FOREST INSECT AND DISEASE CONDITIONS IN VERMONT

CALENDAR YEAR 1991

AGENCY OF NATURAL RESOURCES

DEPARTMENT OF FORESTS,
PARKS AND RECREATION

WATERBURY, VT 05671-0602

AGENCY OF NATURAL RESOURCES

JAN EASTMAN, SECRETARY

DEPARTMENT OF FORESTS, PARKS AND RECREATION

CONRAD M. MOTYKA, COMMISSIONER

FOREST INSECT AND DISEASE CONDITIONS IN VERMONT CALENDAR YEAR 1991

Prepared by

H. Brenton Teillon, Chief, Forest Resource Protection

Barbara S. Burns, Forestry Protection Specialist

Ronald S. Kelley, Forestry Protection Specialist

AGENCY OF NATURAL RESOURCES

DEPARTMENT OF FORESTS, PARKS AND RECREATION

Division of Forestry

Forest Resource Protection Section

DEPARTMENT OF FORESTS, PARKS AND RECREATION
FOREST RESOURCE PROTECTION PERSONNEL - 1992

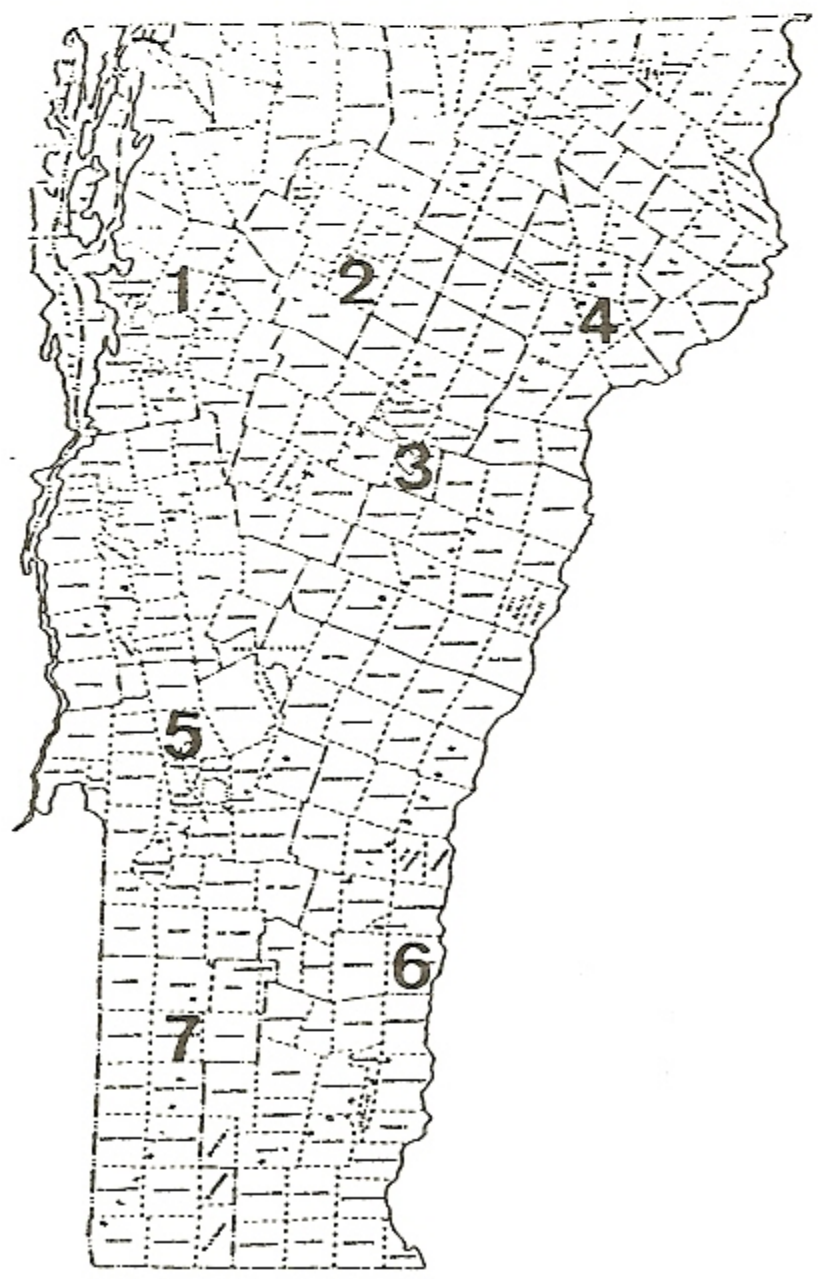
H. Brenton Teillon — Chief, Forest Resource Protection
Waterbury, VT 05671-0602
Tel. 802-244-8716 (B) 888-4086 (R)

Barbara S. Burns — Forest Protection Specialist
North Springfield, VT 05150
Tel. 802-886-2215 (B) 885-9227 (R)

Ronald S. Kelley — Forest Protection Specialist
Morrisville, VT 05661
Tel. 802-888-5733 (B) 253-4632 (R)

Sandra H. Wilmot — Forest Protection Specialist
Waterbury, VT 05671-0602
Tel. 802-244-8716 (B) 899-4366 (R)

Barbara Sheltra — Secretary, Forest Resource Protection
Waterbury, VT 05671-0602
Tel. 802-244-8716 (B)



DISTRICT FOREST RESOURCE PROTECTION TECHNICIANS

1.	Pete Reed	879-6565 (B)
	Essex Jct.	849-6958 (R)
	Tom Simmons	879-6565 (B)
	Essex Jct.	862-0282 (R)
2.	Bernie Barton	888-5733 (B)
	Morrisville	888-2632 (R)
3.	Jay Lackey	479-3241 (B)
	Barre	476-8125 (R)
4.	Hollis Prior	748-8787 (B)
	St. Johnsbury	684-2276 (R)
	John St. Arnauld	748-8787 (B)
	St. Johnsbury	748-2446 (R)
5.	John Barrows	483-2314 (B)
	Pittsford	746-8340 (R)
6.	Allan Sands	886-2215 (B)
	N. Springfield	875-2279 (R)
7.	Nate Fice	362-2307 (B)
	Manchester	447-1929 (R)

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Birch Defoliation was widespread late in the season, caused by birch leaf miners, birch skeletonizer, and birch leaf folders. Damage was mapped on 29,300 acres, mostly in the Northeast Kingdom and the central Green Mountains.

Bruce Spanworm moths were frequently observed, indicating that defoliation may occur in 1992.

Cherry Scallop Shell Moth caused heavy defoliation of forest stands in Greensboro, Brattleboro, and Wilmington.

Forest Tent Caterpillar populations continue to be very low, with no defoliation observed.

Gypsy Moth populations declined with only 8,000 acres of defoliation detected from the air, compared to 61,270 acres in 1990. Concentrations of egg masses can still be found in a few locations in Bennington County.

Maple Leaf Cutter populations increased again this year with 5,200 acres of defoliation mapped from the air.

Maple Trumpet Skeletonizer was unusually common, although damage was generally less than 1990.

Oak Leaf Tier was not observed causing any damage. However, the number of moths caught in traps in Rockingham increased substantially.

Saddled Prominent populations declined with no defoliation observed, compared to 2,780 acres mapped in 1990. Larvae were occasionally observed and moths were easily caught in black light and experimental pheromone traps.

Satin Moth was unusually noticeable, causing heavy defoliation of balsam poplar ornamentals and cottonwoods in riparian areas in widely scattered locations.

Hemlock Looper populations increased dramatically. Moths of *Lambdina fiscellaria* were unusually abundant. Damage from *Lambdina athasaria* was mapped on 1,600 acres in southeastern Windham County, compared to about 10 acres of defoliation observed in 1990. Mortality is expected where 90% or more of the needles have been lost.

Spruce Budworm pheromone traps experienced a sudden increase in the number of moths caught. Trapping will continue in 1992 to determine whether this signals the beginning of another outbreak, or reflects a blow-in of moths that will not materialize in a population increase.

Balsam Gall Midge caused damage to Christmas trees, but the area and severity of damage dropped from 1990 levels.

Balsam Twig Aphid caused more widespread damage, although populations decreased in some areas which had heavy damage in 1990.

Hemlock Woolly Adelgid eradication continued at the site where the insects were introduced in 199Ø. No evidence of hemlock woolly adelgid was found in surveys of nine native hemlock stands in the valleys around the introduction site.

Pear Thrips damage to sugar maple was very light due to low insect populations and rapid leaf flush. No damage was mapped from the air compared to 29,76Ø acres mapped in 199Ø. Soil counts suggest that populations will remain low in 1992.

Spruce Spider Mite damage was heavy in Bennington and Windham Counties. Dry summer conditions are thought to be responsible for the sudden build-up.

Beech Bark Disease was somewhat less noticeable, but 6ØØ acres of damage were mapped. In monitoring plots, Nectria fruiting has increased, although crown conditions have generally improved.

Butternut Canker was observed in several new, widely scattered locations. More intensive surveys for this disease are planned.

Scleroderris Canker was not found in any new locations for the fifth consecutive year.

A **Needlecast of White Pine**, caused by an unknown fungus, was responsible for symptoms in early June, in scattered locations throughout southern Vermont.

Drought Conditions in June and July led to leaf scorch of hardwoods that was especially noticeable in the Northeast Kingdom where 55,6ØØ acres were mapped. Hardwood chlorosis and thin crowns were widespread throughout the state. By the end of the summer, trees growing on stressed sites, or which were planted improperly, developed dieback.

Frost Damage, from a frost on 19-2Ø May, killed scattered new growth on balsam fir Christmas trees throughout much of northern Vermont, and killed emerging leaves of sensitive hardwoods such as butternut and white ash.

White Pine Browning occurred in scattered southern Vermont locations in early June. The damage is thought to have been due to winter injury.

VERMONT

1991 FOREST INSECT & DISEASE MANAGEMENT RECOMMENDATIONS

The following recommendations summarize information in this report of particular importance to forest managers. Additional information can be found under specific pests mentioned. Separate summaries are available for sugarbush and Christmas tree managers.

For assistance in identifying pests, diagnosing forest health problems, on-site evaluations, and insect sampling, or to obtain copies of defoliation maps, management recommendations, and additional literature, contact forest resource protection personnel (page 1) or your county forester.

Sugar Maple - Maples remained generally healthy this year. Plentiful moisture during the two previous growing seasons, with warm weather and adequate moisture during leaf expansion, led to excellent foliage density. Trees in maple health monitoring plots had the least dieback and densest foliage since the plots were established in 1988.

Dry conditions during June and July led to scorch, off-color foliage or leaf drop in mid-summer, especially on trees growing under stressed conditions. Symptoms were particularly severe in the Northeast Kingdom, where 55,600 acres of leaf scorch were mapped. Additional symptoms are expected to show up on generally wet or droughty sites over the next couple of years.

Maple leaf cutter damage was mapped on 5,200 acres, mostly in east-central counties. Because maple leaf cutter damage peaks late in the growing season, it causes less impact on tree health than other defoliators. However, past outbreaks of this pest have tended to increase slowly, remain at high levels for several years, and decrease slowly. Repeated defoliation can reduce tree vigor.

Other maple pests occurred only at low levels this year. Numbers of thrips were low, and rapid budbreak reduced the possibility of damage. Soil populations were somewhat higher in fall 1991, but numbers suggest that thrips damage will remain low. No defoliation from forest tent caterpillar or saddled prominent is predicted, however, bruce spanworm moths were seen throughout the state in the fall, suggesting that this insect may cause some damage in spring 1992.

Birch - Birch defoliation was widespread late in the season, particularly in the Northeast Kingdom, and at high elevations in the central Green Mountains. Defoliation may lead to dieback, especially if populations of defoliating insects remain high.

Previous declines of birch have been linked to climatic factors, such as open winters and dry summers. Subsequent research has shown that birch is sensitive to small increases in soil temperature. Since opening up a stand will increase soil temperature, avoid thinning on wet or droughty sites, or where trees have been defoliated. This will allow trees to recover from dry 1991 conditions.

Beech - Beech bark disease continues to cause scattered dieback and chlorosis, although acreage mapped from the air decreased, and tree condition in monitoring plots improved from 1990. Oystershell scale remains low, although dieback associated with recent past infestations remains noticeable.

Oak - Gypsy moth populations have generally collapsed, although concentrations of egg masses can still be found in a few locations in Bennington County. Eight thousand acres of defoliation were mapped, mostly in southwestern Vermont. Where defoliation occurred on droughty sites, tree stress may be more severe because of dry summer weather.

Trees which were stressed by defoliation should show dieback symptoms within one or two growing seasons after defoliation. Cutting should be delayed until symptoms show up, so that vigorous crop trees can be selected.

Spruce-Fir - Spruce-fir forests experienced few pest problems in 1991, however, populations of several defoliators are of concern. Spruce budworm trap catches increased suddenly from previous years. This may reflect a blow-in of moths that will not materialize, or may signal the beginning of another outbreak.

Hemlock looper moths were commonly seen in the fall throughout the state. This insect has caused widespread balsam fir defoliation in Maine and eastern Canada over the last ten years. Branch samples can help determine if numbers of overwintering eggs are sufficient to cause defoliation.

White Pine - Although no widespread problems occurred on white pine, a number of symptoms were observed. Semi-mature tissue needle blight, was seen on scattered trees in a number of locations. Needles of current growth on symptomatic trees have tipburn, which may be variable in severity between needles within a fascicle. The disease is attributed to weather at needle elongation, with a fungus or ozone possibly playing a role. Pine bark adelgid continued to be heavy on scattered trees, causing some chlorosis. No major tree health impact is expected from either of these.

Mortality continues to occur on some marginally wet sites, brought on by high water levels in the wet growing seasons in 1989 and 1990.

Hemlock - The spring hemlock looper caused moderate to heavy defoliation on 1,600 acres in Windham County in 1991. Mortality is expected where defoliation exceeds 90%, although any trees which have lost over 75% of their needles are at risk. A leaflet, "Hemlock Loopers in Vermont" provides information on hemlock looper, and management recommendations for landowners and foresters for use in 1992.

We are not able to predict defoliation by the spring hemlock looper, although experience from Maine is that outbreaks of this insect are short-lived. However, moths of the fall hemlock looper were common throughout the state in 1991. Overwintering egg surveys are being done statewide to help determine whether defoliation by this insect is likely to occur.

Vermont Forest Health Insect & Disease Publications: 1991

For copies of the publications listed below, contact the authors or Forest Resource Protection personnel (Page 1).

Allen, D.C. and J. Barnett. 1991. Temporal change in sugar maple crown condition in Vermont. A report submitted to VT FPR (NAMP results for VT from 1988-199Ø).

Allen, D.C., C.J. Barnett, I. Millers, and Denis Lachance. 1991 [in press]. Temporal change in sugar maple health, and factors associated with maple crown condition. (NAMP results for 1988-199Ø).

Brooks, R.T., M. Miller-Weeks, and W. Burkman. 1991. Forest health monitoring, 1991. USDA Forest Service NE-INF-94-91. 9 pp. (executive summary of the New England Forest Health Monitoring Program results for 199Ø).

Brownbridge, M., B.L. Parker & M. Skinner. 1991. From pink pear thrips to... continuing biological control research in Vermont. Maple Syrup Digest. December 1991:16-17.

Burns, B. and B. DeGeus. 1992. Hemlock Loopers in Vermont: A Guide for Landowners and Foresters for 1991, VT Dept. of Forests, Parks and Recreation. 4 pp.

Cox, S. and M. Miller-Weeks. 1991. Damage agents associated with visual symptoms on red spruce and balsam fir in the Northeastern United States. USDA Forest Service NA-TP-Ø1-91. 31 pp.

DeHayes, D.H., F.C. Thornton, C.E. Waite, and M.A. Ingle. 1991. Ambient cloud deposition reduces cold tolerance of red spruce seedlings. Can. J. For. Res. 21:1292-1295.

Grehan, J.R., B.L. Parker, D.L. Wagner, J. Rosovsky & J. Aleong. 1992. Root damage by the conifer swift moth: a mortality factor in montane red spruce regeneration. In press. For Sci.

Halik, S. and D.R. Bergdahl. 1991. Survival of *Bursaphelenchus xylophilus* in wood chips with soil and potential for infesting pine seedlings. Journal of Nematology 23: (submitted for publication).

Leonard, J.G., D.R. Tobi & B.L. Parker. 1991. Spatial and temporal distribution of *Korscheltellus gracilis* larvae (Lepidoptera:Hepialidae) in the Green Mountains, Vermont. Envir. Entomol. 2Ø:371-76.

Millers, I., D. Lachance, W.G. Burkman, and D.C. Allen. 1991. North American Sugar Maple Decline Project: Organization and Field Methods. USDA Forest Service Gen. Tech. Rep. NE-154. 26 pp.

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Parker, B.L. & E.N. Doane. 1991. The 199Ø Conference on Thysanoptera. Abstracts: So. Burlington, VT. Oct. 23-24. Vt Agric. Expt. Sta. Bull. 698. Univ. Vt., Burlington. 68 pp.

Parker, B.L., J. Grehan & M. Skinner. 1992. A Method for extracting pear thrips from forest soil. *In press.* J. Econ. Entomol.

Parker, B.L. & M. Skinner. 1991. Recent developments in biological control of pear thrips. Maple Syrup Digest. June 1991:19.

Parker, B.L., M. Skinner & T. Lewis. 1991. Towards Understanding Thysanoptera. Gen. Tech. Rep. NE-147. Radnor, PA: USDA, Forest Service, Northeastern Forest Expt. Sta. 464 p.

Parker, B.L., M. Skinner & H. B. Teillon. 1991. Should we forget pear thrips? An update from Vermont. Maple Syrup Digest. October 1991:12-13.

Skinner, M.S., B.L. Parker & D. Bergdahl. 1991. *Verticillium lecannii*, isolated from larvae of pear thrips, *Taeniothrips inconsequens*, in Vermont. J. Inv. Path. 58:157-163.

Tobi, D.R. 1991. Life history and distribution of the conifer swift moth *Korscheltellus gracilis* (Grote) (Lepidoptera:Hepialidae), in Vermont. M.S. Univ. of Vermont, Burlington. 86 pp.

Tobi, D.R., J.G. Leonard, B.L. Parker & W.E. Wallner. 1992. Survey methods, distribution and seasonality of *Korscheltellus gracilis* (Grote) (Lepidoptera: Hepialidae) in the Green Mountains, Vermont. In press. Envir. Entomol.

Tobi, D.R., B.L. Parker & W.E. Wallner. 1992. Larval feeding by *Korscheltellus gracilis* (Grote) (Lepidoptera:Hepialidae) on roots of spruce and fir. In press. J. Econ. Entomol.

Tomminen, J., S. Halik, and D.R. Bergdahl. 1991. Incubation temperature and time effects on life stages of *Bursaphelenchus xylophilus* in wood chips. Journal of Nematology 23:477-484.

Vermont Dept. of Forests, Parks and Recreation. 1991. Are New England's Forests Healthy?; video 28:15 minutes length.

Wagner, D.L. & J. Rosovsky. 1991. Mating systems in primitive Lepidoptera, with emphasis on the reproductive behaviour of *Korscheltellus gracilis* (Hepialidae). J. Linn. Soc. 1Ø2:277-3Ø3.

Wagner, D.L., D.R. Tobi, W.E. Wallner & B.L. Parker. 1991. *Korscheltellus gracilis* (Grote): A pest of red spruce and balsam fir roots (Lepidoptera:Hepialidae). Can. Entomolo. 123:255-63.

Wallner, W.E., D.L. Wagner, B.L. Parker & D.R. Tobi. 1991. Bioecology of the conifer swift moth, *Korscheltellus gracilis*, a root feeder associated with spruce-fir decline. pp 199-2Ø4. *In* Forest insect guilds: patterns of interaction with host trees. Barnchikov, Y.S., W.J. Mattson, F.P. Hain & T.L. Payne (eds). USDA. F.S. Tech Rep. NE-153.

Wilmot, S.H. 1991. Field testing of inherited sterility for gypsy moth (Lepidoptera:Lymantriidae) suppression with subsequent parasitism enhancement. M.S. Univ. of Vt., Burlington. 1Ø4 pp.

