutland	Castleton	Castleton Hubbardton Elem. School	43.619623	-73.211399	50
Rutland	Hydeville	Hydeville Ball Field	43.604961	-73.229946	7
Rutland	Pittsford	Lothrop School	43.705447	-73.018670	16
Rutland	Proctor	Proctor Junior/Senior High School	43.655607	-73.028018	64
Rutland	Rutland Town	Dewey Field	43.607180	-73.013244	52
Rutland	Brandon	Otter Valley Union	43.762969	-73.052689	1
Rutland	W. Rutland	Sabotkas Recreation Field	43.585506	-73.040778	7
Washington	Montpelier	Montpelier High School	44.260380	-72.589250	3
Windham	Bellows Falls	Bellows Falls Union High School	43.111720	-72.438390	50
Windham	Jamaica	Stephen Ballantine Memorial Field	43.07638	-72.733690	163
Windham	Marlboro	Augur Hole	42.922100	-72.71030	35
Windsor	Norwich	Dothan Brook School	43.688980	-72.321390	51
Windsor	Windsor	Windsor Town Rec Field	43.469240	-72.403290	20
Windsor	Quechee	Stone Patio	43.652682	-72.451137	5
					659

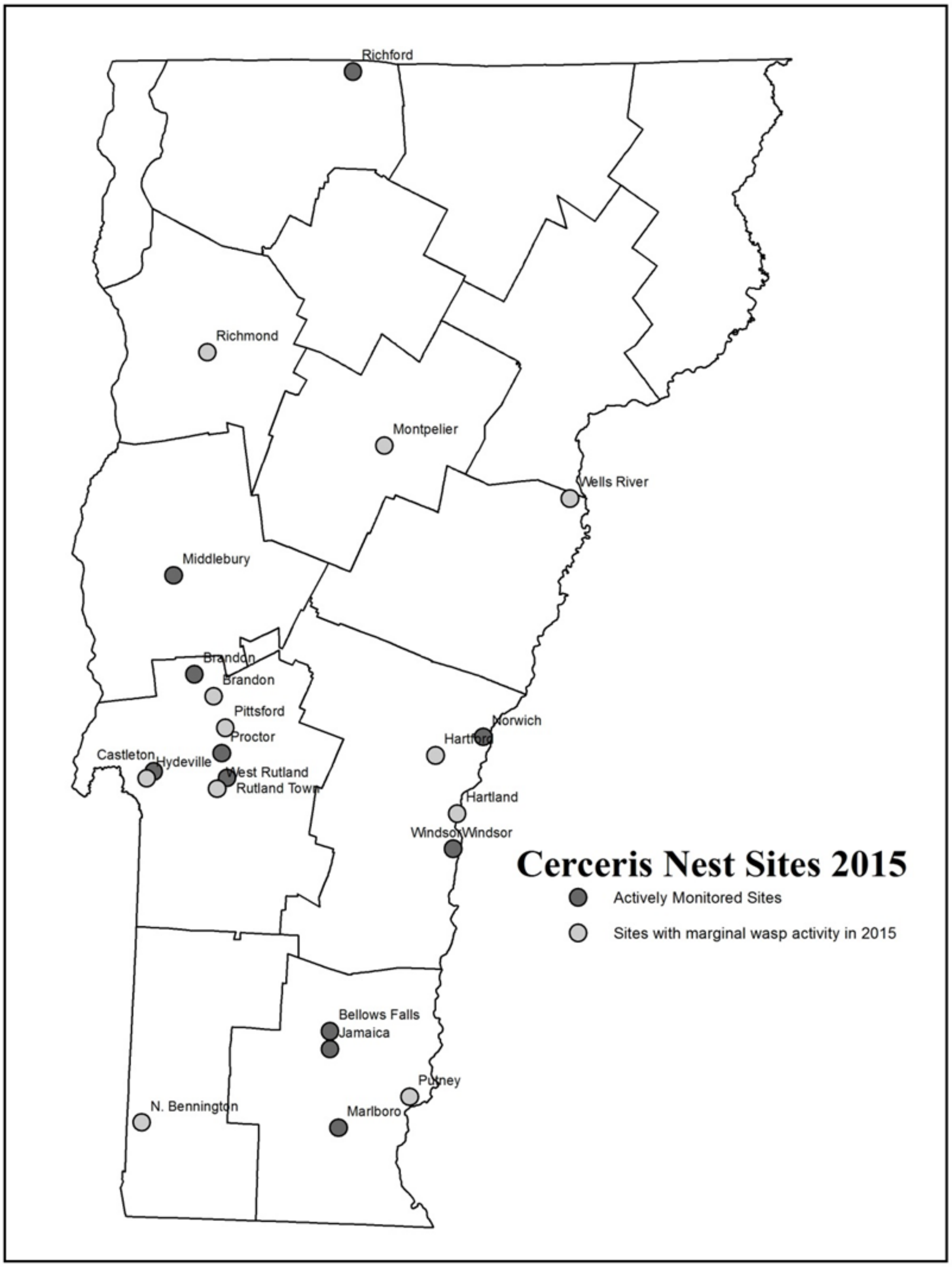


Figure 25. Location of Cerceris nest sites in 2015.

As part of ongoing efforts, USDA APHIS oversaw the deployment of 658 purple panel traps and 30 green funnel traps. No EAB were collected in the traps. Figure 26 shows the locations of the complete suite of EAB monitoring efforts in Vermont in 2015.

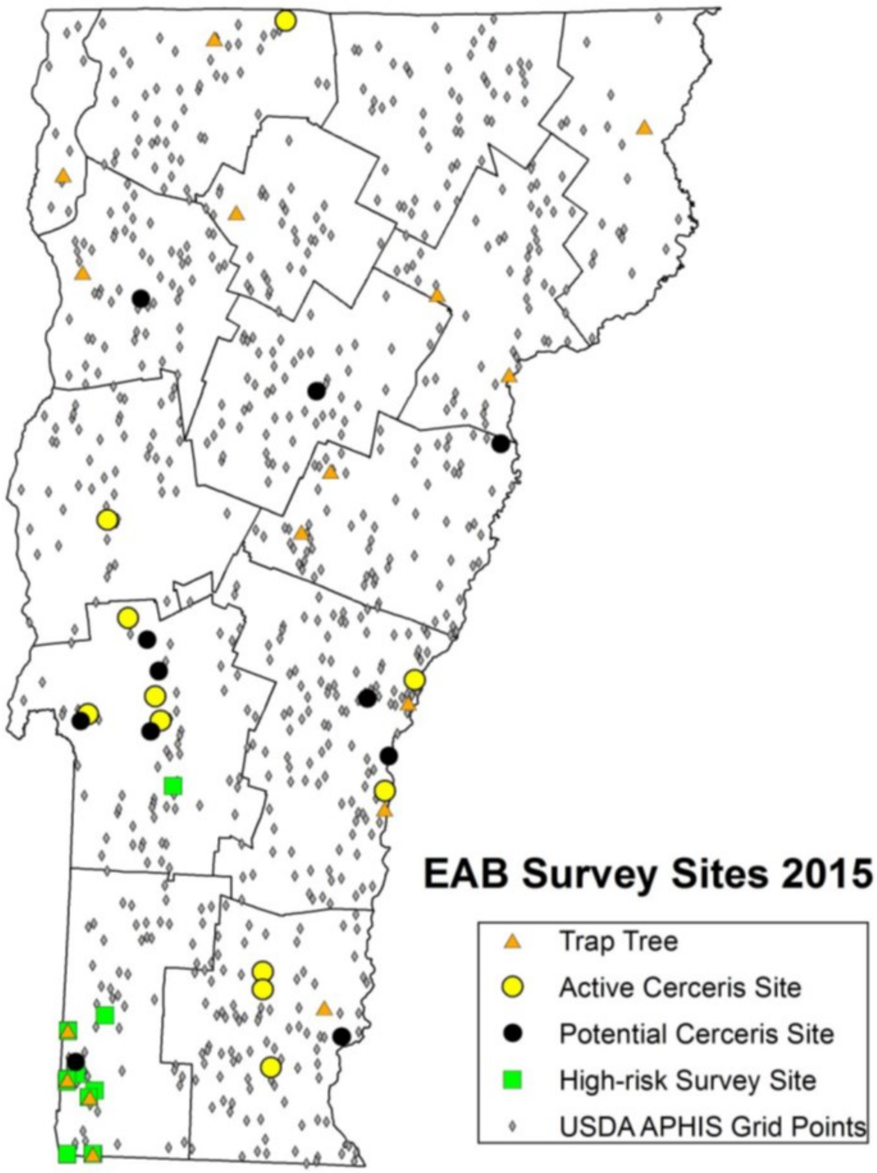


Figure 26. 2015 survey locations for Emerald Ash Borer in Vermont, including trap trees, *Cerceris fumipennis* nest sites, and baited purple prism and green funnel traps.

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.

Firewood remains a focus, as it has been a common pathway for wood insect movement, including several risk reduction activities.

Firewood Awareness Week, a week long campaign to raise awareness of the importance of buying and burning locally sourced firewood, was hosted by UVM Extension, the VT Agency of Agriculture, Food, and Markets, VT Department of Forests, Parks, and Recreation, USDA APHIS and the Green Mountain National Forest in 2015. The effort included tree tagging displays at 13 federal and state campgrounds, 14 rest areas, and two trailheads in Vermont. The displays remained up through Labor Day Weekend and reached an estimated 400,000 people with the “Don’t Move Firewood” message.

A Proposed Firewood Quarantine Rule has been filed with the Secretary of State as required by Act 112, "relating to the importation of firewood", signed in 2014. Following are basic elements of the proposed rule:

- Firewood is defined as wood processed for burning and less than 48 inches in length, but does not include wood chips, pellets, pulpwood, or wood for manufacturing purposes.
- Untreated firewood cannot be brought into Vermont.
- Treated firewood must be treated to the highest USDA standard (160° F/71.1° C for at least 75 minutes), which kills Asian longhorned beetle among other pests.
- Treated firewood must be accompanied by certification of treatment, such as a phytosanitary certificate, invoice, bill of lading, or label stating that the firewood has been heat treated to the 160° F/75 minute standard.
- By written request, FPR can grant a waiver allowing untreated firewood to be moved into Vermont, but only if there is minimal threat to forest health, and not restricted by existing state or federal pest quarantines.
- Enforcement is through the Agency of Natural Resource's Enforcement Division.
- The rule is scheduled to go into effect on May 1, 2016.

The State Parks Firewood Exchange Project continued in support of Department policy stating that untreated firewood originating from any location outside Vermont cannot be transported into Vermont State Parks or State Forests. The 2015 camping season was the seventh year that our State Parks exchanged firewood with campers who brought wood in from out of state. As in previous years, visitors who arrived at a Vermont State Park with firewood from outside Vermont were asked to exchange their firewood for an equal amount of park-supplied firewood. Campers were allowed to bring firewood into the park only if it was obtained within Vermont. Wood brought from outside the state must be packaged and labeled as having been heat treated, and certified by USDA or the appropriate department of agriculture.

The total number of bags of firewood collected statewide in 2015 was 46 (1.25 cords). This is very close to what was collected in 2014. It is good to see the downward trend continue.

The Parks that collected firewood this year include: Stillwater (13 bags), Grand Isle (10 bags), Elmore (5 bags), Little River (4 bags), Branbury (3 bags), Emerald Lake (2 bags), Button Bay (2 bags), Wilgus (2 bags), Coolidge (1 bag), Underhill (1 bag), and an unknown Park, (3 bags).

Firewood brought into our Parks this year came from: Maryland, Kentucky, Illinois, Pennsylvania, Rhode Island, Maine, New York, Massachusetts and New Hampshire. Forest Protection staff opened and examined all of the wood collected. No evidence of invasive pests was found. All of the firewood collected has been donated to state-owned wood burning facilities for use during the current heating season.

Table 17. Numbers of bags of firewood brought into Vermont State Parks during the 2009-2015 camping seasons. From 2009-2012, firewood from over 50 miles away was exchanged. Beginning in 2013, all out-of-state firewood was included in the exchange program.

Year	Number of Bundles
2009	212
2010	379
2011	158
2012	136
2013	148
2014	51
2015	46

Exotic Wood Borer/Bark Beetle National Survey

In 2015, staff with the USDA APHIS Plant Protection and Quarantine (PPQ) and the Vermont Agency of Agriculture deployed traps for exotic woodboring beetles at Island Pond, Burke, Ryegate and Groton. Various traps in these sets were baited with Ips lures, lures for brown spruce longhorn beetle (*Tetropium fuscum*), straight alpha-pinene, alpha-pinene/Monochamus, ethanol, and lineatin lures.

Trap catches (225 specimens) were submitted to the Carnegie Museum for identification. Single specimens of two targeted insects were collected in Burlington during the July 16-30, 2015 trapping period. One was *Sirex noctilio* (see below) and the other was *Tomicus piniperda.*

Sirex Woodwasp, *Sirex noctilio,* has been trapped in six Vermont counties since 2007 (Table 18). In 2015, the insect was trapped again by the Agency of Agriculture, Food and Markets in Chittenden County. No new observations of *Sirex noctilio* infesting trees were reported.

Table 18. Historical records of *Sirex noctilio* collected in baited and unbaited traps in Vermont. Note that the lure for brown spruce longhorned beetle (*Tetropium fuscum*) (BSLB) appeared to be the attracting agent for eight of these finds.

