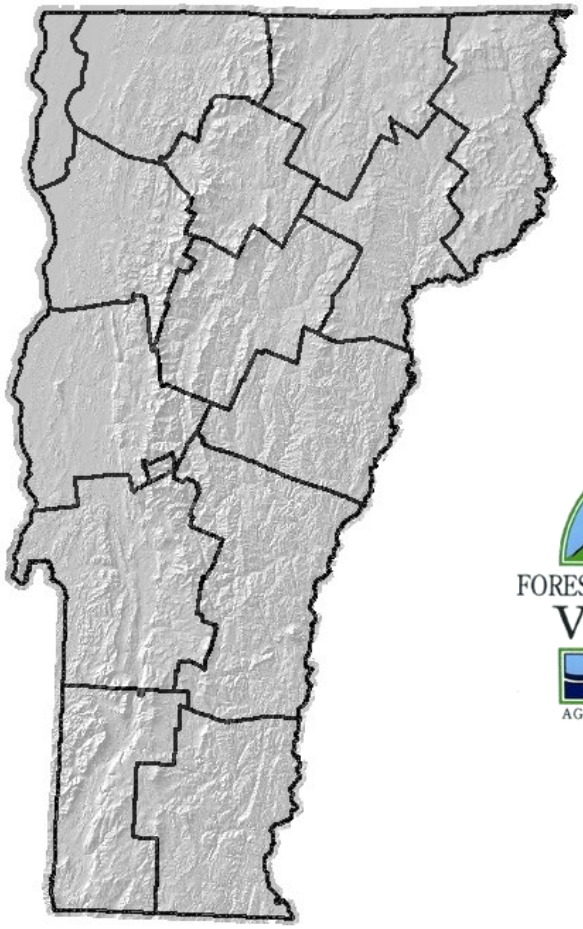
FOREST INSECT AND DISEASE CONDITIONS IN VERMONT 2017



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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 2017

PREPARED BY:

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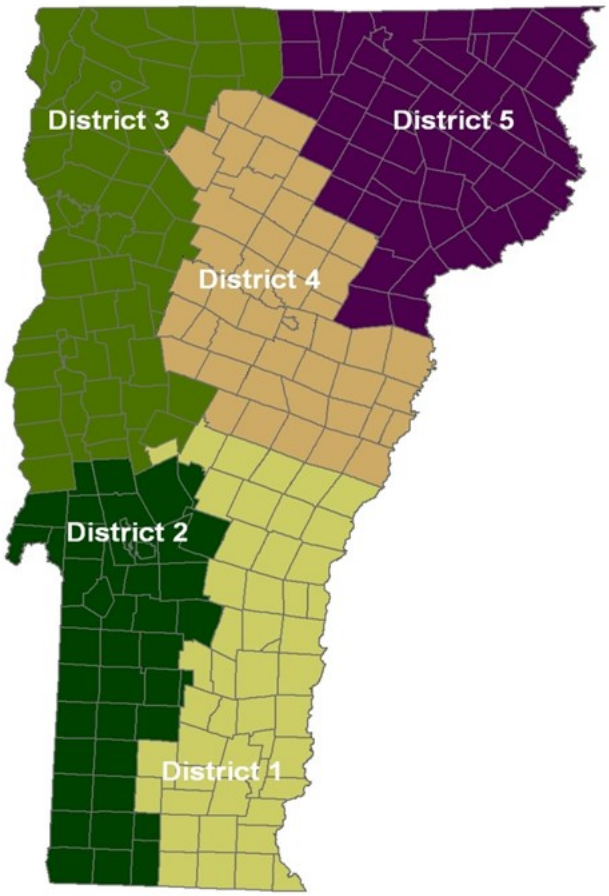

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INTRODUCTION

The report of Forest Insect and Disease Conditions in Vermont documents survey results and observations by Vermont Department of Forests, Parks and Recreation (FPR) 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. On June 21, the US Forest Service conducted an aerial survey over the Green Mountain National Forest. An FPR survey covering the rest of the state, to map forest tent caterpillar defoliation and general forest conditions, was flown between June 30 and July 21 (6/30, 7/5, 7/10, 7/12, 7/19, 7/20, 7/21). The range of dates flown in 2016 and 2017 is about a month earlier than the survey has been flown in recent years. As a consequence, changes in acres mapped from previous years are sometimes due to the survey timing rather than a change in damage incidence.

Ground data include tree health and pest population survey results. Additional data and metadata are available through the Forest Ecosystem 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 hard-copy 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 fifth year. In 2017, 33 new volunteers attended Vermont's Forest Pest First Detector Program training, bringing the statewide total of trained volunteers to 199. We thank the many continuing First Detectors, and welcome new volunteers: Sandra Andreasson, Farrah Ashe, John Barnes, Barb Blauvelt, Wendelyn Bolles, Fran Cohen, Rosemarie Conn, Steven Farnham, Donna Fialkoff, Jennifer Goyne, Rachel Grigorian, Jessica Halterman, Alice Haskins, Eddie Haynes, Sarah Holland, Maria Javanainen, Roy Karros, Charls Kletcka, Katie Kull, Carl LaShomb, Jennifer Many, Darsey Moon, Tammy Morissette, Andrew Morrison, David Palumbo, Kate Reeves, Rebecca Roman, Hannah Senecal, Kathy Swigon, Chad Ummel, Claire Whittaker, Brendan Whittaker, and Chris Young.

Welcomed assistance with **hemlock woolly adelgid surveys** came from Ellen Allman, Alma Beals, Kathleen Hacker, Helen Hamman, Candi Hess, Peter Isakson, Frankie Knibb, Irwin Kuperberg, Lynn Morgan, Nick Potter, Kathie Stone, and staff and students from Burr and Burton's Mountain Campus. Julia Lund assisted with **aerial survey ground checking**.

Many thanks to all the **invasive plant survey** participants who helped continue the Mapping for Healthy Forests citizen science project on iNaturalist.org, and helped the project reach over 3,000 observations. Many groups, towns, and organizations took part in **invasive plant management and outreach** across the state. Huge thanks to VT Coverts, Winooski Valley Park District, Birds of Vermont Museum, New Hampshire Vermont Christmas Tree Association, Green Works, Vermont Nursery & Landscape Association, Society of American Foresters Green Mountain Division, the Friends of the Hort Farm, Vermont Woodlands Association, the Green Mountain Club, Conservation Commissions and other municipal and private organizations across Vermont and many others.

The **Forest Biology Lab** received taxonomic and other assistance from Don Chandler, Rod Crawford, Kevin Dodds, Charley Eiseman, Aaron Ellison, Nick Gotelli, Alan Graham, Ann Hazelrigg, Rick Hoebeke, Ron Kelley, Warren Kiel, Gabriella Maya, Isabel Munck, Michael Sabourin, Scott Schneider, Nate Siegert, and Dave Wagner. Warren Kiel continued to contribute Lepidoptera specimens for our insect reference collection. Thanks to Warren, we have been able to rebuild our post-Irene collection and to add new species records.

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 Vermont State Parks, as well as many others in the Vermont Agency of Natural Resources.

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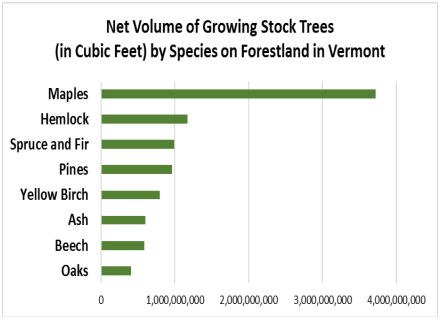
Forest Health VERMONT *highlights* 2017

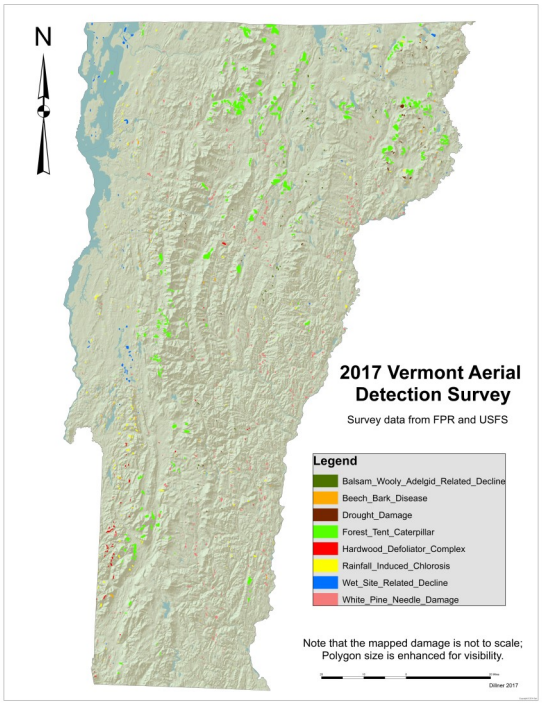
These Forest Health Highlights summarize information from the annual report on Forest Insect and Disease Conditions in Vermont. This summary provides an overview of the forest resource in Vermont, forest health program highlights, a weather summary, sections on hardwood and softwood insects and diseases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



Vermont forest health information is on-line at http://fpr.vermont.gov/forest/forest_health, or you can contact us:

- for assistance in identifying pests or diagnosing forest health problems
- to request on-site evaluations or management recommendations
- to obtain defoliation maps and hard-copy publications
- to participate in invasive pest citizen monitoring.

Data are from US Forest Service Forest Inventory and Analysis (FIA) plots. Estimates were calculated from FIA DataMart (FIADB_1.6.0.02), November 2017 https://apps.fs.usda.gov/fia/datamart/datamart_excel.html.



Forest Resource Summary

Vermont's forests cover about three-quarters of the state, and include billions of trees. 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 and eastern hemlock 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 Health Program Highlights

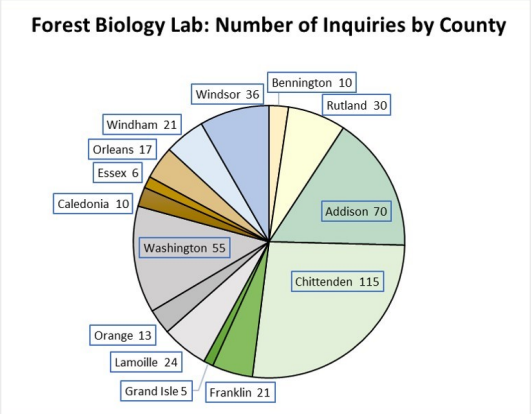
The Vermont Department of Forests, Parks and Recreation (FPR) conducts aerial and ground surveys to detect forest damage. In addition, long-term monitoring plots are inspected to evaluate forest health.

In 2017, 98,555 acres of forest damage were sketchmapped during statewide **Aerial Detection Surveys**. This represents just over 2% of Vermont's forestland, and is similar to the area mapped in 2016. Defoliation by forest tent caterpillar and white pine needle damage accounted for 61% and 17%, respectively, of the area mapped.

Healthy forests are ecologically functional and resilient to disturbance. They are valued by communities and have the capacity to produce economic benefits. The mission of the Vermont Division of Forests is to manage for and protect healthy forests. We work with Vermont citizens to promote forest health, supporting best management practices, sustainable use, and respect for the land.

At the **Forest Biology Lab**, we continue to provide invertebrate identifications, tree disease diagnoses and pest management recommendations, and support environmental education and outreach. In 2017, 38% of our inquiries came directly from the public; 30% from forest and tree care professionals; questions from other labs, researchers and commissions made up 17% of our inquiries; 9% came from other state or federal agencies; and 6% involved education and outreach. Forest health inquiries came from all 14 Vermont counties. Six percent of our inquiries were from out-of-state. Planning efforts continue for eventual relocation of the Vermont Agriculture and Environmental Laboratory to a new facility in Randolph.

The Forest Biology Lab responded to inquiries from throughout the state.



Climate Change remained a focus in 2017. Recommendations have been drafted on assisted migration for use on ANR lands, and State Park Interpretive Naturalists have begun including climate change information in their educational programming. In 2017, the Vermont Urban & Community Forestry Program partnered with the Vermont Climate & Health Program and the Arbor Day Foundation to provide 200 trees to residents in urbanized areas of Bennington and Newport. These communities were selected based on their relatively high risk for heat illnesses, in part due to lack of tree cover. For more information, visit our website on Climate Change and Forests.

The Vermont Monitoring Cooperative completed its 27th year of monitoring forest ecosystem health by broadening its focus to include neighboring states. Now called the **Forest Ecosystem Monitoring Cooperative**, survey and monitoring results are available at the new FEMC website.

FPR and the Agency of Agriculture, Food and Markets (AAFM) collaborate with USDA agencies to survey and manage **Non-Native Forest Pests**, and with University of Vermont (UVM) Extension on education and outreach. UVM Extension led an effort this year focusing on private campgrounds. Host tree maps were created and pest surveys were conducted for participating campgrounds, and they received educational materials to share with campers.

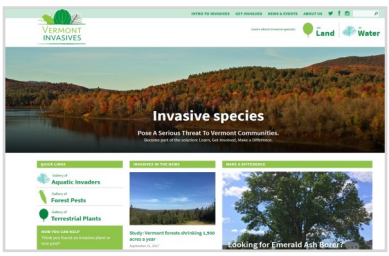
The Forest Pest Outreach program included host tree surveys on private campgrounds.

Photo: UVM Extension

To maintain our ability to respond to Invasive Pests, an Interagency ICS exercise was held in June. The tabletop exercise was facilitated by USDA APHIS, and included four other agencies, in a run-though of a simulated Asian longhorned beetle detection. Vermont continues to participate in the Northeastern Forest Fire Compact's Forest Health Working Team, which streamlines resource sharing among northeastern states and provinces in response to forest pest incidents. Vermont participated in a Compact mobilization to assist with brown spruce longhorned beetle detection in New Brunswick. An update to Vermont's Invasive Forest Pest Response plan is under review.

Two Forest Pest First Detector trainings were held in 2017 with 33 arborists, tree wardens, and concerned citizens attending. Volunteers assisted in detection surveys and community outreach.

The website vtinvasives.org has been re-launched with a new look. The expanded site continues to offer information on terrestrial plants, forest pests, and aquatics. To publicize the availability of this information, posters were distributed to 186 libraries in the state. On average, the website has approximately 400 online users per week.



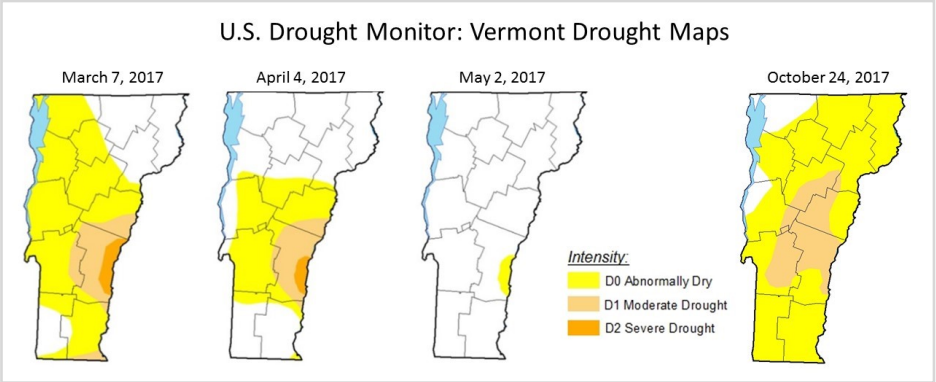
The vtinvasives.org website was updated. Posters announcing the website were distributed to 186 libraries.

Vermont's **Firewood Quarantine**, the Rule Governing the Importation of Untreated Firewood into the State of Vermont, went into effect in 2016. Untreated firewood, less than 48 inches in length, cannot be brought into Vermont, unless a waiver has been granted to the person moving the firewood. Several waivers have been approved for wood from adjacent counties in New Hampshire that are not under quarantine for emerald ash borer.

2017 Weather Influences on Forest Health

The winter of 2016-2017 lacked extremes, though it was somewhat warmer and drier than normal through February, and colder and wetter in March. Going into the winter, however, the entire state was abnormally dry or in moderate to severe drought. Dryness tapered off through the winter, finally ending by early May in eastern Windsor and Orange Counties.

Late spring and early summer 2017 were a different story, with May, most of June, and early July being cooler and wetter than normal. Cold temperatures May 8 and 9 resulted in snow at higher elevations and scattered frost damage.



Dry conditions from the 2016 drought persisted through early spring. Rainfall was plentiful in late spring and early summer. However, by late October most of the state was abnormally dry or in drought.

Map Authors: Anthony Artusa and Eric Luebehusen NOAA/USDA/NDMC http://droughtmonitor.unl.edu/

By mid-July, weather conditions changed again, with generally drier than normal weather through September. That period remained cooler than normal in most of the state through mid-September, when warmer temperatures arrived. There were record-breaking high temperatures in late September, frequently reaching the mid-80s and sometimes exceeding 90°, and October was the warmest on record. By late October, most of the state was abnormally dry or in moderate drought.

Severe tree-damaging storms punctuated the growing season. A partial list includes gravity wave storms on May 5th, microburst storms on May 18th, storms including hail on May 31st, July 18th, and August 12th, and multiple days of torrential rain June 29 through July 2 and October 24 to 30th.

With the see-saw between wet and dry, unusual cool and warm periods, and severe storms, weather conditions, as always, were a major driver of tree health. In addition to direct hail injury, tree breakage, or windthrow from severe storms, these included the following:

The drought of 2016 continued to affect tree health long after moisture conditions improved, including the following conditions observed in 2017:

- This was a **heavy seed year** for many tree species: notably maple, beech, oak, basswood, apple, and hop hornbeam (but not white ash) among hardwoods, and among conifers including white pine, balsam fir, red, white, and Norway spruce and northern white cedar. Heavy seed production, sometimes referred to as a "distress crop", is common following drought conditions. When trees put lots of resources into seed production, they may look sparser than normal. We should also expect an uptick in squirrel damage in the near future, with exploding populations from the recent glut of food.

Severe tree-damaging storms included a gravity wave storm that hit Rutland County on May 5th. (left).

Drought conditions in 2016 contributed to heavy seed production on multiple species, including white pine (center). It also led to dieback on maple (right) and ash, especially in eastern Vermont.

- New **ash mortality** and **maple dieback** was noticeable by mid-June in multiple locations in eastern Vermont where drought conditions had persisted into early spring. Ash trees are particularly sensitive to fluctuating water conditions. Affected maples often had foliage of good size and color on living branches, suggesting that plentiful moisture later in the spring is allowing trees to recover.

- Heavy production of **Armillaria** "honey mushrooms" suggests that this fungus successfully invaded drought-stressed roots.
- More attacks by **hemlock borer** were reported on wounded hemlocks.

Cool, wet weather in May and June slowed leaf development, saturated soil, and promoted the spread of fungi, resulting in the following conditions observed in 2017:

2016 drought conditions likely led to a heavy crop of honey mushrooms (left) and more frequent hemlock borer attacks (right).

Photos: K. Jones, R. Freeberg

- Light **frost damage** to sugar maple and beech was observed in widely scattered locations, including northeastern and southwestern Vermont, and the central mountains.
- Conditions were ideal for leaf infection by **fungal pathogens**, and for caterpillar infection by fungal and viral diseases.
- Delayed leaf development led to increased damage by **pear thrips** on sugar maple.
- Stands of **chlorotic sugar maples**, were observed in scattered locations statewide, with 6,494 acres mapped from the air. This is frequently observed in unusually rainy summers.
- Saturated soil made trees more vulnerable to **windthrow** in stormy weather.

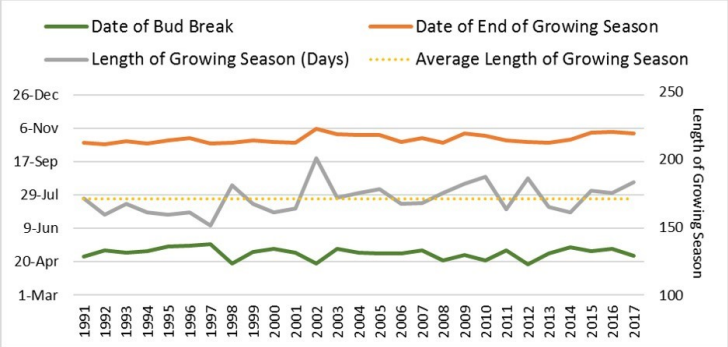
Warm dry conditions in late summer into fall led to:

- **Refoliation failures** from forest tent caterpillar and other defoliators, along with infection by leaf fungi and other factors.
- A general **delay in fall foliage**, with the exception of swamps and other stressed areas that start to turn color early.
- **Early leaf drop** of sugar maple and ash, especially on roadsides, openings, river corridors, and edges. Once leaves are compromised by disease infection they are more likely to brown and drop early under dry conditions.

Cool wet spring conditions resulted in scattered frost damage to sugar maple and beech (bottom left), stands of chlorotic sugar maple (top left) and made trees more vulnerable to windthrow in stormy weather (top center). Warm dry late summer and early fall contributed to early leaf drop of ash (right) and refoliation failures (bottom center).

Frost Photo: E. Crumley

We continue to monitor **phenology** for the timing of budbreak, leaf out, and fall leaf color and drop. Sugar maple budbreak on April 29th was 4 days earlier than the long-term average, but the timing of full leaf-out was nearly indistinguishable from the long-term average. In general, peak color was later than usual in 2017. Double-peaks in sugar maple color were likely due to initial color change that stalled, followed by some leaf drop due to dry conditions of early fall. Growing season length in 2017 was the longest since 2012, and exceeded the long-term average by 12 days.



Based on sugar maple phenology monitoring, the 2017 growing season was the longest since 2012, and exceeded the long-term average by 12 days.

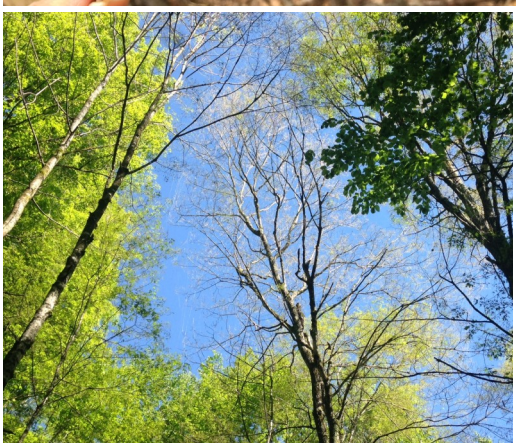
Hardwood Insects and Diseases

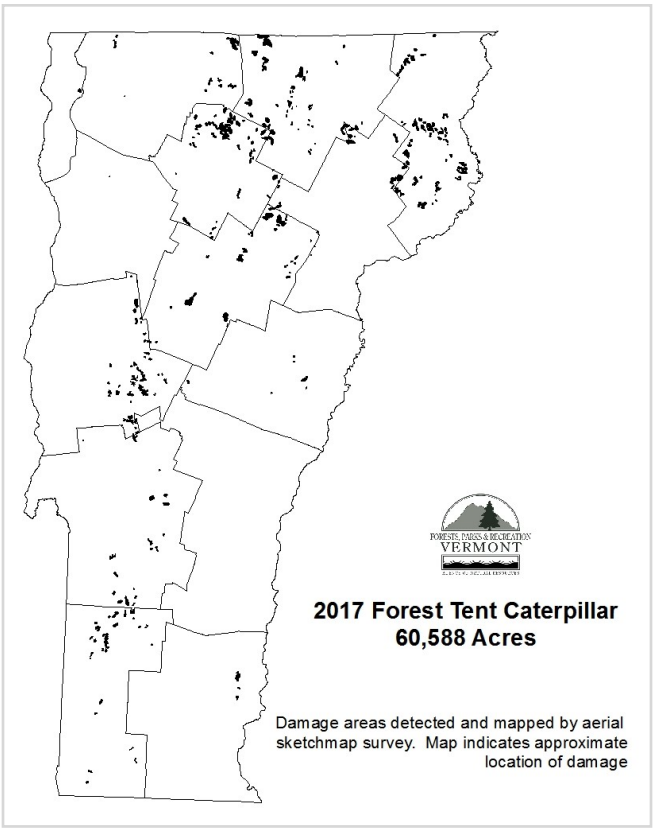
Forest Tent Caterpillar (FTC) populations increased statewide in 2017, with 60,588 acres of defoliation mapped during statewide aerial surveys. This accounts for roughly 2% of the northern hardwood forest in Vermont. Defoliation was mapped in every county and total acres more than doubled compared to 2016. Defoliation data are available on the ANR Natural Resources Atlas.

In the spring, leaf development, caterpillar hatch, and defoliation were monitored at four sites. Hatching was first observed during the last week of April. By the last week of May, some trees were 90% defoliated.

In late 2016 and early 2017, FPR staff assisted landowners with FTC egg mass surveys to determine the likelihood of defoliation on their property. Of the 64 sugarbushes surveyed, 32 were identified as at risk of defoliation. Eighteen landowners made arrangements with an aerial applicator to have their sugarbushes treated with Foray 48B, a *Btk* product that is registered for use in certified organic production. In total, these accounted for 3,434 acres. At the time of treatment, defoliation averaged 18%. This increased to just 24% after FTC feeding had ended, suggesting that treatment was highly effective. Several additional landowners also had their forestland treated.

Forest tent caterpillar (left) populations increased statewide in 2017. Hatching began in April (above right). By late May, some trees were completely defoliated (below right). Defoliation was mapped in every county.



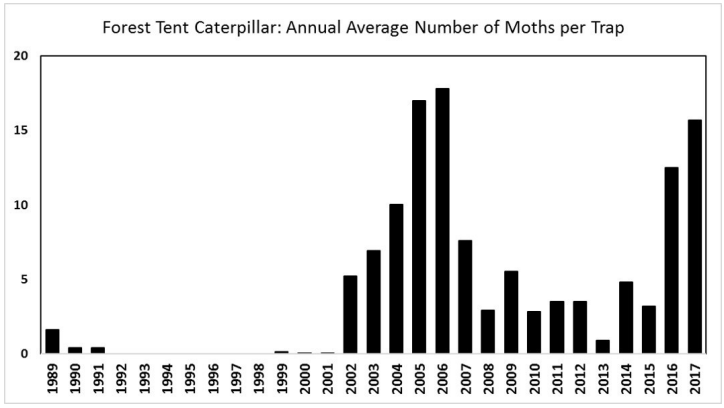


FTC parasitoids known as friendly flies were reported throughout the defoliated areas, and there was some early caterpillar mortality likely due to viral and/or fungal infection. However, moth capture in pheromone traps increased from 2016 levels, suggesting that we can expect more defoliation from FTC in 2018. By request, FPR is conducting egg mass surveys in late 2017 and early 2018 for landowners who might use the results to adjust management practices.

Parasitic friendly flies were common.

Photo: R. Kelley

Some FTC mortality occurred which was likely due to fungal or viral disease.



The number of FTC moths trapped in 2017 increased from 2016, indicating that the outbreak will continue next year.

Trees typically respond to the relatively early-season feeding by FTC by sending out a new flush of leaves. However, in both 2016 and 2017, some defoliated areas remained noticeable all summer because of a lack of refoliation. Factors that may have contributed to this include the lingering effects of 2016 drought, heavy seed, a late start of feeding in 2017, infection by leaf fungi and dry mid-summer conditions. In late October, after a burst of rainfall and continued warm temperatures, some defoliated sugar maples attempted another refoliation.

Dieback and off-color leaves have been observed in some locations where defoliation was heavy in 2016 and trees were under stress from other factors. The second year of defoliation, and lack of refoliation, will almost certainly affect wood production, the amount of foliage and shoot growth next year.

More details on FTC biology and management are in the most recent Forest Tent Caterpillar Update.

Some defoliated trees failed to refoliate all summer (top right) while others attempted to refoliate in late October (left). Dieback has been observed in some locations where defoliation was heavy in 2016 (below right).

Pear thrips damage was noticeable, and numbers in our only monitoring plot are up compared to the last 2 years. Damage was still mostly light, and mixed with frost, fungus disease and other defoliators. Pollen increases thrips fecundity, so the heavy flower production may produce a lot more thrips next spring.

Other maple insects observed in 2017, included persistent populations of maple webworm, maple leafcutter and maple trumpet skeletonizer. New this year were frequent observations of orange humped mapleworm.

Pear thrips damage may be more common next spring, since pollen increases thrips fecundity.

Photo: R. Kelley

Vermont continued to dodge the **gypsy moth** outbreak occurring elsewhere in New England, with no significant defoliation, and infrequent caterpillar reports. Egg mass monitoring plots indicate populations will remain low in 2018.

Beech bark disease remains a chronic cause of dieback and mortality, with damage mapped on 2,807 acres.

Other hardwood insects observed in 2017 included birch leaf folder which increased noticeably statewide, although no significant defoliation was observed. Poplar and willow defoliation by non-native satin moth caterpillars was more widespread than in 2017. Locust leafminer damage was particularly heavy on many roadside locusts. A large variety of tussock moth caterpillar species were reported from throughout the state, but only light feeding was observed. New this year were noticeable feeding by the red humped oakworm and scattered observations of oystershell scale, which can cause dieback when populations are heavy.

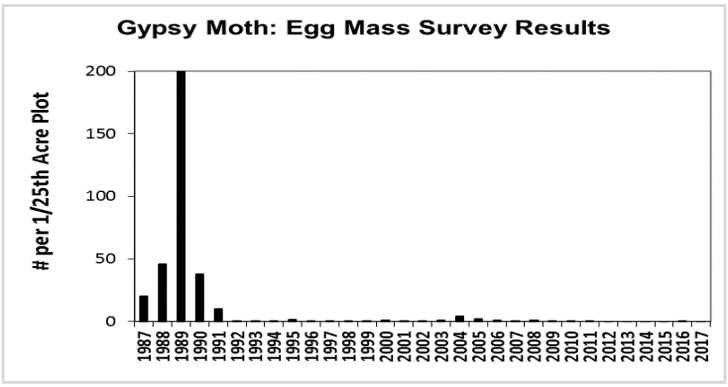
Hardwood insects which were more common in 2017 included (clockwise from top left): orange-humped mapleworm, birch leaf folder, locust leafminer, and oystershell scale.

Photos: R. Kelley

Certain **foliage diseases** were common due to the wet weather in late spring. Sycamore anthracnose kept sycamores bare into early June, wherever they grow, but foliage emerging later was unaffected, and trees were green all summer. Apple scab was heavy throughout the state, and cedar apple rust was also common. Giant tarspot caused substantial early leaf drop of Norway maple in southwestern Vermont.

Common foliage diseases included sycamore anthracnose (left) and giant tar spot on Norway maple (right).

Tar spot photo: R. Kelley



Egg mass survey plots indicate gypsy moth populations will remain low in 2018.

There's no simple answer to the **early leaf drop** of sugar maple and white ash, but a number of fungi appear to have contributed. The UVM Plant Diagnostic Lab identified the Anthracnose fungi *Discula* and *Aureobasidium* and the leafspot fungi *Phyllosticta* and *Septoria* on symptomatic sugar maple leaves, and the Anthracnose fungi *Gloeosporium* and *Aureobasidium* and the leafspot fungi *Mycosphaerella*, *Marssonina*, *Cercospora*, and *Phyllosticta* on symptomatic white ash leaves.

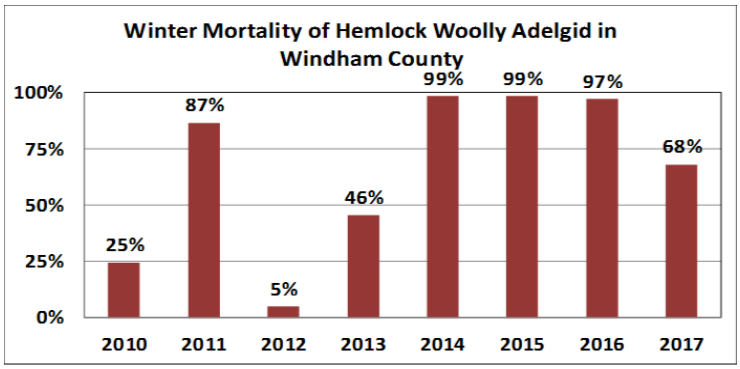
A variety of anthracnose and leafspot fungi have been identified on sugar maple leaves that dropped in late summer.

Softwood Insects and Diseases

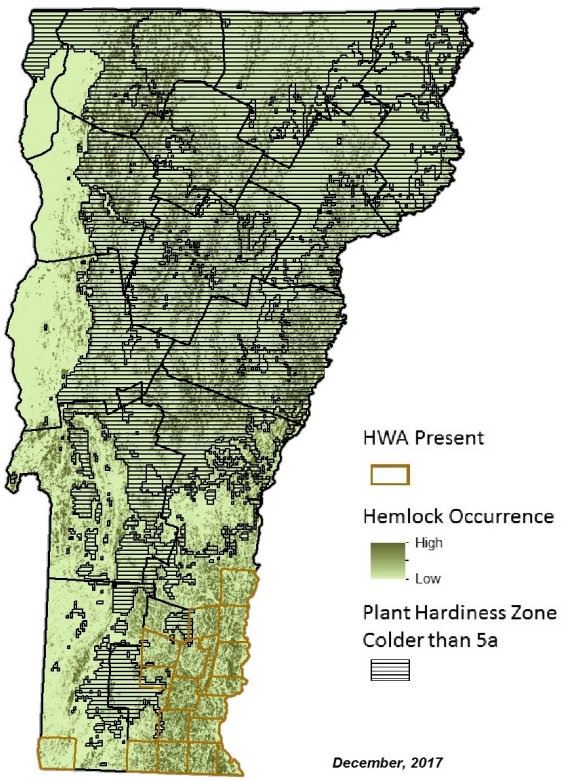
Vermont's **hemlock woolly adelgid** (HWA) infestation remains centered primarily in Windham County, with small spots in Springfield and Pownal. In 2017, hemlock woolly adelgid was detected just south of Lake George in New York, posing an additional threat to western Vermont.

Thirty sites were surveyed in 2017, with significant assistance from volunteers, to delineate Vermont's HWA infestation. No newly infested towns were reported. This limited spread is due in large part to three successive years with high winter mortality. However, the mortality rate for winter 2016-2017 was approximately 65%, well below the threshold that seems to slow new invasions. Consequently, we expect to see more HWA over the coming winter. Spread is most likely to occur into warmer regions of the state.

In spite of high adelgid mortality rates, some stands of hemlock are in noticeable decline. Compounding the situation are the spread of elongate hemlock scale into Windham County and the 2016 drought.



HWA mortality in winter 2016-17 was well below the threshold that seems to slow new invasions.



Hemlock woolly adelgid spread has been limited, due to three successive years with high overwintering mortality. No newly infested towns were detected in 2017. Spread is most likely within zones 5a and 5b.

No predatory beetles, *Laricobius nigrinus,* were recovered during fall sampling of the three sites where they had been released in 2009 and 2012, so the status of this introduction remains unknown. To augment the population at the Brattleboro site, 468 beetle adults that had been field collected in North Carolina were released in late November.

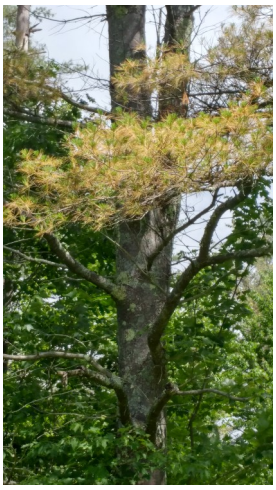
Laricobius nigrinus beetles from North Carolina were released to augment a biocontrol site in Brattleboro.

Fir mortality is continuing, although, in some areas, the balsam woolly adelgid infestation has collapsed.