INTRODUCTION

The information in this report is based largely on aerial surveys to detect defoliation, dieback, and mortality, as well as ground surveys and observations of Forest Resource Protection personnel and other forestry staff.

Complete aerial surveys were flown in June, mid-to-late July, and late August to early September. A partial survey was flown in mid-September to map additional defoliation by maple leaf cutter, hemlock looper, and birch defoliators.

A survey is conducted annually on Christmas tree plantations in north-central Vermont as part of the Scleroderris quarantine. Observations are made on all pests during this survey. Acreages reported for Christmas tree problems refer to changes in these surveyed plantations, and are not statewide totals.

Diagnostic assistance was provided by the University of Vermont, the U.S. Forest Service, the Maine Forest Service, and the University of Pennsylvania.

WEATHER SUMMARY

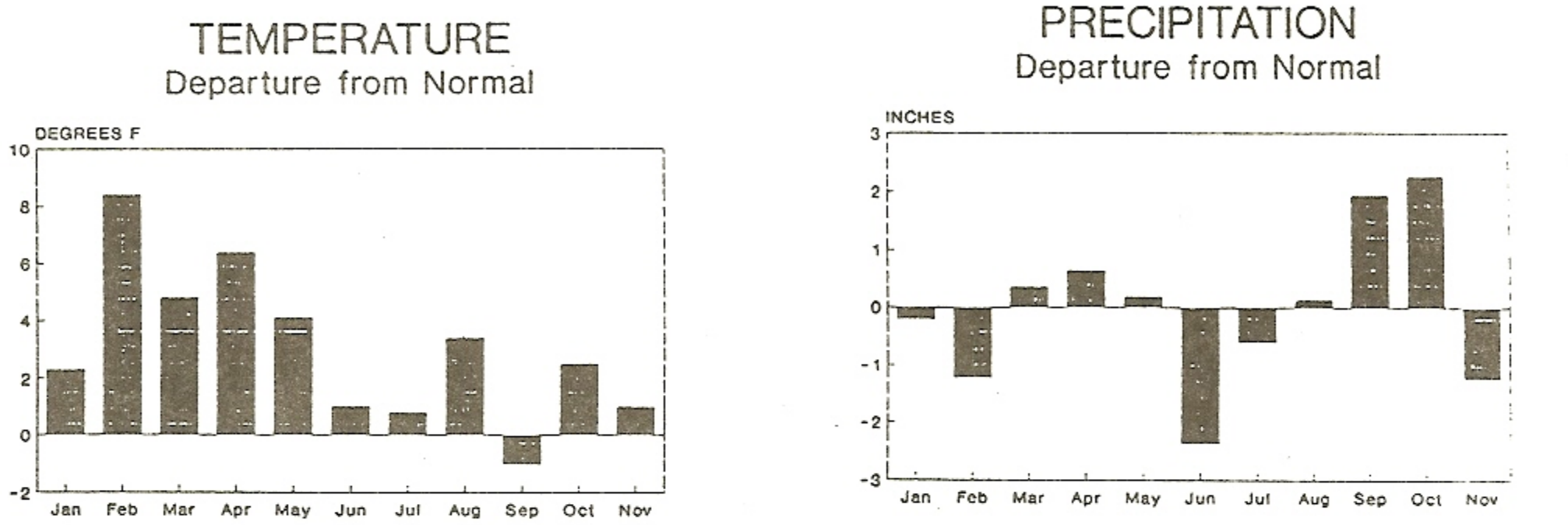
Spring was generally warm, bringing on rapid budbreak and leaf development generally a week earlier than normal. Plentiful moisture during the two previous growing seasons caused leaves to be large and dark green this spring. A late spring frost in northern Vermont, May 19-20, killed scattered new growth on Christmas trees and leaves of sensitive hardwood trees such as butternut and some white oak.

The overall growing season was warmer than normal, with near-normal precipitation. However, rainfall was poorly distributed, with moderate drought conditions in June and July. Light showers kept things growing. The water table had dropped considerably by mid-summer, and the effects of the dry conditions are expected to show up on generally wet or droughty sites over the next couple of years. August was wetter than normal, primarily due to Hurricane Bob, which skirted the New England coast on 19 August. Ample rain in the fall continued to replenish the water table.

1991 was a heavy seed year for conifers such as northern white cedar, balsam fir, spruce and hemlock. Adequate moisture going into the flowering season, followed by dry conditions during flowering, led to good fruit development on some hardwood species, including oak, beech, and apple but seed for sugar maple was scarce. Monarch butterflies, yellow jackets, wasps, and hornets were unusually common.

Weather conditions are summarized in Figure 1 and Table 1. Phenology is summarized in Table 2.

Figure 1. Departure from normal of 1991 precipitation and temperature at Burlington International Airport.[1]



1. Data from NOAA Local Climatological Data: Monthly Summary.

Table 1. North-Central Vermont Precipitation During the 1991 Growing Season.[1]

Month	Average Precipitation	Departure From Normal	% of Normal
May	3.Ø2"	- .2Ø"	94%
June	1.7Ø"	- 1.57"	52%
July	2.51"	- 1.15"	69%
August	5.61"	+ 2.24"	166%
September	4.25"	+ 1.Ø5"	133%

1 Vermont Division of Forestry Stations in Wolcott, Barre, Orange, Randolph, Fairlee and Worcester.

Table 2. 1991 Growing Degree Days and Observations of Phenological Development.

Week Ending	Growing Degree Days:* Burlington 1991	Phenology**			
			Other Plants		
		Sugar Maple	Budswell	Leaves	Flowers
4/14	91		Elm	Willow	Red Maple Popple
4/21	1Ø2	Budswell		Cherry	
4/28	15Ø	Leaves Flowers	Red Oak Beech		Shadbush Birch
5/5	194		Pine Candles 1-2"	Red Maple Oak Basswood	
5/13	269	Full Size	Hemlock Spruce	Ash Birch	Apples
5/2Ø	345				
5/27	461		Full Green Up		

* 86/5Ø calculations based on NOAA Local Climatological Data.

** Observations from southeast Windsor County.

1991 OZONE SUMMARY

Ozone may be important to the long-term health of Vermont's forests and therefore warrants our attention when considering forest stressors. High ozone levels are not confined to urban areas, and symptoms of foliage damage from ozone have been observed in remote areas such as the Lye Brook Wilderness Area in Southern Vermont. Symptoms of ozone injury appear on the foliage, with reduced growth and vigor also known to occur, but it is difficult, at this time, to know what the total impact is to our forests.

The levels of ozone that affect sensitive plants are well below the National Ambient Air Quality Standard for ozone, Ø.12Ø ppm for 1 hour, which is intended to protect human health. Some sensitive plants can exhibit damage symptoms from levels as low as Ø.Ø6Ø ppm, and most sensitive species will show symptoms at Ø.Ø8Ø ppm concentrations.

To gain an appreciation for the sensitivity of tree species, some species are listed according to their known sensitivity to ozone (Table 3). Species can vary in sensitivity to the pollutant, depending on the seed source, so it is not always easy to categorize species as sensitive or tolerant.

There were no exceedances of the National Ambient Air Quality Standard for ozone in 1991, although levels damaging to sensitive plants were recorded. Both acute and chronic levels of ozone can affect plants. Presently there is no standard method of expressing ozone levels to reflect injury to plant growth. The figures presented (Table 4) show the number of hours during the growing season when levels were Ø.Ø6Ø ppm or higher (affecting some sensitive species) or Ø.Ø8Ø ppm or higher (affecting most sensitive species). "Episodes" reflect the number of times during the growing season when trees were exposed to long periods of high ozone levels.

Table 3. Ozone sensitivity of Vermont tree species that have been tested under controlled conditions, categorized by their usual response to various concentrations.[1]

Tolerant Species	Sensitive Species
Sugar Maple	Eastern White Pine
Eastern Hemlock	Black Cherry
Balsam Fir	Red Maple
Northern Red Oak	Quaking Aspen
Red Pine	White Ash
Douglas Fir	Scotch Pine
Colorado Blue Spruce	Yellow Birch
Norway Maple	Jack Pine
White Spruce	Sycamore

1. From "Review of selected articles on the ozone sensitivity and associated symptoms for plants commonly found in the forest environment" by S. E. Dowsett, R. L. Anderson and W. H. Hoffard of the USDA Forest Service.

Table 4. Ozone levels recorded during the 1991 growing season at two sites.[1]

Monitor Site	Total # Hours With ≥ .Ø6Ø ppm	≥ .Ø8Ø ppm	Maximum Concentration[2] ppm	Date	# of Episodes[3]
Underhill	366	42	.Ø93	5/24	3
Bennington	373	89	.1Ø8	6/27	6

1. Data provided by the Vermont Air Pollution Control Division.
2. Maximum recorded in a single hour.
3. "Episodes" are two consecutive days when ozone exceeded Ø.Ø8Ø ppm for at least 2 hours.

FOREST INSECTS

Hardwood Defoliators

Birch Defoliation, caused by **Birch Skeletonizer**, *Bucculatrix canadensisella*, **Birch Leaf Folders**, apparently *Ancylis discigerana* and *A. nubeculana*, and **Birch Leaf Miners**, *Fenusa pusilla* and *Messa nana*, was widespread late in the season. Twenty-nine thousand three hundred acres of defoliation were aerially detected (Figure 2, Table 5). Most of the damage occurred within stands of paper birch in the Northeast Kingdom and at high elevations in the central Green Mountains. Damage to paper birch was made more severe by drought stress in all areas. Additional light to moderate defoliation occurred almost anywhere birch was found. A monitoring plot was established in Granville State Forest to follow the impact on tree condition. Defoliation in that area averaged over 80%.

Table 5. Mapped acres of late season birch defoliation in 1991.

County	Acres Mapped
Addison	900
Bennington	500
Caledonia	9,100
Chittenden	400
Essex	3,300
Franklin	200
Orleans	9,200
Rutland	900
Washington	500
Windham	1,200
Windsor	3,100
Total	29,300

Bruce Spanworm, *Operophtera bruceata*, caused light defoliation in Cabot. Moths were frequently observed throughout the state in November, indicating that more widespread defoliation may occur in 1992. Numbers at windows and lights in Stowe were higher than during the last outbreak in 1983.

Cherry Scallop Shell Moth, *Hydria prunivorata*, heavily defoliated black cherry trees within hardwood stands in Bennington, Caledonia and Windham Counties. A 140 acre stand was detected by aerial survey in Greensboro. Elsewhere, the webs built by this insect were more common than in previous years, but damage was widely scattered.

Forest Tent Caterpillar, *Malacosoma disstria*, populations continued to be very low this year. Few larvae were observed in sugar maple stands and no defoliation was observed. Moth catches in pheromone traps remain low. Only 6 traps of 40 put out by the Vermont Division of Forestry (Table 6), and none of the 27 pheromone traps placed in the Green Mountain National Forest by the U.S. Forest Service, caught any forest tent caterpillar moths.

Table 6. Average number of forest tent caterpillar moths caught in pheromone traps, 1988-1991.[1]

Location	1988	1989	1990	1991
Roxbury	Ø.Ø	Ø.6	Ø.2	Ø.Ø
Waterbury	1.2	3.6	Ø.Ø	Ø.4
Waterville	Ø.2	2.2	Ø.Ø	Ø.Ø
Fairfield	-	Ø.Ø	Ø.Ø	Ø.Ø
Bethel	-	Ø.4	Ø.2	Ø.4
Sherburne	-	2.6	Ø.Ø	Ø.Ø
Barnard	Ø.6	-	2.6	2.2
Underhill	-	-	-	Ø.Ø
Average	Ø.6	1.6	Ø.4	Ø.4

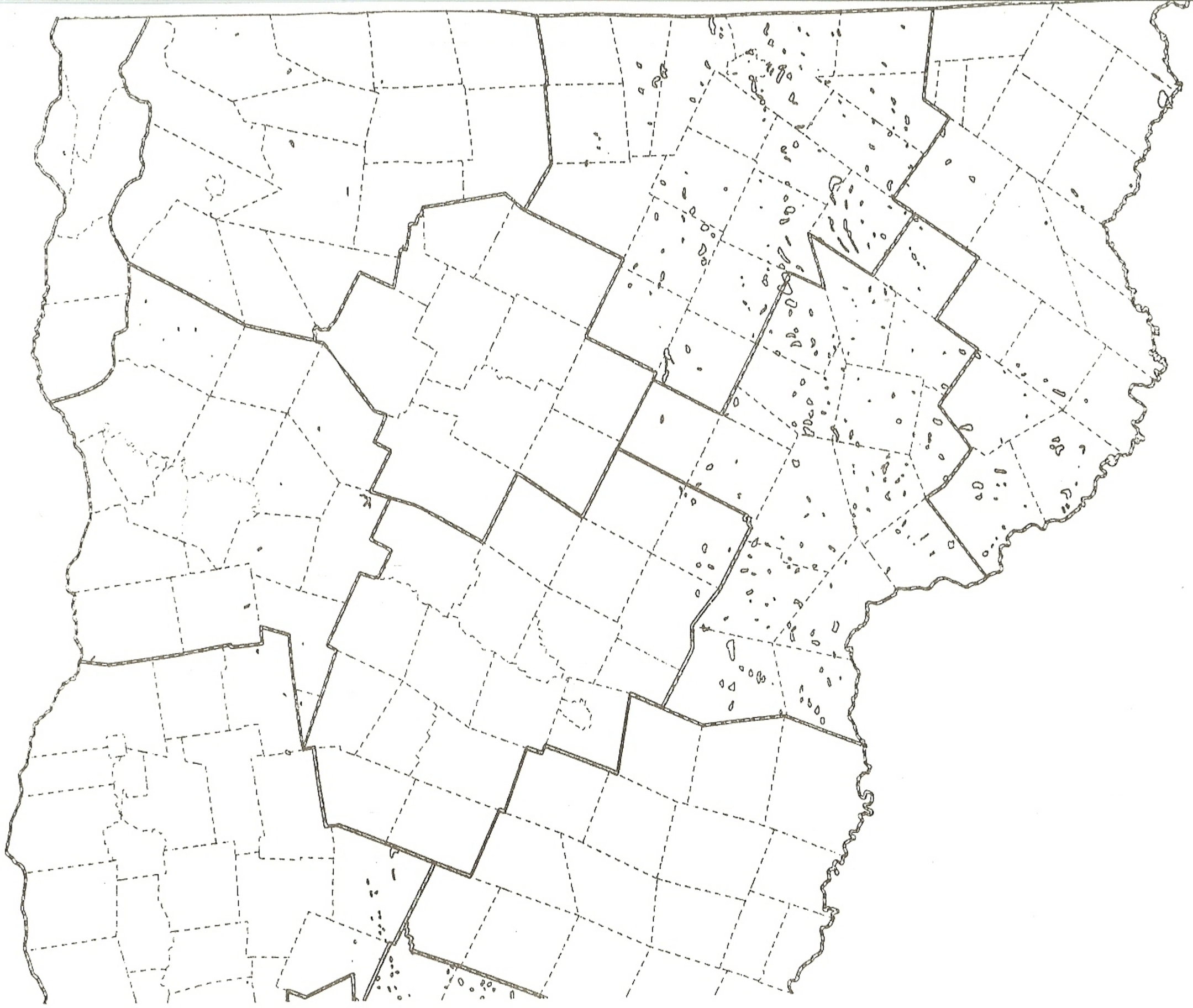
1. Multi-pher traps baited with RPC-2 component lures, 5 traps per location.

Gypsy Moth, *Lymantria dispar*, defoliation declined, with only 8,ØØØ acres mapped from the air compared to 61,27Ø acres in 199Ø (Figure 3, Table 7). Most of the damage occurred in small scattered areas in Addison, Bennington, Chittenden and Rutland Counties. Although the summer was dry, most areas refoliated completely. However, oak dieback and mortality have begun to show up in a few areas which have had several years of defoliation.

Diseased caterpillars and heavy parasitism on scattered egg masses, indicate that the outbreak is ending. There are occasional concentrations of egg masses in Bennington County, which could cause some defoliation next year. Egg masses can occasionally be found in northern hardwood areas of the southern Green Mountain range, where population buildup is not expected.

One 5Ø-acre block of forestland in Pownal was sprayed with Dipel 8AF at a rate of 13 b.i.u. per acre. Good control was achieved.

Counts of 1991 gypsy moth egg masses within focal area monitoring plots were low, reflecting a general population decline (Table 8). The only plots to receive visible defoliation this year were Petersburg and Brigham Hill. It appears that the population cycle for Brigham Hill was delayed one year by the early intervention with a *Bacillus thuringiensis* application in 1988.