Date collected	Town	County	Lure (if used)
7/21/2007	Stowe	Lamoille	Sirex
8/15/2012	Brattleboro	Windham	BSLB
7/11/2013	East Burke	Caledonia	BSLB
8/1/2013	Jericho	Chittenden	NA
8/22/2013	Randolph	Washington	BSLB
9/4/2013	Swanton	Franklin	BSLB
9/19/2013	Randolph	Washington	BSLB
10/25/2013	Island Pond	Essex	BSLB
9/19/2014	Swanton	Franklin	BSLB
10/8/2014	Ryegate	Caledonia	BSLB
9/17/2014	Island Pond	Essex	Monochamol, ethanol and alpha-pinene
9/30/2015	Burlington	Chittenden	BSLB

OTHER BARK AND WOOD INSECTS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Asian Longhorned Beetle	*Anoplophora glabripennis*	Various hardwoods		Not observed or known to occur in Vermont. See narrative.
Bronze Birch Borer	*Argrilus anxius*	Birch	Scattered throughout	Frequently observed though damage is usually regarded as minor.
Black Spruce Beetle	*Tetropium castaneum*	Spruce, pine, fir and larch		Not observed or known to occur in Vermont.
Brown Prionid	*Orthosoma brunneum*	Hardwoods	Montgomery	Adult observed.
Brown Spruce Longhorned Beetle	*Tetropium fuscum*	Spruce, pine and fir		Not observed or known to occur in Vermont.
Carpenter Ant	*Camponotus* sp.	Wood products	Scattered	Continue to receive inquiries, mostly from worried homeowners.
Carpenterworm	*Prionoxystus robiniae*	Ash	Barnard, Bethel, Peacham	More attention to ash due to EAB threat may be resulting in more observations of ash insects like this one.
Eastern Ash Bark Beetle	*Hylesinus aculeatus*	Ash	Scattered reports, including Peacham, Mt Holly and elsewhere	Beetles encountered as they emerged from firewood and logs; galleries observed in downed ash.
Eastern Larch Beetle	*Dendroctonus simplex*	Larch	Northeast Kingdom	Associated with scattered larch decline.
Elderberry Borer	*Desmocerus palliatus*	Elderberry	Plainfield	Showy adult oberved on elderberry flowers.
Emerald Ash Borer	*Agrilus planipennis*	Ash		Not observed or known to occur in Vermont. See narrative.
European Woodwasp	*Sirex noctilio*	Red and Scots pine		See narrative.

OTHER BARK AND WOOD INSECTS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Hemlock Borer	*Phaenops fulvoguttata*	Hemlock and occasionally other conifers	Widely scattered	Observed on dead and dying trees. Some affected trees were predisposed to attack by wind disturbance of their roots, by flooding, or drought. Increased activity likely next year on ledgey sites stressed by late summer's dry conditions. Because of its shallow root system, hemlock is particularly susceptible.
Japanese Cedar Longhorned Beetle	*Callidiellum rufipenne*	Arborvitae, eastern redcedar, juniper and others		Not observed or known to occur in Vermont.
Locust Borer	*Megacyllene robiniae*	Locust	Colchester	Larvae tunnel in trunk and branches; conspicuous, brightly-colored adults appear when goldenrod is in bloom.
Nearctic Carpenter Ant	*Camponotus nearcticus*	Dead wood of living trees	Fair Haven	Found inside a recently built cabin in the woods. Only previous record of this species for VT was 2014 from Black Mountain Preserve in Dummerston. Experts say that it should be "all over" the state, but we have few VT ant records overall.
Northeastern Sawyer	*Monochamus notatus*	Conifers	Scattered	More reports than usual during adult flight period.
Pigeon Tremex	*Tremex columba*	Sugar maple	Scattered throughout	Commonly observed in declining trees or turning up while splitting firewood.
Redheaded Ash Borer	*Neoclytus acuminatus*	Ash	Franklin	

OTHER BARK AND WOOD INSECTS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Roundheaded Apple Tree Borer	*Saperda candida*	Apple	Widely scattered	Found in trees already weakened due to some other stress.
Southern Pine Beetle	*Dendroctonus frontalis*	Pine		Not observed or known to occur in Vermont.
Sugar Maple Borer	*Glycobius speciosus*	Sugar maple	Scattered throughout	Borer wounds commonly observed throughout the state.
Whitespotted Sawyer	*Monochamus scutellatus*	White pine and other conifers	Common throughout	Adults commonly observed.

Other Bark and Wood Insects not reported in 2015 included Allegheny Mound Ant, *Formica exsectoides;* Elm Bark Beetles, *Hylurgopinus rufipes* and *Scolytus multistriatus* ; Red Turpentine Beetle, *Dendroctonus valens.*

FRUIT, NUT AND FLOWER INSECTS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Asiatic Garden Beetle	*Autoserica castanea*	Many	Scattered observations	Light damage.
Rose Chafer	*Macrodactylus subspinosus*	Many	Statewide	Few reports in 2015.
Western Conifer Seed Bug	*Leptoglossus occidentalis*	Conifers	Statewide	No damage to Vermont conifers has been recorded, but a common household invader. Fewer reports as people have become accustomed to their appearance.

Fruit, Nut and Flower Insects not reported in 2015 included Butternut Curculio, *Conotrachelus juglandis;* Fir Coneworm, *Dioryctria abietivorella;* Green Stink Bug, *Chinavia hilaris;* Pine Coneworm, *Dioryctria reniculelloides;* Plum Curculio, *Conotrachelus nenuphar* .

FOREST DISEASES

STEM DISEASES

Dieback from **Beech Bark Disease** was mapped on 35,866 acres, an increase from the 14,479 acres mapped in 2014 (Table 19 and Figure 27). Most of the mapped area includes scattered trees with bright yellow crowns, indicating dieback and mortality. Yellow crowns, dieback and mortality are also commonly observed on the ground. 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.

Table 19. Mapped acres of beech bark disease in 2015.

County	Acres
Addison	2,046
Bennington	1,548
Caledonia	1,946
Chittenden	1,209
Essex	7,448
Franklin	729
Grand Isle	4
Lamoille	3,339
Orange	1,142
Orleans	1,510
Rutland	918
Washington	6,378
Windham	4,029
Windsor	3,620
Total	**35,866**

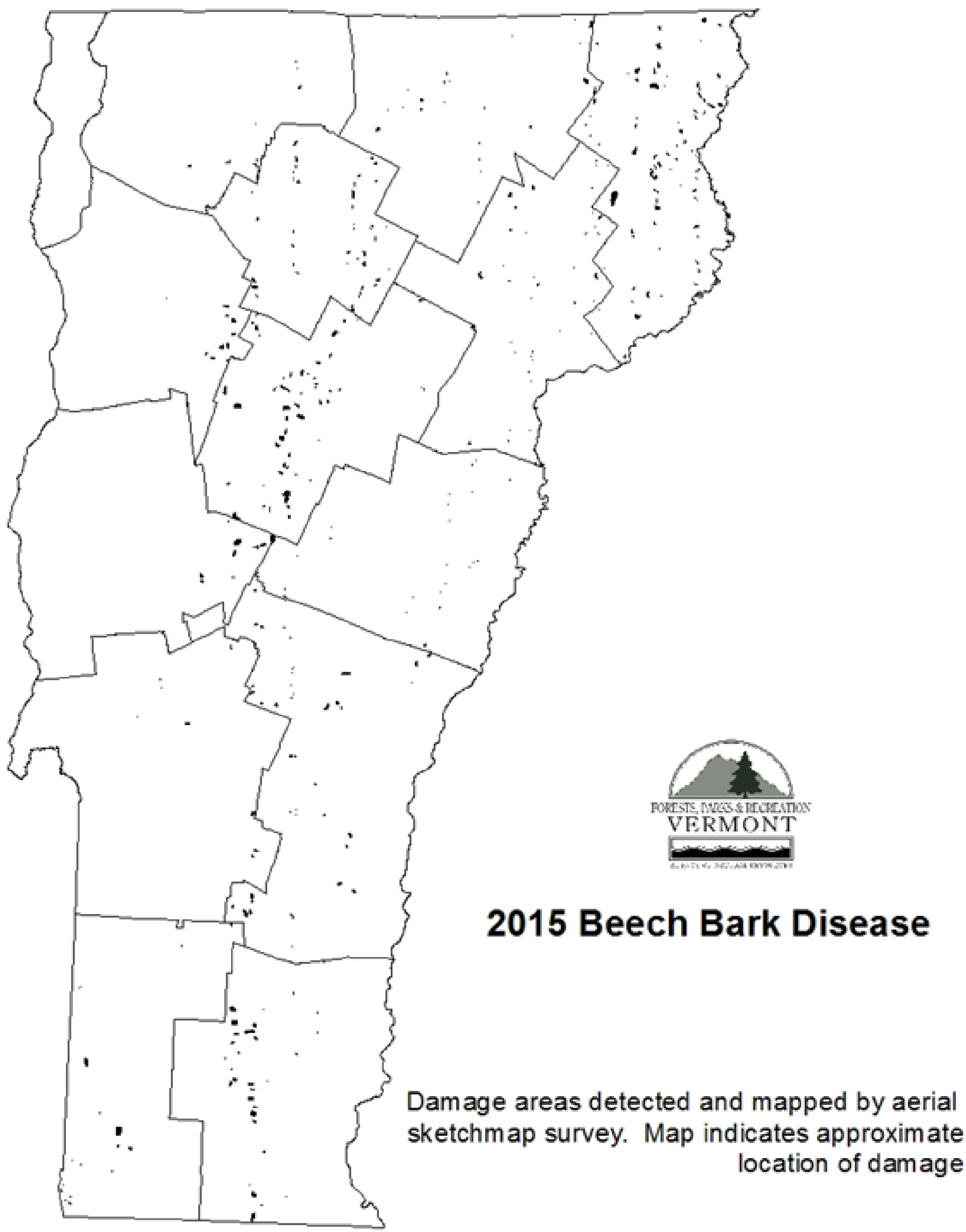


Figure 27. Beech bark disease related decline and mortality mapped in 2015. Mapped area includes 35,866 acres.

White Pine Blister Rust, caused by *Cronartium ribicola*, levels of topkill and mortality remain higher than normal. During aerial surveys, 169 acres of scattered mortality were mapped (Table 20). This underestimates the area affected, as affected trees are so widely scattered on the landscape and difficult to map.

Table 20. Mapped acres of mortality caused by white pine blister rust in 2015.

County	Acres
Franklin	3
Orange	19
Orleans	38
Washington	90
Windham	5
Windsor	15
Total	**169**

OTHER STEM DISEASES

DISEASE	LATIN NAME	HOST	LOCALITY	REMARKS
Ash Yellows	*Candidatus Phytoplasma fraxini*	White ash	Southern and Northwestern Vermont	Remains heavy in scattered locations.
Beech Bark Disease	*Cryptococcus fagisuga and Nectria coccinea var. faginata*			See narrative.
Black Knot	*Dibotryon morbosum*	Cherry	Scattered throughout	Common at normal levels.
Butternut Canker	*Sirococcus clavigignenta-juglandacearum*		Widespread	Remains stable, with most butternuts showing signs of the disease.
Caliciopsis Canker	*Caliciopsis pinea*	White pine	Widely scattered	Associated with decline where trees are stressed by recurrent needle diseases.
Chestnut Blight	*Cryphonectria parasitica*	American chestnut	Southern Vermont, Champlain Valley	Observed on sprouts. The American Chestnut Foundation remains active in establishing seed orchards in Vermont.
Cytospora Canker	*Leucostoma kunzei*	Blue spruce	Widely scattered	Damage levels remain low.
Diplodia Shoot Blight	*Sphaeropsis sapinea*	Red pine	Widespread	Role in red pine decline is unclear (see Diebacks, Declines, and Environmental Diseases).
Dutch Elm Disease	*Ophiostoma novo-ulmi*	Elm	Throughout	Levels similar to 2014.
Fireblight	*Erwinia amylovora*	Apple	Morrisville	
Hypoxylon Canker	*Hypoxylon pruinatum*	Poplar	Widely scattered	Damage levels low.
Nectria Canker	*Nectria galligena*	Hardwoods	Scattered throughout	
Oak Wilt	*Ceratocystis fagacearum*			Not observed or known to occur in Vermont.

OTHER STEM DISEASES

DISEASE	LATIN NAME	HOST	LOCALITY	REMARKS
Phomopsis Blight	*Phomopsis sp.*	Juniper	Northeastern Vermont	Ornamentals.
Red Ring Rot	*Phellinus pini*	White pine	Scattered throughout	Common in unthrifty stands, especially where basal area is high and soils are poorly drained.
Sapstreak	*Ceratocystis coerulescens*	Sugar maple	Whitingham	Found on dying trees in a sugarbush tapped with buckets.
Sirococcus Shoot Blight	*Sirococcus tsugae*	Hemlock	Widely scattered	Rarely observed. Less than 2014.
Thousand Cankers Disease	*Geosmithia morbida* and *Pityophthorus juglandis*	Walnut		Not observed or known to occur in Vermont.
Verticillium Wilt	*Verticillium albo-atrum*	Sugar maple	Burlington	Ornamental.
White Pine Blister Rust	*Cronartium ribicola*	White pine		See narrative.
Woodgate Gall Rust	*Endocronartium harknessii*	Scots pine	Northern Vermont	Present in pockets of unthrifty roadside Scots pine.
Yellow Witches Broom Rust	*Melampsorella caryophyllacearum*	Balsam fir	Widely scattered	Continues to be noticeable, especially in northern Vermont.

Other Stem Diseases not reported in 2015 included Cedar Apple Rust, *Gymnosporangium juniperi-virginianae* ; Delphinella Tip Blight of Fir, *Delphinella balsamae* ; Eastern Dwarf Mistletoe, *Arceuthobium pusillum* ; Scleroderris Canker, *Ascocalyx abietina* ; Sirococcus Blight, *Sirococcus conigenus.*

FOLIAGE DISEASES

Needle Diseases of White Pines, primarily attributed to the Brown Spot Needle Blight fungus (*Mycosphaerella dearnessii*), but also to two needlecast fungi Dooks' Needlecast, (*Lophophacidium dooksii)* and *Bifusella linearis*, continued to be widespread with an increase in damage from 2014. Greater chlorosis of foliage was present than in 2014 (Figure 29). Needles infected by brown spot needle blight 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 Dooks' Needlecast.