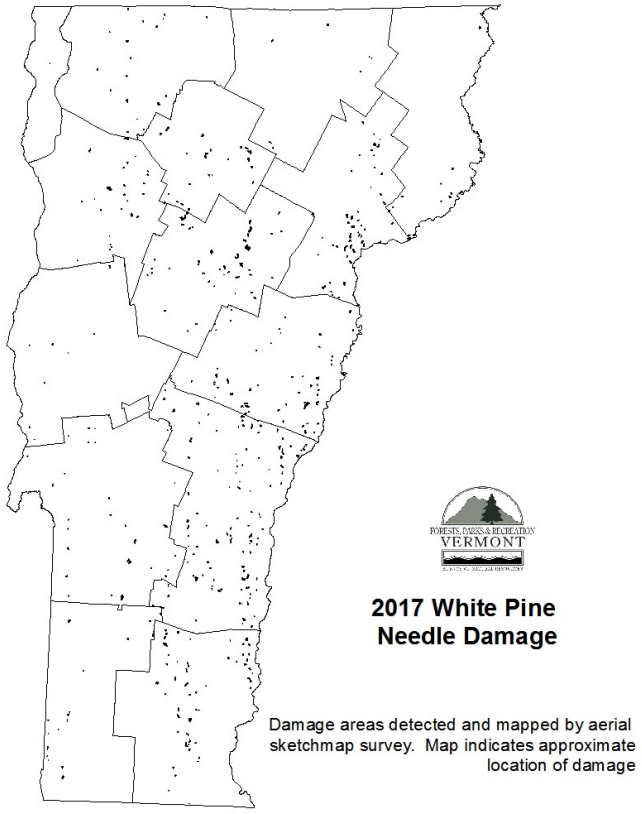
Fir mortality caused by **balsam woolly adelgid** is continuing but only 1,641 acres were mapped compared to 5,616 acres in 2016. Active populations are widely scattered, and the infestation has collapsed in some areas.

Although **white pine needle damage** was widespread again this year, with 16,413 acres mapped, this was about half of the acreage mapped in 2016. This likely underestimates the area affected since damage is mapped from above, while much of the damage is in lower crowns. This damage has been attributed to a complex of fungal pathogens. Since symptoms appear the year following infection, the dry conditions in spring 2016 may have reduced disease severity in 2017. Symptoms didn't develop until the second week of June, and with heavy winds and rains, many brown needles were already cast by late June.

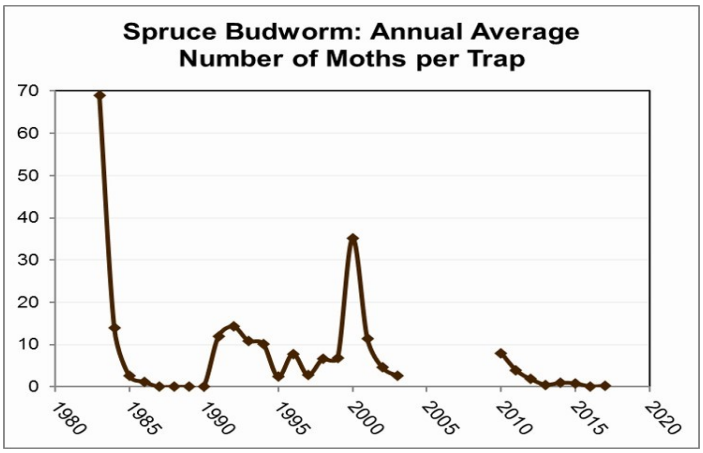
The damage has been widespread since 2010, and the current epidemic has been building at least since 2005. Needle damage continues to affect the same trees each year, and some are now exceedingly thin. Decline and mortality of white pine have been observed where other stress factors are also present.



White pine needle damage has been widespread since 2010. The disease was less severe in 2017, with only half as many acres mapped compared to 2016.



While **spruce budworm** continues to cause widespread defoliation in eastern Canada, the number of moths captured in our Vermont pheromone traps this summer remains low.



The number of spruce budworm moths caught in our traps remains low.

Reports of **red pine mortality** continued in 2016, with 516 acres mapped, scattered in seven counties. The exotic insect, red pine scale, detected in 2015 in Rutland and Orange Counties, continues to be a suspect, although it remains premature to say that red pine scale is the sole "cause" of this red pine mortality. In 2017, we were not able to detect scale insects in any stands that were visited. It's possible that cold winters have knocked populations back. It's also possible that the decline in these stands is not related to red pine scale. Pests that were observed included Diplodia shoot blight and pine gall weevil.

In 2017 we did not detect red pine scale in stands with shoot dieback. Diplodia shoot blight and pine gall weevil were commonly observed.

Exotic Forest Pests Threatening Vermont

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 Massachusetts, eastern New York, and New Hampshire in 2017. The insect is now reported from thirty-one states. Anyone using ash products from infested states should be aware of current regulations. Information is available by contacting USDA APHIS, AAFM, or an FPR office below.

The emerald ash borer detection effort continues in Vermont. USDA APHIS continued its statewide survey by deploying 214 purple traps throughout Vermont. We follow-up on all suspects, and conducted on-site inspections at ten locations where dying ash were observed or reported.

Asian longhorned beetle (ALB), is not known to occur in Vermont and no forest management changes are recommended in anticipation of the insect. Nonetheless, education and outreach that can promote early detection remain a priority. Early detection is particularly important with the Asian longhorned beetle, since small, newly-discovered populations can be successfully eradicated.

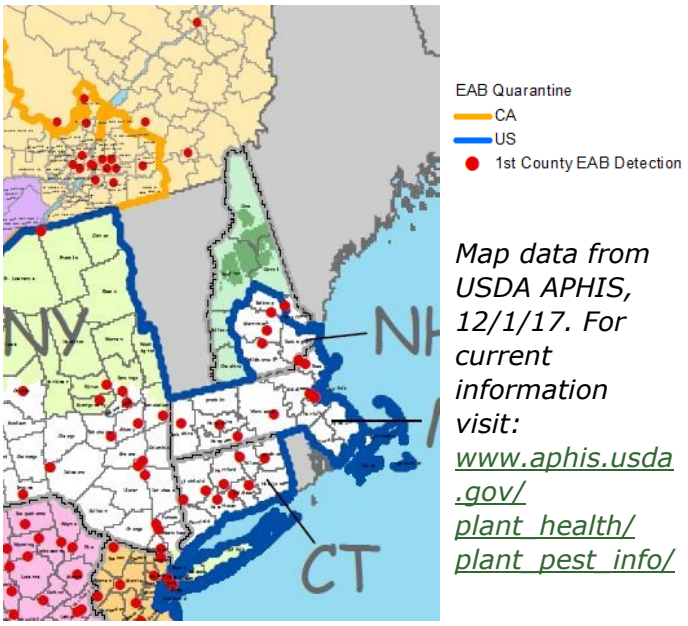
Outreach remains a priority for detecting exotic forest pests.

Photo: E. Schadler

AAFM and USDA APHIS continue efforts to trap non-native forest insects. **Sirex woodwasp** has been trapped in eight Vermont counties since 2007. In 2017, it was trapped in Chittenden and Rutland Counties. No new observations of Sirex infesting trees were reported, with the only known location in Jericho.

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.

The **brown marmorated stinkbug** has been found in Addison, Bennington, Chittenden, Lamoille, Washington, Windham, and Windsor Counties, but may occur statewide.



Map data from USDA APHIS, 12/1/17. For current information visit: www.aphis.usda.gov/plant_health/plant_pest_info/

As of December 2017, five counties in New Hampshire, and all of New York, Connecticut and Massachusetts are included in the emerald ash borer quarantine area. EAB is not known to occur in Vermont.

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

Non-native invasive plant (NNIP) management efforts continued in 2017, with progress on mapping, control, outreach and education. FPR's invasive plant coordinator led over 22 workshops for a variety of stakeholders, and worked with multiple state departments and agencies to unify Vermont's approach to NNIPs. Management activities are being conducted on state lands, including efforts to reclaim invaded meadows, to prevent invasions from becoming established, and to improve conditions to regenerate native species. A tool loan program loans out weed wrenches to local organizations, municipalities, and private landowners.

Non-native invasive plant efforts included over 22 workshops and other outreach events.

The Vermont Invasive Exotic Plant Committee updated its Watch List of NNIP. Two early detection species of recent concern are species of *Petasites*, butterbur sweet coltsfoot (first documented in Vermont 2009) and Japanese sweet coltsfoot (first documented in 2016). Populations have been detected in 18 towns scattered throughout the state, and appear to be increasing rapidly.

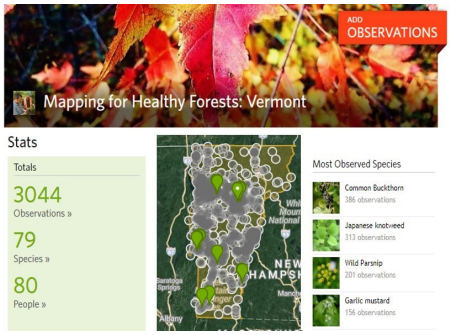
Several targeted NNIP efforts are made possible through US Forest Service grant funding:

- The Mapping for Healthy Forests project continued efforts to provide a resource for tracking NNIP, with a focus on private and municipal lands. This citizen science project trains volunteers to conduct assessments and prioritize treatment areas. The information from this project is stored on the iNaturalist website; by mid-October the project exceeded 3,000 observations.
- A Habitat Restoration Crew was hired to lead a project focused on Education, Volunteer Outreach, & Capacity Building in southwestern Vermont. Management activities were conducted on over 20 state-owned properties. One example of the benefit of early detection and response was the crew's effort to control a population of *Phragmites australis* threatening 300 acres of wetland in the Coolidge Management Unit. In 2016, the crew conducted drip application of herbicide to 1,000 Phragmites stems. By 2017, only five stems survived, which were treated. Elsewhere, management efforts included volunteers, with 348 assisting in 2017. Since 2014, this program has worked with 1,791 volunteers contributing 7,408 volunteer hours. Additionally, the crew worked on curriculum development for schools and creating interpretive materials for State Parks.

Local volunteer efforts contribute significantly to NNIP management.

Local efforts contribute significantly to NNIP management. Highlights in 2017 included projects like South Burlington's Weed Warriors, the Great Richmond Root-Out!, and NNIP management work completed by the Battenkill Watershed Comprehensive Invasive Species Management Association, Moving Towards Sustainability students at CCV-Winooski, and the Winooski Valley Park District.

The Mapping for Healthy Forests project trains volunteers to conduct assessments. The website contains over 3,000 observations.



A Habitat Restoration Crew conducted NNIP management activities on over 20 state-owned properties (above). In the Plymsbury Basin, 1000 Phragmites stems were treated in 2016 (below left). Only five had survived when the site was revisited in 2017 (below right).

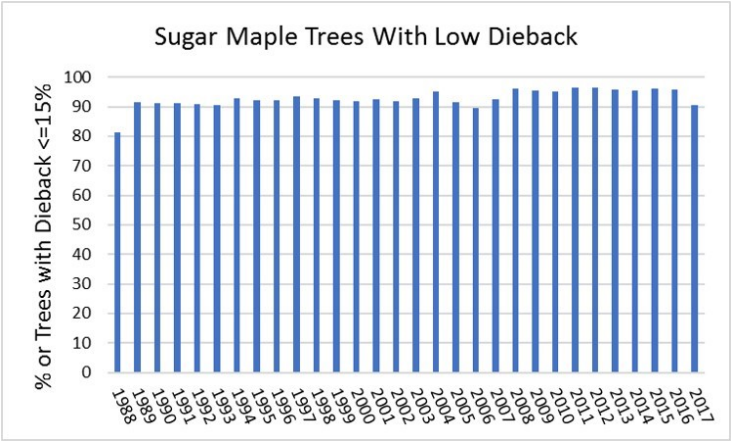
Monitoring Forest Health

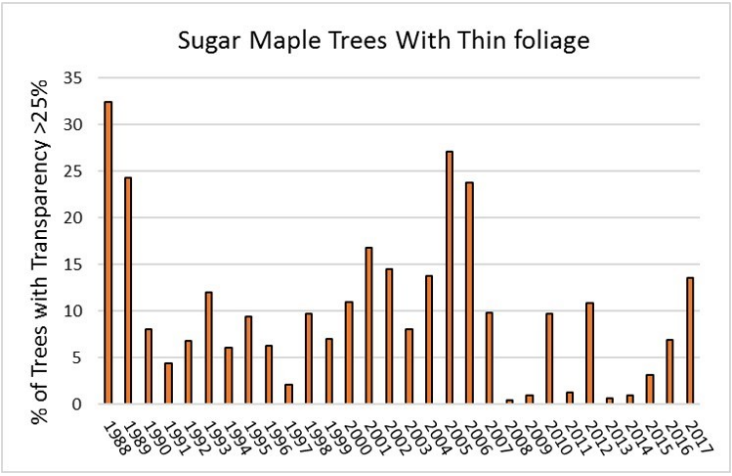
UrbanFIA work continued for the second year in Vermont. This US Forest Service program parallels traditional Forest Inventory and Analysis (FIA), measuring changes to forest demography and health through a network of long-term plots. Vermont was the first state to commit to a full UrbanFIA program, targeting urban areas statewide rather than focusing on a single metropolitan area. In 2017, all plots were completed by the end of June through the combined efforts of the USDA Forest Service, Vermont Department of Forests, Parks and Recreation, and the Forest Ecosystem Monitoring Cooperative. Data are collected on a seven year cycle, after which a statewide report will be published.

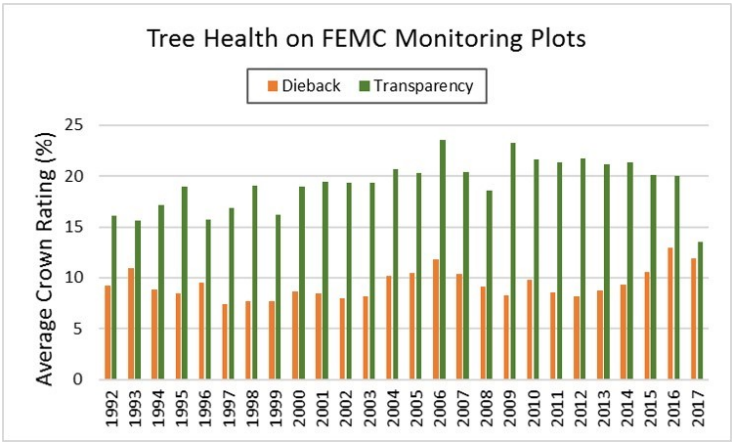
Vermont has continued to monitor sugar maple health in sugarbushes and in maple stands since 1988. In these **North American Maple Project** (NAMP) plots, 90% of trees were rated as having low dieback (less than 15%), compared to 95% in 2016. Dry conditions in 2016 may have been a factor in reduced tree health in 2017.

Thin foliage due to forest tent caterpillar defoliation was measured 9 of the 36 monitoring plots (25%). Seven had moderate-heavy defoliation (20%) and 2 had light defoliation (6%). Tree recovery through refoliation was minimal at most sites. Two additional sites were affected by pear thrips and frost. Statewide, there was an increase in trees with thin foliage from 7% in 2016 to 14% in 2017. Foliage transparency is sensitive to current stress factors. Other spikes in transparency were due to frost injury (2010, 2012, 2015), forest tent caterpillar defoliation (2004-2007, 2016), and pear thrips (1988-1989).

Fewer sugar maples had low dieback in 2017 than in 2016 in the North American Maple Project plots (above). Dry conditions and defoliation in 2016 may have been a factor. Thin foliage in 2017 was mostly due to forest tent caterpillar defoliation.







In addition, 48 forest health monitoring plots were sampled across Vermont in 2017 as part of the **Forest Ecosystem Monitoring Cooperative** (FEMC). Results from the original 23 sites on Mount Mansfield and Lye Brook Wilderness Area showed a decrease in both average dieback and foliage transparency, indicators of tree stress. An improvement in tree health in 2017 at these sites follows dry summer conditions in 2016.

FEMC monitoring sites include Mount Mansfield (right) and Lye Brook Wilderness Area. Tree health generally improved in these sites in 2017.

FORESTS, PARKS & RECREATION VERMONT
AGENCY OF NATURAL RESOURCES

For more information, contact the Forest Biology Laboratory at 802-879-5687 or:		
	Windsor & Windham Counties.....	Springfield (802) 289-0613
	Bennington & Rutland Counties.....	Rutland (802) 786-0060
	Addison, Chittenden, Franklin & Grand Isle Counties.....	Essex Junction (802) 879-6565
	Lamoille, Orange & Washington Counties.....	Barre (802) 476-0170
	Caledonia, Orleans & Essex Counties.....	St. Johnsbury (802) 751-0110

Forest health programs in the Vermont Department of Forests, Parks and Recreation (FPR) are supported, in part, by the US Forest Service, State and Private Forestry. 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. Jointly operated pest survey, detection, and management projects are conducted in cooperation with the Vermont Agency of Agriculture, Food and Markets. We gratefully acknowledge additional contributions by the University of Vermont, USDA-APHIS, cooperating landowners, resource managers, and citizen volunteers.

FIGURES AND TABLES

FIGURES

TABLES

2017 PUBLICATIONS & OUTREACH

Esden, J. "White Pine Needle Damage Persist in Vermont; Fungi and Weather Play a Part." Vermont Invasives Newsletter. Web. April 2017

Esden, J. "Summer 2017 Hemlock Woolly Adelgid Update." Vermont Invasives Newsletter. Web. August 2017.

Esden, J. "A Spectacular Display of Extreme Webbing." Vermont Invasives Newsletter. Web. June 2017.

Gaucher, T. "Invasive Bug is Killing Trees in Southern Vermont." myChamplainValley.com. Web. 4 August 2017.

Halman, J. "Forest Tent Caterpillar." Across the Fence, WCAX TV, Burlington, Vermont. TV. 6 July 2017.

Halman, J. "Fighting Back Against Forest Tent Caterpillars." NECN, Newton, Massachusetts. TV. 7 June 2017.

Hanson, T. "Are You Seeing Brown Marmorated Stink Bugs?" Vermont Invasives Newsletter. Web October 2017.

Hanson, T. et al. "Vermont Insect & Disease Observations 2017." Vermont Department of Forests, Parks & Recreation, Vermont Division of Forestry. Web. 2017.

Ready-Campbell, C. "Booming Caterpillar Population Munches Through Forests." VTDigger. Web 18 July 2017.

Sinclair, S. "Maples are Not Going Away." Rutland Herald. Web. 11 July 2017.

Spinney, E. "Vermont Flower Show and VTinvasives." Vermont Invasives Newsletter. Web. February 2017.

Spinney, E. "Making an Invasive Plant Management Plan: Part 1." Vermont Invasives Newsletter. Web. April 2017.

Spinney, E. "Making an Invasive Plant Management Plan: Part 2." Vermont Invasives Newsletter. Web. June 2017.

Spinney, E. "New Recommendations for Disposal of Invasive Plant Material." Vermont Invasives Newsletter. Web. August 2017.

Spinney, E. "Dandelion Look-a-Like is an Early Detection Invasive." Vermont Invasives Newsletter. Web. October 2017.

Spinney, E. "Vermont's Invasive Exotic Plant Watch List Updated." Vermont Woodlands Association Newsletter. Web. March 2017.

Spinney, E. "Watch List Species Highlight: European Spindle Tree (*Euonymus europaeus*)." Vermont Woodlands Association Newsletter. Web. June 2017.

Spinney, E. "New Recommendations for Disposal of Invasive Plant Material." Vermont Woodlands Association Newsletter. Web. September 2017.

Spinney, E. "Watch List Species Highlight: Autumn Olive and Russian Olive." Vermont Woodlands Association Newsletter. Web. December 2017.

Vermont Department of Forests, Parks & Recreation. 2017. "Forest Tent Caterpillar Update." Vermont Forest Health Leaflet 2017-08. 4pp. Web. September 2017.

WEATHER AND PHENOLOGY

2017 Weather Summary

2017 was the 3rd warmest average temperature on record in Burlington dating back to 1892 (2016 was the 2nd warmest year). However, the year ended with a dramatic cold snap reminiscent of an old-fashioned Vermont winter. High temps the week after Christmas in the single digits either side of zero were felt across the state. Low temps bottomed out in the negative single digits in typically warmer locations to the negative twenties in cold pockets. This bone chilling cold continued into 2018.

Winter 2016-2017

Winter 2016-2017 was the 2nd warmest on record in Burlington, the 3rd warmest in Montpelier (2015-2016 the warmest) and the 5th warmest in St. Johnsbury (2015-2016 the warmest). This is the second year in a row that warm winters were observed at the National Weather Service in Burlington, Vermont.

From December 2016 through February 2017, temperatures were 3° to 7° above normal across the state and snowfall was near normal to below normal through most of the period. Some Vermont maple producers took advantage of the warmer weather, got trees tapped early and even made some syrup starting in January.

A series of snow storms through mid-February blanketed the state in snow with amounts ranging from 12 to 50 inches in the mid and upper elevations and a trace to 8 inches in the Champlain valley. The snowpack took a hit, however, from February 23-26, when record breaking high temperatures were recorded. Temperatures reached the upper 50's, the low, mid and upper 60's and even 72° in Burlington. No snow remained in the Champlain valley east to the base of the Green Mountains and a trace to 16 inches remained across the rest of the state except for the highest elevations and Essex County.

The snow returned in March along with intense cold. By March 4, temps plunged into the single digits and low teens breaking lowest maximum high temperature records across the state. The cold continued through much of the month averaging 4 to 8 degrees below normal. Along with the cold came snow. March averaged above normal snowfall statewide with the most snow falling in the northern part of the state. A single 2-day storm on March 14-15, known as the "Pi Day" nor'easter, brought snow, wind and headaches from Virginia to Maine. Between 1 and 3 feet of snow fell across the state. Schools, businesses and state offices closed, and flights were cancelled across the country. Blowing and drifting snow made road clearing difficult. The storm ranked number 2 for Burlington's all time snowiest storms with 30.4 inches.

Spring, 2017

Snow melted rapidly during a warm and dry period the week of April 9. By April 15, only small patches of snow remained on north facing, shaded and wooded areas of the northeast and in high elevations. This dry period was enough to elevate fire danger. From April 9 to 15, thirteen fires were reported with 8 reported on April 15. This was the most active period for fires all year.

May averaged cooler and wetter than normal. The 2016 drought hung on in parts of Vermont despite a snowy winter and damp April. The last abnormally dry area along the Connecticut River Valley in Windsor County finally received enough rain to take it out of drought on May 2 (Figure 1).

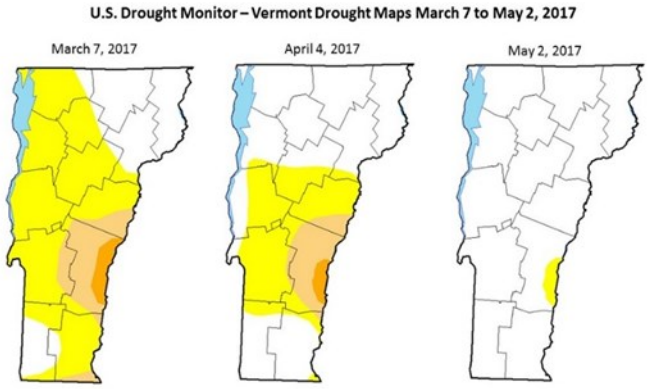


Figure 1. Vermont drought maps, March 7 to May 2, 2017. Source: U.S. Drought Monitor

The rest of the month was chilly and gloomy with frequent light rain amounting to less than a tenth of an inch on most rainy days. However, there were a few severe storms as well. A severe windstorm knocked down trees and powerlines in Rutland County on May 5. On May 18 and again on May 31, strong storms with torrential rain, gusty winds and hail caused damage in Rutland, Addison, Chittenden, Lamoille, Washington, Orange Counties and northeastern Vermont. (See the May, 2017 Forest Health Insect & Disease Observations report for more storm details.)

The lack of sunshine during the month kept temperatures below normal for all but the northwest corner of the state. On May 8 and 9, one to two inches of snow was recorded at the higher elevations of the Green Mountains, the NEK and Orange County. Scattered frost damage resulted in some areas where temperatures were well below normal.

The month wasn't without warmth. The week of May 14, had the greatest temperature swings. High temperatures in Burlington fluctuated from 54° on May 14 to record breaking 90's on the 17th and 18th and back into the low 60's by the end of the week. Elsewhere in the state saw similar variations except that temps were cooler on the 14th in higher elevations and warmer on the 20th in lower Connecticut River valley.

Summer, 2017

Meteorological summer - June, July and August, was cooler and wetter than normal. After a similar trend in May, it seemed that summer would never come. Despite the chilly, gloomy weather, high temperature records were broken in June with 88° in Montpelier on June 11 and 12 and in Burlington on June 11 with a high of 95° and June 12 with a high of 94°. A heat wave occurred in Springfield on June 11, 12, and 13 with 90°, 94°, and 90° respectively. Temps in the 90° range were reported in several locations around the state. It would be September before 90° temps were recorded again in 2017.

In fact, lowest maximum temperature records were recorded in July with temps in the upper 50's to upper 60's on July 14-15 and again on July 24-25. South Lincoln set the lowest minimum temperature record of 34° on July 29.

A dry stretch of weather accompanied the warm temps…a welcome and noticeable break after a soggy May, but by mid-June, the rain and chill returned. A series of severe storms occurred during the latter part of the month. Damage was generally minimal and localized. The last week of June was unsettled with bouts of rain, severe weather including strong winds and hail and even some breaks of sun. Soils were saturated, especially in northern Vermont. A long duration storm, from June 29 through July 1, brought more rain and flooding. Total rain amounts from 0.10 to over 4 inches were recorded statewide. Several roads were closed or were down to a single lane and the Vermonter Amtrak rail service was interrupted. Homes and businesses, hayfields and corn crops were affected as well. Damage was widespread affecting Addison, Bennington, Caledonia, Lamoille, Orange, Rutland, Washington and Windsor Counties. By mid-July, 6.5 million dollars in damage to roads, culverts, bridges and municipal buildings was assessed in preparation for a FEMA declaration. (See the July, 2017 Forest Health Insect & Disease Observations report for more details.)

Rainfall was below normal from mid-July through August, and like May, frequent cloudy and rainy days with hit or miss storms were the common weather pattern that caused localized damage. On August 21, sunny skies in Vermont allowed an unobstructed view of a partial solar eclipse. A full solar eclipse was visible across the country with the path of totality stretching from Oregon to South Carolina. Eclipse fever was short-lived, however, when category 4-Hurricane Harvey made landfall in Texas on August 25.

While rain dumped on Texas and the southern U.S., a blocking high pressure system over the northeastern U.S. brought dry weather to Vermont and the northeast. Temperatures felt more like fall with overnight temps in the 40's, even 30's in the cold spots and daytime highs only reaching the 60's.

Fall, 2017

September got off to a normal start. Temps were actually below normal early in the month with some localized frosts in the colder pockets of the northeast and sheltered valleys. Fall color brightened under sunny skies and shorter days and then the pattern reversed. A huge ridge of high pressure, a northward bulge in the jet stream, stalled in place due to lack of strong winds. Tropical warm air moved north. Temperatures soared and records were shattered. Summer had finally arrived.

On September 24, Burlington recorded 91° breaking the record of 84° set in 1961. This was the latest occurrence of 90° or warmer on record going back to September 15, 1939. This record was broken again on the September 25, 26 and 27, 2017. It was also the latest heat wave on record with the previous occurring September 8-10, 2002 and tied the record for most 90° or warmer days in September. That record had only been reached once before in 1945.

Well above normal temperatures were recorded statewide from mid-September through the end of the month. Heat waves were also recorded in Springfield, Essex, Danby and even at the Nulhegan fire weather station in Brunswick.

The ridge of high pressure that brought the heat also blocked remnants of Hurricane Irma and the northern progress of Hurricanes Jose and Maria. As a result, September was drier than normal after a widespread rainfall on September 3 and scattered storms on September 5. By September 28, the U.S. Drought Monitor listed most of Rutland County into Windsor County as abnormally dry.

Burlington recorded a streak of 20 dry days. This tied the 7th longest stretch of dry weather on record dating back to January 1884. The streak ended on September 30 with .01 inch of rain. The same weather system brought light rain to other parts of the state. The highest amounts were just over 0.3 inches. A trace of snow was recorded on the top of Mt. Mansfield.

With the onset of the hot and dry weather pattern, fall color change stalled. Except for an occasional pop of bright color here and there, lots of green persisted into October. A short return to cooler, damper weather sparked the color change just in time for Columbus Day weekend. Color was brilliant along roadways and villages and where leaves remained on the hillsides. Color remained in the Champlain valley and southern Vermont through the end of the month. A quote from a FPR report describing the 1999 foliage season said, "Depending on where you looked, the foliage season was everything from spectacular to disappointing. The distant panoramas in the high country were muted by the dry summer, but the closeup views along the roadways and in the villages were as gorgeous as ever." Except for the dry summer reference, that sums up the 2017 season quite well.

The warm, dry weather pattern brought an elevated risk for wildfires by mid-October. With an abundance of cured vegetation and newly fallen leaves, fire danger increased but only 10 small fires were

U.S. Drought Monitor
October 24, 2017

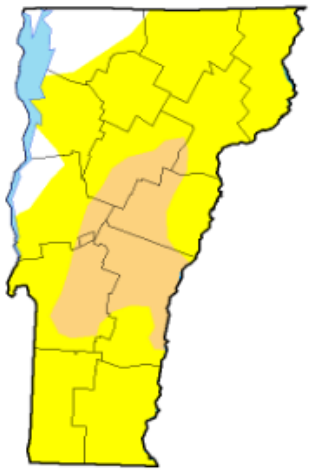


Figure 2. State of drought in Vermont as of October 24, 2017.

reported. By October 24, moderate drought was in place in parts of Rutland, Windsor, Orange and Washington Counties. Most of the rest of the state was abnormally dry (Figure 2). Despite heavy rains late in the month, abnormally dry conditions persisted through November in parts of Rutland, Windsor, Orange and Washington Counties.

A summerlike storm with warm temps and high humidities brought some much needed rain on October 25. A record 78° in Burlington was 24 degrees above normal. Rainfall amounts from 0.25 to 0.75 of an inch were recorded in western Vermont and from 1 to 3 inches in eastern Vermont. Strong, gusty winds accompanied this storm as well with gusts 30 to 40 mph especially in western Vermont.

An even more powerful and destructive storm arrived a few days later, on October 29-30. Rain and winds were forecast days in advance. The storm was part of a larger east coast system that drew winds from the east and pulled in the remnants of Tropical Storm Philippe similar to what happened with Superstorm Sandy. Downed trees and powerlines caused power outages to over 1 million people across New England. Flooding was reported in parts of the region as well. In Vermont, rainfall amounts varied from 0.25 of an inch in northwestern Vermont to over 4 inches in southeastern Vermont.

The destructive winds, though, were the most significant part of this storm. Tree damage occurs when wind speeds exceed 40 mph. Very few parts of the state saw wind gusts less than that. These strong winds brought down trees and powerlines overnight on October 29. Wind gusts in the upper 30 and 40 mph range were common with gusts over 60 mph in the Champlain valley and western slopes of the Green Mountains. The National Weather Service reported wind speeds on Mt. Mansfield of 115 mph. By the morning of October 30, power outages to nearly 70,000 Vermont homes and businesses were reported across the state. Some outages involved broken poles and damage to substations requiring specialized crews to restore. A limited number of out-of-state crews were available to help with restoration as the storm affected an area from Virginia to Maine. For many utilities in Vermont and northern New England, damage from this storm was worse than each utility's most historic storm. It would be a week or more before power was restored to everyone.

Damage was widespread. Roads were blocked from downed trees, debris and powerlines. Over 200 schools were closed across the state and travel was difficult. In Stowe, 13 roads were closed and 60% of the town was without power. State land in central Vermont received significant blowdowns. The Cady Hill Town Forest and the Cotton Brook/Nebraska Valley areas of Mt. Mansfield State Forest were hard hit. Also affected by the storm was the trail to Spruce Mountain in Plainfield (LR Jones State Forest).

The month of October finished with above normal temperatures. It was the warmest on record at the National Weather Service in Burlington, more than 10° warmer than normal. October was also the warmest for Montpelier, almost 8° above normal. The month was wetter than normal in eastern Vermont and drier than normal on the western side.

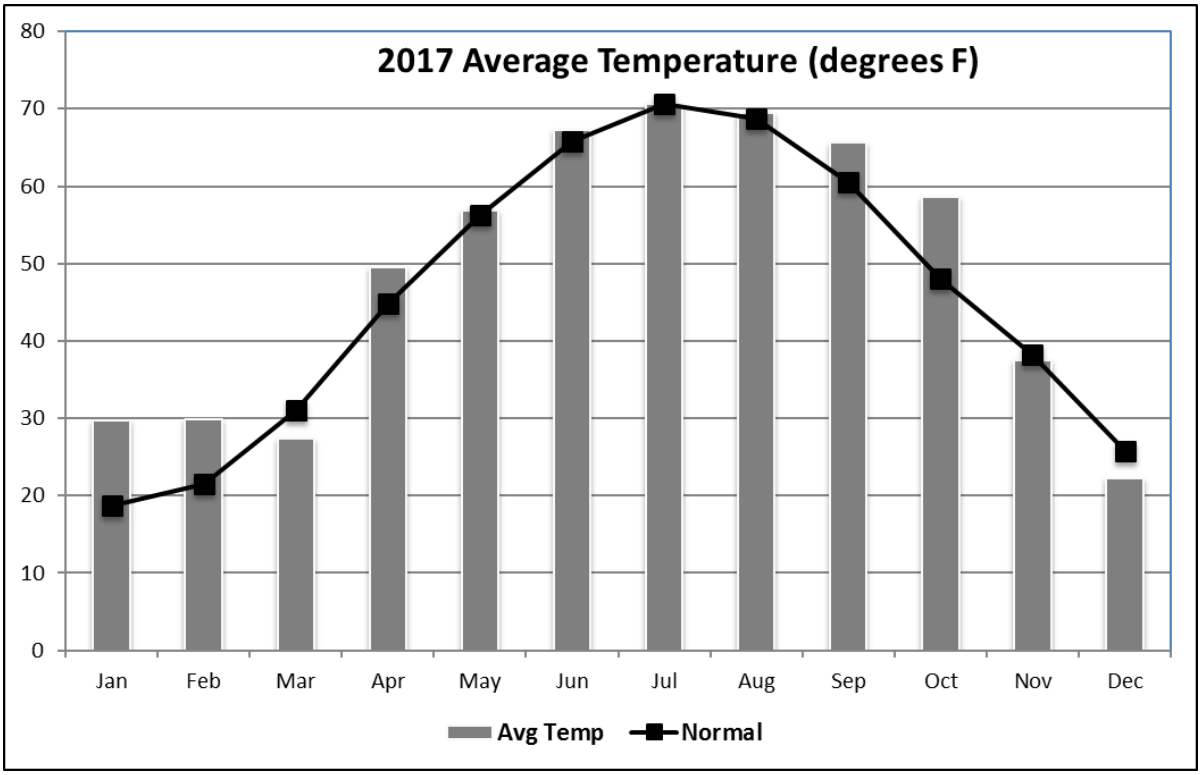
October warmth lingered into the first week of November, but normal chilly temps arrived by November 8. On the 7th, drizzle turned to snow in southern Vermont and New England late in the afternoon with a dusting of snow overnight. Ski areas across the region cranked up the snow guns in anticipation of a Veteran's Day weekend opening. Natural snow was harder to come by through the month. On November 20, lake effect snow from Lakes Superior, Huron, Ontario and Erie made it to Vermont. The

western slopes of the Green Mountains received the most with reports of 6 inches in Jericho Center and 5 inches in Jonesville but by the end of the month, very little remained.

December snow lagged as well until mid-month. A substantial snowstorm started on December 12 and continued through the afternoon of December 13. Up to 18 inches of snow fell in the southern Green Mountains, 8 to 12 inches from the western slopes of the Greens east and 4 to 8 inches in western Vermont. Another light, fluffy 2 to 12 inches fell on December 22, just in time for Christmas. However, rain on December 23 turned frozen surfaces to ice and washed the snow from trees. Slick roads impacted travel and made for many accidents as rain hit below freezing surfaces across the state. The Connecticut River valley was hit the hardest from just south of St. Johnsbury down to Brattleboro. More than 5,000 homes and businesses lost power. Weather improved for Christmas Eve, but snow returned again on Christmas morning with an additional 2 to 12 inches statewide. Eastern and southern Vermont received the most, but a White Christmas was had by all.

