FOREST INSECT AND DISEASE CONDITIONS IN VERMONT

CALENDAR YEAR 1989

AGENCY OF
NATURAL RESOURCES

DEPARTMENT OF FORESTS,
PARKS, AND RECREATION

WATERBURY, VERMONT 05676

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FOREST INSECT AND DISEASE

CONDITIONS IN VERMONT

CALENDAR YEAR 1989

Prepared by

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AGENCY OF NATURAL RESOURCES

DEPARTMENT OF FORESTS, PARKS AND RECREATION

Division of Forestry

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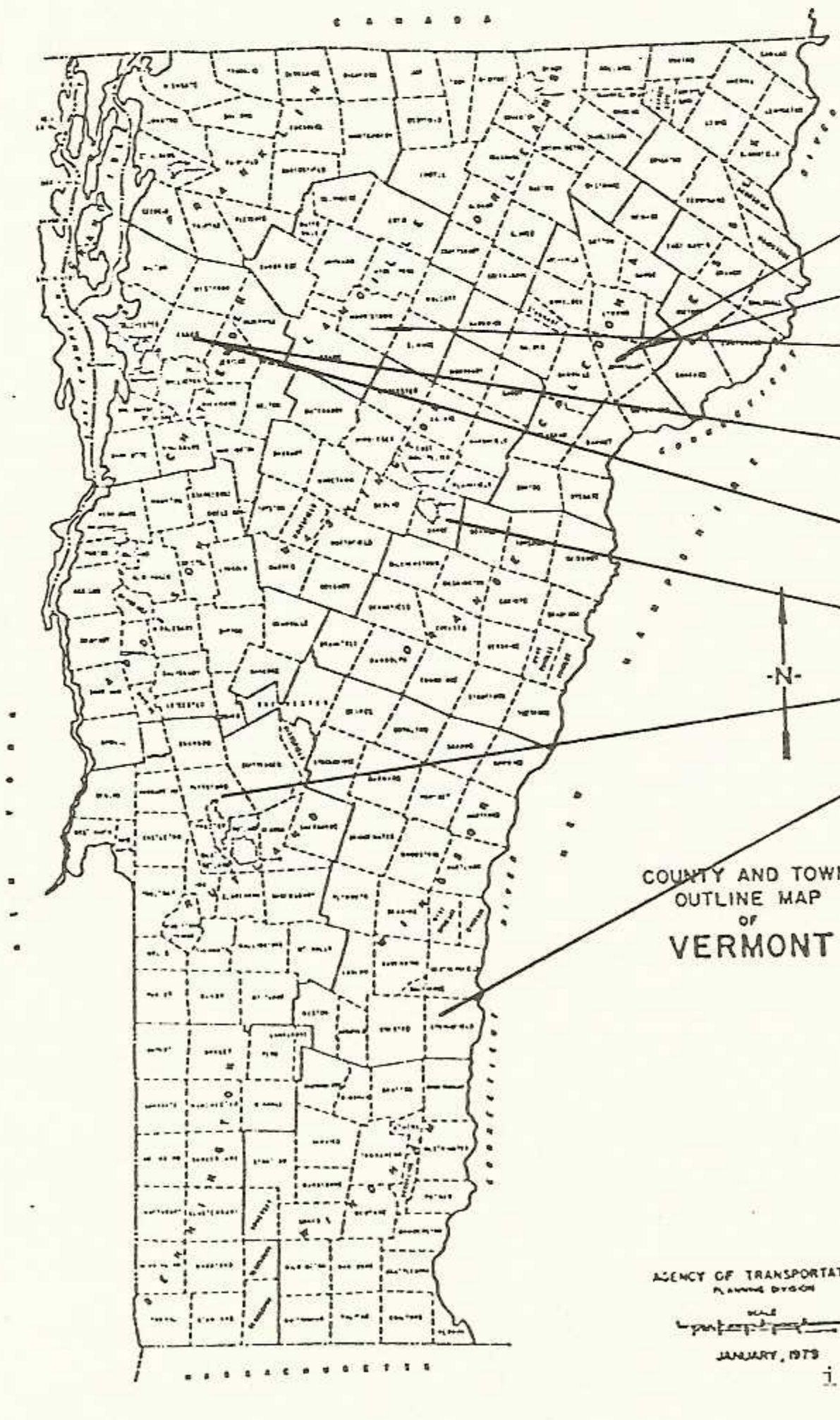

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VERMONT

INSECT AND DISEASE HIGHLIGHTS
1989

Birch Leaf Miner caused widespread moderate to heavy defoliation of grey and paper birch. 2,500 acres of damage were mapped in the Champlain Valley.

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

Gypsy Moth populations exploded, with 21,510 acres defoliated, mostly in the Champlain Valley. An epizootic of the fungus Entomophaga maimaiga affected populations in southern Vermont. Egg mass counts indicate that populations will remain at outbreak levels in 1990.

Maple Leaf Cutter increased noticeably throughout, with occasional moderate damage to sugar maple.

Saddled Prominent populations continued to increase with 280 acres of heavy defoliation in Windsor County. Feeding activity was noticeable throughout.

Spruce Budworm populations continued at extremely low levels.

Aphids (Periphyllus sp.) on sugar maple buds and early foliage were much less common than 1988.

Balsam Gall Midge increased significantly in plantations throughout the state. Although damage remains light, the problem may increase next year.

Balsam Twig Aphid was widespread, causing occasional heavy damage. Lower populations are expected in 1990.

Hemlock Woolly Adelgid was not detected during a survey covering the four southern counties.

Oystershell Scale populations decreased but beech dieback, associated with previous infestations, was more noticeable.

Pear Thrips damage dropped substantially, with only 3,170 acres mapped, compared to 469,000 acres in 1988. Most of the noticeable injury was in northern Vermont. The low damage is attributed to rapid budbreak, frozen soil, and lower populations in the southern counties. The white halo fungus was found killing thrips in soil throughout the state.

Beech Bark Disease remains steady at low levels in monitoring plots, although trees white with scale were observed in scattered locations.

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

Anthracnose was widespread on maple leaves following rainy periods in June and August. Damage was mapped on 95,430 acres.

Birch Decline continues to be noticeable in scattered locations, particularly at upper elevations. This may be associated with repeated defoliation by birch leaf miner.

Drought conditions in 1988, and lack of snow cover, contributed to widespread mortality and winterburn in recently planted conifers.

Larch Decline continues in some areas, but is mostly limited to scattered individuals.

Maple Chlorosis was detected on 103,390 acres in north-central and northeastern Vermont, associated with a variety of insects, diseases and poor site conditions.

Maple Decline continues to be of concern, although, in much of the state, above average rainfall contributed to healthy foliage. Some dieback, associated with the 1988 drought, was observed.

VERMONT

1989 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 i) or your county forester.

Sugar Maple - the general health of maples was better than usual early in the season, when ample rainfall led to healthy green foliage. Fall root starch levels were generally higher than 1987 or 1988.

By mid-summer, foliage appeared off-color over a large area in north-central and northeastern Vermont. This was mapped on over 100,000 acres. Although a variety of insects and diseases were responsible, symptoms were most noticeable in areas of past forest tent caterpillar defoliation, or frost damage, and on shallow sites, which were vulnerable to dry conditions in 1988. Trees which have not fully recovered from past stresses should not be disturbed.

The most widespread damage to maple in 1989 was caused by anthracnose. The anthracnose fungus is always present in maple woodlands. Damage becomes noticeable following periods of wet weather, particularly where topography or stand structure allow moisture to accumulate. Some defoliation occurred in early summer. Refoliation was rapid, thanks to adequate moisture. Tree impact was probably not severe. More widespread damage, which occurred later, is unlikely to have caused much stress. However, damaged areas should be monitored for additional defoliation in 1990, particularly if the season is rainy.

Forest tent caterpillar populations did not build as expected. Saddled prominent did increase in 1989, leading to isolated areas of heavy defoliation. Where saddled prominent has been a problem in the past, and where management activities are planned or have been recently completed, stands should be inspected for this insect.

Thanks to weather conditions, and low populations in some areas, pear thrips damage was way down from 1988. Although soil sampling results will be available before spring, it will be difficult to predict defoliation for next year because there is no "track record" for this insect.

Limited starch testing suggests that stands stressed by previous defoliations have recovered. Additional research on tree impact is being initiated by the University of Pennsylvania. In the meantime, a Landowner and Sugarmaker Guide for Use in 1989-90 is available which gives guidelines for managing stands affected by thrips.

Birch - Dieback continues in scattered, upper-elevation locations where repeated defoliation by birch leaf miner has occurred. Thinning is not recommended in these stands because stressed birches are particularly vulnerable to "thinning shock".

Beech - Twig dieback in northern Vermont may be the result of past infestation by oystershell scale. Elsewhere, favor beech trees that are resistant to beech bark disease. They are the ones that have "clean" stems when their neighbors are scarred, or whitened with scale.

Oak - Although disease, favored by wet weather, killed many gypsy moth caterpillars, many more survived to lay eggs throughout the state. Many oak stands have already been defoliated, or will be soon. Quarantine regulations require that logs being shipped to non-infested areas be inspected for gypsy moth egg masses.

Although most trees can survive several defoliations, some dieback and growth loss are likely. The most vulnerable trees are in stands where thinnings have been recently completed. Egg mass counts can help predict where defoliation will occur. If defoliation is expected, and tree health is at risk, it may be desirable to protect the stand by aerial spraying. Contact the Division of Forestry for more information.

Spruce-Fir - Although spruce budworm populations remain very low, this is still the ideal time to prevent losses in the future. Information developed by the Spruce Budworm Demonstration Project is available to help improve stand resistance to the next outbreak.

Guidelines will be available soon for preventing losses from root rot where stagnant trees are growing on secondary sites.

White Pine - Diseases causing resin flow on pine stems continue to cause confusion. Suspect white pine blister rust where heavy resin flow comes from a single whorl or branch stub. Suspect red rot where lighter pitch flow comes from many knots or stubs. Suspect caliciopsis canker if pitching is coming from the internodes. The latter two are most common in stands with a history of stagnation.

Hemlock - A systematic survey failed to find hemlock woolly adelgid in Vermont, so our hemlock products can be shipped to other non-infested areas. The insect has been found as far north as Springfield, Massachusetts.

INTRODUCTION

The information in this report is based 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.

Aerial surveys were flown in mid-June to early July to detect pear thrips damage and mid-July to early August to detect gypsy moth defoliation and anthracnose. U. S. Forest Service personnel flew over the Green Mountain National Forest.

Diagnostic assistance was provided by the University of Vermont, Vermont Department of Agriculture, the U. S. Forest Service, Penn State University, the University of Massachusetts, Cornell University, and the Boyce Thompson Institute.

WEATHER SUMMARY

1989 started out with a serious moisture deficit. In the winter of 1988-89 there was little or no snow cover. Temperatures were generally average or above average. However, soil was frozen at least 6" deep throughout southern Vermont in the woods, and up to 6' deep in open land.

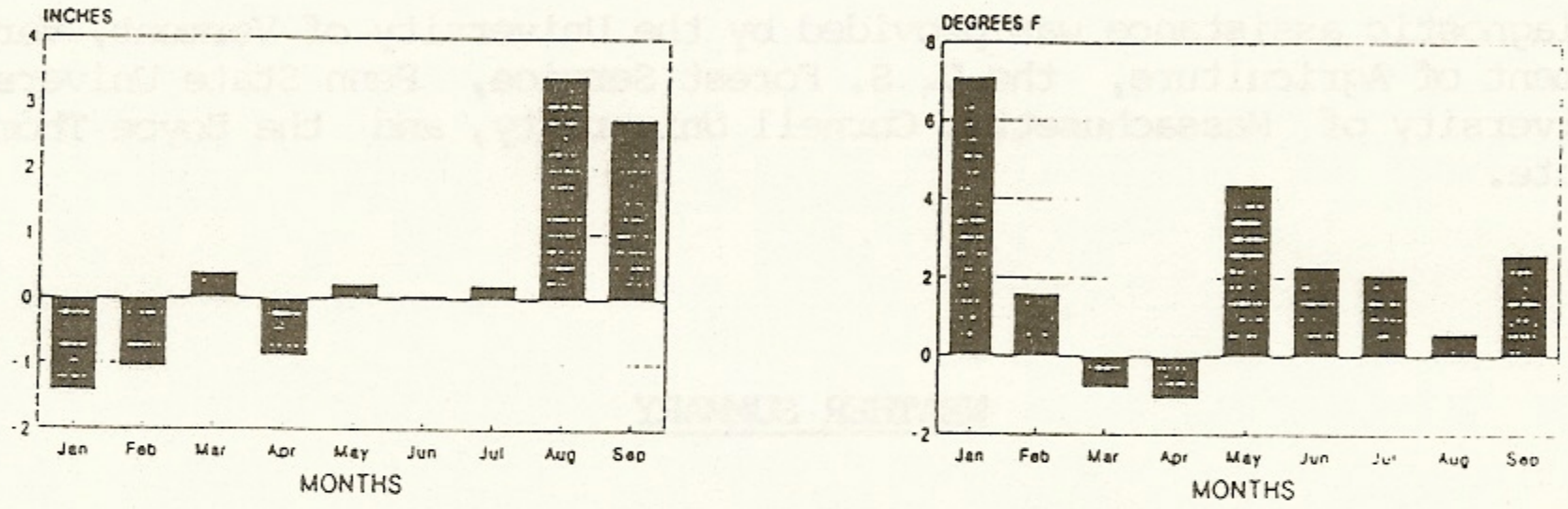
Spring began normally, and progressed quickly. The growing season was generally warm with above average precipitation, bringing groundwater levels back to normal. Foliage was generally lush; refoliation was unusually quick in defoliated areas. After May it turned dry in much of the northern Champlain Valley area, but the rest of the region averaged above normal for precipitation. Periods of rain in June and mid-August preceded the widespread development of fungus diseases.

High winds and heavy rain in late September knocked foliage off early at high elevations, but, elsewhere, autumn foliage was colorful and persisted through much of October.

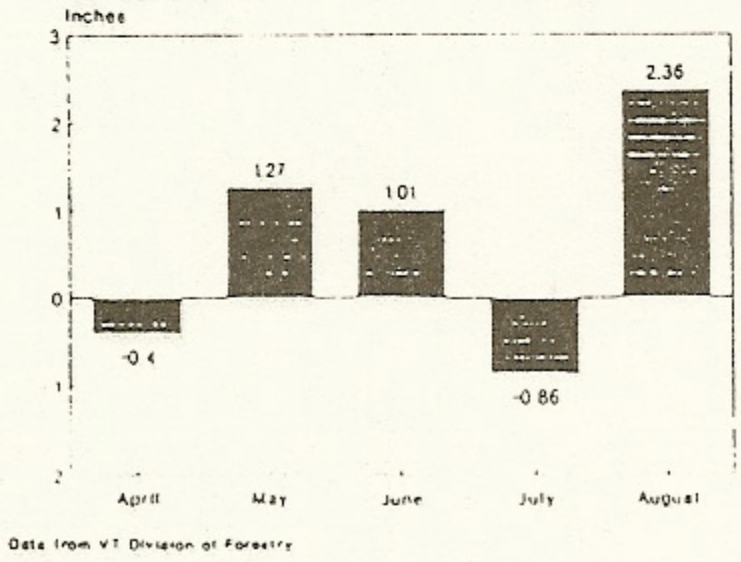
Weather for the season is summarized in Figure 1. Phenology observations are summarized in Table 1.