Thin crowns were observed statewide due to early casting and consecutive years of disease. During aerial surveys, 11,488 acres were mapped. Because the June survey covered only the Green Mountain National Forest, and the damage was harder to detect by the August survey when a statewide survey was conducted, this acreage is a small percentage of the total area affected.

Table 21. Mapped acres of thin crowns due to needle diseases of white pines in 2015.

County	Acres
Addison	2,633
Bennington	1,518
Caledonia	219
Chittenden	298
Franklin	63
Lamoille	17
Orange	499
Orleans	17
Rutland	948
Washington	310
Windham	1,346
Windsor	3,619
Total	**11,488**

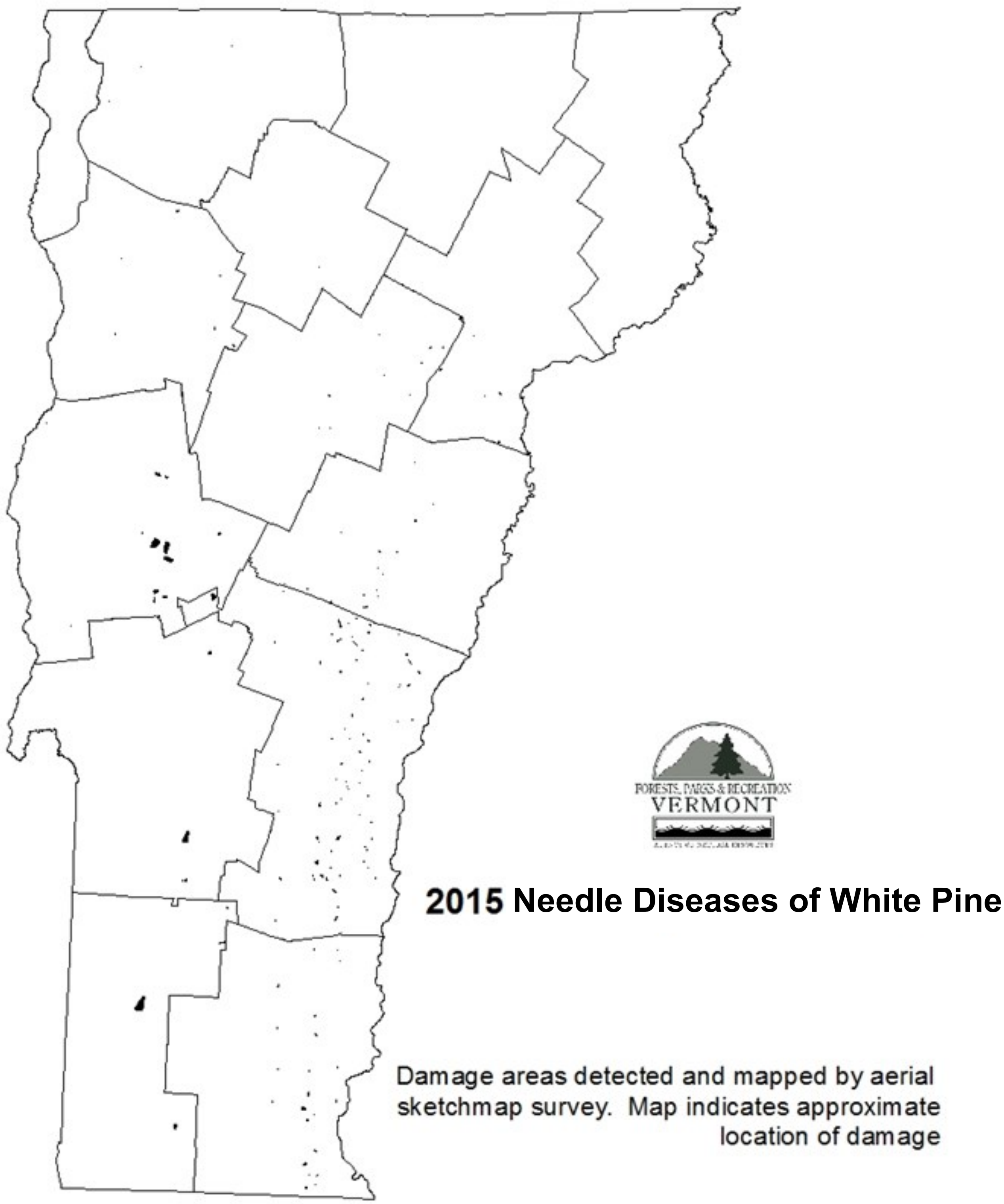


Figure 28. Thin crowns of white pines due to needle diseases mapped in 2015. Mapped area includes 11,488 acres.

These diseases are most severe in the lower crown where fungi have been thriving due to multiple wet springs. The damage has been widespread since 2010, and the current epidemic has been building at least since 2005. Decline and mortality of white pine have been observed in stands which have had multiple years of needle damage where other stress factors are also present such as wet site conditions, wind impact, or wounding. Weak pests and pathogens, such as turpentine beetles, Caliciopsis canker, and Armillaria root rot have been observed in some stressed stands.

The US Forest Service, in cooperation with UNH and affected states, continues to investigate this malady, including studies to clarify the roles of needlecast fungi and weather. As part of this project, we are monitoring plots in Plymouth, Richmond, St. Johnsbury, and Springfield (Figure 31).

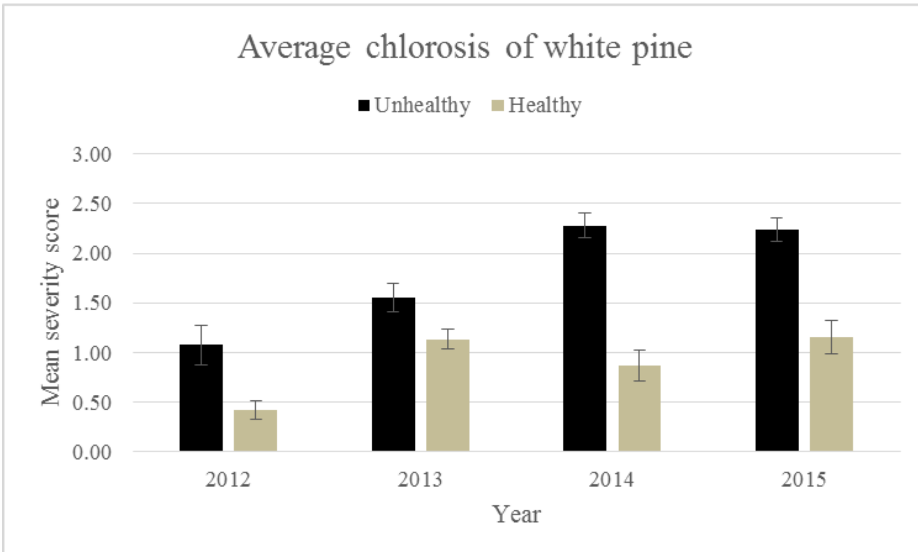


Figure 29. Chlorosis (yellowing of foliage) severity of unhealthy and healthy white pines surveyed between 2012-2015 in Vermont. Data presented are mean severity scores (0 = no chlorosis, 1 = less than 1/3 crown affected, 2 = between 1/3 and 2/3 affected, 3 = more than 2/3 affected) ± standard error.

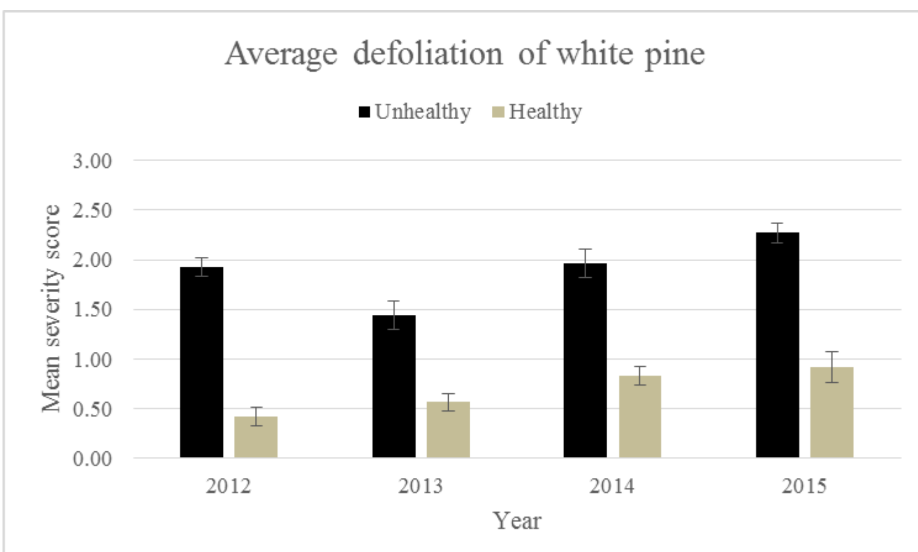


Figure 30. Defoliation severity of unhealthy and healthy white pines surveyed between 2012-2015 in Vermont. Data presented are mean severity scores (0 = no defoliation, 1 = less than 1/3 crown affected, 2 = between 1/3 and 2/3 affected, 3 = more than 2/3 affected) ± standard error.

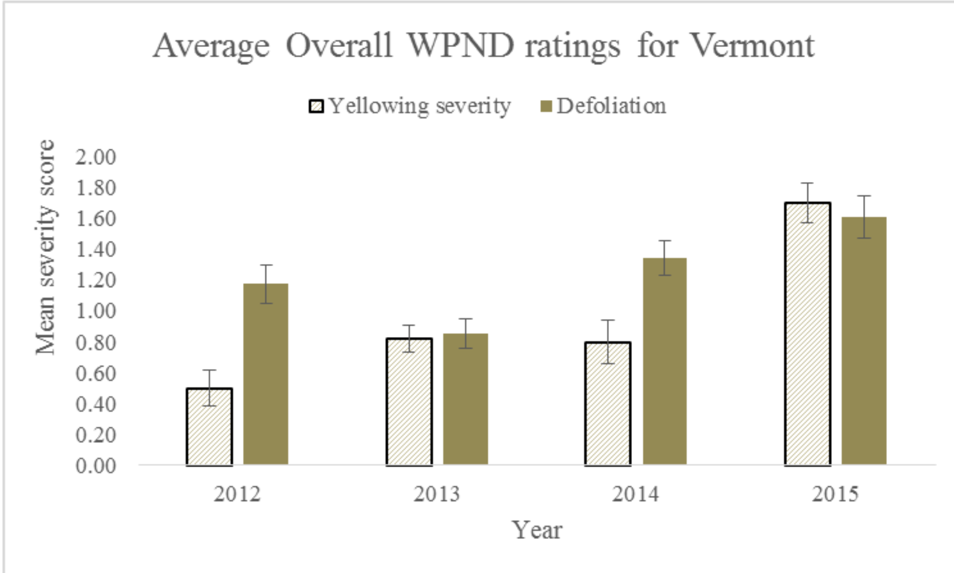


Figure 31. Average trends in yellowing severity and defoliation for all trees sampled in Vermont between 2012-2015. Data presented are mean severity scores (0 = no chlorosis/defoliation, 1 = less than 1/3 crown affected, 2 = between 1/3 and 2/3 affected, 3 = more than 2/3 affected) ± standard error.

Poplar Leaf Fungus, attributed to *Marssonina spp*., caused scattered heavy damage to balsam poplar and cottonwoods. Although weather was too dry for fungus infection early in the spring, wet conditions later in the season allowed infection of young foliage on species with indeterminate growth. During aerial surveys, 134 acres were mapped, but since most damage is in difficult to map riparian and roadside areas, the actual acreage is much larger. The etiology of this defoliation has not been investigated, including the role of *Melampsora larici*.

OTHER FOLIAGE DISEASES

DISEASE	LATIN NAME	HOST	LOCALITY	REMARKS
Anthracnose	*Gloeosporium Glomerella spp. Apiognomonia spp.*	Ash, Oak, Maple		Due to the dry spring, very uncommon on sugar maple. Scattered at light levels on other species. See Hardwood Defoliation.
Apple Scab	*Venturia inaequalis*	Apple	Rutland County	Common, but less than in 2014.
Brown Spot Needle Blight	*Mycosphaerella dearnessii*	Red pine	Statewide	Role in red pine decline is unclear (see Diebacks, Declines, and Environmental Diseases).
		Scots pine	Statewide	Continues to be very noticeable. Contributing to decline and mortality of ornamentals.
		White pine	Statewide	See White Pine Needlecast.
Canavirgella Needlecast	*Canavirgella banfieldii*			Now called Dooks Needlecast.
Cherry Leaf Spot	*Blumeriella jaapii* (formerly *Coccomyces hiemali*)	Black cherry	Northern Vermont	Incidental observation.
Dooks Needlecast	*Lophophacidium dooksii*			See White Pine Needlecast.
Fir-Blueberry Rust	*Pucciniastrum geoppertianum*	Blueberry	Rutland	Incidental observation.
Fir-Fern Rust	*Uredinopsis mirabilis*	Balsam fir	Scattered statewide	Much less common than 2014.
Giant Tar Spot	*Rhytisma acerinum*	Norway maple	Statewide	Continues to be noticeable, but only light damage observed.

