

TERRESTRIAL IMPACT STUDIES IN FOREST  
ECOSYSTEMS TREATED WITH DOUBLE  
APPLICATIONS OF PERMETHRIN

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## ABSTRACT

Studies were conducted on the effects of two applications of 17.5 g/ha of the synthetic pyrethroid Permethrin on breeding songbirds, small mammals, honeybees (*Apis mellifera* Linnaeus) and other non-target terrestrial insects. Breeding songbirds inhabiting three different forest types (open plantation, coniferous forest, deciduous forest) were not affected by the treatments, nor were small mammals or their reproduction. Effects on honey bees was minimal, apparently due to a weather related lack of foraging activity after each treatment. A heavy knockdown of target and non-target insect fauna occurred after the first Permethrin application, but the effects of the second application were much smaller. Permethrin residues reached peak levels of 0.12 ppm in forest soils, 0.24 ppm in spruce foliage, 0.32 ppm in pine foliage and 1.55 ppm in maple foliage.

## RÉSUMÉ

On a étudié les effets de deux applications de 17.5 g/ha de Permethrine pyrétroïde synthétique sur des oiseaux chanteurs reproducteurs, de petits mammifères, des abeilles domestiques (*Apis mellifera* Linnaeus) et des insectes non visés. Les oiseaux chanteurs vivant dans trois types différents de forêts (plantation à découvert, forêt de résineux et forêt de feuillus) ne furent pas affectés par le traitement, non plus que les petits mammifères ou leur progéniture. Les abeilles domestiques ont subi des effets minimes, apparemment dus à un manque de nourriture relié au climat, après chaque traitement. Il se produisit une baisse sensible chez les insectes tant visés que non visés après la première application de Permethrine, mais les effets observés après la seconde application furent beaucoup moindres. Les résidus de Permethrine atteignirent le niveau maximal de 0.12 ppm dans le sol des forêts, 0.24 ppm dans le feuillage des Épinettes, 0.32 ppm dans le feuillage des Pins et 1.55 ppm dans le feuillage des Erables.

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## INTRODUCTION

Research into the development of environmentally acceptable forest pest control methods has recently focused on the potential of a synthetic pyrethroid, Permethrin, as a chemical insecticide. The Forest Pest Management Institute (formerly Chemical Control Research Institute) has previously studied and reported on the effects of Permethrin applied at rates of between 35.0 and 140.0 g AI/ha to trout streams and lakes (Kingsbury 1976a and b, 1977). Spruce budworm, *Choristoneura fumiferana* (Clemens), efficacy tests conducted in 1977 indicated that double treatments of 17.5 g AI/ha (0.25 oz. AI/ha) Permethrin were effective in controlling budworm populations (DeBoo, pers. comm.).

In 1978, Chipman Chemicals Inc. applied to the Department of Supply and Services and was granted funding through the unsolicited proposal program for research into the effects of double applications of 17.5 g AI/ha Permethrin. This involved studies of the environmental impact and fate of Permethrin residues in treated terrestrial and aquatic ecosystems of an eastern Ontario forest block and in coldwater streams of the Gaspé Peninsula. Approximately 930 ha (2300 acres) of natural and plantation forest in the Larose County Forest near Ottawa, Ontario, were treated twice within a six day interval at an application rate of 17.5 g Permethrin/ha. Spray application was timed to take place at the normal period for spruce budworm control programs. Selected non-target components such as birds, small mammals, honey bees and terrestrial insects were monitored throughout the experimental period. Spray deposit cards were placed at each biological data collection point and soil and foliage samples were collected for insecticide residue. Aquatic fauna impact data has been reported separately (Kingsbury and Kreutzweiser, 1979).

## PLOT DESCRIPTIONS

Three different ecological sites in the Larose Forest were selected in which to carry out the various studies to assess the impact of two applications of Permethrin within a six day interval. An open plantation, a coniferous forest and a deciduous or hardwoods forest were selected in both the treated and untreated blocks to study the effects of the application upon resident breeding bird and small mammal complex, as well as for studying Permethrin persistence in soil and foliage. Open areas in the centre of each block were selected for placement of the honeybee colonies while sampling for non-target insects was sited at locations randomly selected throughout the block.

### *Open plantation*

The open plantations on the two experimental blocks were quite similar with plantings of white pine, *Pinus strobus* L., and white spruce, *Picea glauca* (Moench) Voss, about three metres high. The understory was

sparse with thickets of *Salix*, *Alnus* and *Ericaceae* and a ground cover of grasses, mosses and ferns.

#### *Coniferous forest*

The coniferous forest stands were comprised mainly of white spruce about 12 metres high with a scattering of white pine. The understory was light with clumps of *Salix* and *Alnus* as well as scattered reproduction spruce and pine. The ground cover comprised mainly of grasses, mosses and a moderate leaf litter layer.

#### *Deciduous forest*

The hardwood stands were made up of a mixed stand of sugar maple, *Acer saccharum* Marsh, and white birch, *Betula papyrifera* Marsh, with scattered white elm, *Ulmus americana* L., yellow birch, *Betula lutea* Michx. f., and trembling aspen, *Populus tremuloides* Michx. The understory was made up of *Salix* and *Alnus* thickets with a moderate growth of reproduction broadleaf trees. A moderate ground cover of grasses, mosses, ferns and miscellaneous plants was recorded.

Many flowering shrubs were observed in the immediate vicinity of the honeybee colonies, the main ones being chokecherry, *Prunus virginiana* L., Nannyberry, *Viburnum lentago* L., wild raspberry, *Rubus* spp. and the common lilac, *Syringa vulgaris* L.

## METHODS

#### *Insecticide application and deposit*

Permethrin<sup>1</sup> was mixed with insecticide diluent 585<sup>2</sup> and sufficient Automate "B" red dye to give a 1% dye concentration, and applied at the rate of 17.5 g Permethrin/ha (0.25 oz/acre) in a total emitted volume of 1.34 l/ha (18.4 oz/acre). The spray was applied by a Pawnee D aircraft with micronair atomizers (model AU 3000) set at the #7 setting. The aircraft flew at 160 kmh at a height of approximately 15 metres above canopy level with a spray swath width of 60 metres.

Spray deposit was collected at ground level with aluminum plates 10.7 cm<sup>2</sup> placed at the various biological data collecting stations throughout the block. The plates were collected about 1 hour after the completion of each application, labelled and returned to the

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<sup>1</sup>JF 5751, Chipman Chemicals Ltd., Stoney Creek, Ontario

<sup>2</sup>Shell Canada Ltd., Montreal, Quebec



laboratory for colorimetric analysis, the volume of spray deposited being calculated from the amount of dye on the plates. Spray deposit was also measured by counting and measuring spray droplets landing on Kromecote® cards placed beside the aluminum pans.

#### *Insecticide residue analysis*

Foliage, soil, and pollen were sampled periodically before and after the Permethrin applications for insecticide residue analysis. Foliage was collected from three treatment and three control plantation areas and consisted of white pine (C1, T1), white spruce (C2, T2), and sugar maple (C3, T3). The foliage was picked randomly at breast height from throughout the bird census plots, placed in plastic bags, labelled frozen, and subsequently transported to the laboratory for analysis.

A representative 50 g sample of the foliage was taken and macerated in a blender containing 200 ml of 80%:20%, v:v, hexane:acetone. The ground material was filtered and then extracted three times with 150 ml distilled water and 25 ml of a 1 M sodium sulphate solution. After the lower aqueous and emulsified material phases were discarded, a 40 ml portion of the solution was drained off and evaporated to near dryness, resulting in a final extract volume of 10.0 ml. A 2 ml aliquot of this solution was transferred to a chromatographic column containing 2 g of Merkogel and washed with 20 to 35 ml of hexane to remove the impurities, followed by 15 ml of 2.5% diethyl-ether in hexane solution to elute the Permethrin. This volume was collected, reduced to near dryness on a rotary evaporator, redissolved in hexane, and then transferred to a 5 g activated florisil column for final washing with 25 to 35 ml of hexane. The Permethrin was then eluted with 50 ml of a 5% diethyl-ether in hexane solution. The elute was collected and its volume reduced to 2 ml from which a 7.5 µl fraction was taken and injected into a gas chromatograph fitted with an electron capture detector. A concentration (ppm) was derived by comparison of its peak with a reference standard peak.

Soil samples were collected at intervals following the Permethrin applications from each of the treatment and control plots. Two samples were taken from each plot, one from areas beneath the forest canopy and one from an area with no overhead cover. The soil was collected using a 2.5 cm diameter core sampler which penetrated from the surface to a depth of 10 cm. Each sample consisted of 15 such cores placed in a plastic bag, mixed, and frozen. In the laboratory, a representative 100 g portion of each sample was put in a 1 l bottle with 200 ml of a 80%:20% v:v, hexane:acetone and mixed for one hour. The

material and solution were then filtered and extracted as described for foliage analysis. From this, a 2 ml aliquot was transferred to an activated florisil column and washed with 10 ml of hexane to remove the impurities. The Permethrin was then eluted with 100 ml of a 5% diethyl-ether in hexane solution, collected, and reduced to 2 ml from which a 7.5  $\mu$ l subsample was injected into the gas chromatograph.

Samples of pollen were taken from bee colonies located on one treatment and one control plot. The pollen from 5 hives on each plot was collected and combined, transferred to the laboratory and frozen. The samples were reduced to 25 g and ground, filtered, and extracted in the usual acetone:hexane solution. A volume of 250 ml of water was used for the first extraction, followed by a further 50 ml for the second and final extractions. A 100 ml aliquot of the extract was collected and reduced to 10.0 ml. A 2 ml aliquot of this solution was then cleaned on an activated florisil column with 30 ml of wash, and 150 ml of a 5% ether in hexane solution to elute the Permethrin. This eluate was collected and reduced to 2 ml from which a 7.5  $\mu$ l fraction was injected into the gas chromatograph.

#### *Birds*

Three different ecological habitats were selected in which to carry out the pesticide impact studies on forest avifauna. Four hectare plots were established in open plantation, coniferous forest and deciduous forest stands in the treated and untreated control blocks. Forest bird populations were censused beginning five days prior to the initial application and monitored throughout the experimental period. Census methods were similar to those described by Kendeigh (1947), with all singing and sighted birds being recorded on plot maps while slowly traversing lines marked throughout each plot. On the day of each application, plot searches were carried out to recover any sick or dead birds for insecticide residue analysis.

#### *Honey bees*

Five colonies of honeybees, *Apis mellifera* Linnaeus, from the institute's apiary were placed in open areas near the centre of each of the treated and untreated control blocks. All colonies were of approximate equal strength and were checked for queens prior to relocation. Pollen and dead bee traps were fitted to each hive and hive weights taken prior to the initial treatment. Pollen and dead bees were collected daily and hive weights taken at intervals throughout the experimental period. An estimate of production between the hives on the treated and untreated blocks was made at the end of the season.



*Non-target insects*

Small plastic containers measuring 29 x 18 x 12 mm were placed under the canopy of various shrub and tree species to collect non-target terrestrial insect knockdown. Five containers were placed under each major tree species in both the treated and untreated blocks and samples were collected daily throughout the census period. All samples were preserved (10% formalin solution) labelled and returned to the laboratory for counting and identification.

*Small mammals*

Small mammal populations were sampled from the three ecological areas (open plantation, coniferous and deciduous forest) on both the treated and untreated control blocks. Snap-back kill traps were baited with a mixture of dried rolled oats and peanut butter and 50 traps were placed at 1 chain intervals in a grid fashion (5 chains x 10 chains) in each location. Traps were serviced each morning and specimens captured were returned to the laboratory for identification, sexing and age determination. Adult females were dissected to determine breeding condition.

Trapping was carried out approximately three weeks after the second application in order that juvenile animals (nestlings during the time of the applications) be available for capture with snap-traps.

## RESULTS

*Weather*

Weather data was supplied by the Ministry of Natural Resources weather station at the forestry headquarters in the Larose forest. Varied weather conditions prevailed throughout the experimental period (Table 1) ranging from warm humid weather with accompanying thunder storms (31 May) to frost and sub-freezing temperatures in low areas (6 June).

Weather conditions were also monitored throughout the actual spray operations (Table II). Temperature, relative humidity and wind speed and direction were measured 2 metres above the forest floor (below the forest canopy) during both spray applications. During the second treatment, air temperature was also measured above the forest canopy at a height of 21 metres in order to ensure the presence of a temperature inversion during the treatment.

Temperatures prior to dawn on 6 June were somewhat lower than recorded during the operation. Ice formed on water in ditches and puddles and frost had to be scraped from the wings of the spray aircraft prior to its initial run in the morning.

*Spray deposit*

Results of deposit measurements from the Permethrin applications indicate a substantial degree of variation in the amount of insecticide deposited (Table III). In all instances following the first application, colourimetric analysis produced higher deposit measurements than the spot counting method and ranged from 0.12 to 0.89 l/ha (9.0 to 66.4% deposited). The amount of deposit measured by spot counting varied from 0.06 to 0.32 l/ha (4.7 to 24.1% deposited). The second application again produced higher results from colourimetric analysis in all but one instance with values ranging from 0.09 to 0.55 l/ha (6.7 to 41.0% deposited), while spot counting results varied from 0.09 to 0.35 l/ha (6.8 to 25.9% deposited). No insecticide deposit was measured on the control plots from either application.

The plantation and coniferous plots both received 2.4 to 3.5 times higher deposited volumes from the second application. The deciduous plot showed similar amounts of insecticide deposited from both sprays, while the bee yard plot received 1.7 to 3.6 times greater amounts of deposit from the first application.

Table I  
Weather record data for the experimental period of  
28 May - 16 June, Larose Forest, Ontario, 1978

Date	Temperatures		% Relative Humidity		Rainfall (mm)		Remarks
	0800 hrs	1300 hrs	0800 hrs	1300 hrs	0800 hrs	1300 hrs	
May 28	17.0	30.5		46			Sunny
29	23.0	30.5	73	54			Sunny
30	19.3	29.5	91	61			Sunny
31	19.5	25.0	91	81			Cloudy, humid thunderstorms
June 1	16.0	19.5	81	71	17.0	17.0	Cloudy-rain
2	16.0	25.5	95	68	1.0	1.0	Cloudy-rain
3	10.0	15.0					Cloudy-rain
4	15.0	20.0					Cloudy-rain
5	8.5	15.0	100	76	9.4	10.0	Rain
6	10.0	19.5	94	52	1.4	1.6	Sunny, cool in a.m.
7	13.0	24.0	84	57			Sunny
8	15.5	21.0	100	79	3.0	3.4	Cloudy
9	12.0	19.5	84	56		.03	Sunny
10	12.0	18.0					Sunny
11	15.0	25.0					Sunny, windy
12	21.0	28.5	83	58	18.0	18.0	Sunny, windy
13	12.0	13.5	95	80	7.6	7.3	Cloudy
14	6.0	14.0	87	53	4.0	4.0	Cloudy
15	10.0	18.0	67	36			Sunny
16	11.5	23.0	89	49			Sunny

Table II  
Weather data in the Permethrin experimental block  
during spray operations, Larose Forest, 31 May and 6 June, 1978

Date	Time and Load Number	Temperature (°C)		% Relative Humidity	Wind Speed/Direction
		Top	Bottom		
31 May	0510 hrs load 1		17.6	84	00
	0525		17.0	86	00
	0540		17.5	86	00
	0550		17.2	87	00
	0615 load 2		17.5	84	0 - 0.5/W
	0700		17.5	89	0 - 1/W
	0758 load 3		20.2	83	0 - 1/W
6 June	0515 hrs load 1	6.9	6.7	94	2 - 4/W
	0545	7.0	7.0	86	2 - 5/W
	0611 load 2	7.9	7.3	87	0 - 2/W
	0658	7.3	7.6	86	0 - 1/W
	0734 load 3	10.0	9.7	86	0 - 3/W



Table III

Deposit analysis of 17.5 g AI/ha Permethrin applied at an emission rate of 1.34 l/ha to plots in Larose Forest, Ontario in 1978

	Spot Counting Analysis		Colourimetric Analysis		Mean Density	Mean Droplet
	l/ha	% deposit	l/ha	% deposit	(Drops per cm <sup>2</sup> )	Diameter deposited (μ)
Control plots - first application	0	0	0	0	-	-
- second application	0	0	0	0	-	-
Plantation plot - first application	0.14	10.6	0.22	16.4	7.8	64.1
- second application	0.35	25.9	0.55	41.0	23.1	62.0
Coniferous plot - first application	0.06	4.7	0.14	10.4	4.8	62.4
- second application	0.21	15.7	0.33	24.6	13.6	62.4
Deciduous plot - first application	0.08	5.7	0.12	9.0	8.8	46.9
- second application	0.09	6.8	0.09	6.7	4.4	70.5
Bee Yard - first application	0.32	24.1	0.89	66.4	21.6	60.1
- second application	0.19	13.8	0.25	18.7	9.9	66.0

*Insecticide residues*

Detectable amounts of Permethrin were found in foliage samples from the three treated plots within two hours of the first application and persisted through to the second application (Table IV). In two of the three treated plots (open plantation and deciduous forest), the amounts of Permethrin in the foliage increased after the second spray, while levels remained at rather low levels in the coniferous forest plot. Residues in the treatment plots persisted to the end of the postspray sampling period (four days after the second treatment) but had declined somewhat from the peak levels of 0.24 ppm, 0.32 ppm and 1.55 ppm measured in spruce, pine and maple foliage respectively. Comparatively small amounts of Permethrin (0.03 ppm) were found on two occasions after the second application in foliage from untreated control plots.

Permethrin residues found in the soil of the three treatment plots were fairly low but persisted for at least four days after both applications (Table V). There appeared to be little correlation between the levels of insecticide residues found in the soil and the extent of the overhead forest canopy. Residues did not increase significantly after the second spray and the highest concentration of Permethrin found in soil was 0.12 ppm. A detectable amount of Permethrin (0.02 ppm) was found on one occasion after the second application in the soil from an untreated control plot.

Measurable levels of Permethrin were found in pollen collected by domestic honeybees located within the treatment plot after both applications, but did not show up beyond the first day after the first application and the seventh day after the second application (Table VI). Permethrin residues in pollen were generally fairly low (0.06 to 0.18 ppm) with the exception of one very high measurement of 5.21 ppm in pollen collected by bees on the treatment plot a week after the second application. Significant amounts of Permethrin (up to 0.39 ppm) were also found in several of the pollen samples collected by bees located in an untreated control area approximately 5 km from the Permethrin spray block.

Table IV  
 Permethrin residues (ppm) in foliage\* from study plots  
 Larose Forest, Ontario  
 1978

Sample Period	C-1	C-2	C-3	T-1	T-2	T-3
First Application						
prespray	N.D.	N.D.	-	N.D.	N.D.	N.D.
2 hr	N.D.	-	N.D.	0.21	0.08	0.75
24 hr	-	-	-	0.02	0.04	0.60
48 hr	-	-	-	0.15	0.07	0.61
96 hr	N.D.	N.D.	N.D.	0.07	0.24	0.47
Second Application						
2 hr	N.D.	0.03	N.D.	0.25	0.15	1.55
24 hr	-	-	-	0.26	N.D.	1.12
48 hr	-	-	-	0.32	N.D.	0.98
96 hr	N.D.	N.D.	0.03	0.25	0.12	1.00

N.D. - nondetectable

limit of detection - 0.01 ppm

\*Foliage samples consisted of white pine (C1, T1), white spruce (C2, T2) and sugar maple (C3, T3).



Table V  
Permethrin residues in soil from study plots  
Larose Forest, Ontario  
1978

Sample Period	C-1		C-2		C-3		T-1		T-2		T-3	
	Open	Covered	Open	Covered	Open	Covered	Open	Covered	Open	Covered	Open	Covered
First Application												
2 hr	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.04	0.02	0.10	0.05	0.12	0.06
1 day	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.03	0.02	0.04	0.09	0.08	0.05
2 day	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.02	N.D.	0.07	0.06	0.05	0.05
4 day	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.02	N.D.	0.04	0.02	0.05	N.D.
Second Application												
2 hr	N.D.	N.D.	0.02	N.D.	N.D.	N.D.	0.03	0.06	0.07	N.D.	N.D.	0.08
1 day	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.03	0.11	0.04	-	0.02	0.08
2 day	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.09	N.D.	N.D.	0.06	0.04
4 day	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.06	0.04	N.D.	0.02	0.03

N.D. - nondetectable

limit of detection - 0.01 ppm

Table VI  
 Permethrin residues (ppm) in pollen collected by  
 domestic honey bees, *Apis mellifera* L., from study  
 plots. Larose Forest, Ontario. 1978

Sample Period	Treatment	Control
First Application		
2 day prespray	N.D.	trace
1 day prespray	N.D.	N.D.
day of application	0.06	0.39
1 day	0.09	N.D.
2 day	N.D.	N.D.
3 day	N.D.	0.10
4 day	N.D.	N.D.
Second Application		
day of application	0.18	N.D.
1 day	0.06	N.D.
3 day	0.08	N.D.
5 day	trace	N.D.
7 day	5.21	N.D.
9 day	N.D.	0.06
12 day	N.D.	N.D.
14 day	N.D.	0.08
16 day	N.D.	N.D.
19 day	N.D.	N.D.
21 day	N.D.	N.D.
25 day	N.D.	N.D.

N.D. - nondetectable  
 limit of detection

## Birds

Open plantation, plots C-1 and T-1: A total of 44 species of birds representing 18 families were recorded on the treated plot (T-1) and 37 species representing 14 families on the untreated control plot (C-1) throughout the experimental period of 27 May to 11 June.

Similar avian activity patterns were recorded throughout the prespray and initial treatment period on both plots with no immediate or short-term insecticide impact indicated (Figure 1). Increased activity of birds on 4 May were recorded on T-1 with only a slight increase recorded on C-1. Activity patterns following the second application were somewhat more erratic on C-1 where daily activity of certain species fluctuated noticeably.

None of the major family groups were affected by either application. Flycatchers (family *Turdidae*) declined steadily on both plots throughout the experimental period while activity of wood warblers (family *Parulidae*) and sparrows, finches, etc. (family *Fringillidae*) remained relatively constant (Tables VII and VIII).

Populations and activity of the various species present were not affected by either application. Populations of the eastern phoebe, *Sayornis phoebe* (Latham), and the great-crested flycatcher, *Myiarchus cinerascens* (Linnaeus), declined on both C-1 and T-1 while activity of the brown-headed cowbird, *Molothrus ater* (Bobbaert), increased (Appendix tables A-I and A-II).

