STUDIES OF THE IMPACT OF THE CARBAMATE INSECTICIDE MATACIL® ON COMPONENTS OF FOREST ECOSYSTEMS

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ABSTRACT

The impact of the carbamate insecticide MATACIL® was studied on various components of the ecosystem in experimental and operational treatments in eastern Canada during the years 1971-1974. Dosage rates ranged from 52 g/ha (3/4 oz/acre) to 105 g/ha (1.5 oz/acre) of active ingredient. Particular emphasis was placed upon the effects of the chemical on small forest songbirds, small mammal, honey bees, amphibians and components of the aquatic ecosystem. At these dosage rates, little environmental impact was measured. There is some evidence that certain of the exposed songbirds such as ruby-crowned kinglets (*Regulus calandula* L.), black and white warblers (*Mniotilta varia* L.), bay-breasted warblers (*Dendroica castanea* Wilson) and yellowthroats (*Geothlypis trichas* L.) were slightly affected by the treatments. Bees were subjected to adult forager knock-down but the effects were not lasting and the recovery was rapid. There was no observable impact on small mammals or amphibians. Minimal disturbance to aquatic organisms was noted, with stonefly nymphs the only groups suffering significant impact. It was concluded that at the application rates studied no serious or lasting ecological effects of the treatments could be descerned.

RÉSUMÉ

On a étudié les effets de l'insecticide MATACIL® de la famille des carbamates sur divers éléments de l'écosystéme, à l'occasion d'épandages expérimentaux et en réel, effectués dans l'est du Canada de 1971 à 1974. Les doses utilisées allaient de 52 g/ha (3/4 oz/acre) à 105 g/ha (1.5 oz/acre). On s'est intéressé surtout aux effets sur les petits oiseaux chanteurs forestiers, les petits mammiféres, les abeilles, les amphibiens et les être aquatiques. Les doses utilisées, ne semblent avoir eu que peu d'effets sur l'environnement. Il semblerait, toutefois, que certains oiseaux comme le roitelet à couronne rubis (*Regulus calandula* L.), les fauvettes noire et blanche (*Mniotilta varia* L.), à poitrine baie (*Dendroica castanea* Wilson) et masquée (*Geothlypis trichas* L.) aient souffert quelque peu des traitements. L'insecticide a eu un effet de choc éphémère sur les abeilles butineuses adultes. On n'a pu relever aucun effet sur les petits mammiféres et les amphibiens. Chez les organismes aquatiques, l'effet a été négligeable n'atteignant une importance significative que sur les nymphes de plécoptères. On en a conclu que les doses utilisées ne produisaient aucun effet grave ni durable dans l'écosystème.

INTRODUCTION

The environmental impact section of the Chemical Control Research Institute is deeply involved in cataloguing the short and long term effects of chemical insecticide applications on the non-target components of forest ecosystems. To assist in the evolution of safe chemical control procedure, the section is active in evaluating the ecological side effects of promising new insecticides being considered for widescale use in forest protection operations. This report presents the findings of impact studies conducted by members of the section from 1971 to 1974 within areas treated with the carbamate insecticide MATACIL®.

PLANNED APPLICATIONS

Experimental control operations using several dosage rates of MATACIL® emitted under operational conditions have been monitored for possible adverse side effects to the non-target component of the environment (Table I).

Table I

Non-target Fauna Checked for Effects from Several MATACIL® Field Applications

Location and dosage rate of active ingredient (AI) emitted	Non-target organisms monitored				
	Birds	Mammals	Aquatic Insects	Honey Bees	Amphibians
52 g AI/ha, Menjou Depot, Que.	X	X		X	
52 g AI/ha, Parent, Que.	X	X	X		
70 g AI/ha, Larose Forest, Ont.	X		X	X	X
105 g AI/ha, Harcourt, N.B.		X			

A single application of MATACIL® was applied to the forests in the Menjou Depot area approximately 2 weeks after an application of fenitrothion at 140 g AI/ha. In the Parent area the treatment blocks received 2 applications of insecticide at 52 g AI/ha approximately two weeks apart. The Larose Forest and Harcourt treatments were single applications.

DESCRIPTION OF TREATMENT AREAS

Menjou Depot, Quebec: The Menjou Depot area is a typical spruce fir biome averaging 10 to 14 meters in height and up to 20 to 25 cm diameter at breast height (d.b.h.). A scattered overstory of maple (*Acer* spp.), poplar (*Populus* spp.) and birch (*Betula* spp.) occurs throughout the area. A moderate understory of willow (*Salix* spp.) and alder (*Alnus* spp.) thickets is present and the ground is covered with a light mat of mosses and grasses.

Parent, Quebec: Forests in the Parent area are similar to those encountered at Menjou Depot with the exception of the control plot which contains a mixture of white spruce, (*Picea glauca* (Moench) Voss) and jack pine (*Pinus banksiana* Lamb) and is an open growing stand. The understory in all plots in the Parent area is sparse and the ground covered with a heavy layer of mosses and duff.

Larose Forest, Ontario: The Larose Forest is a plantation forest comprised mainly of spruce (*Picea* spp.), pine (*Pinus* spp.) and tamarack (*Larix* spp.). The conifer component in the treatment plots averages 8 to 12 meters in height and up to 23 cm d.b.h. Maple, birch and poplar provide a scattered overstory. A light to moderate understory of willow, alder and spruce regeneration occurs throughout the area. Grasses and scattered patches of mosses cover the forest floor.

Harcourt, New Brunswick: Balsam fir (*Abies balsamea* (L) Mill) and white spruce averaging 9 to 12 meters in height are the dominant tree species in the treatment block. A scattered overstory of maple, poplar and birch is common throughout the area. A light understory of willow and alder is scattered throughout regeneration spruce and fir. The forest floor is

covered with a layer of grasses, mosses and miscellaneous plants.

METHODS

Birds: Song bird populations were measured on plots located in treated and untreated areas using techniques similar to those described by Kendeigh (1944) and Buckner and Turnock (1965). Eight hectare (20 acre) plots were censused before and after treatment by counting all singing and sighted birds along predetermined parallel lines and recording the information on plot maps.

The resulting bird populations are expressed as numbers of birds per 40 hectares (100 acres). Special attention was paid to groups of birds inhabiting certain ecological areas such as upper crowns, open shrubbery or fringe areas, and those inhabiting lower crown and forest floor habitat. Plot searches were conducted after treatment to recover any dead or sick birds as soon as possible.

Small Mammals: Small mammal populations were censused using standard snap-back traps positioned on 80 x 4 m trap lines. The traps were located at 9 m intervals along the center line. Five traps were placed at 1 m intervals perpendicular to the center line with one trap on the line and two placed on either side, giving a total of 50 traps per line. The trapping period ran for three consecutive nights providing a total of 150 trap nights per line. Captured animals were identified, and sex, age and breeding condition determined. All adult female animals were dissected for embryo and placental scar counts. Populations were censused approximately six weeks after treatment to allow any litter being carried by the female at the time of application to leave the nest and become

available for capture. The absence of any group could reflect an impact of the insecticide upon that portion of the small mammal population.

Domestic Honey Bees: Domestic honey bees, *Apis mellifera* L. are sensitive to pesticides. Colonies were located in treatment areas whenever possible. A "yard" usually consists of 5 colonies, each containing 1.1 kg (3 lb.) of bees (12,000 - 15,000 individuals) with mated queens. All colonies were set up and maintained at the headquarters apiary until a few days prior to treatment. Five colonies were transferred to each treatment area and located in a small clearing. Each colony was left to acclimate after the transfer, then weighed, and fitted with a pollen trap, dead bee traps and an electronic counter (to record activity at the hive entrance). Daily records were kept of activity, pollen collected and mortality to the foraging bees at the hive. Queens and brood were checked regularly. The routines were duplicated in untreated control areas. The colonies were normally returned to the headquarters yard 5-10 days after treatment to prevent disturbance by bears and vandalism by humans.

Aquatic Environment: Populations of benthic invertebrates were monitored in two treatment and control streams near Parent (52 g AI/ha) and in a small forest pond in Larose Forest (70 g AI/ha). Periodic groups of 0.1 sq. m (foot square) Surber samples (Surber, 1936) were taken over the treatment period and preserved with formaldehyde. Organisms were separated from the substrate in the lab by elutriation in a "bubbler" (Kingsbury and Beveridge, in press) and then identified to Order, or Family, and counted. Over the sampling period incidental observations were made on populations of fish and aquatic insects in the treatment areas.

Amphibians: Adult and larval anurans were collected from untreated ponds

within the Larose Forest and placed in enclosures in the experimental spray pond and the control pond. The adult enclosure consisted of 1.5 m x 1.5 m nylon screen fence, one meter high. Three-quarters of the enclosure bottom was situated in the pond, the remainder on the shore. The bottom edge of the fence was folded into the enclosure and covered with earth and debris to prevent burrowing under the fence. Ten male American toads (*Bufo americanus*) and three male leopard frogs (*Rana pipiens*) were placed in each of the experimental and control enclosures. Observations were made from 5 June to 24 June on these individuals to determine if any gross behavioural changes or mortality had occurred.

The larval enclosures were made from screened-in laundry baskets each divided into two compartments. Two such enclosures were placed partially submerged in the ponds at each of the locations. Tadpoles of two species, (wood frog, *Rana sylvatica* and green frog, *Rana clamitans*) at different developmental stages and of different numbers, were placed in the different compartments of the baskets. Similar setups were utilized for both the experimental and control enclosures (Table II). Along with observations to determine possible behavioural changes and mortality, tadpole samples were also periodically removed and preserved in 10 percent formalin to determine their rate of growth and development.

Table II

Contents of the Compartments of the Tadpole Enclosures

Compartment	A	B	C	D
Species	R. clamitans	R. sylvatica	P. sylvatica	R. sylvatica
No. of individuals	20	25	100	200
Mean Developmental Stage[1]	?	33	25	25

[1] after Gosner, 1960

Prior to and following the 6 June 1974 spray application, sight counts of natural anuran populations were made on both the MATACIL® experimental spray pond and the control location. The census consisted of counting flushed or sighted frogs while walking approximately 90 meters along the margin of the pond. The sighted frogs were identified to species and were judged adults or subadults depending on their size. Splashes in the immediate vicinity were considered to be unknowns.

Combination drift-fence pit-fall traps were set up on the experimental plot and two control plots to determine species and size composition of the anuran community. The trap consisted of five, 2 m long sections of 0.5 m high nylon screen placed linearly with one 10 litre bucket sunk in the ground between the lengths of screen and at each end. Water was allowed to accumulate in the buckets to prevent desiccation and escape of the anurans. The frogs and toads captured in this manner were identified, weighed, measured, and released in the vicinity of the trap. The trap was sampled from 18 July to 27 August.

RESULTS

52 g AI/ha

Birds: Monitoring of small forest inhabiting birds in the Menjou Depot area (Table III) indicated a reduction in the populations of ruby-crowned kinglets, *Regulus calendula* (Linnaeus) and black and white warblers, *Mniotilta varia* (Linnaeus). Bay-breasted warbler, *Dendroica castanea* (Wilson) numbers were noticably reduced while those of the yellowthroat, *Geothlypis trichas* (Linnaeus) showed slight reductions. Rose-breasted grosbeaks, *Pheucticus ludovicianus* (Linnaeus) and white-throated sparrows, *Zonotrichia albecollis* (Gmelin) were not affected by the treatment.