OTHER FOLIAGE DISEASES

DISEASE	LATIN NAME	HOST	LOCALITY	REMARKS
Lirula Needlecast	*Lirula spp.*	Balsam fir	Scattered statewide	Occasionally observed on Christmas trees.
Maple Anthracnose	*Gloeosporium sp.*			See Anthracnose.
Poplar Leaf Fungus	Attributed to *Marssonina spp.*			See narrative.
Rhizosphaera Needle Blight	*Rhizosphaera pini*	Balsam fir	Scattered statewide	Occasionally observed on Christmas trees.
Rhizosphaera Needlecast	*Rhizosphaera kalkhoffii*	Blue spruce	Scattered statewide	Less damage than previous years. Some mortality remains visible, caused by repeated defoliations in the past.
Septoria Leaf Spot on Birch	*Septoria betulae*	Birch	Widespread	Increase from 2014. See Birch Defoliation
Septoria Leaf Spot on Maple	*Septoria aceris*	Sugar maple	Northeastern Vermont	Unusually common, causing noticeable symptoms but only light damage to forest trees. See Hardwood Defoliation.
Tar Spot	*Rhytisma* sp.	Red maple	Ludlow	Noticeable, but only light damage to forest trees.
Willow Blight	Attributed to *Venturia saliciperda*	Black Willow	Statewide	Willow defoliation remains widespread in riparian areas, with willow leaf beetle contributing to the damage. Fungus identity has not been confirmed.

Foliage Diseases not reported in 2015 included Cedar-apple Rust, *Gymnosporangium juniperi-virginianae* ; Dogwood Anthracnose, *Discula destrutiva* ; Larch Needlecast, *Mycosphaerella sp.* ; Weir's Cushion Rust, *Chrysomyxa weirii.*

ROOT DISEASES

DISEASE	LATIN NAME	HOST	LOCALITY	REMARKS
Annosus Root Rot	*Heterobasidion annosum*			No new infection centers reported.
Armillaria Root Rot	*Armillaria spp.*	Balsam fir	Scattered statewide, especially central VT	Decline sometimes initiated by balsam woolly adelgid. Percentage of dying trees in areas of mapped balsam fir mortality remains high.
		Christmas Trees	Widely scattered	Occasionally observed.
		Hardwoods	Statewide	Commonly found on declining trees.
Brown Cubical Root Rot	*Polyporus schweinitzii*	Balsam fir	Shaftsbury	
Feeder Root Diseases	*Phytophthora cinnamomi, Fusarium spp.*	Balsam fir, Fraser fir	Scattered statewide	Losses continue in Christmas tree plantations previously known to be infected.
Hypoxylon Root Disease	*Hypoxylon sp* .	Sugar maple	Weathersfield	Ornamental tree invaded through root wounds.

DIEBACKS, DECLINES, AND ENVIRONMENTAL DISEASES

Birch Decline decreased from previous years, but repeated foliage injury from various insects and diseases has continued. Aerial survey detected 245 acres of birch decline in 2015, (Table 22) down from 5,335 acres the previous year, and a substantial decrease from 2013 when 98,329 acres of birch decline was recorded.

Table 22. Mapped acres of birch decline in 2015.

County	Acres
Windsor	245
Total	**245**

Drought Damage. Extended warm weather in May without significant precipitation created dry conditions that resulted in tree injury. The US Monthly Drought Outlook showed moderate drought for May in southern Vermont, and the entire state was reported as abnormally dry. Although June and July were very wet, August and September were hot and dry, again affecting tree health. Symptoms included leaf scorch (brown leaf margins), early leaf drop, and in the case of ash, a particularly drought-sensitive species, complete defoliation of some white ash trees by late summer. Evidence of drought damage was recorded from aerial surveys affecting 8,774 acres (Table 23, Figure 32).

Table 23. Mapped acres of drought symptoms in 2015.

County	Acres
Addison	2,198
Bennington	2,465
Chittenden	67
Orange	192
Rutland	3,278
Washington	190
Windham	39
Windsor	346
Total	**8,774**

Fire Damage. By April, the heavy snow of winter had melted and no heavy spring rains had replenished ground moisture, leading to spring wildfires. A statewide burn ban was implemented on May 5 for the first time since 2005. The ban was rescinded on May 12 except for Bennington and Windham Counties where the ban expired on May 19. Two prescribed burns were successfully completed as a useful tool in managing wildlife in early successional habitat. Fall weather was warm and dry and high fire danger, an unusual fall event, was reported. A total of 6 acres of forestland was mapped from the air with fire damage (Table 24).

Table 24. Mapped acres of forest fire damage in 2015.

County	Acres
Windsor	6
Total	**6**

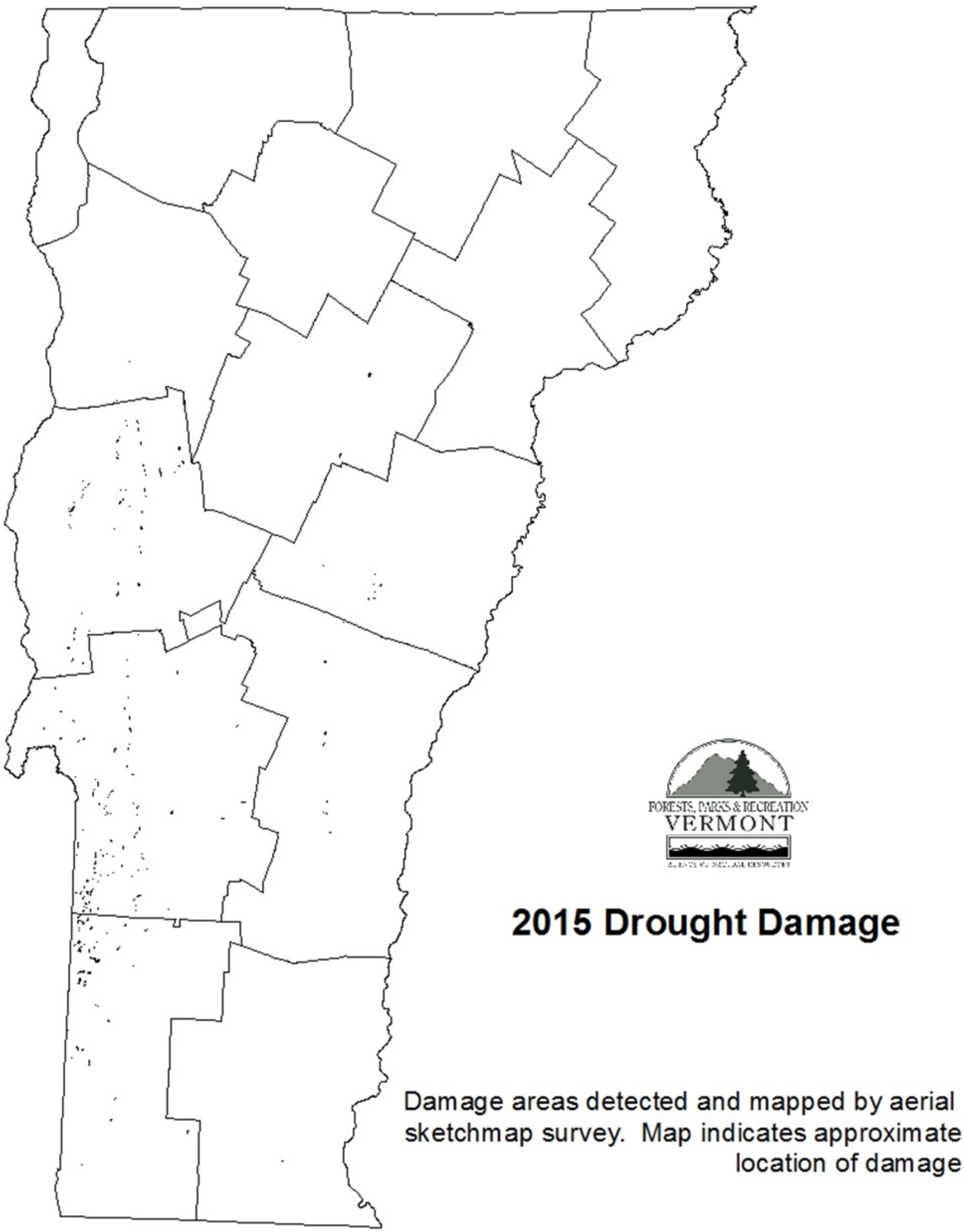


Figure 32. Symptoms of drought damage mapped in 2015. Mapped area includes 8,874 acres.

Frost Damage. A late May frost (May 22) left newly flushed leaves vulnerable, and frost damage was reported on ash, maple and beech at upper elevations, and some understory trees elsewhere. This resulted in large patches of frost damage and 24,360 acres of frost injury were mapped during aerial surveys (Table 25, Figures 33 and 34). Damage was most severe on western slopes and at elevations between 1600—2400 feet. Some affected areas were noticeable throughout the summer as brown margins developed on old foliage, refoliation remained off-color, and crowns remained thin. Locations especially hard hit included: the Northfield and Braintree ranges, the Vershire area, and the southern Green Mountains.

Table 25. Mapped acres of frost damage in 2015**.**

County	Acres
Addison	10,017
Bennington	1,476
Caledonia	26
Chittenden	888
Franklin	465
Lamoille	208
Orange	1,429
Orleans	229
Rutland	4,766
Washington	1,180
Windham	188
Windsor	3,488
Total	**24,360**

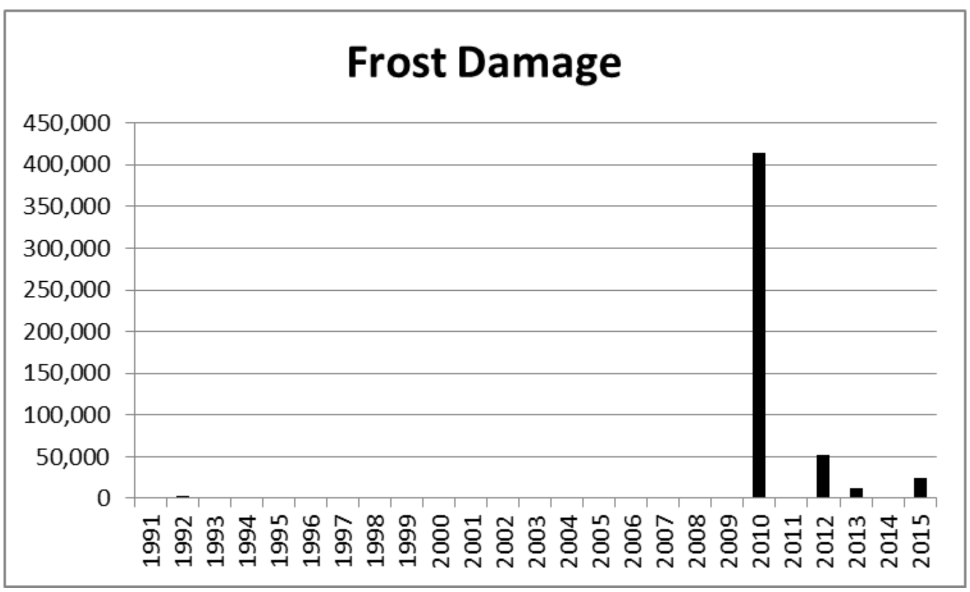


Figure 33. Acres of frost damage mapped during aerial survey from 1991-2015. In 2015, 24,360 acres were mapped.

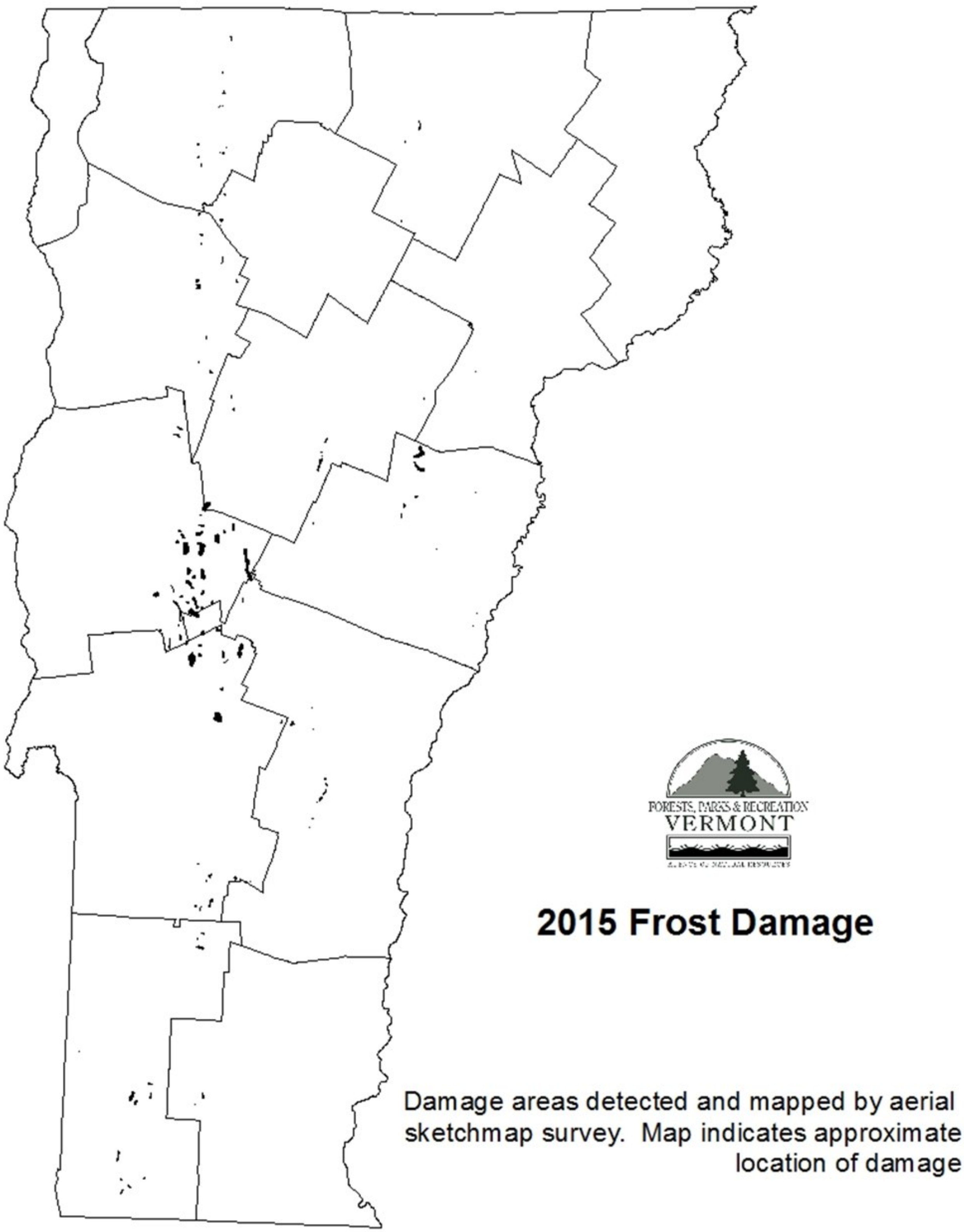


Figure 34. Frost damage mapped in 2015. Mapped area includes 24,360 acres.