Nesting territories of the veery, *Hylocichla fuscescens* (Stephens), the common yellowthroat, *Geothlypis trichas* (Linnaeus), the Nashville warbler, *Vermivora ruficapilla* (Wilson), the ovenbird, *Seiurus aurocapillus* (Linnaeus), and the white-throated sparrow, *Zonotrichia albicollis* (Gmelin), (Figures 2 to 6) were all defined and none were found to have been abandoned as a result of the applications of Permethrin. Intensive plot searches failed to recover any avian mortality and no birds exhibiting symptoms of pesticide stress were observed.



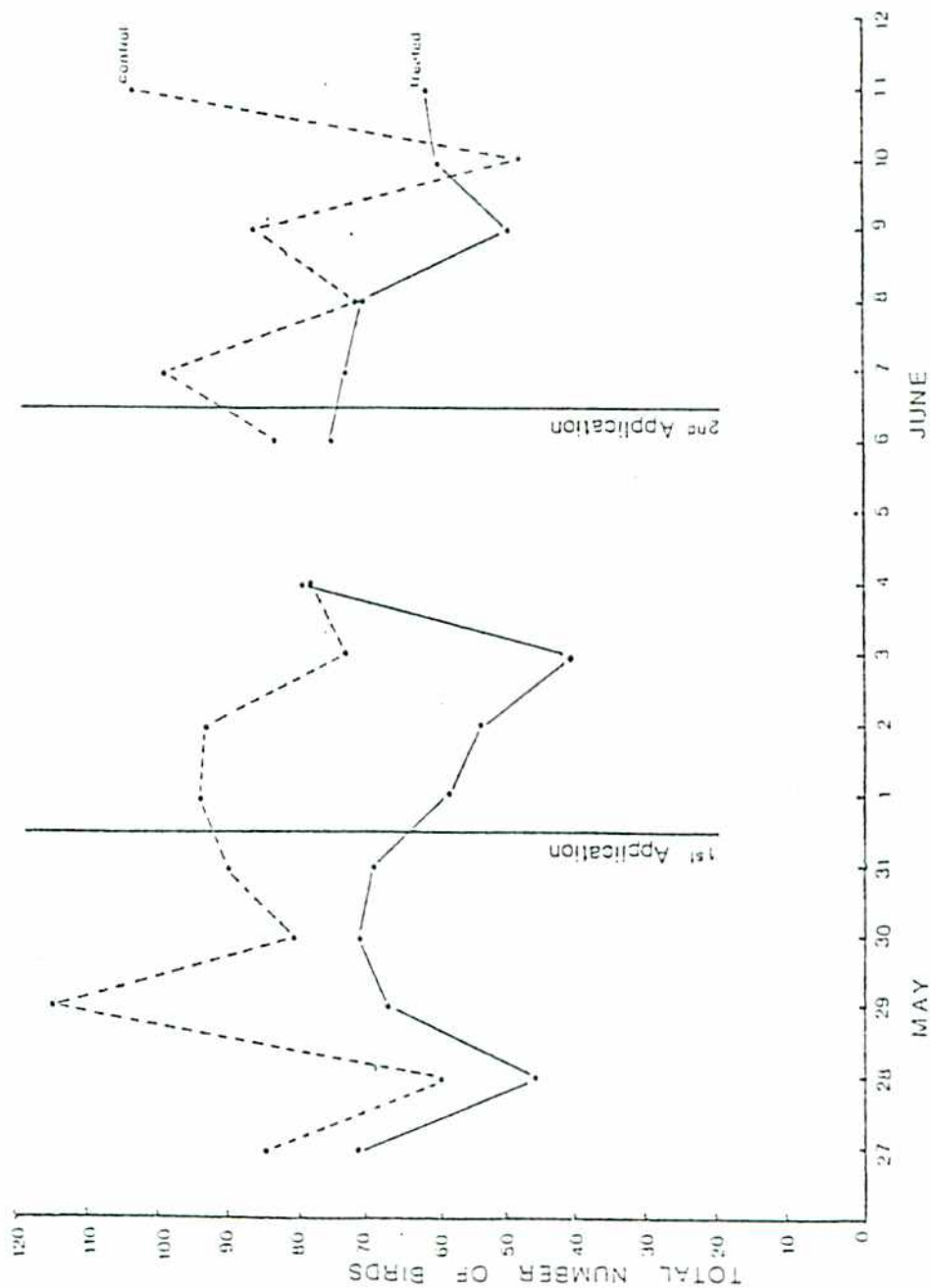


Fig. 1. Forest songbird activity on plots C-1 and T-1 throughout the Permethrin experimental trials, Larose Forest, Ontario. May-June, 1978.

Table VII  
Forest bird population census  
Permethrin control plot C-1 (open plantation)  
Larose Forest, Ontario  
May 27 - June 11, 1978

Family	Pre-spray						Post-spray, 1st application						Post-spray, 2nd application					
	May 27	May 28	May 29	May 30	May 31	Daily Ave.	June 1	June 2	June 3	June 4	June 6	Daily Ave.	June 7	June 8	June 9	June 10	June 11	Daily Ave.
	4	3	2	1	0		+1	+2	+3	+4	+6		+1	+2	+3	+4	+5	
Ardeidae	2	1	0	1	0	0.8	0	0	0	0	1	0.2	0	0	0	0	0	0.0
Accipitridae	0	0	0	0	0	0.0	0	0	1	0	0	0.2	0	0	0	0	0	0.0
Columbidae	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	0	0	2	0.4
Trochilidae	0	0	1	0	0	0.2	0	0	1	0	0	0.2	0	0	0	0	0	0.0
Picidae	0	0	0	0	1	0.2	0	1	0	0	2	0.6	0	0	1	0	0	0.2
Tyrannidae	8	6	20	8	12	10.8	8	12	9	6	10	9.0	4	4	6	2	6	4.4
Hirundinidae	0	0	1	0	0	0.2	0	0	0	0	0	0.0	0	0	1	0	0	0.2
Corvidae	1	0	0	0	1	0.4	0	0	1	2	0	0.6	3	0	0	2	0	1.0
Paridae	0	0	4	0	0	0.8	0	0	0	0	0	0.0	0	0	0	2	2	0.8
Simidae	0	2	2	4	4	2.4	2	2	4	4	4	3.2	2	6	4	2	4	3.6
Turdidae	4	0	3	0	0	1.4	2	0	2	1	0	1.0	5	0	0	0	3	1.6
Parulidae	33	38	52	53	41	40.4	48	49	33	42	43	43.0	51	38	39	20	51	39.8
Icteridae	11	6	13	6	20	11.2	12	9	6	12	17	11.2	16	12	16	5	16	13.0
Erngillidae	26	12	20	10	12	16.0	23	21	17	12	7	16.0	19	12	20	16	21	17.6
Total Birds	85	65	116	82	91	87.8	95	94	74	79	84	85.2	100	72	87	49	105	82.6

Table VIII  
Forest bird population census  
Permethrin treatment plot T-1 (open plantation)  
Larose Forest, Ontario  
May 27 - June 11, 1978

Family	Pre-spray						Post-spray, 1st application						Post-spray, 2nd application					
	May 27	May 28	May 29	May 30	May 31	Daily Ave.	June 1	June 2	June 3	June 4	June 6	Daily Ave.	June 7	June 8	June 9	June 10	June 11	Daily Ave.
	4	3	2	1	0		+1	+2	+3	+4	+6		+1	+2	+3	+4	+5	
Ardeidae	0	0	0	0	0	0.0	0	0	0	0	2	0.4	0	0	0	0	0	0.0
Tetraonidae	1	1	0	1	0	0.6	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Scolopacidae	0	0	0	0	0	0.0	0	0	0	0	1	0.2	0	0	0	0	0	0.0
Columbidae	3	0	2	4	0	1.8	0	0	2	6	2	2.0	4	0	3	4	2	2.6
Caprimulgidae	0	0	0	0	5	1.0	0	0	0	0	8	1.6	0	0	0	0	0	0.0
Picidae	4	0	1	0	4	1.8	0	2	2	4	0	1.6	2	1	2	2	2	1.8
Tyrannidae	8	4	12	6	6	7.2	4	4	3	9	10	6.0	2	4	0	7	4	3.4
Hirundinidae	0	0	0	2	0	0.4	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Corvidae	3	3	1	6	0	2.6	2	3	0	6	0	2.2	6	4	2	0	4	3.2
Paridae	0	0	0	0	0	0.0	2	0	0	2	0	0.8	2	0	2	2	0	1.2
Sittidae	0	0	0	0	2	0.4	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Turdidae	3	2	5	9	15	6.8	1	20	0	13	12	9.2	2	10	11	7	5	7.0
Bombycillidae	0	0	0	0	0	0.0	1	0	0	0	0	0.2	0	4	0	0	0	0.8
Vireonidae	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	4	2	0	4	2.0
Parulidae	24	28	20	28	16	23.2	18	14	20	21	20	18.6	22	20	10	20	17	17.8
Icteridae	10	2	10	7	2	6.2	11	6	4	10	7	7.0	18	10	7	9	14	11.6
Thraupidae	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	4	0	0	0.8
Fringillidae	16	7	17	9	20	13.8	21	6	6	4	17	12.8	14	15	10	8	8	11.0
Total Birds	72	47	68	72	70	65.8	59	55	42	80	76	62.4	74	72	51	61	63	64.2



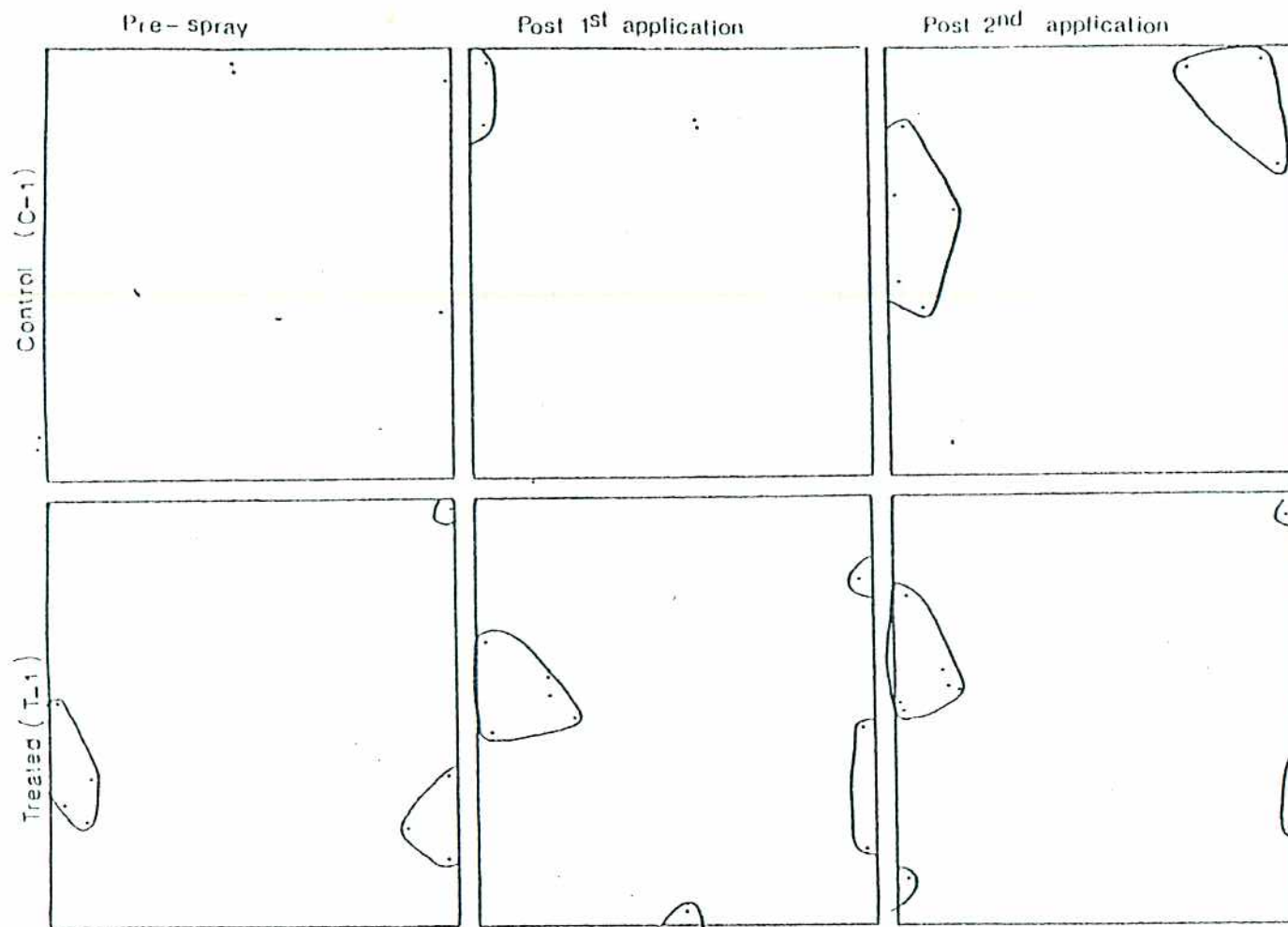


Fig. 2. Nesting territories of the Veery, *Hylocichla fuscescens* (Stephens) on plots C-1 and T-1 before and after two applications of Permethrin (17.5 gm AI/ha), Larose Forest, Ontario.

May - June, 1978

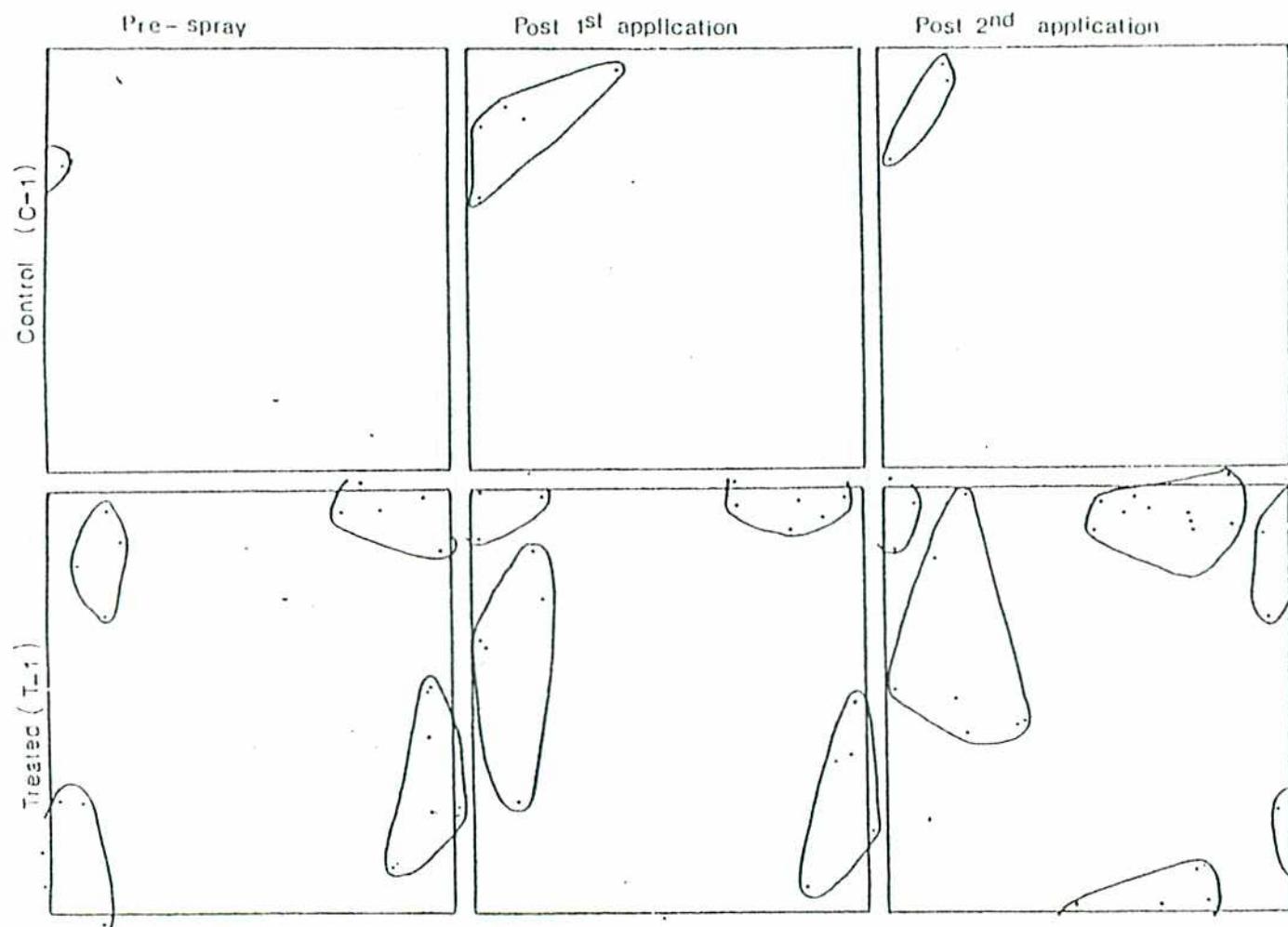


Fig. 3. Nesting territories of the Ovenbird, *Seiurus aurocapillus* (Linnaeus) on plots C-1 and T-1 before and after two applications of Permethrin (17.5 gm AI/ha), Larose Forest, Ontario.

May - June, 1978

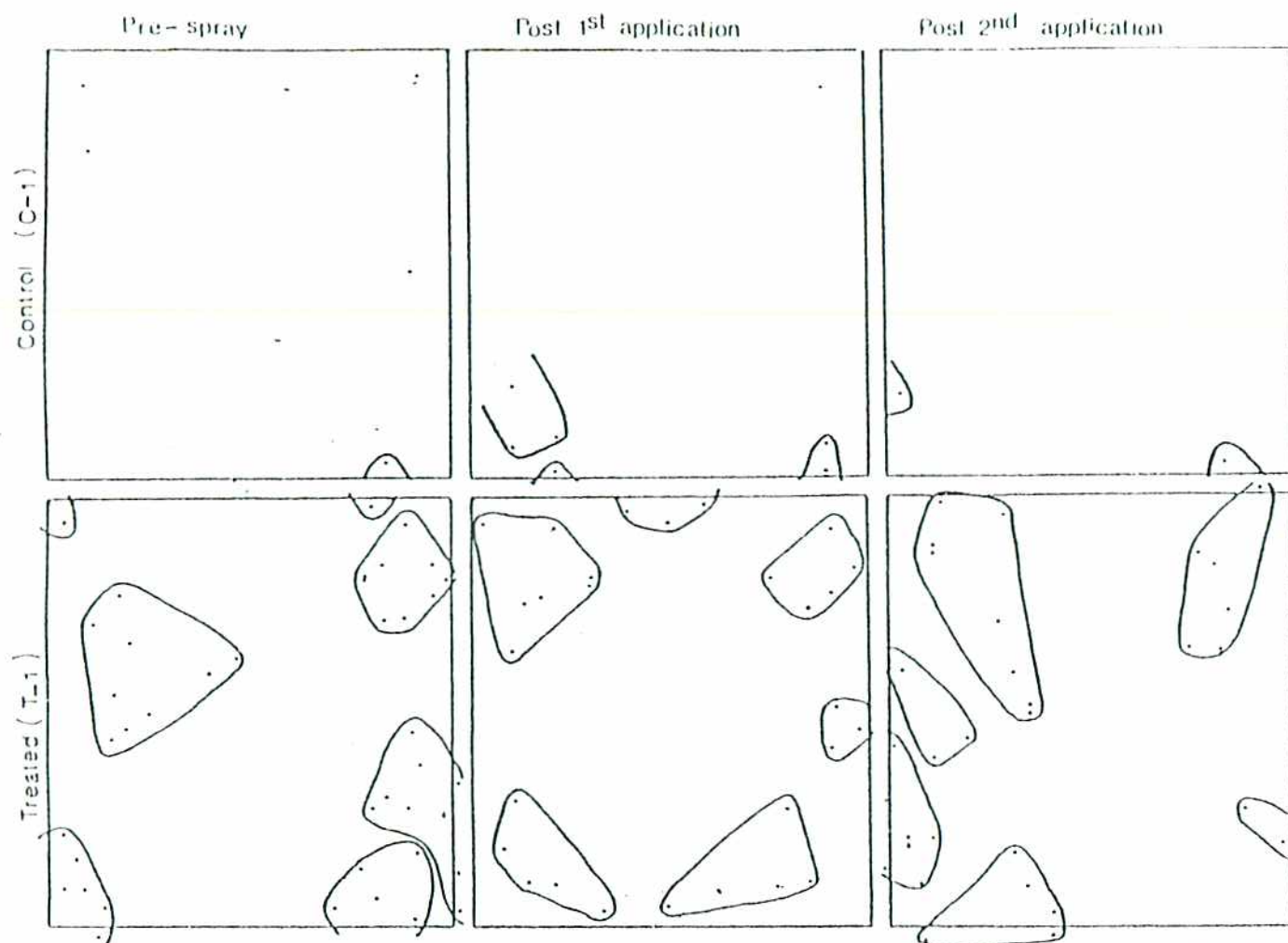


Fig. 4. Nesting territories of the Nashville Warbler, *Vermivora ruficapilla* (Wilson) on plots C-1 and T-1 before and after two applications of Permethrin (17.5 gm AI/ha), Larose Forest, Ontario.