Figure 1. 1989 Weather Summary.

A. Burlington International Airport: Data from NOAA Local Climatological Data: Monthly Summary.



B. North Central Vermont: Data from VT Division of Forestry weather stations in Wolcott, Barre, Randolph, and Fairlee.



C. North Springfield Dam: Data from U.S. Army Corps of Engineers.

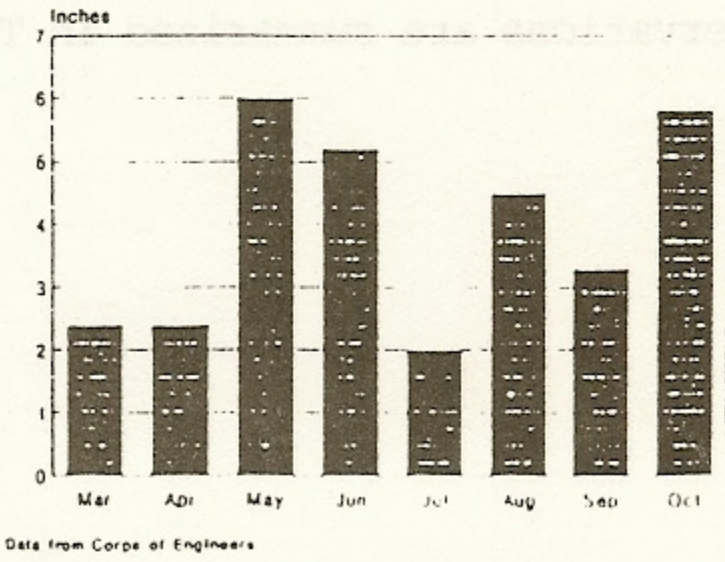


Table 1. 1989 Growing Degree Days and Observations of Phenological Development.

Week Ending	Growing Degree Days* Burlington 1989	(Normal)	Albany 1989	(Normal)	Phenology** Sugar Maple	Other Plants: Budswell	Leaves	Flowers	Misc.
4/19	45					Red Maple		Silver Maple Popple	
4/16	48				Budswell				
4/23	65							Red Maple Elm	Thrips
4/30	89		161		First leaves		Rubus Trout Lily Trillium	Hepatica Coltsfoot Violet	Eastern Tent Caterpillar Nest
5/7	135		210		Buds still present	Spruce	Larch Red Maple	Shadbush Spring Beauty	
5/14	189		258		Leaves 1-2" Flowers	Red Oak White Ash	Cherry Willow Beech Ironwood	Birch Jack-in-the Pulpit	
5/21	314	(188)	380	(227)	Leaves full size	Hemlock	Red Oak Chesnut White Pine	Blueberry	Gypsy moth 2nd instar
5/28	396	(236)	466	(282)					
6/4	519	(326)	599	(380)					Green up complete

* 86/50 Calculations from UVM Extension Service Entomology and Plant Pathology News or based on NOAA Local Climatological Data.

** Observations from Connecticut River Valley south of White River Junction.

AIR POLLUTION SUMMARY

Provided by Richard L. Poirot; Air Quality Planner

Ozone has been identified as one of the most important air pollution stress factors which may cause or contribute to adverse effects on forest health. The current National Ambient Air Quality Standard for ozone (0.120 ppm for 1 hour) is intended to protect human health, but is clearly not adequate to protect sensitive vegetation from ozone damage, which can occur at concentrations well below the federal standard.

During the summer of 1989, the U. S. Forest Service documented visible symptoms of ozone damage on sensitive trees and other plants in Vermont's Lye Brook Wilderness Area. The Forest Service confirmed that ozone was responsible for the observed foliar damage by exposing ozone-sensitive plants to ambient air and ozone filtered air in adjacent open top chambers on nearby Mt. Equinox. The observed 1989 damage was less severe than that observed during the previous summer of 1988, which was the worst ozone season ever recorded in the northeastern U. S. (including Vermont, where for the first time, several exceedances [0.125 ppm] of the 1 hour National Ambient Air Quality Standard were recorded). Compared to 1988, peak short-term ozone concentrations in 1989 were much less frequent and less extreme, although long-term seasonal average exposures were only slightly different.

There are currently no universally accepted standardized methods for reporting ozone data in averaging times or other indices most relevant to forest health. The U. S. Forest Service has recently suggested that some adverse effects on individual leaves of sensitive species are likely to occur from any ozone exposure above natural background conditions, but that "significant" ecosystem damage is unlikely to occur if "growing season" average concentrations are below 0.035 ppm and short term (second highest hour) concentrations are below 0.075 ppm. Ozone data collected at sites in Southern and Northern Vermont during the past three summers by the State's Air Pollution Control Division are summarized in several different ways in the table below.

Vermont Ozone Data: April 1 through October 31, 1987-1989 (ppm).

	Year	Long-Term Seasonal Averages				Short-Term Maxima		
		4/1-10/31		5/1-8/31		Max.	2nd Max.	Hrs. ≥
		All	9AM-4PM	All	9AM-4PM	Hour	Hour	.080 ppm
Bennington	1987	.032	.041	.034	.045	.101	.100	44
	1988	.036	.048	.042	.056	.125	.125	196
	1989	.035	.045	.037	.048	.106	.101	40
Burlington	1987	.030	.039	.032	.041	.089	.089	22
	1988	.032	.040	.036	.046	.108	.106	75
Underhill	1989	.039	.043	.041	.045	.091	.090	16

FOREST INSECTS

Hardwood Defoliators

Birch Leaf Miner, Fenusa pusilla, caused widespread, moderate to heavy defoliation of gray and paper birch again this year in northern Vermont. 2,500 acres of defoliation were detected in Chittenden, Addison, Franklin, and Grand Isle Counties during the aerial survey (Map 1). Damage was present but not mapped in the other counties. Defoliation this year did not show up until late summer, apparently because the second generation of the insect did the most damage. Heavy rainfall earlier in the season may have contributed to the poor success of the first generation. Occasional twig dieback of paper birch was observed, but it was mostly light and scattered.

Forest Tent Caterpillar, Malacosoma disstria, populations continued to be very low this year. Fewer larvae were observed within sugar maple stands than in 1987 and moth catch in pheromone traps remained low (Table 2). The population increase observed in 1988 may have been a temporary one in response to the hot, dry weather.

Table 2. Average number of forest tent caterpillar moths caught in pheromone traps, 1988-1989.[1]

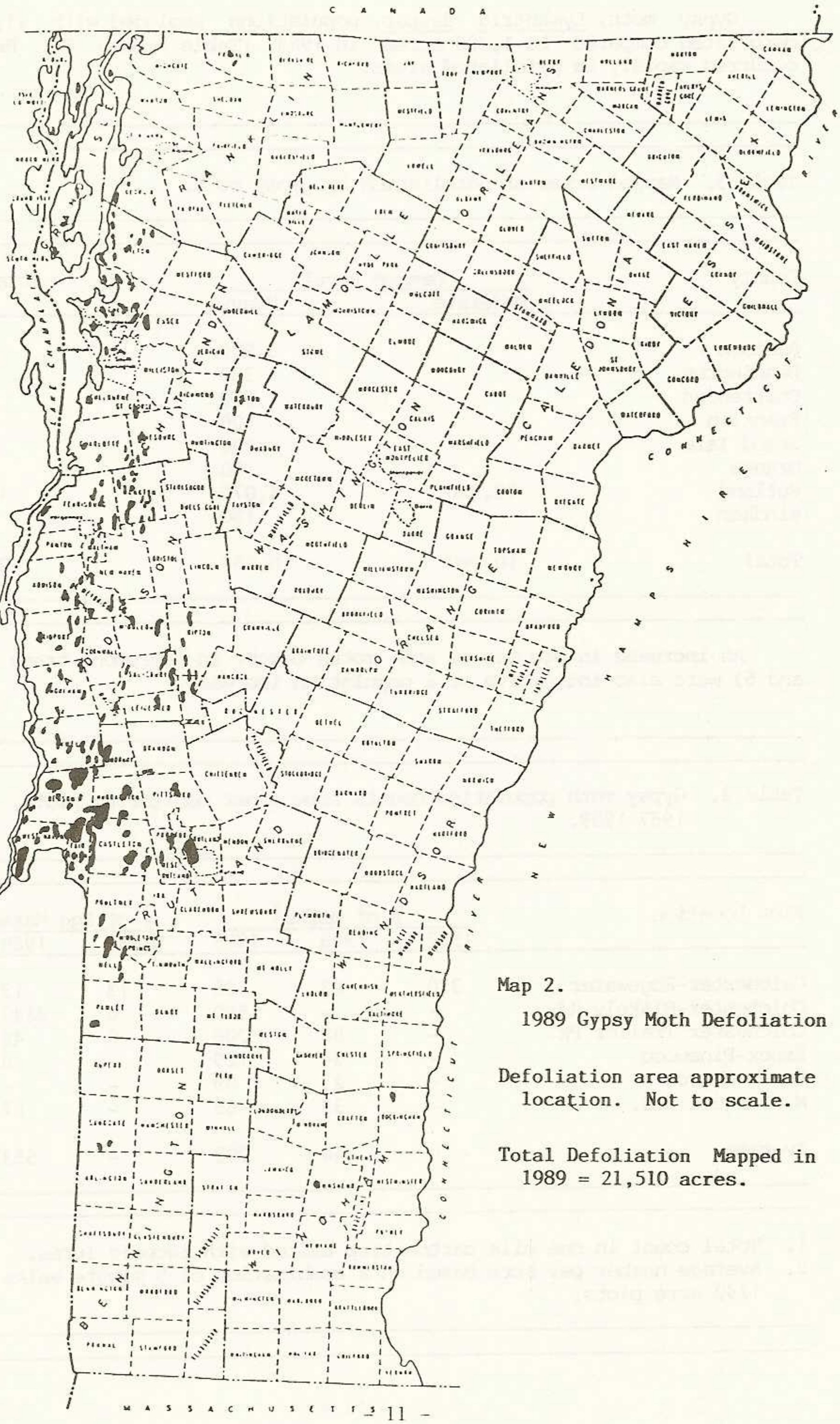
Location	1988		1989
	RPC-3 Lure	RPC-2 Lure	RPC-2 Lure
Roxbury	0.0	0.0	0.6
Waterbury	1.0	1.2	3.6
Waterville	2.2	0.2	2.2
Fairfield	0.2	-	0.0
Bethel	1.8	-	0.4
Sherburne	15.0	-	2.6
Average	5.0	0.5	1.6

1. Multi-pher traps baited with RPC-2 component lures in 1989 and 2 and 3 component lures in 1988; 5 traps per lure type for each location.

Map 1.
1989 Birch Leaf Miner
Defoliation

Defoliation area approximate location. Not to scale.

Total defoliation mapped in 1989 = 2,500 acres.



Map 2.

1989 Gypsy Moth Defoliation

Defoliation area approximate location. Not to scale.

Total Defoliation Mapped in 1989 = 21,510 acres.

Gypsy moth, Lymantria dispar, populations exploded with 21,510 acres defoliated compared to 1,300 acres in 1988 (Table 3, Map 2). Refoliation occurred rapidly in defoliated areas.

Table 3. Mapped acres of defoliation by gypsy moth.

County	Damage Level		Total Acres
	Moderate	Heavy	
Addison		3,900	3,900
Bennington		360	360
Chittenden		1,670	1,670
Franklin		100	100
Grand Isle		290	290
Orange		10	10
Rutland	10,960	4,070	15,030
Windham		150	150
Total	10,960	10,550	21,510

An increase in egg masses and moths caught in pheromone traps (Tables 4 and 5) were also indicative of a population increase.

Table 4. Gypsy moth population counts from other monitoring plots, 1987-1989.

Plot Location	# of Moths[1]			# of Egg Masses/Acre[2]		
	1987	1988	1989	1987	1988	1989
Colchester-Edgewater	370	23	168	13	13	1200
Colchester-Blakely Rd.	-	-	550	0	2640	4680
Colchester Trailer Pk.	-	88	200	0	44	4880
Essex-Pinewood	-	34	129	-	0	4000
Essex-Church	-	23	99	-	-	3760
Missisquoi H.S.	-	33	68	-	67	-
Average	-	40	202	-	553	3704

1. Total count in one milk carton trap baited with racemic lures.
2. Average number per acre based on a combination of 5 minute walks and 1/40 acre plots.

Table 5. Gypsy moth counts from focal area monitoring plots 1986-1989.

Plot Location	# of Moths[1]			# of Egg Masses[2,3]			
	1987	1988[4]	1989	1986	1987	1988	1989
Minards Pond	495	45	-	0	0	7	99
Fort Dummer	324	-	-	2	0	1	1
Handley Mountain	273	0	-	1	1	4	417
Perch Pond[5]	718	0	-	0	115	226	168
Rocky Pond	176	0	-	0	6	53	>400
Petersburg	359	8	-	1	0	1	296
Tate Hill	127	15	-	0	0	6	498
Brigham Hill[5]	193	24	61	10	37	28	74
Arrowhead	127	70	380	5	21	48	96
Middlesex	66	24	77	0	0	1	19
Sandbar	-	-	66	-	45	173	129
Average	286	16	173	2	20	46	200

1. Total count per one trap.
2. Total number in 15m diameter plots.
3. Average of 2 or 3 plots in 1986 and 2 plots in 1987 and 1988-1989.
4. 1988 traps are believed to have been defective.
5. Sprayed with Bt in 1988 as part of a cooperative research project.

Gypsy moth populations were affected by the fungus Entomophaga maimaiga, which was introduced to the Boston area from Japan in 1910-1911. Cadavers from throughout southern Vermont were confirmed as being infected with the fungus by the Boyce Thompson Institute and the University of Massachusetts and the University of Vermont (Map 3). Mortality data was taken at one site (Fort Dummer) where 44% of the larvae and pupae were killed.

Map 3. Confirmed distribution of Entomophaga maimaiga in gypsy moth larvae.

● Towns where E. maimaiga was recovered from cadavers

Larval mortality was observed even where populations were still at low levels. Wet conditions are thought to have been responsible for the epizootic. Most dead caterpillars were observed hanging from rear prolegs, and fell apart when handled. On some trees, dead larvae covered the lower 2-4' of the trunk.

In general, egg mass counts and observations indicate that populations will be at outbreak levels next year. Extensive defoliation is expected in 1990, unless the fungus disease and parasitism have substantially reduced egg viability.

