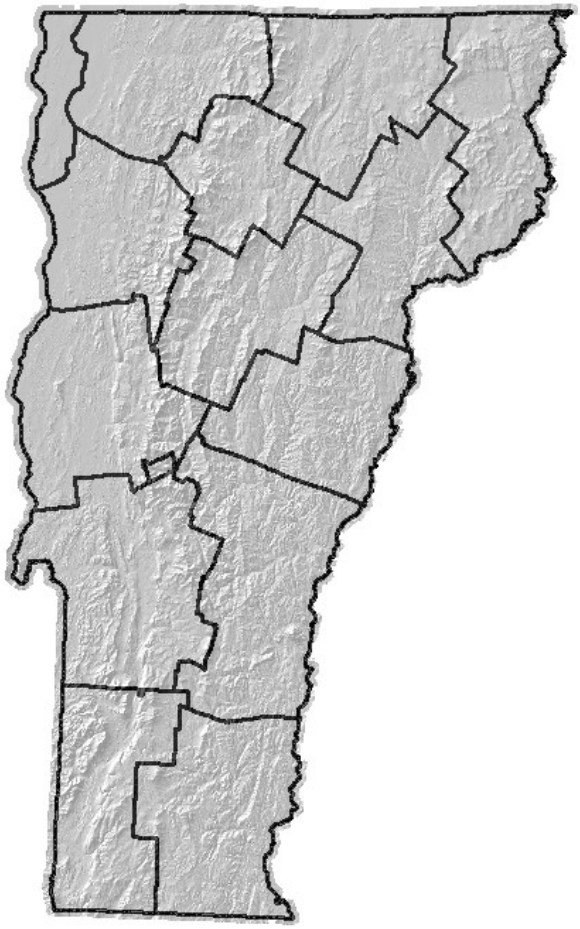
FOREST INSECT AND DISEASE CONDITIONS IN VERMONT 2022



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http://www.vtfpr.org/

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 2022

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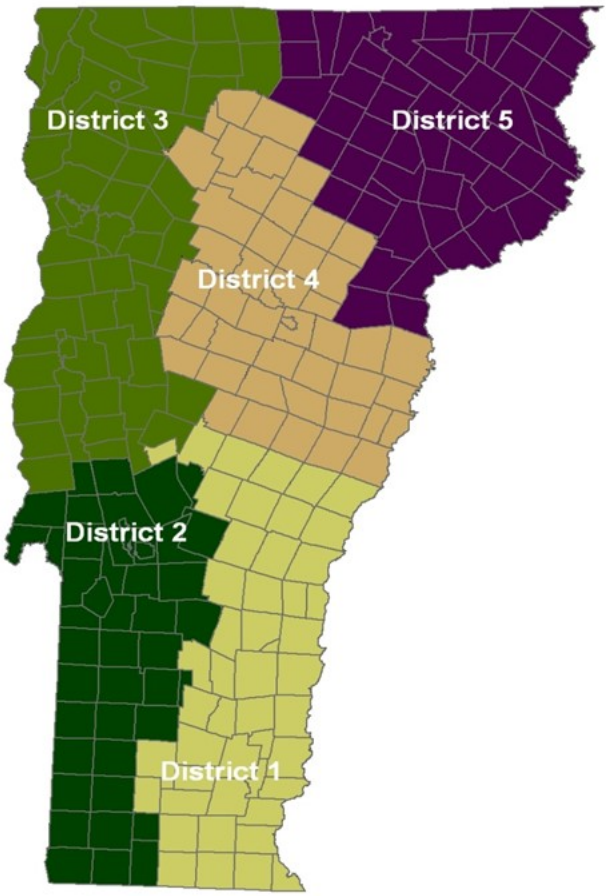

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INTRODUCTION

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, and were funded, in part, by the US Forest Service, State and Private Forestry.

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 Summary. Details follow about weather and phenology, forest insects, forest diseases, animal damage, invasive plants, and trends in forest health.

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 online at https://fpr.vermont.gov/forest/forest-health/current-forest-health-issues-and-updates or in hardcopy format. For additional information, including defoliation maps, management recommendations, and other literature, assistance in identifying pests, diagnosing forest health problems, on-site evaluations, and insect population sampling, or to participate in invasive pest citizen monitoring, contact Forest Protection Personnel or your County Forester.

ACKNOWLEDGEMENTS

Many thanks to everyone who took part in **invasive plant management and outreach** across the state, individually or through groups, towns, Conservation Commissions, CISMAs, other municipal and private organizations across Vermont. These shared efforts are vital for spreading the word and not the plants. Special recognition goes out to our close colleagues at the Agency of Agriculture, Food & Markets, the Agency of Transportation, Forest Hero! Volunteers, Vermont Woodlands Association, VT Coverts: Woodlands for Wildlife.

The **Forest Biology Lab** received taxonomic and other assistance from Dave Adams, Allison Kanoti, Alexandra Kosiba, Andrew Hirsch, Rich Holschuh, Cameron Mcintire, Mike Parisio, Judy Rosovsky, Mike Sabourin, Joellen Stivala, and Patrick Thompson.

Vermonters utilized the **Report It!** feature on the VTinvasives website to report potential cases of invasive fungal pathogens, insect stressors, and early detection of invasive plants. These voluntary submissions help in the early detection and rapid response of invasive species that are not yet established in the state. In addition, reports of EAB suspects helped establish a finer resolution of the extent of the EAB infestation in VT.

Support in many program areas was provided by the 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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2022 PUBLICATIONS AND OUTREACH

Vermont Department of Forests, Parks & Recreation. 2022. Insect and Disease Observations -March 2022. Vermont Forest Health Leaflet 2022. Available at vtforest.com. March 2022.

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Vermont Department of Forests, Parks & Recreation. Bud Buds and Shrub Honeysuckle. Vermont Invasives podcast. https://vtinvasives.org/bud-buds-and-shrub-honeysuckle, 2022.

Outreach

The Vermont Forest Pest Outreach Program, implemented by the Urban and Community Forestry Program and UVM Extension with oversight and funding provided through Vermont Agency of Agriculture, Food and Markets (VAAFM), reached 753 people at workshops, presentations, and trainings and an estimated 39,988 people were exposed to forest pest educational material through exhibits, newsletters, radio, and social media messaging.

On-line Forest Pest First Detector Training for Birders: We offered an eight-week, online Forest Pest First Detector curriculum in partnership with the Vermont Agency of Agriculture, Food and Markets; the Vermont Department of Forests, Parks, and Recreation; Audubon Vermont; the Vermont Center for Ecostudies; and the Vermont Fish and Wildlife Department. New content focused on the impact of invasive pests on forest ecology, the ripple effects these pests can have on other organisms, especially birds, and overall forest health. The course included six live webinars and three in-person field trips. The field trips involved hands-on training to monitor for hemlock woolly adelgid forest management practices for birds and forest health; and a visit to an emerald ash borer biocontrol release site.

A total of 115 people from 72 Vermont municipalities, five other states, and Canada, registered for the course. At the conclusion of the course, 36 participants volunteered to become Forest Pest First Detectors to monitor pests and educate others in 24 municipalities in Vermont and two in New Hampshire. As of mid-August 2022, these volunteers had conducted direct education in at least seven communities reaching at least 120 individuals, and indirect outreach in at least 11 towns, reaching a minimum of 445 people. Their activities included writing articles for local newsletters and newspapers; giving presentations to garden clubs and senior centers; hosting an invasive-pest themed birthday party; posting information on social media; visiting suspect trees; making displays for local libraries; posting information on community bulletin boards; and engaging landowners and neighbors in conversations about invasive insects and pathogens and the importance of cleaning gear and not moving firewood as preventive measures.

Technical Assistance: worked with Addison County Community Trust, a housing trust, to inventory ash and other trees at their mobile home park in Vergennes, and make recommendations for ash management.

Hosted webinars:
The Forest Pest Outreach Program (FPOP) had been primarily focused since 2018 on EAB and hemlock woolly adelgid. In 2022 the program broadened its education and outreach to include both other invasive pests that are likely to be established in Vermont soon, such as spotted lanternfly and important vectors, such as firewood.
Invasive Earthworms and their Effect on Forest Soils and Vegetation (Josef Gorres)
Status of hemlock woolly adelgid and elongate hemlock scale in Vermont and the potential effects of climate change (Jim Esden and Savannah Ferreira)
Ecological, silvicultural, and cultural consideration for ash preservation in northern forests (Tony D'Amato)

Podcast Series:
The Forest Pest Outreach Program partnered with Our Vermont Woods and Vermont Coverts to produce two episodes for their podcast series, Heartwood, http://ourvermontwoods.org/heartwood. The cultural and ecological significance of black ash in the face of EAB: check it out here (episode 6). In Episode 7, they spoke with city arborists and conservationists about the relationship between diversity of tree species in urban forests and resilience to invasive forest pests.

Created New Educational Materials: Our team designed and distributed new handouts and posters on spotted lanternfly and tree of heaven.

WEATHER

2022 WEATHER SUMMARY

Winter 2021-2022

Vermonters faced a slightly colder and wetter winter of 2021- 2022, compared to years past. From December 1 to February 28, state-wide temperatures averaged 20.9°F, which was 1.2 degrees colder than the winter of 2020–2021. Average precipitation across the state was 7.99 inches, which was 0.14 inches more than last year's average.

Abnormally dry conditions were less common during the 2021-2022 winter than the year before, but persisted in northeastern Vermont. By the end of winter, most of the northern half of the state was experiencing abnormally dry conditions, though this lessened in the spring.

Spring 2022

By the end of April, most locations in the state were no longer experiencing abnormally dry conditions, and were receiving average, if not elevated, amounts of rainfall (Figs. 1-6). Although May rain totals were below average at our weather stations (Fig. 1-6), the entire state was free of any signs of drought by the end of the month. However, by the end of June over 70% of the state returned to abnormally dry conditions. This was not a year of heavy flowering for Vermont forests.

Summer 2022

July brought increased temperatures to much of the state which, coupled with lower rainfall totals, continued a drying trend in parts of the state. By the end of July, nearly 40% of the state was experiencing moderate drought and another 23% was listed as abnormally dry. August conditions were near normal for temperature but with lower than average precipitation. Drought conditions covered the state by the end of the month. September brought with it increased precipitation which helped to reduce the portion of the state affected by drought, but far southern and central Vermont continued to be categorized as abnormally dry.

Fall 2022

Average temperatures in October were 2 degrees warmer than the long-term (20-yr) average, whereas November temperatures were more than 4 degrees warmer than average.

Some mountain summits received their first snowfall in late October, but snow evaded most of the state until late November. However, precipitation was sufficient enough to bring the proportion of the state unaffected by drought up to 75% by mid-December.

Figures 1-9 *and* ***Tables 1-3*** *provide details on 2022 precipitation and phenological observations.*

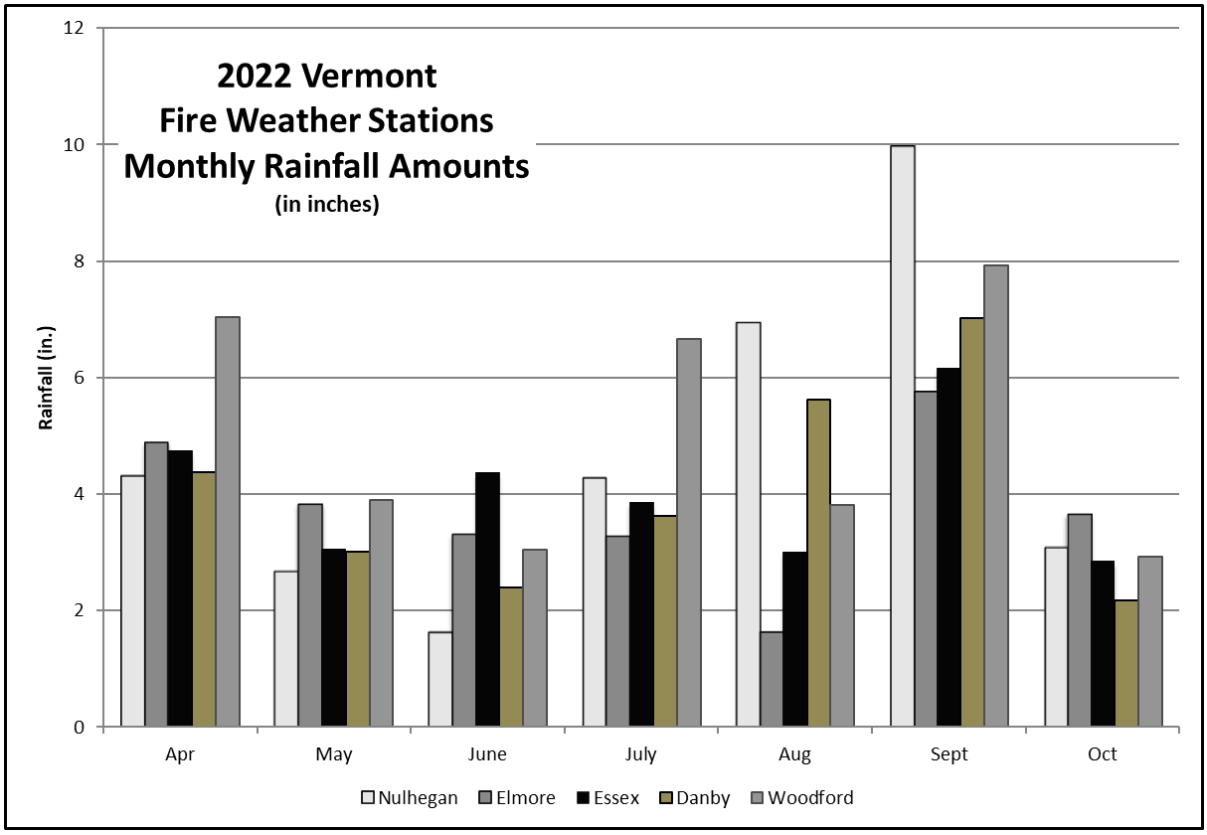

Figure 1. Monthly rainfall amounts (in inches) at Vermont fire weather observation stations through fire season, April-October, 2022.

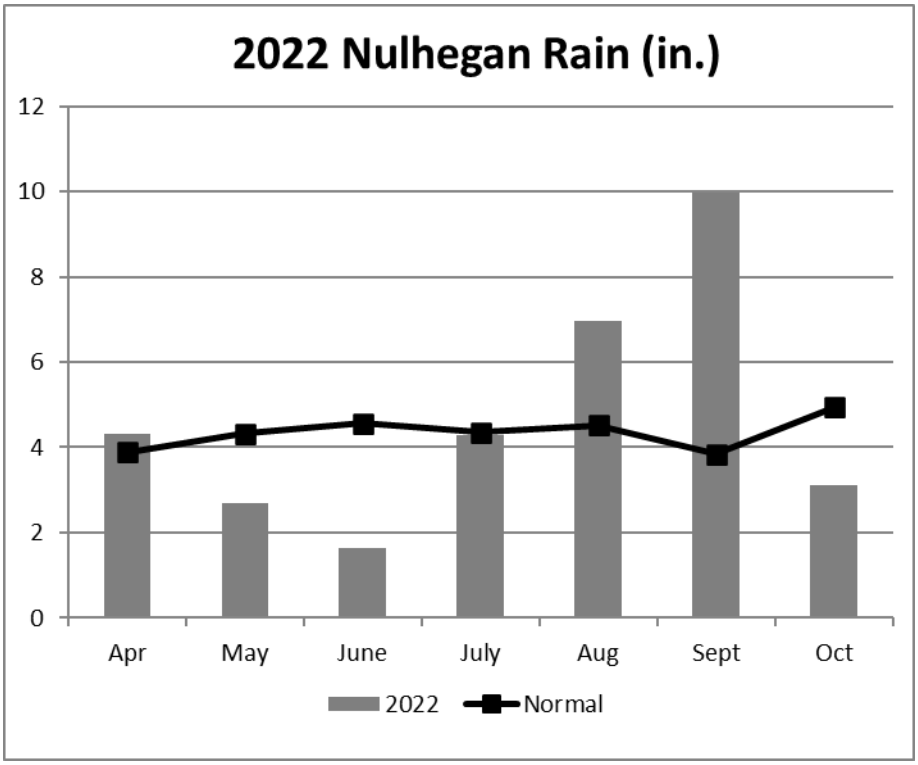

Figure 2. Monthly rainfall amounts (in inches) at the Nulhegan fire weather observation station in Brunswick, VT compared to normal during the fire season, April-October, 2022. Normal is based on 20 years of data.

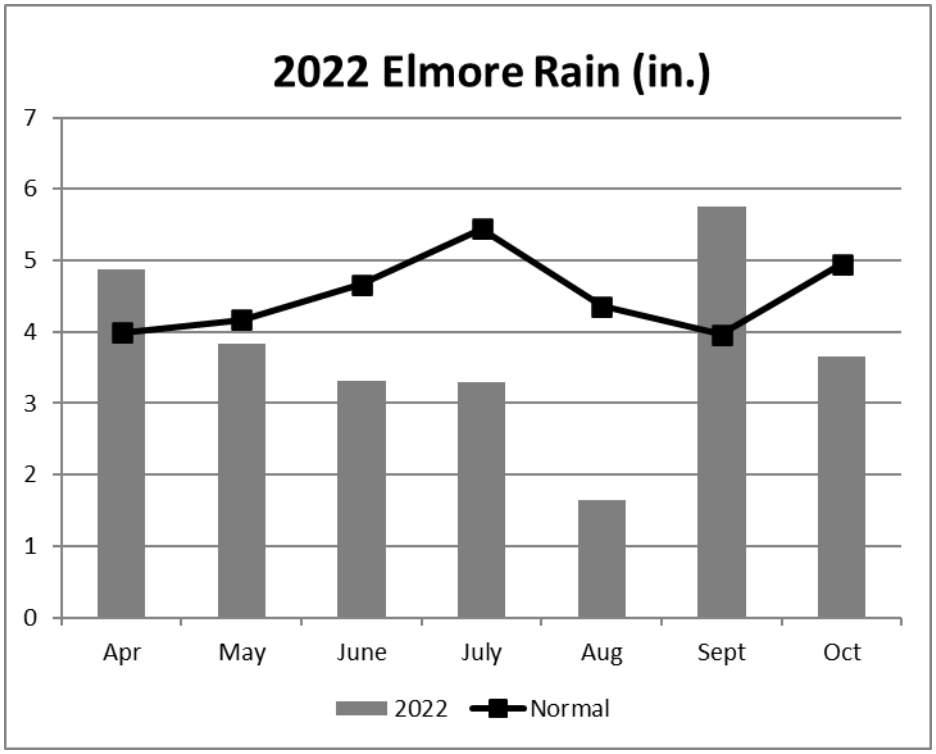

Figure 3. Monthly rainfall amounts (in inches) at the fire weather observation station in Elmore, VT compared to normal during the fire season, April-October, 2022. Normal is based on 28 years of data.

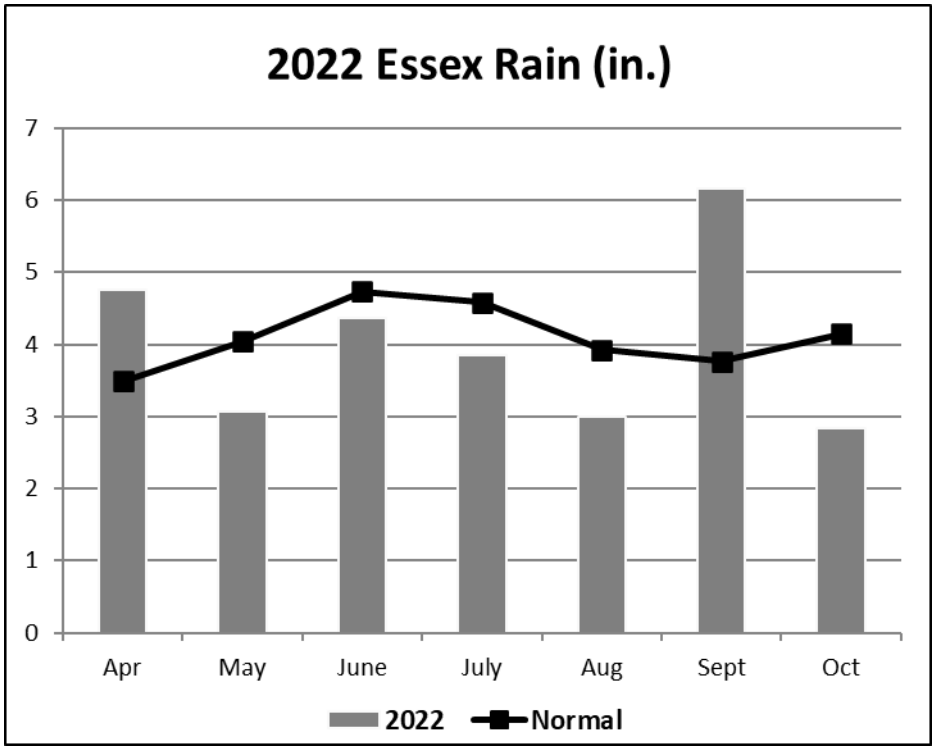

Figure 4. Monthly rainfall amounts (in inches) at the fire weather observation station in Essex, VT compared to normal during the fire season, April-October, 2022. Normal is based on 29 years of data.

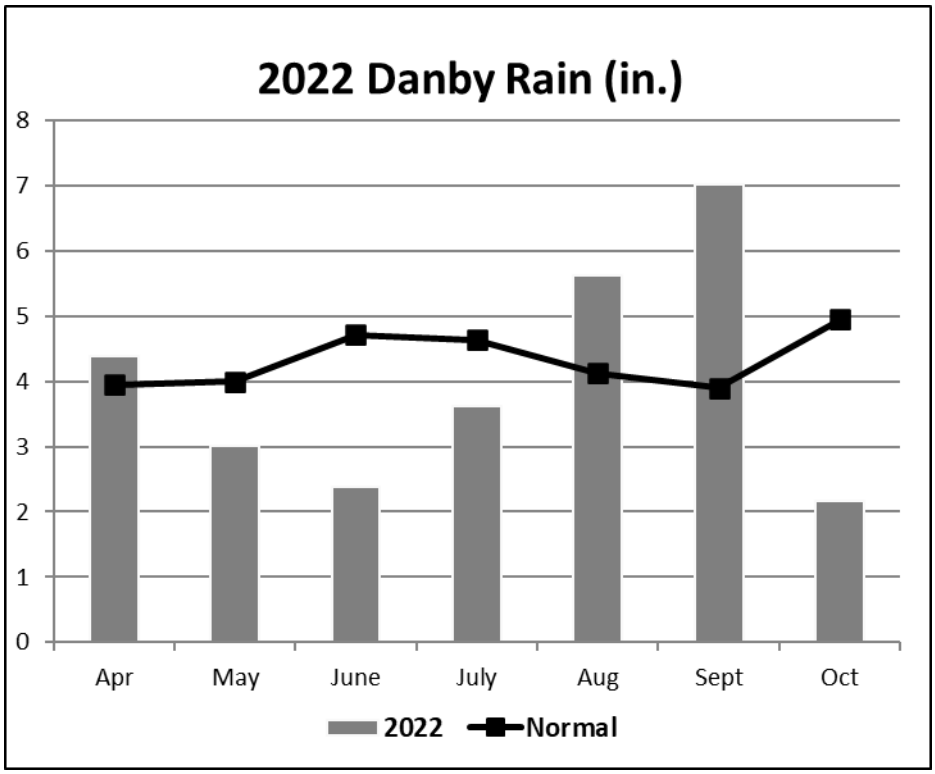

Figure 5. Monthly rainfall amounts (in inches) at the fire weather observation station in Danby, Vermont compared to normal during the fire season, April-October, 2022. Normal is based on 22 years of data.

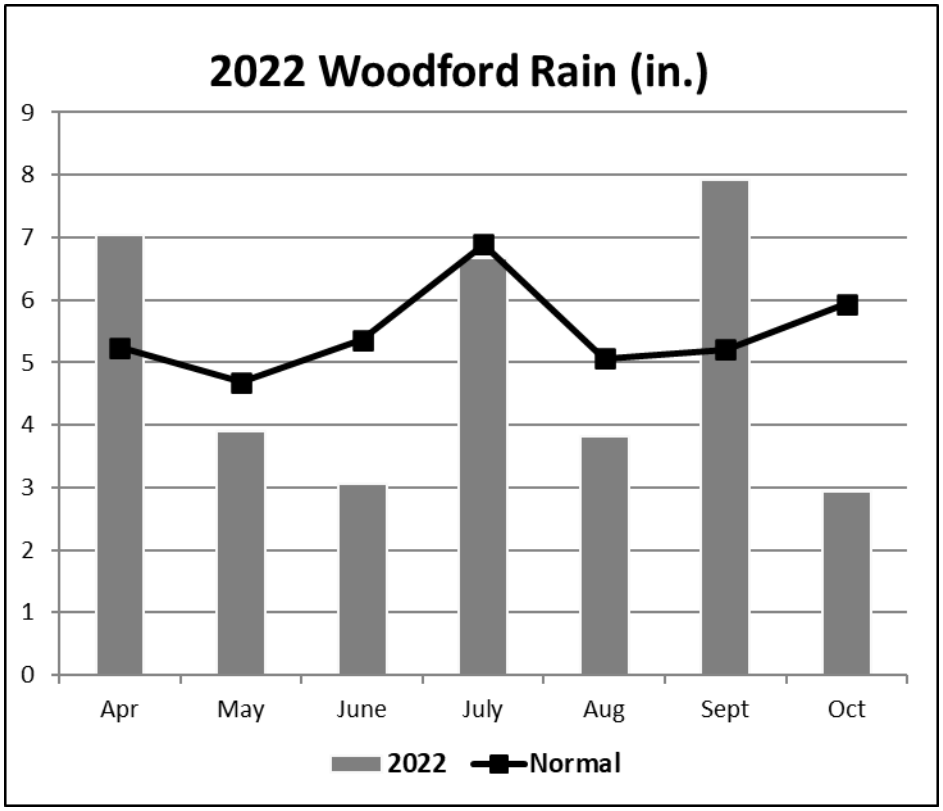

Figure 6. Monthly rainfall amounts (in inches) at the fire weather observation station in Woodford, Vermont during the fire season, April-October, 2022. Normal is based on 10 years of data.

PHENOLOGY

2022 PHENOLOGY SUMMARY

Spring Budbreak 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. Spring phenology progressed very similar to the long-term average, with budbreak occurring on May 5 (just slightly earlier than the long-term average of May 3), and full leaf out occurring on May 16 (Figure 7, Figure 8). We did not observe heavy flowering of sugar maple in 2022.

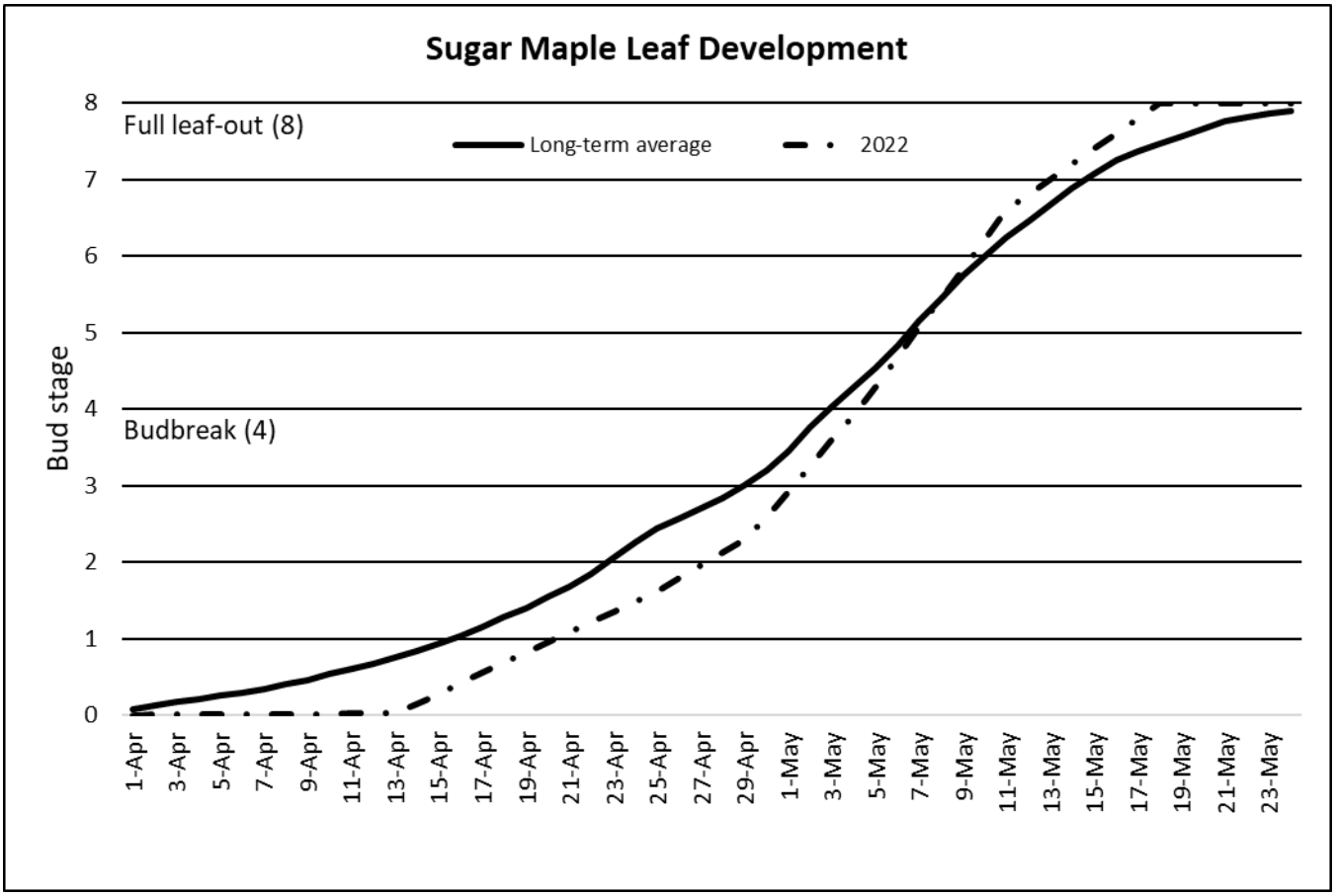

Figure 7. Sugar maple budbreak and leaf-out at Proctor Maple Research Center, Underhill, VT.