Hardwood Chlorosis. Wet weather in June and July contributed to general hardwood chlorosis. Trees in poorly drained areas showed signs of stress from saturated soils and the reduced supply of oxygen to the soil and roots, resulting in yellowing or early fall coloring of foliage. Aerial surveys mapped hardwood chlorosis symptoms on 9,047 acres (Table 26). This is in addition to Wet Site tree stress (see below).

Table 26. Mapped acres of hardwood chlorosis in 2015**.**

County	Acres
Addison	313
Caledonia	1,074
Chittenden	570
Essex	76
Franklin	376
Lamoille	1,075
Orange	528
Orleans	1,200
Rutland	1,991
Washington	873
Windham	60
Windsor	913
Total	**9,047**

In 2015 there were 1,153 acres of forests with significant damage that could not be associated with any specific cause. A variety of species and locations, especially in Orange County, were mapped during aerial survey and ascribed as **unknown causes** (Table 27).

Table 27. Mapped acres of damage from unknown causes in 2015.

County	Acres
Addison	23
Chittenden	67
Franklin	50
Grand Isle	5
Orange	903
Rutland	3
Windham	39
Windsor	63
Total	**1,153**

Seven locations were visited between August 4 and August 13 to survey for **ozone injury** to sensitive plant species (Table 28). Of the 764 plants examined, symptoms of ozone injury (stippling on upper leaf surface) were recorded at 4 of the 7 Vermont locations: Rupert, Dover, Sudbury and Clarendon. This represents an increase over recent years despite lower ozone concentrations. Early season moisture provided conditions for continual ozone uptake by foliage and may have accounted for this increase. No ozone damaged forests were mapped during aerial survey.

Table 28. Ozone bioindicator sites visited in 2015 and observed ozone injury.

Town	Ozone injury
Clarendon	Present on white ash
Dover	Present on black cherry
Groton	Absent
Orange	Absent
Rupert	Present on milkweed and blackberry
Sudbury	Present on white ash and milkweed
Woodstock	Absent

Extreme Weather Events consist of storms or abnormal weather patterns impacting tree health. In 2015, frost and drought were the most significant and extensive weather damages. Other weather-related tree damage was caused by inundated sites and from winter and summer storms.

Table 29. Trend in acres of forest damage from weather events and major factors involved mapped during aerial surveys.

Year	Total Acres from Weather Damage	Extensive Damage Factors	Other Damage Factors
1991	64,529	Drought	
1992	17,790		Flooded sites, drought, frost
1993	54,067	Spruce winter injury	Flooded sites
1994	10,780		Flooded sites
1995	17,365		Flooded sites, drought
1996	19,324		Spruce winter injury, wet sites
1997	10,557		Flooded sites
1998	1,031,716	Ice storm, flooded sites	
1999	122,024	Drought	Ice, flooded sites, wind
2000	10,634		Flooded sites
2001	180,494	Drought	Flooded sites
2002	210,534	Drought	Flooded sites
2003	106,238	Spruce winter injury, flooded sites	Wind, drought
2004	19,877		Flooded sites
2005	11,078		Flooded sites
2006	6,786		Flooded sites
2007	21,656		Drought, flooded sites, wind
2008	2,401		Flooded sites
2009	15,315		Winter injury, flooded sites
2010	417,180	Frost	
2011	10,029		Flooded sites
2012	55,872	Frost	Flooded sites
2013	15,332*	Frost, ice*	Flooded sites, wind
2014	4,848		Flooded sites, wind, ice storm, hail damage
2015	35,898	Frost, drought	Flooded sites, wind, ice/snow breakage

Wet or Flooded Site Declines were mapped on 1,869 acres in 2015, a decrease from 2,030 acres recorded in 2014. Wet June weather provided excess moisture and floodplains and riparian areas expanded, inundating forests. Although drier conditions later in the summer caused waters to recede, the prolonged period of inundation resulted in tree declines.

County	Acres
Addison	151
Bennington	31
Caledonia	47
Chittenden	86
Essex	53
Franklin	495
Grand Isle	75
Lamoille	121
Orange	68
Orleans	226
Rutland	343
Washington	96
Windham	79
Total	**1,869**

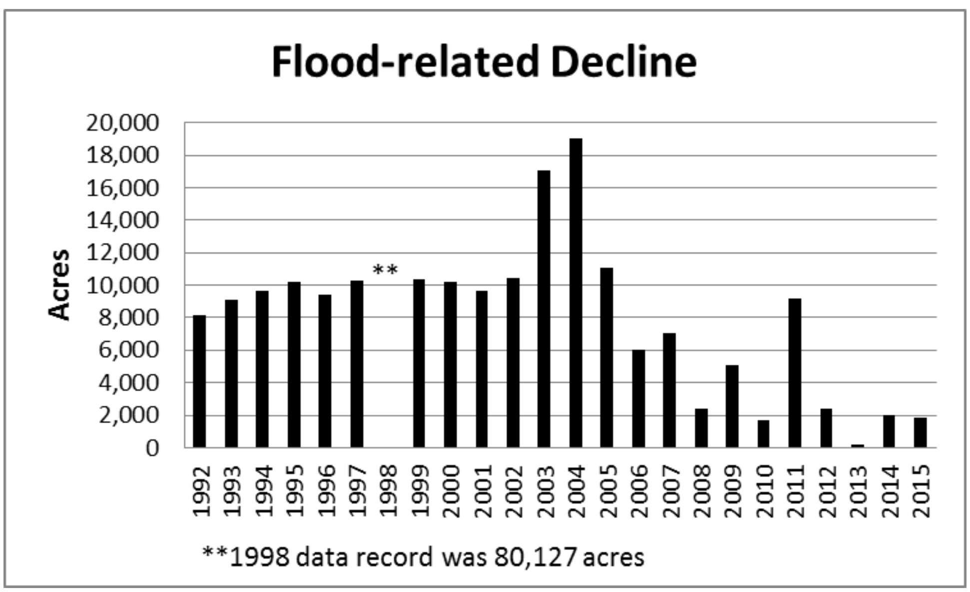


Figure 35. Trend in acres of forest decline related to wet or flooded sites. In 2015 1,869 acres were mapped during aerial survey, similar to 2014.

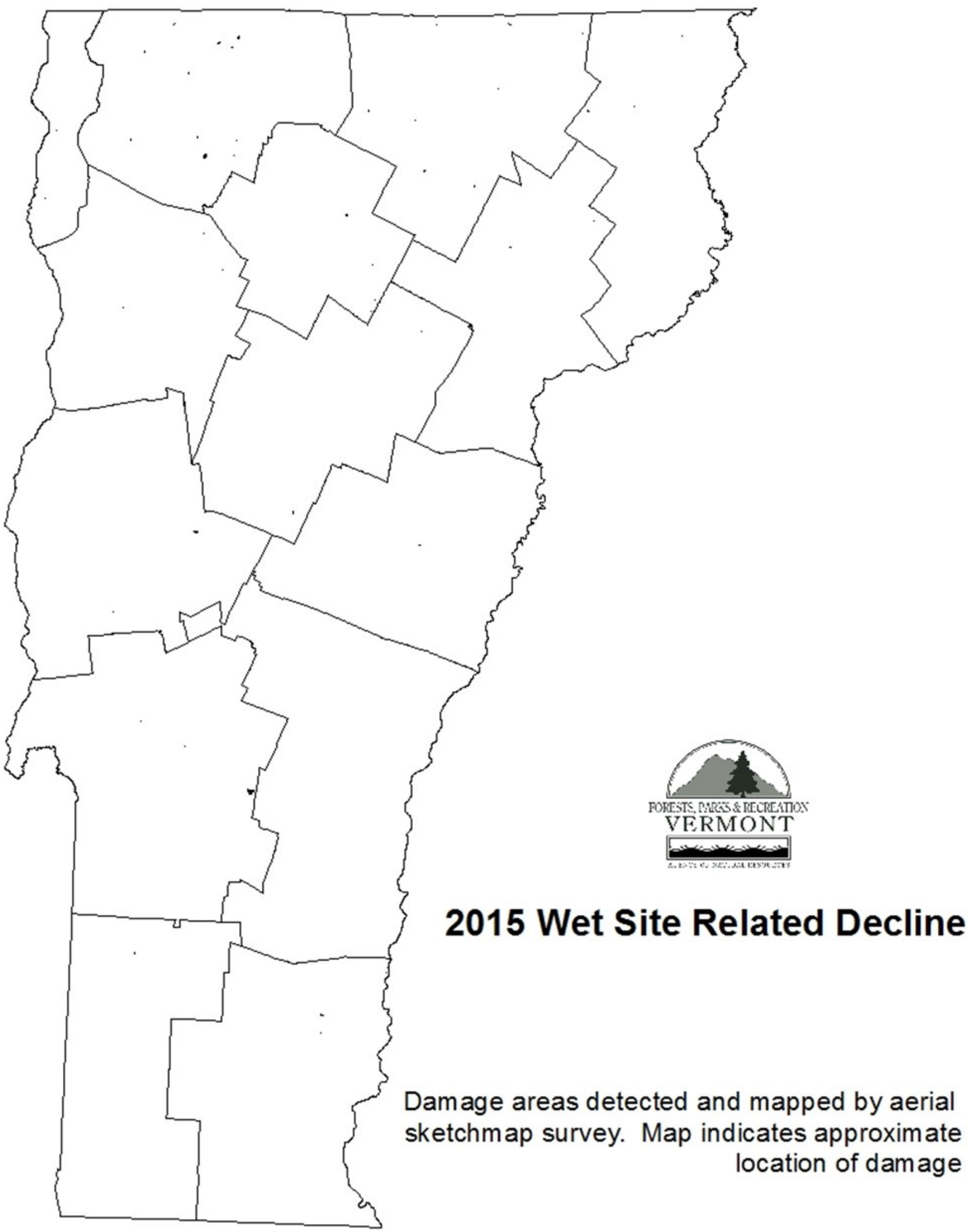


Figure 36. Wet or flooded site related decline mapped in 2015. Mapped area includes 1,869 acres.

Wind Damage from a variety of storms affected forests across the state. 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. Caledonia and Orleans Counties had the largest areas affected and a total of 764 acres were mapped statewide in 2015 (Table 31, Figures 37 and 38). This was an increase from 369 acres mapped in 2014.

Table 31. Mapped acres of wind damage in 2015.

County	Acres
Addison	31
Chittenden	63
Franklin	212
Lamoille	35
Orange	27
Orleans	14
Washington	148
Windham	142
Windsor	93
Total	**764**

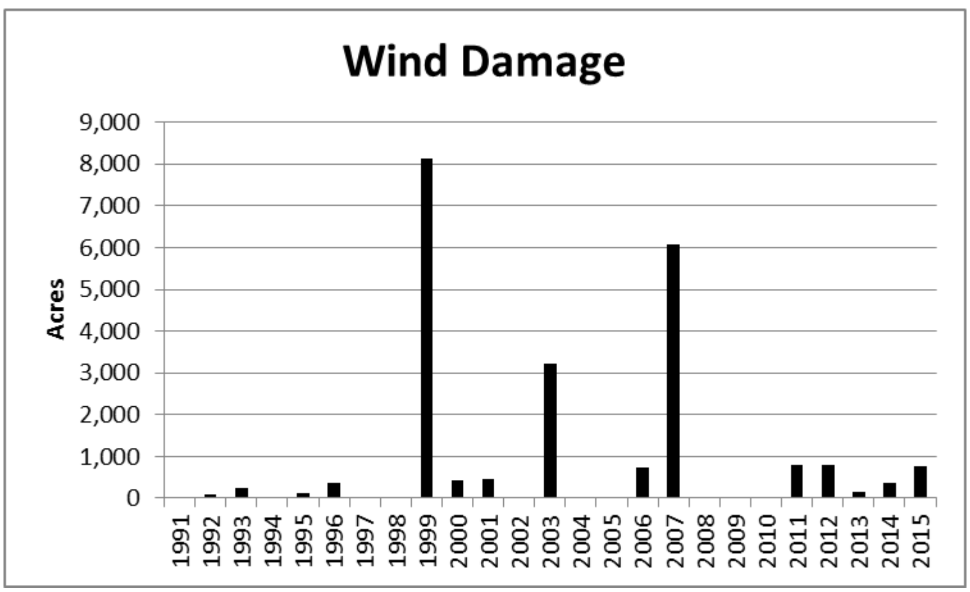


Figure 37. Trend in acres of tree damage from wind events. In 2015, 764 acres of wind damage were mapped during aerial survey.

