

ENVIRONMENTAL EFFECTS OF A
SPLIT APPLICATION OF SEVIN-2-OIL®

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ABSTRACT

A split application of SEVIN-2-OIL® had no significant adverse effect on either forest songbirds or wild pollinators, and only a slight knockdown effect on non-target terrestrial arthropods. Carbaryl residues as high as 313.7 ppb and 122.6 ppb were detected in stream water immediately after the first and second applications respectively. Residues declined rapidly but were still detected (0.9 ppb) up to 10 days after the completion of spraying. Although both treatments resulted in disruptions in the normal diurnal drift pattern of aquatic invertebrates, the overall effect on benthic invertebrate populations was negligible. Analyses of brook trout and slimy sculpin stomach contents indicated that availability of food was not significantly reduced. No mortality was recorded among native brook trout caged in the treatment stream for up to 10 days after the second application. SEVIN-2-OIL® was applied twice at a dosage rate of 280 g/ha/application to a 400 ha spray block located near Allardville in Gloucester County, New Brunswick.

RÉSUMÉ

Un traitement fractionné progressif au SEVIN-2-OIL^{MD} n'a eu aucun effet nocif important sur les oiseaux chanteurs sylvoles et les pollinisateurs sauvages, et n'a fait qu'assommer légèrement des arthropodes terrestres non cibles. Des résidus de carbaryl, à des concentrations atteignant jusqu'à 313,7 et 122,6 x 10⁻⁹, ont été décelés dans l'eau du cours d'eau, immédiatement après le premier et le deuxième arrosages respectivement. Les concentrations ont baissé rapidement mais étaient encore décelables (0,9 x 10⁻⁹) jusqu'à 10 jours après l'arrosage. Même si les deux épandages ont modifié le mode diurne normal de dérive des invertébrés aquatiques, ils ont eu un effet global négligeable sur les populations d'invertébrés benthiques. Des analyses du contenu stomacal d'ombles de fontaine et de chabots visqueux ont indiqué que la disponibilité de nourriture n'avait pas été réduite de façon importante. On n'a enregistré aucune mortalité d'ombles de fontaine indigènes gardés en cages dans le cours d'eau traité jusqu'à 10 jours après le deuxième épandage. Le bloc traité d'une superficie de 400 ha se trouve près d'Allardville, dans la circonscription de Gloucester (Nouveau-Brunswick), et le traitement a été appliqué en deux fois à la dose de 280 g/ha chaque fois.

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INTRODUCTION

Carbaryl (1-naphthyl N-methylcarbamate) is a broad spectrum carbamate insecticide which, since its introduction in 1958 under the trade name SEVIN®, has been registered for control of over 300 insect pests worldwide. SEVIN-4-OIL®, an oil-based dispersion containing 4 pounds of carbaryl insecticide per U.S. gallon, is registered for forest insect control in both Canada and the United States, and is presently the product of choice for spruce budworm control in Maine.

In the United States, where SEVIN-4-OIL® is registered at 1120 grams active ingredient per hectare (1120 g (AI)/ha), the typical strategy has been, up until fairly recently at least, a single application at or near the maximum allowable dose. In 1978 however, the operational use of split applications of SEVIN-4-OIL® was initiated in Maine. It was theorized that split applications would allow a reduction in the amount of active insecticide used, while at the same time improving foliage protection and budworm population reduction (Trial, 1978).

In Canada, SEVIN-4-OIL® is registered for spruce budworm control at 550 to 1250 g (AI)/ha, but has to date received only limited use in small scale experimental tests. High cost, a large required spray volume and limited knowledge of performance and impact under Canadian forest conditions have all been identified as obstacles to gaining acceptance by Canadian regulatory agencies and bodies (Webb, 1978). Consequently, in view of the successful results obtained recently with split applications of SEVIN-4-OIL® at relatively low dosage rates in Maine, an experimental split application was planned for New Brunswick in 1980, with a view to overcoming some or all of the aforementioned obstacles. The experimental design originally called for a split application of SEVIN-4-OIL®, but because of the low dosage (280 g (AI)/ha) and emission (1.46 l/ha) rates, it was necessary to use a different formulation (SEVIN-2-OIL®) containing 2, rather than 4, pounds of carbaryl insecticide per U.S. gallon.

The Environmental Impact Section of the Forest Pest Management Institute conducted a number of studies on the environmental effects of this experimental application, the results of which are reported here.

SITE DESCRIPTION

Environmental impact studies were conducted in a 400 ha spray block located in an old cut-over area approximately 65 km southeast of the town of Allardville in Gloucester County, New Brunswick (Figure 1). The nearest operational spray blocks were located about 5 km to the west and 6.5 km to the southeast, and the nearest experimental block was 1.7 km to the northeast.

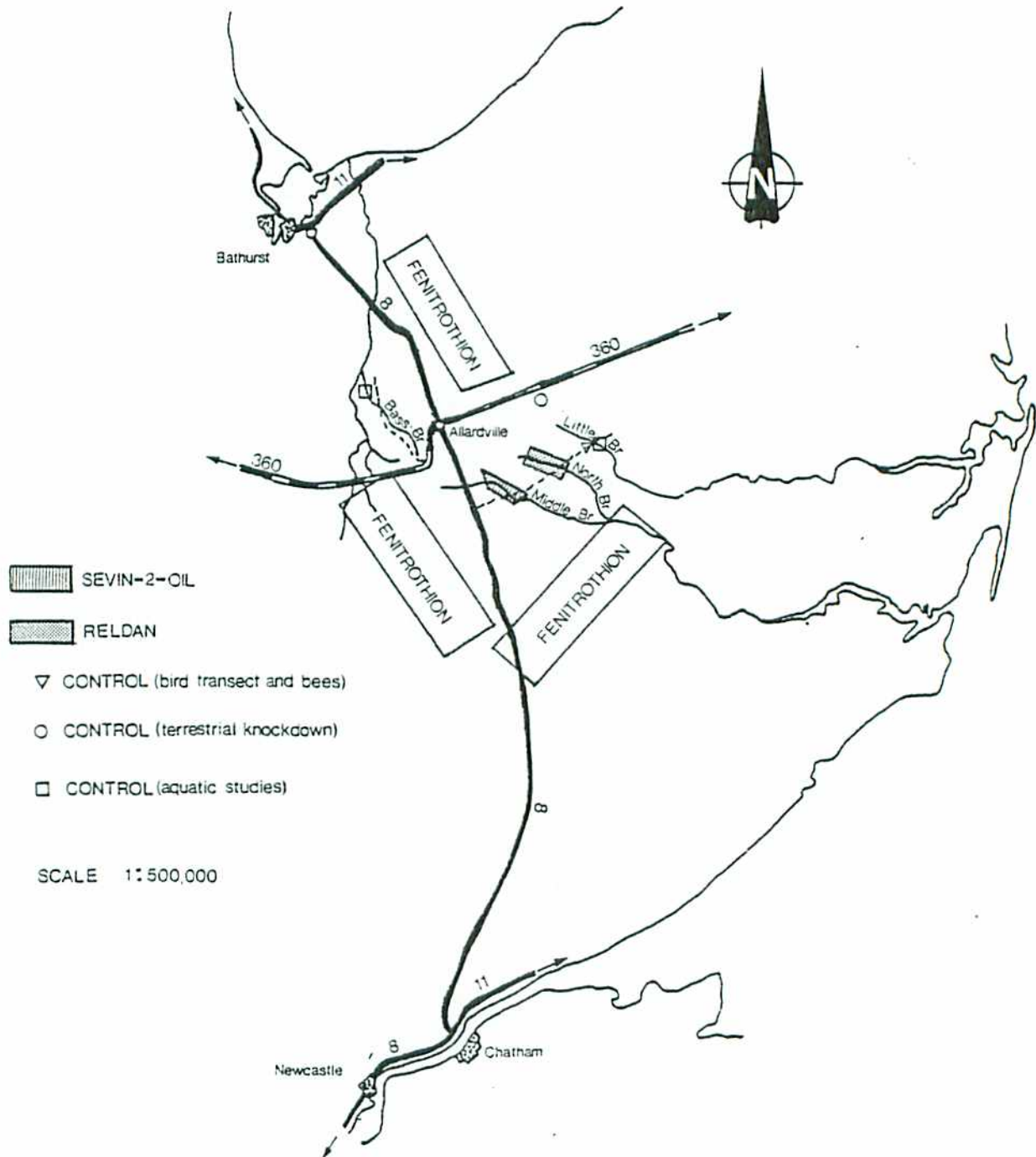


Figure 1. Location of spray blocks, Gloucester County, New Brunswick 1980.

Terrestrial impact studies were conducted along a gravel fire road which transected the southeastern end of the spray block (Figure 2). Fourteen vegetation survey points were located at 120 m intervals along this transect, 60 m on either side of the road. The predominant species present and their relative abundances at these survey points were considered to be fairly indicative of the vegetative complex of this portion of the block as a whole (Table 1). In general, the forest stand within the spray block was mixed and fairly open, with canopy cover provided primarily by immature second growth trees. Mature trees were uncommon and restricted for the most part to the uncut stream valley.

The control area for songbird and pollinator studies was located about 6 km east of the spray block on the same road (Figure 1). Vegetation was surveyed in the same manner as described above. This area was generally quite similar to the spray block (Table 2), with the exception of a small boggy area and a small clearcut which were located at the extreme eastern and western ends of the transect respectively. The control area for terrestrial invertebrate knockdown studies was located about 500 m south of Highway 360, 7.7 km east of Allardville (Figure 1).

Within the spray block, aquatic impact studies were conducted in Middle Brook, a small headwater trout stream approximately 3-6 m wide and 10-50 cm deep, with a rocky bottom and a moderate current. Discharge measurements taken on 8 June and 24 June were 0.07 m³/sec and 0.09 m³/sec respectively. Balsam fir, *Abies balsamea* Mill., white spruce, *Picea glauca* (Moench) Voss, sugar maple, *Acer saccharum* Marsh., red maple, *Acer rubrum* L., mountain maple, *Acer spicatum* Lam., yellow birch, *Betula lutea* Michx., black ash, *Fraxinus nigra* Marsh., speckled alder, *Alnus rugosa* (Du Roi) Spreng., smooth alder, *Alnus serrulata* (Ait.) Willd., red osier, *Cornus stolonifera* Michx., raspberry, *Rubus* sp. L. and ferns were all common along the stream, and provided between 50 and 75% stream cover.

Two streams, Bass Brook and Little Brook, were used as controls for the aquatic studies. Bass Brook is 2-4 m wide, 10-40 cm deep, and has a rocky bottom and moderate current. Discharges on 8 June and 15 June were 0.12 m³/sec and 0.14 m³/sec respectively. Stream cover was provided by white cedar, *Chamaecyparis thyoides* (L.) BSP., balsam fir, white spruce, red, sugar and mountain maple, yellow birch, white birch, *Betula papyrifera* Marsh., black ash, mountain ash, *Sorbus americana* Marsh., speckled alder, smooth alder, willow, *Salix* sp. L., grape, *Vitis* sp. L., and ferns. Little Brook is 3-5 m wide, 15-60 cm deep, and has a moderate current and rock and gravel bottom. Discharge on 8 June was 0.13 m³/sec. The most common species found along this stream included balsam fir, white spruce, black spruce, *Picea mariana* (Mill.) BSP., white pine, *Pinus strobus* L., white birch, red, sugar and mountain maple, speckled alder and common elder, *Sambucus canadensis* L.

Water quality parameters for Middle and Bass Brooks are summarized in Table 3.

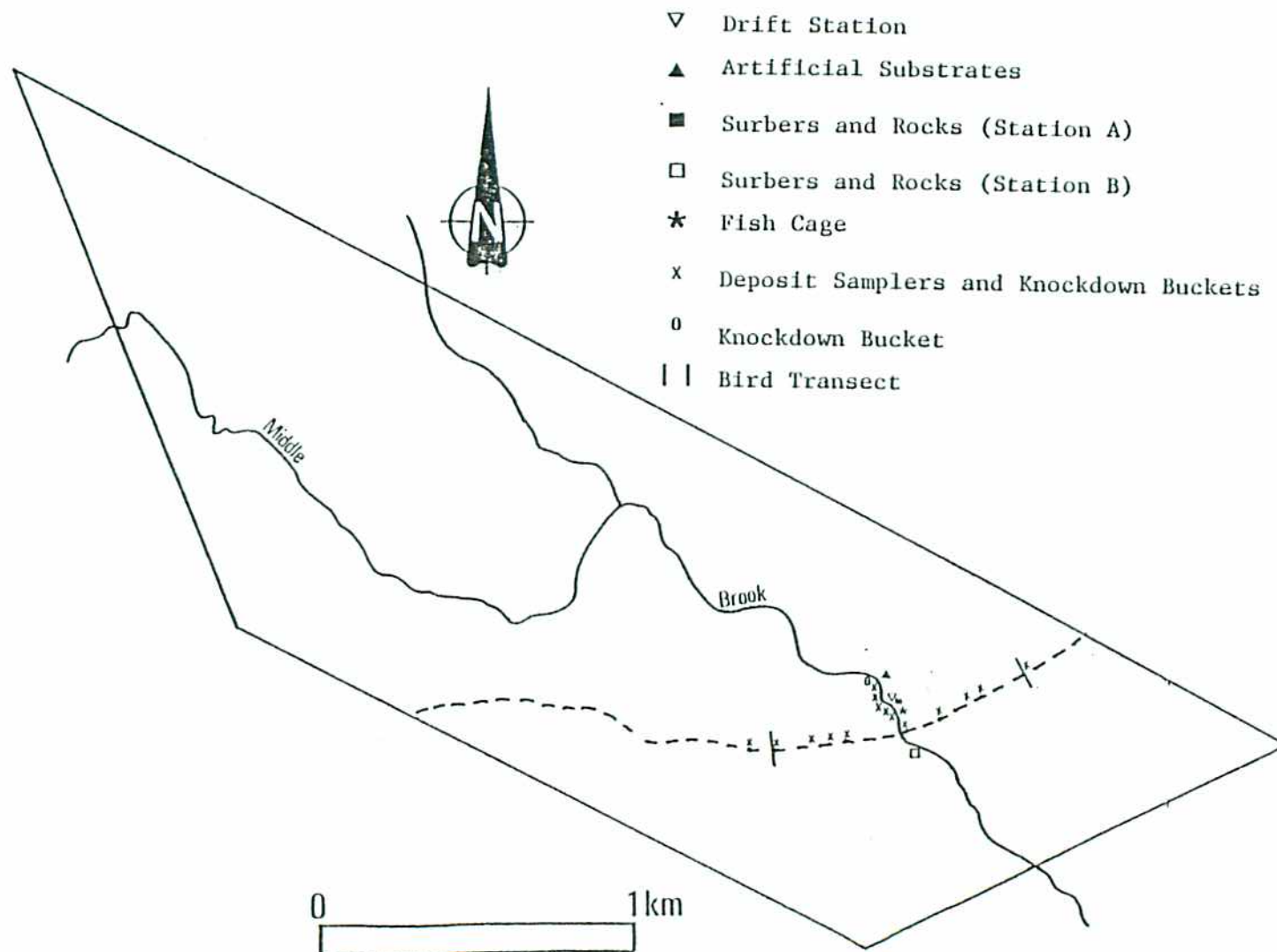


Figure 2. Location of sampling stations in SEVIN-2-OIL spray block, Gloucester County, New Brunswick 1980.

Table 1. Relative abundance of predominant plant species in the SEVIN-2-OIL spray block, Gloucester County, New Brunswick 1980.

Overstory			Understory		
	Major Species	Percent		Major Species	Percent
White spruce	<i>Picea glauca</i> (Moench) Voss	37.3	Balsam fir	<i>Abies balsamea</i> (L.) Mill.	30.9
Red maple	<i>Acer rubrum</i> L.	28.7	Pin cherry	<i>Prunus pensylvanica</i> L.	11.6
White birch	<i>Betula papyrifera</i> Marsh.	16.0	White birch	<i>Betula papyrifera</i> Marsh.	10.0
Balsam fir	<i>Abies balsamea</i> (L.) Mill.	10.4	Red maple	<i>Acer rubrum</i> L.	9.8
Pin cherry	<i>Prunus pensylvanica</i> L.	4.2	Mountain maple	<i>Acer spicatum</i> Lam.	9.7
Yellow birch	<i>Betula lutea</i> Michx.	1.9	Smooth alder	<i>Alnus serrulata</i> (Mill.) Willd.	9.0
Poplar	<i>Populus tremuloides</i> Michx.	1.4	Speckled alder	<i>Alnus rugosa</i> (Du Roi) Spreng	3.3
White pine	<i>Pinus strobus</i> L.	0.1	Willow	<i>Salix</i> L.	1.2
			White spruce	<i>Picea glauca</i> (Moench) Voss	1.2
			Poplar	<i>Populus tremuloides</i> Michx.	1.0

Percent cover of overstory = 26.3%

Percent cover of understory = 56.5%

Table 2. Relative abundance of predominant plant species in the control area, Gloucester County, New Brunswick 1980.

Overstory			Understory		
	Major Species	Percent		Major Species	Percent
Red maple	<i>Acer rubrum</i> L.	32.7	Balsam fir	<i>Abies balsamea</i> (L.) Mill.	43.9
White birch	<i>Betula papyrifera</i> Marsh	18.0	Red maple	<i>Acer rubrum</i> L.	11.3
Black spruce	<i>Picea mariana</i> (Mill.) BSP	15.4	Black spruce	<i>Picea mariana</i> (Mill.) BSP	11.1
White spruce	<i>Picea glauca</i> (Moench) Voss	14.5	White birch	<i>Betula papyrifera</i> Marsh.	10.0
White pine	<i>Pinus strobus</i> L.	7.7	White spruce	<i>Picea glauca</i> (Moench) Voss	9.1
Yellow birch	<i>Betula lutea</i> Michx.	7.3	Rhodora	<i>Rhodora canadense</i> (L.) Torr.	4.7
Beech	<i>Fagus grandifolia</i> Ehrh.	1.8	Pin cherry	<i>Prunus pennsylvanica</i> L.	2.3
Balsam fir	<i>Abies balsamea</i> (L.) Mill.	1.3	Yellow birch	<i>Betula lutea</i> Michx.	1.0
Pin cherry	<i>Prunus pennsylvanica</i> L.	0.7	Speckled Alder	<i>Alnus rugosa</i> (Du Roi) Spreng	1.0
Hemlock	<i>Tsuga canadensis</i> (L.) Carr.	0.6	Spiraea	<i>Spiraea</i> sp.	0.7
Percent cover of overstory = 36.5%			Percent cover of understory = 48.1%		

Table 3. Water quality parameters* in study streams, Gloucester County, New Brunswick,
31 May-1 August 1980.

Sampling Station	Date	Temperature (°C)	pH	Dissolved O ₂ (mg/l)	Hardness (gpg CaCO ₃)	Alkalinity (gpg CaCO ₃)
Middle Brook Station A	31/5/80	10.5	7.0	10	-	-
	21/6/80	11.0	7.5	9	4	-
	27/6/80	16.5	7.0	8	3	-
	1/8/80	16.5	6.5	8	2	1
	Station B					
	2/6/80	11.5	7.0	10	-	-
	21/6/80	11.0	7.5	9	6	-
	27/6/80	16.5	7.0	8	3	-
	1/8/80	15.5	6.5	8	2	1
Bass Brook Control	31/5/80	8.5	7.5	11	-	-
	21/6/80	12.0	7.0	9	6	-
	26/6/80	14.5	7.5	9	4	-
	1/8/80	16.0	7.0	7	3	1

* determined using a Hach Kit, Model AL-36B

METHODS

INSECTICIDE FORMULATION AND APPLICATION

SEVIN-2-OIL® was applied twice to the 400 ha spray block, with a 6 day interval between applications, at a dosage rate of 280 g (AI)/ha in 1.46 l/ha of oil solution. A small amount of Automate B red dye was added to the formulated spray mixtures to facilitate deposit assessment so that the final composition of each spray mixture was as follows:

473.2 l	SEVIN-2-OIL® (240 g (AI)/l) ¹	80% by volume
106.4 l	Insecticide Diluent 585 ²	18% by volume
11.8 l	Automate B red dye ³	2% by volume

Application was carried out using a Cessna Agtruck equipped with 4 AU 3000 Micronair® atomizers and flying at a speed of 160 km/hr, 25-30 m above ground level. Spraying commenced at 0542 Atlantic Daylight Time (ADT) on 11 June 1980 with the plane making its initial pass along the northeast edge of the block. Subsequent swaths were alternately from northwest to southeast and from southeast to northwest along parallel lines 60 m apart progressing toward the southwest edge of the block. The last pass of the first application was at 0653 ADT. The second application began at 0758 ADT and ended at 0903 ADT on 17 June 1980. The same basic flight plan was followed. Meteorological measurements taken just outside the spray block on the mornings of application are summarized below:

	First Application	Second Application
Temperature (°C)	4.5	11.5
Relative Humidity (%)	100	64
Inversion	+	+
Wind Speed (km/hr)	0-3	0-3
Wind direction	SW	NW
Cloud Cover (%)	100	10

¹ Union Carbide Corporation, Jacksonville, Florida

² Shell Canada Ltd., Toronto, Ontario

³ Morton Williams Ltd., Ajax, Ontario

DEPOSIT MEASUREMENT

Deposit samplers consisted of two 11 x 16 cm stainless steel plates attached along one edge with duct tape. One plate was covered with a 10 x 10 cm Kromekote® paper card. Sampling stations were located just off the road and along the treatment stream (Figure 2). At each road station samplers were held approximately 1 m off the ground on aluminum stakes. Two samplers were located at each stream station, one on the top of a 1 m aluminum stake near the middle of the stream and the other on a 30 cm stake on the stream bank.

A NCR microcard reader was used to count droplets deposited on Kromekote® cards and a drop density value (drops/cm²) was calculated for each card. Deposit on plates not covered by Kromekote® cards was estimated by colorimetry. Each plate was washed with a small constant volume of toluene and the quantity of dye rinsed off was measured using a Bausch and Lomb Spectronic 100 spectrophotometer. This was compared with a reference standard from the original spray formulation.

TERRESTRIAL STUDIES

Terrestrial Invertebrate Knockdown

Terrestrial invertebrate knockdown was monitored by collecting invertebrates in 39 x 33 x 15 cm deep plastic wash buckets. Twenty buckets were placed under balsam fir, 10 in the treatment plot and 10 in the control area. Treatment buckets were distributed along the bird transect (Figure 2) in order to sample a number of swaths over the study area. Another 10 buckets (5 treatment, 5 control) were placed under typical stream cover (speckled alder) to measure knockdown into the stream. Organisms were collected in the evening from 7 June to 23 June, and transferred directly into vials containing a 30% methanol solution. A separate vial was kept for each bucket. Collections were later identified in the lab.

Insect Pollinators

Caged Bees

Screened exposure cages with individual compartments were used to hold wild bees (Table 4) for tests of contact toxicity. Cages were set on the ground in the open, one cage in the treatment block and another in the untreated control area, immediately before spraying began and were picked up 1 hour after treatment was completed. Bees were fed a 50% sugar solution and inspected daily for 10 days after the first application and 7 days after the second application. A record was kept of bee mortality/survival each day. All specimens were pinned for later identification.

Table 4. Tentative identifications of bee species from exposure cages.

Treatment			Control	
<u>First application</u>	<u>Species that died</u>	<u>Date of mortality</u>	<u>Species that died</u>	<u>Date of mortality</u>
	<i>Psithyrus</i> sp. (1)	21 June	<i>B. vagans</i> (1Q)* <i>Psithyrus</i> sp. (1)	14 June 21 June
	<u>Species that survived to end of experiment</u>		<u>Species that survived to end of experiment</u>	
	<i>Bombus vagans</i> Smith (1Q)		<i>B. vagans</i> (4Q and 1W)**	
	<i>Psithyrus</i> sp. (6)		<i>Psithyrus</i> sp. (3)	
	<i>Bombus ternarius</i> Say (1Q)		<i>B. ternarius</i> (1Q)	
	<i>Bombus fervidus</i> Fabricius (1Q)		<i>B. fervidus</i> (1Q)	
	<i>Bombus borealis</i> Kirby (1Q)		Andrenidae (1)	
<u>Second application</u>	<u>Species that died</u>	<u>Date of mortality</u>	<u>Species that died</u>	<u>Date of mortality</u>
	<i>B. ternarius</i> (1Q)	17 June	<i>B. vagans</i> (2Q)	21 and 23 June
	<i>Psithyrus</i> sp. (1)	27 June	<i>B. terricola</i> (1Q and 1W)	23 and 24 June
	<u>Species that survived to end of experiment</u>		<u>Species that survived to end of experiment</u>	
	<i>B. ternarius</i> (4Q)		<i>B. ternarius</i> (3Q, 1W)	
	<i>B. vagans</i> (4Q)		<i>B. vagans</i> (4Q, 1W)	
	<i>Psithyrus</i> sp. (2)		<i>B. terricola</i> (2Q, 2W)	
	<i>Bombus terricola</i> Kirby (1Q and 2W)			
	<i>B. borealis</i> (1Q)			

*Q: queen

**W: worker

Seed set in *Clintonia*

To study the effect of the insecticide on natural pollinators, seed set in *Clintonia borealis* (Ait.) Raf. was compared before and after treatment. For prespray samples, *Clintonia* plants with open flowers were tagged 5 days before treatment. As *Clintonia* is receptive for about 3 days (Thompson, pers. comm.), pollination of these flowers occurred prior to the first spray application. Plants still in bud 2 days after the first and second applications were tagged as 'Post-spray 1' and 'Post-spray 2' samples, respectively. Samples were spread over a number of different sites to ensure that variation was not due to habitat differences:

Number of sites collections were made from:

	Treatment Sites	Control Sites
Pre-spray	25	16
Post-spray 1	10	9
Post-spray 2	14	15

After subsequent observations, it was obvious that the plants would have to be covered to protect them from herbivores. This also enabled collection of fruits at the end of the study without losing those fruits which ripened early and fell off the plants. Calculations were made using bagged fruits only, as it was difficult to determine the number of fruits lost from the unbagged plants. Mesh bags were placed over the inflorescence when the plants were no longer receptive (at abscission of the petals). The fruit was collected a month later (30 and 31 July) and preserved in the field with Romeis's Formyl Acetic Acid (Gray 1973). Samples were dissected in the lab and the number of fertilized and unfertilized ovules were recorded for each sample. The percent seed set was calculated by using the formula $\frac{100K}{N}$ where K is the number of fertilized ovules or seeds and N is the number of fertilized plus unfertilized ovules (Plowright and Rodd, 1980). A mean value of percent seed set was calculated for the pre-spray and both post-spray samples.

Birds

Forest songbirds were censused along an 840 m transect running across the block, using a singing male technique similar to that described by Kendeigh (1947). Flags were stationed every 2 chains along the road running through the treatment block, and all birds seen or heard on either side of the road were recorded on census maps in relation to these markers. The majority of birds recorded were within 80 m of the road, but some individuals of species with loud songs were recorded up to

140 m from the road. Censuses were conducted simultaneously in the control area along a transect of the same length.

Censuses were conducted daily during the first few hours of light, and were usually completed within 1 hour. All birds were identified to species, sex and type of activity at the time of record. Male birds vocally defending a territory were assumed to be mated and recorded as 2 birds; all others (non-singing, sighted, females or immatures) were recorded as one.

Daily census maps were compiled for each species over the pre-spray and post-spray periods to delimit boundaries of breeding territories. A territory was designated to be an area vocally defended for a minimum of 2 days during any one time period. The number of birds observed during each census was used to indicate activity trends and relative abundance in each area.

Extensive plot searches were conducted on the treated block immediately following, and for 3 days after, each application to check for birds exhibiting signs of pesticide stress. Efforts were concentrated in areas of possible double swathing.

Meteorological measurements, including wind speed and direction, temperature, relative humidity, cloud cover and precipitation, were taken at the beginning and end of each census to differentiate the effects of weather on songbird activity.

AQUATIC STUDIES

Insecticide Residues

Water

Carbaryl residues were measured in samples of water collected from the treatment stream 0.15 hour, 0.5, 1, 1.5, 2, 3, 5 h, 1 day, 2, 3, 4 and 5 d after the first application, and 0h, 0.5, 1, 1.5, 2, 3, 4 h, 1 d, 2, 3, 4, 5, 6, 7, 8, 9 and 10 d after the second application. Water samples were taken from the top 1 cm of the flowing portion of the treatment stream and packed in ice in styrofoam coolers where they were held for no longer than 6 hours before extraction. With minor modifications the procedures used for extraction and analyses of carbaryl residues were similar to those described by Sundaram, Szeto and Hindle (1979). Carbaryl was extracted from the water samples by percolation through a column of Aberlite XAD-2, followed by elution with ethyl acetate. Carbaryl residues were directly analyzed by GLC with a Hewlett Packard Model 7610 gas chromatograph equipped with a nitrogen-phosphorus detector.

Fish

Tissues of brook trout (*Salvelinus fontinalis* Mitchill) and slimy sculpins (*Cottus cognatus* Richardson) collected from the treatment stream 11 days before and 1 day after the first application, and 3, 9 and 47 days after the second application were examined for residues of carbaryl. All fish collected for residue analyses were frozen whole immediately after capture and removal of their stomachs for diet studies. An attempt was made to collect 4 brook trout of approximately the same size on each date and these were analyzed individually (Table 10), but because of the smaller size of sculpins it was often necessary to pool 2 or more together to make up a minimum required weight of 5 g. Carbaryl residues were extracted from the fish tissues and analyzed according to the methods of Szeto and Sundaram (1980). Fish tissues were first homogenized in ethyl acetate and the interfering co-extractives present in these crude extracts were removed by filtration through Whatman GF/A glass microfibre filters after coagulation. The carbaryl residues were then re-extracted into dichloromethane and directly analyzed intact by GLC as described for stream water.

Drift

Aquatic invertebrate drift was monitored before and after the insecticide application. At the treatment (Middle Brook) and control (Bass Brook) sampling stations, drift samples of 15 minutes duration were taken each morning and evening between 2 and 22 June (from 9 days before the first to 5 days after the second application) using a standard 0.47 x 0.032 m drift net with a No. 54 (363 μ m) mesh. Additional drift samples were taken on spray days to document any immediate effects of the insecticide applications. Drift nets were placed in the streams to sample a column of water from surface to bottom, including the surface film. Current speed was measured at the opening to each drift net half-way between the surface and bottom using a Teledyne Gurley No. 625 Pygmy Current Meter. Using the above information, the following were calculated:

depth at station (m) x width of drift net opening (m)
x current velocity (m/sec) x duration of drift sample
(sec) = m^3 of water in drift column

width of drift net opening (m) x current velocity
(m/sec) x duration of drift (sec) = m^2 of surface
area of drift column

All drift samples were sorted within 24 hours and the organisms preserved in a 30% methanol solution. Organisms were later counted and identified to order or family under a dissecting microscope and the results expressed as:

number of organisms/m³ of water in drift column (aquatic organisms)

number of organisms/m² of surface area of drift column (terrestrial organisms)

Artificial Substrates

Artificial substrates consisted of 1 ± 0.02 kg of crushed rock (13-19 mm screen size) tightly wrapped in nylon seine netting (3 x 7 mm aperture size). Three weeks before the first planned sampling date, enough samplers for 5 replicates on each of 4 sampling dates were placed in the treatment (Middle Brook) and control (Bass Brook) streams. Artificial substrates were collected before and after the insecticide applications. Aquatic organisms were separated from other materials in the samples by hand sorting in the field and were preserved in a 30% methanol solution. Organisms were later counted and identified to order or family under a dissecting microscope.

The mean number of organisms in each taxon on each sampling date was compared within each stream using Student-Newman-Keuls multiple range test ($\alpha = 0.05$). A $\log x + 1$ transformation was used on the raw data to help meet the assumptions of this test (Elliott, 1977).

Surber and Rock Sampling

Surber and rock samples were collected before and after the insecticide applications from 2 dissimilar riffle areas in the treatment stream (Middle Brook Stations A and B) and from a riffle area in the control stream (Bass Brook). The major difference between the 2 treatment stations was that the stream bottom at Station A was almost completely covered with moss, whereas very little aquatic vegetation was present at Station B. Different areas within the same riffle were sampled throughout the season at each site. Samples were handled and the data statistically analysed in the same way as for artificial substrates.