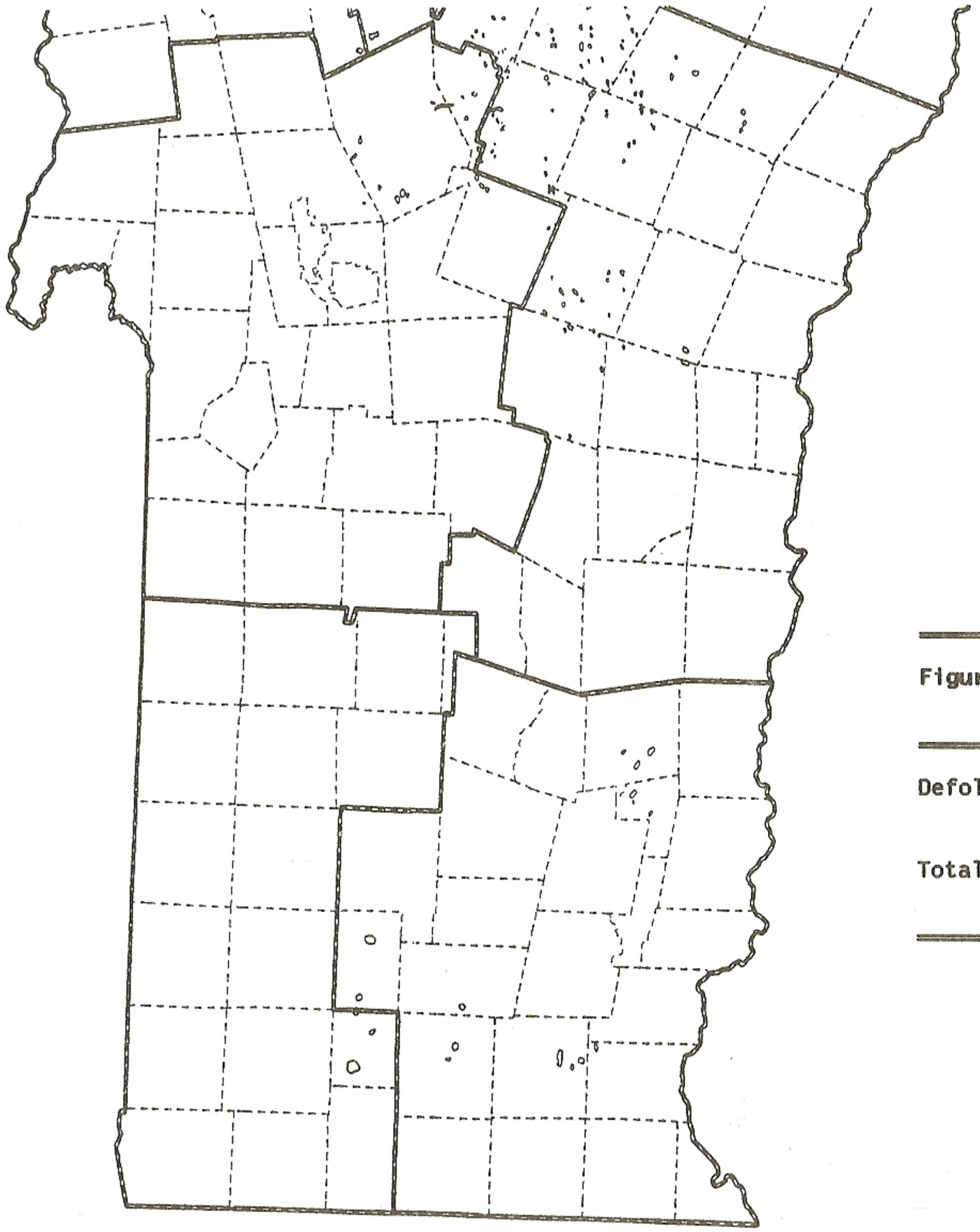
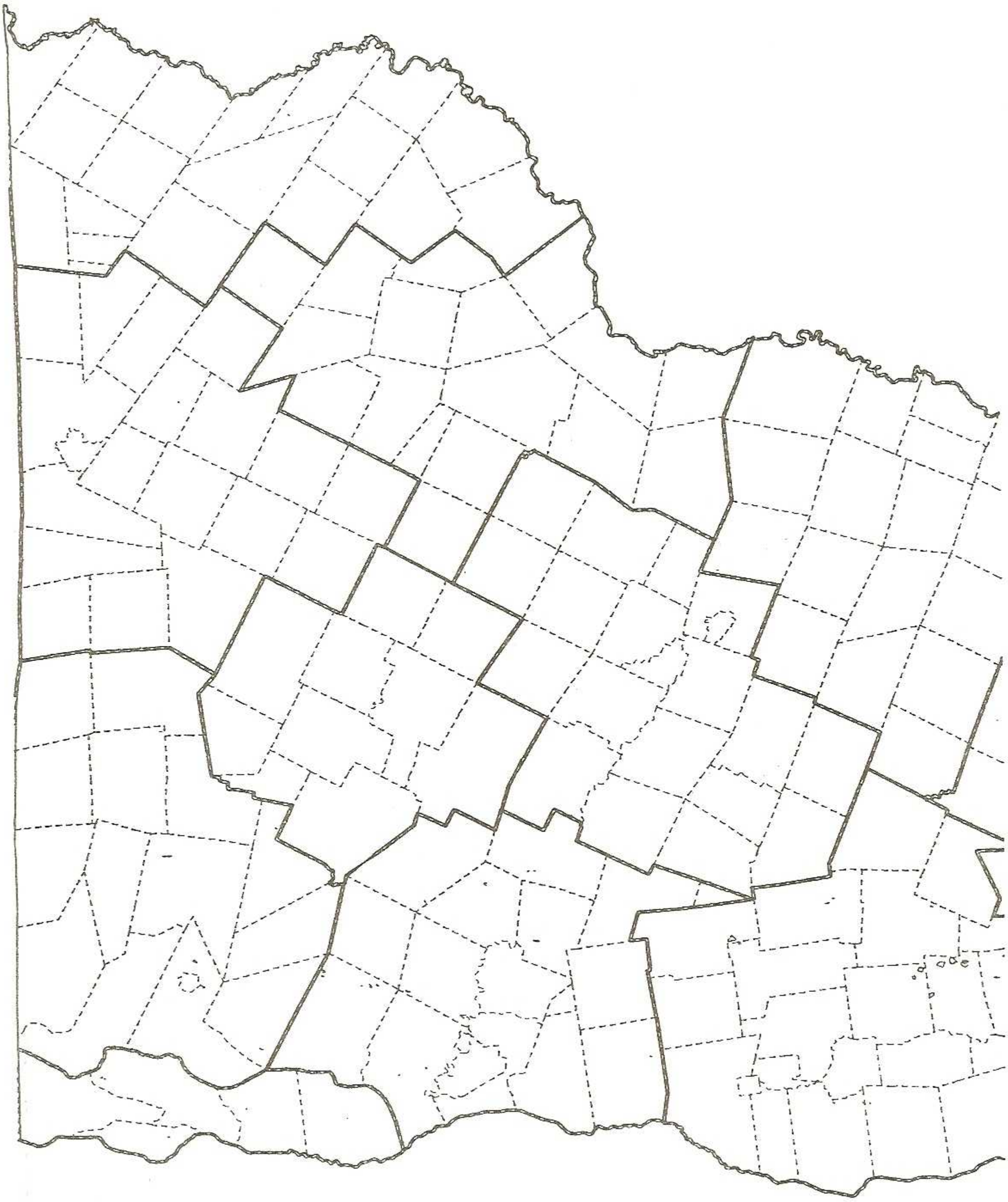


Figure 2. 1991 Birch defoliation.

Defoliation area approximate location.

Total defoliation mapped in 1991 = 29,300 acres



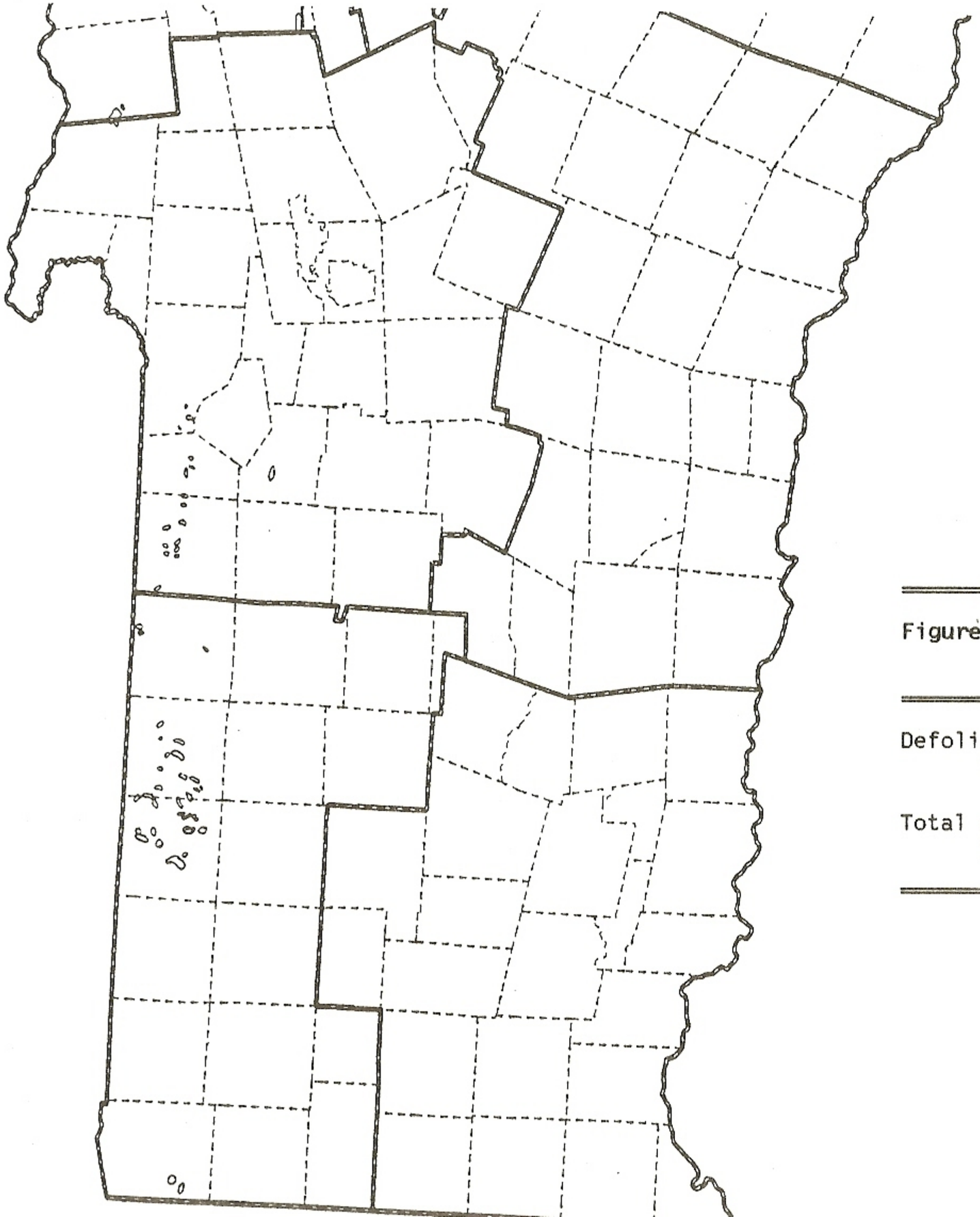


Figure 3. 1991 Gypsy moth defoliation.

Defoliation area approximate location.

Total defoliation mapped in 1991 = 8,000 acres

Table 7. Mapped acres of defoliation by gypsy moth in 1991.

County	Damage Level: Light (<30%)	Moderate (30-60%)	Heavy (>60%)	Total Acres
Addison	100	800	600	1,500
Bennington	200	3,100	1,700	5,000
Chittenden	--	100	100	200
Franklin	--	100	--	100
Rutland	100	900	200	1,200
Total	400	5,000	2,600	8,000

Table 8. Gypsy moth counts from focal area monitoring plots 1986-1991.[1, 2]

Plot Location	1986	1987	1988	1989	1990	1991
Minards Pond	0	0	7	99	10	0
Fort Dummer	2	0	1	1	0	0
Handley Mountain	1	1	4	417	7	2
Perch Pond	0	115	226	168	1	1
Rocky Pond	0	6	53	>400	11	0
Petersburg	1	0	1	296	89	51
Tate Hill	0	0	6	498	5	25
Arrowhead[3]	5	21	48	96	3	2
Brigham Hill[4]	10	37	28	74	212	22
Middlesex	0	0	1	19	23	3
Sandbar	-	45	173	226	57	6
Average	2	20	46	200	38	10

1. Total number in 15m diameter burlap-banded plots.
2. Average of 2 or 3 plots in 1986 and 2 plots in 1987-1991.
3. Aerial sprayed with B.t. (Foray) in 1990.
4. Aerial sprayed with B.t. (SAN415) in 1988.

An oak growth study was established by the U.S. Forest Service on Chandler Ridge, near Middlebury, Vermont on the Green Mountain National Forest. The objective of the study was to determine and quantify lost growth due to gypsy moth defoliation. Thinned, unthinned and sprayed versus unsprayed blocks were established. First year measurements were complete this year. The study will measure growth for five years and is a result of a monitoring need identified with the 1990 Bt spray project.

Research on natural enemies of gypsy moth is being completed by the University of Vermont. Approximately 3Ø species of ants were collected from pitfall traps on Bryant Mountain in 1984-1988. Eggs, larvae, and pupae of gypsy moth (as well as forest tent caterpillar and maple leaf cutter) are being screened to determine the relative susceptibility to several fungal pathogens.

Maple Leaf Cutter, *Paraclemensia acerifoliella*, populations increased, with 5,2ØØ acres of defoliation mapped from the air (Figure 4, Table 9). In addition, heavy damage, confined to lower crowns of sugar maple as well as understory trees, was widespread. Much of the heavy damage was not visible until the last week of August.

Table 9. **Mapped acres of defoliation by maple leaf cutter in 1991.**

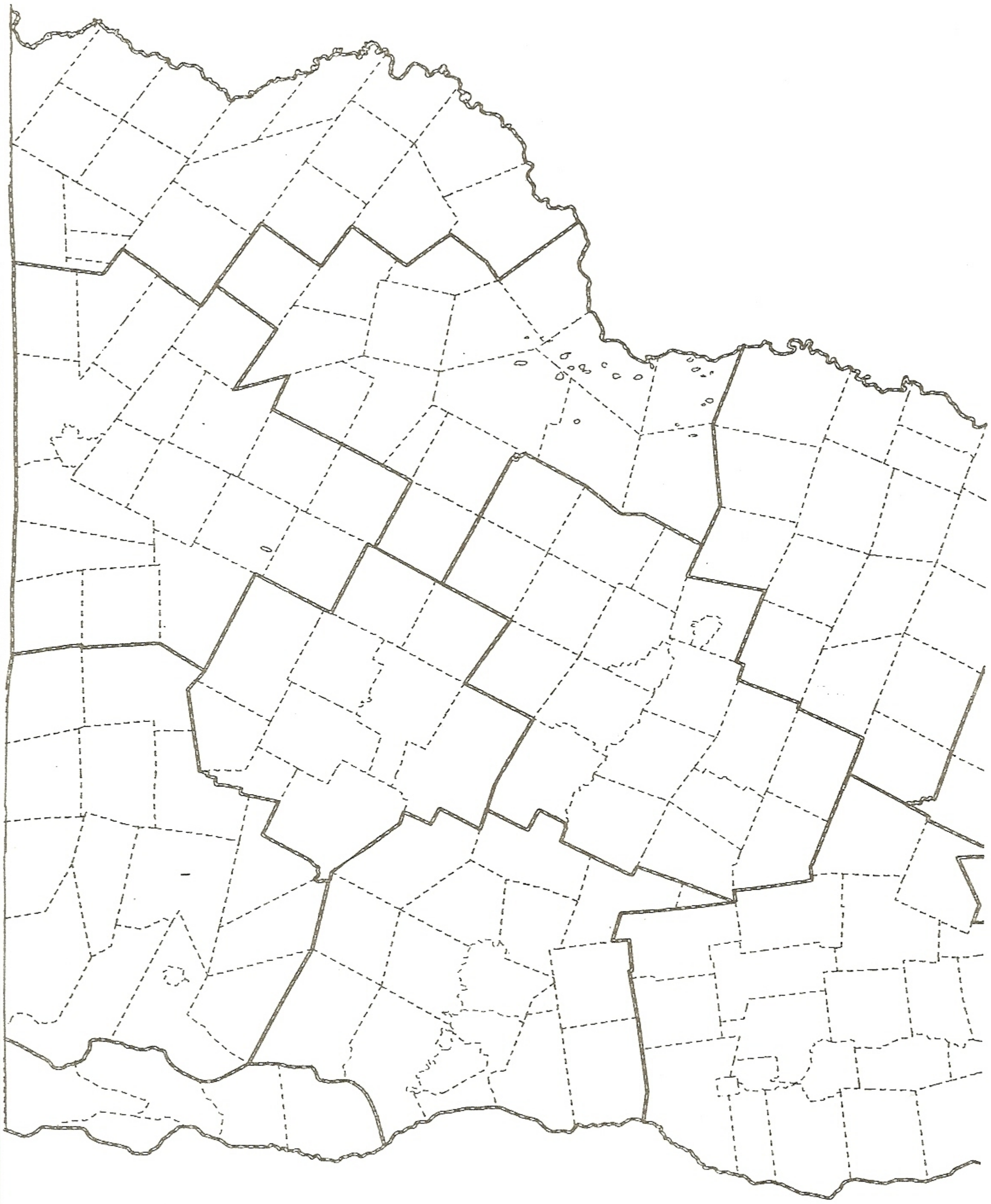
County	Acres Mapped
Caledonia	1,8ØØ
Orange	1ØØ
Orleans	1ØØ
Rutland	1ØØ
Windham	3ØØ
Windsor	2,8ØØ
Total	5,2ØØ

Maple leaf cutter larvae were sampled in two locations in mid-June. A sugarbush in Pomfret averaged 6.7 live larvae and 1.1 dead larvae per leaf. A sugarbush in Hartford, which had been sprayed with Bt in 199Ø, averaged Ø.5 live larvae and Ø.Ø3 dead larvae. The Pomfret sugarbush received heavy damage, while the Hartford sugarbush had only light defoliation.

The area of damage detected is the greatest since 1982, and populations are expected to continue increasing in 1992. Past outbreaks of this pest have tended to increase slowly, remain at high levels for many years, and then decrease slowly. Duration of the last outbreak was about 1Ø years.

Maple Trumpet Skeletonizer, *Epinotia aceriella*, was unusually common again this year although damage was generally less than 199Ø. Heaviest damage occurred in Addison and Windsor Counties, where some sugar maples were moderately defoliated. Moths were commonly seen in Windsor County in June.

Oak Leaf Tier, *Croesia semipurpurana*, was not observed causing any damage. The number of moths caught in the pheromone trap cluster in Rockingham increased substantially. No moths were caught elsewhere (Table 1Ø).



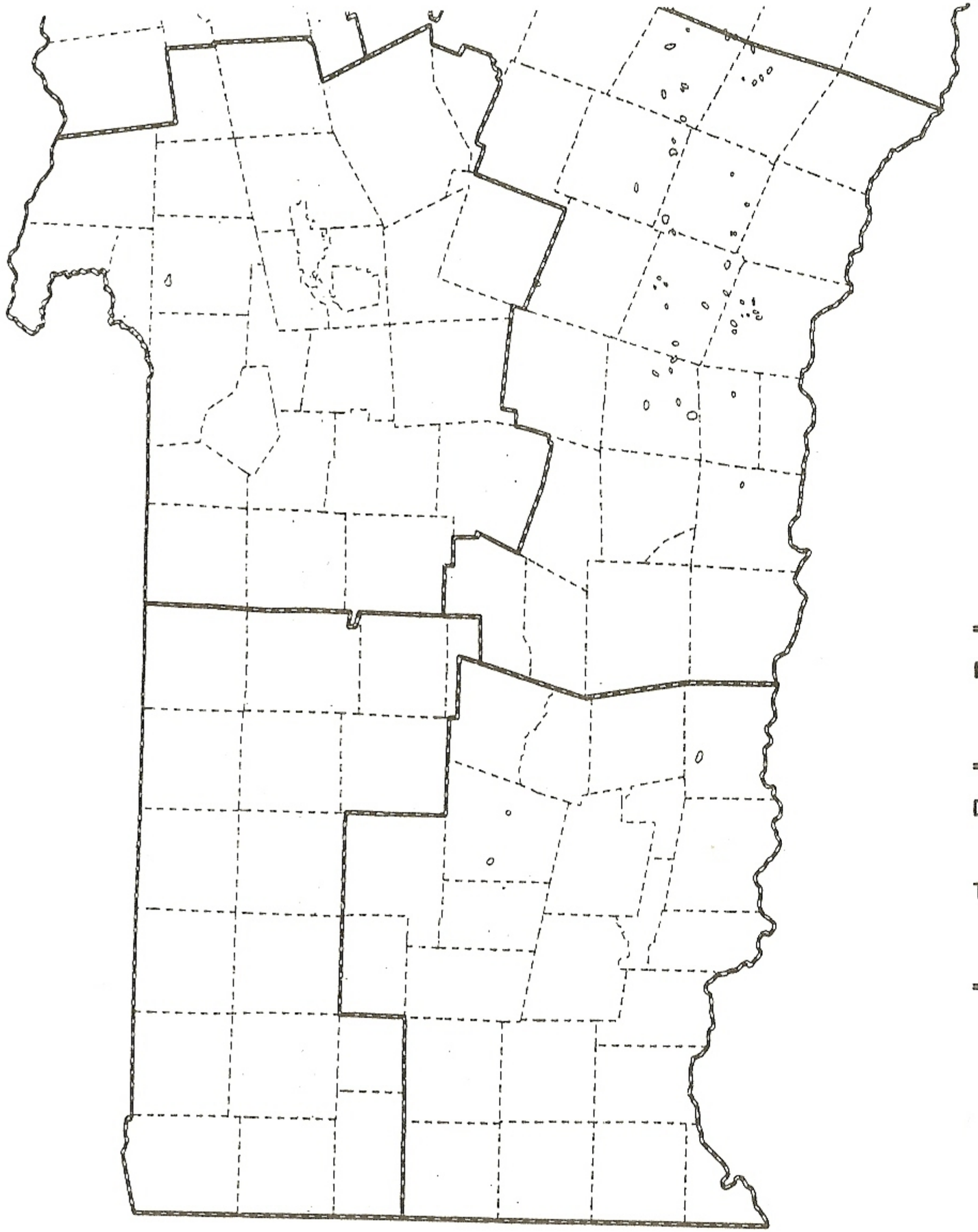


Figure 4. 1991 Maple leaf cutter defoliation.

Defoliation area approximate location

Total defoliation mapped in 1991 = 5,200 acres

Table 10. Oak leaf tier in pheromone traps 1988-1991.

Location	# of Moths/Trap*			
	1988	1989	1990	1991
Brattleboro	40	0	1.3	0
Brigham Hill	--	--	0.3	0.3
Rockingham	60	0	1.3	26
Rupert	--	0	0	0
Sandbar	--	--	0	0

* Average of three traps, except Rockingham in 1988.