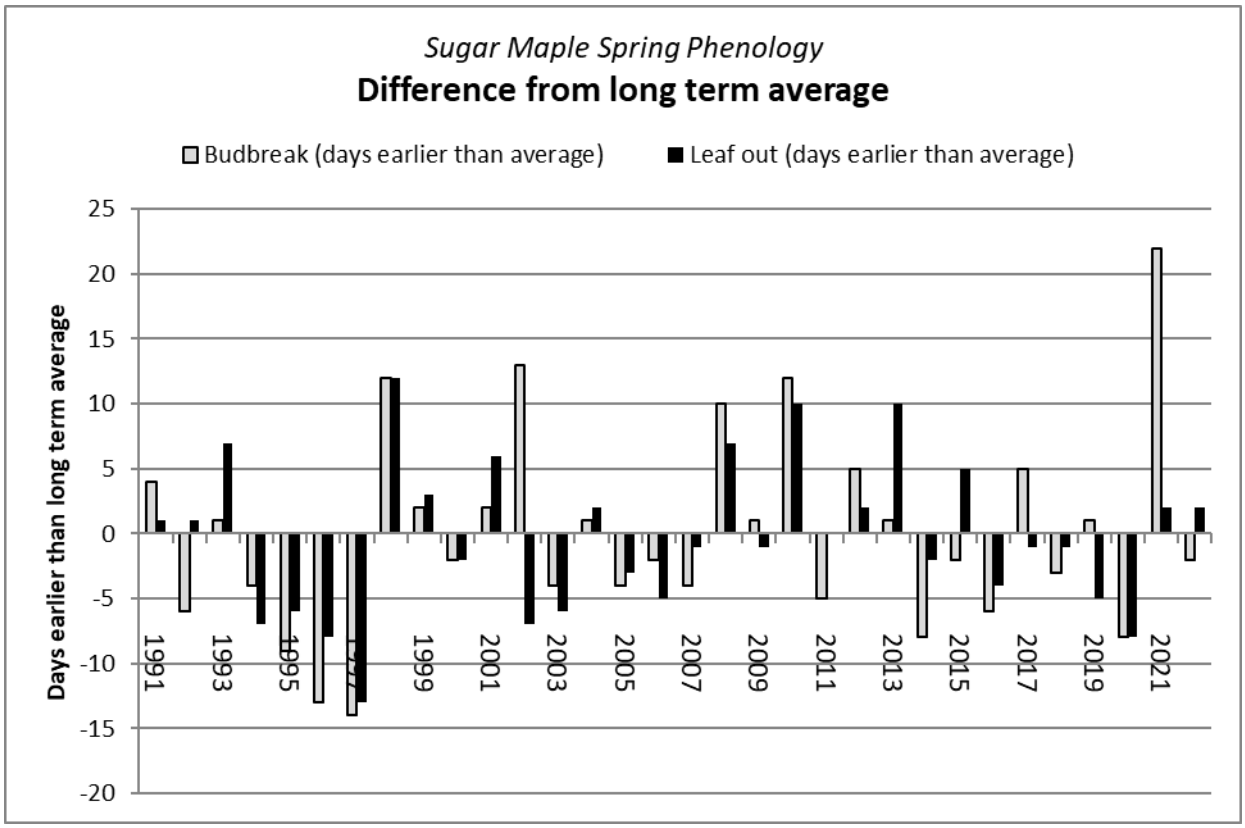

Figure 8. Difference from long-term average of sugar maple budbreak and leaf out at Proctor Maple Research Center, Underhill, VT.

Fall Color Monitoring at Mount Mansfield

Trees at three elevations in Underhill at the base of Mount Mansfield were monitored for the timing of peak fall color and leaf drop (Fig. 9). Field data recorded included the percent of tree expressing fall color, as well as the portion of the crown where leaves have fallen. These two measures are integrated to yield an "estimated color" percentage, which helps to indicate when a given tree has the most foliage with the most color present in the fall.

Peak color at our highest elevation (2600') was slightly earlier than the long-term average, but was similar to the long-term average at other elevations (1400' and 2200'). Maples (both red and sugar) at 1400' dropped their leaves earlier than average in 2022. At upper elevations (2200' and 2600') leaves fell slightly earlier than usual as well. The growing season length for sugar maples at 1400' was slightly longer than the average (Table 3) but not as long as in 2021 (206 days).

Figure 9. Timing of fall color (Figure 9a-9f) and leaf drop was monitored at three elevations on Mount Mansfield in 2022: 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.

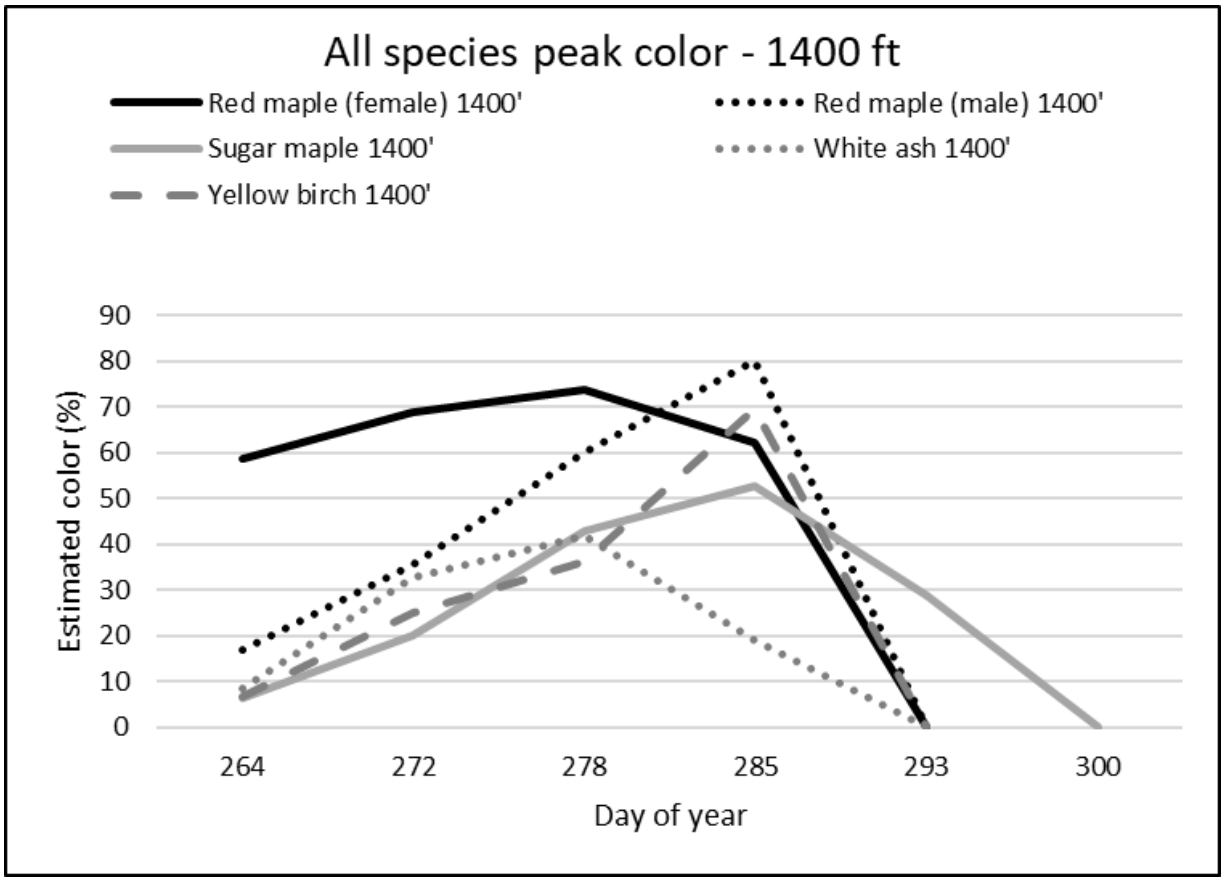

Figure 9a.

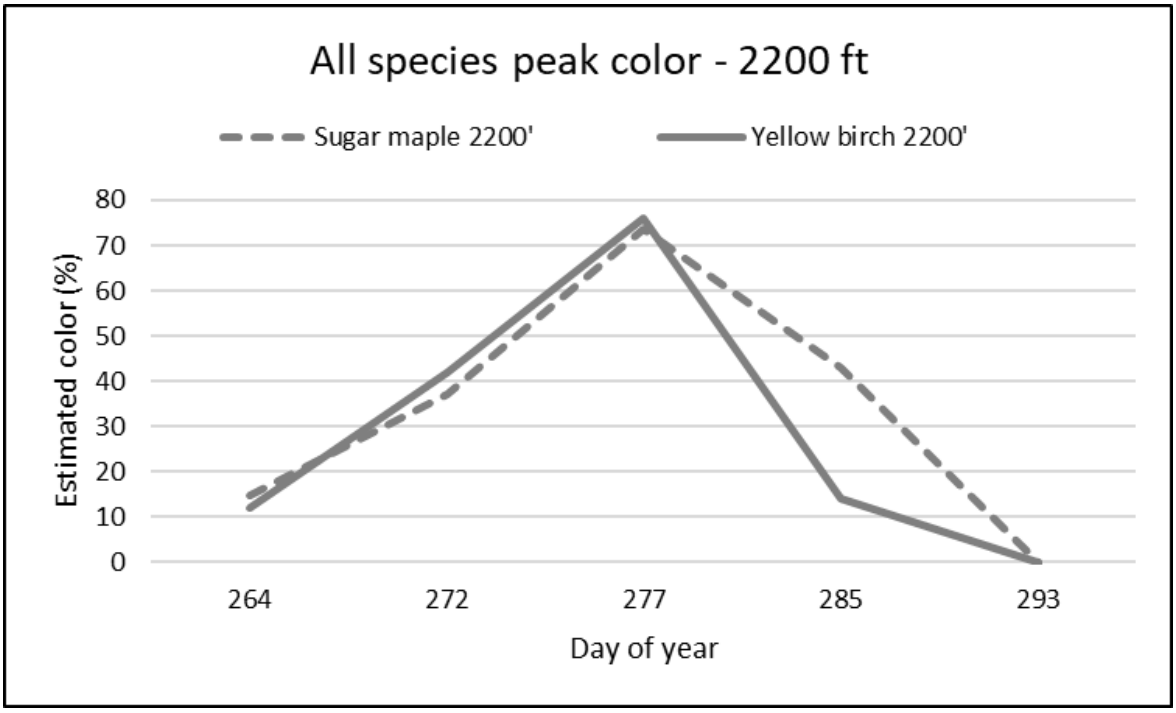

Figure 9b.

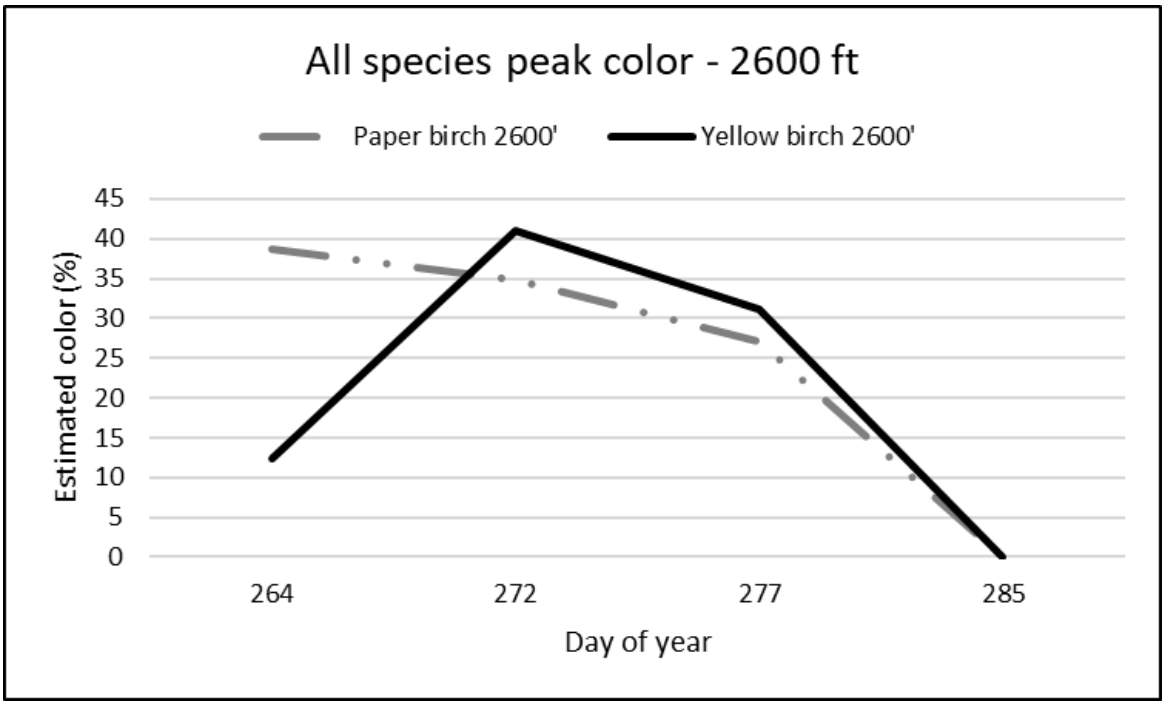

Figure 9c.

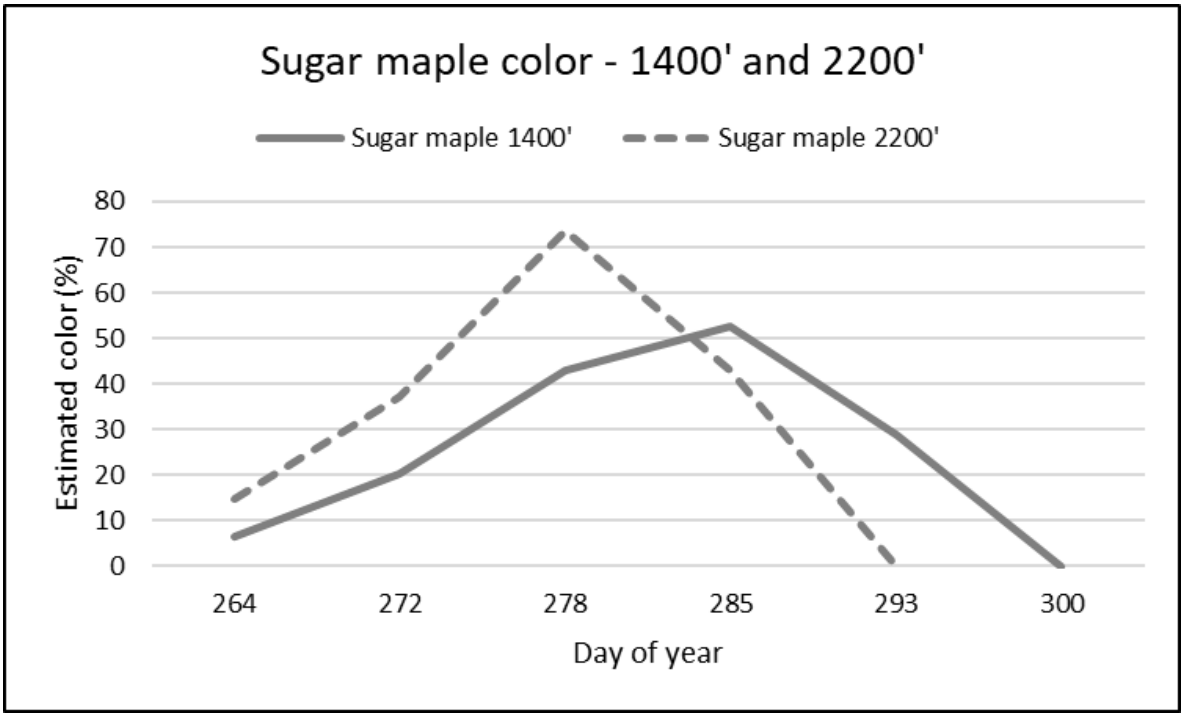

Figure 9d.

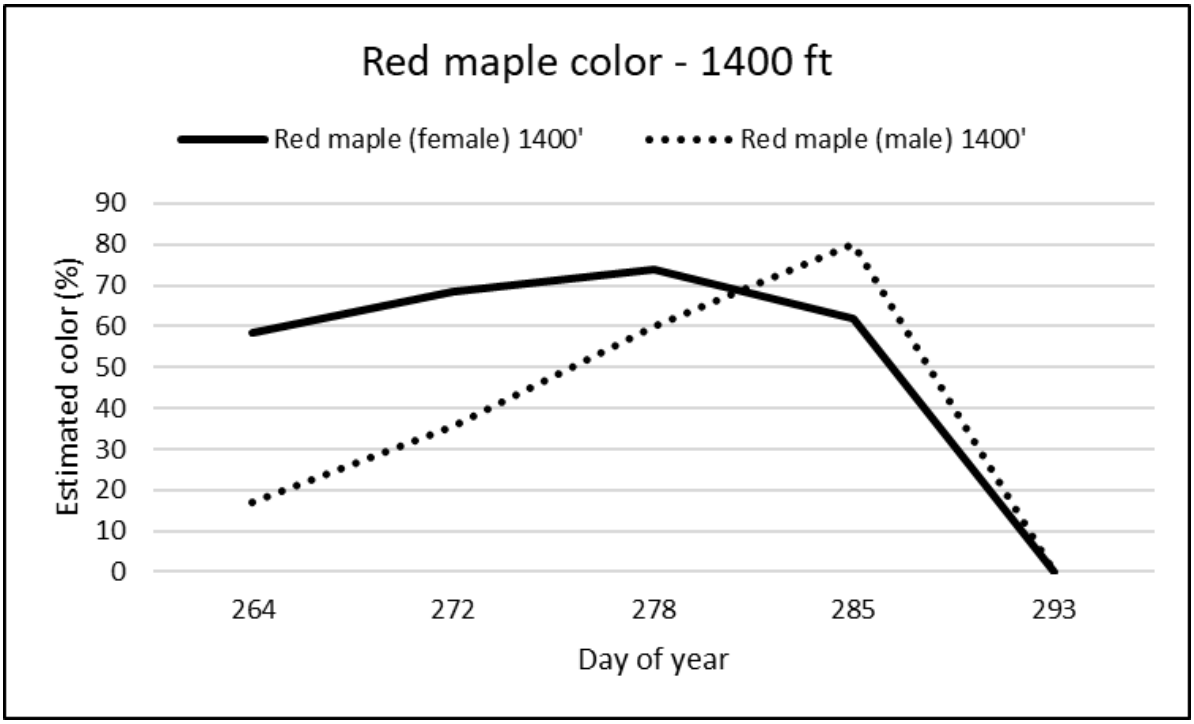

Figure 9e.

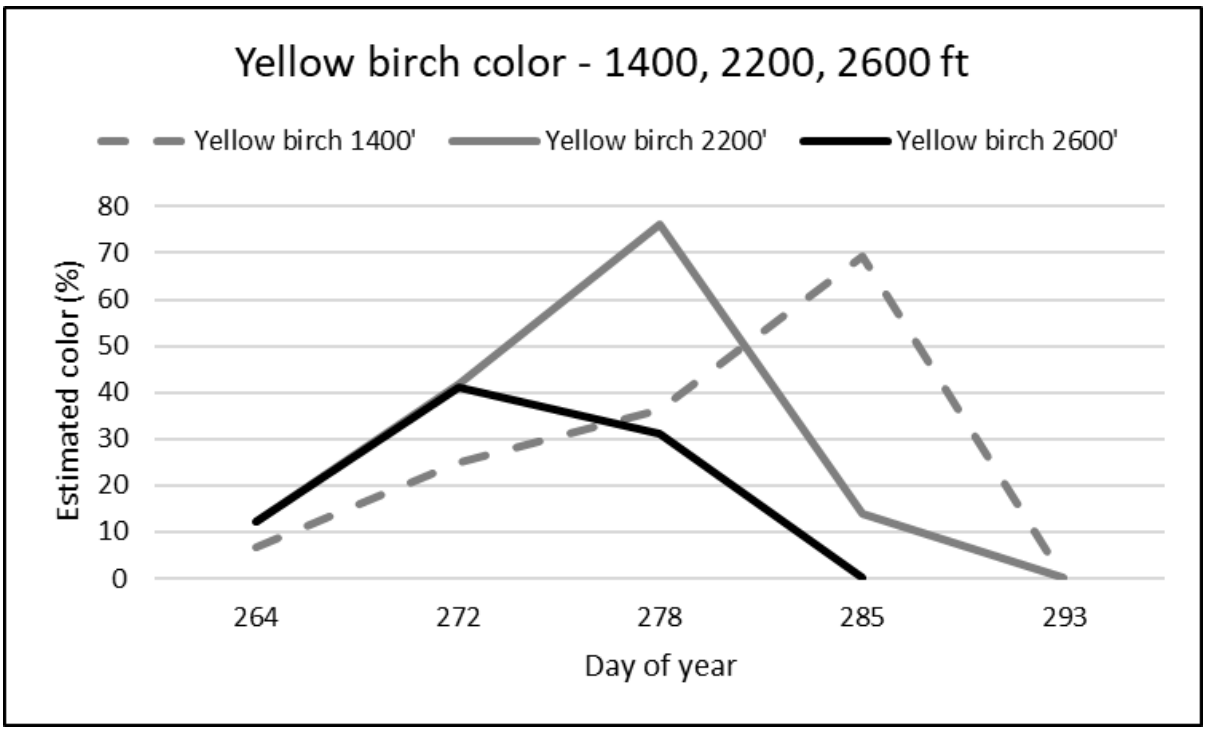

Figure 9f.

Table 1. Estimates of peak color based on percent color and percent of foliage present. Length of long-term averages differ by species, with trees at 2600 ft having a 24-year record, red maple and white ash a 28-year record, sugar maple at 1400 ft a 32-year record, and all other trees a 31-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)	2022 data (Day of year)
Elevation 1400'		
Red maple (Female)	281	278
Red maple (Male)	284	285
Sugar maple	287	285
Yellow birch	285	285
White ash	279	278
Elevation 2200'		
Sugar maple	277	277
Yellow birch	276	277
Elevation 2600'		
Yellow birch	276	272
Paper birch	269	264

Table 2. Date of leaf drop for trees at 3 elevations on Mt. Mansfield. Day of year when more than 95% of foliage had fallen are included for both 2022, and the long-term average (see Table 1 for details on length of long-term averages).

Leaf drop		
	> 95% leaf drop	
	Long-term average (Day of year)	2022 data (Day of year)
Elevation 1400'		
Red maple	299	293
Red maple	300	293
Sugar maple	303	299
Yellow birch	298	293
White ash	296	291
Elevation 2200'		
Sugar maple	295	293
Yellow birch	292	291
Elevation 2600'		
Yellow birch	289	284
Paper birch	286	284

Table 3. Average dates of sugar maple budbreak, end of growing season (leaf drop), and length of the growing season at the Proctor Maple Research Center in Underhill, VT.

Year	Date of Bud break	Date of End of Growing Season	Length of growing season (days)
1991	28-Apr	15-Oct	171
1992	7-May	13-Oct	159
1993	4-May	18-Oct	167
1994	6-May	14-Oct	161
1995	13-May	19-Oct	159
1996	14-May	22-Oct	161
1997	16-May	14-Oct	151
1998	17-Apr	15-Oct	181
1999	5-May	19-Oct	167
2000	9-May	17-Oct	161
2001	4-May	15-Oct	164
2002	18-Apr	5-Nov	201
2003	9-May	28-Oct	172
2004	4-May	27-Oct	175
2005	2-May	27-Oct	178
2006	2-May	16-Oct	167
2007	7-May	22-Oct	168
2008	22-Apr	15-Oct	175
2009	30-Apr	29-Oct	182
2010	22-Apr	26-Oct	187
2011	7-May	19-Oct	163
2012	16-Apr	16-Oct	186
2013	3-May	15-Oct	165
2014	12-May	20-Oct	161
2015	6-May	30-Oct	177
2016	9-May	31-Oct	175
2017	29-Apr	29-Oct	183
2018	7-May	30-Oct	176
2019	3-May	26-Oct	176
2020	11-May	24-Oct	167
2021	12-Apr	4-Nov	206
2022	5-May	27-Oct	175
Long term Average (1991-2022)	**3-May**	**22-Oct**	**172**

HARDWOOD DEFOLIATORS

Forest Tent Caterpillar (FTC), *Malacosoma disstria*, is a native hardwood defoliator of sugar maple, poplars, oaks and other hardwoods. In 2022, no reports of defoliation were received, nor were incidental observations or defoliation recorded by aerial detection surveys. Twenty two traps were once again deployed in 2022 to assess current FTC populations and gauge the risk of defoliation in 2023. The average number of moths per trap declined again this year (0.15 moths/trap) from the already low number observed in 2021 (0.26 moths/trap; Figure 10, Table 4).

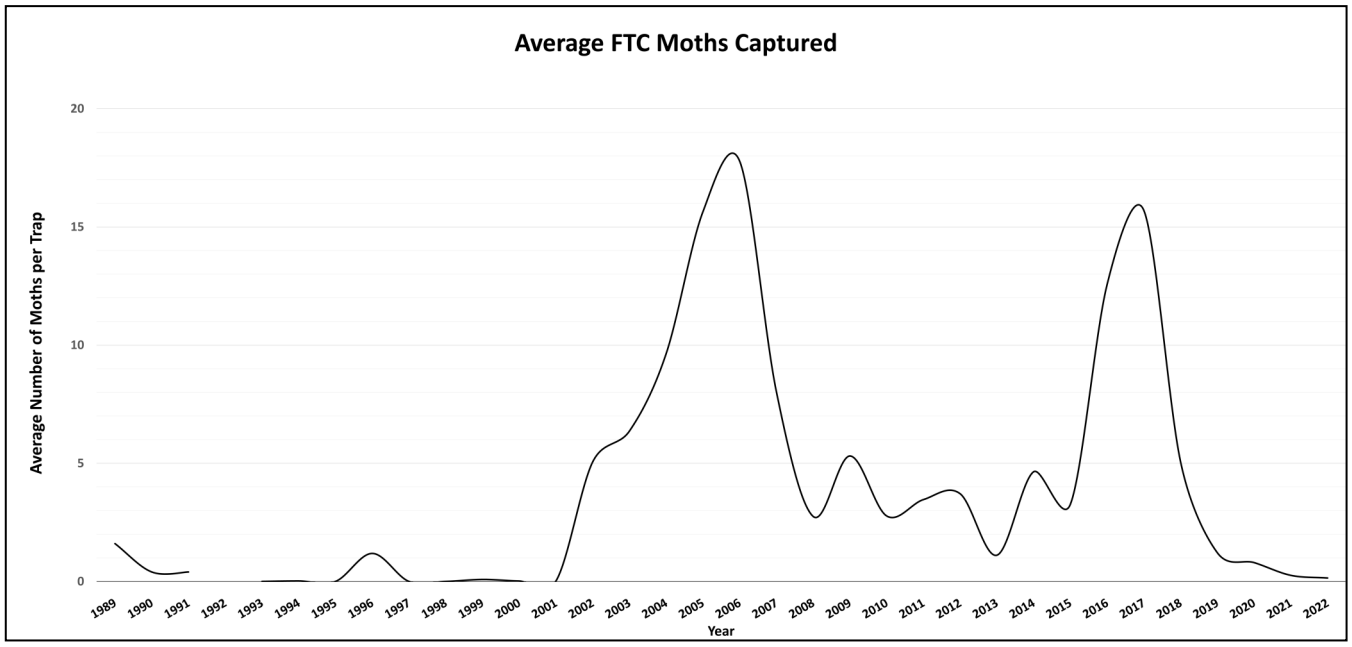

Figure 10. Average number of forest tent caterpillar moths caught in pheromone traps 1999-2022. Populations were not monitored in 1992. Three multi-pher pheromone traps per site, with PheroTech lures, were used in 2022.

Table 4. Average number of forest tent caterpillar (FTC) moths caught in pheromone traps, 2007-2022. Three multi-pher traps baited with PheroTech lures were deployed at each of the 22 survey locations.

Site	Year															
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Castleton	8.0	1.5	4.7	1.0	1.7	0.3	2.3	1.7	1.7	14.0	13.3	8.7	0.7	1.3	0.3	0.0
Fairfield (NAMP 29)	4.7	4.0	10.3	2.0	6.0	4.0	1.7	3.3	1.3	1.3	8.0	2.0	0.0	0.3	0.0	0.0
Huntington (NAMP 027)	6.3	4.3	4.3	2.7	6.3	6.0	1.7	2.7	0.0	10.3	11.0	6.0	0.7	0.0	0.0	0.0
Killington/ Sherburne (Gifford Woods)	17.3	7.3	8.0	2.7	0.0	1.0	0.7	6.0	5.3	8.3	18.7	6.7	0.3	0.0	0.0	0.0
Manchester	-	0.0	5.7	3.0	1.0	0.7	0.3	1.3	10.3	12.0	19.3	3.7	0.7	0.3	0.0	0.0
Rochester (Rochester Mountain)	10.3	0.7	-	0.3	0.0	0.0	0.0	3.5	2.3	9.0	7.3	2.0	0.0	0.3	0.0	0.0
Roxbury (Roxbury SF)	22.7	8.0	2.7	7.0	2.0	1.5	1.7	6.3	8.5	29.0	15.0	3.3	0.3	0.0	0.0	0.0
SB 2200 (Stevensville Brook)	6.3	5.7	7.3	2.7	6.3	8.0	1.3	5.3	2.7	7.3	29.0	6.7	-	0.3	0.0	0.0
Underhill (VMC 1400)	2.7	1.3	8.3	5.7	8.3	7.7	0.3	5.7	0.7	14.3	11.3	2.7	1.0	0.3	0.0	0.0
Underhill (VMC 2200)	4.7	1.3	4.3	2.0	2.7	4.7	0.7	2.5	1.3	3.7	9.0	3.0	0.3	0.0	0.0	0.0
Waterbury (Cotton Brook)	0.3	1.0	5.0	3.3	4.3	7.0	0.3	9.3	5.7	36.3	15.7	3.3	0.3	0.3	0.0	0.5
Waterville (Codding Hollow/ Locke)	2.7	2.3	1.3	3.0	4.3	3.0	1.5	12.5	3.3	13.3	28.3	13.3	2.7	1.3	0.0	1.5
Stowe (VMC 3800)	5.0	1.3	1.7	0.7	2.0	2.3	1.3	1.7	-	-	-	-	-	-	-	-
Valley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dillner Farm (Montgomery)	-	-	-	-	-	-	-	-	1.0	4.3	18.0	4.3	0.0	0.0	0.0	0.0
Vershire (NAMP 37)	-	-	-	-	-	-	-	-	-	-	-	-	1.7	0.3	0.0	0.0
Wilmington (NAMP 25)	-	-	-	-	-	-	-	-	-	-	-	-	2.7	4.7	0.0	0.0
Westminster (NAMP 21)	-	-	-	-	-	-	-	-	-	-	-	-	0.7	0.0	0.0	-
Woodstock (NAMP 24)	-	-	-	-	-	-	-	-	-	-	-	-	1.0	2.0	.7	0.0
Lincoln (NAMP 34)	-	-	-	-	-	-	-	-	-	-	-	-	1.0	0.0	0.0	0.0
Lahar NAMP	-	-	-	-	-	-	-	-	-	-	-	-	1.0	0.7	1.3	0.5
Glover (NAMP 1)	-	-	-	-	-	-	-	-	-	-	-	-	1.0	1.0	0.0	0.0
Norton	-	-	-	-	-	-	-	-	-	-	-	-	8.3	4.0	1.7	0.0
Victory (Victory SF)	-	-	-	-	-	-	-	-	-	-	-	-	1.0	0.3	0.3	0.0
Rupert (Merck Forest)	-	-	-	-	-	-	-	-	-	-	-	-	1.3	0.7	1.3	0.0
Average	**8.0**	**2.8**	**5.3**	**2.8**	**3.5**	**3.7**	**1.1**	**4.6**	**3.3**	**12.6**	**15.7**	**5.1**	**1.2**	**0.8**	**.3**	**0.2**

Maple leafcutter (MLC), *Paraclemensia acerifoliella,* damage is predominately found on sugar maples, although this insect also feeds on other hardwoods such as red maple, beech, and birch species.
This insect caused observable damage to hardwoods during late summer and early autumn in 2021, causing 27,791 acres of mapped damage (Figure 11). In 2022, observable damage decreased dramatically across the state, with only 1,557 acres of damage mapped.