Evening grosbeaks, *Hesperiphona vespertina* (Cooper) completely disappeared from the Menjou Depot area for several days after application. This species has been recorded as vacating insecticide treated areas for suitable habitat that had not been sprayed (Bent 1968).

In the Parent area (Tables IV to X), ruby-crowned kinglet numbers declined throughout the operational and control areas resulting from factors other than the application of MATACIL®. Winter wrens, *Troglodytes troglodytes* (Linnaeus) showed slight declines as a result of the second treatment as did nashville warblers. Sizable populations of white-throated sparrows *Zonotrichia albicollis* (Gmelin) remained unaffected.

Table III

Populations of Small Forest Songbirds
on MATACIL ® Treatment and Control Plots
Menjou Depot Quebec
1973

Family	Species	Post spray - Control plot					Post-spray Treatment plot				
		+2	+3	+4	+5	Daily ave	+2	+3	+4	+5	Daily ave
Picidae	Yellow-shafted Flicker	0	0	0	0	0	6	0	24	0	.8
Tyrannidae	Least Flycatcher	0	12	18	12	10	0	12	12	6	8
	Olive-sided Flycatcher	0	6	6	0	3	0	0	0	0	0
Hirundinidae	Barn Swallow	0	0	6	0	1	0	0	0	0	0
Corvidae	Blue Jay	0	0	24	12	9	6	0	6	6	5
Sittidae	Red-breasted Nuthatch	0	0	0	0	0	0	0	0	0	0
	White-breasted Nuthatch	0	0	0	0	0	0	0	6	0	1
Troglodytidae	Winter Wren	0	0	6	0	1	6	12	24	6	12
Turdidae	American Robin	0	0	3	0	1	6	0	0	12	5
	Swainson's Thrush	0	12	0	12	6	0	15	0	0	4
	Wood Thrush	0	0	0	6	1	0	0	0	0	0
	Veery	0	12	0	12	6	12	0	24	18	14
Sylviidae	Ruby-crowned Kinglet	12	12	6	0	7	0	0	0	12	3
Vireonidae	Red-eyed Vireo	6	0	6	12	6	24	6	6	12	12
Parulidae	Black and White Warbler	0	12	12	18	10	6	0	0	0	1
	Nashville Warbler	0	24	12	70	28	18	18	12	6	14
	Yellow Warbler	6	0	0	0	1	0	0	0	0	0
	Blackburnian Warbler	0	6	6	12	6	6	0	0	0	1
	Bay-breasted Warbler	18	60	60	132	67	0	0	6	0	1

Table III Cont...

Family	Species	Post-spray Control plot +2	+3	+4	+5	Daily ave	Post-spray Treatment plot +2	+3	+4	+5	Daily ave
Parulidae (Cont'd)	Ovenbird	12	6	12	12	10	18	12	6	12	12
	Yellowthroat	6	12	6	0	6	0	0	0	0	0
	Canada Warbler	0	0	12	18	9	0	0	18	18	9
Fringillidae	Rose-breasted Grosbeak	0	12	0	0	3	0	0	0	0	0
	Evening Grosbeak	18	30	39	70	39	0	12	0	0	3
	American Goldfinch	0	0	0	6	1	0	9	0	6	4
	Chipping Sparrow	0	0	0	6	1	6	0	12	0	5
	White-throated Sparrow	6	18	0	18	10	6	12	42	18	20
	Song Sparrow	6	9	6	6	7	0	0	0	0	0
Unidentified	Species	6	18	0	0	6	12	0	6	6	6
Totals		102	267	234	428	257	132	114	210	138	149

TABLE IV

Population of Small Forest Songbirds
Before and After Treatment 1
on MATACIL® Treatment Plot 1
Parent, Quebec, 1974

Family	Species	Pre-spray, treatment 1			Post-spray, treatment 1					
		- 2	- 1	Daily ave.	+ 0	+ 1	+ 2	+ 3	+ 4	Daily ave.
Tetraonidae	Ruffed Grouse	0	12	6	6	6	12	6	6	7
Alcedinidae	Belted Kingfisher	0	12	6	0	0	0	0	0	0
Picidae	Yellow-shafted Flicker	0	15	8	0	0	6	6	6	4
	Yellow-bellied Sapsucker	6	12	9	0	18	0	0	0	4
Tyrannidae	Eastern Phoebe	0	0	0	0	0	0	0	0	0
	Least Flycatcher	6	30	18	30	54	66	36	42	46
Paridae	Black-capped Chickadee	0	0	0	0	0	0	0	0	0
Sittidae	Red-breasted Nuthatch	12	12	12	0	0	0	0	0	0
Troglodytidae	Winter Wren	6	42	24	39	12	48	36	33	34
Turdidae	American Robin	15	9	12	15	12	18	30	24	20
	Hermit Thrush	6	6	6	6	12	60	66	60	29
	Swainson's Thrush	6	0	3	0	30	60	12	6	22
	Veery	0	0	0	30	72	36	42	42	44
Sylviidae	Ruby-crowned Kinglet	18	30	24	0	12	0	48	12	14
	Golden-crowned Kinglet	0	0	0	12	0	0	0	0	2
Vireonidae	Solitary Vireo	0	12	6	0	12	0	0	0	2
	Red-eyed Vireo	0	6	3	0	0	0	0	0	0
Parulidae	Black and White Warbler	0	6	3	0	0	0	0	0	0
	Nashville Warbler	6	18	12	78	42	54	30	48	50

TABLE IV (Cont'd)

Family	Species	Pre-spray, treatment 1			Post spray, treatment 1					
		- 2	- 1	Daily ave.	+ 0	+ 1	+ 2	+ 3	+ 4	Daily ave.
Parulidae (Cont'd)	Magnolia Warbler	0	0	0	24	48	60	18	0	30
	Cape-May Warbler	0	0	0	0	0	0	18	0	4
	Black-throated Blue Warbler	6	18	12	18	0	0	6	0	5
	Myrtle Warbler	0	0	0	0	18	6	0	0	5
	Black-throated Green Warbler	6	18	12	0	0	0	0	0	0
	Blackburnian Warbler	0	0	0	0	0	0	0	0	0
	Chestnut-sided Warbler	18	72	45	60	60	60	102	78	72
	Bay-breasted Warbler	0	0	0	0	0	0	24	24	10
	Ovenbird	18	48	33	66	30	30	54	36	43
	Mourning Warbler	0	18	9	0	0	0	0	0	0
	Yellowthroat	6	0	3	0	0	0	0	0	0
	Canada Warbler	0	24	12	12	18	24	24	18	19
	American Redstart	6	63	35	45	66	42	18	36	41
Icteridae	Red-winged blackbird	0	0	0	6	0	0	0	0	1
Fringillidae	Evening Grosbeak	0	0	0	0	6	6	0	0	2
	Purple Finch	0	6	3	0	0	0	0	0	0
	Slate-coloured Junco	0	6	3	0	0	0	0	0	0
	White-throated Sparrow	24	114	69	120	114	108	126	72	108
Totals		165	597	381	567	642	636	702	543	618

Table V

Populations of Small Forest Songbirds
Before and After Treatment 1
on MATACIL® Treatment Plot 4
Parent, Quebec, 1974

Family	Species	Pre-spray, treatment 1				Post-spray, treatment 1					
		-2	-1	-0	Daily ave	+1	+2	+3	+4	+5	Daily ave
Trochilidae	Ruby-throated Hummingbird	0	0	0	0	0	3	0	0	0	1
Picidae	Yellow-bellied Sapsucker	12	6	18	12	0	0	0	0	0	0
Tyrannidae	Least Flycatcher	0	0	0	0	0	6	6	0	6	4
	Olive-sided Flycatcher	0	0	0	0	6	0	0	0	0	1
Corvidae	Blue Jay	0	0	3	1	0	0	0	0	0	0
	Gray Jay	0	0	0	0	6	0	0	0	0	1
Paridae	Black-capped Chickadee	6	0	0	2	0	0	0	0	0	0
Sittidae	Red-breasted Nuthatch	0	0	0	0	12	12	6	6	0	7
Troglodytidae	Winter Wren	18	0	0	6	24	30	30	24	30	32
Turdidae	Hermit Thrush	6	6	6	6	24	12	12	18	18	17
	Swainson's Thrush	0	0	0	0	6	12	0	12	42	14
	Veery	0	6	6	3	0	0	0	0	18	5
Sylviidae	Ruby-crowned Kinglet	54	66	114	78	48	48	51	84	54	57
Vireonidae	Red-eyed Vireo	6	0	0	2	0	0	0	0	0	0
	Solitary Vireo	0	0	6	2	0	0	0	0	0	0
Parulidae	Tennessee Warbler	0	60	72	44	108	66	66	14	42	59
	Nashville Warbler	0	48	42	30	78	30	66	48	30	50
	Magnolia Warbler	6	18	12	12	0	12	18	24	12	13
	Black-throated Green Warbler	0	0	0	0	0	0	6	18	12	7

Table V Cont...

Family	Species	Pre-spray, treatment 1				Post-spray, treatment 1					
		-2	-1	-0	Daily ave	+1	+2	+3	+4	+5	Daily ave
Parulidae (Cont'd)	Chestnut-sided Warbler	0	0	6	2	6	6	6	0	18	7
	Cape May Warbler	0	66	78	48	78	54	84	54	12	56
	Bay-breasted Warbler	0	6	12	6	12	12	36	18	60	28
	Yellowthroat	0	0	0	0	24	0	0	6	18	11
Icteridae	Rusty Blackbird	0	0	6	2	0	0	0	0	0	0
	Brown-headed Cowbird	0	6	0	2	0	0	0	0	0	0
Fringillidae	Evening Grosbeak	0	15	21	12	0	0	0	0	0	0
	Slate-coloured Junco	0	0	6	2	0	0	0	0	12	2
	White-throated Sparrow	57	84	96	79	128	48	72	60	90	80
	Swamp Sparrow	0	18	12	10	0	6	6	6	6	5
Unidentified	Species	0	0	0	0	6	3	9	9	0	3
Totals		165	351	516	344	566	360	474	401	480	456

Table VI

Populations of Small Forest Songbirds
Before and After Treatment 1
on MATACIL® Control Plot
Parent, Quebec, 1974

Family	Species	Pre-spray treatment 1	Post-spray treatment 1					
		-1	+ 0	+ 1	+ 2	+ 3	+ 4	Daily ave
Caprimulgidae	Common Nighthawk	9	0	0	0	0	0	0
Alcedinidae	Belted Kingfisher	0	0	0	0	0	0	0
Picidae	Yellow-shafted Flicker	12	6	12	6	0	0	0
	Yellow-bellied Sapsucker	0	0	0	0	0	0	0
Tyrannidae	Eastern Kingbird	0	0	6	0	6	0	2
	Eastern Phoebe	0	0	0	0	0	12	2
	Least Flycatcher	0	0	6	0	0	6	2
	Olive-sided Flycatcher	0	0	0	0	0	0	0
Hirundinidae	Tree Swallow	0	6	6	0	0	6	4
Corvidae	Gray Jay	0	0	6	12	0	12	6
Sittidae	Red-breasted Nuthatch	0	6	0	6	0	0	2
Troglodytidae	Winter Wren	0	0	0	0	0	0	0
Turdidae	American Robin	9	0	6	15	0	3	5
	Hermit Thrush	48	36	42	24	6	18	25
	Swainson's Thrush	0	0	0	3	12	0	3
	Veery	6	0	0	0	0	0	0
Sylviidae	Ruby-crowned Kinglet	36	18	24	36	60	18	31

Table VI Cont...