Along with the snow came colder than normal temperatures. By mid-month, temperatures were colder than normal by 4 to 8 degrees due in part to the wave of arctic air from Canada the last week of the year. This cold wave settled in across much of the eastern two-thirds of the U.S. late in the month. Vermont felt the blast of cold temperatures and wind chills after Christmas that lingered into the new year. You know it's cold when Jay Peak Resort shuts down lifts to the upper mountain. On December 28, the temperature above 2,500 feet on Jay was -31 not counting the wind.

Figures 3-12 and Tables 1-4 *provide details on 2017 temperatures, precipitation and phenological observations.*



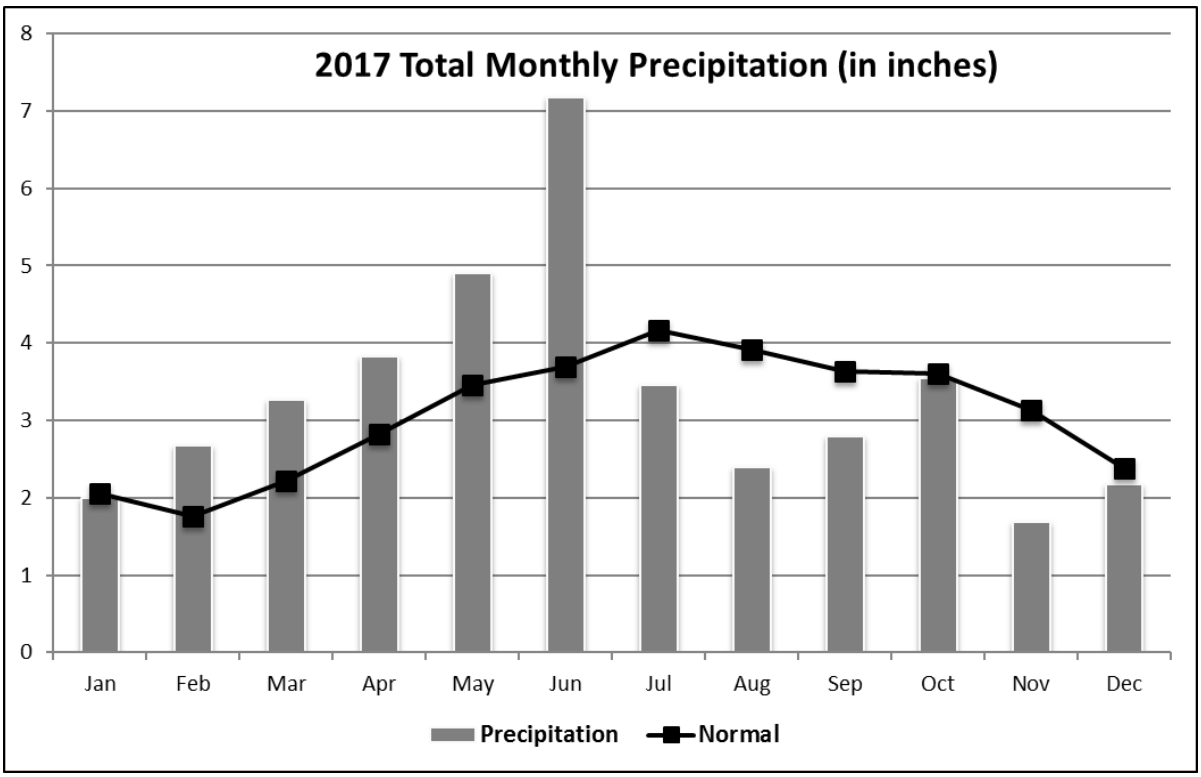


Figure 3. Monthly average temperature and total monthly precipitation in 2017, compared to normal for Burlington, Vermont. (Normals are for years 1981-2010.) *Source: National Weather Service, Burlington, Vermont.*

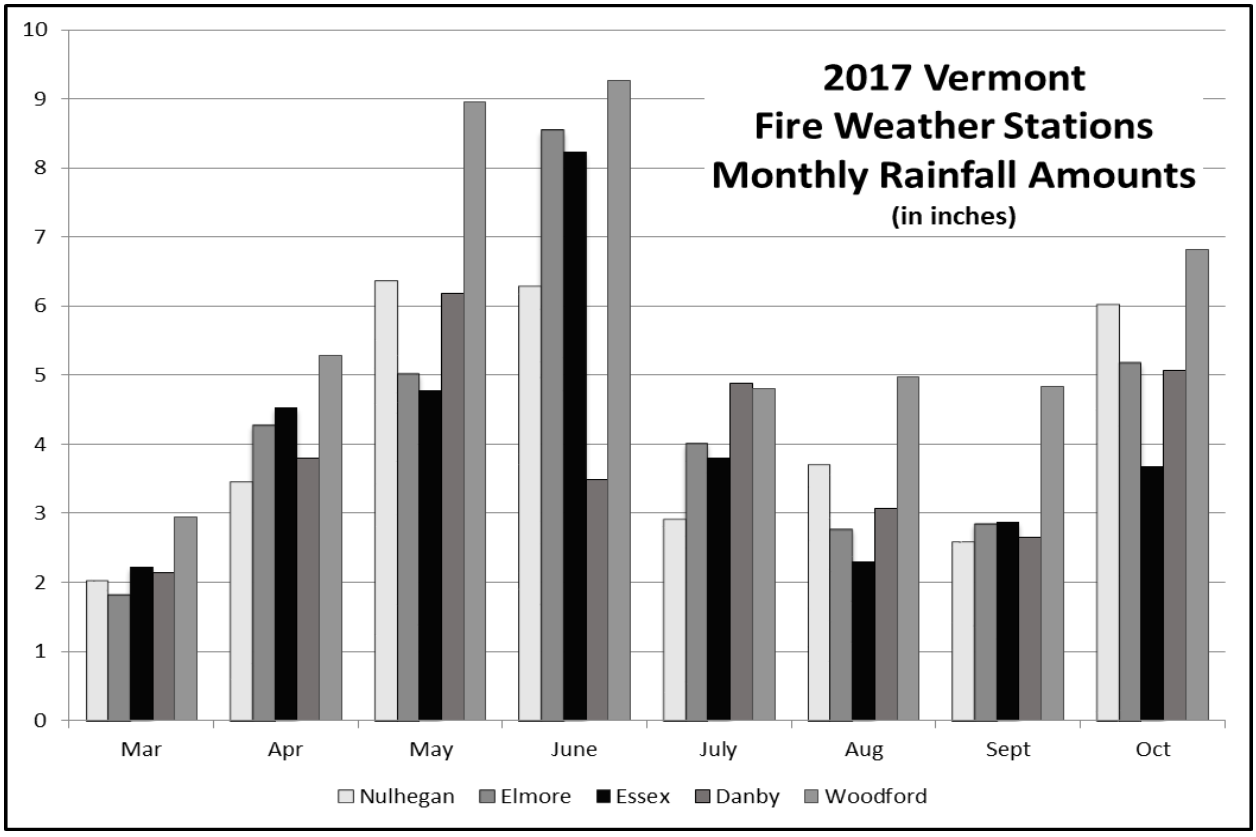


Figure 4. Monthly rainfall amounts (in inches) at Vermont fire weather observation stations through fire season, March-October, 2017.

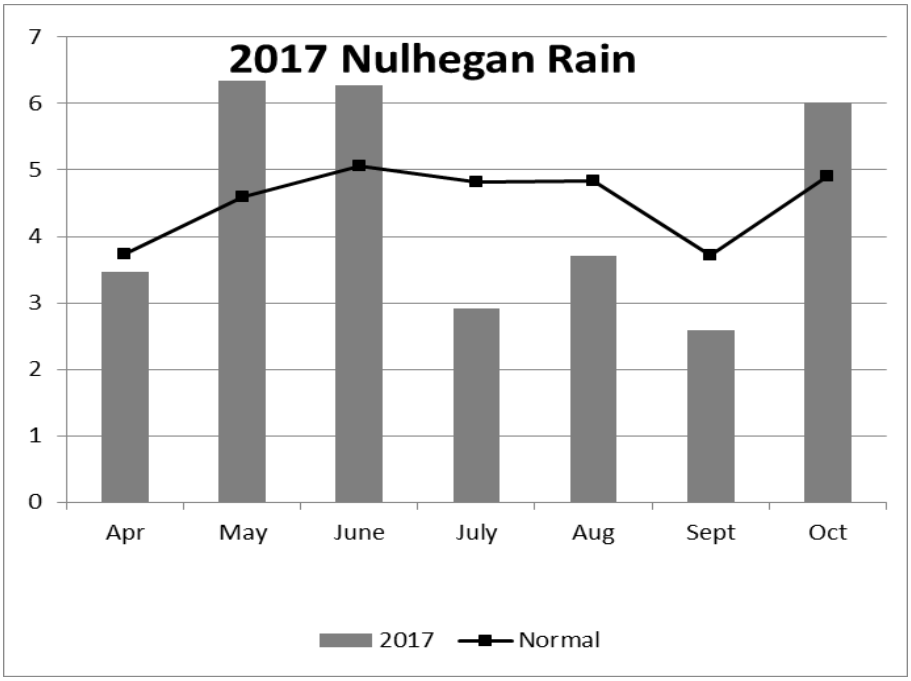


Figure 5. Monthly rainfall amounts (in inches) at the Nulhegan fire weather observation station in Brunswick, Vermont compared to normal through fire season, April-October, 2017. Normal is based on 15 years of data.

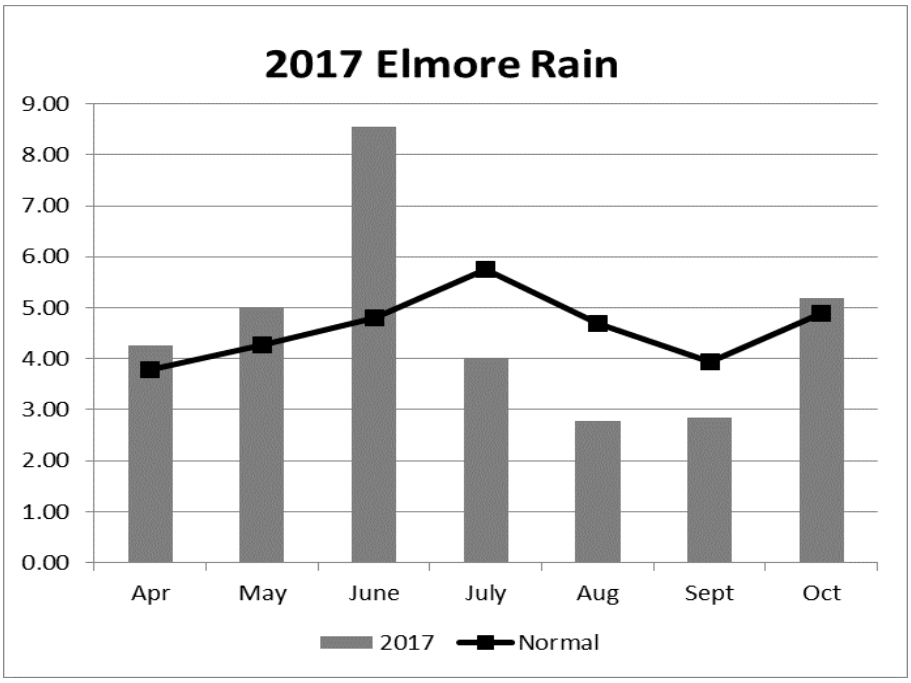


Figure 6. Monthly rainfall amounts (in inches) at the fire weather observation station in Elmore, Vermont compared to normal through fire season, April-October, 2017. Normal is based on 23 years of data.

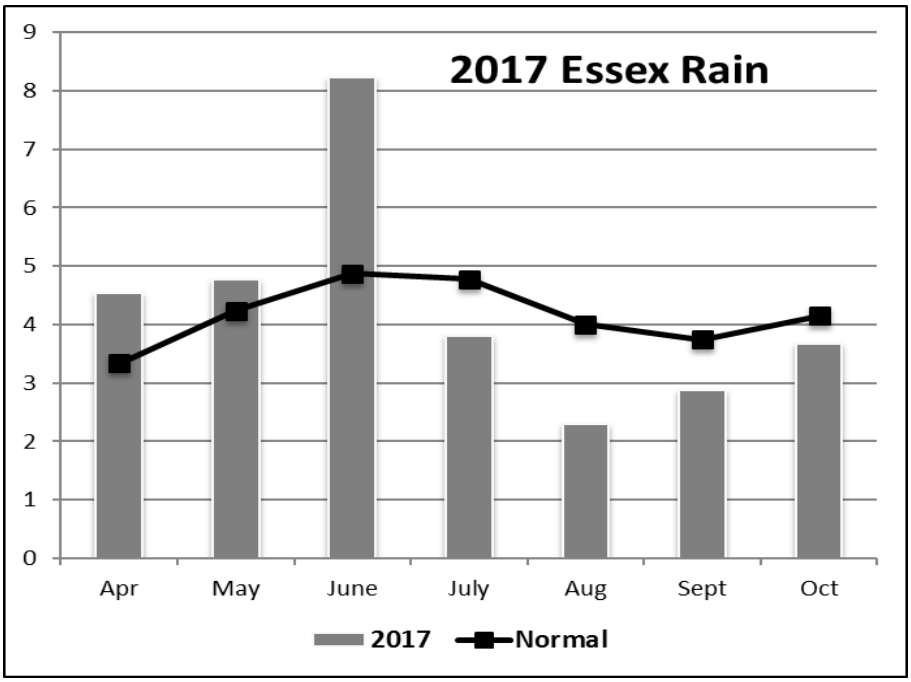


Figure 7. Monthly rainfall amounts (in inches) at the fire weather observation station in Essex, Vermont compared to normal through fire season, April-October, 2017. Normal is based on 24 years of data.

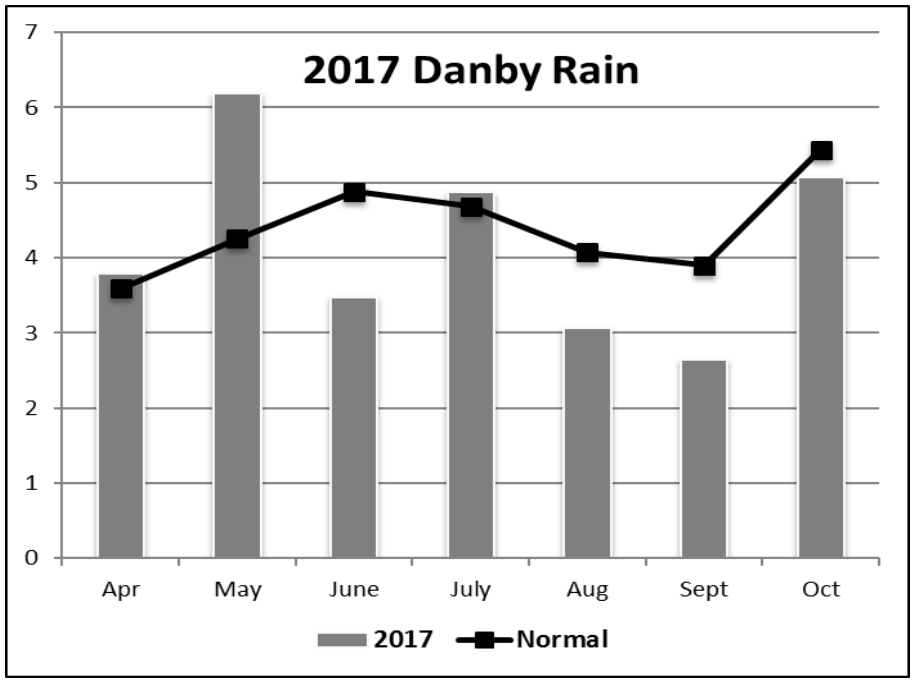


Figure 8. Monthly rainfall amounts (in inches) at the fire weather observation station in Danby, Vermont compared to normal through fire season, April-October, 2017. Normal is based on 17 years of data.

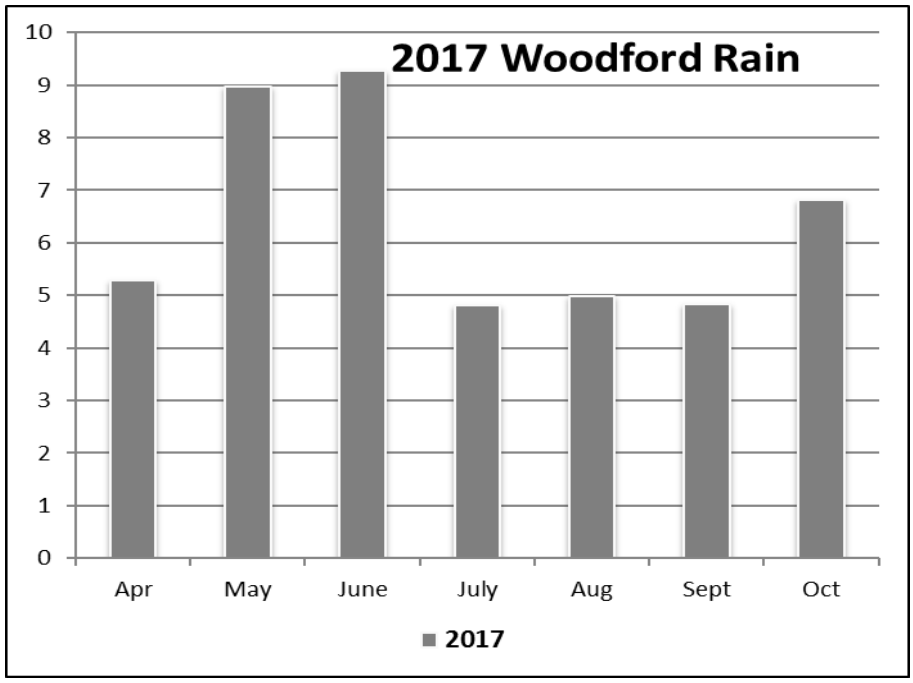


Figure 9. Monthly rainfall amounts (in inches) at the fire weather observation station in Woodford, Vermont through fire season, April-October, 2017. The Woodford weather station was initially installed in 2013. Normal for this site is not yet established.

Spring Bud Break and Leaf Out at Mount Mansfield

Sugar maple trees were monitored for the timing of budbreak and leaf out in the spring at the Proctor Maple Research Center in Underhill as part of the Forest Ecosystem Monitoring Cooperative. Sugar maple leaf bud expansion was slightly earlier than normal in 2017. Budbreak on April 29th was 4 days earlier than the long-term average. Full leaf-out was nearly indistinguishable from the long-term average (Figure 10), but was two days earlier than in 2016.

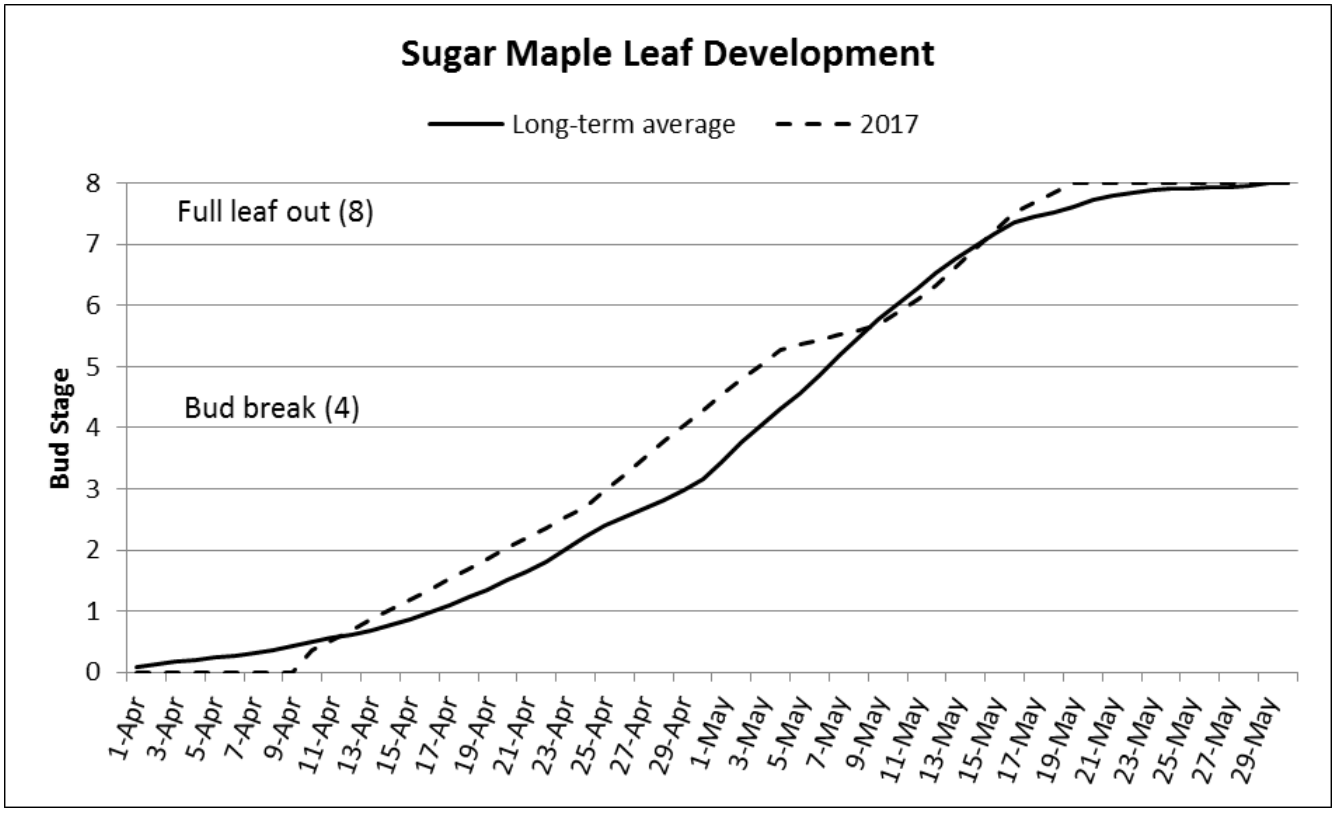


Figure 10. Sugar maple bud break (Bud Stage 4) and leaf-out (Bud Stage 8) at Proctor Maple Research Center, Underhill, Vermont.

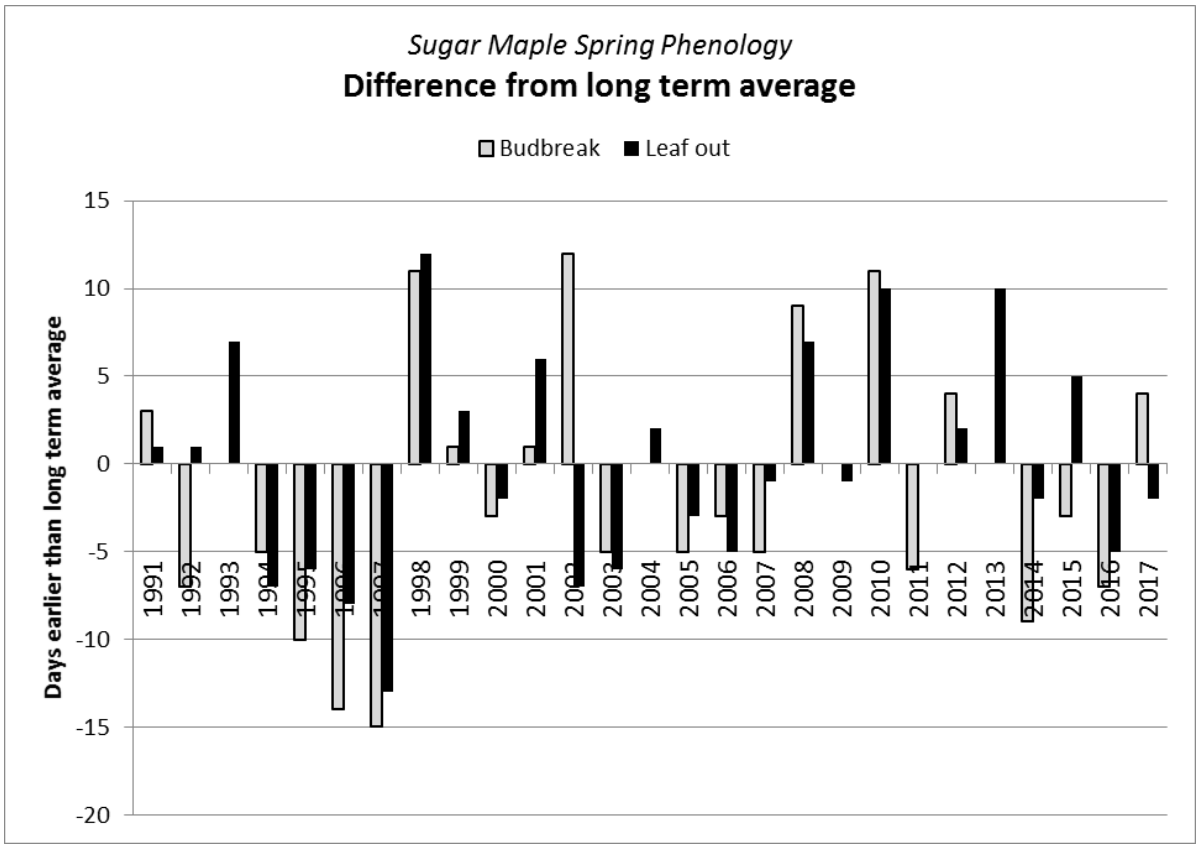


Figure 11. Difference from long-term average of sugar maple bud break and leaf-out at Proctor Maple Research Center, Underhill, VT.

Table 1. Dates of vegetative bud development for five species by observation location in Vermont.

Species	Location	Bud swell	Bud break	Leaf-out
Sugar maple	Underhill	4/20	4/29	5/19
Red maple	Underhill	4/12	5/4	5/22
White ash	Underhill	5/4	5/11	5/30
Yellow birch	Underhill	4/26	5/6	5/22
Eastern hemlock	Springfield	5/9	5/18	5/26

Fall Color Monitoring at Mount Mansfield

A total of 45 trees (5 trees per elevation per species) at three elevations in Underhill were monitored for the timing of peak fall color and leaf drop (Figure 12). Five trees from each of the following species were monitored per elevation:

At 1400 feet: Red maple (male), Red maple (female), Sugar maple, White ash, Yellow Birch
At 2200 feet: Sugar maple, Yellow Birch
At 2600 feet: Paper birch, Yellow Birch

In general, peak color was later than usual in 2017, with low elevation sugar maple, and high elevation paper birch being the exceptions (Table 2). Some aberrations were noted in the progression of color with double-peaks presenting themselves in the data (Figure 12 b). This was likely due to initial color change that stalled, followed by some leaf drop due to dry conditions of early fall. Color development subsequently continued, leading to peak color after this early period. Growing season length in 2017 was the longest since 2012, and exceeded the long-term average by 12 days (Table 4).

Figure 12. Timing of fall color (Figure 12 a-f) and leaf drop were monitored at three elevations on Mount Mansfield in 2017: 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.

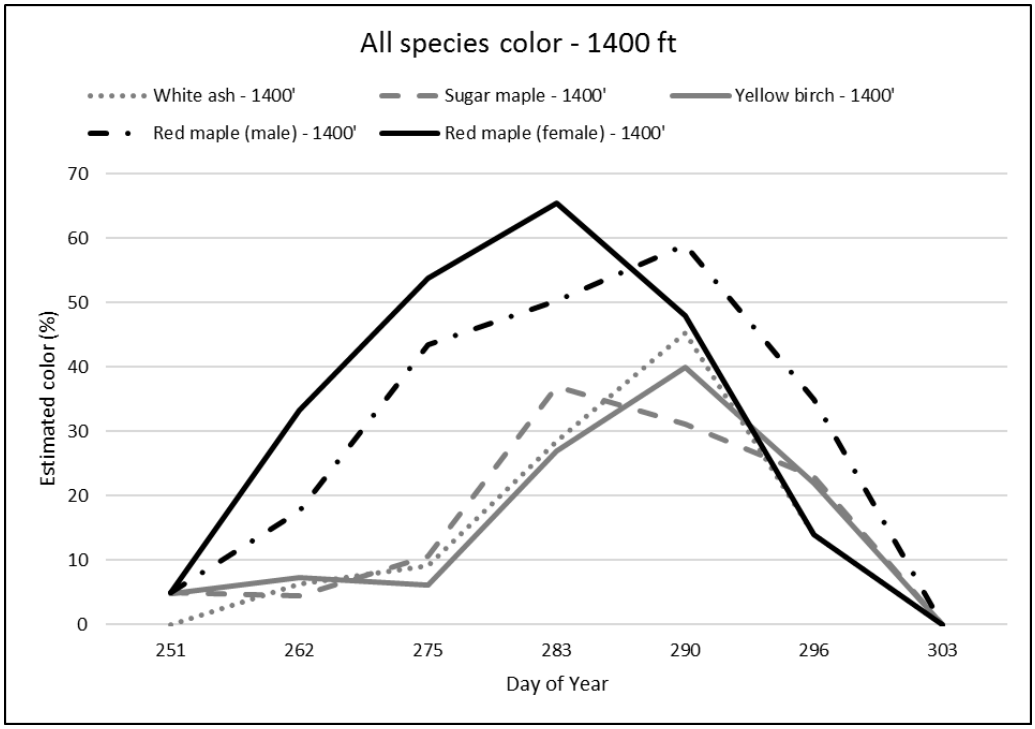


Figure 12 a.

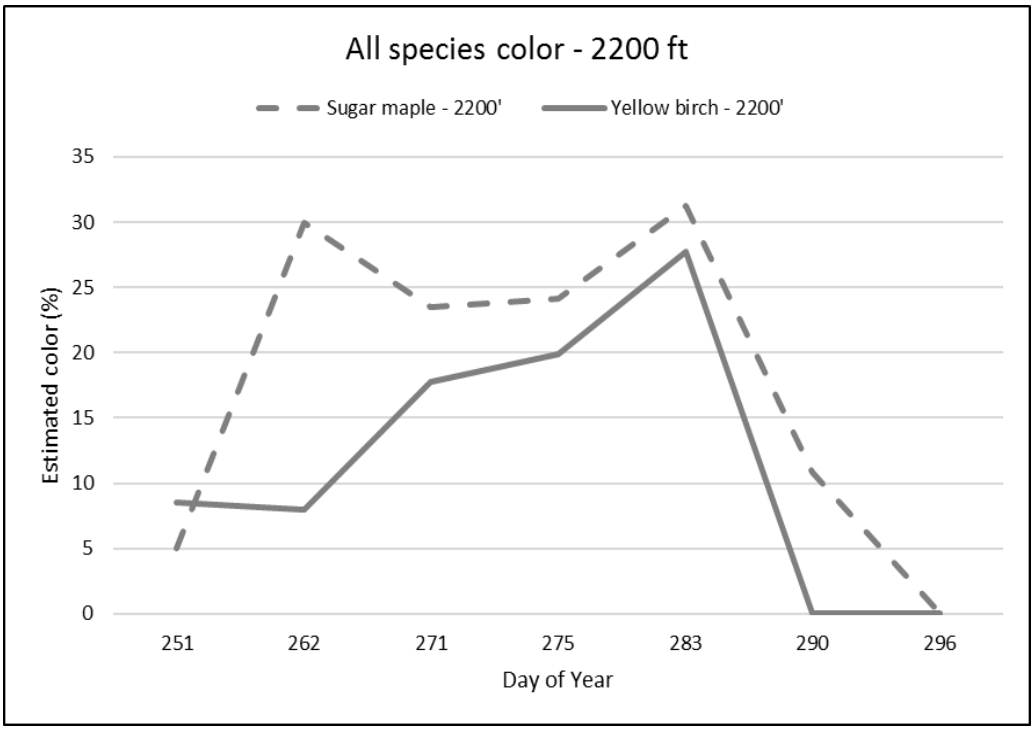


Figure 12b.

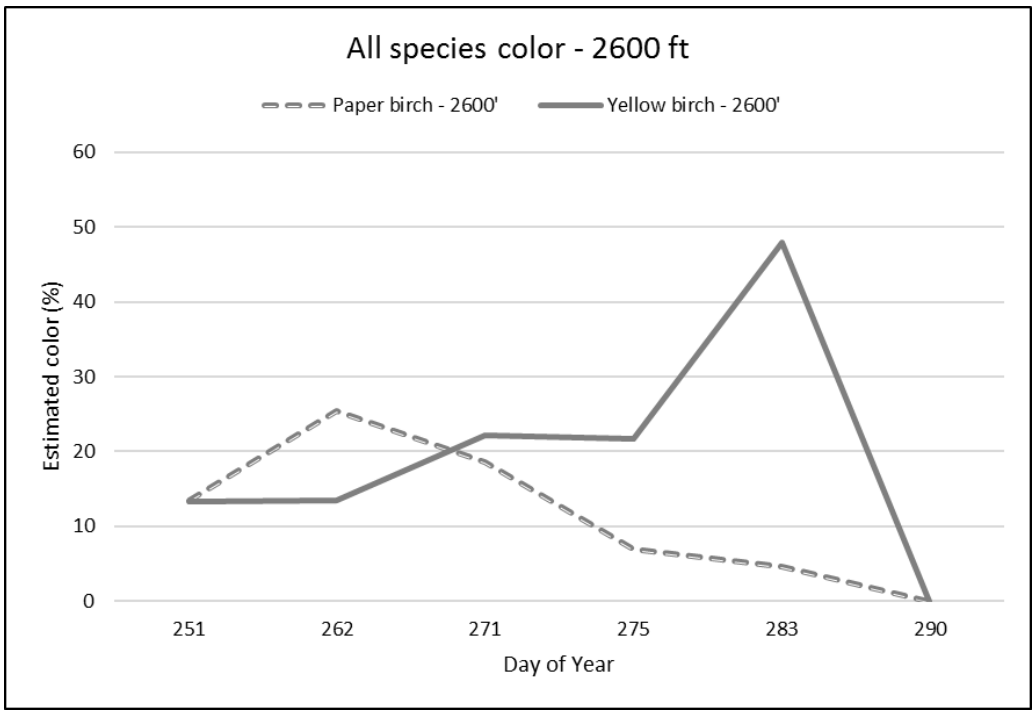


Figure 12c.

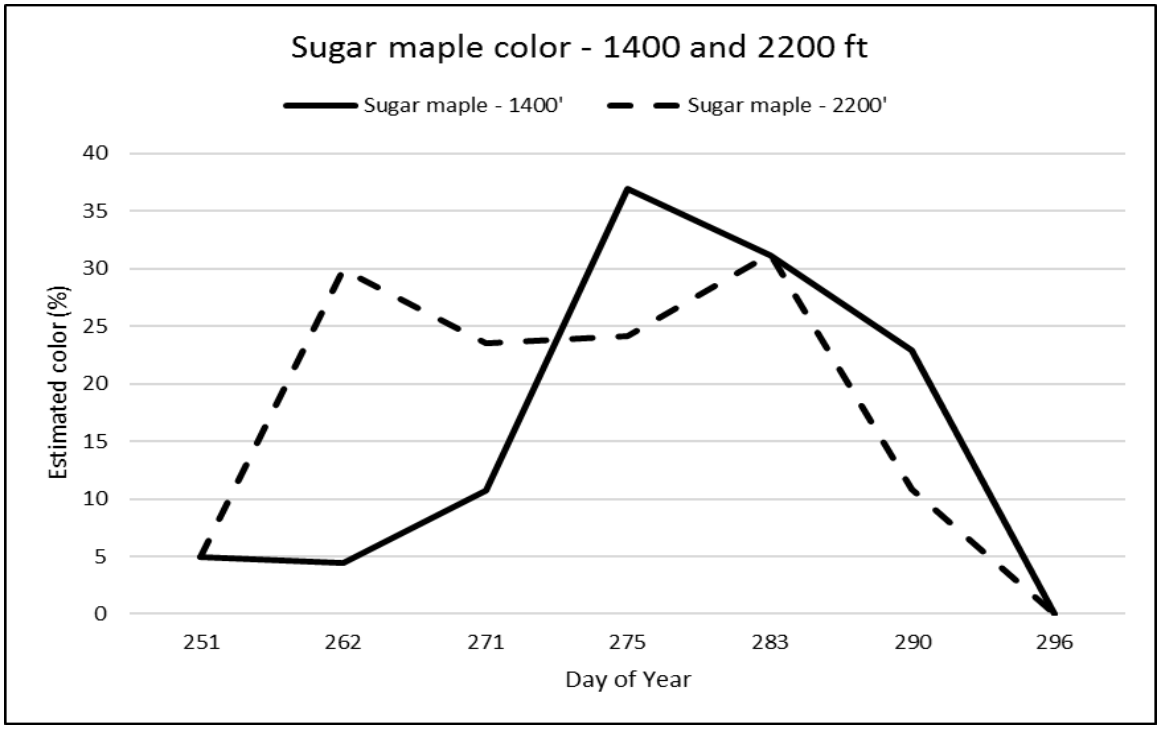


Figure 12 d.

