

FOREST PEST REPORT



MINNESOTA

DEPARTMENT OF AGRICULTURE
DIVISION OF PLANT INDUSTRY

670 STATE OFFICE BLDG
ST. PAUL, MINNESOTA 55101

The photos on the cover are to illustrate some of the multiple uses of Minnesota's forests. Not only are forest trees used for pulp, lumber, and other specialized wood products but for recreation, tourism, wildlife, water and soil retention, oxygen production, and many other aspects. Usage by man is increasing rapidly year by year.

Forest insect and disease pests cause a great dollar loss to these forests annually. In some locations we cannot afford such losses at the present time and will be able to afford less in future years.

Photos - Courtesy of Boise Cascade, Incorporated,
Big Falls, Minnesota and U.S. Forest Service, St.
Paul, Minnesota.

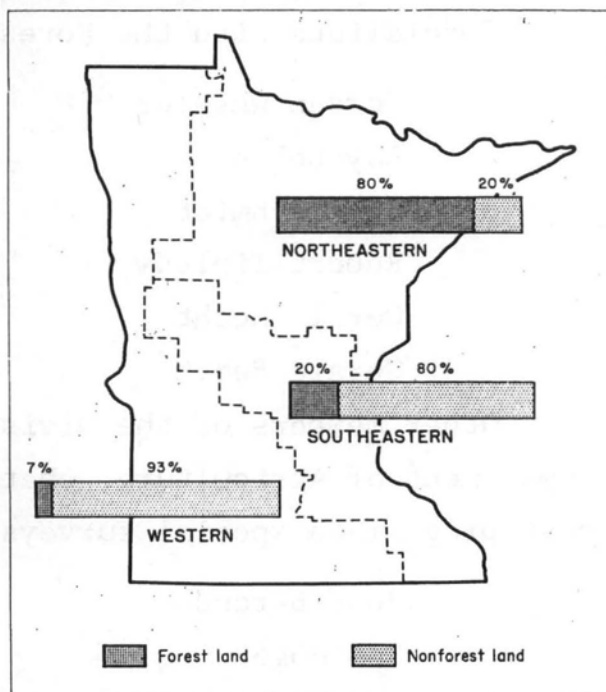
INTRODUCTION

At the present time there is approximately 19,500,000 acres of forested land in Minnesota. About 80% of the commercial forests are located in the northeastern portion of the state. Twenty-five per cent of the forest acreage is of softwood type (pine, spruce, spruce-fir, tamarack, and cedar), 25% is poorly or non-stocked, and 50% is in hardwoods (aspen, birch, oak, elm, maple, and ash). The non-stocked area is composed mainly of low-land brush and is quite swampy.

Public agencies control 56% of the forest area in Minnesota, including two national forests, many state forests, a number of Indian forests, and county and municipal forests.

With increasing utilization of Minnesota's forested area (timber products, recreation, and wildlife habitat), better forest management techniques and direct control of forest insects and diseases that are not only causing extensive mortality but are reducing annual growth and quality need to be implemented at the present time. It is not too far in the future where we will not be able to afford such losses.

The forest pest survey and control program is operated by the Minnesota Department of Agriculture, programming cooperatively with all land managers and industries involved in forests and forest products. The department employs specialists to make surveys of major forest insect and disease problems, to identify



and recommend controls on incidental and minor pests and to program controls of major pests cooperatively with land managing agencies.

The annual forest pest report is a summary of the 1970 field program and contains observations and reports of the Forest Pest Section, Minnesota Department of Agriculture, as well as reports from state, private, county, and federal land managing agencies. In addition, an increasing amount of time is being spent on urban forest and shade tree problems within municipalities each year and is becoming an important part of the forest pest program.

Specialists with the Forest Pest Section are as follows:

Jordan Wheeler	Minneapolis
Ray Dolan	Cloquet
Gene Schmidt	Virginia
Robert Tiplady	Brainerd
Gerald Hecht	St. Paul
Gerald Beach	St. Paul

Other members of the Division of Plant Industry, Minnesota Department of Agriculture, that have helped in the 1970 forest pest program on special surveys are:

John Berends	St. Paul
Bob Hoger	St. Paul
Gary Kuyava	Duluth
Gary Miller	St. Paul
Al Pruszinske	St. Paul
Ken Blanchard (Soil Samples)	St. Paul

Gerald Beach, Supervisor
Forest Pest Survey and Control

SPRUCE BUDWORM
Choristoneura fumiferana (Clem.)

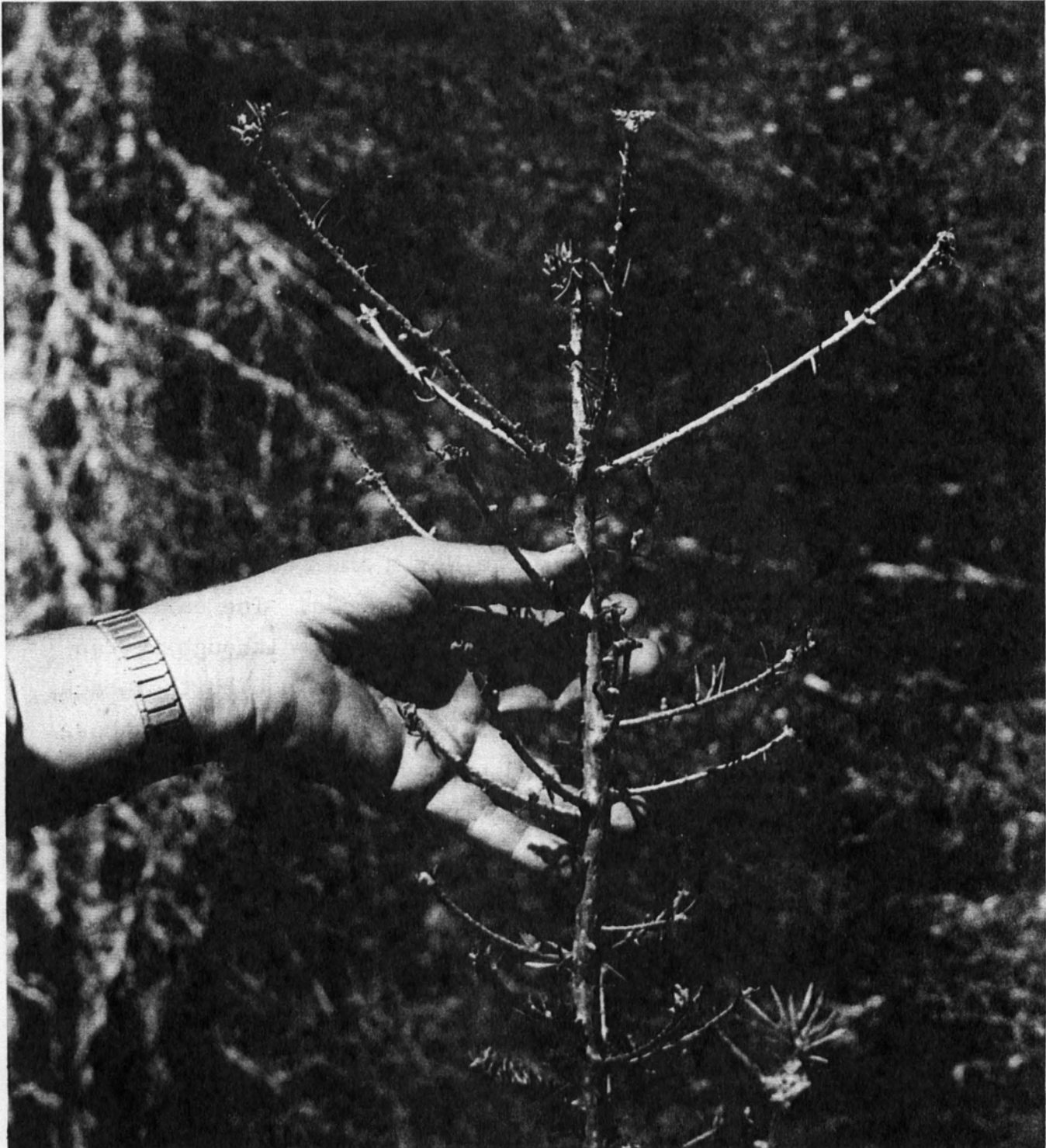
The spruce budworm is the most damaging forest pest in the state of Minnesota and has caused millions of cords of mortality to the white spruce-balsam fir forests in northeastern Minnesota. There is approximately one and one-fourth million acres of white spruce-balsam fir type in Minnesota with about 90% of this in balsam fir.

Balsam fir is the favored host; although white spruce is heavily defoliated, especially when it is mixed with a high percentage of fir.

The spruce budworm is native to North America with recorded defoliation dating to the late 1700's in Canada. The earliest recorded damage in Minnesota goes back to 1912; although it can be assumed that there was severe damage dating much further back, since the Minnesota balsam fir forests are continuous with those of Canada. There was an estimated twenty million cords of balsam fir destroyed by the spruce budworm in the 1912-1918 infestation period. Other heavy defoliation periods were 1923, 1950-1964, and the present population outbreak that started in 1967 in southeastern Koochiching County.

In 1968, there was moderate to heavy defoliation in Koochiching, St. Louis and into Lake Counties over a 275,000 acre area. In 1969, there was moderate to heavy defoliation over a gross area of 1,958,000 acres of which about 25% is white spruce-fir type or slightly less than 500,000 acres of actual type.

In 1970, the area of defoliation was about the same as in 1969, although damage was heavier than last year. An estimated 250,000 cords of balsam fir were destroyed



Defoliation of Understory Balsam Fir by the Spruce Budworm-
Courtesy of Boise Cascade, Incorporated, International Falls,
Minnesota.

from budworm defoliation in 1970. In addition, there is top-kill on approximately 5% of the type over 200,000 acres of balsam fir. With lessened vigor, other insects and diseases will eventually add to the mortality figure. Thus with present and projected mortality from 1970 damage, the economic loss in stumpage values approaches \$750,000 to one million dollars. Added to that is growth loss over the balance of the defoliation area.

1970 Surveys and Results

A. Aerial Survey - July 8-10

Flight Program - flight observations at 1000 feet and flight lines four to twelve miles apart in an east-west direction. In observable defoliation areas, flight lines were four to six miles apart. In light or non-defoliation areas flight lines were twelve miles apart. Follow-up ground surveys were made in a number of areas to correlate aerial findings and to record light defoliation that could not be observed from a 1000 foot altitude. Observations were sketched on large scale maps. Flight time totaled 22.5 hours with two observers and a navigator in addition to the pilot.

Observations - The defoliation recorded by aerial and ground observation extended over approximately a 2.3 million gross acreage area or about 500,000 acres of white spruce-balsam fir type. (See map on following page.)

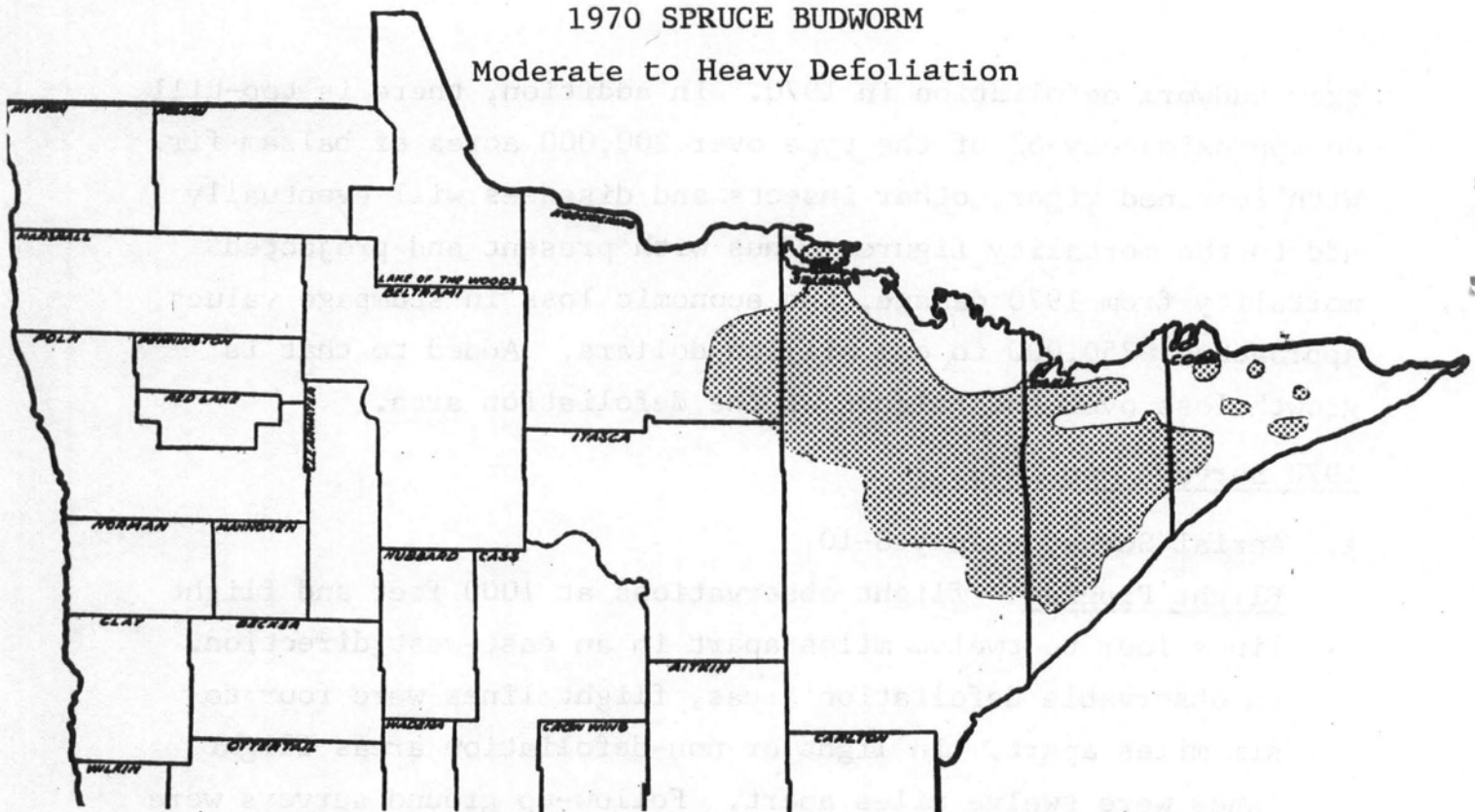
B. Ground Surveys -

Ground surveys were made primarily to supplement the aerial program. Since most of the spruce budworm defoliation area has little or no all-season roads, a detailed survey system would be too time consuming to get good records. In making each check, branches were cut and both new and old foliage retention was determined.