May - June, 1978



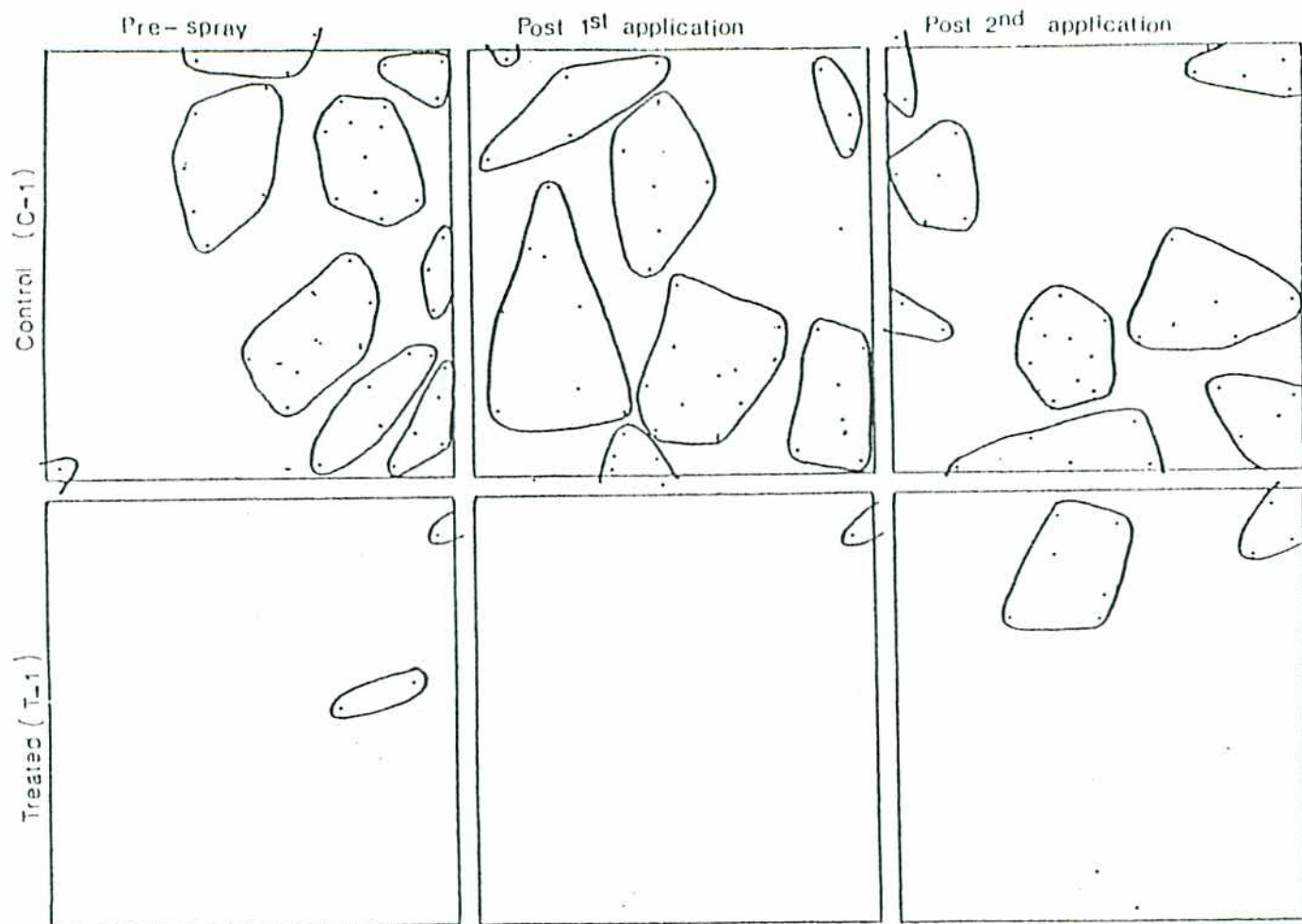


Fig. 5. Nesting territories of the Common Yellowthroat, *Geothlypis trichas* (Linnaeus) in plots C-1 and T-1 before and after two applications of Permethrin (17.5 gm AI/ha), Larose Forest, Ontario.

May - June, 1978

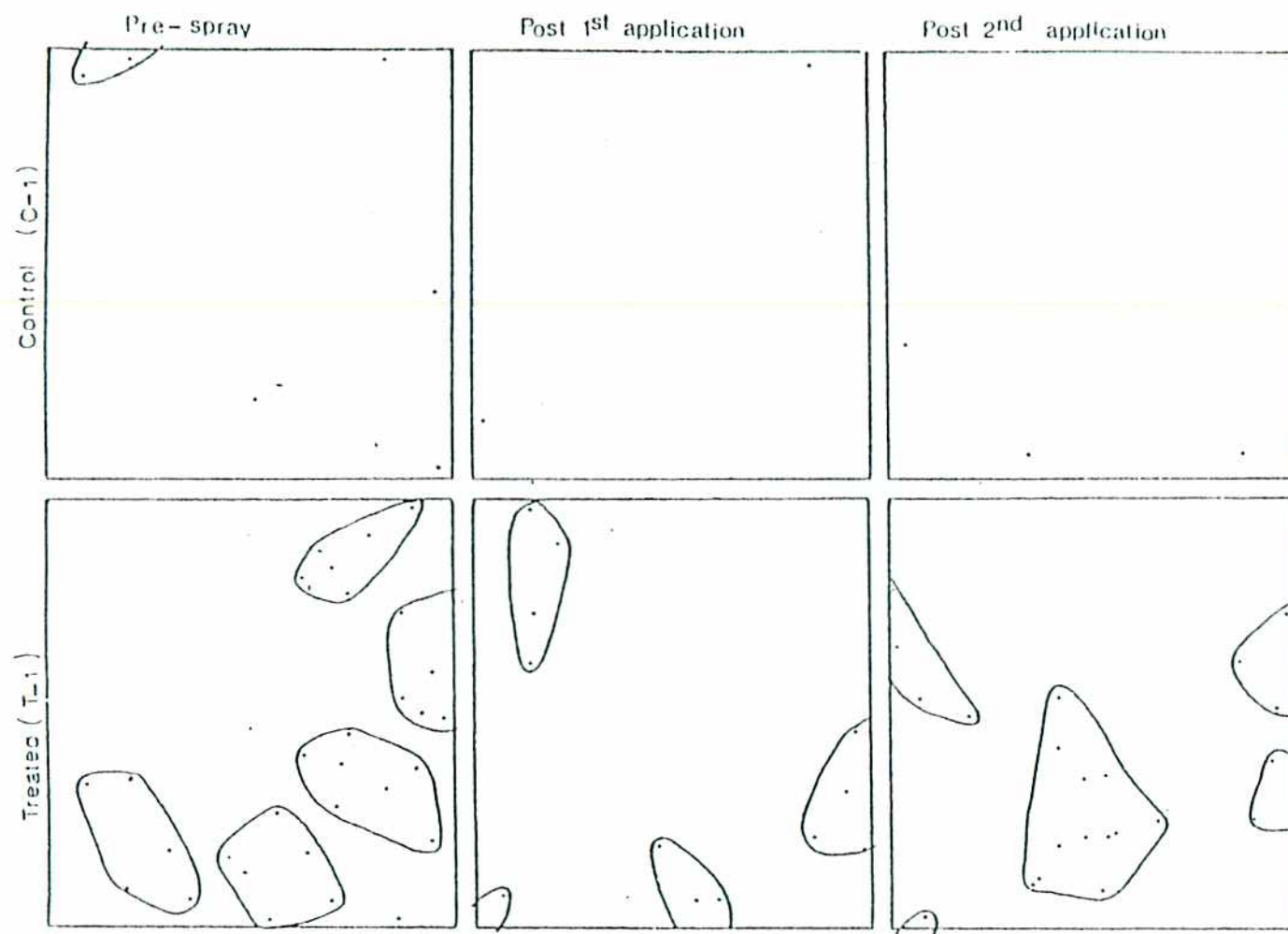


Fig. 6. Nesting territories of the White-throated Sparrow, *Zonotrichia albicollis* (Gmelin) on plots C-1 and T-1 before and after two applications of Permethrin (17.5 gm AI/ha), Larose Forest, Ontario.

May - June, 1978

Coniferous forest, plots C-2 and T-2: A total of 54 species of birds representing 23 families were recorded on T-2 and 38 species representing 11 families on plot C-2.

Avian activity patterns recorded throughout the experimental period were similar on both plots. A decline in bird activity on T-2 occurred on 8 June following the second application while activity patterns fluctuated somewhat on C-2 (Figure 7).

Warbler activity declined on both plots throughout the experimental period (a result of natural decline in breeding activity) while that of the thrushes and sparrow-finch-grosbeak group remained relatively constant (Tables IX and X).

Great-crested flycatchers declined slightly on both plots. A small group of black-capped chickadees, *Parus atricapillus* (Linnaeus) were not observed on T-2 following the initial treatment. The golden-crowned kinglet, *Regulus strapa* (Lichtenstein), (a small, pesticide sensitive species) was not affected and populations remained stable on both plots. Populations of the Nashville warbler, an inhabitant of the mixedwoods forest, declined slowly throughout the census period on both plots. A small flock of rose-breasted grosbeaks, *Pheucticus ludovicianus* (Linnaeus) which appeared on T-2 on 8 June moved out the following day (Appendix tables A-III and A-IV).

Nesting territories for the veery, common yellowthroat, Nashville warbler, ovenbird and white-throated sparrow (Figures 8 to 12) demonstrate that none of the species abandoned territories as a result of the two Permethrin treatments. Diligent plot searches failed to identify any birds suffering the effects of pesticide poisoning and no mortality was recorded.



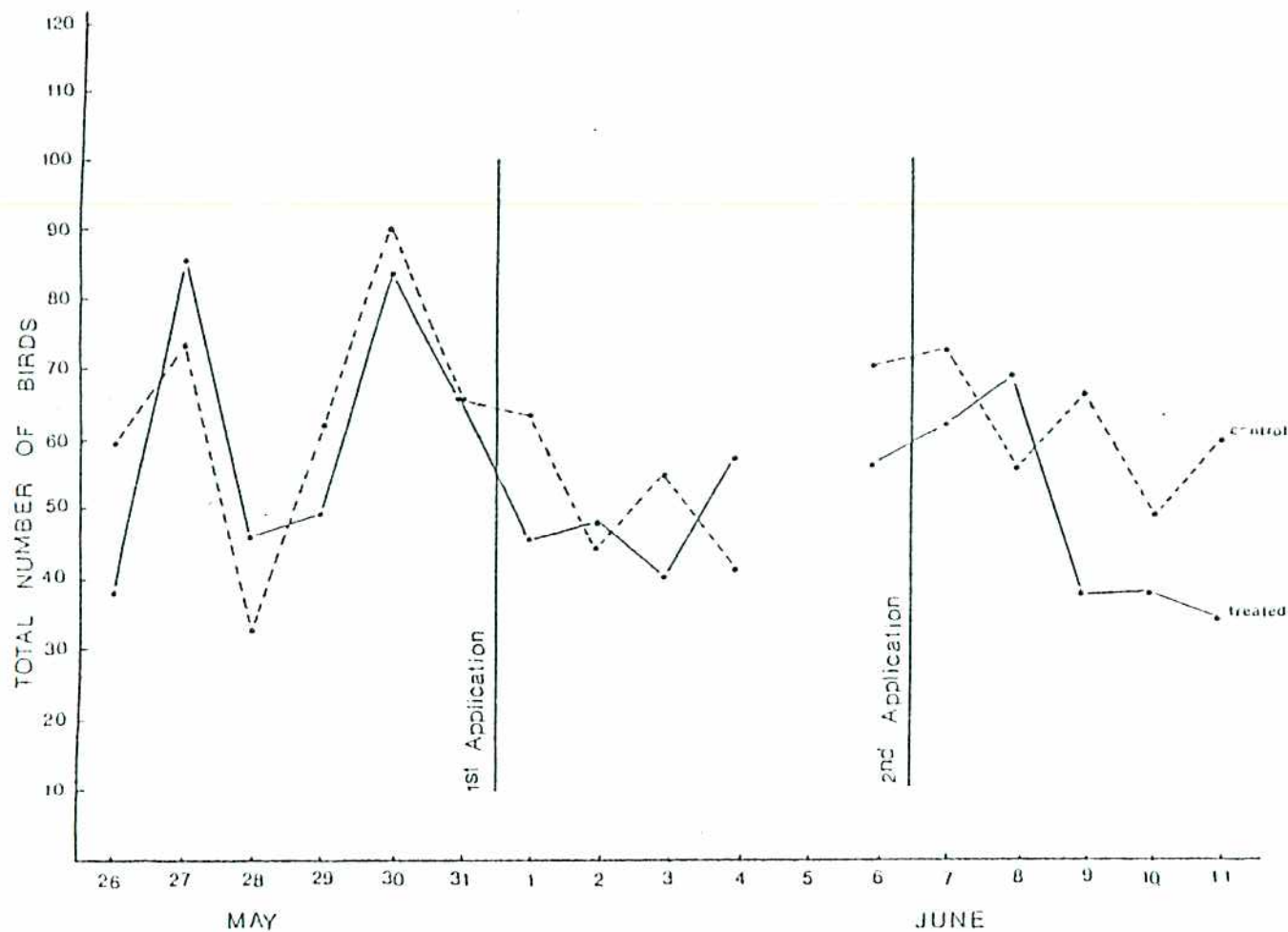


Fig. 7. Forest songbird activity on plots C-2 and T-2 throughout the Permethrin experimental trials, Larose Forest, Ontario. May-June, 1978.

Table IX  
Forest bird population census  
Permethrin treatment plot T-2 (softwoods)  
Larose Forest, Ontario  
May 27 - June 11, 1978

Family	Pre-spray						Post-spray, 1st application						Post-spray, 2nd application					
	May 27	May 28	May 29	May 30	May 31	Daily Ave.	June 1	June 2	June 3	June 4	June 6	Daily Ave.	June 7	June 8	June 9	June 10	June 11	Daily Ave.
	4	3	2	1	0		+1	+2	+3	+4	+6		+1	+2	+3	+4	+5	
Ardeidae	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	1	0	0	0	0.2
Anatidae	0	0	0	0	0	0.0	0	0	1	0	0	0.2	0	0	0	0	0	0.0
Accipitridae	0	0	1	0	0	0.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Tetraonidae	0	1	0	0	0	0.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Charadriidae	0	0	0	1	0	0.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Scelopacidae	0	0	3	0	0	0.6	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Columbidae	0	0	0	2	2	0.8	0	0	0	0	2	0.4	2	4	2	0	0	1.6
Picidae	1	2	0	0	0	0.6	0	0	0	0	0	0.0	2	0	0	2	0	0.8
Tyrannidae	8	0	2	4	2	3.2	0	4	6	0	0	2.8	0	1	0	0	4	1.0
Hirundinidae	0	0	0	0	0	0.0	0	0	0	4	0	0.8	0	0	0	0	0	0.0
Corvidae	3	7	4	3	3	4.0	0	7	1	6	0	2.8	5	6	0	1	0	2.4
Paridae	2	0	1	6	2	2.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Sittidae	4	0	0	2	0	1.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Certhiidae	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	0	2	0	0.4
Nimidae	0	0	0	0	0	0.0	0	2	0	0	0	0.4	0	2	0	0	0	0.4
Turdidae	3	9	4	15	28	11.8	14	4	8	13	19	11.6	18	10	13	10	10	12.2
Sylviidae	8	0	2	6	6	4.4	6	2	0	10	4	4.4	8	0	2	8	0	3.6
Bombycillidae	0	0	0	0	0	0.0	0	0	0	0	1	0.2	0	4	7	0	0	2.2
Vireonidae	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	2	0	0	0.4
Parulidae	36	20	26	30	20	26.4	20	22	16	18	22	19.6	18	30	12	14	10	16.8
Icteridae	8	4	2	8	0	4.4	7	0	6	2	2	3.4	9	2	0	2	9	4.4
Thraupidae	0	2	0	0	0	0.4	0	0	0	2	0	0.4	0	0	0	0	0	0.0
Frugillidae	12	2	6	8	4	6.4	0	8	4	4	6	4.4	2	12	2	2	4	4.4
Unidentified	2	0	0	0	0	0.4	0	0	0	0	2	0.4	0	0	0	0	0	0.0
Total Birds	87	47	51	85	67	67.4	47	49	42	59	58	51.0	64	72	40	41	37	50.8

Table X  
Forest bird population census  
Permethrin untreated control plot C-2 (softwoods)  
Larose Forest, Ontario  
May 27 - June 11, 1978

Family	Pre-spray						Post-spray, 1st application						Post-spray, 2nd application					
	May 27	May 28	May 29	May 30	May 31	Daily Ave.	June 1	June 2	June 3	June 4	June 6	Daily Ave.	June 7	June 8	June 9	June 10	June 11	Daily Ave.
	4	3	2	1	0		+1	+2	+3	+4	+6		+1	+2	+3	+4	+5	
Tetraonidae	0	0	1	0	0	0.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Picidae	0	0	0	0	0	0.0	2	2	0	0	0	0.8	0	2	0	0	0	0.4
Tyrannidae	2	2	2	4	2	2.4	0	2	2	2	4	2.0	2	6	4	2	4	3.6
Corvidae	1	0	8	3	4	3.2	4	2	4	1	2	2.6	2	4	1	2	1	2.0
Paridae	0	0	0	2	0	0.4	0	0	0	0	2	0.4	0	0	0	0	0	0.0
Turdidae	9	8	4	10	9	8.0	7	6	10	13	6	8.4	8	6	8	6	5	6.6
Sylviidae	6	2	2	4	4	3.6	6	2	2	2	4	3.2	10	2	2	2	6	4.4
Bombycillidae	0	0	0	0	0	0.0	0	0	0	0	2	0.4	0	2	3	0	0	1.0
Parulidae	38	10	30	50	28	31.2	36	14	26	16	34	25.2	32	18	15	14	20	19.8
Icteridae	0	0	2	3	2	1.4	2	8	0	0	5	3.0	7	4	4	13	9	7.4
Fringillidae	17	12	14	16	16	15.0	8	10	9	8	12	9.4	12	12	30	10	15	15.8
Unidentified	2	0	0	0	2	0.8	0	0	2	0	0	0.4	0	0	0	0	0	0.0
Total Birds	75	34	63	92	67	66.2	65	46	55	42	71	55.8	73	56	67	49	60	61.0



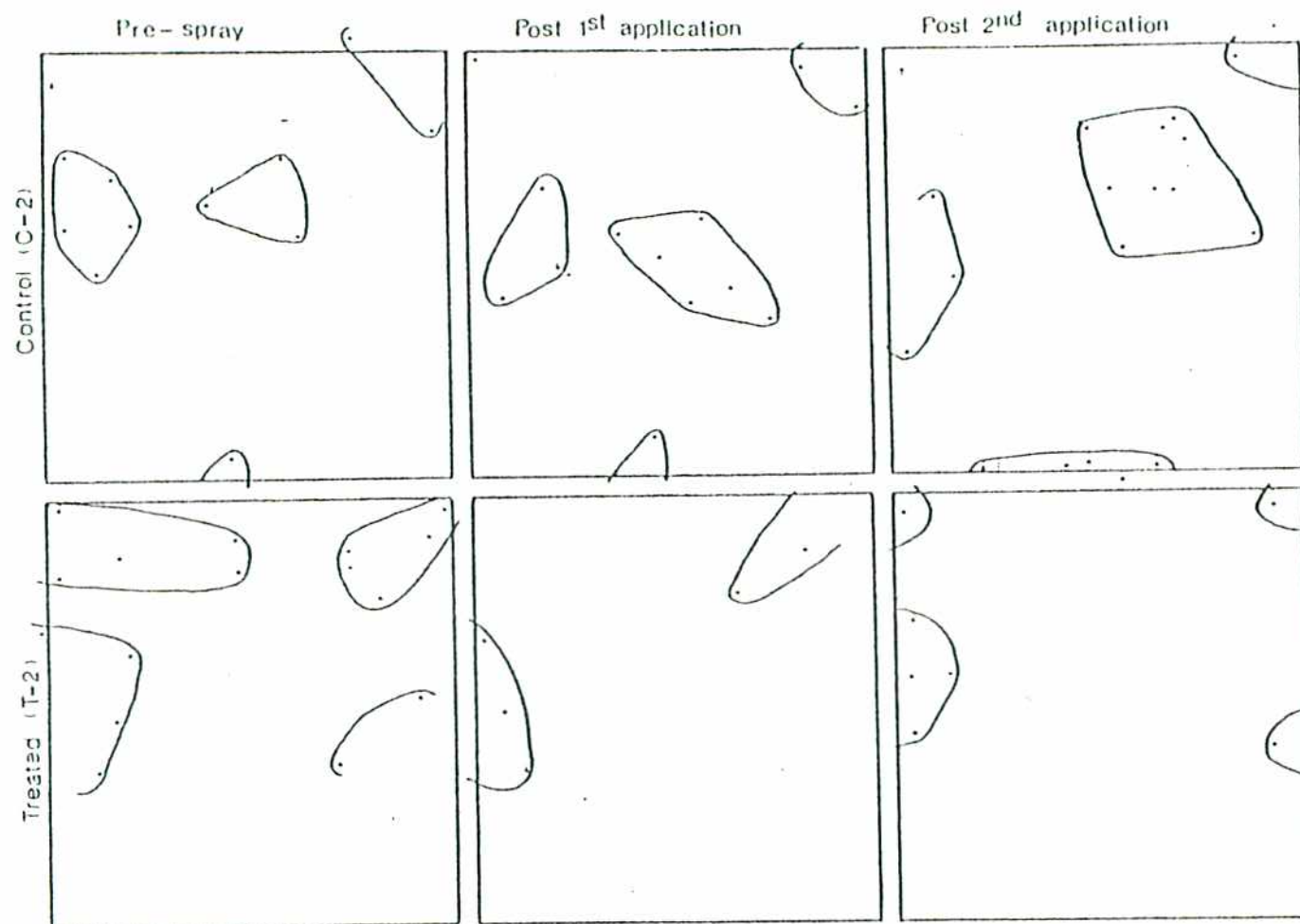


Fig. 8. Nesting territories of the Veery, *Mylocichla fuscescens* (Stephens) on plots C-2 and T-2 before and after two applications of Permethrin (17.5 gm AI/ha), Larose Forest, Ontario.