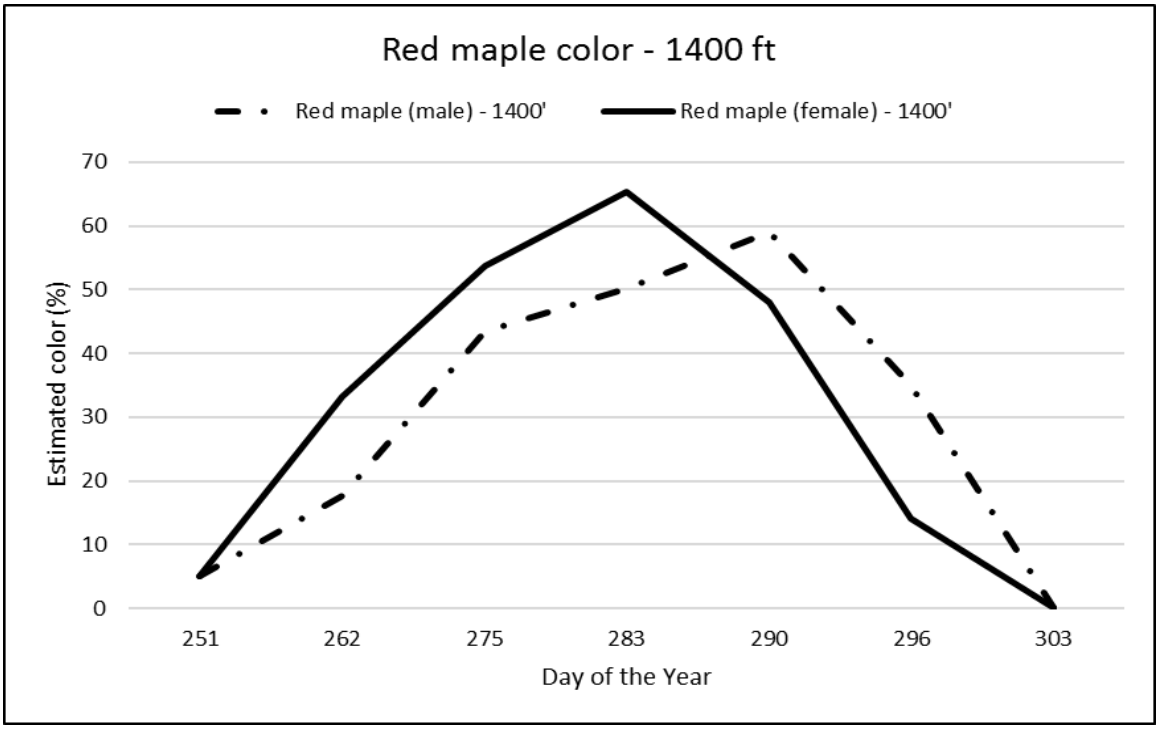


Figure 12 e.

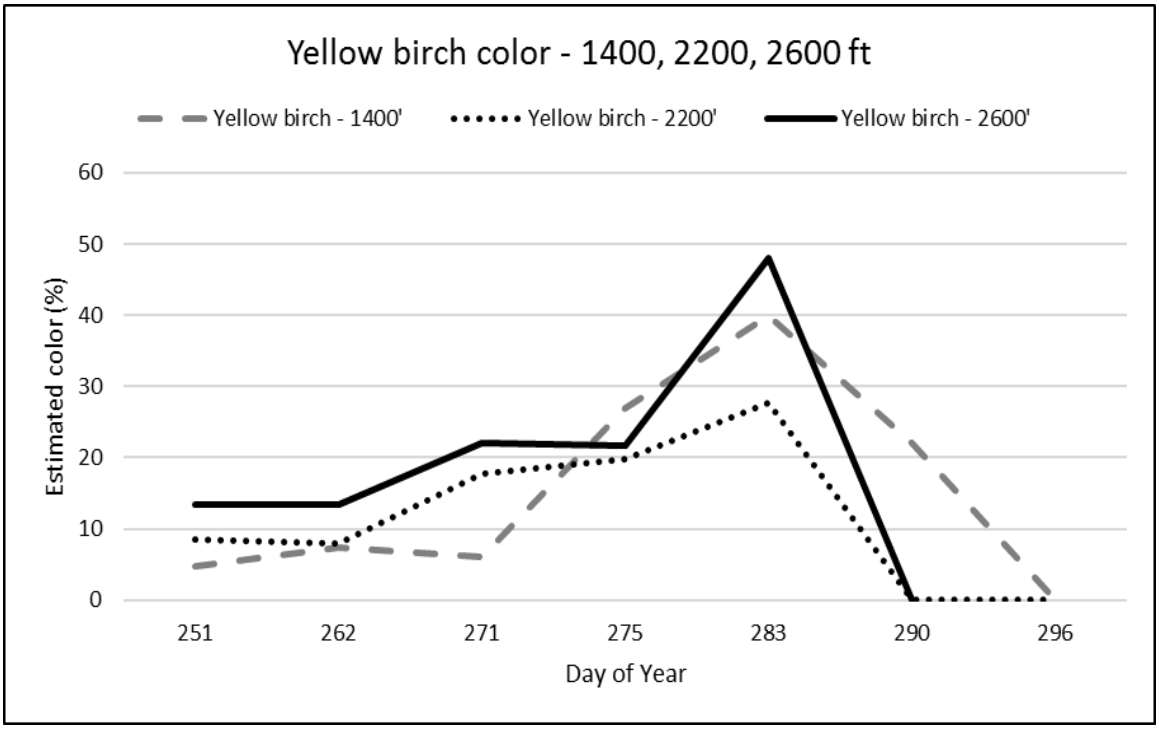


Figure 12 f.

Table 2. Estimates of peak color based on percent color and percent of foliage present for trees at three elevations on Mt. Mansfield. Lengths of long-term averages differ by species, with trees at 2600 feet having a 19-year record, red maple and white ash a 23-year record, sugar maple at 1400 feet a 27-year record, and all other trees a 26-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)	**2017 data (Day of year)**
Elevation 1400'		
Red maple (Female)	281	283
Red maple (Male)	284	290
Sugar maple	287	283
Yellow birch	285	290
White ash	279	290
Elevation 2200'		
Sugar maple	278	283
Yellow birch	276	283
Elevation 2600'		
Yellow birch	276	283
Paper birch	269	262

Table 3. Progression of leaf drop for trees at three 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 for the long-term average.

Leaf Drop					
	50% leaf drop			**> 95% leaf drop**	
	Long-term average (Day of year)	**2017 data (Day of year)**		**Long-term average (Day of year)**	**2017 data (Day of year)**
Elevation 1400'					
Red maple (Female)	289	291		300	301
Red maple (Male)	291	295		300	302
Sugar maple	290	291		303	302
Yellow birch	288	293		298	302
White ash	285	292		297	301
Elevation 2200'					
Sugar maple	282	282		295	294
Yellow birch	279	280		292	289
Elevation 2600'					
Yellow birch	278	282		290	290
Paper birch	272	262		287	283

Table 4. Average dates of sugar maple bud break, end of growing season (leaf drop) and length of the growing season 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
2016	5/9	10/31	175
2017	4/29	10/29	183
Long term Average (1991-2017)	**5/4**	**10/21**	**171**

HARDWOOD DEFOLIATORS

Forest Tent Caterpillar (FTC), *Malacosoma disstria*, populations increased statewide in 2017, with 60,588 acres of defoliation mapped during aerial surveys. This accounts for roughly 2% of the northern hardwood forest in Vermont. Acres of defoliation more than doubled this year compared to 2016, when 24,278 acres were defoliated. The footprint also expanded considerably. Although over half of the acreage was in Essex, Lamoille, and Orleans Counties, defoliation was mapped in all counties of the state in 2017 (Table 5 and Figure 13). Defoliation data are available on the ANR Natural Resources Atlas.

In late 2016 and early 2017, FPR staff assisted landowners with FTC egg mass surveys to determine the likelihood of defoliation on their property. Of the 64 sugarbushes surveyed, 32 locations were identified as at risk of defoliation.

In the spring, FPR monitored leaf development, caterpillar hatch, and defoliation at four sites in northern Vermont. Weekly data from these sites were posted on the FPR website. Hatching was first observed during the last week of April and continued into early May. Cold weather slowed hatch and leaf development, but not for long. The week of May 14th, warm temperatures made a huge difference over a three day period, and then cool weather slowed everything down again. By the last week of May, some trees were 80 - 90% defoliated, although there was substantial variability from tree to tree. By the end of the month, defoliated areas could be detected on the landscape, and caterpillars in some of these areas were observed feeding on understory beech, ferns, and hobblebush.

During aerial surveys, locations where egg mass surveys had been done over the winter were observed to determine if defoliation was easily visible. Based on these rapid evaluations, there was no significant defoliation in 87% of the sugarbushes where defoliation was not expected based on egg mass surveys. Defoliation was observed in, or close to, 62% of the unsprayed sugarbushes where defoliation was predicted (Figure 14).

Eighteen landowners made arrangements with an aerial applicator to have their sugarbushes treated with Foray 48B, a Btk product that is registered for use in certified organic production. In total, these accounted for 3,434 acres. Several additional forest landowners also had their forestland treated. Treatments were conducted on May 21, 27 and 28.

Landowners were surveyed following treatment, and of those respondents, 18% reported seeing more dead trees on their property since the beginning of the outbreak, 45% have made changes to their sugaring operation to alleviate stress on their trees, and 100% would treat again if defoliation is predicted and valued FPR involvement. As such, Forestry staff are again conducting FTC egg mass surveys in late 2017 and early 2018 in preparation for defoliation again in 2018.

FTC parasitoids known as friendly flies (*Sarcophaga aldrichi*) were reported throughout the state in areas that had experienced FTC defoliation last year. Mortality of caterpillars was also noted in early summer, likely due to viral and/or fungal infection associated with the wet weather we experienced in May and June. Pheromone traps for FTC were again deployed throughout the state in 2017, and moth capture increased from 2016 levels (Figure 15) despite the presence of natural predators. This suggests that we can expect more defoliation from FTC in Vermont in 2018.

Trees typically respond to the relatively early-season feeding by FTC by sending out a new flush of leaves. However, in both 2016 and 2017, some defoliated areas remained noticeable all summer because of a lack of refoliation. On some sites, the only visible refoliation was on ash. On sugar maple, refoliated leaves were small. The exact mechanism by which trees did not refoliate is unclear, but factors that may have contributed to this include the lingering effects of 2016 drought, heavy seed on sugar maple in 2017, and a late start of feeding this year due to wet weather. Infection by leaf fungi and dry mid-summer conditions may also have played a role. With a burst of rainfall, and continued warm temperatures, some defoliated sugar maples attempted another refoliation in late October.

Dieback and off-color leaves were observed in some locations where defoliation was heavy last year and trees were under stress from other factors. The second year of defoliation, and lack of refoliation will almost certainly affect wood production, the amount of foliage and shoot growth next year.

For more details on FTC biology and management, refer to the most recent Forest Tent Caterpillar Update.

Table 5. Mapped acres of forest tent caterpillar defoliation in 2017.

County	Acres
Addison	4,872
Bennington	3,724
Caledonia	3,927
Chittenden	11
Essex	12,088
Franklin	3,070
Grand Isle	173
Lamoille	10,154
Orange	696
Orleans	10,370
Rutland	3,537
Washington	7,111
Windham	853
Windsor	2
Total	**60,588**

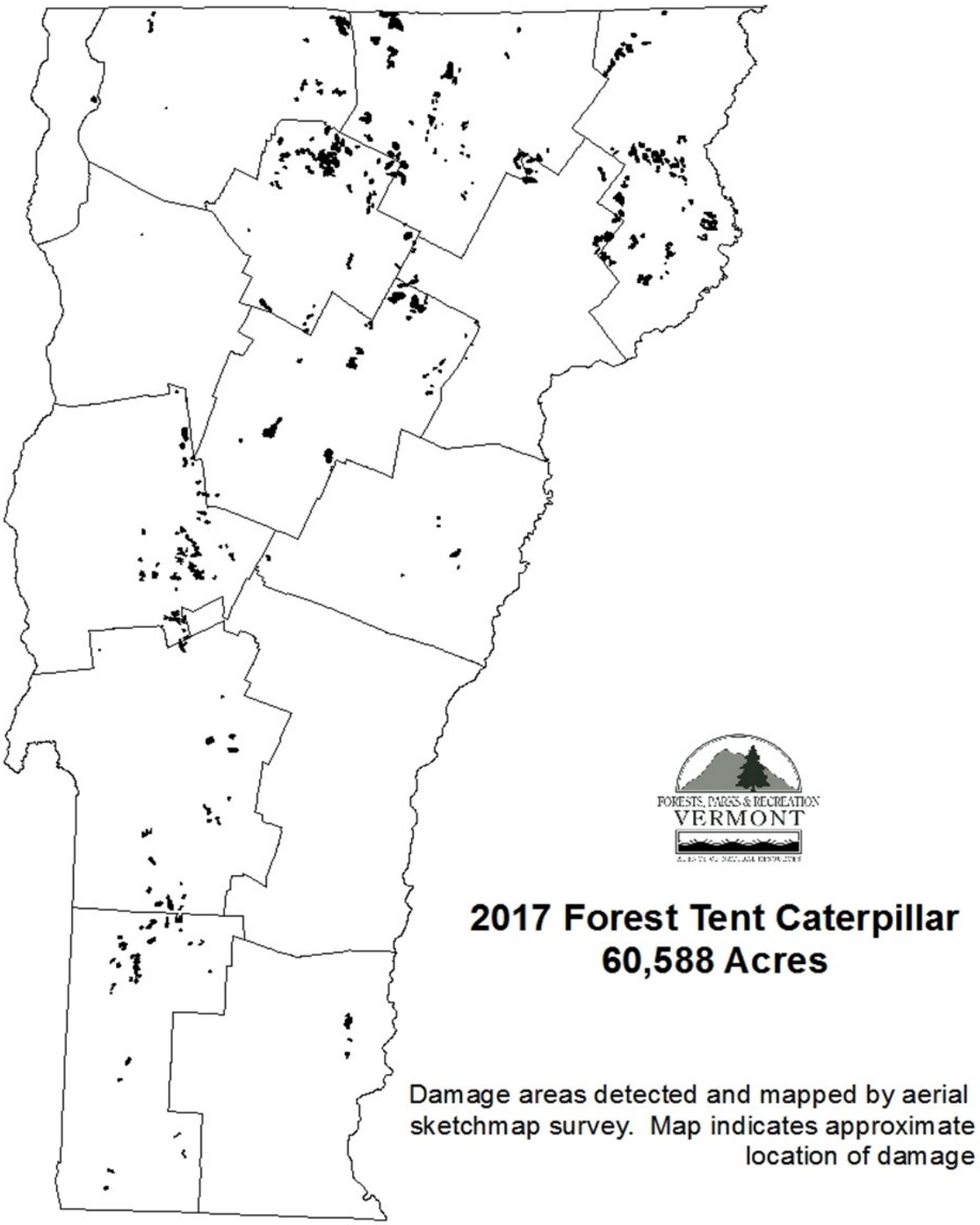
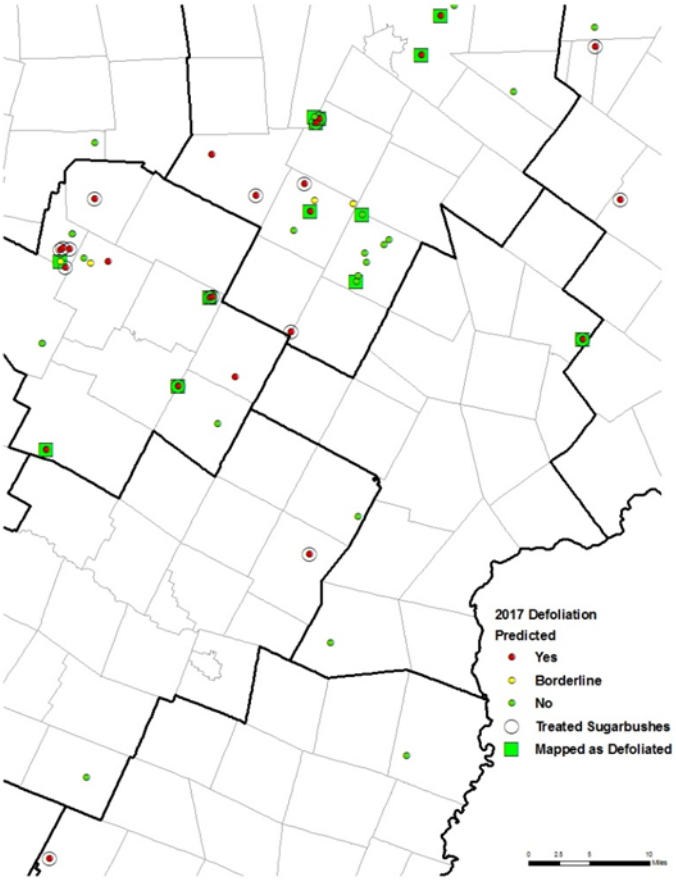


Figure 13. Forest tent caterpillar defoliation mapped in 2017. Mapped area includes 60,588 acres.



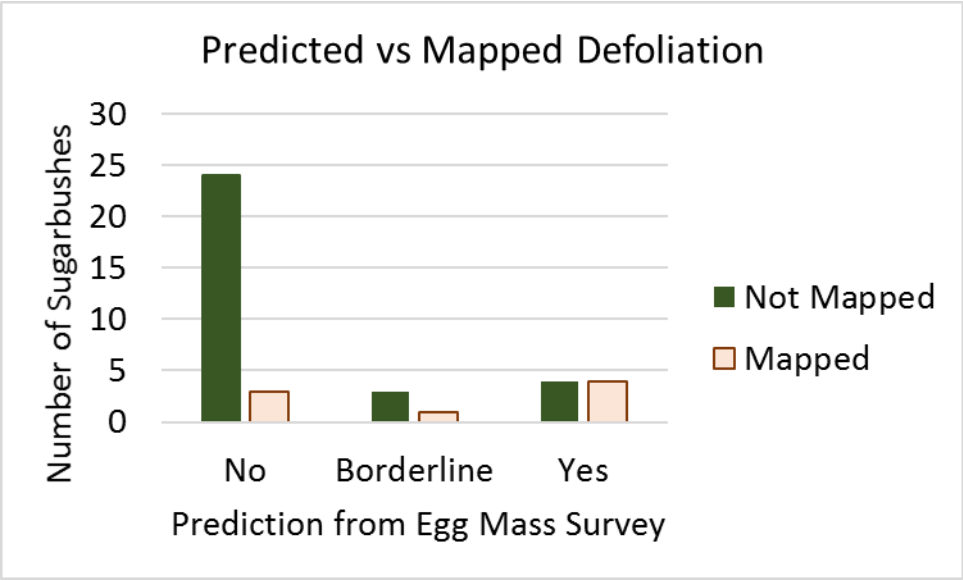


Figure 14. Predicted versus mapped defoliation by forest tent caterpillar based on egg mass surveys. Data are from 39 sugarbush locations.

Table 6. Average number of forest tent caterpillar moths caught in pheromone traps, 2002-2017. Three multi-pher pheromone traps baited with PheroTech forest tent caterpillar lures were deployed at each survey location in 2017.

Site	Year															
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Castleton	----	----	----	17	17.3	8	1	4.7	1	1.7	0.3	2.3	1.7	1.7	14.0	13.3
Fairfield (NAMP 29)	----	1.3	1.7	----	4.3	4.7	4	10.3	2.0	6	4	1.7	3.3	1.3	1.3	8.0
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	10.3	11.0
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	8.3	18.7
Manchester	----	----	----	----	----	----	0	5.7	3	1	0.7	0.3	1.3	10.3	12.0	19.3
Rochester (Rochester Mountain)	5.0	4.7	9	4.7	29	10.3	0.7	----	0.3	0	0	0	3.5	2.3	9.0	7.3
Roxbury (Roxbury SF)	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	29.0	15.0
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	7.3	29.0
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	14.3	11.3
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	3.7	9.0
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	36.3	15.7
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	13.3	28.3
Dillner Farm Montgomery	----	----	----	----	----	----	----	----	----	----	----	----	----	1.0	4.3	18.0
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**	**12.5**	**15.7**

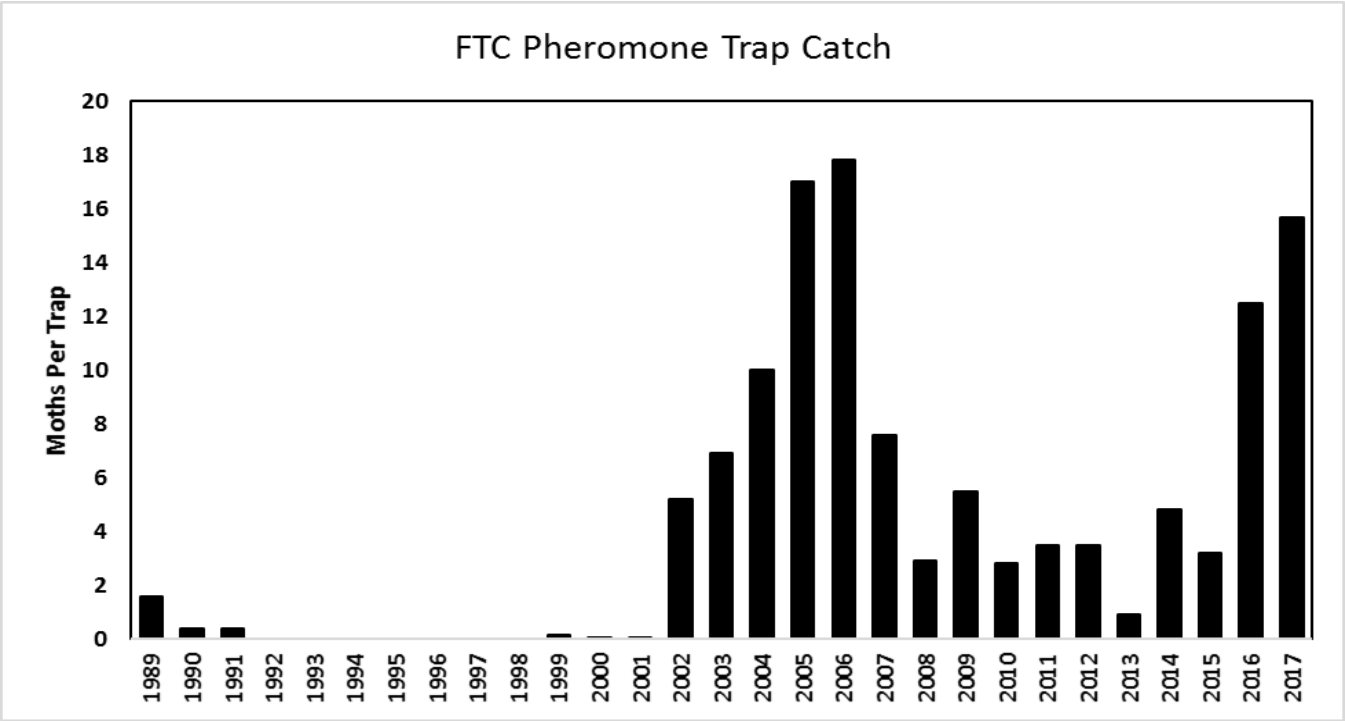


Figure 15. Average number of forest tent caterpillar moths caught in pheromone traps 1989-2017. Three multi-pher pheromone traps per site, with PheroTech forest tent caterpillar lures, were used in 2017.

Gypsy Moth, *Lymantria dispar*, caterpillars were reported in a handful of areas in 2017, including Hyde Park (on grey birch), Fayston (on ornamental plants, including sedum), Shrewsbury and Brattleboro. Overwintering egg masses are uncommon. In focal area monitoring plots, no egg masses were found (Figure 16 and Table 7).

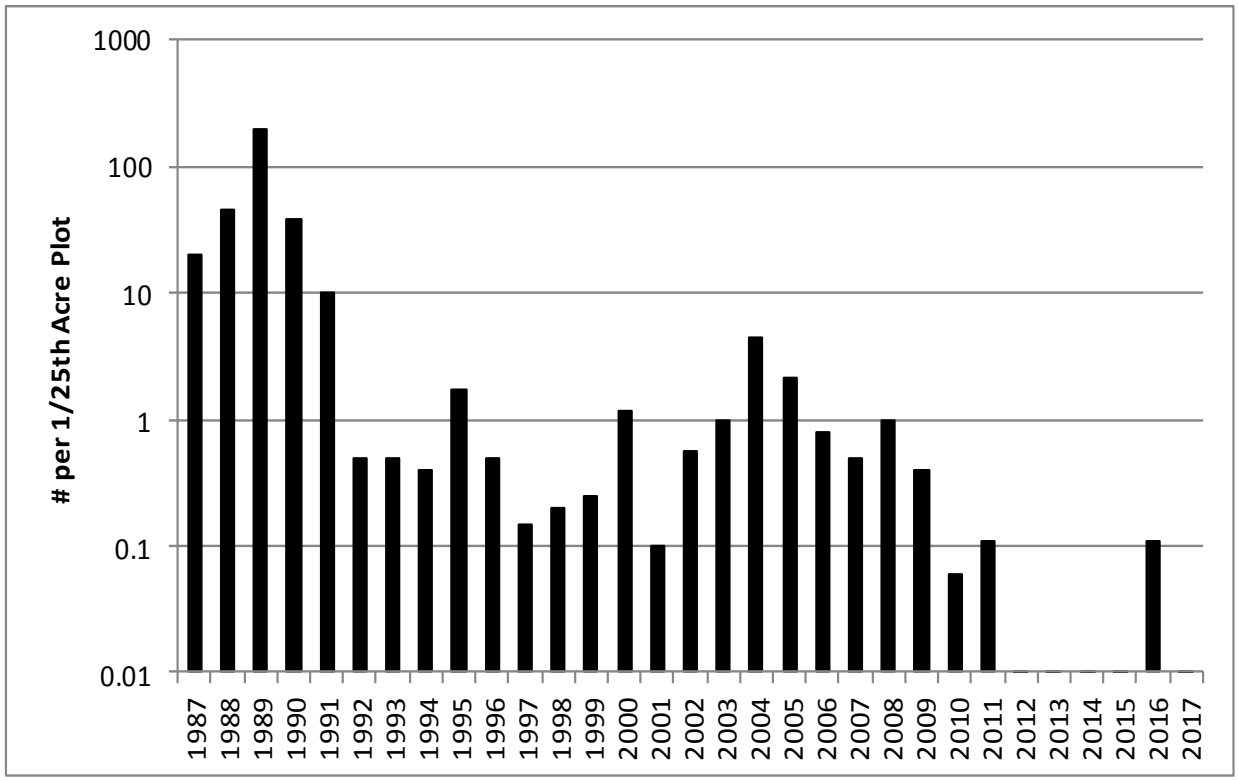


Figure 16. Number of gypsy moth egg masses per 1/25th acre in focal area monitoring plots, 1987-2017. Data reflect the average egg mass counts from ten locations, with two 15-meter diameter burlap-banded plots per location. No egg masses were found in 2017.

Table 7. Number of gypsy moth egg masses per 1/25th acre in focal area monitoring plots, 2003-2017. Counts are the average of two 15-meter burlap-banded plots per location.

Site	Town	Year														
		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Arrowhead	Milton	1.5	2.5	0	0	0	2.5	0	0	0.5	0	0	0	0	0	0
Brigham Hill	Essex	2.5	2	1.5	0	0	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	0	0
Minard's Pond	Rockingham	0.5	2	0	0	0	0	0.5	0	0	0	0	0	0	0	0
Mount Anthony	Bennington	1.5	0	0	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	0	0
Rocky Pond	Rutland	0	0	0.5	3	3	0.5	0	0	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	0	0
Tate Hill	Sandgate	0	30	18	3	0	1.5	0.5	0	0	0	0	0	0	1	0
Average		**1**	**4.4**	**2.3**	**0.8**	**0.3**	**0.8**	**0.2**	**0.06**	**0.11**	**0**	**0**	**0**	**0**	**0.11**	**0**

Saddled prominent, *Heterocampa guttivitta*, surveys continued in 2017, with 21 pheromone traps deployed. An additional 15 traps were deployed on the Green Mountain National Forest by the U.S. Forest Service. Average catch dropped from 1.2 moths per trap in both 2015 and 2016 to 0.2 in 2017 (Table 8 and Figure 17). No moths were collected at seven of the 12 sites surveyed in 2017. The map below shows locations of trap sites, and the table provides details of traps that were deployed in 2017.

Table 8. Average number of saddled prominent moths caught in pheromone traps 2014-2017. Data include location, town, county, coordinates and average number of moths per site. (NT – not trapped).

Location	Town County	Lat	Long	Ave # SP moths/ trap 2014	Ave # SP moths/ trap 2015	Ave # SP moths/ trap 2016	Ave # SP moths/ trap 2017
Gale/Orvis (USFS)	Lincoln Addison	44.15115	-72.95627	4.3	1	0	0
Hagelberg (NAMP 40)	Arlington Bennington	43.06350	-73.17630	21.3	0.7	NT	NT
Sprague (USFS)	Searsburg Bennington	42.87463	-72.91520	12	0	0	0
Willoughby S.F.	Sutton Caledonia	44.71037	-72.03990	10.3	0.3	0	0
Groton S.F.	Peacham Caledonia	44.31163	-72.28880	3.3	0	NT	NT
Honey Hollow	Bolton Chittenden	44.34702	-72.91	31	1.7	NT	NT
VMC 1400-PMRC	Underhill Chittenden	44.52405	-72.86510	10	1.3	0	0
Reed (NAMP 8)	Sheldon Franklin	44.86471	-72.87340	NT	6	5.3	0.7
Smith (NAMP 37)	Vershire Orange	43.96919	-72.34424	13	1	0	0.3
Butterfield (NAMP 39)	Topsham Orange	44.17331	-72.29451	11.7	1.7	NT	NT
Ward	Vershire Orange	43.98590	-72.37471	NT	1.7	0	0
Bartley (NAMP 6)	Derby Orleans	44.96356	-72.17170	6	NT	NT	NT
Shelton (NAMP 9)	Glover Orleans	44.70073	-72.20980	26	0.3	NT	NT
Spring Lake Ranch (NAMP 16)	Shrewsbury Rutland	43.48305	-72.90990	20	2	0.7	0.7
Smokey House (NAMP 17)	Danby Rutland	43.35054	-73.06020	47.3	1.3	NT	NT
Griffith (USFS)	Mt. Tabor Rutland	43.34283	-72.97840	4.7	1.7	0.7	0
Ascutney	Weathersfield Windsor	43.42785	-72.46550	1.3	0	NT	NT
Camp Plymouth SP	Ludlow Windsor	43.47553	-72.69430	5.7	0.3	NT	NT
Begin (USFS)	Stockbridge Windsor	43.78549	-72.78468	6.7	1	1.1	0
Harrington (USFS)	Pomfret Windsor	43.70859	-72.44882	6.7	2	2.7	0.3
Downer SF	Sharon Windsor	43.78901	-72.38104	NT	0.3	4.3	0.7
Average				**13.4**	**1.2**	**1.2**	**0.2**

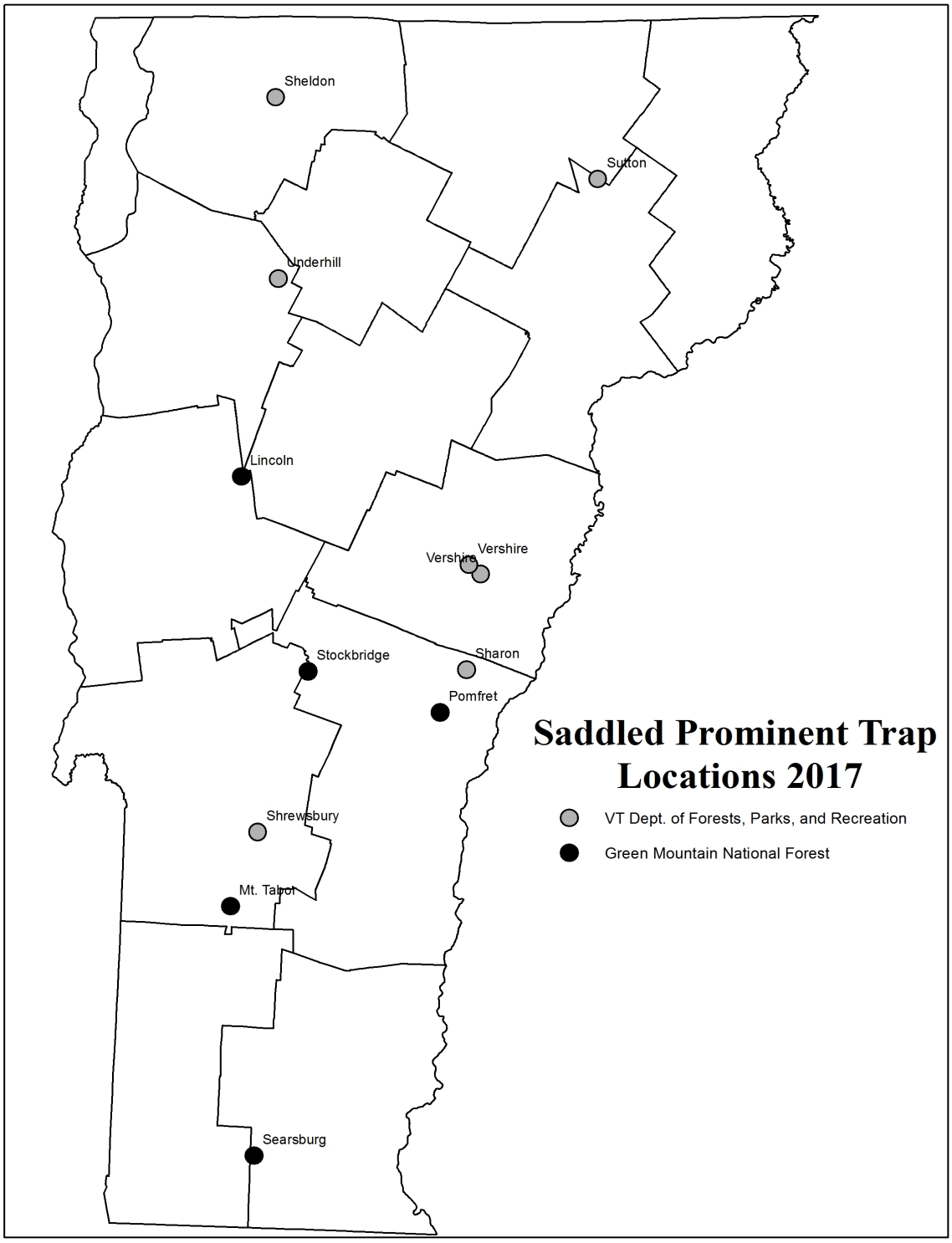


Figure 17. Location of saddled prominent pheromone traps set in Vermont in 2017 by VT FPR and the US Forest Service.