Caged Fish

Six days before the first application 25 wild brook trout were placed in cages in both the treatment (Middle Brook) and the control (Little Brook) streams. Cages measured 61 x 61 x 46 cm high, had plywood tops and bottoms and were covered on all 4 sides with 13 mm square screening. Although it was originally intended to use fish native to each stream in the caging study, it was not possible to capture the 25 brook trout required in Middle Brook, and consequently all fish caged in this stream had to be collected and transported from Little Brook. Mean fork lengths of caged fish were as follows:

	Mean Fork Length (mm)	Range
Middle Brook Treatment	122.0	94-165
Little Brook Control	122.8	101-184

Cages were checked periodically for mortality and fish exhibiting unusual behavior or symptoms of pesticide poisoning.

Fish Diets

A minimum of 10 brook trout and/or 10 slimy sculpins were collected by electrofishing on each sampling date before and after the insecticide applications, and dissected for analysis of stomach contents. Both brook trout and sculpins were collected from Middle Brook (Treatment) and Little Brook (Control) but only brook trout were collected from Bass Brook (Control). Fork length and weight were recorded for each fish caught (Appendix 5: Tables 1-5) and condition coefficients were calculated for brook trout using Fulton's formula ($K = \text{weight} \times 10^5 / \text{length}^3$). Stomachs were excised and preserved immediately in a 10% solution of formaldehyde. In the laboratory, the volume of the stomach contents was measured and the composition of food items determined. In measuring the volume of the stomach contents, the amount of indigestible material present was estimated and the measured volume corrected accordingly so as to represent actual volume of food items.

RESULTS

DEPOSIT

Deposit results are summarized in Table 5. Approximately the same volume of spray products was deposited at Middle Brook Station A from each application. Mean drop density was considerably higher for the first spray however, and for each application drop density on instream samplers was greater than on stream-bank samplers. Deposit along the road was more than 3 times greater for the first spray than for the second spray, both in terms of volume deposited and drop density.

TERRESTRIAL STUDIES

Terrestrial Invertebrate Knockdown

Knockdown from balsam fir was generally light (Figure 3). Effects of the first application were immediate and lasted for 2 days. The second application had both an immediate and a delayed effect, with the combined effect lasting for 3 days. Organisms collected from treatment buckets 5 days after the first application were drowned due

Table 5. Deposit assessment summary from the SEVIN-2-OIL treatment block*, sprayed 11 and 17 June, 1980, Gloucester County, New Brunswick.

		No. of deposit samplers	Mean drop density ₂ drops/cm	Mean volume deposited l/ha	Mean % of emitted volume recovered
First Application	Instream	6	12.12		
	Streambank	6	10.85	0.26	17.8
	Road	10	23.78	0.42	28.8
Second Application	Instream	6	5.17		
	Streambank	6	3.29	0.27	18.5
	Road	10	7.56	0.12	8.2

*spray emission rate of 1.46 l/ha

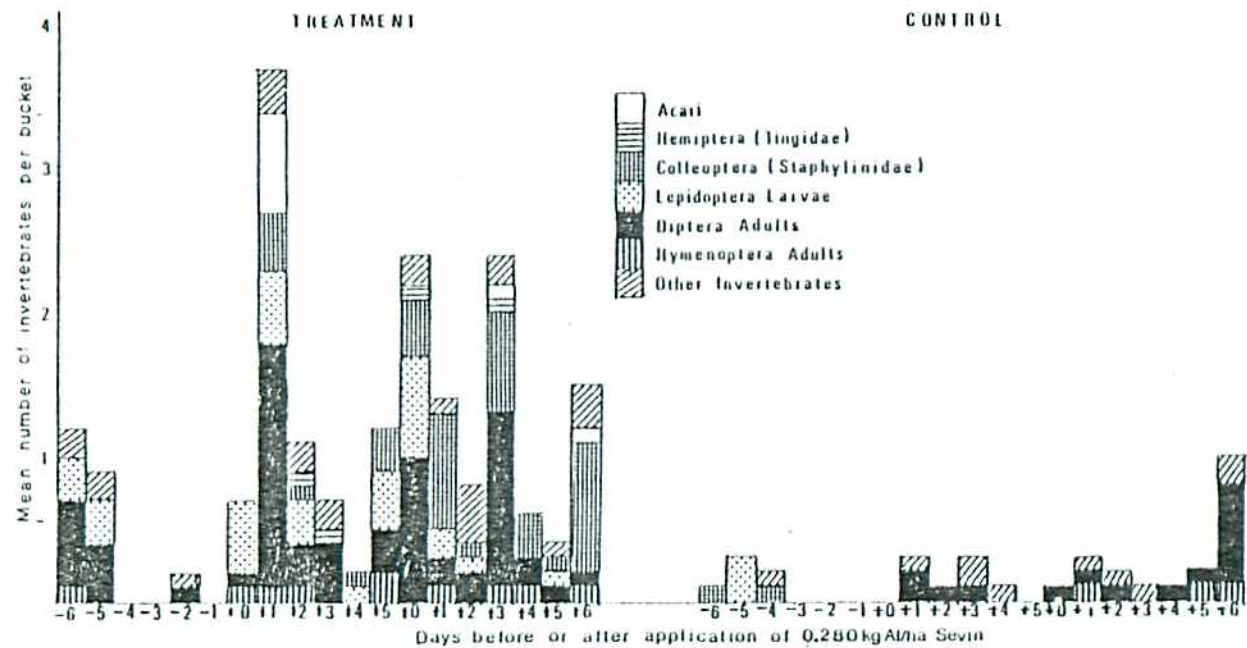


Figure 3. Terrestrial invertebrates collected from buckets placed under balsam fir, Gloucester County, New Brunswick 1980.

to heavy rainfall. Although a fairly large knockdown was indicated 6 days after the second application, a comparable increase was observed on control.

Adult Diptera, Lepidoptera larvae and Staphylinidae (Coleoptera) were affected immediately. The effect on Diptera was not confined to any particular family, but numbers of Sciaridae were proportionally large (Appendix 1: Table 1). Although knockdown of Lepidoptera was less pronounced, the magnitude of increase was not indicative of the actual effect, as the post-spray specimens were found curled or weak, while the pre-spray specimens were quite active. Knockdown of Tingidae (Hemiptera) was delayed following the first application, but was immediate after the second application. Although a delayed effect was also indicated for Acari, these were probably parasitic mites found in association with the beetles collected, and therefore, not directly related to the application.

Knockdown from stream bank vegetation was more pronounced, but similar in trends to that observed on balsam fir. Effects of the spray were still evident 1 day after the first application and 2 days after the second application (Figure 4). Large numbers of Diptera collected 5 days after the second application were probably not pesticide-related, as the numbers collected on the previous day were very low.

Knockdown of adult Diptera, Lepidoptera larvae, adult Hymenoptera and Plecoptera was immediate. Diptera were most affected with increases in all families recorded, but primarily Chironomidae and Sciaridae (Appendix 1: Table 3). Increases were also noted for Chironomidae and Sciaridae in the control area (Appendix I: Table 4), but these generally occurred before the spray. Knockdown of Lepidoptera larvae involved Tortricidae and to a lesser extent Geometridae. Knockdown of Hymenoptera was very slight. Delayed effects were observed for Trichoptera and Tingidae. Although post-spray collections of both Trichoptera and Tingidae were small, none were collected in the pre-spray period, nor were they collected in the control area.

Insect Pollinators

Caged bees

Caged bees in the treatment block experienced 8% mortality in the 10 days immediately following the first application, and 11% mortality in the 7 days immediately following the second application (Table 6). Mortality rates for control bees were slightly higher (11 and 24% respectively).

The estimated horizontal distance between the caged bees and the closest pass of the spray plane was 28 m for the first application, and 62 m for the second application.

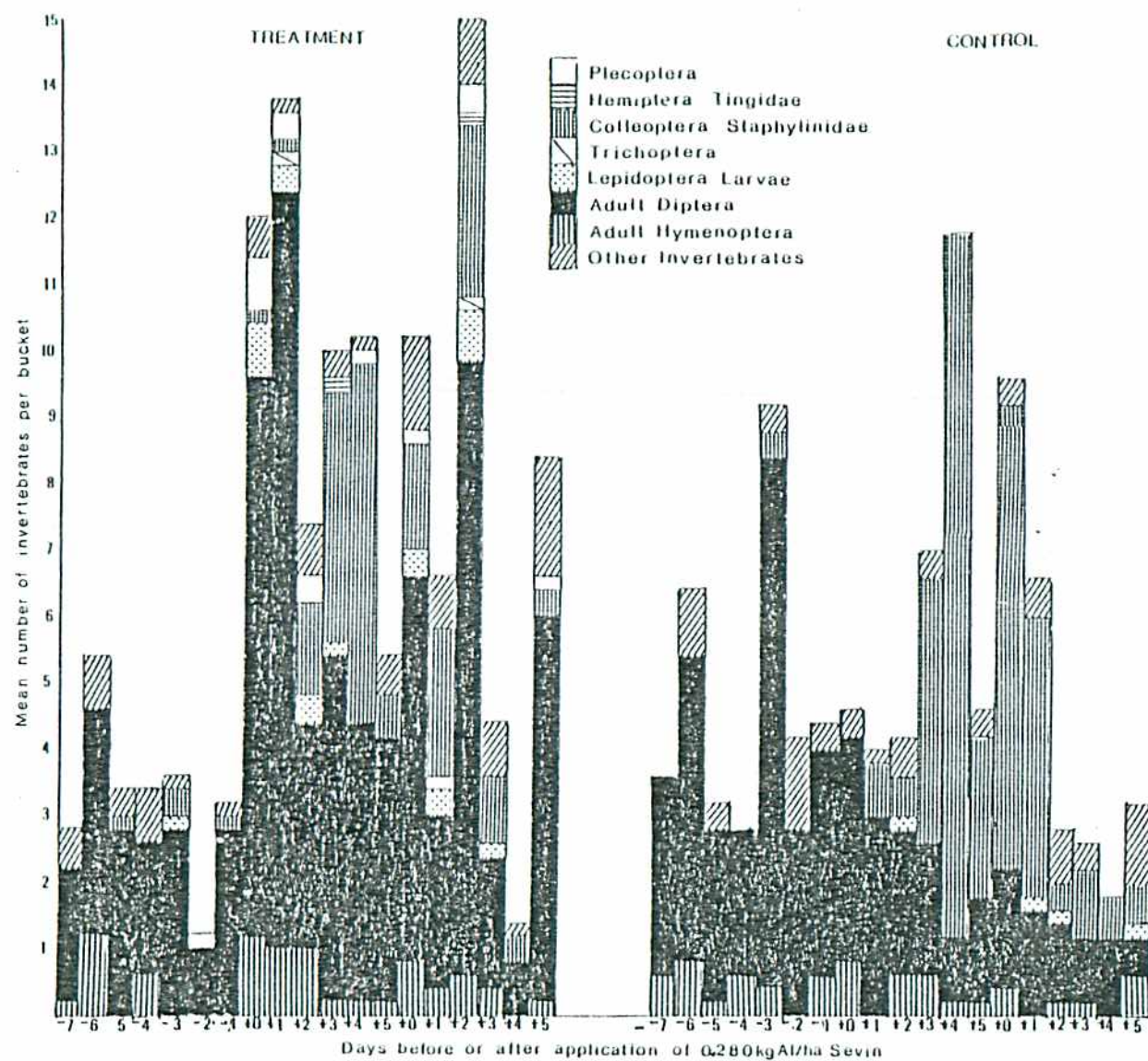


Figure 4. Terrestrial invertebrates collected from buckets placed under typical stream cover, Gloucester County, New Brunswick 1980.

Table 6. Mortality/survival of caged bees, Gloucester County, New Brunswick 1980.

First application												
Day of June	11	12	13	14	15	16	17	18	19	20	21	Percent
Days after the application	0	1	2	3	4	5	6	7	8	9	10	mortality
Treated bees	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13	0/13	1/12	7.7
Control bees	0/13	0/13	0/13	1/12	1/12	1/12	1/12	1/12	1/12	1/12	2/11	15.4
Second application												
Day of June	17	18	19	20	21	22	23	24	Percent			
Days after the application	0	1	2	3	4	5	6	7	mortality			
Treated bees	2/16	2/16	2/16	2/16	2/16	2/16	2/16	2/16	11.1			
Control bees	0/17	0/17	0/17	0/17	1/16	1/16	3/14	4/13	23.5			

Seed Set In Clintonia

The reproductive success of *Clintonia* did not appear to be affected as a result of either SEVIN-2-OIL® application (Figure 5). Seed set in the treatment block was 22.4% higher in plants pollinated after the first application, than in plants pollinated before the first application. Seed set was also higher in control plants after the first application but only by 8.6%. Although seed set was reduced on treatment after the second application, this can hardly be attributed to the insecticide treatment, since a more pronounced reduction was noted on control (4.9% as opposed to 0.6%).

Bumblebees, particularly *Bombus ternarius*, were observed visiting *Clintonia* flowers in the treatment block on several occasions both before and after treatment.

Birds

Within the treatment block, the pre-spray population was estimated to be 165 birds of 32 species (Appendix II: Table 1). The population on control was estimated to be 180 birds of 31 species (Appendix II: Table 2). The census of 10 June was excluded from the data compilation due to the abnormally low numbers of birds censused on that date. These low numbers were attributed to adverse weather conditions.

In general, fluctuations in the total number of birds censused in the treatment area were similar to those exhibited in the control area. There were no missing family groups and no significant reductions in any one family following treatment (Figure 6).

Breeding activities of species potentially at a high risk to insecticide poisoning (due to their feeding niches and to their dependence on insects for food) were not interrupted by the treatments (Table 7). Territorial analyses of these species, and others occupying less exposed niches, (Appendix III: Figures 1-12) indicate that, in general, the number of pre-spray territories and the average number of days the territories were occupied, remained fairly constant during the study period, or exhibited trends similar to those in the control area (Table 8). Possible discrepancies were the solitary vireo and the Swainson's thrush. Activity of the solitary vireo in the control area was much reduced during the second post-spray time period, but individuals in the treatment block continued to actively defend their territories (Appendix III: Figure 3). A similar situation occurred with the Swainson's thrush (Appendix III: Figure 10), where activity during the post-spray time periods increased considerably in the treatment but not in the control areas. There is no indication that these were adverse consequences of treatment however, as the territories were not displaced, which would have been expected if nesting had been

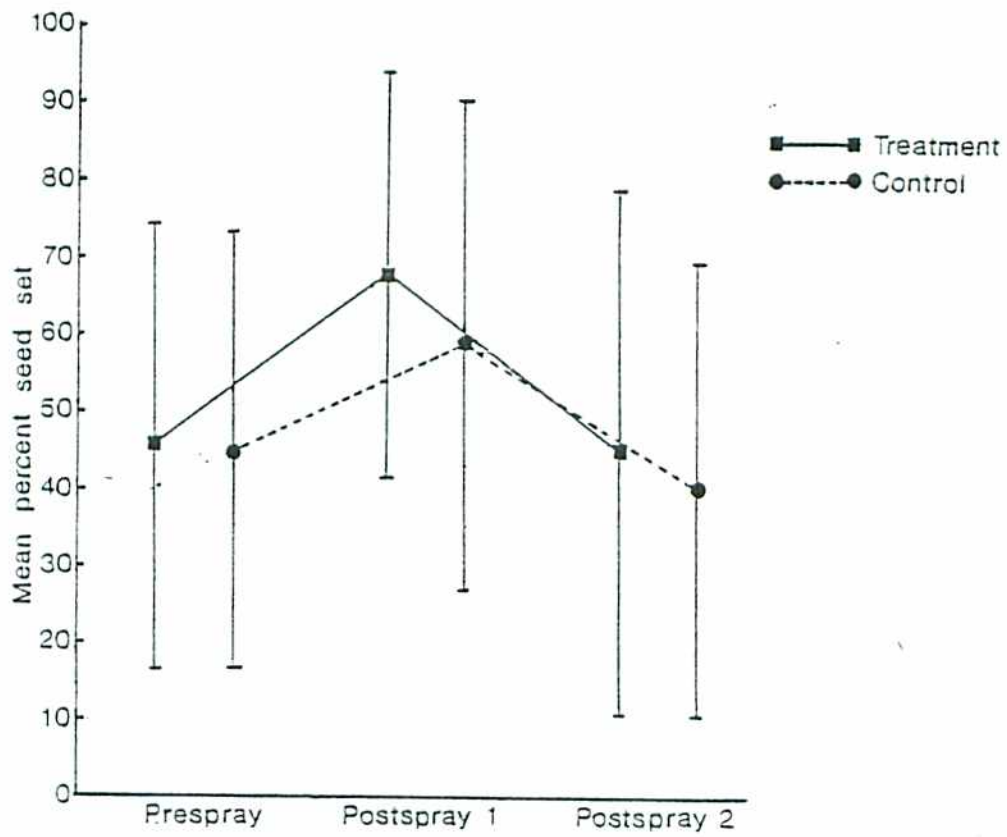


Figure 5. Changes in percent seed set in Clintonia in treatment and control areas, Gloucester County, New Brunswick 1980.

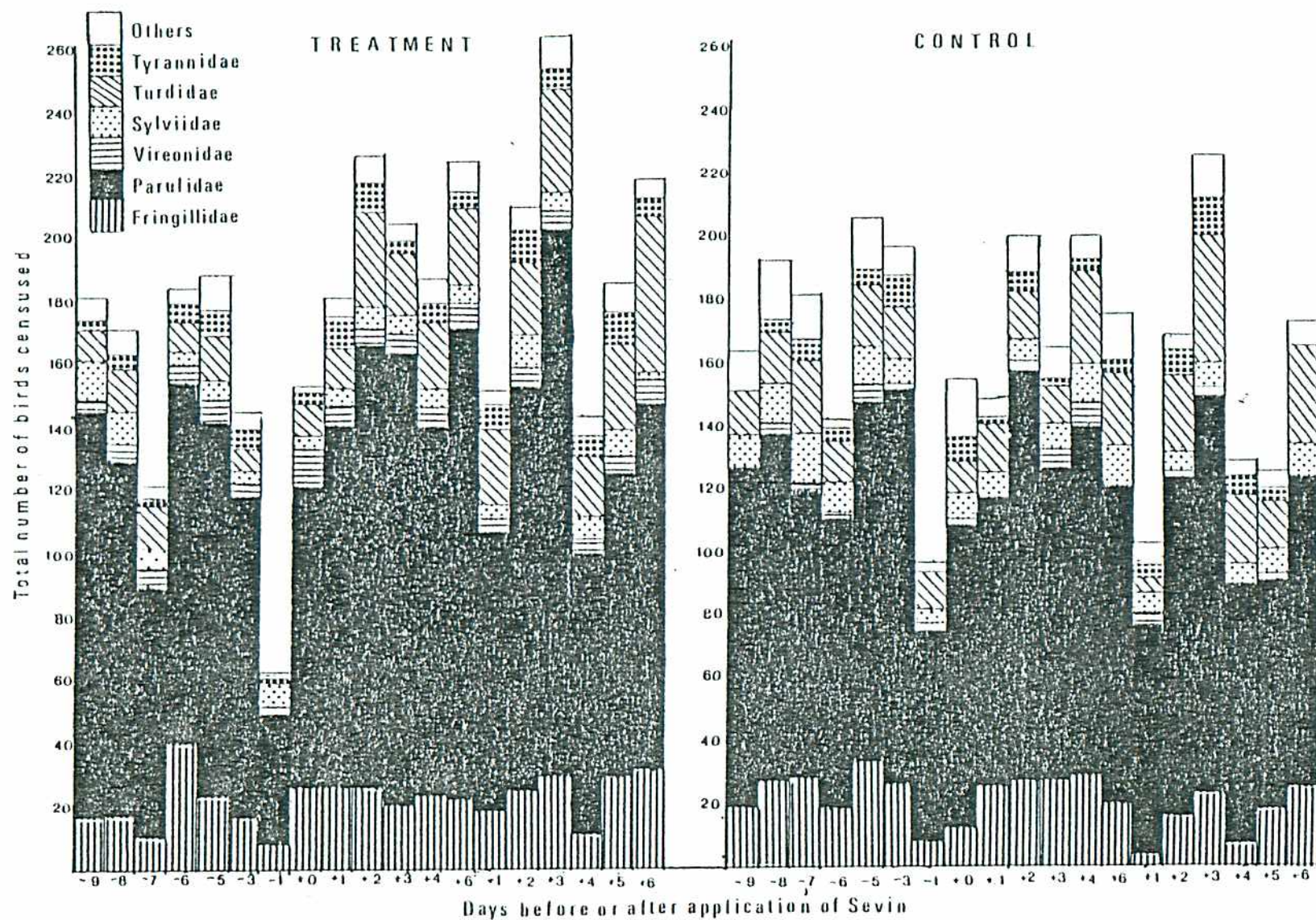


Figure 6. Activity trends of major families of forest songbirds in treatment and control areas, Gloucester County, New Brunswick 1980.

Table 7. Breeding activity^{*} of songbird species with a potentially high risk to insecticide poisoning.

Species	Treatment				Control			
	Pre-spray Avg.	Post-spray 1 Avg.	Post-spray 2 Avg.	Change	Pre-spray Avg.	Post-spray 1 Avg.	Post-spray 2 Avg.	Change
Least flycatcher	2.9	4.0	6.3	+3.4	2.9	3.3	6.3	+3.4
Ruby-crowned kinglet	7.1	4.8	4.7	-2.4	10.1	9.5	7.3	-2.8
Solitary vireo	4.6	7.3	5.3	+0.7	2.9	2.3	1.3	-1.6
Black-throated green warbler	3.7	0.7	4.7	+1.0	7.1	5.7	5.0	-2.1
Blackburnian warbler	7.1	10.3	9.3	+2.2	6.4	5.8	7.3	+0.9
Bay-breasted warbler	8.4	12.8	9.3	+0.9	16.3	14.5	14.1	-2.0
Total change				+5.8				-4.2

* average number of breeding pairs of birds censused per day

Table 8. Changes in the number of territories and the average number of days territories were occupied for several selected species of forest songbirds, Gloucester County, New Brunswick 1980.

	Treatment		Control	
	Number of territories	Average number of days	Number of territories	Average number of days
<u>Feeds in flight</u>				
Least flycatcher	+2	-1	S*	+3
<u>Canopy feeders</u>				
Ruby-crowned kinglet	-2	S	-2	S
Solitary vireo	-2	-4	-1	+1
Blackthroated green warbler	S	-1	-1	+1
Blackburnian warbler	-1	S	+1	S
Baybreasted warbler	-1	-1	+1	S
<u>Shrub Feeders</u>				
Common yellowthroat	-1	-1	S	-1
Tennessee warbler	-1	S	S	+1
Magnolia warbler	+2	-1	S	S
<u>Ground Feeders</u>				
Swainsons thrush	+2	-1	+7	+5
Ovenbird	-1	S	+1	S
Whitethroated sparrow	S	-1	+1	+1

*S = same

disturbed and renesting had occurred. There was an apparent shift in the territories of the blackthroated green warbler following treatment (Appendix III: Figure 4), possibly because the pre-spray territories were not as well established in the treatment area (an average of 3 days in territory) as in the control area (an average of 5 days in territory). Although least flycatcher and common yellowthroat territories also appeared to shift after treatment (Appendix III: Figures 1 and 7), these were really only fluctuations in the activity of individuals within their territories. 'Single records' on the territory maps of these species indicate that the individuals remained in the vicinity of their territories throughout the study. A reduction in the number of ruby-crowned kinglet territories in the treatment block during the first post-spray period (Appendix III: Figure 2) was accompanied by a similar reduction in the control area during the second post-spray period.

Plot searches throughout the block, with concentrated efforts along lines of possible double swathing, did not reveal any sick or dead birds.

AQUATIC STUDIES

Insecticide Residues

The results of analyses of stream water samples from Middle Brook are presented in Table 9. Peak levels of carbaryl in water were measured shortly after each application (313.7 ppb detected 9 minutes after the first treatment and 122.6 ppb detected at the time of the second treatment). Residue levels were reduced by greater than 80% within $\frac{1}{2}$ hour of each application (to 40.0 ppb after the first treatment and 24.0 ppb after the second treatment) and by greater than 90% after 1 day (to 7.2 ppb after the first treatment and 4.4 ppb after the second treatment). Carbaryl residues were still detected (0.9 ppb) 10 days after the second application.

Carbaryl residues were detected in all 4 brook trout (40-46 ppb) and slimy sculpin (24 - 32 ppb) tissue samples collected 1 day after the first application (Tables 10 and 11). Carbaryl residues were not detected (< 20 ppb) 3 days after the second application however, or in either of the 2 later samples.

Aquatic Invertebrates

Drift

Two peaks in aquatic invertebrate drift were observed following the first application of SEVIN-2-OIL® (Figure 7; Appendix IV: Table 1); the first $\frac{1}{2}$ hour after application (approximately 47 times the pre-spray morning average of 1.03 organisms per m^3) and the second $3\frac{1}{2}$ hours later (approximately 71 times the pre-spray morning average).

Table 9. Carbaryl residues in stream water following a double application of SEVIN-2-OIL, Gloucester County, New Brunswick 1980.

	Time after application	Carbaryl (ppb)
First application (280g AI/ha)	0.15 hour	313.7
	0.5 hour	40.0
	1.0 hour	18.7
	1.5 hours	30.2
	2.0 hours	21.2
	3.0 hours	13.3
	5.0 hours	15.1
	1 day	7.2
	2 days	1.5
	3 days	1.0
	4 days	0.6
	5 days	3.4
Second application (280g AI/ha)	0 hour	122.6
	0.5 hour	24.0
	1.0 hour	13.7
	1.5 hours	10.8
	2.0 hours	11.5
	3.0 hours	15.1
	4.0 hours	9.7
	1 day	4.4
	2 days	3.1
	3 days	1.2
	4 days	1.6
	5 days	2.0
	6 days	0.8
	7 days	0.4
	8 days	1.3
	9 days	0.7
	10 days	0.9

Table 10. Residues of carbaryl in brook trout tissues following a double application of SEVIN-2-OIL, Gloucester County, New Brunswick 1980.

Date	Tail length (mm)**	Body weight (g)**	Carbaryl (ppb)
31 May	136	18.9	N.D.
	124	16.9	N.D.
	151	25.5	N.D.
	120	14.9	N.D.
* 12 June	126	17.4	42
	128	18.4	46
	131	19.9	40
	* 139	23.2	40
20 June	136	25.7	N.D.
	130	19.8	N.D.
	128	17.5	N.D.
	132	22.1	N.D.
26 June	134	21.1	N.D.
	135	21.4	N.D.
	136	22.6	N.D.
	143	25.4	N.D.
3 August	134	23.7	N.D.
	170	52.5	N.D.
	98	8.7	N.D.
	96	7.7	N.D.

*application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980

**tail lengths and body weight were measured after fish had been frozen and thawed

N.D. = not detectable (<20 ppb)

Table 11. Residues of carbaryl in slimy sculpin tissues following a double application of SEVIN-2-OIL, Gloucester County, New Brunswick 1980.

Date	Number of Fish Analysed	Tail length (mm)**		Sample Weight (g)**	Carbaryl (ppb)
		Mean	Range		
31 May	2	62.5	52-73	5.3	N.D.
	4	54.3	49-57	6.1	N.D.
* 12 June	1	82.0	-	5.9	25
	2	67.5	67-68	6.6	32
	2	66.5	65-68	5.8	24
	* 2	61.5	60-63	4.9	25
20 June	2	65.5	52-79	5.4	N.D.
	1	84.0	-	5.7	N.D.
	2	66.5	66-67	5.6	N.D.
	3	59.3	58-60	6.5	N.D.
26 June	1	85.0	-	7.2	N.D.
	1	77.0	-	5.3	N.D.
	2	72.5	72-73	7.9	N.D.
	2	65.5	64-67	5.5	N.D.
	1	84.0	-	5.9	N.D.
	2	66.5	66-67	5.8	N.D.
	3	54.7	50-58	5.4	N.D.

*application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980

**tail lengths and sample weights were measured after fish had been frozen and thawed

N.D. = not detectable (<20 ppb)

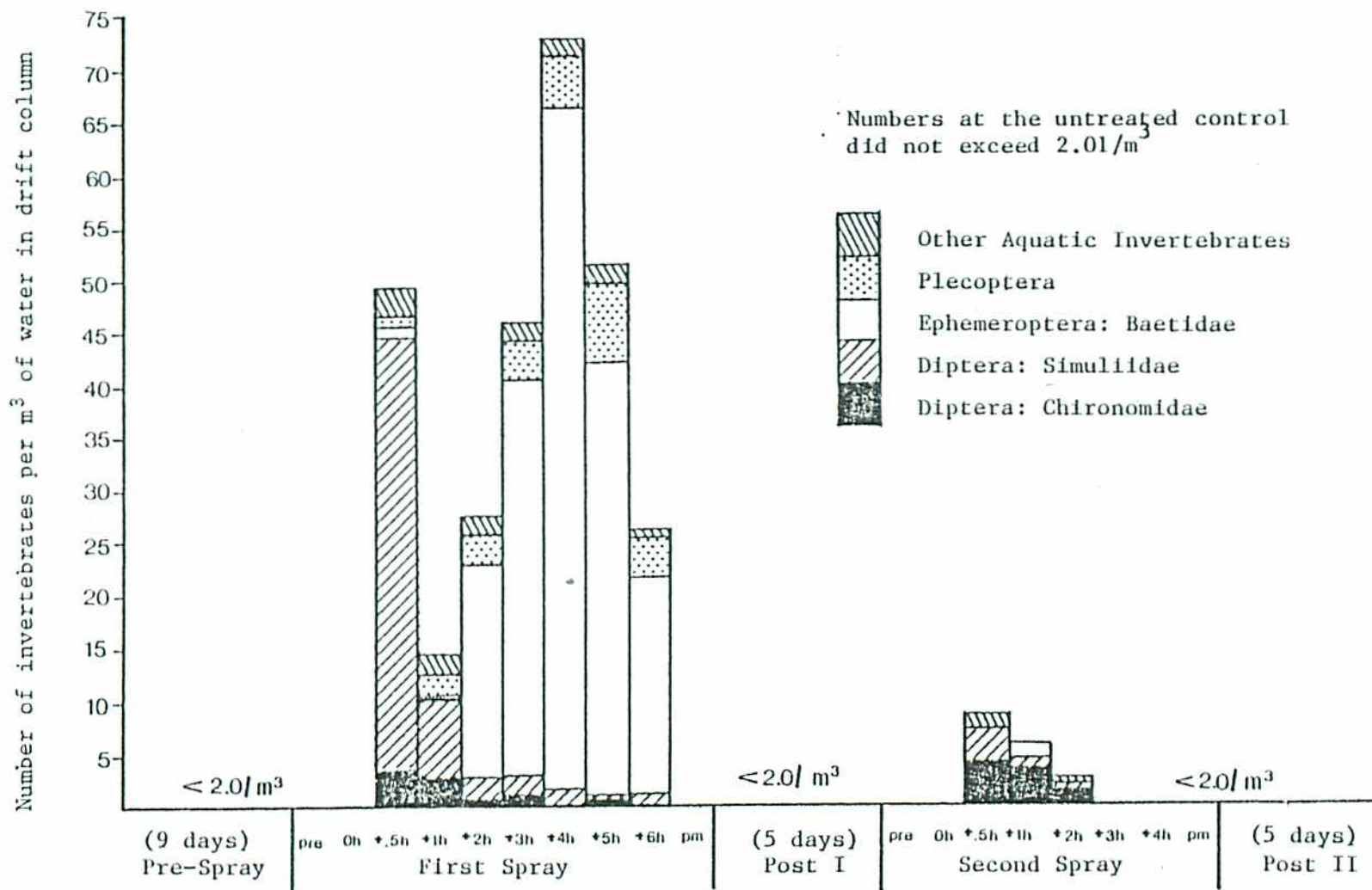


Figure 7. Aquatic invertebrates collected in drift net sets in the treatment stream, Gloucester County, New Brunswick 1980.

Simuliidae and Chironomidae (Diptera) were the most abundant organisms in the first peak making up 83 and 8% of the total respectively. The drift rate for Simuliidae at this time was approximately 145 times greater than the pre-spray morning average of 0.28 larvae per m^3 , and for Chironomidae was approximately 74 times greater than the pre-spray morning average of 0.05 larvae per m^3 . Baetidae (Ephemeroptera) and Plecoptera were the most abundant organisms in the second peak making up 89 and 7% of the total, with drift rates approximately 648 and 102 times their pre-spray morning averages of 0.10 and 0.05 nymphs per m^3 respectively. Polycentropodidae (Trichoptera) and three other families of Ephemeroptera (Heptageniidae, Leptophlebiidae and Ephemerellidae) also demonstrated post-spray drift increases. Very small increases in the drift of Nematoda, Hydracarina, Hydropsychidae (Trichoptera) and Rhagionidae (Diptera) also appear to have been spray related. Plecoptera, Baetidae, Polycentropodidae and Simuliidae were still drifting in abnormally high numbers 6 hours after application, but by that evening drift rates for all aquatic invertebrate groups had returned to near the pre-spray level. In the 11 morning and evening drift samples taken after the first spray day, the average number of organisms collected was reduced by almost one half to 0.58 per m^3 from 0.97 per m^3 in the pre-spray.