C. Egg Mass Survey - August 1-15

Three to five 15-inch twig samples were taken from balsam

1970 SPRUCE BUDWORM
Moderate to Heavy Defoliation



fir plots established in Koochiching, St. Louis, Lake, and Cook Counties. The objective was to reveal a possible population trend. In comparing 1970 egg mass counts to those in 1969, there appears to be a slight downward trend in most areas; although the final determination on such a trend will be the overwintering population success. Below is an average of egg mass counts per 15-inch balsam fir twigs for a number of locations in northeastern Minnesota. The numbers below are an average for each of the regions.

<u>Location</u>	<u>Average No. of Egg Masses Per 15" Twig</u>
Kabetogama Peninsula (East of Intl. Falls, Minnesota)	1.73
Northeast Koochiching County (South of Black Bay of Rainy Lake)	.71
Southeast Koochiching County (West of Nett Lake)	2.66

<u>Location</u>	<u>Average No. of Egg Masses Per 15" Twig</u>
Northeast of Cook County (area at end of Gunflint Trail)	1.04
Southern Lake County	.68
Northern Half of St. Louis County (Road accessible locations)	2.94

Most of the 15-inch twig samples were taken from the mid-crown area of balsam fir. None were taken from white spruce. Since the above figures are averages, there are sample trees showing much higher counts and some lower. The tree with the highest count that was sampled was in northern St. Louis County with 32 egg masses from three 15-inch twig samples or 10.67 egg masses per twig sample.

All of the plots within a defoliation area (light to heavy) indicated a continued and increasing spruce budworm population and defoliation problem. The aforementioned slight egg mass decrease does not indicate a population decrease but only a slowdown in the population increase.

Projected 1971 Control Programs

Meetings were called by the Minnesota Department of Agriculture and included all major forest landmanagers in the spruce budworm threatened areas. The meetings were held at Boise Cascade Inc., International Falls, Minnesota on September 24 and again on November 5 to discuss the problem, present viewpoints, markets and other economic aspects, and possible 1971 chemical controls. It was determined there would be no 1971 chemical control program, but suggestions were made to consider field tests on several chemicals. At the present time, only malathion is registered for such use and control has been generally unsatisfactory with this chemical. There is a vital need for a chemical that will give reasonably long range control (several years) and that will have no adverse effect on the environment.

1970 Spruce Budworm Development

June 5 - Larvae mostly in the second instar with some in third in northern Minnesota. Buds and needles are being mined and defoliation is just beginning to show.

June 10 - Mostly in third instar with some in fourth. An average of 15% of the new growth defoliated in high population areas.

June 19 - Most larvae in the fifth and sixth instars.

FOREST TENT CATERPILLAR

Malacosoma disstria (Hbn.)

The present forest tent caterpillar high population cycle started in 1963 in northern Minnesota in the vicinity of Lake Kabetogama and Lake Namakan. Since that time, the defoliation area has moved eastward slightly and then west and southwestward for the last several years.

The 1970 heavy defoliation area was primarily in Koochiching County with a smaller amount in northwestern St. Louis County adjacent to the Koochiching line. Two additional small outbreaks occurred in Ottertail and Douglas Counties. Light and scattered defoliation occurred in the balance of Koochiching and in portions of Lake of the Woods, St. Louis, Itasca, Beltrami and Lake Counties as delineated on the map. The total acreage of heavy defoliation was approximately 400,000 acres. Light to moderate (15 to 55%) defoliation occurred over an estimated 200,000 acres and very light defoliation (1 - 15%) over 3.5 million acres. Aspen, the primary host of the forest tent caterpillar, approximates slightly less than one-third of the forest type in the problem area. Most of the defoliation in the "very light" zone is not noticeable unless trees are cut with very close observation.

The Ottertail County defoliation area covered approximately 200 acres adjacent to Clitherall Lake and Battle Lake. Defoliation was 40-50%. Basswood and elm were the primary hosts.

The Douglas County area was adjacent to Lobster Lake and covered about 125 acres. Defoliation was 60-70% on basswood and elm.

Aerial Survey - July 1-3

Two separate aerial surveys were conducted on the forest tent caterpillar in 1970. One flight originated from International Falls and the other from Grand Rapids.

Objective - to determine hardwood defoliation from reported infestation areas in the northern half of Minnesota. Forest tent caterpillar, large aspen tortrix, and aspen leaf tier defoliation coverage was programmed over eastern St. Louis, Koochiching, northern Itasca, northern Lake of the Woods, and portions of Beltrami, Hubbard, Cass, Wadena, Ottertail, and Douglas Counties.

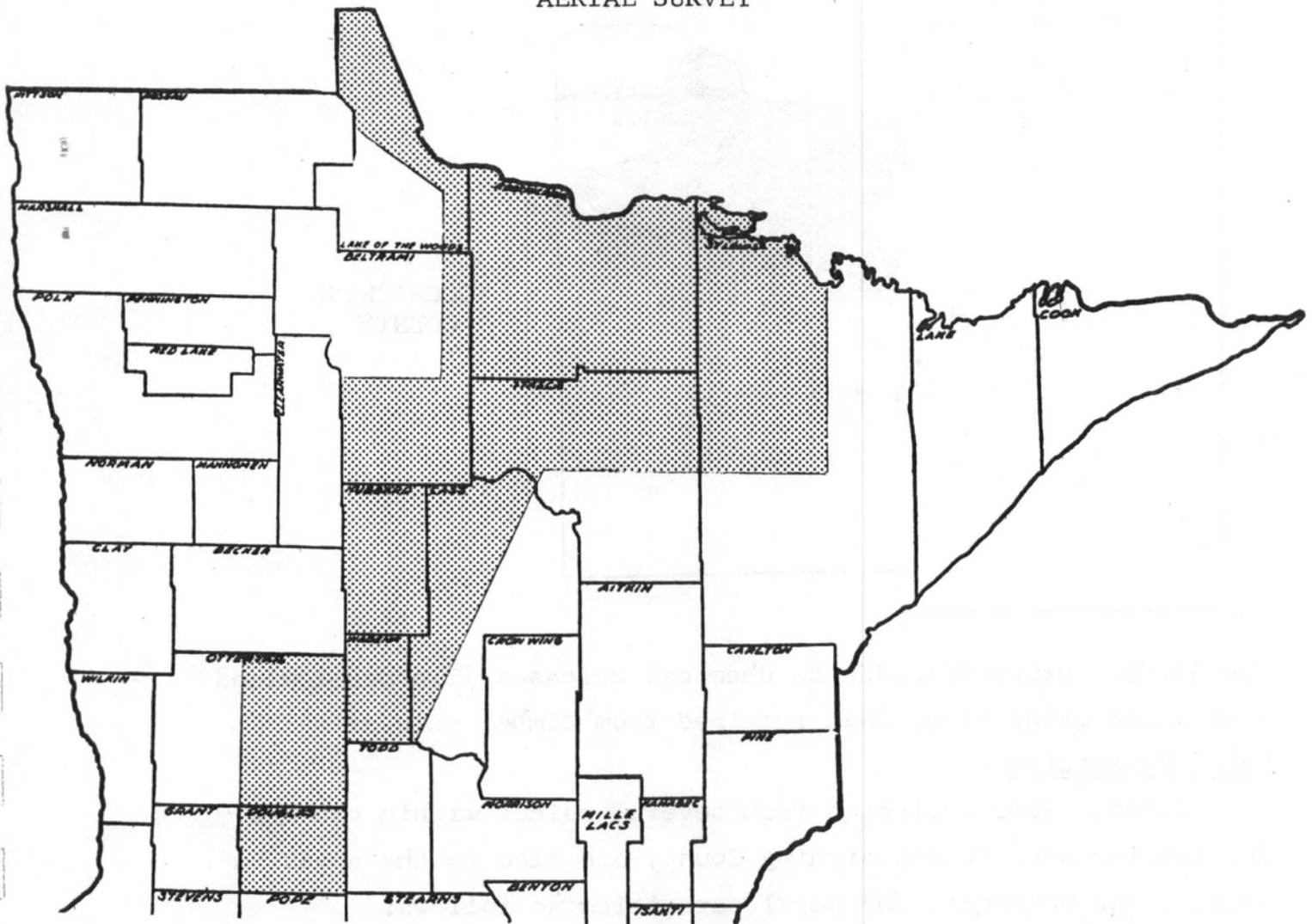
Methods - Cessna 180's were used in each flight at 1000 feet altitude. Flight lines were generally six to twelve miles apart. Two observers recorded on large scale maps while a navigator checked flight lines and notified observers of sections and townships by roads and other landmarks.

Results - Aspen defoliation in excess of 40% was recorded in Koochiching County with very little in northwestern St. Louis. The gross area of defoliation (60-100%) was approximately 400,000 acres. In addition, there were the two small locations in Ottertail and Douglas Counties. The heavy defoliation area moved slightly westward and about ten miles southwest from the 1969 area in Koochiching County.

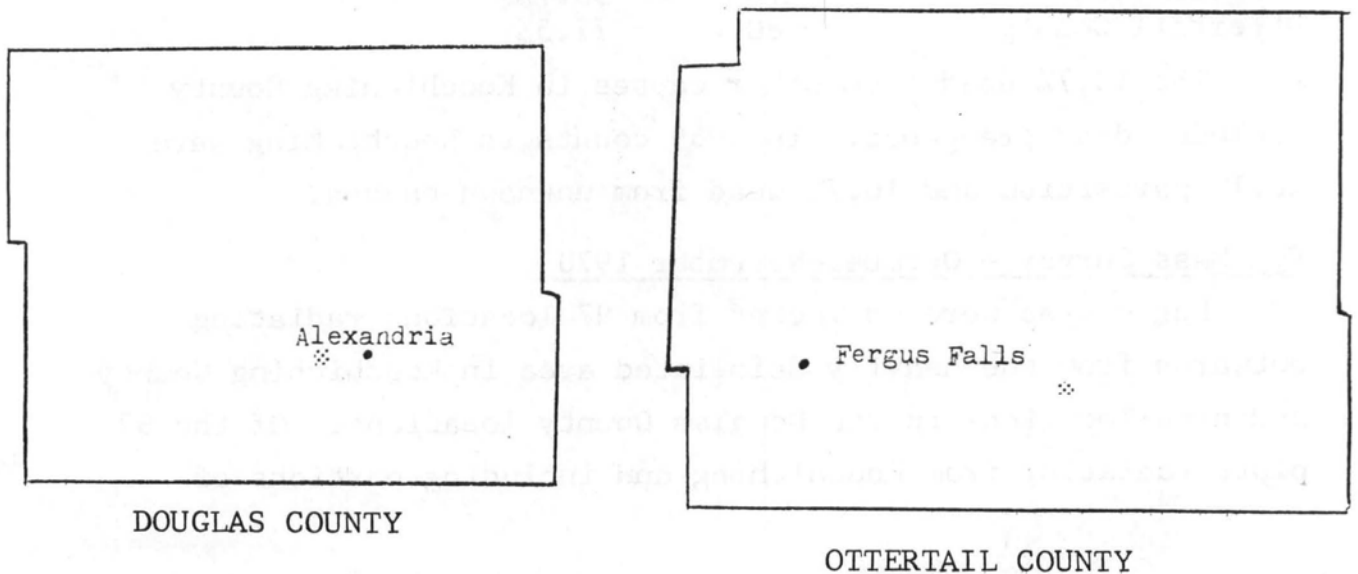
Ground Surveys -

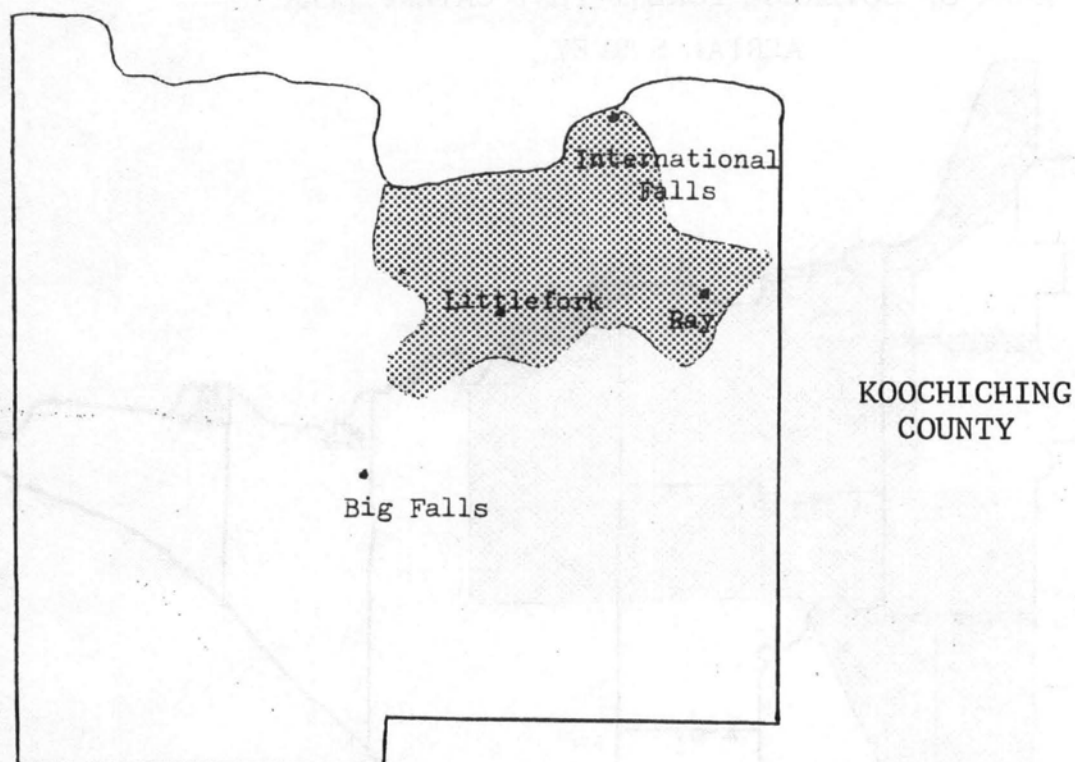
Ground surveys were made to check the nature of problems of all areas observed during the aerial survey. Defoliation levels and the causal agents were recorded. Other than the forest tent caterpillar, the aspen leaf tier (*Enargia decolor*) and the large aspen tortrix were responsible for aspen defoliation. Some of the other locations with "defoliation" observed during

AREA OF COVERAGE-FOREST TENT CATERPILLAR
AERIAL SURVEY



1970 FOREST TENT CATERPILLAR
HEAVY DEFOLIATION AREAS





the aerial survey were due to chemical releases, flooded lowland areas, and dying trees that remained from timber sale areas.