OTHER HARDWOOD DEFOLIATORS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Beech Leaftier	*Psilocorsis* sp.	Beech	Statewide	Common, but less noticeable than 2016.
Birch Leaf Folder	*Ancylis discigerana*	Yellow Birch	Statewide	Much more noticeable throughout than 2016, although no significant defoliation observed.
Birch Skeletonizer	*Bucculatrix canadensisella*	Birch	Hyde Park	Light population reported.
Browntail Moth	*Euproctis chrysorrhoea*	Hardwoods		Not observed or known to occur in Vermont. Last serious infestation in Vermont was reported in 1917.
Bruce Spanworm	*Operophtera bruceata*	Sugar maple, aspen, beech and other hardwoods	Statewide	No feeding reported and few moths observed.
Cherry Scallop Shell Moth	*Hydria prunivorata*	Cherry	Statewide	Individual nests observed in widely scattered locations.
Dogwood Sawfly	*Macremphytus tarsatus*	Dogwood	Swanton	Observed on ornamental.
Eastern Tent Caterpillar	*Malacosoma americanum*	Cherry and apple	Statewide	Variable reports; fewer nests observed in Addison, Chittenden, Franklin, Windham and Windsor Counties, more in Caledonia and Orleans Counties, and stable populations elsewhere.
Euonymus Caterpillar	*Yponomeuta cagnagella*	Euonymus	Bethel	Extensive defoliation on specific trees.
European Snout Beetle	*Phyllobius oblongus*	Sugar Maple	Bridgewater, Hartland	Light feeding.
Fall Webworm	*Hyphantria cunea*	Hardwoods	Statewide	Only light damage, similar to 2016.

OTHER HARDWOOD DEFOLIATORS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Forest Tent Caterpillar	*Malacosoma disstria*			See narrative.
Green-striped Mapleworm	*Dryocampa rubicunda*	Sugar Maple	Albany, Lincoln	Larvae occasionally observed.
Gypsy Moth	*Lymantria dispar*			See narrative.
Hickory Tussock Moth	*Lophocampa caryae*	Hardwoods	Newfane, Shrewsbury and elsewhere.	Individual larvae observed.
Imported Willow Leaf Beetle	*Plagiodera versicolora*	Willow	Bennington County	Although 45 acres of heavy defoliation were observed from the air, generally less common than 2015.
Japanese Beetle	*Popillia japonica*	Many	Statewide	Widely scattered. Heavy damage observed on ornamentals in northeastern VT.
Locust Leafminer	*Odontata dorsalis*	Black Locust	Statewide	Areas of heavy defoliation in mid-summer; increase from 2016.
Maple Leaf Cutter	*Paraclemensia acerifoliella*	Sugar Maple	Statewide	Similar to 2016. Remains very noticeable, with damage ranging from light and restricted to lower foliage to extensive and heavy. Observed in NAMP Plots, especially areas defoliated by FTC.
Maple Trumpet Skeletonizer	*Catastega aceriella*	Sugar maple	Statewide	Variable, ranging from mostly light to heavier in the northern part of the state.

OTHER HARDWOOD DEFOLIATORS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Maple Webworm	*Pococera asperatella*	Sugar Maple	Statewide	Very noticeable, although feeding still classified as light (<30% defoliation). Noted in stands defoliated by FTC.
Mountain Ash Sawfly	*Pristiphora geniculata*	Mountain Ash	Barre City	On ornamental.
Oak Slug Sawfly	*Caliroa quercuscoccineae*	Red oak	Rutland	Light feeding in upper to mid canopy of small ornamental.
Orange-humped Mapleworm	*Symmerista leucitys*	Maples	Elmore, Northfield Rupert, Springfield	In some locations, observed in FTC outbreak areas.
Red-headed Flea Beetle	*Systena frontalis*	Ornamentals	Colchester	Numerous on ornamentals.
Red-humped Caterpillar	*Schizura concinna*	Apple	Huntington	Minor feeding.
Red-humped Oakworm	*Symmerista canicosta*	Oak	Brattleboro, Rockingham, Springfield, Westminster	Numerous larvae observed in September associated with light defoliation and noticeable leaf fragments on the ground.
Saddled Prominent	*Heterocampa guttivata*	Sugar maple		See narrative.
Satin Moth	*Leucoma salicis*	Poplar	Statewide	Defoliation in widely scattered locations. Heaviest damage observed along roadsides and from the air in central Vermont.
Variable Oakleaf Caterpillar	*Lochmaeus manteo*	Oak	Brattleboro	Individual larva.

OTHER HARDWOOD DEFOLIATORS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
White-marked Tussock Moth	*Orgyia leucostigma*	Various	Scattered	Individual larvae reported from a number of locations.
Winter Moth	*Operophtera brumata*	Hardwoods		Not known to occur in Vermont.

Hardwood defoliators not reported in 2017 include Apple and Thorn Skeletonizer, *Choreutis pariana;* Elm Sawfly, *Cimbex americana* ; Large Aspen Tortrix, *Choristoneura conflictana* ; Mimosa webworm, *Homadaula anisocentra* ; Oak Shothole Leafminer, *Japanagromyza viridula* ; Oak Skeletonizer, *Bucculatrix ainsliella* ; Oak Slug Sawfly, *Caliroa quercuscoccineae* ; Rose Chafer, *Macrodactylus subspinosa* ; Spiny Oak Sawfly, *Periclista* sp.; Uglynest Caterpillar, *Archips cerasivorana,* Viburnum Leaf Beetle, *Pyrrhalta viburni.*

SOFTWOOD DEFOLIATORS

Spruce Budworm, *Choristoneura fumiferana*, moth trap catches in Vermont remain low. Traps were deployed in Caledonia, Chittenden, Essex and Orleans Counties in 2010-2017. A total of five moths was collected in 2017, three in traps in Underhill and one each from Norton and Holland (Figures 18 and 19, Table 9). We do not anticipate defoliation by the spruce budworm in 2018.

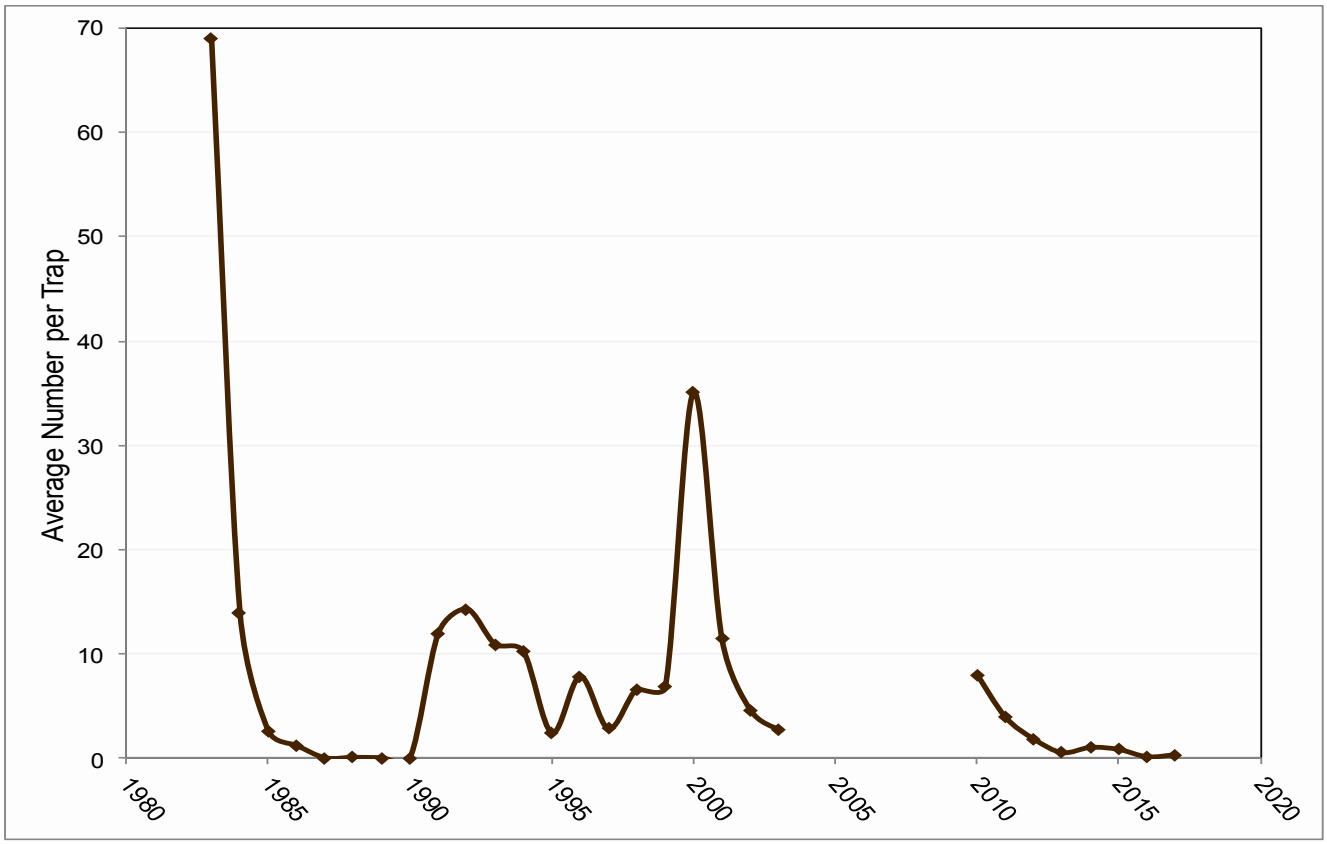
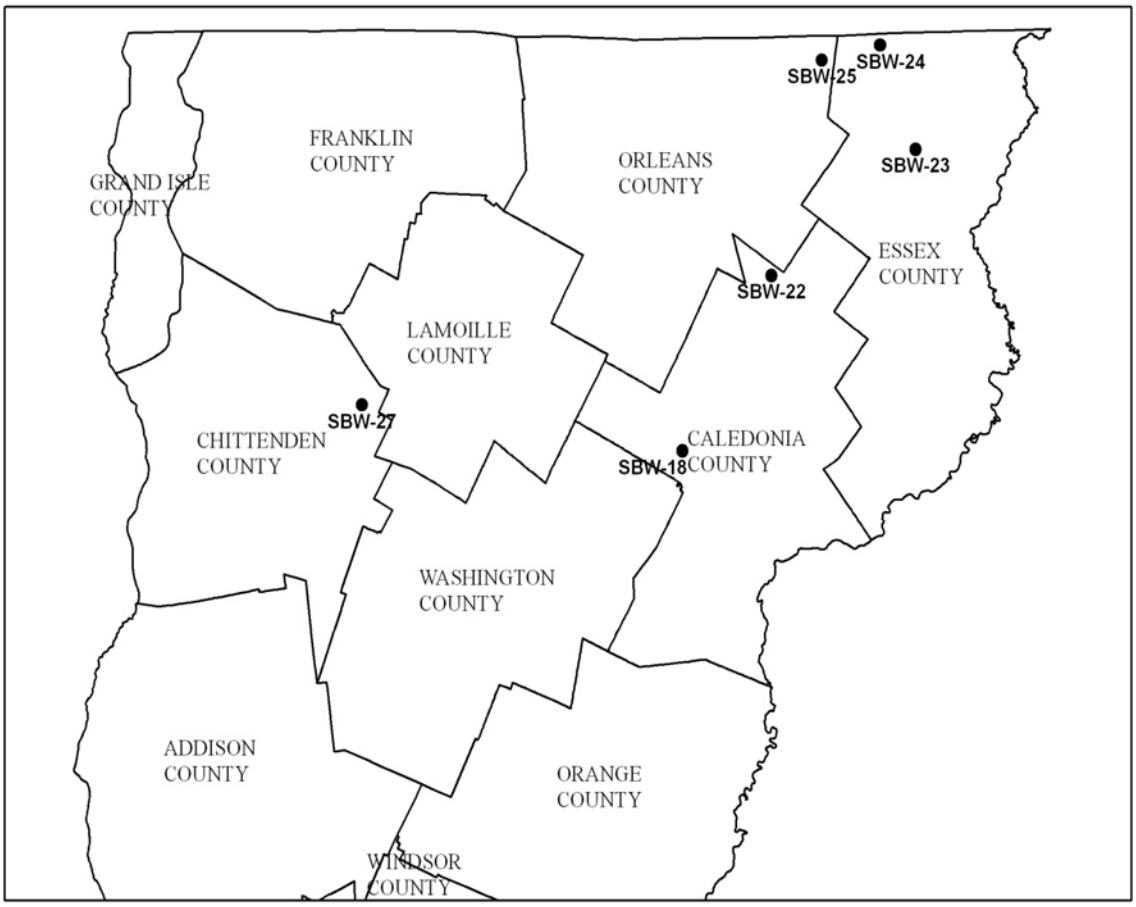


Figure 18. Average number of spruce budworm moths caught in pheromone traps 1983-2017. Trapping was discontinued, 2004-2009. Average of six locations in 2017.

Table 9. Average number of spruce budworm moths caught in pheromone traps, 1991-2017. Trapping had been discontinued 2004-2009. There were 3 traps per location, one location per town in 2017.

County and Town	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2010	2011	2012	2013	2014	2015	2016	2017
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	0.3	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	0	0.3
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	0	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	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	0	1
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	0	0
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	0.1	0.3

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 19. Locations of spruce budworm pheromone traps in 2017. Coordinates are NAD83.

OTHER SOFTWOOD DEFOLIATORS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Arborvitae Bagworm	*Thyridopteryx ephemeraeformis*	Arborvitae	Grand Isle	Observed this fall in 3 locations on Grand Isle on trees imported from out-of-state. The bagworms had successfully overwintered in one site, but do not appear to be established on local native trees. Bagworms are not thought to be able to successfully overwinter in northern climes but with milder winters this insect may become more of a pest.
Eastern Spruce Budworm	*Choristoneura fumiferana*	Balsam fir and spruce	Statewide	See narrative.
Fall Hemlock Looper	*Lambdina fiscellaria*	Hemlock	Woodstock Underhill Plainfield	Moths reported as common in some locations.
Imperial Moth	*Eacles imperialis pini*		Bristol	Observed in a driveway August 22, just after the partial solar eclipse.

Softwood defoliators not reported in 2017 included Arborvitae Leafminer, *Argyresthia thuiella* ; Balsam Fir Sawfly, *Neodiprion abietus* ; European Pine Sawfly, *Neodiprion sertifer,* Larch Casebearer, *Coleophora laricella* , Introduced Pine Sawfly, *Diprion similis;* Spruce Needleminer, *Taniva albolineana* ; Yellow-headed Spruce Sawfly, *Pikonema alaskensis* ; White Pine Sawfly, *Neodiprion pinetum.*

SAPSUCKING INSECTS, MIDGES, AND MITES

Balsam Woolly Adelgid (BWA), *Adelges piceae***,** infestations have collapsed in some areas, but new fir mortality is continuing, mostly where decline has been observed previously, and there are some pockets of heavy mortality. BWA is still noticeable in occasional ornamental plantings (southern Vermont) and Christmas tree plantations (Canaan). Populations are less noticeable in native stands.

During 2017 aerial surveys, 1,641 acres of fir dieback and mortality attributed to BWA were mapped as compared to 5,615 in 2016 (Table 10 and Figure 20).

For more information, a leaflet entitled "Balsam Woolly Adelgid" can be found on the Vermont Forest Health website.

Table 10. Mapped acres of balsam woolly adelgid-related decline in 2017.

County	Acres
Caledonia	412
Essex	20
Lamoille	13
Orange	320
Orleans	399
Rutland	122
Washington	279
Windham	4
Windsor	72
Total	**1,641**

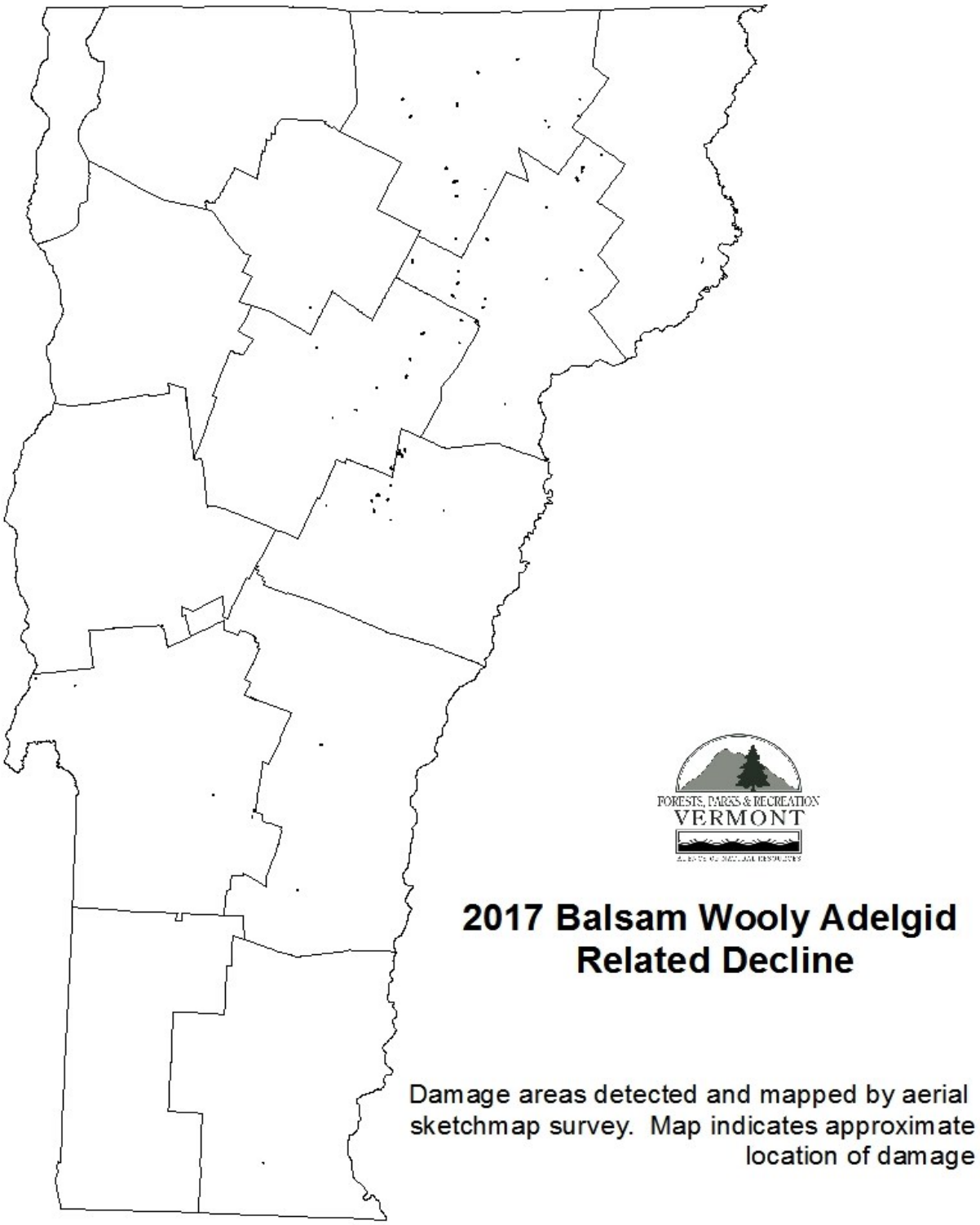


Figure 20. Balsam wooly adelgid related decline mapped in 2017. Mapped area includes 1,641 acres.

Elongate Hemlock Scale (EHS), *Fiorinia externa*, has been noticed in Windham County with increasing frequency. The combination of EHS, which was not known to be established in Vermont prior to 2014, hemlock woolly adelgid, and the 2016 drought has resulted in tree decline in a few locations.

Hemlock Woolly Adelgid (HWA), *Adelges tsugae*, continues to be a threat to hemlocks in Southern Vermont. The infestation remains centered primarily in Windham County, with small spots in Springfield and Pownal. The detection of HWA just south of Lake George in New York in 2017 poses an additional threat to western Vermont.

During the winter of 2016-2017, 30 sites in 10 high risk towns were surveyed. No spread of the infestation to new towns was observed. Six survey sites were positive for HWA. Eleven volunteers logged 78 hours and did a significant portion of the survey work (Table 11).

Towns currently known to be infested include: Brattleboro, Brookline, Dummerson, Grafton, Guilford, Halifax, Jamaica, Marlboro, Newfane, Putney, Rockingham, Townshend, Vernon, Wardsboro, Westminster, and Whitingham in Windham County; Pownal in Bennington County and Springfield in Windsor County.

HWA winter mortality study is evaluated towards the end of March at four sites. Enough branches are collected to yield well over 200 adelgids. They are inspected in the lab to determine if alive, recently dead or long dead. The mortality rate for the winter of 2016-2017 was 66%. This is well below the threshold of 91 or 92 percent that seems to limit spread. The three previous winters had rates of 97 to 99 percent and there was no noticeable spread of the infestation boundary (Table 12 and Figure 21).

Volunteers assisted with the winter mortality study and also helped to mark study branches, do field counts and then collect samples for the sisten/progredien density study. Field work was done at the Townshend site in February and June 2017 and sent to Virginia Tech for inclusion with similar data from other eastern states.

In 2017, we received multiple calls about sick or suddenly dying hemlocks in Windham and Windsor Counties. In many cases, drought response was the most likely explanation for the decline.

Table 11. Number of sites inspected for the presence of hemlock woolly adelgid (HWA) by visual survey, winter 2016-2017, including number of sites where HWA was detected.

County	Town	Number of sites inspected	Number of sites positive for HWA
Windham	Grafton	1	0
	Rockingham	6	3
	Westminster	2	1
	Londonderry	3	0
Windsor	Springfield	8	2
	Weathersfield	3	0
	Chester	2	0
Bennington	Woodford	1	0
	Stamford	2	0
	Bennington	2	0
TOTAL		**30**	**6**

Table 12. Assessment of hemlock woolly adelgid winter mortality over the winter of 2016-2017. Data from four assessment sites include location, date hemlock wooly adelgid samples were collected, number of dead and live adelgids, and percent mortality.

Site	Date	No. alive	No. dead	Percent Mortality
Vernon	3/20/17	233	562	71
Cersosimo	3/20/17	40	779	95
Townshend	3/20/17	671	747	53
Jamaica	3/20/17	472	390	45

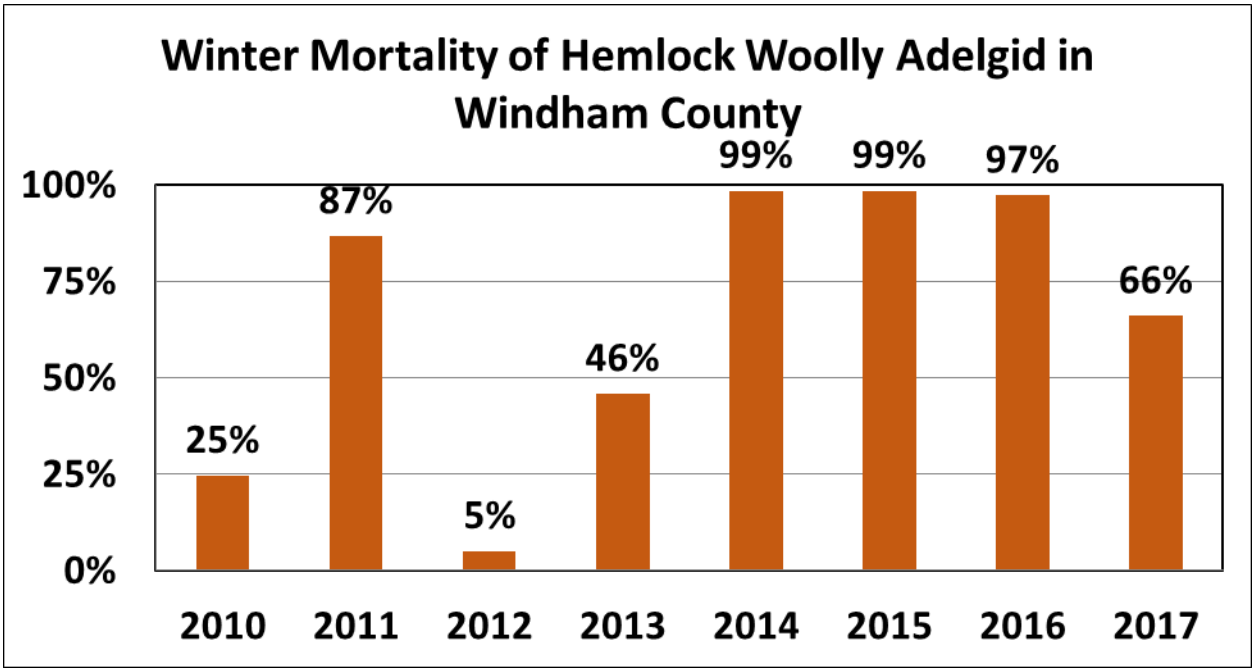


Figure 21. Average overwintering mortality of hemlock woolly adelgid at four sites in Windham County 2010-2017.

Maintenance work was conducted on all five HWA impact plots. Monitoring on these plots will be done every other year and staggered. This year, two plots were done; three will be undertaken next year. On the plots at Roaring Brook Wildlife Management Area and the Guilford Visitor Center, DBH was re-measured and crowns were reassessed for live crown ratio, crown density and crown transparency. Re-production was also tallied.

Monitoring for *Laricobius nigrinus* (Ln) adult beetles is done on mild winter days in November and December. No Ln were found in 2017 in any of the release sites: Pownal, Vernon and Brattleboro. To augment the population at the Brattleboro site, 468 Ln beetle adults that had been field collected in North Carolina were released in late November. Monitoring efforts will be expanded this coming spring to look for Ln larvae.

Numerous outreach activities were conducted, many through volunteers and Forest Pest First Detectors, in the form of articles, public presentations, displays at town meeting, parades, county fairs, etc. A new discovery of HWA in NY's Adirondack State Park stimulated a wave of new interest. FPR staff were interviewed for newspaper articles and television coverage.

Early surveys for the 2017-2018 season revealed settled sistens that were alive, but still aestivating. Consequently, it is likely that reports of spread are expected in 2018.

Pear Thrips, *Taeniothrips inconsequens*, damage was noticeable, and numbers in our only monitoring plot are up compared to the last 2 years. Damage was still mostly light, and mixed with frost, fungus disease and other defoliators. Pollen increases thrips fecundity, so the heavy flower production may produce a lot more thrips next spring.

This year, pear thrips emergence began April 17, as indicated on yellow sticky traps at our long-term monitoring site at Proctor Maple Research Center in Underhill. Counts totaled 334 in 2017. The highest numbers were present the first week of May, averaging just over 23 insects per trap. Emergence was complete by June 12 (Table 13 and Figure 22).

Table 13. Pear thrips counts on yellow sticky traps at Proctor Maple Research Center in Underhill, VT in 2017. Sticky traps are deployed in sets of four. Traps are evaluated and replaced each week and monitored throughout pear thrips emergence.

Sample dates	Counts
4/10-4/17	49
4/17-4/21	12
4/21-5/4	91
5/4-5/12	94
5/12-5/19	56
5/19-5/26	25
5/26-6/12	7
Total	**334**

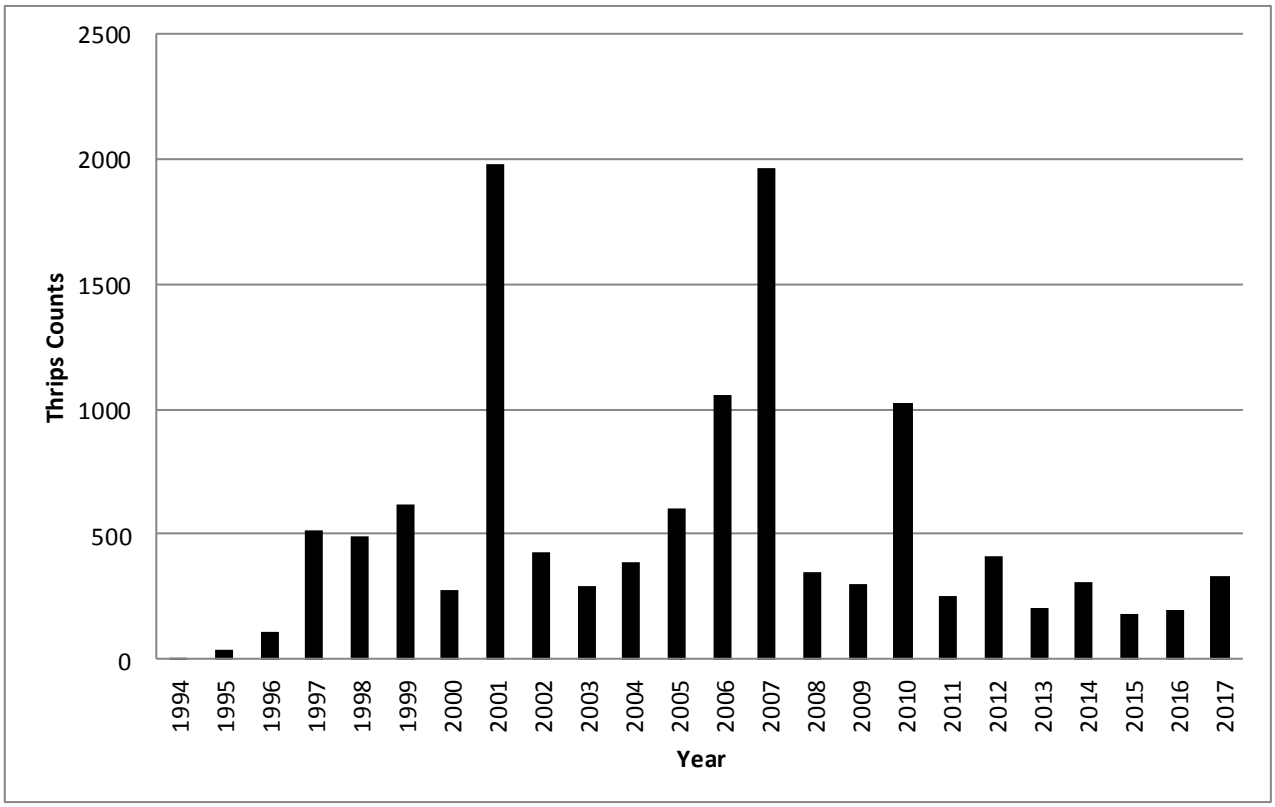


Figure 22. Total number of thrips collected at Proctor Maple Research Center in Underhill, VT on sets of four sticky traps, 1993-2017.

Red Pine Scale, *Matsucoccus resinosae*, was not detected in any stands visited in 2017, but reports of red pine mortality continued in 2017, with 516 acres mapped, scattered in seven counties. (Table 14 and Figure 23). Red pine scale, detected in 2015 in Rutland and Orange Counties, continues to be a suspect, although it remains premature to say that it is the sole cause of this red pine mortality. It's possible that cold winters have knocked scale populations back. It's also possible that the decline in these stands is not related to red pine scale. Pests that were observed included Diplodia shoot blight and pine gall weevil.

Table 14. Mapped acres of red pine decline in 2017. Red pine scale continues to be a suspect, but the causal agent and/or contributing factors of the mortality remain under investigation.

County	Acres
Caledonia	99
Franklin	47
Lamoille	17
Orange	154
Washington	101
Windham	27
Windsor	71
Total	**516**

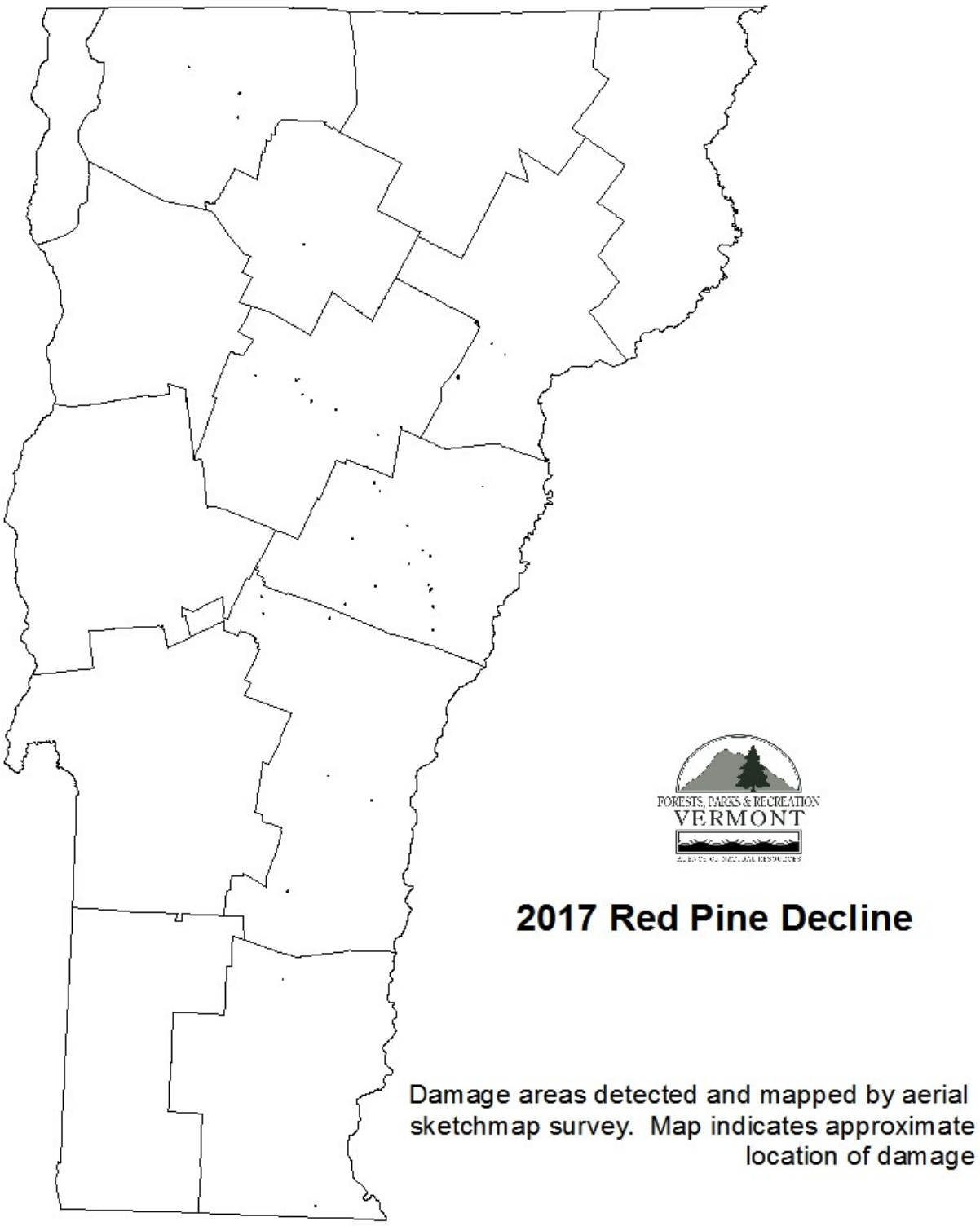


Figure 23. Red pine decline mapped in 2017. Mapped area includes 516 acres.