Alterations in the normal drift pattern were much less pronounced following the second application (Figure 7). Peak drifts of Simuliidae and Chironomidae occurred $\frac{1}{2}$ hour after application with drift rates approximately 13 and 80 times their pre-spray morning averages respectively. Plecoptera, Polycentropodidae and adult Elmidae (Coleoptera) also appear to have been slightly affected. By 4 hours after application effects of the second spray were no longer apparent. The average number of organisms collected in the 10 morning and evening drift samples taken after the second spray day increased to 0.86 per m^3 .

Apart from very small increases in the numbers of adult Diptera and Collembola in the drift, both applications appeared to have had very little knockdown effect on terrestrial invertebrates (Figure 8; Appendix I: Table 5).

No obvious changes in the normal drift patterns of terrestrial and aquatic invertebrates were observed at the untreated control station on either spray day (Appendix I: Table 6; Appendix IV: Table 2). The average number of organisms collected in morning and evening drift samples decreased over the study period from 0.77 per m^3 in the pre-spray to 0.74 per m^3 for the 5 days following the first spray and to 0.62 per m^3 for the 5 days following the second spray.

Artificial Substrates

No statistically significant ($P < .05$) reductions in numbers were noted in any taxa between 7 and 22 June (from 4 days prior to any

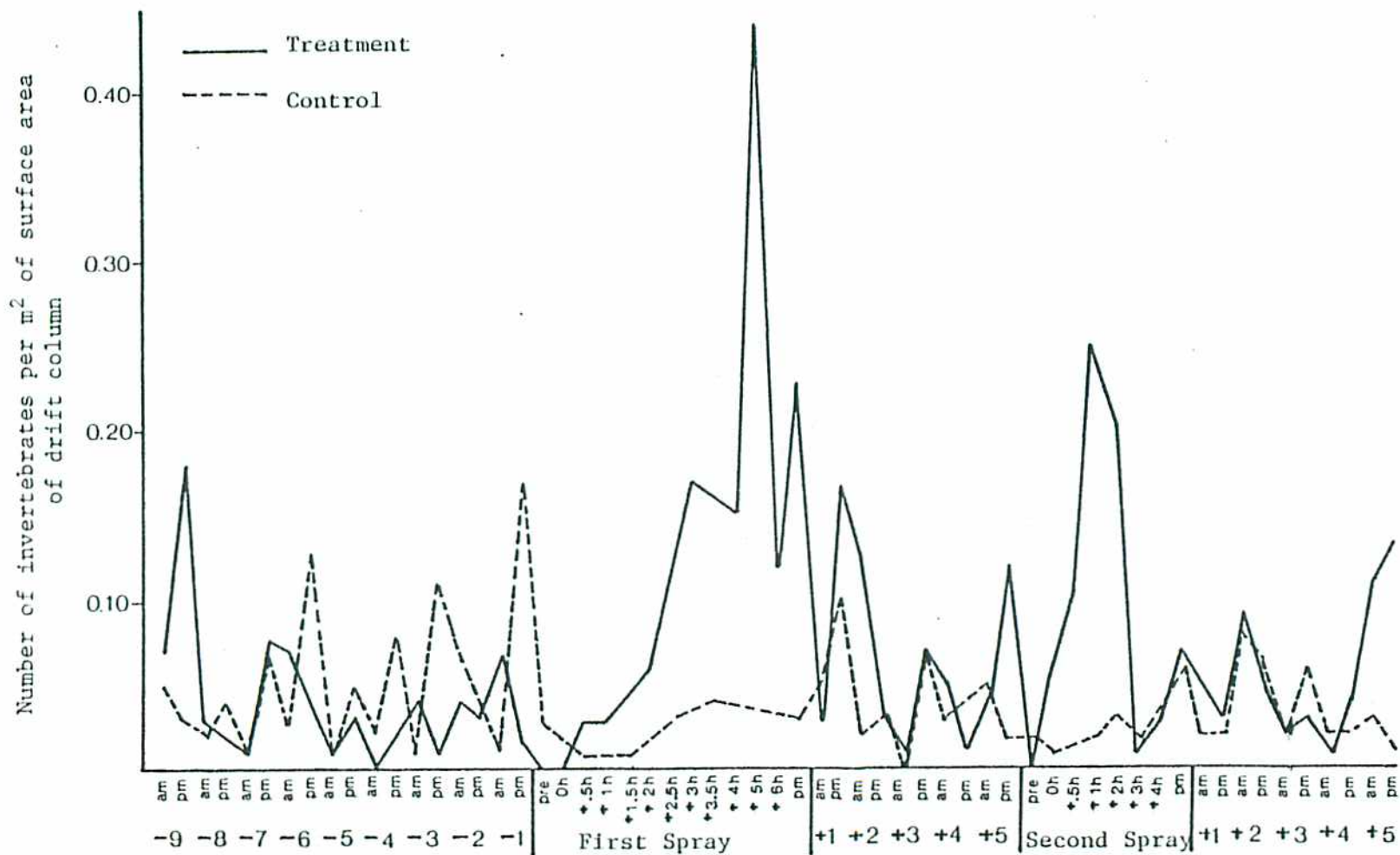


Figure 8. Terrestrial invertebrates collected in drift net sets, Gloucester County, New Brunswick 1980.

insecticide application to 5 days after the second application) (Appendix IV: Table 3). Numbers of Baetidae, Leptophlebiidae, Ephemerellidae, Plecoptera and Elmidae all decreased slightly within the treatment stream after the first spray but increased again after the second spray. The same pattern was observed for Baetidae and Plecoptera in the control stream (Appendix IV: Table 4). Over the same period significant increases were noted for Chironomidae and Empididae (Diptera) in the treatment stream, and for Hydracarina, Ephemerellidae and Chironomidae in the control stream.

In general, artificial substrates from the treatment and control streams demonstrated very similar patterns of colonization up to and including the +11(+5) day post-spray sample on 22 June (Figure 9; Appendix IV: Tables 3-4). By +51(+45) days post-spray (1 August), however, although a very highly significant increase ($P < .001$) in total number of individuals was noted in the treatment stream, there was no significant change, and even a slight reduction, in the control stream. This difference reflects significant increases within several taxa collected in artificial substrates from the treatment stream, including Baetidae, Heptageniidae and Leptophlebiidae (Ephemeroptera), Hydropsychidae, Hydroptilidae and Rhyacophilidae (Trichoptera), Chironomidae, Tipulidae and Rhagionidae (Diptera), Elmidae (Coleoptera) and Oligochaeta. In contrast, numbers of Hydracarina were significantly reduced in both the treatment and control streams at this time.

Surber Samples

The mean number of invertebrates collected in Surber samples did not change significantly ($P < .05$) over the course of the study at either of the 2 treatment stations or at the control station (Figure 10; Appendix IV: Tables 5-7). An apparent peak +51(+45) days post-spray (1 August) at Station A resulted from the collection of a large number of Sphaeriidae (Pelecypoda) in 2 of the 4 Surber samples taken on that date.

Numbers of Hydropsychidae and Brachycentridae (Trichoptera) collected at Station A 2 days after the first application were significantly lower than in either of the 2 pre-spray samples taken at the same site. Numbers of Baetidae were also apparently reduced, but the difference was not significant. Likewise a reduction in Hydracarina numbers after the first spray was not significant, although a reduction noted prior to this application was. Following the second application Plecoptera numbers were reduced but not significantly. Hydracarina, Baetidae and Brachycentridae all remained at a low level of abundance to the end of the study, but by +51(+45) days post-spray (1 August) Hydropsychidae had increased in abundance to a level not significantly different from the pre-spray. Numbers of Plecoptera and Ephemerellidae were significantly lower in the +51(+45) day post-spray sample than in

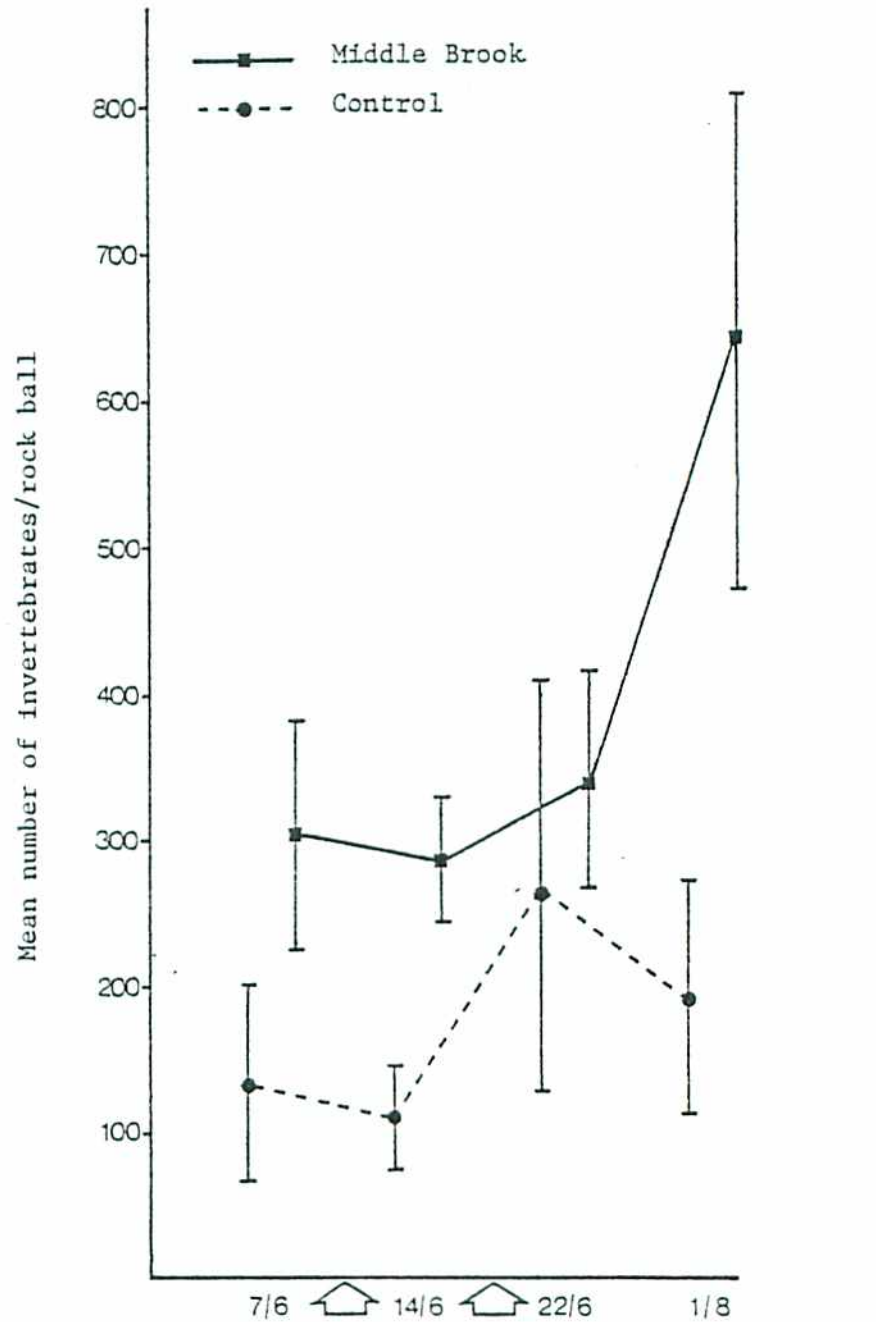


Figure 9. Mean numbers of aquatic invertebrates collected from artificial substrates, Gloucester County, New Brunswick 1980.

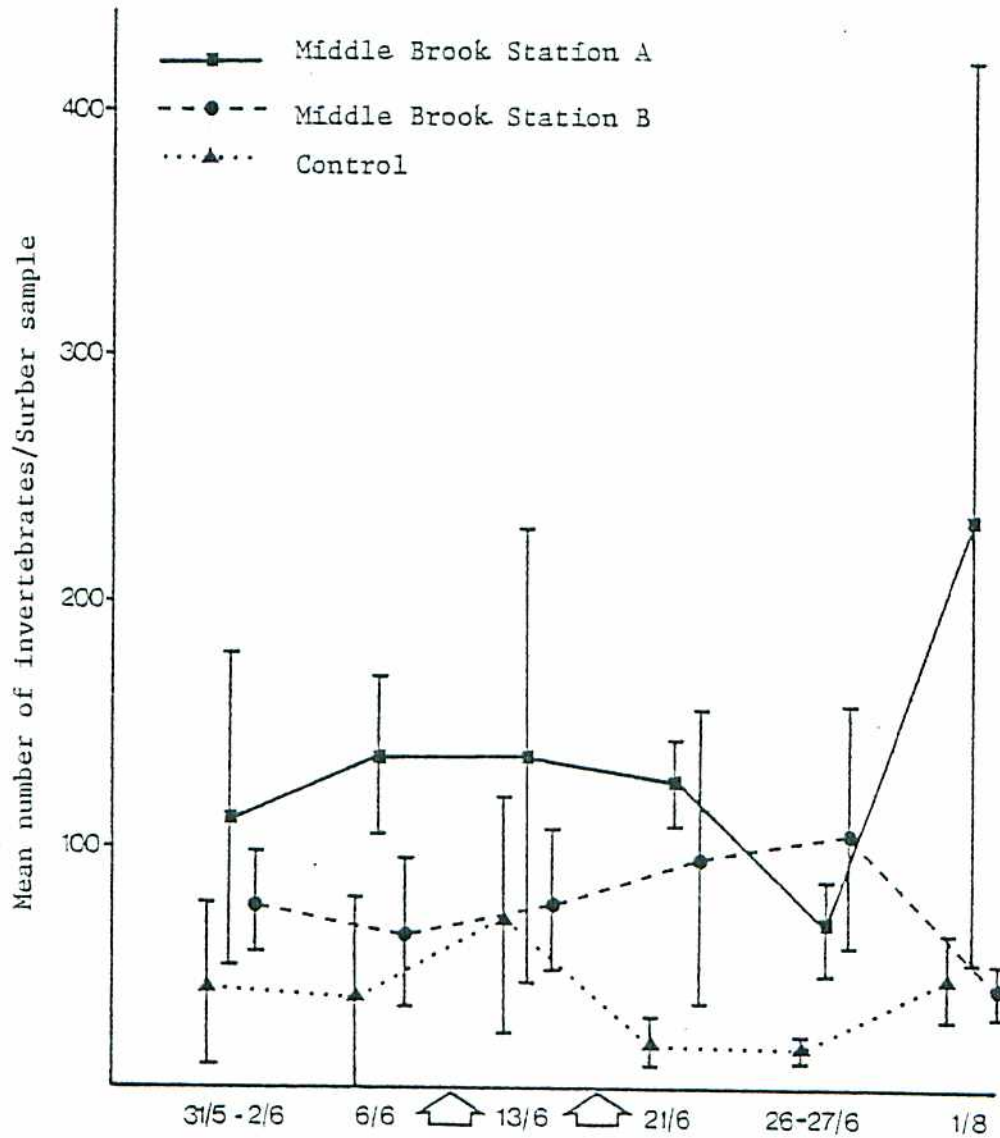


Figure 10. Mean numbers of aquatic invertebrates collected in Surber samples, Gloucester County, New Brunswick 1980.

either pre-spray sample. Numbers of Elmidae larvae were not significantly reduced in the +16(+10) day post-spray sample, but by +51(+45) days post-spray had returned to normal.

At Station B numbers of Baetidae, Heptageniidae, Plecoptera, Brachycentridae and Hydropsychidae all decreased slightly between -11 days and -5 days pre-spray (31 May-6 June) and then again between -5 days pre-spray and +2 days post-spray (13 June). Simuliidae and Chironomidae numbers were also reduced after the first spray. Numbers of Baetidae, Heptageniidae and Brachycentridae were further reduced after the second spray, while numbers of Hydropsychidae and Chironomidae increased. With the exception of the increase in Chironomidae noted in the +10(+4) day post-spray (21 June) sample, none of these changes were found to be statistically significant. Baetidae, Plecoptera and Simuliidae numbers remained low to the end of the study, but Heptageniidae and Hydropsychidae both increased in abundance in the +51(+45) day post-spray (1 August) sample. Numbers of Ephemerellidae and Brachycentridae were significantly lower in the +51(+45) day post-spray sample than in either pre-spray sample.

The total number of invertebrates collected in Surber samples at the control station was generally lower than at either treatment station, making the identification of seasonal trends much more difficult. This was particularly true for the Trichoptera which were present in only very small numbers on all sampling dates. In addition, because the sampling site had to be moved several times due to a lack of enough suitable substrate for Surber sampling in any one area, localized clumping of organisms on the stream bottom may have abnormally influenced the data. This is probably the reason for the high numbers observed for several taxa in the +2 day post-spray sample. Nevertheless 2 distinct trends were identified:

- 1) Plecoptera were at their lowest level of abundance in the +51(+45) day post-spray sample.
- 2) Baetidae were much reduced in Surber samples after the second application. Only 1 nymph was collected in the +51(+45) day post-spray sample, and none in either the +10(+4) or the +15(+9) day post-spray sample.

Similar trends were previously noted for the treatment stream.

Rock Samples

All 3 sampling stations demonstrated a similar trend in terms of seasonal change in abundance of aquatic invertebrates on rocks (Figure 11; Appendix IV: Tables 8-10). In general, total numbers remained essentially unchanged over the first part of the study, began to increase near the end of June, and increased still further in August. The large

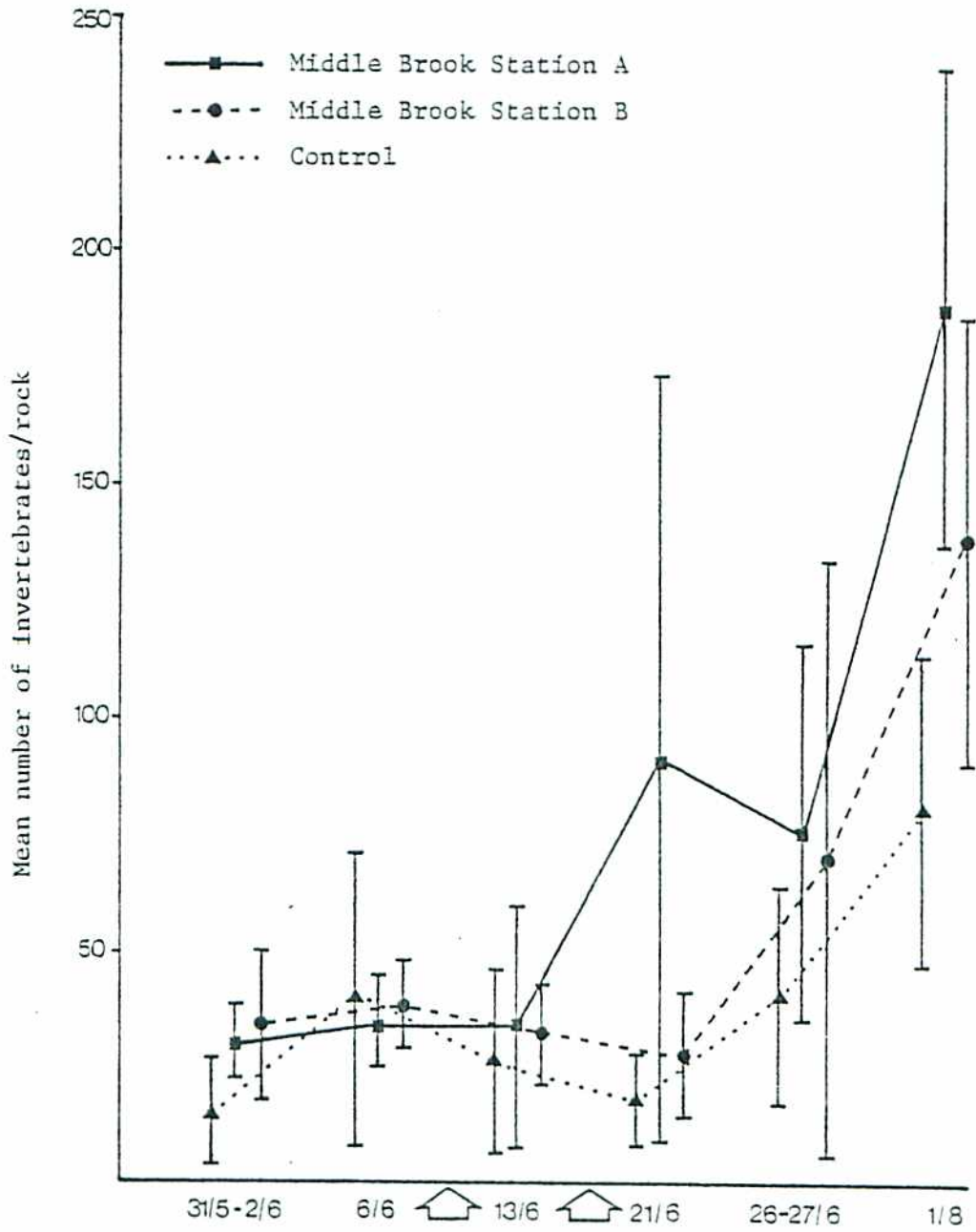


Figure 11. Mean numbers of aquatic invertebrates collected from rocks, Gloucester County, New Brunswick 1980.

increases observed in August occurred primarily as a result of significant ($P < .05$) increases in the number of Chironomidae at the 2 treatment stations, and Elmidae at the control station. Baetidae also increased significantly in abundance in the August sample at all 3 stations while Plecoptera and Hydracarina were reduced in abundance.

No significant reductions were noted within any taxa immediately following either application. Small reductions in the numbers of Hydracarina and Elmidae in +2 day post-spray collections were noted at both treatment stations and at the control station.

Fish

Caged Fish

No mortality of caged fish was observed in either the treatment or control stream up to 10 days after the second insecticide application. In all, fish were caged for a total of 22 days without food and this was reflected in their very poor condition at the end of the study. Fulton's coefficients of condition (K) ranged from 0.80 to 1.06 (mean 0.94) for brook trout caged in Middle Brook and from 0.63 to 1.06 (mean 0.91) for brook trout caged in the control stream (Little Brook). Brook trout sampled for stomach content analysis at this time had condition coefficients ranging from 1.16 to 1.35 (mean 1.26) for Middle Brook and from 1.09 to 1.34 (mean 1.20) for the control stream (Little Brook).

Brook trout caged in Middle Brook were observed actively feeding on drifting aquatic invertebrates 1-3 hours after the first application. This behaviour was not seen to any great extent at any other time, including the second spray day. Otherwise no obvious behavioural changes or ill effects were observed in those fish exposed to the insecticide applications.

Fish Diets

Results of stomach content analyses for brook trout and slimy sculpins from the treatment stream (Middle Brook) and the control streams (Little and Bass Brooks) are summarized in Appendix V: Tables 1-10 and are illustrated graphically in Figures 12-16. Organisms not consumed in significant amounts on any particular sampling date (i.e., <1 percent of the total volume of food consumed on that date) are omitted from the graphs.

Brook trout: Prior to the first application terrestrial invertebrates and Trichoptera larvae were the most important food items in the diets of Middle Brook brook trout, making up 38.0 and 43.8% of the total volume of food organisms consumed respectively. Aquatic Coleoptera, Simuliidae, Chironomidae and Ephemeroptera were also consumed in significant amounts on this date. Immediately after the first spray large numbers of Plecoptera and Simuliidae were found in brook trout stomachs. Increases in the volumes of Plecoptera and Simuliidae

TREATMENT

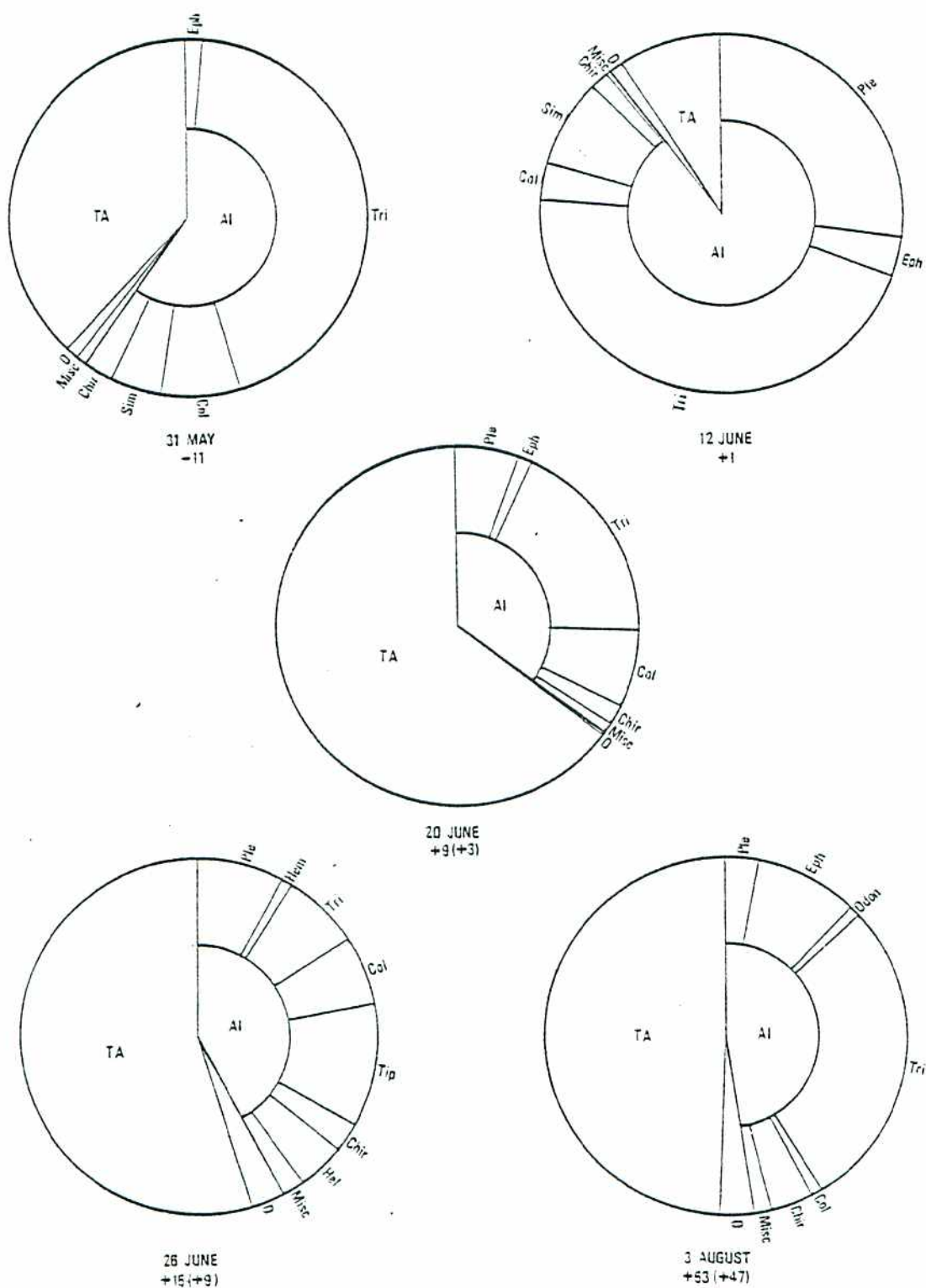


Figure 12. Dietary changes in brook trout sampled from Middle Brook, Gloucester County, New Brunswick 1980 (abbreviations are explained in Table 12).

CONTROL

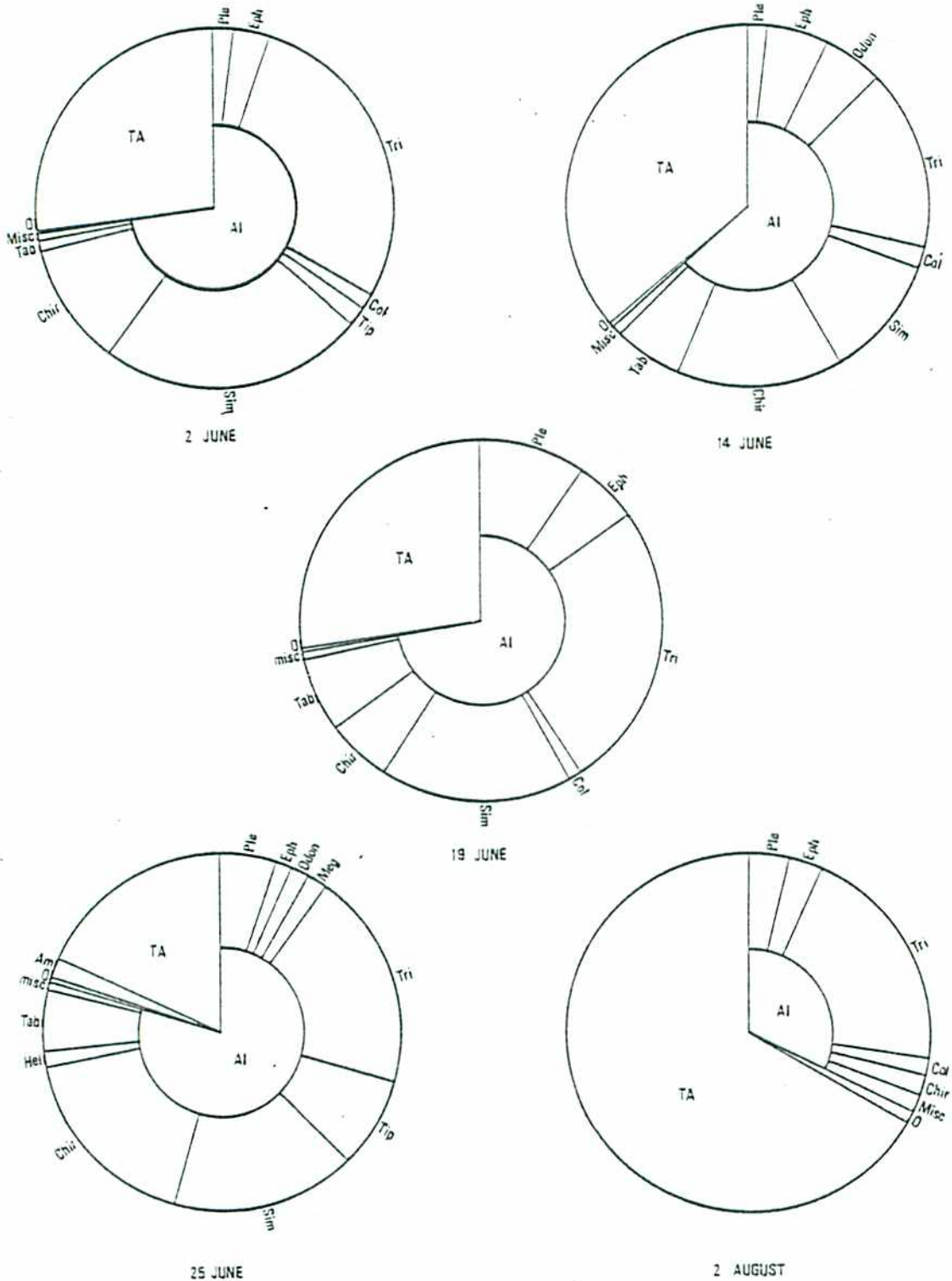


Figure 13. Dietary changes in brook trout sampled from Little Brook, Gloucester County, New Brunswick 1980 (abbreviations are explained in Table 12).