May - June, 1978

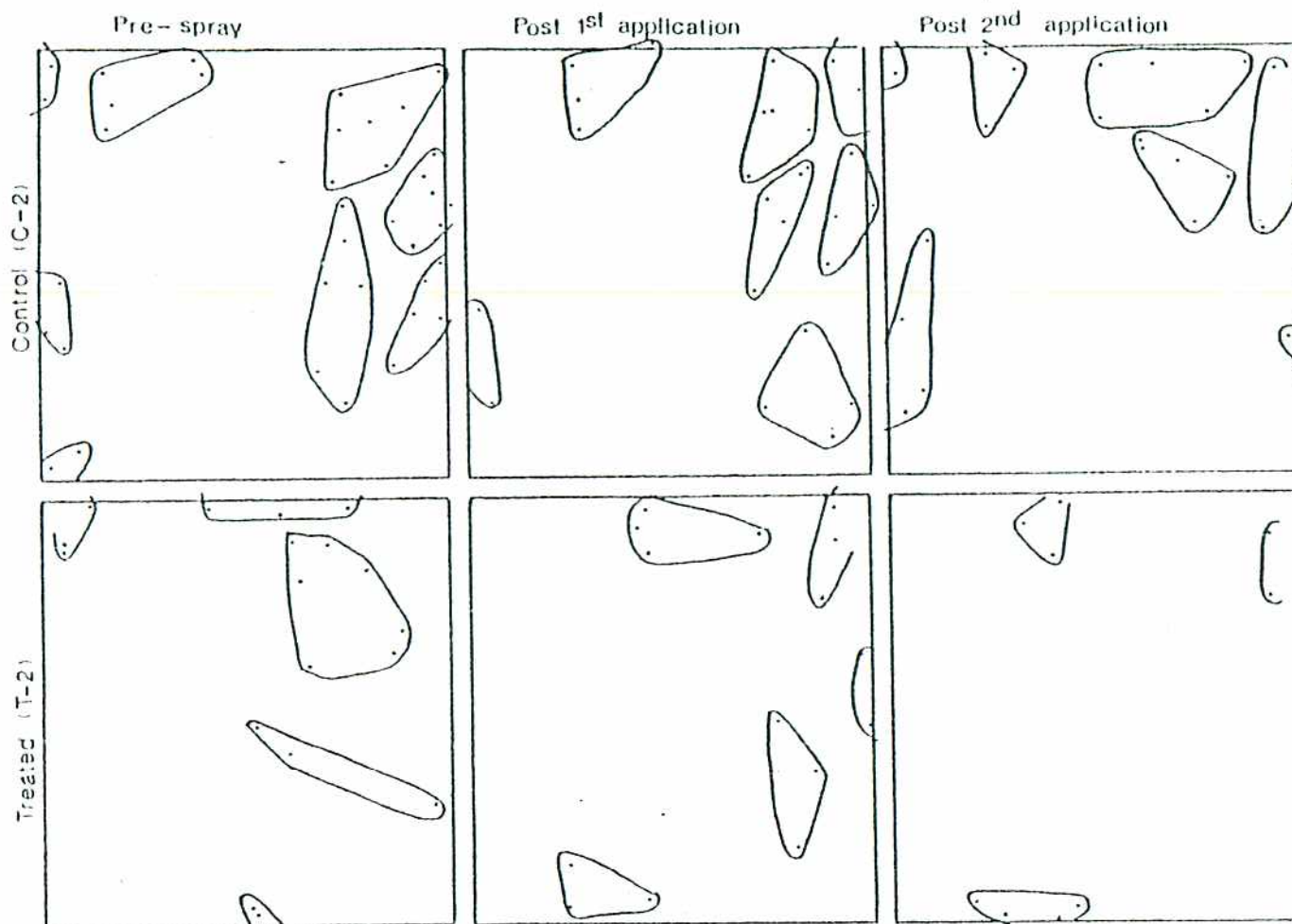


Fig. 9. Nesting territories of the Nashville Warbler, *Vermivora ruficapilla* (Wilson) on plots C-2 and T-2 before and after two applications of Permethrin (17.5 gm AI/ha), Larose Forest, Ontario.

May - June, 1978

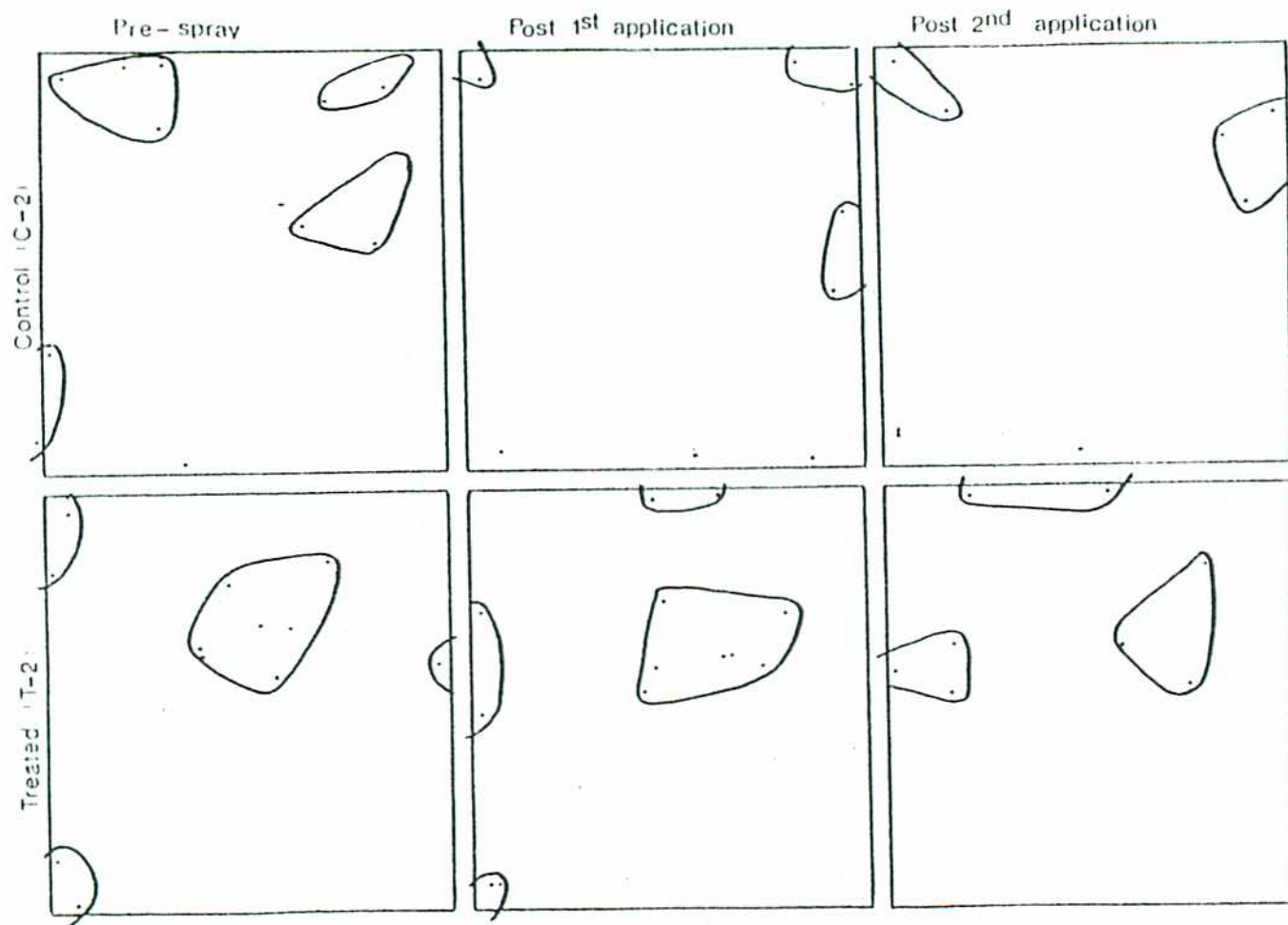


Fig. 10. Nesting territories of the Common Yellowthroat, *Geothlypis trichas* (Linnaeus) on plots C-2 and T-2 before and after two applications of Permethrin (17.5 gm AI/ha), Larose Forest, Ontario.

May - June, 1978

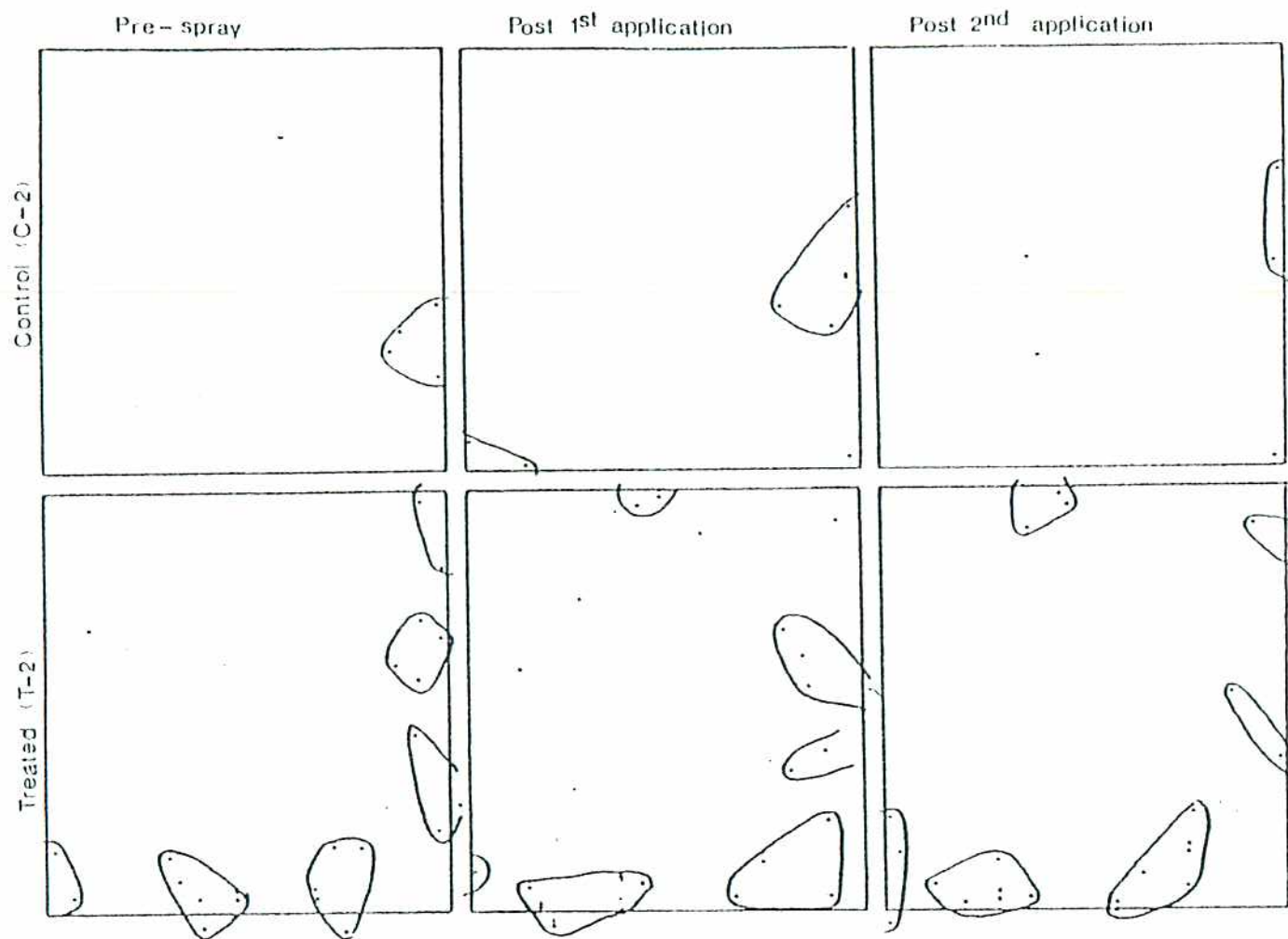


Fig. 11. Nesting territories of the Ovenbird, *Seiurus aurocapillus* (Linnaeus) on plots C-2 and T-2 before and after two applications of Permethrin (17.5 gm AI/ha), Larose Forest, Ontario.  
May - June 1978



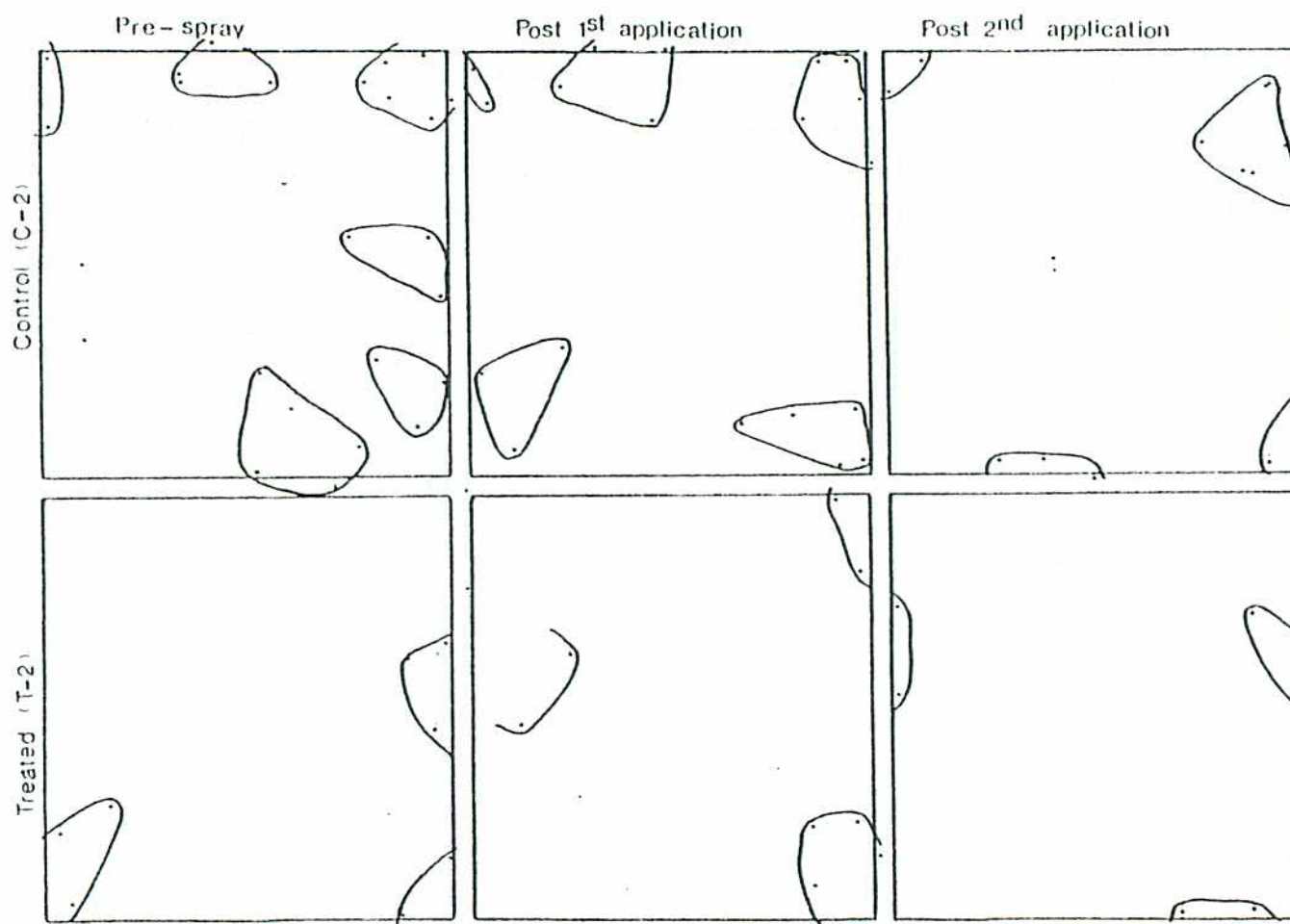


Fig. 12. Nesting territories of the white-throated sparrow, *Zonotrichia albicollis* (Gmelin) on plots C-2 and T-2 before and after two applications of Permethrin (17.5 gm AI/ha), Larose Forest, Ontario.

May - June, 1978

Deciduous forest, plots C-3 and T-3: A total of 44 species of birds representing 16 families were recorded on the C-3 plot and 44 species representing 14 families recorded on the T-3 plot.

Avian activity patterns recorded on both plots were quite similar during the period prior to the initial application. A notable decline in song and foraging activity was recorded on 2 June (the second day following the first treatment) (Figure 13). Nashville warbler activity had started to decline on 30 May (prior to the first treatment), reached a low on 2 June, increased to pretreatment levels on 4 June and then slowly declined throughout the remainder of the experimental period. This same pattern is evident on the untreated control plot but to a much lesser degree as populations of Nashvilles were somewhat lower (Tables XI and XII). Several other species of warblers were recorded on 30 May but did not reappear for several days after the first or second application (Cape May warbler, *Dendroica tigrina* (Gmelin), magnolia warbler, *Dendroica magnolia* (Wilson) and yellow-rumped warbler, *Dendroica coronata* (Linnaeus)). White-throated sparrow activity also declined and remained at a low level throughout the remainder of the programme. On 2 June notable increases in the activity of the yellow warbler, *Dendroica petechia* (Linnaeus), and Magnolia warbler were recorded (Appendix tables A-V and A-VI). Nashville warbler activity declined on both plots during the course of the experiment but both territories defined on C-3 remained occupied while several territories on T-3 could not be relocated following the treatments (Figure 15). The unaccounted for territories were located along the plot boundaries and, therefore, may have shifted outwards from the plot and not been recorded. The common yellowthroat also declined on both plots with the accompanying disappearance of nesting territories (Figure 16), probably related to the natural decline of breeding activity at this time of year. Activity of the ovenbird, a warbler species inhabiting the lower canopy and forest floor, declined slightly on T-3 following the initial spray (Appendix Tables A-V and A-VI) but their territories remained virtually intact (Figure 17). White throated sparrows did not appear to have been affected by either treatment but activity fluctuated around the borders of the hardwoods plot (not a preferred habitat for this and other above mentioned species). Veery activity also declined slightly on both plots but territories remained occupied (Figure 14). Plot searches again failed to reveal any mortality or abnormal activity resulting from either application.

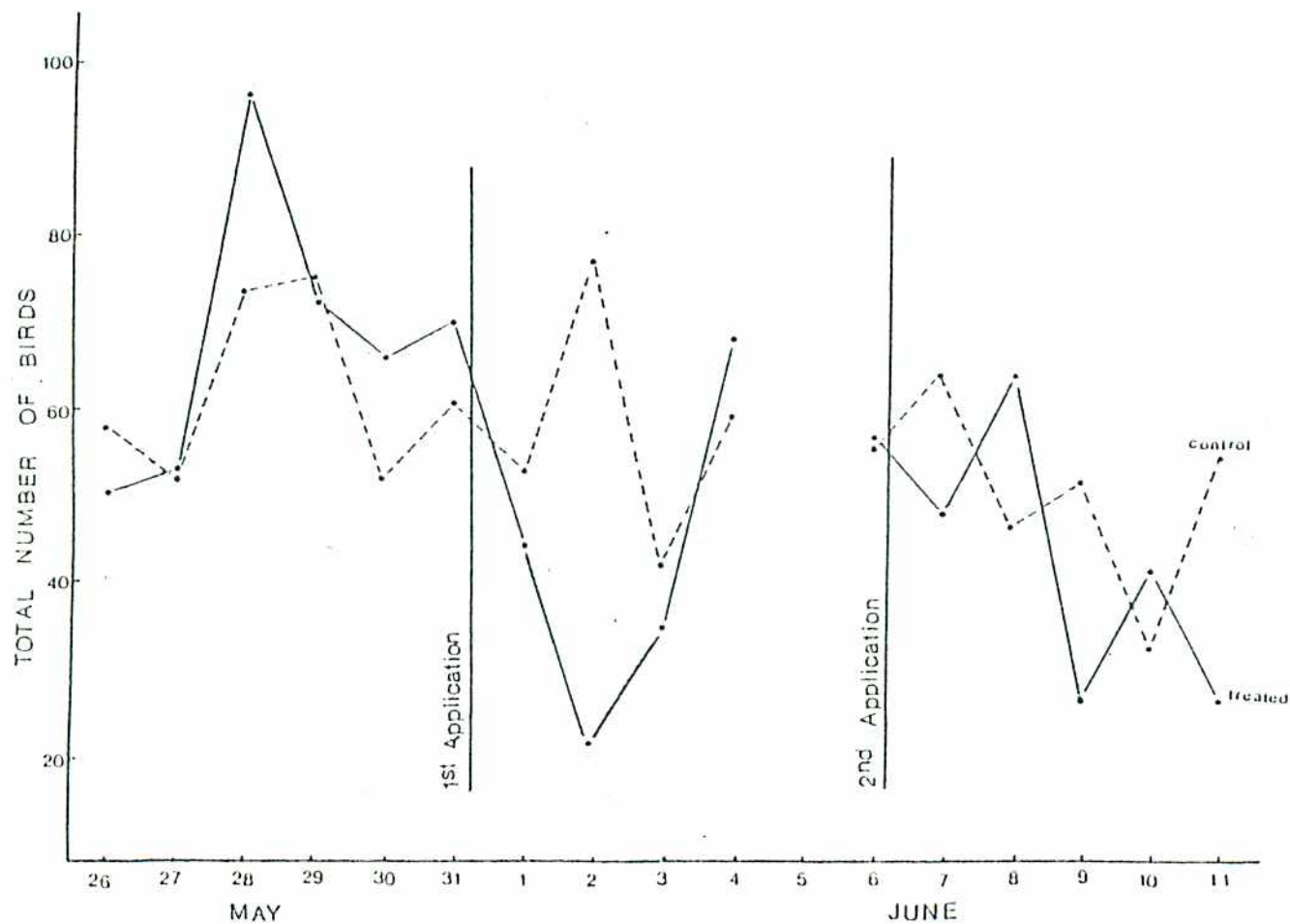


Fig. 13. Forest songbird activity on plots C-3 and T-3 throughout the Permethrin experimental trials, Larose Forest, Ontario. May-June, 1978.