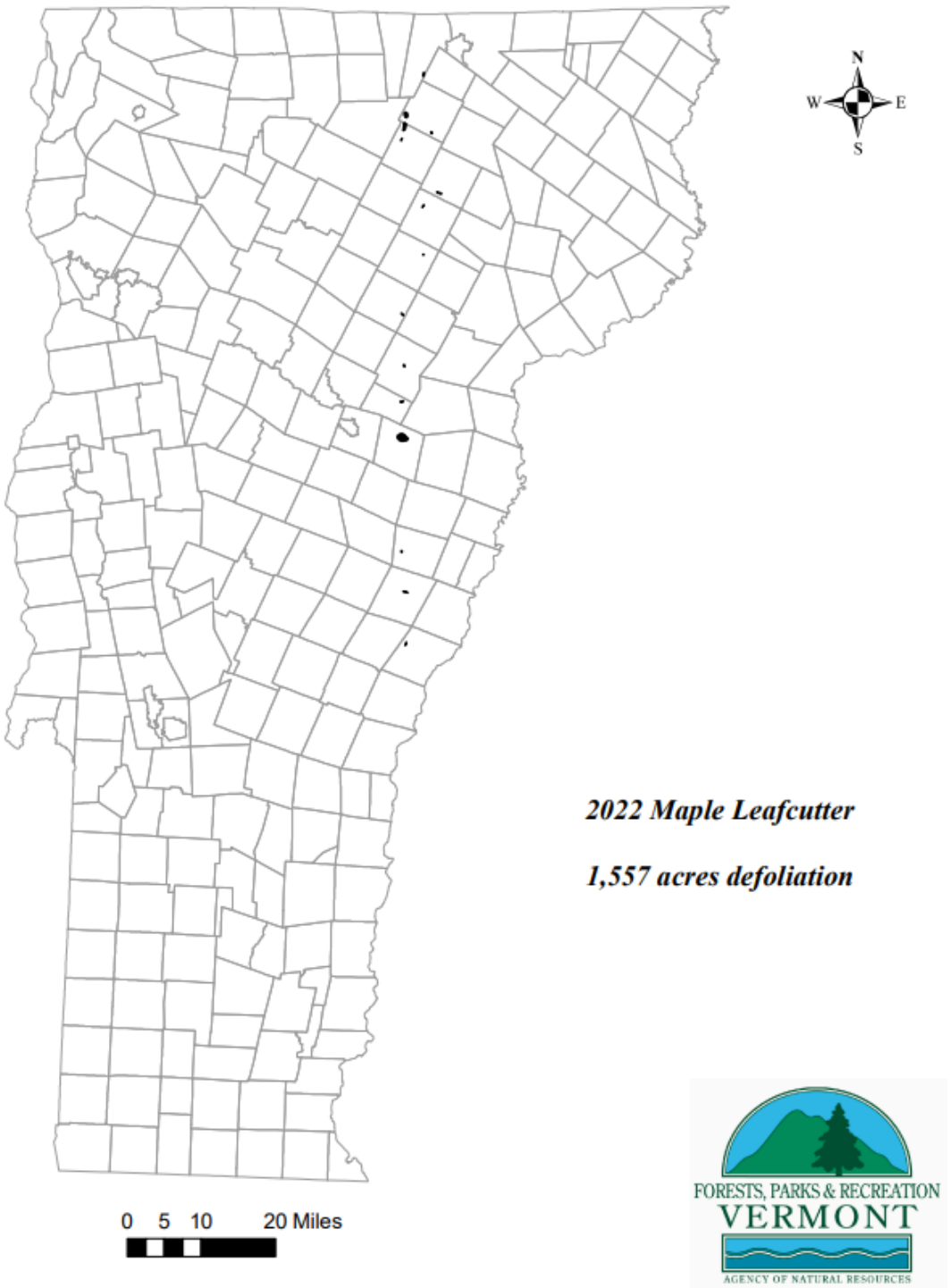

Figure 11. Maple leafcutter defoliation 2022. Mapped area includes 1,557 acres affected.

Saddled prominent (SP), *Heterocampa guttivitta,* are native hardwood defoliators that commonly feed on sugar maple, beech and other hardwoods. Unlike other pests we monitor, SP populations do not follow a typical outbreak cycle, with populations reaching outbreak levels sporadically, and then crashing within 1-3 years. Increased reports of defoliation during the growing season of 2020 led to reestablishing trapping efforts in 2021.

To track population outbreaks, pheromone traps for SP were deployed statewide in late spring at nine sites. The number of moths per trap averaged 2.2, evidence that populations are decreasing in Vermont compared to 3.3 moths per trap in 2021 (Figure 12,Table 5).

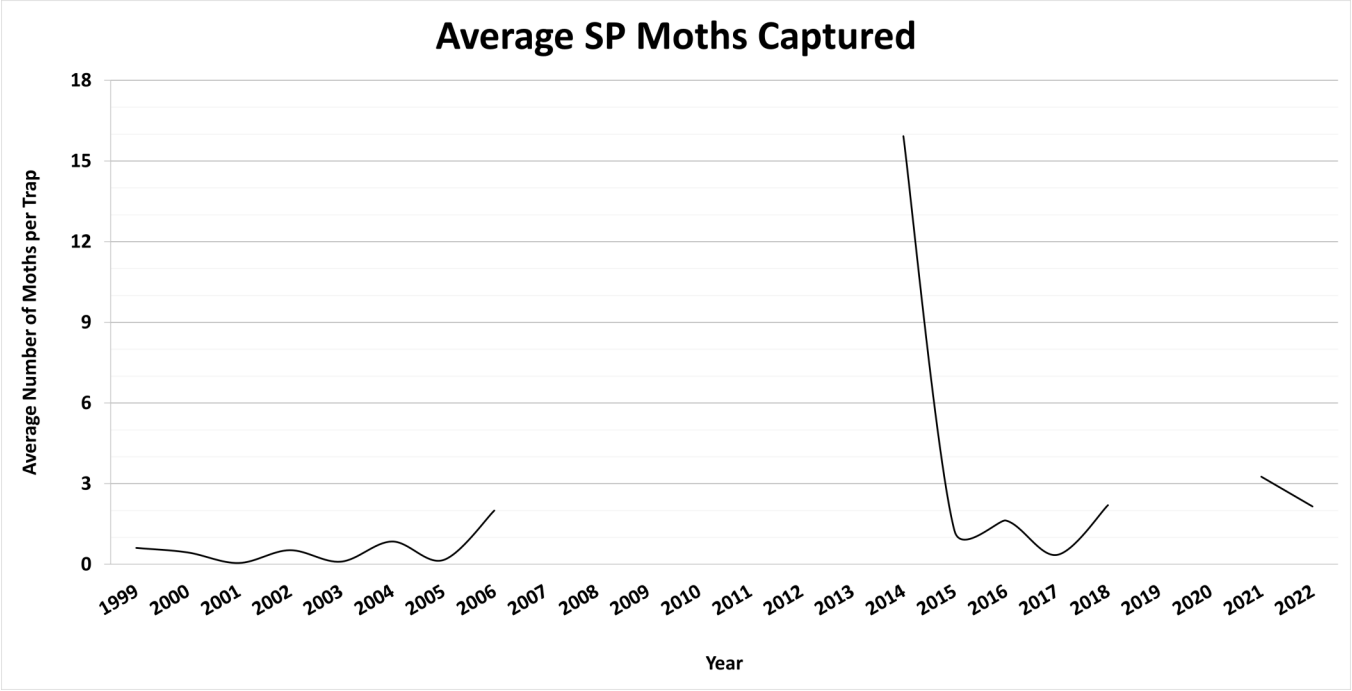

Figure 12. Average number of saddled prominent moths caught in 9 pheromone traps 1999-2022. Populations were not monitored 2007-2013 and 2019-2020. Three multi-pher pheromone traps per site, with aPhinity SP lures, were used in 2022.

Table 5. Average number of saddled prominent moths caught in pheromone traps, 1999-2022. Three multi-pher traps baited with PheroTech lures were deployed at each of the 9 survey locations in 2022.

County and Town	1999	2000	2001	2002	2003	2004	2005	2006	2014	2015	2016	2017	2018	2021	2022
Chittenden Underhill	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	10.0	1.3	0.0	0.0	2.3	2.0	0.5
Washington Groton	1.0	0.0	0.0	0.3	0.7	2.3	0.0	3.3	3.3	0.0	-	-	-	-	-
Orleans Westmore	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	10.3	0.3	0.0	0.0	0.0	5.7	0.3
Orange Vershire (WP)	0.7	0.5	0.0	0.0	0.0	1.0	0.0	0.3	-	1.7	0.0	0.0	4.0	7.3	11.3
Rutland Shrewsbury	0.0	1.0	0.0	0.0	0.0	1.2	0.0	2.0	20.0	2.0	0.7	0.7	1.3	2.0	1.3
Chittenden Bolton	2.0	1.0	0.3	0.0	0.0	0.3	0.7	5.3	31.0	1.7	-	-	-	1.7	0.0
Rutland Danby	-	-	-	-	-	-	-	-	47.3	1.3	-	-	-	-	
Bennington Arlington	-	-	-	-	-	-	-	-	21.3	0.7	-	-	-	-	
Orleans Derby	-	-	-	-	-	-	-	-	6.0	-	-	-	-	-	
Orange Vershire (JS)	-	-	-	-	-	-	-	-	13	1.0	0.0	0.3	3.0	3.0	2.0
Orange Topsham	-	-	-	-	-	-	-	-	11.7	1.7	-	-	-	-	-
Orleans Glover	-	-	-	-	-	-	-	-	26	0.3	-	-	-	-	-
Windsor Plymouth	-	-	-	-	-	-	-	-	5.7	0.3	-	-	-	-	-
Windsor Windsor	-	-	-	-	-	-	-	-	1.3	-	-	-	-	-	-
Windsor Sharon	-	-	-	-	-	-	-	-	-	0.3	4.3	1.0	0.7	1.3	0.3
Windsor Weathersfield	-	-	-	-	-	-	-	-	-	0.0	-	-	-	-	-
Franklin Sheldon	-	-	-	-	-	-	-	-	-	6.0	5.3	0.7	4.7	-	-
Franklin Montgomery	-	-	-	-	-	-	-	-	-	-	-	-	-	1.3	2.0
Caledonia Walden	-	-	-	-	-	-	-	-	-	-	-	-	-	5.0	1.0
Average	**0.6**	**0.4**	**0.1**	**0.5**	**0.1**	**0.9**	**0.2**	**2.0**	**15.9**	**1.2**	**1.6**	**0.4**	**2.2**	**3.3**	**2.2**

Spongy moth, *Lymantria dispar* (formerly gypsy moth and LDD moth) caterpillars were responsible for the largest disturbance to Vermont forests as mapped through aerial detection surveys in 2022 (Figure 14). Defoliation was significant in the Champlain Valley of western Vermont, with 42,979 acres mapped as moderately or severely defoliated, a decrease from 50,945 acres of damage mapped in 2021.

Egg mass counts from nine focal area plots (Figure 13, Table 6) suggest that defoliation is likely to be observed in Vermont again in 2023, although populations are starting to decline. We will be monitoring the severity and extent of defoliation as the growing season begins. One year of defoliation is unlikely to cause substantial damage to most trees, but repeated defoliation can have significant impacts on tree and forest health. The fungus *Entomophaga maimaiga* helps control populations of spongy moth when spring conditions are wet and/or humid, conditions we observed in the majority of the state in 2022. The drought from 2020-2021 may have allowed spongy moth populations to build and expand, and likely contributed to the current outbreak.

Additional information for landowners impacted or concerned about spongy moth (LDD) can be found at:
https://fpr.vermont.gov/forest/forest-health

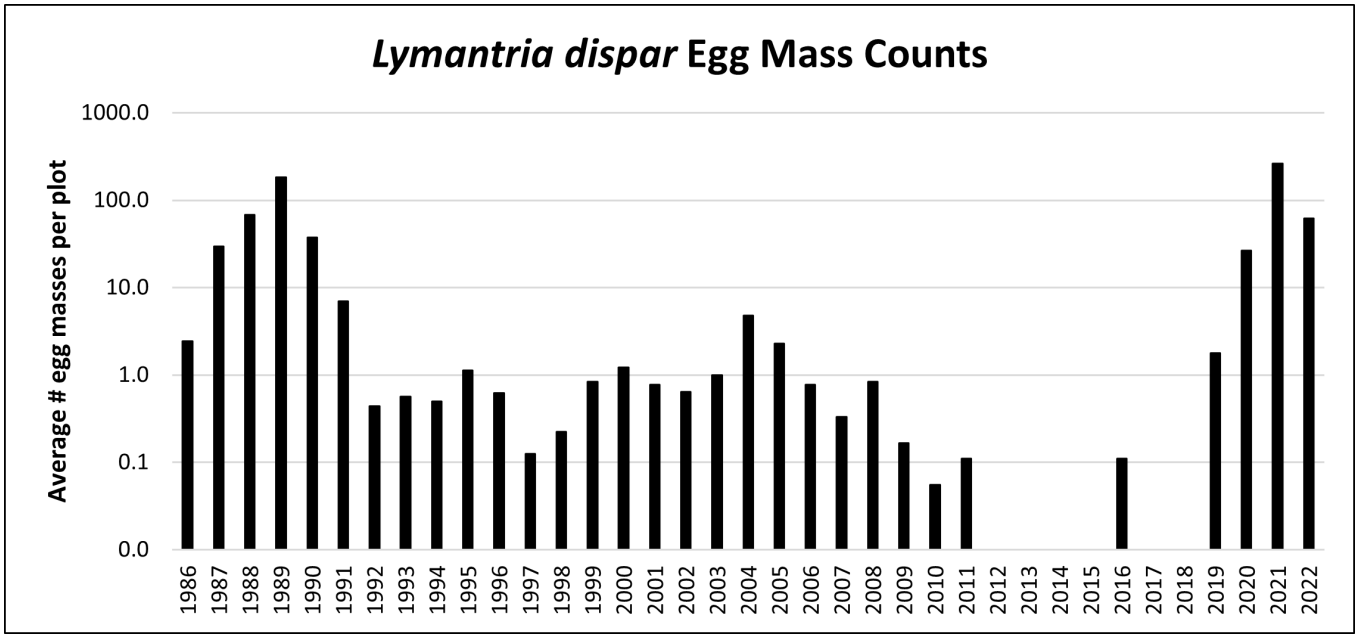

Figure 13. Number of spongy moth egg masses per 1/25th acre in focal area monitoring plots, 1987-2022. Data reflect the average egg mass counts from nine locations, with two 15-meter diameter plots per location containing burlap-banded trees.

Table 6. Number of spongy moth egg masses per 1/25th acre in focal area monitoring plots, 2003-2022. Counts are the average of two 15 meter plots per location containing burlap-banded trees.

Site	Town	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Arrow-head	Milton	1.5	2.5	0.0	0.0	0.0	2.5	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	28	72.5	8.0
Brigham Hill	Essex	2.5	2.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	82	137	33.5
Ft. Dummer	Guilford	0.0	-	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0
Minard's Pond	Rocking-ham	0.5	2.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	15	186	0.0
Mount Anthony	Benning-ton	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Perch Pond	Benson	0.0	0.0	0.5	1.0	0.0	0.5	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	106.5	618	239.5
Rocky Pond	Rutland	0.0	0.0	0.5	3.0	3.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	28	137
Sandbar	Colchester	3.0	1.5	0	0.0	0.0	2.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	2.5	1313.5	139.5
Tate Hill	Sandgate	0.0	30	18	3.0	0.0	1.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	6.0	0.5	0.0	1.5
Average		1.0	4.4	2.3	0.8	0.3	0.8	0.2	0.06	0.11	0.0	0.0	0.0	0.0	0.11	0.0	0.0	1.8	26.3	261.7	62.1

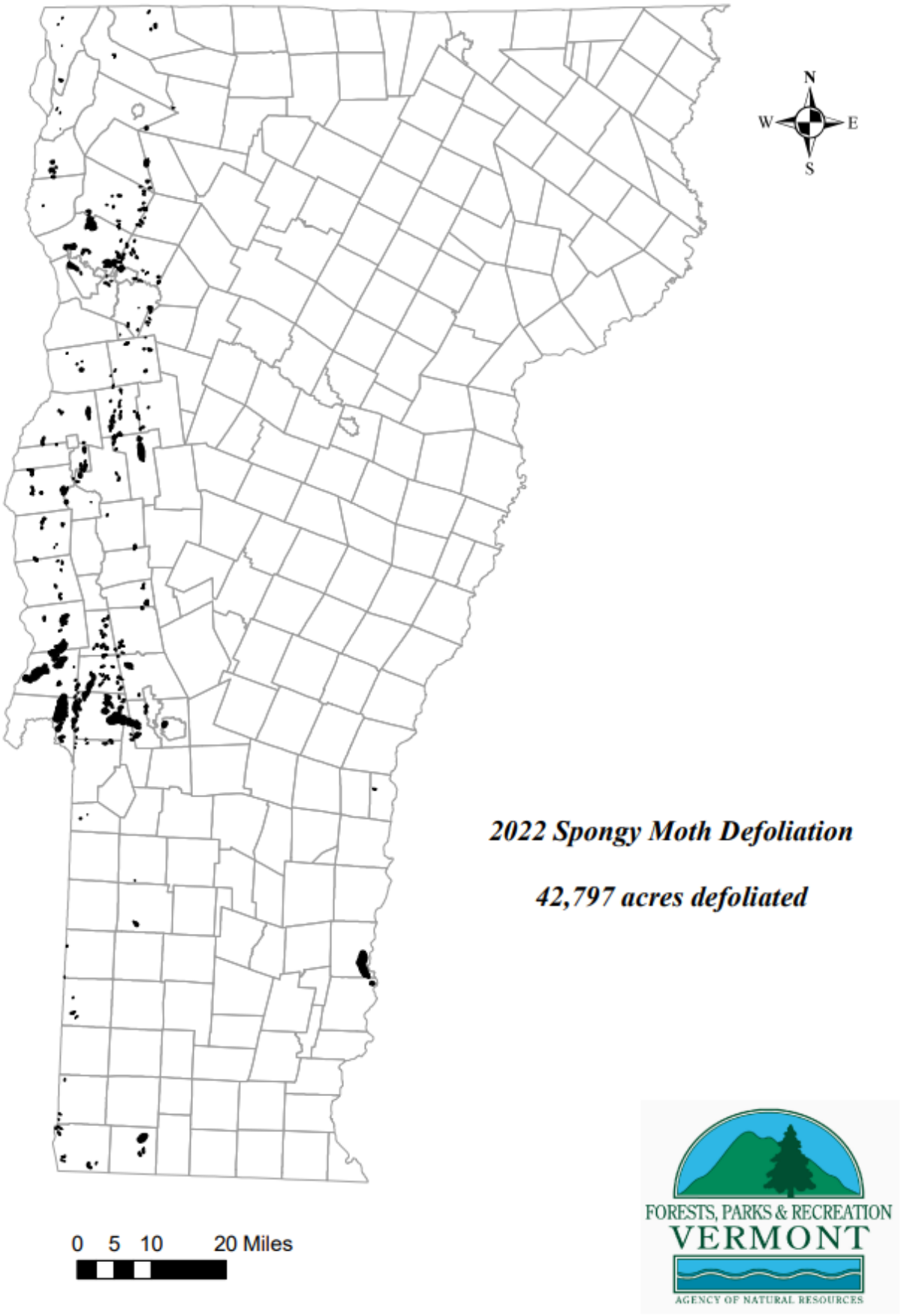

Figure 14. Spongy moth defoliation 2022. Mapped area includes 42,797 acres defoliated.

OTHER HARDWOOD DEFOLIATORS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
	Acleris cornana	Dogwood	Northeastern Vermont	
Aspen petiole gall moth	*Ectoedemia populella*	Poplar	Chittenden County	
Banded tussock moth	*Halysidota tessellaris*	Many	Statewide	Observed as bycatch in trap catch.
Angulose prominent caterpillar	*Peridea angulosa*	Oak	Central Vermont	
Biltmore checkerspot	*Euphydryas phaeton*	Honeysuckle	Washington County	
Birch skeletonizer	*Bucculatrix canadensisella*	Birch	Northeastern Vermont	
Brown-tail moth	*Euproctis chrysorrhoea*	Hardwoods		Not observed or known to occur in Vermont.
Cherry scallop shell moth	*Rheumaptera prunivorata*	Cherry	Statewide	Observed as bycatch in trap catch.
Curve-toothed geometer moth	*Eutrapela clemataria*	Many	Statewide	Observed as bycatch in trap catch.
Definite tussock moth	*Orgyia definita*	Many	Central Vermont	
Dogwood sawfly	*Macremphytus tarsatus*	Dogwood	Windham County	
Dotted leaftier moth	*Psilocorsis reflexela*	Beech	Windham County	
Eastern tent caterpillar	*Malacosoma americanum*	Cherry and apple	Widely scattered	Populations remain low.
Euonymus caterpillar	*Yponomeuta cagnagella*	Euonymus	Montpeiler, VT	
Fall webworm	*Hyphantria cunea*	Hardwoods, especially cherry and ash	Statewide	
Friendly Proble	*Probole amicaria*	Poplar	Statewide	Observed as bycatch in trap catch.

OTHER HARDWOOD DEFOLIATORS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Forest tent caterpillar	*Malacosoma disstria*	Hardwoods	Statewide	*See narrative.*
Green-striped mapleworm/ rosy maple moth	*Dryocampa rubicunda*	Sugar maple	Statewide	Larvae occasionally observed, often in association with saddled prominent.
Harris' three spot	*Harrisimemna trisignata*	Many	Southern Vermont	
Hickory tussock moth	*Lophocampa caryae*	Hardwoods	Essex County	
Isabella tiger moth	*Pyrrharctia isabella*	Hardwoods	Statewide	
Japanese beetle	*Popillia japonica*	Many	Statewide	Observed in gardens, but tree injury not reported in 2022.
Luna moth	*Actias luna*	Many	Rutland, VT	
Maple leafcutter moth	*Paraclemensia acerifoliella*	Sugar maple, occasional yellow birch and beech	Statewide	*See narrative* . Populations were lower than in 2021.
Maple trumpet skeletonizer moth	*Catastega aceriella*	Sugar maple	Statewide	Occasionally observed, but negligible damage.
Mimosa webworm	*Homadaula anisocentra*	Honeylocust	Central Vermont	
Mountain ash sawfly	*Pristiphora geniculata*	Mountain ash	Northeastern Vermont	
Oak shothole leafminer	*Japanagromyza viridula*	Red oak	Statewide	Characteristic feeding damage widely observed in June.
Oblique banded leaf roller	*Choristoneura rosaceana*	Many	Statewide	Observed as bycatch in trap catch.
Pale tussok moth	*Halysidota tessellaris*	Many	Statewide	

OTHER HARDWOOD DEFOLIATORS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Pink underwing	*Catocala concumbens*	Poplars, Maples	Statewide	Mulitple inquiries from people concerned about spotted lanternfly.
Pink-striped oakworm	*Anisota virginiensis*	Oak	Southern Vermont	
Saddled prominent moth	*Heterocampa guttivata*	Sugar maple	Widely scattered; Especially southeastern Vermont	*See narrative.*
Sharp-angled carpet	*Euphyia intermediata*	Elm	Statewide	Observed as bycatch in trap catch.
Spongy moth	*Lymantria dispar*	Hardwoods	Statewide	*See narrative* . Also observed as bycatch in trap catch.
Ultronia underwing	*Catocala ultronia*	Apple, cherry	Statewide	Observed as bycatch in trap catch.
Viburnum leaf beetle	*Pyrrhalta viburni*	Viburnum	Chittenden County	Heavy defoliation on ornamental shrubs.
Winter moth	*Operophtera brumata*	Hardwoods		Not observed or known to occur in Vermont.
Variable Zanclognatha	*Zanclognatha laevigata*	Hardwoods	Statewide	Observed as bycatch in trap catch.

Hardwood defoliators not reported in 2022 include birch leaf-mining sawflies, Messa nana, Fenusa pusilla, and others; birch leaf folder, *Ancylis discigerana;* black-headed ash sawfly, *Tethida barda;* brown angle shades moth, *Phlogophora periculosa* ; bruce spanworm, Operophtera bruceata; butternut woolly worm, *Eriocampa juglandis* ; cecropia moth, Hyalophora cecropia; cleft-headed looper, *Biston betularia;* dark-banded owlet, *Phalaenophana pyramusalis;* elm leaf beetle, *Xanthogaleruca luteola* ; eyed baileya moth, *Baileya ophthalmica* ; hackberry leaf miner, *Agromyza* spp.; large maple spanworm moth, *Prochoerodes lineola;* orange-humped maple worm moth, *Symmerista leucitys;* salt and pepper moth, *Syngrapha rectangula* ; satin moth, *Leucoma salicis* ; spiny oak sawfly, *Periclista albicollis* ; spotted sawfly, *Macremphytus lovetti* ; two-lined hooktip, *Drepana bilineata;* White-marked tussock moth, *Orgyia leucostigma* ; white spring moth, *Lomographa vestaliata.*

SOFTWOOD DEFOLIATORS

Spruce Budworm (SBW), *Choristoneura fumiferana*, are native softwood defoliators commonly found in Vermont forests. In consecutive years of severe outbreaks, trees may experience complete defoliation which can lead to dieback and mortality of infested hosts. SBW moth trap catches in Vermont increased to an average of 99.33 moths per trap in 2022, compared to an average of 3.70 moths per trap in 2021. Traps were deployed in Caledonia, Chittenden, Essex, and Orleans Counties from 2010-2022, with the addition of Victory Basin WMA in Essex county in 2021. Catches increased at all locations (Figure 15, Table 7, Table 8). We do anticipate increased populations of SBW in 2023, with additional survey and monitoring efforts planned for 2023.

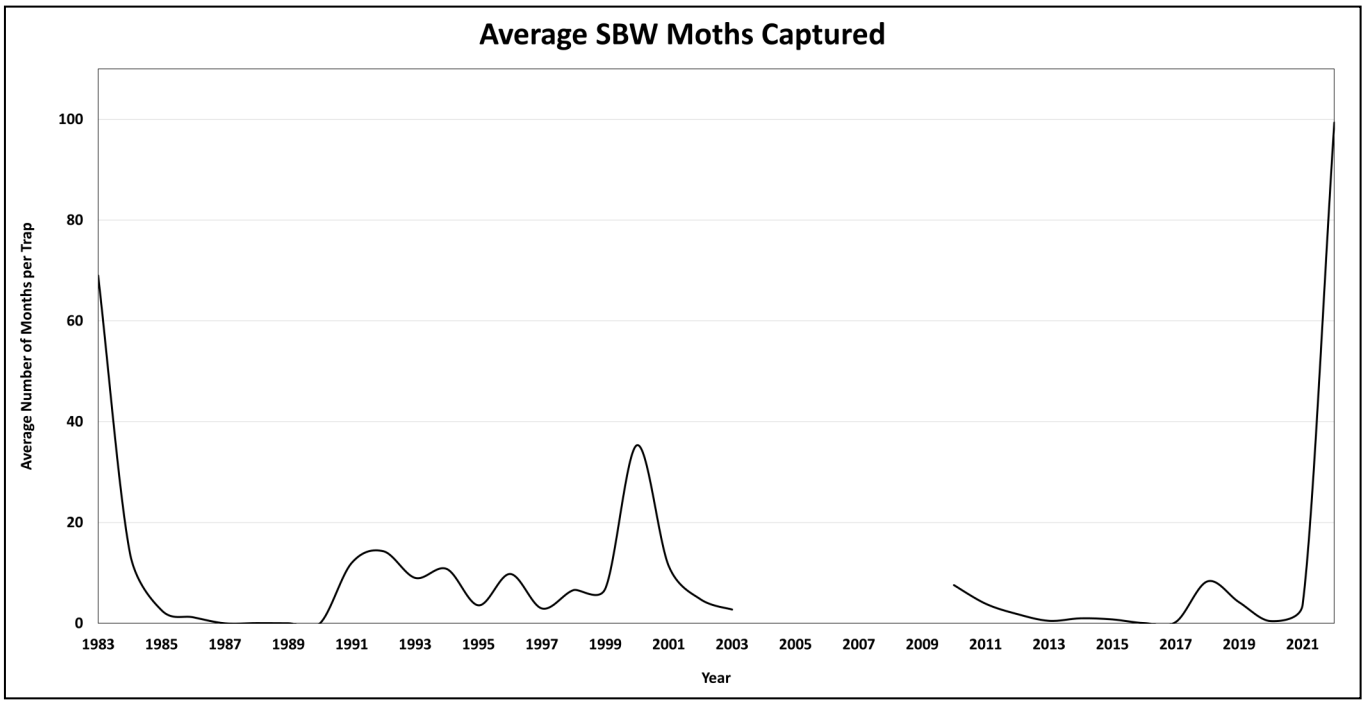

Figure 15. Average number of spruce budworm moths caught in pheromone traps 1983-2022. Trapping was discontinued, 2004-2009. Average of seven locations in 2022.