CONTROL

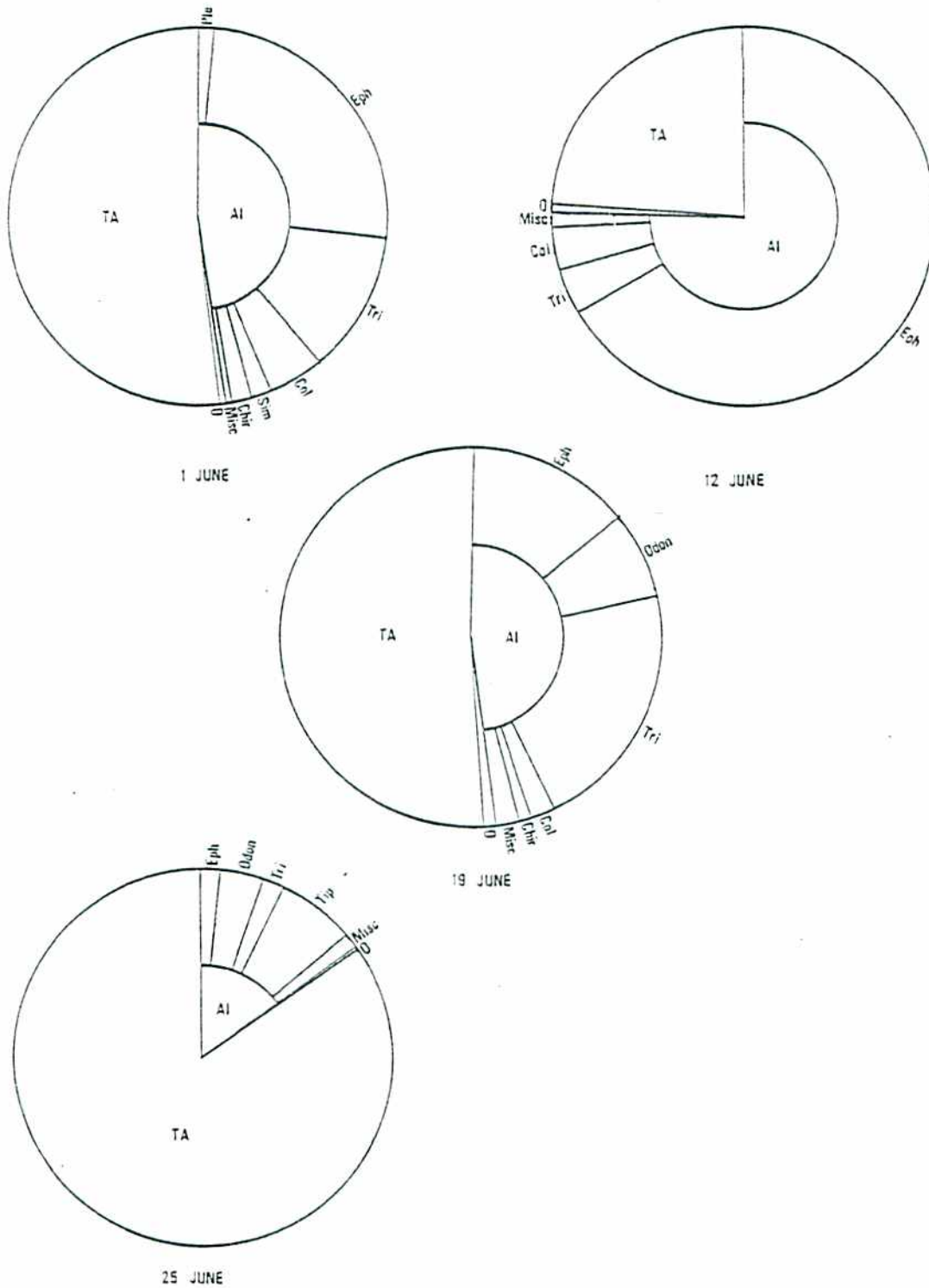


Figure 14. Dietary changes in brook trout sampled from Bass Brook, Gloucester County, New Brunswick 1980 (abbreviations are explained in Table 12).

TREATMENT

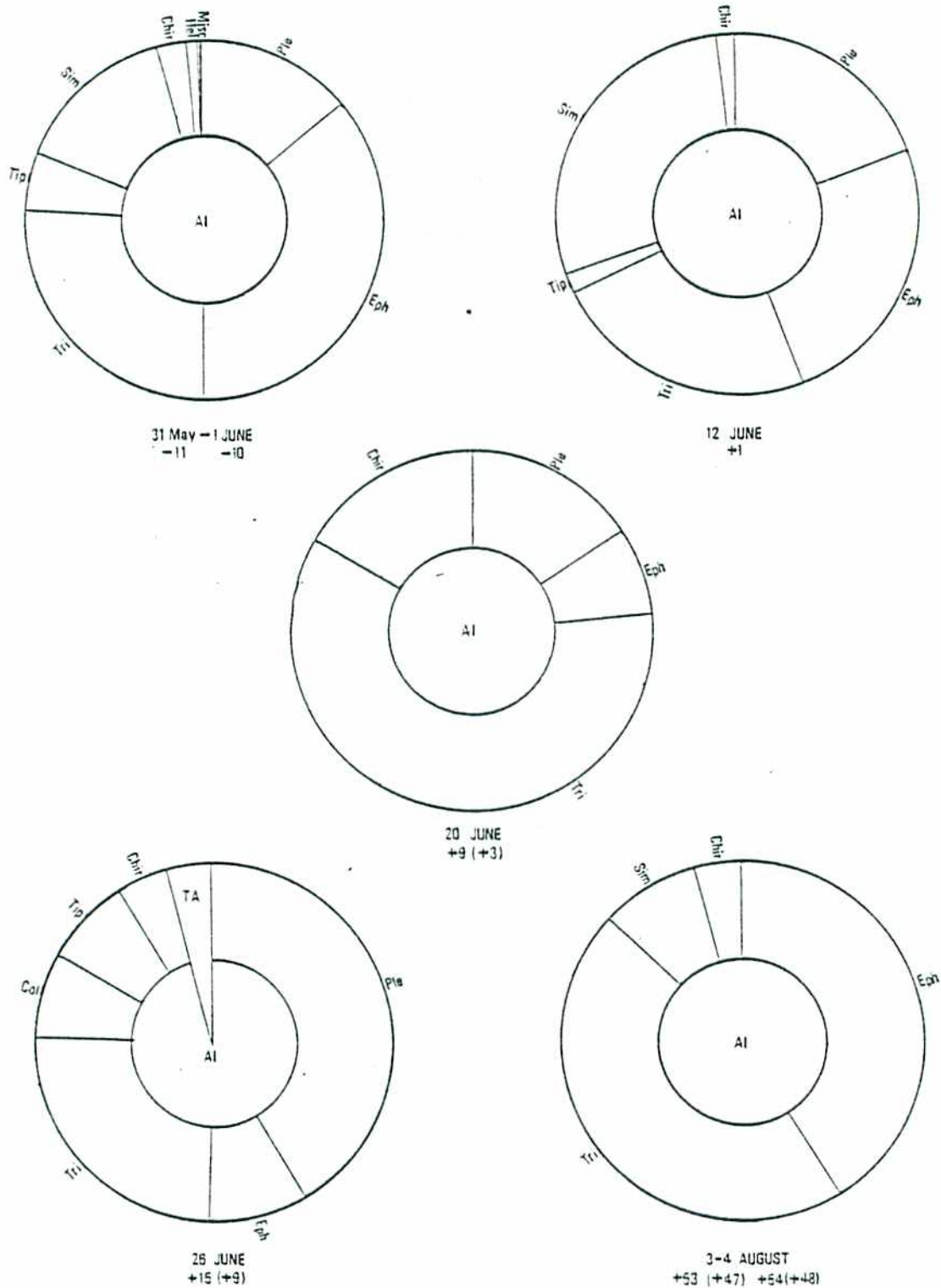


Figure 15. Dietary changes in slimy sculpins sampled from Middle Brook, Gloucester County, New Brunswick 1980 (abbreviations are explained in Table 12).

CONTROL

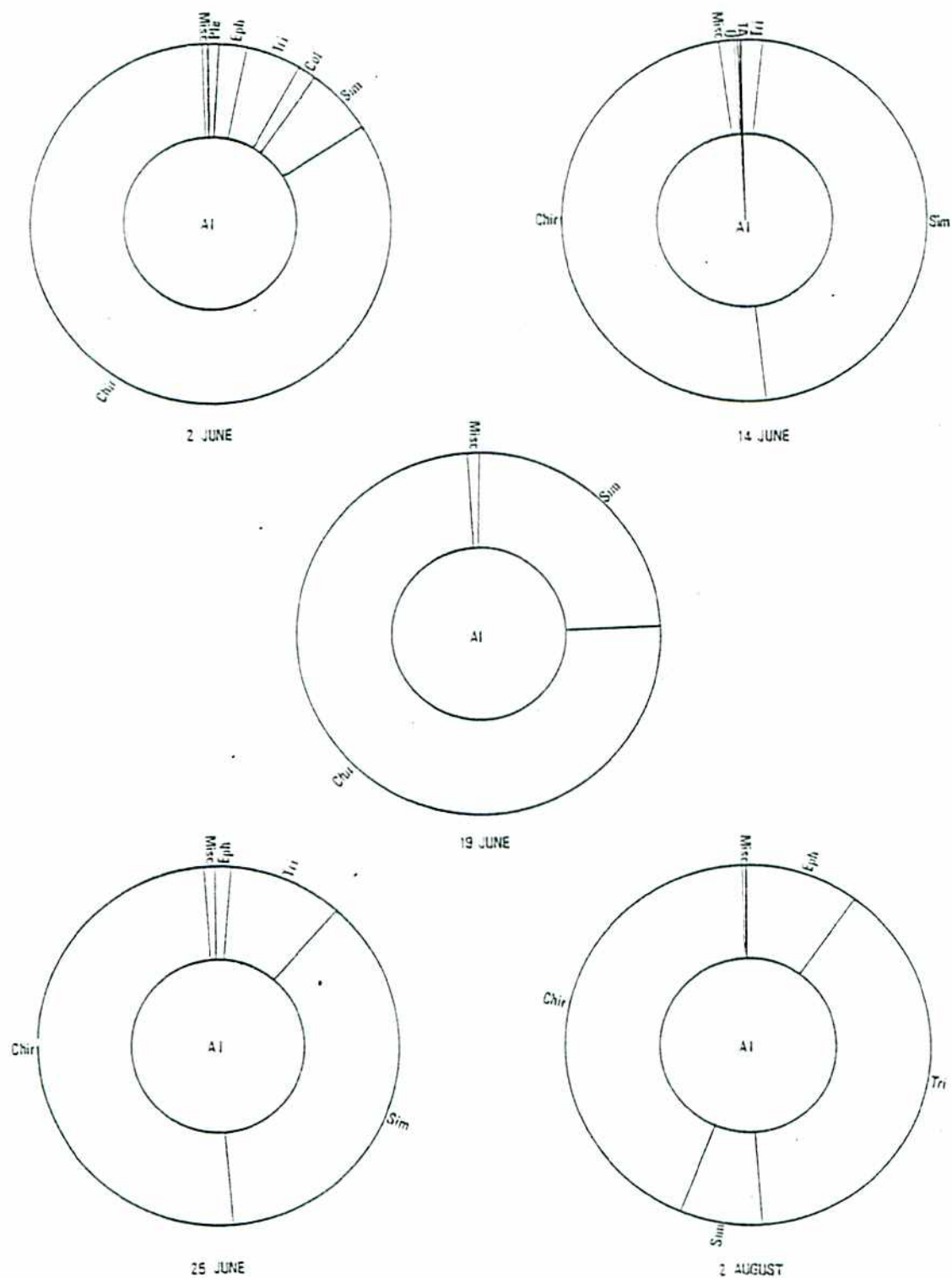


Figure 16. Dietary changes in slimy sculpins sampled from Little Brook, Gloucester County, New Brunswick 1980 (abbreviations are explained in Table 12).

Table 12. Codes used to represent various food items in the diets of brook trout and slimy sculpins from the treatment and control streams.

TA	terrestrial arthropods
AI	aquatic insects
Ple	Plecoptera
Eph	Ephemeroptera
Odon	Odonata
Hem	Hemiptera
Meg	Megaloptera
Tri	Trichoptera
Col	Coleoptera
Tip	Diptera: Tipulidae
Sim	Diptera: Simuliidae
Chir	Diptera: Chironomidae
Hel	Diptera: Heleidae
Tab	Diptera: Tabanidae
Misc	Miscellaneous
O	other aquatic invertebrates
Am	Amphibian eggs

in the diet at this time (from 0.9 to 27.3 and from 5.0 to 8.0% of the total respectively) were offset by an almost equal reduction in the volume of terrestrial arthropods consumed (from 38.0 to 9.1% of the total). Following the second application terrestrial arthropods increased in importance to make up 64.5% of the total volume consumed, while Plecoptera, Trichoptera and Simuliidae all decreased in importance. Trichoptera were further reduced in importance to only 6.5% of the total volume in the next sample taken 6 days later. In this sample Gerridae (Hemiptera), Tipulidae and Heleidae (Diptera) were all consumed in significant amounts for the first and only time in the study. By 47 days after the second application terrestrial invertebrates and Trichoptera were again the most important food items in brook trout diets, making up 49.2 and 28.0% of the total volume respectively. At this time almost half of the Trichoptera eaten were pupae, however, whereas very few pupae were eaten in any of the 4 previous samples.

Between 2 June and 19 June brook trout diets changed very little in the Little Brook control stream. Over this period terrestrial invertebrates were the most important food source for resident brook trout, contributing between 27.2 and 36.3% to the total volume of food eaten. A variety of aquatic organisms including Trichoptera, Simuliidae, Chironomidae, Ephemeroptera, Tabanidae (Diptera), and Plecoptera (in order of their importance), made up the bulk of the diet, contributing between 55.0 and 70.5% to the total volume. In the 25 June sample terrestrial invertebrates were somewhat reduced in importance contributing only 18.3% to the total volume. In this sample, as in the treatment stream, Tipulidae and Heleidae, as well as Sialidae (Megaloptera), were consumed in significant amounts for the first and only time in the study. Terrestrial invertebrates were by far the most important food source for brook trout at the time of the 2 August sample making up 66.8% of the total volume of food organisms consumed. At this time Simuliidae and Tabanidae had all but disappeared from brook trout diets and Chironomidae were much reduced in importance.

In the 1 June sample from the Bass Brook control stream terrestrial invertebrates, Ephemeroptera and Trichoptera larvae were the most important food items in the diets of brook trout, making up 52.0, 25.3 and 12.0% of the total volume of food organisms consumed respectively. By 12 June Ephemeroptera had increased in importance to make up 66.1% of the total diet with a corresponding decrease in the volumes of terrestrial invertebrates and Trichoptera larvae. Brook trout stomachs in the 12 June sample contained almost 20 times as many mayfly nymphs as in the previous sample. Brook trout feeding habits on 19 June were similar to those observed on 1 June, but by 25 June the volume of terrestrial organisms consumed had increased to 84.6% of the total with a corresponding decrease in the amounts of aquatic organisms eaten.

The amount of food eaten by Middle Brook brook trout fluctuated considerably during the course of the study, with the greatest amount being eaten 1 day after the first insecticide application, and the least amount in August. A similar trend was noted for Bass Brook brook trout 1 day after the first application. There was no reduction in the amount of food eaten by Little Brook brook trout in August however.

Slimy sculpins

Middle Brook sculpin diets were very similar prior to and immediately after the first insecticide application, with Ephemeroptera, Trichoptera, Simuliidae, Plecoptera, Tipulidae and Chironomidae all being consumed in significant amounts. Sculpin diets were altered following the second application, however. Both Simuliidae and Tipulidae disappeared from sculpin stomachs 3 days after the second spray. Simuliidae were still absent from the diet 6 days later but Tipulidae had reappeared. Aquatic Coleoptera and terrestrial Lepidoptera larvae were consumed in significant amounts at this time. Sculpin diets in August were quite similar to pre-spray diets except that no Plecoptera or Tipulidae were eaten.

Chironomidae and Simuliidae were important food sources for sculpins in the Little Brook control stream on all sampling dates between 2 June and 2 August. Trichoptera were consumed in significant amounts in all samples except on 19 June, and were particularly important in the 2 August sample. Taken together these 3 taxa made up 90% or more of the total volume of food organisms consumed on all 5 sampling dates.

A reduction in the quantity of food ingested by Middle Brook sculpins was noted 3 days after the second application, and was still evident up to 45 days later. A similar trend was noted in the control stream.

Fish Condition Coefficients

Condition coefficients of brook trout from Middle Brook increased gradually over the first part of the summer to a peak on 26 June followed by a decline (Figure 17; Appendix V: Table 1). A similar trend was seen in the Bass Brook control stream except that the peak was reached a few days earlier on 19 June (Figure 17; Appendix V: Table 5). In the Little Brook control stream brook trout condition coefficients demonstrated a very unusual trend. Two peaks were observed, one early in the summer on 14 June followed by a decline and a gradual rise to a second peak on 2 August (Figure 17; Appendix V: Table 3).

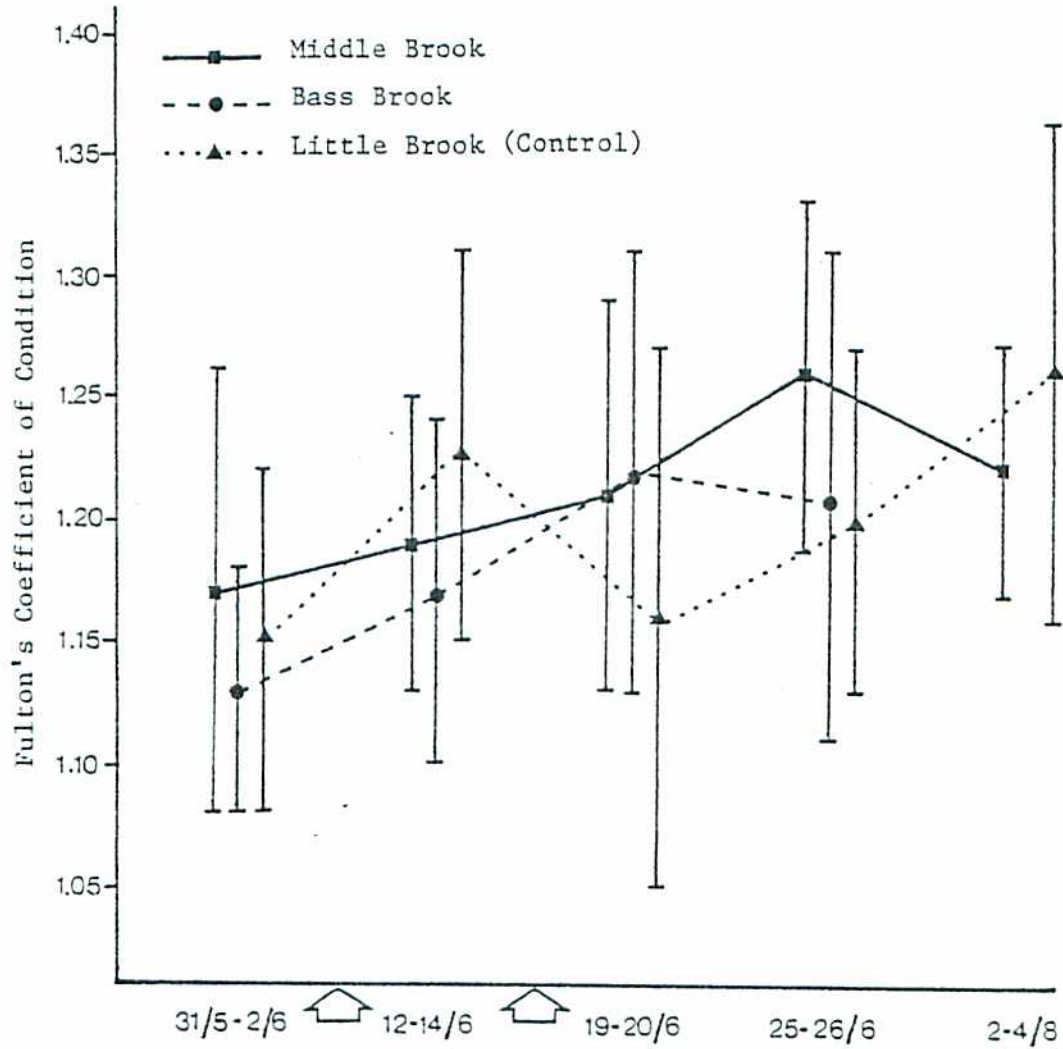


Figure 17. Condition coefficients of brook trout from the treatment and control streams, Gloucester County, New Brunswick 1980.

DISCUSSION

TERRESTRIAL EFFECTS

SEVIN-2-OIL® had a slight, but fairly general, knockdown effect on terrestrial invertebrates. Most invertebrate groups were affected immediately, with Diptera the group most affected. Knockdown of Hemiptera was delayed. Although significant post-spray increases were noted for Staphylinidae, these were probably not pesticide related since large fluctuations were also observed in the control area.

Meteorological conditions at the time of spraying can affect knockdown in various ways; two prominent ones being:

- 1) by increasing or decreasing insect activity
- 2) by varying length of exposure to the insecticide due to weathering of the chemical. Cool temperatures at the time of the first application (4.5°C) may have reduced insect activity during treatment and limited immediate knockdown from balsam fir. This may have been masked in the stream bank results by the generally larger deposit for the first application, resulting in a magnified knockdown effect. Although meteorological conditions during the second post-spray time period were more favourable to advance weathering of the chemical (it rained earlier and more frequently), duration of knockdown was longer, possibly due to a combined pesticide effect from the 2 applications. This prolonged effect following a second application has been observed in various other studies conducted by the Forest Pest Management Institute, where an impact on non-target terrestrial invertebrates occurred. After second applications of azamethiphos (Kingsbury et al. 1980), permethrin (Kingsbury and McLeod 1979) and aminocarb (Millikin and Mortensen 1980), duration of knockdown was 4, 1 and 3 days, respectively, longer than that of the first application.

The high toxicity of SEVIN® to honeybees has been well documented (Johansen, 1972, 1977, Moffett et al. 1970; Morse, 1961, Strang et al. 1968; Bart and Hunter, 1978). Much less information is available on the effect of SEVIN® on native bees. Substantial reductions in wild bees, and a marked reduction in the fecundity of *Viburnum cassinoides* L., were reported by Miliczy and Osgood (1979) following a SEVIN-4-OIL® treatment in Maine at a dosage rate of 840 g (AI)/ha. In light of the above information, part of the present study was apportioned to determine whether the treatment had any detrimental effect on natural pollinators and if so, whether this could be measured in reduced seed set of *Clintonia*, a plant common within the spray block and dependent upon biotic pollinators, particularly bumblebees, for fruit set (Thaler and Plowright 1980). No significant contact toxicity to wild bees was indicated however, nor was there any observed reduction in the fecundity of *Clintonia*. Reasons for the lack of effect may have been the lower sensitivity of bumblebees as compared to honeybees (Johansen 1977), and

the relatively low dosage rate used in this study. The argument could also be made that exposure cages are artificial and that the exposure time was too short. Using the same method however, Plowright et al. (1978) found that fenitrothion, at a dosage rate of 210 g (AI)/ha caused significant mortality. Plowright and Pendrel (1978) determined that most insecticide-induced mortality to pollinators occurs within the first 48 hours of an insecticide application. In the present study, mortality did not occur until 10 days after the first application, and even then was clearly less than for control bees. Thus, it is highly unlikely that this mortality was pesticide-induced. Mortality of treatment bees did occur within 24 hours of the second application however, with no simultaneous loss on control, suggesting a possible correlation with treatment.

A number of studies have been conducted on the effects of SEVIN-4-OIL® on forest songbirds. Gramlich (1979) monitored cholinesterase levels in songbirds exposed to a split application of SEVIN-4-OIL® (550 g (AI)/ha + 340 g (AI)/ha, and found no significant difference between pre-spray and post-spray levels. May (1978) found no visible effects on birds and small mammals following an operational application of SEVIN-4-OIL® in Maine, and cites a number of studies with the same conclusions. Bart and Hunter (1978) cite 6 studies in which applications of SEVIN® were shown to have no effect on forest songbirds at dosage rates up to 1400 g (AI)/ha. Even at a dosage rate of 6720 g (AI)/ha, Bart (1976) was unable to detect any significant decline in singing male surveys. Moulding (1976), on the other hand, was able to demonstrate a 55% reduction in bird populations in areas sprayed twice at a dosage rate of 1120 g (AI)/ha. Richmond et al. (1979) found no major effect on forest birds following a single application at a dosage rate of 2240 g (AI)/ha, however, and attributes Moulding's results to alterations in the available food supply.

Methods used in the present study differed from former impact studies conducted by the Forest Pest Management Institute, in that the normal 4 ha plot was replaced with a transect which was 3 times longer, enabling a greater portion of the block to be monitored in the same amount of time. Because of the increased number of birds censused, a better measure of significance was obtained. Using these methods, our findings were in keeping with the majority of the above studies, in that breeding bird populations did not appear to be adversely affected by the SEVIN-2-OIL® applications.

The conclusions of Richmond et al. (1979) point out the importance of food supply to the stability of bird populations. In the present study, fruit set was unaffected by the insecticide applications, and consequently there was little potential for disruption of feeding in fructivorous species. Populations of terrestrial invertebrates were reduced however, and this may have had some effect on the availability of food for certain insectivorous species. Flycatchers, which feed in

flight, and canopy feeders, are potentially the most vulnerable to this type of insecticide effect. The fact that none of these species exhibited post-spray population reductions suggests that reduction in food supply did not approach critical levels in this study.

AQUATIC EFFECTS

A number of environmental impact studies on the effects of operational and experimental spruce budworm control programs using SEVIN-4-OIL® in Maine and the western United States have included analyses of contaminated stream waters for carbaryl residues. Pieper et al. (1978) reported residue levels in stream water as high as 260 ppb shortly after an experimental application of SEVIN-4-OIL® at a dosage rate of 1121 g (AI)/ha to control spruce budworm in Montana in 1975. The following year Tracy et al. (1977) detected carbaryl concentrations as high as 5.0 ppb and 11.0 ppb in 2 streams which flowed through an experimental SEVIN-4-OIL® spray block in Washington State. Marancik (1976) recorded residues of carbaryl in Maine streams in 1975 ranging from 1.2 to 12.8 ppb 24 hours after spraying with SEVIN-4-OIL® at a dosage rate of 1121 g (AI)/ha. In an independent monitoring study of the same control operation (LOTEL, 1977), carbaryl residues as high as 40 ppb were found in streams, but this amount diminished rapidly and none could be detected by the seventh day after spraying. Twenty-four hours after spraying with SEVIN-4-OIL® (840 g (AI)/ha) in 1976, Hulbert (1978) measured carbaryl concentrations in 3 Maine streams ranging from 25.60 to 42.45 ppb. Gibbs et al. (1979) monitored a split application of SEVIN-4-OIL® (350 g (AI)/ha + 770 g (AI)/ha) in northern Maine in 1978 and reported peak levels of carbaryl up to 23 ppb shortly after the last application and detectable residues up to 7 days later. Stanley and Trial (1980) measured carbaryl residues in 6 streams and 3 rivers in Maine in 1978 and 1979 which had been contaminated from spraying of nearby forests with SEVIN-4-OIL® at 840 g (AI)/ha. Peak concentrations occurred shortly after spraying with maximum measured levels in brooks and rivers protected by an unsprayed buffer zone ranging from 0.93 to 7.8 ppb and from 0.44 to 2.0 ppb respectively. In one stream unprotected by a buffer zone the maximum level was 16.0 ppb.

Peak levels of carbaryl in Middle Brook (313.7 ppb after the first spray and 122.6 ppb after the second spray) were much higher than in any of the Maine studies or the Washington study, even though the dosage rate was 3 to 4 times lower. One possible reason for the difference is that peak levels of carbaryl were measured in Middle Brook within a very few minutes of direct aerial application of the insecticide. Within $\frac{1}{2}$ to 1 hour after spraying, carbaryl concentrations in Middle Brook were in the same range as peak concentrations measured in Maine and Washington. Another possible reason is that in the present study water samples were collected from that portion of the water column in which an insecticide formulated in oil is most concentrated immediately after spraying (i.e., the top 1 cm including the surface film). The peak concentration measured in Montana agrees more closely with the

findings of the present study, but unfortunately it is not clear exactly how long after the spray this sample was taken or from what depth in the water column.

Carbaryl residues disappeared very rapidly from the surface waters of Middle Brook in the first few hours after spraying. Two mechanisms are suggested to account for this rapid disappearance:

- 1) downstream flushing and dilution from upstream sources, and;
- 2) mixing within the water column (i.e., as the most volatile fraction of the spray formulation, the insecticide diluent oil, evaporated, the slightly water soluble active ingredient (40 ppm at 30°C) became more evenly distributed throughout the water column and less concentrated at the surface).

Carbaryl residues in Middle Brook 24 hours after the first and second application were lower than those reported by Hulbert (1978), and in the same range as those reported by Marancik (1976), both in Maine. Residue levels continued to decline in subsequent samples, but the rate of decline was much lower. Downstream flushing and dilution was still probably the major factor contributing to the decline of residues in these samples, but other factors such as downward migration to the sediment, as well as conjugation, hydrolysis, photolysis and transformation by microorganisms, may also have played an important role in the disappearance of this compound. Carbaryl residues were still present in stream water at very low levels 6 to 10 days after the second spray. At this time, carbaryl, because of its slight solubility in water, may have been moving up into the water column from the bottom sediments.

Carbaryl residues were detected in Middle Brook brook trout (40-46 ppb) and slimy sculpins (24-32 ppb) 1 day after the first SEVIN-2-OIL® application. Since the concentration of carbaryl in water at this time was 72 ppb, this represents a concentration factor of approximately 6 (5.5-6.4) for brook trout and 4 (3.3-4.4) for slimy sculpins. Residues were below the limit of detection in fish tissues (<20 ppb) 3 days after the second application when the concentration of carbaryl in stream water was only 1.2 ppb. In comparison, Haque et al. (1977) reported a bioaccumulation ratio (concentration factor) of 140 for catfish exposed to carbaryl for 30 days in a model ecosystem, and Matsumura (1977) calculated a concentration factor of 45 for a related carbamate insecticide, mexacarbate (Zectran®), in northern brook silver-side, also in a model ecosystem.

Acute toxicity testing by means of static and flow-through bioassays can be valuable in providing base line toxicity data on candidate forestry insecticides, and with some care the results of these bioassays can be extrapolated to predict effects in the field. Post and Schroeder (1971) found a 96 hour LC₅₀ for technical carbaryl (98% active ingredient) of 1070 ppb for brook trout averaging 1.15 g in weight, and 1450 ppb for brook trout averaging 2.04 g in weight.

Schoettger and Mauck (1976) obtained 96 hour LC₅₀s for technical carbaryl (99.5% active ingredient) to brook trout ranging between 1100 ppb and 5400 ppb depending on water temperature, water hardness and pH, and concluded that aerial applications of this compound should not have a major toxic effect on brook trout. In view of the above, it is not surprising that no mortality of caged brook trout was observed in the present study where carbaryl residues in stream water peaked at a level well below the above LC₅₀s and declined very rapidly.

A number of investigators have demonstrated increases in aquatic invertebrate drift following single aerial applications of SEVIN-4-OIL® for spruce budworm control in Maine, Washington, Montana and New Mexico (Hulbert 1978; Trial and Gibbs 1978, Tracey et al. 1977, Haugen 1978, Parker and Ragenovich 1980). In the present study both applications of SEVIN-2-OIL® resulted in increased drift rates, with the higher rate occurring after the first application. This observation concurs with the results of Gibbs et al. (1979), who found a higher drift rate after the first of 2 consecutive aerial applications of SEVIN-4-OIL® in Maine, even though the first application was at a lower dosage rate. Kingsbury and Kreutzweiser (1979) demonstrated a similar trend with permethrin, and were able to correlate lower peak drift rates at the time of their second applications with previously reduced bottom fauna populations. In the case of Middle Brook, however, the observed difference in peak drift rate was at least partly due to a difference in exposure, since levels of carbaryl in stream water were significantly higher after the first application than after the second.

Two peaks in aquatic invertebrate drift were noted following the first SEVIN-2-OIL® application. Maximum drifts of Simuliidae and Chironomidae were recorded ½ hour after application, while maximum drifts of Baetidae and Plecoptera were not recorded until 4 hours and 5 hours after application respectively. This difference in timing of impact probably reflects a difference in sensitivity. The fact that peak drifts of Baetidae and Plecoptera occurred only after 4-5 hours exposure to the insecticide, may suggest that carbaryl concentrations in the stream were close to the no effect level for these insects.

At the peak of impact in Middle Brook, it is estimated that approximately 75,000 aquatic invertebrates drifted past the sampling station in the 6 hours immediately following the first spray, and 3000 in the 4 hours immediately following the second spray. By comparison, it is estimated that, over these same 2 time periods, only 560 and 380 aquatic invertebrates drifted past the Bass Brook control station. In spite of these fairly substantial drifts, however, there was no evidence of any severe depletion in the benthos. There are at least 2 possible explanations for this:

- 1) that the number of aquatic invertebrates drifting was small in relation to total stream populations. Some support for this theory is provided by Eidt (1975) in his study of the effects of an operational fenitrothion application on the benthos of headwater streams in New Brunswick. In this study he estimated that over 80,000 dead insects drifted past his sample point in the 24 hours immediately following the spray, but that this represented the standing crop of only 3 square metres or rubble stream bottom. He concluded that there was no evidence of depletion in the benthos because the kill of aquatic insects was small in relation to production
- 2) that the methods used in the present study to detect changes in the benthos were not sensitive enough to identify very small reductions in bottom fauna populations. A certain amount of variability between replicate samples was associated with each method of sampling benthic invertebrates. This variability was generally smallest in artificial substrate collections and greatest in rock collections. Consequently, when comparing pre-spray to post-spray samples, small reductions in bottom fauna populations would tend to be masked by the normal variability in the sampling method.