Saddled Prominent, *Heterocampa guttivata*, populations declined. No defoliation was mapped from the air compared to 2780 acres in 1990. Although moths were easily caught in light traps in Windham and Orange Counties, larvae were only occasional observed statewide. It is expected that a fungal pathogen is responsible for the collapse. Pheromone traps were set out in Vershire, Wilmington and Shrewsbury as part of a cooperative effort coordinated by the U.S. Forest Service to test different lures. Saddled prominent moths were caught in all locations.

Populations are expected to remain low in 1992. In late summer, four pupae were found in 25 1-sq. ft. samples in a sugarbush in the Shrewsbury trap site. Pupae were also difficult to find in the Orange County sites.

OTHER HARDWOOD DEFOLIATORS

INSECT	HOST(S)	LOCALITY	REMARKS
American Aspen Beetle *Gonioctena americana*			Not observed.
American Dagger Moth *Acronicta americana*			Not observed.
Apple & Thorn Skeletonizer *Choreutis pariana*	Apple	Middlebury	

OTHER HARDWOOD DEFOLIATORS

INSECT	HOST(S)	LOCALITY	REMARKS
Birch Leaf Folder *Ancylis discigerana*			See narrative.
Birch Leaf Miner *Fenusa pusilla*			See narrative.
Birch Skeletonizer *Bucculatrix canadensisella*			See narrative.
Blackheaded Ash Sawfly *Tethida cordigera*	White Ash	Readsboro	Noticeable defoliation along roadside.
Bruce Spanworm *Operophtera bruceata*			See narrative.
Cecropia Moth *Hyalophora cecropia*	Apple	Poultney	Individual larvae.
Cherry Scallop Shell Moth *Hydria prunivorata*			See narrative.
Comma Butterfly *Polygonia comma*	Elm	Huntington	
Dogwood Sawfly *Macremphytus sp. (prob. tarsatus)*	Dogwood Lilac	Chester Grafton Wallingford Bloomfield	Ornamentals.
Early Birch Leaf Edgeminer *Messa nana*			See narrative.
Eastern Tent Caterpillar *Malacosoma americanum*	Cherry Apple	Throughout	Common. Similar to 199Ø levels.

OTHER HARDWOOD DEFOLIATORS

INSECT	HOST(S)	LOCALITY	REMARKS
Elm Leaf Beetle *Pyrrhalta luteola*	Elm	Throughout	Heavy damage to elms along riverbank in Arlington. Light damage common elsewhere.
Elm Leaf Miner *Fenusa ulmi*	Elm	North Hero	
Euonymus Caterpillar *Yponomeuta multipunctella*	Burning Brush	Peacham	
Fall Cankerworm *Alsophila pometaria*			Not observed.
Fall Webworm *Hyphantrea cunea*	Cherry	Throughout, especially along roadsides and field edges.	Marked increase. Causing complete defoliation in Brattleboro and Guilford. Damage visible from the air.
Flat Leaf Tiers *Psilocorcis sp.*			Not observed.
Forest Tent Caterpillar *Malacosoma disstria*			See narrative.
Green Striped Mapleworm *Anisota rubicunda*	Sugar Maple	Northeast Kingdom, Shrewsbury	Individual larvae.
Gypsy Moth *Lymantria dispar*			See narrative.
Half Winged Geometer *Phigalia titea*			Not observed.
Imported Willow Leaf Beetle *Plagiodera versicolora*	Willows	Franklin & Washington Counties	Common. Caused moderate defoliation, including 25 acres mapped in Enosburg.

OTHER HARDWOOD DEFOLIATORS

INSECT	HOST(S)	LOCALITY	REMARKS
Japanese Beetle *Popillia japonica*	Ornamentals	Widespread	Abundant. Increasing in northern Vermont compared to 199Ø. Heavy on birch in Chittenden County.
Large Aspen Tortrix *Choristoneura conflictana*	Quaking Aspen	Guildhall	Locally noticeable.
Large Oak-Apple Gall *Amphibolips confluenta*	Red Oak	Throughout, especially Windham County	Commonly observed in southern Vermont.
Linden Looper *Erranis tiliaria*	Hardwoods	West Rutland	Individual larvae.
Locust Leaf Miner *Odontata dorsalis*	Black Locust	Chittenden Washington & Windham Counties	Some moderate to heavy defoliation in same locations as in the past. Similar to 199Ø.
Maple Leaf Cutter *Paraclemensia acerifoliella*			See narrative.
Maple Leafblotch Miner *Cameraria aceriella*	Sugar Maple	Addison Chittenden & Franklin Counties	Fairly common throughout.
Maple Trumpet Skeletonizer *Epinotia aceriella*			See narrative.
Maple Webworm *Tetralopha asperatella*	Sugar Maple	Widespread	Common again this year in northern Vermont. Increasing over 199Ø levels; light defoliation.
Mountain Ash Sawfly *Pristiphora geniculata*	Mountain Ash	Chittenden & Addison Counties	Locally heavy defoliation of high-elevation wild trees. Unusually absent on ornamentals.

OTHER HARDWOOD DEFOLIATORS

INSECT	HOST(S)	LOCALITY	REMARKS
Oak Leafroller *Archips semiferanus*			Not observed.
Oak Leaf Tier *Croesia semipurpurana*			See narrative.
Oak Skeletonizer *Bucculatrix ainsliella*	Oak	Throughout Southern Vermont	Light defoliation in red oak stands. Most common in Windham County.
Orange-humped Mapleworm *Symmerista leucitys*			Not observed.
Pear Sawfly *Caliroa cerasi*			Not observed.
Pin Oak Sawfly *Caliroa sp.*			Not observed.
The Question Sign *Polgonia interrogationis*	Camperdown Elm	Morristown	
Red-humped Oakworm *Symmerista canicosta*	Oak	Castleton	Individual larvae.
Rose Chafer *Macrodactylus subspinosus*	Hardwood Ornamentals	St. Johnsbury Danville	Heavy.
Saddled Prominent *Heterocampa guttivata*			See narrative.
Satin Moth *Leucoma salicis*	Balsam Poplar Cottonwood	Widespread	Locally heavy defoliation of ornamentals and trees in riparian areas. Noticeably increasing.

OTHER HARDWOOD DEFOLIATORS

INSECT	HOST(S)	LOCALITY	REMARKS
Solitary Leaf Roller *Sparganothis pettitana*	Sugar Maple	Lamoille County	Scattered, light. Same as 199Ø.
Solitary Oak Leaf Miner *Cameraria hamadryadella*			Not observed.
Spiny Elm Caterpillar *Nymphalis antiopa*	Willows Birches	Dover	Ornamentals.
Spring Cankerworm *Paleacrita vernata*		Brandon	
Uglynest Caterpillar *Archips cerasivoranus*	Cherry	Northern Vermont	Occasionally observed, similar to 199Ø.
White-marked Tussock Moth *Orgyia leucostigma*	Hardwoods	Lamoille & Rutland Counties	Heavy defoliation of a potted mountain ash. Elsewhere, individual larvae observed, including on Scots pine Christmas trees.
Wood Sower Gall *Callirhytis seminator*	Red Oak	Brattleboro Vernon	Ornamentals.

SOFTWOOD DEFOLIATORS

Hemlock Looper, *Lambdina sp.*, populations increased dramatically in 1991. Damage from the **Spring Hemlock Looper**, *L. athasaria*, was mapped on 1,600 acres in southeastern Windham County, compared to about 10 acres of defoliation observed in 1990 (Figures 5-6, Table 11).

Several additional stands which were defoliated in 1990 became apparent by spring of 1991. Damage became more obvious as damaged needles dried out and dropped. Branch samples were taken from four of these stands in winter 1990-91 and analyzed for the **Fall Hemlock Looper**, *L. fiscellaria*, by the Maine Forest Service. Samples from the three stands in Dummerston had no *L. fiscellaria* eggs. Samples from the stand in Vernon had <3 eggs per meter of branch, indicating that damage due to *L. fiscellaria* would be moderate. All four stands had heavy defoliation due to *L. athasaria* in 1991.

Clouds of *L. athasaria* moths were seen in late May in stands which had been damaged the previous year. Larvae were first observed in mid-June, along with a number of unhatched eggs. Damage was not visible from the air during the third week of August, but approached 100% defoliation in some areas by September. Pupation was beginning by mid-September, and continued into October.

Hemlocks were salvaged in one stand that was damaged in 1990. Twenty trees in that stand had been marked to monitor survival through budbreak. Trees were dead by June if they were missing all of their old needles, and over 80% of their new needles, by April. Most trees survived through spring if they had complete defoliation of older needles, but only 50-75% of new foliage missing. However, these trees had dieback by early summer (Table 11).

In general, mortality is expected where 90% or more of the needles have been lost. A leaflet, "Hemlock Loopers in Vermont", is being developed to provide recommendations for managing the insect, based on current knowledge.

No method is known to predict defoliation by the spring hemlock looper. Pupae can be found in the duff of defoliated stands, indicating that the insect will be present in 1992. Pupae were collected by the UVM Entomology Research Laboratory in four $1m^2$ plots located at the bases of each of three moderately defoliated hemlock trees in one stand in Dummerston. Litter and duff were hand sorted to a depth of about 2 cm. Fifty five, 33, and 17 pupae were recovered, providing an average of 8 pupae per square meter. Four fungal infected specimens were collected. Pupae were found in a variety of situations, including the upper compacted hemlock duff and attached to hardwood leaves deposited this year and in the previous year. They were often between layers of damp decaying hardwood leaves.

Surveys will be conducted to assess populations of both the fall and the spring loopers, and to evaluate the impact of existing defoliation. Research is beginning at the University of Vermont on spring-flying hemlock looper biology.

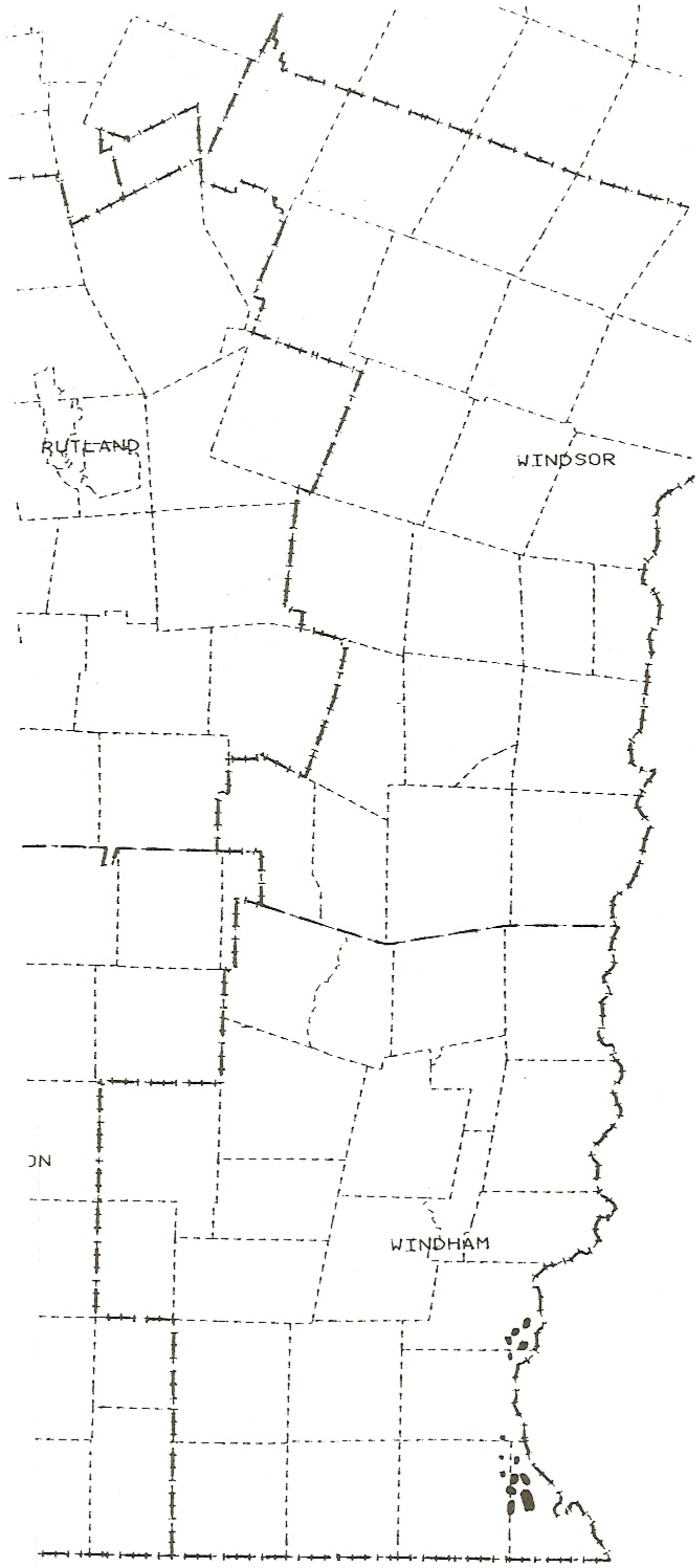


Figure 5. 1991 hemlock looper defoliation.

Defoliation area approximate location

Total defoliation mapped in 1991 = 1,600 acres

Figure 6. Spring hemlock looper damage to hemlock in Vernon in June 1991 following 1990 defoliation.

A. Thin crowns and mortality in defoliated trees.

B. Tufted shoots showing hemlock looper preference for older foliage.

C. Close-up showing notched needles from looper feeding.

Table 11. Condition of hemlocks in late May 1991 following hemlock looper defoliation in 1990.

% Defoliation by April		Condition in Late May (# of Trees)		
New Foliage	Old Foliage	Dead	with Top Dieback	with New Shoots Throughout
90-100	100	6	0	0
70-75	100	2	4	1
50-60	100	0	6	0
<50	100	0	0	1

Two Loopers

Spring Hemlock Looper
Lambdina athasaria

Defoliated 1600 acres of hemlock in Windham County in 1991. Additional defoliation in New Hamsphire, Massachusetts, and Connecticut. Outbreak of this insect in Maine has collapsed.

Moths fly in late spring. Most eggs seem to be laid on undersides of hemlock needles and shoots. Larvae feed from June to October. Winter spent as pupae in the leaf layer on the ground.

Defoliates upper branches first.

May cause complete defoliation in a single year.

No significant feeding on species other than hemlock.

No method is known for predicting defoliation.

Fall Hemlock Looper
Lamdina fiscellaria

Caused 225,000 acres of heavy hemlock and fir defoliation in Maine in 1991. No recent defoliation has occurred elsewhere in New England. Moths were commonly seen statewide in 1991, indicating damage may occur in Vermont in 1992.

Moths fly in late summer. Winter is spent as eggs which are laid on a variety of surfaces, including hemlock shoots, bark, & lichens. Larvae feed from June to August. Pupae are found on tree trunks, in leaf litter and other sites.

Defoliates lower branches & understory trees first.

First year defoliation tends to be less severe. Seldom defoliates more than two thirds of current year's needles.

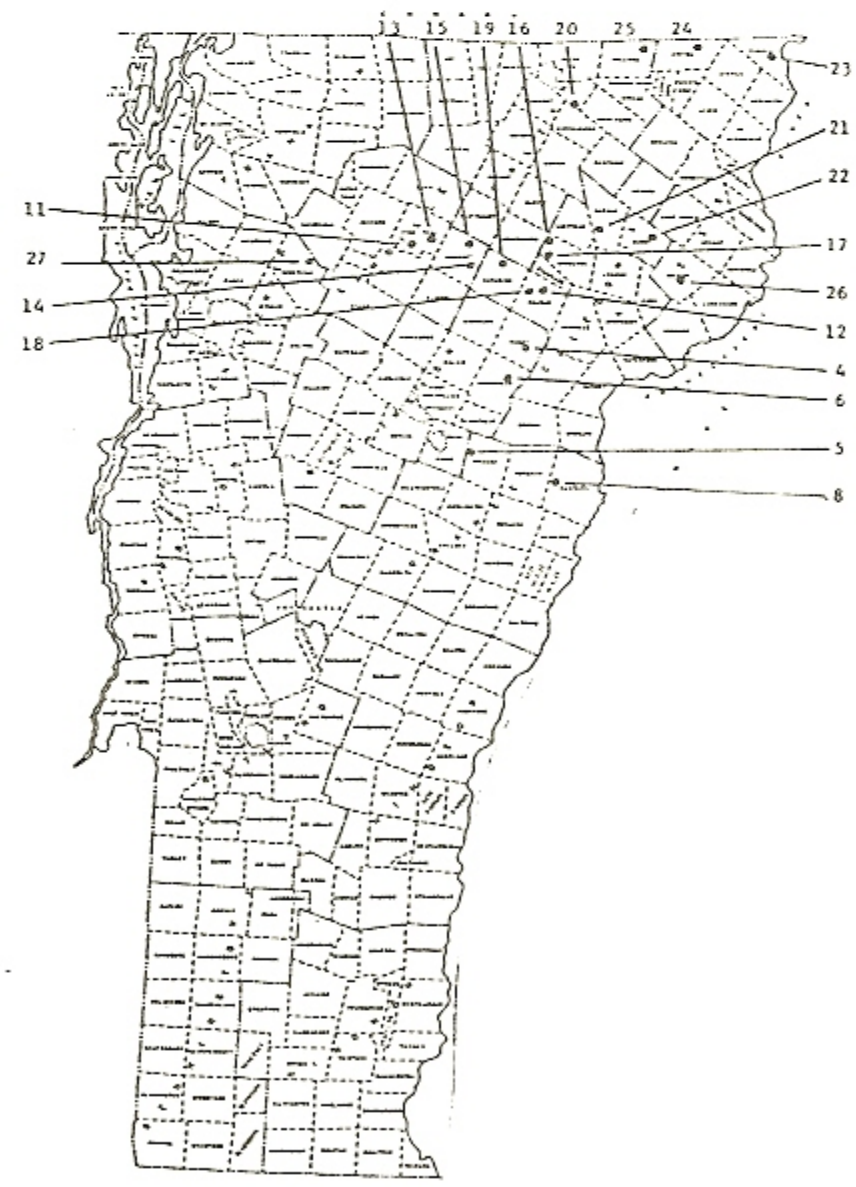
Feeds on a variety of species. May cause defoliation of balsam fir & white spruce as well as hemlock.

Defoliation can be predicted by counting overwintering eggs on hemlock branches.

Moths of the Fall Hemlock Looper, *Lambdina fiscellaria*, were very noticeable throughout most of the state, especially during September. Although no damage is known to have occurred yet from this insect, the sudden abundance of moths is of concern. Adults emerged from early August until late October. A couple of moths were captured in oak leaf tier pheromone traps in Milton and Essex, collected 5 and 9 August, and more were present in spruce budworm and forest tent caterpillar collected in mid-August. Black Light traps deployed by the University of Vermont (J. R. Grehan) at three elevations along the west slope of Mount Mansfield caught *L. fiscellaria* moths from 7 August until 25 October, with peak capture (5Ø/night) during early to mid-September. The Underhill State Park site at an elevation of 6ØØ meters caught the most moths, with a total of 58Ø for the season. A smaller Black Light trap deployed at the edge of a Morristown hemlock stand in late September caught a maximum of about 2Ø moths per night.

Spruce Budworm, *Choristoneura fumiferana*, continued at low levels, with no visible defoliation or larvae detected, but there was a sudden increase in the number of moths captured in pheromone traps (Figure 7, Table 12). This is the most moths caught since 1984 when the last outbreak collapsed (Figure 8). The U.S. Forest Service caught fewer moths in traps located in six Green Mountain National Forest locations. These traps averaged only Ø.6 moths per trap. High moth catch may be due to a blow-in from higher populations areas in Canada, since north-central New York also experienced a sudden increase in moth catch. Moth catch in 1992 should tell the story; if it increases again, it may signal the beginning of another outbreak.

Figure 7. Spruce budworm pheromone plot locations and average number of moths caught per trap in 1991.