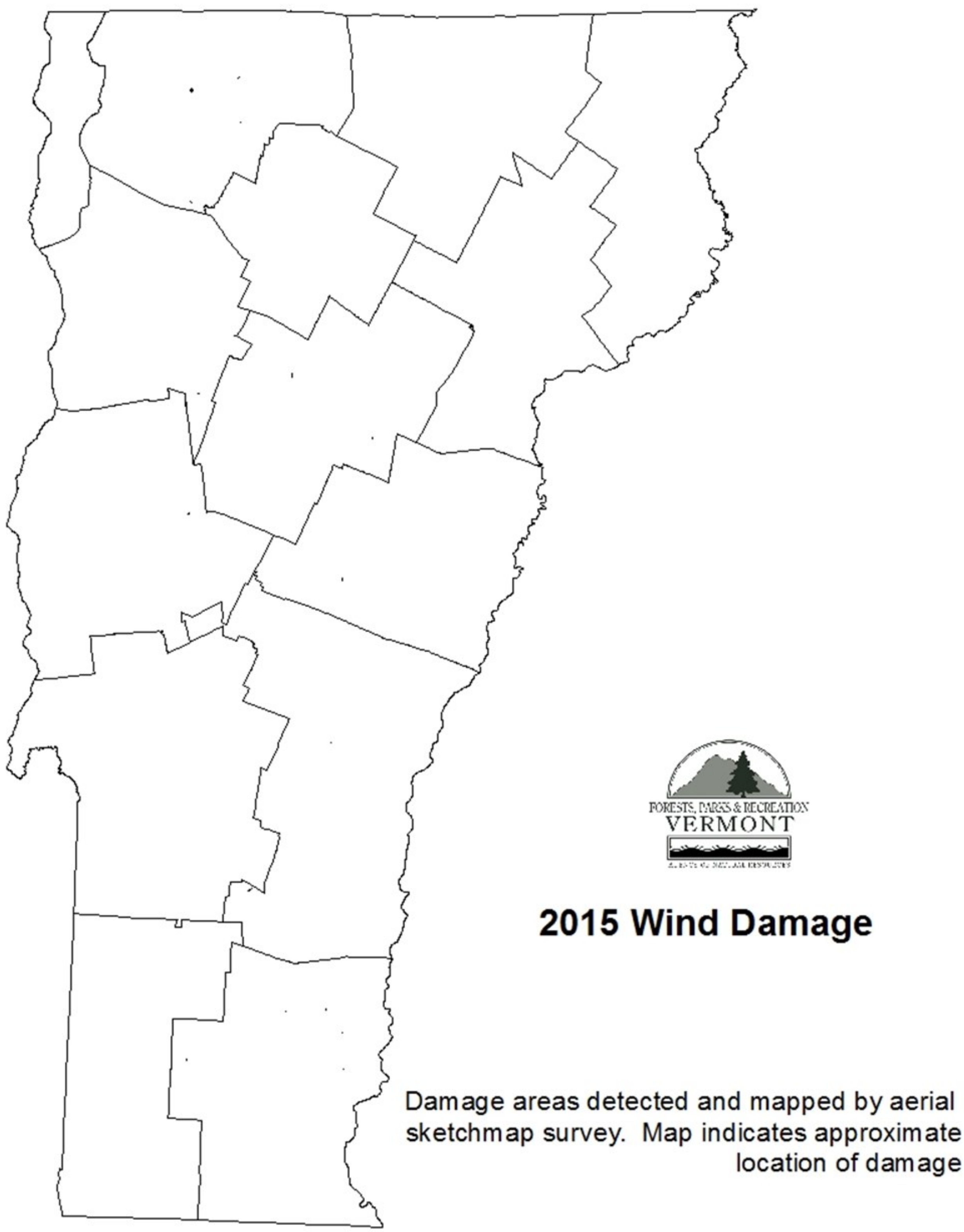


Figure 38. Wind and storm damage mapped in 2015. Mapped area includes 764 acres.

OTHER DIEBACKS, DECLINES, AND ENVIRONMENTAL DISEASES

CONDITION	HOST	LOCALITY	REMARKS
Air Pollution Injury			See narrative for ozone injury
Ash Decline	White Ash	Statewide	Occasional heavy mortality, cause not completely understood. See EAB (page 59) for more details.
Birch Decline	White birch	Statewide, especially Windsor County	Aerial survey mapped 245 acres; higher elevations. See narrative.
Drought			See narrative.
Fire Damage		Windsor County	Aerial survey mapped 6 acres; see narrative
Frost Damage			See narrative.
Girdling Roots	Norway maple	Brattleboro, Springfield	
Hardwood Decline and Mortality	Hardwoods	Scattered statewide	
Heavy Seed	Silver and red maple, ash, conifers	Statewide	Some maples looked devoid of leaves once seeds fell. Refoliation eventually replenished many trees.
Ice and Snow Damage		Chittenden County	Aerial survey mapped 131 acres.
Larch Decline	Larch	Scattered statewide, especially Caledonia and Essex Counties	Aerial survey mapped 153 acres.
Logging-related Decline		Caledonia and Washington Counties	Aerial survey mapped 92 acres.

OTHER DIEBACKS, DECLINES, AND ENVIRONMENTAL DISEASES

CONDITION	HOST	LOCALITY	REMARKS
Red Pine Decline	Red pine	Statewide, especially north and central Orange and east-central Rutland Counties	Cause not completely understood. See Red Pine Scale (page 52) for more details.
Salt Damage	Conifers	Scattered statewide	Roadside damage visible in April.
Snow Breakage			See Ice Damage.
Spruce/Fir Dieback and Mortality	Red spruce, Balsam fir	Widely scattered statewide	
Wet Site			See narrative for Flood-related Decline.
White Pine Mortality	White pine	Statewide	Decline and mortality observed in stands with multiple years of needle damage and other stress factors also present such as wet site conditions, wind impact, or wounding.
Wind Damage			See narrative.
Winter Injury	Conifers	Widely scattered statewide	Rural and urban trees, locally heavy. Christmas tree growers reported 20% of trees with marked browning.

ANIMAL DAMAGE

ANIMAL	SPECIES DAMAGED	LOCALITY	REMARKS
Beaver	Many	Scattered throughout	Damage levels stable.
Deer	Regeneration	Statewide	Damage uncommon in the northeastern counties and common in southern Vermont.
Moose	Many	Northern Vermont	
Porcupine	Many	Statewide	Uncommon.
Sapsucker	Many	Statewide	Decrease in observations and reports of damage.
Squirrel	Many		Low damage. Grey and red squirrel populations expected to increase due to heavy seed.

INVASIVE PLANTS

2015 saw the growth of invasive plant early detection and management efforts statewide. Progress with mapping, control, outreach and education have been made possible through several grant-funded opportunities. A statewide invasive plant coordinator was hired within the Department of Forests, Parks and Recreation, thanks to collaborative efforts between the departments in the Agency of Natural Resources, The Nature Conservancy, and Jane's Trust.

Early Detection Species

Isolated populations of an early detection species, **Black Swallowwort (*Cynanchum louiseae*),** are identified around the state. The population of black swallowwort at Lake Bomoseen State Park was discovered in an undeveloped forested area adjacent to an old logging road, with a few dense patches within a 0.05 acre area. The plants were of various age classes, and some were fruiting. Efforts to control this population took over 40 staff hours, and an integrated management approach (mechanical - digging of the root crown and root system, chemical - 2% glyphosate solution). Continued efforts will focus on stopping the spread.

TNC Staff have noticed an increase in populations of another early detection species, **Wall Lettuce (*Mycelis muralis*)** throughout the state. In the last few years they have identified this plant in Hartland, Dummerston, Calais, Charlotte, Montpelier, and on Knight Island off of North Hero. Infestations seem to occur in areas with rich, moist soils and it easily spreads even in dense shade. Populations can be dense but ecological impacts are not known and there is very little literature about this species.

Regional Grant-Funded Activities

Education, Outreach, Capacity Building & Treatment in Vermont's Forest Priority Areas: Efforts continued to train volunteers to take part in a citizen science project to assess and prioritize treatment areas for invasive plant management. Observations made by volunteers are linked to spatial location, photos, information on seed production, and level of infestation of the specific observation. 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.

Invasive Plant Mitigation on State Land in Vermont: Education Volunteer Outreach, & Capacity Building: Two seasonal staff were hired onto the Habitat Restoration Crew out of the Rutland regional office, running volunteer days and performing invasive control work in state forests and state parks throughout southwestern Vermont. The Crew has worked with over 430 volunteers in 2015, with over 2,100 volunteer hours logged this season. The Habitat Restoration Crew worked with the Castleton Village School for a second year, integrating invasive ecology into their school-wide curriculum and taking an entire day to get all the students and staff outside and doing great invasive plant removal and native plant restoration at Lake Bomoseen State Park.

Invasive Terrestrial Plant Treatment on Working Forests and Conserved Natural Areas in Vermont's Forest Priority Areas: The Nature Conservancy (TNC) and the Vermont Land Trust held one invasive plant workshop attended by 10 professional land managers. Polatin Ecological Services Inc. led the workshop, held at Raven Ridge Natural Area in Charlotte, VT. Contractors completed follow-up invasive plant treatment on ~50 acres first treated in 2014 at Raven Ridge Natural Area. This consisted of spot treating small bush honeysuckle (*Lonicera sp.*), Japanese barberry (*Berberis thunbergii*), and cutting and treating the stumps of common buckthorn (*Rhamnus cathartica*). 100 acres at TNC's Equinox Highlands Natural Area, Manchester, VT were also managed for woody invasive plants under a contract with Polatin Ecological Services.

Other Activities

County foresters continue to work with land owners and consulting foresters on addressing invasive plants in forest management plans and forest management activities on private lands. Other department staff continue to identify and consider control efforts for invasive terrestrial plants on state lands.

The Invasive Plant Coordinator hosted over 18 workshops for a variety of stakeholders across the state (state parks, conservation commissions, non-profits, community groups, others), focusing on invasive plant information, management and prioritization.

The Vermont Invasive Species Website (www.vtinvasives.org) is undergoing an assessment and reboot, but continues to provide a wide range of information to a variety of user groups from citizen scientist to professional foresters, including educational resources and Best Management Practices.

Sugar Maple Health in 2015

Sugar maple tree health, based on the amount of twig dieback, remained stable in 2015, based on the 30 monitoring plots formerly part of the North American Maple Project (NAMP) (Figure 39). Nearly 96% of trees were rated as having dieback ≤ 15% (Figure 40).

Foliage on monitoring plots was generally dense this year (Figure 41), and little defoliation was observed. Frost injury affected 20% of sites, and an additional 33% of sites had evidence of new weather-related branch and bole breakage (Table 32). Trace to light defoliation was recorded at 6 of the 30 sites, with varied insects involved: forest tent caterpillar, gypsy moth and saddled prominent. Septoria leaf spot was confirmed at one site, but was evident on many other sites statewide. New mortality of overstory sugar maple trees was 0.7% in 2015.

Vigor ratings incorporate several tree health measures into a more comprehensive view of a tree's photosynthetic capacity. Vigor ratings have held steady for the past few years (Figure 42).

Stand density can influence crown health by determining the level of competition between trees. A NAMP plot's basal area per acre, a measure of stand density, shows relative differences between the density of overstory sugar maples compared to all live trees (Figure 43). Sites 8 and 17 have high basal areas suggesting overcrowding, while Sites 6 and 31 have low stocking of overstory sugar maple trees.

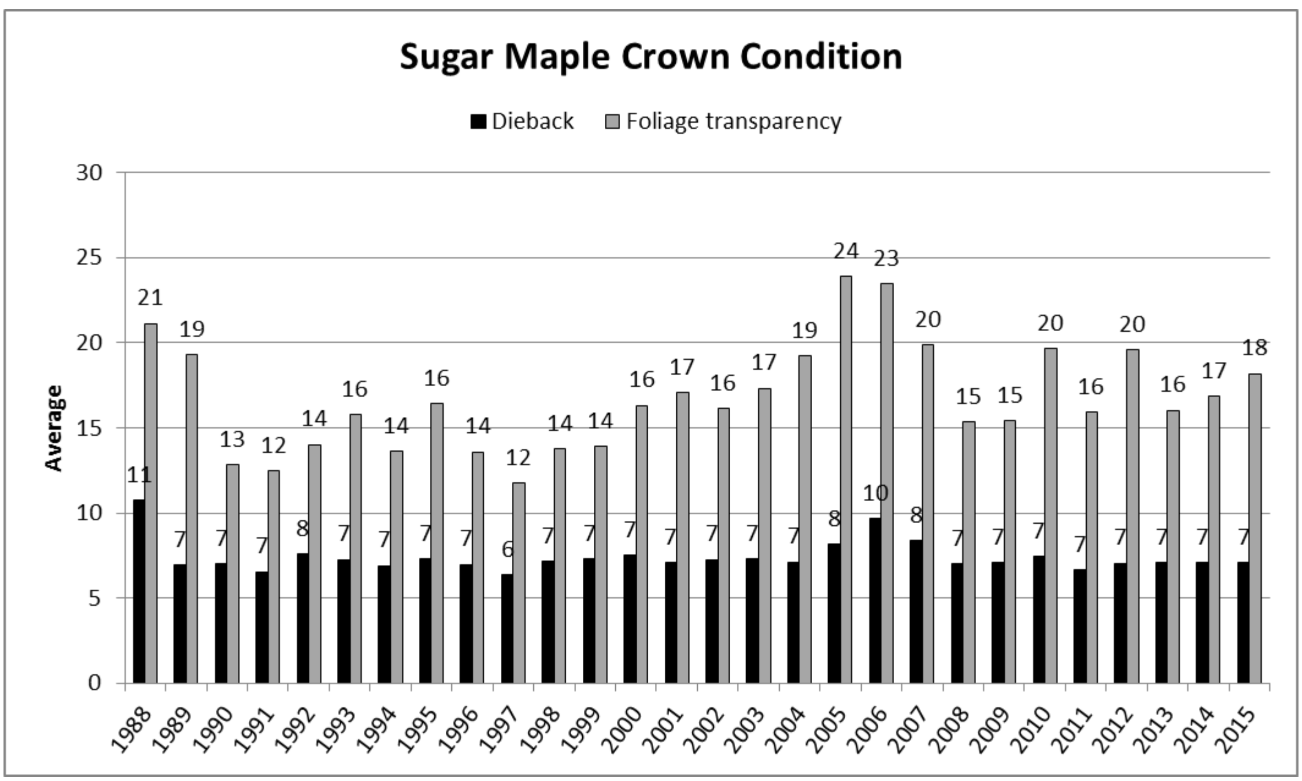


Figure 39. Trend in average dieback and foliage transparency of overstory sugar maple trees on NAMP plots. N=991 trees at 30 sites.