As stated previously, the standing crop of aquatic organisms in Middle Brook was not significantly reduced by the insecticide applications. Furthermore, artificial substrate and rock sampling revealed no apparent reduction in numbers within any particular invertebrate taxa. At one station Brachycentridae and Hydropsychidae were significantly reduced in Surber samples. Small post-spray decreases were also noted in Baetidae, Heptageniidae, Plecoptera and Simuliidae, and may have been insecticide-induced. By the end of the study numbers of Baetidae, Plecoptera, Brachycentridae and Simuliidae were still low, but Heptageniidae and Hydropsychidae had both at least partially recovered.

Much more severe impacts have been documented following single applications of SEVIN-4-OIL® at dosage rates of 840 g (AI)/ha and 1120 g (AI)/ha in Maine (Trial and Gibbs, 1978; Trial, 1978; Trial, 1979). Following applications at these dosage rates, populations of Ephemeroptera, Diptera and Plecoptera were all significantly decreased and aquatic insect communities were altered in terms of generic composition for up to 2 years. Gibbs et al. (1979) studied split applications of SEVIN-4-OIL® in Maine in 1978 and found that, at a dosage rate of 350 g (AI)/ha + 770 g (AI)/ha, decreases in Ephemeroptera, Plecoptera and Trichoptera populations occurred. Where the second application was at a lower dosage rate (350 g (AI)/ha + 350 g (AI)/ha) however, no effect on the standing crop of aquatic organisms was observed.

The insecticide applications appear to have had little overall effect on brook trout diets. Plecoptera, Ephemeroptera, Simuliidae and Chironomidae were all found in increased numbers in brook trout stomachs

1 day after the first application, probably as a result of increased feeding by brook trout on insecticide-induced drift. A similar pattern of increased post-spray feeding by brook trout on immature aquatic insects was reported with SEVIN-4-OIL® in Maine (Hulbert, 1978). Terrestrial arthropods significantly increased in importance in brook trout diets 3 days after the second application, but not apparently as a result of increased feeding on terrestrial invertebrate knockdown, since the total number of terrestrial invertebrates eaten in this sample was not significantly different from the number eaten in either of the 2 previous samples.

Slimy sculpins diets also appear to have been only slightly altered as a result of the insecticide application. Simuliidae larvae were totally absent from sculpin diets 3 and 9 days after the second application which may be indicative of temporarily reduced populations.

Fish condition factors can be useful for comparing the relative well-being of fish populations. Condition factors for brook trout from the treated stream were in the same general range as those from the 2 control streams, suggesting that the insecticide applications did not have any significant effect on the general health of brook trout.

CONCLUSIONS

A split application of SEVIN-2-OIL® at a dosage rate of 280 g (AI/ha application had no obvious harmful effects on forest songbirds, wild pollinators or native fish. Knockdown of non-target terrestrial arthropods was generally light. Although there was some indication of population reductions in at least a few benthic invertebrate groups, overall effects were slight, and neither the standing crop of aquatic invertebrates, nor the quantity of food available to brook trout and slimy sculpins, appeared to be reduced.

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APPENDIX I

Terrestrial invertebrate knockdown in
treated and control areas
Gloucester County, New Brunswick

Table 1. Terrestrial invertebrate knockdown from balsam fir, Treatment Block, Gloucester County, New Brunswick, 5 - 23 June 1980.

Days before or after application of 0.280 kg AI/ha SEVIN-2-011%*	Prespray							Postspray I							Postspray II							Avg.
	-6	-5	-4	-3	-2	-1	Avg.	+0	+1	+2	+3	+4	+5	Avg.	+0	+1	+2	+3	+4	+5	+6	
Snails																					.1	.01 ± .04
Acarid									.7					.12 ± .28				.1			.1	.03 ± .05
Araneida					.1		.02 ± .04		.1					.02 ± .04			.2	.1			.1	.06 ± .08
Collembola																				.1		.01 ± .03
Hemiptera																						
Tingidae										.1	.1			.03 ± .05	.1			.1				.03 ± .05
Others	.1						.02 ± .04									.1						.01 ± .03
Homoptera																						
Coleoptera																						
Carabidae adults		.1					.02 ± .04		.1	.1	.1			.05 ± .05								
Scaphyllinidae adults								.4	.1			.1	.3	.15 ± .16	.4	.8	.1	.7	.3	.1	.9	.47 ± .33
Scarabaeidae adults																	.1					.01 ± .03
Elateridae adults	.1	.1					.03 ± .05			.1	.1			.02 ± .04	.1		.1	.1				.04 ± .05
Other adults								.1		.1				.03 ± .05	.1						.1	.03 ± .05
Leptidoptera																						
Tortricidae larvae	.3	.3					.1 ± .15	.5	.4	.2		.1	.4	.27 ± .20	.7	.2	.1			.1		.16 ± .25
Geometridae larvae									.1	.1				.03 ± .05								
Diptera																						
Tipulidae adults					.1		.02 ± .04													.1		.01 ± .03
Chironomidae adults								.3						.05 ± .12			.1		.1			.03 ± .05
Bibionidae adults									.1	.1				.03 ± .05		.1		.1	.1			.04 ± .05
Hycetophilidae adults	.1						.02 ± .04	.1					.2	.05 ± .08				.1				.01 ± .03
Scleridae adults	.4	.2					.1 ± .17	.9	.2					.18 ± .36	.2	.1		.6				.13 ± .22
Cecidomyiidae adults								.1						.02 ± .04				.1				.01 ± .03
Other adults	.1	.2					.05 ± .08	.1	.3		.3		.1	.13 ± .14	.8		.1	.3		.1		.19 ± .29
Unidentified larvae					.3		.05 ± .12															
Hymenoptera																						
Symphyta adults	.1						.02 ± .04												.1			.01 ± .03
Ichneumonidae adults								.1						.02 ± .04								
Braconidae adults													.1	.02 ± .04								
Chalcidoidea adults										.1				.02 ± .04								
Formicidae adults								.1					.1	.03 ± .05		.1		.1		.1		.04 ± .05
Total terrestrial invertebrates	1.2	.9	0	0	.2	.3	.43 ± .5	.8	3.7	1.1	.7	.2	1.2	1.28 ± 1.24	2.4	1.4	.8	2.4	.6	.4	1.5	1.36 ± .82

*Application from 0552 to 0640 ADT on 11 June 1980 and from 0808 to 0852 ADT on 17 June 1980.

Table 2. Terrestrial invertebrate knockdown from balsam fir, Untreated Control, Gloucester County, New Brunswick, 5 - 23 June 1980.

Days before or after application of 0.280 kg AI/ha SEVIN-2-011®*	Prespray						Avg.	Postspray I						Avg.	Postspray II						Avg.		
	-6	-5	-4	-3	-2	-1		+0	+1	+2	+3	+4	+5		+0	+1	+2	+3	+4	+5		+6	
Araneida									.1					.02 ± .04		.1							.01 ± .04
Homoptera																					.1	.01 ± .04	
Coleoptera																							
Carabidae adults																	.1				.1	.03 ± .05	
Staphylinidae adults	.1						.02 ± .04																
Scarabaeidae adults											.1	.1		.03 ± .05									
Elateridae adults				.1			.02 ± .04											.1				.01 ± .04	
Other adults											.1			.02 ± .04									
Lepidoptera																							
Tortricidae larvae		.3	.1				.07 ± .12																
Diptera																							
Tipulidae adults											.1			.02 ± .04									
Bibionidae adults															.1							.01 ± .04	
Sciariidae adults									.2					.03 ± .08			.1			.1	.4	.09 ± .15	
Cecidomyiidae adults																.1						.01 ± .04	
Phoridae adults																					.1	.01 ± .04	
Other adults										.1				.02 ± .04					.1		.2	.04 ± .08	
Hymenoptera																							
Ichneumonidae adults																.1						.01 ± .04	
Formicidae adults																				.1	.1	.03 ± .05	
Total terrestrial invertebrates	.1	.3	.2	0	0	0	.10 ± .13	0	.3	.1	.3	.1	0	.13 ± .14	.1	.3	.2	.1	.1	.2	1.0	.29 ± .32	

*Application from 0552 to 0640 ADT on 11 June 1980 and from 0808 to 0852 ADT on 17 June 1980.

Table 3. Terrestrial invertebrate knockdown, Treatment stream, Gloucester County, New Brunswick, 4 - 22 June 1980.

Days before or after application of 0.280 kg AI/ha SEVIN-2-0118*	Prespray								Postspray I								Postspray II							
	-7	-6	-5	-4	-3	-2	-1	Avg.	+0	+1	+2	+3	+4	+5	Avg.	+0	+1	+2	+3	+4	+5	Avg.		
Phalangida														0.2	.03 ± .08									
Acarid				0.4				.06 ± .15	0.2						.03 ± .08					0.2	0.4	.10 ± .17		
Araneida	0.4	0.4	0.2	0.2			0.2	.20 ± .16			0.2			0.2	.07 ± .10	0.4		0.6	0.6		0.2	.30 ± .28		
Collembola	0.2	0.2						.06 ± .10	0.2		0.2		0.2	0.2	.13 ± .10									
Plecoptera						0.2		.03 ± .08	0.8	0.4	0.4		0.2		.30 ± .30	0.2		0.4			0.2	.13 ± .16		
Hemiptera																								
Tingidae											0.2				.03 ± .08			0.2				.05 ± .08		
Others											0.2				.03 ± .08						0.2	.03 ± .08		
Homoptera																								
Aphididae																					0.2	.03 ± .08		
Others												0.2			.03 ± .08			0.2				.03 ± .08		
Coleoptera																								
Carabidae adults				0.2	0.2			.06 ± .10			0.2				.03 ± .08									
Staphylinidae adults				0.2		0.4	0.2	.11 ± .16	0.2	0.2	1.4	3.8	5.4	0.6	1.93 ± 2.17	1.6	2.2	2.6	1.0	0.4	0.4	1.37 ± .92		
Curculionide adults		0.2						.03 ± .08									0.4					.07 ± .16		
Other adults						0.2		.03 ± .08	0.2	0.2	0.2				.10 ± .11	1.0	0.4	0.2	0.2		0.8	.43 ± .39		
Trichoptera adults											0.2				.03 ± .08			0.2	0.2			.07 ± .10		
Lepidoptera																								
Tortricidae larvae						0.2		.03 ± .08	0.8	0.2	0.4	0.2			.27 ± .30	0.4	0.4	0.8	0.2			.30 ± .30		
Geometridae larvae											0.2				.03 ± .08									
Diptera																								
Tipulidae adults		0.2						.03 ± .08		0.2	0.2	0.8		0.2	.23 ± .29						0.4	.07 ± .16		
Psychodidae adults									0.2	0.2		0.2		0.4	.17 ± .15		0.2		0.2			.07 ± .10		
Chironomidae adults	0.2	1.0	0.2	0.4				.26 ± .36	3.2	2.8	0.4	0.8	0.6	0.4	1.37 ± 1.28	0.6		0.6		0.2	1.4	.47 ± .53		
Bibionidae adults															.07 ± .16		0.2	0.6				.13 ± .24		
Mycetophilidae adults																		0.2				.03 ± .08		
Sciariidae adults	1.8	2.0	2.0	1.4	2.4	1.0	2.6	1.89 ± .55	4.2	7.0	2.0	3.0	3.6	2.6	3.73 ± 1.77	4.2	1.8	4.2	1.6		3.0	2.47 ± 1.65		
Cecidomyiidae adults		0.2	0.2		0.2			.09 ± .11			0.6	0.2	0.2		.17 ± .23			1.2				.20 ± .49		
Phoridae adults					0.2			.03 ± .08			0.4	0.2			.10 ± .17			1.2			0.4	.27 ± .48		
Other adults			0.4		0.2	0.2		.11 ± .16	0.4	0.2	0.4	0.2		0.4	.27 ± .16	1.0	0.4	1.2	0.2	0.6	0.6	.67 ± .37		
Hymenoptera																								
Symphyta adults		0.2						.03 ± .08							.03 ± .08									
Apocrita adults											0.2				.17 ± .23							.07 ± .10		
Ichneumonidae adults					0.2			.03 ± .08	0.6	0.2	0.2				.17 ± .23	0.2	0.2					.10 ± .11		
Braconidae adults		0.2						.03 ± .08	0.2		0.4				.10 ± .17				0.2	0.2		.10 ± .11		
Chalcidoidea adults	0.2	0.8			0.4			.20 ± .31	0.4	0.6	0.4	0.2	0.2	0.2	.33 ± .16	0.2	0.2		0.2			.13 ± .21		
Other adults																0.4		0.4						
Total terrestrial invertebrates	2.8	5.4	3.4	3.4	3.6	1.2	3.2	3.3 ± 1.2	12.0	13.8	7.4	10.0	10.2	5.4	9.8 ± 3.0	10.2	6.6	15.0	4.4	1.4	8.4	7.7 ± 4.7		

*Application at 0631 on 11 June 1980 and 0819 on 17 June 1980.

Table 4. Terrestrial invertebrate knockdown, Untreated control stream, Gloucester County, New Brunswick,
4 - 22 June 1980.

Days before or after application of 0.280 kg AI/ha SEVIN-2-0118*	Prespray							Avg.	Postspray I							Avg.	Postspray II							Avg.
	-7	-6	-5	-4	-3	-2	-1		+0	+1	+2	+3	+4	+5	+0		+1	+2	+3	+4	+5			
Acarid			0.2					.03 ± .08			0.4				.07 ± .16		0.4		0.2		0.6		.20 ± .25	
Araneida		0.4				0.6	0.2	.17 ± .24	0.2			0.2			.07 ± .10	0.2		0.6	0.2		0.2		.20 ± .22	
Chilopoda		0.2						.03 ± .08																
Collembola						0.8		.11 ± .30		0.2					.03 ± .08									
Ephemeroptera					0.2			.03 ± .08																
Hemiptera																								
Aphididae		0.2						.03 ± .08					0.2		.03 ± .08									
Coleoptera																								
Carabidae adults			0.2			0.2		.06 ± .10					0.2		.03 ± .08	0.2							.03 ± .08	
Staphylinidae adults					0.4			.06 ± .15		0.8	0.6	4.0	10.6	2.4	3.07 ± 3.97	7.0	4.2	0.4	1.0	0.6	0.6		2.30 ± 2.71	
Elateridae		0.2					0.2	.06 ± .10																
Other									0.2		0.2	0.2			.10 ± .11		0.2	0.2			0.4		.13 ± .16	
Lepidoptera																								
Tortricidae larvae											0.2				.03 ± .08		0.2	0.2			0.2		.10 ± .11	
Diptera																								
Tipulidae adults						0.2		.03 ± .08	0.2	0.2					.07 ± .10	0.4		0.4					.13 ± .21	
Chironomidae adults	0.4	1.8	0.4	1.8	3.4	1.6	0.6	1.43 ± 1.08	0.6	1.2	0.4	0.8	0.2		.53 ± .43	0.4			0.4	0.8			.27 ± .33	
Bibionidae adults											0.2				.03 ± .08									
Sciaridae adults	2.2	2.4	1.8	0.4	4.4	0.6	2.0	1.97 ± 1.32	2.2	0.8	1.0	0.8	0.4	1.2	1.07 ± .62	0.4	0.6	0.2	0.4	0.4	0.4		.40 ± .13	
Cecidomyiidae adults		0.4	0.2			0.4	0.2	.17 ± .18		0.2				0.2	.07 ± .10	0.4	0.6	0.2					.20 ± .25	
Phoridae adults	0.2		0.2		0.2		0.2	.11 ± .11		0.2		0.2	0.4		.13 ± .16		0.2						.03 ± .08	
Other adults	0.2						0.4	.09 ± .16	0.4	0.4	0.6	0.2		0.2	.30 ± .21	0.2	0.2	0.4	0.2		0.2		.20 ± .13	
Hymenoptera																								
Ichneumonidae adults	0.2							.03 ± .08			0.2				.03 ± .08									
Ichneumonidae adults		0.4					0.4	.11 ± .20	0.4		0.2	0.2		0.2	.17 ± .15			0.2	0.2		0.2		.10 ± .11	
Braconidae adults				0.2	0.2			.06 ± .10	0.2						.03 ± .08	0.2							.03 ± .08	
Chalcidoidea adults	0.4	0.4	0.2	0.4	0.2		0.2	.26 ± .15			0.2	0.4	0.2		.13 ± .16	0.2					0.2		.07 ± .10	
Formicidae adults									0.2						.03 ± .08									
Other adults																					0.2		.03 ± .08	
Total terrestrial invertebrates	3.6	6.4	3.2	2.8	9.2	4.2	4.4	4.8 ± 2.3	4.6	4.0	4.2	7.0	11.8	4.6	6.0 ± 3.0	9.6	6.6	2.8	2.6	1.8	3.2	4.4	± 3.0	

*Application at 0631 on 11 June 1980 and 0819 on 17 June 1980.

Table 5. Terrestrial organisms caught in drift net sets*, Middle Brook Treatment Station A, Gloucester County, New Brunswick, 2 - 22 June 1980.

Days before or after application of 0.280 kg AI/ha SEVIN-2-0112**		-9		-8		-7		-6		-5		-4		-3		-2		-1	
		AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Current speed (m/sec)		0.27	0.24	0.24	0.30	0.27	0.18	0.21	0.24	0.27	0.21	0.24	0.24	0.24	0.21	0.37	0.21	0.24	0.24
Surface Area of Drift Column (m ²)		114.21	101.52	101.52	126.90	114.21	76.14	88.83	101.52	114.21	88.83	101.52	101.52	101.52	88.83	156.51	88.83	101.52	101.52
Araneida								0.01						0.01					0.01
Collembola		0.02	0.08	0.01				0.01		0.01	0.02			0.02		0.01	0.01		
Ephemeroptera	A	0.01												0.01					
Plecoptera	A																		
Thysanoptera	A							0.01							0.01	0.01		0.01	
Hemiptera			0.02	0.01															
Homoptera																			
Coleoptera	A																		
Trichoptera	A		0.01			0.01													
Lepidoptera	L															0.02	0.02	0.05	0.01
Diptera	A	0.04	0.07	0.01	0.02		0.07	0.03	0.04		0.01		0.02						
Hymenoptera	L																	0.01	
Unidentified	A	0.01					0.01												
Total Terrestrial Invertebrates		0.07	0.18	0.03	0.02	0.01	0.08	0.07	0.04	0.01	0.03	0.00	0.02	0.04	0.01	0.04	0.03	0.07	0.02

*expressed as number of organisms per m² of surface area of drift column

**application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980

A = adult

L = larvae

Table 5. Terrestrial organisms caught in drift net sets*, Middle Brook Treatment Station A, Gloucester County, New Brunswick, 2 - 22 June 1980. (Concluded)

Days before or after application of 0.280 kg AI/ha SEVIN-2-ONE***		Pre	0hr	+½ hr	Spray Day		+1 hr	+2 hr	+3 hr	+4 hr	PH	AM	+1	PH	AM	+2	PH	AM	+3	PH	AM	+4	PH	AM	+5	PH
Current speed (m/sec)			0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.27	0.18	0.15	0.15	0.21	0.21	0.15	0.21	0.18	0.21	0.24					
Surface Area of Drift Column (m ²)			101.52	101.52	101.52	101.52	101.52	101.52	101.52	114.21	76.14	63.45	63.45	88.83	88.83	63.45	88.83	76.14	88.83	101.52						
Araneida			0.01			0.01								0.02		0.01	0.02				0.01					
Collembola				0.01	0.08	0.03			0.04					0.03					0.01	0.03						
Ephemeroptera		A																								
Plecoptera		A				0.01																				
Thysanoptera		A																								
Hemiptera																										
Homoptera												0.01														
Coleoptera		A													0.01	0.01		0.01							0.01	
Trichoptera		A				0.01																				
Lepidoptera		L																								
Diptera		A	0.05	0.10	0.15	0.14	0.01	0.03	0.03	0.04	0.03	0.05	0.03		0.02			0.01	0.08	0.11						
Hymenoptera		L				0.01																				
Unidentified		A				0.01													0.01							
Total Terrestrial Invertebrates			0.00	0.06	0.11	0.25	0.20	0.01	0.03	0.07	0.05	0.03	0.09	0.05	0.02	0.03	0.01	0.04	0.11	0.13						

*expressed as number of organisms per m² of surface area of drift column

**application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980

A = adult

L = larvae

Table 6. Terrestrial organisms caught in drift net sets, Bass Brook Control Station, Gloucester County, New Brunswick, 2 - 22 June 1980.

Days before or after application of 0.280 kg AI/ha SEVIN-2-0115**		-9		-8		-7		-6		-5		-4		-3		-2		-1	
		AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Current speed (m/sec)		0.40	0.37	0.34	0.34	0.37	0.34	0.37	0.37	0.34	0.37	0.34	0.34	0.37	0.34	0.34	0.37	0.37	0.34
Surface Area of Drift Column (m ²)		169.20	156.51	143.82	143.82	156.51	143.82	156.51	156.51	143.82	156.51	143.82	143.82	156.51	143.82	143.82	156.51	156.51	143.82
Araneida					0.01				0.01										
Chilopoda																			
Collembola				0.01		0.01	0.05			0.01		0.01			0.01		0.01		
Ephemeroptera	A												0.01						
Homoptera									0.01										
Coleoptera	A																		
Trichoptera	A	0.01			0.01			0.01						0.01				0.01	
Lepidoptera	L	0.01									0.01								
Diptera	L															0.01			
Hymenoptera	A	0.04	0.03	0.01	0.03		0.02	0.02	0.12		0.04	0.01	0.08	0.01	0.09	0.06	0.03		0.17
															0.01		0.01		
Total Terrestrial Invertebrates		0.05	0.03	0.02	0.04	0.01	0.07	0.03	0.13	0.01	0.05	0.02	0.08	0.01	0.11	0.07	0.04	0.01	0.17

*expressed as number of organisms per m² of surface area of drift column

**application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980

A = adults

L = larvae

Table 6. Terrestrial organisms caught in drift net sets, Bass Brook Control Station, Gloucester County
New Brunswick, 2 - 22 June 1980. (Concluded)

Days before or after application of 0.230 kg AI/ha SEVIN-2-011:2**		0600	0700	Spray Day		0800	0900	1000	1100	PH	11		12	13	14	15	
											AH	PH	AH	PH	AH	PH	PH
Current speed (m/sec)		0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.30	0.30	0.30	0.30	0.30	0.34	0.30
Surface Area of Drift Column (m ²)		143.82	143.82	143.82	143.82	143.82	143.82	143.82	143.82	143.82	126.90	126.90	126.90	126.90	126.90	143.82	126.90
Araneida													0.02			0.01	
Chilopoda																	
Collembola		0.01	0.01	0.01	0.01					0.01			0.01				
Ephemeroptera	A																
Homoptera																0.01	
Coleoptera	A									0.01							
Trichoptera	A																
Lepidoptera	L												0.01				
Diptera	L																
Hymenoptera	A	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.04	0.02	0.02	0.06	0.06	0.02	0.06	0.02
	A								0.01						0.01		0.01
Total Terrestrial Invertebrates		0.01	0.02	0.01	0.02	0.03	0.02	0.06	0.02	0.02	0.02	0.02	0.08	0.06	0.02	0.06	0.02

*expressed as number of organisms per m² of surface area of drift column

**application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980

A - adults

L - larvae

APPENDIX II

Population structure of bird communities
on treatment and control plots,
Gloucester County, New Brunswick.

Common and Scientific names of bird species censused

Scientific name	Common name	Scientific name	Common name
ACCIPITRIDAE		VIREONIDAE	
<i>Buteo platypterus</i>	Broad-winged hawk	<i>Vireo solitarius</i>	Solitary vireo
TETRAONIDAE		<i>Vireo olivaceus</i>	Red-eyed vireo
<i>Bonasa umbellus</i>	Ruffed grouse	PARULIDAE	
APODIDAE		<i>Mniotilta varia</i>	Black-and-white warbler
<i>Chaetura pelagica</i>	Chimney swift	<i>Vermivora peregrina</i>	Tennessee warbler
TROCHILIDAE		<i>Vermivora ruficapilla</i>	Nashville warbler
<i>Archilochus colubris</i>	Ruby-throated hummingbird	<i>Parula americana</i>	Parula warbler
PICIDAE		<i>Dendroica magnolia</i>	Magnolia warbler
<i>Colaptes auratus</i>	Common flicker	<i>Dendroica tigrina</i>	Cape May warbler
<i>Dryocopus pileatus</i>	Pileated woodpecker	<i>Dendroica caerulescens</i>	Black-throated blue warbler
<i>Sphyrapicus varius</i>	Yellow-bellied sapsucker	<i>Dendroica coronata</i>	Yellow-rumped warbler
<i>Dendrocopos villosus</i>	Hairy woodpecker	<i>Dendroica virens</i>	Black-throated green warbler
TYRANNIDAE		<i>Dendroica fusca</i>	Blackburnian warbler
<i>Myiarchus cinerascens</i>	Great-crested flycatcher	<i>Dendroica pennsylvanica</i>	Chestnut-sided warbler
<i>Empidonax flaviventris</i>	Yellow-bellied flycatcher	<i>Dendroica castanea</i>	Bay-breasted warbler
<i>Empidonax traillii</i>	Alder flycatcher	<i>Dendroica striata</i>	Blackpoll warbler
<i>Empidonax minimus</i>	Least flycatcher	<i>Dendroica palmarum</i>	Palm warbler
<i>Contopus virens</i>	Eastern wood pewee	<i>Seiurus aurocapillus</i>	Ovenbird
<i>Mniotilta borealis</i>	Olive-sided flycatcher	<i>Seiurus noveboracensis</i>	Northern waterthrush
CORVIDAE		<i>Oporornis philadelphia</i>	Hourning warbler
<i>Perisoreus canadensis</i>	Gray Jay	<i>Geothlypis trichas</i>	Common yellowthroat
<i>Cyanocitta cristata</i>	Blue Jay	<i>Wilsonia pusilla</i>	Wilson's warbler
<i>Corvus corax</i>	Common raven	<i>Wilsonia canadensis</i>	Canada warbler
PARIDAE		<i>Setophaga ruticilla</i>	American redstart
<i>Parus atricapillus</i>	Black-capped chickadee	ICTERIDAE	
<i>Parus hudsonicus</i>	Boreal chickadee	<i>Quiscalus quiscula</i>	Common grackle
SITTIDAE		<i>Molothrus ater</i>	Brown-headed cowbird
<i>Sitta canadensis</i>	Red-breasted nuthatch	THRAUPIDAE	
CERTHIDAE		<i>Piranga olivacea</i>	Scarlet Tanager
<i>Certhia familiaris</i>	Brown creeper	FRINGILLIDAE	
TROGLODYTIDAE		<i>Richmondia cardinalis</i>	Cardinal
<i>Troglodytes troglodytes</i>	Winter wren	<i>Pheucticus ludovicianus</i>	Rose-breasted grosbeak
TURDIDAE		<i>Coereba bartholemica</i>	Evening grosbeak
<i>Turdus migratorius</i>	American robin	<i>Carpodacus purpureus</i>	Purple finch
<i>Mylocichla guttata</i>	Hermit thrush	<i>Pinicola enucleator</i>	Pine grosbeak
<i>Mylocichla ustulata</i>	Swainson's thrush	<i>Spinus tristis</i>	American goldfinch
<i>Mylocichla fuscescens</i>	Veery	<i>Junco hyemalis</i>	Dark-eyed Junco
SYLVIIDAE		<i>Spizella passerina</i>	Chipping sparrow
<i>Regulus satrapa</i>	Golden-crowned kinglet	<i>Zonotrichia albicollis</i>	White-throated sparrow
<i>Regulus calendula</i>	Ruby-crowned kinglet	<i>Melospiza lincolni</i>	Lincoln's sparrow
BOMBYCILLIDAE			
<i>Bombycilla cedrorum</i>	Cedar waxwing		

Table 1
Forest bird population census
Sevin Treatment Block
Allardville, New Brunswick
2-23 June, 1980

Family	Species	Prespray								Postspray 1								Postspray 2							
		June 2	June 3	June 4	June 5	June 6	June 8	June 10	Avg.	June 11	June 12	June 13	June 14	June 15	June 17	Avg.	June 18	June 19	June 20	June 21	June 22	June 23	Avg.		
		-9	-8	-7	-6	-5	-3	-1		+0	+1	+2	+3	+4	+6		+1	+2	+3	+4	+5	+6			
Tetraonidae	Ruffed Grouse	4	2	0	2	0	0	0	1.1	0	0	0	0	0	2	0.3	0	0	0	0	2	0	0.3		
Apodidae	Chimney Swift	0	0	0	0	6	0	0	0.9	0	0	0	0	2	0	0.3	0	0	0	0	0	0	0.0		
Trochilidae	Ruby-throated Hummingbird	0	0	0	1	0	0	0	0.1	0	0	0	0	1	0	0.2	0	0	0	0	0	0	0.0		
Picidae	Common Flicker	0	1	0	0	0	0	0	0.1	0	0	1	0	0	0	0.2	0	0	3	2	2	0	1.2		
	Piliated Woodpecker	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0.0	0	0	0	0	1	0	0.2		
	Yellow-bellied Sapsucker	0	1	0	1	2	2	1	1.0	0	2	2	0	2	3	1.5	0	3	2	2	0	0	1.2		
Tyrannidae	Great-crested Flycatcher	1	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0.0		
	Yellow-bellied Flycatcher	0	0	0	0	0	0	0	0.0	0	0	0	0	2	0	0.3	2	2	2	0	2	0	1.3		
	Alder Flycatcher	0	0	0	0	0	0	0	0.0	0	2	0	0	0	0	0.3	0	0	0	0	0	0	0.0		
	Least Flycatcher	2	4	0	6	4	4	0	2.9	4	2	6	4	4	4	4.0	6	8	4	6	8	6	6.3		
	Eastern Wood Pewee	0	0	0	0	2	2	0	0.6	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0.0		
	Olive-sided Flycatcher	0	0	2	0	2	0	0	0.6	0	6	3	0	0	1	1.7	0	0	0	0	0	0	0.0		
Corvidae	Gray Jay	0	0	0	0	0	0	0	0.0	0	0	2	0	0	0	0.3	0	1	0	1	2	1	0.8		
	Blue Jay	1	0	0	0	0	2	0	0.4	1	0	0	1	0	0	0.3	0	0	0	0	0	0	0.0		
Paridae	Black-capped Chickadee	2	0	0	1	0	0	0	0.4	0	4	3	2	0	2	1.8	0	1	2	1	1	4	1.5		
	Boreal Chickadee	0	1	2	0	1	0	1	0.7	1	0	1	0	1	3	1.0	2	0	0	0	0	1	0.5		
Certhiidae	Brown Creeper	0	1	0	0	0	0	0	0.1	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0.0		
Troglodytidae	Winter Wren	0	0	2	0	0	2	0	0.6	0	0	0	2	2	0	0.7	2	2	2	0	0	0	1.0		
Turdidae	American Robin	3	8	4	4	4	3	0	3.7	0	3	3	2	10	5	3.8	8	2	8	8	8	6	6.7		
	Hermit Thrush	2	2	0	2	0	0	0	0.9	1	1	5	0	0	1	1.3	2	1	0	2	4	7	2.7		
	Swainson's Thrush	1	2	9	3	8	0	0	3.3	7	9	15	11	9	13	10.7	8	12	18	8	15	27	14.7		
	Veery	4	2	1	0	2	4	1	2.0	2	0	7	7	2	5	3.8	6	8	7	2	0	9	5.3		
Sylviidae	Golden-crowned Kinglet	0	0	0	0	0	0	0	0.0	0	0	0	0	2	2	0.7	0	4	2	3	0	0	1.5		
	Ruby-crowned Kinglet	12	10	6	4	6	4	8	7.1	4	5	6	6	4	4	4.8	4	6	4	4	8	2	4.7		
Bombycillidae	Cedar Waxwing	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0.0	0	0	2	0	0	0	0.3		
Vireonidae	Solitary Vireo	2	6	6	6	4	6	2	4.6	12	6	6	6	6	8	7.3	4	6	6	4	4	8	5.3		
	Red-eyed Vireo	2	0	0	0	4	0	0	0.9	0	0	0	0	0	0	0.0	0	0	0	0	2	0	0.3		

(cont'd)