Table XI  
Forest bird population census  
Permethrin treatment plot T-3 (hardwoods)  
Larose Forest, Ontario  
May 27 - June 11, 1978

Family	Pre-spray						Post-spray, 1st application						Post-spray, 2nd application					
	May	May	May	May	May	Daily	June	June	June	June	June	Daily	June	June	June	June	June	Daily
	27	28	29	30	31		1	2	3	4	6		7	8	9	10	11	
	4	3	2	1	0	Ave.	+1	+2	+3	+4	+6	Ave.	+1	+2	+3	+4	+5	Ave.
Ardeidae	0	0	2	0	3	1.0	0	0	1	0	1	0.2	0	0	0	0	0	0.0
Tetraonidae	0	0	1	0	0	0.2	0	0	1	2	0	0.6	0	0	0	0	0	0.0
Columbidae	0	2	0	0	2	0.8	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Picidae	0	0	0	3	0	0.6	0	0	0	1	0	0.2	0	0	0	0	1	0.2
Tyrannidae	4	14	8	6	4	7.2	2	2	3	6	2	3.0	8	10	5	8	5	7.2
Corvidae	3	3	4	5	3	3.6	0	0	4	1	2	1.6	4	5	2	0	0	2.2
Paridae	0	6	4	2	0	2.4	2	0	0	0	0	0.4	0	0	0	0	0	0.0
Sittidae	0	0	0	0	0	0.0	0	0	0	2	0	0.4	0	0	0	0	0	0.0
Certhiidae	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	2	0	2	0	0.8
Mimidae	0	0	0	0	0	0.0	0	0	0	0	2	0.4	0	0	0	0	0	0.0
Turdidae	4	9	12	6	10	8.2	1	4	2	11	12	6.0	5	6	2	7	5	5.0
Bombycillidae	2	0	0	0	2	0.8	1	0	0	0	0	0.2	1	4	2	0	2	1.8
Vireonidae	0	4	6	2	2	2.8	2	2	2	2	2	2.0	0	2	2	0	0	0.8
Parulidae	36	38	24	30	34	32.4	22	10	16	34	20	20.4	18	22	12	18	10	16.0
Icteridae	0	0	1	0	0	0.2	4	0	2	4	2	2.4	4	11	0	5	2	4.4
Fringillidae	4	20	10	12	8	10.8	10	3	4	5	14	7.2	8	2	2	2	2	3.2
Unidentified	0	0	0	0	2	0.4	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Total Birds	53	96	72	66	70	71.4	44	21	35	68	57	45.0	48	64	27	42	27	41.6



Table XII  
Forest bird population census  
Permethrin control plot C-3 (hardwoods)  
Larose Forest, Ontario  
May 27 - June 11, 1978

Family	Pre-spray						Post-spray, 1st application						Post-spray, 2nd application					
	May 27	May 28	May 29	May 30	May 31	Daily Ave.	June 1	June 2	June 3	June 4	June 6	Daily Ave.	June 7	June 8	June 9	June 10	June 11	Daily Ave.
	4	3	2	1	0		+1	+2	+3	+4	+6		+1	+2	+3	+4	+5	
Ardeidae	0	0	0	0	1	0.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Accipitridae	0	0	0	0	0	0.0	0	0	0	0	0	0.0	1	0	0	0	0	0.2
Tetraonidae	1	4	3	1	2	2.2	2	0	3	2	3	2.0	2	0	0	1	0	0.6
Columbidae	0	0	0	0	0	0.0	0	0	0	0	2	0.4	1	0	0	0	0	0.2
Picidae	0	0	0	1	2	0.6	0	0	0	0	0	0.0	0	1	2	2	1	1.2
Tyrannidae	6	2	6	8	6	5.6	6	10	3	9	4	6.4	2	4	3	1	4	2.8
Corvidae	0	0	1	0	0	0.2	1	0	0	0	2	0.6	0	0	0	0	1	0.2
Paridae	0	2	0	0	0	0.4	0	0	2	0	0	0.4	0	0	0	0	0	0.0
Mimidae	2	2	0	4	0	1.6	4	6	4	4	4	4.4	5	5	4	0	2	3.2
Turdidae	10	16	8	6	8	9.6	5	4	2	4	8	4.6	6	4	8	3	8	5.8
Vireonidae	0	0	8	0	0	1.6	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Parulidae	30	43	43	26	38	36.0	31	50	26	32	30	33.8	40	28	32	24	26	30.0
Icteridae	0	2	0	2	0	0.8	2	2	2	3	1	2.0	1	3	0	0	3	1.4
Frugillidae	2	3	6	4	4	3.8	2	5	0	5	2	2.8	6	2	3	2	10	4.6
Unidentified	1	0	0	0	0	0.2	0	0*	0	0	0	0.0	0	0	0	0	0	0.0
Total Birds	52	74	75	52	61	62.8	53	77	42	59	56	57.4	64	47	52	33	55	50.2

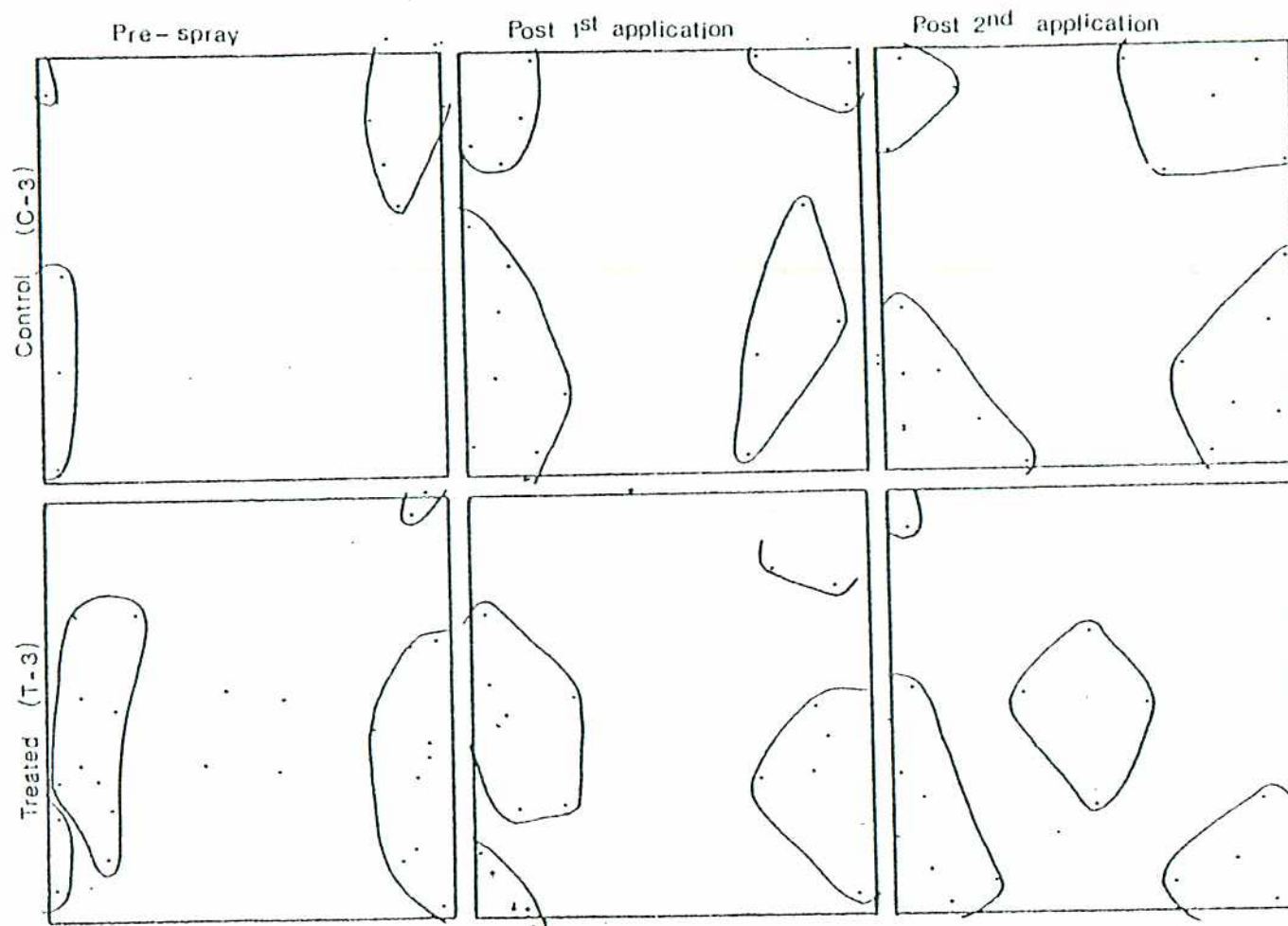


Fig. 14. Nesting territories of the Veery *Mylocichla fuscescens* (Stephens) on plots C-3 and T-3 before and after two applications of Permethrin (17.5 gm AI/ha), Larose Forest, Ontario.  
May - June, 1978

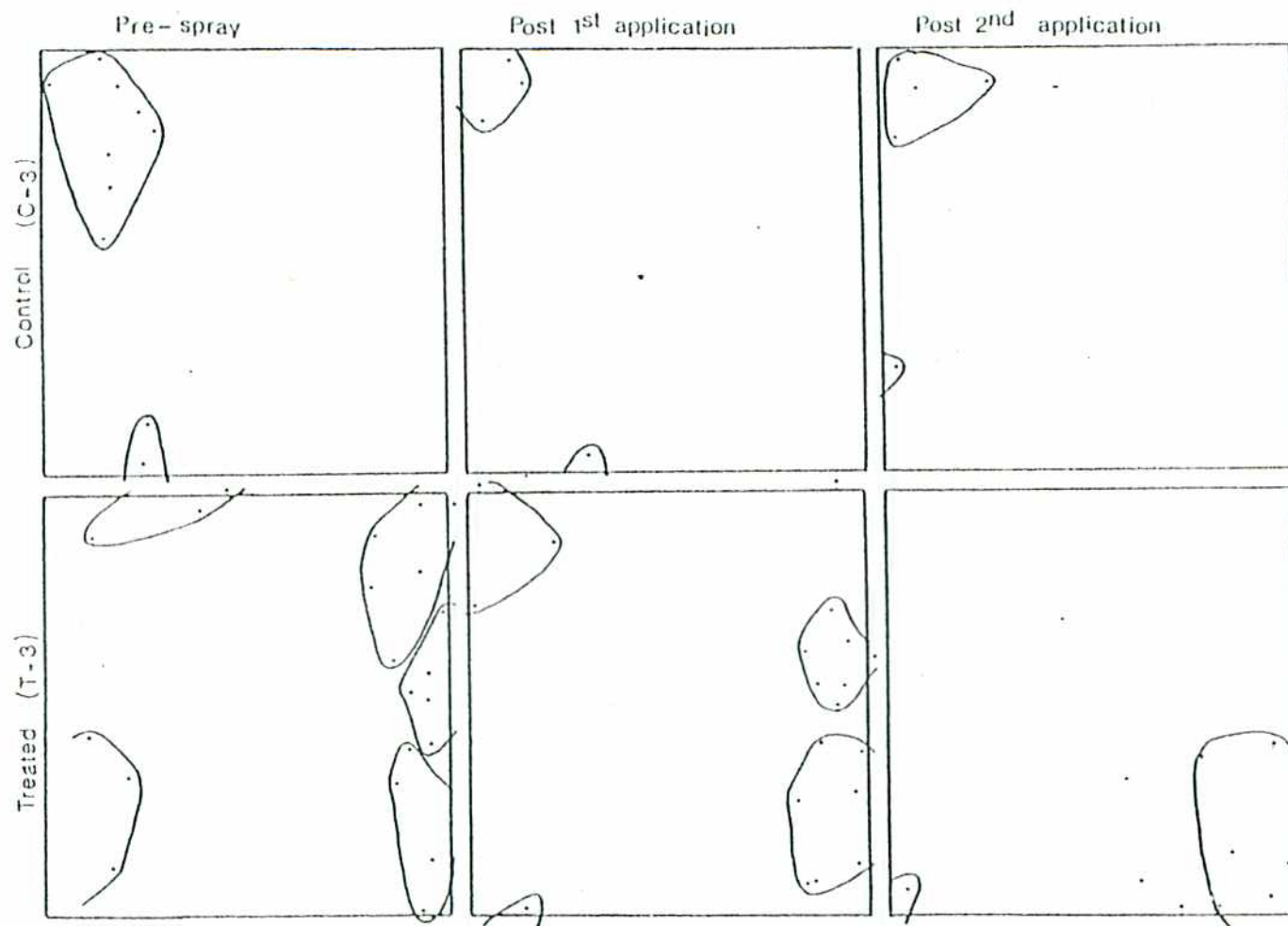


Fig. 15. Nesting territories of the Nashville Warbler, *Vermivora ruficapilla* (Wilson) on plots C-3 and T-3 before and after two applications of Permethrin (17.5 gm AI/ha), Larose Forest, Ontario.

May - June, 1978

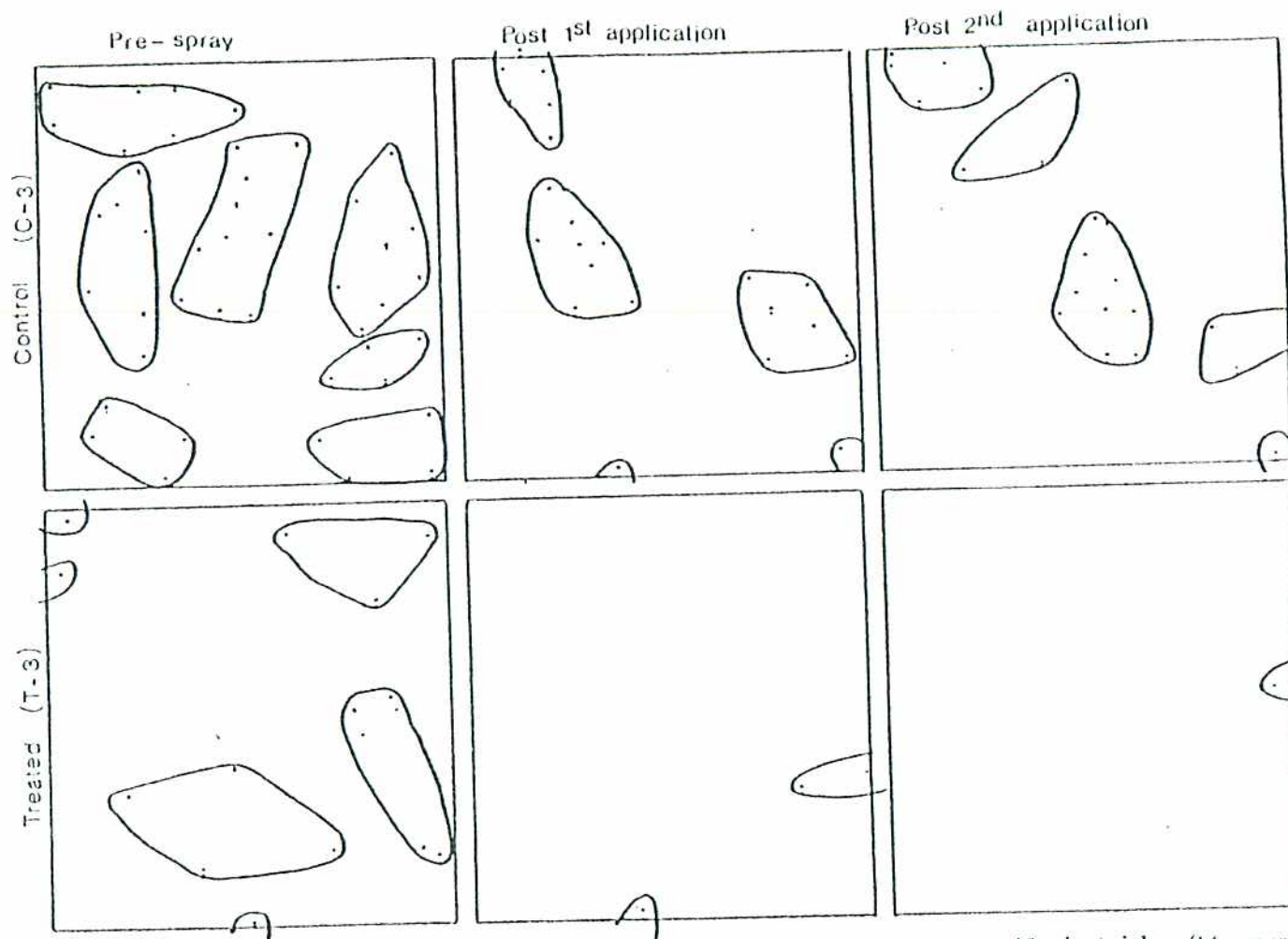


Fig. 16. Nesting territories of the Common Yellowthroat *Geothlypis trichas* (Linnaeus) on plots C-3 and T-3 before and after two applications of Permethrin (17.5 gm AI/ha), Larose Forest, Ontario.  
May - June, 1978



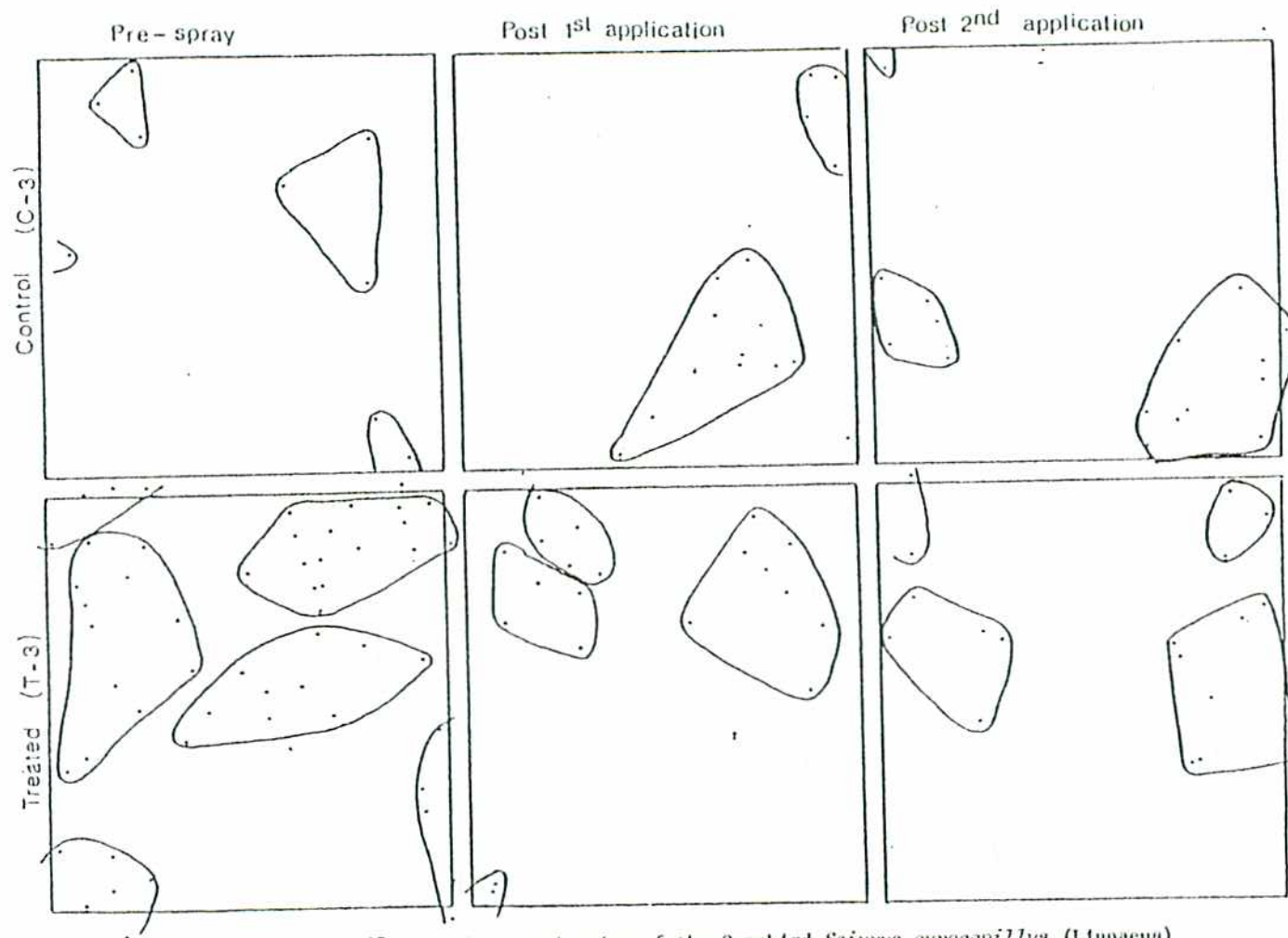


Fig. 17. Nesting territories of the Ovenbird *Seiurus aurocapillus* (Linnaeus) on plots C-3 and T-3 before and after two applications of Permethrin (17.5 gm AI/ha), Larose Forest, Ontario.  
May - June, 1978

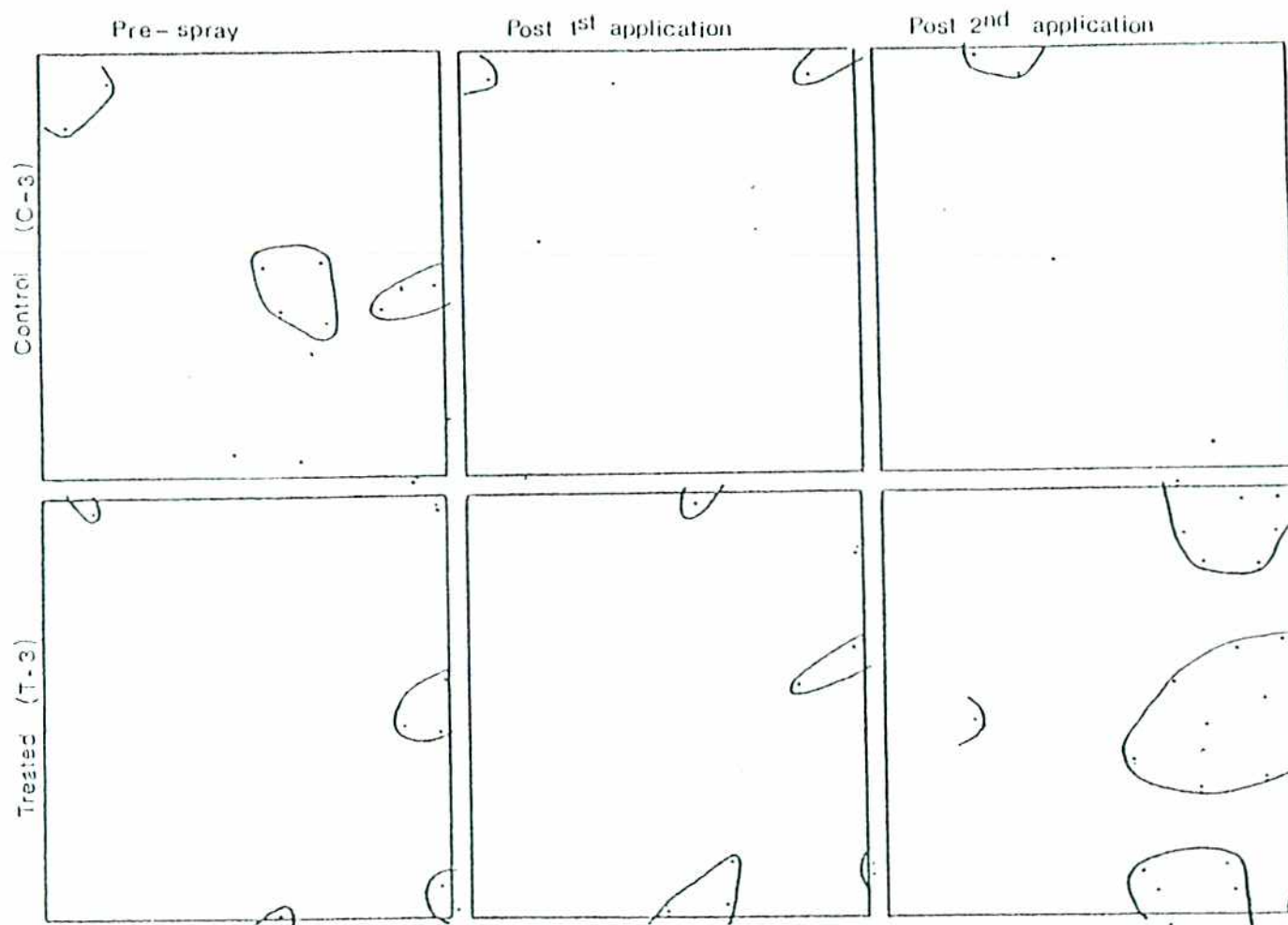


Fig. 18 . Nesting territories of the white-throated sparrow, *Zonotrichia albicollis* (Gmelin) on plots C-3 and T-3 before and after two applications of Permethrin (17.5 gm AI/ha), Larose Forest, Ontario.  
May - June, 1978

### *Honey bees*

Weather conditions throughout the early part of the day of the two Permethrin applications served to restrict foraging bee flight activity for at least two hours after the completion of each treatment. A slight increase in adult bee mortality was recorded from colonies located in the treated block after each application (Table XIII). No comparable increase in mortality occurred to colonies in the untreated control block after the first treatment but the increase in mortality on the treated block after the second treatment was also observed on the control block. Trends in pollen collection in the two areas were remarkably similar and appear to be related to prevailing weather conditions, with the severe depression in pollen collection on 5 June and 8 June resulting from rainfall during these days (Figure 19, Table 1).