Gypsy moth egg mass surveys were conducted during October in the following municipalities in response to concerns over a building gypsy moth outbreak: Burlington, South Burlington, Essex, Colchester, Winooski, Shelburne, Charlotte, Hinesburg, Leicester, and Salisbury. As a result of those surveys, heavy defoliation is predicted for about 8,500 forested residential areas, mostly in the greater Burlington area. At the request of the towns, an aerial suppression project is planned to treat these areas with Bacillus thuringiensis (B.t.) beginning in late May 1990. This project is expected to receieve matching funds from the U. S. Forest Service.

Maple Leaf Cutter, Paraclemensia acerifoliella, populations noticeably increased throughout, with light to occasionally moderate defoliation of sugar maple. Most of the damage was confined to lower crowns and understory trees. In some cases,this was combined with pear thrips damage, resulting in substantial overall leaf damage.

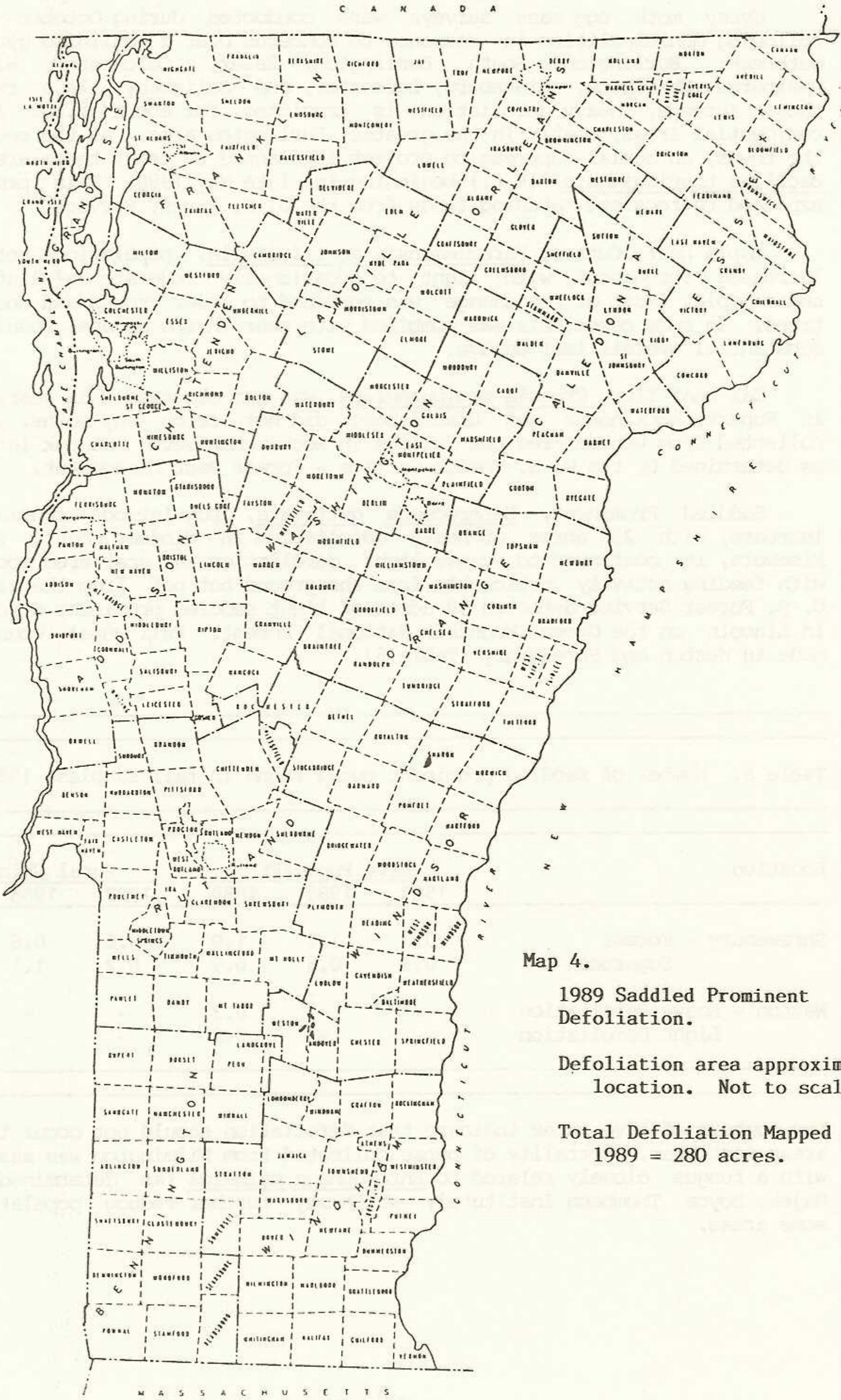
Oak Leaf Tier, Croesia semipurpurana, was not observed this year. Traps in Rupert, Rockingham and Brattleboro did not catch any moths. Larvae collected from webbed red oak foliage in Rockingham were not oak leaf tier, as determined by the U. S. Forest Service - Forest Pest Management.

Saddled Prominent, Heterocampa guttivata, populations continued to increase, with 280 acres of heavy defoliation in Windsor County (Map 4). Elsewere, it continued to cause light defoliation in scattered locations, with feeding activity noticeable from the ground but not from the air. The U. S. Forest Service detected 38 acres of light saddled prominent defoliation in Lincoln on the Green Mountain National Forest. Fall pupal counts were made in Weston and Shrewsbury (Table 6).

Table 6. Number of saddled prominent pupae found in fall samples, 1987-1989.

Location	Live Pupae/Ft^2			Pupal Skins/Ft^2		
	1987	1988	1989	1987	1988	1989
Shrewsbury - Forest	0.3	1.7	1.0	0.6	0.6	0.2
Sugarbush	0.3	0.6	0.7	0.2	1.1	0.5
Weston - Heavy Defoliation	-	-	0.3	-	-	1.1
Light Defoliation	-	-	0.3	-	-	0.2

Low numbers of live pupae indicate that defoliation should not occur in these areas next year. Mortality of pupae collected from Wilmington was associated with a fungus closely related to Entomophaga maimaiga (as determined by Ann Hajek, Boyce Thompson Institute), which may further reduce populations in some areas.



Map 4.

1989 Saddled Prominent Defoliation.

Defoliation area approximate location. Not to scale.

Total Defoliation Mapped in 1989 = 280 acres.

OTHER HARDWOOD DEFOLIATORS

INSECT	HOST(S)	LOCALITY	REMARKS
American Aspen Beetle Gonioctena americana			Not observed.
American Dagger Moth Acronicta americana			Not observed.
Birch Leaf Folder Ancylis discigerana	Yellow Birch	Hyde Park Bolton Hancock	Light damage observed.
Birch Leaf Miner Fenusa pusilla	White Birch Gray Birch Yellow Birch	Throughout	See narrative.
Birch Skeletonizer Bucculatrix canadensisella	White Birch Yellow Birch	Orange, Rutland & Washington Counties	Occasionally observed.
Bruce Spanworm Operophtera bruceata	Sugar Maple	Stowe	Some moths observed during November.
Cherry Scallop Shell Moth Hydria prunivorata			Not observed.
Early Birch Leaf Edgeminer Messa nana			Not observed.
Eastern Tent Caterpillar Malacosoma americanum	Cherry Apple	Widespread	Common but less defoliation than in 1988.

OTHER HARDWOOD DEFOLIATORS

INSECT	HOST(S)	LOCALITY	REMARKS
Elm Leaf Beetle Pyrrhalta luteola	Elm	Rutland Fair Haven	Shade trees.
Elm Leaf Miner Fenusa ulmi	Elm		Not observed.
Fall Cankerworm Alsophila pometaria			Not observed.
Fall Webworm Hyphantrea cunea	Hardwoods	Widespread	Noticeable, but less common than 1988.
Flat Leaf Tiers Psilocorcis sp.	Red Oak	Rockingham	Understory trees.
Forest Tent Caterpillar Malacosoma disstria			See narrative.
Green Striped Mapleworm Anisota rubicunda	Maples	Widely scattered	A few individual larvae seen.
Gypsy Moth Lymantria dispar			See narrative.
Half Winged Geometer Phigalia titea			Not observed.
Japanese Beetle Popillia japonica	Ornamentals	St. Johnsbury Lyndonville Champlain Valley	Little defoliation.

OTHER HARDWOOD DEFOLIATORS

INSECT	HOST(S)	LOCALITY	REMARKS
Large Aspen Tortrix Choristoneura conflictana			Not observed.
Linden Looper Erranis tiliaria			Not observed.
Locust Leaf Miner Odontata dorsalis	Black Locust	St. Johnsbury Richmond Putney	Mostly light defoliation.
Maple Leaf Cutter Paraclemensia acerifoliella			See narrative.
Maple Trumpet Skeletonizer Epinotia aceriella	Sugar Maple Red Maple	Widespread	Very common compared to past years but mostly light defoliation.
Maple Webworm Tetralopha asperatella	Sugar Maple	Widespread	Increasing in northern Vermont. Light defoliation in Franklin County.
Mountain Ash Sawfly Pristiphora geniculata	Mountain Ash		No reports for the first time in many years.
Oak Leafroller Archips semiferanus			Not observed.
Oak Skeletonizer Bucculatrix ainsliella	Oak		Not observed.

OTHER HARDWOOD DEFOLIATORS

INSECT	HOST(S)	LOCALITY	REMARKS
Orange-humped Mapleworm *Symmerista leucitys*	Sugar Maple	Danville Proctor	Larvae.
Pear Sawfly *Caliroa cerasi*	Hawthorne	Danville	Heavy defoliation of one tree.
Pin Oak Sawfly *Caliroa sp.*			Not observed.
Red-humped Oakworm *Symmerista canicosta*	Red Oak		Not observed.
Rose Chafer *Macrodactylus subspinosus*	Hardwood Ornamentals	St. Johnsbury Barnet Lyndon	Numerous in scattered locations.
Saddled Prominent *Heterocampa guttivata*			See narrative.
Satin Moth *Leucoma salicis*	Silver Poplar Balsam Poplar	Widely scattered	Occasional heavy defoliation of individual trees.
Solitary Leaf Roller *Sparganothis pettitana*	Sugar Maple	Franklin County	Commonly observed at very light but increasing population levels.
Solitary Oak Leaf Miner *Cameraria hamadryadella*			Not observed.
Spiny Elm Caterpillar *Nymphalis antiopa*			Not observed.

OTHER HARDWOOD DEFOLIATORS

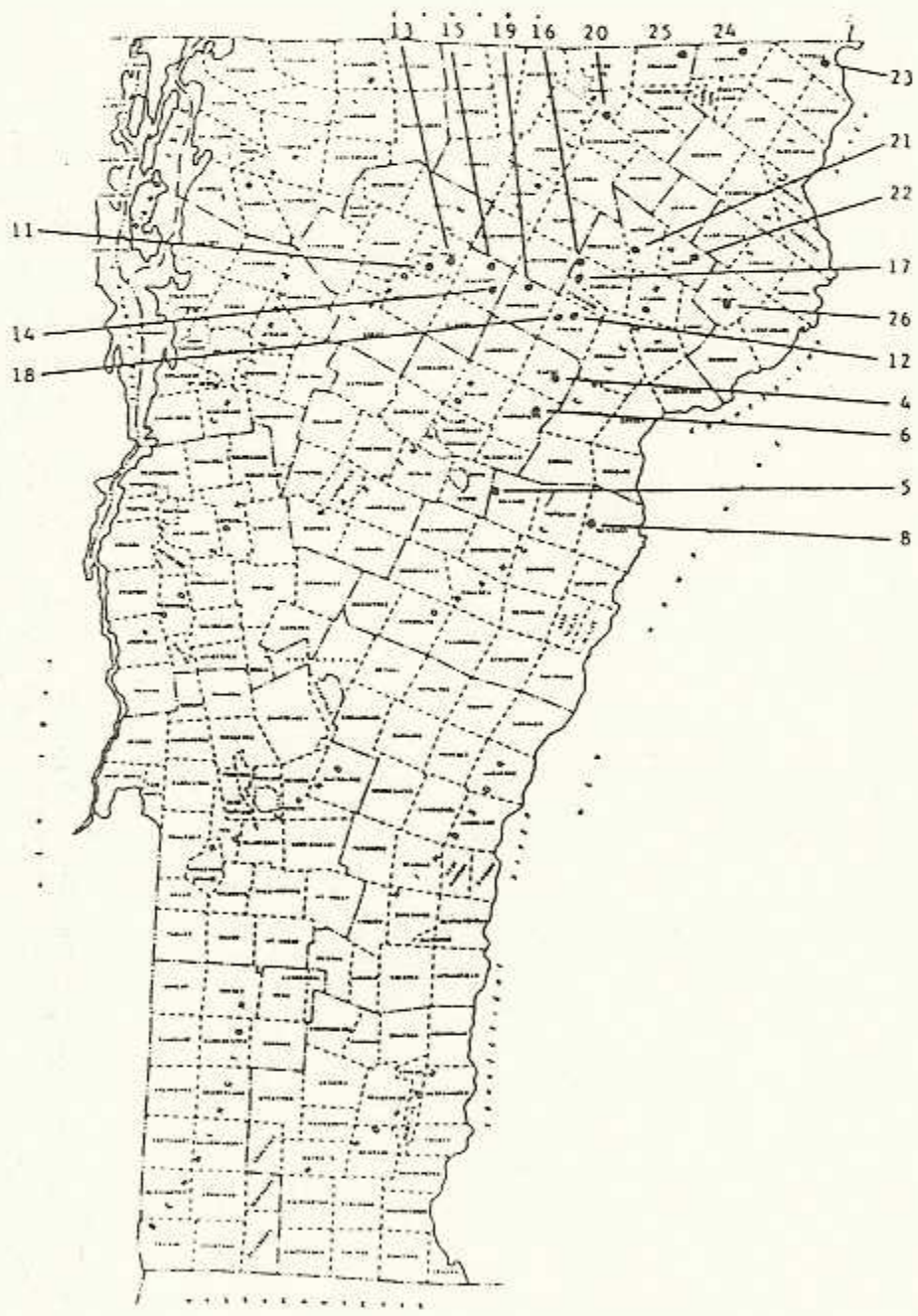
INSECT	HOST(S)	LOCALITY	REMARKS
Spring Cankerworm Paleacrita vernata			Not observed.
Uglynest Caterpillar Archips cerasivoranus	Cherry	Widely scattered in northern Vermont	Occasionally observed; down from 1988.

Softwood Defoliators

Spruce Budworm, Choristoneura fumiferana, populations continued at extremely low levels in 1989, with no visible defoliation. No budworm larvae were seen this year and only one budworm moth was caught by use of pheromone traps.