Table 1
Forest bird population census
Sevin Treatment Block
Allardville, New Brunswick
2-23 June, 1980 (concl)

Family	Species	Prespray								Postspray 1								Postspray 2							
		June 2	June 3	June 4	June 5	June 6	June 8	June 10	Avg.	June 11	June 12	June 13	June 14	June 15	June 17	Avg.	June 18	June 19	June 20	June 21	June 22	June 23	Avg.		
		-9	-8	-7	-6	-5	-3	-1		+0	+1	+2	+3	+4	+6		+1	+2	+3	+4	+5	+6			
Parulidae	Black-and-white Warbler	0	2	0	4	2	1	2	1.6	2	2	4	2	0	6	2.7	2	4	2	0	4	2	2.3		
	Tennessee Warbler	14	12	6	9	6	6	2	7.9	6	4	10	6	10	8	7.3	10	8	14	12	8	8	10.0		
	Nashville Warbler	4	2	2	2	2	2	0	2.0	4	2	2	2	2	0	2.0	0	4	2	2	0	2	1.7		
	Parula Warbler	8	6	6	5	6	4	2	5.3	2	4	4	4	6	6	4.3	2	2	18	8	2	6	6.3		
	Magnolia Warbler	13	13	10	12	14	2	2	9.4	12	12	18	18	16	20	16.0	8	10	10	12	6	8	9.0		
	Cape May Warbler	14	4	6	4	9	4	0	5.9	4	4	2	4	2	2	3.0	6	12	10	2	2	6	6.3		
	Black-throated Blue Warbler	0	2	4	15	10	6	0	5.3	6	6	8	10	2	14	7.7	8	8	14	0	6	8	7.3		
	Yellow-rumped Warbler	2	0	0	6	2	4	2	2.3	0	5	9	4	6	2	4.3	5	12	10	3	3	6	6.5		
	Black-throated Green Warbler	10	6	6	2	0	2	0	3.7	0	0	2	0	2	0	0.7	2	8	6	6	4	2	4.7		
	Blackburnian Warbler	6	6	6	10	8	10	4	7.1	14	4	16	16	6	6	10.3	6	10	12	8	4	15	9.3		
	Chestnut-sided Warbler	10	12	4	6	6	8	4	7.1	5	5	6	10	6	6	6.3	8	8	10	4	4	5	6.5		
	Bay-breasted Warbler	10	18	2	5	8	10	6	8.4	8	18	14	8	16	13	12.8	10	6	14	4	10	12	9.3		
	Blackpoll Warbler	2	0	2	0	2	4	2	1.7	0	2	2	0	0	2	1.0	2	2	0	0	0	0	0.6		
	Palm Warbler	0	1	0	0	0	0	0	0.1	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0.0		
	Ovenbird	4	4	4	6	6	8	4	5.1	8	6	12	16	10	10	10.3	4	10	10	2	10	10	7.7		
	Northern Waterthrush	4	4	4	2	4	4	2	3.4	2	4	4	2	2	4	3.0	2	2	6	2	2	2	2.7		
	Mourning Warbler	4	0	0	0	0	2	0	0.9	0	2	0	2	4	2	1.7	0	0	0	0	0	0	0.0		
	Common Yellowthroat	4	1	0	5	4	4	2	2.9	2	2	0	2	4	8	3.0	0	0	2	6	2	4	2.3		
	Wilson's Warbler	2	0	0	2	6	0	0	1.4	0	0	2	2	0	0	0.7	0	2	0	0	0	0	0.3		
	Canada Warbler	8	10	6	9	13	10	6	8.9	10	14	15	16	10	16	13.5	4	8	12	6	8	4	7.0		
	American Redstart	10	9	11	10	10	9	1	8.6	10	19	10	18	13	24	15.7	20	12	21	12	21	16	17.0		
Thraupidae	Scarlet Tanager	0	0	0	0	2	0	0	0.3	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0.0		
Fringillidae	Rose-breasted Grosbeak	6	7	4	13	10	9	0	7.0	8	10	10	10	8	4	8.3	4	7	13	4	8	14	8.3		
	Evening Grosbeak	0	0	0	6	2	0	0	1.1	3	0	0	0	0	4	1.2	8	8	0	0	2	0	3.0		
	Purple Finch	0	2	0	0	0	0	0	0.3	0	0	2	2	2	0	1.0	2	0	0	0	2	2	1.0		
	Pine Grosbeak	0	0	0	14	4	2	0	2.9	1	0	0	0	0	0	0.2	2	0	0	0	2	0	0.6		
	Dark-eyed Junco	2	3	0	2	1	0	0	1.1	2	0	2	0	0	2	1.0	0	0	0	0	2	0	0.3		
	Chipping Sparrow	0	2	0	0	0	0	0	0.3	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0.0		
	White-throated Sparrow	8	3	6	5	6	5	8	5.9	12	16	12	9	13	12	12.3	2	10	16	7	13	15	10.5		
Unidentified Birds	0	2	0	0	0	0	0	0.3	0	0	0	0	0	0	0.0	0	0	0	0	1	0	0.2			
Total Birds		181	171	121	184	188	145	62	150.3	153	181	226	204	187	224	195.8	161	209	264	143	185	218	196.7		

Table 2
Forest bird population census
Untreated Control Block
Allardville, New Brunswick
2-23 June, 1980

Family	Species	Prespray								Postspray 1								Postspray 2							
		June 2	June 3	June 4	June 5	June 6	June 8	June 10	Avg.	June 11	June 12	June 13	June 14	June 15	June 17	Avg.	June 18	June 19	June 20	June 21	June 22	June 23	Avg.		
		-9	-8	-7	-6	-5	-3	-1		+0	+1	+2	+3	+4	+6		+1	+2	+3	+4	+5	+6			
Accipitridae	Broad-winged Hawk	0	0	0	0	0	1	0	0.1	0	1	0	0	0	0	0.2	0	0	0	0	0	0	0.0		
Tetraonidae	Ruffed Grouse	1	0	0	0	1	1	0	0.4	0	1	0	0	0	1	0.3	0	0	0	0	0	0	0.0		
Apodidae	Chimney Swift	0	0	0	0	0	1	0	0.1	0	0	0	2	0	0	0.3	0	0	1	0	0	1	0.3		
Trochilidae	Ruby-throated Hummingbird	1	1	1	0	1	1	0	0.7	0	0	0	0	0	0	0.0	0	0	1	0	0	0	0.2		
Picidae	Common Flicker	0	2	1	0	1	1	0	0.7	2	2	3	2	0	1	1.7	0	0	1	0	2	1	0.7		
	Yellow-bellied Sapsucker	2	2	3	1	1	1	0	1.4	1	1	2	1	2	3	1.7	0	1	1	2	2	1	1.2		
	Hairy Woodpecker	0	0	0	0	0	0	0	0.0	1	1	0	0	0	0	0.3	0	0	0	0	0	0	0.0		
Tyrannidae	Yellow-bellied Flycatcher	0	0	0	0	1	0	0	0.1	0	0	2	0	2	0	0.7	0	0	0	0	0	0	0.0		
	Alder Flycatcher	0	0	2	0	0	0	0	0.3	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0.0		
	Least Flycatcher	0	4	4	4	2	6	0	2.9	8	2	2	2	2	4	3.3	2	8	12	6	4	6	6.3		
	Eastern Wood Pewee	0	0	0	0	0	4	0	0.6	0	0	0	0	0	0	0.0	2	0	0	0	0	0	0.3		
	Olive-sided Flycatcher	0	0	0	0	2	0	0	0.3	0	0	2	0	0	0	0.3	0	0	0	0	0	2	0.3		
Corvidae	Gray Jay	0	5	0	0	1	0	0	0.9	5	0	0	0	0	0	0.8	0	4	0	0	0	0	0.7		
	Blue Jay	1	1	3	0	5	1	0	1.6	2	0	1	1	1	1	1.0	2	0	2	0	2	3	1.5		
	Common Raven	0	0	2	0	1	0	0	0.4	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0.0		
Paridae	Black-capped Chickadee	1	1	0	1	1	1	1	0.9	0	0	2	0	1	1	0.7	1	0	0	0	0	0	0.2		
	Boreal Chickadee	3	0	1	1	0	1	1	1.0	0	0	0	0	0	2	0.3	0	0	0	2	0	0	0.3		
Sittidae	Red-breasted Nuthatch	0	0	0	0	0	0	0	0.0	2	0	0	2	2	4	1.7	4	0	2	0	0	0	1.0		
Troglodytidae	Winter Wren	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0.0	0	0	0	0	0	2	0.3		
Turdidae	American Robin	3	0	6	2	3	2	2	2.6	0	1	1	5	10	6	3.8	3	7	7	6	4	8	5.8		
	Hermit Thrush	4	8	10	4	7	4	4	5.9	2	6	4	0	4	6	3.7	0	4	7	6	0	4	3.5		
	Swainson's Thrush	7	8	8	7	9	10	5	7.7	8	8	10	7	15	11	9.8	2	13	26	10	11	11	12.2		
	Veery	0	0	0	0	0	0	1	0.1	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0.0		
Sylviidae	Ruby-crowned Kinglet	10	12	15	10	12	8	4	10.1	8	8	8	8	12	13	9.5	6	6	8	6	8	10	7.3		
Bombycillidae	Cedar Waxwing	1	0	2	0	0	0	0	0.4	2	1	0	1	1	1	1.0	0	0	0	1	0	0	0.2		
Vireonidae	Solitary Vireo	0	4	4	2	6	2	2	2.9	2	0	2	6	4	0	2.3	2	2	2	0	2	0	1.3		
	Red-eyed Vireo	0	0	0	0	0	0	0	0.0	0	0	0	0	4	0	0.7	2	0	0	0	0	0	0.3		
Parulidae	Black-and-white Warbler	4	6	0	2	6	7	2	3.9	2	4	8	6	4	6	5.0	0	2	8	6	0	6	3.7		
	Tennessee Warbler	10	11	10	12	12	14	10	11.3	12	12	18	14	14	20	15.0	12	16	12	12	4	18	12.3		
	Nashville Warbler	0	0	0	0	2	6	0	1.1	2	2	2	2	4	0	2.0	2	2	2	2	0	0	1.7		
	Parula Warbler	4	8	8	0	0	4	2	3.4	2	2	0	0	4	2	1.7	0	0	6	4	0	4	2.3		
	Magnolia Warbler	22	26	20	27	28	22	17	23.4	28	24	36	18	25	26	26.2	10	24	32	24	22	24	22.7		
	Black-throated Blue Warbler	2	6	2	2	0	4	0	2.3	2	0	4	4	0	2	2.0	2	0	2	4	2	2	2.0		

(cont'd)

Table 2
Forest bird population census
Untreated Control Block
Allardville, New Brunswick
2-23 June, 1980 (concl)

Family	Species	Prespray								Postspray 1								Postspray 2							
		June 2	June 3	June 4	June 5	June 6	June 8	June 10	Avg.	June 11	June 12	June 13	June 14	June 15	June 17	Avg.	June 18	June 19	June 20	June 21	June 22	June 23	Avg.		
		-9	-8	-7	-6	-5	-3	-1		+0	+1	+2	+3	+4	+6		+1	+2	+3	+4	+5	+6			
Parulidae (Cont'd)	Yellow-rumped Warbler	6	6	6	4	2	2	2	4.0	4	8	8	9	7	4	6.7	2	7	6	0	4	4	3.8		
	Black-throated Green Warbler	8	8	4	6	8	12	4	7.1	4	4	10	6	6	6	5.7	6	8	6	6	2	2	5.0		
	Blackburnian Warbler	6	8	8	2	9	8	4	6.4	8	6	3	4	12	2	5.8	8	6	8	4	10	8	7.3		
	Chestnut-sided Warbler	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0.0	2	0	0	0	0	0	0.3		
	Bay-breasted Warbler	18	14	16	14	24	18	10	16.3	14	14	17	14	18	10	14.5	14	14	24	8	8	18	14.3		
	Blackpoll Warbler	0	0	0	2	0	0	0	0.3	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0.0		
	Ovenbird	16	11	6	14	14	18	12	13.0	14	16	18	14	12	12	14.3	8	16	10	8	12	12	11.0		
	Northern Waterthrush	2	0	0	0	0	0	0	0.3	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0.0		
	Common Yellowthroat	8	6	10	4	9	8	4	7.0	4	0	6	4	2	8	3.7	4	6	6	4	6	0	4.3		
	Canada Warbler	2	0	0	0	0	2	0	0.6	0	0	0	2	0	0	0.3	0	2	4	0	0	0	1.0		
American Redstart	0	0	0	2	0	0	0	0.3	0	0	0	2	2	2	1.0	2	4	0	0	0	0	1.0			
Icteridae	Common Grackle	0	0	0	0	0	0	0	0.0	2	0	1	1	0	0	0.7	0	0	0	0	0	0	0.0		
	Brown-headed Cowbird	0	2	0	0	0	0	0	0.3	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0.0		
Thraupidae	Scarlet Tanager	0	0	0	0	0	0	1	0.1	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0.0		
Fringillidae	Cardinal	0	0	0	0	0	0	0	0.0	2	0	0	0	0	0	0.3	0	0	0	0	0	0	0.0		
	Rose-breasted Grosbeak	5	8	4	6	8	6	0	5.3	2	4	7	0	8	2	3.8	0	2	10	0	0	4	2.7		
	Evening Grosbeak	0	0	0	2	2	2	0	0.9	0	4	0	0	0	1	0.8	0	2	0	0	4	2	1.3		
	Purple Finch	2	0	0	0	0	2	0	0.6	0	0	0	0	2	0	0.3	0	0	0	0	0	0	0.0		
	Pine Grosbeak	0	0	2	2	0	0	0	0.6	0	2	2	2	0	6	2.0	0	0	2	4	0	2	1.3		
	American Goldfinch	0	0	1	1	3	0	0	0.7	0	0	1	0	0	0	0.2	0	0	1	0	0	0	0.2		
	Dark-eyed Junco	2	6	7	6	4	4	3	4.6	2	5	2	8	9	3	4.8	0	4	2	2	6	6	3.3		
	White-throated Sparrow	10	13	12	2	14	10	5	9.4	6	10	13	17	10	8	10.7	4	8	8	1	8	11	6.7		
	Lincoln's Sparrow	0	0	2	0	2	2	0	0.9	0	0	2	0	0	0	0.3	0	0	0	0	0	0	0.0		
Unidentified Birds	2	5	1	0	4	0	0	1.7	0	0	2	0	0	0	0.3	0	0	6	0	0	0	1.0			
Total Birds	163	192	181	142	205	196	96	167.9	153	149	199	164	199	174	173.0	102	168	225	128	125	172	153.3			

APPENDIX III

Breeding territories of selected bird species occupying
niches of varying exposure to the insecticide,
Gloucester County, New Brunswick.

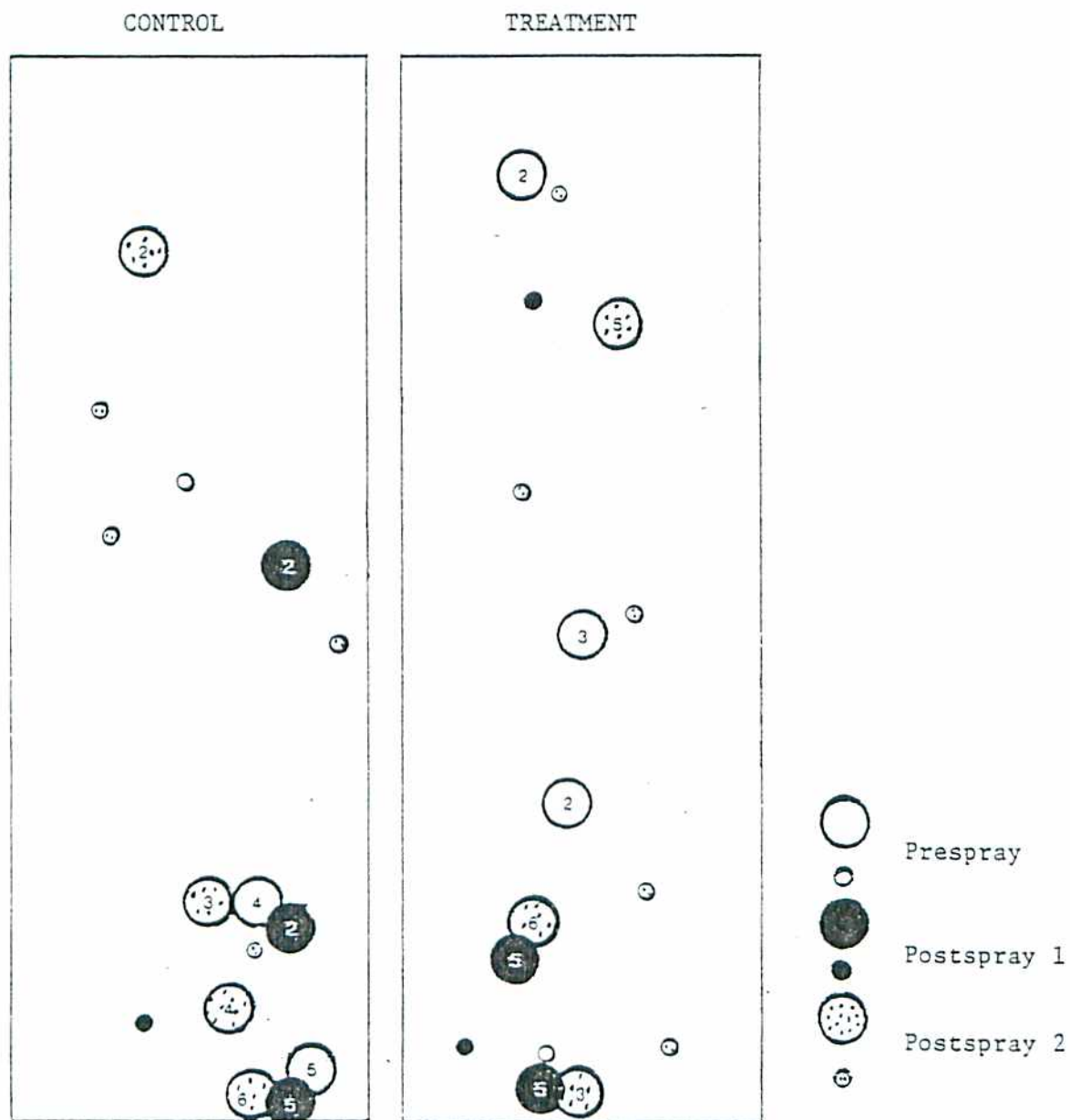


Figure 1: Breeding territories of the Least flycatcher. Large circles represent nesting territories and small circles represent single records. Numbers within circles represent number of days recorded in territory.

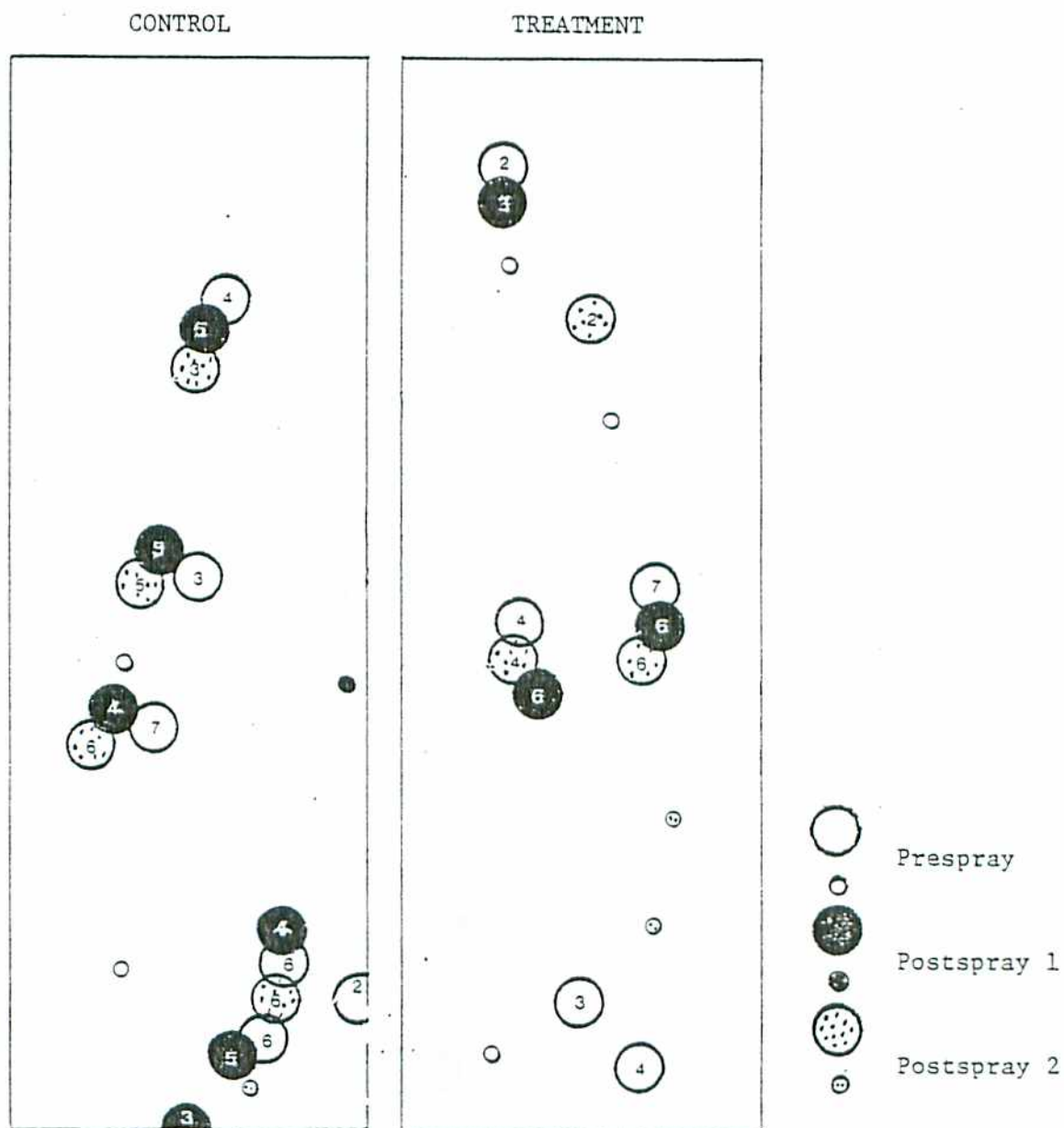


Figure 2: Breeding territories of the Ruby-crowned kinglet. Large circles represent nesting territories and small circles represent single records. Numbers within circles represent number of days recorded in territory.

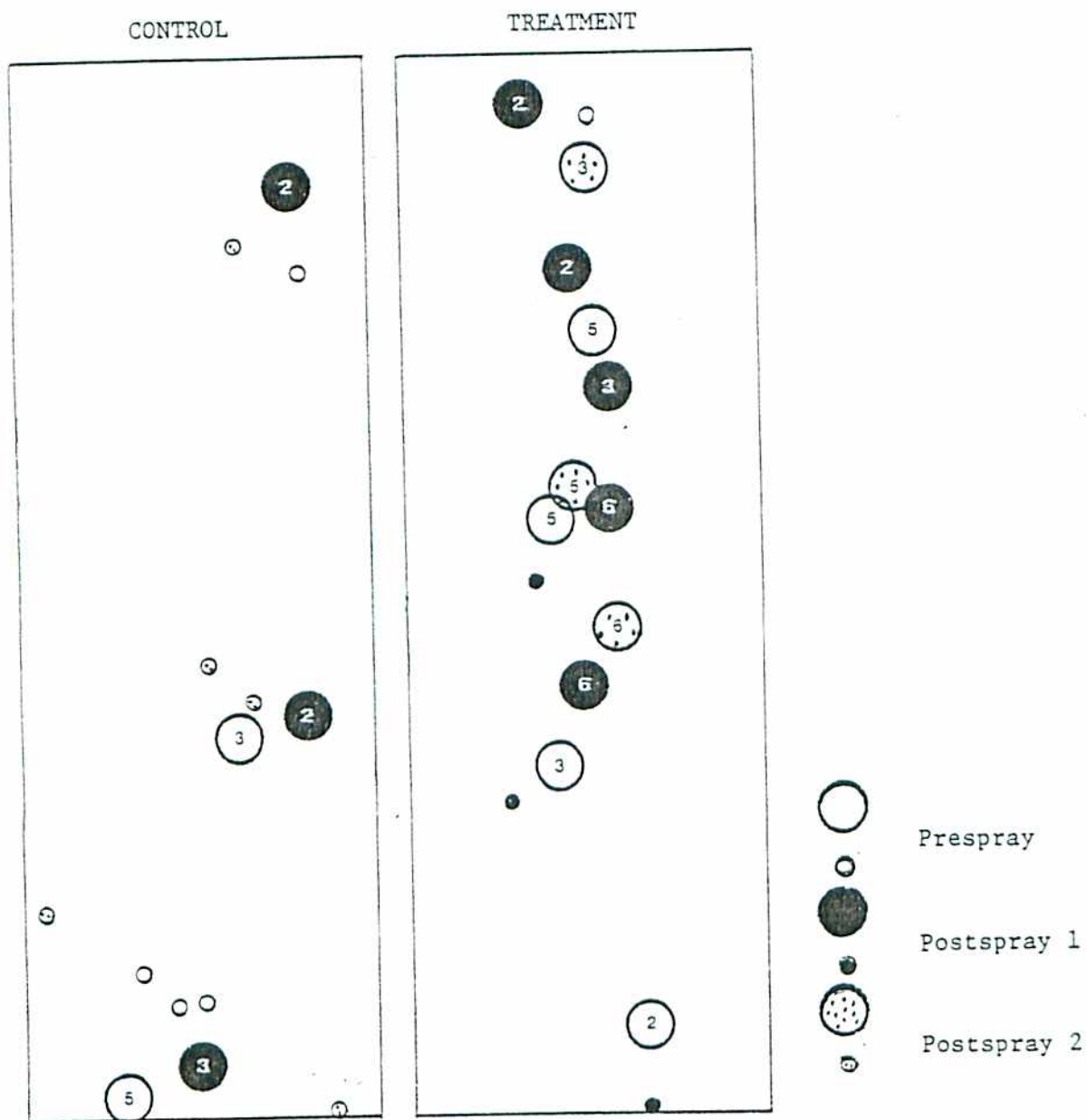


Figure 3: Breeding territories of the Solitary vireo. Large circles represent nesting territories and small circles represent single records. Numbers within circles represent number of days recorded in territory.

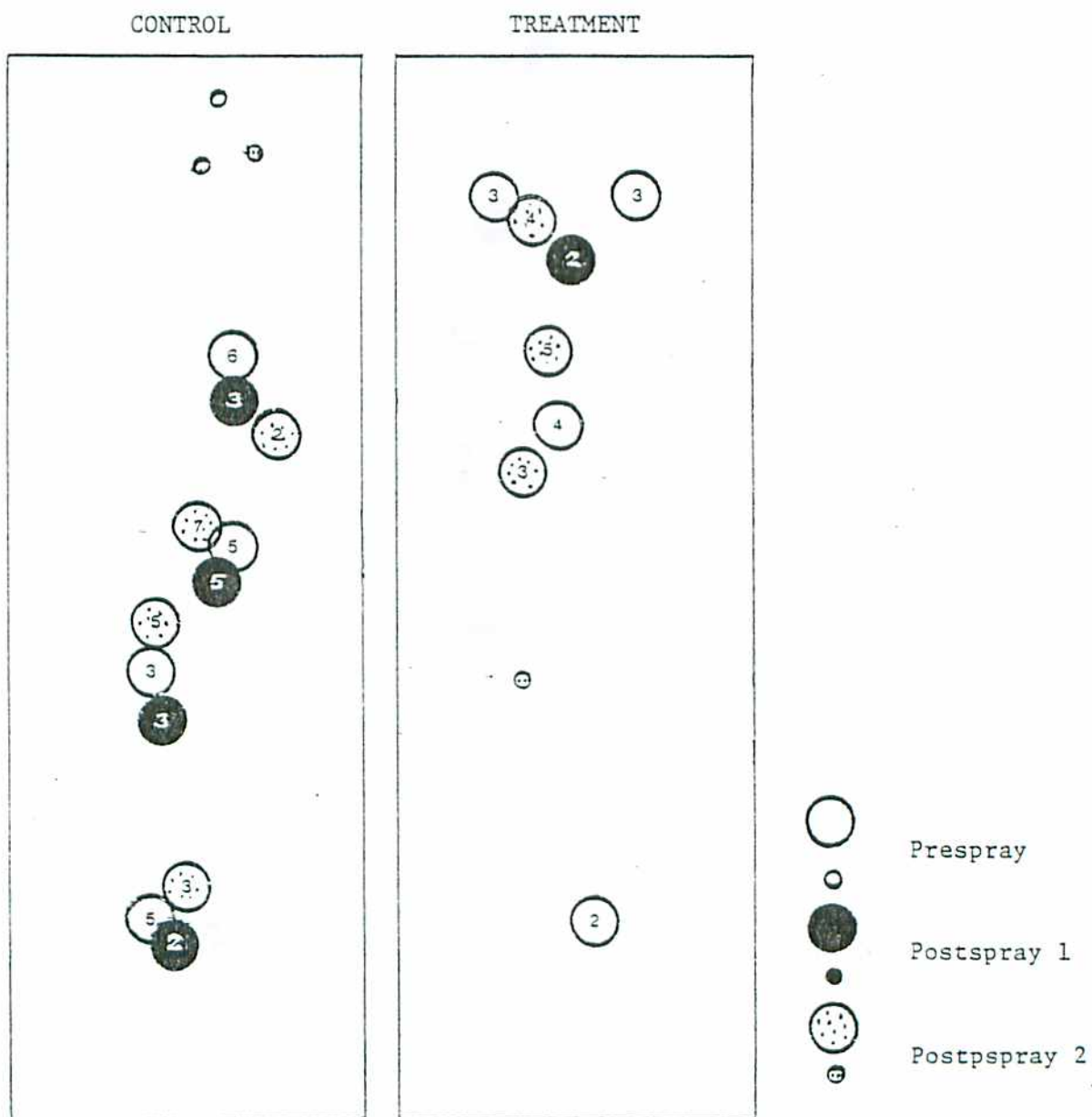


Figure 4: Breeding territories of the Black-throated green warbler. Large circles represent nesting territories and small circles represent single records. Numbers within circles represent number of days recorded in territory.

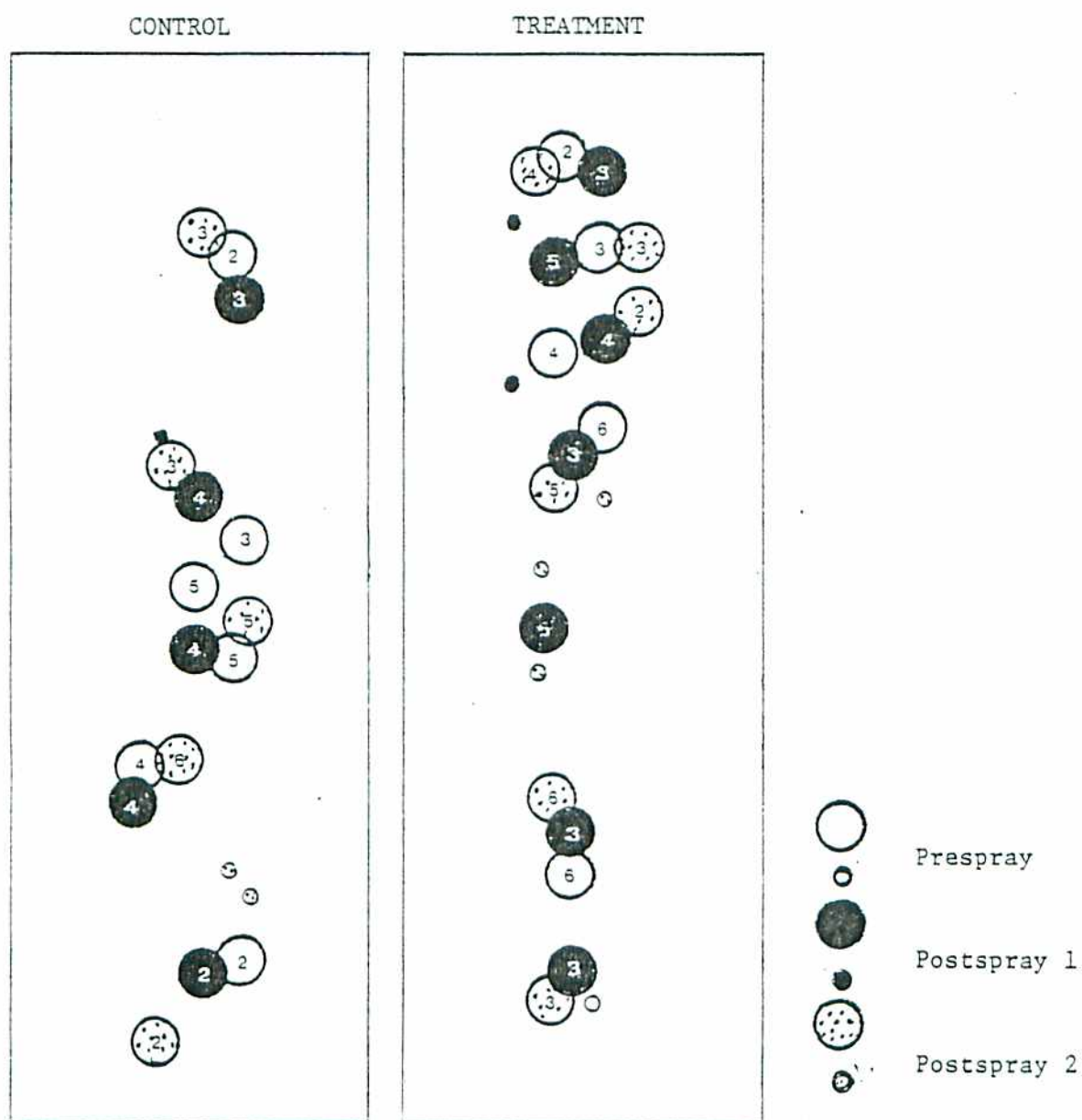


Figure 5: Breeding territories of the Blackburnian warbler. Large circles represent nesting territories and small circles represent single records. Numbers within circles represent number of days recorded in territory.