Family	Species	Pre-spray treatment 1	Post-spray treatment 1					Daily ave
		-1	+0	+ 1	+ 2	+ 3	+ 4	
Bombycillidae	Cedar Waxwing	0	0	0	0	0	0	0
Vireonidae	Solitary Vireo	0	0	0	6	6	0	2
	Red-eyed Vireo	0	0	0	0	0	0	0
Paulidae	Black and White Warbler	0	0	0	0	0	0	0
	Tennessee Warbler	0	0	12	6	12	0	6
	Nashville Warbler	0	6	36	24	18	0	17
	Yellow Warbler	0	6	0	0	0	0	1
	Magnolia Warbler	6	0	0	0	12	6	4
	Myrtle Warbler	6	12	0	0	0	0	2
	Chestnut-sided Warbler	0	0	0	0	0	0	0
	Bay-breasted Warbler	0	0	0	0	0	0	0
	Ovenbird	0	0	6	0	0	0	1
Icteridae	Red-winged Blackbird	12	12	6	24	24	6	14
	Rust Blackbird	0	0	0	0	0	0	0
	Common Grackle	0	0	24	15	3	12	11
Fringillidae	Evening Grosbeak	0	0	0	12	6	6	5
	American Grosbeak	0	0	0	0	0	0	0
	Slate-coloured Junco	12	18	6	15	57	36	26
	White-throated Sparrow	30	54	84	45	51	36	54
	Swamp Sparrow	0	0	0	0	0	0	0
Unidentified	Species	6	0	0	6	0	0	1
Totals		192	180	282	255	273	183	234

Table VII

Populations of Small Forest Songbirds
Before and After Treatment 2
on MATACIL® Treatment Plot 1
Parent, Quebec, 1974

Family	Species	Pre-spray, treatment 2						Post-spray, treatment 2					
		-6	-5	-4	-3	-2	Daily ave	+ 0	+ 1	+ 2	+ 3	+ 4	Daily ave
Tetraonidae	Ruffed Grouse	6	6	6	6	6	6	0	6	6	6	6	
Alcedinidae	Belted Kingfisher	0	0	0	0	0	0	0	0	0	0	0	0
Picidae	Yellow-shafted Flicker	6	6	6	12	12	8	0	3	0	0	30	7
	Yellow-bellied Sapsucker	0	0	0	6	0	1	0	18	3	12	0	7
Tyrannidae	Eastern Phoebe	0	6	0	0	0	1	0	0	0	0	0	0
	Least Flycatcher	30	18	24	18	18	22	24	24	12	30	30	24
Paridae	Black-capped Chickadee	0	0	0	0	0	0	6	0	0	0	0	1
Sittidae	Red-breasted Nuthatch	0	0	0	0	0	0	6	0	0	0	0	1
Troglodytidae	Winter Wren	42	24	18	24	36	29	12	30	12	30	12	19
Turdidae	American Robin	21	24	0	18	12	15	3	24	12	66	33	28
	Hermit Thrush	54	12	24	6	12	22	0	6	18	24	30	16
	Swainson's Thrush	6	6	18	12	12	11	30	30	36	18	42	31
	Veery	30	30	48	30	60	40	0	30	36	42	42	30
Sylviidae	Golden-crowned Kinglet	0	0	0	0	0	0	6	0	0	0	0	1
	Ruby-crowned Kinglet	0	66	54	42	84	49	18	30	24	24	24	24
Vireonidae	Solitary Vireo	0	0	0	0	0	0	0	0	0	0	0	0

Table VII Cont...

Family	Species	Pre-spray, treatment 2						Post-spray, treatment 2					
		-6	-5	-4	-3	-2	Daily ave	+ 0	+ 1	+ 2	+ 3	+ 4	Daily ave
Vireonidae (Cont'd)	Red-eyed Vireo	0	0	0	0	0	0	60	48	78	108	120	83
Parulidae	Black and White Warbler	0	0	0	0	0	0	0	0	0	0	0	0
	Nashville Warbler	36	36	0	24	18	23	18	24	0	24	18	17
	Magnolia Warbler	12	0	0	0	18	6	6	24	18	42	24	23
	Cape May Warbler	6	24	0	0	0	6	6	0	24	24	36	18
	Black-throated Blue Warbler	0	0	0	0	0	0	30	0	0	0	0	6
	Myrtle Warbler	0	0	0	0	0	0	0	6	0	0	0	1
	Black-throated Green Warbler	0	0	0	0	0	0	6	0	0	0	0	1
	Blackburnian Warbler	0	0	0	0	0	0	18	0	0	0	0	4
	Chestnut-sided Warbler	90	84	48	24	42	58	18	54	24	48	54	40
	Bay-breasted Warbler	6	0	0	0	6	2	18	36	12	18	42	25
	Ovenbird	30	42	30	18	54	35	48	24	30	42	30	35
	Mourning Warbler	6	0	0	0	0	1	24	0	0	0	0	5
	Yellowthroat	0	0	0	0	0	0	0	0	0	0	0	0
	Canada Warbler	0	0	0	0	0	0	24	0	6	0	0	6
	American Redstart	36	24	12	36	12	24	18	12	0	18	12	12
Icteridae	Red-winged Blackbird	0	0	0	0	0	0	0	0	0	0	0	0
Fringillidae	Evening Grosbeak	0	0	0	0	0	0	0	0	0	0	0	0
	Purple Finch	0	0	0	0	0	0	12	0	0	0	0	0
	Slate-coloured Junco	6	0	0	0	0	0	0	0	0	0	0	0
	White-throated Sparrow	60	60	72	72	126	78	18	60	84	120	90	74
Totals		477	468	360	336	528	433	429	489	435	969	675	545

Table VIII

Populations of Small Forest Songbirds
Before and After Treatment 2
on MATACIL® Treatment Plot 3
Parent, Quebec, 1974

Family	Species	Pre-spray treatment 2						Post-spray, treatment 2					
		-6	-5	-4	-3	-2	Daily ave	+ 0	+ 1	+ 2	+ 3	+ 4	Daily ave
Tetraonidae	Spruce Grouse	0	0	0	0	0	0	0	0	0	0	0	1
Caprimulgidae	Common Nighthawk	0	0	0	6	0	1	0	0	0	6	0	1
Picidae	Yellow-shafted Flicker	3	12	0	12	6	6	6	0	6	6	0	4
	Yellow-bellied Sapsucker	0	3	0	9	6	4	0	0	0	0	0	0
Tyrannidae	Eastern Phoebe	18	0	6	0	6	6	0	6	0	6	0	2
	Least Flycatcher	0	6	6	6	0	4	6	0	0	0	12	4
Paridae	Boreal Chickadee	0	0	0	0	0	0	0	6	0	0	0	1
Sittidae	Red-breasted Nuthatch	0	0	0	6	0	1	0	0	0	0	0	0
Troglodytidae	Winter Wren	6	48	12	12	0	16	12	6	0	18	0	7
Turdidae	American Robin	0	3	0	0	0	1	0	0	0	0	0	0
	Hermit Thrush	24	12	12	0	12	12	18	24	24	0	12	16
	Swainson's Thrush	12	6	30	6	12	11	0	12	54	6	12	17
	Veery	0	0	0	0	0	0	0	0	0	0	6	1
Sylviidae	Ruby-crowned Kinglet	42	30	42	54	24	38	42	30	42	30	48	38
Vireonidae	Solitary Vireo	0	0	0	0	0	0	0	0	0	0	6	1

Table VIII Cont'd...

Family	Species	Pre-spray, treatment 2						Post-spray, treatment 2					
		-6	-5	-4	-3	-2	Daily ave	+ 0	+ 1	+ 2	+ 3	+ 4	Daily ave
Parulidae	Tennessee Warbler	18	42	78	42	78	52	150	135	126	138	84	127
	Nashville Warbler	36	48	36	42	30	38	12	0	18	30	18	16
	Magnolia Warbler	33	18	42	30	30	31	0	0	48	18	36	20
	Cape-May Warbler	12	0	12	36	6	13	0	6	12	0	72	18
	Myrtle Warbler	0	0	0	0	0	0	12	0	0	0	6	4
	Black-throated Green Warbler	12	0	0	0	0	2	0	0	0	0	0	0
	Chestnut-sided Warbler	0	12	0	0	0	2	0	0	0	0	0	0
	Bay-breasted Warbler	42	24	24	18	6	23	0	12	24	24	18	16
	Ovenbird	6	0	6	0	0	2	0	0	0	0	0	0
	Yellowthroat	0	0	6	12	0	4	0	0	0	6	18	5
	Canada Warbler	0	0	0	0	0	0	6	0	0	0	0	1
	American Redstart	0	0	0	0	0	0	0	0	6	0	0	1
Fringillidae	Purple Finch	0	0	0	0	6	1	0	0	0	0	0	0
	American Goldfinch	0	0	0	0	6	1	0	0	0	0	0	0
	Slate-coloured Junco	36	6	12	6	12	14	42	18	0	21	6	17
	White-throated Sparrow	66	90	78	90	78	73	87	87	72	105	84	87
	Song Sparrow	0	0	0	0	0	0	6	0	0	0	0	1
Unidentified	Species	6	0	0	6	6	4	0	0	0	0	0	0
Totals		372	360	402	393	324	370	405	342	432	414	438	406

Table IX

Populations of Small Forest Songbirds
Before and After Treatment 2
on MATACIL® Treatment Plot 4
Parent, Quebec, 1974

Family	Species	Pre-spray, treatment 2					Post-spray, treatment 2				
		-5	-3	-1	-0	Daily ave	+ 1	+2	+3	+4	Daily ave
Picidae	Yellow-shafted Flicker	6	0	0	0	2	18	0	0	0	5
	Yellow-bellied Sapsucker	0	0	6	6	3	0	0	0	0	0
Tyrannidae	Least Flycatcher	0	0	0	6	2	0	6	0	0	2
	Olive-sided Flycatcher	6	0	0	0	2	0	0	0	0	0
Troglodytidae	Winter Wren	30	30	24	45	32	18	18	0	18	14
Turdidae	American Robin	0	0	0	6	2	0	0	0	0	0
	Hermit Thrush	6	6	18	12	11	6	18	24	12	17
	Swainson's Thrush	48	30	18	30	32	60	48	18	36	41
	Veery	0	0	0	18	5	0	0	18	0	5
Sylviidae	Ruby-crowned Kinglet	66	54	30	78	57	42	30	42	24	35
Vireonidae	Red-eyed Vireo	12	0	0	0	3	0	0	6	6	3
	Solitary Vireo	6	0	0	0	2	0	0	0	0	0
Parulidae	Tennessee Warbler	66	78	126	84	89	128	150	96	150	131
	Nashville Warbler	6	36	60	66	47	12	12	42	12	24
	Magnolia Warbler	24	12	66	36	36	18	24	12	30	21
	Myrtle Warbler	6	0	0	0	2	0	0	0	0	0
	Black-throated Green Warbler	6	0	0	0	2	0	0	0	0	0
	Black-throated Blue Warbler	0	0	6	0	2	0	0	0	0	0

Table IX Cont'd...