Pheromone traps were deployed in 20 stands this year, in the same locations as in 1988 (Map 5). Each plot consisted of three Multi-pher traps in a cluster. Half of the traps were baited with PVC pellet lures as used in the past, and half were baited with Biolures. Biolures are supposedly more attractive to very low population levels and have replaced the PVC lure in most other states and provinces. Even with this lure, only one moth was caught (Table 7).

Map 5. Spruce budworm pheromone plot locations.



4. Danville Hill
5. Reservoir
6. Marshfield Pd.
8. Scotch Hollow
11. Centerville
12. Coles Pd.
13. Diggins
14. Wolcott F&G
15. Bear Swamp
16. Withers
17. Mason
18. Star School
19. Beagle Club
20. Brownington Pd.
21. Calendar Brk.
22. Chieppo
23. Bunnel Brk.
24. Norton Cem.
25. Holland Pd.
26. Victory Bog

Table 7. Average number of spruce budworm moths caught per trap in pheromone traps, 1987-1989.[1]

Lure	1987	1988	1989
PVC	0.01	0.05	0.00
Biolure	--	--	0.03
Number of Sites	19	20	10

1. Multi-pher traps: 3 per site in 1989 and 1988; 3-5 per site in 1987.

OTHER SOFTWOOD DEFOLIATORS

INSECT	HOST(S)	LOCALITY	REMARKS
Arborvitae Leaf Miner Argyresthia thuiella	Arborvitae	Ludlow Marlboro Rutland	Ornamentals.
Balsam Fir Sawfly Neodiprion abietis	Balsam Fir Blue Spruce	Windsor, Washington, Lamoille, Orange Counties	Fairly common in 1989 for the first time; mostly light defoliation.
Green Hemlock Needleminer Coleotechnites apicitripunctella	Hemlock	Quechee	Light defoliation of ornamentals.
Gypsy Moth Lymantria dispar	White Pine White Spruce	Springfield Dummerston	Light defoliation of Christmas trees and ornamentals.

OTHER SOFTWOOD DEFOLIATORS

INSECT	HOST(S)	LOCALITY	REMARKS
Hemlock Looper Lambdina fiscellaria	Hemlock	Hubbardton	Individual larva.
Introduced Pine Sawfly Diprion similis	White Pine	Rutland Mendon	Ornamentals.
Larch Casebearer Coleophora laricella	Larch	Widely scattered	Approximately 1000 acres defoliated in Rutland and Bennington Counties.
Larch Sawfly Pristophora erichosonii	Larch	Rutland	Ornamentals.
Microbagworm Psychidae	Balsam Fir	Pownal	Occasional cases.
Orange Spruce Needleminer Pulicalvaria piceaella	Balsam Fir	Weston	Light defoliation of Christmas trees.
Pine False Webworm Acantholyda erythrocephala	White Pine Scots Pine	Derby Cornwall Orleans Craftsbury Danville Brookfield	Mostly light defoliation but this insect was unusually common this year.
Pine Webworm Tetralopha robustella			Not observed.
Red-Headed Pine Sawfly Neodiprion lecontei	Red Pine		Not observed.

OTHER SOFTWOOD DEFOLIATORS

INSECT	HOST(S)	LOCALITY	REMARKS
Spruce Bud Moth Zeiraphera canadensis	White Spruce	Widely scattered in northern Vermont	Occasionally observed; light defoliation.
Spruce Budworm Choristoneura fumiferana			See narrative.
White Pine Sawfly Neodiprion pinetum			Not observed.
Yellow-headed Spruce Sawfly Pikonema alaskensis	Blue Spruce Red Spruce	St. Johnsbury Danville Randolph	Caused moderate defoliation of a 20-year old plantation in Randolph that received heavy defoliation to red spruce in 1988.

Sapsucking Insects, Midges, and Mites

Aphids, Periphyllus spp., probably P. americanus and P. testudinacea, were common but at light population levels on developing maple buds early in the season. Populations dropped dramatically in southern Vermont (Table 8), although high populations were seen in one stand in Rupert.

Table 8. Total number of Periphyllus aphids per 100 buds in 6 sugarbushes: 1987-1989.

Location	1987	1988	1989
Woodstock	-	184	2
Landgrove	-	200	16
Smokey House	-	38	3
Danby	3	48	1
Sunderland	559	101	8
Dummerston	262	3	0
Regional Average	275	96	5

The mid-summer dimorph stages that were commonly seen on sugar maple leaves in 1988 were not detected in 1989. Rainy weather this year may have been a factor in the population collapse.

Balsam Gall Midge, Paradiplosis tumifex, increased significantly in many balsam fir plantations throughout the state this year. Of the northern Vermont plantations annually surveyed for pests, 157 acres were found to be infested with gall midge compared to only 28 acres in 1988. Most of the damage was light, but the sudden appearance of galled needles in many plantations where no damage was evident a year ago, indicates that populations are increasing and likely to be a serious problem next year. The previous two outbreaks of gall midge peaked in 1983 and 1976, seven years apart, so the insect appears to be right on schedule.

Balsam Twig Aphid, Mindarus abietinus, caused widespread curling of balsam fir needles, similar to what was seen in 1988 except for more heavy damage this year. Damage was reported for 272 acres of Christmas trees in northern Vermont, with about 40 percent of the acreage having moderate to heavy damage. Some trees that appeared heavily damaged early in the season outgrew the damage and looked fine by fall. Rains may have reduced later stages of the insect as few overwintering eggs have been found on twigs searched to date. Expect lower populations in 1990.

The use of Acecap systemic implants for trees was tested this spring on seven to 14-foot tall balsam fir trees being attacked by balsam twig aphid and balsam gall midge. Six trees received one to three mini-Acecap 97 implants each, containing 0.25 grams of acephate per cartridge, just when buds were beginning to break. Acecap-treated trees ended up with less than one percent of the branches damaged by twig aphid compared to 16 percent for untreated trees. However, there was no difference in gall midge damage between treated trees and untreated trees.

Hemlock Woolly Adelgid, Adelges tsugae, has not been observed in Vermont. It has not been detected during the systematic survey in southern Vermont now being conducted in cooperation with the U. S. Forest Service - Forest Pest Management. The region was divided into 34 100-square mile blocks; at least one hemlock stand is being sampled per block. To date, 31 stands have been sampled (Map 6).

Map 6. Location of 1989 hemlock woolly adelgid survey sites.

• Location of hemlock stands inspected for A. tsugae

Oystershell Scale, Lepidosaphes ulmi, populations noticeably decreased. Beech dieback associated with infestations of the past three years was much more evident in northern Vermont this year. An evaluation of scale population levels within Camel's Hump State Forest showed a drop in number of insects that reflects what was observed throughout (Table 9).

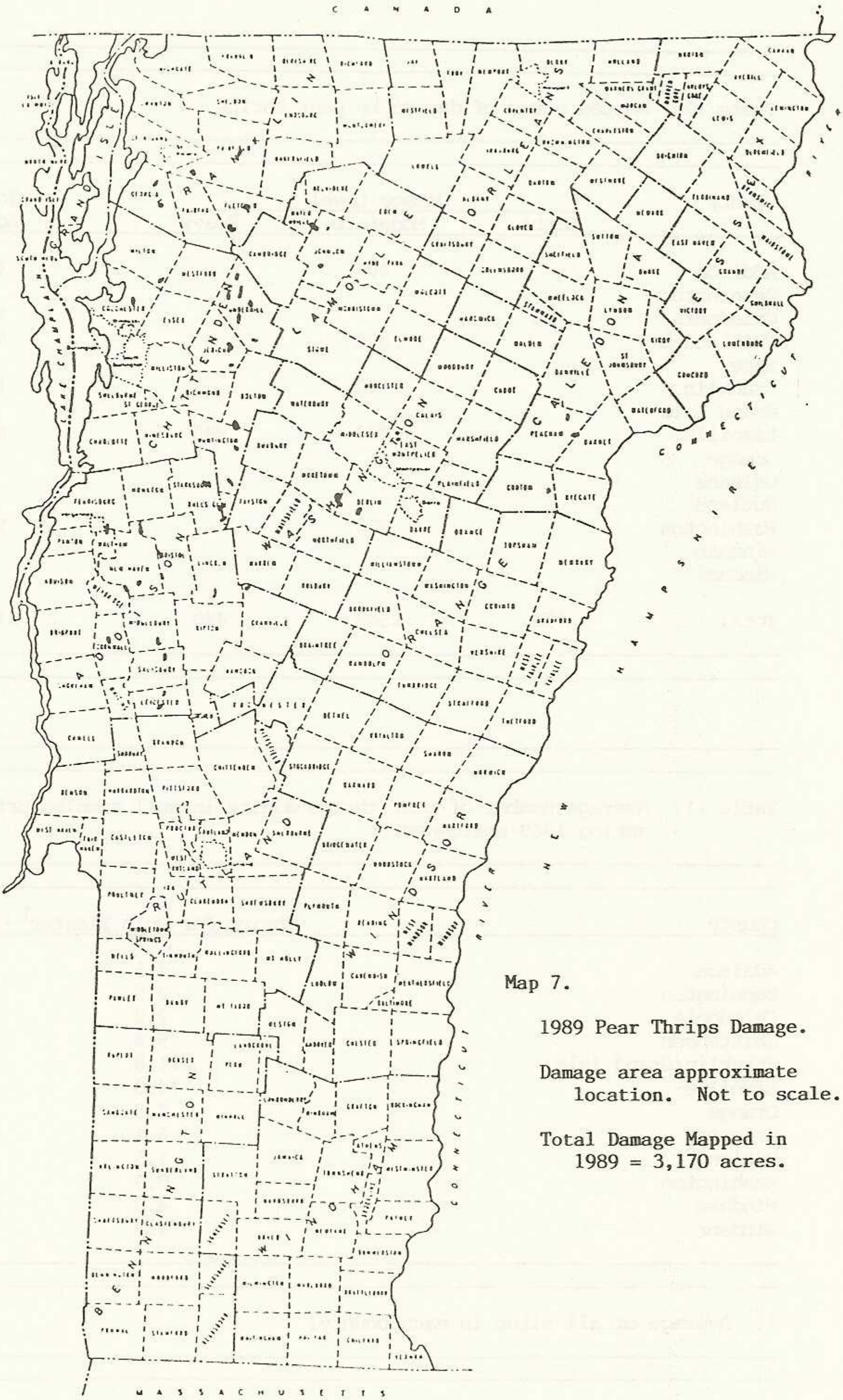
Table 9. Number of oystershell scales on current year twigs in Camel's Hump State Forest, 1987-1989.[1]

Tree Dominance	Average Number of Mature Viable Scales per:					
	Twig			Millimeter		
	1987	1988	1989	1987	1988	1989
Suppressed	3.7	3.4	1.7	0.10	0.22	0.05
Intermediate	6.8	2.8	1.0	0.07	0.12	0.01
Codominant	9.3	8.8	3.7	0.27	0.64	0.09

1. Average for 10 branches from one tree per dominance class, collected in September 1988 and November 1989.

Pear Thrips, Taeniothrips inconsequens, damage to sugar maples was less severe and less extensive than in 1988, with only 3,170 acres mapped from the air compared to 469,000 acres in 1988 (Table 10, Map 7). Most of this damage was moderate with the only heavy damage (440 acres) occurring in Lamoille County. Many northern Vermont sugar maple stands received light defoliation, but this could not be detected from the air. A high incidence of anthracnose, other leaf spot diseases, general leaf chlorosis, and maple leaf cutter made it difficult to differentiate damage caused by thrips.

Soil sampling was used to estimate population levels before thrips emerged from the soil. Populations were generally low in southern Vermont, with the highest levels found in Franklin, Chittenden and Lamoille Counties (Table 11). Over 100 sites were sampled, taking 10 soil samples per sugarbush, using a bulb planter (Map 8). The samples were processed at the University of Vermont Entomology Laboratory. Soil sampling was repeated in September 1989 to make predictions for 1990.



Map 7.

1989 Pear Thrips Damage.

Damage area approximate location. Not to scale.

Total Damage Mapped in 1989 = 3,170 acres.

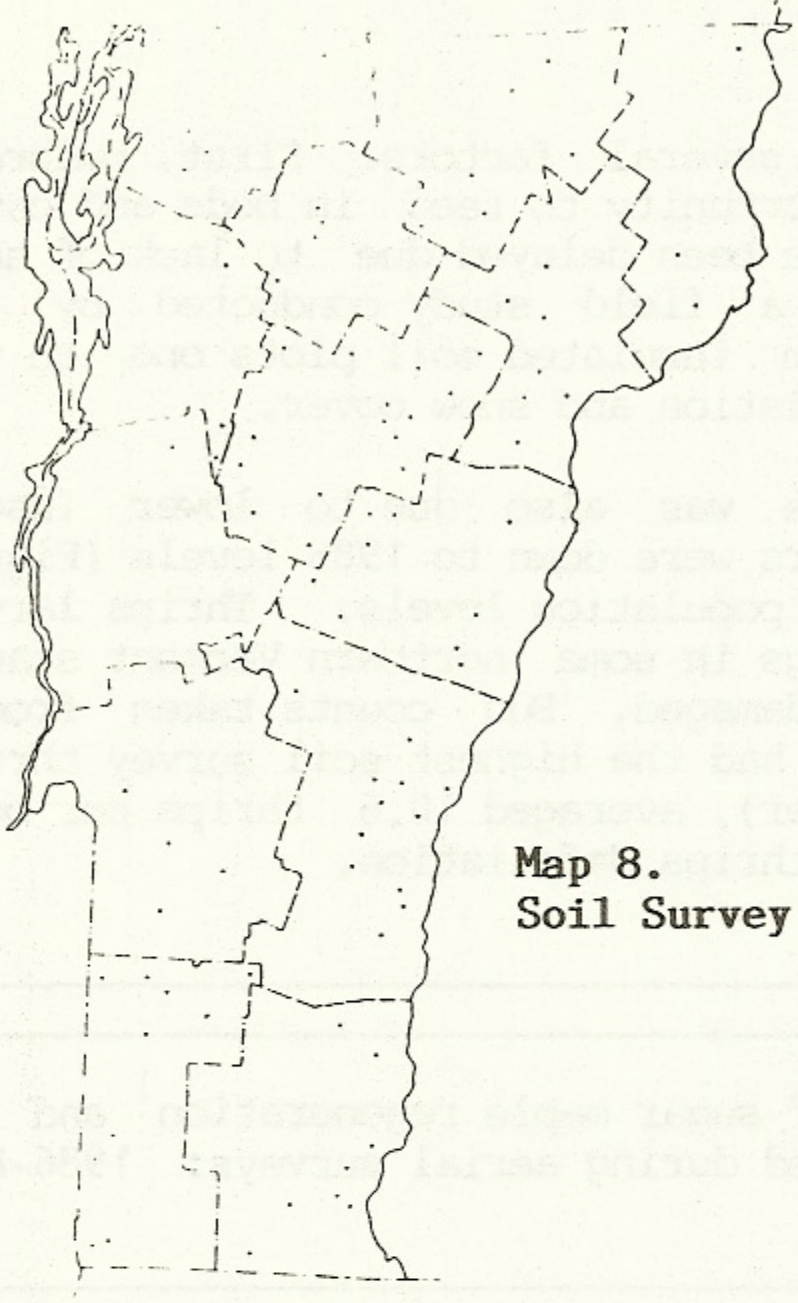
Table 10. Mapped acres of damage by pear thrips.