Pupal Parasitism -

Cocoons were collected from several points within the heavy defoliation area in Koochiching County and also in the spots in Douglas and Ottertail for pupal parasitism as follows:

<u>Location</u>	<u>No. of Cocoons</u>	<u>Parasitism</u>	<u>Dead from Other Causes</u>
Koochiching County	1548	56.4%	13.7%
Douglas County	79	55.7%	
Ottertail County	80	77.5%	

The 13.7% dead from other causes in Koochiching County includes dead pre-pupae. In 1969 counts in Koochiching were 48.1% parasitism and 16.7% dead from unknown causes.

Egg Mass Survey - October-November 1970

Egg masses were collected from 97 locations radiating outwards from the heavily defoliated area in Koochiching County and nine locations in the Douglas County locations. Of the 97 plots radiating from Koochiching and including portions of

Beltrami, Itasca, Lake, Lake of the Woods, Roseau, and St.

Louis Counties, no egg masses were found in 37 locations. The

60 plots with egg masses are listed below.

<u>County</u>	<u>S</u>	<u>T</u>	<u>R</u>	<u>Ave. Egg Mass/Tree</u>	<u>Location</u>
Itasca	10	62	27	.3	Jct. Minn. #1 & #6
	13	148	25	.3	Talmoon
	30	60	22	.33	13.5 S. of Jct 1 & 65 on 65
	18	61	22	.67	Jct. Thistledeew Rd & 65 on Thistledeew
	35	62	24	.33	13.1 mi E. of Effie on 1
	24	62	25	.33	8.3 mi E of Effie on 1
Koochiching	17	160	28	1.0	E. of Border
	25	160	28	2.3	W. of Birchdale
	31	159	26	2.7	E. of Birchdale
	6	159	25	39.0	3 mi. W. Indus
	35	160	26	2.7	W. of Indus
	3	158	25	10.5	1.2 W of Loman on S side of Hwy. 71
	22	158	27	1.0	15 mi SW of Loman
	25	158	26	1.3	8 mi SW of Loman
	5	69	26	32.0	1 mi S of Hwy 11 E of Loman near river
	36	69	26	17.0	W. of Pelland
	25	70	25	17.0	W. of Intl. Falls
	20	69	25	17.3	S. of Pelland
	23	68	26	36.7	4 mi SW of Littlefork
	6	67	26	5.0	8 mi SW of Littlefork
	30	67	26	1.7	North of Big Falls
	26	155	27	1.3	15 mi W of Big Falls
	26	155	26	.3	7 mi W of Big Falls
	3	154	25	2.3	Big Falls
	30	154	25	.3	5 mi SW of Big Falls
	16	153	26	.3	SW of Margie
	17	65	26	1.0	5 mi S of Big Falls
	24	64	26	.7	13 mi S of Big Falls
	6	68	22	4.67	Jct 53 & Co Rd. 3 on 3
	9	69	23	33.0	Jct 53 & 110 on 53
	2	69	23	28.67	Jct 53 & 119 on 119
	26	70	24	26.67	2.9 mi S of S Intl. Falls on 53
	11	70	24	18.67	Jct Airport Rd & 53 Townledge S Intl. Falls

<u>County</u>	<u>S</u>	<u>T</u>	<u>R</u>	<u>Ave. Egg Mass/Tree</u>	<u>Location</u>
Koochiching	5	68	23	28.0	4.9 mi W of Ray on 217
	9	68	24	38.33	10.3 mi W of Ray on 217
	33	67	25	4.0	10 mi S of Jct 217 & 65 on 65
	2	65	24	.67	21.2 mi S of Littlefork on 65
	36	63	26	.67	4.7 N of Effie on Co. Rd. 5
	32	65	25	2.33	15.8 mi N Effie on Co. Rd. 62
	19	66	26	4.33	Jct Deer River Line and 62
	25	156	25	5.33	7.1 mi N Jct 13 & 71 on 13
	12	66N	26	1.0	West side of Hwy 71
	23	66	26	.67	7.3 E of Big Falls on Co. Rd. 31
	5	66	24	1.0	4.5 mi E Jct 65 & 8 on 8
	29	68	24	11.0	7 mi SE of Jct City 8 & 217
	12	67	24	.33	6.5 mi S of Galvin Truck Tr
	2	67	23	.67	7 mi S Jct 29 & 217 on 29
	27	65	21	.33	3.9 mi E of Nett Lake
Lake	3	62	11	.33	1 mi W of E end of Lake Co. #16
	27	60	10	.33	.6 mi S Jct Two Harbors Rd on 1
Lake of the Woods	9	160	30	.3	W. of Clementson
	5	158	31	.3	S. of Baudette
Roseau	12	162	36	.3	W. of Roosevelt
St. Louis	11	55	15	.33	Co Rd 4, Jct, White Face Forest Rd.
	8	57	15	.33	1.6 mi W of Jct 99 & 100 on 100
	2	61	16	1.0	1.1 Mi E Jct 169 & 1 on 169
	36	64	18	.33	9 mi W of Vermillion R. on 24
	32	64	21	2.33	2.4 mi W of Greeney
	11	68	21	1.33	Jct Ash River Rd & 53 on Ash R. Rd.

Douglas County - Lobster Lake

Sugar Maple - Ave. 6 inch DBH -- Average 5 egg masses/
tree

Ottertail County - Clitherall Lake

Basswood - Ave. 5 3/4 inch DBH -- Average 9 egg masses/
tree

Ottertail County - West Battle Lake

Basswood - Ave. 6 inch DBH -- Average 6 egg masses/
tree

The Ottertail and Douglas counts were taken from within the
defoliation area.

The results of the egg mass survey is combined with
defoliation observations and larval reports to give a prediction
map for the forthcoming year. Natural factors can affect forest
tent caterpillars to a high degree between the time of such a
prediction and egg hatch, survival, and defoliation during May
and June of the following year. Thus, the map on the next page
is based on normal weather conditions that would be reasonably
favorable to the forest tent caterpillar.

To obtain egg mass distribution, the above plots were
established and three co-dominant aspen were selected from each
plot. All branches and twigs were clipped, egg masses were
counted and put in bags for egg parasite counts.

Egg Parasitism

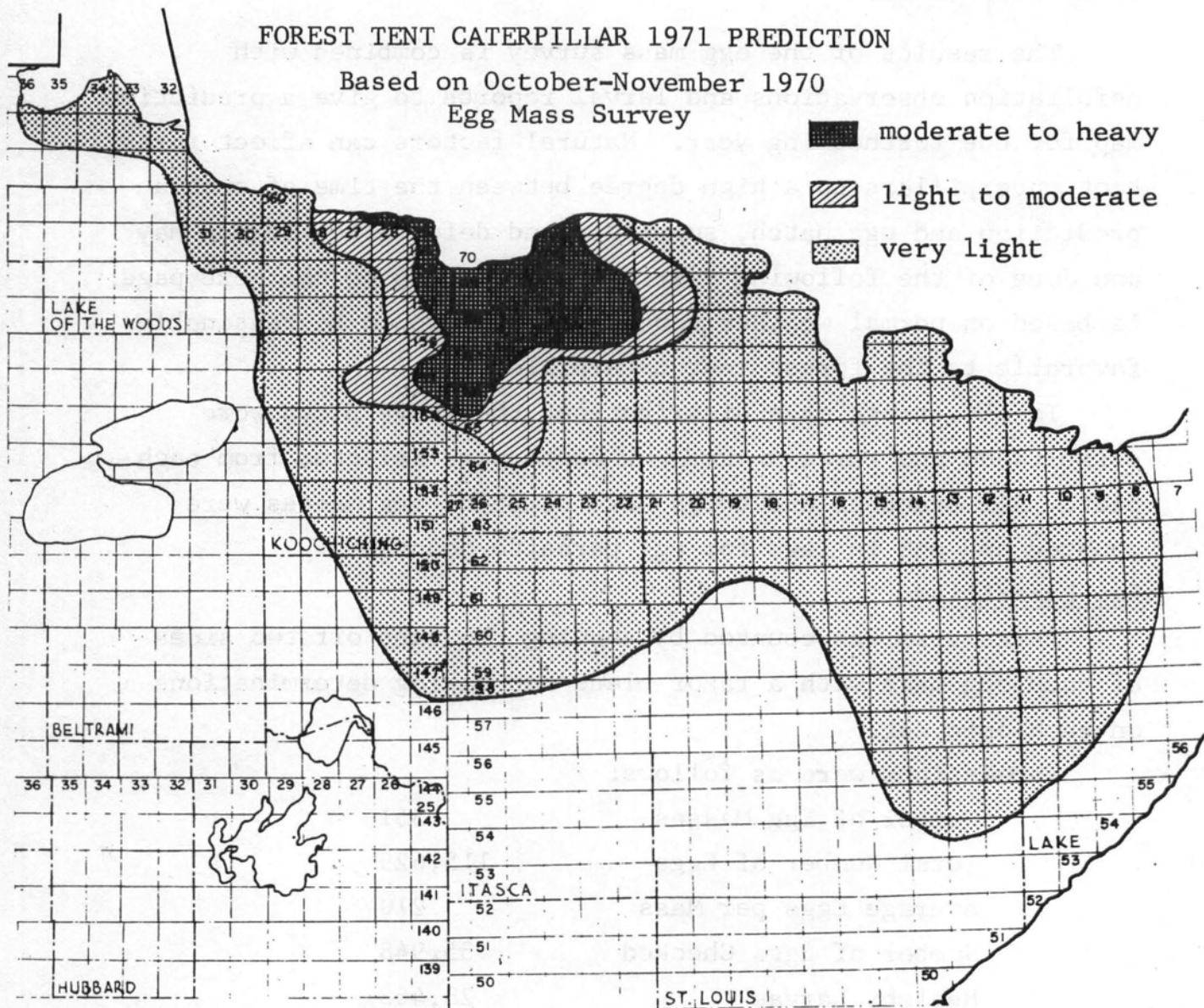
Parasitism was counted by shaving the caps off two sides
of each egg mass with a razor blade and making determinations
on each open egg.

Tabulations were as follows:

Number of Egg Masses	551
Total Number of Eggs	115,629
Average Eggs per Mass	210
Number of Eggs Checked	35,948
Healthy Larvae	28,463

Parasitized Larvae	3,930
Dead Larvae or Dead Eggs	3,597
Percentage of Healthy Pre-Larvae	79.18%
Percentage of Parasitized Eggs	10.94%
Percentage of Dead Larvae	3.69%
Percentage of Dead Eggs	6.19%

The category "healthy larvae" are unhatched pre-larvae.



1970 Economic Losses Due to Forest Tent Caterpillar Defoliation of Aspen

There are several categories of loss from defoliation: mortality, growth loss, reduced vigor (with other causal agents increasing the problem), and where the above losses affect recreation and aesthetic aspects.

It is virtually impossible to estimate some of the losses, but there is reasonable estimates of past losses that can be compared to get some approximation of present losses. About 30% of the 400,000 gross acreage is made up of aspen type. When there is two to three years of successive defoliation in the same location, losses have averaged about one cord per acre over the total defoliation period (two to three years). Approximately 100,000 acres of aspen type has received heavy defoliation from 1968 to 1970. About 100,000 acres of aspen type have received one year of heavy defoliation or two or more years of light-moderate defoliation. The total 1970 estimated growth losses are in the neighborhood of 135,000 cords with a stumpage value of \$1.00 per cord and a delivered value of \$16.50 per cord.

The recreation-aesthetic category affects municipalities within the affected areas and tourism (especially the resort trade). Although the present problem does not include too much of this category, past forest tent caterpillar high population cycles have seriously, although temporarily, impaired this area. Tourists will not come into a "supposed" beautiful forested-lake area that is denuded of leaves and over-run with "worms."

Other Natural Controls

"Sacking out" of forest tent caterpillar larvae (dead or apparently dead larvae in a limp position) was noted in several locations in the northern infestation, but was most conspicuous in the Ottertail County infestation near Clitherall Lake. Unfortunately, no affected larvae were collected for laboratory

examination. A program is being developed now for a close look at the viruses that affect the forest tent caterpillar in 1971.

1970 Forest Tent Caterpillar Development

May 12-13 Beginning egg hatch reported in northern Minnesota.

May 15-16 Heavy egg hatch in the International Falls area.

May 22 Virtually all viable forest tent caterpillar eggs hatched.

June 12 Larval range one to one and one-half inches in the International Falls area. Defoliation very apparent. Few spots to 70%. Some migrations across Highway 53 at Ericsburg and Highway 11 near the junction of 11 and 71.

June 15 Most of the larvae are two inches in length in Ottertail County. Some spinning cocoons.

June 26 Feeding almost complete with most forest tent caterpillars in pre-pupal and pupal stages.

July 24 Forest tent caterpillar defoliated aspen almost completely refoliated. Leaves are much smaller than normal and lighter green.

LARGE ASPEN TORTRIX

Choristoneura conflictana (Wlk.)

The present widespread-heavy defoliation period of the large aspen tortrix started in 1969 where moderate to heavy damage was recorded in scattered locations in Beltrami, Lake of the Woods, Hubbard, Koochiching, Cass, Itasca, and Carlton Counties and large areas in St. Louis, Lake and Cook Counties.

The year, 1970, was the second successive year of severe large aspen tortrix defoliation in St. Louis, Lake, and Cook Counties. Much of the defoliation this year is in the same general location as last year, only more widespread. Thus, about 40% of the area depicted on the map has received two severe defoliations.