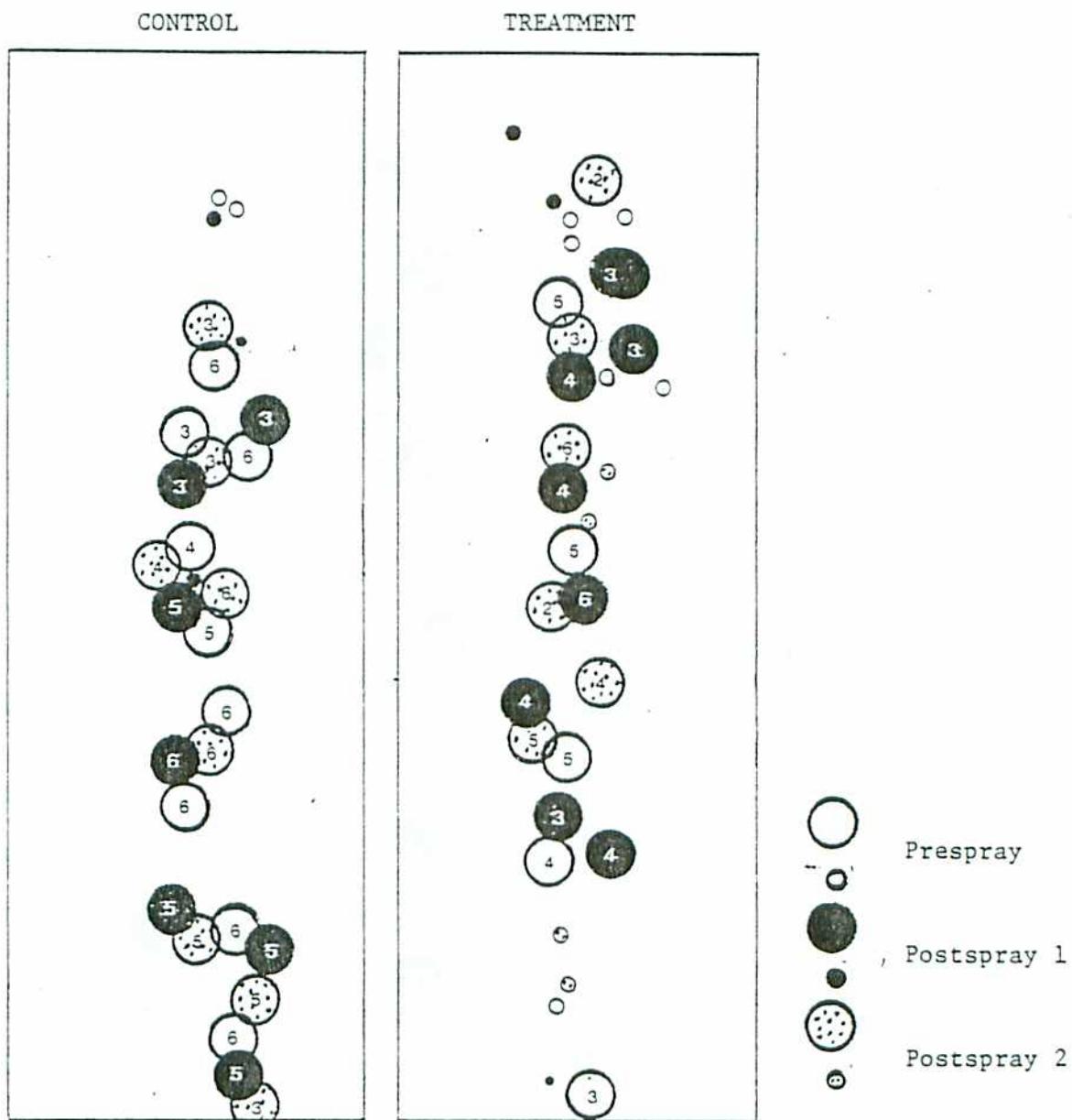


Figure 6: Breeding territories of the Baybreasted warbler. Large circles represent nesting territories and small circles represent single records. Numbers within circles represent number of days recorded in territory.

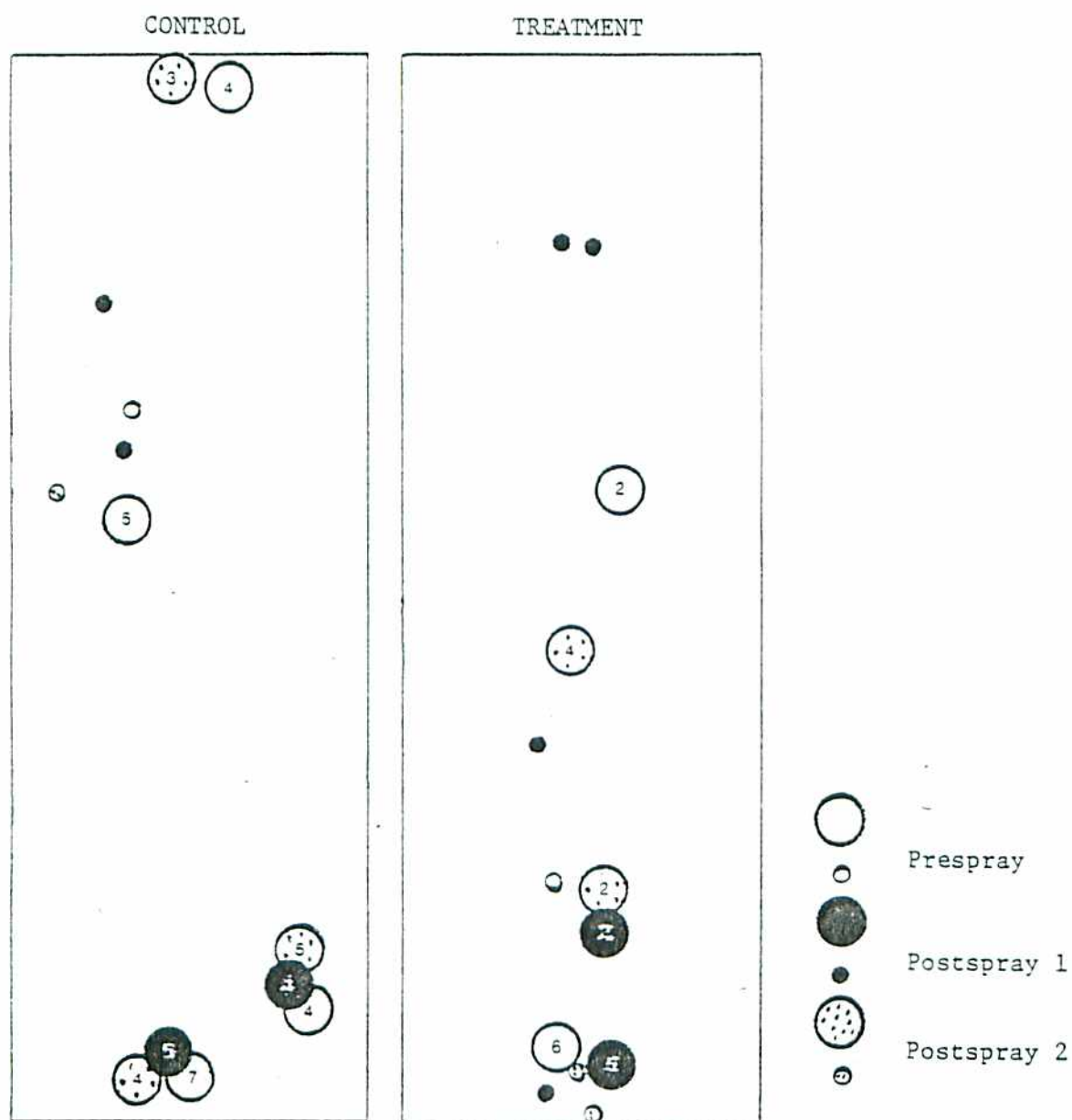


Figure 7: Breeding territories of the Common yellowthroat. Large circles represent nesting territories and small circles represent single records. Numbers within circles represent number of days recorded in territory.

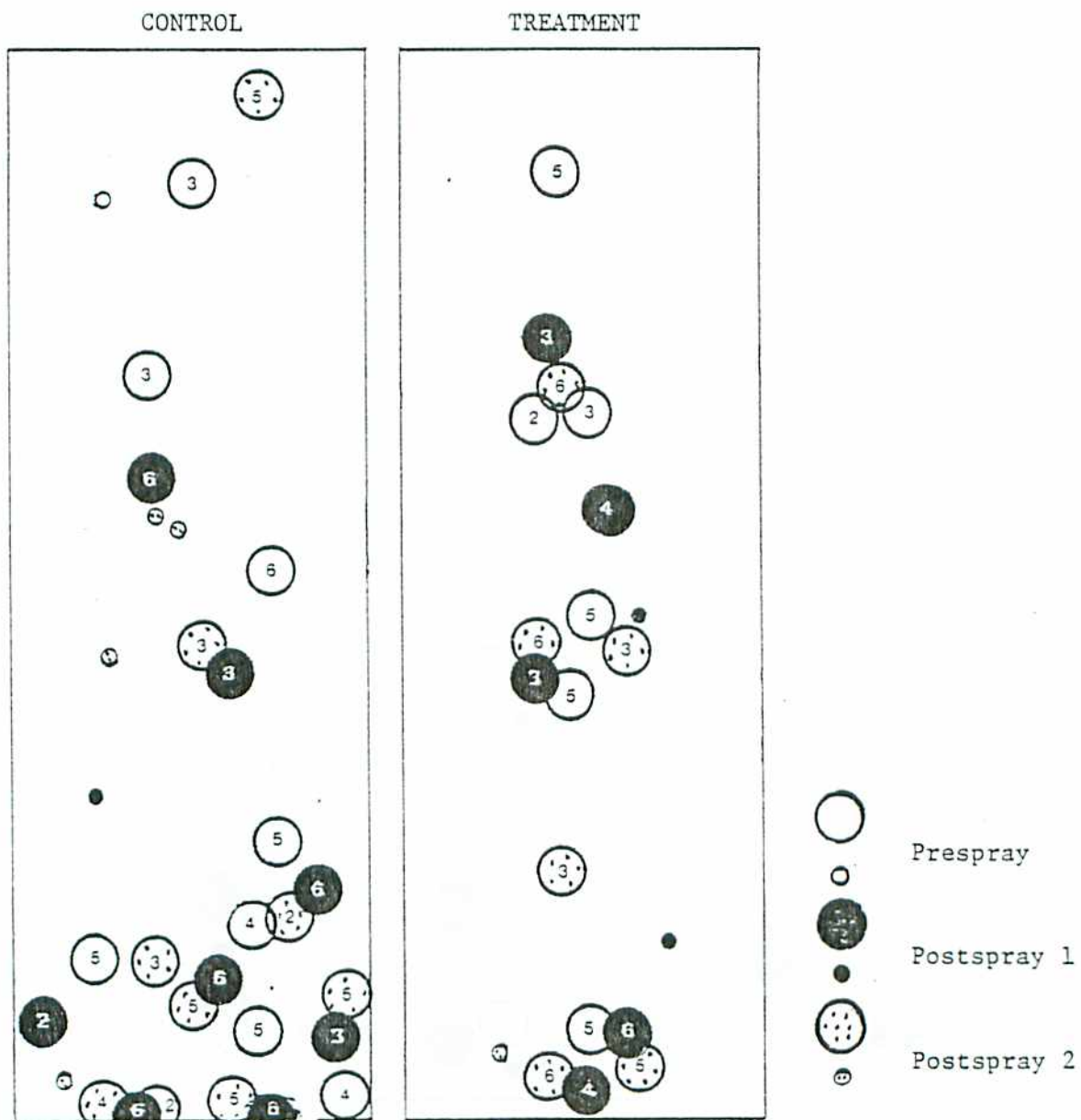


Figure 8: Breeding territories of the Tennessee warbler. Large circles represent nesting territories and small circles represent single records. Numbers within circles represent number of days recorded in territory.

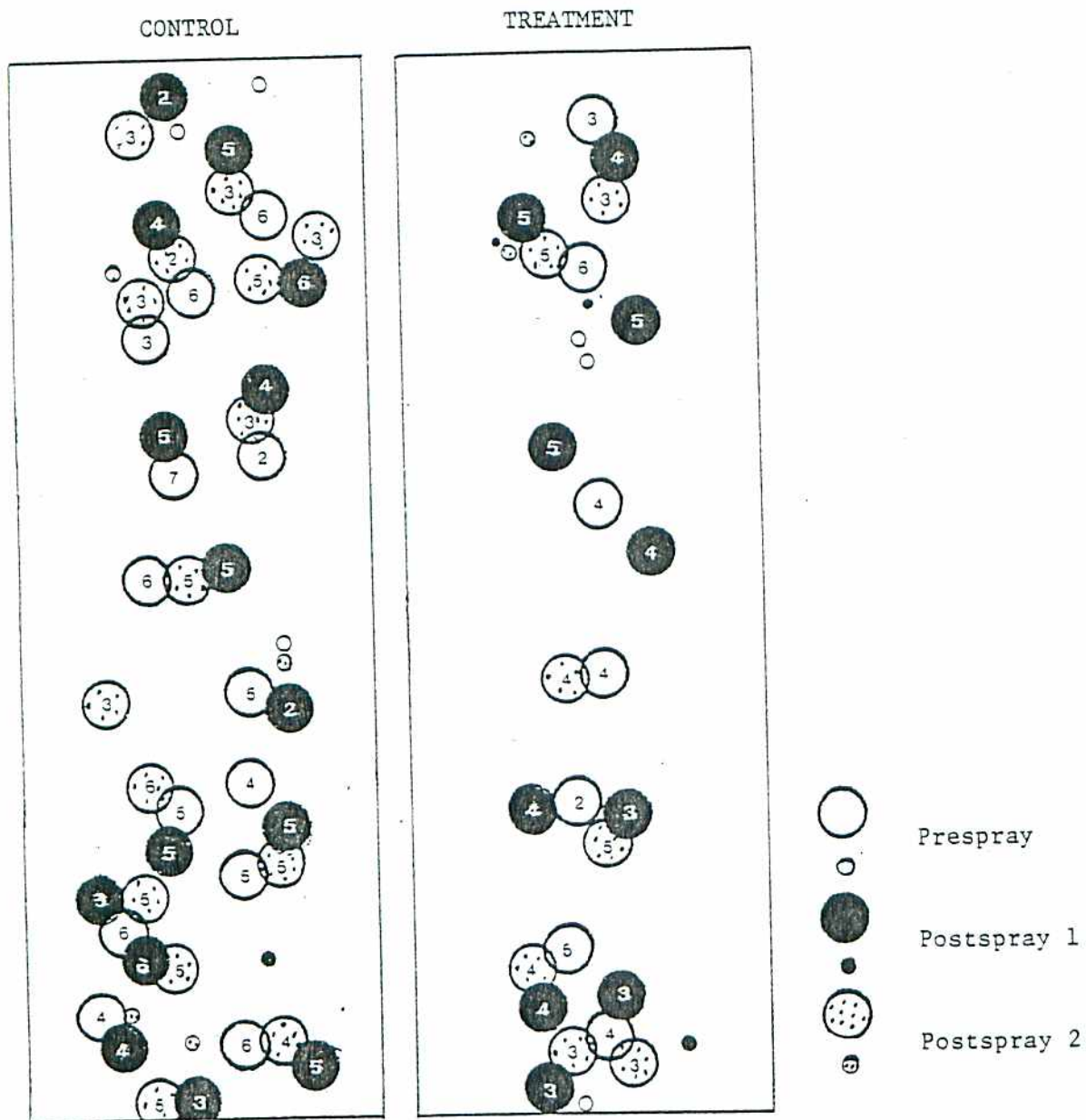


Figure 9: Breeding territories of the Magnolia warbler. Large circles represent nesting territories and small circles represent single records. Numbers within circles represent number of days recorded in territory.

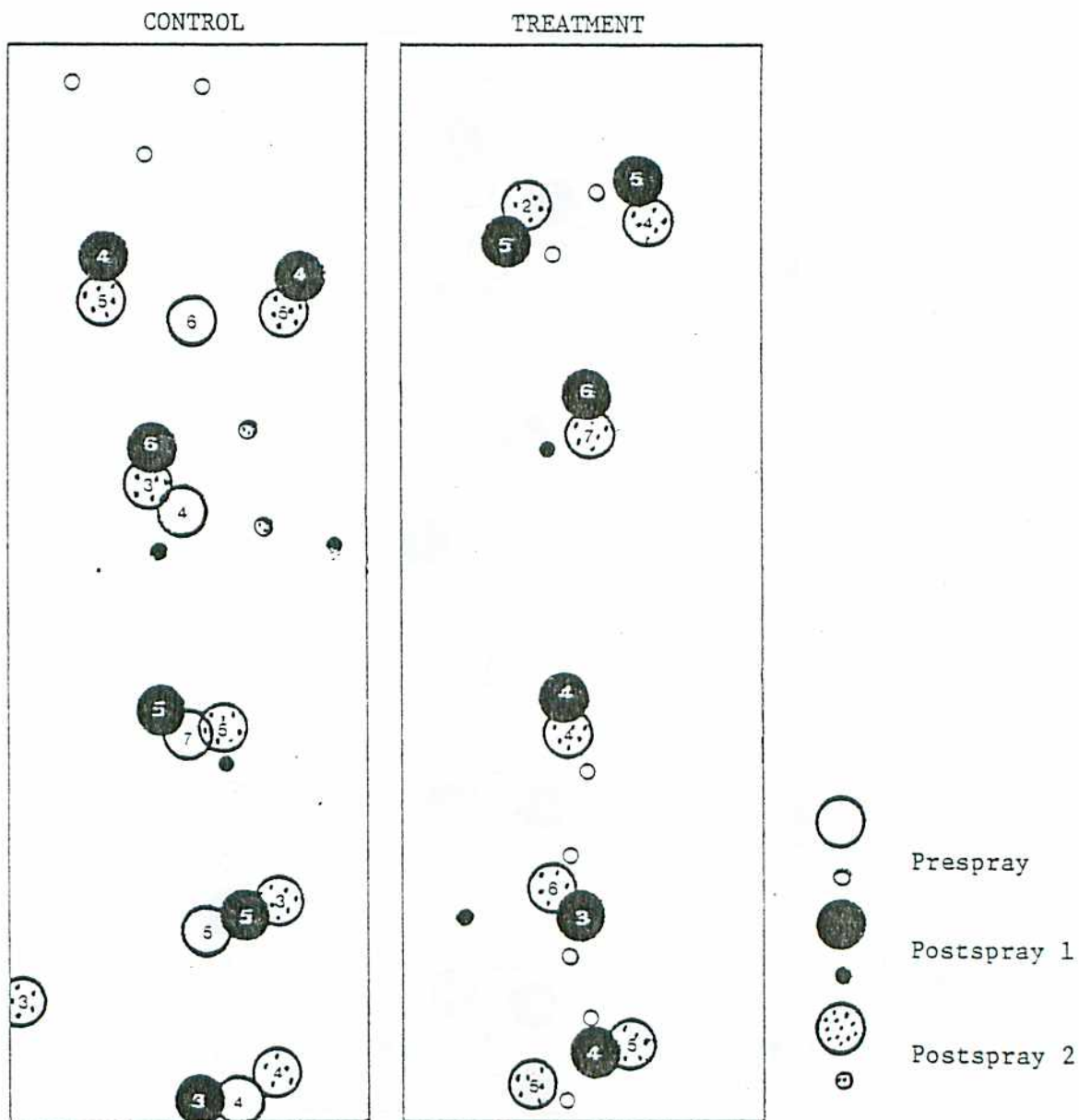


Figure 10: Breeding territories of the Swainson's thrush. Large circles represent nesting territories and small circles represent single records. Numbers within circles represent number of days recorded in territory.

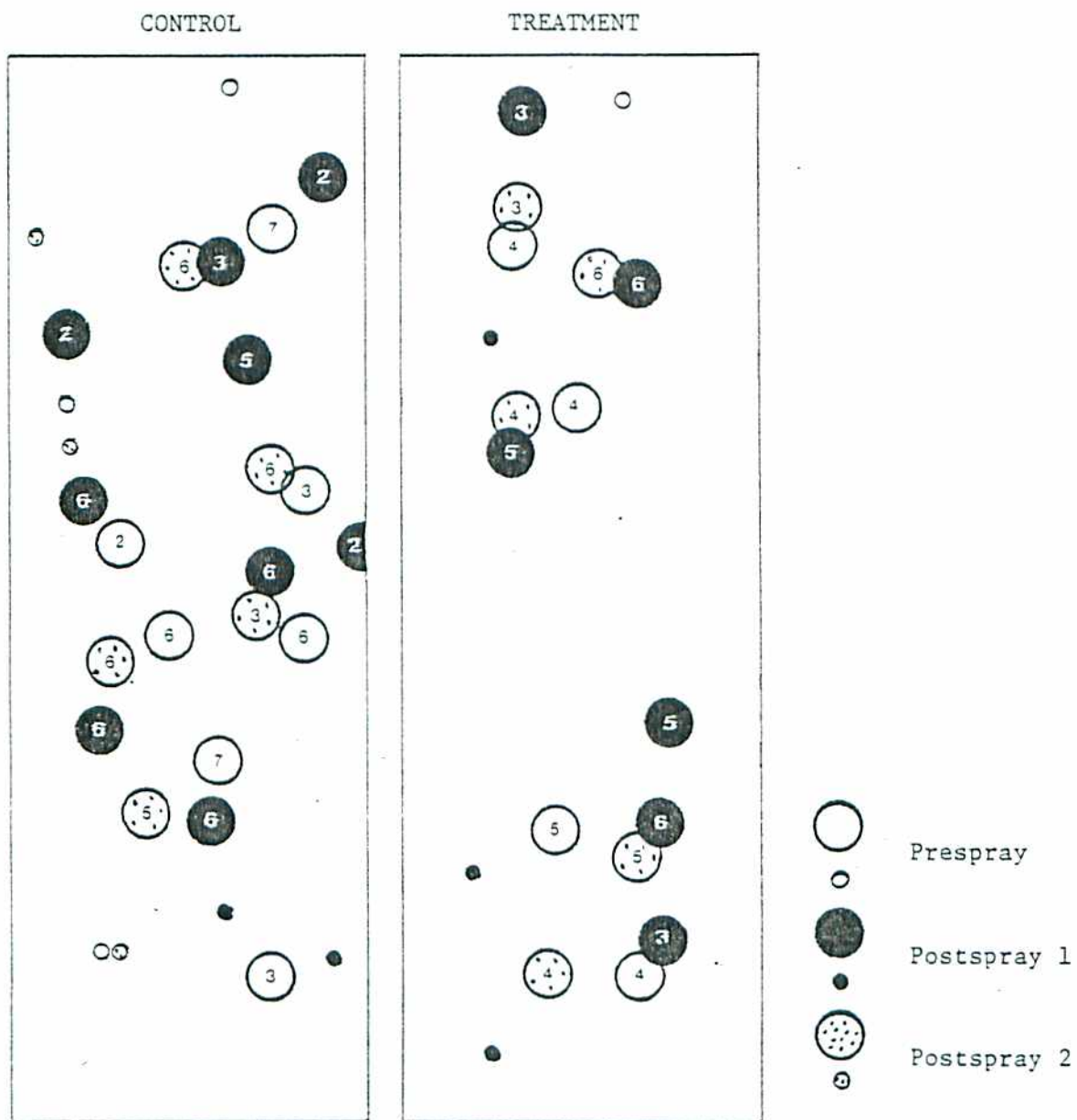


Figure 11: Breeding territories of the Ovenbird. Large circles represent nesting territories and small circles represent single records. Numbers within circles represent number of days recorded in territory.

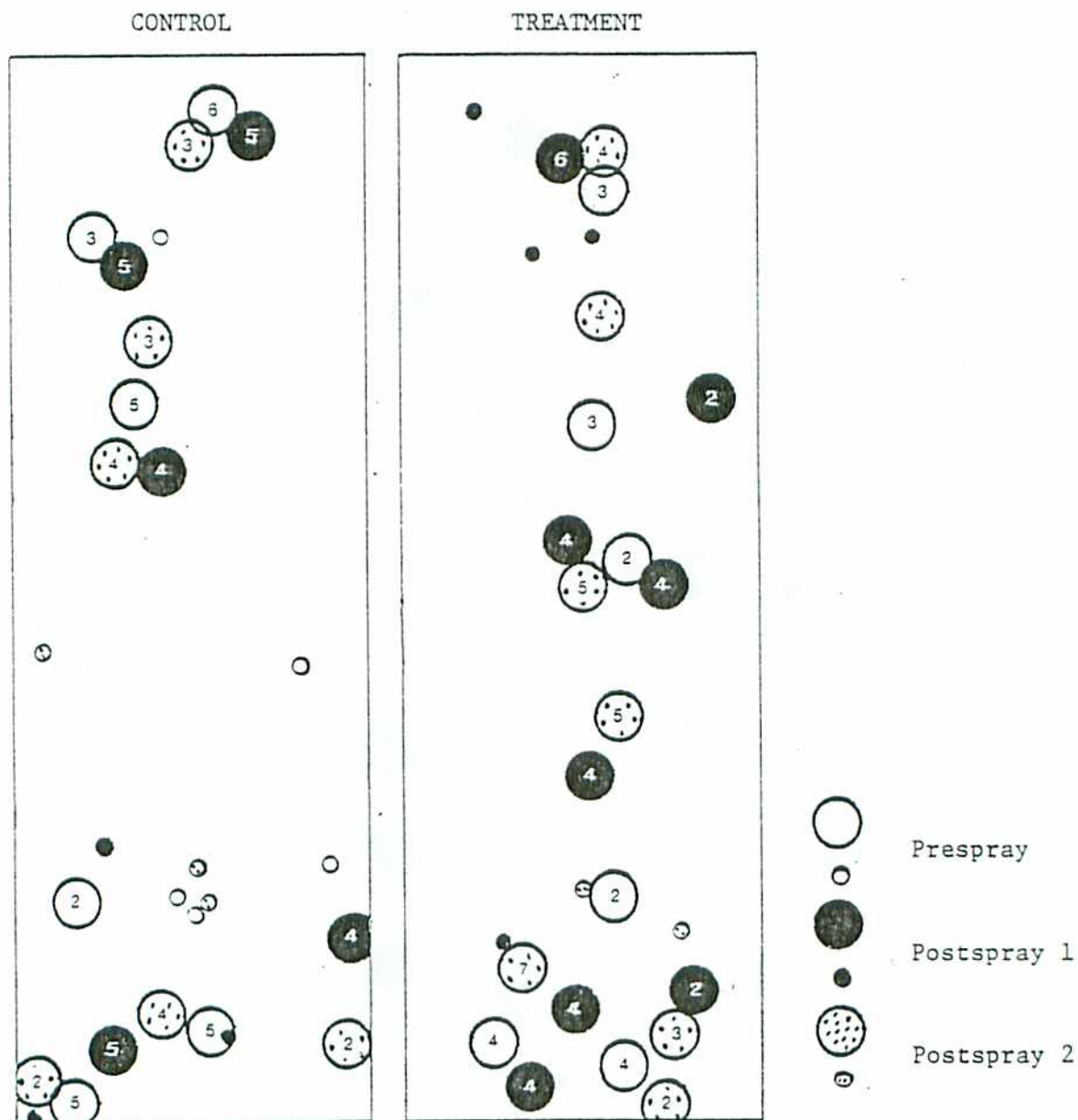


Figure 12: Breeding territories of the White-throated sparrow. Large circles represent nesting territories and small circles represent single records. Numbers within circles represent number of days recorded in territory.

APPENDIX IV

Aquatic invertebrates collected in drift net sets and by Surber, rock and artificial substrate sampling in the treatment and control streams, Gloucester County, New Brunswick.

Table 1. Aquatic organisms caught in drift net sets*, Middle Brook Treatment Station A, Gloucester County, New Brunswick, 2 - 22 June, 1980.

Days before or after application of 0.280 kg AI/ha SEVIN-2-011:8**		-9		-8		-7		-6		-5		-4		-3		-2		-1		
		AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	
Depth (cm)		18.0	18.0	18.0	18.0	15.0	16.5	15.0	15.0	16.0	15.0	14.5	13.5	15.0	14.5	17.0	17.0	16.5	16.0	
Current Speed (m/sec)		0.27	0.24	0.24	0.30	0.27	0.18	0.21	0.24	0.27	0.21	0.24	0.24	0.24	0.21	0.37	0.21	0.24	0.24	
Volume of Drift Column (m ³)		20.56	18.27	18.27	22.84	17.13	12.56	13.32	15.23	18.27	13.32	14.72	13.71	15.23	12.88	26.61	15.10	16.75	16.24	
Nematoda																				
Nematomorpha																				
Oligochaeta										0.05										
Ostracoda			0.33	0.11	0.53	0.12	0.40	0.15	0.53	0.05	0.53	0.20		0.13		0.04	0.53	0.24	0.31	
Hydracarina			0.11	0.11	0.22		0.08			0.05		0.07		0.20		0.04	0.26	0.12	0.12	
Plecoptera		N	0.29		0.11				0.26					0.07						
Ephemeroptera																				
Baetidae		N	0.19		0.13		0.24	0.08	0.33		0.08	0.07	0.15	0.07	0.23	0.11	0.20	0.24		
Leptageniidae		N																		
Leptophlebiidae		N																		
Ephemereillidae		N	0.10										0.07		0.08					
Odonata (Zygoptera)																				
Unidentified		N																		
Hemiptera																				
Gerridae																				
Megaloptera																				
Stalidae		L	0.10	0.05		0.04	0.06										0.07			
Trichoptera																				
Brachycentridae		L			0.11	0.04														
Hydropsychidae		L														0.04				
Hydroptilidae		L											0.07							
Limnephilidae		L	0.15	0.11				0.08	0.07				0.07				0.13	0.06	0.06	
Polycentropodidae		L																		
Rhyacophilidae		L																		
Unidentified		P											0.07							
Coleoptera																				
Halipilidae		L																		
		A																		
Elmidae		L	0.05	0.05		0.04										1.24	0.07	0.48		
		A	0.05	0.05	0.05	0.09	0.06	0.08	0.23	0.13			0.07		0.08	0.13	0.06	0.06		
Diptera																				
Tipulidae		L	0.05			0.04														
Simuliidae		L	0.34	0.05	0.99	0.18	0.12		0.75	0.20	0.11	0.15		0.07		0.04	0.07	0.18		
		P				0.04														
Chironomidae		L	0.05		0.05				0.23	0.13								0.06		
		P																		
Rhagionidae		L																		
Pelecypoda							0.08													
Total Aquatic Invertebrates			1.36	0.77	1.53	1.36	0.35	0.88	1.50	1.64	0.27	0.75	0.34	0.51	0.53	0.31	1.58	1.46	1.43	0.55

*expressed as number of organisms per m³ of water in drift column.