OTHER SAPSUCKING INSECTS, MIDGES, AND MITES

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Ash Flowergall Mite	*Aceria fraxiniflora*	Ash	West Haven	Light, scattered damage.
Balsam Woolly Adelgid	*Adelges piceae*	Balsam fir and Fraser fir	Statewide	See narrative.
Beech Scale	*Cryptococcus fagisuga*	Beech	Statewide	See Beech Bark Disease narrative.
Boxelder Bug	*Leptocoris trivittatus*	Boxelder	Scattered	Usual number of reports of "nuisance" bugs in and around homes; no damage to trees reported.
Brown Marmorated Stink Bug	*Halyomorpha halys*	Wide variety of hosts, including apples	Burlington, Vergennes	No damage observed. Records from past years include Bennington, Chittenden, Lamoille, Washington, Windham and Windsor Counties.
Eastern Spruce Gall Adelgid	*Adelges abietis*	Spruce	Scattered reports, including Bristol, Shelburne and Wilmington	More obvious than in recent past.
Elongate Hemlock Scale	*Fiorinia externa*	Hemlock, Korean fir	Windham County; ornamental Korean fir in Charlotte	See narrative.
Hemlock Woolly Adelgid	*Adelges tsugae*	Hemlock	Windham, Bennington and Windsor Counties	See narrative.
Magnolia Scale	*Neolecanium cornuparvum*	Magnolia	Williston	Light infestation.
Oystershell Scale	*Lepidosaphes ulmi*	Beech	Rupert	Heavy populations on individual understory twigs. No dieback observed.

OTHER SAPSUCKING INSECTS, MIDGES, AND MITES

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Pear Thrips	*Taeniothrips inconsequens*	Hardwoods	Statewide	See narrative.
Pine Bark Adelgid	*Pineus strobi*	White pine	Milton	Light populations.
Red Pine Scale	*Matsucoccus resinosae*			See narrative. Also see Red Pine Decline.
Woolly Alder Aphid	*Paraprociphilus tessellatus*	Alder	Morgan	Lakeside trees.

Sapsucking Insects, Midges and Mites that were not reported in 2017 include Balsam Gall Midge, *Paradiplosis tumifex* ; Balsam Twig Aphid, *Mindarus abietinus* ; Cinara Aphids, *Cinara* sp.; Conifer Root Aphid, *Prociphilus americanus* ; Gouty Vein Midge, *Dasineura communis* ; Grape Phylloxera, *Daktulosphaira vitifoliae;* Green Stink Bug, *Chinavia hilaris;* Pine Leaf Adelgid; *Pineus pinifoliae;* Pine Needle Scale, *Chionapsis pinifoliae* ; Pine Spittlebug, *Aphrophora parallela* ; Spruce Spider Mite; *Oligonychus ununguis* ; Woolly Elm Aphid, *Eriosoma americanum.*

BUD AND SHOOT INSECTS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Common Pine Shoot Beetle	*Tomicus piniperda*	Pines	Barre and Island Pond	Trapped by APHIS. Since first detected in 1999, has been found in many counties. Under federal quarantine, but pine is free to move through most of the northeast.
Oak Twig Pruner	*Anelaphus parallelus*	Red oak	Statewide	Similar to 2016, except less noticeable in Southern Vermont.
Pine Gall Weevil	*Podapion gallicola*	Red pine	Rutland and Orange Counties	Found in declining trees that were surveyed for the presence of red pine scale.
White Pine Weevil	*Pissodes strobi*	White pine and Colorado blue spruce	Statewide	Damage to young conifers remains low.

Bud and Shoot Insects not reported in 2017 included Balsam Shootboring Sawfly, *Pleroneura brunneicornis.*

ROOT INSECTS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Broadnecked Root Borer	*Prionus laticollis*	Various	Brattleboro and elsewhere	Specimen found in swimming pool; most inquiries about these insects result from the appearance of the large adult beetles.
Dog day cicada	*Neotibicen canicularis*	Soil	Burlington	Surprise for a homeowner.
Japanese Beetle	*Popillia japonica*	Many	Scattered throughout	Heavy in scattered locations, but generally few reports than in the recent past.
June Beetle	*Phyllophaga* spp.	Many	Scattered	Few reports were received in 2017.

Root Insects not reported in 2017 included Conifer Root Aphid, *Prociphilus americanus* ; Conifer Swift Moth, *Korsheltellus gracillis* .

BARK AND WOOD INSECTS

Asian Longhorned Beetle (ALB), *Anoplophora glabripennis*, was not observed and is not known to occur in Vermont and no forest management changes are recommended in anticipation of the insect. Nonetheless, education and outreach that can promote early detection remain a priority. Early detection is particularly important with the Asian longhorned beetle, since small, newly-discovered populations can be successfully eradicated.

As part of our invasive pest preparedness, an interagency ICS exercise was held in June to help prepare for future invasive pest invasions. The tabletop exercise was facilitated by USDA APHIS, and included four other agencies, in a run-though of a simulated Asian longhorned beetle detection. An update to Vermont's Invasive Pest Response plan is under review.

Emerald Ash Borer (EAB), *Agrilus planipennis*, is not known to occur in Vermont and was not detected by survey. However, new counties were found to be infested in Massachusetts, eastern New York, and New Hampshire in 2017. The insect is now reported from thirty-one states. Anyone using ash products from infested states should be aware of current regulations. Information is available by contacting USDA APHIS, AAFM, or an FPR office. As of December 2017, five counties in New Hampshire, and all of New York, Connecticut and Massachusetts are included in the emerald ash borer quarantine area.

The emerald ash borer detection effort continues in Vermont. USDA APHIS continued its statewide survey by deploying 214 purple traps throughout Vermont. We follow-up on all suspects, and conducted on-site inspections at ten locations where dying ash were observed or reported.

Firewood Program: Invasive insects, like the emerald ash borer and Asian longhorned beetle, can live inside firewood and are unknowingly transported to new locations where they will emerge as adults and start new infestations. The impacts from such infestations are devastating to the environment, economy, and society.

State Parks Firewood Exchange Project: The 2017 camping season was the 9th year that Vermont State Parks exchanged firewood. This year the total number of firewood bags collected from campers who brought firewood in from out-of-state was 27. This number of bags is slightly less than one half the amount collected last year (Table 15.)

The State Parks that collected firewood this year include: Elmore (12 bags), Little River (4 bags), Smugglers Notch (2 bags), Townshend (7 bags) and 1 bag each from Branbury and Jamaica. Firewood brought into Vermont State Parks this year came from: New York, Massachusetts, Connecticut, New Hampshire, Maine, and Quebec. Forest Protection staff opened and examined all the bags of firewood collected. No evidence of invasive pests were found.

Table 15. Numbers of bags of firewood brought into Vermont State Parks during the 2009-2017 camping seasons. From 2009-2012, firewood from over 50 miles away was exchanged. Since 2013, wood has been exchanged if it was brought in from out of state.

Year	Number of Bundles of Firewood
2009	212
2010	379
2011	158
2012	136
2013	148
2014	51
2015	46
2016	64
2017	27

The Rule Governing the Importation of Untreated Firewood into the State of Vermont has been in effect since May 2016. We continue to focus on outreach, so firewood users are aware of this rule. UVM Extension has been a partner in this effort along with Vermont Agency of Agriculture, Food, and Markets, Animal and Plant Health Inspection Service (APHIS), and the National Don't Move Firewood. A focus in 2017 was a campaign to support private campground owners, supplying educational materials and suggested best management practices for preventing the movement of firewood. Don't Move Firewood information is also available through the vtinvasives website.

Currently six waivers are in effect allowing importation of untreated firewood from adjacent counties in New Hampshire. One additional waiver allows importation of firewood from an adjacent county in NY, provided the firewood complies with the emerald ash borer quarantine. Three additional requests were received from New York, but the requester chose not to follow through, given the EAB quarantine restrictions.

One enforcement action was taken by DEC. Untreated firewood imported from Massachusetts was confiscated and destroyed off-site.

Exotic Wood Borer/Bark Beetle National Survey: In 2017, staff with the USDA APHIS Plant Protection and Quarantine (PPQ) and the Vermont Agency of Agriculture, Food and Markets (VAAFM) deployed traps for exotic woodboring beetles. Trap catches were submitted to the Carnegie Museum for identification. Sirex woodwasp (*Sirex noctilio*) was the only targeted insect collected, and it was found in four traps (Table 16).

Table 16. Target insects collected by USDA APHIS and VAAFM in Vermont as part of the Exotic Wood Borer/Bark Beetle National Survey.

Target	County	Collection Dates	Trap Type	Lure Combo	Agency
Sirex noctilio	Chittenden	8/17/16-8/31/2016	Lindgren	Alpha-pinene, UHR Ethanol, Monochamol	VAAFM
Sirex noctilio	Chittenden	8/31/2017-9/14/2017	Lindgren	Alpha-pinene, Ethanol UHR	VAAFM
Sirex noctilio	Chittenden	8/31/2017-9/14/2017	Lindgren	Alpha-pinene, Ethanol UHR	VAAFM
Sirex noctilio	Rutland	8/31/2017-9/13/2017	Lindgren	Alpha-pinene, Ethanol UHR	VAAFM

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.
Black and Red Horntail	*Urocerus cressoni*	Firewood	Wolcott	Encountered while splitting firewood.
Black Spruce Beetle	*Tetropium castaneum*	Spruce, pine, fir and larch		Not observed or known to occur in Vermont.
Bronze Birch Borer	*Argrilus anxius*	Birch	Scattered throughout	Sometimes observed on stressed ornamentals.
Brown Prionid	*Orthosoma brunneum*	Conifers and hardwoods	Calais, Underhill	Sightings of adults.
Brown Spruce Longhorned Beetle	*Tetropium fuscum*	Spruce, pine and fir		Not observed or known to occur in Vermont. As part of the Northeastern Forest Fire Compact's Forest Health Working Teams resource sharing among northeastern states and provinces, two Vermonters travelled to New Brunswick to assist in surveys for this insect. Other *Tetropium* species that were captured in traps deployed by VAAFM in Vermont included *T. cinnamopterum* (11 specimens) and *T. schwarzianum* (26 specimens).
Carpenter Ant	*Camponotus* sp.	Wood products	Scattered	Usual number of homeowner inquiries.
Eastern Ash Bark Beetle	*Hylesinus aculeatus*	Ash	Scattered reports	Beetles encountered in homes as they emerged from firewood and logs.
Deathwatch Beetle	*Ptilinus ruficornis*	Firewood	Norwich	Encountered while splitting firewood.

OTHER BARK AND WOOD INSECTS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Eastern Carpenter Bee	*Xylocopa virginica*	Wood product	Weybridge	Nesting in wood framing of home.
Elderberry Borer	*Desmocerus palliatus*	Elderberry	Essex Junction	Showy adult observed.
Emerald Ash Borer	*Agrilus planipennis*	Ash		Not observed or known to occur in Vermont. See narrative.
European Woodwasp	*Sirex noctilio*	Red and Scots pine		Trapped in eight counties since 2007. In 2017, AAFM and USDA APHIS trapped it in Chittenden and Rutland Counties. No new observations of Sirex infesting trees were reported, with the only known location in Jericho.
Hemlock Borer	*Phaenops fulvoguttata*	Hemlock and occasionally other conifers	Statewide	Increase in hemlock borer following dry year in 2016. Associated with widely scattered hemlock mortality on compromised sites.
Japanese Cedar Longhorned Beetle	*Callidiellum rufipenne*	Arborvitae, eastern redcedar, juniper and others		Not observed or known to occur in Vermont.
Northeastern Sawyer	*Monochamus notatus*	Conifers	Scattered	Occasional reports during adult flight period.
Pigeon Tremex	*Tremex columba*	Sugar maple	Scattered throughout	Commonly observed in declining trees or turning up while splitting firewood.
Russian leather beetle	*Osmoderma eremicola*	Sugar maple	Charlotte	

OTHER BARK AND WOOD INSECTS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Southern Pine Beetle	*Dendroctonus frontalis*	Pine		Not observed or known to occur in Vermont.
Sugar Maple Borer	*Glycobius speciosus*	Sugar maple	Scattered throughout	Stable populations.
Turpentine Beetles	*Dendroctonus* spp.	White pine	Scattered throughout	Observed in stands stressed by white pine needle diseases.
Whitespotted Sawyer	*Monochamus scutellatus*	White pine and other conifers	Throughout	Adults commonly observed.

Other Bark and Wood Insects not reported in 2017 included Allegheny Mound Ant, *Formica exsectoides;* Carpenterworm, *Prionoxystus robiniae* ; Eastern Larch Beetle, *Dendroctonus simplex;* Elm Bark Beetles, *Hylurgopinus rufipes* and *Scolytus multistriatus* ; Red-headed Ash Borer, *Neoclytus acuminatus* ; Round-headed Apple Tree Borer, *Saperda candida;* Spruce Beetle, *Dendroctonus rufipennis;* Tanbark Borer, *Phymatodes testaceus.*

FRUIT, NUT AND FLOWER INSECTS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Asiatic Garden Beetle	*Autoserica castanea*		Vershire	Ornamentals.
Autographa californica - a plusiinae moth	*Autographa californica*	Vineyards	Chittenden and Grand Isle Counties	Found outside of its described western North America range during Farm Bill-funded grape commodity survey for federal target pest *Autographa gamma* . GBIF and iDigBio databases indicate that a specimen was found in Maine (date unknown) and southern Connecticut (1973), plus two locations in Michigan (1992 and 2003). Otherwise, documented only in the west.
Rose Chafer	*Macrodactylus subspinosus*	Many	Statewide	Few reports in 2017.
Western Conifer Seed Bug	*Leptoglossus occidentalis*	Conifers	Statewide	A common household invader, with a significant increase in some areas. Damage to Vermont conifers has not been recorded.

Fruit, Nut and Flower Insects not reported in 2017 included Butternut Curculio, *Conotrachelus juglandis;* Fir Coneworm, *Dioryctria abietivorella;* Pine Coneworm, *Dioryctria reniculelloides;* Plum Curculio, *Conotrachelus nenuphar*.

STEM DISEASES

Dieback from **Beech Bark Disease** was mapped on 2,807 acres, a decrease from the 7,278 acres mapped in 2016 (Table 17 and Figure 25).

While bark symptoms remain common, crown symptoms from beech bark disease have been generally less noticeable over the past decade, following a period when symptoms were more widespread (Figure 24). Weather contributing to the survival of beech scale crawlers or the susceptibility of beech bark are likely to have contributed to the severity of the disease in the early 2000's. The more recent drop in acreage mapped may also be due to the mid-summer timing of the aerial survey in 2016 and 2017 compared to the late summer surveys in other recent years. The bright yellow crowns of symptomatic trees develop over the growing season, and would be less noticeable in mid-summer than in late summer.

Table 17. Mapped acres of beech bark disease in 2017.

County	Acres
Addison	327
Bennington	212
Caledonia	44
Chittenden	412
Essex	726
Franklin	94
Orange	89
Orleans	55
Rutland	414
Washington	254
Windham	74
Windsor	106
Total	**2,807**

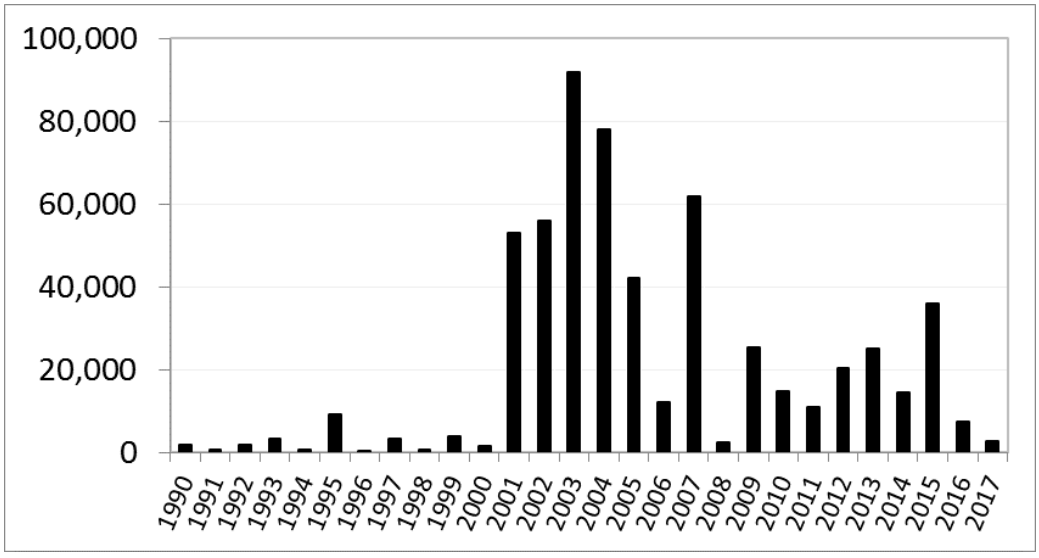


Figure 24. Acres of beech bark disease mapped in Vermont during statewide aerial surveys, 1990 – 2017.

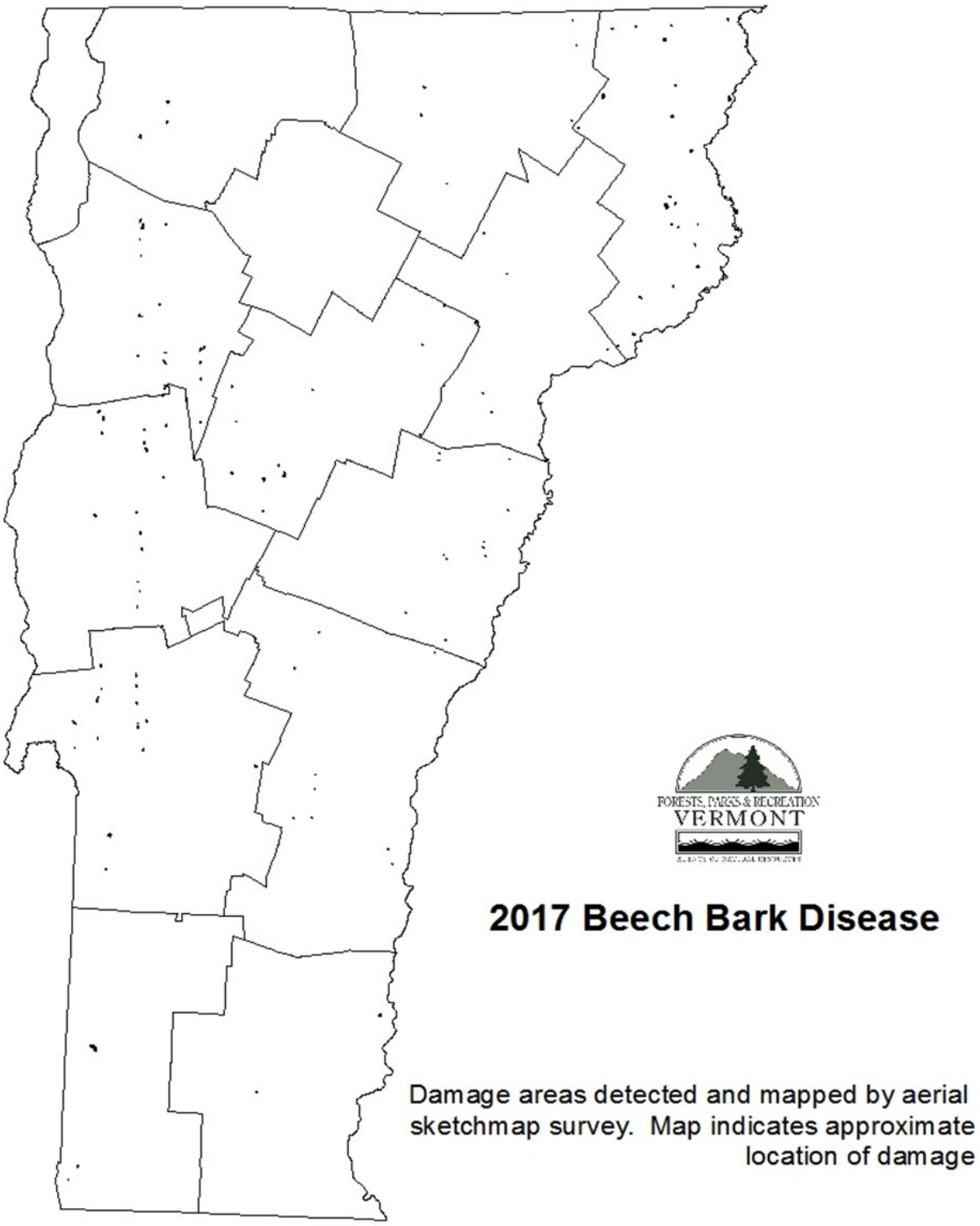


Figure 25. Beech bark disease related decline and mortality mapped in 2017. Mapped area includes 2,807 acres.

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. See Ash Dieback (page 95).
Beech Bark Disease	*Cryptococcus fagisuga and Nectria coccinea var. faginata*			See narrative.
Black Knot	*Dibotryon morbosum*	Cherry	Scattered throughout	Common at normal levels. Most severe where cherry is near edge of range.
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. Heavy damage in a deteriorating stand in South Royalton.
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. Confirmed by the USFS FHP in a historically declining stand in Reading.
Dutch Elm Disease	*Ophiostoma novo-ulmi*	Elm	Throughout	Flagging and mortality continued to be more noticeable than normal by mid-summer.
Fireblight	*Erwinia amylovora*	Apple	Woodstock	Submitted to the lab.

OTHER STEM DISEASES

DISEASE	LATIN NAME	HOST	LOCALITY	REMARKS
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.
Red Ring Rot	*Phellinus pini*	White pine	Scattered throughout	Common in unthrifty, heavily wounded, or overstocked stands.
Thousand Cankers Disease	*Geosmithia morbida* and *Pityophthorus juglandis*	Walnut		Not observed or known to occur in Vermont.
Verticillium Wilt	*Verticillium albo-atrum*	Sugar maple	Woodstock	Ornamental.
White Pine Blister Rust	*Cronartium ribicola*	White pine	Scattered throughout	Incidence remains higher than normal with 197 acres of scattered mortality mapped during aerial surveys.
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 very noticeable, especially in northern Vermont. Observed on Christmas trees in Springfield.

Other Stem Diseases not reported in 2017 included Cedar Apple Rust, *Gymnosporangium juniperi-virginianae* ; Delphinella Tip Blight of Fir, *Delphinella balsamae* ; Eastern Dwarf Mistletoe, *Arceuthobium pusillum* ; Sapstreak, *Ceratocystis coerulescens* ; Scleroderris Canker, *Ascocalyx abietina;* Verticillium Wilt, *Verticillium albo-atrum.*

FOLIAGE DISEASES

Hardwood Foliage Diseases – Wet conditions early in the growing season led to an increase in some foliage diseases this year. Foliage compromised by fungal infection was more susceptible to the dry conditions present late in the growing season and dropped as early as mid-September.

- Defoliation of apple species was widespread, with an increase from 2016 levels in both **apple scab** (*Venturia inaequalis*) and **cedar-apple rust** (*Gymnosporangium juniperi-virginianae*).

- **Sycamore anthracnose (***Apiognomonia veneta*) was severe wherever sycamore occurs naturally. Defoliated trees refoliated by early summer.

- Excessive moisture also produced signs of **anthracnose** (including genera listed below) on other hardwood species. Misshapen and discolored leaves associated with the disease were visible on oaks, maples and ash species through May and June.

- The impact of anthracnose and other fungi on foliage extended beyond spring, and contributed to **early leaf drop** for some species, particularly maple and ash. The UVM Plant Diagnostic Lab identified *Discula* sp., *Aureobasidium* sp., *Alternaria* sp. and an abundance of *Phyllosticta sp* on fallen sugar maple leaves, and *Gloeosporium* sp., *Marssonina* sp., *Phyllosticta* sp., *Mycosphaerella* sp., *Alternaria* sp., Powdery mildew (unidentified; chasmothecia), *Alternaria* sp., and Botryosphaeria-like fungi on fallen white ash leaves. Symptoms resembling Septoria Leafspot were also reported, especially in northeastern Vermont. Other players in the early leaf drop of 2017 included the legacy of the 2016 drought, and heavy seed by some species.

Needle Diseases of White Pines – White pine needles were affected once again this year by a complex of fungal species including Brown Spot Needle Blight (*Mycosphaerella dearnessii*), and two needlecast fungi (*Lophophacidium dooksii* and *Bifusella linearis*). During aerial surveys over 16,000 acres were mapped, which is a reduction from 2016 (Table 18 and Figure 26). This likely underestimates the area affected since damage is mapped from above the trees, while much of the damage is observed within, and in lower portions of tree crowns.

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.

Table 18. Mapped acres of white pine needle damage in 2017.

County	Acres
Addison	175
Bennington	600
Caledonia	2,102
Chittenden	763
Essex	466
Franklin	530
Grand Isle	9
Lamoille	913
Orange	1,930
Orleans	172
Rutland	974
Washington	2,223
Windham	2,110
Windsor	3,446
Total	**16,413**

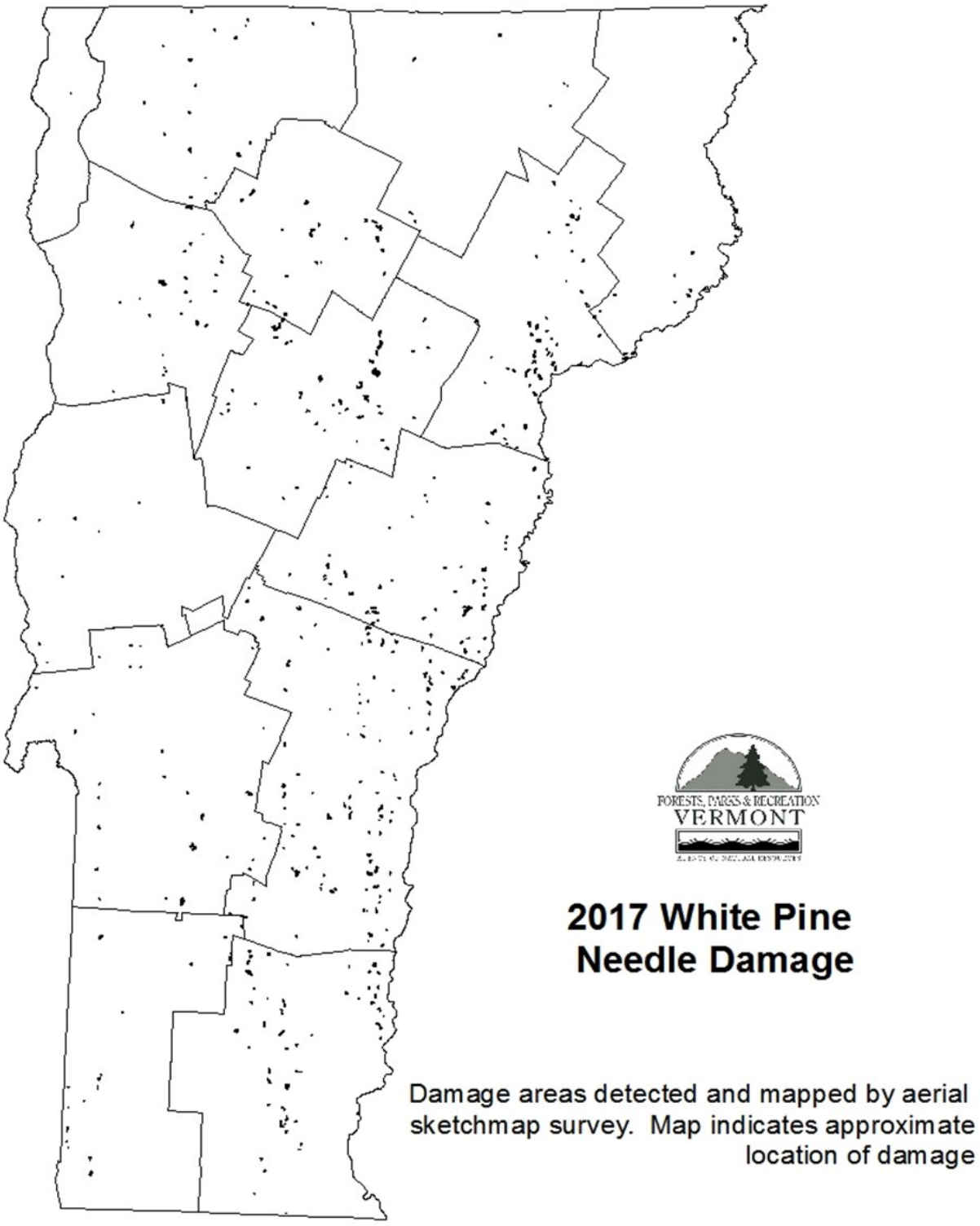


Figure 26. White pine needle damage mapped in 2017. Mapped area includes 16,413 acres.

The U.S. 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 (Figures 27-29). These data suggest general trends, but likely underestimate the severity of damage across the landscape since some of our original trees have died, thereby reducing the sample size. We, along with neighboring states and the USFS, are pursuing efforts to expand our sampling in future years.

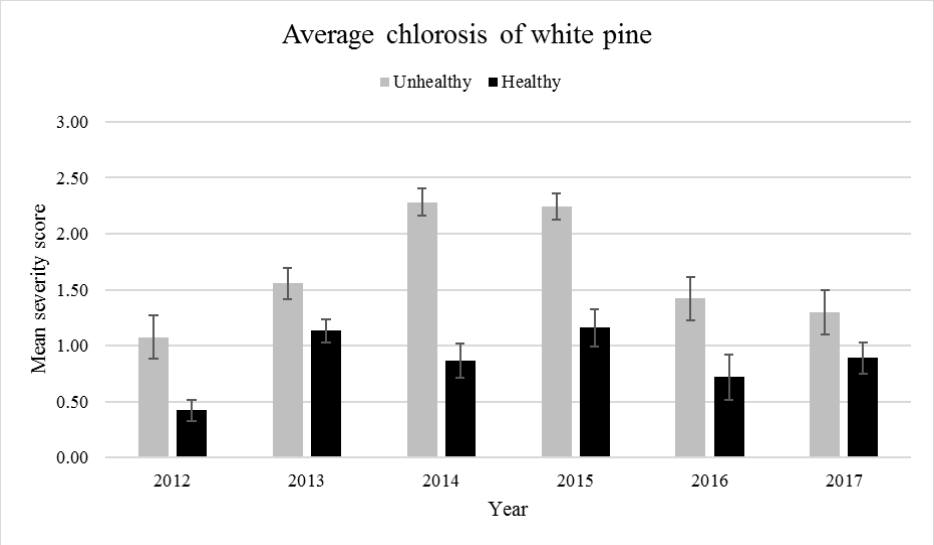


Figure 27. Chlorosis (yellowing of foliage) severity of unhealthy and healthy white pines surveyed between 2012-2017 at four sites in Vermont. Trees were rated unhealthy or healthy in 2012. Data presented are mean severity scores (0 = no chlorosis, 1 = less than 1/3 crown affected, 2 = between 1/3 and 2/3 affected, 3 = more than 2/3 affected) ± standard error.

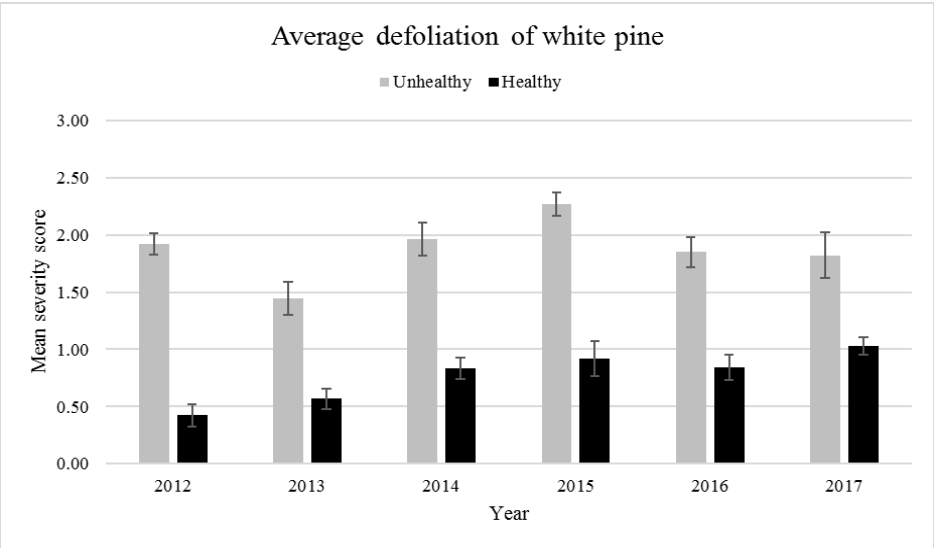


Figure 28. Defoliation severity of unhealthy and healthy white pines surveyed between 2012-2017 at four sites in Vermont. Trees were rated unhealthy or healthy in 2012. Data presented are mean severity scores (0 = no defoliation, 1 = less than 1/3 crown affected, 2 = between 1/3 and 2/3 affected, 3 = more than 2/3 affected) ± standard error.

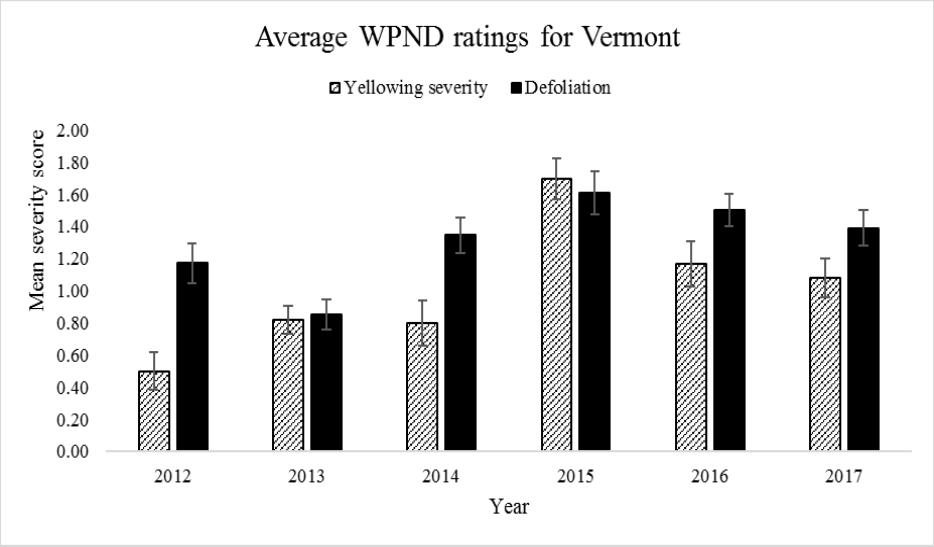


Figure 29. Average trends in yellowing severity and defoliation for all trees sampled at four sites in Vermont between 2012-2017. Data presented are mean severity scores (0 = no chlorosis/defoliation, 1 = less than 1/3 crown affected, 2 = between 1/3 and 2/3 affected, 3 = more than 2/3 affected) ± standard error.

OTHER FOLIAGE DISEASES

DISEASE	LATIN NAME	HOST	LOCALITY	REMARKS
Anthracnose	*Glomerella* spp.*; Apiognomonia*	Maples, Oaks, Ash, Sycamore	Statewide	See narrative.
Apple Scab	*Venturia inaequalis*	Apple	Statewide	See narrative.
Brown Spot Needle Blight	*Scirrhia acicola*	Pines	Northeastern Vermont	Thin crowns, some decline and mortality.
Cedar-Apple Rust	*Gymnosporangium juniperi-virginianae*	Apple	Southern Vermont	See narrative.
Fir-Fern Rust	*Uredinopsis mirabilis*	Balsam Fir	Southeastern Vermont	Incidental observation.
Giant Tar Spot	*Phytisma acerinum*	Norway Maple	Statewide	Increase from 2016 levels; Bennington county had early defoliation as a result.
Phyllosticta leafspot	*Phyllosticta spp.*	Sugar Maple	Windham County	See narrative.
Poplar Leaf Blight	*Marssonina spp.*	Balsam Poplar	Statewide	Similar to 2016 damage.
Powdery Mildew	*Eryiphaceae*	Lilac, Norway Maple, Honeysuckle	Statewide	Increase in damage from 2016.
Rhizosphaera Needlecast	*Rhizosphaera kalkhoffi*	Spruce	Statewide	Mortality of ornamental blue spruce continues due to heavy defoliation in the past.
Septoria Leaf Spot	*Septoria aceris*	Hardwoods	Statewide	See narrative.