Aerial Survey - July 8-10

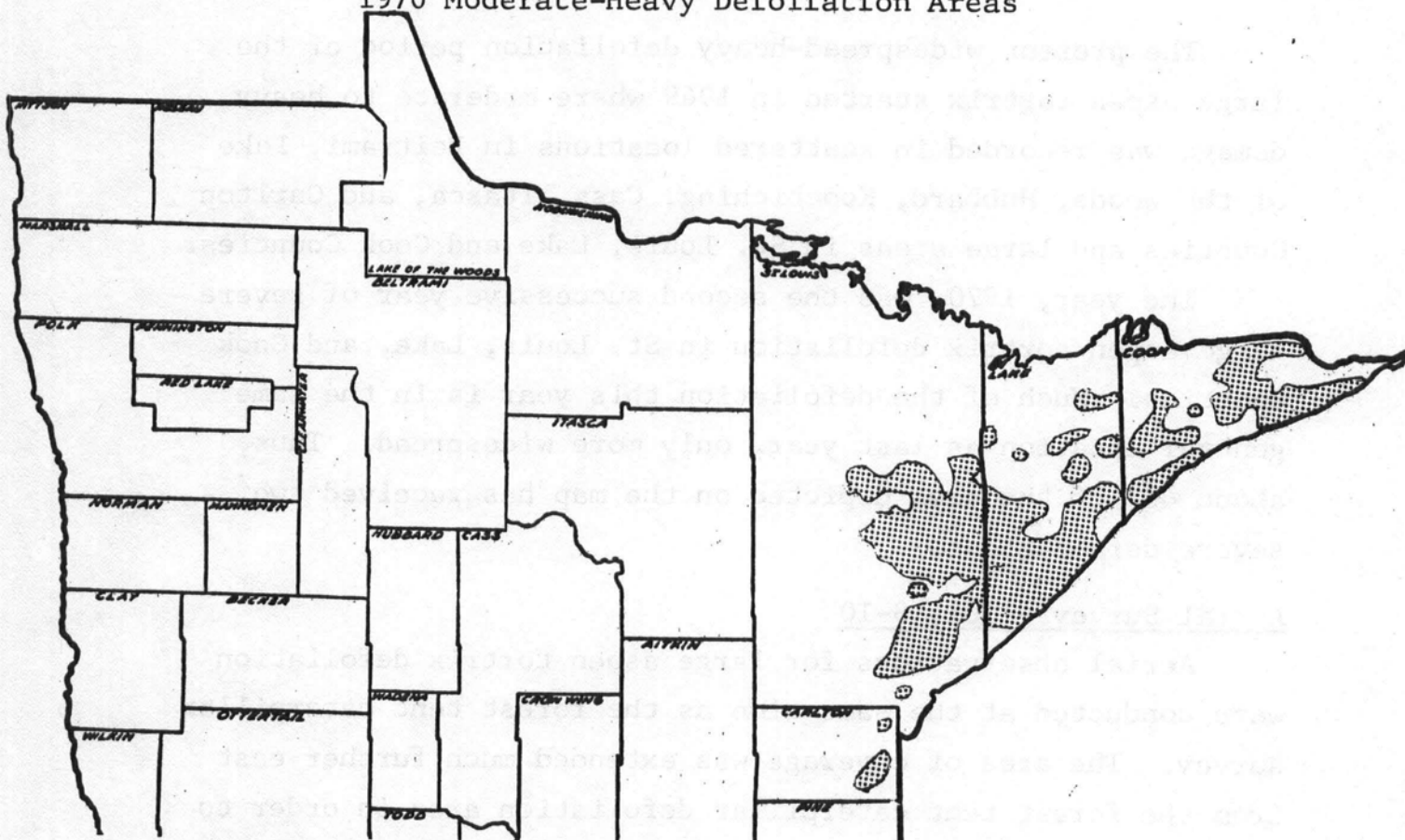
Aerial observations for large aspen tortrix defoliation were conducted at the same time as the forest tent caterpillar survey. The area of coverage was extended much further east from the forest tent caterpillar defoliation area in order to pick up the extensive damage on aspen in St. Louis, Lake, Cook, and Carlton Counties. Flight lines were the same as for forest tent caterpillar, six to twelve miles apart, at an altitude of 1000 feet. Aerial observation could not detect defoliation less than 30%.

Ground Surveys

Ground surveys were made in the heavy defoliation areas of St. Louis, Lake and Cook Counties, as well as spot surveys and defoliation reports in most other counties in north-central

Minnesota. Light to moderate defoliation was recorded in many scattered locations in Itasca, Koochiching, Beltrami, Lake of the Woods, Cass, and Pine Counties; as well as locations outside the heavy defoliation areas in Carlton, Cook, Lake, and St. Louis Counties. The results of all the surveys are indicated on the map.

LARGE ASPEN TORTRIX
1970 Moderate-Heavy Defoliation Areas



1970 Development

June 5 - The early instars of the large aspen tortrix were approximately one-fourth inch long and were defoliating and rolling aspen leaves.

June 19 - Heavy defoliation apparent on aspen. Large aspen tortrix about 90% in pupation.

July 24 - No egg hatch reported at this date.

July 31 - Aspen tortrix mostly in the second instar and feeding on the upper epidermis of aspen leaves. The second instar larvae will seek bark crevices and duff at the base of the tree to overwinter shortly.

1970 Economic Loss

About 560,000 acres of aspen type (over 1.5 million gross acres) was heavily defoliated in 1970. Approximately 200,000 acres has received two successive heavy defoliations. An estimated 1970 loss is 330,000 cords of aspen, which includes both growth loss and a small amount of mortality. At the standard stumpage rate of \$1.00 per cord, this would be a minimum loss of \$330,000.00. If projected at the delivery price of \$16.50 per cord or the value in the retail product form, such dollar losses would be much higher.

In addition to the fiber loss, there are some values that cannot be estimated, where defoliation is in recreation areas or other locations that attract the tourist because of the wooded lakeside scenery. This value is increasing each year.

What can be done to reduce or eliminate such losses is difficult to say at this time. The Minnesota Department of Agriculture is programming increased 1971 biological evaluations aimed primarily at parasites and virus diseases. It is hoped that such efforts, combined with those of other cooperative agencies, will eventually implement such natural forces to reduce or control predictable defoliation outbreaks.

Natural Controls

Twelve hundred large aspen tortrix pupae were collected from Carlton, Cook, and St. Louis Counties. Twenty-six per cent were parasitized and 49% were dead from unidentified causes. Since "sacked out" (flaccid) larvae were quite commonly observed, it is possible that a virus disease is at least partially.

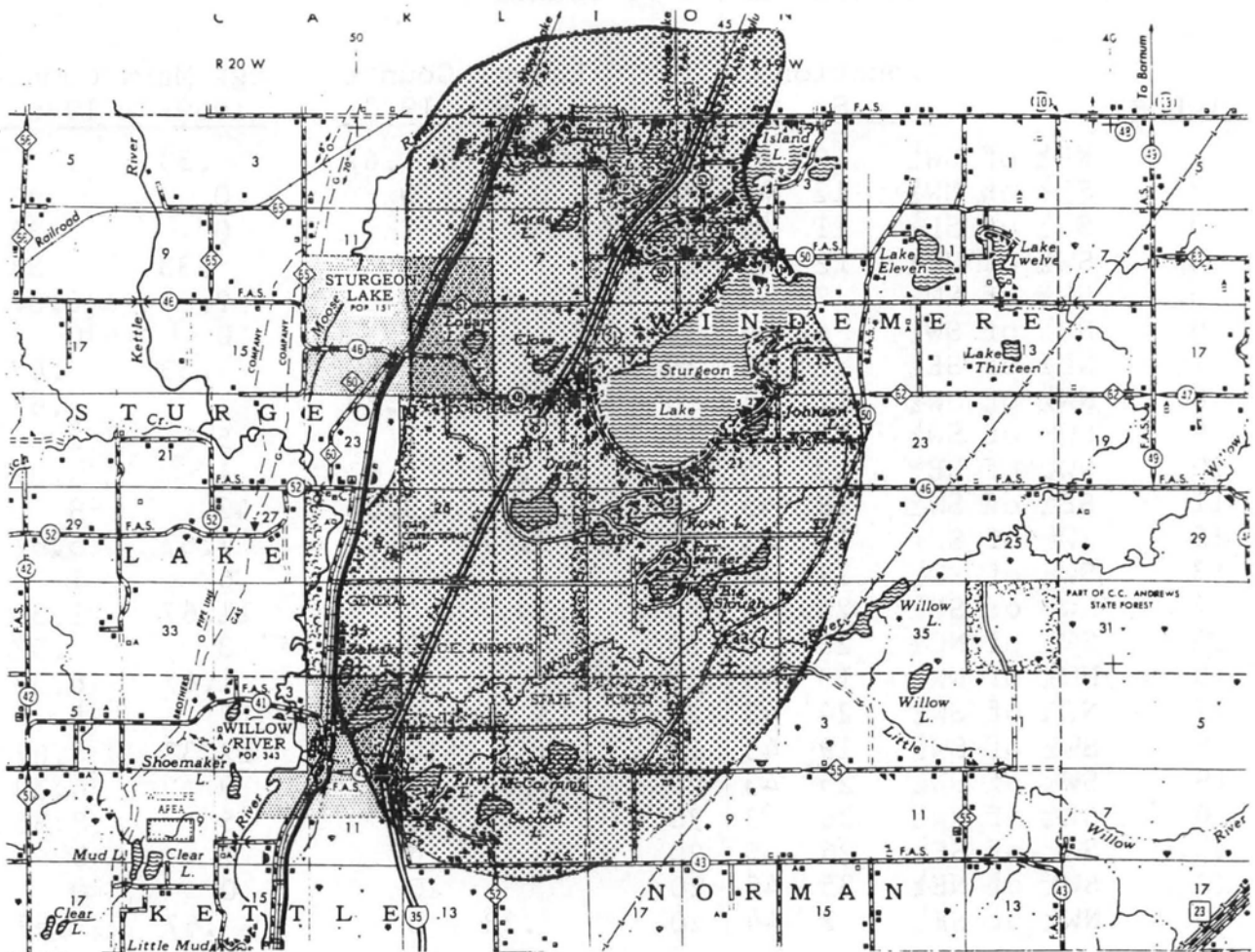
responsible for the high percentage of dead, unparasitized pupae.

1971 Forecast

Egg mass sampling was done in Carlton, Cook, and St. Louis Counties in scattered locations. In comparing the counts to those taken in 1969, it appears that the large aspen tortrix population will trend downwards somewhat in 1971, especially in the Cloquet Valley area north of Duluth and in Carlton County.

PINE TUSSOCK MOTH
Dasychira plagiata (Walker)

A population increase of pine tussock moth was recorded in 1968 when dropcloth counts increased several times from those of 1967. The location was again northern Pine County near Willow River, Minnesota where the pine tussock caused serious mortality to jack pine in 1961. In 1969, populations of the pine tussock were increased but not to a level where chemical control was needed. Defoliation was noticeable in several spots in northern Pine County but was generally light. The area of defoliation covered about 4,000 acres of jack pine.



1970 Pine Tussock Very Light to Moderate Defoliation

Populations in 1970 did not increase as were expected but moderate defoliation was again apparent in the tops of jack pine in a few scattered locations of northern Pine County. Populations throughout the rest of Minnesota were "normal" with the usual zero tussock larvae per dropcloth in most all checks. There would be an occasional one or two larvae found.

Egg mass surveys indicated that the 1971 problem will remain about the same as 1970 with a slight shift in location, possibly due to prevailing winds during moth flight. The areas with the highest egg mass counts were generally plantation and wolf-type jack pine.

Larval and Egg Mass Counts in Willow River Area - A Comparison
of 1969 and 1970 Counts

Plot #		Location			Larval Counts		Egg Mass Counts	
		S	T	R	1969	1970	1969	1970
1	NE $\frac{1}{4}$ of NW $\frac{1}{4}$	12	45	20	1	.67	.33	1
2	SE $\frac{1}{4}$ of NW $\frac{1}{4}$	12	45	20	0	0	0	.33
3	SE $\frac{1}{4}$ of SE $\frac{1}{4}$	11	45	20		1	0	.33
4	SW $\frac{1}{4}$ of NE $\frac{1}{4}$	12	45	20	1	1	.33	.33
5	SW $\frac{1}{4}$ of NW $\frac{1}{4}$	7	45	19	.67	5	2.33	6.67
6	NE $\frac{1}{4}$ of SW $\frac{1}{4}$	6	45	19			0	0
7	NE $\frac{1}{4}$ of SE $\frac{1}{4}$	7	45	19		.33	.33	.67
8	NW $\frac{1}{4}$ of SW $\frac{1}{4}$	17	45	19		.33	1	.67
9	SW $\frac{1}{4}$ of SW $\frac{1}{4}$	17	45	19		1	5	2
10	NW $\frac{1}{4}$ of NE $\frac{1}{4}$	19	45	19	.33	.67	1	.67
11	SE $\frac{1}{4}$ of SW $\frac{1}{4}$	18	45	19	19	13.67	43	8
12	SW $\frac{1}{4}$ of SE $\frac{1}{4}$	13	45	20	5.67	2.67	7.67	5.67
13	SW $\frac{1}{4}$ of SW $\frac{1}{4}$	18	45	19		1.33	6	1
14	NW $\frac{1}{4}$ of SE $\frac{1}{4}$	24	45	20	11	4	11.67	1.33
15	SW $\frac{1}{4}$ of NE $\frac{1}{4}$	23	45	20		0	3	.33
16	NW $\frac{1}{4}$ of NW $\frac{1}{4}$	13	45	20	3	5.67	1.67	6.33
17	NE $\frac{1}{4}$ of SW $\frac{1}{4}$	24	45	20	13	8	17	5
18	SW $\frac{1}{4}$ of SW $\frac{1}{4}$	19	45	19	15	10.33	12.33	6.67
19	SW $\frac{1}{4}$ of SW $\frac{1}{4}$	25	45	20	6.33	4.67	9	6.33
20	SE $\frac{1}{4}$ of NW $\frac{1}{4}$	36	45	20		6	5	8.33
21	SW $\frac{1}{4}$ of SE $\frac{1}{4}$	26	45	20		0	1	0
22	SW $\frac{1}{4}$ of NE $\frac{1}{4}$	35	45	20		0	0	0
23	NW $\frac{1}{4}$ of NE $\frac{1}{4}$	2	44	20	.33	0	.67	.67