Table 7. Locations of spruce budworm pheromone traps in 2022. Note: the trap site in Willoughby State Forest is in the town of Sutton rather than Burke, as designated in some earlier reports.

Trap Location	Town	Latitude	Longitude
Steam Mill Brook WMA	Walden	44.47432	-72.19198
Willoughby S.F.	Sutton	44.6955	-72.03608
Tin Shack/Silvio Conte	Lewis	44.85911	-71.74221
Black Turn Brook S.F.	Norton	44.9949098	-71.812856
Holland Pond WMA	Holland	44.97635	-71.9311387
VMC 1400	Underhill	44.526127	-72.871459
Victory Basin WMA	Victory	44.53437	-71.79086

Table 8. Average number of spruce budworm moths caught in pheromone traps, 1998-2022. Trapping had been discontinued from 2004-2009. There were three traps per location, one location per town, in 2022.

County	1999	2000	2001	2002	2003	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Essex	34.7	44.5	26.5	1.3	2.0	5.7	1.0	1.3	0.7	0.0	0.3	0.3	0.3	6.0	1.3	0.0	8.0	58.7
Orleans	4.7	29.3	5.0	5.7	3.7	7.3	8.0	1.0	0.7	1.7	1.3	0.0	0.3	9.0	1.0	0.0	5.0	141.7
Caledonia	5.0	85.0	16.7	9.7	3.7	6.7	1.0	0.7	0.0	0.3	1.0	0.0	0.0	4.0	3.3	0.3	2.5	64.7
Essex	4.3	14.0	6.7	1.3	1.7	4.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.3	0.0	0.5	22.3
Chittenden	7.3	14.7	7.0	8.5	2.4	19.0	11.3	8.0	1.3	3.7	1.7	0.0	1.0	26.3	18.3	1.7	2.3	233.7
Caledonia	9.3	34.7	32.7	3.3	2.3	4.0	1.7	0.0	0.3	0.3	0.3	0.0	-	2.0	0.7	0.7	2.5	38.3
Caledonia	6.0	22.5	15.0	3.0	1.7	-	-	-	-	-	-	-	-	-	-	-	-	-
Essex	9.3	31.7	8.0	2.7	1.3	-	-	-	-	-	-	-	-	-	-	-	5.0	136.0
Orleans	3.3	73.0	13.3	0.0	1.7	-	-	-	-	-	-	-	-	-	-	-	-	-
Caledonia	6.7	93.0	35.7	9.7	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Orange	0.7	20.0	0.0	3.3	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-
Orange	0.3	16.0	0.0	7.0	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-
Caledonia	3.2	53.2	10.8	10.7	2.5	-	-	-	-	-	-	-	-	-	-	-	-	-
Lamoille	5.3	17.2	3.7	0.4	3.2	-	-	-	-	-	-	-	-	-	-	-	-	-
Lamoille	11.7	25.7	6.3	0.3	4.3	-	-	-	-	-	-	-	-	-	-	-	-	-
Lamoille	-	43.0	17.0	12.0	4.7	-	-	-	-	-	-	-	-	-	-	-	-	-
Washington	2.0	22.5	14.7	2.3	2.0	-	-	-	-	-	-	-	-	-	-	-	-	-
Washington	-	5.5	5.0	2.0	4.0	-	-	-	-	-	-	-	-	-	-	-	-	-
Washington	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Average	**6.9**	**35.3**	**11.4**	**4.9**	**2.7**	**7.6**	**3.9**	**1.8**	**0.5**	**1.0**	**0.8**	**0.1**	**0.3**	**8.3**	**4.2**	**0.4**	**3.7**	**99.3**

High SBW moth counts can sometimes be the result of weather patterns that blow moths in from afar. To assess whether moth numbers were indicative of a building population, we sampled for SBW larvae (i.e., L2 sampling) in our trapping areas (n = 7) in December 2022 (Table 9). From the mid-canopy of 3 trees per site, branches were cut using pole pruners and trimmed to 30" in length. These were bagged and sent to the University of Maine Spruce Budworm Lab, where samples were processed and number of larvae per branch was determined. Only 3 of 7 sites had any SBW larvae, and of those sites where SBW was present, only 1 larvae per site was found. This is well below the threshold of 7 larvae per branch that would suggest intervention may be necessary, and indicates that we are not currently in a SBW outbreak in Vermont. Should our moth catch be similarly high in 2023, we plan to conduct L2 sampling again.

Table 9. Spruce budworm larval counts, based on sampling in December 2022. Three samples per site were analyzed at the University of Maine Spruce Budworm Lab and averaged to yield number of larvae per branch.

Trap Location	Town	Avg. L2 Larvae per Branch
Steam Mill Brook WMA	Walden	0.33
Willoughby S.F.	Sutton	0
Tin Shack/Silvio Conte	Lewis	0.33
Black Turn Brook S.F.	Norton	0
Holland Pond WMA	Holland	0
VMC 1400	Underhill	0.33
Victory Basin WMA	Victory	0

OTHER SOFTWOOD DEFOLIATORS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Eastern spruce budworm	*Choristoneura fumiferana*	Balsam fir and spruce	Northern Vermont	*See narrative.*
European pine sawfly	*Neodiprion sertifer*	Red pine	Statewide	
Gray spruce looper moth	*Caripeta divisata*	Spruce, fir, hemlock		Observed as bycatch in trap catch.
Hemlock looper	*Lambdina fiscellaria*	Hemlock	Southern Vermont	Observed as bycatch in trap catch.
Larch caseberer	*Coleophora laricella*	Larch	Northern Vermont	

Softwood defoliators not reported in 2022 included arborvitae leafminer, *Argyresthia thuiella* ; balsam fir sawfly, *Neodiprion abietis* ; introduced pine sawfly, *Diprion similis* ; larch sawfly, *Pristiphora erichsonii* ; pine false webworm, *Acantholyda erythrocephala* ; rusty tussock moth, *Orygia antigua* ; yellow-headed spruce sawfly, *Pikonema alaskensis* ; spruce needleminer,*Taniva albolineana* ; web-spinning sawfly, *Pamphiliidae* ; white pine sawfly, *Neodiprion pinetum* .

SAPSUCKING INSECTS, MIDGES, AND MITES

Balsam Woolly Adelgid (BWA), *Adelges piceae*, has been reported in all VT counties, with an increase in public reports in 2022. During 2022 aerial survey, 3,945 acres of fir dieback and mortality attributed to BWA were mapped as compared to 589 acres mapped in 2021 (Table 10). Due to aerial survey restrictions, we were not able to document tree mortality in 2020 for areas where BWA-initiated mortality was previously reported.

Table 10. Mapped acres of balsam woolly adelgid-related decline 2016-2022. Due to aerial survey restrictions in 2020, no acres were mapped.

County	Acres Mapped						
	2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Addison	107	0	0	0	X	0	0
Bennington	69	0	0	17	X	0	0
Caledonia	1,096	412	807	211	X	79	346
Chittenden	51	0	0	0	X	0	631
Essex	736	20	1,082	0	X	336	475
Franklin	59	0	5	0	X	0	1,798
Grand Isle	0	0	0	0	X	0	0
Lamoille	683	13	188	174	X	15	231
Orange	1,101	320	322	53	X	0	6
Orleans	518	399	316	252	X	147	132
Rutland	240	122	88	0	X	12	0
Washington	895	279	561	235	X	0	332
Windham	57	4	9	0	X	0	0
Windsor	4	72	56	0	X	0	0
Total	**5,616**	**1,641**	**3,434**	**942**	X	**589**	**3,945**

BWA Monitoring Sites: To monitor BWA population levels and further study the link between balsam fir mortality and BWA, a monitoring site was established in Black Turn Brook State Forest, Norton Vermont, in a several hundred-acre stand of balsam fir in the late fall of 2022.

Plot Layout and Metrics: The site consists of 4 permanent subplots. In addition to collecting standard forest inventory data, live crown ratio, vigor, dieback, crown density, foliar transparency, and the number of BWA woolly masses per 8 in2 were observed and recorded for all firs in the plot. At each micro plot, all fir saplings (1-5 in. DBH) are tallied and the presence of gout on twigs is noted. Subplots and micro plots will be remeasured annually in the late fall when the presence of BWA woolly masses is likely high. In the following years of remeasurement, site information and results will include basal area percentage of live and dead fir, percentage of fir with BWA flocculence including severity, and severity of gout on saplings. Other sites may be added to the monitoring effort as needed.

By establishing this monitoring site, FPR will be able to observe and document BWA spread and severity within a stand. This information will allow us to better understand balsam fir health and future management across the state.

Hemlock Woolly Adelgid (HWA), *Adelges tsugae*, continues to threaten hemlock trees in southern Vermont, especially in combination with drought and elongate hemlock scale. Traditionally infested sites are still infested, with observed spread into Athens, a previously surrounded town. No northern or western spread was detected despite low winter mortality and higher population counts.

No hemlock decline related to HWA was mapped during aerial surveys in 2022.

As of 2022, known infested counties that were ground-surveyed for additional locations of HWA included Windham, Windsor, and Bennington counties. High-risk counties adjoining known infested counties were also surveyed including Rutland and Orange counties. High-risk areas, and plant hardiness zones 5a and 5b, in Windsor County, were also surveyed since Windsor County is only known to be infested at its southernmost edge.

Twenty-seven sites in seven counties were surveyed (Table 11), with new positive finds in Springfield and Pownal, VT. A positive find was also found in Weathersfield VT, a site previously known to be infested.

Table 11. Sites inspected for the presence of hemlock woolly adelgid (HWA) and elongate hemlock scale (EHS) by visual survey, winter 2021-2022.

County	Town	Number of Sites	Positive for HWA	Positive for EHS
Windsor	Springfield	2	1	0
	Weathersfield	2	1	0
	Windsor	1	0	0
	Hartland	1	0	0
	Hartford	3	0	0
Orange	Thetford	4	0	0
	Fairlee	1	0	0
Bennington	Bennington	1	0	0
	Pownal	1	1	0
Rutland	Wallingford	1	0	0
	Fairhaven	1	0	0
	Poultney	2	0	0
	Hubbardton	1	0	0
Washington	Duxbury	1	0	0
	Moretown	1	0	0
Chittenden	Jericho	1	0	0
	South Burlington	1	0	0
	Charlotte	1	0	0
Addison	Weybridge	1	0	0
Totals	19	27	3	0

Sixty-one percent of the hemlock woolly adelgids (HWA) examined during the annual winter mortality survey were dead (Table 12, Figure 17). Although winter temperatures were only slightly colder than last year, in March we experienced periods of warming temperatures followed by successive days of deep freezes. This temperature fluctuation could have contributed to winter mortality by killing otherwise surviving HWA before they could reproduce. In the past, we have often found infestations in new locations following years with mild winters and low levels of HWA mortality.

Table 12. Assessment of hemlock woolly adelgid winter mortality over the 2020-2022 winter. Data from four assessment sites include location, date, number of HWA ovisacs collected, number of HWA that were dead, number of HWA that were alive, and percent mortality.

Site	Date	Total Number	Number Alive	Number Dead	% Mortality
Brattleboro	3/16/2022	362	149	213	58.84
Jamaica	3/16/2022	454	152	302	66.52
Townshend	3/16/2022	348	105	243	69.83
Vernon	3/16/2022	447	228	219	48.99

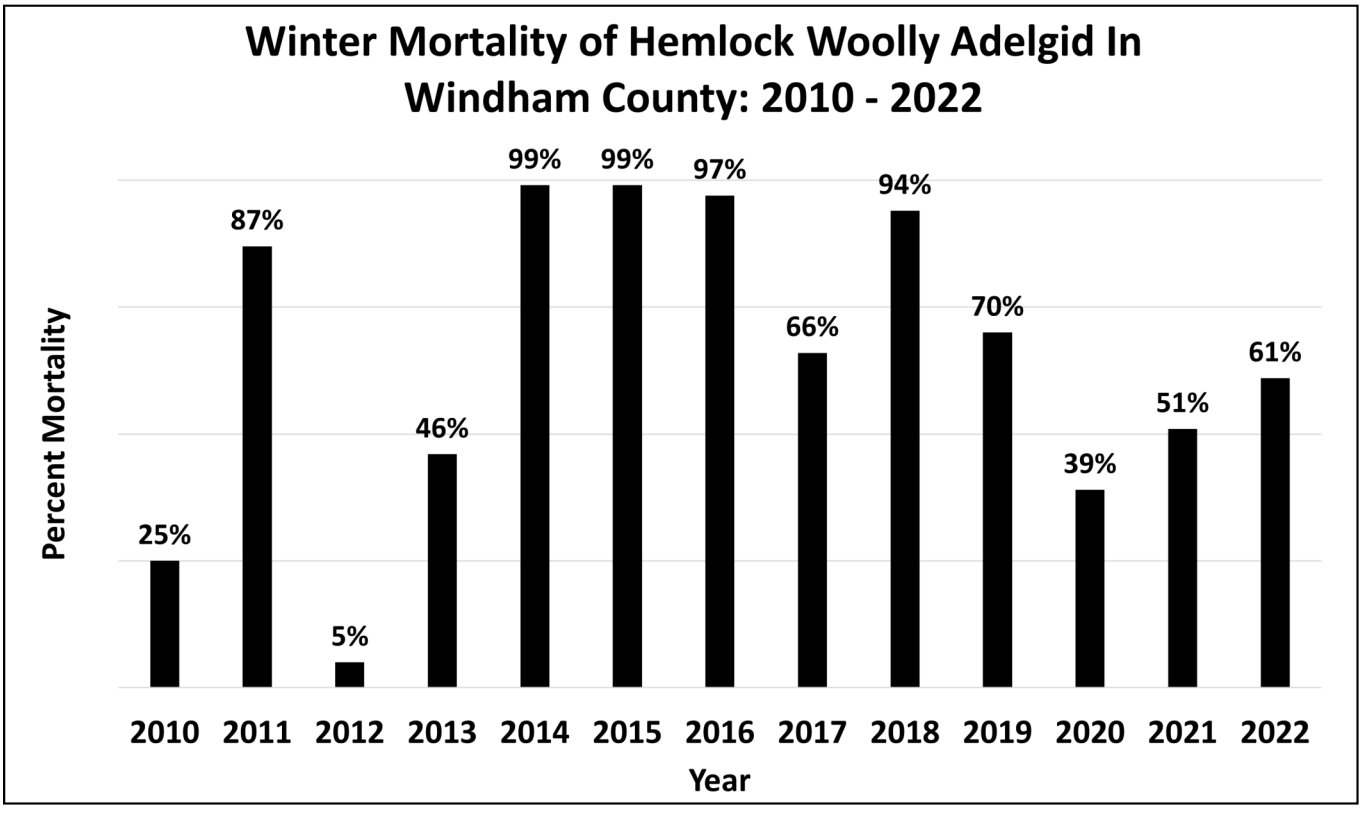

Figure 17. Average overwintering mortality of hemlock woolly adelgid at four sites in Windham County, 2010-2022.

We continue to maintain five HWA impact monitoring plots where HWA is known to be present and impacts of infestation are documented. In 2022, monitoring assessments were done at the Atherton Meadows Wildlife Management Area and Townshend State Park. Diameters were re-measured, and crowns were assessed for live crown ratio, crown density, crown transparency, and crown position. In general, appeared smaller and thinner than in previous monitoring.

Biocontrol efforts in 2022 used 2,000 predatory beetles (*Laricobius nigrinus*) obtained from the rearing laboratory at Virginia Tech, were released at Jamaica State Park this fall. Follow-up monitoring in winter and spring had no recoveries.

Thirty six percent of the hemlock woolly adelgids (HWA) examined during the third annual summer mortality survey were dead (Table 13, Figure 18). In these cases, HWA did not break aestivation or the dormancy period that this insect enters during the summer months. The reasons why summer mortality happens are still being researched, but some studies suggest that warming temperatures and excessive sunlight increase mortality. Although low, summer mortality may be supplementing low winter mortality enough to limit the spread of HWA in Vermont, however, more surveys are needed.

Table 13. 2022 assessment of hemlock woolly adelgid summer. Data from 4 assessment site includes location, date, number of HWA ovisacs collected, number of HWA that were dead, number of HWA that were alive, and percent mortality.

Site	Date	Total Number	Number Alive	Number Dead	% Mortality
Brattleboro	12/6/22	1040	652	388	37.31
Jamaica	12/6/22	1010	573	437	43.27
Townshend	11/14/22	2249	1480	769	34.19
Vernon	11/14/22	1164	832	332	28.52

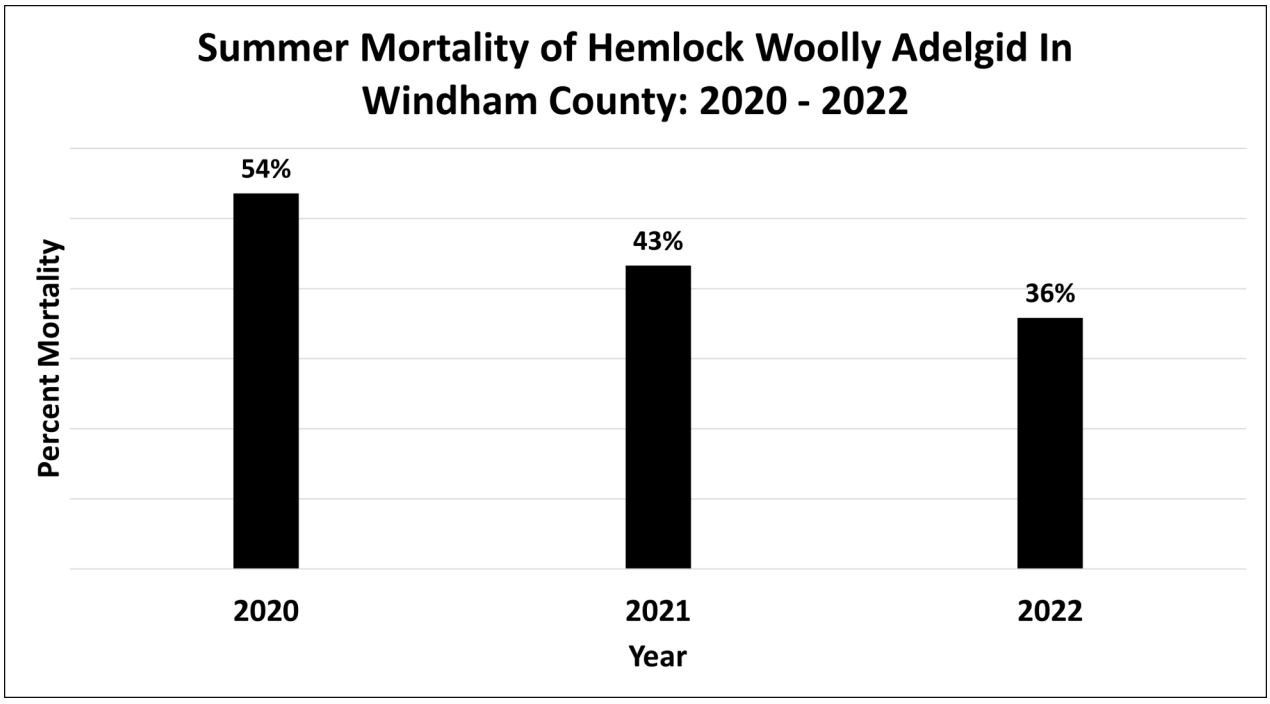

Figure 18. Average summer mortality of hemlock woolly adelgid at four sites in Windham County, 2020-2022. 2020 average is only from one site in Jamacia due to COVID-19 restrictions.

Pear Thrips, *Taeniothrips inconsequens*, numbers in our long-term monitoring plot at the Proctor Maple Research Center in Underhill were slightly higher in 2022 than in recent years. Sticky trap counts totaled 775 (Table 14), compared to 505 in 2021 (Figure 18). Emergence began the week of April 4. Scattered damage was reported throughout Vermont.

Table 14. Pear thrips counts on yellow sticky traps at Proctor Maple Research Center in Underhill, VT in 2022. Sticky traps are deployed in sets of four. Traps are evaluated and replaced each week and monitored throughout pear thrips emergence.

Sample Dates	Counts
4/7-4/15	124
4/15-4/22	165
4/22-4/29	129
4/29-5/5	87
5/5-5/11	99
5/11-5/18	130
5/18-5/31	38
5/31-6/10	3
Total	**775**

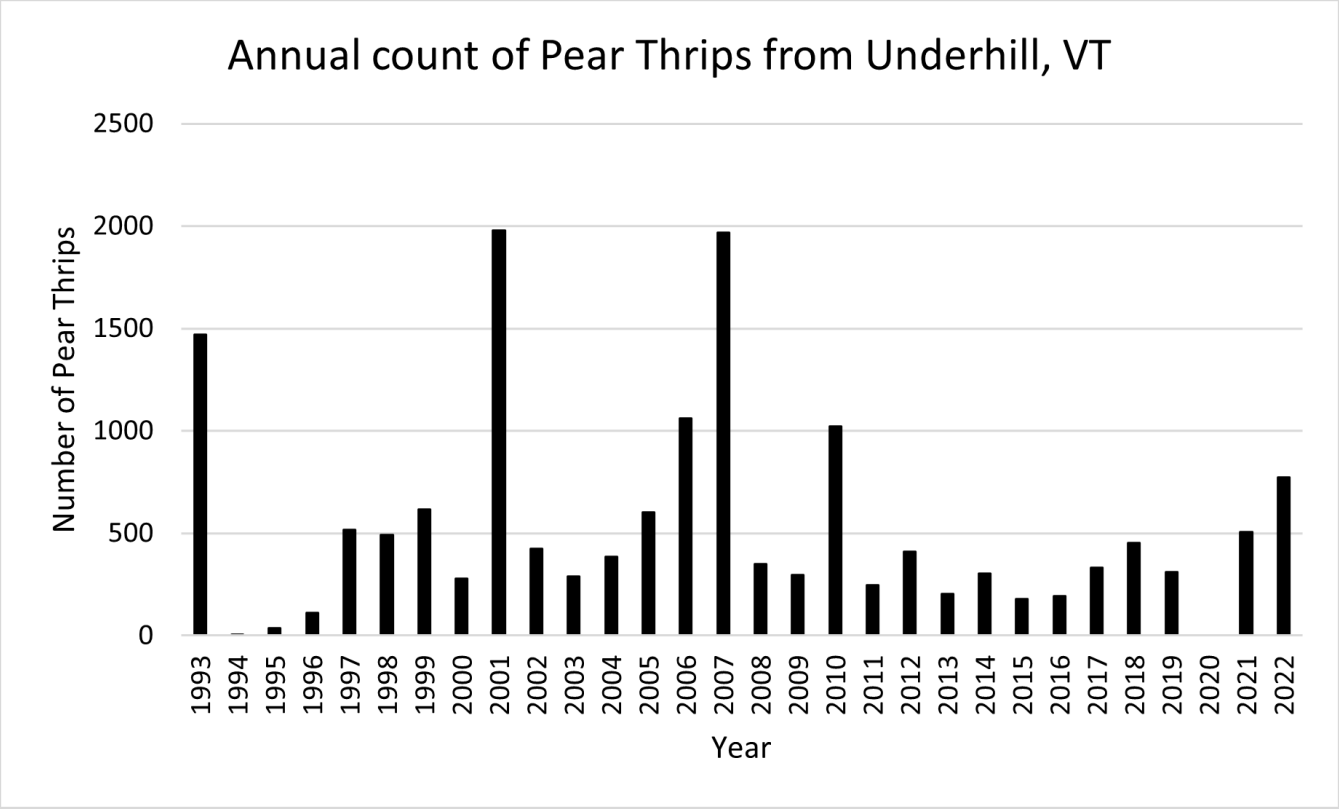

Figure 18. Total number of pear thrips collected at Proctor Maple Research Center in Underhill, VT on sets of four sticky traps, 1993-2022. Data were not collected in 2020 due to COVID-19 restrictions.

OTHER SAPSUCKING INSECTS, MIDGES, AND MITES

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Aphids	Aphididae	Many hosts	Statewide	
Ash flower gall	*Aceria fraxiniflora*	Ash	Arlington, VT	
Ash leafcurl aphids	*Prociphilus fraxinifolii*	Ash	Washington County	
Balsam woolly adelgid	*Adelges piceae*	Balsam and Fraser fir	Northern Vermont	*See narrative.*
Balsam twig aphid	*Adelges piceae*	Balsam fir	Statewide	
Bark lice	*Psocidae*	Hornbeam	Montpeiler, VT	
Beech blight aphid	*Grylloprociphilus imbricator*	Beech	Statewide	
Beech scale	*Cryptococcus fagisuga*	Beech	Statewide	*See Beech Bark Disease narrative.*
Boxelder bug	*Leptocoris trivittatus*	Boxelder	Widely scatttered	
Crimson erineum mite	*Aceria elongata*	Sugar maple	Widely scatttered	
Eastern spruce gall adelgid	*Adelges abietis*	Spruce	Statewide	Observed on regeneration.
Elongate hemlock scale	*Fiorinia externa*	Hemlock and balsam fir	Southeastern Vermont and Champlain Valley	Co-occurring with HWA in SE VT; isolated area without HWA in Champlain Valley
Eriophyidae mites	*Eriophyidae*	Many	Widely scatttered	
Hemlock woolly adelgid	*Adelges tsugae*	Hemlock	Southern Vermont	*See narrative.*
Hickory leaf stem gall aphids	*Phylloxera caryaecaulis*	Hickory	Chittenden County	
Magnolia Scale	*Neolecanium cornuparvum*	Magnolia	Pittsford, VT	
Pear thrips	*Taeniothrips inconsequens*	Maples and beech	Statewide	*See narrative.*

OTHER SAPSUCKING INSECTS, MIDGES, AND MITES

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Pine bark adelgid	*Pineus strobi*	White pine	Widely scattered	Light population.
Pine needle scale	*Chionaspis pinifoliae*	Hemlock and red pine	Widely scattered	*See Red Pine Decline and Mortality Narrative.*
Red pine scale	*Matsucoccus resinosae*	Red pine		Not observed in Vermont. Also see *Red Pine Decline and Mortality narrative* .
Spider mites	*Tetranychidae*	Many	Widely scattered	
Spotted lanternfly	*Lycorma delicatula*	Many hosts	Multiple single reports.	No infestations observed in Vermont.
White-margined burrower bug	*Sehirus cinctus*	Knotweed	Windsor County	
Woolly poplar aphid	*Phloeomyzus passerinii*	Poplar	Orleans County	

Sapsucking Insects, Midges and Mites that were not reported in 2022 include ash plant bug, *Tropidosteptes amoenus;* balsam gall midge, *Paradiplosis tumifex* ; elm cockscomb aphid, *Colopha compressa* ; jumping oak galls, *Neolecanium cornuparvum;* oak leaf blister mite, *Aceria triplacis* ; orange tipped leaf footed bug, *Acanthocephala terminalis;* oystershell scale pine, *Lepidosaphes ulmi* ; woolly apple aphid, *Eriosoma lanigerum;* woolly elm aphid *Eriosoma americanum;* woolly larch aphid *Adelges laricis* and *A. lariciatus* .

BUD AND SHOOT INSECTS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Oak twig pruner	*Anelaphus parallelus*	Red oak	Lamoille County	
Pine gall weevil	*Podapion gallicola*	Red pine	Widely scattered	Commonly observed in areas of red pine mortality.
Willow pine gall	*Rhabdophaga strobiloides*	Willows	Southern Vermont	
White pine weevil	*Pissodes strobi*	White pine and other conifers	Statewide	Shoot mortality in July continues at low levels.

Bud and Shoot Insects not reported in 2022 included balsam shootboring sawfly, *Pleroneura brunneicornis;* common pine shoot beetle, *Tomicus piniperda.*

ROOT INSECTS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Japanese beetle	*Popillia japonica*	Many	Statewide	See hardwood defoliators.
Oriental beetle	*Anomala orientalis*	Many	Statewide	Observed as bycatch in trap catch.

Root Insects not reported in 2022 included Asiatic garden beetle, *Maladera castanea* ; broadnecked root borer, *Prionus laticollis* ; conifer root aphid, *Prociphilus americanus* ; conifer swift moth, *Korsheltellus gracilis* ; June beetle, *Phyllophaga spp* .;

BARK AND WOOD INSECTS

Asian longhorned beetle (ALB), *Anoplophora glabripennis*, was not observed and is not known to occur in Vermont.

2022 marked our sixth year of deploying flight intercept/pheromone traps for detection of ALB (Table 15, Figure 20). We deployed six traps across the state in locations that were potentially high risk based on the chance that infested firewood might have been in the area. Most trap sites were also considered "high profile" in terms of public outreach, providing opportunities to connect with campers and others about ALB and invasive pests. Lures were comprised of six different pheromones and volatiles. Pheromone "B" was replaced at 30 days; at 60 days all of the pheromone components were replaced. Traps were removed at 90 days. No ALB suspects were found. Education and outreach that can prevent the movement of infested wood and promote early detection remain priorities. Early detection is particularly important with Asian longhorned beetle since small, newly discovered populations can be successfully eradicated.