Hive weights did not change significantly over the immediate post-treatment periods with average weight gains of 0.5 and 3.6 per cent recorded for the treated and untreated control colonies respectively. Weight gain and honey production into late summer was similar among both groups of hives.

### *Non-target insects*

The initial application of Permethrin resulted in an immediate and substantial knockdown of insects from the various plant species being monitored. The knockdown reached it's peak within the first 24 hours, declining rapidly to pre-treatment levels by day 3 (Figure 20). The low recorded on 5 June resulted from the cool rainy weather conditions which prevailed throughout the day. The second application did not produce nearly as great an impact as that recorded following the first treatment and the recovery trend parallels that recorded on the untreated control block.

All sample areas (shrub or tree species) were affected by the first application with the exception of the station where collecting containers had been placed in open areas on the surface of a pond (Table XIV).

The greatest impact occurred to the insect fauna infesting *Salix* spp. where many species infesting the catkins were affected (Table XV). Spruce budworm, *Choristoneura fumiferana* Clemens, were observed spinning out of the trees shortly after the passage of the spray plane and were the most abundant species collected from the collecting containers placed under the spruce (Table XVI). Small increases in knockdown of a variety of insect groups were recorded from flowering Nannyberry and chockcherry in the treated block (Tables XVII and XVIII).

The sampling of non-target insect fauna was terminated on 11 June due to vandalism at some of the sample stations.

Table XIII  
Honey bee activity recorded on Permethrin treated\* and  
untreated hives, Larose Forest, Ontario, 1978  
(average of five colonies)

Treated block				Untreated control block		
Date	Adult bee mortality	Pollen collected (gm)	Hive weight (kg)	Adult bee mortality	Pollen collected (gm)	Hive weight (kg)
May 27	4.6	1.5	--	6.4	1.0	--
28	3.6	2.8	--	11.6	3.0	--
29	4.6	3.2	--	7.2	5.1	--
30	4.4	8.8	17.0	6.3	6.7	16.3
31	10.6	4.8	--	7.8	4.6	--
June 1	1.6	9.0	17.3	4.4	9.1	17.0
2	3.0	27.1	16.9	5.4	13.9	16.4
3	4.4	24.0	17.0	2.4	22.2	16.7
4	7.2	23.9	17.3	4.8	22.1	16.4
5	1.2	0.0	16.9	2.4	0.0	16.8
6	11.0	26.6	16.9	12.8	26.2	16.1
7	5.2	35.1	16.6	7.6	36.0	16.3
8	1.0	0.0	16.6	2.2	0.0	16.3
9	4.6	27.8	--	6.0	31.1	--
10	--	--	16.4	--	--	16.5
11	2.0	29.2	--	6.2	32.1	--
13	12.2	24.5	16.4	14.6	26.2	16.2
15	6.0	27.3	16.4	13.6	30.1	16.4
18	7.4	44.1	17.1	7.4	39.1	17.1

\*Permethrin treatments were applied early in the mornings of 31 May and 6 June.



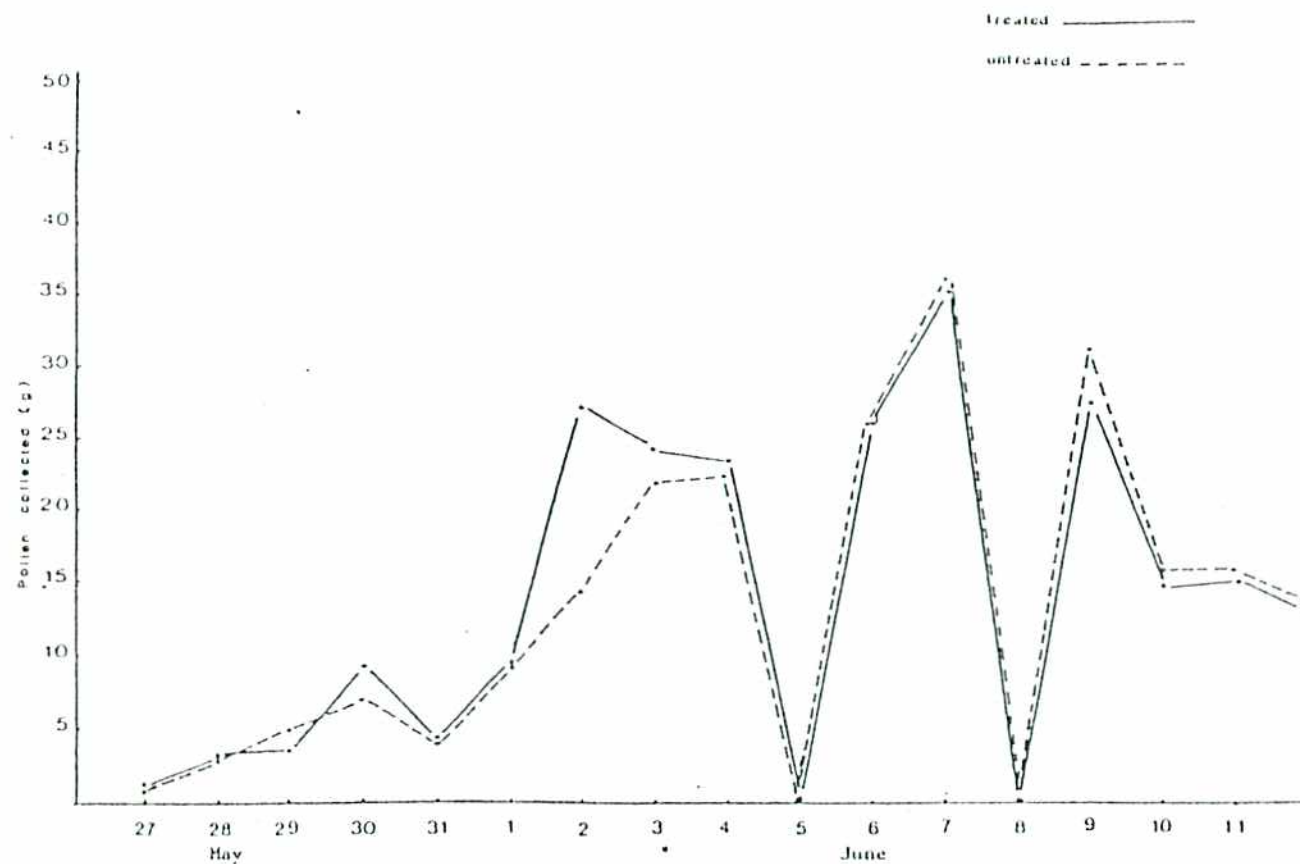


Fig. 19. Pollen collected from honey bee colonies on Permethrin treated and untreated control blocks (average of 5 colonies)

Larose Forest, Ontario, 1978

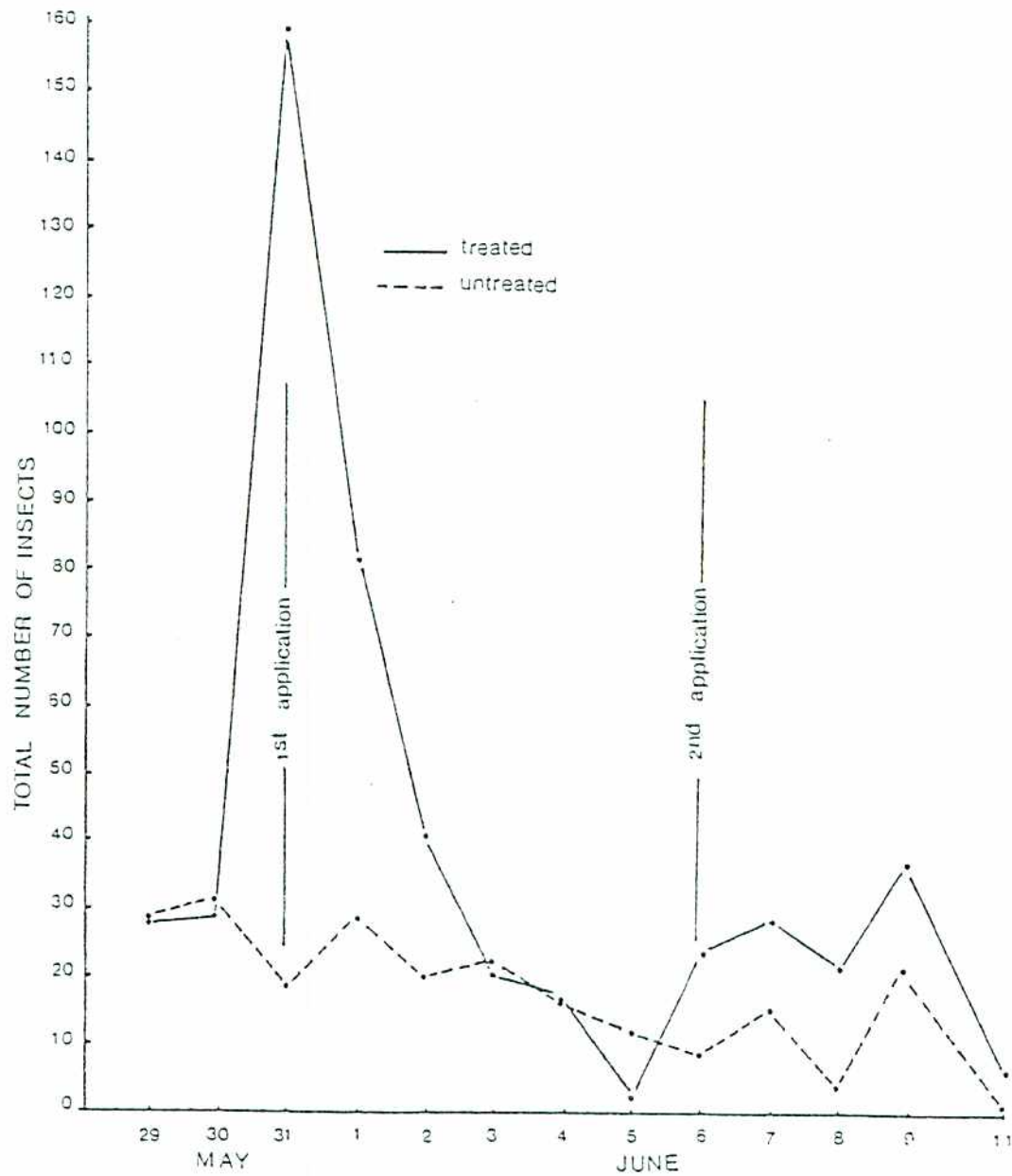


Fig. 20. Knockdown of terrestrial insects resulting from two applications of Permethrin in Larose forest experimental area.

May - June, 1978

Table XIV  
Non-target insect knockdown in an open area over water  
Larose Forest, Ontario  
29 May to 11 June, 1978

Number of days before or after		-2	-1	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+11
first		-8	-7	-6	-5	-4	-3	-2	-1	+0	+1	+2	+3	+5
second														
Permethrin treatment														
<u>Treated area</u>														
Araneida		--	--	--	--	--	--	--	--	--	--	--	--	2
Collembola		1	1	1	--	--	--	--	--	--	2	--	--	--
Hemiptera		--	--	--	1	--	--	--	--	--	--	--	--	--
Coleoptera		1	--	1	--	1	--	1	--	1	1	2	--	--
Diptera		--	--	2	--	--	--	--	--	5	3	--	--	--
Hymenoptera		1	1	--	1	--	--	--	--	--	1	--	--	--
Totals		3	2	4	2	1	0	1	0	6	7	2	0	2
<u>Untreated area</u>														
Araneida		--	2	--	1	--	2	--	--	--	--	--	--	--
Collembola		--	--	--	--	--	--	--	--	1	--	--	--	--
Hemiptera		--	2	--	--	--	--	--	--	--	--	--	--	--
Coleoptera		--	--	--	1	--	--	--	--	1	--	--	--	--
Lepidoptera		--	--	--	--	--	--	--	--	--	--	--	1	--
Diptera		--	--	--	--	--	--	--	--	1	3	--	--	--
Hymenoptera		--	--	--	1	--	--	--	--	1	--	--	--	--
Totals		0	4	0	3	0	2	0	0	4	3	0	1	0

Table XV  
Non-target insect knockdown from willow, *Salix* spp.,  
Larose Forest, Ontario  
29 May to 11 June, 1978

Number of days before or after first second Permethrin application	-2	-1	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+11
	-8	-7	-6	-5	-4	-3	-2	-1	+0	+1	+2	+3	+5
<u>Treated area</u>													
Araneida	--	--	3	--	1	--	--	--	--	--	--	1	--
Acarid	--	--	--	--	--	--	--	--	--	--	--	1	--
Collembola	--	--	--	--	--	--	--	--	--	--	--	1	--
Hemiptera	--	--	7	1	--	--	--	--	--	3	--	2	--
Homoptera	--	--	28	6	1	--	--	--	--	--	--	--	--
Coleoptera	1	1	27	3	3	--	1	--	--	--	1	1	--
Mecoptera	--	--	--	--	--	--	--	--	--	1	--	--	--
Lepidoptera	--	--	18	3	1	--	--	--	--	--	--	--	--
Diptera	--	--	11	1	3	--	--	--	--	1	10	5	--
Hymenoptera	9	7	12	4	2	--	2	--	--	--	1	2	--
Totals	10	8	106	18	11	0	3	0	0	5	12	13	0
<u>Untreated area</u>													
Araneida	1	4	--	1	1	--	--	--	--	1	--	--	--
Acarid	--	--	--	2	--	--	--	--	--	--	--	--	--
Hemiptera	--	--	--	--	--	--	--	1	--	1	--	1	--
Homoptera	3	9	2	4	2	--	3	--	--	--	--	--	--
Coleoptera	4	3	1	2	1	2	3	3	--	--	--	--	--
Lepidoptera	--	1	1	2	--	1	1	1	--	--	--	1	--
Diptera	4	--	6	1	2	1	--	4	--	--	1	1	--
Hymenoptera	1	--	--	--	1	2	2	--	--	--	--	2	--
Totals	13	17	10	12	7	6	9	9	0	2	1	5	0



Table XVI  
Insect knockdown from white spruce, *Picea glauca* (Moench) Voss,  
Larose Forest, Ontario  
29 May to 11 June, 1978

Number of days before or after		-2	-1	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+11
first		-2	-1	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+11
second		-8	-7	-6	-5	-4	-3	-2	-1	+0	+1	+2	+3	+5
Permethrin application														
<u>Treated area</u>														
Mollusca		--	--	--	1	--	--	--	--	--	--	1	--	--
Phalangida		--	1	--	1	--	--	--	--	--	--	--	--	--
Araneida		1	2	2	--	1	--	--	1	--	--	--	--	--
Hemiptera		--	--	--	3	--	--	--	--	--	--	1	--	--
Homoptera		1	--	--	1	--	--	--	--	--	--	--	--	--
Coleoptera		2	1	3	4	--	--	1	--	2	1	--	1	1
Lepidoptera														
-Spruce budworm larvae		1	--	14	24	14	14	4	1	5	2	--	2	--
-Others		--	--	3	2	--	--	--	--	--	--	--	--	--
Diptera		--	--	7	5	--	--	1	--	2	1	1	4	--
Hymenoptera		2	3	--	1	2	1	1	--	--	--	--	4	--
Totals		7	7	29	42	17	15	7	2	9	4	3	11	1
<u>Untreated area</u>														
Araneida		--	1	--	1	2	--	--	--	1	3	--	--	--
Homoptera		--	1	--	4	--	--	--	--	--	--	--	1	--
Coleoptera		--	1	--	1	--	1	1	2	--	1	--	--	1
Lepidoptera*		2	1	--	1	1	1	1	--	--	--	--	1	--
Diptera		1	1	3	1	1	1	1	1	--	1	1	3	--
Hymenoptera		3	3	1	1	3	4	1	--	--	--	--	--	--
Totals		6	8	4	9	7	7	4	3	1	5	1	5	1

\* None spruce budworm larvae.

Table XVII  
Non-target insect knockdown from flowering Nannyberry, *Viburnum lentago* L.  
Larose Forest, Ontario  
29 May to 11 June, 1978

Number of days before or after		-2	-1	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+11
first		-8	-7	-6	-5	-4	-3	-2	-1	+0	+1	+2	+3	+5
second														
Permethrin application														
<u>Treated area</u>														
Mollusca		--	--	--	--	--	--	--	--	1	--	--	--	--
Araneida		--	--	--	--	1	--	--	--	--	--	--	--	--
Collembola		--	--	--	1	--	--	--	--	--	--	--	--	--
Homoptera		--	--	--	8	--	--	--	1	--	--	--	1	--
Coleoptera		--	--	--	--	4	--	--	--	2	--	1	1	--
Lepidoptera		--	--	4	5	--	--	--	--	--	--	--	--	--
Diptera		--	1	6	1	1	--	--	--	1	1	4	--	--
Hymenoptera		--	--	--	4	--	--	--	--	--	--	--	2	--
Totals		0	1	10	19	6	0	0	1	4	1	5	4	0
<u>Untreated area</u>														
Araneida		1	--	2	1	--	1	1	--	--	--	--	--	--
Acari		--	1	--	--	--	--	--	--	--	--	--	--	--
Hemiptera		--	--	--	--	1	--	--	--	--	1	--	2	--
Coleoptera		6	2	3	--	2	1	--	--	--	1	--	4	--
Lepidoptera		--	--	--	--	--	--	1	--	2	--	--	1	--
Diptera		--	--	--	1	1	--	2	1	--	--	1	2	--
Hymenoptera		--	5	--	2	2	4	1	--	--	--	--	2	--
Totals		7	8	5	4	6	6	5	1	2	2	1	11	0

Table XVIII  
Non-target insect knockdown from flowering chokecherry, *Prunus virginiana* L.  
Larose Forest, Ontario  
29 May to 11 June, 1978

Number of days before or after		-2	-1	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+11
first		-2	-1	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+11
second		-8	-7	-6	-5	-4	-3	-2	-1	+0	+1	+2	+3	+5
Permethrin application														
Treated area														
Araneida		1	2	--	--	--	--	--	--	--	--	--	--	--
Plecoptera		--	--	--	--	--	--	--	--	--	--	--	1	--
Psocoptera		1	--	--	--	--	--	--	--	--	--	--	--	--
Hemiptera		--	--	--	--	--	--	--	--	--	--	--	--	1
Coleoptera		--	--	1	2	1	1	--	--	--	2	--	--	1
Lepidoptera		--	--	--	--	--	--	--	--	1	2	--	--	--
Diptera		--	--	1	--	2	1	5	--	1	4	1	3	--
Hymenoptera		4	8	13	2	4	2	--	--	1	--	1	--	1
Totals		6	10	15	4	7	4	5	0	3	8	2	4	3

No suitable untreated area available.

### *Small mammals*

A total of 879 trap-nights resulted in the capture of 41 small mammals representing eight species on the treated block and 957 trap-nights produced 87 small mammals representing five species on the untreated control block (Table XIX).

In the treated block, the woodland jumping mouse, *Napaeozapus insignis* (Miller), was the species most commonly trapped with 13 specimens, followed by the white-footed mouse, *Peromyscus leucopus* (Rafinesque), with 7 specimens and the red-back vole, *Clethrionomys gapperi* (Vigors) with 6. Two species of the shrews, the common shrew, *Sorex cinereus* Kerr and the short-tailed shrew, *Blarina brevicauda* (Say) were also trapped with five specimens of each collected. Other small mammals trapped were the eastern chipmunk, *Tamias striatus* Linnaeus, the meadow vole, *Microtus pennsylvanicus* (Ord) and the meadow jumping mouse, *Zapus hudsonius* (Zimmerman).

Only five species were collected on the untreated block with the common shrew the most common species with 59 specimens followed by the short-tailed shrew with 24 specimens. Other species trapped were the eastern chipmunk, the red-backed vole and the meadow jumping mouse.

Approximately 22% of all the animals collected on the treated block were "young of the year" as compared to 60% in the untreated control. Sixty-one per cent of the adult females trapped on the treated area were in breeding condition (either pregnant or contained placental scars from a recent litter) and fifty-eight per cent of the adult females on the untreated control block were in breeding condition.