Plot #	Location	Location			Larval Counts		Egg Mass Counts	
		S	T	R	1969	1970	1969	1970
24	NE $\frac{1}{4}$ of NE $\frac{1}{4}$	2	44	30	1.33	1	.33	.67
25	NE $\frac{1}{4}$ of NW $\frac{1}{4}$	11	44	20		0	.33	0
26	SE $\frac{1}{4}$ of NE $\frac{1}{4}$	11	44	20	0	0	0	0
27	NW $\frac{1}{4}$ of SW $\frac{1}{4}$	12	44	20		.33	0	1.67
28	NE $\frac{1}{4}$ of NE $\frac{1}{4}$	13	44	20	.33	0	.33	2.33
29	NE $\frac{1}{4}$ of SW $\frac{1}{4}$	7	44	19		0	0	0
30	NE $\frac{1}{4}$ of NW $\frac{1}{4}$	8	44	19		0	.67	0
31	NE $\frac{1}{4}$ of SW $\frac{1}{4}$	5	44	19	0	2.67	1.67	3.33
32	NW $\frac{1}{4}$ of NW $\frac{1}{4}$	4	44	19		0	.33	.67
33	SW $\frac{1}{4}$ of NW $\frac{1}{4}$	5	44	19		5	2.33	8
34	SE $\frac{1}{4}$ of NW $\frac{1}{4}$	6	44	19		15.67	10	18.33
35	SW $\frac{1}{4}$ of NW $\frac{1}{4}$	6	44	19	.33	13.67	13	16.33
36	NE $\frac{1}{4}$ of NE $\frac{1}{4}$	12	44	20		1.67	2.33	4
37	SE $\frac{1}{4}$ of SW $\frac{1}{4}$	27	45	19	0	2	0	2.67
38	NE $\frac{1}{4}$ of NW $\frac{1}{4}$	29	45	19		1	.33	1
39	SE $\frac{1}{4}$ of NW $\frac{1}{4}$	30	45	19	2.33	5.67	8.67	13
40	SW $\frac{1}{4}$ of SW $\frac{1}{4}$	29	45	19	1.33	4.67	2	6
41	SE $\frac{1}{4}$ of SE $\frac{1}{4}$	25	45	20	20	23	44.33	21.33
42	SE $\frac{1}{4}$ of SE $\frac{1}{4}$	15	44	20		0	0	0
43	SW $\frac{1}{4}$ of NE $\frac{1}{4}$	2	44	20		.33		1.67
44	SE $\frac{1}{4}$ of SE $\frac{1}{4}$	27	45	19		1		2
45	NE $\frac{1}{4}$ of NE $\frac{1}{4}$	29	45	19		1.67		11.33
46	SW $\frac{1}{4}$ of NW $\frac{1}{4}$	28	45	19		.67		.67
47	NE $\frac{1}{4}$ of NW $\frac{1}{4}$	32	45	19		1.67		17.67
48	SE $\frac{1}{4}$ of NW $\frac{1}{4}$	31	45	19		2.67		7
49	SW $\frac{1}{4}$ of NW $\frac{1}{4}$	31	45	19		.67		6.67
50	SE $\frac{1}{4}$ of NE $\frac{1}{4}$	12	45	20		2.33		10
51	SW $\frac{1}{4}$ of SE $\frac{1}{4}$	31	45	19		1.33		5.67
52	NW $\frac{1}{4}$ of NW $\frac{1}{4}$	6	44	19		4.67		7.67
53	SE $\frac{1}{4}$ of NE $\frac{1}{4}$	11	44	20		.33		0
54	SW $\frac{1}{4}$ of SE $\frac{1}{4}$	18	45	19		1.67		1
55	NE $\frac{1}{4}$ of NW $\frac{1}{4}$	19	45	19		8.33		2
56	NE $\frac{1}{4}$ of NW $\frac{1}{4}$	19	45	19		8		2
57	SE $\frac{1}{4}$ of NW $\frac{1}{4}$	19	45	19		6.67		2.33
58	NE $\frac{1}{4}$ of SW $\frac{1}{4}$	29	45	19		9.33		9.33
59	SW $\frac{1}{4}$ of SE $\frac{1}{4}$	24	45	20		3		3
60	SW $\frac{1}{4}$ of SW $\frac{1}{4}$	24	45	20		.33		1.67
61	SW $\frac{1}{4}$ of NW $\frac{1}{4}$	25	45	20		3.33		3.33

General Andrews Nursery Survey

A late fall survey was conducted in General Andrews Nursery near Willow River, Minnesota to evaluate the potential of pine tussock distribution when the seedlings are programmed for lifting in the spring of 1971. A total of 151 plots of pine seedlings

were inspected totaling 2,885 seedlings. Two dormant second instar tussock larvae were found. A total of 72 plots were taken in other conifers (primarily spruce) totaling 1,917 seedlings and no dormant tussock larvae were found. With the extremely low seedling bed counts, it was determined that the potential tussock population distribution would not measurably increase any local population in other portions of the state. Thus, no controls are projected for the seedling beds in 1971.

1970 Pine Tussock Development

May 18 - Second instar larvae began emerging from dormancy in east-central Minnesota.

May 20 - First observed larval feeding on jack pine.

June 5 - Larvae mostly in the third instar but many still in the second instar.

July 8 - Larvae mostly in the fifth and sixth instars. Some defoliation apparent in jack pine tops.

July 13 - Larvae just beginning to pupate.

July 17 - Feeding virtually complete.

July 24 - Mostly in pupation in northern Pine County. Beginning adult emergence.

July 30 - 52% pine tussock adult emergence. Eggs commonly observed on jack pine.

August 14 - Pine tussock still mostly in egg stage but many first instar larvae observed.

1971 Outlook

It appears that controls will not be needed in 1971 but chemical standby measures will be ready in case the tussocks don't read the book. A 1971 biological survey will be set up primarily to detect the incidence of polyhedral or cytoplasmic viruses but also will include parasites.

JACK PINE BUDWORM

Choristoneura pinus (Freeman)

The year, 1970, was the third successive year where there was generally very light to no jack pine budworm defoliation in Minnesota. There were a few moderately defoliated pockets in east-central and northeast areas of the state. Overall, the 1970 counts were even less than those in 1969.

1970 Surveys

No aerial survey was conducted because of the low level of defoliation. A dropcloth survey with plot distribution in all of the jack pine stands was conducted. This gives relatively little additional information on the budworm (defoliation and foliage retention of new and old needles are the primary jack pine budworm survey targets) but does have value on population trends of other jack pine defoliators that would otherwise be very difficult to get. In any event, the budworm counts were consistently low.

1970 Development

May 26 - Male cones swollen but no active second instar budworms found.

May 31 - Southern, open grown male cones ripe, some actively feeding budworms in central Minnesota.

June 3 - Second instars beginning to feed on staminate flowers in east-central Minnesota.

June 30 - Budworms average about one inch long in central Minnesota.

July 8 - Most in larval stage but fair percentage in pupation.

1971 Outlook

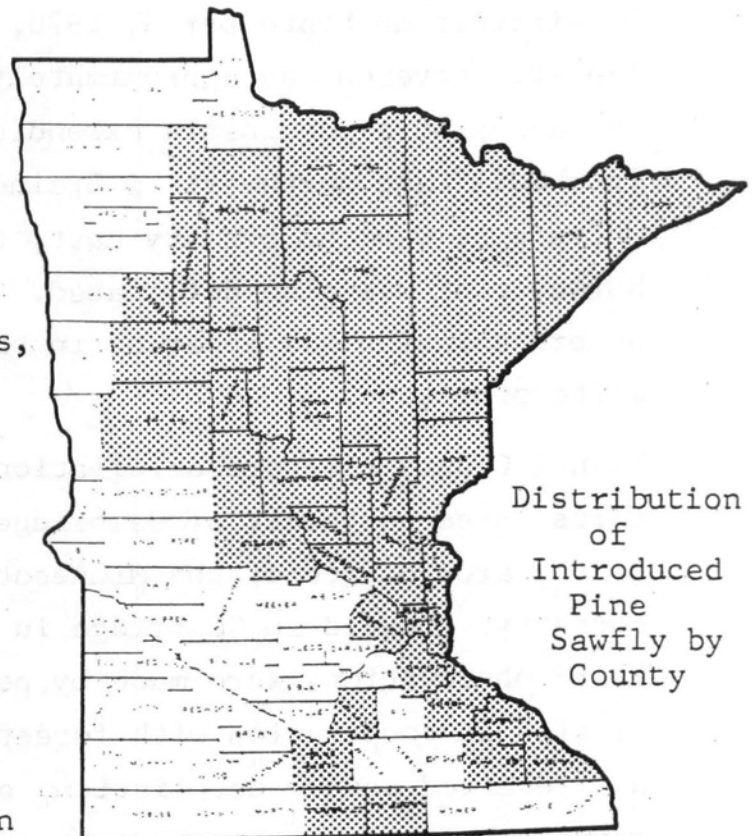
No egg mass survey was programmed because of the very low overall budworm population. If defoliation increases substantially in 1971, egg mass counts will be taken, otherwise probably not. It appears that 1971 defoliation will be negligible in most of the jack pine area with a few possible moderate to heavy scattered spots in east-central and northeastern Minnesota.

INTRODUCED PINE SAWFLY
Diprion similis (Htg.)

Since the introduced pine sawfly was first observed in Minnesota in 1939, this pine defoliator is now found from the south to north borders of the state. With the widespread and scattered distribution of white pine in Minnesota, comprehensive surveying on this insect is virtually impossible. Most of the records on serious defoliation locations depend upon cooperative reports and requests for aid to interpret a problem and recommend controls.

For the last several years, low levels of first generation damage and widely scattered areas of second generation damage was observed. The last public land controls were in 1965. If there were small private controls, they were not reported. In 1969, there were spots of second generation damage in Crow Wing, Morrison, and Todd Counties.

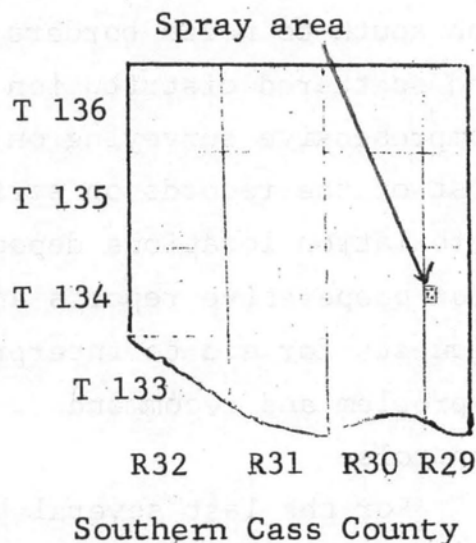
In 1970, first generation populations were low. The second generation of introduced pine sawfly caused serious



defoliation on mature white pine stands in Isanti, Morrison, Cass, and Crow Wing Counties. Chemical control was used in Isanti and southern Cass. Additional light to moderate populations were observed in Itasca, St. Louis, Carlton, Pine, Koochiching, Aitkin, Mille Lacs, Wadena, Becker, Mahnomen, Hubbard, and Beltrami Counties. There were probably a number of more serious small acreage defoliation areas that were not reported from the above areas. Light populations were recorded on jack pine in central and east-central Minnesota.

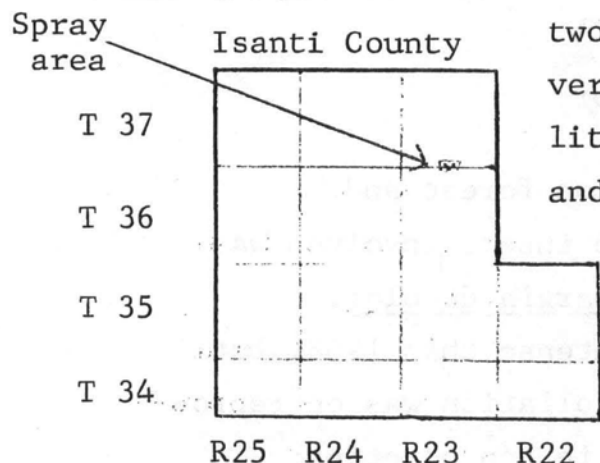
1970 Chemical Controls

Southern Cass County - Chemical control with a foliar application of malathion in water was applied by aircraft on September 3, 1970. The area covered was approximately 160 acres on a peninsula extending into Gull Lake northwest of Brainerd. White pine was the primary host, but Norway pine was also defoliated. Severe thinning was apparent in the white pine tops.



Isanti County - Severe defoliation of a mature white pine forest area northwest of Cambridge, Minnesota was reported by the area office of the Minnesota Division of Lands and Forestry, located in Cambridge in early September, 1970. Field observations were made by personnel of the forest pest section in cooperation with foresters. Much of the white pine had received severe defoliation, especially in the tops. An emergency spray program was set up by the Minnesota Department of Agriculture and treatment was conducted on September 10.

Application was by helicopter with Sevin at the rate of one pound actual material per 1.5 gallons of water per acre. Coverage of the highly affected areas was very good and control in the sprayed locations was excellent. Inspection seventy-



two hours after application revealed very little new frass. Dead larvae littered the ground beneath pine trees and no new cocoons were observed.

Close post spray observations revealed 85% defoliation in many of the white pine tops. A number of trees will be marked for 1971 observation.

1970 Development

June 19 - Larvae are in the last instars of the first generation.

July 25 - The first generation is mostly in the cocoon stage with no reports at this time of any high population areas.

August 14 - Mostly in the cocoon stage but second generation early instars common.

September 2 - Mostly last instars causing serious defoliation in Cass and Itasca Counties.

ASPEN LEAF TIER

Enargia decolor

In 1968, widespread defoliation on forest and reproduction aspen was recorded. The insect involved was identified as the aspen leaf tier, Enargia decolor.

In 1969, defoliation was less intense than 1968, but was more widespread. Most of the defoliation was on reproduction aspen in scattered locations in ten counties; Koochiching, Beltrami, Itasca, Hubbard, Cass, Crow Wing, Aitkin, Pine, Carlton, and St. Louis. Defoliation was observed from June into August.

1970 Surveys and Observations

Defoliation was again widespread but very scattered. Much of the damage was on reproduction aspen but forest stands received much more defoliation than in 1968 or 1969. Most of the forest areas affected were a few trees to approximately 40 acres in size with the most severe defoliation about 50 to 60%. Defoliation on some roadside and reproduction aspen was in excess of 90%. The same counties as in 1969 were involved. The 1970 defoliation observations indicate a trend in north to northeast direction. Many aspen leaf tiers were found in the heavy aspen tortrix defoliation areas.

1970 Development

June 7 - Early instar larvae observed on roadside aspen.

June 17 - Larvae mostly in the third instar in Aitkin and Itasca counties.

June 30 - Some larvae to one inch in length. Defoliation averaging 30% in scattered locations in Cass County.

July 8 - Most larvae are one inch in length.

July 15 - Larvae about one and one-fourth inch, still actively feeding in northern Minnesota. Some adult moths observed.

July 22 - Moths commonly observed in northern Minnesota. Some larvae still present.

WALNUT CATERPILLAR

Datana intergerrima (G. & R.)

Many reports of scattered defoliation by the walnut caterpillar were received in August of 1970 from southwest, south central, and southeast portions of Minnesota. The reported defoliation was on black walnut in yards, boulevards, and windbreaks. It appears that the intensity of defoliation has increased each year over the last several years.

VARIABLE OAK LEAF CATERPILLAR

Heterocampa manteo (Dblady.)