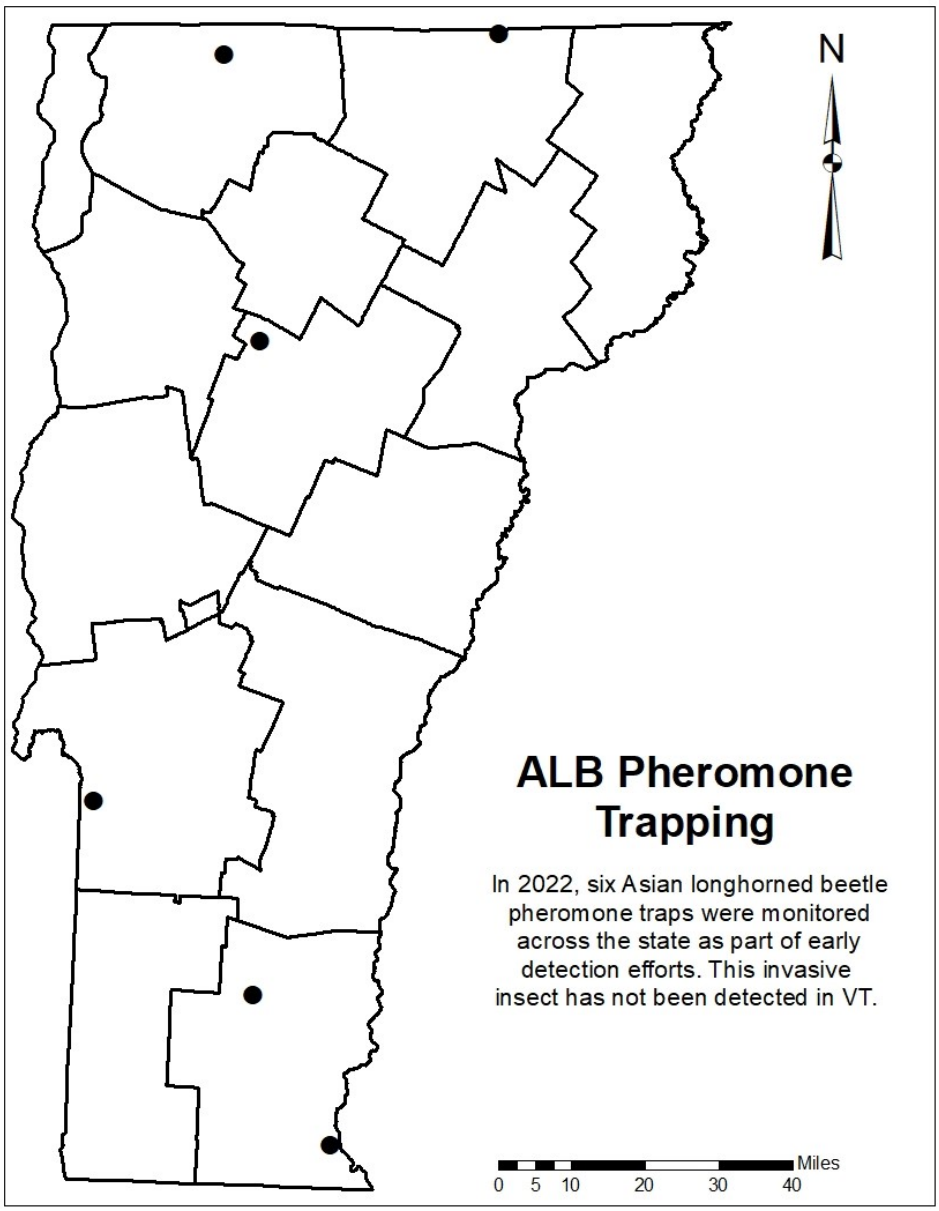

Figure 20. Asian longhorned beetle trap locations in 2022. There was a single trap at each location.

Table 15. Location of Asian longhorned beetle traps deployed in Vermont in 2022. Data include county, town, site, tree species, coordinates, dates of deployment and number of trap checks.

County	Town	Site	Tree Species	Lat	Long	Date Out	Date In	Number of Trap Checks
Windham	Guilford	I-91 Visitor Center	sugar maple	42.81367	-72.56736	6/29/22	9/23/22	6
Windham	Jamaica	Jamaica State Park	sugar maple	43.10862	-72.77452	6/29/22	9/23/22	6
Rutland	Poultney	Lake St. Catherine State Park	sugar maple	43.48906	-73.20797	6/30/22	9/20/22	5
Franklin	Franklin	Lake Carmi State Park	sugar maple	44.95542	-72.865526	7/1/22	10/7/22	4
Washington	Waterbury	Little River State Park	red maple	44.393861	-72.761408	7/1/22	9/22/22	6
Orleans	Derby Line	Derby Line Welcome Center	sugar maple	44.99595	-72.1032	7/1/22	9/23/22	6

Emerald Ash Borer (EAB), *Agrilus planipennis*, was first discovered in Vermont in February 2018, and new detections continued in 2022. As a result, EAB has now been confirmed in thirteen counties in the state. We continue to send specimens from new counties to a USDA APHIS identifier, while specimens from new towns within counties known to be infested are confirmed by FPR or VT Agency of Agriculture, Food and Markets' identifiers.

Emerald ash borer was detected in many new locations in 2022, including 10 new towns (Table 16). No new counties with EAB were identified in 2022. Essex county is currently the only county in the state without a confirmed detection.

Table 16. Locations of new emerald ash borer discoveries in 2022.

Town	County	State
Barton	Orleans	VT
Cabot	Washington	VT
Milton	Chittenden	VT
Pomfret	Windsor	VT
Poultney	Rutland	VT
Pownal	Bennington	VT
Somerset	Windham	VT
Townshend	Windham	VT
Williamstown	Orange	VT
Williston	Chittenden	VT

Maps indicating known EAB-infested areas in Vermont (Figure 21) are posted at VTinvasives.org. The mapped areas indicate the likelihood of EAB based on where it has actually been observed; EAB is not necessarily present throughout the mapped infested areas. By the time the insect is detected, it has already dispersed, so any ash within ten miles of a known EAB location is considered to be at-risk. The infested areas are also available for download on the ANR Atlas http://anrmaps.vermont.gov/websites/anra5/.

EAB inspections continued in Vermont in 2022 and were conducted in response to many landowner or FPR staff requests. Additionally, the Report It! feature at vtinvasives.org allowed users to submit locations, symptoms, and/or photographs of suspect trees. These submissions were reviewed by FPR and Agency of Agriculture, Food and Markets (AAFM) staff and relayed to district Protection staff to investigate. These yielded additional EAB finds in 2022.

Due to the deregulation of the federal quarantine in 2021, USDA APHIS did not conduct any trapping efforts in the state for EAB. However, FPR staff and volunteers were able to hang 20 pheromone traps for EAB in 2022 (Figure 22).

Girdled trap tree surveys are the most sensitive technique currently used for the early detection of EAB. In total, 31 ash trees were girdled across 9 Vermont counties in 2022. Girdled trap trees were established by state forestry staff and USDA Forest Service staff, on state lands (n = 21) and the Green Mountain National Forest (n =10), respectively (Figure 23). EAB was positively identified in trap trees in Barnet and Williamstown. Together with requested site visits, these tools resulted in 12 new detections and 10 new towns with EAB in Vermont in 2022 (Figure 24).

The State of Vermont's management strategy continues to focus on recommendations to Slow the Spread of EAB and recommendations for managing ash in urban and forested landscapes.

EAB Biocontrol Release—biological control agents were released in 2022 in the same locations that were established in 2020. One release site was located on LR Jones State Forest in Plainfield, the first State Forest to be infested with EAB in Vermont, and the second located in the town of South Hero. The first year of releases included *Tetrastichus planipennisi* exclusively, with over 4,300 wasps released at each site. In 2021, all three parasitoids were available for release, and each site received at least 4,000 *T. planipennisi*, 1,100 *Spathius galinae*, and 1,000 *Oobius agrili*.

Releases in 2022 at these sites included at least 300 *S. galinae* and 1800 *O. agrili* at each location. A new release site in Whipstock Hill Wildlife Management Area (Bennington, VT) was established in 2022, and all three parasitoid species were released. Recovery efforts will begin in 2023 for *T. planipennisi*, *S. galinae* and *O. agrili* at the two original locations, with another year of releases planned for Whipstock Hill. Two additional release sites in Swanton and Randolph will be established in 2023.

The goal of these releases is not to eradicate EAB (which is considered impossible in the U.S. at this point), but to establish a self-sustaining population of the parasitic wasps that will improve ash regeneration and lessen the impact of EAB in infested areas in Vermont.

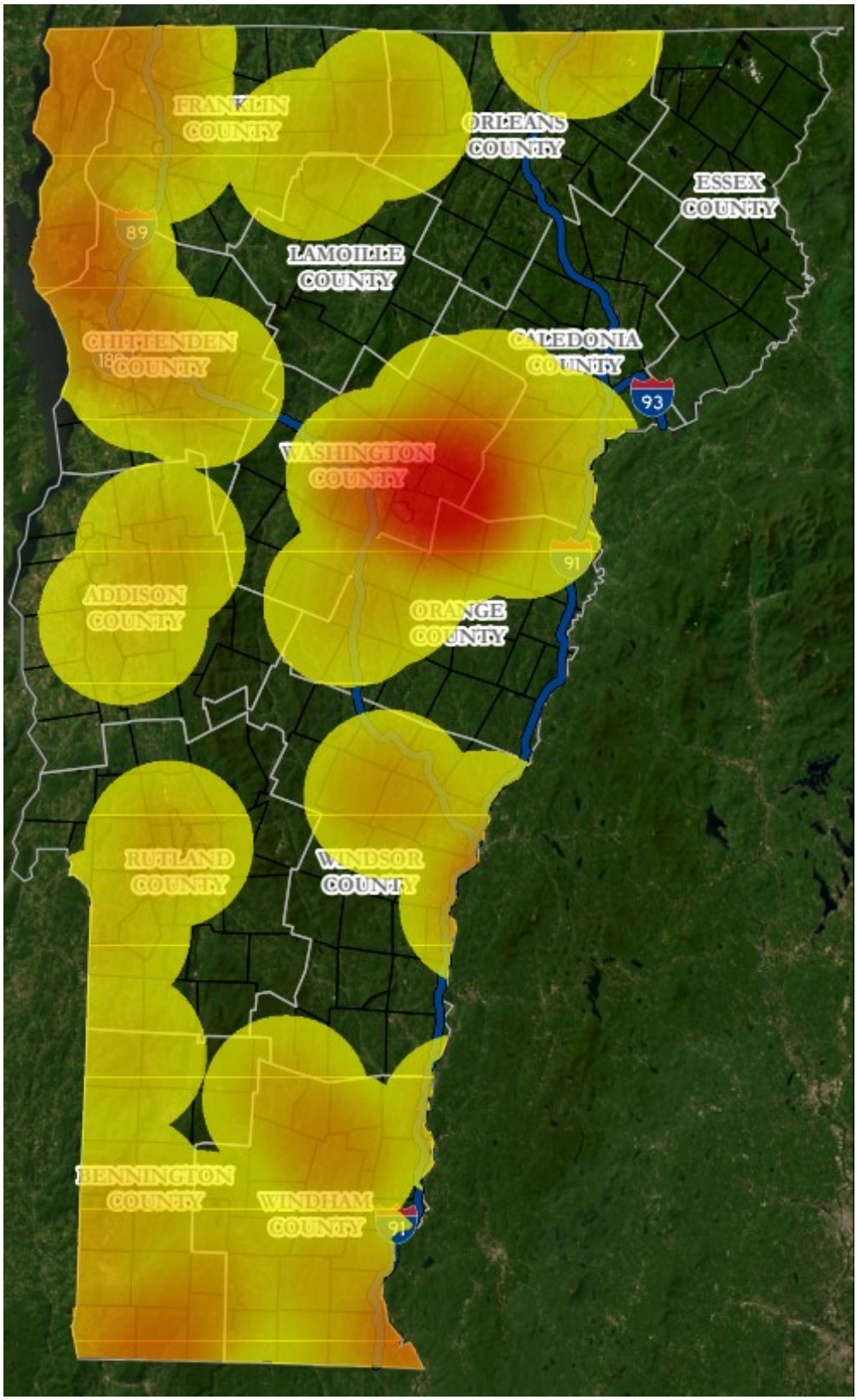

Figure 21. The mapped emerald ash borer infested area (February 2023). For each infested area, the relative EAB infestation severity is represented along a color spectrum. A dark orange infested area indicates a severe infestation and a yellow infested area indicates a less severe infestation. The "confirmed infested areas" are within five miles of these locations. High-risk areas extend five miles from the outside of the confirmed infested areas; EAB is likely expanding into and present in some of these areas.

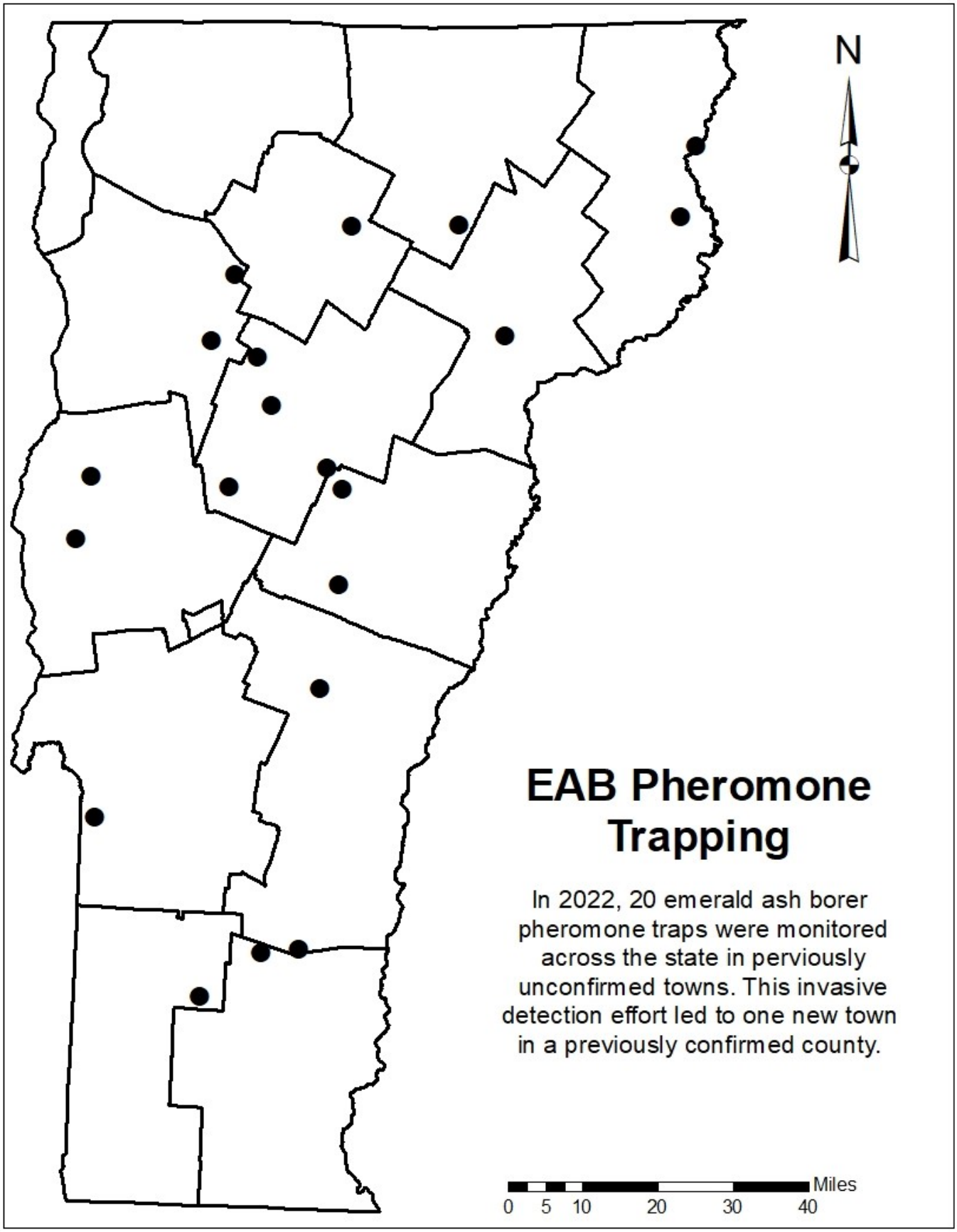

Figure 22. Locations of purple pheromone traps for emerald ash borer deployed by FPR staff in 2022.

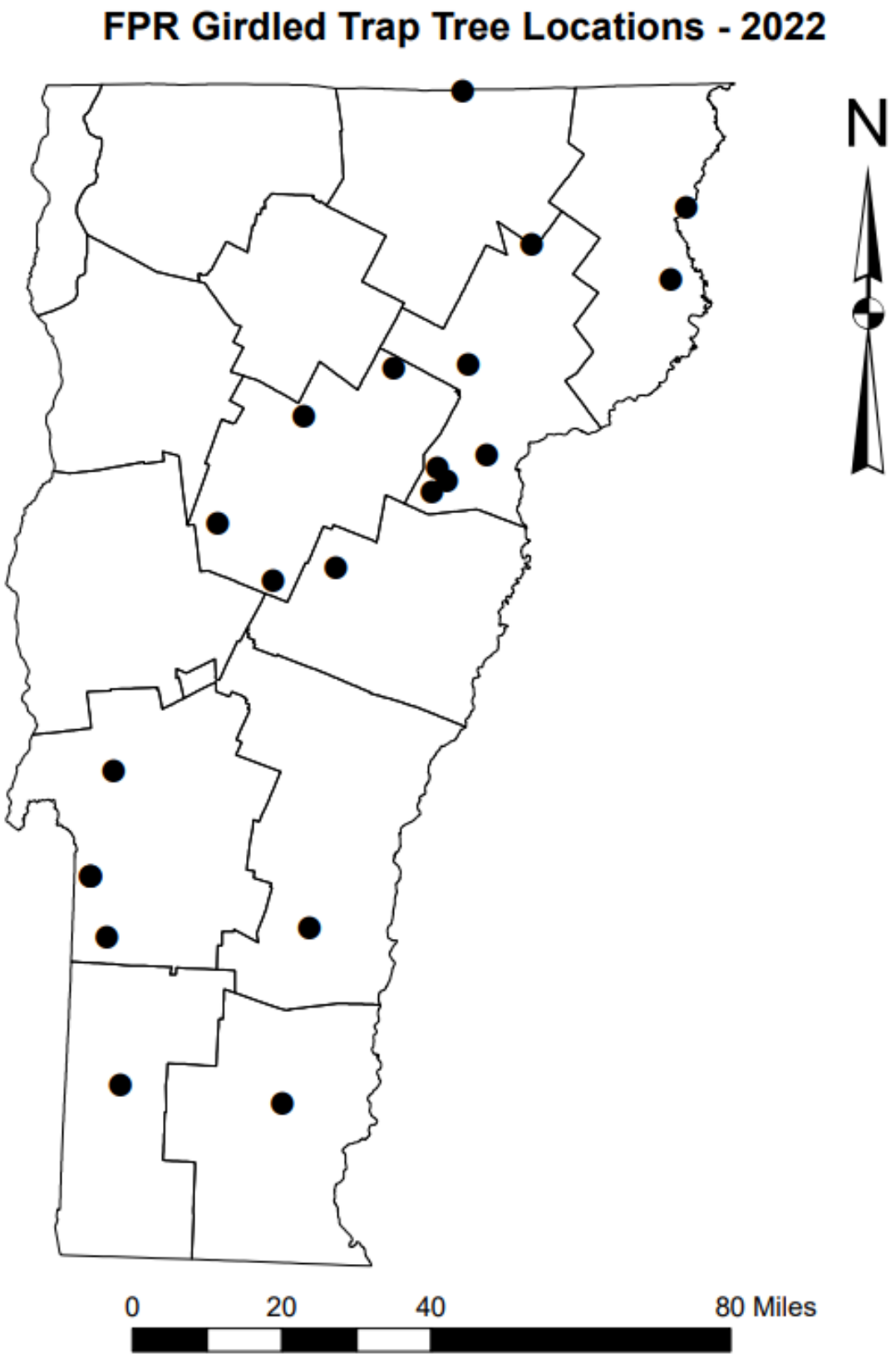

Figure 23. Location of girdled trap trees on state and private lands in Vermont in 2022. A single ash was girdled and later peeled, at each location. Two trees containing EAB were found on state land as a result.

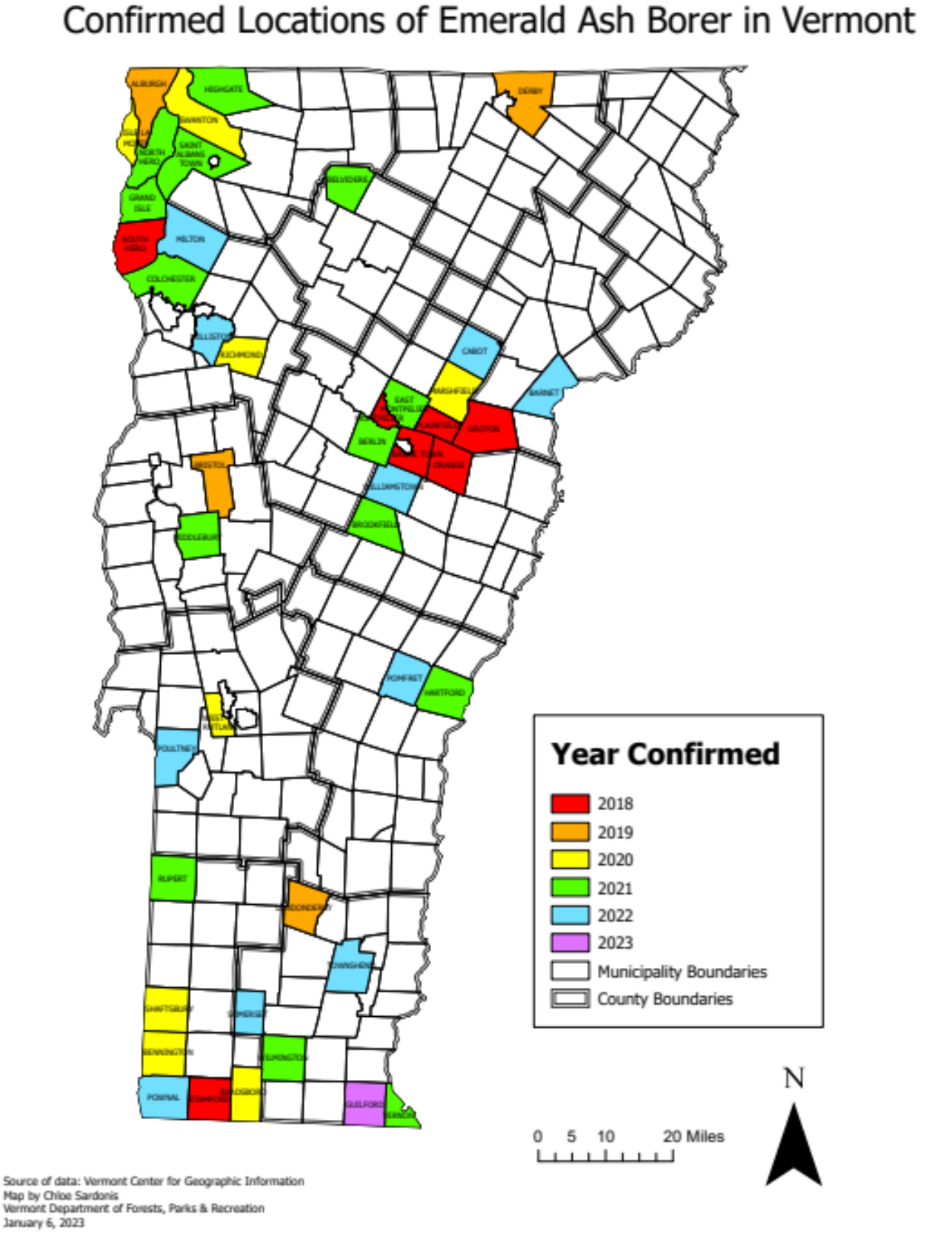

Figure 24. Towns with confirmed detections of EAB color-coded by year of detection. Note that one detection from early 2023 (Guilford) is included in the map.

Sirex Woodwasp, *Sirex noctilio*, was recovered in one trap deployed as part of the AAFM and USDA APHIS trapping effort for non-native wood-boring insects in 2022. This insect has been trapped in twelve Vermont counties since 2007 (Table 17). No new observations of *Sirex*-infested trees were reported, with the only known location in Jericho.

Table 17. Locations in Vermont where *Sirex noctilio* has been collected by APHIS, AAFM and FPR.

Year	Town	County
2007	Stowe	Lamoille
2010	Burlington	Chittenden
2012	Brattleboro	Windham
2012	Montpelier	Washington
2013	East Burke	Caledonia
2013	Jericho	Chittenden
2013	Randolph	Orange
2013	Swanton	Franklin
2013	Randolph	Orange
2013	Island Pond	Essex
2014	Island Pond	Essex
2014	Swanton	Franklin
2014	Ryegate	Caledonia
2015	Burlington	Chittenden
2016	Rockingham	Windham
2016	Middlebury	Addison
2016	Rutland	Rutland
2017	Burlington	Chittenden
2017	Burlington	Chittenden
2017	Burlington	Chittenden
2017	Rutland	Rutland
2018	Lyndon/Lyndonville	Caledonia
2018	Hardwick	Caledonia
2018	Newport	Orleans
2018	Royalton/South Royalton	Windsor
2018	Lyndon	Caledonia
2020	Randolph	Orange
2021	Chelsea	Orange
2022	Swanton	Franklin

Early Detection Rapid Response Survey: In 2022, FPR staff deployed traps for non-native bark and ambrosia beetles, to complete the 2021 EDRR survey. Trap catches were submitted to the Michigan State University for identification. Twelve sites across the state were chosen in locations that were potentially high risk for importing, storing or recycling potentially infested solid wood packing material, dunnage, crating, pallets or other items (Figure 25). Three traps were deployed at each site, using ultra high release (UHR) alpha-pinene, UHR ethanol lure and a three-component exotic *Ips* lure. One trap had only UHR ethanol lure, one trap had UHR alpha-pinene and UHR ethanol lure, and one trap had only three-component exotic *Ips* lure. Lure combination was for the target insects *Hylurgops palliates, Hylurgus ligniperda,* Orthotomicus erosus, *Ips sexdentatus*, *Ips typographus, Tomicus minor, Tomicus piniperda, Trypodendron domesticum, Xyleborus* and *Xylosandrus* spp. Traps were checked every two weeks for a total of two times from March-April, 2022.

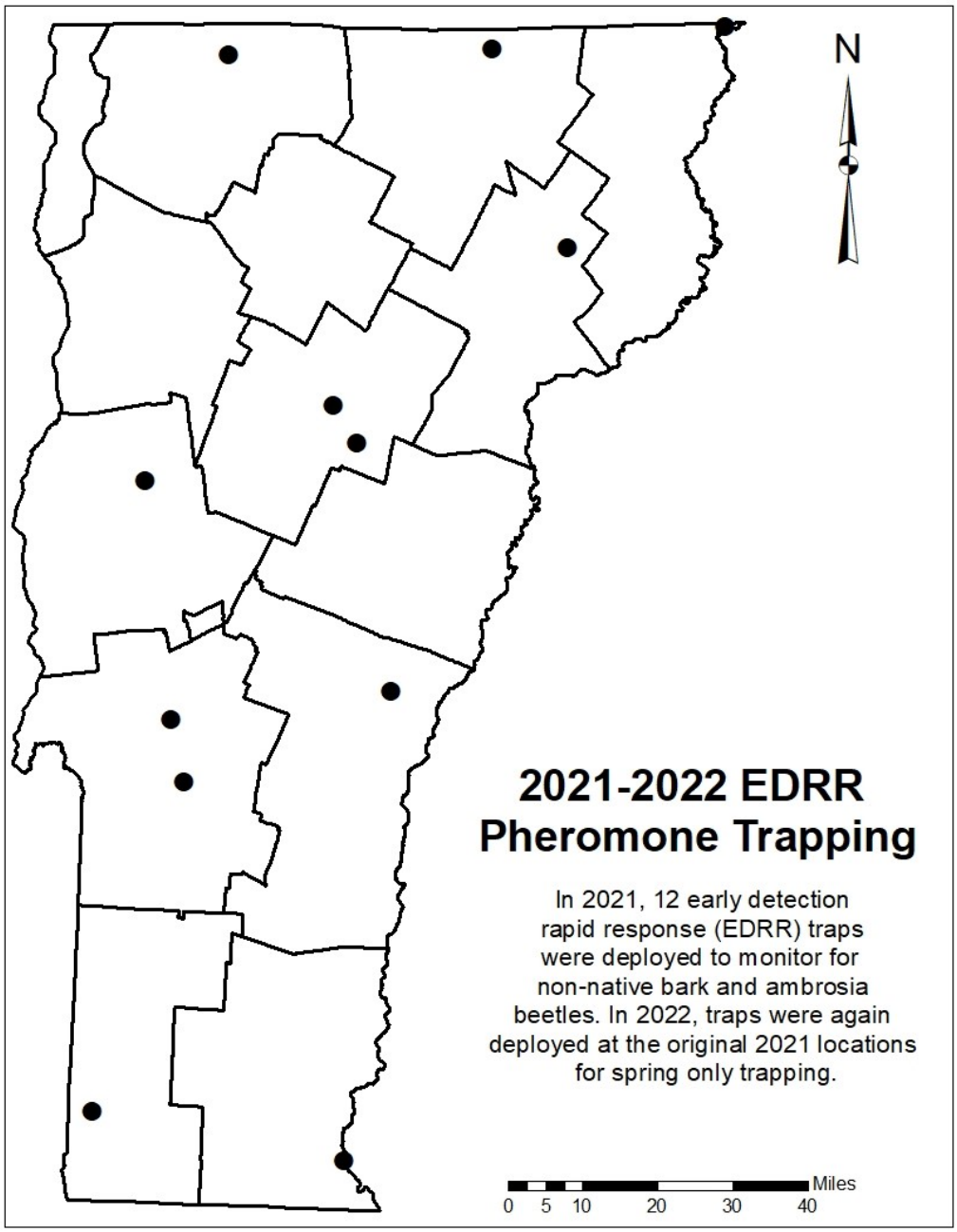

Figure 25. Early detection rapid response (EDRR) trapping locations in 2021-2022. Three traps were monitored at each location.

Table 18. Beetles that were trapped in EDRR 2021-2022 pheromone traps.