Foliage Diseases not reported in 2017 included Birch Leaf Fungus, *Septoria betulae* ; Dogwood Anthracnose, *Discula destructiva* ; Lirula Needlcast, *Lirula sp.* ; Rhizosphaera Needle Blight, *Rhizosphaera pini* .

ROOT DISEASES

DISEASE	LATIN NAME	HOST	LOCALITY	REMARKS
Annosus Root Rot	*Heterobasidion annosum*	Red Pine	Brattleboro	Although no conks were found, confirmed to be present by spore trapping in a stand where infection centers had occurred in the past.
Armillaria Root Rot	*Armillaria spp.*	Balsam Fir	Northeastern Vermont	Contributing to mortality associated with balsam woolly adelgid.
Armillaria Root Rot	*Armillaria spp.*	Many	Statewide	Heavy sporophore production statewide indicates the drought in 2016 has increased root infection levels.

DIEBACKS, DECLINES, AND ENVIRONMENTAL DISEASES

Drought conditions have affected forests at several times during the past year. Going into the winter of 2016-2017, the entire state was abnormally dry or in moderate to severe drought. Dryness tapered off through the winter, finally ending by early May in eastern Windsor and Orange Counties. Then in September 2017, dry conditions returned and were coupled with record-breaking high temperatures, at times reaching 90^0F. By late-October abnormally dry conditions, and at times moderate drought conditions, affected forest health.

Evidence of drought damage was recorded from aerial surveys affecting 1,601 acres (Figure 30). Symptoms of drought varied depending on which drought episode affected tree health.

Heavy seed production, sometimes referred to as a "distress crop", is common following drought conditions. When trees put lots of resources into seed production, they may look sparser than normal. Drought symptoms included heavy seed on a variety of species: hardwood species notably maple, beech, oak, basswood, apple, and hop hornbeam, and among conifers, white pine, balsam fir, red, white and Norway spruce, and northern white cedar. An increase in squirrel damage is likely in the near future, as populations benefit from the recent glut of food.

New ash mortality and maple dieback were noticeable by mid-June in multiple locations in eastern Vermont where drought conditions had persisted into early spring. Ash trees are particularly sensitive to fluctuating water conditions. Affected maples often had foliage of good size and color on living branches, suggesting that plentiful moisture later in the spring allowed trees to recover.

Other symptoms of drought effects on forest health included: heavy production of Armillaria "honey mushrooms" suggesting that this fungus successfully invaded drought-stressed roots; more attacks by hemlock borer were reported on wounded hemlocks.

Warm dry conditions in late summer into fall led to: refoliation failures from forest tent caterpillar and other defoliators, along with infection by leaf fungi and other foliage injury factors; a general delay in fall foliage, with the exception of swamps and other stressed areas that start to turn color early; and early leaf drop of sugar maple and ash, especially on roadsides, openings, river corridors, and edges. Once leaves are compromised by disease infection they are more likely to brown and drop early under dry conditions.

Table 19. Mapped acres of drought symptoms in 2017**.** Drought symptoms were more visible late in the summer, so some areas mapped early in the summer may not be well-represented in these data.

County	Acres
Addison	28
Caledonia	176
Chittenden	56
Essex	1,114
Orange	25
Orleans	1
Rutland	13
Washington	109
Windsor	79
Total	**1,601**

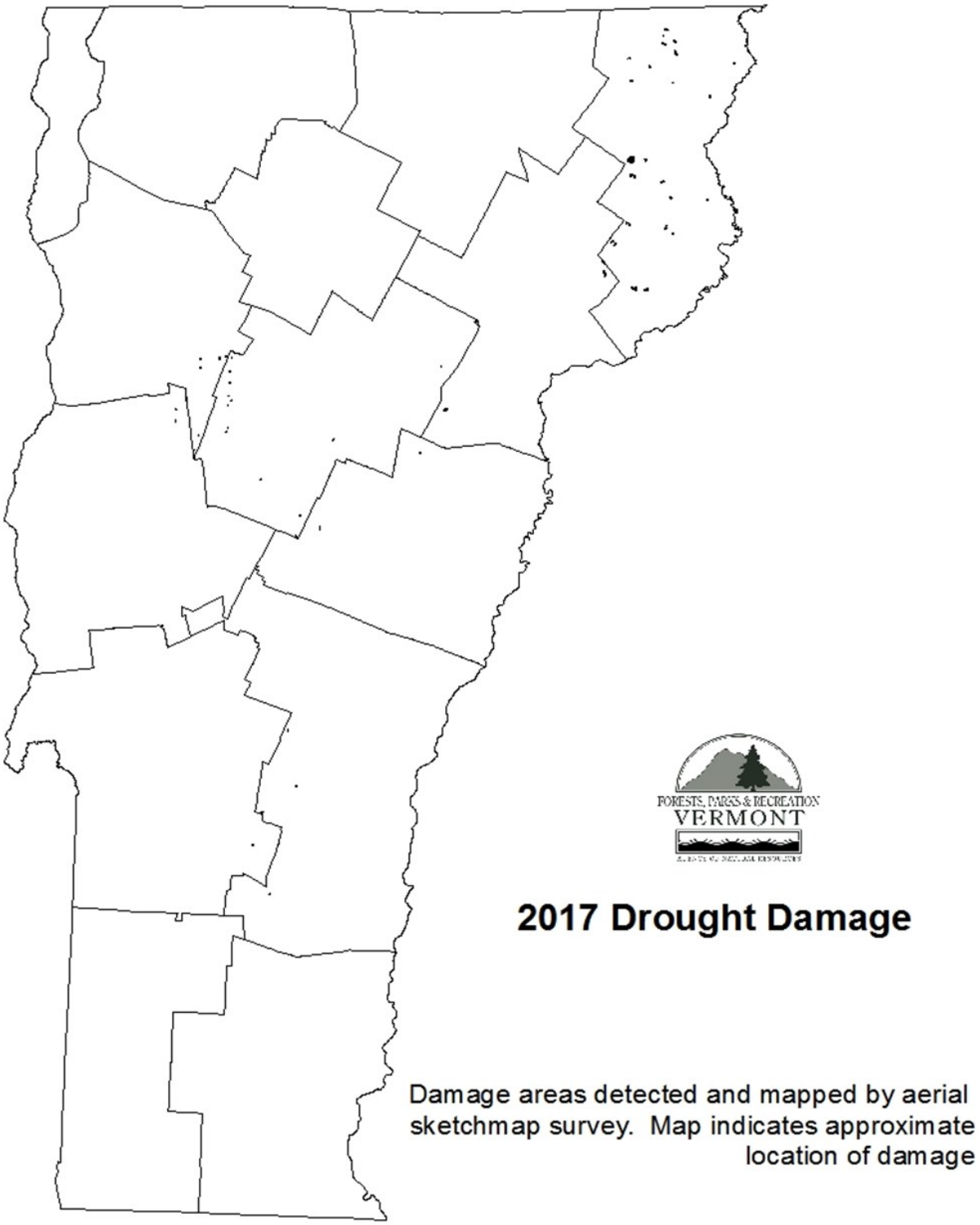


Figure 30. Symptoms of drought damage mapped in 2017. Mapped area includes 1,601 acres.

Frost Damage resulting from stalled leaf development in the spring followed by a cold snap in early May affected scattered locations in Caledonia and Windham Counties, and other locations statewide (Table 20). Acres affected were much less than in 2015 when frost damage affected over 24,000 acres.

Table 20. Mapped acres of frost damage in 2017**.**

County	Acres
Caledonia	3
Windham	94
Total	**97**

Tree stress related to recent **logging-related decline** increased in 2017 to 629 acres, spread across 5 counties (Table 21). The majority of the areas mapped during aerial survey, 439 acres, occurred in Essex County. Drought conditions in late summer 2016 likely affected trees already stressed following harvesting.

Table 21. Mapped acres of logging-related damage in 2017**.**

County	Acres
Addison	52
Bennington	42
Caledonia	19
Essex	439
Washington	77
Total	**629**

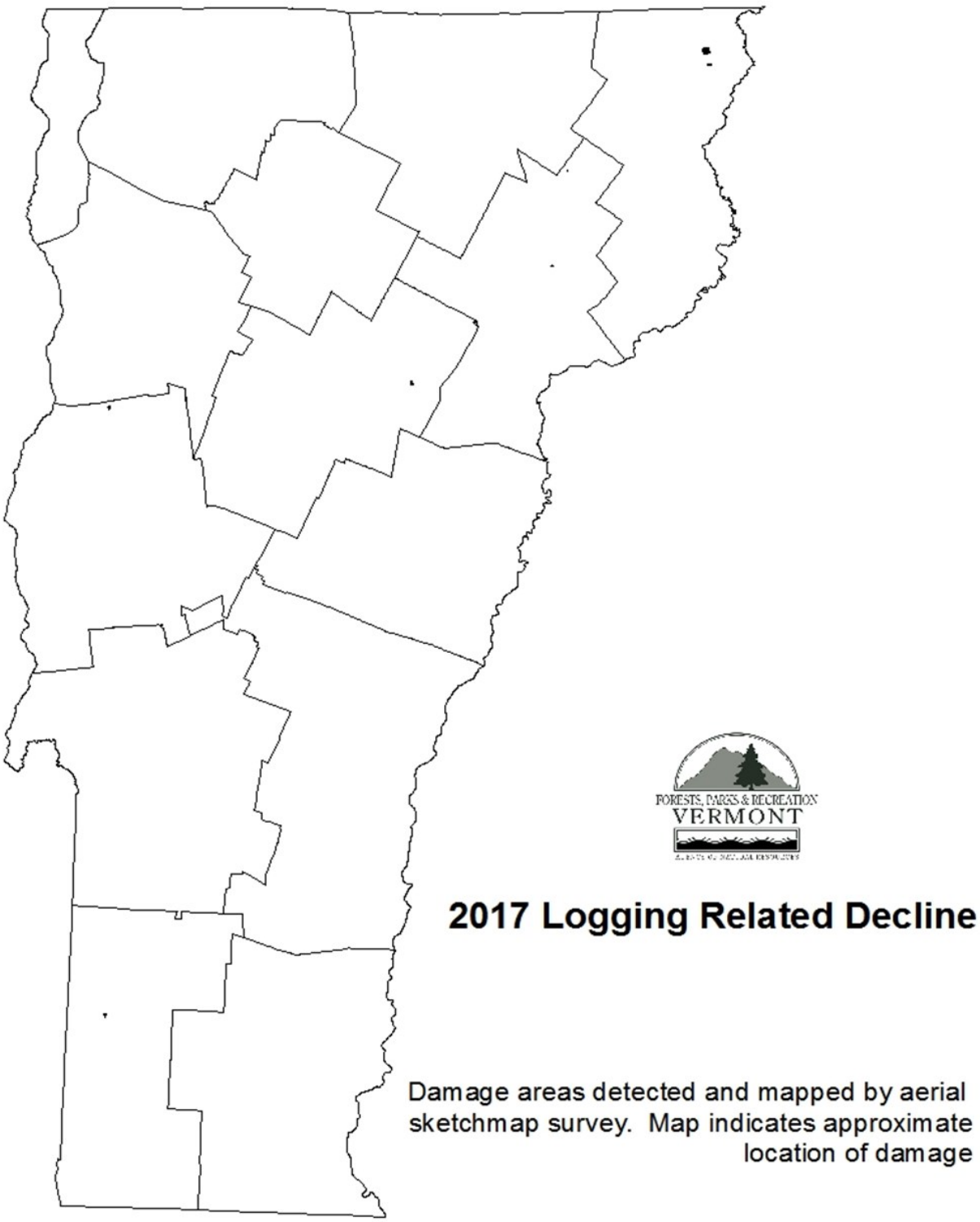


Figure 31. Symptoms of logging-related damage mapped in 2017. Mapped area includes 629 acres.

Ozone injury on sensitive plants was evaluated at 6 monitoring locations in August (**Table 22**). Of the 592 plants examined, symptoms of ozone injury (stippling on upper leaf surface) were recorded at 2 of the locations, Orange and Rupert. Injury at the Orange site was on blackberry affecting 10 plants with moderate severity. Injury at the Rupert site was on milkweed affecting 5 plants with light severity. No ozone damaged forests were mapped during aerial survey.

Table 22. Ozone bioindicator sites visited in 2017 and observed ozone injury.

Town	Ozone injury
Clarendon	None
Dover	None
Groton	None
Orange	Moderate
Rupert	Light
Sudbury	None
Woodstock	No data

Rainfall caused a variety of symptoms due to due to excessive precipitation in late spring and early summer, with May, most of June, and early July being cooler and wetter than normal. The cool, wet weather slowed leaf development, saturated soil, and promoted the spread of fungi, resulting in the following conditions observed in 2017: Stands of **chlorotic sugar maples**, were observed in scattered locations statewide, with 6,494 acres mapped from the air. This is frequently observed in unusually rainy summers. Conditions were ideal for leaf infection by **fungal pathogens**, and for caterpillar infection by fungal and viral diseases. Wet spring weather led to sycamore anthracnose, which kept sycamores bare into early June (see Disease Section). Saturated soil made trees more vulnerable to **windthrow** in stormy weather.

Table 23. Mapped acres of rainfall-induced chlorosis in 2017.

County	Acres
Addison	608
Bennington	716
Caledonia	504
Chittenden	591
Essex	275
Franklin	341
Grand Isle	107
Orange	574
Orleans	371
Rutland	1,781
Washington	87
Windham	232
Windsor	307
Total	**6,494**

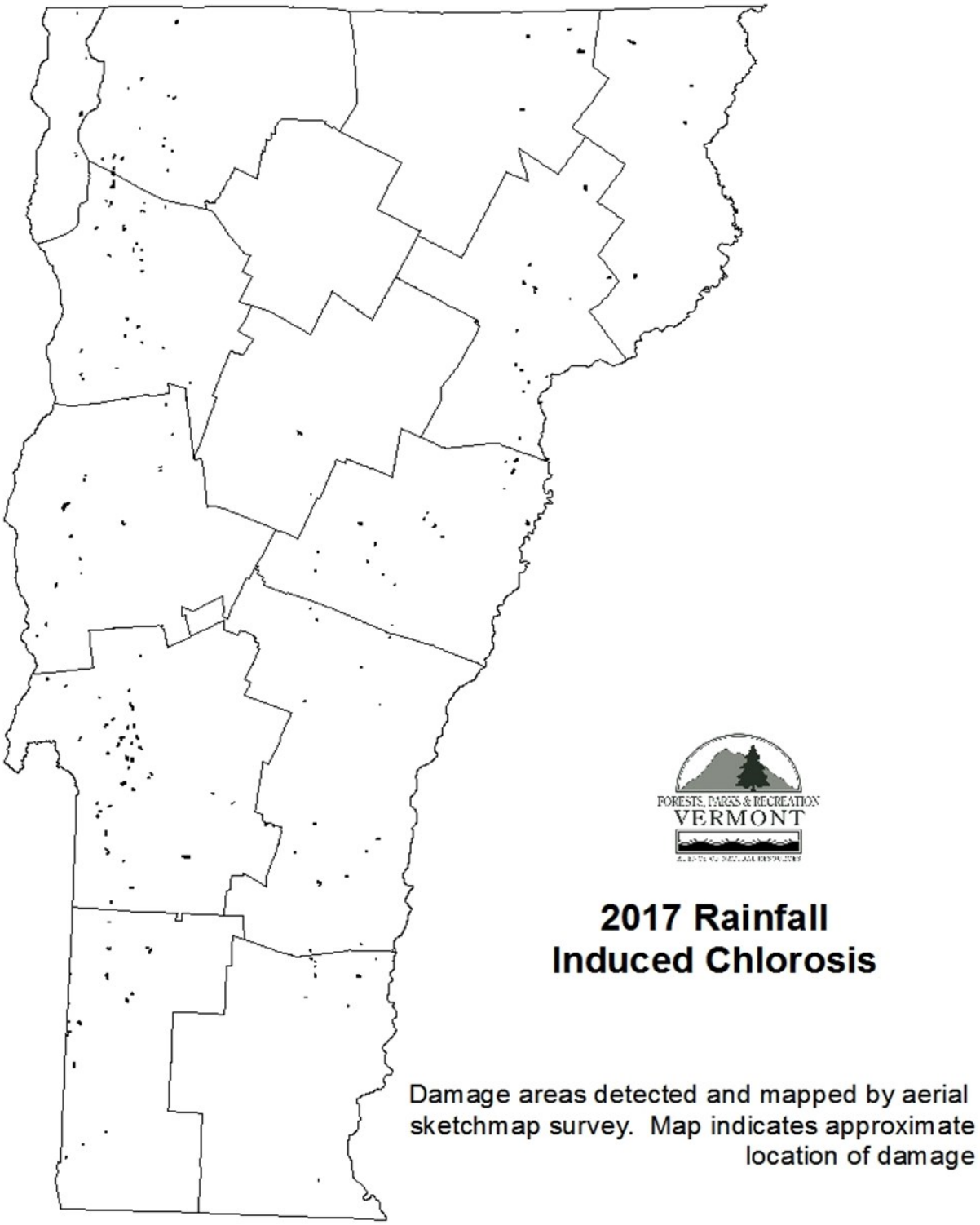


Figure 32. Symptoms of rainfall-induced chlorosis mapped in 2017. Mapped area includes 6,494 acres.

Red Pine Decline in plantations statewide has been mapped on 516 acres. Several new locations were observed, such as in Goshen. This decline is believed to be associated with red pine scale, *Matsucoccus resinosae,* although identification of causal agents has been challenging (see Red Pine Scale in section on Sapsucking Insects, page 60).

Damage from Unknown Causes

In 2017 there were 1,298 acres of forests with significant damage that could not be associated with any specific cause (Table 24). A variety of species and locations, especially in the northeastern counties, were mapped during aerial survey and ascribed as unknown causes.

Table 24. Mapped acres of damage from unknown causes in 2017.

County	Acres
Addison	10
Caledonia	241
Chittenden	15
Essex	657
Orange	195
Orleans	97
Rutland	21
Washington	4
Windham	16
Windsor	42
Total	**1,298**

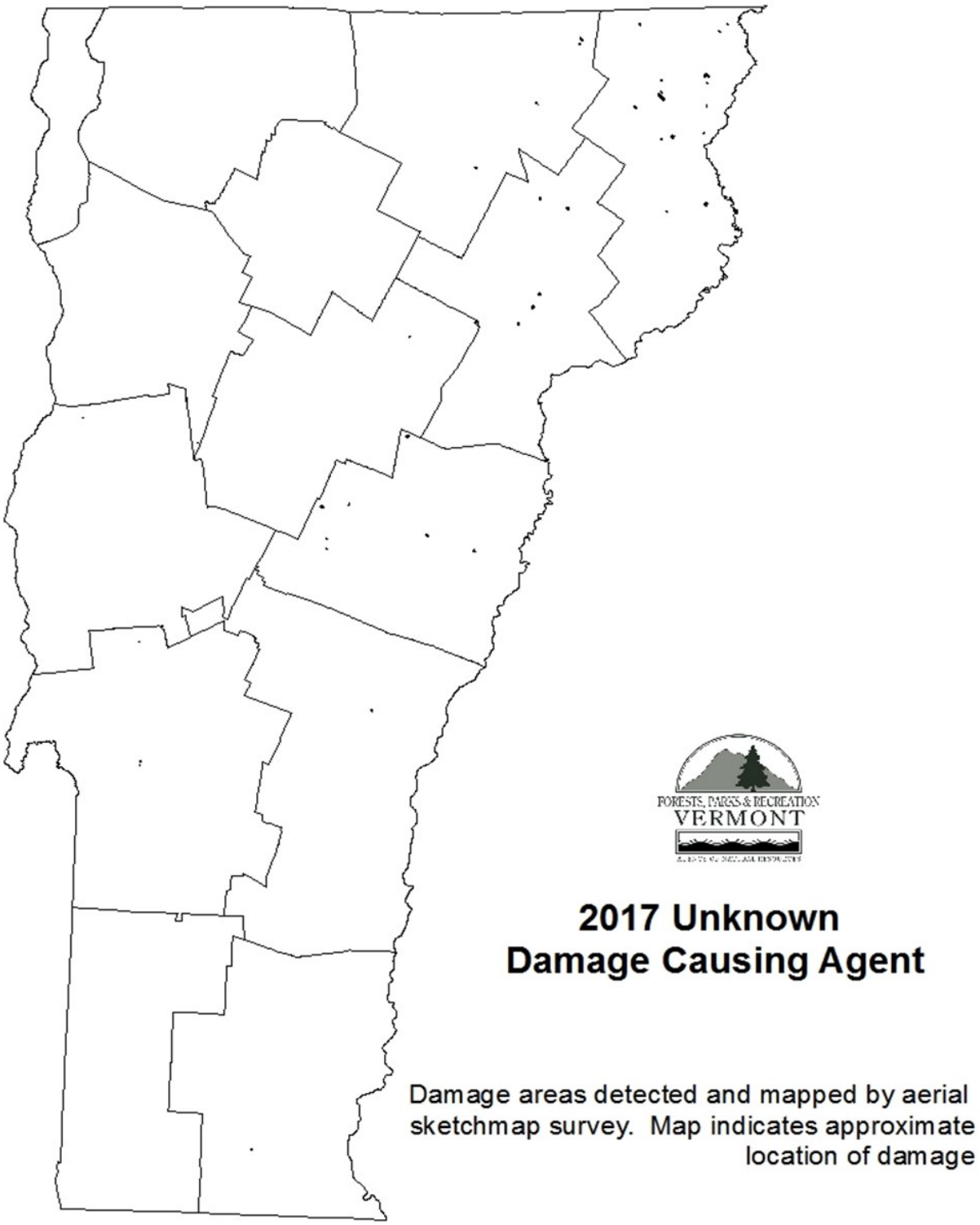


Figure 33. Symptoms of damage from unknown causal agent mapped in 2017. Mapped area includes 1,298 acres.

Extreme weather events consist of storms or abnormal weather patterns that result in impacts to tree health. With the see-saw between wet and dry, unusual cool and warm periods, and severe storms, weather conditions were a major driver of tree health. In addition to direct hail damage, trees suffered breakage and windthrow in severe storms.

Aerial survey mapping of weather-related damages totaled 11,915 acres in 2017. These estimates of weather-related damage likely under represent actual impacts since some of the damages are not visible during aerial survey. In 2017, drought was the most significant and extensive weather damage (Table 25), although a late fall wind storm affected forests statewide and was not included in these data. Other weather-related tree damage mapped during aerial survey was caused by late spring frost, inundated sites, and from spring wind events.

Table 25. 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
2016	9,320	Drought	Flooded sites, frost, wind
2017	11,915	Excessive Rain	Flooded sites, drought, wind, frost

*A December 2013 ice storm was not mapped during aerial survey but affected large areas in northern Vermont.

Wet or Flooded Site Declines were mapped on 3,647 acres in 2017, an increase from 1,183 acres recorded in 2016. Some of these sites may have been a result of past year's flooding.

Table 26. Mapped acres of forest decline associated with flooded or otherwise wet sites.

County	Acres
Addison	780
Bennington	23
Caledonia	47
Chittenden	350
Essex	438
Franklin	729
Grand Isle	534
Orange	66
Orleans	154
Rutland	503
Washington	23
Total	**3,647**

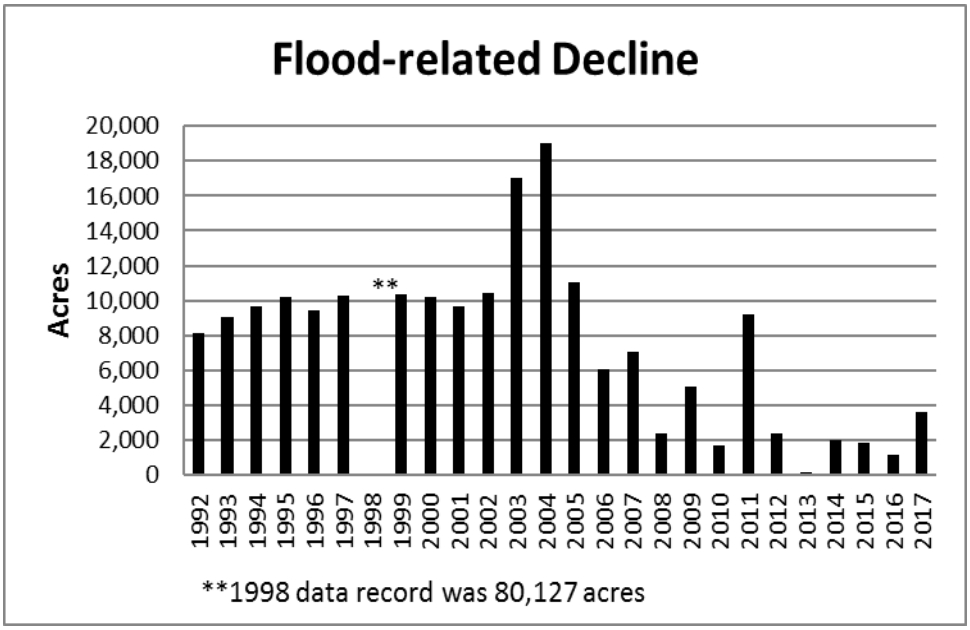


Figure 34. Trend in acres of forest decline related to wet or flooded sites mapped during aerial surveys. In 2017, the mapped area included 3,647 acres, a increase from 1,183 in 2016.

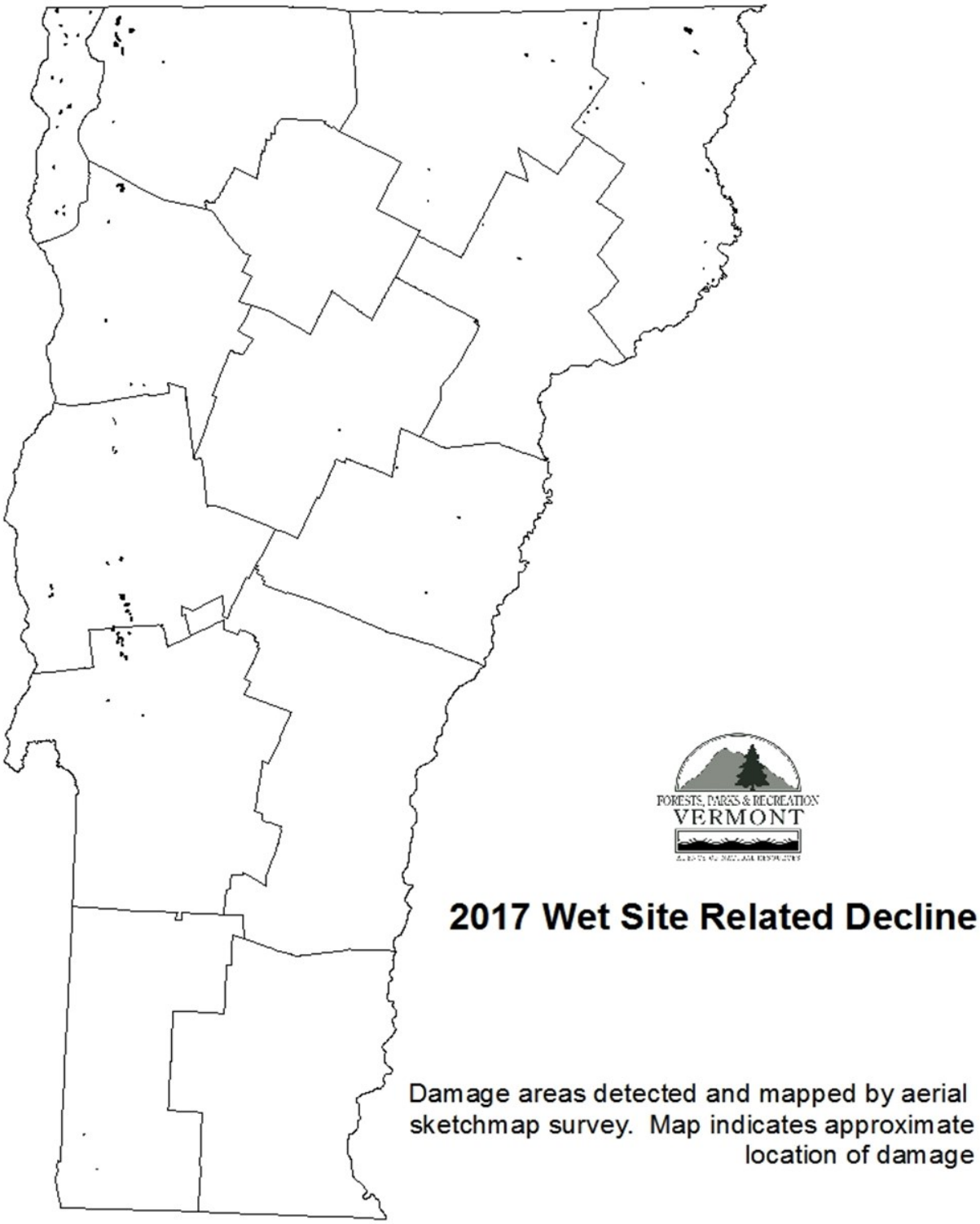


Figure 35. Wet or flooded site related decline mapped in 2017. Mapped area includes 3,647 acres.

Wind Damage from a variety of storms affected forests statewide: a gravity wave storm on May 5, microburst storms on May 18, and storms including hail on May 31, July 18, and August 12. A wind storm on October 29 affected forests statewide but damage will not be mapped until next field season. A total of 76 acres were mapped in Caledonia County during aerial surveys (Table 27).

Table 27. Mapped acres of wind damage in 2017.

County	Acres
Caledonia	76
Total	**76**

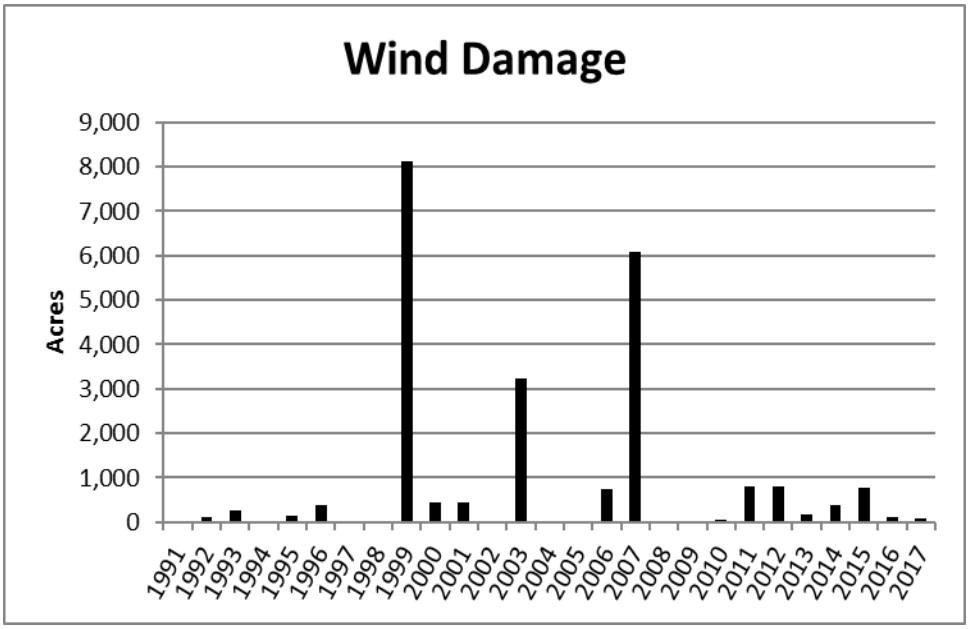


Figure 36. Trend in wind and storm damage mapped during aerial surveys. Mapped area includes 76 acres in 2017.

OTHER DIEBACKS, DECLINES, AND ENVIRONMENTAL DISEASES

CONDITION	HOST	LOCALITY	REMARKS
Air Pollution Injury	Milkweed, dogbane, blackberry	Groton, Orange	See Ozone Injury.
Ash Dieback	White ash	Scattered Statewide	Remains heavy in scattered locations, perhaps compounded by 2016 drought.
Chlorosis	Hardwoods, especially sugar maple	Statewide	Similar symptoms also mapped in 2008 (among other years) when "All this rain produced one of the greenest summers in recent memory."
Drought Damage	Hardwoods	Statewide	Dry conditions in late September 2016 led to browning and early leaf drop of white ash and sugar maple. Spring 2017 fungal diseases exacerbated damage.
Frost Damage	Hardwoods	Scattered statewide	Especially at higher elevations.
Girdling roots	Hardwoods	Colchester	
Hail	Sugar maple, ornamental hosta	Northeastern towns	Noticeable damage to understory.
Heavy Seed	Select species of hardwoods and softwoods	Statewide	Especially sugar maple, red maple, beech, oaks, pines, fir and spruce.
Logging-related Decline			See narrative.
Salt damage	Conifers	Statewide	Damage noticeable in the spring on roadside pines and other conifers.
Red Pine Decline	Red pine	Statewide	Plantations, both in previously known and new locations (e.g. Goshen).
Spruce Dieback and Mortality	Blue spruce	Statewide	Mortality of ornamental blue spruce is still noticeable and is due to previous defoliation by Rhizosphaera.

OTHER DIEBACKS, DECLINES, AND ENVIRONMENTAL DISEASES

CONDITION	HOST	LOCALITY	REMARKS
Wet Site			See narrative.
White Pine Decline	White pine	Royalton	Significant mortality of sawtimber size trees. Cause unknown, but thought to be initiated by wind or another abiotic factor.
White Pine Needle Damage			See Foliage Diseases.
White Spruce Decline	White spruce	Northeast and north central Vermont	White spruce mortality continues to be noticeable in scattered locations in NE and NC VT likely from needlecast, although the causative organisms are unknown. Mortality levels in young white spruce stands were reported to be as high as 90%.
Wind Damage	Varied, especially white pine, sugar maple, poplars	Statewide	May 5th windstorm in Rutland County resulted in breakage and blowdown; an October 29-30 windstorm affected forests and infrastructure statewide.

Other Diebacks, Declines, and Environmental Diseases not reported in 2017 included birch decline, fire damage, hardwood decline and mortality, ice damage, interior needle drop, larch decline, lightning damage, snow damage, winter injury.

ANIMAL DAMAGE

ANIMAL	SPECIES DAMAGED	LOCALITY	REMARKS
Squirrel	Oaks, Norway spruce	Statewide	Noticeable late season clipping
Woodpecker	Wood products; Balsam fir	Statewide	

INVASIVE PLANTS

2017 saw the continued growth of non-native invasive plant (NNIP) early detection and management efforts statewide. Progress with mapping, control, outreach and education have been made possible through several grant-funded opportunities, and varied strategies within local communities. The statewide invasive plant coordinator within FPR led over 23 workshops for a variety of stakeholders (state parks, conservation commissions, non-profits, community groups, others), focusing on NNIP information, management, and prioritization. Department staff continue to provide outreach and information about NNIP to the public and professionals, and are building the capacity to continue to identify and manage NNIP on state lands across Vermont.

Early Detection Species

Populations of early detection species, *Petasites hybridus* and *Petasites japonicus*, have been identified in Vermont. *P. hybridus* was first documented in 2009, and *P. japonicus* was first documented in 2016. Additional populations of petasites have been noted in: Barton, Warren, Waitsfield, Woodbury, Burlington, Readsboro, Barnet, Plainfield, East Montpelier, Sharon/Hartford (one population on the town line), South Pomfret, Dorset, Wallingford, Canaan, Weathersfield, Springfield, and Guilford.

All known populations appear to be increasing rapidly. Some are reportedly small and contained at first, for as much as 10 years, before aggressively spreading. Populations of both species are known to propagate extensively by rhizome fragments, which can break away in floods and be carried long distances downstream, and regrow. Both species need soil that is permanently moist, which would potentially make the species more invasive in northern and higher elevations of Vermont. The species reportedly prefers fertile sites, so some of the acid sites on granitic bedrock in the Northeast Kingdom may be less suitable. Elsewhere in the country, these species have been reported to be aggressive to at least hardiness zone 3 in Minnesota, where winter temperatures reach -40^{o}F.