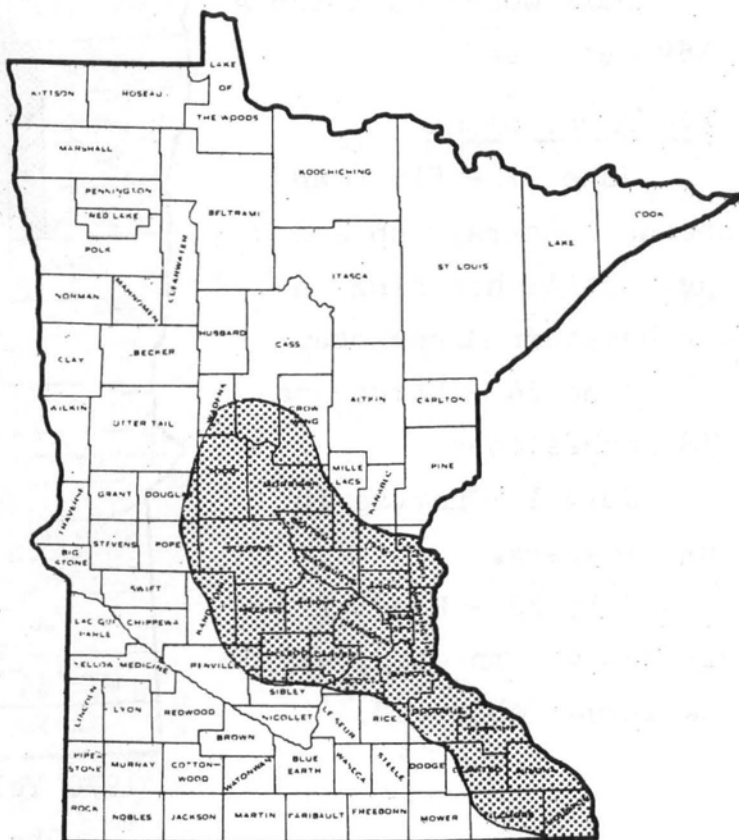
The 1970 defoliation by the variable oak leaf caterpillar was expanded considerably over that of 1969. The only reported 1969 defoliation was in Ottertail County where this year damage was recorded in sporadic locations in much of the forested areas of west-central and northwestern Minnesota. The areas of moderate to heavy damage, primarily on oak and basswood (but including other broadleaves) included spots in Kandiyohi, Ottertail, Itasca, Mahnomon, Clearwater, and Beltrami Counties. Light defoliation and larval reports were received from Stearns, Pope, Isanti, Todd, and Cass Counties. It is an assumption that there was extended light defoliation in adjacent counties to those listed above.

The largest area of heavy defoliation (almost 100%) was in Ottertail County, covering over 5,000 acres, in the vicinity of Battle Lake, Lake Blanche, Lake Emma, Clitherall Lake and points north to Frazee and Perham. The total estimated acreage in the moderate-heavy defoliation class is 25,000 acres over all of the above counties.

OAK SKELETONIZER

Buccalatrix ainsliella (Murtfeldt)

Widespread feeding damage by the oak skeletonizer was observed and reported in 1970. The primary host was red oak. Extensive areas were observed by aircraft in the southeast quarter of the state, concentrated mainly in the river valley and lowland locations but also in a number of highland areas. The areas of damage include Houston, Fillmore, Winona, Wabasha, Goodhue, Dakota, Washington, Ramsey, Chisago, Sherburne, Anoka, Almsted, Becker, Isanti, Crow Wing, Benton, Morrison, Stearns, Scott McLeod, Sibley, Pope, Carver, Renville, Kandiyohi, Douglas, Wadena, Cass, Mille Lacs, Meeker, Wright, and Todd Counties. It is likely that other counties received some damage but were not reported.



Two periods of skeletonizing were observed: late June-early July and September-early October. The damage by both generations (when heavy the leaves appear brownish, obviously giving the oaks a diseased appearance. Many requests for oak wilt assistance were received.)

YELLOW HEADED SPRUCE SAWFLY

Pikonema alaskensis (Roh.)

The yellow headed spruce sawfly again caused widespread but scattered defoliation to plantation and roadside white spruce in the northern half of Minnesota and to a much lesser degree on black spruce. Populations increased slightly in Koochiching and northern St. Louis Counties after a 1969 decrease.

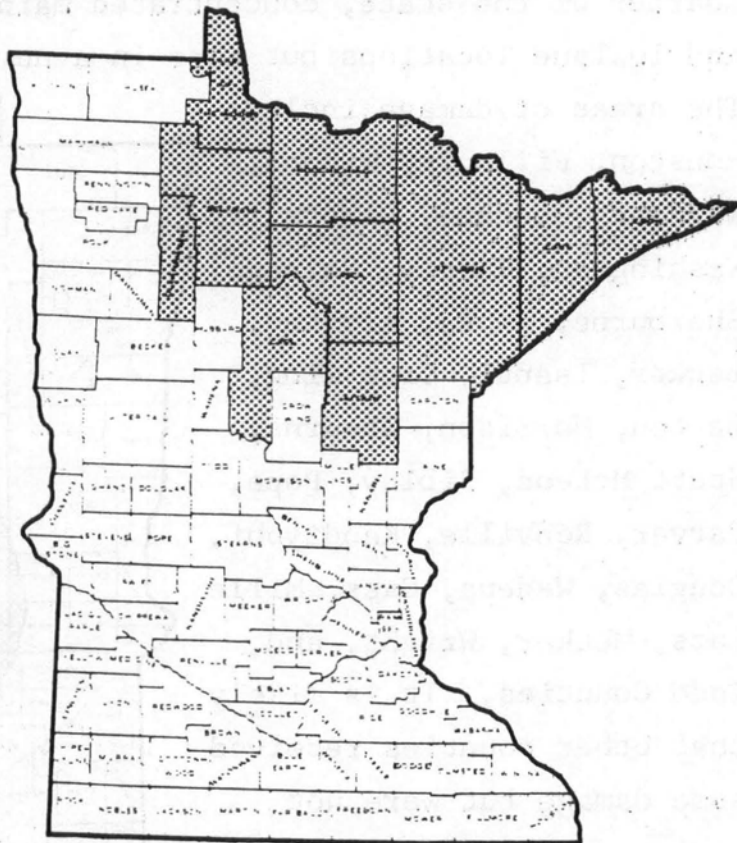
1970 Development

June 17 - First and second instars with a few eggs still hatching in northeastern Minnesota.

June 24 - Larvae now 5/8 inches long.

July 1 - Larvae in last instars.

July 20 - Feeding virtually completed, very few larvae observed.



1970 Yellow Headed Spruce Sawfly
Observations By County

SARATOGA SPITTLEBUG

Aphrophora saratogensis (Fitch)

Early 1970 winter surveys (scar damage) for saratoga spittlebug damage revealed five plantations in St. Louis and Cass Counties with scar counts averaging over fifteen. Early summer nymphal surveys in these plantations revealed low populations. Late summer and fall plantation checks showed no serious "flagging" of Norway pine.

RED SQUIRRELS

The red squirrel was causing measurable damage to stagnated black spruce areas in northern Minnesota in 1970. These trees are selected and cut for Christmas trees. When the squirrels were gathering cones in the fall, many cone-bearing limbs were cut off and dropped to the ground resulting in a large vacancy in the tree. When this happened, the tree was ruined for the Christmas tree market. Also, the tree never grows out to cover such damage.

This condition was noticed in past years but was never so damaging in the reproduction trees.

RED-HUMPED OAKWORM

Symmerista canicosta (Franc.)

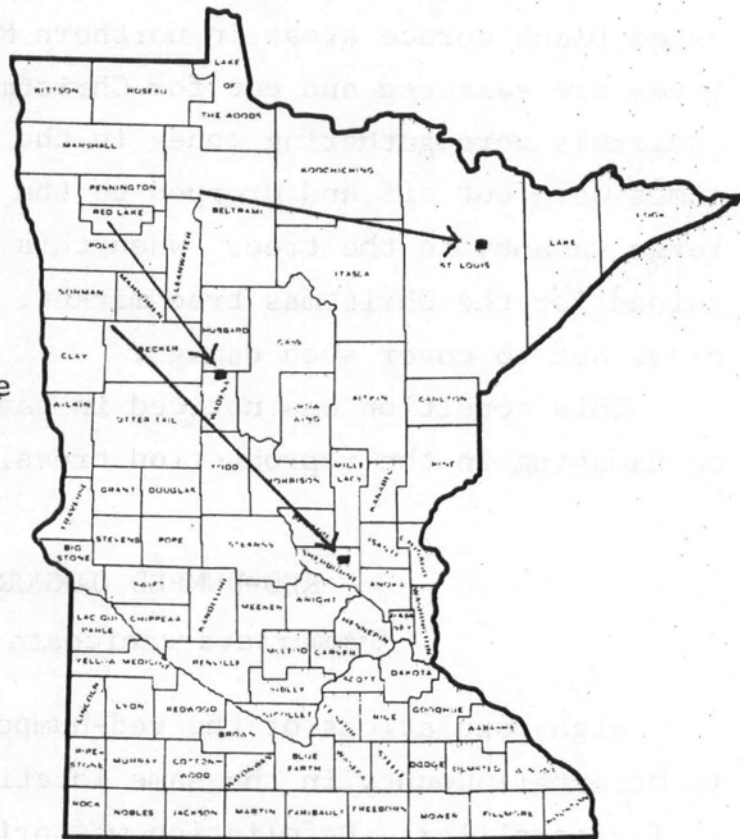
High populations of the red-humped oakworm were observed in Ottertail County in the same locations as the variable oak leaf caterpillar. Defoliation was primarily on oak. There were no reports of this insect in 1969. It was estimated that approximately 20% of the oak defoliators in this area were the red-humped oakworm and that the population would have been capable of light to moderate defoliation if no other insects were involved.

PINE ENGRAVER

Ips pini (Say)

In 1970, three small locations suffered some mortality from damage by *Ips pini*, as indicated on the map. The Sherburne County infestation included only five acres of jack pine (five-inch DBH). The bark beetles multiplied in slash from thinnings the previous year. The St. Louis County area, east of Tower, was a portion of a 1969 tornado path through seven-ten inch DBH Norway pine in a lakeside residential location. Some salvage was made in late 1969 but many of the logs were left in piles. The bark beetles multiplied, emerged and attacked the adjacent healthy pines causing some mortality.

The Wadena County location covers about 20 acres of Norway pine (five-inch DBH) and the problem was again due to slash from thinnings.



OTHER 1970 FOREST PROBLEMS

<u>Forest Insect</u>	<u>Host</u>	<u>Location</u>	<u>Observation Date</u>	<u>Comments</u>
Agrilus anxius (Gory) Bronze Birch Borer	Birch	Widespread	June-August	High incidence on ornamentals
Anisota virginiensis (Drury) Brown Anisota	Oak	Douglas County	August	
Anomala oblivia (Horn) Pine Chafer	Jack Pine	Central and east central Minnesota	Early July	Adult stage, populations low
Aphrophora parallela (Say) Pine Spittlebug	Pines	Widespread	Early July	Populations lower than usual-most problems in Scotch pine
Archips cerasivoranus (Fitch)	Prunus	Scattered	late May-June	Reports from northern half of state
Caliroa cerasi (Linneaus) Cherry Slug	Mountain Ash	St. Paul-Mpls.	July	Minor
Cameraria cinnamomiella (Chambers) Gregarious Oak Leaf Miner	Bur Oak	Central Minn.	July 10	Located in Charles Lindberg State Park
Chermes cooleyi (Gillette) Cooleys Spruce Gall Aphid	Colorado Blue Spruce	Winona	September	
Chrysomela scripta (Fabricius) Poplar leaf beetle	Poplar	Widespread	June	Numbers generally low
Contarinia virginianae (Felt) Chokecherry Midge	Chokecherry	Central Minn.	June	
Corythucha ulmi (Osborn & Drake) Elm lace bug	Elm	Scattered	July	Southeast Minnesota

<u>Forest Insect</u>	<u>Host</u>	<u>Location</u>	<u>Observation Date</u>	<u>Comments</u>
Datana ministra (Drury) Yellow-necked Caterpillar	Willow, Hickory white oak	Scattered	July- August	Many samples received but defoliation very minor-up to moderate defoliation
Dioryctria zimmermani (Grote) Zimmerman Pine Moth	Pines	Scattered	June-July	Localized and scattered stem infestation and damage, primarily on white and Scotch pine but also Ponderosa, Norway and jack pines. Widespread twig damage especially on Norway pine.
Elaphidion villosum (Fabricius) Oak Twig Pruner	Oak	Southern half of Minnesota	July	Many reports and samples received, primarily from municipal locations Yards littered with twigs containing larvae.
Eriophyes fraxiniflora Ash Flower Gall	Green ash	Widespread	June-October	
Eucosma sonomana (Kearfott) Jack Pine Shoot Borer	Scotch pine	Scattered	July	Moderate
Fenusa pusilla (Lepeletier) Birch leaf miner	Paper Birch	Northeast Minn.	June-July	Moderate to heavy mining in scattered locations
Fenusa ulmi (Sundevall) Elm leaf miner	Elm	Widespread	June, July	Widespread in central, south-central and south-east Minnesota

<u>Forest Insect</u>	<u>Host</u>	<u>Location</u>	<u>Observation Date</u>	<u>Comments</u>
<i>Ilyobius radialis</i> (Buchanan) Pine Root Collar Weevil	Scotch pine	Widespread	April - September	Widely scattered observations and reports with some scattered mortality, needs more field evaluation.
<i>Lyphantria cunea</i> (Drury) Fall Webworm	Aspen, apple	Northern Minn.	July 29	Second and third instars
<i>Lecanium fletcherii</i> (Cockerall) Fletchers scale		Mpls-St. Paul	June 26	Crawler stage
<i>Malacosoma americana</i> (Fabricius) Eastern Tent Caterpillar	Prunus	Very scattered	May, June	All reports from the northern half of Minn.
<i>Neoborus amoenus</i> (Reuter) Ash Plant Bug	Ash	Widespread	June-July	
<i>Neodiprion abietis</i> (Harris) Balsam Fir Sawfly	Spruce	Ottertail Co.	June	
<i>Neodiprion lecontei</i> (Fitch) Red-Headed Pine Sawfly	Jack pine	Central and east central Minnesota	Late July- early August	Overall populations at low levels. A few moderate plantation and roadside problems.
<i>Neodiprion nanulus nanulus</i> (Schedl) Red Pine Sawfly	Jack pine	Central Minn.	July-August	Very light populations
<i>Neodiprion pratti banksianae</i> (Rohwer) Jack pine sawfly	jack pine	Central Minn.	Late June	
<i>Nymphalis antiopa</i> (Linnaeus) Spiny Elm Caterpillar	Hackberry, elm aspen	Scattered throughout state	June, July	Up to moderate defoliation.