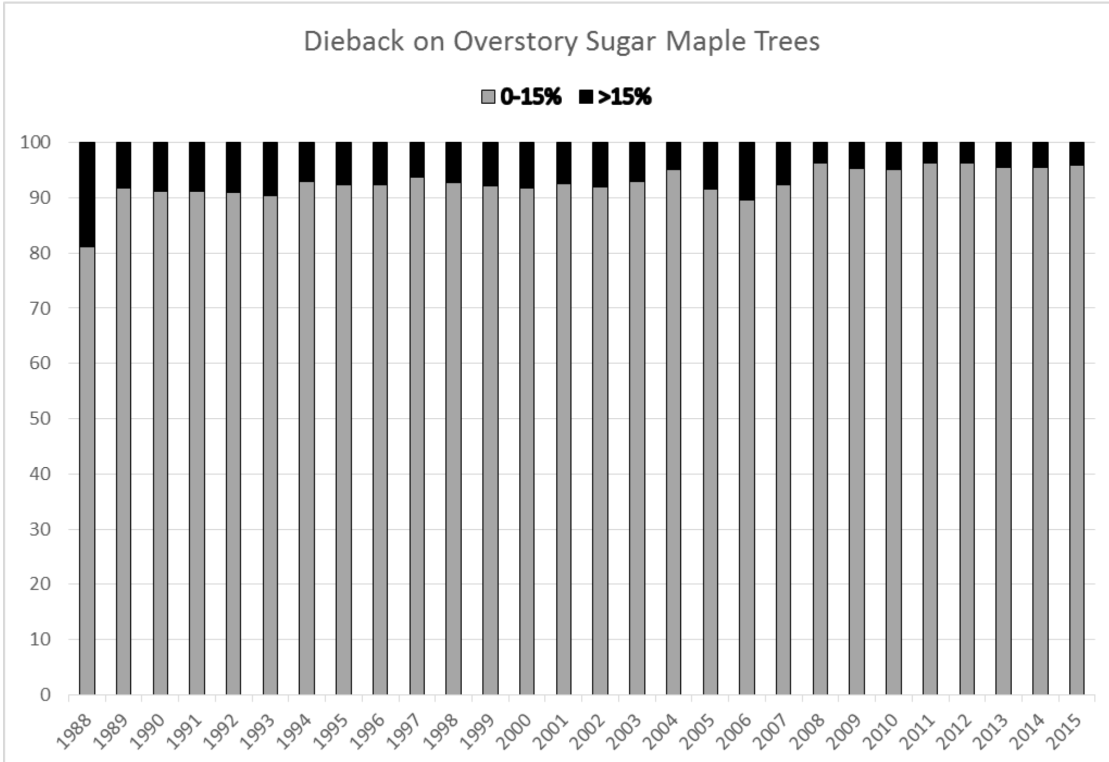


Figure 40. Percent of overstory sugar maple trees on NAMP plots with low (0-15%) or high (>15%) dieback levels. N=991 trees at 30 sites.

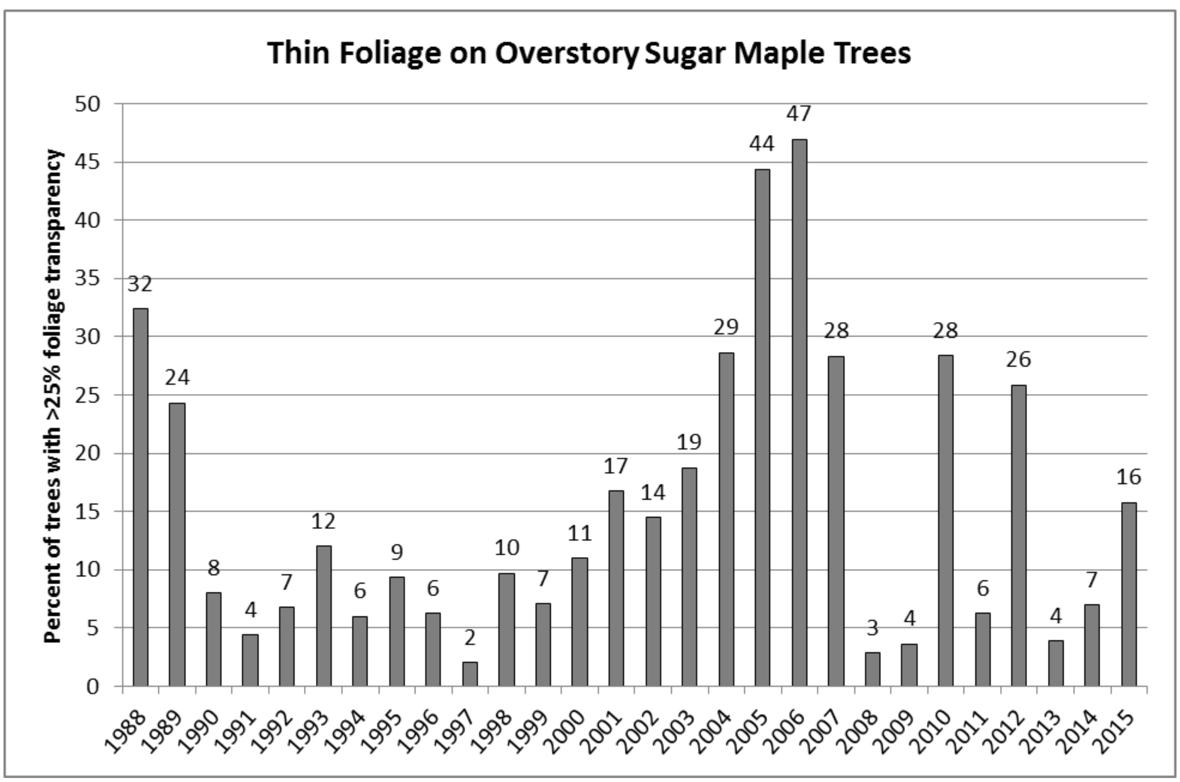


Figure 41. Trend in the percent of overstory sugar maple trees on NAMP plots with thin foliage, >25% foliage transparency. N=991 trees at 30 sites.

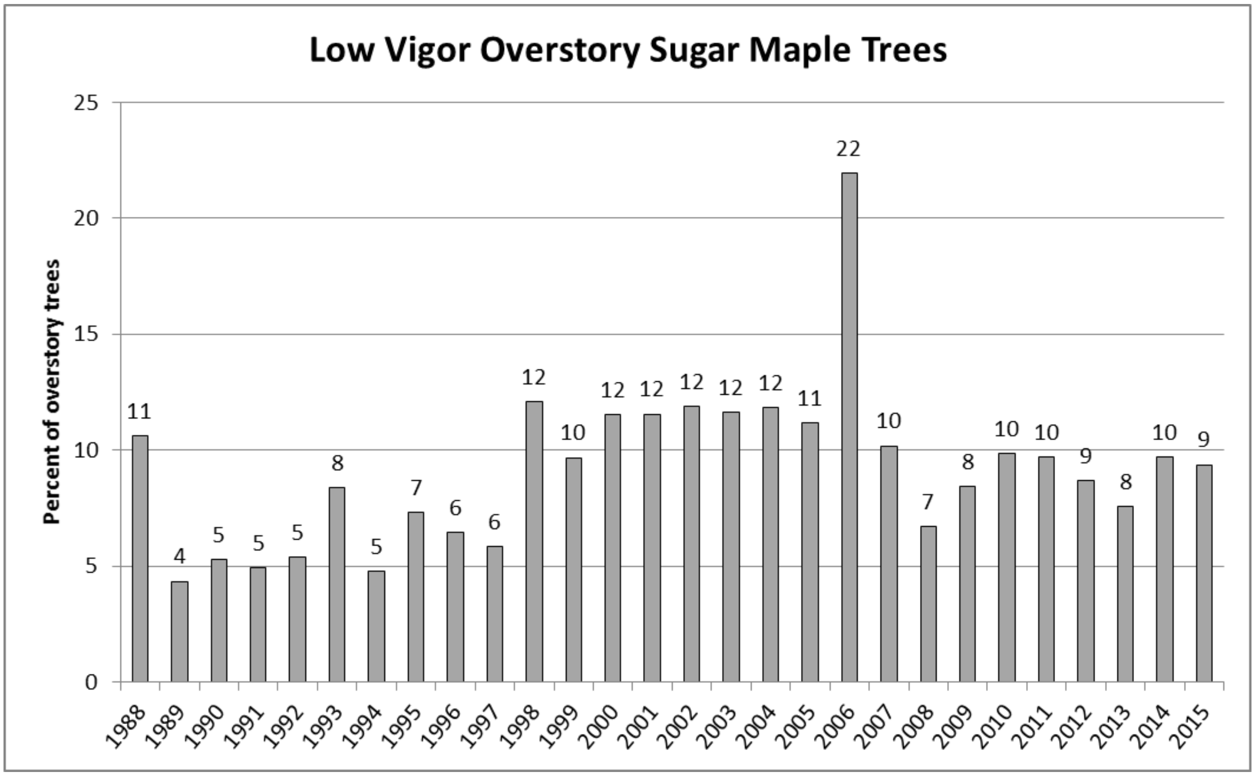


Figure 42. Trend in the percent of overstory sugar maple trees on NAMP plots with low vigor ratings (vigor>2). N=991 trees at 30 sites.

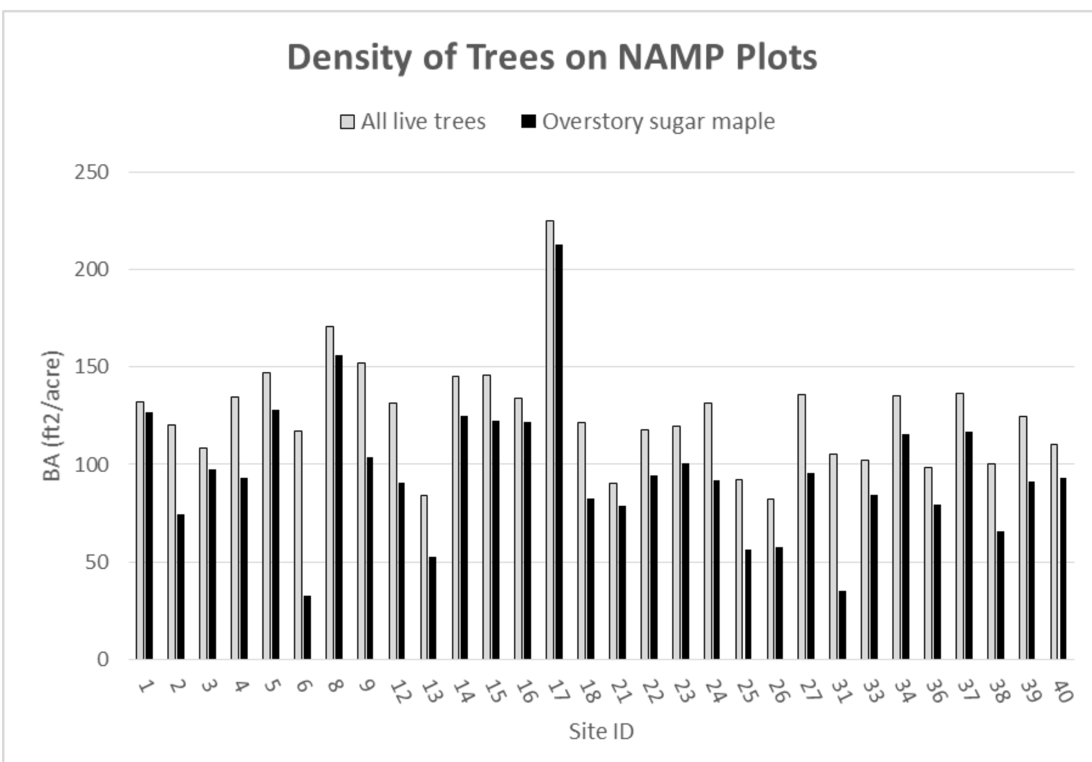


Figure 43. Stand density on NAMP plots calculated as basal area per acre showing differences between density of overstory sugar maples compared to all live trees.

Table 32. Percent of NAMP sites reporting various damages in 2015.

Frost	Forest Tent Caterpillar	Gypsy Moth	Saddled Prominent	Septoria	Weather Breakage
20.0	6.7	6.7	6.7	3.3	33.3

Vermont Monitoring Cooperative

Trends in Forest Health at Mount Mansfield and Lye Brook in 2015

In 2015, 41 forest health monitoring plots were sampled across Vermont; 19 were previous VMC plots (results reported below) and 22 were additions to the statewide system (Table 33). Plots were added at sites where historical data were available from other plot networks such as: 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 partners of the VMC: Vermont Department of Forests, Parks & Recreation, University of Vermont, and U.S. Forest Service.

Table 33. Biophysical regions and forest types represented by the 41 Vermont forest health monitoring plots.

Biophysical Region	Number of plots
Champlain Valley	3
Northern Green Mountains	22
Northeastern Highlands	1
Northern Piedmont	4
Southern Green Mountains	3
Southern Piedmont	3
Taconics	2
Vermont Valley	3

Forest Type	Number of plots
Hemlock-northern hardwood	3
Hemlock-pine-ash	2
Maple-birch-spruce	4
Mixed hardwoods	4
Northern hardwoods-oak	2
Northern hardwood	16
Pine-oak-ash	1
Spruce-fir	6

Fourteen plots on Mount Mansfield and 5 plots on the Lye Brook Wilderness Area were remeasured in 2015 using standard forest health metrics. Additional metrics and canopy photos were collected by University of Vermont field crews to better document tree growth and regeneration changes.