The Vermont Invasive Exotic Plant Committee updated the unofficial watch list of NNIP. The complete list can be found at: http://fpr.vermont.gov/forest/forest_health/invasive_plants

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 NNIP management (NNIPM) on town or private land. Observations made by volunteers are linked to spatial location, photos, information on seed production, and level of infestation of the specific observation. This information is stored on the iNaturalist website and is accessible through this link: https://www.inaturalist.org/projects/mapping-for-healthy-forests-vermont. On October 12, 2017, the project exceeded 3,000 observations, and is continuing to grow.

Invasive Plant Mitigation on State Land in Vermont: Education Volunteer Outreach & Capacity Building: Two seasonal staff were hired onto the Habitat Restoration Crew in District 2 (southwest), running volunteer days and conducting NNIPM in state forests and state parks throughout the district. The Crew worked with 348 volunteers in 2017, with 1,282 volunteer hours. This program has worked with 1,791 volunteers (7,408 volunteer hours) from 2014-2017. Additionally, this year the Crew worked on mapping, curriculum development for programs with schools, and creating interpretive panels about demonstration sites for NNIPM for state parks.

Figure 37. *Plymsbury Beaver Meadow WMA; before (2016) with 1,000 stems, after (2017) with only 5 stems.*

One example of NNIPM conducted by the Crew includes a small population of *Phragmites australis* in the Plymsbury beaver meadow in Coolidge State Forest. In late 2014, this site was brought to FPR staff's attention by local residents who had participated in a volunteer day that summer. And in 2016 the Crew conducted drip application of herbicide to the 1,000 phragmites stems. A return visit in 2017 revealed that the treatment was successful, with only 5 stems surviving. This precision, strike team effort ended up protecting 300 acres of wetlands from further spread of phragmites.

Invasive Terrestrial Plant Treatment on Working Forests and Conserved Natural Areas in Vermont's Forest Priority Areas: The Nature Conservancy (TNC) completed a variety of NNIPM work across VT. Volunteers removed garlic mustard and wall lettuce in the spring, and woody NNIP in the fall, at Williams Woods in Charlotte. These efforts were part of a follow-up of the long-term control there that was funded through WHIP. Volunteers removed NNIP along the LaPlatte River, and TNC contracted with Redstart Forestry to do a large NNIP control project on 50 acres along the east side of the river. This contract work included brush-hogging extensive honeysuckle populations in the spring, and fall herbicide follow-up. The contractors will return next year to treat anything that was missed. Volunteers pulled wall lettuce at Chickering Bog this spring. Garlic mustard and wall lettuce were controlled on the Raven Ridge property in Monkton in the spring, and woody NNIP were removed along the edge of the old field and around the beaver pond in the fall. Volunteers helped control woody NNIP this fall at Wilmarth Woods in Addison. Wall lettuce was controlled at Eshqua Bog this spring.

Other Activities

The growing season for 2017 saw many projects across the state on NNIPM. Below are highlights of some of these local efforts.

Tool Loan Pilot Program: In an effort to increase access to NNIPM tools, the District 3 (Northwest) office started a pilot program, loaning out weed wrenches to local organizations, municipalities, and private landowners. FPR's Invasive Plant Coordinator communicated with participants, and organized pick up and return dates. The wrenches were successfully borrowed and returned 8 times throughout 2017. The Coordinator shared information about the program at speaking engagements throughout the year, and the tools are stored and available for pick up at FPR's main office in District 3.

South Burlington, VT: The City of South Burlington completed its first Weed Warrior season in September of 2017. The goal of the program is to create a corps of trained volunteers focused on removing NNIP in City parks. 2017 efforts were focused on City Center Park. Each of two trainings were followed up by a separate Invasive Plant Removal Day (May, September). These trainings and workdays were assisted by a professional NNIP expert, and weed wrenches were loaned by VT Forests, Parks & Recreation. Species of concern included: glossy and common buckthorn, multiflora rose, and bush honeysuckles.

Volunteers at the park this summer included members of the community, Vermont Youth Conservation Corps, students from the Frederick H. Tuttle Middle School, and employees from Stantec Consulting

Services. In total, 33 volunteers participated in the Weed Warrior Program and 47 additional volunteers helped out via the other events. Approximately 50,000 individual buckthorn (or other plant) were physically removed.

The City will be monitoring the regrowth of all NNIP in the park in 2018, and plan on holding more events next year to assist the City in managing these plants in the years to come. Additionally, the City is hoping to expand the program and begin it at a different park to attract a new community of volunteers. These efforts were made possible by the following community organizations: City of South Burlington; Vermont Forests, Parks & Recreation; Starbucks Coffee; The Mill Market & Deli; and Gardener's Supply Company.

Richmond, VT: Since 2009, the Great Richmond Root-Out! has worked to control invasive plants on 120 acres of state-significant silver maple-ostrich fern floodplain forest—the largest remaining example of this now rare natural community on the upper Winooski River. In addition to its ecological importance, this area is also prized by the people of Richmond who use it extensively for hiking, biking, bird-watching, fishing, boating, and nature exploration. Participating lands are owned by the Town of Richmond, the Richmond Land Trust, The Nature Conservancy and private landowners.

Figure 38. *There's more than invasive plants to remove from the Floodplain forest in Richmond, VT.*

Many volunteers have helped the Root-Out! over the years, including community members, middle and high school science classes, UVM, land trust members and more. This past year both 5th and 7th grade science classes from Camel's Hump Middle School got very connected. They spent class and field time learning about floodplain ecology and they helped remove invasive plants. Thanks to their help and that of all Root-Out! volunteers, knotweed, barberry, honeysuckles and phragmites infestations have all been shrunk by 95-99% since the program's inception.

Bennington County, VT: The Battenkill Watershed Comprehensive Invasive Species Management Association, along with the Bennington County Conservation District, spent 54 hours this field season mapping Japanese knotweed in the Green River subwatershed of the Batten Kill (digitally and on the ground). These groups also reached out to and met with 37 landowners along Tidd Brook and the Green River in the watershed in efforts to build a landowners' Japanese knotweed management association. The new habitat steward for the BK CISMA has hand-pulled 2.3 acres for over 10 hours, with the help of Equinox Preservation Trust (caretaker Rick LaDue), removing honeysuckle, common buckthorn, glossy buckthorn, bittersweet, burning bush, goutweed, barberry, and wall lettuce. The habitat steward also co-hosted a workshop with VT Fish and Wildlife on October 21, with 11 individuals in attendance.

Burlington, VT: With the help of a Community Colleges for Environmental Sustainability grant, Heather Fitzgerald's Moving Towards Sustainability students at CCV-Winooski organized a restoration effort on impaired Englesby Brook where it runs next to Champlain Elementary School. They worked with Roger Klinger and Betsy Patrick's 3rd grade classes to uproot buckthorn and plant 60 bare root dogwoods from Intervale Conservation Nursery in place of the buckthorn. They also planted 15 dogwoods in an area of bare, compacted soil and 30 live stakes in riprap. The 3rd graders also collected garlic mustard and made pesto with Champlain school chef Kaye Douglas. Heather's Landscape Natural History students from the University of Vermont took the 3rd graders on a tour of Burlington Urban Wild Crescent Woods, just upstream from the school, so they could see what an older, more intact forest looks like and imagine what their efforts might help lead to.

Burlington, VT: The Winooski Valley Park District (WVPD) works with and relies on local schools, youth groups and other volunteer groups to manage NNIP across their parklands. This year they continued mapping NNIP at the Ethan Allen Homestead property in Burlington and also at Derway Island in Burlington. This mapping work has helped to focus their efforts on higher priority areas. Recent removal days targeted these high priority areas and involved a removal day at the Ethan Allen Homestead with a Boy Scout Troop and a staff training/removal day at Derway Island. They plan to continue mapping and targeting future removal and mitigation efforts at all of their parklands.

County foresters continue to work with land owners and consulting foresters on addressing NNIP in forest management plans and forest management activities on private lands. Other department staff continue to identify NNIP on state lands.

Numerous NNIPM activities took place on State Lands.

District 1 (southeast): Numerous NNIPM projects were completed, including follow up on a multi-year approach to managing woody NNIP at the New Windsor Grasslands WMA in Windsor. 2017's work was a follow-up from last years chemical control of knotweed/ multiflora rose/honeysuckle in adjacent areas.

This project involved a tracked Kubota skid steer with a Fecon mower attachment. The contractor mowed down the field in the project area, excluding apples. These fields had been abandoned, and consisted of mostly multiflora rose and honeysuckle species. After mowing, the area was overseeded with a rye grass mixture. The current plan is to return in the spring and chemically treat the stump sprouts, and continue a regime of mowing the area annually. If this project is successful, this methodology will be expanded to other abandoned fields.

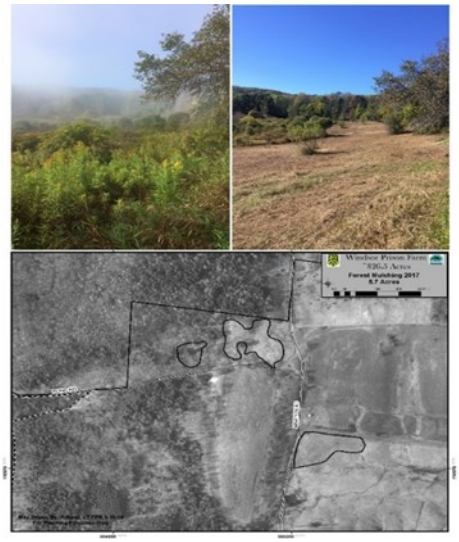


Figure 39. *New Windsor Grasslands WMA before (left) and after (right) mowing, field to the north.*

District 2 (southwest): See Invasive Plant Mitigation on State Land in Vermont: Education, Volunteer Outreach, & Capacity Building (page 99).

District 3 (northwest): The seasonal Forestry technician revisited areas treated in 2016 and found that for the most part, initial treatment was highly successful. Some areas did require follow-up treatment. One particularly challenging project was the treatment of a widespread multiflora rose and barberry infestation located on Honey Hollow road. This site was treated using a foliar application of herbicide, and was done in advance of an apple tree release project which would have given the invasive plants lots of light to thrive and expand.

Work has also been completed at Lower Otter Creek WMA, in Ferrisburgh. In the fall of 2016 approximately 20 acres received a commercial herbicide treatment to control NNIP. The project area was overwhelmed and infested with large, established honeysuckles, buckthorns, and barberries. The forest floor below the NNIP was

Figure 40. *Before, during and after treatment for honeysuckles, buckthorns and barberries. Lower Otter Creek WMA in Ferrisburgh.*

nearly bare, and practically void of any native vegetation. The target NNIP received foliar and basal bark treatments. The initial herbicide treatment was highly effective, achieving nearly 90% efficacy. In the fall of 2017, the project area received a follow-up brontosaurus treatment. The goal of the brontosaurus treatment was to grind up the standing dead NNIP material, thereby returning woody organic materials, nutrients, and minerals to the soils. In doing so, this work improved light conditions on the forest floor, and soil scarification resulted, aiding in preparing a seed bed for native species to become established. All red oak, swamp white oak, black cherry, and shagbark hickory were retained in the project area for their mast and as future seed sources. Sparse grey birch, mature cottonwoods, and white pine were also retained for seed. A follow-up foliar herbicide treatment has been started to address residual NNIP, and is planned to be completed in the spring/summer 2018. The project area will be monitored annually, and NNIP will be controlled as needed through employing this Integrated Pest Management program.

District 4 (central): A variety of NNIPM control projects were done this year. Staff treated a number of areas in Cotton Brook that had extensive populations of honeysuckle species. This work was completed before the area was mowed.

Staff also participated in two District work days this year, focused on NNIPM. On May 19, 7 people worked at Pine Mountain WMA for 6 hours, hand-pulling smaller stems of honeysuckle, buckthorn, burning bush, false spiraea and barberry, and doing cut stump treatment on all of these species. A larger area of false spiraea was also treated with a backpack sprayer. On June 9, 7 people worked at Clover Hill WMA for 8 hours, covering a 2-acre area, hand-pulling smaller stems of buckthorn and cut stump treating honeysuckle, buckthorn, barberry, and autumn olive. This site will require continued monitoring and treatment. The staff also came away with over 100 ticks. Most were dog ticks found on clothing, and 2 deer ticks were identified. Three people had 4 attached dog ticks.

District 5 (northeast): Much of the NNIPM occurred on a variety of WMAs, by F&W staff with assistance by FPR staff. Phragmites was treated by over a dozen people at West Mountain WMA; honeysuckle was removed prior to brushmowing in a field at Calendar Brook WMA; Japanese knotweed was removed from a cellarhole at Calendar Brook WMA; Phragmites was treated along roadsides, and honeysuckles species were treated in the woods at Eagle Point WMA; and a number of new sites of honeysuckle and Japanese knotweed were mapped at Victory Basin WMA, and new sites of honeysuckle were mapped at West Mountain WMA.

VTinvasives.org website: The VTinvasives.org website has been re-launched. On average, there are approximately 400 online users per week to the website. Content now includes information on terrestrial and aquatic invasive plants and animals, insects, and diseases. The website continues to provide a wide range of information to a variety of user groups from landowners to professional foresters to municipalities, including educational resources and Best Management Practices.

Sugar Maple Health in 2017

Vermont has continued to monitor sugar maple health in sugarbushes and in maple stands since 1988, and currently measures health annually in 36 North American Maple Project (NAMP) plots. In 2017, 90% of trees on these plots were rated as having low dieback (less than 15% dieback) (Figure 41).

Thin foliage due to forest tent caterpillar defoliation was measured on nine of the 36 monitoring plots (25%). Seven had moderate-heavy defoliation (20%) and two had light defoliation (6%). Tree recovery through refoliation was minimal at most sites. Two additional sites were affected by pear thrips and frost damage. There was an increase in the average number of trees with thin foliage over last year, from 7% in 2016 to 14% in 2017 (Figure 42). Foliage transparency is sensitive to current stress factors. Past spikes in transparency were due to frost injury (2010, 2012, 2015), forest tent caterpillar defoliation (2004-2007, 2016), and pear thrips (1988-1989). Dry conditions in 2016 may have been a factor in reduced tree health in 2017. There were only five new dead overstory sugar maple trees on plots in 2017 (0.4%).

Of the 1,659 live sugar maple trees (all crown classes) surveyed in 2017, 247 (14.8%) had damages from a variety of damage agents. The most common damage type was bole injury from sugar maple borer, which made up nearly a third of damages (Table 28).

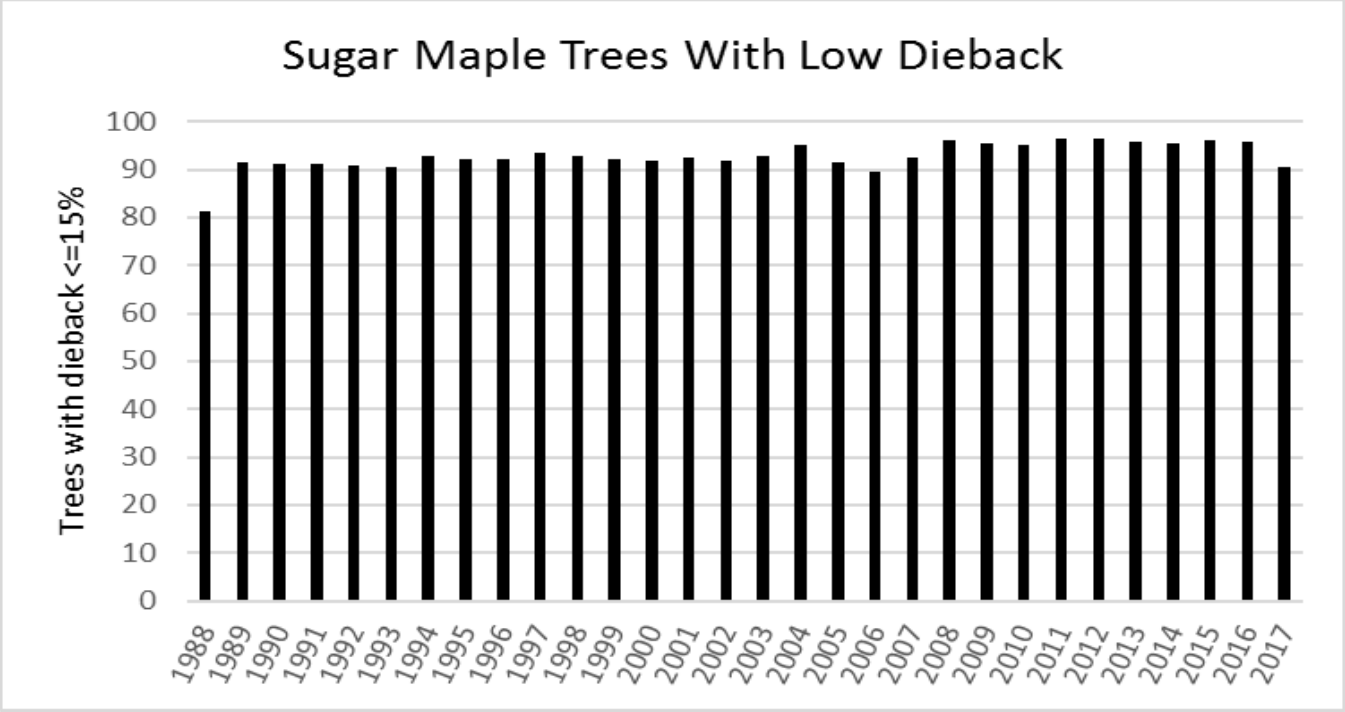


Figure 41. Percent of overstory sugar maple trees on NAMP plots with low dieback (0-15%). N=1,142 trees at 36 sites.

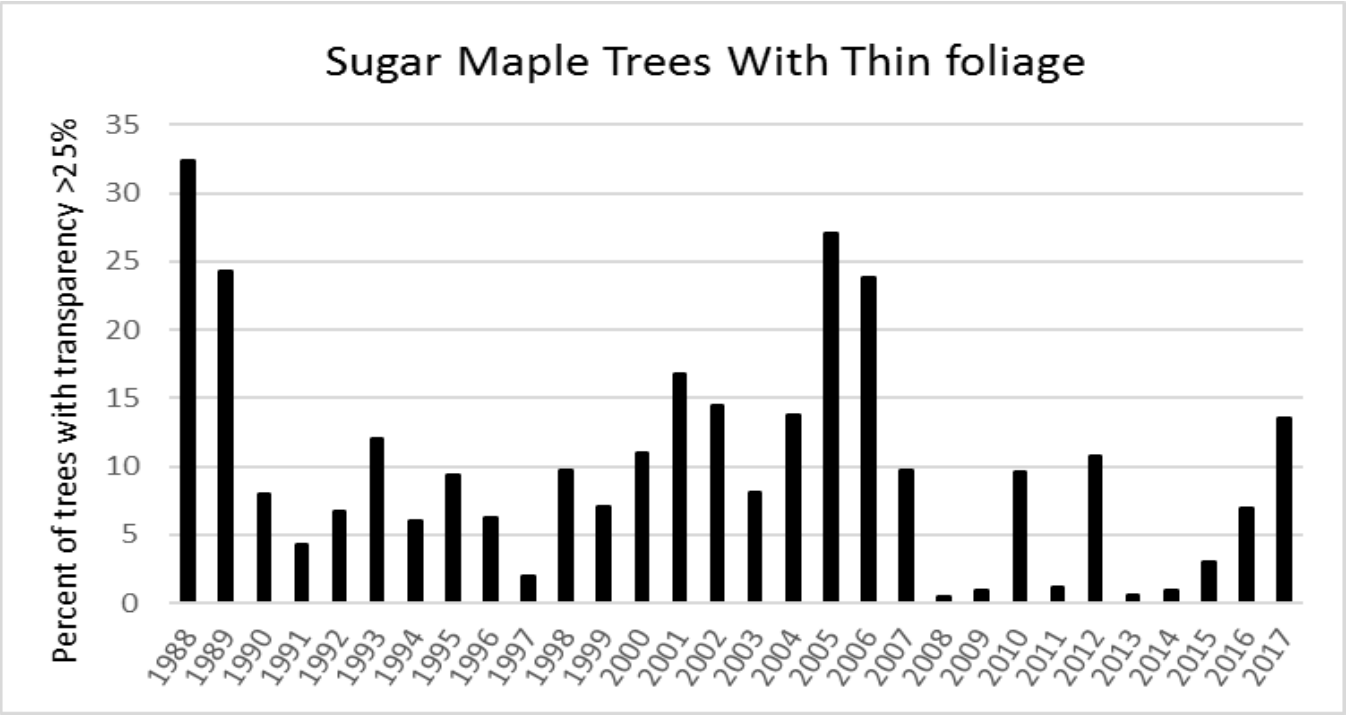


Figure 42. Trend in the percent of overstory sugar maple trees on NAMP plots with thin foliage (>25% foliage transparency). N=1,142 trees at 36 sites.

Table 28. Percent of damage types observed on NAMP sites in 2017.

Damage Agent	Percent of sites
Sugar maple borer	33.1
Cracks/seams	19.2
Other conks	12.8
Eutypella canker	10.9
Other weather damage	8.6
Other canker	7.1
Logging wounds (>20% of circumference)	2.6
Sapsucker damage	2.3
Other animal damage	0.8
Wind thrown/uprooted	0.8
Broken bole	0.4
Nectria canker	0.4
Other borers	0.4
Porcupine damage	0.4

Forest Ecosystem Monitoring Cooperative

Trends in Forest Health at Mt. Mansfield and Lye Brook in 2017

Vermont forest health monitoring plots were sampled at 48 sites across the state in 2017 as part of the Forest Ecosystem Monitoring Cooperative (formerly the Vermont Monitoring Cooperative). Results from the original 23 sites on Mt. Mansfield and Lye Brook Wilderness Area showed a decrease in both average dieback and foliage transparency (Figure 43). An improvement in tree health is also reflected in a reduced number of trees with thin foliage (Figure 44), which reflects current year stress. However, there was an increase in the number of trees with high dieback in 2017 (Figure 45 and 46). Trees showing moderate dieback in 2016 may have been further stressed by the late season drought, leading to further decline.

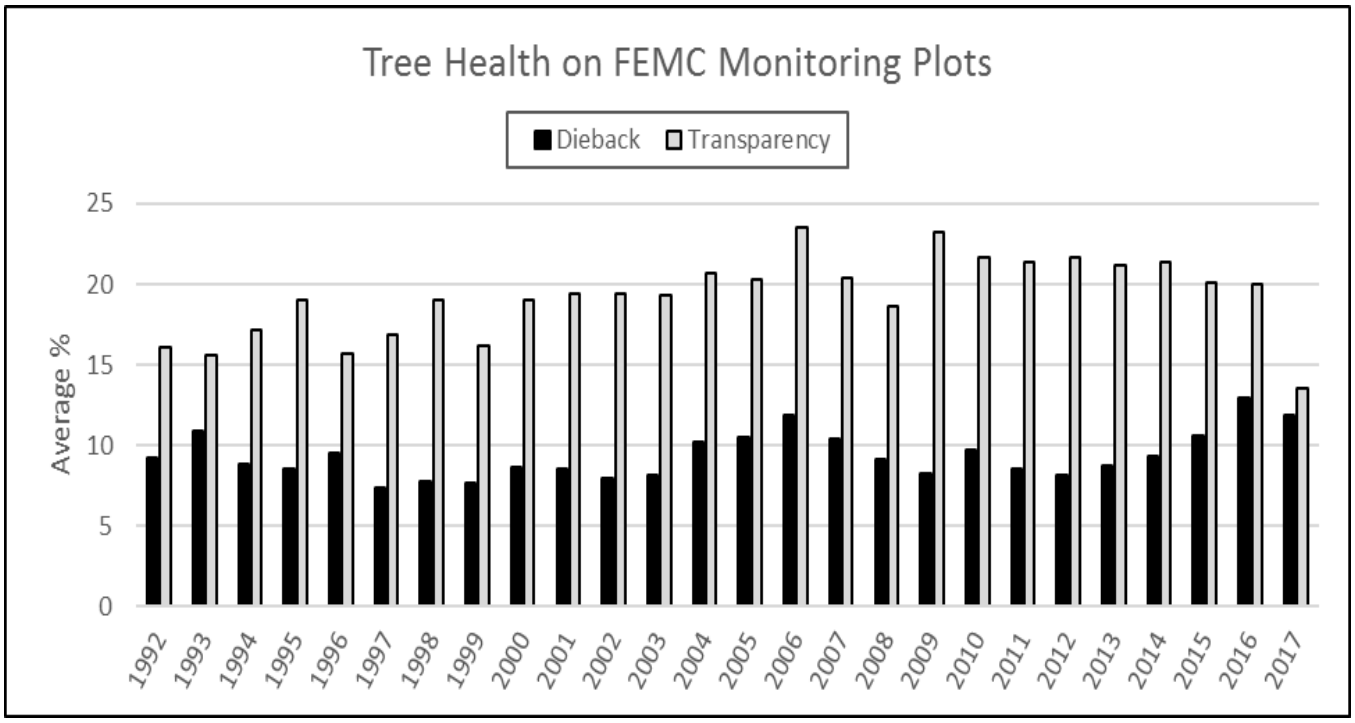


Figure 43. Trend in the average dieback and foliage transparency of overstory trees on 14 monitoring plots on Mt. Mansfield.

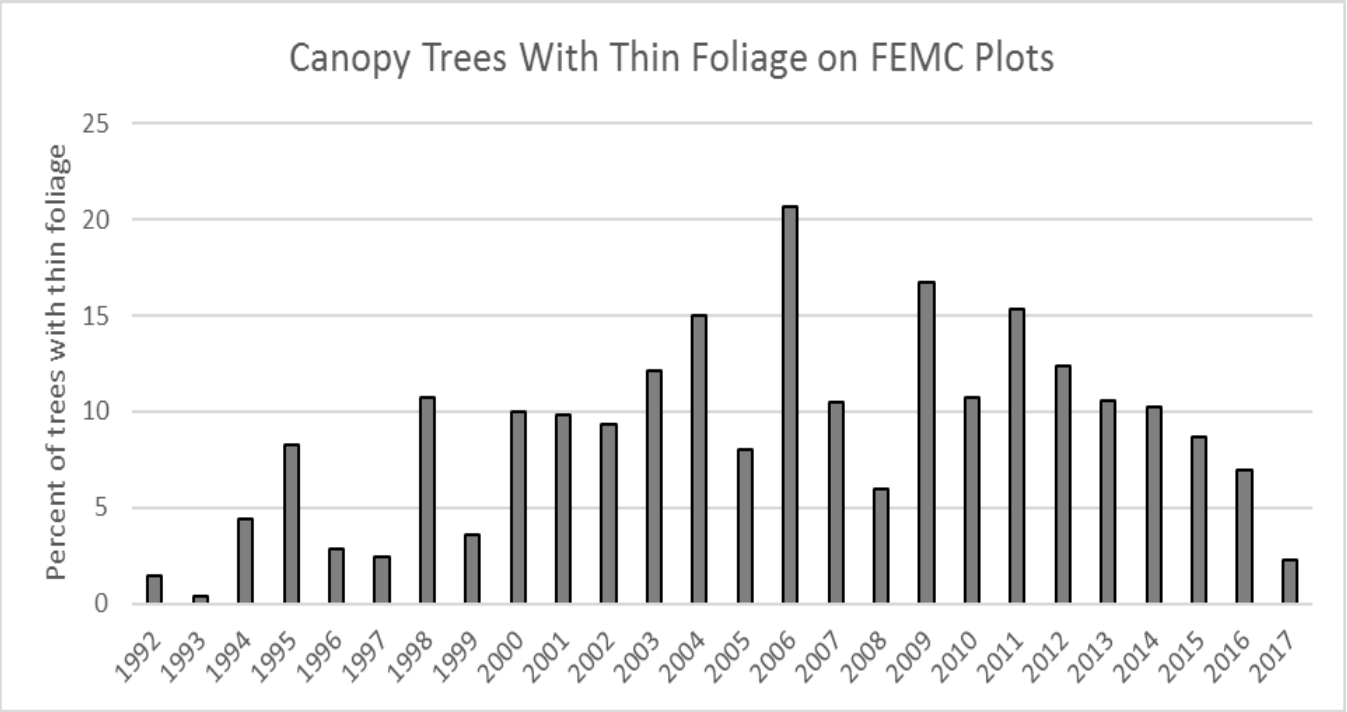


Figure 44. Trend in the percent of overstory trees with thin foliage (>25% foliage transparency) on Mt. Mansfield and Lye Brook plots.

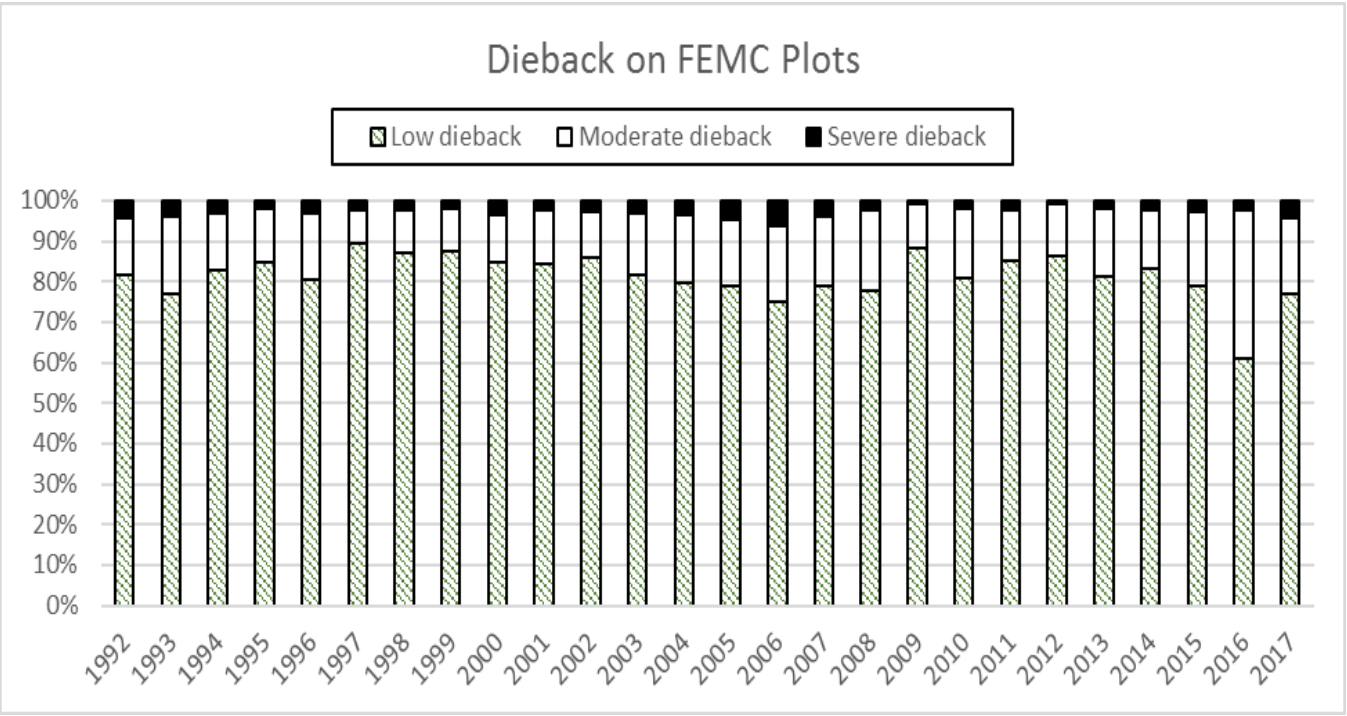


Figure 45. Trend in the percent of overstory trees with low (0-15%), moderate (16-40%) or severe (>40%) dieback on Mt. Mansfield and Lye Brook plots.

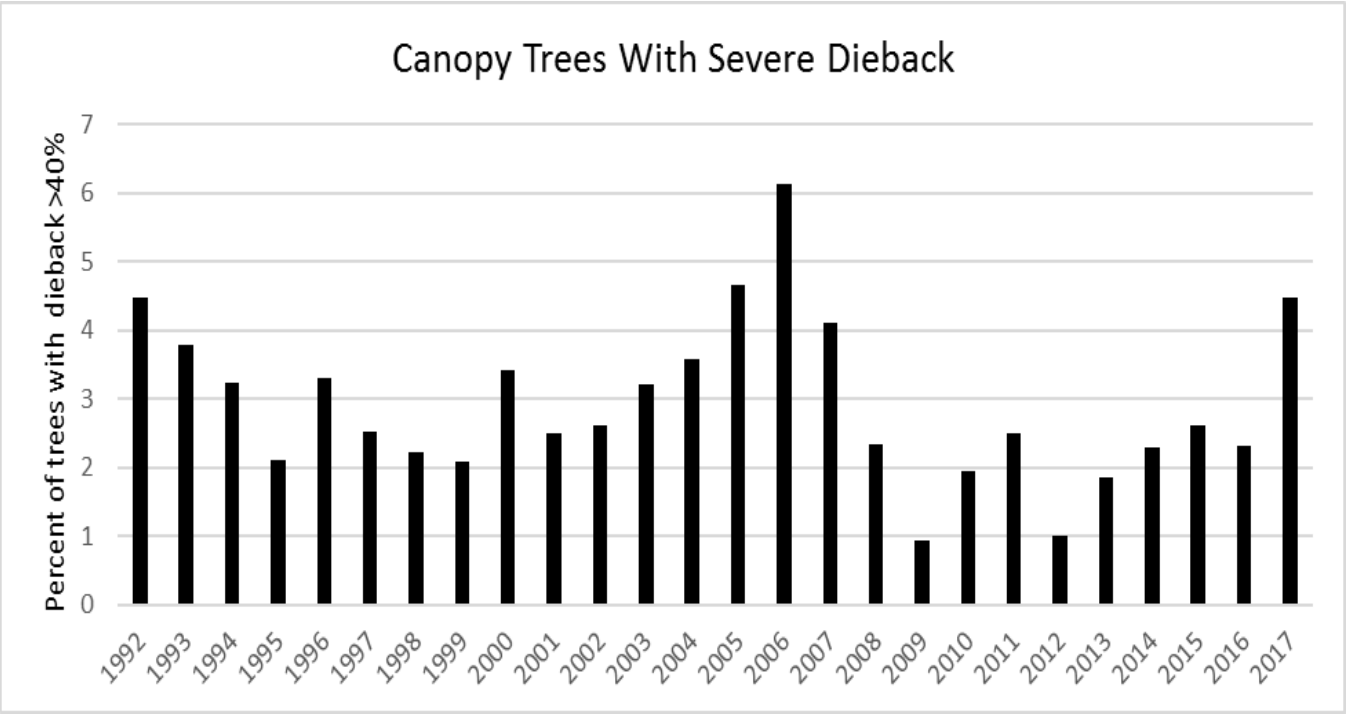


Figure 46. Trend in overstory trees with severe (>40%) dieback on Mt. Mansfield and Lye Brook plots.

Mortality of overstory trees in 2017 was 0.71% at Lye Brook and 2.44% at Mt. Mansfield (Table 29). Mansfield mortality was higher on the west slope plots and on the high elevation plots (>=3000 ft).

Table 29. New dead overstory trees on monitoring plots at Mt. Mansfield and Lye Brook.

	New dead over-story trees (%)
Lye Brook	0.71
Mansfield	2.44
Mansfield west	3.24
Mansfield east	1.23
Mansfield low	1.81
Mansfield high	3.30

Significant tree damages were recorded. Beech bark disease was the most common damage, accounting for 64% of damaged trees (Table 30). Other damages recorded included: cracks or seams (24%), dwarf mistletoe on balsam fir at upper elevations (4%), and sugar maple borer, eutypella canker, sapsucker damage and logging damage (2% each).

Table 30. Percent of total number of damaged trees recorded by special damage types in 2017 on plots at Mt. Mansfield and Lye Brook.

Tree Damage	Percent of damaged trees
Beech bark disease	64
Cracks or seams	24
Dwarf mistletoe	4
Sugar maple borer	2
Eutypella canker	2
Sapsucker damage	2
Logging damage	2