County	Damage Level			Total Acres
	Light	Moderate	Heavy	
Addison		400		400
Bennington				0
Caledonia	150			150
Chittenden		870		870
Essex				0
Franklin		140		140
Grand Isle				0
Lamoille		240	440	680
Orange				0
Orleans				0
Rutland				0
Washington		930		930
Windham				0
Windsor				0
Total	150	2580	440	3170

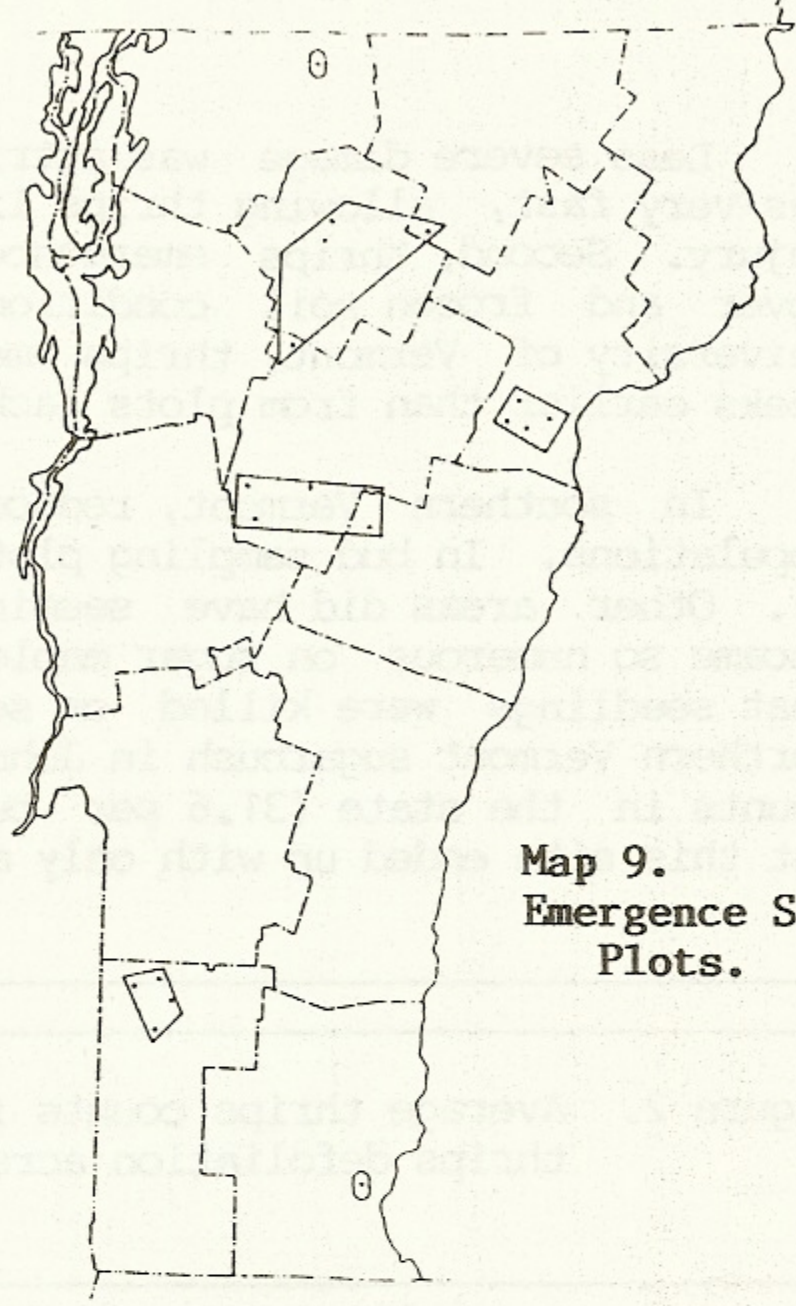
Table 11. Average number of pear thrips adults in soil samples prior to spring 1989 emergence.

County	Thrips Per Bulb Planter[1]
Addison	4.5
Bennington	2.9
Caledonia	2.2
Chittenden	9.4
Franklin/Grand Isle	11.8
Lamoille	14.0
Orange	4.5
Orleans	6.1
Rutland	1.5
Washington	8.9
Windham	4.3
Windsor	2.3

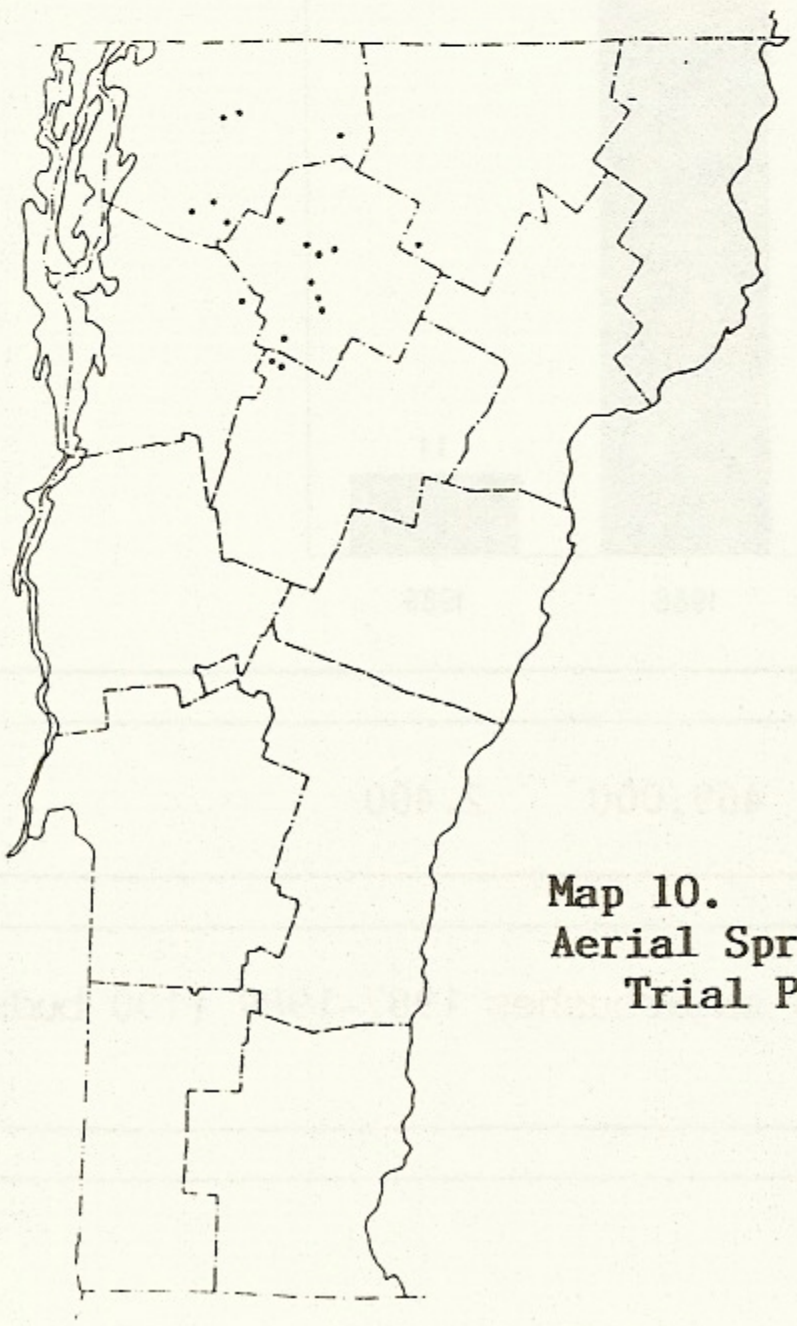
1. Average of all sites in each county.



Map 8.
Soil Survey Plots.



Map 9.
Emergence Survey
Plots.



Map 10.
Aerial Spray
Trial Plots.

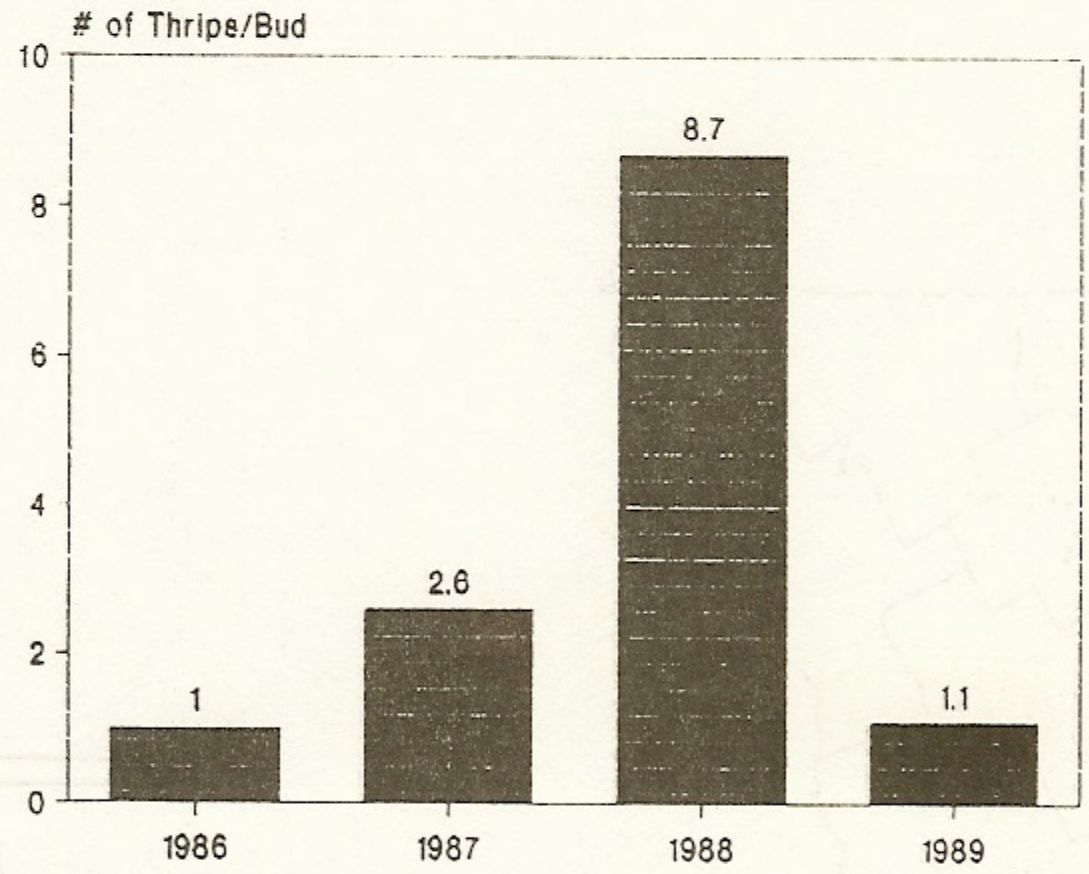
1989 Pear Thrips

Study Site Locations

Less severe damage was attributed to several factors. First, budbreak was very fast, allowing thrips little opportunity to feed in buds and cause injury. Second, thrips emergence may have been delayed due to lack of snow cover and frozen soil conditions. In a field study conducted by the University of Vermont, thrips emerged from insulated soil plots one to two weeks earlier than from plots lacking insulation and snow cover.

In southern Vermont, reduced damage was also due to lower insect populations. In bud sampling plots, numbers were down to 1986 levels (Figure 2). Other areas did have seemingly high population levels. Thrips larvae became so numerous on sugar maple seedlings in some northern Vermont stands that seedlings were killed or severely damaged. Bud counts taken from a northern Vermont sugarbush in Johnson that had the highest soil survey thrips counts in the state (31.6 per bulb planter), averaged 10.6 thrips per bud. Yet this site ended up with only moderate thrips defoliation.

Figure 2. Average thrips counts in buds of sugar maple regeneration[1] and thrips defoliation acreage mapped during aerial surveys: 1986-89.

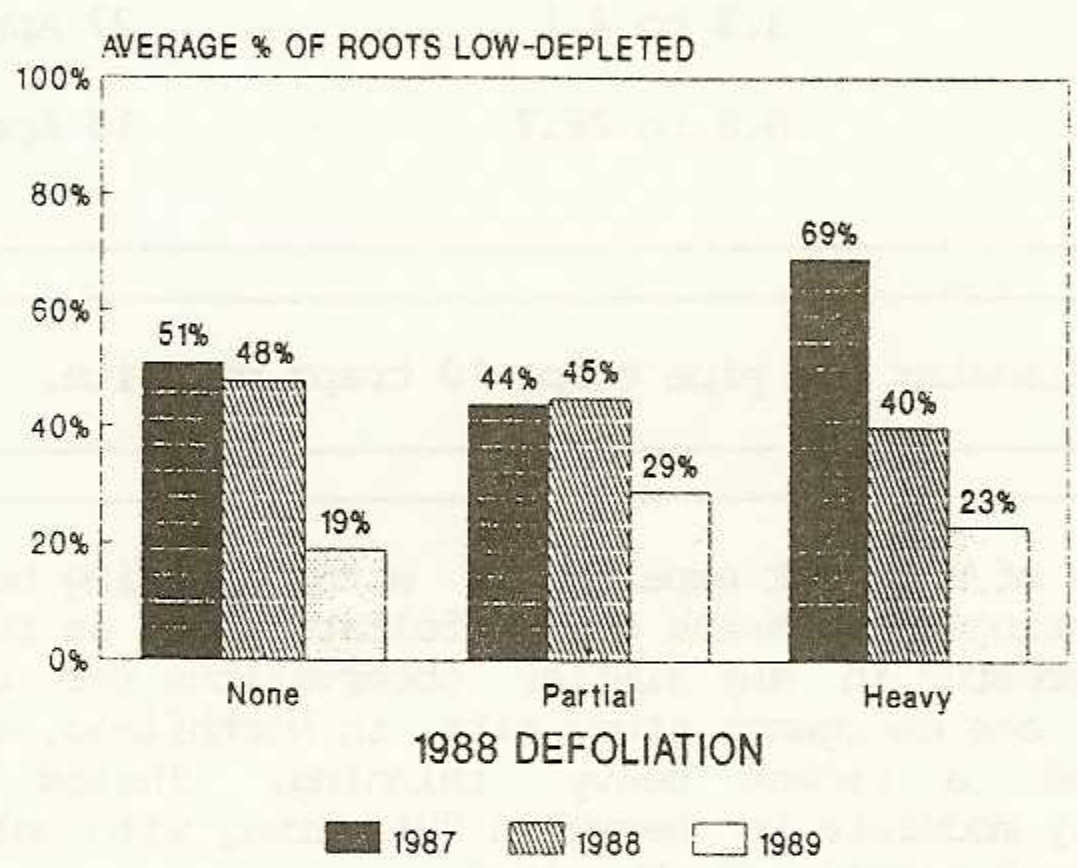


Acres Defoliated	<100	21,800	469,000	2,400

1. Average of 2 sugarbushes in 1986 and 6 sugarbushes 1987-1989 (100 buds/ sugarbush.

Foliage looked healthy on trees which were defoliated in 1987 and 1988. Root starch testing was continued in some sugarbushes. In general, trees with heavy defoliation in 1988 had levels of starch similar to non-defoliated trees, by the end of the same season (1988). Starch levels improved, regionwide, in 1989, regardless of defoliation history (Figure 3).