Table XIX  
Population structure and reproduction of small mammal  
complex on Permethrin treated and untreated control blocks  
Larose forest experimental area  
July, 1978

species	males			females				total females	total animals
	sub- adult	adult	total males	adults					
				sub adult	not pregnant	with embryos	with placental scars		
UNTREATED CONTROL BLOCK									
<i>S. cinereus</i>	7	9	16	31	4	3	1	39	59
<i>B. brevicauda</i>	5	3	8	8	3	2	3	16	24
<i>T. striatus</i>	0	0	0	0	0	1	0	1	1
<i>C. gapperi</i>	0	1	1	0	0	0	0	0	1
<i>Z. hudsonius</i>	1	0	1	1	0	0	0	1	2
Totals	13	13	26	40	7	6	4	57	87
TREATED BLOCK									
<i>S. cinereus</i>	0	1	1	3	1	0	0	4	5
<i>B. brevicauda</i>	1	0	1	2	0	1	1	4	5
<i>T. striatus</i>	0	0	0	1	0	0	0	1	1
<i>P. leucopus</i>	0	6	6	1	0	0	0	1	7
<i>C. gapperi</i>	0	2	2	0	0	3	1	4	6
<i>M. pennsylvanicus</i>	0	1	1	0	0	0	0	0	1
<i>Z. hudsonius</i>	0	1	1	0	1	0	1	2	3
<i>N. insignis</i>	0	3	3	1	5	1	3	10	13
Totals	1	14	15	8	7	5	6	26	41

## DISCUSSION

*Spray deposit*

The quantity of emitted spray products reaching deposit samplers placed at ground level in the three forest types demonstrate the screening effects of the overhead forest canopy present. In the open plantation plot, the small size of the trees and lack of overstory permitted a fairly large proportion of the emitted spray products to reach the forest floor. Deciduous foliage appeared to have the greatest screening effect as the deposit measured at ground level was lower on this plot than on any other after both applications. By monitoring the various levels of exposure to the insecticide during foraging, nesting and perching activities, the potential for identifying possible selective effects of the insecticide on specific components of the avifauna is maximized.

*Insecticide residues*

The results from foliage residue analyses demonstrate that deciduous foliage collected considerably more insecticide than coniferous foliage in the treated areas, as was suggested by its greater effects in screening out the quantity of spray products deposited on the forest floor. The short duration of the sampling period was not sufficient to demonstrate breakdown and disappearance of Permethrin residues in foliage. Permethrin residues found in soil from all the treated plots were considerably lower than the levels found in foliage.

Relatively small amounts of Permethrin were found in pollen collected by domestic honey bees, with the exception of one very high residue (5.21 ppm) found in pollen from the treated colonies one week after the second application. This result is very difficult to explain and may be due to contamination of the sample during sampling or analysis.

Another possible explanation for it would be the bees finding and utilizing a source of pollen on this day which was highly contaminated with Permethrin for some unknown reason.

*Forest birds*

Forest dwelling birds occupying ecological niches in three different forest habitats were not affected by two applications of Permethrin applied at the emitted dosage rate of 17.5 g AI/ha. Foraging and singing activity patterns of the various species residing on plots established in the three forest habitats in both the treated and untreated blocks are relatively similar with some short-lasting (single day) variations. The apparent reduction in activity which occurred on the treated hardwoods plot (T-3) between 31 May (prior to spraying) and

3 June (3 days after spraying) resulted from the sporadic activity of species foraging on the fringe of adjacent mixwoods and coniferous stands. Irregular activity patterns which occurred following the second application appear to be related to a general decline in breeding activity (with an accompanying decline in vocal defence of territories). Most nesting territories (excepting for some lying along plot boundaries) remained occupied throughout the program.

#### *Honey bees*

Adverse weather conditions prevented flight activity until well after the completion of each application resulting in dissipation of the spray cloud and the drying of spray droplets which greatly reduced the hazard to foraging bees. The similarity in trends in pollen collection, weight gain and honey production between the treated and untreated control colonies show that the Permethrin treatments did not significantly effect the vitality of the treated colonies.

#### *Non-target insects (terrestrial)*

A significant knockdown and mortality of non-target insect species was recorded following the initial application. Mosquitoes and biting flies virtually disappeared from the treated block. Butterflies, moths and bumblebees were observed in stress immediately following the treatment. The very cold weather conditions prevailing during the second applications may have served to restrict insect movement until well after the spray cloud had dissipated and the droplets of formulated material had dried, limiting the extent of direct contact with the insecticide so little knockdown and mortality occurred.

The rather massive impact of the initial application upon the various insect fauna did not appear to have affected certain bird species such as the flycatchers which take a large portion of their food on the wing or warblers which forage throughout forest canopy for their food.

#### *Small mammals*

Approximately the same percentage of adult female animals in breeding condition were trapped from both the untreated control (58%) as the Permethrin treated block (60%) but there is a wide discrepancy in numbers of "young of the year" taken from the two blocks. Sixty per cent of the total small mammals trapped on the untreated control block were young of the year as compared to only 21 per cent for the treated block. This difference in age class structure is directly related to the species complex encountered on the two blocks. The greatest number of specimens and numbers of young animals on the untreated block were confined to the two shrew species encountered in



the sample, while the proportion of shrews in the sample taken from the treated block was much lower, resulting in a very low number of "young of the year" being trapped. Since the proportion of young of the year among the two shrew species from the two blocks was almost identical (61.4% on the untreated control and 60% on the treated block), there is no indication of an effect of the Permethrin treatment on shrew mammal reproduction.

Aquatic amphibians were observed throughout the programme and no mortality was observed in ponds or water filled ditches in the treated block.

### CONCLUSIONS

Data generated by the 1978 Larose forest experimental aerial applications of Permethrin to a forest ecosystem indicate that the two treatments of 17.5 g AI of insecticide emitted as a formulated spray at 1.46 l/ha within a six day interval presented no immediate short-term impact to non-insect terrestrial fauna. Forest birds, small mammals and amphibians were not harmed by either application. Substantial knockdown and mortality occurred to the terrestrial insect fauna inhabiting various shrub and tree species. The biting fly and mosquito complex was virtually eliminated from the treated block following the initial application. Honeybee colonies were only slightly affected as weather conditions prevailing at the time of each treatment prevented foraging activity well into the day when the spray cloud had dissipated and the droplets of spray materials had dried, thus presenting little danger to foraging bees.

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APPENDIX

Forest bird population census  
on Permethrin treated and un-  
treated control plots, Larose  
Forest, Ontario.

May - June 1978

Table A-I  
Forest bird population census  
Permethrin control plot C-1 (softwoods)  
Latose Forest, Ontario  
May 27 - June 11, 1978

Family	Species	Pre-spray						Post-spray, 1st application						Post-spray, 2nd application					
		May 27	May 28	May 29	May 30	May 31	Daily Ave.	June 1	June 2	June 3	June 4	June 6	Daily Ave.	June 7	June 8	June 9	June 10	June 11	Daily Ave.
		-4	-3	-2	-1	-0		+1	+2	+3	+4	+6		+1	+2	+3	+4	+5	
Ardeidae	Great Blue Heron	0	0	0	0	0	0.0	0	0	0	0	1	0.2	0	0	0	0	0	0.0
	American Bittern	2	1	0	1	0	0.8	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Accipitridae	Marsh Hawk	0	0	0	0	0	0.0	0	0	1	0	0	0.2	0	0	0	0	0	0.0
Columbidae	Mourning Dove	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	0	0	2	0.4
Trochilidae	Ruby-throated Hummingbird	0	0	1	0	0	0.2	0	0	1	0	0	0.2	0	0	0	0	0	0.0
Picidae	Common Flicker	0	0	0	0	1	0.2	0	1	0	0	2	0.6	0	0	1	0	0	0.2
Tyrannidae	Eastern Kingbird	0	0	3	0	0	0.6	0	0	0	0	0	0.0	0	0	0	0	0	0.0
	Great Crested Flycatcher	2	0	4	0	2	1.6	0	0	0	0	0	0.0	0	0	0	0	0	0.0
	Eastern Phoebe	6	6	13	8	6	7.8	8	8	7	4	8	7.0	2	4	6	2	6	4.0
	Least Flycatcher	0	0	0	0	0	0.0	0	0	0	2	0	0.4	0	0	0	0	0	0.0
	Eastern Wood Pewee	0	0	0	0	4	0.8	0	4	2	0	2	1.6	2	0	0	0	0	0.4
Hirundinidae	Tree Swallow	0	0	1	0	0	0.2	0	0	0	0	0	0.0	0	0	1	0	0	0.2
Corvidae	Blue Jay	0	0	0	0	0	0.0	0	0	1	0	0	0.2	2	0	0	0	0	0.4
	Common Crow	1	0	0	0	1	0.4	0	0	0	2	0	0.4	1	0	0	2	0	0.6
Faridae	Black-capped Chickadee	0	0	4	0	0	0.8	0	0	0	0	0	0.0	0	0	0	2	2	0.8
Alcedidae	Catbird	0	2	2	4	4	2.4	2	2	4	4	4	3.2	2	6	4	2	4	3.6
Turdidae	Veery	4	0	3	0	0	1.4	2	0	2	1	0	1.0	5	0	0	0	3	1.6
Parulidae	Black-and-white Warbler	0	0	0	0	0	0.0	0	2	0	0	0	0.4	0	0	0	0	0	0.0
	Nashville Warbler	0	2	0	0	0	0.4	0	2	2	0	6	2.0	0	0	0	0	4	0.8
	Yellow Warbler	13	16	19	15	22	17.0	14	20	18	8	25	17.0	18	12	22	14	22	17.6
	Magnolia Warbler	2	4	8	6	4	4.8	6	2	2	2	0	2.4	0	2	0	0	2	2.4
	Black-throated Blue Warbler	0	0	2	2	2	1.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
	Yellow-rumped Warbler	0	0	0	0	0	0.0	0	0	0	2	0	0.4	0	0	0	0	0	0.0
	Chenutnut-sided Warbler	0	2	2	0	0	0.8	2	0	0	8	0	2.0	8	4	0	2	8	4.4
	Ovenbird	0	0	2	0	0	0.4	4	2	2	0	0	1.6	4	0	2	0	0	1.2
	Mourning Warbler	0	0	0	0	0	0.0	2	0	0	0	0	0.4	0	0	0	0	0	0.0
	Yellowthroat	18	14	19	30	13	18.8	18	17	9	22	10	15.2	11	16	15	7	15	12.2
	American Redstart	0	0	0	0	0	0.0	0	2	0	0	0	0.4	0	2	0	0	0	0.4
		8	6	6	4	10	6.8	4	0	0	8	9	4.2	6	4	9	1	6	5.2
		0	0	2	2	4	1.6	0	4	0	0	0	0.8	0	0	2	0	0	0.4
		1	0	0	0	0	0.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Fringillidae	Common Grackle	2	0	5	0	6	2.6	8	5	6	4	8	6.2	10	8	5	4	10	7.4
	Brown-headed Cowbird	0	4	6	4	2	3.2	6	0	0	0	0	1.2	4	0	1	0	2	1.4
	Rose-breasted Grosbeak	2	0	0	0	4	1.2	1	6	5	0	0	2.4	0	0	0	0	0	0.0
	American Goldfinch	0	0	4	0	0	0.8	0	2	2	0	0	0.8	2	2	0	0	2	1.2
	White-throated Sparrow	20	8	4	6	6	8.8	14	13	10	10	7	10.8	11	10	11	16	15	12.6
	Swamp Sparrow	4	0	6	0	0	2.0	2	0	0	2	0	0.8	2	0	8	0	2	2.4
	Song Sparrow	0	0	0	0	0	0.0	2	2	0	0	2	1.2	2	2	0	0	0	0.8
Unidentified Species		0	0	0	0	0	0.0	2	2	0	0	2	1.2	2	2	0	0	0	0.8
Total Birds		85	65	116	82	91	87.8	95	94	74	79	84	85.2	100	72	87	49	105	82.6

Table A-II  
Forest bird population census  
Permethrin treatment plot T-1 (open plantation)  
Larose Forest, Ontario  
May 27 - June 11, 1978

Family	Species	Pre-spray						Post-spray, 1st application						Post-spray, 2nd application					
		May 27	May 28	May 29	May 30	May 31	Daily Ave.	June 1	June 2	June 3	June 4	June 6	Daily Ave.	June 7	June 8	June 9	June 10	June 11	Daily Ave.
		-4	-3	-2	-1	-0		+1	+2	+3	+4	+6		+1	+2	+3	+4	+5	
Ardidae	American Bittern	0	0	0	0	0	0.0	0	0	0	0	2	0.4	0	0	0	0	0	0.0
Tetraonidae	Ruffed Grouse	1	1	0	1	0	0.6	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Scolopacidae	American Woodcock	0	0	0	0	0	0.0	0	0	0	0	1	0.2	0	0	0	0	0	0.0
Columbidae	Hourning Dove	3	0	2	4	0	1.8	0	0	2	6	2	2.0	4	0	1	4	2	2.6
Caprimulgidae	Whip-poor-will	0	0	0	0	2	0.4	0	0	0	0	6	1.2	0	0	0	0	0	0.0
	Common Nighthawk	0	0	0	0	3	0.6	0	0	0	0	2	0.4	0	0	0	0	0	0.0
Picidae	Common Flicker	4	0	1	0	4	1.8	0	2	2	4	0	1.6	2	1	2	2	2	1.8
Tyrannidae	Eastern Kingbird	0	0	2	0	0	0.4	0	0	0	1	0	0.2	0	0	0	0	0	0.0
	Great Crested Flycatcher	4	0	2	0	2	1.6	0	2	0	3	2	1.4	0	0	0	3	0	0.6
	Eastern Phoebe	2	2	6	6	4	4.0	4	2	0	2	8	3.2	2	4	0	4	4	2.8
	Eastern Wood Pewee	2	2	2	0	0	1.2	0	0	2	4	0	1.2	0	0	0	0	0	0.0
Hirundinidae	Tree Swallow	0	0	0	2	0	0.4	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Corvidae	Blue Jay	3	2	1	5	0	2.2	2	3	0	6	0	2.2	6	4	2	0	4	3.2
	Common Crow	0	1	0	1	0	0.4	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Paridae	Black-capped Chickadee	0	0	0	0	0	0.0	2	0	0	2	0	0.8	2	0	0	2	2	1.2
Sittidae	White-breasted Nuthatch	0	0	0	0	2	0.4	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Turdidae	American Robin	0	0	1	5	9	3.0	1	11	0	6	6	4.8	0	6	7	4	5	4.4
	Wood Thrush	1	0	2	0	2	1.0	0	0	0	0	0	0.0	0	0	0	0	0	0.0
	Hermit Thrush	2	0	2	0	2	1.2	0	0	0	0	0	0.0	0	0	2	0	0	0.4
	Veery	0	2	0	4	2	1.6	0	8	0	7	6	4.2	2	4	2	3	0	2.2
Bombycillidae	Cedar Waxwing	0	0	0	0	0	0.0	0	1	0	0	0	0.2	2	4	0	0	0	1.2
Vireonidae	Solitary Vireo	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	0	0	2	0.4
	Red-eyed Vireo	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	4	0	0	0	0.8
	Warbling Vireo	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	2	0	2	0.8
Parulidae	Black-and-white Warbler	0	2	0	0	0	0.4	0	0	0	1	0	0.2	0	0	0	2	0	0.4
	Banksville Warbler	12	14	12	20	6	12.8	8	10	12	8	10	9.6	6	12	6	6	7	7.4

(Cont'd)



Table A-II (Concl)

Family	Species	Pre-spray						Post-spray, 1st application						Post-spray, 2nd application					
		May	May	May	May	May	Daily	June	June	June	June	June	Daily	June	June	June	June	June	Daily
		27	28	29	30	31	Ave.	1	2	3	4	5	Ave.	7	8	9	10	11	Ave.
		-4	-3	-2	-1	0		+1	+2	+3	+4	+5		+1	+2	+3	+4	+5	
Parulidae (cont'd)	Yellow Warbler	4	2	0	4	0	2.0	0	0	0	0	0	0.0	0	0	0	0	0	0.0
	Magnolia Warbler	0	0	0	0	2	0.4	0	0	0	0	4	0.8	0	0	0	0	0	0.0
	Yellow-rumped Warbler	0	2	0	0	0	0.4	0	0	0	0	0	0.0	0	0	0	0	0	0.0
	Chestnut-sided Warbler	0	0	0	0	0	0.0	0	0	0	2	0	0.4	0	0	0	0	0	0.0
	Ovenbird	8	4	8	4	8	6.4	8	4	8	8	2	6.0	12	4	4	8	6	6.8
	Mourning Warbler	0	0	0	0	0	0.0	2	0	0	0	0	0.4	2	0	0	0	0	0.4
	Common Yellowthroat	0	4	0	0	0	0.8	0	0	0	2	4	1.2	2	4	0	4	4	2.8
Icteridae	Redwinged Blackbird	0	0	0	0	0	0.0	0	0	0	2	0	0.4	6	2	0	1	1	2.0
	Baltimore Oriole	2	0	2	0	0	0.8	0	2	0	0	0	0.4	0	0	0	0	2	0.4
	Common Grackle	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	1	0	0	0.2
	Brown-headed Cowbird	8	2	8	7	2	5.4	11	4	4	8	4	6.2	12	8	6	8	11	9.0
Thraupidae	Scarlet Tanager	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	4	0	0	0.8
Fringillidae	Rose-breasted Grosbeak	2	2	4	0	2	2.0	6	0	2	2	0	2.0	4	2	2	4	2	2.8
	Purple Finch	0	0	2	0	4	1.2	0	0	0	0	4	0.8	0	2	0	0	0	0.4
	American Goldfinch	1	0	0	1	0	0.4	6	0	0	0	1	1.4	0	0	0	0	1	0.2
	Dark-eyed Junco	0	0	0	0	0	0.0	1	0	0	0	0	0.2	0	0	0	0	0	0.0
	Chipping Sparrow	0	0	0	0	0	0.0	0	2	4	2	0	1.6	4	4	2	0	2	2.4
	White-throated Sparrow	13	5	11	8	14	10.2	8	4	6	4	12	6.8	6	7	6	4	4	5.4
Unidentified		0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	0	2	0	0.4
Total Birds		72	47	68	72	70	65.8	59	55	42	80	76	62.4	74	72	51	61	63	64.7

Table A-III

Forest bird population census  
Permethrin treatment plot T-2 (softwood forest)  
Larose Forest, Ontario  
May 27 - June 11, 1978

Family	Species	Pre-spray						Post-spray, 1st application						Post-spray, 2nd application					
		May 27	May 28	May 29	May 30	May 31	Daily Ave.	June 1	June 2	June 3	June 4	June 6	Daily Ave.	June 7	June 8	June 9	June 10	June 11	Daily Ave.
		-4	-3	-2	-1	0		+1	+2	+3	+4	+6		+1	+2	+3	+4	+5	
Ardelidae	American Bittern	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	1	0	0	0	0.2
Anatidae	Hallard	0	0	0	0	0	0.0	0	0	1	0	0	0.2	0	0	0	0	0	0.0
Accipitridae	Goshawk	0	0	1	0	0	0.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Tetraonidae	Ruffed Grouse	0	1	0	0	0	0.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Charadriidae	Killdeer	0	0	0	1	0	0.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Scolopacidae	American Woodcock	0	0	3	0	0	0.6	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Columbidae	Mourning Dove	0	0	0	2	2	0.8	0	0	0	0	2	0.4	2	4	2	0	0	1.6
Picidae	Common Flicker	1	2	0	0	0	0.6	0	0	0	0	0	0.0	2	0	0	0	0	0.4
	Hairy Woodpecker	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	0	2	0	0.4
Tyrannidae	Great Crested Flycatcher	8	0	2	4	2	3.2	0	0	4	0	0	0.8	0	0	0	0	2	0.4
	Eastern Phoebe	0	0	0	0	0	0.0	0	4	0	0	0	0.8	0	0	0	0	0	0.0
	Eastern Wood Pewee	0	0	0	0	0	0.0	0	0	2	0	0	0.4	0	0	0	0	2	0.4
Hirundinidae	Tree Swallow	0	0	0	0	0	0.0	0	0	0	4	0	0.8	0	0	0	0	0	0.0
Corvidae	Blue Jay	3	7	4	3	3	4.0	0	4	1	6	0	2.2	4	6	0	1	0	2.2
	Common Crow	0	0	0	0	0	0.0	0	3	0	0	0	0.6	1	0	0	0	0	0.2
Paridae	Black-capped Chickadee	2	0	1	6	2	2.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Sittidae	Red-breasted Nuthatch	4	0	0	2	0	1.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Certhiidae	Brown Creeper	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	0	2	0	0.4
HMidae	Brown Thrasher	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	2	0	0	0	0.4
	Catbird	0	0	0	0	0	0.0	0	2	0	0	0	0.4	0	0	0	0	0	0.0
Turdidae	American Robin	0	7	0	4	12	4.6	8	2	4	4	6	4.8	8	0	8	6	6	5.6
	Wood Thrush	2	0	0	2	8	2.4	6	0	4	6	10	5.2	6	2	4	2	2	3.2
	Hermit Thrush	0	0	0	0	0	0.0	0	0	0	0	0	0.0	2	0	0	0	0	0.4
	Veery	1	2	4	9	8	4.8	0	2	0	3	3	1.6	2	8	1	2	2	3.0
Sylviidae	Golden-crowned Kinglet	8	0	2	6	6	4.4	6	2	0	10	4	4.4	8	0	2	8	0	3.6
Bombacillidae	Cedar Waxwing	0	0	0	0	0	0.0	0	0	0	0	1	0.2	0	4	7	0	0	2.2

(Cont'd)

Table A-III (Concl)