Family	Species	Pre-spray, treatment 2					Post-spray, treatment 2				
		-5	-3	-1	-0	Daily ave	+1	+2	+3	+4	Daily ave
Parulidae (Cont'd)	Chestnut-sided Warbler	0	0	0	6	2	0	0	0	0	0
	Bay-breasted Warbler	42	18	18	6	21	48	24	72	66	53
	Cape May Warbler	24	6	12	60	26	30	24	42	0	24
	Yellowthroat	24	24	24	0	18	18	12	36	12	20
	American Redstart	0	0	0	24	6	0	0	0	0	0
Icteridae	Red-winged Blackbird	0	0	0	0	0	0	0	0	6	2
Fringillidae	Purple Finch	0	6	0	0	2	6	0	0	0	2
	Slate-coloured Junco	24	24	15	0	16	12	6	12	6	14
	White-throated Sparrow	102	30	84	180	99	72	42	84	24	56
Unidentified	Species	12	0	12	0	6	0	0	0	0	0
Totals		516	354	519	663	513	488	414	504	402	452

Table X

Populations of Small Forest Songbirds
Before and After Treatment 2
on MATACIL® Control Plot
Parent, Quebec, 1974

Family	Species	Pre-spray treatment 2						Post-spray treatment 2					
		-6	-5	-4	-3	-1	Daily ave	+ 0	+ 1	+ 2	+ 3	+ 4	Daily ave
Caprimulgidae	Common Nighthawk	0	0	0	0	0	0	6	0	0	3	0	2
Alcedinidae	Belted Kingfisher	0	0	0	0	6	1	0	0	0	0	0	0
Picidae	Yellow-shafted Flicker	0	0	0	0	0	0	0	0	0	0	0	0
	Yellow-bellied Sapsucker	0	6	0	0	0	1	0	0	0	0	0	0
Tyrannidae	Eastern Kingbird	0	0	0	0	0	0	0	0	0	0	0	0
	Eastern Phoebe	0	6	0	18	6	6	0	0	0	6	6	2
	Least Flycatcher	0	0	0	6	6	2	0	0	0	0	0	0
	Olive-sided Flycatcher	0	6	6	6	0	4	0	0	0	0	0	0
Hirundinidae	Tree Swallow	0	0	0	0	0	0	0	0	0	6	0	1
Corvidae	Gray Jay	6	0	0	0	6	2	0	0	0	0	0	0
Sittidae	Red-breasted Nuthatch	0	0	12	6	18	7	0	0	0	0	0	0
Troglodytiade	Winter Wren	0	0	0	0	6	1	0	0	0	0	0	0
Turdidae	American Robin	12	6	0	6	6	6	0	9	0	0	0	2
	Hermit Thrush	24	12	27	18	30	22	48	21	48	24	0	28
	Swainson's Thrush	15	12	24	24	24	20	54	24	18	54	30	36
	Veery	0	6	0	0	0	1	0	0	0	0	0	0

Table X Cont...

Family	Species	Pre-spray treatment 2						Post-spray treatment 2					
		-6	-5	-4	-3	-1	Daily ave	+ 0	+ 1	+ 2	+ 3	+ 4	Daily ave
Sylviidae	Ruby-crowned Kinglet	66	66	54	78	66	66	6	18	36	30	24	23
Bombycillidae	Cedar Waxwing	0	0	0	15	9	5	0	0	0	0	0	0
Vireonidae	Solitary Vireo	0	0	0	18	6	5	0	0	0	0	0	0
	Red-eyed Vireo	0	0	0	0	0	0	6	6	6	12	12	8
Parulidae	Black and White Warbler	6	0	0	6	6	4	0	0	0	0	0	0
	Tennessee Warbler	0	0	0	0	0	0	0	0	12	12	0	5
	Nashville Warbler	0	0	0	0	0	0	0	18	6	6	24	11
	Yellow Warbler	0	0	0	0	0	0	0	0	0	0	0	0
	Magnolia Warbler	0	0	0	0	0	0	0	6	0	6	6	4
	Myrtle Warbler	3	6	0	0	0	2	0	0	0	0	0	0
	Chestnut-sided Warbler	6	6	0	0	0	2	0	0	0	0	0	0
	Bay-breasted Warbler	0	0	0	0	0	0	0	6	0	0	0	1
	Ovenbird	0	0	0	6	0	1	0	0	0	0	0	0
Icteridae	Red-winged Blackbird	6	6	18	6	12	10	0	6	18	18	12	11
	Rusty Blackbird	0	12	6	30	6	11	0	0	0	0	0	0
	Common Grackle	0	0	0	0	0	0	0	0	9	3	0	2
Fringillidae	Evening Grosbeak	6	6	0	30	0	8	0	0	0	0	0	0
	American Goldfinch	0	6	6	0	0	2	0	0	0	0	0	0
	Slate-coloured Junco	15	51	6	24	36	26	6	12	36	6	12	14
	White-throated Sparrow	84	90	72	90	66	80	48	78	60	36	30	50
	Swamp Sparrow	0	6	0	0	0	1	0	0	0	0	0	0
Unidentified	Species	3	3	0	3	3	2	0	0	0	0	0	0
Totals		252	312	231	390	318	301	174	204	249	222	156	201

Mammals: Low populations of the small mammal complex were encountered in Menjou Depot (Table XI) and Parent (Table XII) areas. A total of 21 animals were trapped at Menjou Depot and included the red-backed vole, *Clethrionomys gapperi* (Vigors), the deer mouse, *Peromyscus maniculatus* (Wagner), the meadow vole, *Microtus pennsylvanicus* (Ord), the woodland jumping mouse, *Napaeozapus insignis* (Miller) and the eastern chipmunk *Tamias striatus* (Linnaeus).

A total of 9 animals were taken at Parent including P. *maniculatus*, N. *insignis*, T. *striatus*, M. *pennsylvanicus* and the meadow jumping mouse, *Zapus hudsonius* (Zimmermann). Sub-adult and juvenile animals were taken from the treatment plots and some adult females were pregnant. In spite of the few numbers of animals trapped, the data indicates that the low populations found reflect natural population fluctuations rather than an insecticide impact.

Table XI

Small Mammal Population Census
MATACIL® Treatment and Control Plots
Menjou Depot Quebec
1973

	Males				Females						
					Adult						
PLOT	Adults	Sub-adult	Juvenile	Total Males	Not Pregnant	Pregnant	with placental scars	Sub-Adults	Juvenile	Total Females	Total Animals
Control	6	1	2	9	0	2	3	0	0	5	14
Treatment	3	0	1	4	0	0	1	0	2	3	7

Table XII

Small Mammal Population Census
MATACIL® Treatment and Control Plots
Parent Quebec
1974

	Males				Females						
					Adult						
PLOT	Adults	Sub-Adult	Juvenile	Total Males	Not Pregnant	Pregnant	with Placental scars	Sub-Adults	Juvenile	Total Females	Total Animals
Control	0	0	0	0	0	1	0	0	1	0	2
Treatment	4	1	0	5	0	1	0	1	0	2	7

Honey Bees: Five colonies of domestic honey bees were placed in an opening within the treatment area near Menjou Depot several days prior to the application of the insecticide MATACIL®. Mortality due to the transfer had subsided before treatment and each colony had been checked for healthy queens and brood. Each colony was then fitted with a pollen collecting trap, an electronic activity counter and a dead bee collecting trap. The area was sprayed between 12 and 1 o'clock (E.D.T.) June 10. Distressed bees were observed within the hour and the mortality count reached 505 within the first 24 hours, then returned to normal within 3 days (Table XIII). Pollen collection declined on both plots, partly as a result of a rain storm the day after application; the control plot returning to normal the next day, the treatment plot within 3 days. Activity decreased on the control (also as a result of the rain) but did not do so on the treated hives. This appears to be solely related to clustering around the hive entrances in a confused and disorganized manner and in removing dead bees from within the hive. Examination of each hive revealed that the treatment did not affect the queens, brood or newly emerged bees and appeared to have affected only the foraging component of each colony. After five days, each colony had returned to normal activity and the hives were returned to the headquarters yard and observations taken periodically until the end of the season. Normal populations and good honey production were recorded for both treatment and control colonies by mid September.

Table XIII

Activity Measurements of Honey Bee Colonies
Located on MATACIL®Treatment and Control Plots
Menjou Depot Area, Quebec
1973

	Control plot			MATACIL®treated plot		
Spray Day	Adult bee mortality	Activity count	Pollen collected (grams)	Adult bee mortality	Activity count	Pollen collected (grams)
-1	3	72586	13.6	0	97648	16.8
-0.5	1	115968	13.4	3	34038	19.8
+1	4	40704	3.8	505	55050	1.2
+2	3	79588	31.0	46	77314	9.6
+3	1	82560	32.7	1	97048	33.9
+4	3	80104	35.4	5	33152	10.2
Average	3	78585	22.5	93.3	65706	15.2

Based on an average of 5 colonies from each plot.

Aquatic Environment: Treatment plots 2 and 3 at Parent were treated on June 4th and again on June 15th with 52 g MATACIL® /ha. No pre-treatment bottom samples were taken from these plots because of the late arrival of the sampling team, but series of samples were taken right after the first treatment and again before and after the second insecticide application. A similar sampling program was carried out at the control stream. All three streams were narrow (1 to 2 meters) and relatively deep (average depths 0.3 to 0.7 meters) but the control stream was slower flowing and consequently had a siltier bottom than the treated streams.

Over the treatment period bottom fauna populations increased in the two treated streams while they remained relatively constant in the control stream (Tables XIV, XV and XVI). These increases were primarily due to increases in midge larvae (Diptera: Chironomidae) populations at Plot 3 and midge larvae, oligcliaete and fingernail clam (Mollusca: Sphaeriidae) populations at Plot 4. Stoneflies disappeared completely from Plot 3 samples and decreased at Plot 4 after the second MATACIL® application. Stonefly populations in the control stream were very low throughout the treatment period. Blackfly larvae (Diptera: Simuliidae) populations also decreased in the two treatment streams after the second MATACIL® application but this may have been due to the emergence of adult blackflies from the streams. Blackfly larvae populations in the control stream fluctuated erratically but on the whole decreased over the treatment period. Throughout the sampling period no dead or distressed fish or aquatic insects were observed in the treatment plots.