<u>Forest Insect</u>	<u>Host</u>	<u>Location</u>	<u>Observation Date</u>	<u>Comments</u>
Pachypsylla celtidis-mamma (Riley) Hackberry Nipple Gail	Hackberry	Widespread	May through August	All reports from the southern half of state
Pachypsylla globulus (Riley)	Hackberry	Wabasha County	October	
Paleacreta vernata, Alsophila pometaria (Peck) (Harris) Cankerworms	Elm, oak other broadleafs	Widespread and scattered	May-June	Observations and reports on cankerworm defoliation scattered throughout the state. St. Paul conducted chemical control with Sevin.
Pemphigus populi-globuli (Fitch) Poplar petiole gall aphid/Cottonwood		Carver County	Late June	
Pineus strobi (Hartig) Pine bark aphid	Pines	Widespread	July-August	Overall populations appear to be down from 1969. Many observations on white and Norway pine. Some control in state nurseries on Norway pine
Pissodes strobi (Peck)	White spruce blue spruce white pine Norway pine jack pine	Statewide	May-August	Apparently causing increased damage on ornamental and plantation blue spruce-many samples received. Overall low white pine incidence, spotted incidence on Norway and jack pine.

<u>Forest Insect</u>	<u>Host</u>	<u>Location</u>	<u>Observation Date</u>	<u>Comments</u>
Pristophora erichsonii (Hartig) Larch sawfly	Eastern larch	Northern half of Minnesota	June-August	Widespread moderate to heavy defoliation over most of 500,000 acres of tamarack. Defoliation about the same as 1968 and 1969.
Pulvinaria innumerabilis (Rathvon) Cottony Maple Scale	Maple	Kandiyohi Co.	May	Moderate
Retinodiplosis resinicola Pine Pitch Midge	Jack pine	Scattered	May-June	Much lower populations compared to last several years. Flagging of jack pine twigs much less noticeable. Some moderate to heavy infestation in central Minn.
Saperda calcarata (Say) Poplar & cottonwood leaf beetle	Bolleana poplar, aspen	Widespread	July-September	Causing scattered mortality
Schizura concinna (Smith) Red-humped caterpillar	Apple, aspen	Scattered	June	Most numbers found on apple-light and scattered numbers on aspen
Scolytus muticus (Say) Hackberry Engraver	Hackberry	Blue Earth Co.	August	Causing some twig mortality
Anthrenus forticornis (Walsh) Oak Fig Gall	Oak	Roseau County	August	

1970 FOREST DISEASES

DUTCH ELM DISEASE

Dutch elm disease continued to spread slowly in Minnesota, although the disease was found in thirteen counties for the first time in 1970. The total number of positive cases from Minnesota municipalities was 795 for this year. This does not represent all Dutch elm disease in the state, as there is little sampling or surveying for the problem on rural elm trees.

There are two major rural epidemic areas. One is in south-east to south central Minnesota, centered mostly by the Root River and tributaries. The other is along the Mississippi River from Anoka to St. Cloud. In the later two areas alone, many thousands of elms have died from Dutch elm disease in the last few years.

In addition to these two major outbreak areas, there are numerous other small outbreak areas in the southern half of Minnesota. Most of these are only one or two trees in each location.

The map represents the incidence of Dutch elm disease by county. In St. Louis County, the disease is only in Mt. Iron and in Crow Wing County, it was found only in Ironton.

The heaviest municipal incidence in 1970 was St. Paul with 207 positive cases, Albert Lea with 47, and Austin with 90.

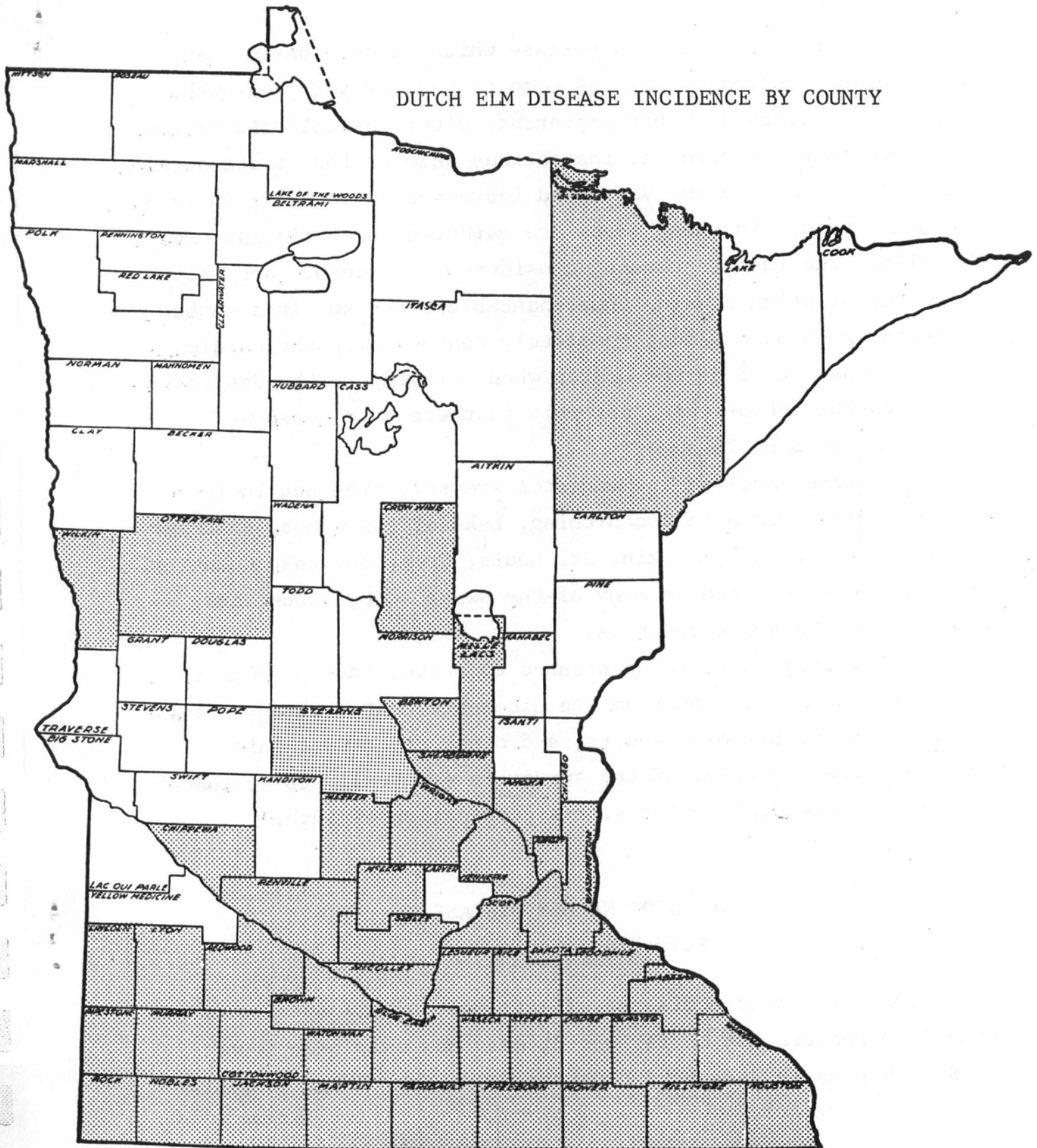
Below is a listing of the number of cases of Dutch elm disease by year. Almost all of the positive cases are from municipal locations.

1961 - 8 positive cases	1964 - 54 positive cases
1962 - 2	1965 - 23
1963 - 43	1966 - 49

1967 - 139 positive cases
1968 - 283

1969 - 549 positive cases
1970 - 795

DUTCH ELM DISEASE INCIDENCE BY COUNTY



CHRY SOMYXA SPP.

(Rust of black spruce)

Spruce needle rust is a disease which causes loss of many of the older needles as well as some of the new year's growth. It gives the trees a shabby appearance after one epidemic season.

This rust has been causing serious defoliation to stagnated black spruce for several years and increased in severity in 1970. The black spruce in these areas are marketed for Christmas trees annually. The rust is causing considerable concern. Not only is the defoliation causing unmerchantable trees but in a number of cases trees were almost completely denuded with the needles piled in the bottom of the crates when arriving at the destination. In the latter case, not only is there tree loss but potential customer loss.

The areas involved in Minnesota are scattered but include considerable acreage in Koochiching, Lake of the Woods, Beltrami, Roseau, Itasca, Cass, Aitkin, St. Louis, Cook, and Lake Counties. The rust is widespread in many of the swamp spruce locations over all of the above counties.

A 1971 program is being planned to survey this problem to check spore transmission from the alternate host, Labrador Tea, the duration of airborne spores, and other aspects of this problem. The objective of the survey is eventually to evaluate cultural or chemical controls or a combination of such.

BROWN SPOT NEEDLE DISEASE

Scirrhia acicola

Brown spot needle disease affects most or all species of pine in Minnesota but so far the disease has only been found on Scotch pine in Wabasha and Dakota Counties. There is little

doubt that the disease is much more widespread than is recorded. Surveys in the next few years should prove this out. It is difficult to predict what impact such a disease will have on pine plantations, but it has already caused severe damage to Christmas tree Scotch pine plantations in Wisconsin.

LOPHODERMIIUM PINASTRI

In 1969, Lophodermium pinastri, a pine needle cast, was found in two private nurseries in Sherburne County. In 1970, the disease was identified from Crow Wing County on jack pine. There is little doubt that this disease is quite widespread in Minnesota and needs more detection surveys. The primary problem area again is the Christmas tree plantations and nurseries.

LEAF ANTHRACNOSE

This disease was very common in the southern two-thirds of Minnesota in 1970, causing leaf spot and leaf drop, giving the trees a shabby, semi-defoliated appearance. Oak was most commonly reported, with sugar maple and lombardy poplar also being affected.

OTHER DISEASES

<u>Disease</u>	<u>Host</u>	<u>Location</u>	<u>Report Date</u>
Eastern Oak Gall	Jack pine Scotch pine	Central Minnesota	May-September
Cytospora Canker	White and blue spruce	Scattered ornamentals	May-July
Balsam Needle Rust	Balsam fir	North central Minnesota	Mid-July
Fire Blight	Mountain Ash	SW Minnesota	September
Nectria Canker	Hardwoods	Widespread	May-September

OAK WILT

Oak wilt was first found in Minnesota in the early 1940's although the disease was apparently here before that. Without factual record, it is anybody's guess. The map shows the present area of established oak wilt in Minnesota by county.

The northern line is quite well established by samples from dying oaks that were cultured and identified as oak wilt; so is the western spread, as far as Mankato and Blue Earth. The incidence west of these two municipalities is not well established.

1970 Surveys, Reports and Observations

An aerial survey over southeastern Minnesota, primarily the Minnesota Memorial Hardwood

Forest, was flown on July 21-23, 1970. Observers and recorders were:

Jordan Wheeler

Minnesota Dept. of Agriculture

Gerald Hecht

Minnesota Dept. of Agriculture

John Nelson

Minnesota Div. of Lands and Forestry

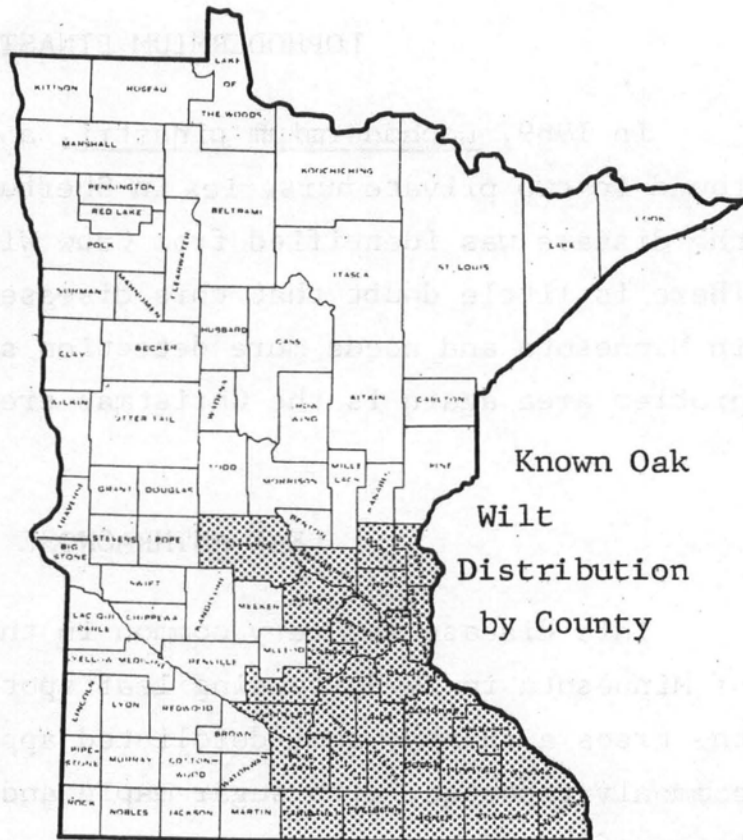
John Dowd

Minnesota Div. of Lands and Forestry

Art Hendrickson

Minnesota Div. of Lands and Forestry

The purpose of this flight was to make a rapid interpretation of the present situation with oak wilt in the Minnesota Memorial Hardwood Forest. There are commercial oak forests in



the more southern portion of this forest, the balance being primarily a scrub level of red oak. Municipal areas were not observed, thus they are not in the report.

Procedure

East-west flight lines were flown four to six miles apart at 1000 feet altitude. River valley systems were also flown. A Cessna 172 was used traveling at approximately 100 mph. Besides the pilot, there was a navigator and two observers sketching and marking problem oak locations on large scale county maps, as well as blue line reproductions of the Mark Hurd aerial photos.

Area Boundaries

North - State Highway 97 in Washington County

South - Iowa border

East - Wisconsin border

West - Washington County Road #5, continuing southwards to Fed. Hwy. 52, to Hader; State Hwy. 57 to State Hwy. 30, Fillmore County line.

General Observations

The heaviest damage follows the same general areas where red oak trees are found. The area along the Mississippi and St. Croix Rivers and those tributaries westwards from these rivers for a distance of thirty to forty miles showed the heaviest incidence. Site location appeared to be important since the higher incidence was on well-drained limestone areas with south facing slopes. The droughty location probably reduces the vigor of the oaks causing some dieback and inviting potential vectors of oak wilt such as the Pseudopityophthorus spp. This latter aspect was not investigated and is only assumed at this point. If cooperative agencies feel additional follow-up on this aspect is needed in 1971, it will be processed. Such has not been determined at this time.