	Location	# of moths/trap
4.	Danville Hill	15.3
5.	Reservoir	28.3
6.	Marshfield Pd.	1Ø.Ø
8.	Scotch Hollow	16.3
11.	Centerville	17.3
12.	Coles Pd.	7.5
13.	Diggins	11.3
14.	Wolcott F&G	2.7
15.	Bear Swamp	8.7
16.	Withers	11.3
17.	Mason	3.7
18.	Star School	17.7
19.	Beagle Club	6.3
2Ø.	Brownington Pd.	12.Ø
21.	Calendar Brk.	3Ø.Ø
22.	Chieppo	3.5
23.	Bunnel Brk.	2.Ø
24.	Norton Cem.	3.Ø
25.	Holland Pd.	3.3
26.	Victory Bog	5.7
27.	VMC	31.7
	Average	12.Ø

Figure 8. Average number of spruce budworm moths caught in pheromone traps, 1983-1991.

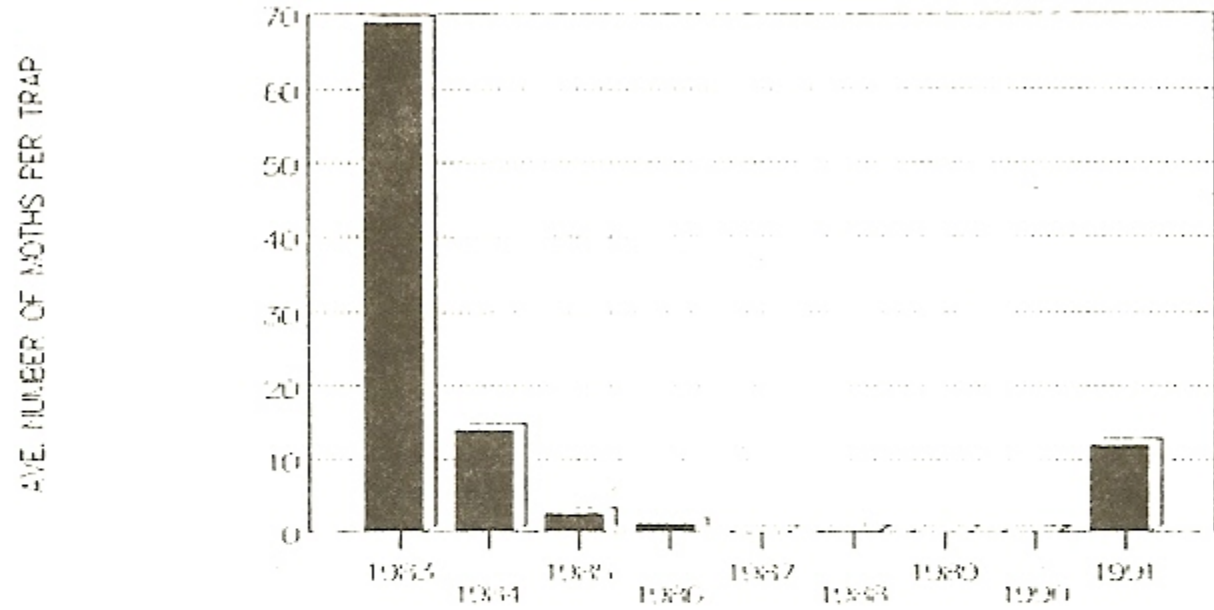


Table 12. Average number of spruce budworm moths caught per trap in pheromone traps, 1988-1991.[1]

Lure	1988	1989	1990	1991
PVC	Ø.Ø5	Ø.ØØ	--	--
Biolure	--	Ø.Ø3	Ø.Ø2	12.ØØ
Number of Sites	2Ø	1Ø per lure	2Ø	21

1. Multi-pher traps.

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OTHER SOFTWOOD DEFOLIATORS

INSECT	HOST(S)	LOCALITY	REMARKS
Arborvitae Leaf Miner *Argyresthia thuiella*	Arborvitae	Widespread	Most common in northern Vermont. Scattered damage to ornamentals in Rutland & Caledonia Counties.
Balsam Fir Sawfly *Neodiprion abietis*			Not observed.
European Spruce Needleminer *Taniva albolineana*	White Spruce	Northfield Ludlow	Light to moderate defoliation on ornamentals and nursery trees.
Green Hemlock Needleminer *Coleotechnites apicitripunctella*			Not observed.
Gypsy Moth *Lymantria dispar*			See Hardwood Defoliators.
Hemlock Looper *Lambdina athasaria*			See narrative.
Introduced Pine Sawfly *Diprion similis*	White Pine Scots Pine	Widely scattered	Increasing. Frequently reported. Present in 50 acres of surveyed Christmas trees. It was not observed in the 1990 survey.
Larch Casebearer *Coleophora laricella*		widely scattered	Light damage. Down somewhat from 1990.
Larch Looper *Semiothisa sexmaculata*	Larch	Shaftsbury	Light damage.
Larch Sawfly *Pristophora erichsonii*			Not observed.

OTHER SOFTWOOD DEFOLIATORS

INSECT	HOST(S)	LOCALITY	REMARKS
Microbagworm *Psychidae*			Not observed.
Nursery Pine Sawfly *Diprion frutetorum*	Scots Pine	Newport	Light damage to Christmas trees. Not observed in 1990.
Orange Spruce Needleminer *Pulicalvaria piceaella*			Not observed.
Pine False Webworm *Acantholyda erythrocephala*	Scots Pine Mugho Pine	Brookfield St. Albans	Two reports of moderate-heavy Christmas tree damage. Not observed in 1990.
Pine Webworm *Tetralopha robustella*			Not observed.
Red-headed Pine Sawfly	Scots Pine	Bennington County	Light damage to Christmas trees in scattered locations.
Neodiprion lecontei	Mugho Pine	Brattleboro	Ornamentals.
Spruce Bud Moth *Zeiraphera canadensis*	White Spruce	Walden Peacham Cabot Lyndon Wolcott	Light infestations in Christmas tree plantations. Stable to decreasing.
Spruce Budworm *Choristoneura fumiferana*			See narrative.
Spruce Needleminer *Taniva albolineana*		Caledonia & Essex Counties	Moderate damage to ornamentals.
White Pine Sawfly *Neodiprion pinetum*			Not observed.
Yellow-headed Spruce Sawfly *Pikonema alaskensis*	Blue Spruce	Montpelier	Heavy on two ornamentals. Overall, down from 1990.

SAPSUCKING INSECTS, MIDGES, AND MITES

Balsam Gall Midge, *Paradiplosis tumifex*, damage to balsam fir Christmas trees continued this year, but area and severity of damage dropped from 1990 levels. Of the northern Vermont plantations annually surveyed for pests, 146 acres of balsam fir were reported infested compared to 253 acres in 1990 and 157 acres in 1989. Moderate to heavy damage was reported for only 31 of these acres compared to 144 acres in 1990.

Galls examined this fall from Stannard and Wolcott showed that more than 80 percent of the galled needles from each location contained larvae of the non-gall-making midge, *Dasineura balsamifera*, which ends up preventing *P. tumifex* from reaching maturity. Thus, the dominant midge in 1992 for most locations should be the beneficial one, and damage should decrease significantly.

Balsam Twig Aphid, *Mindarus abietinus*, populations increased in southern Vermont, with damage occurring throughout the region. In occasional Christmas tree plantations where the population was not controlled, heavy sooty mold developed.

In the Northern Vermont plantations annually surveyed for pests, the area and severity dropped somewhat. Damage was reported for 256 acres of fir compared to 424 acres in 1990. Only 20 percent of the acreage had heavy damage compared to 80 percent in 1990 and 40 percent in 1989.

Eggs present for 1991 are scarce in plantations that have had more than one year of consecutive damage. Look for damage to decrease in these areas in 1992, but to continue in newly-infested plantations.

Hemlock Woolly Adelgid, *Adelges tsugae*, eradication continued at the site in Stockbridge where the insects were introduced in 1990. During a systematic survey in early May, six planted seedlings were found, of which one was infested. When the area was resurveyed in early November, seven planted seedlings were found, of which three were infested. A tiny wilding was also pulled. Two additional seedlings, one infested, were found in mid-December. To date, one hundred and fifty-five planted trees have been pulled from the site and destroyed.

Nine native hemlock stands in the valleys around the introduction site were scouted, totalling about 500 acres. No evidence of hemlock woolly adelgid was found.

To continue monitoring the state for other possible infestations, a sub-sample of the original survey plots is being checked. To date, six stands were revisited. No adelgids were detected.

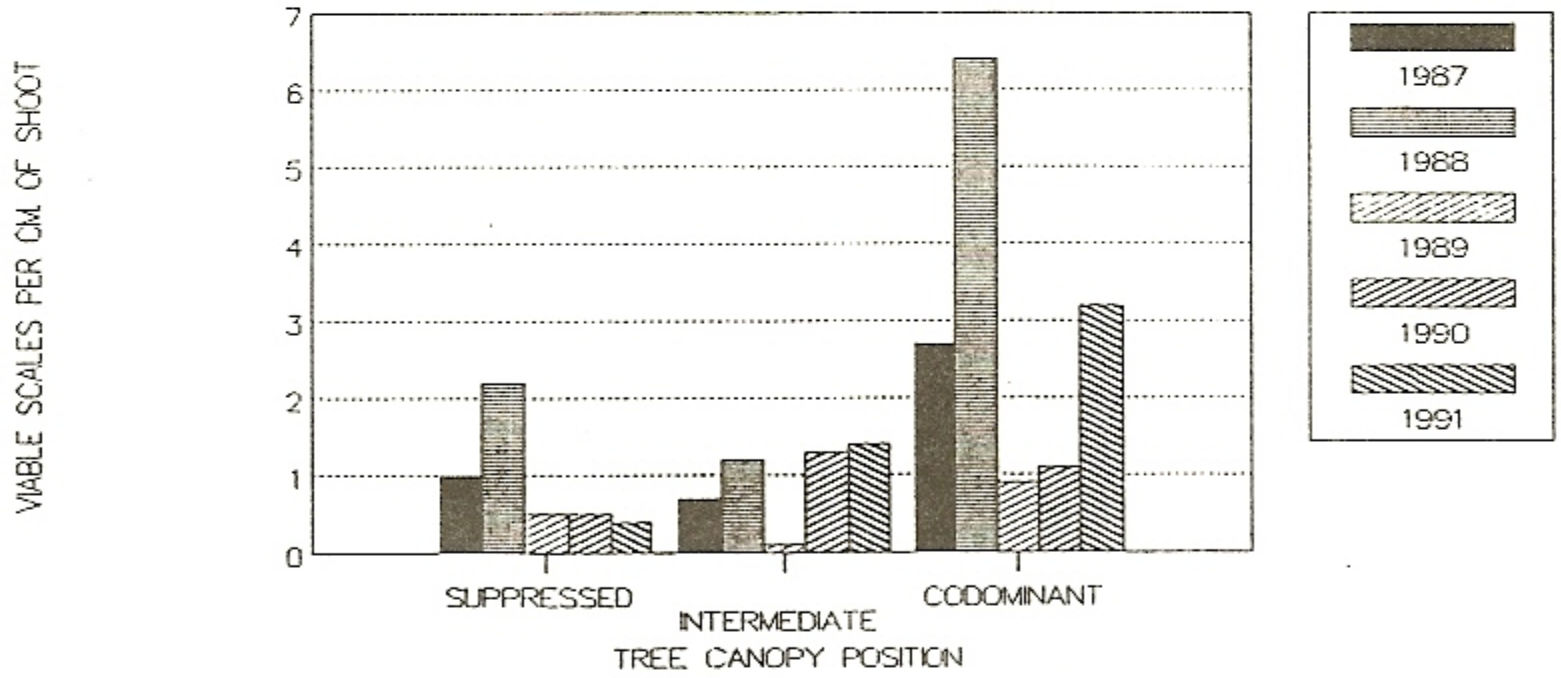
Oystershell Scale, *Lepidosaphes ulmi*, is currently causing little damage although heavy insect populations are occasionally observed on regeneration. Beech dieback associated with recent past infestations remains noticeable. An evaluation of scale population levels within Camel's Hump State Forest showed a noticeable increase in number of insects from overstory branches, but populations per linear centimeter remain below the high levels last seen in 1988 (Table 13, Figure 9).

Table 13. Number of oystershell scales on current year twigs in Camel's Hump State Forest, 1987-1991.[1]

	Average Number of Mature Viable Scales per:									
	Twig					Millimeter				
	1987	1988	1989	199Ø	1991	1987	1988	1989	199Ø	1991
Suppressed	3.7	3.4	1.7	2.1	Ø.9	Ø.1Ø	Ø.22	Ø.Ø5	Ø.Ø5	Ø.Ø4
Intermediate	6.8	2.8	1.Ø	8.5	5.9	Ø.Ø7	Ø.12	Ø.Ø1	Ø.13	Ø.14
Codominant	9.3	8.8	3.7	7.4	1Ø.7	Ø.27	Ø.64	Ø.Ø9	Ø.11	Ø.32

1. Average for 1Ø branches from one tree per crown class, collected in Autumn, each year.

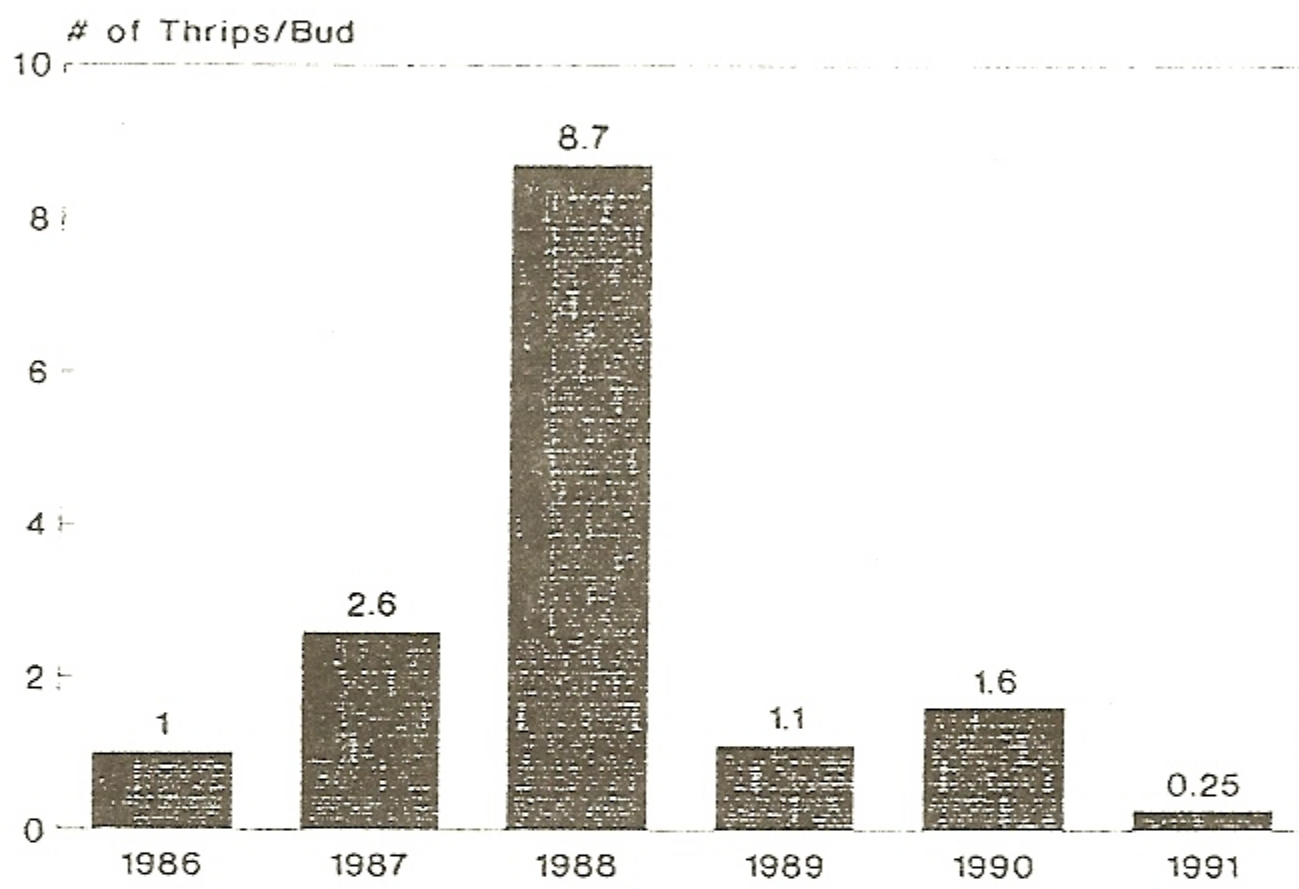
Figure 9. Oystershell scale populations in three tree canopy positions in Camel's Hump State Forest, 1987-1991.



Pear Thrips, *Taeniothrips inconsequens*, caused little damage to sugar maple with only very light damage observed in widely scattered locations. No defoliation was mapped from the air, compared to 29,76Ø acres mapped in 199Ø. Insect populations were low and rapid leaf flush, caused by warm spring weather and adequate precipitation, reduced thrips damage.

Average overwintering soil counts in fall 1990 were down throughout the state from the average counts in fall 1989 (Table 14). However, thrips were found from 93% of the sites surveyed. Bud counts, in the six sugarbushes which have been monitored since 1986, averaged .25 per bud, compared to 1.6 per bud in 1990 (Figure 10). Additional bud counts were done in nine sugarbushes in Rutland County, and averaged .14 per bud.

Figure 10. Average thrips counts in buds of sugar maple in southern Vermont 1986-1991.[1]



1. Average of 2 sugarbushes in 1986 and 6 sugarbushes in 1987-1991 (100 buds/ sugarbush).

Soil sampling was continued in fall 1991, in cooperation with the University of Vermont, at the same sites which have been sampled in 1988. Populations remain generally low, although county averages are up in 5 of 13 counties. Large scale defoliation is not expected.

Dieback is continuing in one sugar maple stand in Rupert that was severely defoliated by thrips in 1988, and damaged again in 1989. Droughty site conditions are responsible for the severity of losses and the length of recovery.

Table 14. Average number of live pear thrips adults in soil samples prior to spring emergence and subsequent acres of damage mapped during aerial survey.

County	Fall/ Winter 88-89 Avg. # of Live Thrips/Sample[1]	Spring '89 Acres Damaged	Fall '89 Avg. # of Live Thrips/Sample[1]	Spring '90 Acres Damaged	Fall '90 Avg. # of Live Thrips/Sample[1]	Spring '91 Acres Damaged	Fall '91 Avg. # Live Thrips/Sample[1]
Addison	4.5	400	14.3	670	1.1	0	1.1
Bennington	2.9	0	5.2	0	0.7	0	1.7
Caledonia	2.5	150	5.7	0	0.4	0	0.4
Chittenden	11.9	870	12.2	1,300	1.3	0	1.3
Essex	0.5	0	1.6	0	0.1	0	0.6
Franklin	12.3}	140	18.1}	200	3.1	0	2.4
Grand Isle	--}		4.0}		1.8	0	1.5
Lamoille	15.5	680	7.1	8,990	2.0	0	1.9
Orange	4.6	0	3.3	4,150	0.9	0	1.2
Orleans	6.9	0	3.7	0	2.0	0	1.5
Rutland	1.5	0	2.1	120	0.3	0	1.7
Washington	8.4	930	6.3	11,080	1.8	0	2.2
Windham	3.0	0	6.9	3,250	0.6	0	1.5
Windsor	4.6	0	7.8	0	0.7	0	2.1

1. A sample is approximately 16 in.^{3}, taken with a bulb planter.

Research continues at the University of Vermont on pear thrips biology, survey, and biological control. The biological control work has two major components, 1. development of a selective media to detect and isolate *Verticillium lecanii* in the soil and, 2. further testing of fungal pathogens, particularly strains of *V. lecanii*, with the goal of conducting a field test in the future. Symptomatic pink, mummified pear thrips larvae were extracted from soils sampled from maple stands in MA, ME, NH, NY, NJ, CT, PA and VT during 1990-91. All were infected with *Verticillium lecanii*, indicating the broad distribution of the fungus even at times of low thrips population densities. Data indicate that inoculum occurs in forest soils independently of an insect host. Pathogenicity studies have been done on 18 of the pear thrips *V. lecanii* strains and 15 exotic *V. lecanii* strains using western flower thrips as the test insect. The pear thrips strains were more pathogenic than the exotic strains causing mortality of 90-100% after 5 days. All of the artificially infected larvae developed the characteristic pink coloration seen in naturally infected pear thrips larvae. Strains of *Metarhizium anisopliae*, *Beauveria bassiana*, and *Paecilomyces farinosus* were also assayed. Results indicate that the pear thrips *V. lecanii* strains are as efficacious as the other species tested.