Table XIV

Stream Bottom Fauna Populations at Plot 3, MATACIL® Spray Block 327B,

as Mean Numbers and Standard Deviations of Organisms/ 0.1 sq. m.

Parent, Quebec, June 6 to June 18, 1974.

Number of days before or after treatment	+ 2	+ 8	+ 14 (+ 3 second treatment)
Number of Samples	3	4	4
Trichoptera	4.0 ± 3.0	14.2 ± 7.9	9.8 ± 6.5
Ephemeroptera	0.3 ± 0.6	0.5 ± 1.0	--
Plecoptera	6.0 ± 6.1	19.0 ± 20.9	--
Coleoptera	--	0.2 ± 0.6	--
Diptera-Chironomidae	29.3 ± 32.3	159.0 48.2	245.8 ± 152.1
Diptera-Simuliidae	15.7 ± 6.1	30.8 ± 33.8	0.5 ± 0.6
Other Diptera	1.7 ± 2.1	2.5 ± 3.0	4.0 ± 5.4
Nematoda	1.7 ± 2.9	1.5 ± 1.9	3.2 ± 2.5
Oligochaeta	19.7 ± 12.5	30.0 ± 41.4	20.5 ± 13.8
Hydracarina	--	4.2 ± 2.5	2.5 ± 3.0
Sphaeridae	0.3 ± 0.6	2.8 ± 3.6	7.0 ± 3.6
Total	78.7 ± 44.7	264.8 ± 127.9	293.2 ± 180.0

Table XV

Stream Bottom Fauna Populations at Plot 4, MATACIL® Spray Block 327B,

as Mean Numbers and Standard Deviations of Organisms/ 0.1 sq. m,

Parent, Quebec, June 6 to June 18, 1974.

Number of days before or after treatment	+ 2	+ 8	+ 14 (+ 3 second treatment)
Number of samples	4	4	4
Trichoptera	0.8 ± 1.0	17.0 ± 20.6	17.5 ± 18.1
Plecoptera	1.2 ± 0.5	1.5 ± 1.7	0.2 ± 0.5
Neuroptera	---	0.2 ± 0.5	---
Diptera-Chironomidae	8.0 ± 3.8	69.5 ± 39.6	45.5 ± 66.7
Diptera-Simuliidae	3.5 ± 3.0	1.5 ± 1.7	0.5 ± 1.0
Other Diptera	0.8 ± 0.5	0.5 ± 1.0	0.5 ± 1.0
Nematoda	1.0 ± 1.4	2.2 ± 0.5	0.5 ± 1.0
Oligochaeta	4.5 ± 4.6	63.0 ± 10.0	64.5 ± 56.9
Sphaeridae	1.0 ± 0.8	13.2 ± 10.3	77.5 ± 46.6
Total	20.8 ± 6.6	168.8 ± 65.7	207.0 ± 135.4

Table XVI

Stream Bottom Fauna Populations at the Untreated Check Plot, Matacil Spray Area, as Mean Numbers and Standard Deviations of Organisms/ 0.1 sq. m, Parent, Quebec, June 5 to June 19, 1974.

Number of days before or after treatment	+ 1	+ 9	+ 15 (+4 second treatment)
Number of samples	4	4	4
Trichoptera	1.5 ± 1.3	0.2 ± 0.5	1.0 ± 1.4
Ephemeroptera	1.8 ± 2.4	-	0.2 ± 0.5
Plecoptera	- -	0.5 ± 1.0	0.2 ± 0.5
Coleoptera	2.5 ± 1.8	0.2 ± 0.5	-
Hemiptera	0.2 ± 0.5	- -	-
Diptera-Chironomidae	6.2 ± 4.4	4.0 ± 2.8	4.8 ± 3.3
Diptera-Simuliidae	17.8 ± 15.6	0.8 ± 1.0	9.5 ± 8.7
Other Diptera	0.2 ± 0.5	0.2 ± 0.5	0.2 ± 0.5
Oligochaeta	0.5 ± 1.0	13.0 ± 9.9	16.2 ± 13.1
Sphaeriidae	0.2 ± 0.5	- -	-
Total	31.0 ± 21.7	19.0 ± 11.3	32.2 ± 23.0

70 g A.I./ha, Larose Forest Ontario

Insecticide deposit: Deposit sampling stations were located throughout the two bird plots at 5.5 m, 4.0 m, 0.3 m and at ground level. Sample cards were also placed on top of each colony of honey bees and around the amphibian sampling area. Insecticide deposit at these locations in grams of active ingredient per hectare is presented in Table XVII.

Table XVII

MATACIL® Deposit Sampling Results (g AI/ha)

Larose Forest Experimental Area, 1974

	Bird Plot 1	Bird Plot 2	Bee yard	Amphibian Plot
Average Plot Deposit	2.59	1.12	3.57	17.99
5.5 m level (ave)	2.66	1.12		
4.0 m level (ave)	2.17	1.05		
0.3 m level (ave)	1.40	1.33		
Ground level (ave)	2.59	2.38		

Birds: Total avian populations were reduced somewhat on Larose treatment plot 1 (Table XVIII) and remained almost the same on Larose treatment plot 2 (Table XIX) and control (Table XX). Examination of the data collected shows that the small songbird component did not suffer any adverse ecological damage due to this dosage of MATACIL® . . .

Table XVIII

Small Songbird Populations on
MATACIL® Treatment Plot 1
Larose Forest Ont.
1974

Family 1	Species	Pre-spray						Post-spray					
		-4	-3	-2	-1	-0	Daily ave	+ 1	+ 2	+ 3	+ 4	+ 5	Daily ave
Tetraonidae	Ruffed Grouse	6	0	0	0	0	1	0	0	0	0	0	0
Columbidae	Mourning Dove	18	12	6	0	12	10	6	0	6	12	0	5
Picidae	Yellow-bellied Sapsucker	6	0	0	0	0	1	0	0	0	0	0	0
	Downy Woodpecker	0	3	0	0	0	1	0	0	0	0	0	0
Tyrannidae	Eastern Wood Pewee	6	0	6	0	12	5	6	12	6	18	12	11
	Eastern Kingbird	0	0	0	0	0	0	0	6	0	3	0	2
	Great-crested Flycatcher	0	0	0	0	0	0	0	0	0	6	0	1
Corvidae	Blue Jay	6	0	2	0	3	2	3	0	0	0	0	1
Paridae	Black-capped Chickadee	0	0	0	0	0	0	0	0	0	6	0	1
Sittidae	Red-breasted Nuthatch	0	0	0	0	0	0	0	0	0	6	0	1
Mimidae	Catbird	0	0	6	0	0	1	0	0	0	0	0	0
Turdidae	American Robin	24	18	18	27	6	19	12	18	21	6	6	13
	Swainson's Thrush	0	6	12	6	6	6	9	12	0	0	0	4
	Wood Thrush	6	0	0	0	0	1	0	0	0	0	0	0
	Veery	18	12	12	24	30	19	12	24	24	12	0	14
Sylviidae	Ruby-crowned Kinglet	6	12	12	6	12	10	12	0	18	0	0	
	Golden-crowned Kinglet	6	6	0	0	0	1	0	0	0	0	0	0

Table XVIII Cont...

Family	Species	Pre-spray						Post-spray					
		-4	-3	-2	-1	-0	Daily ave	+1	+2	+3	+4	+5	Daily ave
Parulidae	Nashville Warbler	18	30	18	12	12	18	30	24	30	30	12	25
	Myrtle Warbler	36	42	48	30	30	37	30	42	36	36	24	34
	Black-throated Green Warbler	0	6	0	0	0	1	0	0	0	0	0	0
	Chestnut-sided Warbler	0	12	6	0	0	4	0	0	0	0	0	0
	Bay-breasted Warbler	18	18	36	0	36	22	12	24	30	6	12	17
	Blackpoll Warbler	0	0	12	0	0	2	0	0	0	0	0	0
	Yellowthroat	0	6	12	12	30	12	12	12	6	6	12	10
Icteridae	Baltimore Oriole	0	0	6	0	6	2	0	6	0	0	0	1
	Red-winged Blackbird	12	0	0	0	0	2	0	0	0	0	0	0
	Rusty Blackbird	6	0	0	12	15	7	3	3	12	9	6	7
	Common Grackle	0	3	0	0	0	1	0	0	0	0	0	0
	Brown-headed Cowbird	6	6	6	0	0	4	3	9	0	0	12	5
Fringillidae	Purple Finch	0	6	6	6	0	4	0	0	0	0	0	0
	White-throated Sparrow	18	18	18	6	6	13	12	6	12	6	0	7
	American Goldfinch	0	0	0	0	0	0	0	3	0	0	0	1
	Fox Sparrow	0	0	0	0	0	0	0	6	0	0	0	0
	Chipping Sparrow	0	0	0	0	0	0	12	0	6	0	0	4
	Slate-coloured Junco	6	0	0	0	0	1	0	0	0	0	0	0
Totals		222	216	242	141	213	207	171	201	207	162	96	167

Table XIX

Populations of Small Forest Songbirds
on MATACIL® Treatment Plot 2
Larose Forest Ont.
1974

Family	Species	Pre-spray						Post-spray					
		-4	-3	-2	-1	-0	Daily ave	+1	+2	+3	+4	+5	Daily ave
Scolopacidae	Common Snipe	0	0	0	0	0	0	0	6	0	0	0	1
Columbidae	Mourning Dove	12	0	6	0	0	4	0	9	0	0	0	2
Tyrannidae	Eastern Wood Pewee	0	0	0	0	0	0	6	0	0	12	0	4
Corvidae	Blue Jay	0	3	0	0	3	1	3	6	0	3	0	2
	Common Crow	0	0	6	0	0	1	0	0	0	0	0	0
Paridae	Black-capped Chickadee	6	0	0	6	0	2	0	0	0	0	0	0
Sittidae	Red-breasted Nuthatch	0	0	0	0	6	1	0	6	0	6	0	2
Turdidae	American Robin	30	12	18	12	12	17	24	18	30	24	24	24
	Swainson's Thrush	6	6	0	0	6	4	0	6	0	6	0	2
	Veery	6	6	6	6	6	6	6	6	6	12	0	6
Sylviidae	Ruby-crowned Kinglet	0	0	0	0	0	0	0	6	0	6	0	2
Parulidae	Nashville Warbler	0	0	0	0	0	0	0	0	6	0	6	2
	Myrtle Warbler	24	48	42	36	30	36	48	42	36	48	30	41
	Black-throated Green Warbler	6	0	6	0	0	2	0	0	0	0	0	0
	Bay-breasted Warbler	0	6	12	0	3	4	6	0	6	0	6	4
	Ovenbird	0	0	0	0	0	0	0	6	0	0	0	1

Table XIX Cont...