Summary

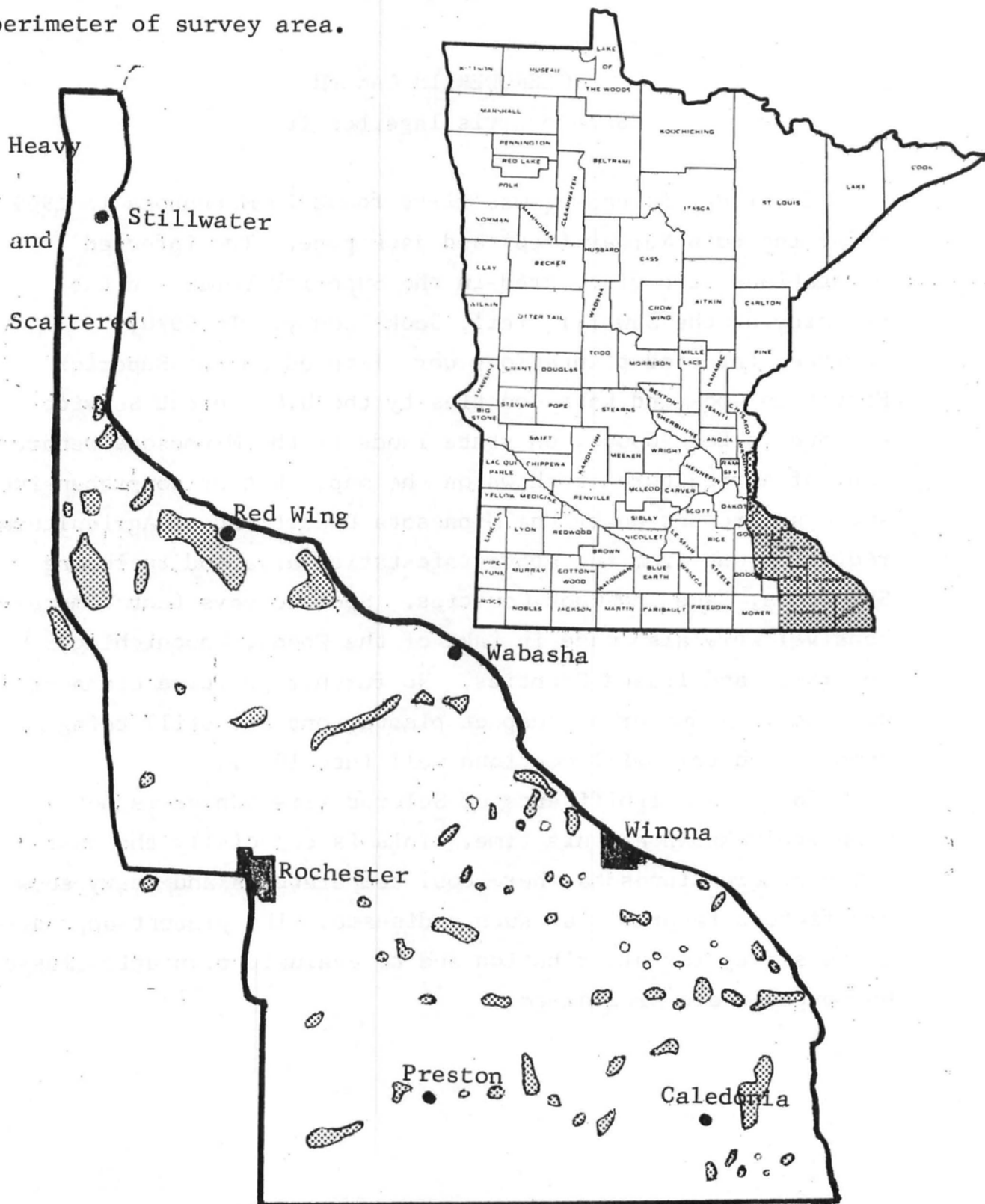
A total of twelve different locations observed from the aerial survey were sampled for oak wilt and all twelve cultured positive in the laboratory. This is not saying that all dying and dead oaks in the survey area were caused by oak wilt, but it does suggest that a high percentage is due to this disease.

Even though there are many rural locations with oak wilt, some of them quite extensive, it must be realized that oaks in this area have been dying for possibly thirty years or more. It was estimated by ground survey (following aerial mapping) that an average of three to five oak trees are currently dying per section of area covered. Less than 5% of the sections covered in the aerial survey were appraised for current mortality, thus much follow-up in this respect remains for 1971. Possibly with more intense sampling the above figures will change somewhat. In any event, it appears that there is an extremely low percentage of current mortality. When specific sites (with adverse locations) are considered, oak wilt may cause a much higher rate.

Conclusion

Apparently this survey gave us some indications of current oak wilt condition, but much more field work must be done in 1971 to lend more fact. Also, flying at four to six miles, lines did not give complete coverage to the survey area. Many small locations were no doubt missed between two flight lines. This is not extremely important to the objective of this survey, since percentages of dying oaks will be taken from plot locations close to the flight lines.

Map illustrates random pattern of larger oak wilt areas in the open circles and irregular patterns (does not include scattered or isolated oak wilt). Heavy line is perimeter of survey area.

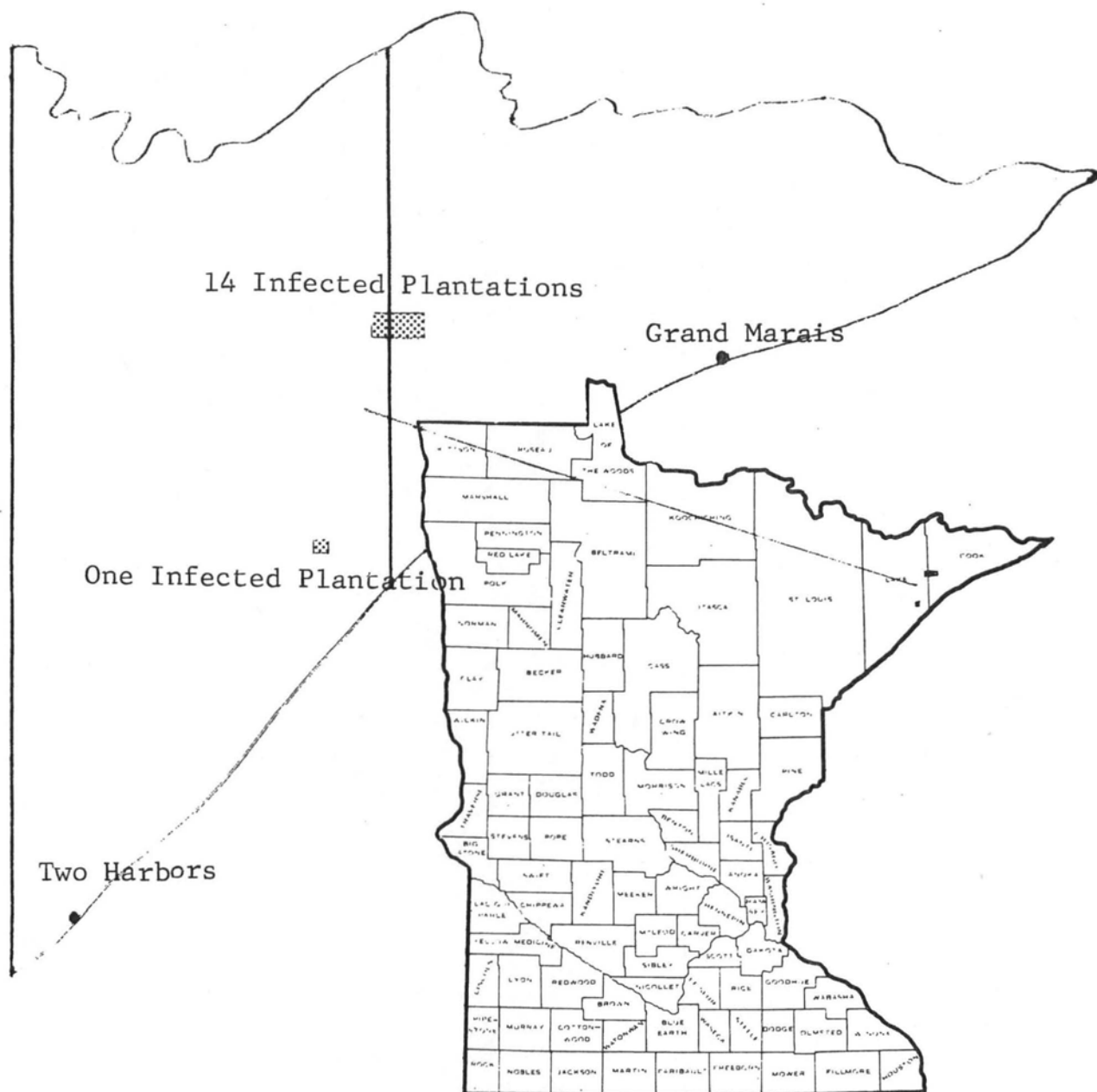


SCLERODERRIS CANKER

Scleroderris lagerbergii

Scleroderris canker was first found in Minnesota in 1969 affecting both Norway (red) and jack pine. Two infected plantations were discovered in the Superior Forest in the vicinity of the Sawbill Trail, Cook County. In 1970, fourteen infected plantations were located in the Superior Forest in Cook and Lake Counties by the U.S. Forest Service and one in Lake County on state lands by the Minnesota Department of Agriculture as shown on the map. Rather comprehensive surveys were set up by the Minnesota Department of Agriculture radiating out from the above infestation area and including St. Louis, Lake and Cook Counties. Spot surveys (not comprehensive) were also made in Lake of the Woods, Koochiching, Beltrami, and Itasca Counties. No further positive diagnosis was made. A number of suspect plantations are still being sampled and this will continue well into 1971.

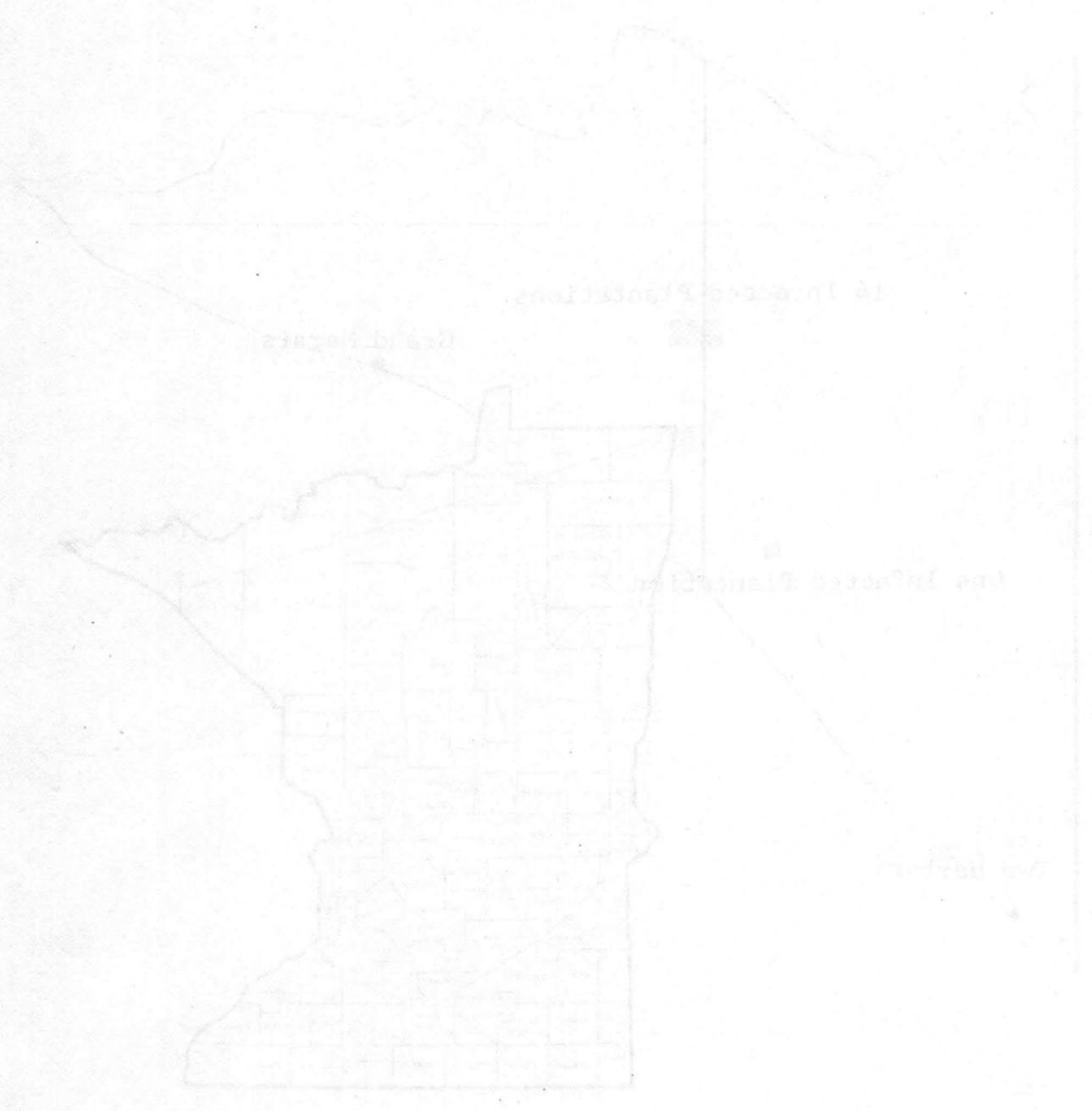
The total significance of Scleroderris canker is not completely known at this time. This is especially the case for northern Minnesota where cool temperatures and heavy snows are factors favorable to such a disease. The present approach is to survey for distribution and to evaluate plantation losses--no controls are programmed.



References:

O'Brien, James T. 1971. Survey for Scleroderris Canker on the Tofte District of the Superior National Forest. USDA, Division of Forest Pest Control, Northeastern Area.

Skilling, D. D. 1970. Scleroderris Canker on Red and Jack Pine in Minnesota. Plant Disease Reporter Vol. 54, 132.



Minnesota
 Survey, June 1, 1907. Survey for Subordinate
 of the State of Minnesota National Forest, USA.
 Division of Forest Land Control, North American
 Division, U. S. Forest Service, Washington, D. C.
 State of Minnesota, State Office, St. Paul, Minn.