The detection and survey work includes conducting the statewide soil survey, analyzing the four years of data, and evaluating ways to reduce the labor demands associated with the survey. Foliage damage assessments are conducted annually in each sample site to determine the relationship between thrips numbers in the soil and resultant damage. Based on the past 3 years, thrips numbers can only be used as a

rough predictive tool. Early spring weather conditions, which govern the rate of budbreak, strongly influence whether damage occurs. A cool spring, which slows budbreak, is ideal for damage because the leaf tissue remains tender and highly sensitive to thrips feeding for a long time.

Refinement of pear thrips rearing methods is under investigation, as are experiments to determine pear thrips diapause requirements, which will be useful for predicting the timing of emergence. Bud development is being monitored in relation to soil and air temperature in four sites statewide. This will be related to thrips emergence and damage. Finally a study of the effect on sugar maple saplings of drought stress and injury from early- and late-season insect defoliators, pear thrips and maple leaf cutter respectively has been initiated. The effect of drought on insect fecundity and survival will be evaluated.

Spruce Spider Mite, *Oligonychus ununguis*, damage was widely observed in southern Vermont. Damage from last years feeding showed up in scattered locations early in the season. While early damage was generally light, one white spruce Christmas tree plantation in Bennington County had heavy damage.

By late summer, heavy damage began to show up in a number of locations in Bennington and Windham Counties. Species affected included hemlock, arborvitae, larch, fraser fir and white spruce Christmas trees. The dry summer conditions are thought to be responsible for the sudden build-up of mites.

OTHER SAPSUCKING INSECTS, MIDGES AND MITES

INSECT	HOST(S)	LOCALITY	REMARKS
Aphids *Cinara sp.*	Fraser Fir Scots Pine Balsam Fir	Danville Morristown E. Albany Ludlow	Similar to 1990 in abundance but causing less damage. Lightly damaging 40 acres of surveyed Christmas trees.
Aphids *Periphyllus sp.*			Not observed.
Arborvitae Aphid *Cinara tujafilina*	Arborvitae	Brattleboro	Ornamentals.
Balsam Gall Midge *Pardiplosis tumifex*			See narrative.
Balsam Twig Aphid *Mindarus abietinus*			See narrative.

OTHER SAPSUCKING INSECTS, MIDGES, AND MITES

INSECT	HOST(S)	LOCALITY	REMARKS
Balsam Woolly Adelgid *Adelges piceae*	Balsam Fir	Mendon	
Beech Scale *Cryptococcus fagisuga*			See Beech Bark Disease.
Birch Budgall Mite *Aceria rudis*			Not observed.
Blister Mite *Eriophyes sp.*	Butternut	Brattleboro	Ornamentals.
Cooley Spruce Gall Adelgid *Adelges cooleyi*	Douglas Fir Blue Spruce White Spruce	Widely scattered	Moderate damage to Douglas fir Christmas trees in Springfield. Light damage to spruce Christmas trees in Wolcott.
Cottony Maple Scale *Pulvinaria innumerabilis*	Sugar Maple	Shelburne	
Eastern Spruce Gall Aphid *Adelges abietis*	Red Spruce White Spruce	Widespread	Decreasing with generally lighter damage. In surveyed northern Vermont plantations, 32 acres of mostly light-moderate damage to white spruce Christmas trees compared to 82 acres of moderate-heavy damage in 1990. More calls on ornamentals than in 1990.
Eriophyid Mites *Eriophyidae*	White Pine	Lyndon	Moderate damage to single Christmas tree. Not detected in the past.
European Birch Aphid *Euceraphis betulae*	White Birch	Poultney West Windsor Springfield	Ornamentals.

OTHER SAPSUCKING INSECTS, MIDGES AND MITES

INSECT	HOST(S)	LOCALITY	REMARKS
Fletcher Scale *Lecanium fletcheri*	Arborvitae	Rutland	Heavy on recently planted ornamentals.
Green Erineum Gall *Eriophyidae*			Not observed.
Hemlock Woolly Adelgid *Adelges tsugae*			See narrative.
Lacebugs *Corythucha sp.*	Sycamore Sugar Maple American Elm Basswood	Widespread	Heavy damage in scattered locations by mid-summer. Noticeable along roads and streams.
Leafhoppers	Sugar Maple Other Hardwoods	Widespread	Very light damage noticeable in northern Vermont.
Lecanium Scale *Lecanium sp.*	Red Oak American Beech	Grand Isle	Very few detected.
Maple Spindle Gall Mites *Vasates aceris-crumena*	Sugar Maple	Widespread	Less noticeable than in previous years.
Oystershell Scale *Lepidosaphes ulmi*	American Beech		See narrative.
Pear Thrips *Taeniothrips inconsequens*	Sugar Maple		See narrative.
Pine Bark Adelgid *Pineus strobi*	White Pine	Throughout	Remains heavy on individual trees in many locations.
Pine Leaf Adelgid *Pineus pinifoliae*	White Pine	Throughout	Scattered dead shoots seen from 1990 feeding.
Pine Needle Midge *Contarinea baeri*			Not observed.

OTHER SAPSUCKING INSECTS, MIDGES AND MITES

INSECT	HOST(S)	LOCALITY	REMARKS
Pine Needle Scale *Chionapsis pinifoliae*	White Pine Mugho Pine	Ludlow Waterford	Moderate infestation of nursery trees. Light damage.
Pine Spittlebug *Aphrophora parallela*	Conifers	Throughout	Very common, but less than 199Ø. Widely observed on pines and hemlocks. Light damage in occasional Christmas tree plantations, including 6Ø acres of Scots pine in northern Vermont survey.
Pine Thrips *Gnophothrips sp.*	Scots Pine	Bakersfield Hyde Park	Moderate to heavy damage to 15 acres of Christmas trees.
Pine Tortoise Scale *Toumeyella parvicornis*			Not observed.
Ragged Spruce Gall Adelgid *Pineus similis*	Red Spruce	Wolcott Walden Brookfield	Some moderate-heavy Christmas tree damage. Observed on 8 acres of surveyed trees.
Root Aphid *Prociphilus americanus*			Not observed.
Spruce Bud Scale *Physokermes piceae*			Not observed.
Spruce Spider Mite *Oligonychus ununguis*			See narrative.
Treehoppers *Membracidae*			Not observed.
Vein Pocket Gall *Macrodiplosis erubescens*	Red Oak	Dummerston	Single tree.

OTHER SAPSUCKING INSECTS, MIDGES AND MITES

INSECT	HOST(S)	LOCALITY	REMARKS
Woolly Alder Aphid *Prociphilus tessellatus*	Silver Maple Red Maple White Maple Alder	Widely scattered	Ornamentals and wild trees.
Woolly Apple Aphid *Eriosoma lanigerum*			Not observed.

BUD, SHOOT AND STEM INSECTS

The **Balsam Shootboring Sawfly**, *Pleroneura brunneicornis*, caused more damage than expected for what is usually an off (odd) year, but was still down from 1990 levels. Damage of Fraser and balsam fir was reported for 197 acres in the northern Vermont survey, compared to 373 acres in 1990. Only 38 of these acres had moderate to heavy damage compared to 213 acres in 1990. Warm weather in early spring may have resulted in a greater abundance of this pest than expected. Look for heavier damage in 1992.

OTHER BUD, SHOOT & STEM INSECTS

INSECT	HOST(S)	LOCALITY	REMARKS
Allegheny Mound Ant *Formica exsectoides*	Balsam Fir & Ornamentals	Ludlow Danville	Mortality of Christmas trees and ornamentals.
Ambrosia Beetle *Scolytidae*	Paper Birch	Groton	Light damage. Similar to 1990.
Balsam Shootboring Sawfly *Pleroneura brunneicornis*			See narrative.
Butternut Curculio *Conotrachelus juglandis*	Black Walnut	Pittsford	Ornamentals.
Coneworm *Dioryctria spp.*	White Spruce	Rutland	Light damage to Christmas trees.
Locust Borer *Megacyllene robiniae*	Black Locust	Rutland	Ornamental.
Maple Petiole Borer *Caulocampus acericaulis*			Not observed.
Northeastern Sawyer *Monochamus notatus*	White Pine	Winhall	Overwintering in dead trees associated with wet site and white pine blister rust.
Northern Pine Weevil *Pissodes approximatus*	White Pine	Bennington Pownal Shaftsbury	Attacking Christmas trees stressed by Zimmerman pine moth.

OTHER BUD, SHOOT AND STEM INSECTS

INSECT	HOST(S)	LOCALITY	REMARKS
Pales Weevil *Hylobius pales*	Scots Pine	Widespread	Damage to Christmas trees similar to 1990. 134 acres of light to moderate damage reported in northern Vermont survey.
Pine False Webworm *Acantholyda erythrocephala*	Scots Pine	Bennington	Heavy damage to Christmas trees.
Pine Gall Weevil *Podapion gallicola*	Red Pine	Thetford	Branch mortality continues in Thetford State Park.
Pine Root Collar Weevil *Hylobius radicis*	Scots Pine	Milton	Causing heavy mortality of small to overmature Christmas trees in a largely unmanaged plantation.
Pitch Nodule Maker *Petrova albicapitana*	Scots Pine	Ferrisburg	Associated with Zimmerman Pine Moth. Continuing to cause branch and tree mortality in a 50 acre plantation. Visible during aerial survey this year.
Pitted Ambrosia Beetle *Corthylus punctatissimus*	Sugar Maple Seedlings	Franklin & Caledonia Counties	Some damage visible. Down from 1990.
Pseudanthonomus validus	Yellow Birch		Not observed.
Round-headed Apple Tree Borer *Saperda candida*	Apple Mountain Ash	Lyndon Lunenburg Chester Wallingford	Damaging nursery and ornamental trees.
Sawyer *Monochamus sp.*	Scots Pine	Lamoille Caledonia Essex & Addison Counties	Causing light-moderate damage to 34 acres of Christmas trees. Not detected in 1990. Elsewhere, common on recently dead trees. See Pine Wood Nematode about related research.

OTHER BUD, SHOOT AND STEM INSECTS

INSECT	HOST(S)	LOCALITY	REMARKS
Sugar Maple Borer *Glycobius speciosus*	Sugar Maple	Widespread	Abundant damage in many stands, especially where maples are slow-growing. Two adults observed.
Twig Pruner *Elaphidionoides villosus*			Not observed.
White Pine Weevil *Pissodes strobi*	Conifers	Throughout	Damage remaining constant. Reported for 171 acres of Christmas trees in northern Vermont survey.
Zimmerman Pine Moth *Dioryctria zimmermanni*	White Pine Scots Pine	Bennington Ferrisburg Shaftsbury Sudbury Weston	Causing scattered mortality to Christmas trees. Associated with pitch nodule maker in one plantation.

BARK BEETLES

INSECT	HOST(S)	LOCALITY	REMARKS
Bronze Birch Borer *Agrilus anxius*	White Birch	West Windsor Springfield Reading	Associated with dieback of recently planted trees.
Eastern Ash Bark Beetles *Hylesinus aculeatus*			Not observed.
Eastern Larch Beetle *Dendroctonus simplex*	Eastern Larch	Widespread	Continues to decrease. Only 19 acres of associated larch mortality (Orleans County) reported this year.
Elm Bark Beetles *Hylurgopinus rufipes* *Scolytus multistriatus*			See Dutch Elm Disease.
Hemlock Borer *Melanophila fulvoguttata*	Hemlock	Dummerston Vernon	Occasionally seen in stands with hemlock looper damage.
Ips avulsus	White Pine	Fairlee	Attacking the smooth-barked portions of trees being killed by *Ips pini*.
Pine Engraver *Ips pini*	Red Pine White Pine Scots Pine	Essex Fairlee Middletown Springs Townshend Brattleboro	Associated with mortality on a wet site, with mortality of overstocked trees and with wounding.
Red Turpentine Beetle *Dendroctonus valens*	Red Pine White Pine	Middletown Springs Norwich	Associated with pine mortality on wet sites.

ROOT INSECTS

INSECT	HOST(S)	LOCALITY	REMARKS
Broad Necked Root Borer *Prionus laticollis*			Not observed.
Conifer Swift Moth *Korscheltellus gracilis*	Red Spruce Balsam Fir	Northern Vermont	Associated with feeding wounds at high elevations.
Wireworms *Elateridae*			Not observed.
June Beetle *Phyllophaga spp.*			Not observed.

FOREST DISEASES

Stem Diseases

Beech Bark Disease, caused by *Cryptococcus fagisuga* and *Nectria coccinea* var. *faginata*, continues to cause scattered dieback and chlorosis. Symptoms were less noticeable than last year, with 600 acres mapped compared to 1,690 acres in 1990 (Table 15). This reflects a decrease in the Northern Kingdom and an increase in the Champlain Valley.

Table 15. Mapped acres of 1991 beech decline and mortality due to beech bark disease.

County	Acres
Addison	200
Essex	100
Franklin	200
Orleans	200
Total	600

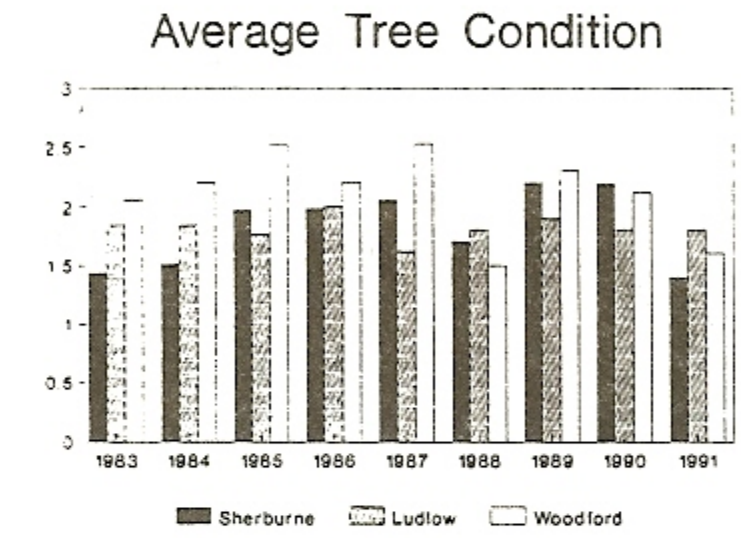
In monitoring plots, *Nectria* fruiting has increased, although crown conditions have generally improved (Figure 11). Good growing conditions in 1989 and 1990 may be responsible for the trees' ability to remain healthy in spite of increased disease incidence.

Butternut Canker, caused by *Sirococcus clavigignenta-juglandacearum*, is frequently found throughout the range of butternut. It was discovered causing dieback and mortality of butternut in several new locations, including Orange, Lamoille, and Chittenden Counties. This disease has resulted in more than 50 percent tree mortality in a Berlin stand that was first observed as infected in 1986. Renewed interest in butternut canker is expected to lead to more intensive surveys in 1992 and beyond.

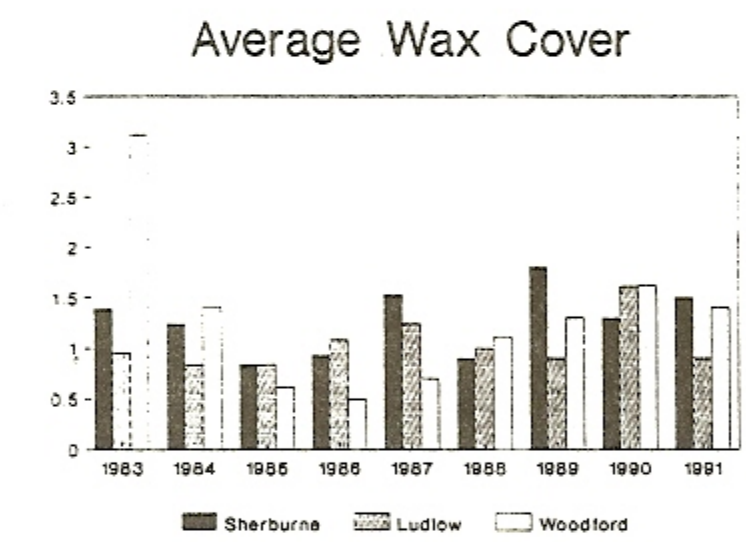
Caliciopsis Canker, caused by *Caliciopsis pinea*, is widespread on overstocked or off-site trees. Twelve pole-sized trees in Springfield were dissected to determine whether Caliciopsis canker may affect the future value of the tree. The analysis is in progress. Generally, cankers did not kill the bark to the cambium. This suggests that defects will remain superficial.

Pinewood Nematode, *Bursaphelenchus xylophilus*, research continued at the University of Vermont. Pine wood nematodes in white pine wood chips did not survive 40°C temperatures when incubated up to 130 days, but thrived at 30°C. When infested wood chips were mixed with soil, nematodes survived but populations remained static. Pinewood nematode killed some seedlings treated with infested chips, with Scots pine being more susceptible than red or white pines. Dispersal by *Monochamus notatus* and *M. scotellatus* was also studied.

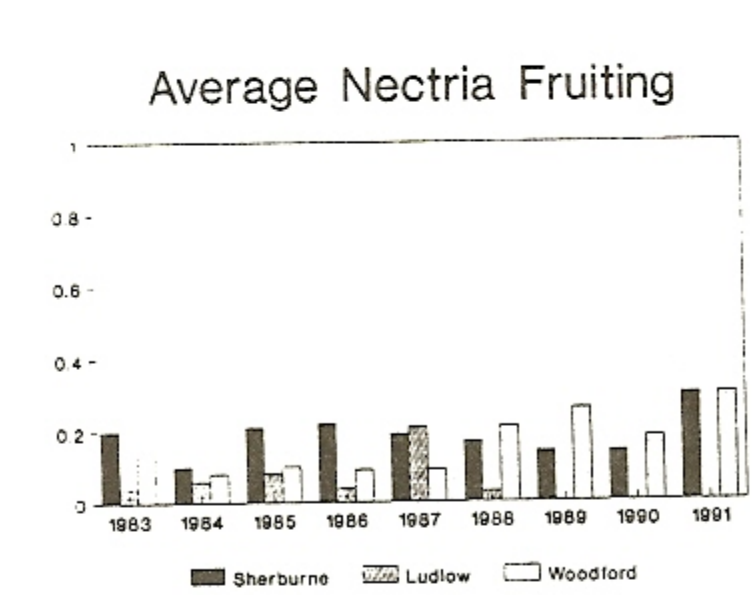
Figure 11. Summary of beech bark disease monitoring plots 1983-1991.



1 Good,2 Fair,3 Poor,4 Dead



0 None,1 Trace,2 Light,3 Mod,4 Heavy



0 None,1 Sparse,2 Moderate

Scleroderris Canker, caused by *Ascocalyx abietina*, was not found in any new locations for the fifth consecutive year. A total of 56 Christmas tree plantations within the quarantine zone (Figure 12), and 78 red and Scots pine plantations in seven towns bordering the quarantine area, were surveyed for the presence of the disease, all with negative results. The disease does not appear to be spreading outside of previously-infected plantations, and within infested plantations the rate of spread remains slow.

The total number of plantations in the state known to be infected remains at 124, consisting of 106 red pine and 18 Scots pine plantations. This represents 842 and 150 acres respectively, for a total of 992 acres infected. Another six plantations were infected at one time, but have since had the disease eradicated or the trees cut. Some recent infection can be found within most of the quarantine zone.

OTHER STEM DISEASES

DISEASE	HOST(S)	LOCALITY	REMARKS
Annual Canker *Fusarium sp.*	Sugar Maple	Windham County	Stable.
Ash Yellows *Mycoplasma-like organism*	White Ash	Southern Vermont Champlain Valley	Generally stable. Causing dieback and mortality of pole size and smaller trees in St. Albans where witches-brooms are present.
Balsam Fir Twig Abnormality *Sclerotinia kerneri*	Balsam Fir		Not observed.
Beech Bark Disease *Cryptococcus fagisuga* and *Nectria coccinea* var. *faginata*			See narrative.
Black Knot *Dibotryon morbosum*	Cherry	Widespread	Remains common.
Butternut Canker *Sirococcus clavigignenta-juglandacearum*			See narrative.