Family	Species	Pre-spray						Post-spray					
		-4	-3	-2	-1	-0	Daily ave	+1	+2	+3	+4	+5	Daily ave
	Yellowthroat	0	0	0	0	12	2	0	0	0	6	6	2
Icteridae	Brown-headed Cowbird	6	0	6	0	0	2	0	0	0	6	0	1
	Rusty Blackbird	12	0	6	3	6	5	6	9	3	9	6	7
Fringillidae	Rose-breasted Grosbeak	0	6	6	0	0	2	6	0	0	0	0	0
	Purple Finch	6	0	6	0	0	2	6	0	0	0	0	1
	Chipping Sparrow	0	0	0	0	0	0	0	0	0	0	6	1
	White-throated Sparrow	0	6	12	0	12	6	12	6	6	6	0	6
Totals		114	93	132	63	96	100	117	126	93	144	84	113

Table XX

Populations of Small Forest Songbirds
on MATACIL® Control Plot
Larose Forest, Ont.
1974

Family	Species	Pre-spray						Post-spray					
		-4	-3	-2	-1	-0	Daily ave	+1	+2	+3	+4	+5	Daily ave
Columbidae	Mourning Dove	6	15	0	0	12	7	0	0	0	9	6	3
Tyrannidae	Eastern Phoebe	36	36	54	30	42	40	36	30	24	36	48	35
	Eastern Kingbird	0	0	6	0	0	1	0	0	0	0	0	0
Corvidae	Blue Jay	0	0	3	0	0	1	0	0	3	0	6	2
Mimidae	Catbird	18	12	9	6	12	11	12	12	12	6	12	11
Turdidae	American Robin	6	6	0	6	0	4	9	0	0	0	6	3
	Hermit Thrush	6	0	6	0	0	2	0	0	0	0	0	0
	Swainson's Thrush	6	18	18	12	36	18	30	27	15	18	12	20
	Veery	0	0	12	12	36	12	6	12	30	6	30	
Sylviidae	Ruby-crowned Kinglet	18	18	12	12	24	17	12	24	18	12	18	17
Parulidae	Myrtle Warbler	6	12	0	0	6	5	0	6	0	0	0	1
	Bay-breasted Warbler	30	36	24	24	30	29	24	12	30	36	18	24
	Nashville Warbler	12	54	24	24	48	32	48	30	36	30	42	37
	Yellow Warbler	72	141	168	102	135	124	138	150	156	174	168	157
	Magnolia Warbler	12	0	6	0	0	4	0	0	0	0	0	0
	Chestnut-sided Warbler	0	12	6	6	18	8	0	6	6	12	0	5
	Yellowthroat	24	30	18	24	36	26	24	42	6	6	18	19
Icteridae	Rusty Blackbird	6	12	12	6	15	10	18	12	15	6	15	13
	Common Grackle	0	6	6	3	0	3	0	0	0	0	0	0
	Red-winged Blackbird	6	6	12	12	12	10	6	12	12	30	6	13

Table XX Cont...

Family	Species	Pre-spray						Post-spray					
		-4	-3	-2	-1	-0	Daily ave	+1	+2	+3	+4	+5	Daily ave
Fringillidae	Purple Finch	0	12	6	12	18	10	6	3	6	6	0	4
	American Goldfinch	6	6	12	12	0	7	3	9	12	6	12	8
	Rosebreasted Grosbeak	0	0	0	0	0	0	0	0	0	0	0	1
	White-throated Sparrow	36	48	42	30	48	41	36	6	24	21	60	29
	Song Sparrow	0	6	0	6	0	2	0	0	0	0	6	1
	Chipping Sparrow	24	48	42	54	24	38	18	24	18	12	12	17
Totals		324	519	501	405	540	458	426	417	423	432	495	439

Small Mammals: The Larose Forest area does not provide good habitat for small mammals. Trapping the MATACIL® experimental area approximately 6 weeks after application resulted in the capture of a single specimen of woodland jumping mouse, *Napaeozapus insignis* (Miller). The specimen was a sub-adult male in good condition. The low numbers encountered no doubt reflect the natural population density normally encountered in the Larose Forest rather than a result of the application of MATACIL®.

Honey Bees: Ten colonies of domestic honey bees were located on both a control and treatment block. Each hive was fitted with a pollen collecting trap, electronic activity counter and dead bee collecting trap. All colonies were examined for queens and brood and were weighed throughout the experimental period. One half the plot was treated in the early morning (0530 E.D.T.) the other half just before dark (2000 E.D.T.). All the foraging bees were in the hive during the morning application while a few were still active outside the hive during the evening application. The data presented in Table XXI shows that the colonies were not affected by this operation. Sampling cards placed on top of each hive show that approximately 3.6 grams of active ingredient / ha fell on the bee yard.

Table XXI

Activity Measurements of Honey Bee Colonies
Located on MATACIL® Treatment
(70 g AI/ha) and Control Plots
Larose Forest, Ontario
1974

Spray day	Mortality	Activity	Pollen collected (grams)	Hive weights (kg)	Mortality	Activity	Pollen collected (grams)	Hive weights (kg)
-6	3	33920	52.3	17.2	3	27264	39.6	17.4
-5	5	74624	37.3		4	40576	26.1	
-4	4	99072	41.6		3	45696	26.2	
-3	4	65536	37.2	20.8	8	51840	27.9	21.5
-2	4	57600	34.6		6	35200	33.0	
-1	2	110336	14.6		2	37120	19.0	
-0	1	61952	31.2	20.9	6	52608	28.8	21.7
Pre-spray averages	3	71954	35.5	19.6	5	41472	28.6	20.2
+1	3	91776	21.8	20.9	13	57216	22.4	21.7
+2	2	61824	22.3		1	60672	33.1	
+3	2	75648	39.2		1	58624	38.7	
+4	4	153344	57.2		4	75648	49.8	
+5	6	12544	11.3	21.0	4	14720	9.7	21.6
+6	3	13312	11.5		3	12288	8.4	
Post-spray averages	4	68074	27.2	20.9	4	46528	27.0	21.6

Based on the average of ten colonies from each plot.

Aquatic Environment: Bottom fauna populations in a small silty bottomed forest pond in Larose Forest exposed to an aerial application of 70 g MATACIL® /ha are presented in Table XXII. The pond was about 9 m by 6 m with a maximum depth of 1.2 m and average depth of 0.6 m. The water level in the pond dropped 0.15 m over the sampling period.

Bottom fauna populations in the pond increased over the sampling period. This was primarily due to large increases in the midge larvae and isopod (Crustacea: Isopoda) populations. Pond dwelling caddisfly larvae (Trichoptera) and dragonfly nymphs (Odonta) were unaffected by the treatment. Adult and larval aquatic beetles (Coleoptera) were present in small numbers before treatment but were not found in the post-treatment samples. Tadpoles were observed to be unaffected by the treatment but a decrease in surface dwelling insects, primarily water striders and whirligig beetles, was noted.

Table XXII

Pond Bottom Fauna Populations at MATACIL® Treatment Plot

as Mean Numbers and Standard Deviations of Organisms/ 0.1 sq. m,

Larose Forest, Ontario, June 5 to June 24, 1974

Number of days before or after treatment	- 2	+ 17
Number of samples	5	5
Trichoptera	1.0 ± 1.4	1.8 ± 1.9
Odonata	1.8 ± 1.6	2.6 ± 2.8
Coleoptera	1.0 ± 0.7	- ± -
Hemiptera	0.6 ± 0.5	0.4 ± 0.5
Diptera	1.2 ± 1.3	19.0 ± 15.6
Nematoda	0.2 ± 0.7	- ± -
Oligochaeta	5.4 ± 4.9	1.0 ± 1.0
Hydracarina	0.2 ± 0.7	- ± -
Isopoda	0.4 ± 0.5	7.6 ± 5.4
Amphibia	1.6 ± 2.1	0.4 ± 0.5
Total	13.4 ± 8.2	32.8 ± 13.1

Amphibians: The adult and larval anurans showed no visible effects of insecticide poisoning immediately following the aerial application of 70 g AI/ha of technical MATACIL®. No mortality of caged adults could be attributed to the insecticide, when compared with the higher mortality in the control enclosure (Table XXIII). There was no mortality in tadpoles throughout the study on either the experimental or control locations.

Observations on the natural anuran population at the experimental pond revealed no mortality or hyperactivity, and individual male *R. clamitans* continued calling throughout the study period. The adult census showed no obvious variations in the population between the experimental and control ponds (Table XXIV) prior to or following spray application. Newly metamorphosed individuals of *R. clamitans* were first noted 24 June at the control pond and not until 3 July at the experimental pond. This difference may reflect only the limited number of sampling trips during this period.

Pit-fall trapping indicated the presence of *B. americanus*, *R. clamitans* and *R. sylvatica* adults and sub-adults on the spray plot and the control plots (Table XXV). The *R. clamitans* populations are larger on the control plots than on the test plot, but the larger number of *R. sylvatica* on the test plot would indicate microhabitat differences and not the result of insecticide activity. The size range of *R. clamitans* (Figure 1) for the sprayed plot (42-47 mm) was within the size range of the control samples (35-53 mm; 38-50 mm) and the means are similar, even with the small sample size. Analysis of variance for unequal sample size revealed no significant difference in the mean snout-vent lengths at a .01 level of significance. This would suggest no observed adverse effects of the insecticide on post-metamorphic growth.

Figures 2, 3 and 4 show comparisons of the growth and development of tadpoles caged in experimental and control ponds. Tadpole groups C and D at the experimental location became accidentally mixed, but the small variation between the same groups at the control location suggests that the tadpole density in the enclosures has little effect on development and growth. The data for control groups C and D were then pooled to get one mean at each sampling day. There was also little difference between these variables for the control and treatment plots, (Figures 2 and 3) indicating a lack of insecticide activity at these earlier developmental stages. A significant difference exists for both variables, in the group B tadpoles at the treatment pond, when compared with the control tadpoles (Figures 2 and 3). There appears to be a retarded development in the treated tadpoles at approximately developmental stage 40. As indicated by the reduction in total body length (Figure 4), this is when tail resorption is occuring and any stored pesticides would be mobilized. This has been previously noted for *Rana temporaria* treated with DDT (Cooke, 1973 a, b). This developmental retardation may also explain the later appearance of newly metamorphosed *R. clamitans* on the treated plot already mentioned. This will, however, have to be further substantiated.

As part of a continuing laboratory project, the LC_{50} of MATACIL® to anuran tadpoles and its effect on growth and development will be determined.