Trends in crown health on Lye Brook plots showed foliage transparency similar to previous years, but an increase in dieback, in fact, the highest average dieback recorded over the past 22 years (Figure 44). The most prevalent damage recorded was beech bark disease.

Trends in crown health measurements at Mount Mansfield show no change in crown dieback from recent years, and a slight improvement in foliage transparency from last year (Figure 45). However, there is a long term trend towards increasing foliage transparency. Grouping plots on Mount Mansfield into those on the west slope, summit and east slope showed site differences in long term trends (Figures 46 & 47). West slope and summit plots gradually increased average transparency, while transparency on the east slope plots has been more variable. Summit dieback, while continuing to be greater than lower elevation plots, has improved following a 2006 spike. West slope plots have never exceeded 10% average dieback. East slope plot dieback has improved since a 2006 spike and remains below 10% average dieback.

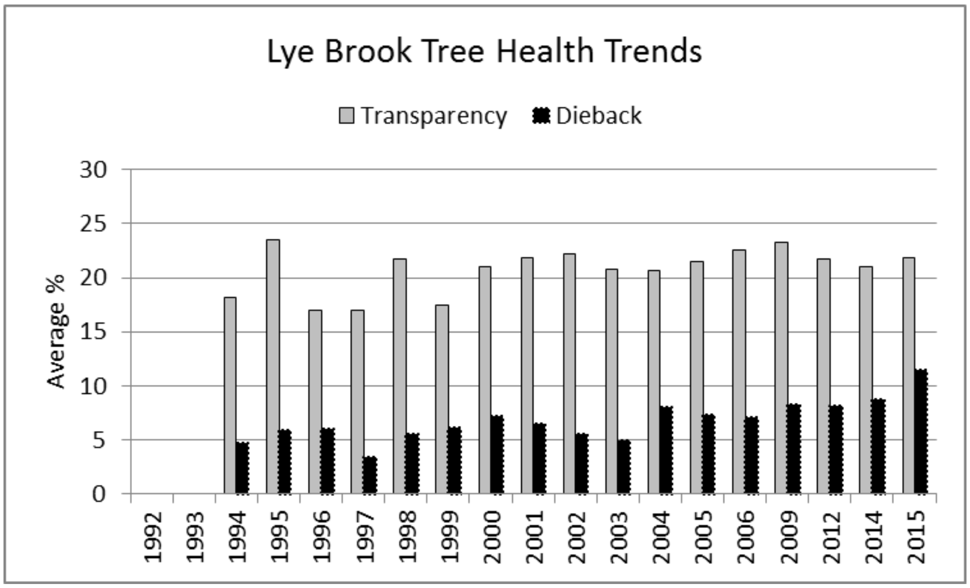


Figure 44. Average dieback and foliage transparency of overstory trees on 5 forest health monitoring plots in the Lye Brook Wilderness Area.

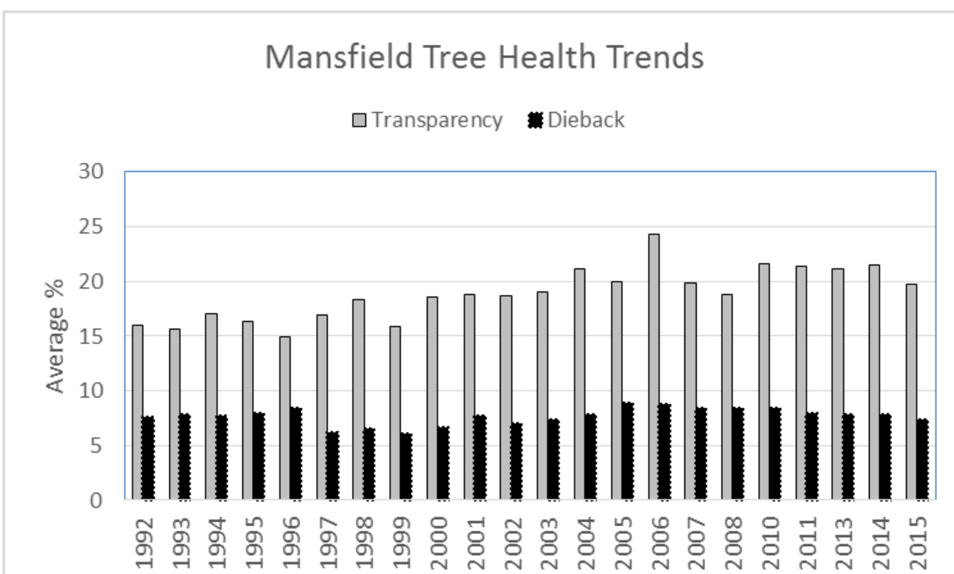


Figure 45. Average dieback and foliage transparency of overstory trees on 14 forest health monitoring plots on Mount Mansfield.

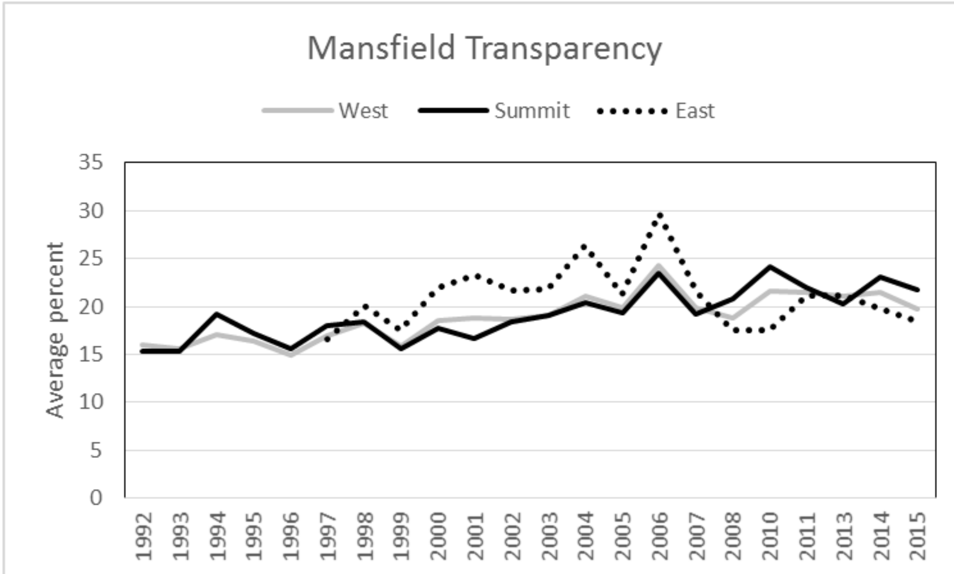


Figure 46. Trend in foliage transparency of overstory trees on west slope (6 plots), summit (4 plots), and east slope (4 plots) of Mount Mansfield.

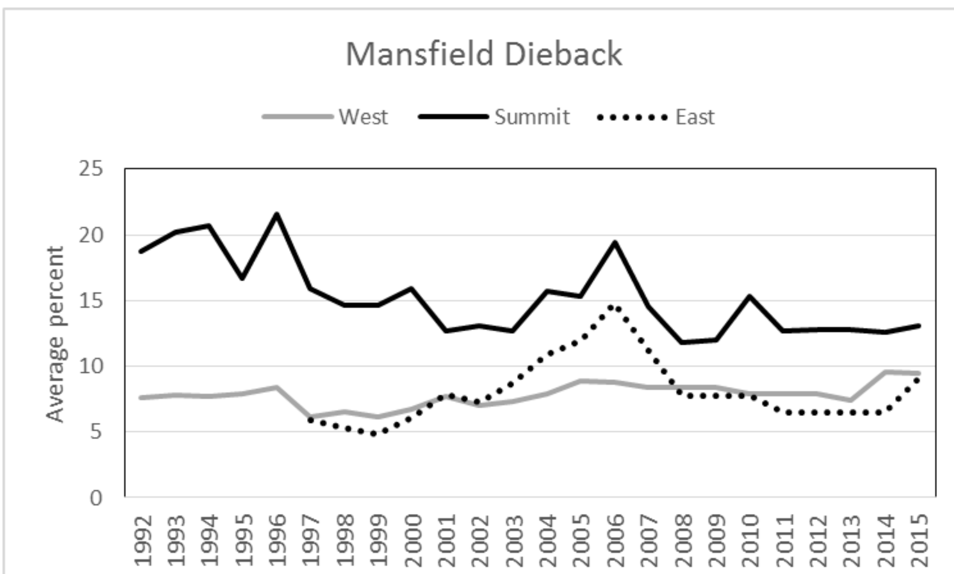


Figure 47. Trend in crown dieback of overstory trees on west slope (6 plots), summit (4 plots), and east slope (4 plots) of Mount Mansfield.

Seed production was not as prevalent on these monitoring plots as other sites statewide. At both sites, 8% of trees had light seed, and only 0.3% of trees had moderate seed in 2015. Trees with moderate seed were sugar maples.

Several plots had elevated mortality in 2015. One plot on the east slope of Mansfield at 2200 feet had 12.9% mortality, mostly yellow birch, and one plot on the west slope had 11.5% mortality, mostly beech. Average mortality on all plots was 2.7%, and mortality of overstory trees only was 2.0%.

Tree damages were recorded on 67 trees (10 % of live trees). Beech bark disease was the most prevalent (43 %) damage type (Table 34). Other damages included weather-related cracks and seams (25 %), several canker species (24%), and several borers and animal damages.

Table 34. Number of occurrences of special damages in 2015 on plots at Mount Mansfield and Lye Brook.

Beech Bark Disease	Cracks and Seams	Canker	Eutypella Canker	Borer	Animal Damage
29	17	9	7	2	1

Additional analyses were conducted on data through 2014 as part of the VMC Annual Report (VMC Annual Monitoring Report for 2014), and are accessible on the VMC website. Results from all 41 forest health plots will be included in the VMC Annual Monitoring Report for 2015.

Vermont
Forest Health

Tree Condition in Maple Sugaring Sites on State Lands: Results for 2015

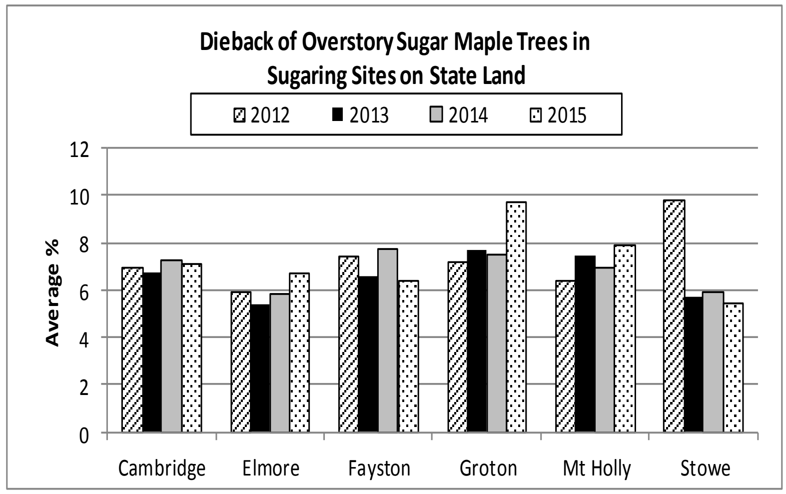
Department of Forests, Parks, & Recreation
October 2015 vtforest.com

Results For 2015

In 2012, forest health monitoring plots were established in six sites on state lands under license agreement for maple sugaring. Plot design and measurements are the same as for the 30 other sugar maple health monitoring plots in Vermont previously established under the North American Maple Project (NAMP).

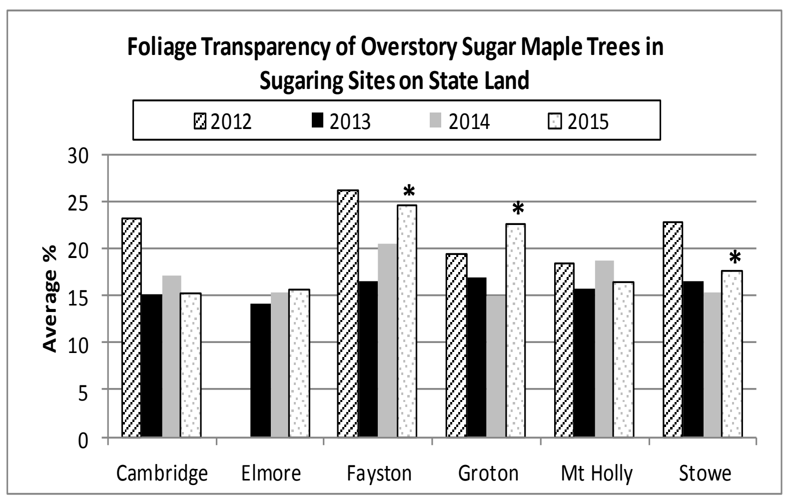
Substantial defoliation affected four of the sites in 2012 but none of the sites had significant defoliation in 2013. In 2014, two sites, Fayston and Mt. Holly, had scattered moderate defoliation, most likely caused by saddled prominent. As a consequence, the foliage transparency ratings, which indicate leaf density, showed significant increase at these two sites over 2013. And in 2015, alt-hough no specific defoliators were identified, foli-age transparency increased significantly on the Fayston, Groton, and Stowe sites. Other locations in Groton showed frost damage in 2015. Only the Groton site showed an increase in crown dieback in 2015 although this was not statistically significant. No new mortality was reported.

The 2015 sugar maple condition ratings on the six sites were similar to average ratings for the 30 NAMP plots statewide, which include sugarbush and untapped maple stands scattered throughout the state. Dieback and transparency for overstory trees averaged 7.2% and 18.7%, compared to 7.0% and 18.1% for the NAMP plot maples.



Dieback evaluates new dead twigs. Higher ratings indicate current or past stress effects on tree health.

Foliage transparency evaluates the density of leaves. Higher ratings indicate thinner foliage, and reflect current year stress.



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