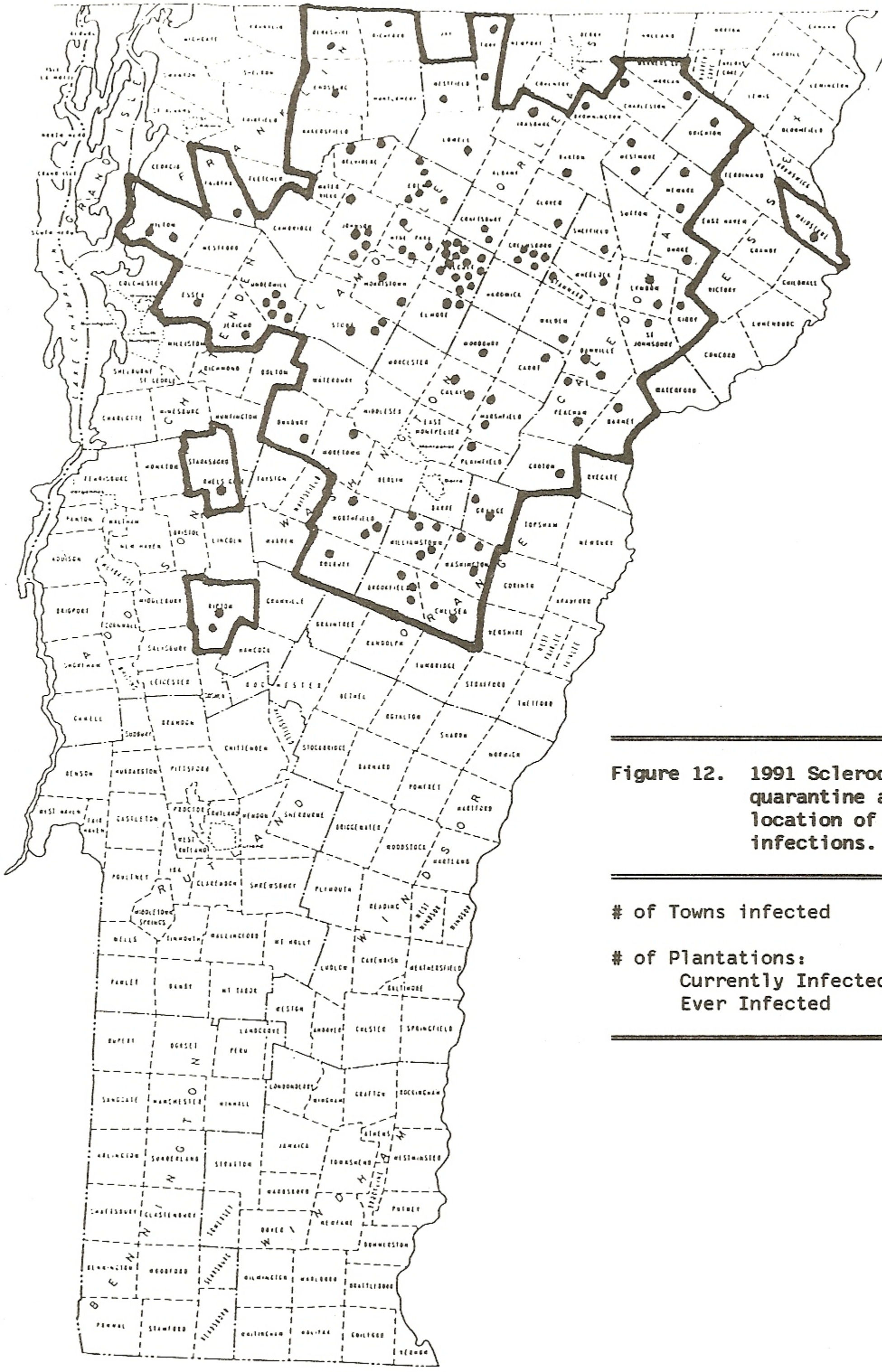


Figure 12. 1991 Scleroderris canker quarantine area and location of positive infections.

# of Towns infected	=	64
# of Plantations:		
Currently Infected	=	124
Ever Infected	=	130

OTHER STEM DISEASES

DISEASE	HOST(S)	LOCALITY	REMARKS
Caliciopsis Canker *Caliciopsis pinea*			See narrative.
Chestnut Blight *Cryphonectria parasitica*	Chestnut	Colchester Monkton	Several roadside trees affected.
Cytospora Canker *Leucostoma kunzei*	Blue Spruce	Widespread	Common on ornamentals. Incidence lower than normal in southern Vermont.
Diplodia Shoot Blight *Diplodia pinea (Sphaeropsis pinea)*	Red Pine Scots Pine	Addison County Shaftsbury	Throughout county. On dying trees in heavily-used area.
Dutch Elm Disease *Ceratocystis ulmi*	American Elm	Throughout	Mortality, dieback and new infection commonly observed in northern Vermont. Stable in southern Vermont.
Eastern Dwarf Mistletoe *Arceuthobium pusillum*			Not observed.
Fir Broom Rust *Melampsorella caryophyllacearum*	Balsam Fir	Plymouth	Light damage to forest trees.
Fireblight *Erwinia amylovora*	Hawthorn Apple	Rockingham Lyndon	Ornamental. Down from 1990.
Hypoxylon Canker *Hypoxylon pruinatum*	Quaking Aspen	Throughout	Remains common. Trees frequently break off at canker during heavy snow and ice storms.
Maple Canker *Steganosporium sp.* *Nectria sp.*	Sugar Maple	Westminster	Associated with lower branch death of sugarbush trees.

OTHER STEM DISEASES

DISEASE	HOST(S)	LOCALITY	REMARKS
Oak Wilt *Ceratocystis fagacearum*			No suspects seen by trained observers during aerial flights.
Phomopsis Canker *Phomopsis arnoldiae*		Peacham Brighton	Affecting cedar hedges.
Phomopsis Gall *Phomopsis sp.*	Hickory	Springfield	Ornamentals.
Sapstreak *Ceratocystis coerulescens*	Sugar Maple	Whitingham Caledonia & Washington Counties	Stained roots associated with injuries from grazing and equipment. Occasionally observed.
Scleroderris Canker *Asocalyx abietina*			Not observed.
Sirococcus Shoot Blight *Sirococcus strobilinus*			Not observed.
Smooth Patch *Dendrothele macrodens*	White Ash	Throughout	Particularly abundant in sites near water.
Verticillium Wilt *Verticillium albo-atrum* or *V. dahliae*			Not observed.
White Pine Blister Rust *Cronartium ribicola*	White Pine	Throughout	Disease incidence on Christmas trees down. In northern Vermont survey, 66 acres infested compared to 291 acres in 199Ø. Stable elsewhere. Observed causing significant mortality and top dieback in a sawlog sized stand, and heavy damage in several young plantations.

OTHER STEM DISEASES

DISEASE	HOST(S)	LOCALITY	REMARKS
Woodgate Gall Rust *Endocronartium harknessii*	Scots Pine	Throughout	Occasional heavy damage to ornamentals. Damage to Christmas trees generally decreased. In northern Vermont survey, 86 acres of light-moderate damage compared to 200 acres of mostly moderate damage in 1990.

Foliage Diseases

A **Needlecast of White Pine**, caused by an unknown fungus but resembling symptoms of *Mycosphaerella dearnessii*, was responsible for widely scattered symptoms on white pine in southern Vermont in early June. Current growth was green, while last year's growth, on lower branches, was yellow. Often, affected trees were growing on sites with poor air drainage, or near water. Symptomatic needles dropped within a few weeks. No fungus structures were found on cast needles early in the season. Fruiting bodies produced on cast needles in the fall are being identified.

OTHER FOLIAGE DISEASES

DISEASE	HOST(S)	LOCALITY	REMARKS
Anthracnose *Gloeosporium spp.*	Butternut Sugar Maple	Widely scattered	Occasionally observed. Much less common than 199Ø.
Apple Scab *Venturia inequalis*	Apples	Throughout	Common, not as heavy as in 199Ø.
Cedar-Apple Rust *Gymnosporangium juniperi-virginianae*	Eastern Red Cedar Apple	Addison & Chittenden Counties	Light damage.
Cyclaneusma Needlecast (formerly Naemacyclus) *Cyclaneusma minus*	Scots Pine	Throughout	Remains common but decreasing. Reported present in 1Ø3 acres of Christmas trees surveyed, compared to 427 acres in 199Ø.
Fir-Fern Rust *Uredinopsis mirabilis*	Balsam Fir	Widely scattered	Very light damage in southern Vermont. Increasing in northern Vermont. Reported causing light-moderate needle loss in 8 surveyed plantations, comprising 56 acres.
Horsechestnut Leaf Blotch *Guignardia aesculi*	Horsechestnut	Rutland Weathersfield	Ornamentals.
Lophodermium Needlecast *Lophodermium seditiosum*	Scots Pine	Widely scattered	Remains less common than Cyclaneusma. At levels similar to 199Ø in 4 surveyed Christmas tree plantations (19 acres).

OTHER FOLIAGE DISEASES

DISEASE	HOST(S)	LOCALITY	REMARKS
Peach Leaf Curl *Taphrina deformans*	Peach	Springfield	Ornamentals.
Phyllosticta Leafspot *Phyllosticta sp.*	Red Maple	Bennington County Guilford	Ornamentals and forest trees.
Pine Needle Rust *Coleosporium asterum*	Red Pine	Bennington	Single tree.
Poplar Leaf Bronzing Virus or virus-like casual agent	Balsam Poplar	Caledonia, Orleans & Essex Counties	Remains common.
Rhabdocline Needlecast *Rhabdocline pseudotsugae*	Douglas Fir	Widely scattered	Generally light damage to Christmas trees. Heavy damage to occasional ornamentals.
Rhizosphaera Needlecast *Rhizosphaera kalkhoffi*	Blue Spruce	Widely scattered	Decrease since 199Ø. Generally light damage to occasional Christmas trees and ornamentals.
Sooty Mold *Perisporiaceae*	Balsam Fir	Ludlow Mt. Holly	Heavy in Christmas tree plantations following heavy balsam twig aphid damage.
Swiss Needlecast *Phaeocryptopus gaumanni*	Douglas Fir	Springfield Pittsford	Heavy damage to Christmas trees. Not detected in northern Vermont.
Tar Spot *Rhytisma acerinum*	Red Maple Silver Maple	Widely scattered	Less common than in 199Ø. Only light damage.

ROOT DISEASES

DISEASE	HOST(S)	LOCALITY	REMARKS
Annosus Root Rot *Heterobasidion annosum*	White Pine	Weathersfield	Causing butt rot and windthrow.
Shoestring Root Rot *Armillaria spp.*	Balsam Fir	Stannard	Killing about 5% of Christmas trees in a naturally established 2Ø acre site containing trees of many ages.
		Widely scattered	Common on stressed ornamental and forest trees.
Xylaria Root Rot *Xylaria sp.*			Not observed.

DIEBACKS, DECLINES, AND ENVIRONMENTAL DISEASES

Ash Dieback remains common, at stable levels, in the Champlain Valley and southern Vermont. Dieback is most obvious where the basal area of pole-sized white ash is substantial (30% or more). Ash yellows, a mycoplasma-like organism, continues to be a factor in these lower elevation sites, especially in sites that are abandoned farm lands.

Birch Decline and scattered mortality remains present in areas that have been noticeable in the past, but trees appear to be recovering. However, widespread birch defoliation, combined with dry summer weather, is expected to cause dieback in the future.

Drought conditions in June, which persisted throughout the summer, led to widespread symptoms, especially on trees growing under stressed conditions. Symptoms included leaf scorch, chlorosis, leaf curling, and leaf or fruit drop. Hardwood leaf symptoms were mapped on 63,300 acres throughout Vermont (Table 16, Figure 13). Sugar maple was the species most affected. Especially noticeable was Leaf Scorch on 55,600 acres in the Northeast Kingdom. In addition, hardwood chlorosis, mostly of maple, was detected on 7,100 acres in widely scattered locations. An additional 600 acres in the Northeast Kingdom had thin crowns as a result of drought-related leaf curling.

Table 16. Acres of drought-related symptoms on hardwoods mapped in 1991.

	Symptom			
County	Scorch	Chlorosis	Thin Crowns	Total Acres
Addison		1,100		1,100
Bennington		2,400		2,400
Caledonia	16,100	500	100	16,700
Chittenden		600		600
Essex	30,100	500	100	30,700
Franklin		400		400
Grand Isle		100		100
Lamoille		100		100
Orleans	8,400	1,100	400	9,900
Rutland		200		200
Washington	1,000			1,000
Windsor		100		100
Total	55,600	7,100	600	63,300

By the end of the summer, ornamental sugar maples with girdling roots, trees planted too deep, trees on wet sites, and wounded trees began to show substantial dieback. Additional symptoms are expected to show up in the next couple of years.

Fertilizer Injury to a balsam fir Christmas tree plantation in Sheffield resulted from placing handfuls of 15-15-15 in spots near trees. The same method used in 199Ø did not cause problems, but 1991 was a much drier year. Root kill beneath the fertilizer spots resulted in branch dieback to portions of tree crowns and, in some cases, entire crowns.

Frost Damage due to a late spring frost on 19-2Ø May killed mostly scattered new growth on balsam fir, and other Christmas trees, throughout much of northern Vermont. It also killed emerging leaves of sensitive hardwoods such as butternut, and to a lesser extent, white ash. Christmas tree damage was reported for 211 acres of balsam fir, 27 acres of white spruce, 1 acre of Scots pine, 5 acres of Douglas fir, for a total of 25Ø acres. Most of the heavy damage (1Ø5 acres) occurred in Orleans County.

Hailstones the size of golf balls caused some local defoliation in Shaftsbury.

Hemlock Mortality was occasionally observed on scattered locations in southern Vermont. Individual trees, often on shallow soils or roadside sites, died suddenly. Hemlock borer was associated with some dead trees.

Higrading in the past has led to general poor health of predominantly red maple stands on shallow sites in Glastonbury and mixed hardwood stands in Woodford. At the Woodford sites, past cutting and beech bark disease have led to a dense, large-sapling sized understory of susceptible beech.

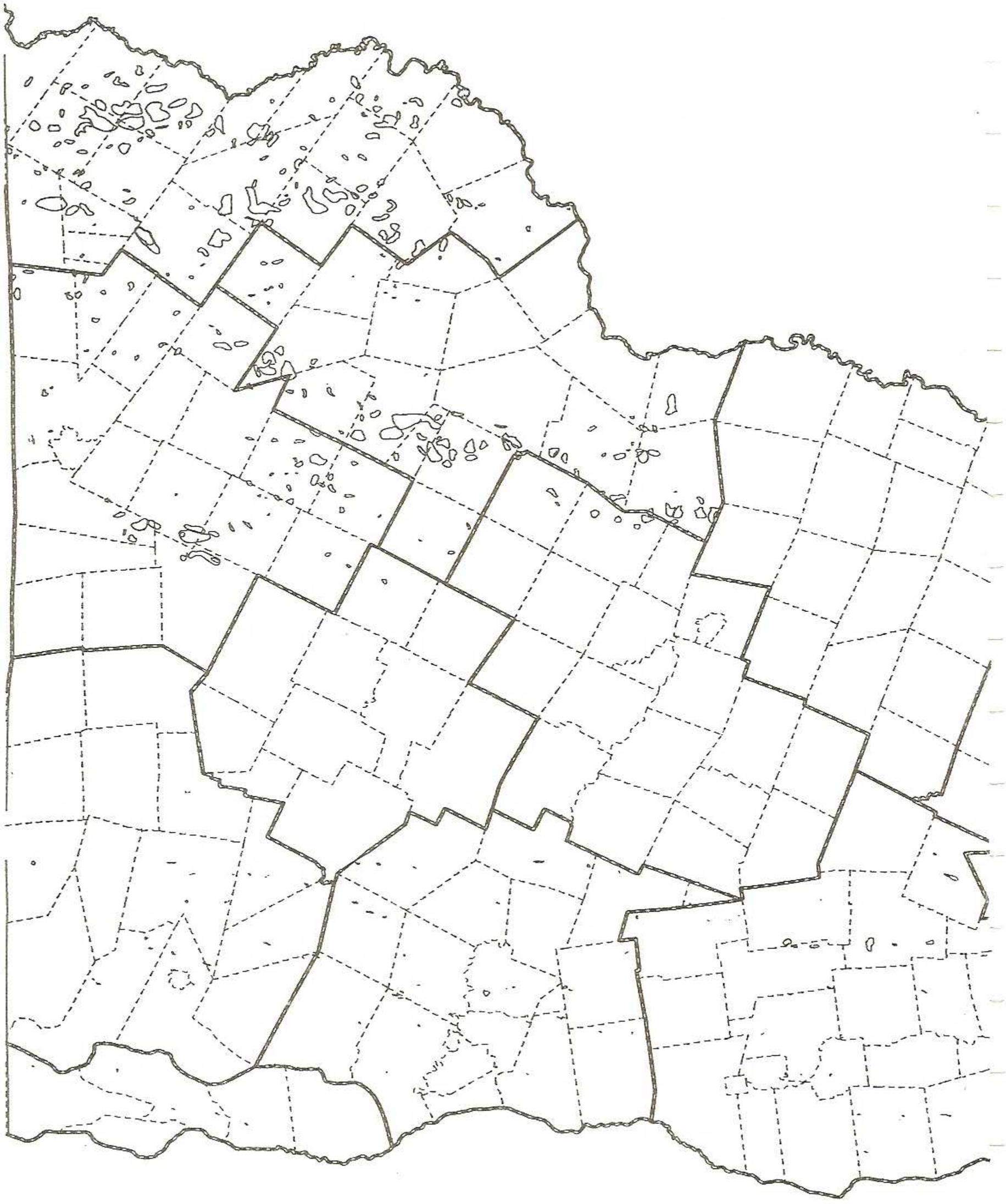
Ice Damage from a storm in November caused scattered damage at high elevations in Rutland County.

Improper Planting, exacerbated by dry summer conditions, was responsible for dieback on ornamental maples. Affected trees, many of which were 2Ø-4Ø years old, were planted too deep or had girdling roots. Planting too deep was also responsible for mortality of hemlocks and white pines.

Larch Decline associated with past outbreaks of the eastern larch beetle has largely subsided, although older dead trees are still noticeable. Only 19 acres of larch mortality was detected by aerial survey this year (Orleans County).

Lightning killed a large group of balsam fir Christmas trees in Weston.

Maple Decline and associated **Hardwood Decline**, was less noticeable than in previous years. Trees generally looked the best this year than they have in many years because of a vigorous flush of leaves in the spring. Excellent foliage density was recorded in most health monitoring plots. However, maple decline and hardwood decline remain visible in scattered locations, especially those that received past defoliation and where there has been hygrading in the past on poor sites. This year, 3,3ØØ acres of decline and mortality was mapped during aerial survey (Table 17, Figure 14). Dry conditions are expected to lead to some decline next year on poor sites, and where trees have been stressed.