Pest Scientific Name	Pest Common Name	2021 Count	2022 Count
Trypodendron lineatum	striped ambrosia beetle	2312	401
Polygraphus rufipennis	four-eyed spruce bark beetle	1073	
Orthotomicus caelatus		1018	10
Dryocoetes autographus		613	
Xylosandrus germanus	black timber bark beetle	384	
Gnathotrichus materiarius		350	
Anisandrus sayi		249	
Dendroctonus valens	red turpentine Beetle	135	1
Pityogenes hopkinsi	chestnut brown bark beetle	126	3
Hylastes opacus		113	6
Ips pini	pine engraver	110	12
Ips grandicollis	eastern five-spined engraver	101	
Hylastes porculus		97	1
Anisandrus dispar	European shot-hole borer	65	
Xyleborinus saxesenii	fruit-tree pinhole borer	62	
Dryocoetes affaber		60	
Pityokteines sparsus	balsam fir bark beetle	60	
Hylesinus criddlei		53	2
Monarthrum mali		50	1
Dendroctonus rufipennis		41	
Pityophthorus		41	
Xyloterinus politus		40	3
Xyleborus seriatus		31	
Hylesinus pruinosus		27	29
Hylurgopinus rufipes	native elm bark beetle	21	
Anisandrus obesus		19	
Xyleborinus attenuatus		14	162
Crypturgus		12	
Phloeotribus liminaris	peach bark beetle	11	
Dendroctonus simplex	eastern larch beetle	9	
Hylurgops pinifex		8	
Hypothenemus		7	
Monarthrum fasciatum		7	
Lymantor decipiens		6	
Euwallacea validus		5	
Hylurgops rugipennis pinifex		4	26
Xyleborus xylographus		4	
Hylocurus rudis		3	
Ips calligraphus		3	
Phloeosinus canadensis	cedar bark beetle	3	
Hylastes salebrosus		2	
Cyclorhipidion pelliculosum		1	
Phloeotribus piceae		1	
Scolytus multistriatus		1	
Xyleborus ferrugineus		1	
Xyleborus pubescens		1	
Trypodendron retusum	poplar ambrosia beetle		7
Tomicus piniperda	common pine shoot beetle		3

OTHER BARK AND WOOD INSECTS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Apple wood stainer	*Monarthrum mali*	Various hardwoods		Observed as bycatch in trap catch.
Asian longhorned beetle	*Anoplophora glabripennis*	Various hardwoods		Not observed or known to occur in Vermont.
Native ash borers	*Cerambycidae*	Ash	Statewide	Ash cerambycid larvae widely observed while following up on EAB suspect trees. Trees involved are usually dead or dying.
Black Turpentine Beetle	*Dendroctonus tenebrans*	Eastern white pine	Southern Vermont	
Bronze birch borer	*Agrilus anxius*	Birch	Grand Isle County	
Chestnut brown bark beetle	*Pityogenes hopkinsi*	Pines		Observed as bycatch in trap catch.
Common pine shoot beetle	*Tomicus piniperda*	Pine		Observed as bycatch in trap catch.
Eastern ash bark beetle	*Hylesinus aculeatus*	Ash	Scattered statewide	Mulitple inquiries initiated by galleries from people concerned about emerald ash borer.
Eastern larch beetle	*Dendroctonus simplex*	Larch	Northeastern Vermont	Also observed as bycatch in trap catch.
Elm bark beetle	*Hylurgopinus rufipes*	Elm, baswood, ash	Scattered statewide	
Emerald ash borer	*Agrilus planipennis*	Ash	Widely scattered	See narrative.
European elm bark beetle	*Scolytus multistriatus*	Elm and Zelkova	Scattered statewide	
	Hylastes criddlei			Observed as bycatch in trap catch.
	Hylastes opacus	Pine		Observed as bycatch in trap catch.

OTHER BARK AND WOOD INSECTS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
	Hylastes porculus	Pine		Observed as bycatch in trap catch.
	Hylesinus pruinosus	Ash		Observed as bycatch in trap catch.
Jewel beetle	*Dicerca sp.*	Various hardwoods and conifers		Mulitple inquiries from people concerned about emerald ash borer.
Golden buprestid	*Buprestis aurulenta*	Conifers		Inquiries from people concerned about emerald ash borer.
	Hylurgops rugipennis pinifex	conifers		Observed as bycatch in trap catch.
Japanese cedar longhorned beetle	*Callidiellum rufipenne*	Arborvitae and other conifers		Not observed or known to occur in Vermont.
Northeastern sawyer	*Monochamus notatus*	Conifers	Widely scattered	Mulitple inquiries from people concerned about Asian longhorned beetle.
	Orthotomicus caelatus	Pine, spruce, larch		Observed as bycatch in trap catch.
Pigeon tremex	*Tremex columba*	Maple and various hardwoods		Also observed as bycatch in trap catch.
Pine engraver	*Ips pini*	Pines	Widely scattered	Also observed as bycatch in trap catch.
Poplar ambrosia beetle	*Trypodendron retusum*	Poplar		Observed as bycatch in trap catch.
Red headed ash borer	*Neoclytus acuminatus*	Ash and various harwoods		Mulitple inquiries initiated by galleries from people concerned about emerald ash borer.
Red turpentine beetle	*Dendroctonus valens*	Fir, spruce and pine		Observed as bycatch in trap catch.
Shothole borer	*Scolytus rugulosus*	red oak	Caledonia County	
Striped ambrosia beetle	*Trypodendron lineatum*	Conifers		Observed as bycatch in trap catch.

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*	red oak	Scattered throughout	Stand-level damage occasionally significant.
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	Scattered throughout	We continue to receive adults submitted as Asian longhorned beetle suspects.
	Xyleborinus attenuatus	Alder, birch, oak, willow, basswood		Observed as bycatch in trap catch.
	Xyloterinus politus			Observed as bycatch in trap catch.

Other Bark and Wood Insects not reported in 2022 included *Anisandrus obesus* ; *Anisandrus sayi* ; balsam fir bark beetle, *Pityokteines sparsus* ; black timber bark beetle, Xylosandrus germanus; brown prionid, *Orthosoma brunneum* ; cedar bark beetle, *Phloeosinus canadensis* ; *Crypturgus* ; *Cyclorhipidion pelliculosum* ; *Dendroctonus rufipennis* ; *Dryocoetes affaber* ; *Dryocoetes autographus* ; eastern larch beetle, *Dendroctonus simplex* ; eastern five-spined engraver, *Ips grandicollis* ; European shot-hole borer, *Anisandrus dispar* ; *Euwallacea validus* ; four-eyed spruce bark beetle, *Polygraphus rufipennis* ; fruit-tree pinehole borer, *Xyleborinus saxesenii* ; *Gnathotrichus materiarius* ; golden jewel beetle, *Buprestis striata* ; hemlock borer, *Phaenops fulvoguttata* ; Hylastes salebrosus; *Hylocurus rudis* ; *Hylurgops pinifex* ; H*ypothenemus* ; *Ips calligraphus* ; Lymantor decipiens; *Monarthrum fasciatum;* native elm bark beetle, *Hylurgopinus rufipes;* peach bark beetle, *Phloeotribus liminaris* ; *Phloeotribus piceae* ; *Pityophthorus* ; red shouldered pine borer, *stictoleptura canadensis* ; *Scolytus multistriatus* ; Six-banded longhorned beetle, *Dryobius sexnotatus* ; *Xyleborus ferrugineus* ; Xyleborus pubescens; Xyleborus seriatus; *Xyleborus xylographus*

FRUIT, NUT AND FLOWER INSECTS

INSECT	LATIN NAME	HOST	LOCALITY	REMARKS
Brown marmorated stink bug	*Halyomorpha halys*		Washington County	
Butternut curculio	*Conotrachelus juglandis*	Butternut	Southern Vermont	
Western conifer seed bug	*Leptoglossus occidentalis*		Chittenden County	Reported as accidental home invaders

Fruit, Nut and Flower Insects not reported in 2022 included acorn plum gall wasp, *Amphibolips*

STEM DISEASES

Dieback from **beech bark disease,** caused by *Cryptococcus fagisuga* and *Nectria coccinea* var. *fagina-ta*, was mapped on 31,086 acres in 2022 (Table 20, Figure 26), an increase from the 21,093 acres mapped in 2021. Bark symptoms remain common and crown symptoms are increasingly noticeable in mid-summer. Indeed, symptomatic trees were highly visible in 2022, likely due to multiple years of drought. Symptoms were especially severe along ridges where drought effects may be most commonly experienced.

Table 20. Mapped acres of beech bark disease in 2022.

County	Acres
Addison	155
Bennington	1015
Caledonia	1917
Chittenden	1676
Essex	7704
Franklin	1568
Grand Isle	0
Lamoille	6062
Orange	1226
Orleans	6829
Rutland	0
Washington	2022
Windham	175
Windsor	737
Total	31,086

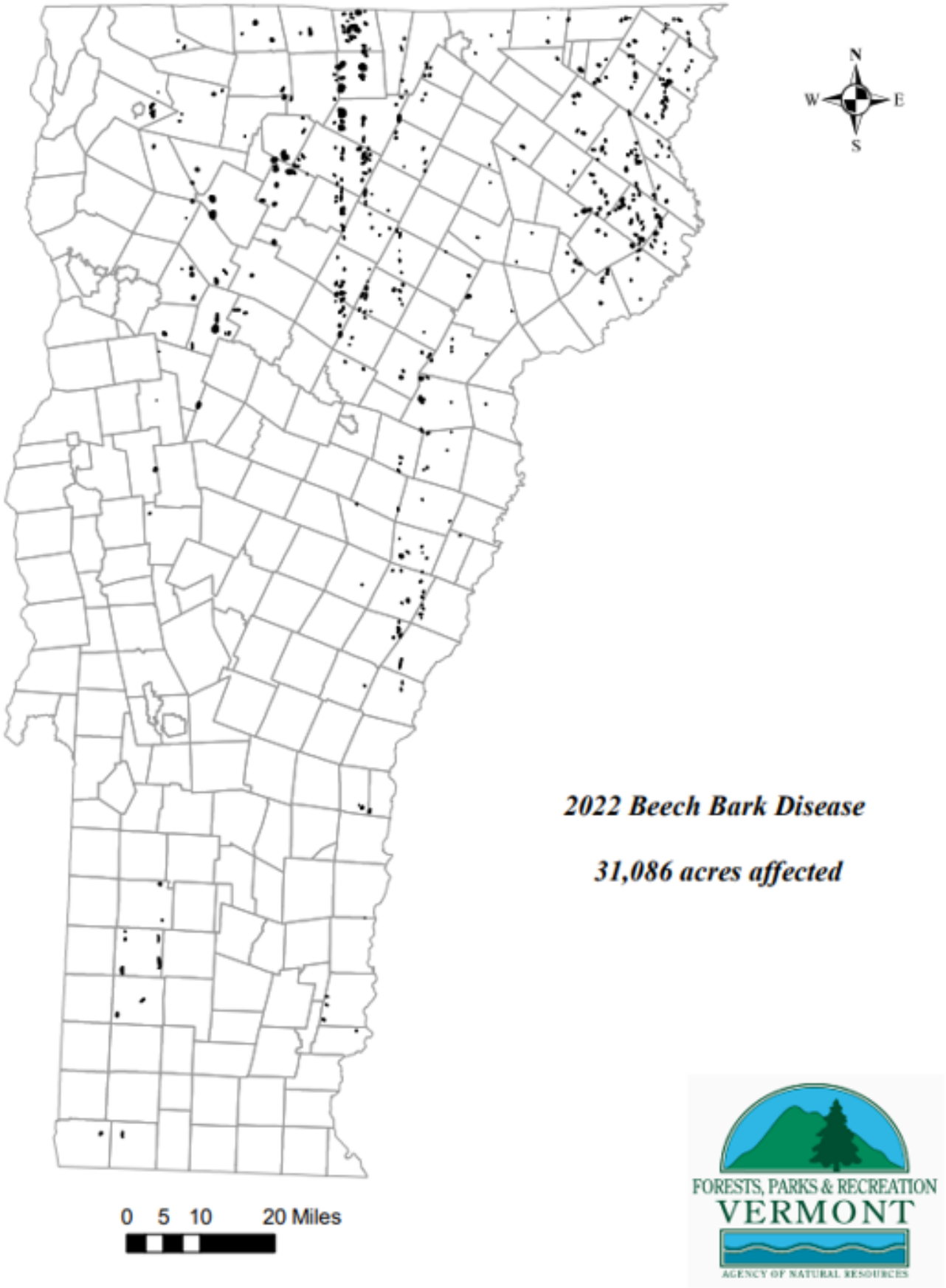

Figure 26. Beech bark disease related decline and mortality mapped in 2022. Mapped area includes 31,086 acres.

Oak wilt, caused by the fungal pathogen *Bretziella fagacearum*, is a vascular tree disease of oak trees, which causes rapid decline and mortality in infected hosts. This pathogen was first documented in Wisconsin in 1944 and has currently not been observed in Vermont. Due to the fast progression of this disease, it is thought to be introduced to the United States, however, its exact origin is unknown. This pathogen can spread large distances through a variety of bark and sap-feeding beetles as well as locally, through root graphs. Humans can expedite the spread by moving infected firewood or transporting insect vectors.

This pathogen has currently been reported in 12 states, with the most recent being in New York in 2008. Due to recent detections in New York State, Vermont and nearby states are participating in a regional effort to monitor for this pathogen. In Vermont, the primary detection method is outreach, with an estimated 3,300 contacts through newsletters and social media and 531 contacts through workshops in 2022. As a result of this effort, two oak wilt suspects were reported in 2022, however, symptoms were not consistent with oak wilt symptoms and no samples were sent to Cornell for lab testing.

OTHER STEM DISEASES

DISEASE	LATIN NAME	HOST	LOCALITY	REMARKS
Ash yellows	*Candidatus phytoplasma fraxini*	White ash	Southern and Northwestern Vermont	Remains present in scattered locations. See ash dieback.
Beech bark disease	*Cryptococcus fagisuga* and *Nectria coccinea* var. *faginata*	Beech	Widespread	See narrative.
Black knot	*Dibotryon morbosum*	Cherry	Scattered throughout	Remains common at low levels.
Butternut canker	*Ophiognomonia clavigignenti-juglandacearum*	Butternut	Widespread	Remains stable, with most butternuts showing signs of the disease. Infections are now obvious on some trees developed by grafts from healthy butternuts and outplanted 2012-13.
Caliciopsis canker	*Caliciopsis pinea*	Eastern white pine	Widespread at low levels.	Associated with heavy mortality of small poles under an oak canopy.
Cedar apple rust	*Gymnosporangium juniperi-virginianae*	Eastern red cedar	Statewide	
Chicken of the woods	*Laetiporus spp.*	hardwoods	Widespread	
Decay fungi	*Polyporus spp.*	Hardwoods	Widespread	Low levels.
Diplodia tip blight	*Diplodia pinea*	Red pine	Statewide	See Red Pine Decline and Mortality and Foliage Diseases Other.
Dutch elm disease	*Ophiostoma ulmi; Ophiostoma himal-ulmi; Ophiostoma novo-ulmi*	Elm	Scattered throughout	Similar to other years. Dead trees commonly observed along roadsides.
Eutypella canker	*Eutypella parasitica*	Maples	Scattered throughout	
Fir-brrom rust	*Melampsorella caryophyllacearum*	Balsam fir	Pittsfield, VT	
Golden canker pagoda dogwood	*Cryptodiaporthe corni*	Pagoda dogwood	Northern Vermont	
Hypoxylon canker	*Hypoxylon pruinatum*		Scattered throughout	Occurs on many hardwoods at low levels.

OTHER STEM DISEASES

DISEASE	LATIN NAME	HOST	LOCALITY	REMARKS
Nectria canker	*Nectria galligena*	Hardwoods	Scattered throughout	
Oak wilt	*Bretziella fagacearum*			Not observed or known to occur in Vermont. See narrative.
Phomopsis galls	*Phomopsis spp.*	Hickory	Addison County	
Poplar trunk rot	*Phellinus tremulae*	Poplar	Newport, VT	
Smooth patch	*Aleurodiscus spp., Dendrothele spp. and Hyphoderma spp.*	Ash	Statewide	
Sydowia blight	*Sydowia polyspora*	Red pine	Statewide	See Red Pine Decline and Mortality.
Thousand cankers disease	*Geosmithia morbida*	Walnut		Not observed or known to occur in Vermont.
White pine blister rust	*Cronartium ribicola*	Eastern white pine	Scattered throughout	Generally a decrease from a recent spike in occurrence that began in 2009.
Yellow witches' broom rust	*Melampsorella caryophyllacearum*	Fir	Scattered throughout	

Other Stem Diseases not reported in 2022 included American mistletoe, *Phoradendron leucarpum* ; chestnut blight, *Cryphonectria parasitica* ; cytospora canker, *Leucostoma kunzei* ; eastern dwarf mistletoe, *Arceuthobium pusillum* ; red ring rot, *Phellinus pini;* sapstreak, *Ceratocystis coerulescens* ; verticillium wilt, *Verticillium albo-atrum;* woodgate gall rust, *Endocronartium harknessii.*

FOLIAGE DISEASES

Eight long-term **Beech Leaf Disease** (BLD) monitoring sites were established across the state in 2021 (Figure 27) as part of a regional monitoring effort coordinated by the USDA – Forest Service. No BLD was detected in any of these sites in 2022. BLD affects both American and European beech trees and causes leaf deformation, dieback, and mortality of infested hosts. The causal agent of BLD is an introduced nematode from Japan, *Litylenchus crenatae mccannii*. This pest can affect all ages and sizes of beech, being most deadly to saplings and understory beech. This pest has currently been reported in 13 states and Ontario, Canada. The most recent reports are in New Hampshire (2022), Michigan (2022), Maine (2021), Massachusetts (2020), and Rhode Island (2020). This pest has currently not been observed in Vermont. Data collected from asymptomatic sites in Vermont are critical to serving as a baseline to track disease severity and progression if, and when, BLD becomes established in the state.

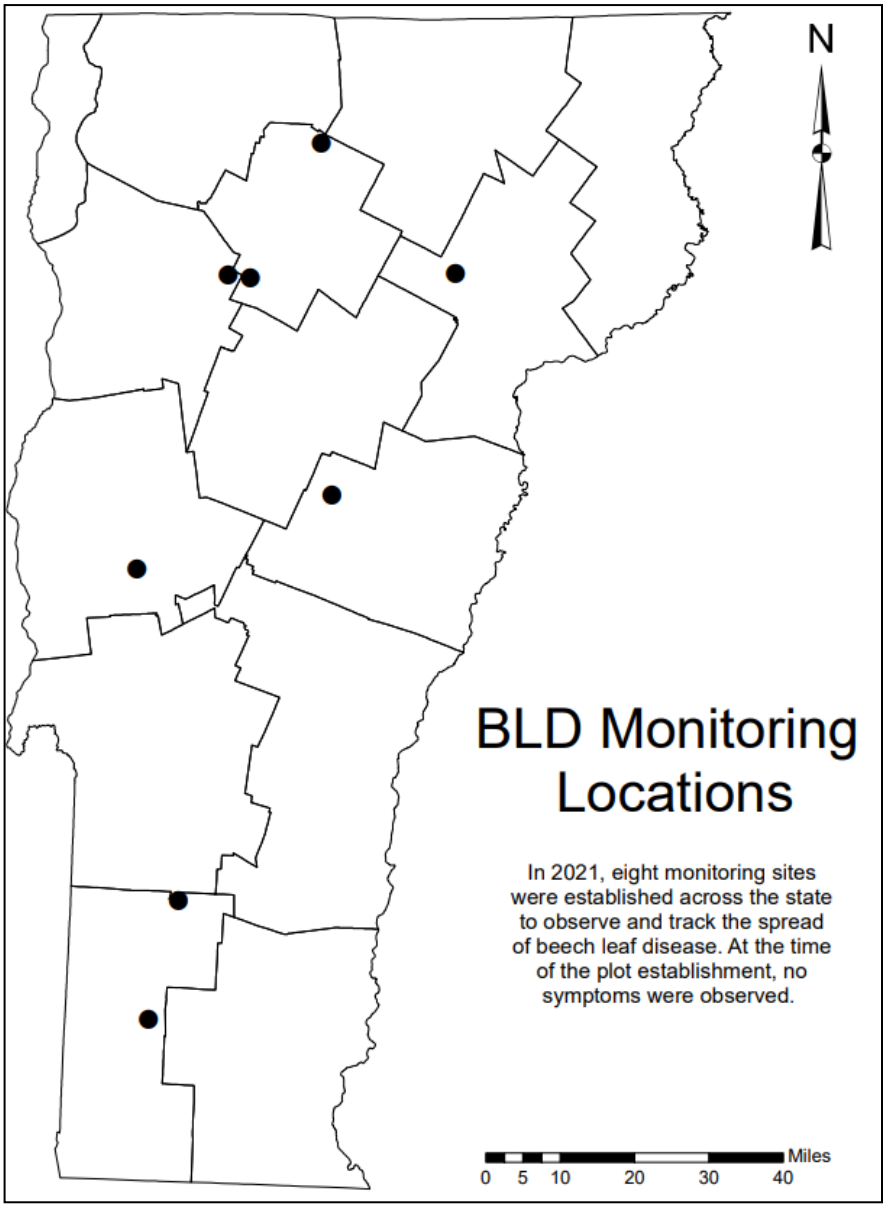

Figure 27. BLD Monitoring locations established in 2021.

White pine needle damage (WPND) is a fungal complex of four different foliar pathogens, *Bifusella linearis*, *Lecanosticta acicola*, *Lophophacidium dooksii*, and *Septorioides strobi*, that have been associated with both needle cast and needle blight on eastern white pine trees throughout Vermont. Although this is an increasingly damaging complex, individually these pathogens are not documented as causal agents of large-scale defoliation. Infected trees have been observed having chlorosis (yellowing) and necrosis (browning) of 1-year-old needles, with heavy infections having defoliation and dieback (Figure 28, 30 and 31). Decline and mortality of white pine have been observed in stands that have had multiple years of needle damage where other stress factors are also present such as wet site conditions, wind impact, wounding, or weak pests and pathogens, such as turpentine beetles, *Caliciopsis* canker, and Armillaria root rot.

The expression of WPND is linked to the amount of humidity and moisture from the previous spring (e.g., 2022 damage is influenced by 2021 weather). Spore production typically peaks in June during shoot elongation. WPND accounted for 4,624 acres of observable damage on white pine trees throughout the state in 2022 (Figure 29), compared to 2,683 acres mapped in 2021. We expect WPND to be present again in 2023, with an increase in damage due to the wet spring in 2022.

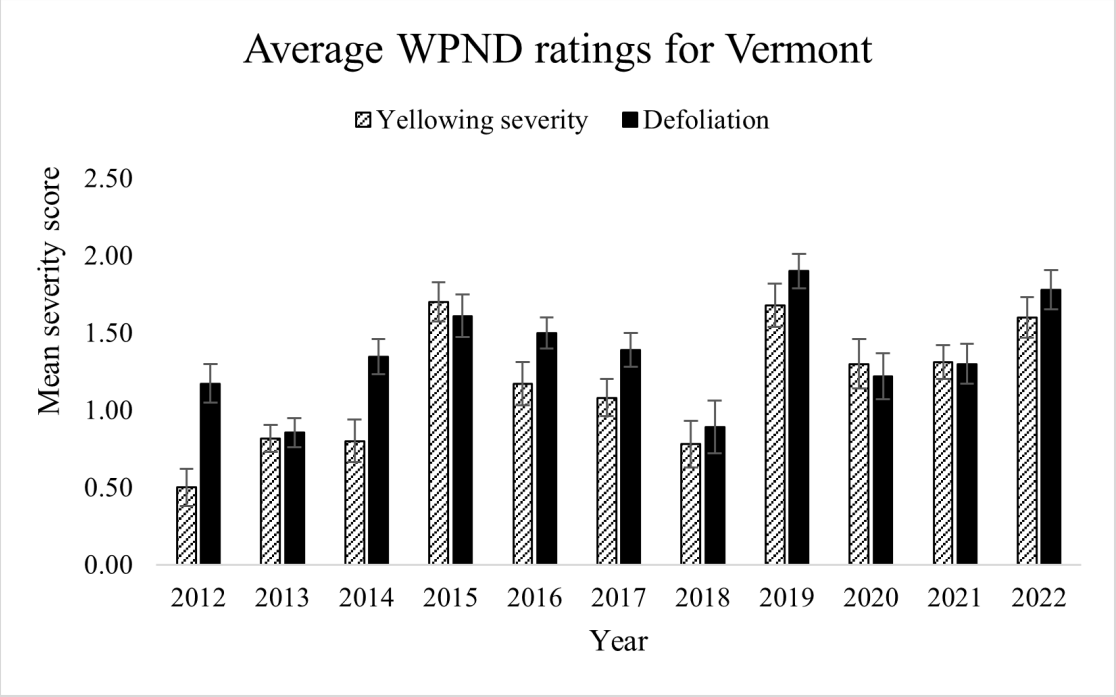

Figure 28. Mean chlorosis (yellowing) and defoliation of white pine trees from four plots (n = 50) in Vermont in 2022. Mean severity score indicates what portion of the crown is impacted (1 = 1/3, 2 = 2/3, 3 = entire crown).

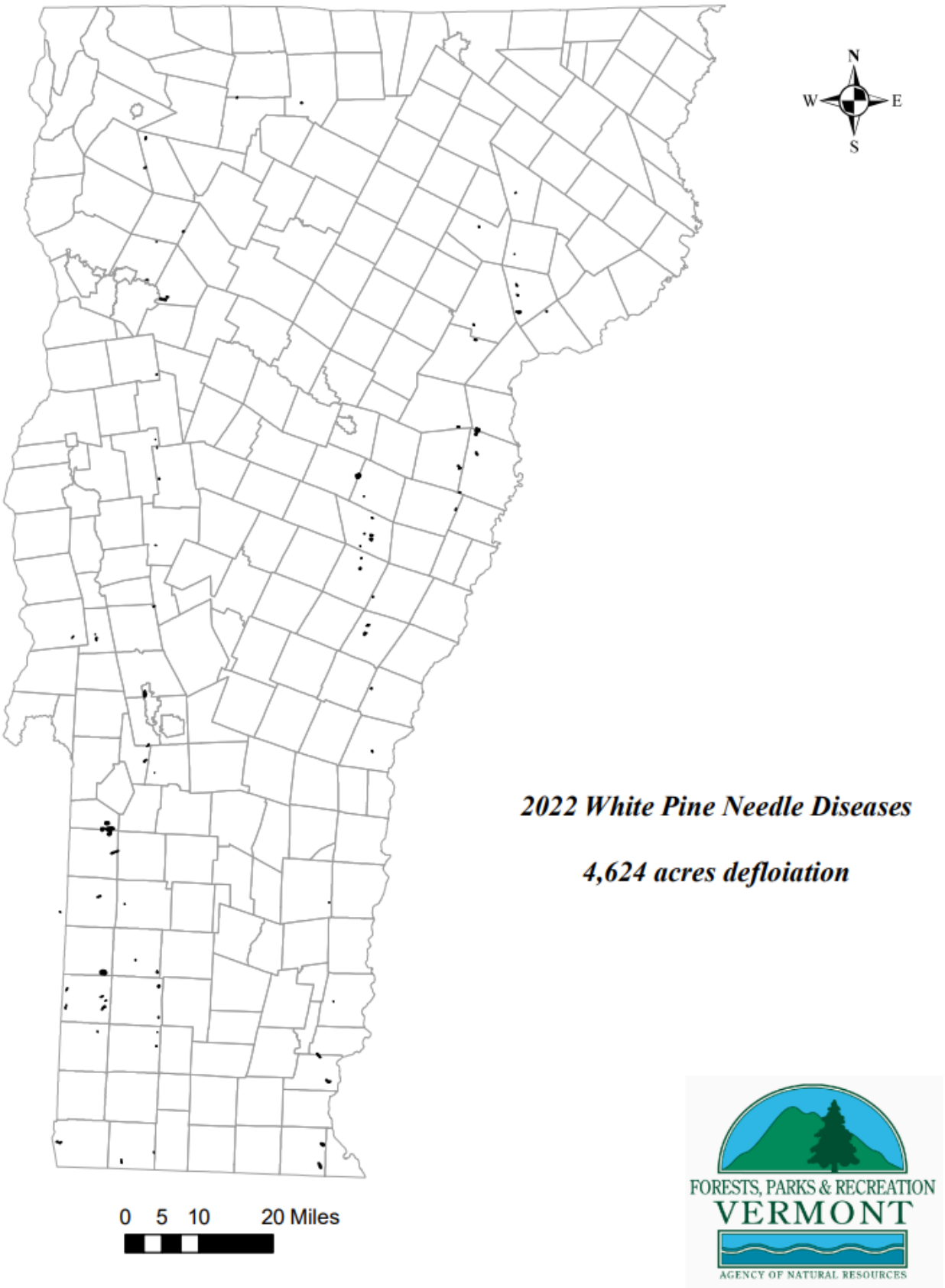

Figure 29. Defoliation caused by white pine needle diseases (WPND) affected 4,624 acres in the state in 2022.

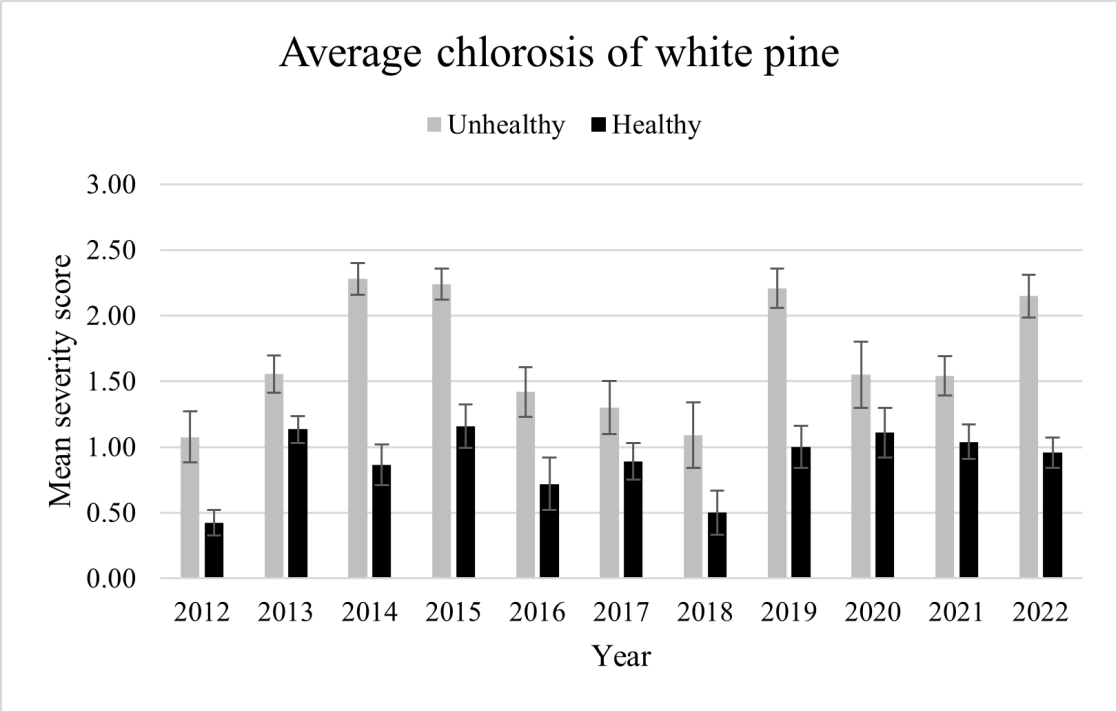

Figure 30. Chlorosis (yellowing of foliage) severity of unhealthy and healthy white pines surveyed between 2012-2022 at four sites in Vermont. Trees were rated as unhealthy or healthy in 2012, based on white pine needle damage symptoms. Data presented are mean severity scores (0 = no chlorosis, 1 = less than 1/3 crown affected, 2 = between 1/3 and 2/3 affected, 3 = more than 2/3 affected) ± standard error.