Family	Species	Pre-spray						Post-spray, 1st application						Post-spray, 2nd application					
		May	May	May	May	May	Daily	June	June	June	June	June	Daily	June	June	June	June	June	Daily
		27	28	29	30	31	Ave.	1	2	3	4	5	Ave.	7	8	9	10	11	Ave.
		-4	-3	-2	-1	0		+1	+2	+3	+4	+5		+1	+2	+3	+4	+5	
Vireonidae	Red-eyed Vireo	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	2	0	0	0.4
Parulidae	Tennessee Warbler	6	0	4	2	2	2.8	0	0	2	0	4	1.2	2	2	2	0	0	1.2
	Nashville Warbler	8	6	2	8	6	6.0	8	4	0	10	6	5.6	4	4	2	2	2	2.8
	Parula Warbler	0	0	2	0	0	0.4	0	0	0	0	0	0.0	0	0	0	0	0	0.0
	Yellow Warbler	0	0	0	0	0	0.0	0	4	0	0	0	0.8	0	2	0	0	0	0.4
	Magnolia Warbler	0	0	0	0	0	0.0	2	2	0	0	0	0.8	0	0	0	0	0	0.0
	Cape May Warbler	0	0	0	2	0	0.4	0	0	0	0	0	0.0	0	0	0	0	0	0.0
	Yellow-rumped Warbler	0	0	0	2	0	0.4	2	0	0	0	0	0.4	0	0	0	0	0	0.0
	Black-throated Green Warbler	2	0	2	0	0	0.8	0	0	0	0	0	0.0	0	0	0	0	0	0.0
	Blackburnian Warbler	0	0	0	0	0	0.0	0	2	0	0	0	0.4	0	2	0	0	0	0.4
	Chestnut-sided Warbler	0	0	0	0	0	0.0	0	2	0	0	0	0.4	0	0	0	0	0	0.0
	Bay-breasted Warbler	2	4	2	0	0	1.6	0	0	0	0	0	0.0	0	2	0	0	0	0.4
	Ovenbird	8	10	4	12	8	8.4	8	2	12	8	8	7.6	8	10	4	8	6	7.2
	Hourning Warbler	2	0	0	2	0	0.8	0	0	0	0	0	0.0	0	0	0	2	0	0.4
	Common Yellowthroat	2	0	10	2	4	3.6	0	6	2	0	4	2.4	0	8	4	0	0	2.4
	Canada Warbler	2	0	0	0	0	0.4	0	0	0	0	0	0.0	4	0	0	2	2	1.6
	American Redstart	4	0	0	0	0	0.8	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Icteridae	Redwinged Blackbird	0	0	0	0	0	0.0	1	0	0	0	0	0.2	0	0	0	0	2	0.4
	Baltimore Oriole	2	0	0	2	0	0.8	2	0	2	0	0	0.8	0	0	0	0	0	0.0
	Common Grackle	0	0	0	0	0	0.0	0	0	2	0	0	0.4	2	0	0	0	0	0.4
	Brown-headed Cowbird	6	4	2	6	0	3.6	4	-	2	2	2	2.0	7	2	0	2	7	3.6
Thraupidae	Scarlet Tanager	0	2	0	0	0	0.4	0	0	0	2	0	0.4	0	0	0	0	0	0.0
Fringillidae	Rose-breasted Grosbeak	5	0	4	0	0	1.8	0	2	0	0	2	0.8	0	8	2	0	0	2.0
	Purple Finch	0	0	0	2	0	0.4	0	0	0	0	0	0.0	0	0	0	0	0	0.0
	American Goldfinch	1	0	0	0	0	0.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
	Dark-eyed Junco	0	0	0	0	0	0.0	0	6	0	0	0	1.2	0	0	0	0	0	0.0
	White-throated Sparrow	6	2	0	6	4	3.6	0	0	4	4	4	2.4	2	4	0	2	4	2.4
	Song Sparrow	0	0	2	0	0	0.4	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Unidentified Species		2	0	0	0	0	0.4	0	0	0	0	2	0.4	0	0	0	0	0	0.0
Total Birds		87	47	51	85	67	67.4	47	49	42	59	58	51.0	64	72	40	41	37	50.8

Table A-IV  
Forest bird population census  
Permethrin control plot C-2 (softwood forest)  
Larose Forest, Ontario  
May 27 - June 11, 1978

Family	Species	Pre-spray						Post-spray, 1st application						Post-spray, 2nd application					
		May 27	May 28	May 29	May 30	May 31	Daily Ave.	June 1	June 2	June 3	June 4	June 6	Daily Ave.	June 7	June 8	June 9	June 10	June 11	Daily Ave.
		-4	-3	-2	-1	-0		+1	+2	+3	+4	+6		+1	+2	+3	+4	+5	
Tetraonidae	Ruffed Grouse	0	0	1	0	0	0.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Picidae	Common Flicker	0	0	0	0	0	0.0	2	0	0	0	0	0.4	0	2	0	0	0	0.4
	Hairy Woodpecker	0	0	0	0	0	0.0	0	2	0	0	0	0.4	0	0	0	0	0	0.0
Tyrannidae	Great Crested Flycatcher	0	0	0	4	2	1.2	0	2	0	0	0	0.4	0	0	0	0	0	0.0
	Eastern Phoebe	2	2	2	0	0	1.2	0	0	2	2	4	1.6	2	6	4	2	4	3.6
Corvidae	Blue Jay	1	0	4	3	3	2.2	3	0	4	0	2	1.8	2	4	1	2	1	2.0
	Common Crow	0	0	4	0	1	1.0	1	2	0	1	0	0.8	0	0	0	0	0	0.0
Paridae	Black-capped Chickadee	0	0	0	2	0	0.4	0	0	0	0	2	0.4	0	0	0	0	0	0.0
Turdidae	American Robin	6	4	2	5	4	4.2	3	0	2	7	2	2.8	4	0	5	2	2	2.6
	Wood Thrush	0	0	0	0	2	0.4	0	4	2	2	0	1.6	0	0	0	0	0	0.0
	Hermit Thrush	2	0	0	0	0	0.4	0	2	0	0	0	0.4	0	0	0	0	0	0.0
	Veery	1	4	2	5	3	3.0	4	0	6	4	4	3.6	4	6	3	4	3	4.0
Sylviidae	Golden-crowned Kinglet	6	2	2	4	4	3.6	6	2	2	2	4	3.2	10	2	2	2	6	4.4
Bombycillidae	Cedar Waxwing	0	0	0	0	0	0.0	0	0	0	0	2	0.4	0	2	3	0	0	1.0
Parulidae	Tennessee Warbler	4	0	0	0	0	0.8	0	2	0	0	0	0.4	0	0	0	0	0	0.0
	Nashville Warbler	18	0	16	14	10	11.6	10	2	12	6	10	8.0	8	8	6	4	8	6.8
	Yellow Warbler	0	2	2	0	2	1.2	12	0	2	8	8	6.0	12	2	4	2	4	4.8
	Hagnolia Warbler	10	6	2	14	4	7.2	12	0	4	2	4	4.4	6	0	2	0	2	2.0
	Cape May Warbler	0	0	2	0	0	0.4	0	0	0	0	0	0.0	0	0	0	0	0	0.0
	Yellow-rumped Warbler	0	0	0	6	0	1.2	0	0	0	0	0	0.0	0	0	0	0	0	0.4
	Chestnut-sided Warbler	0	2	4	0	2	1.6	2	0	2	0	2	1.2	0	4	0	6	4	2.8
	Bay-breasted Warbler	2	0	2	2	0	1.2	0	2	2	0	0	0.8	0	2	0	0	0	0.4
	Blackpoll Warbler	0	0	0	0	0	0.0	0	2	0	0	0	0.4	0	0	0	0	0	0.0
	Pine Warbler	0	0	0	0	0	0.0	0	2	0	0	0	0.4	0	0	0	0	0	0.0
	Ovenbird	0	0	2	2	2	1.2	0	4	2	0	0	1.2	2	0	0	0	0	0.4
	Common Yellowthroat	4	0	0	10	8	4.4	0	0	2	0	8	2.0	2	2	3	2	0	1.8
	Canada Warbler	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	0	0	2	0.4
	American Redstart	0	0	0	2	0	0.4	0	0	0	0	2	0.4	0	0	0	0	0	0.0
Icteridae	Redwinged Blackbird	0	0	0	0	0	0.0	0	0	0	0	0	0.0	1	0	0	0	1	0.4
	Common Grackle	0	0	0	0	0	0.0	0	0	0	0	1	0.2	0	0	0	0	0	0.0
	Brown-headed Cowbird	0	0	2	3	2	1.4	2	8	0	0	4	2.8	6	4	4	13	8	7.0
Fringillidae	Rose-breasted Grosbeak	0	0	4	0	4	1.6	0	4	0	0	0	0.8	0	2	2	0	1	1.0
	Purple Finch	0	0	0	0	0	0.0	0	0	1	0	2	0.6	0	2	4	0	0	1.2
	American Goldfinch	1	0	0	0	2	0.6	0	0	0	0	0	0.0	0	0	4	2	1	1.4
	Chipping Sparrow	2	10	6	4	6	5.6	8	2	2	4	2	3.6	8	6	6	6	10	7.2
	White-throated Sparrow	12	2	4	12	2	6.4	0	4	6	4	8	4.4	4	2	8	2	3	3.8
	Swamp Sparrow	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	2	0	0	0.4
	Song Sparrow	2	0	0	0	2	0.8	0	0	0	0	0	0.0	0	0	4	0	0	0.8
Unidentified Species		2	0	0	0	2	0.8	0	0	2	0	0	0.4	0	0	0	0	0	0.0
Total Birds		75	34	63	92	67	66.2	65	46	59	42	71	55.8	73	56	67	49	60	61.0



Table A-V  
Forest bird population census  
Permethrin treatment plot T3 (hardwood forest)  
Larose Forest, Ontario  
May 27 - June 11, 1978

Family	Species	Pre-spray						Post-spray, 1st application						Post-spray, 2nd application					
		May 27	May 28	May 29	May 30	May 31	Daily Ave.	June 1	June 2	June 3	June 4	June 6	Daily Ave.	June 7	June 8	June 9	June 10	June 11	Daily Ave.
		-4	-3	-2	-1	-0		+1	+2	+3	+4	+6		+1	+2	+3	+4	+5	
Ardeidae	American Bittern	0	0	2	0	3	1.0	0	0	1	0	1	0.4	0	0	0	0	0	0.0
Tetraonidae	Ruffed Grouse	0	0	1	0	0	0.2	0	0	1	2	0	0.6	0	0	0	0	0	0.0
Columbidae	Mourning Dove	0	2	0	0	2	0.8	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Picidae	Common Flicker	0	0	0	0	0	0.0	0	0	0	1	0	0.2	0	0	0	0	0	0.0
	Downy Woodpecker	0	0	0	1	0	0.6	0	0	0	0	0	0.0	0	0	0	0	1	0.2
Tyrannidae	Great Crested Flycatcher	2	10	4	2	4	4.4	0	2	3	2	2	1.8	6	6	3	6	5	5.2
	Eastern Phoebe	0	2	0	2	0	0.8	2	0	0	2	0	0.8	2	4	2	2	0	2.0
	Eastern Wood Pewee	0	2	4	2	0	1.6	0	0	0	2	0	0.4	0	0	0	0	0	0.0
	Olive-sided Flycatcher	2	0	0	0	0	0.4	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Corvidae	Blue Jay	3	3	0	5	2	2.6	0	0	4	1	2	1.4	4	4	2	0	0	2.0
	Common Crow	0	0	4	0	1	1.0	0	0	0	0	0	0.0	0	1	0	0	0	0.2
Paridae	Black-capped Chickadee	0	6	4	2	0	2.4	2	0	0	0	0	0.4	0	0	0	0	0	0.0
Sittidae	Red-breasted Nuthatch	0	0	0	0	0	0.0	0	0	0	2	0	0.4	0	0	0	0	0	0.0
Certhiidae	Brown Creeper	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	2	0	2	0	0.8
Alcedinidae	Catbird	0	0	0	0	0	0.0	0	0	0	0	2	0.4	0	0	0	0	0	0.0
Turdidae	American Robin	0	0	0	0	0	0.0	1	0	0	0	2	0.6	0	0	0	0	0	0.0
	Wood Thrush	0	0	0	0	2	0.4	0	0	0	0	0	0.0	0	0	0	0	0	0.0
	Hermit Thrush	0	1	0	0	0	0.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
	Veery	4	8	12	6	8	7.6	0	4	2	11	10	5.4	5	6	2	7	5	5.0
Bombycillidae	Cedar Waxwing	2	0	0	0	2	0.8	1	0	0	0	0	0.2	1	4	2	0	2	1.8
Vireonidae	Red-eyed Vireo	0	4	6	2	2	2.8	2	2	2	2	2	2.0	0	2	2	0	0	0.8
Parulidae	Black-and-white Warbler	2	0	0	2	2	1.2	2	0	2	2	0	1.2	2	4	2	0	4	2.4
	Nashville Warbler	8	12	10	6	6	8.4	8	2	4	12	6	6.4	4	6	2	2	0	2.8
	Yellow Warbler	0	0	2	2	0	0.8	0	0	0	0	0	0.0	0	0	2	2	0	0.8
	Magnolia Warbler	4	0	0	2	0	1.2	0	0	0	0	0	0.0	2	0	0	0	0	0.4
	Cape May Warbler	0	2	0	4	0	1.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
	Yellow-rumped Warbler	2	0	0	2	0	0.8	0	0	0	0	2	0.4	0	0	0	0	0	0.0
	Blackburnian Warbler	0	0	2	0	0	0.4	0	0	0	0	0	0.0	0	0	0	0	0	0.0

(Cont'd)



Table A-V (Concl)

Family	Species	Pre-spray					Post-spray, 1st application						Post-spray, 2nd application					
		May	May	May	May	May	June	June	June	June	June	Daily	June	June	June	June	June	Daily
		27	28	29	30	31	1	2	3	4	5	Ave.	7	8	9	10	11	Ave.
		-4	-3	-2	-1	-0	+1	+2	+3	+4	+5		+1	+2	+3	+4	+5	
Parulidae (Cont'd)	Chestnut-sided Warbler	0	0	0	0	2	0.4	0	0	0	2	0	0.4	0	0	0	0	0.0
	Bay-breasted Warbler	0	0	0	0	0	0.0	0	0	0	2	0	0.4	0	0	0	4	0.8
	Pine Warbler	0	0	0	0	2	0.4	0	0	0	0	0	0.0	0	0	0	0	0.0
	Ovenbird	12	14	10	8	12	11.2	6	4	6	8	6	6.0	2	12	4	6	5.6
	Mourning Warbler	2	0	0	0	2	0.8	0	0	0	0	0	0.0	0	0	0	0	0.0
	Common Yellowthroat	6	4	0	2	2	2.8	2	0	2	0	2	1.2	2	0	0	0	0.4
	Canada Warbler	0	6	0	0	6	2.4	4	4	2	8	4	4.4	6	0	2	0	2.0
	American Redstart	0	0	0	2	0	0.4	0	0	0	0	0	0.0	0	0	0	4	0.8
Icteridae	Redwinged Blackbird	0	0	0	0	0	0.0	0	0	0	2	0	0.4	0	0	0	1	0.2
	Brown-headed Cowbird	0	0	0	0	0	0.0	4	0	2	2	2	2.0	4	11	0	4	4.2
	Common Grackle	0	0	1	0	0	0.2	0	0	0	0	0	0.0	0	0	0	0	0.0
Fringillidae	Rose-breasted Grosbeak	2	4	6	6	2	4.0	4	3	4	3	8	4.4	0	0	2	0	0.4
	Purple Finch	0	1	0	0	0	0.2	2	0	0	0	0	0.4	0	0	0	0	0.0
	American Goldfinch	0	0	0	0	0	0.0	0	0	0	0	0	0.0	2	0	0	0	0.4
	Dark-eyed Junco	2	2	0	2	2	1.6	0	0	0	0	0	0.0	0	0	0	0	0.0
	White-throated Sparrow	0	13	4	4	4	5.0	4	0	0	2	6	2.4	6	2	0	2	2.4
Unidentified Species		0	0	0	0	2	0.4	0	0	0	0	0	0.0	0	0	0	0	0.0
Total Birds		53	96	72	66	70	71.4	44	21	35	68	57	45.0	48	64	27	42	41.6

Table A-VI  
Forest bird population census  
Permethrin control plot C3 (hardwood forest)  
Larose Forest, Ontario  
May 27 - June 11, 1978

Family	Species	Pre-spray						Post-spray, 1st application						Post-spray, 2nd application					
		May 27	May 28	May 29	May 30	May 31	Daily Ave.	June 1	June 2	June 3	June 4	June 6	Daily Ave.	June 7	June 8	June 9	June 10	June 11	Daily Ave.
		-4	-3	-2	-1	-0		+1	+2	+3	+4	+5		+1	+2	+3	+4	+5	
Ardeidae	American Bittern	0	0	0	0	1	0.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Accipitridae	Red-tailed Hawk	0	0	0	0	0	0.0	0	0	0	0	0	0.0	1	0	0	0	0	0.2
Tetraonidae	Ruffed Grouse	1	4	3	1	2	2.2	2	0	3	2	3	2.0	2	0	0	1	0	0.6
Columbidae	Mourning Dove	0	0	0	0	0	0.0	0	0	0	0	2	0.4	1	0	0	0	0	0.2
Picidae	Common Flicker	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	1	2	2	0	1.0
	Yellow-bellied Sapsucker	0	0	0	0	2	0.4	0	0	0	0	0	0.0	0	0	0	0	0	0.0
	Hairy Woodpecker	0	0	0	1	0	0.2	0	0	0	0	0	0.0	0	0	0	0	1	0.2
Tyrannidae	Great Crested Flycatcher	0	2	4	4	4	2.8	6	6	3	6	2	4.6	0	2	3	1	4	2.0
	Eastern Phoebe	4	0	2	4	2	2.4	0	4	0	3	2	1.8	2	0	0	0	0	0.4
	Eastern Wood Pewee	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	2	0	0	0	0.4
	Olive-sided Flycatcher	2	0	0	0	0	0.4	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Corvidae	Blue Jay	0	0	1	0	0	0.2	1	0	0	0	2	0.6	0	0	0	0	0	0.0
	Common Crow	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	0	0	1	0.2
Paridae	Black-capped Chickadee	0	2	0	0	0	0.4	0	0	2	0	0	0.4	0	0	0	0	0	0.0
Hirundinidae	Catbird	2	2	0	4	0	1.6	4	2	4	4	4	3.6	5	5	4	0	2	3.2
	Brown Thrasher	0	0	0	0	0	0.0	0	4	0	0	0	0.8	0	0	0	0	0	0.0
Turdidae	American Robin	0	0	0	0	0	0.0	0	0	0	0	0	0.0	2	0	0	0	0	0.4
	Wood Thrush	0	0	6	0	0	1.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
	Swainson's Thrush	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	0	0	2	0.4
	Veery	10	16	2	6	8	8.4	5	4	2	4	8	4.6	4	4	8	3	6	5.0
Vireonidae	Solitary Vireo	0	0	8	0	0	1.6	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Parulidae	Black and White Warbler	0	2	0	0	2	0.8	4	4	2	4	0	2.8	2	4	2	0	0	1.6
	Nashville Warbler	2	2	8	2	2	3.2	2	2	0	2	2	1.6	0	0	4	2	0	1.2
	Yellow Warbler	2	1	4	0	0	1.4	0	12	2	6	0	4.0	4	6	2	6	8	5.6
	Magnolia Warbler	2	2	10	4	2	4.0	2	16	4	0	2	4.8	0	6	0	0	0	1.2
	Cape May Warbler	0	0	0	0	2	0.4	2	0	2	0	2	1.2	0	0	0	0	0	0.0
	Black-throated Blue Warbler	0	0	0	0	0	0.0	0	0	0	0	0	0.0	2	0	0	0	0	0.4
	Yellow-rumped Warbler	0	2	0	0	0	0.4	2	0	0	2	0	0.8	2	0	0	0	0	0.4

(Cont'd)

Table A-VI (Concl)

Family	Species	Pre-spray						Post-spray, 1st application						Post-spray, 2nd application					
		May	May	May	May	May	Daily	June	June	June	June	June	Daily	June	June	June	June	June	Daily
		27	28	29	30	31	Ave.	1	2	3	4	5	Ave.	7	8	9	10	11	Ave.
		-4	-3	-2	-1	0		11	12	13	14	15		11	12	13	14	15	
Parulidae (cont'd)	Blackburnian Warbler	2	0	0	0	2	0.8	0	0	0	0	0	0.0	0	0	0	0	0	0.0
	Chestnut-sided Warbler	0	6	8	2	2	3.6	0	4	2	2	2	2.0	6	2	4	2	0	2.8
	Bay-breasted Warbler	2	0	0	0	2	0.8	0	0	0	0	6	1.2	0	0	2	0	4	1.2
	Blackpoll Warbler	0	0	0	0	0	0.0	0	2	0	0	0	0.4	0	0	0	0	0	0.0
	Ovenbird	4	6	6	4	8	5.6	2	4	4	6	4	4.0	12	4	4	2	4	5.2
	Northern Waterthrush	4	4	0	2	0	2.0	2	0	2	0	0	0.8	0	0	0	0	0	0.0
	Hourning Warbler	0	0	0	0	0	0.0	0	0	0	0	0	0.0	0	0	2	0	0	0.4
	Common Yellowthroat	12	12	7	12	12	11.0	9	6	6	4	8	6.6	6	4	8	8	4	6.0
	Canada Warbler	0	2	0	0	4	1.2	6	0	2	6	4	3.6	6	0	0	2	6	2.8
	American Redstart	0	4	0	0	0	0.8	0	0	0	0	0	0.0	0	2	4	2	0	1.6
Icteridae	Red-winged Blackbird	0	0	0	0	0	0.0	2	0	1	1	0	0.8	1	1	0	0	2	0.8
	Baltimore Oriole	0	0	0	0	0	0.0	0	2	0	2	0	0.8	0	2	0	0	0	0.4
	Brown-headed Cowbird	0	2	0	2	0	0.8	0	0	1	0	1	0.4	0	0	0	0	1	0.2
Fringillidae	Rose-breasted Grosbeak	2	0	1	0	0	0.6	0	0	0	0	0	0.0	0	2	2	0	1	1.0
	White-throated Sparrow	0	2	3	2	2	2.2	0	2	0	2	0	0.8	4	0	0	0	0	0.8
	Swamp Sparrow	0	1	0	2	2	1.0	2	3	0	3	2	2.0	2	0	1	2	9	2.8
Unidentified Species		1	0	0	0	0	0.2	0	0	0	0	0	0.0	0	0	0	0	0	0.0
Total Birds		52	74	75	52	61	62.8	53	77	42	59	56	57.4	64	47	52	33	55	50.2