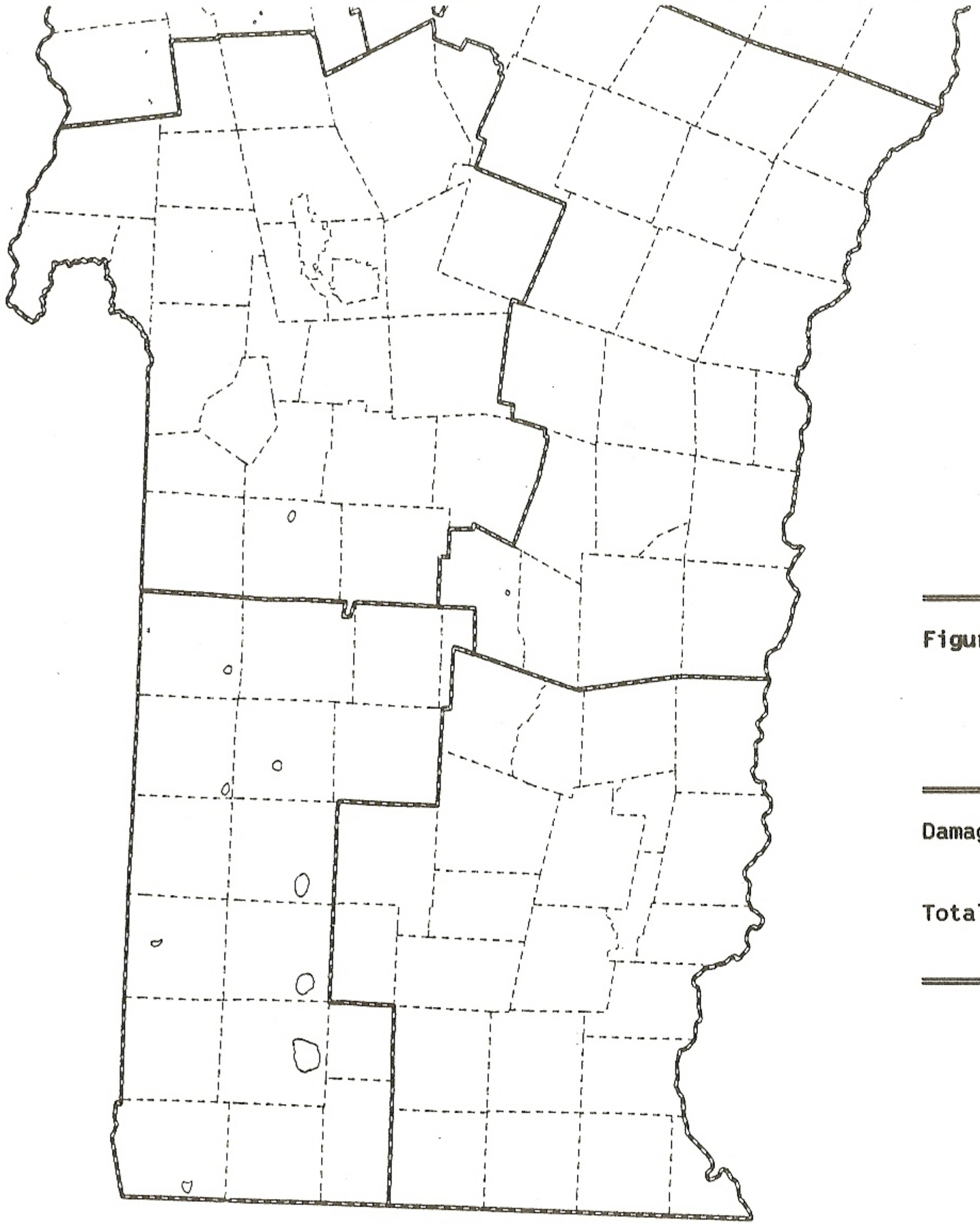


Figure 13. Scorch, chlorosis and thin crowns related to drought on hardwoods in 1991.

Damage area approximate location

Total damage mapped in 1991 = 63,300 acres

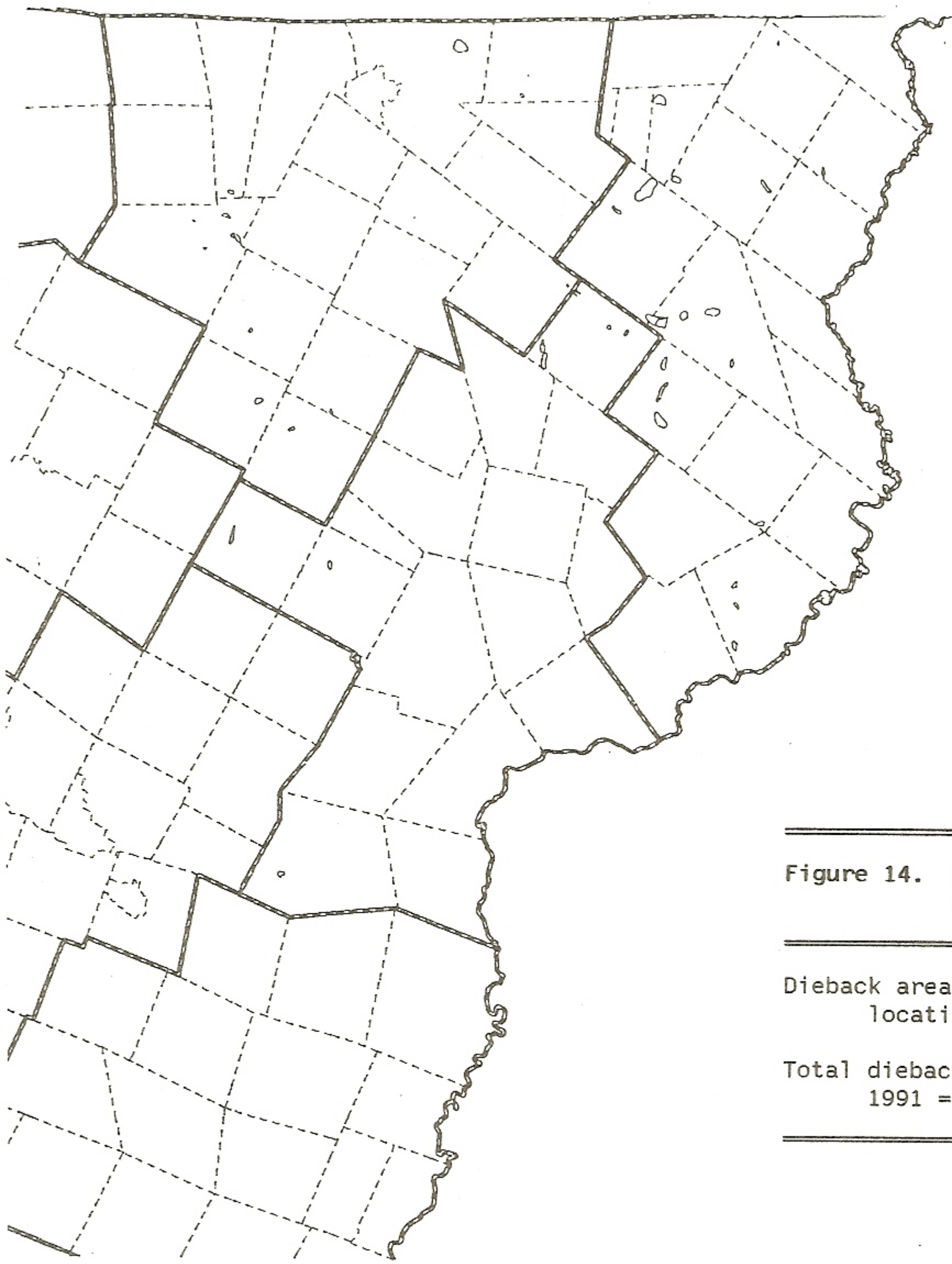


Figure 14. Hardwood decline mapped in 1991.

Dieback area approximate location

Total dieback mapped in 1991 = 3,300 acres

Table 17. Acres of hardwood dieback mapped in 1991.

Caledonia	200
Essex	2,800
Orleans	300
Total	3,300

Red Spruce Mortality remains visible in scattered locations, especially high-elevation sites, but no recent mortality was reported. In Essex County, 381 acres of high-elevation, dead spruce was mapped this year.

Wet Site conditions were responsible for mortality of white pine in Winhall and Norwich, red pines in Middletown Springs, red oaks in Brattleboro, and for chlorosis of white spruce Christmas trees in Pownal and Dummerston. High water levels in marginally wet sites during the wet growing seasons in 1989 and 1990 brought on the decline.

White Pine Browning was observed in southern Vermont in early June, when 900 acres were mapped during aerial surveys. The damage is thought to have been due to winter injury. The symptoms were different from the needlecast of white pine which showed up at the same time, but in the lower crowns.

White Pine Needle Blight, also called Semi-mature tissue needle blight, was visible on widely scattered trees in Lamoille, Windsor and Caledonia Counties. It was also responsible for unusually heavy damage to white pine Christmas trees within a four acre plantation in Williamstown and a five acre plantation in Brookfield (both in Orange County). The disease is attributed to weather at needle elongation, with a fungus or ozone playing a possible role. Symptomatic trees have variable tip burn within a fascicle of the current growth. This is the first very noticeable damage in four years.

Wind Damage resulted from localized down-drafts that blew down trees in several Franklin County and Grand Isle County locations. Damage was limited to areas three-to-five acres in size or less. Wind was also the apparent cause of the death of scattered, tender, elongated shoots of balsam fir Christmas trees in Walden and Bristol. The Maine Forest Service reported similar damage, attributing it to strong northwest winds from the passage of a cold front in late June.

Winter Injury was down compared to 1990. In the northern Vermont survey, 79 acres of light to moderate Christmas tree injury, mostly on Scots pine, were detected compared to 337 acres in 1990. Winter injury was responsible for occasional mortality of both recently planted and established ornamental conifer plantings.

Wounding, exacerbated by drought, led to widely scattered dieback on ornamental maples and oaks.

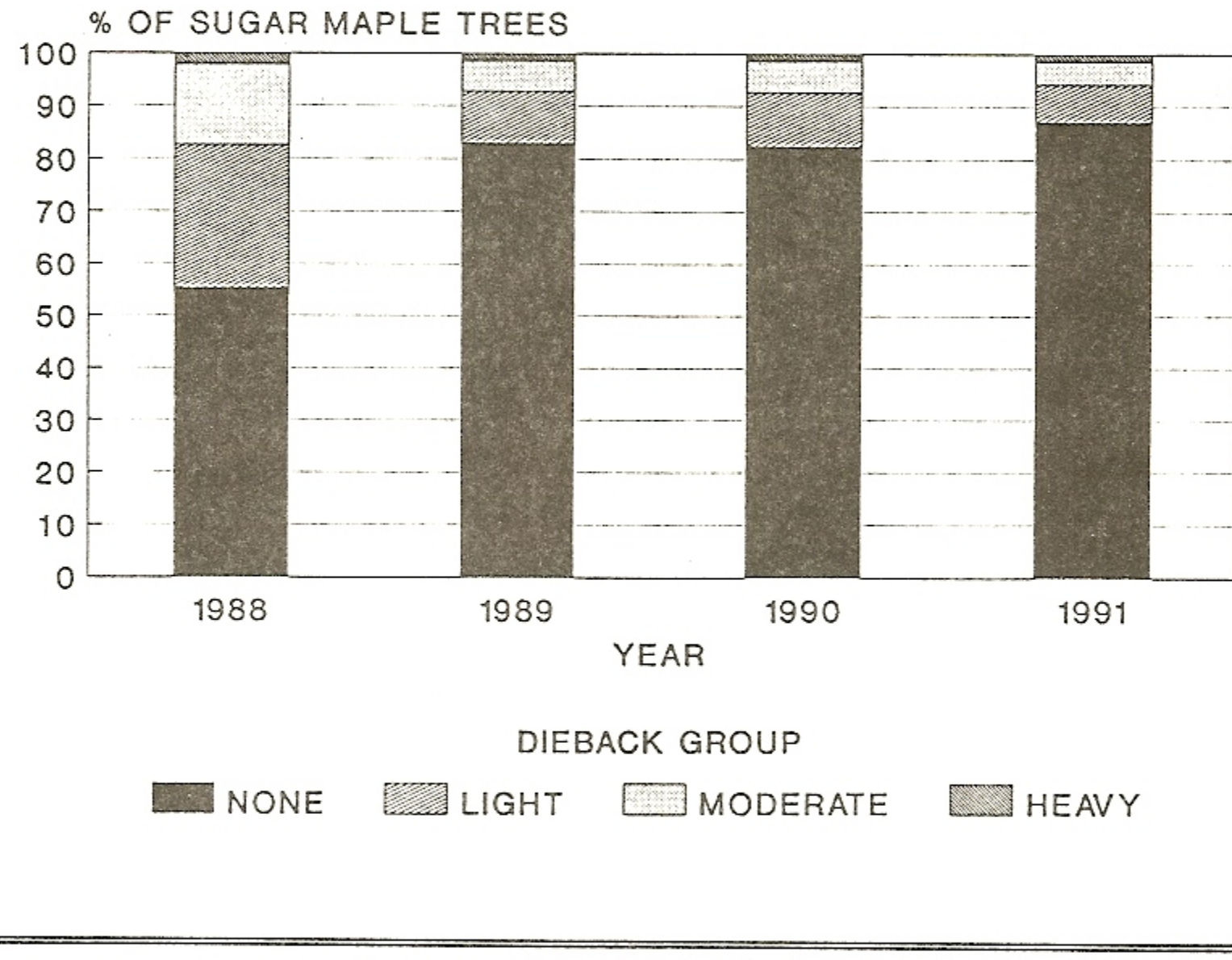
ANIMAL DAMAGE

ANIMAL	SPECIES DAMAGED	LOCALITY	REMARKS
Beaver	Many	Throughout	Populations continue to increase. Flooding damage is common, but remained stable in southern Vermont.
Deer	Many	Throughout	Generally scattered light damage. Locally heavy damage to sugar maple in Shelburne and stem damage to Christmas trees in Shaftsbury.
Grosbeaks			Not observed.
Moose	Mountain Ash	Lemington	Heavy damage reported on mountain tops.
Mouse			Not observed. Down from occasional heavy damage in 1990.
Porcupine	Many	Widely scattered	Increasing in Franklin, Chittenden, Addison and Caledonia Counties, but stable or decreasing elsewhere.
Sapsucker	White Birch Sugar Maple Norway Maple Hemlock Norway Spruce Scots Pine	Widespread	Remains common. Fewer complaints than in the past.
Squirrel	Maple Tubing	Peacham Hardwick Lunenburg Poultney	Heavy damage to maple tubing in these locations, but few complaints elsewhere.

FOREST HEALTH PROGRAMS

The **Northern American Maple Project** (NAMP) continued in 1991, with the 29 Vermont plots giving us information on the trends in sugar maple condition both in sugarbushes and in unmanaged forests. Overall, our sugar maples continued to show signs of improved health, with low dieback and dense foliage (Figure 15). Most trees being monitored have been improving since the beginning of the program in 1988. Reduced leaf injury from pear thrips and good early season growing conditions contributed to this year's tree health.

Figure 15. Percent of sugar maple trees in four dieback groups during surveys of North American Maple Project plots 1988-1991.



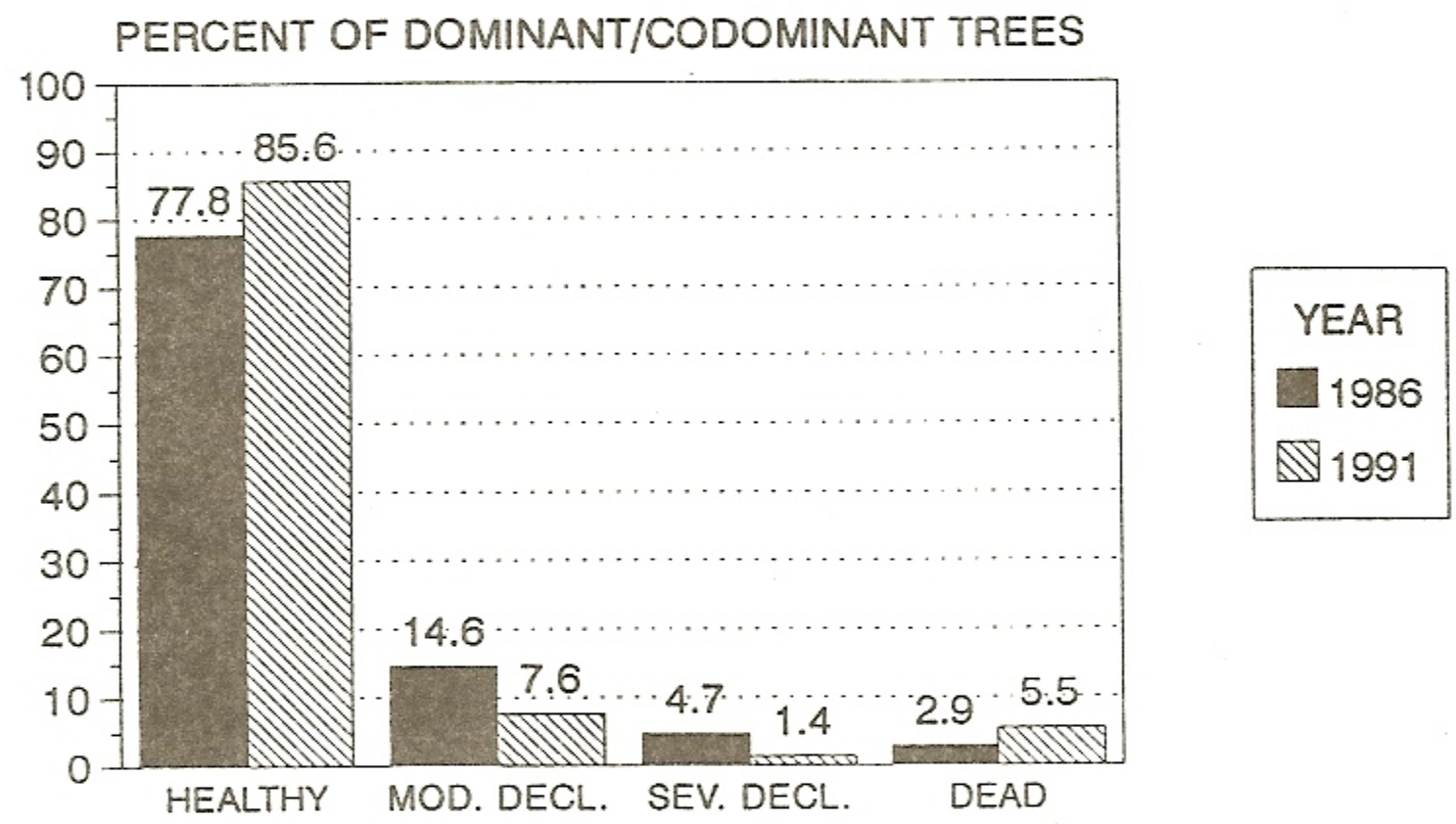
A comprehensive review of the first three years of this regional program will be published in the near future. In the review, the authors discuss effects from pear thrips injury, drought, forest tent caterpillar, air pollution and types of management used.

The **New England Forest Health Monitoring Program** (NEFHM) has expanded into a national program, the National Forest Health Monitoring Program (NFHM). In Vermont, we completed our second year of data collection in 1991, and will be publishing the results in a 1991 Vermont Forest Health Report. This program will provide information on overall forest condition of major species, presence of forest stressors (insect, disease, ozone, etc.), and trends over time.

The **Vermont Hardwood Tree Health Survey**, conducted in 1985 and 1986 was repeated in 199Ø and 1991. The survey is based on photointerpretation of 17Ø photos covering 612,ØØØ acres, and ground survey of 75 plots comprising 188 acres.

Preliminary results indicate that the majority of trees rated as severely declining (more than 5Ø% crown dieback) in 1986 have since died and the surviving trees have improved in crown condition during the past five years (Figure 16). More detailed data, including volume and species specific information, similar to what was in the original report, as well as trend information, will be published in a report expected to be completed in June, 1992.

Figure 16. Percent of dominant/codominant trees in four crown condition classes during surveys of Vermont hardwood stands in 1986 and 1991.[1]



1. Healthy = Ø-1Ø%, Mod. Decl. = 11-5Ø%, Sev. Dec. = 5Ø% + dead crown, Dead = all standing dead except snags.

The **Vermont Monitoring Cooperative**, an intensive forest monitoring and research program, implemented numerous activities in 1991. New wildlife surveys were initiated to establish a base line for presence and abundance of insect, bird, amphibian and aquatic invertebrate species. Additional tree health information was gathered, coupling this with data collected on air quality, weather and other potential stressors. Other vegetation surveys were conducted to compliment tree data. Combined data is meant to provide a more thorough picture of the forest ecosystem, how it is changing with time, and how different stressors may be affecting the health and productivity of the forest. The first annual Vermont Monitoring Cooperative report will present specific results, and will be forthcoming in the near future.

NOTES