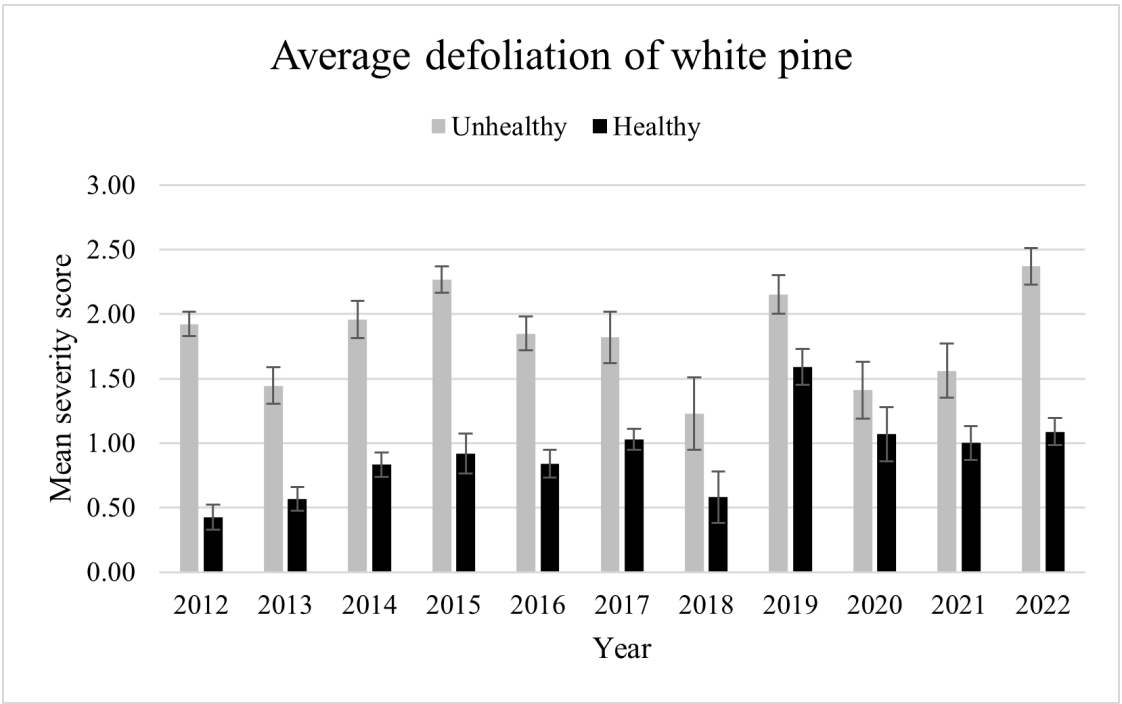

Figure 31. Defoliation severity of unhealthy and healthy white pines surveyed between 2012-2022 at four sites in Vermont. Trees were rated as unhealthy or healthy in 2012, based on white pine needle damage symptoms. Data presented are mean severity scores (0 = no defoliation, 1 = less than 1/3 crown affected, 2 = between 1/3 and 2/3 affected, 3 = more than 2/3 affected) ± standard error.

OTHER FOLIAGE DISEASES

DISEASE	LATIN NAME	HOST	LOCALITY	REMARKS
American hawthorn rust	*Gymnosporangium globosum*	Hawthorn	Jericho, VT	
Anthracnose	*Aureobasidium apocryptum; Discula campestris; Colletotrichum gleosporoides; Discula umbrinella; Gnomoniella fraxini*	Maple, beech, ash	Statewide	Decrease from 2021.
Apple scab	*Venturia inaequalis*	Apple	Statewide	
Balsam fir needlecast	*Lirula sp.*	Balsam fir	Statewide	Commonly observed on ornamental and christmas tree plantings.
Bud blast	*Seifertia azalea*	Rhododendron	Franklin County	
Birch leaf fungus	*Septoria betulae*	Birch	Northern Vermont	
Brown spot needle blight	*Lecanosticta acicola*	Pine	Statewide	Thin crowns, some decline, and heavy early needle drop. Smilar to 2020 levels. See needle diseases of white pine.
Cercospora leaf spot	*Cercospora* spp.	Rhododendron, Linden	Central Vermont	
Cedar apple rust	*Gymnosporangium juniperi-virginianae*	Apple	Statewide	
Diplodia shoot blight	*Diplodia pinea*	Red pine	Statewide	See Red Pine Decline and Mortality and Stem Diseases Other.
Fir-Blueberry Rust	*Pucciniastrum geoppertianum*	Balsam fir	Essex County	

OTHER FOLIAGE DISEASES

DISEASE	LATIN NAME	HOST	LOCALITY	REMARKS
Late leaf rust	*Pucciniastrum americanum*	White spruce	Williamstown, VT	
Linden leaf spot	*Cercospora microspora*	Linden	Montpeiler, VT	
Rhizosphaera needlecast	*Rhizosphaera kalkhoffii, R. pini*	Spruce/Fir	Statewide	Increase in reports and severity in urban trees and Christmas tree plantations.
Spiny looper	*Phigalia titea*	Many	Pawlet, VT	
Tar spots	*Rhytisma: R. acerinum, R. punctatum and R. americanum*	Maple	Statewide	
Sydowia blight	*Sydowia polyspora*	Red pine	Statewide	See Red Pine Decline and Mortality.
White pine needle decline	*Bifusella linearis, Lecanosticta acicola, Lophophacidium dooksii, Septorioides strobi*	Eastern white pine	Statewide	*See narritive* . Increase from 2021 levels.

Foliage diseases not reported in 2022 included dogwood anthracnose, *Discula destructiva* ; oat crown rust, *Puccinia coronata* ; peach leaf curl, *Taphrina deformans* ; phyllosticta leafspot, *Phyllosticta sp* .; poplar leaf blight, *Marssonina* spp.; septoria leafspot, *Septoria aceris* ; Sirococcus tip blight, *Sirococcus tsugae;* tubakia leafspot, *Tubakia dryina* .

ROOT DISEASES

DISEASE	LATIN NAME	HOST	LOCALITY	REMARKS
Armillaria root rot	*Armillaria* spp.	Many	Statewide	
Berkeley's polypore	*Bondarzewia berkeleyi*	Cherry	Windham County	

Root Diseases not reported in 2022 included heterobasidion root disease, *Heterobasidion annosum;*

DIEBACKS, DECLINES, AND ENVIRONMENTAL DISEASES

Red pine (*Pinus resinosa*) has been in a state of undetermined **decline** across Vermont over the last decade. Starting in 2010, pests and pathogens observed in declining red pine stands included pine engravers (*Ips pini*), pine gall weevils (*Podapion gallicola*), parasitic woodwasps (family *Orussidae*), armillaria root rot (*Armillaria* spp.), diplodia shoot blight (*Diplodia sapinea*) and sirococcus shoot blight (*Sirrococcus conigenus*). These observations remained consistent until 2018 with the addition of annosus root rot (*Heterobasidion annosum)* in 2012, European pine sawflies (*Neodiprion sertifer*) in 2013, brown spot needle blight (*Mycosphaerella dearnessii*) in 2014, and with red pine scale (*Matsucoccus resinosae)* in 2015 (Table 21). Although all biotic stressors are capable of reducing tree health and vigor, no individual pest or pathogen observed was determined to be the causal agent of this decline.

Over the course of eight years (2010-2018), affected red pine damage increased from localized and scattered locations to statewide reports totaling approximately 765 acres (Table 21). To try and better understand and quantify this decline, a single monitoring site was established on a 50-acre,100-year-old red pine plantation in Groton State Forest in the town of Peacham in 2019. A harvest was completed in late winter of 2019 to reduce hazards near trails and roads and to salvage lumber, and four acres were left as a reserve for monitoring. Samples were submitted to the USDA Forest Service for further analysis and were found to have spider mites and pine gall weevil. USDA Forest Service plant pathologist Isabel Munck reported *Diplodia pinea, Sirococcus conigenus*, and *Pestaliopsis* spp. shoot blight(s) on stunted shoots and cone scales.

Table 21: Stressors affecting red pine in Vermont from 2010-2020. Information summarized from VT FPR's Annual Reports of Forest Insect and Disease Conditions 2010-2020.

Stressor	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Insect Pests											
Pine engraver (*Ips pini*)	X										
Pine gall weevil (*Podapion gallicola*)	X	X	X		X	X		X	X	X	X
Pine needle scale (*Chionaspis pinifoliae*)										X	X
European pine sawfly (*Neodiprion sertifer*)				X							X
Parasitic woodwasp (*Orussidae*)	X				X						
Red pine scale (*Matsucoccus resinosae*)						X					
Pathogens											
Annosus root rot (*Heterobasidion annosum*)		X	X					X			
Armillaria root rot (*Armillaria spp.*)	X										
Brown spot needle blight (*Mycosphaerella dearnessii*)					X	X					
Diplodia shoot blight (*Diplodia sapinea*)	X		X	X	X	X	X	X		X	X
Pestalotiopsis shoot blight (*Pestalotiopsis spp.*)										X	
Red band needle blight (*Dothistroma septosporum*)											X
Sirococcus shoot blight (*Sirrococcus conigenus*)	X	X	X		X					X	X
Sydowia blight (*Sydowia polyspora*)											X
Abiotic											
Drought conditions (U.S. Drought Monitor droughtmoni-tor.unl.edu)	no drought	No drought/ abnormally dry	abnormally dry/ moderate drought	abnormally dry/ moderate drought	No drought/ abnormally dry	abnormally dry/ moderate drought	abnormally dry	abnormally dry/ moderate drought/ se-vere drought	abnormally dry/ moder-ate drought	abnormally dry/ moderate drought/ se-vere drought	abnormally dry/ moderate drought
Mapping											
Red Pine Decline	scattered locations	Moderate to Severe De-cline in Cen-tral VT			severe in scattered regions	reports of red pine mortality increased substantially	743 acres mapped	516 acres mapped	765 acres mapped	556 acres mapped	

Monitoring Sites: To determine if the 2019 declining pattern and fungal complex are consistent across the state, 12 red pine health monitoring sites were established during the summer of 2020. Including the initial Groton site established in 2019, the 12 monitoring sites were divided evenly among 4 geographical regions: Northeast (NE), Northwest (NW), Central (C), and Southern (S) (Figure 32). At each of the 12 monitoring sites, 4 permanent plots were established. In addition to collecting standard forest inventory data, the following crown metrics were observed and recorded: live crown ratio (LCR), crown density, dead shoots and location, crown transparency, and needle discoloration. FPR is planning on re-measuring plots annually for five years, and sampling as symptoms progress.

Crown Metric Results: Crown metrics and tree measurements as described above were recorded for each tree within the monitoring plot in 2020, 2021 and 2022 (Table 22-25). Standard red pine health metrics for an asymptomatic, open-grown red pine were established as having a crown density of 50%, dead shoots of 10%, crown transparency of 30%, and discoloration of 10%.

In 2022, average crown density of the Northeast region was 52.3% , 2.3% more than our standard, dead shoots of 37.8%, 27.8% more than our standard, crown transparency of 35%, 5% more than our standard, and discoloration of 20.2%, 10.2% more than our standard. No new trees died in 2022 from this region, with 20 dying since 2020 (Table 22).

In 2022, average crown density of the Northwest region was 51.0% , 1.0% more than our standard, dead shoots of 19.1%, 9.1% more than our standard, crown transparency of 42.5%, 12.5% more than our standard, and discoloration of 12.9%, 2.9% more than our standard. One new tree died in 2022 from this region, with two dying since 2020 (Table 23).

In 2022, average crown density of the Central region was 47.3% , 1.1% less than our standard, dead shoots of 44.4%, 34.4% more than our standard, crown transparency of 43.5%, 13.5% more than our standard, and discoloration of 17.0%, 7% more than our standard. Thirteen new trees died in 2022 from this region, with 33 dying since 2020 (Table 24).

In 2022, average crown density of the Southern region was 51.1% , 2.7% more than our standard, dead shoots of 18.5%, 8.5% more than our standard, crown transparency of 37.8%, 7.8% more than our standard, and discoloration of 12.7%, 2.7% more than our standard. No new trees died in 2022 from this region, with four dying since 2020 (Table 25).

Table 22-25. Crown measurements for sampled trees in 2022 compared to 2020, and 2021. Dead Trees have a LCR value of 0%, and Dead shoots value 100%. Density and transparency were not measured on dead trees and were excluded from the dataset.

Northeastern Region Summary

Site	DBH (in)	Sum of Newly Dead Trees 2020	Sum of Newly Dead Trees 2021	Sum of Newly Dead Trees 2022	LCR (%) 2020	LCR (%) 2021	LCR (%) 2022	Density (%) 2020	Density (%) 2021	Density (%) 2022	Dead Shoots (%) 2020	Dead Shoots (%) 2021	Dead Shoots (%) 2022	Transparency 2020	Transparency 2021	Transparency 2022	Discoloration of live trees (%) 2020	Discoloration of live trees (%) 2021	Discoloration of live trees (%) 2022
Groton SF East	15.8	6	13	0	19.2	11.6	9.6	35.6	41.4	51.4	61.6	80.4	77.6	69.4	35.7	35.7	13.3	10.0	38.6
Groton SF West	17.4	0	1	0	32.2	35.2	40.4	45.2	48.2	49.5	15.7	19.1	19.1	32.2	36.4	31.4	10.9	10.5	10.5
West Mtn WMA	13.8	0	0	0	50.4	57.1	57.9	49.2	52.9	55.8	14.2	11.3	16.7	45.0	35.0	37.9	13.3	10.8	11.7
Average					*33.9*	*34.6*	*36.0*	*43.3*	*47.5*	*52.3*	*30.5*	*36.9*	*37.8*	*48.9*	*35.7*	*35.0*	*12.5*	*10.4*	*20.2*

Dead Trees have a LCR value of 0%, and Dead shoots value 100%. Density and transparency were not measured on dead trees and were excluded from the dataset.

Northwestern Region Summary

Site	DBH (in)	Sum of Newly Dead Trees 2020	Sum of Newly Dead Trees 2021	Sum of Newly Dead Trees 2022	LCR (%) 2020	LCR (%) 2021	LCR (%) 2022	Density (%) 2020	Density (%) 2021	Density (%) 2022	Dead Shoots (%) 2020	Dead Shoots (%) 2021	Dead Shoots (%) 2022	Transparency 2020	Transparency 2021	Transparency 2022	Discoloration of live trees (%) 2020	Discoloration of live trees (%) 2021	Discoloration of live trees (%) 2022
Camels Hump SF Bolton	14.4	0	0	0	40.3	34.3	35.7	47.0	43.0	52.4	17.0	14.9	12.7	34.1	38.9	40.8	14.3	10.3	10.0
Camels Hump SF Starksboro N	16.7	0	0	0	40.4	40.7	40.0	47.9	45.7	52.1	10.0	14.6	14.6	30.4	38.9	42.1	10.4	10.0	11.1
Camels Hump SF Starksboro S	12.1	0	1	1	47.6	50.4	50.0	45.2	46.5	48.6	13.6	22.5	30.0	35.6	40.9	44.5	15.2	10.0	17.7
Average					*42.8*	*41.8*	*41.9*	*46.7*	*45.1*	*51.0*	*13.5*	*17.3*	*19.1*	*33.4*	*39.6*	*42.5*	*13.3*	*10.1*	*12.9*

Dead Trees have a LCR value of 0%, and Dead shoots value 100%. Density and transparency were not measured on dead trees and were excluded from the dataset.

Central Region Summary

Site	DBH (in)	Sum of Newly Dead Trees 2020	Sum of Newly Dead Trees 2021	Sum of Newly Dead Trees 2022	LCR (%) 2020	LCR (%) 2021	LCR (%) 2022	Density (%) 2020	Density (%) 2021	Density (%) 2022	Dead Shoots (%) 2020	Dead Shoots (%) 2021	Dead Shoots (%) 2022	Transparency 2020	Transparency 2021	Transparency 2022	Discoloration of live trees (%) 2020	Discoloration of live trees (%) 2021	Discoloration of live trees (%) 2022
LR Jones SF	15.7	0	0	0	33.4	29.0	30.0	49.3	38.8	47.3	12.7	16.8	22.7	30.5	15.1	35.1	10.5	10.2	10.5
Perry Hill SF	13.2	0	20	13	27.1	13.6	3.2	41.8	22.2	32.0	58.9	80.7	90.4	46.8	71.7	62.0	57.5	72.2	26.0
Thetford Hill SF	15.2	0	0	0	42.6	30.7	47.8	52.2	47.0	62.6	10.0	15.9	20.0	30.0	16.3	33.3	14.8	11.1	14.4
Average					*34.4*	*24.4*	*27.0*	*47.8*	*36.0*	*47.3*	*27.2*	*37.8*	*44.4*	*35.8*	*34.4*	*43.5*	*27.6*	*31.2*	*17.0*

Dead Trees have a LCR value of 0%, and Dead shoots value 100%. Density and transparency were not measured on dead trees and were excluded from the dataset.

Southern Region Summary

Site	DBH (in)	Sum of Newly Dead Trees 2020	Sum of Newly Dead Trees 2021	Sum of Newly Dead Trees 2022	LCR (%) 2020	LCR (%) 2021	LCR (%) 2022	Density (%) 2020	Density (%) 2021	Density (%) 2022	Dead Shoots (%) 2020	Dead Shoots (%) 2021	Dead Shoots (%) 2022	Transparency 2020	Transparency 2021	Transparency 2022	Discoloration of live trees (%) 2020	Discoloration of live trees (%) 2021	Discoloration of live trees (%) 2022
Aitken SF	12.0	1	0	0	31.5	33.8	29.2	48.0	46.8	54.0	16.5	23.8	17.6	30.4	33.6	30.8	12.4	10.4	13.2
Downer SF	18.7	0	0	0	35.9	35.0	35.5	49.5	47.7	48.6	10.5	11.4	10.5	28.6	52.3	51.4	12.3	10.0	10.0
WP WMA	10.2	0	3	0	28.7	24.7	22.3	45.0	49.6	50.7	11.7	24.7	27.3	31.3	33.0	31.1	14.3	11.1	14.8
Average					*32.0*	*31.2*	*29.0*	*47.5*	*48.1*	*51.1*	*12.9*	*20.0*	*18.5*	*30.1*	*39.6*	*37.8*	*13.0*	*10.5*	*12.7*

Dead Trees have a LCR value of 0%, and Dead shoots value 100%. Density and transparency were not measured on dead trees and were excluded from the dataset.

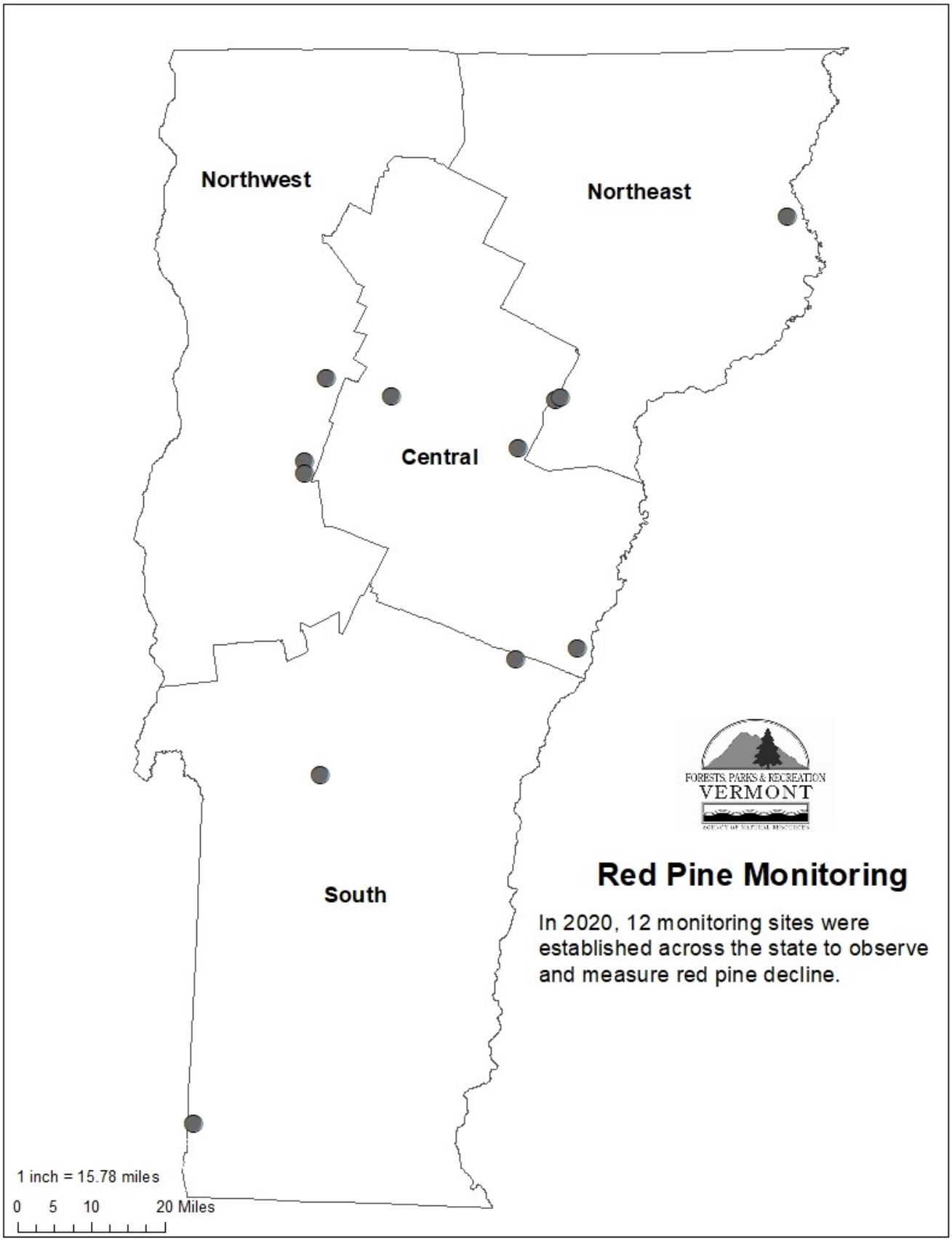

Figure 32. Red pine decline plots established in 2020.

Initial sampling: In 2020, 10 of the 12 total sites were destructively sampled to assess foliar pathogens and insect stressors in symptomatic trees. Felled red pine trees were micro-sampled from the main bole at DBH and from symptomatic branches in the canopy. In addition, symptomatic needles and cones were harvested. Fungal isolates were identified and sub-cultured as they appeared at the FPR Forest Biology Lab. Fungal isolates were identified based on morphology, and a representative subset was PCR sequenced to amplify their ITS gene region to confirm morphology identification, by Nicholas Brazee at UMASS Amherst.

Foliar pathogens observed across the state included diplodia tip blight and sydowia blight (*Sydowia polyspora*). These pathogens are both native and opportunistic and increase in population and severity when conditions favor tree stress and fungal growth. Abiotic stressors that may promote tree stress and predispose trees to fungal pathogens include drought conditions (Table 21) and insect feeding. Insect pests observed included signs of pine gall weevil (9/10 sites), pine needle scale (9/10 sites), and sawflies (9/10 sites). Observed sawfly damage was likely caused by European sawflies, however, due to late summer sampling, no physical insects were observed. Although these insect stressors have the potential to vector tree pathogens within trees and stands, this relationship was not studied during this project.

To determine how these insect stressors and pathogens may have impacted growth over the past few years, cross-sections were taken from nine sampled trees. Tree-ring analysis of sampled trees was conducted by USDA Forest Service, Northern Research Station's biological sciences technician Paula Murakami. Preliminary analysis shows a steady decline in basal area increment over the last 10 years at nine sites (Figure 33).

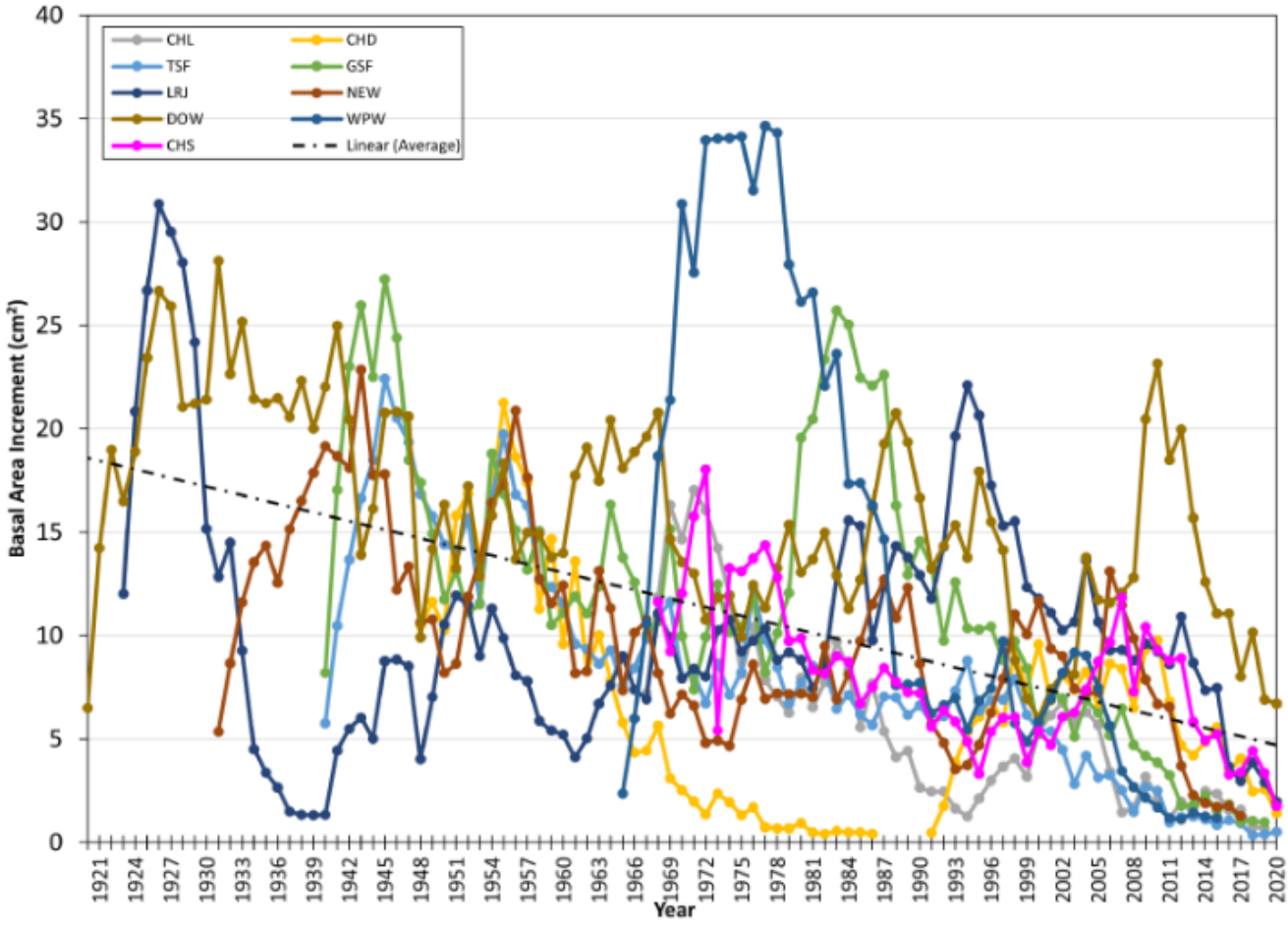

Figure 33: Basal area increment measurements of nine sampled trees with average trendline. Data and Figure credit: Paula Murakami, USDA Forest Service, Northern Research Station.

Repeated sampling: In 2022, Groton SF East was resampled using original 2020 methods due to the number of dead trees reported in 2021. Fungal isolates were identified based on morphology, and included foliar pathogens diplodia tip blight and sydowia blight (*Sydowia polyspora*). Insect pests observed included signs of pine gall weevil, pine needle scale, and sawflies. Observed sawfly damage was likely caused by European sawflies, however, due to early fall sampling, no physical insects were observed. Although these insect stressors have the potential to vector tree pathogens within trees and stands, this relationship was not studied during this project.

Conclusion: Although no single observed stressor was identified to be the causal agent of this decline, current hypotheses are that this declining pattern in red pine health is a combination of abiotic and biotic factors which include severe recent droughts, as well as the before mentioned insect stressors and fungal pathogens.

By establishing monitoring sites across the state, FPR will be able to observe and document red pine decline spread and severity. These sites will allow us to better understand red pine health and future management across the state.

OTHER DIEBACKS, DECLINES, AND ENVIRONMENTAL DISEASES

CONDITION	HOST	LOCALITY	REMARKS
Ash dieback	White ash	Scattered statewide	Remains heavy in scattered locations. Increase attributed to ash susceptibility to drought and widespread EAB infestations.
Black cherry symptoms	Black cherry	Essex and Orange counties	In multiple locations, black cherry had thin crowns, premature leaf drop, and scattered mortality. Causal agent(s) unknown.
Drought damage	Many	Southern Vermont, Northeastern Vermont	Drought symptoms from 2020 is apparent. Light symptoms from drought in 2022.
Fire damage	Many	Killington, VT	76 fires in 2022 totaling 74.47acres. Dead trees at 2021 Killington fire.
Frost damage	Apple, spruce, northern white cedar	Northwestern Vermont	
Larch decline	Eastern larch	Widely scattered; concentration in Northeast Kingdom	
Ozone injury			Ozone monitoring plots were discontinued in 2018.
Salt damage	Eastern white pine	Widespread	While not unusually severe, foliar browning was common in late winter.
Red pine mortality	Red pine	Statewide	See narrative.
Wind damage	Many	Central and, Northeastern Vermont	In multiple locations, blowdowns and breakage due to high wind.
White pine needle damage	Eastern white pine	Statewide	See Foliage Diseases.

Other Diebacks, Declines, and Environmental Diseases not reported in 2022 included air pollution injury, birch decline, chlorosis due to rainfall, hail damage, ice and snow breakage, spruce decline, and winter injury.