Figure 3. Average sugarbush root starch ratings, 1987-1989, by level of pear thrips defoliation in 1988 (n=20).



Thrips were collected as they emerged from the soil, on a daily basis, from PVC pipe emergence traps located in 18 sites in the state in a study coordinated by the University of Vermont (Map 9). Thrips came out of the soil beginning on 18 April, at numerous sites. Numbers emerging were generally higher in northern Vermont (Table 12). Another 38 sites in the state were similarly monitored to collect additional data. Traps will be monitored again next spring to begin to establish yearly trends.

Table 12. Average number of pear thrips emerging and initial emergence dates from five regional study sites, 1989.

Location	Number of Thrips Emerging/Trap[1] (Range)	Range of Starting Dates for Emergence
Southwest	0.6 to 7.5	20 April to 27 April
Southeast	1.5	18 April
Central	0.2 to 9.5	18 April to 7 May
Northeast	3.3 to 4.1	27 April to 1 May
Northcentral	8.8 to 22.7	18 April

1. Per 3" diameter PVC pipe trap, 10 traps per site.

Because of our past experiences with observing heavier damage following thinnings during an outbreak of a defoliator such as forest tent caterpillar, we are interested in any similar observations for other insects, such as thrips. In one emergence study site in Northfield, a portion of the stand had received a recent heavy thinning. Thrips damage in 1989 was conspicuously moderate to heavy in this area, with only light damage in the remaining uncut portion of the stand.

Several tests were conducted to find out an effective control for high thrips populations. Orthene Turf, Tree and Ornamental Spray (75% A.I.) and Margosan-O (Neem seed extract, 0.3% A.I.) were applied to branches and saplings to test their effectiveness in killing pear thrips. The applications were made on 9 May, prior to leaf expansion. Neither material had significantly lower numbers of thrips per bud than unsprayed samples. The unsprayed samples, however, had relatively low counts, 2.34 thrips per bud. Further testing may provide more definitive results.

In another study, Sevin 4-Oil was applied from a fixed wing aircraft at a rate of one pound per acre to test its effectiveness in controlling thrips and preventing leaf injury, and to test application timing. The material was diluted with equal parts deodorized kerosene, and applied to a total of 10 plots in Franklin, Lamoille and Washington Counties (Map 10). The two timings tested were initial emergence of thrips from the soil and peak emergence (when approximately half the estimated population had emerged). Light damage in unsprayed areas made it difficult to determine how effective the material was. Pre- and post-spray bud samples were collected to compare numbers of thrips in buds from sprayed and unsprayed plots. Leaf samples were collected at about three weeks post-spray, to evaluate leaf injury and oviposition scars. Individual trees were rated for thrips damage. Data from sprayed and unsprayed plots will be compared to determine efficacy. Data analysis is being completed at the University of Vermont.

Bartlett Tree Service conducted spray trails using Orthene, Sevin, and Dormant Oil. Due to very low thrips populations at the test site, no conclusive results were obtained. However, the Dormant Oil application burned the emerging maple leaves, causing flagging of many branches.

Natural enemy surveys in Vermont found a fungus killing thrips in the soil from sites throughout the state. The incidence was higher in southern Vermont where damage had been heaviest in 1988. In one site, 73 percent of the thrips collected from the soil had been killed by the fungus named Verticillium lecanii, or the white halo fungus. This fungus is commercially produced in Europe for use against greenhouse pests, including the glasshouse thrips. Further studies are underway to find out more about the fungus in Vermont, and its promise as a biological insecticide for use in sugar maple forests.

A two-year survey of natural enemies of pear thrips in Europe was initiated by a team of researchers coordinated by the University of Vermont. Since the insect originated there and is not a pest problem there, it is thought that natural enemies are keeping populations of pear thrips low. Identification of potential natural enemies could lead to future introductions for control in the U. S. Thus far, three soil fungi have been identified as pear thrips enemies.

Using satellite images to map thrips damage is still being studied by University of New Hampshire researchers. The technique looks promising for damage estimates, but whether the method can be used economically and with enough speed to do field verification is still being evaluated.

State and federal funding was obtained to support pear thrips research in 1989. Continued state support is anticipated, at least through June 1990.

Spruce Spider Mite, Oligonychus ununguis, caused occasional light or moderate damage to Christmas trees and ornamentals in scattered locations. In some northern Vermont locations, populations appeared to build late in the summer. In southern Vermont, few eggs could be found, in the fall, on damaged twigs. If the early growing season is dry in 1990, additional damage could occur.

OTHER SAPSUCKING INSECTS, MIDGES AND MITES

INSECT	HOST(S)	LOCALITY	REMARKS
Aphids Cinara sp.	White Pine	Wilmington Whitingham Stowe	Ornamentals and Christmas trees.
Aphids Periphyllus sp.			See narrative.
Balsam Gall Midge Pardiplosis tumifex			See narrative.

OTHER SAPSUCKING INSECTS, MIDGES AND MITES

INSECT	HOST(S)	LOCALITY	REMARKS
Balsam Twig Aphid Mindarus abietinus			See narrative.
Balsam Woolly Adelgid Adelges piceae	Balsam Fir	Chittenden Groton	Light populations.
Beech Scale Cryptococcus fagisuga			See Beech Bark Disease.
Birch Budgall Mite Aceria rudis			Not observed.
Cooley Spruce Gall Adelgid Adelges cooleyi	Blue Spruce White Spruce Douglas Fir	Widespread	Causing light to moderate damage to Christmas trees.
Cottony Maple Scale Pulvinaria innumerabilis	Sugar Maple	Groton	Light infestation.
Eastern Spruce Gall Adelgid Adelges abietis	White Spruce Red Spruce	Throughout	Occasional heavy damage to Christmas trees and ornamentals. Unevenly distributed in plantations, with up to 30% of trees heavily damaged.
Green Erineum Gall Eriophyidae	Sugar Maple	Windham County	Ornamental.
Hemlock Woolly Adelgid Adelges tsugae			See narrative.

OTHER SAPSUCKING INSECTS, MIDGES AND MITES

INSECT	HOST(S)	LOCALITY	REMARKS
Lacebugs Corythucha sp.	Hardwoods	Widespread	Damage particularly common on red oak, red maple, elm and balsam poplar.
Leafhoppers	Hardwoods	Widespread	Moderate feeding on sugar maple and other hardwood leaves in some locations.
Lecanium Scale Lecanium sp.	Beech	Essex	Down from 1988 levels; difficult to find in 1989.
Maple Spindle Gall Mites Vasates aceris-crumena	Sugar Maple	Widespread	Remains common.
Oystershell Scale Lepidosaphes ulmi			See narrative.
Pear Thrips Taeniothrips inconsequens			See narrative.
Pine Bark Aphid Pineus strobi	Scots Pine	Widespread	Associated with chlorotic Christmas trees and declining ornamentals in several plantations. Observed elsewhere, but populations lighter than in the recent past.
Pine Leaf Adelgid Pineus pinifoliae	Red Spruce	Wolcott	Gall form observed on red spruce but no observations on shoots of white pine in 1989.
Pine Needle Midge Contarinea baeri			Not observed.
Pine Needle Scale Chionapsis pinifoliae	White Pine	Waterford	One ornamental infested.

OTHER SAPSUCKING INSECTS, MIDGES AND MITES

INSECT	HOST(S)	LOCALITY	REMARKS
Pine Spittlebug Aphrophora parallela	Conifers	Widespread	Spittle masses very heavy in places. Light damage, similar to 1988, detected on 87 acres of Scots and white pine Christmas trees.
Pine Thrips Gnophothrips sp.			Not observed.
Pine Tortoise Scale Toumeyella parvicornis			Not observed.
Root Aphid Prociphilus americanus	Balsam Fir Fraser Fir	Widely scattered	Populations down. Only one of 25 plantations checked by VT Dept. of Agriculture in 1989 had aphids, compared to four plantations in 1988.
Spruce Bud Scale Physokermes piceae			Not observed.
Spruce Spider Mite Oligonychus ununguis			See narrative.
Thrips Unknown species	White Fir	Pownal	Moderate damage to scattered individual trees.
Treehoppers Membracidae			Not observed.
Woolly Alder Aphid Prociphilus tessellatus	Silver Maple Alder	Newark Peacham	Heavy on alders.
Woolly Apple Aphid Eriosoma lanigerum			Not observed.

Bud, Shoot and Stem Insects

Balsam Shootboring Sawfly, Pleroneura brunneicornis, appears to be following the past trend of heavy populations only in even years. This year light to moderate damage was detected in 48 acres of balsam and Fraser fir Christmas trees in northern Vermont compared to 39 acres of heavy damage and 42 acres of light damage in 1988. Growers should anticipate heavier damage from this insect in 1990.

OTHER BUD, SHOOT & STEM INSECTS

INSECT	HOST(S)	LOCALITY	REMARKS
Allegheny Mound Ant Formica exsectoides	White Pine	Whitingham	Several trees girdled.
Ambrosia Beetle Scolytidae	White Birch	Caledonia County	Causing sawlog quality loss on state land timber sale.
	Sugar Maple	Townshend	On stressed ornamentals.
Balsam Shoot-boring Sawfly Pleroneura brunneicornis	Balsam Fir Fraser Fir		See narrative.
Butternut Curculio Conotrachelus juglandis			Not observed.
Coneworm Dioryctria spp.	Fraser Fir White Spruce Blue Spruce	Addison Elmore Barre Pownal	Shoot damage observed in some locations.
Locust Borer Megacyllene robiniae			Not observed.
Maple Petiole Borer Caulocampus acericaulis	Sugar Maple	Hardwick	
Northern Pine Weevil Pissodes approximatus	Red Pine White Pine	Morrisville Whitingham	Attacking large trees dug for nursery stock. Caused Christmas tree to snap.

OTHER BUD, SHOOT & STEM INSECTS

INSECT	HOST(S)		
Pales Weevil Hylobius pales	Conifers	Widespread	Damage increased this year; light to moderate damage reported for 170 acres of Scots pine Christmas trees compared to 25 acres in 1988.
Pine Gall Weevil Podapion gallicola			Not observed.
Pine Root Collar Weevil Hylobius radicis	Scots Pine	Walden	
Pitted Ambrosia Beetle Corthylus punctatissimus	Sugar Maple Seedlings	Widely scattered	More common than in the the past, especially where sugar maple seedlings are numerous.
Pseudanthonomus validus			Noticeable in 1988 but not this year.
Round-headed Apple Tree Borer Saperda candida			Not observed.
Twig Pruner Elaphidionoides villosus			Not observed.
White Pine Weevil Pissodes strobi	Conifers	Throughout	Remains common. Light to moderate damage detected on about 300 acres of white and Scots pine Christmas trees compared to 70 acres in 1988.
White Spotted Sawyer Monochamus scutellatus	Balsam Fir White Pine	Bakersfield Brookfield E. Burke Whitingham	Light-moderate damage (branch flagging) to Christmas trees.

BARK BEETLES

INSECT	HOST(S)	LOCALITY	REMARKS
Bronze Birch Borer *Agrilus anxius*	White Birch		Not observed.
Eastern Ash Bark Beetles *Hylesinus aculeatus*	White Ash	Cavendish	On dying trees.
Eastern Larch Beetle *Dendroctonus simplex*	American Larch	Widespread, especially in Caledonia County	Some dying trees associated with attack by this beetle. Only 46 acres of new decline detected by aerial survey this year, compared to 646 acres in 1988.
Elm Bark Beetles *Hylurgopinus rufipes* *Scolytus multistriatus*	American Elm	Widespread	See Dutch Elm Disease.
Hemlock Borer *Melanophila fulvoguttata*	Hemlock	Townshend Dummerston	Opening stand in vicinity of lightening strikes.
Pine Engraver *Ips pini*	White Pine	Grafton	Causing mortality on wet site.
Red Turpentine Beetle *Dendroctonus valens*	Red Pine	Chester	Associated with mortality on ledgey site.
Scolytidae	White Pine	Mt. Holly	Associated with mortality of trees planted too deep.

Root Insects

The Conifer Swift Moth, Korsheltellus gracilis, formerly called the Ghost Moth, remains common in the soil of mid to upper elevation spruce-fir forests. Research conducted at the University of Vermont shows the insect to be more abundant in areas of red spruce decline. Laboratory field feeding experiments showed that one or more larvae per seedling caused a significant increase in dieback of seedling foliage and reduction in root area and weight. This indicates that K. gracilis could play an important role in the current decline of upper elevation spruce-fir forests, both by immediate impact on regeneration as well as by a long-term deterioration of larger trees through exposure of damaged roots to the entry of pathogenic organisms.

OTHER ROOT INSECTS

INSECT	HOST(S)	LOCALITY	REMARKS
Broad Necked Root Borer Prionus laticollis			Not observed.
Conifer Swift Moth Korsheltellus gracilis			See narrative.
Wireworms Elateridae			Not observed.
June Beetle Phyllophaga spp.	Conifer Roots	Danville Wheelock	Larvae commonly seen in new Christmas tree plantations.

FOREST DISEASES

Stem Diseases

Beech Bark Disease, caused by Cryptococcus fagisuga and Nectria coccinea var. faginata appeared to be increasing in many northern Vermont stands, although the disease remained stready, at low levels, in southern Vermont monitoring plots (Figure 4). Some trees severely infested with scale ("white-washed"), were observed in Bennington, Washington, and Windham Counties.

Pine Wood Nematode, Bursaphelenchus xylophilus, has been found in many conifer hosts in Vermont. Three species of Monochamus have been identified as vectors by the University of Vermont. Work on potential spread of the nematode in wood chips is being continued.