Table XXIII

Adult Anuran Enclosure Mortality

Larose Forest, Ontario

1974

Species	Initial number	June 5 -1	6 0	7 +1	9 +3	10 +4	12 +6	14 +8	24 +18	Total mortality
		Matacil Experimental Pond								
B. americanus	10♂	0	0	0	1	1	1	0	3	6
R. pipiens	3♂	0	0	0	0	1	0	0	0	1
		Control								
B. americanus	10♂	0	0	0	4	2	1	0	3	10
R. pipiens	3♂	0	0	0	0	0	0	0	1	1

Table XXIV

Anuran Population Census

Larose Forest, Ontario

Species	June 2 -4	3 -3	4 -2	5 -1	6 0	7 +1	9 +3	10 +4	12 +6	14 +8	July 24 +18	25 +19	28 +22	3 +28	6 +31	10 +35	Total
	Treatment																
B. americanus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R. clamitans																	
Adults	2	3	2	3	7	7	7	1	4	2	5	1	2	3	0	3	52
Sub-adults	0	0	0	0	0	0	0	0	0	0	0	0	0	7	6	5	18
R. pipiens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R. sylvatica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Unknown	0	0	0	0	0	1	0	2	0	0	0	0	1	0	0	0	4
Total	2	3	2	3	7	9	7	3	4	2	5	1	3	10	6	8	75
	Control																
B. americanus	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2
R. clamitans																	
Adults	1	5	8	1	3	3	6	2	0	1	0	0	2	2	3	1	38
Sub-adults	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	3
R. pipiens	0	1	1	0	0	0	0	0	0	0	0	2	0	1	1	0	6
R. sylvatica	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2
Unknown	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	2	6	10	2	3	3	6	2	0	1	1	2	5	3	4	2	52

Table XXV

Adult Anurans Taken in Pit-fall Traps
MATACIL® Treatment and Control Plots
Larose Forest, Ontario

Species	July 18	19	24	26	30	August 6	11	19	27	Total
	Treatment Plot									
Bufo americanus	0	1	0	2	0	0	0	0	0	3
Rana clamitans	0	0	0	1	2	1	0	0	0	4
Rana pipiens	0	0	0	0	0	0	0	0	0	0
Rana sylvatica	0	0	0	4	1	1	0	0	0	6
	Control-1									
Bufo americanus	0	0	0	0	1	0	0	0	0	1
Rana clamitans	0	1	0	0	13	0	1	1	0	16
Rana pipiens	0	0	0	0	0	0	0	0	0	0
Rana sylvatica	0	0	0	0	0	0	0	0	0	0
	Control-2									
Bufo americanus	0	0	0	0	0	1	0	0	1	2
Rana clamitans	0	0	0	7	7	1	1	4	0	20
Rana pipiens	0	0	0	0	0	0	0	0	0	0
Rana sylvatica	0	0	0	0	0	0	0	1	1	2

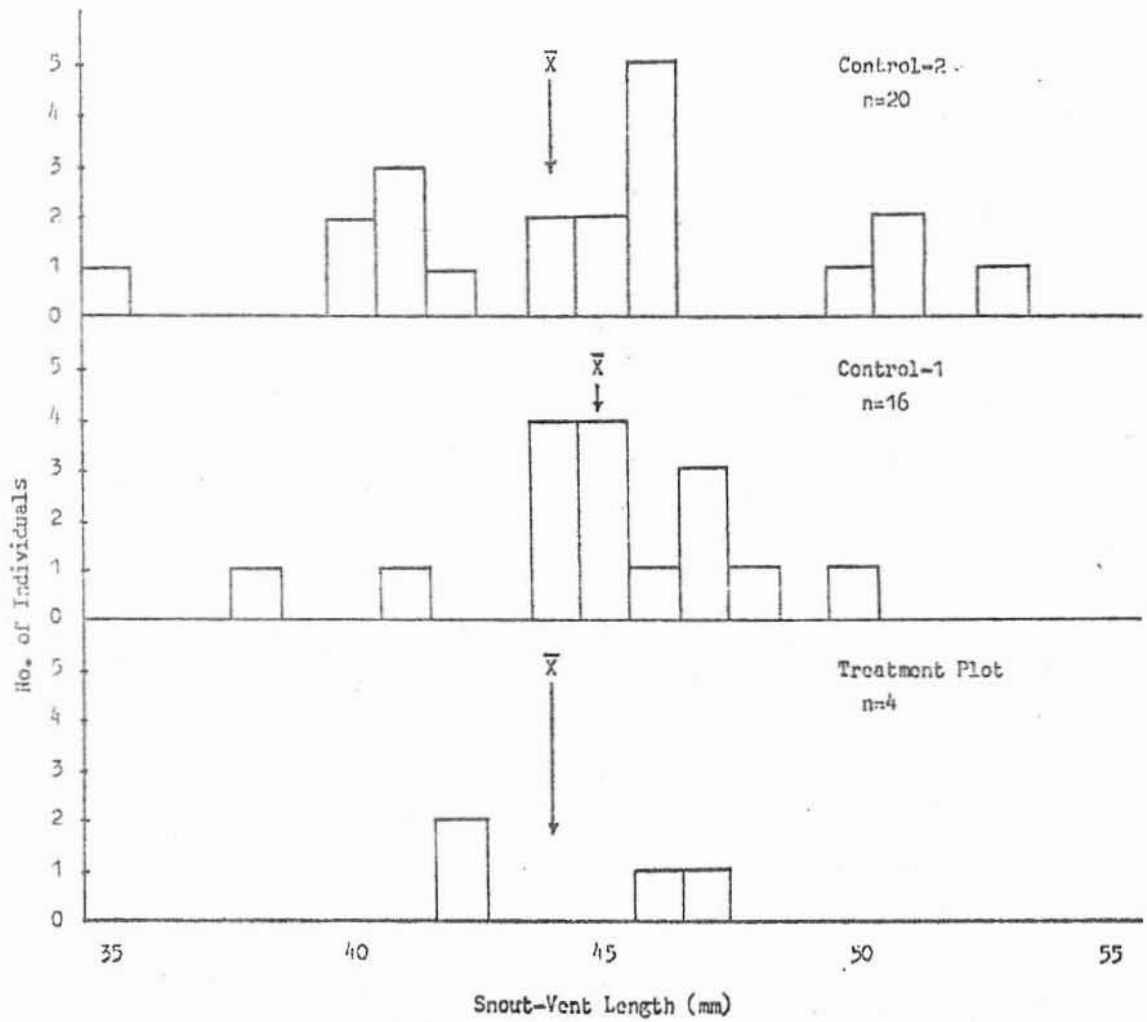

Figure 1 : Size Frequency For Pit-fall Trapped R. clamitans .

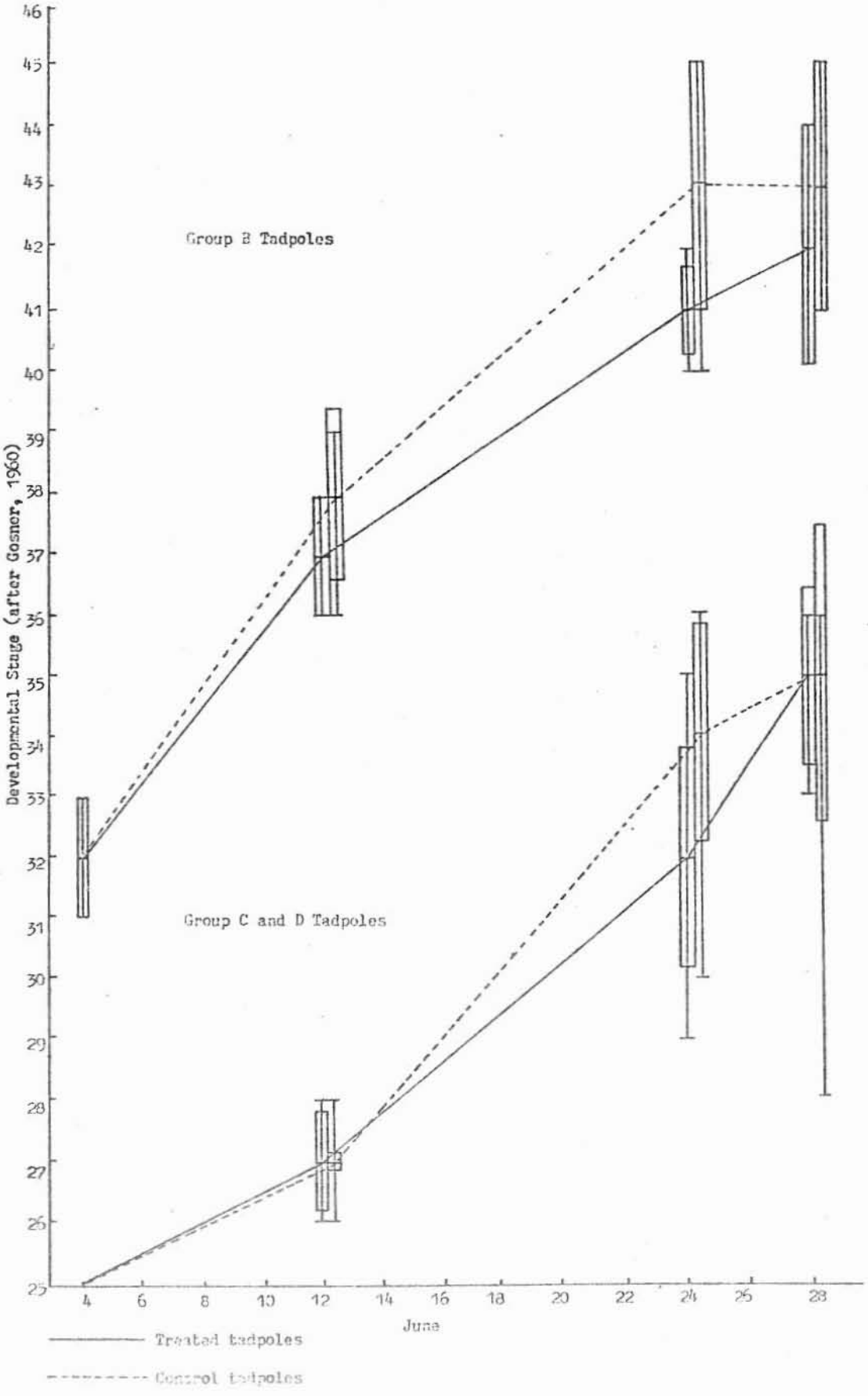

Figure 2 Developmental rate of Rana sylvatica tadpoles. Each rectangle represents one standard deviation on each side of the mean. The vertical lines represent the range of the sample.