ANIMAL DAMAGE			
ANIMAL	**SPECIES DAMAGED**	**LOCALITY**	**REMARKS**
Porcupine	Eastern white pine	Statewide	Scattered throughout the state.
Squirrel	Maples, Oaks	Statewide	Scattered throughout the state.
Woodpecker	Wood products; Ash spp., Balsam fir, Mountain ash, Hemlock	Statewide	Scattered throughout the state.
Deer	Many	Statewide	Browse and girdling damage

2022 INVASIVE PLANT SUMMARY

Non-native invasive plant management (NNIPM) efforts continued in 2022, with progress on **Research and Outreach** made possible through several grant-funded opportunities. In the first half of the year, the Vermont Department of Forests, Parks and Recreation's (FPR) Forest Protection Program's Invasive Plant Coordinator and Invasive Plant Assistant Coordinator finalized deliverables for a multi-year USDA Forest Service Landscape Scale Restoration grant, which included the posting and publication of 69 new outreach resources to VTinvasives.org, all available for free to view and download. This included the new publication 'Youth Volunteer Program Guide', designed as a culminating document of experiences and lessons learned from the work completed by program staff since 2013.
In the second half of the year, the coordinators transitioned full attention to a new USDA Forest Service Landscape Scale grant, focused on phenology, early detection, and mapping of invasive plants; all these new projects are in the early stages of long-term implementation. Additionally, the coordinators created and curated invasive plant content for two external-facing webpages, and one internal-facing webpage. 18 articles were written for a variety of newsletters and publications, on the topics of early detection and phenology, and 2 podcast episodes focused on invasive plant phenology were published on VTinvasives.org. The coordinators also worked with multiple state departments and agencies to unify Vermont's approach to NNIPM. They fielded over 400 inquiries about invasive plants, and when capacity allowed, hosted/participated in 8 workshops related to phenology and early detection. Other FPR staff continued to provide outreach and information about invasive plants to the public and resource professionals, and worked with landowners and consulting foresters on addressing non-native invasive plants (NNIP) on private lands. This includes the work conducted by County Foresters (see Non-native Invasive Plant Management Supported by the Private Lands Program section below), who help landowners and communities manage their forests, including providing recommendations on the treatment of invasive plants. Agency of Natural Resources (ANR) staff, including FPR, the Vermont Department of Fish and Wildlife, and the Vermont Department of Environmental Conservation, continue to identify and manage invasive plants on **State Lands**. Varied NNIPM strategies were conducted within local communities and by many other organizations, some of which are summarized under **Other Activities**.

Early Detection Species

Reports of early detection (ED) terrestrial invasive plants were reported via the VTinvasives.org Report It! Tool, and included 2 confirmed positive finds for ***Petasites spp***., in Westford and Fairfax, 1 confirmed positive find for **giant hogweed** (*Heracleum mantegazzianum*) in Starksboro, and 1 confirmed positive find for **Himalayan balsam** (*Impatiens glandulifera*) in St. Johnsbury. Additional sightings of ED species were made but not reported through the VTinvasives.org Report It! Tool, though were shared with program staff. These included a positive find for **Japanese tree lilac** (*Syringa reticulata*) in Montpelier, and several new locations of **stiltgrass** (*Microstegium vimineum)* in Benson, Guildford, and new patches in Brattleboro. In Windham County, locally driven assessment and management for **stiltgrass** continue, summarized under **Other Activities**. There is also an unconfirmed sighting of **stiltgrass** in North Pownal that was discovered on iNaturalist.org.

The report of **Japanese tree lilac** naturalizing fits into a broadening understanding of this species in the Northeast. Historically, this plant has been touted as a non-invasive alternative to invasive plants. And in New York in 2011, the state's Invasive Plant Risk Assessment gave it a ranting of "unknown" because there wasn't enough known about it. The New York Natural Heritage Program as early as 2010 recorded it naturalizing and outcompeting native species in floodplains. As of 2017, **Japanese tree lilac** has been documented in 4 Vermont counties (Lamoille, Chittenden, Addison, and Bennington). In 2019, New York organizations were putting out recommendations for how to remove this plant, and has been documented as invasive and actively managed in the Adirondack State Park. With the newly launched New York Invasive Species Tier system, this species has been researched and classified as

"moderate" in its invasiveness, and ranked as "Tier 2", a designation that means that it is encourage to be eradicated. As well, 2021, Pennsylvania started researching and monitoring **Japanese tree lilac**, and "preliminary data suggest this tree may pose a risk to riparian habitats, and local landowners and municipal leaders may need to avoid using it in landscaped settings.".

Research and Outreach

Invasive Plant Phenology Monitoring Projects: FPR staff and statewide partners are working to establish a **Vermont Invasive plant Phenology Network** (VIPN). This is a network of projects establishing a baseline dataset for invasive plant phenology in Vermont. Knowing how invasive plants are behaving at different latitudes and elevations helps us all understand how plants respond to changes in climate and growing conditions, and allows us to adjust our treatment plans accordingly. Continuing the 6th season for the **Statewide Invasive Plant Phenology Monitoring Project** (SIPPMoP), FPR staff and volunteers observed any invasive plants phenology across the state in the second full week of each month of the growing season. Results were reported in the monthly FPR Insect & Disease Reports. This was year one for the **Vermont Invasive Plant Phenology Project** (VIPPP). This is a multi-organizational collaboration, with sites across the state, utilizing the **National Phenology Network**'s (NPN) database and their online mapping tool, **Nature's Notebook**. The Invasive Plant Coordinator is an NPN trained Local Phenology Leader, and is coordinating and running the research project. This project is focused on observing the phenology of three invasive plants, *Lonicera morrowii, Celastrus orbiculatus,* and *Rhamnus cathartica*, and ongoing data collection can be viewed for free through the online NPN visualization tool.

VTinvasives.org Website: The VTinvasives.org website continues to offer information on terrestrial and aquatic invasive plants and continues to provide that information to a variety of user groups from landowners to professional foresters to municipalities, including educational resources and Best Management Practices. Since its relaunch in 2017, the website has seen over 300,000 visitors, and from late 2021 to late 2022, saw over 90,000 visitors, with the top ten countries using the site being the US, Philippines, India, Canada, China, UK, Germany, Netherlands, Indonesia, and Spain. 22% of traffic on the website last year was driven from within VT and 40% came from visitors from across the eastern U.S. The Invasive Plant Program continued work on the website to update and curate relevant information and resources pertaining to terrestrial invasive plants. This included adding dozens of newly published free resources and updating website structure to make said resources easily accessible.

Tool Loan Program: In an effort to increase access to NNIPM tools, the District 3 (Northwest) office started a pilot program in 2017, loaning out mechanical tools and outreach kits to local organizations, municipalities, and private landowners. The coordinators communicate with participants and organize pick-up and return dates. The loan program was expanded to include tools available through a library at the District 2 (Southwest) office in 2019. The expanded loan program was used 4 times in 2022. The coordinators shared information about the tool loan program during online presentations throughout the year, and the tools are stored and available for pick up at FPR's Essex Junction and Rutland office.

Mapping for Healthy Forests, Vermont: This iNaturalist project remains active, connecting users with location, photos, information on seed production, and level of infestation of each specific observation of invasive plants. This information is stored on the iNaturalist website and is accessible to anyone. As of January 2023, the project had 4,875 observations provided by 184 observers.

Forest Hero! Volunteer Network: The active network of 26 community volunteers continues to be supported by the coordinators through a quarterly newsletter. Volunteers are regularly offered opportunities to engage as leaders in their communities around invasive plant outreach and management. This program was started and made possible by a USDA Forest Service Landscape Scale Restoration grant, and was made possible by a collaboration with partners like Vermont State Parks and Vermont Coverts: Woodlands for Wildlife. Since October 2018, 5 trainings have taken place and forty-one people have participated in learning how to effectively communicate information to their communities on invasive

plants. As part of the training, participants agree to take what they learn back to their communities and are expected to complete at least one outreach event within a 12-month period.

Non-native Invasive Plant Management on State Lands

District 1 (southeast): FPR staff in District 1 oversaw multiple NNIPM projects in 2022. Approximately 137 acres of state lands were treated for a variety of invasive plants. That work included a mix of contracted and internally conducted NNIPM including 131 acres of ongoing projects and 6 new projects, and was a mix of chemical treatments and mechanical treatments.

District 2 (southwest): FPR staff in District 2 oversaw multiple NNIPM projects in 2022. This included contracted work to treat 6 acres of invasive common reed and 3.4 acres of invasive burning bush located throughout the district at Wildlife Management Areas and State Forests (Plymsbury WMA, Coolidge SF, Whipple Hollow WMA). Additionally, 40 students from Castleton Elementary School helped staff pull over 100 bags of invasive garlic mustard at Lake Saint Catherine State Park, in Poultney, VT.

District 3 (northwest): FPR staff in District 3 oversaw multiple NNIPM projects in 2022. This included staff using chemical treatments on invasive plants along roads and on log landings on Camel's Hump State Park, which spans multiple towns. These foliar treatments of invasive honeysuckles, invasive multiflora rose, and invasive buckthorn were conducted during late summer and fall. Additionally, with the cooperation of the Vermont Department of Fish and Wildlife, 10 volunteers took part in mechanical removal of invasive shrub honeysuckles and invasive buckthorns at Dead Creek Wildlife Management Area in Addison. This work was in part to add capacity to NNIPM at Dead Creek, but also motivated by the volunteers' passion for protecting bird habitat.

District 4 (central): FPR staff in District 4 oversaw multiple NNIPM projects in 2022. Approximately 50 acres were mechanically and chemically treated for invasive plants, including barberries, common buckthorn, shrub honeysuckles, common reed, knotweeds, multiflora rose, and false spirea.

District 5 (northeast): FPR staff in District 5 oversaw the continued monitoring of a barberry treatment at Willoughby State Forest. Initiated in 2019 with mechanical efforts to remove larger stems and patches, there were two subsequent years that barberry plants were chemically treated across approximately 40 acres. The work in 2021 was conducted by Red Start and the need for them to mostly spot treat indicates the success of the previous two years' treatments. Long term honeysuckle and knotweed assessments continued at Calendar Brook WMA.

Non-native Invasive Plant Management Supported by the Private Lands Program

Grand Isle County: With technical support from FPR Franklin and Grand Isle County Forester, Dept. Fish & Wildlife staff, and NRCS, the community of South Hero completed a yearlong effort to protect rare plants on Providence Island. This involved community engagement and active NNIPM. Chemical treatment for shrub honeysuckles, barberries, and buckthorns was completed on the north end of the island by Redstart Consulting.

Orange County: With technical support from FPR Washington County Forester, 3 acres of common reed and 10 acres of bittersweet were treated between July and October, in Randolph Center. With technical support from FPR Orange County Forester, the town of West Fairlee hired Redstart Consulting to inventory and treat invasive plants at the Brushwood Community Forest.

Windsor Counties: With technical support from FPR Orange and Windsor County Forester, the town of Royalton treated 23 acres of invasive plants at Crawford Town Forest. Redstart Consulting did a post-harvest treatment for buckthorn, shrub honeysuckles, burning bush, and barberries. In review, roughly

8 acres had moderate to heavy infestation and the remaining acres were moderate to light. There are plans for the contractors to return and do a follow-up treatment in 2023 if needed.

Other Activities

The 2022 growing season saw many NNIPM projects across the state. These efforts were led by individuals and organizations ranging from community champions, local/state/federal government, non-profits, and businesses. Below are highlights reported by some of these project leaders.

Cooperative Invasive Species Management Areas

Cooperative Invasive Species Management Areas (a.k.a. CISMAs, CWMAs, or PRISMs) are partnerships among local organizations working to manage invasive species through outreach, prevention, and treatment. Participants in a CISMA share resources to be collectively more effective in their work at protecting the ecological health of a particular area. In Vermont, active CISMAs include the Batten Kill Watershed CISMA, the Orleans County CISMA, the Southeast VT CISMA, the Upper Connecticut CISMA, and the Upper White River CWMA. While not technically a CISMA, the Black River Action Team deserve mention for their great work at early detection of and rapid response to, invasive plants.

Batten Kill CISMA: The Batten Kill CISMA, with support from Green Mountain National Forest (GMNF) staff, continued restoration work throughout the CISMA, and engaged with two AmeriCorps members from local organizations (Hildene, the Lincoln Family Home in Manchester and the Brattleboro Office of the Vermont Land Trust). The AmeriCorps members: hosted and participated in multiple invasive plant educational programs for all ages; wrote the first edition of a newsletter for the CISMA; wrote educational articles for social media and local newspapers; and established an ongoing invasive plant virtual BioBlitz via iNaturalist. GMNF staff, as active members of the CISMA, also developed an informal agreement between Hildene and the Batten Kill CISMA, allowing staff to grow out woody plant seeds collected on the National Forest at Hildene nursery and use the resulting plants in restoration work elsewhere in the CISMA, including Richville Road restoration site within the National Forest.

Black River Action Team: The Black River Action Team (BRAT) are working to contain several populations of common reed along the shores of Amherst Lake in Plymouth. In 2022, six volunteers cut and dug common reed roots along the northern shoreline, and a 25’x50’ area was tarped to smother all vegetation over winter and into spring. This effort will continue around the shoreline until each portion of the common reed patch has been treated, and native vegetation can be encouraged or replanted. BRAT is working closely with the Agency of Natural Resources with regards to placement of tarps on the shore to avoid any adverse impacts to the lake.

Upper Connecticut CISMA: The Upper Connecticut CISMA continued invasive plant treatments throughout the Upper Connecticut River watershed. 3 days of treatments were contracted to Vegetation Control Services and included: treating all known populations of knotweed along the mainstem of the Connecticut River from Canaan, VT/Stewartstown, NH down to the Colebrook, NH rest area (4th year of treatment); treating knotweed and buckthorns at Nulhegan Basin Division of the Silvio O Conte Refuge in Brunswick, VT. A new invasion of garlic mustard was also discovered in the floodplain on the Vermont side of the river.

Upper White River CWMA: The Upper White River CWMA continued their efforts, as a collaboration of a coordinator position, volunteers, White River Partnership staff, and GMNF staff. They provided ongoing treatments for various invasive plants including: treating garlic mustard in Chittenden and Goshen; treating wild chervil in Pittsfield and Rochester; treating wild parsnip in Goshen at Brandon Gap; treating barberry in Rochester. Additionally, staff and volunteers provided: residents and businesses in Rochester, Hancock, and Granville, management direction via Front Porch Forum for wild chervil; a public presentation on replanting with native species in the home landscape; a barberry control event at the GMNF Ranger Station in Rochester.

Towns, Municipalities

Fayston, VT: The Fayston Conservation Commission continued efforts to address invasive species management in town. Volunteers continued a multi-year project treating isolated patches of knotweed using mechanical methods throughout the summer, and focused on German Flats Road and North Fayston Road. Knotweed treatment efforts were expanded this year to include the parking area of Chase Brook Town Forest. At this site, in addition to repeated cutting, the Conservation Commission is experimenting with a smothering technique using carboard and plastic, which will be left in place for several years.

Hinesburg, VT: the Town of Hinesburg owns a 301-acre parcel called the LaPlatte Headwaters Town Forest. This year, the Hinesburg Town Forest Committee contracted with Trout Lily Forestry Services to treat invasive shrub honeysuckle, barberry, yellow iris, and buckthorns on the floodplain portion of the town forest. The portion of the trail system that passes through Hidden Meadow was mechanically treated in July for wild parsnip by independent volunteers.

Hyde Park, VT: The town of Hyde Park has a volunteer group, Knot in Hyde Park, dedicated to bringing the community together to actively manage and reduce the spread of knotweed within the town. The group was formed in 2021 and have spent the last two years conducting mechanical treatment of knotweed at over 50 sites throughout town, including a large site along the Lamoille Valley Rail Trail. This work has also included outreach through the town website.

Jericho, VT: In the Town of Jericho, there is a volunteer group, Jericho Invasive Plant Posse, who are actively managing various invasive plants around town. This work involves mechanical treatment of invasive shrub honeysuckles. In April, May, and June of 2022, 5 volunteers spent 36 hours cutting 10-15 acres of honeysuckle. The work happened by permission on private land owned by a local homeowner's association. The hope is that continued removal and replanting will restore space for local plants like American cranberry, nannyberry, oak, and cherry.

Figure 34. Jericho Invasive Plant Posse volunteers cutting back invasive shrub honeysuckle in Jericho. **Photo Credit**: Bernie Paquette, Jericho Vermont.

Monkton, VT: The Monkton Conservation Commission continued efforts to address invasive species management in town. In 2022 this work involved removing invasive wild parsnip from Morse Park (now a 5 year-long effort) and starting a new project on removing invasive buckthorns from behind the Monkton Central School, funded in part by a Tiny Grant from the Association of Vermont Conservation Commissions. Commission members held 4 pull events as part of the wild parsnip project, each event seeing 5-8 participants. The commission used the grant funds to purchase two Uprooter tools, which

were used for a training and two workdays to remove buckthorn near the school, and are also available for use by community members.

Shrewsbury, VT: The Shrewsbury Conservation Commission has an active 5 year program to deal with a variety of invasive plants, led by a commission member whose specific role is to monitor and coordinate management of invasive plants in town. Previous efforts were focused on managing garlic mustard, wild parsnip, wild chervil, and purple loosestrife. Regular volunteer pull days are organized, and outreach is provided through the town newsletter and consultations on proper removal and disposal. Another important component of their outreach efforts is providing learning opportunities to landowners on effective removal efforts and providing support to those taking on initial efforts of management in return for the landowners supporting the town efforts by "adopting" and helping monitor treatment sites. Reintroductions are seen in fill and maintenance materials, and the commission is interested in learning from others about their approaches to managing that. With so many seasons of active removal, seed banks are beginning to be exhausted, and locals are noticing that consistent, patient, and persistent work pays off.

Springfield, VT: The Springfield Trails and Rural Economy Committee conducted wild parsnip removal and invasive specie sinventory on the town's multi-use recreation/transportation path, Toonerville Trail.

Stowe, VT: The Stowe Land Trust, in partnership with the Stowe Conservation Commission and Stowe Trails Partnership began efforts to manage invasive plants at Cady Hill Forest. This year's efforts started with an open meeting in early July that was attended by 12 people, and included discussing the history of invasive barberry at the site and past remediation efforts. In late July, the partnership followed up on that meeting by hosting 8 volunteers for a workday, mechanically removing barberry for about 2 hours.

Waitsfield, VT: Waitsfield, VT: The Waitsfield Conservation Commission continued efforts to address invasive knotweed in town. The commission created an iNaturalist project, mapping 169 sites where knotweed is found, and used the map to identify 66 priority sites for management. Selected locations were along upper roadways to halt spread, and waterways and in highly visible, iconic sites in town because of the opportunities they presented to build community awareness and to improve the beauty of these special places. Twenty-four community volunteers and five University of Vermont interns spent over 1,022 hours in 2022 towards these efforts in late spring and summer. In September, commission members completed post-treatment monitoring surveys. 55 sites (83%) showed significant weakening from the years' work, 10 sites (15%) showed moderate weakening, 1 site showed little impact, and no sites showed knotweed eradicated.

Williston, VT: The Town of Williston is managing the Catamount Community Forest for early successional habitat. Part of that work is managing extensive invasive plant populations. The town has been grinding understory shrubs and trees to replicate a natural disturbance, with contractors following up to chemically treat resprouting invasive plants. By grinding prior to the chemical treatment, it significantly reduces the volume of chemical used and area needed to be treated. In partnership with community members and Scout Troop 692, the Williston Conservation Commission held their annual invasive plant workday in October, where they mechanically and chemically treated buckthorns and shrub honeysuckles in the forest. This was made possible by town volunteers becoming licensed pesticide applicators.

Other Management Entities

Ames-Hill Marlboro Community Center: The Ames-Hill Marlboro Community Center (AHMCC) conducted invasive plant management on their ~600 acre property along the shores of South Pond and the adjoining forests. Assisted by staff from the Vermont Land Trust, AHMCC members mechanically removed glossy buckthorn along a half mile of the eastern shore of the lake on July 20th (4 volunteers)

and July 30th (7 volunteers).

Common Ground Center: The Common Ground Center conducted invasive plant management on their property in Starksboro. Staff and volunteers mechanically treated a densely populated acre of buckthorns and shrub honeysuckles around the cabins.

Forest Care: The forestry consulting firm, Forest Care, worked with private landowners, municipalities, and federal programs providing: management plans for almost 1,500 acres of privately owned land; assessment and management recommendations at Prospect Hill for the town of Dummerston; treatment on 20 acres of glossy buckthorn and barberry and facilitation of contracted machine grinding of 4 acres of dense mixed infestation, in Marlboro as part of an NRCS EQIP funded project; mapping of a property in Putney being considered for NRCS EQIP funding.

Green Mountain National Forest: In addition to support the Batten Kill and Upper White River CISMAs, GMNF staff in partnership with contractors, volunteers, and partner organizations like VYCC and CorpsTHAT completed treatments of various invasive plants across the state. This work included: treating wall lettuce, common reed, goutweed, barberry, Morrow's honeysuckle, knotweed and goutweed at various timber sale sites within the Robinson Integrated Resource Project area; treating wild parsnip at a timber sale area in Mount Tabor, and both wild parsnip and Morrow's honeysuckle in Sunderland, as part of the Early Successional Habitat Creation project; treating wild parsnip and wild chervil within the Somerset Integrated Resource Project area. GMNF staff also treated 0.2 acres of Morrow's honeysuckle in Pittsfield, 0.1 acres of wild chervil, Morrow's honeysuckle, and common buckthorn in Ripton, and a tiny patch of cypress spurge in Salisbury.

Habitat Restoration Solutions: Among various other projects, Habitat Restoration Solutions supported an NRCS EQIP invasive plant management project on private land in Monkton. 2022 was the second year of treatment and the work occurred on 26.7 acres, 17.4 were heavily infested and 9.3 were moderately infested. The treatments focused on invasive buckthorns and shrub honeysuckles, and any additional invasive plants encountered, and took 140 hours to complete.

Missisquoi River Basin Association: Staff from the Missisquoi River Basin Association (MRBA) has been working for two years conducting non-chemical knotweed control experiments, with the goal of providing best management practices for mechanical treatment of knotweed. There are 8'x10' experimental plots located in Montgomery and Troy. MRBA staff oversee and assist in the monitoring of the plots, and provide outreach in neighboring communities about managing for knotweed.

USDA Natural Resources Conservation Service: The USDA Natural Resources Conservation Service (NRCS) have been conducting invasive plant management in restored wetlands across the state, treating over 400 acres over the last 3 years. This work focused on reed canary grass, common and glossy buckthorn, shrub honeysuckles, knotweeds, common reed, and yellow iris.

TRENDS

Sugar Maple Health in 2022

Vermont has continued to monitor sugar maple health in sugarbushes and in maple stands since 1988. In these North American Maple Project (NAMP) plots, 94% of overstory sugar maples were rated as having low dieback (less than 15%), which is nearly the same as in 2021 (Figure 35).

Statewide, there continued to be a decrease in percent of trees with thin foliage (4%) compared with 2021 (6.5%) (Figure 36). Foliage transparency is sensitive to current stress factors. Other spikes in transparency have been due to frost injury (2010, 2012, 2015), forest tent caterpillar defoliation (2004-2007, 2016-2018), and pear thrips (1988-1989).

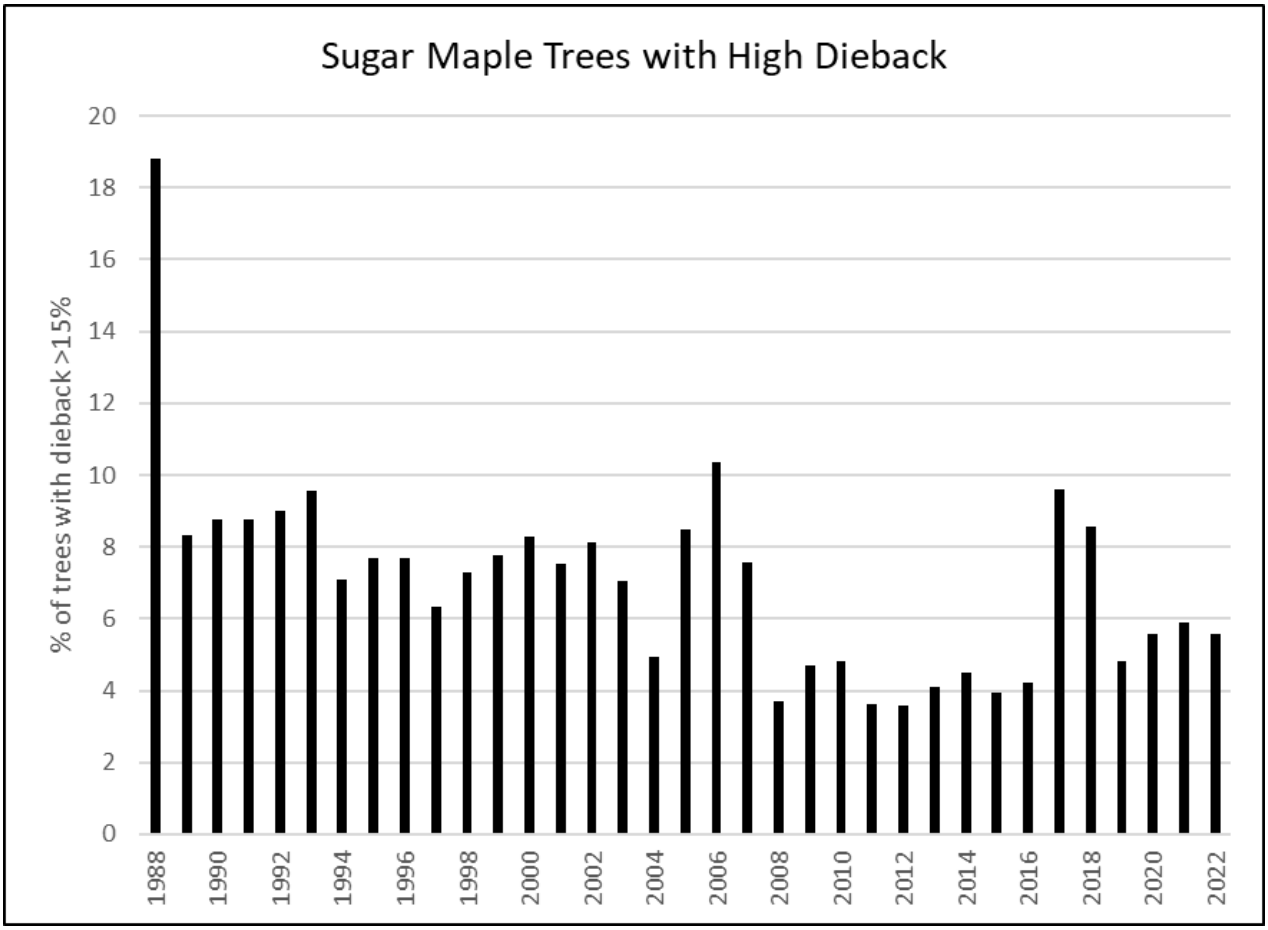

Figure 35. Percent of overstory sugar maple trees on NAMP plots with high dieback (> 15%), 1988-2022. *n* = 1,142 trees at 36 sites.

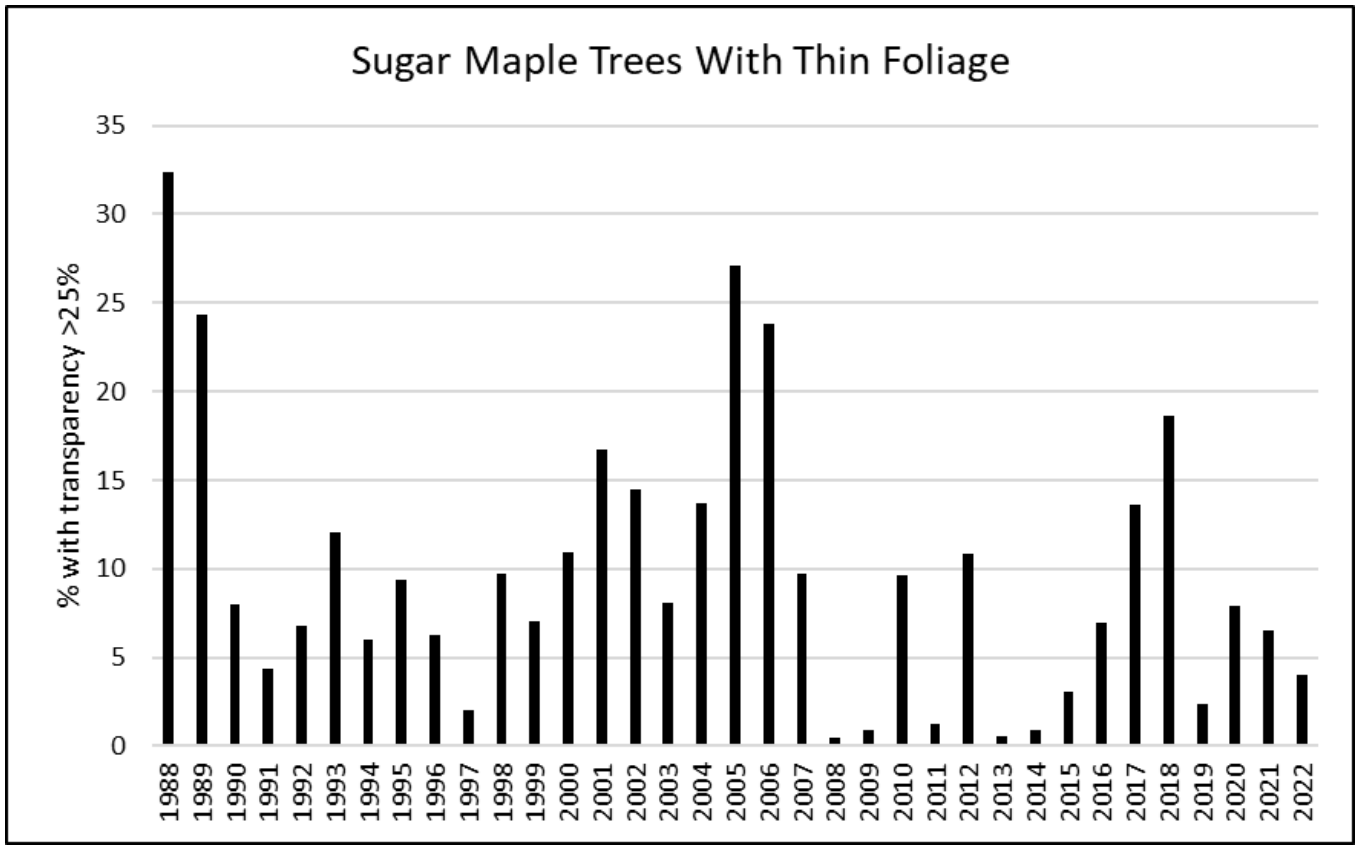

Figure 36. Trend in the percent of overstory sugar maple trees on NAMP plots with thin foliage (>25% foliage transparency), 1988-2022. *n* = 1,142 trees at 36 sites.

Forest Ecosystem Monitoring Cooperative
Trends in Forest Health throughout Vermont in 2022

Vermont forest health monitoring plots were sampled at 48 sites across the state in 2022 as part of the Forest Ecosystem Monitoring Cooperative (formerly the Vermont Monitoring Cooperative). Measures recorded were comparable to those collected for NAMP plots. Results and analysis from this plot network can be obtained in the annual reports produced by FEMC, found at https://www.uvm.edu/femc/products/reports.