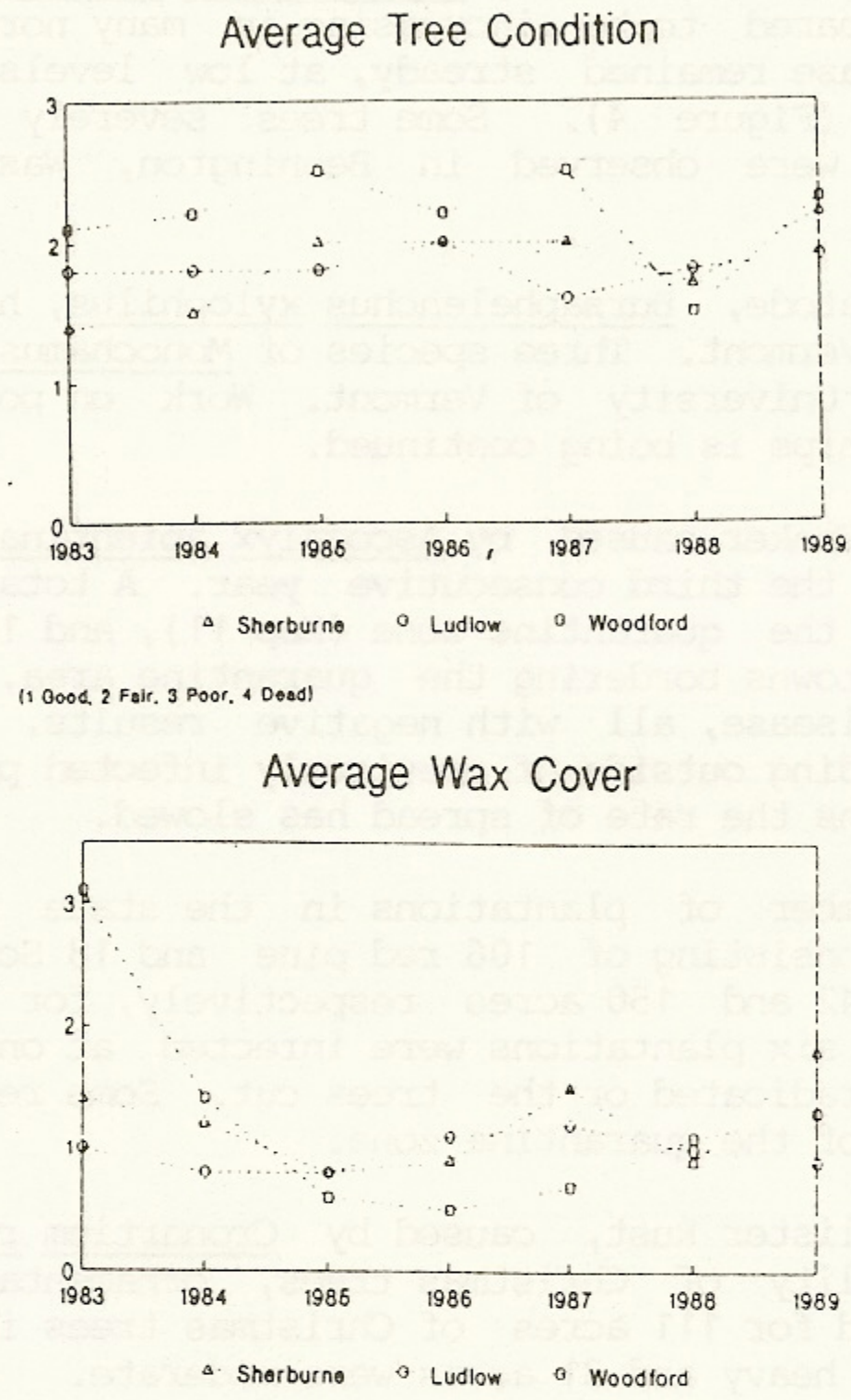
Scleroderris Canker caused by Ascocalyx abientina was not found in any new locations, for the third consecutive year. A total of 56 Christmas tree plantations within the quarantine zone (Map 11), and 105 red and Scots pine plantations in 27 towns bordering the quarantine area, were surveyed for the presence 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 has slowed.

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.

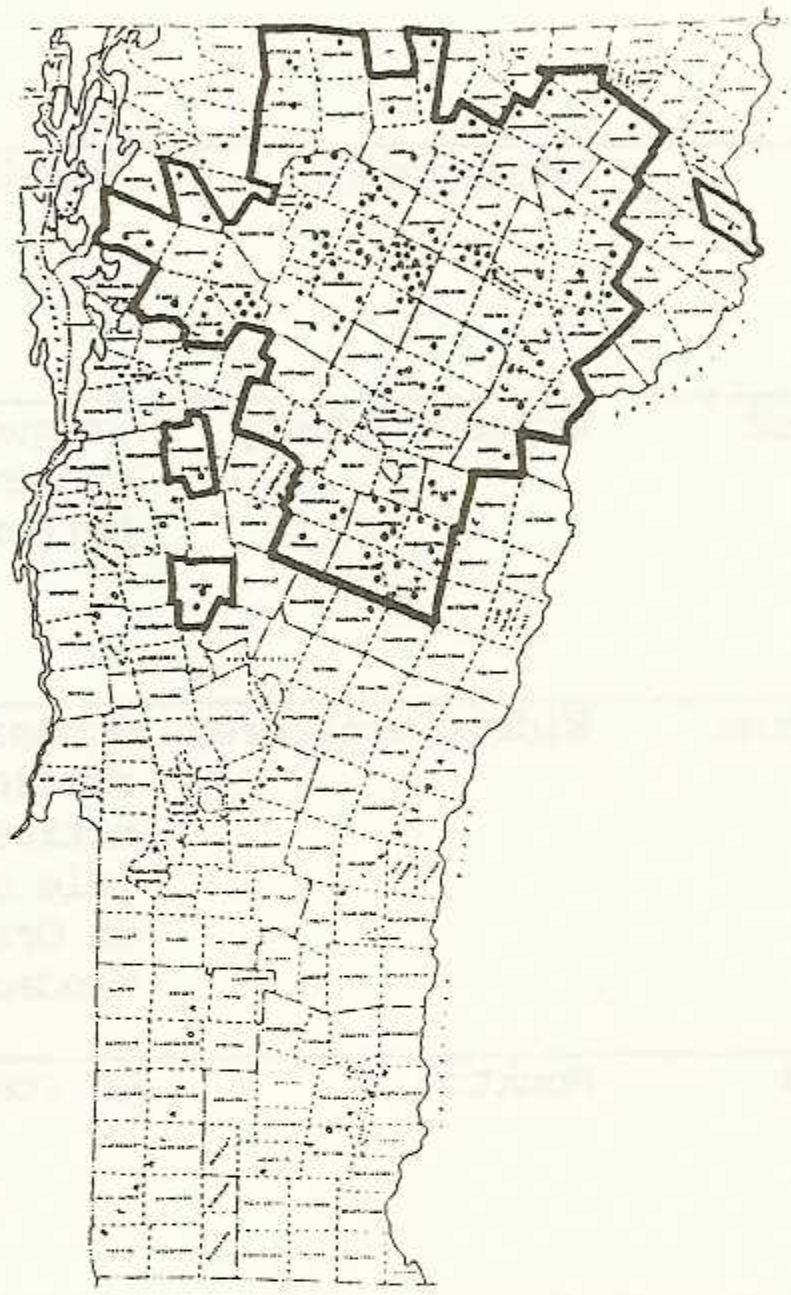
White Pine Blister Rust, caused by Cronartium ribicola, continues to cause some mortality of Christmas trees, ornamentals and regeneration. Damage was reported for 111 acres of Christmas trees in northern Vermont, of which 4 acres were heavy and 31 acres were moderate.

Eighteen cultivars of gooseberries and currants have been screened for susceptibility to the blister rust fungus by the Vermont Department of Agriculture and the University of Vermont. Percent of leaf area infected ranged from 0-50%, depending on the cultivar. Results may be used as a basis for recommending cultivars to gardeners and small fruit growers.

Figure 4. Summary of beech bark disease monitoring plots 1983-1989.



Map 11. 1989 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
Annual Canker			Not observed.
Fusarium sp.			
Balsam Fir Twig Abnormality			Not observed.
Sclerotinia kerneri			

OTHER STEM DISEASES

DISEASE	HOST(S)	LOCALITY	REMARKS
Beech Bark Disease *Cryptococcus fagisuga* and *Nectria coccinea* var. *faginata*			See narrative.
Black Knot *Dibotryon morbosum*	Cherry	Widespread	Abundant.
Butternut Canker *Sirococcus clavigignenta-juglandacearum*	Butternut	Orleans County	Frequently observed wherever there is butternut.
Caliciopsis Canker *Caliciopsis pinea*	White Pine	Widely scattered	Occasionally observed; remains particularly noticeable in overstocked pole and sawtimber stands in Orange, Windham and Windsor Counties.
Chestnut Blight *Cryphonectria parasitica*	Chestnut	Monkton	On roadside trees.
Cytospora Canker *Leucostoma kunzei*	Blue Spruce	Widespread	Common on ornamentals.
Diplodia Shoot Blight *Diplodia pinea* (*Sphaeropsis pinea*)	Red Pine	Widely scattered	No new infections observed.
Dutch Elm Disease *Ceratocystis ulmi*	American Elm	Widespread	Flagging and sudden mortality more common than usual in southern Vermont. Elsewhere, remains common, but not quite as heavy as in 1988.

OTHER STEM DISEASES

DISEASE	HOST(S)	LOCALITY	REMARKS
Eastern Dwarf Mistletoe *Arceuthobium pusillum*	Red Spruce		No new locations discovered.
Fir Broom Rust *Melampsorella caryophyllacearum*	Balsam Fir	Widely scattered	Occasionally observed.
Fireblight *Erwinia amylovora*	Apple	Caledonia and Essex Counties	Numerous calls, causing some tree mortality.
Hypoxylon Canker *Hypoxylon pruinatum*	Quaking Aspen	Widely scattered	Remains common in aspen stands.
Maple Canker *Steganosporium* sp. *Nectria* sp.	Sugar Maple	Widespread	Associated with continued dieback and lower branch mortality. Related to 1988 drought, but damage less common than last year.
Oak Wilt *Ceratocystis fagacearum*	Oaks	Absent	No suspects seen by trained observers during aerial flights.
Phomopsis Canker *Phomopsis arnoldiae*	Russian Olive	Marlboro	Hedgerow.
Phomopsis Gall *Phomopsis* sp.	Butternut	Brattleboro	Severe galling.
Sapstreak *Ceratocystis coerulescens*	Sugar Maple	Vershire Braintree	Sapstreak stain patterns observed on firewood removed from sugarbushes.
Sclerodereris Canker *Asocalyx abietina*			See narrative.

OTHER STEM DISEASES

DISEASE	HOST(S)	LOCALITY	REMARKS
Sirococcus Shoot Blight *Sirococcus strobilinus*	Red Pine		No new infections found.
Smooth Patch *Dendrothele macrodens*	Ash	Chester	Slow-growing trees.
Verticillium Wilt *Verticillium albo-atrum* or *V. dahliae*	Sugar Maple	Rutland	Park trees.
White Pine Blister Rust *Cronartium ribicola*			See narrative.
Woodgate Gall Rust *Endocronartium harknessii*	Scots Pine	Widespread	Remains common on susceptible Scots pine Christmas trees; damage similar to 1988.

Foliage Diseases

Anthracnose, caused by Gloeosporium spp., damaged 95,430 acres of sugar maple (Table 13, Map 12). It was most noticeable at higher elevations, particularly saddles and draws. Where damage was not mapped, it was scattered, and tended to be mixed with pear thrips damage, leaf scorch, leaf spots, and a general leaf chlorosis. Anthracnose was often associated with trees weakened by drought in the understory, and along breaks in the canopy. Heavy damage to whtie ash and birch was common in scattered locations.

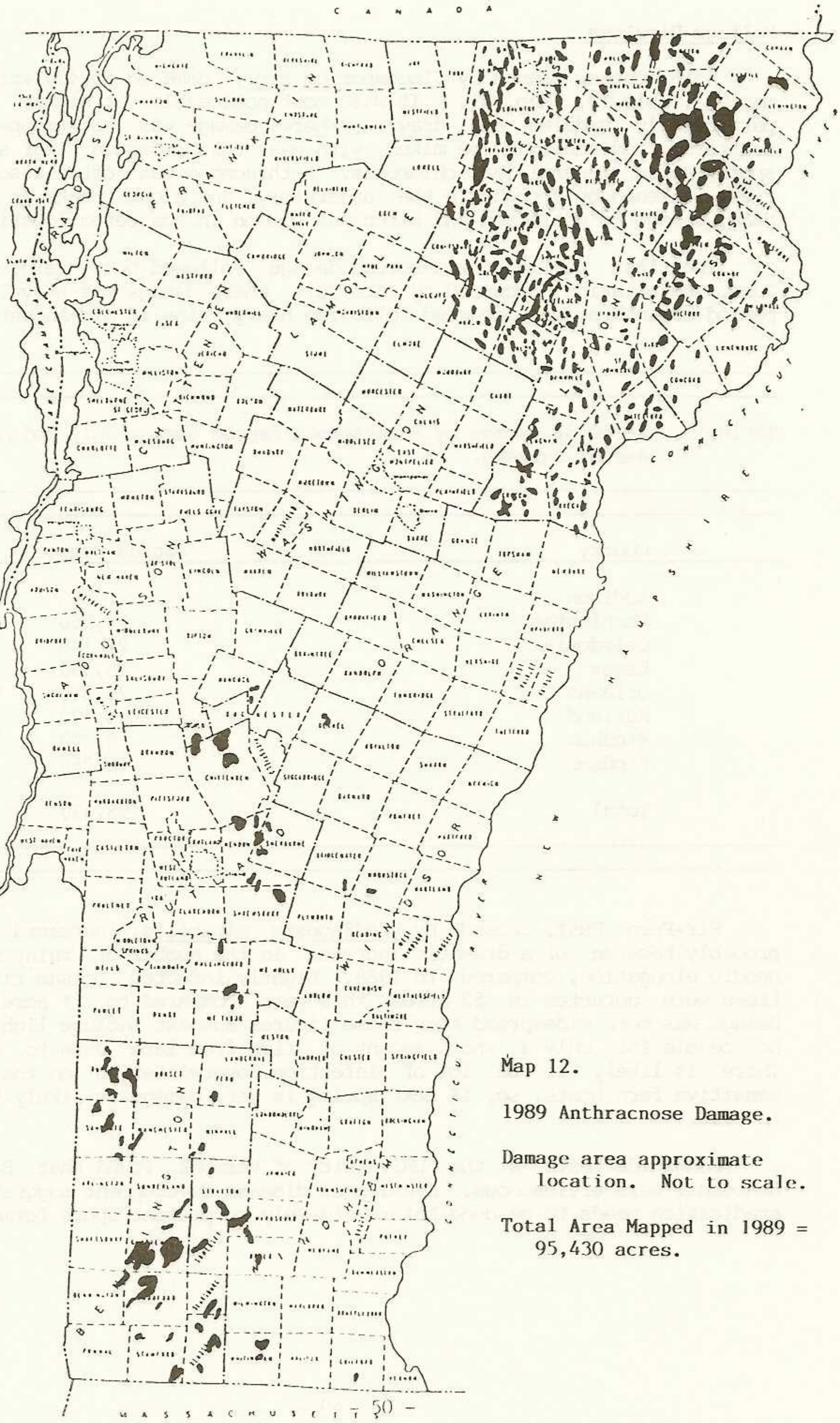
The first period of widespread damage followed heavy rains in May and June. Refoliation occurred by late July where damage was heavy. A second period of anthracnose occurred following heavy rains in mid-August.