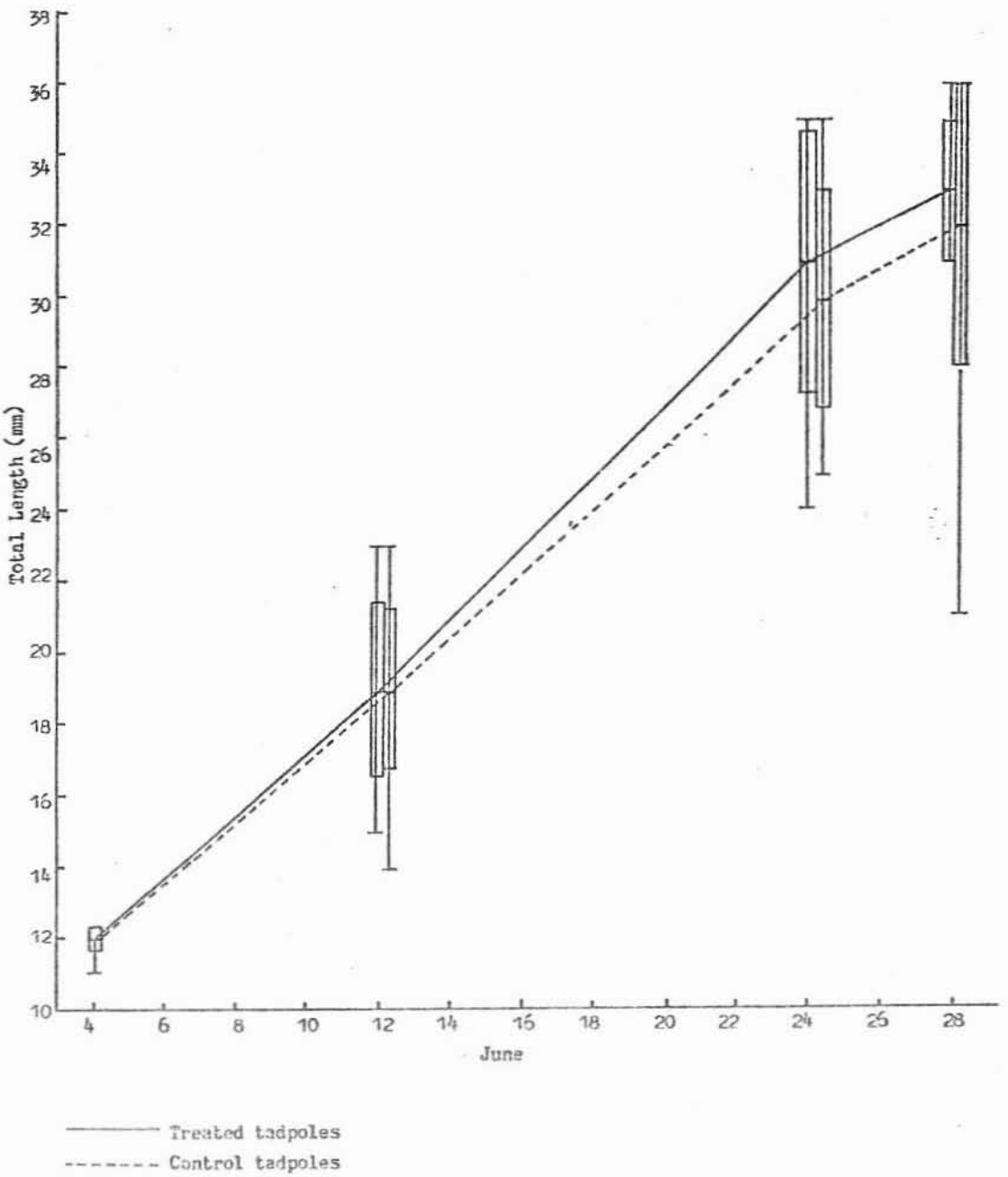

Figure 3 : Total length changes for Rana sylvatica tadpoles in group C and D. Each rectangle represents one standard deviation on each side of the mean. The vertical lines represent the range of the sample.

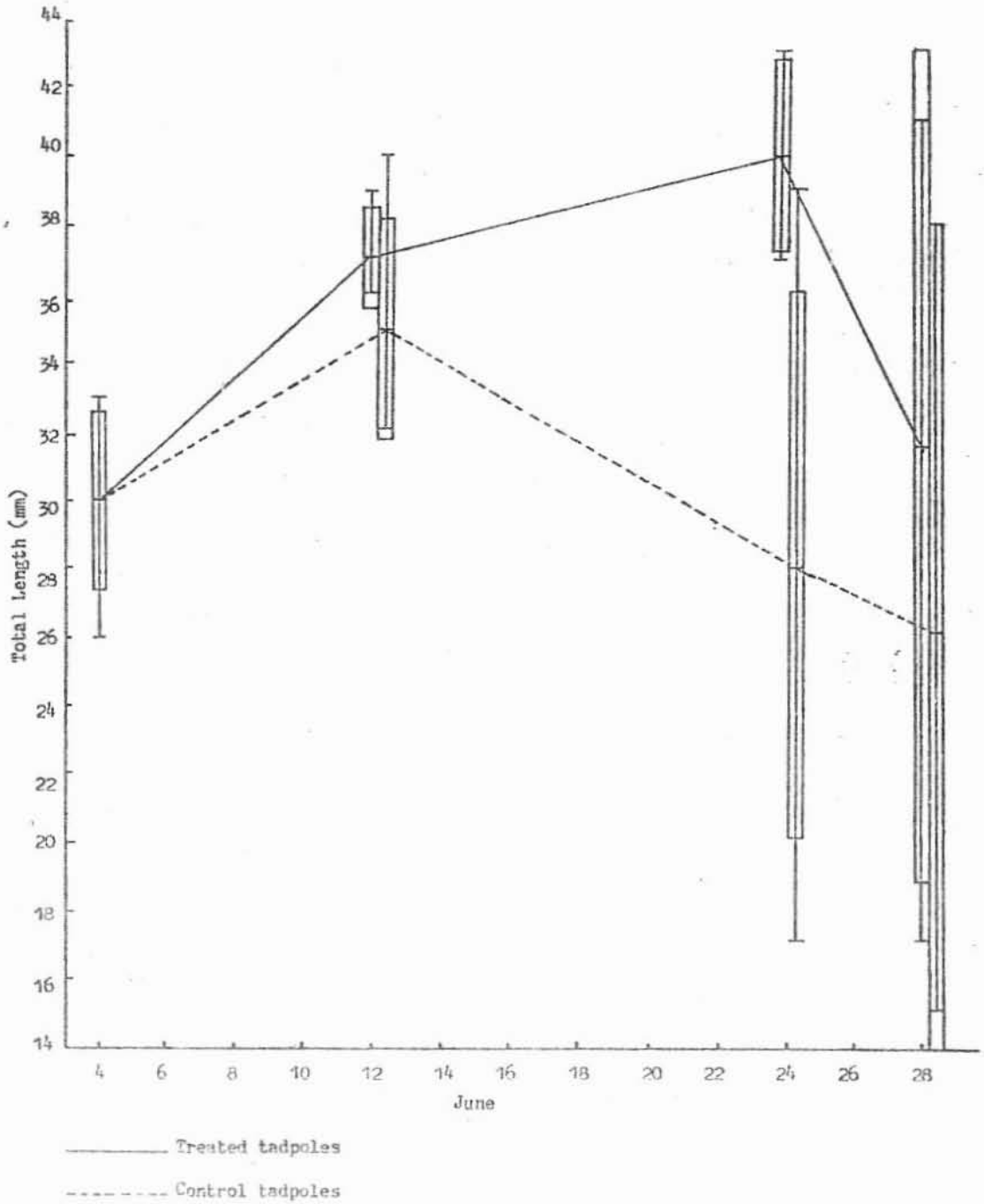

Figure 4 : Total changes for Rana sylvatica tadpoles in group B. Each rectangle represents one standard deviation on each side of the mean. The vertical lines represent the range of the sample.

105 g A.I./ha, Harcourt, N.B.

Small Mammals: Two distinct habitats were trapped, an open meadow and a typical forest environment. Six species of small mammals were encountered. *M. pennsylvanicus* was the only species taken from the open meadow. *C. gapperi*, *Sorex* spp., *N. insignis*, *P. maniculatus* and *Blarina brevicauda* (Say) were trapped only from the forest habitat. (Table XXVI). The two species of voles, *M. pennsylvanicus* and *C. gapperi* made up the largest component with a total of 78 animals out of 89 trapped. Sub-adult and juvenile animals made up a large proportion of the voles trapped (Table XXVII). Adult female voles were dissected and the breeding condition recorded (Table XXVIII). All *C. gapperi* adult females were pregnant while 11 out of 13 *M. pennsylvanicus* were either pregnant or contained placental scars indicating the recent birth of a litter.

The data shows that under the conditions of application, MATACIL® did not affect the population of small mammals in any detectable way.

Table XXVI

Small Mammal Populations from Five Snapback Trap Lines
MATACIL® Spray Plot - Harcourt, New Brunswick - July 1971

Plot No	Habitat	Numbers of Small Mammals Trapped					
		Microtus pennsylvanicus	Clethrionomys gapperi	Sorex spp	Napaeozapus insignis	Peromyscus maniculatus	Blarina brevicauda
1	meadow	45	0	0	0	0	0
2	forest	1	12	1	0	0	0
3	forest	2	2	2	0	1	0
4	forest	2	10	3	2	0	0
5	forest	0	4	0	1	0	1
T o t a l		50	28	6	3	1	1

Table XXVII

Sex and Age Structure of Small Mammals Trapped on
MATACIL® Spray Plot - Harcourt, New Brunswick - July 1971

S p e c i e s	Females			Males		
	Adults	Subadults	Juv	Adults	Subadults	Juv
M. pennsylvanicus	13	15	0	9	12	1
C. gapperi	5	3	0	15	5	0
Sorex spp.	4	0	0	2	0	0
B. brevicauda	0	0	0	1	0	0
P. maniculatus	0	0	0	1	0	0
N. insignis	1	0	0	2	0	0

Table XXVIII

Fecundity of Two Species of Adult Voles Trapped on
the MATACIL® Spray Plot - Harcourt, New Brunswick - July 1972

S p e c i e s	Not pregnant	Not pregnant with placental scars	Embryos only	Placental scars and embryos
Microtus pennsylvanicus	2	2	5	4
Clethrionomys gapperi	0	0	5	0

SUMMARY AND CONCLUSIONS

Birds: Single applications of MATACIL® at the recommended operational dosage rates did not affect the breeding bird population when emitted in the early morning. Mid-day applications caused light reductions in the warbler complex and may have caused grosbeaks to leave the treatment area. Higher than normal dosage rates did not affect bird populations when applied in the morning or evening.

Small Mammals: Small mammal populations were not affected at dosage rates up to 105 g AI/ha either in a forested or open habitat.

Honey Bees: Honey bee colonies suffered moderate damage to the worker force when MATACIL® was applied at the rate of 52 g AI/ha at mid-day when foraging was in progress. Applications of a slightly higher rate (70 g AI/ha) did not affect the colonies when made in the early morning or late evening.

Aquatic environment: The impact of aerial applications of MATACIL® on aquatic fauna has been previously studied during small scale applications in New Brunswick in 1970 and 1971 (G.H. Penney 1971 a, 1971 b). Two consecutive applications of 88 g AI/ha in 1970 had no effect on caged salmon parr or aquatic insect populations in a stream within the treatment plot. A single application of 105 g AI/ha the following year significantly reduced stonefly populations in the two streams studied but had little effect on other aquatic insect orders.

The monitoring studies reported here show similar effects of large scale MATACIL® applications on the aquatic systems studied. No

significant impact on overall aquatic insect populations occurred but stoneflies were selectively affected. Relatively high concentrations of MATACIL® have been shown to disappear from river water in less than four weeks under static conditions in the laboratory (Eichelberger and Lichtenberg, 1971). The combination of this insecticide's lack of serious adverse side effects on aquatic fauna and rapid disappearance from aquatic systems make this chemical insecticide ecologically acceptable from the aquatic system point of view.

Amphibians: When the amphibian complex was subjected to an application of MATACIL® at the emitted rate of 70 g AI/ha, no damage resulted to either the adult or tadpole stage amphibia.

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It is concluded that MATACIL®, if applied at the recommended rates and times, does not adversely affect the environmental components reported on here.

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