Table 13. Acres of damage by anthracnose mapped during July and August aerial surveys.

County	Acres Damaged
Addison	250
Bennington	14,960
Caledonia	21,140
Essex	25,360
Orleans	23,390
Rutland	4,770
Windham	5,300
Windsor	260
Total	95,430

Fir-Fern Rust, caused by Uredinopsis mirabilis, increased this year, probably because of a dramatic increase in the number of rainy days during needle elongation, compared to 1988. Lightly infected balsam fir Christmas trees were detected in 52 acres this year compared to 11 acres in 1989. Damage was more widespread than these figures suggest because light damage is noticeable for only a short amount of time from late June to early July. There is likely to be lot of infection overwintering on the alternate sensitive fern hosts, so, if next spring is wet, damage is likely to increase in 1990.

Fungicide tests at the University of Vermont found that Bayleton and Benodanil were efficaceous. Studies of disease development suggest that fern eradication needs to be done before mid-July to prevent spore formation.



Map 12.

1989 Anthracnose Damage.

Damage area approximate location. Not to scale.

Total Area Mapped in 1989 = 95,430 acres.

OTHER FOLIAGE DISEASES

DISEASE	HOST(S)	LOCALITY	REMARKS
Anthracnose *Gloeosporium* spp.			See narrative.
Apple Scab *Venturia inequalis*	Apple	Westminster Ludlow	Ornamentals.
Cedar-Apple Rust *Gymnosporangium juniperi-virginianae*			Not observed.
Cyclaneusma Needlecast (formerly Naemacyclus) *Cyclaneusma minus*	Scots Pine	Widespread	Heavy damage in one plantation. Distribution similar to Lophodermium needlecast, but damage is heavier. All age needles can be infected any time during the growing season.
European Larch Needlecast *Mycosphaerella laricina*			Not observed.
Fir-Fern Rust *Uredinopsis mirabilis*			See narrative.
Lophodermium Needlecast *Lophodermium seditiosum*	Scots Pine	Widespread, in scattered locations	Causing mostly light damage to Christmas trees at levels similar to 1988.
Phyllosticta Leafspot *Phyllosticta* sp.	Sugar Maple Catalpa	Widely scattered in north-central and northeastern Vermont. Westminster	Suspected cause of tiny leaf spots that were common in some stands. Ornamentals.
Poplar Leaf Bronzing Virus or virus-like casual agent	Balsam Poplar	Caledonia and Orleans Counties	Common by late summer.

OTHER FOLIAGE DISEASES

DISEASE	HOST(S)	LOCALITY	REMARKS
Rhabdocline Needlecast Rhabdocline pseudotsugae	Douglas Fir	Throughout	Continues in heavily-infected plantations. In general, less damage than in 1987-88, probably due to increased control effort. Wet spring conditions made spray timing difficult.
Rhizosphaera Needlecast Rhizosphaera kalkhoffi	Blue Spruce White Spruce	Widely scattered	Appears to be more common and causing heavier needle loss both to ornamentals and Christmas trees, especially where air drainage is poor.
Sooty Mold Perisporiaceae			Not observed.
Swiss Needlecast Phaeocryptopus gaumanni	Douglas Fir	Scattered	Continues in previously infected plantations but damage at somewhat low levels, similar to 1988.
Tar Spot Rhytisma acerinum	Red Maple Sugar Maple	Widely scattered	Occasionally seen. Moderate to heavy on red maple in some areas of Orange and Washington Counties.
Rhytisma punctatum	Sugar Maple	Scattered	Occasionally seen, for the first time since 1986.

ROOT DISEASES

DISEASE	HOST(S)	LOCALITY	REMARKS
Annosus Root Rot Heterobasidion annosum	Norway Spruce	Stockbridge	Plantation.
Shoestring Root Rot	Red Spruce	Throughout	Symptomatic trees much less common that previous years.
Armillaria spp.	Hemlock	Townshend Dummerston	Killing hemlock in vicinity of trees struck by lightening.
	Hardwoods	Throughout	Common on declining trees.
Xylaria Root Rot Xylaria sp.	Hardwoods	Southern Vermont	Dead man's fingers were commonly seen around ornamentals and forest trees.

DIEBACKS DECLINES & ENVIRONMENTAL DISEASES

AIR POLLUTION continues to be a concern. A study to determine the potential impact of ozone on vegetation in the Lye Brook Wilderness area was established on Mt. Equinox under the leadership of the University of Massachusetts.

ASH DIEBACK and mortality remains common in southern Vermont and the Champlain Valley, especially where the basal area of ash is substantial (30% or higher). The presence of witches brooms in many stands indicates that ash yellows is an important factor in the disease. Epicormic sprouts on symptomatic trees, in a northern hardwood stand in Whitingham, suggest that dieback can be attributed to mycoplasma-like organisms (MLOs) at higher elevations, in addition to lower elevations where its presence has been confirmed.

Elsewhere, ash dieback is less noticeable and no witches brooms have been reported.

BIRCH DECLINE and mortality continues to be noticeable in scattered locations, particularly at upper elevations. In some areas this decline may be associated with repeated defoliation by birch leaf miner. The effect of frost heaving and the failure of frozen roots to absorb moisture during recent cold, open winters may also be a factor for this shallow-rooted species. Accelerated dieback of ridgetop yellow birch in northern Vermont was observed late this summer, following the second open winter in eight years.

DROUGHT conditions in 1988 and lack of snowcover contributed to widespread losses of recently planted conifers. Seedlings already under water stress were particularly vulnerable to drying winter winds. Improper planting and poor site conditions contributed to mortality, although losses also occurred to thrify trees with good root development. Spruce and fir had the most losses. Red pine, northern white cedar, and hemlock were also affected. Trees, usually less than 10 feet tall, typically died back to within a few inches of the ground early in the season. The Agricultural Stabilization and Conservation Service provided partial reimbursement to qualifying Christmas tree growers who sustained losses greater than 35%.

FROST DAMAGE was not observed.

IMPROPER PLANTING continues to cause tree mortality, and contributed to drought stress. Balsam fir Christmas trees and white spruce and white pine ornamentals were among the species affected by planting too deep. Excessive mulching can exacerbate this problem. Losses were extensive in one plantation where large Douglas-fir seedlings, with poor root:shoot ratio were planted for Christmas trees.

LARCH DECLINE associated with outbreaks of the eastern larch beetle continues in some areas, but is mostly limited to scattered individual trees (see Eastern Larch Beetle). Decline may increase in southern Vermont following this year's outbreak of larch casebearer.

MAPLE CHLOROSIS was aerially detected on 103,390 acres in north-central and northeastern Vermont from about mid-summer on (Table 14, Map 13). Earlier in the summer, these stands had appeared healthy and green, perhaps partially due to sufficient spring rainfall. But by mid-summer, leaves of many hardwood trees, especially sugar maple, turned very chlorotic. Some of these leaves dropped prematurely.

Table 14. Acres of maple chlorosis mapped during aerial survey.

County	Acres
Lamoille	44,140
Orange	14,570
Orleans	3,050
Washington	41,630
Total	103,390

Contributing to the off-color appearance were numerous foliage diseases, including anthracnose, tar spot of maple, and various leaf spots; leaf scorch on some trees; top dieback and small leaves on yellow birch; and a heavy seed crop on red maple in many northeastern locations. Other contributing factors included defoliation by birch leaf miner and birch skeletonizer on birch, and pear thrips and maple leaf cutter on sugar maple. Areas defoliated in the past by forest tent caterpillar and frost were especially noticeable.

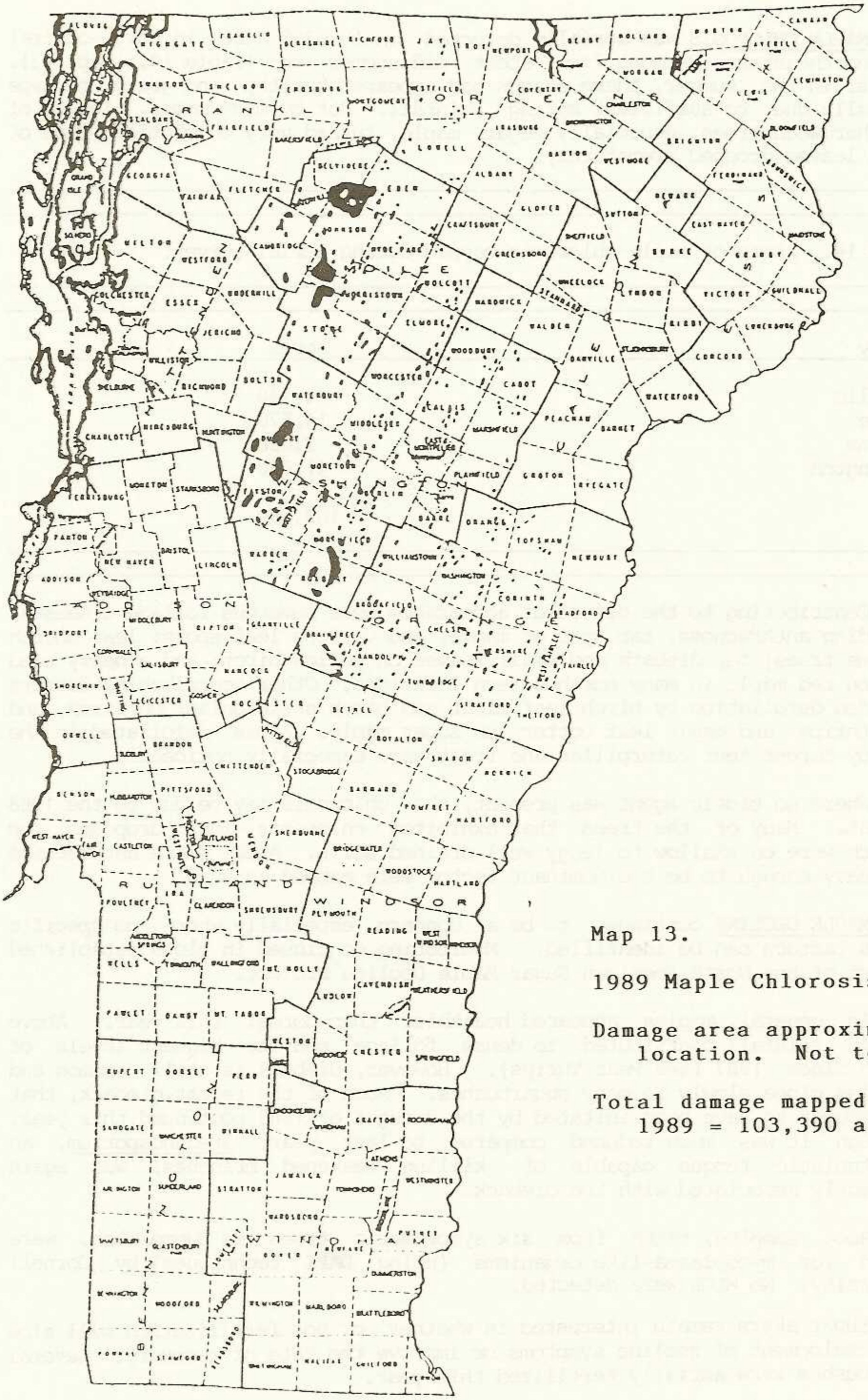
Where no biotic agent was present, the chlorosis may be due to the 1988 drought. Many of the trees that exhibited chlorosis, leaf drop and top dieback were on shallow to ledgy well-drained soils. Areas where anthracnose was heavy enough to be the dominant factor were mapped as such.

MAPLE DECLINE continues to be a concern, especially where no specific stress factors can be identified. Monitoring continued in plots established as part of the North American Sugar Maple Decline Project.

In general, maples appeared healthier than normal this year. Above average rainfall contributed to dense foliage and the highest levels of starch since 1987 (see Pear Thrips). However, dieback is still common and tapholes close slowly in many sugarbushes. Much of the recent dieback, that was thought to have been initated by the drought of 1988 continued this year, although it was much reduced compared to last year. Steganosporium, an opportunistic fungus capable of killing weakened branches, was again frequently associated with the dieback.

Root samples, taken from six symptomatic trees in Dummerston, were tested for mycoplasma-like organisms (using DAPI techniques) by Cornell University. No MLOs were detected.

Sugarmakers remain interested in whether or not fertilization will slow the development of decline symptoms or improve the rate of recovery. Several sugarbushes were aerially fertilized this year.



Map 13.

1989 Maple Chlorosis.

Damage area approximate location. Not to scale.

Total damage mapped in 1989 = 103,390 acres.

NUTRIENT DEFICIENCY is thought to be the cause of chlorosis at the end of white spruce shoots. This symptom is common in Christmas trees and was extensive in one plantation in Windham County.

RED SPRUCE DECLINE continues throughout the state, particularly on high elevation and dry sites. In Essex County, 529 acres of high elevation spruce decline and mortality were detected during the aerial survey.

THINNING SHOCK may lead to dieback where trees fail to respond to selective cutting. This is most severe where weaker trees have been left or site conditions are poor.

WET FEET initiated decline in scattered locations. Where soil conditions force roots to grow near the surface, trees were more vulnerable to last year's drought conditions. Symptoms showed up this year, with secondary agents building in some locations. Pole-sized white pine and Balsam fir Christmas trees were among the species affected.

WHITE PINE NEEDLE BLIGHT was not observed for the second consecutive year.

WINTERBURN was common on recently transplanted conifers because there was no snowcover, and plant tissues were dry going into the winter. Severe dessication led to mortality in some plantations (see Drought).

WOUNDING continues to cause decline and mortality. Mowing damaged Christmas trees. Construction and lawnmower injury to ornamentals were common.

ANIMAL DAMAGE

ANIMAL	SPECIES DAMAGED	LOCALITY	REMARKS
Beaver	Many	Widespread	Increase in complaints from waterfront property owners. Low fur prices have led to a dramatic increase in beaver populations.
Deer	Hardwoods	Rupert Danby	Heavy browse.
Grosbeaks	Sugar Maple	Grafton	Bud damage.
Moose	Mountain Ash	Lemington	Killed numerous 6-8 inch DBH trees at upper elevations.
Mouse	Apples Young Maples	Caledonia County	Increase in reports of damage from overwintering mice.
Porcupine	Many	Scattered	Slight increase in damage and complaints. Damage to telephone line on Pico.
Sapsucker	White Birch Sugar Maple Hemlock	Widely scattered	Remains common.
Squirrel	Sugar Maple Maple tubing	Southern Vermont Widespread	Buds clipped. Complaints down from 1988, although heavy in some sugarbushes.