**application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980.

N = nymph

L = larvae

A = adult

P = pupae

Table 1. Aquatic organisms caught in drift net sets*, Middle Brook Treatment Station A, Gloucester County, New Brunswick, 2 - 22 June, 1980. (Continued)

Days before or after application of 0.280 kg AI/ha SEVIN-2-0118**		Pre	0 hr	+½ hr	+1 hr	Spray Day					+4 hr	+5 hr	+6 hr	PH	AM	+1 PH	+2 AM	+2 PH	+3 AM	+3 PH	+4 AM	+4 PH	+5 AM	+5 PH
Depth (cm)		16.5	16.0	16.0	16.0	16.0	16.0	15.0	15.0	15.0	14.0	15.0	15.0	15.0	15.0	15.0	15.0	13.5	14.0	13.0	12.5	12.5	13.0	14.5
Current Speed (m/sec)		0.21	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.21	0.18	0.24	0.21	0.18	0.18	0.18	0.24	0.18
Volume of Drift Column (m³)		14.66	16.24	16.24	16.24	16.24	16.24	5.08	5.08	5.08	14.21	15.23	13.32	11.42	13.71	12.44	9.90	9.52	9.52	13.20	11.04			
Nematoda				0.12	0.06						0.07													
Rematomorpha		0.07																						
Oligochaeta																								
Ostracoda															0.20	0.08	0.09	0.22		0.20	0.11	0.11	0.08	0.27
Hydracarina		0.14		0.12					0.79		0.07								0.08	0.20	0.32		0.08	
Plecoptera	N		0.12	0.86	1.54	2.71	3.63	5.12	5.31	3.54	0.21	0.13								0.10				
Ephemeroptera																								
Baetidae	N	0.20		1.29	0.43	20.20	37.75	64.76	41.54	20.67	0.14	0.26	0.08							0.10	0.11		0.08	
Heptageniidae	N			0.25	0.25	0.06	0.12		0.20															
Leptophlebiidae	N			0.62	0.18		0.18																	
Ephemerellidae	N		0.18	0.55	0.43	0.25	0.12											0.07			0.11			
Odonata (Zygoptera)																								
Unidentified	N		0.06																					
Hemiptera																								
Gerridae																								
Megaloptera																								
Stalidae	L																							
Trichoptera																								
Brachycentridae	L																							
Hydropsychidae	L				0.18	0.06																		
Hydroptilidae	L							0.20																
Limnephilidae	L					0.06		0.20	0.20		0.07													
Polycentropodidae	L			0.37	0.43	0.74	0.55			0.39														
Rhyacophilidae	L																							
Unidentified	P	0.07																						
Coleoptera																								
Halipidae	L																				0.11			
	A																				0.21			
Elmidae	L	0.41	0.31	0.18	0.06	0.12		0.60	0.20								0.09	0.07	0.08				0.53	0.18
	A	0.14			0.12	0.12	0.12			0.20	0.07							0.07		0.10				
Diptera																								
Tipulidae	L				0.06	0.06																		
Simuliidae	L	0.20	0.06	40.70	7.82	2.46	1.91	1.38	0.39	1.18	0.21			0.08						0.10		0.11	0.08	0.09
	P																							
Chironomidae	L	0.07	0.12	3.69	2.65	0.43	0.86	0.39	0.59		0.21			0.08						0.20			0.08	0.09
	P	0.07		0.06			0.12																	
Rhagionidae	L					0.06		0.20																
Pelecypoda							0.12																	
Total Aquatic Invertebrates		1.36	0.86	48.83	14.22	27.28	45.57	72.83	49.21	25.98	1.06	0.59	0.30	0.18	0.51	0.16	1.11	0.95	0.21	0.91	0.63			

*expressed as number of organisms per m³ of water in drift column.

**application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980.

N = nymph

L = larvae

A = adult

P = pupae

Table 1. Aquatic organisms caught in drift net sets*, Middle Brook Treatment Station A, Gloucester County, New Brunswick, 2 - 22 June, 1980. (Concluded)

Days before or after application of 0.280 kg AI/ha SEVIN-2-OIL***			Pre	0 hr	1/2 hr	Spray Day		+1 hr	+2 hr	+3 hr	+4 hr	PH	AH	+1	PH	AH	+2	PH	AH	+3	PH	AH	+4	PH	AH	+5	PH
Depth (cm)			13.0	13.0	13.5	16.0	16.0	16.0	16.0	16.0	16.0	13.5	14.0	15.5	15.0	13.5	13.0	14.5	15.5	13.5	14.0	13.5					
Current Speed (m/sec)			0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.27	0.18	0.15	0.15	0.21	0.12	0.15	0.21	0.18	0.21	0.24					
Volume of Drift Column (m ³)			13.20	13.20	13.71	16.24	16.24	16.24	16.24	15.42	10.66	9.83	9.52	11.99	11.55	9.20	13.77	10.28	12.44	13.71							
Nematoda																											
Nematomorpha																											
Oligochaeta																											
Ostracoda																											
Hydracarina						0.12	0.06			0.09			0.11		0.08	0.09				0.19	0.08	0.15					
Plecoptera	N			0.29	0.12	0.37										0.08				0.10							
Ephemeroptera																											
Baetidae	N									0.52			0.11							0.10						0.07	
Heptageniidae	N																										
Leptophlebiidae	N									0.13																	
Ephemerellidae	N									0.09	0.10															0.15	
Odonata (Zygoptera)																											
Unidentified	N																										
Hemiptera																											
Gerridae						0.06																					
Megaloptera																											
Stalidae	L												0.10							0.10	0.24	0.07					
Trichoptera																											
Brachycentridae	L																										
Hydropsychidae	L					0.06																					
Hydroptilidae	L																										
Limnephilidae	L									0.06		0.06						0.09								0.07	
Polycentropodidae	L				0.15	0.12	0.06																				
Rhyacophilidae	L		0.08																								
Unidentified	P																										
Coleoptera																											
Halipidae	L																										
Elmidae	L		0.76	0.23		0.37	0.18	0.18	0.12		0.09	0.10	0.21	0.42	0.26	1.30	0.15	0.49	0.48	0.66							
	A		0.08	0.15	0.51			0.06					0.10		0.08					0.10						0.07	
Diptera																											
Tipulidae	L																										
Simuliidae	L			0.08	3.57	0.92	0.62	0.12	0.12	0.39										0.19							
	P																										
Chironomidae	L			0.08	4.01	3.63	0.86	0.37	0.12	0.19					0.08					0.49	0.40	0.15					
	P																										
Rhagionidae	L			0.08																							
Pelecypoda																											
						0.12																					
Total Aquatic Invertebrates			0.83	0.68	8.53	5.42	2.28	0.80	0.37	1.30	0.28	0.41	0.53	0.75	0.52	1.30	0.15	1.75	1.29	1.60							

*expressed as number of organisms per m³ of water in drift column.

**application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980.

N = nymph

L = larvae

A = adult

P = pupae

Table 2. Aquatic organisms caught in drift net sets*, Bass Brook Control Station, Gloucester County, New Brunswick, 2 - 22 June 1980.

Days before or after application of 0.280 kg AI/ha SEVIN-2-OIL***		-9		-8		-7		-6		-5		-4		-3		-2		-1	
		AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Depth (cm)		19.0	15.0	22.0	20.0	19.0	19.5	20.0	19.0	19.0	17.0	18.0	18.0	16.5	18.0	22.0	20.0	21.0	19.5
Current speed (m/sec)		0.40	0.37	0.34	0.34	0.37	0.34	0.37	0.37	0.34	0.37	0.34	0.34	0.37	0.34	0.34	0.37	0.37	0.34
Volume of Drift Column (m ³)		32.15	33.48	31.64	28.76	29.74	28.04	31.30	29.74	27.33	26.61	25.89	25.89	25.82	25.89	31.64	31.30	32.87	28.04
Nematoda							0.04		0.03										0.04
Ostracoda			0.66	0.25	0.59	0.13	0.11		0.81		1.50	0.04	1.35	0.23	0.12	0.41	0.29	0.09	0.32
Hydracarina		0.06	0.03	0.03	0.17	0.07				0.04	0.04	0.08	0.27	0.15	0.04	0.13		0.06	
Plecoptera		0.03				0.10	0.04			0.04			0.12			0.06			
Ephemeroptera																			
Baetidae		0.06		0.03		0.13							0.12			0.06		0.03	0.04
Heptageniidae					0.03														
Leptophlebiidae						0.03													
Ephemerellidae																			
Ephemeridae																			
Unidentified																			
Hemiptera																			
Gerridae																			
Megaloptera																			
Sialidae		L																	
Trichoptera																			
Leptoceridae		L														0.03			
Limnephilidae		L	0.03	0.03	0.03		0.11	0.03											
Polycentropodidae		L																0.03	
Unidentified		L	0.03																
		P																	
Coleoptera																			
Dytiscidae		A																	
Elmidae		L	0.06	0.03		0.03	0.04					0.04				0.09		0.06	
		A	0.02											0.08		0.06	0.03	0.03	
Diptera																			
Culicidae		L																0.13	
Simuliidae		L	0.06	0.06	0.28	0.14	0.24	0.11	0.03	0.07	0.15		0.19	0.12	0.12	0.12	0.60	0.10	0.58
		P				0.03					0.04				0.04				0.04
Chironomidae		L		0.09						0.03	0.04	0.08	0.15	0.04		0.04	0.09		
Rhagionidae		L														0.03		0.03	
Gastropoda																	0.03		
Total Aquatic Invertebrates		0.37	0.75	0.76	0.97	0.77	0.43	0.06	0.94	0.29	1.62	0.50	2.01	0.58	0.35	1.58	0.58	0.91	0.43

* expressed as number of organisms per m³ of water in drift column

***application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980

N = nymphs

L = larvae

P = pupae

A = adults

Table 2. Aquatic organisms caught in drift net sets*, Bass Brook Control Station, Gloucester County, New Brunswick, 2 - 22 June 1980. (Continued)

Days before or after application of 0.280 kg AI/ha SEVIN-2-OIL**		0500	0600	0700	Spray Day		0800	0900	1000	PH	AM	⁺¹ PH	AM	⁺² PH	AM	⁺³ PH	AM	⁺⁴ PH	AM	⁺⁵ PH
Depth (cm)		20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	19.5	18.0	17.5	17.5	16.0	15.5	16.0	16.0	17.0	16.0	19.0
Current speed (m/sec)		0.34	0.34	0.34	0.34	0.34	0.37	0.34	0.37	0.34	0.30	0.30	0.27	0.30	0.27	0.27	0.27	0.30	0.30	0.34
Volume of Drift Column (m ³)		31.30	31.30	31.30	31.30	31.30	31.30	28.04	22.84	22.21	19.99	20.30	17.70	18.27	18.27	21.57	20.30	27.31		
Nematoda																				
Ostracoda											0.09	0.27	0.05	1.03	0.23	0.60	0.33	0.23	0.25	0.22
Hydracarina		0.06					0.03	0.04		0.04	0.09			0.10	0.11	0.05	0.11	0.05	0.05	0.15
Plecoptera	N		0.03				0.06									0.11		0.09	0.05	
Ephemeroptera																				
Baetidae	N										0.04	0.05		0.05		0.11	0.27	0.05	0.05	0.04
Heptageniidae	N																			
Leptophlebiidae	N																			
Ephemerellidae	N													0.05						
Ephemeridae	N																			
Unidentified	N										0.05									
Hemiptera																				
Ceridae															0.06					
Megaloptera																				
Stalidae	L																			
Trichoptera																				
Leptoceridae	L																	0.05		
Limnephilidae	L																			
Polycentropodidae	L																			
Unidentified	L																			
	P																			
Coleoptera																				
Dytiscidae	A													0.05						
Elmidae	L								0.04	0.04	0.05				0.06		0.05			
	A	0.03	0.03	0.03		0.03								0.10					0.05	0.04
Diptera																				
Colicidae	L																			
Simuliidae	L	0.29	0.19	0.03		0.13	0.10	0.07	0.31	0.05	0.15	0.05	0.06	0.16	0.22	0.05	0.30	0.18		
	P																			
Chironomidae	L	0.03	0.03		0.10	0.10	0.06		0.04	0.05	0.05					0.11				
Rhagionidae	L		0.03		0.03		0.03							0.05						
Gastropoda																				
Total Aquatic Invertebrates		0.42	0.32	0.06	0.13	0.26	0.29	0.14	0.57	0.59	0.25	1.48	0.51	1.04	1.15	0.46	0.74	0.62		

*expressed as number of organisms per m³ of water in drift column

**application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980

N = nymphs

L = larvae

P = pupae

A = adults

Table 2. Aquatic organisms caught in drift net sets*, Bass Brook Control Station, Gloucester County, New Brunswick, 2 - 22 June 1980. (Concluded)

Days before or after application of 0.280 kg AI/ha SEVIN-2-0118**		Spray Day										+1		+2		+3		+4		+5	
		0600	0700	0800	0900	1000	1100	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM			
Depth (cm)		16.0	16.0	16.0	16.0	16.0	16.0	15.5	16.0	16.5	18.0	15.0	16.0	17.0	17.5	16.0	16.0	15.0			
Current speed (m/sec)		0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.30	0.30	0.30	0.30	0.30	0.34	0.30	0.30	0.34	0.30			
Volume of Drift Column (m ³)		23.01	23.01	23.01	23.01	23.01	23.01	22.29	20.30	20.94	22.84	19.04	20.30	24.45	22.21	20.30	23.01	19.04			
Nematoda																					
Ostracoda								0.36	0.30	0.14	0.13	0.58	0.15	0.16	0.41	0.05	0.09	0.26			
Hydracarina		0.04		0.04	0.09		0.04	0.04	0.05	0.05	0.18		0.05	0.08	0.05		0.13	0.05			
Plecoptera	N		0.09			0.04		0.09	0.05		0.04	0.05	0.05	0.04		0.05	0.04	0.11			
Ephemeroptera																					
Baetidae	N		0.04	0.09	0.04	0.04	0.04		0.05	0.05	0.13	0.05	0.10	0.04	0.05						
Heptageniidae	N																				
Leptophlebiidae	N																				
Ephemerellidae	N																				
Ephemeridae	N																				
Unidentified	N																				
Hemiptera																					
Gerridae																					
Megaloptera																					
Sialidae	L																	0.04			
Trichoptera																					
Leptoceridae	L																				
Limnephilidae	L																				
Polycentropodidae	L				0.04																
Unidentified	L																				
	P																				
Coleoptera																					
Dytiscidae	A																				
Elmidae	L		0.04						0.05				0.05		0.09	0.05		0.05			
	A							0.04			0.04	0.05		0.08	0.05	0.05					
Diptera																					
Culicidae	L																				
Simuliidae	L	0.22	0.13		0.04	0.04	0.09		0.25	0.05	0.09	0.16	0.15		0.14	0.10	0.09	0.26			
	P					0.04															
Chironomidae	L	0.04	0.04				0.04		0.05							0.05		0.21			
Rhagionidae	L																	0.05			
Gastropoda																					
Total Aquatic Invertebrates		0.30	0.35	0.13	0.22	0.17	0.22	0.54	0.79	0.29	0.61	0.89	0.54	0.41	0.77	0.44	0.39	1.05			

*expressed as number of organisms per m³ of water in drift column

**application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980

N = nymphs

L = larvae

P = pupae

A = adults

Table 3
Aquatic invertebrates collected from artificial substrates*,
Middle Brook Treatment Station,
Gloucester County, New Brunswick
7 June - 1 August 1980

Days before or after first (second) application of 0.280 kg AI/ha SEVIN-2-OIL***			-4	+3	+11 (+5)	+51 (+45)
Hydrozoa	Hydroida		-	-	-	0.2
Turbellaria			-	-	-	0.2
Nematoda			-	0.2	0.3	0.3
Oligochaeta			0.4	-	-	3.0 a
Hydracarina			17.4	23.3	24.6	3.0 a
Plecoptera			52.2	53.4	52.0	75.4
Ephemeroptera	Baetidae	nymphs	7.2	3.8	5.2	51.3 a
	Heptageniidae	nymphs	1.0 a	0.6 a	3.2 ab	3.6 b
	Leptophlebiidae	nymphs	6.3	4.2	6.4	48.6 a
	Ephemereilidae	nymphs	9.3	4.6	5.2	9.4
Odonata	Gomphidae	nymphs	-	-	0.2	0.6
Trichoptera	Hydropsychidae	larvae	0.4	-	0.2	11.2 a
	Hydroptilidae	larvae	0.4	0.2	0.2	0.8 a
	Lepidostomatidae	larvae	0.2	0.4	0.6	-
	Limnephilidae	larvae	0.4	0.2	0.4	-
	Philopotamidae	larvae	-	-	-	0.3
	Polycentropodidae	larvae	0.2	-	0.2	4.4
	Psychomyiidae	larvae	-	0.2	-	-
	Rhyacophilidae	larvae	-	-	-	1.6 a
	Unidentified	larvae	1.6	- a	0.6 a	0.2 a
		pupae	- a	- a	0.6 ab	1.2 b
Coleoptera	Dytiscidae	larvae	0.2	-	-	-
	Elmidae	larvae	22.3	12.0	15.0	111.0 a
		adults	36.3	39.2	31.6	45.0
Diptera	Tipulidae	larvae	-	0.2	0.2	2.6 a
	Psychodidae	larvae	-	-	-	0.4
	Simuliidae	larvae	-	1.2	-	1.4
		pupae	0.4	0.6	0.6	4.0 a
	Chironomidae	larvae	31.6	90.0	126.6	214.3 a
		pupae	0.6	0.2	3.0 a	22.0 b
	Heleidae	larvae	-	-	-	0.2
	Tabanidae	larvae	-	-	-	0.2
	Rhagionidae	larvae	2.3	2.0	3.4	10.0 a
	Empididae	larvae	0.2	-	1.3 a	-
Pelecypoda			-	-	-	0.2
Total Aquatic Invertebrates			303.4	287.0	342.0	638.6 a

*mean numbers of organisms collected from five artificial substrates
numbers followed by the same character are not significantly different at the 5% significance level (a Student-Newman-Keuls test was used after transforming the data to log ($x + 1.0$))

***application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980

Table 4
Aquatic invertebrates collected from artificial substrates*,
Bass Brook Control Station,
Gloucester County, New Brunswick
7 June - 1 August 1980

Days before or after first (second) application of 0.230 kg AI/ha SEVIN-2-OIL***			-4	+3	+11 (+5)	+51 (+45)
Turbellaria			-	-	1.0	1.4
Nematoda			-	-	-	0.2
Oligochaeta			-	-	-	0.2
Hydracarina			1.0 a	3.3 a	7.0 a	0.2
Placoptera			36.2 a	15.0 a	31.0	12.3 a
Ephemeroptera	Baetidae	nymphs	13.0	7.0	9.2	7.6
	Heptageniidae	nymphs	-	-	-	1.4 a
	Leptophlebiidae	nymphs	1.2	1.2	2.4	7.2 a
	Ephemereilidae	nymphs	2.6	3.6	10.4 a	1.2
Odonata	Cordulegastridae	nymphs	-	-	0.2	-
Trichoptera	Hydropsychidae	larvae	-	-	-	6.4 a
	Hydroptilidae	larvae	0.2	1.0	1.4	-
	Lepidostomatidae	larvae	-	-	0.2	-
	Limnephilidae	larvae	0.2	-	-	0.2
	Odontoceridae	larvae	0.2	-	0.4	-
	Philopotamidae	larvae	-	-	1.4	3.6
	Polycentropodidae	larvae	0.6	-	-	0.2
	Psychomyiidae	larvae	-	-	-	0.4
	Rhyacophilidae	larvae	-	0.2	0.4	-
	Unidentified	larvae	-	-	-	0.2
Coleoptera		pupae	-	-	-	0.4
	Elmidae	larvae	6.0	9.6	9.6	21.4 a
Diptera		adults	38.4	48.0	62.4	58.2
	Tipulidae	larvae	1.6	1.4	1.2	7.0 a
	Simuliidae	larvae	4.0	3.6	7.4	0.6
		pupae	1.2 a	0.2 ab	0.4 ab	- b
	Chironomidae	larvae	24.8 a	14.2 a	120.0 b	29.2 ab
		pupae	0.3	0.6	0.6	9.6 a
	Heleidae	larvae	0.2	0.2	1.0	4.0 a
	Rhagionidae	larvae	0.3	0.6	1.0	3.4
Gastropoda			0.2	-	0.2	-
			0.4	-	-	-
Pelecypoda			0.4	0.2	-	9.6
Total Aquatic Invertebrates			134.0	110.4	268.8	191.6

*mean numbers of organisms collected from five artificial substrates
numbers followed by the same character are not significantly different at the 5% significance level (a Student-Newman-Keuls test was used after transforming the data to log (x + 1.0))

**application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980

Table 5. Aquatic invertebrates collected in Surber samples*, Middle Brook Treatment Station A, Gloucester County, New Brunswick, 31 May - 1 August 1980,

Days before or after first (second) application of 0.280 kg AI/ha SEVIN-2-011,8AA			-11	-5	+2	+10 (+4)	+16 (+10)	+51 (+45)
Nematoda			-	-	-	-	-	0.75
Oligochaeta			0.25	0.75	0.25	0.25	0.25	0.75
Hydracarina			2.50	1.25 a	0.25 a	- a	0.25 a	0.25 a
Plecoptera			6.75 a	13.00 a	8.50 a	3.25 ab	5.25 a	1.50 b
Ephemeroptera	Baetidae	nympha	2.50 ab	4.75 b	0.75 ab	0.75 a	0.50 a	1.00 ab
	Heptageniidae	nympha	0.75	1.00	1.75	0.25	2.25	1.25
	Leptophlebiidae	nympha	-	0.75	0.50	-	-	0.75
	Ephemereilidae	nympha	12.75	23.75	19.00	16.50	15.25	2.75 a
	Unidentified	nympha	-	-	0.25	-	-	-
Odonata	Cordulegastridae	nympha	0.50	0.25	-	-	-	-
	Gomphidae	nympha	8.25 ab	2.00 a	4.00 a	20.50 b	5.25 ab	4.25 a
Megaloptera	Slalidae	larvae	-	-	-	-	0.25	-
Trichoptera	Brachycentridae	larvae	4.50	4.25	2.00 a	0.50 a	- a	- a
	Glossosomatidae	larvae	-	-	0.25	-	-	0.50
	Hydropsychidae	larvae	8.00 ac	11.75 a	0.25 b	1.75 bc	0.25 b	5.50 abc
	Hydroptilidae	larvae	0.75	-	0.75	-	-	1.00
	Lepidostomatidae	larvae	-	-	-	0.50	-	-
	Limnephilidae	larvae	2.50	4.00	3.00	1.50	1.75	2.50
	Polycentropodidae	larvae	-	-	-	-	-	7.25
	Rhyacophilidae	larvae	0.75	1.25	0.25	0.50	-	1.00
	Unidentified	larvae	-	0.25	-	-	-	-
		pupae	1.25	1.75	1.00	1.00	4.00	3.25
		larvae	-	-	0.50	0.25	0.50	0.25
		larvae	27.25	26.75	54.75	28.25	1.00 a	63.00
Coleoptera		adults	16.50	13.75	27.75	27.25	13.75	17.25
	Psephenidae	adults	-	-	-	-	1.25	-
Diptera	Tipulidae	larvae	5.00	0.75	1.25	2.00	1.75	1.50
	Simuliidae	larvae	0.75	7.25	-	0.50	1.00	1.00
		pupae	0.25 ab	0.75 ab	0.25 ab	- a	0.25 ab	1.50 b
	Chironomidae	larvae	2.50	7.00	2.75	13.25	8.75	23.50
		pupae	1.25 a	0.50	-	-	0.25	-
	Rhagionidae	larvae	7.00	8.25	5.50	4.50	1.25	1.75
	Empididae	larvae	-	-	0.25	-	-	-
		pupae	0.50	0.25	-	-	-	-
Pelecypoda			0.25	-	-	1.25	-	90.25 a
Total Aquatic Invertebrates			111.25	136.00	135.75	124.50	65.00	234.25

*mean numbers of organisms collected in four Surber samples
 numbers followed by the same character are not significantly different at the 5% significance level (a Student-Newman-Keuls test
 was used after transforming the data to $\log(x + 1.0)$)

**application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980

Table 6. Aquatic invertebrates collected in Surber samples*, Middle Brook Treatment Station B, Gloucester County, New Brunswick, 2 June - 1 August 1980.

Days before or after first (second) application of 0.280 kg AI/ha SEVIN-2-OH ^{***}			-9	-5	+2	+10 (+4)	+16 (+10)	+51 (+45)
Oligochaeta			-	-	1.00	3.25	-	2.00
Hydracarina			0.25	2.25	0.75	1.50	1.75	-
Plecoptera		nymphs	3.50	3.00	1.75	1.75	2.00	1.50
Ephemeroptera	Baetidae	nymphs	4.50	3.50	2.25	0.25	1.00	0.25
	Heptageniidae	nymphs	7.00 a	2.25 ab	1.50 b	- b	- b	2.50 ab
	Leptophlebiidae	nymphs	-	0.25	0.75	-	1.50	0.25
	Ephemerellidae	nymphs	13.75	16.50	23.50	17.50	22.25	3.25 a
Odonata	Gomphidae	nymphs	0.25	-	1.50	1.25	0.75	1.75
Trichoptera	Brachycentridae	larvae	4.75	2.00 a	1.50 ab	0.50 ab	0.75 ab	- b
	Glossosomatidae	larvae	0.25	0.25	0.25	0.75	4.75 a	0.25
	Hydropsychidae	larvae	2.00	1.25	0.25	1.00	0.50	2.75
	Hydroptilidae	larvae	-	-	1.25	2.75	3.75	-
	Lepidostomatidae	larvae	-	0.25	0.50	-	-	0.25
	Leptoceridae	larvae	-	-	-	-	0.50	-
	Limnephilidae	larvae	1.00	1.75	3.25	1.25	10.25	2.25
	Philopotamidae	larvae	-	-	-	-	-	2.50 a
	Rhyacophilidae	larvae	0.75	-	0.25	-	0.25	0.50
	Unidentified	larvae	-	-	0.50	-	-	-
		pupae	0.75	3.00	1.00	0.50	0.75	3.00
Lepidoptera		larvae	-	-	-	0.50	-	-
Coleoptera	Halipidae	adults	-	-	0.25	-	-	-
	Elmidae	larvae	6.00	2.50	9.75	6.25	5.75	6.50
		adults	14.25	12.25	16.25	31.50	10.75	5.25
	Chrysomelidae	adults	-	-	0.25	-	-	-
Diptera	Tipulidae	larvae	4.00 a	0.75 b	2.00 ab	1.75 ab	1.25 ab	0.25 b
	Simuliidae	larvae	5.00 a	4.50 ab	0.75 ab	0.50 ab	1.25 ab	- b
		pupae	1.00	0.50	1.00	-	-	-
	Chironomidae	larvae	5.50 ab	5.00 ab	2.50 a	17.75 bc	32.00 c	2.50 a
		pupae	0.25	0.25	0.25	0.25	3.25	0.75
	Heleidae	larvae	0.25	0.50	-	2.25 a	-	-
	Rhagionidae	larvae	0.75	1.00	0.75	1.50	0.75	1.50
	Empididae	larvae	-	0.25	1.75	0.25	0.50	0.25
		pupae	-	-	-	-	0.25	-
Total Aquatic Invertebrates			76.25	63.75	77.25	94.50	106.50	40.00

*mean numbers of organisms collected in four Surber samples
 numbers followed by the same character are not significantly different at the 5% significance level (a Student-Newman-Keuls test was used after transforming the data to log (x + 1.0))

**application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980

Table 7. Aquatic invertebrates collected in Surber samples*, Bass Brook Control Station, Gloucester County, New Brunswick, 31 May - 1 August 1980.

Days before or after first (second) application of 0.280 kg AI/ha SEVIN-2-011:8**			-11	-5	+2	+10 (+4)	+15 (+9)	+51 (+45)
Turbellaria			0.25	0.25	-	-	-	-
Nematoda			0.25	-	1.00	-	-	0.25
Oligochaeta			-	-	0.75	0.25	0.25	0.25
Hydracarina			-	1.25	-	0.25	-	-
Plecoptera		nympha	1.50	0.75	2.50	2.75	1.00	0.50
Ephemeroptera	Baetidae	nymphs	9.25 a	2.25 ab	2.75 ab	- b	- b	0.25 b
	Heptageniidae	nymphs	3.25	0.25	2.75	1.25	0.75	1.75
	Leptophlebiidae	nymphs	-	-	0.25	0.25	0.75	0.50
	Ephemereiliidae	nymphs	4.50 ab	4.25 a	15.50 b	2.00 a	1.75 a	2.25 a
	Unidentified	nymphs	-	-	-	-	0.50	-
Odonata	Cordulegastridae	nymphs	0.25	0.25	0.25	-	0.25	-
	Gomphidae	nymphs	0.25	-	0.25	-	0.25	-
Trichoptera	Brachycentridae	larvae	-	-	0.25	-	-	0.50
	Glossosomatidae	larvae	-	-	-	-	-	0.50
	Hydropsychidae	larvae	0.75	-	0.75	0.25	-	0.25
	Hydroptilidae	larvae	0.25	-	0.25	-	0.25	-
	Leptoceridae	larvae	-	-	0.50	-	-	-
	Limnephilidae	larvae	0.75	0.75	0.50	-	0.50	1.00
	Polycentropodidae	larvae	0.25	-	-	0.50	-	-
	Rhyacophilidae	larvae	0.50	0.25	0.25	1.25	-	-
	Unidentified	larvae	-	-	0.25	-	-	-
		pupae	0.75	2.00	1.50	0.50	0.50	0.75
Lepidoptera		larvae	-	-	-	0.25	-	-
Coleoptera	Elmidae	larvae	4.25 ab	5.00 ab	10.25 b	0.75 a	2.50 ab	12.75 b
		adults	10.00	17.50	23.00	8.00	2.75	19.50
Diptera	Tipulidae	larvae	1.75	1.00	3.50	0.25	1.00	1.25
	Simuliidae	larvae	2.50	0.25	1.25	0.25	0.75	-
		pupae	0.50	0.25	0.25	-	-	-
	Chironomidae	larvae	-	1.50	2.00	0.50	2.00	2.00
		pupae	-	-	0.25	-	-	-
	Rhagionidae	larvae	0.50	0.50	-	-	0.25	0.75
Pelecypoda			-	-	-	-	-	0.50
Total Aquatic Invertebrates			42.25	38.25	70.75	19.25	16.00	45.50

*mean numbers of organisms collected in four Surber samples
 numbers followed by the same character are not significantly different at the 5% significance level (a Student-Newman Keuls test
 was used after transforming the data to log (x + 1.0))

**application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980

Table 8
Aquatic invertebrates collected from rocks*,
Middle Brook Treatment Station A,
Gloucester County, New Brunswick
31 May - 1 August 1980

Days before or after first (second) application of 0.280 kg AI/ha SEVIN-2-011,80A*			-11	-5	+2	+10 (+4)	+16 (+10)	+51 (+45)
Nematomorpha			-	-	0.25	-	-	-
Hydracarina			5.75	17.25	8.00	14.00	16.00	- a
Plecoptera		nymphs	-	1.00	1.00	2.25	1.50	-
Ephemeroptera	Baetidae	nymphs	0.75	0.75	1.25	1.75	1.00	19.50 a
	Heptageniidae	nymphs	0.75	1.00	0.50	1.50	0.50	2.00
	Leptophlebiidae	nymphs	-	-	0.25	-	1.00	0.50
	Ephemereiliidae	nymphs	1.25	1.25	1.50	5.50	6.75	8.00
Odonata	Aeshnidae	nymphs	-	-	0.25	-	-	-
Trichoptera	Brachycentridae	larvae	-	-	0.25	-	-	-
	Hydropsychidae	larvae	-	-	-	0.50	-	-
	Hydroptilidae	larvae	-	0.25	0.25	0.25	-	0.25
	Lepidostomatidae	larvae	-	0.25	-	-	-	-
	Leptoceridae	larvae	-	0.25	-	-	-	0.25
	Limnephilidae	larvae	1.75	2.50	3.00	2.50	2.75	1.25
	Polycentropodidae	larvae	0.75	0.50	0.75	1.25	0.25	0.25
	Unidentified	larvae	-	-	-	0.25	-	-
		pupae	-	1.25	0.75	0.50	-	1.25
Lepidoptera		larvae	-	-	-	0.25	-	-
Coleoptera	Elmidae	larvae	1.75 ab	2.00 ab	0.50 a	3.75 ab	7.50 bc	13.50 c
		adults	0.50	0.25	0.50	10.25	-	-
Diptera	Tipulidae	larvae	1.25	0.25	0.75	0.50	0.25	0.25
	Simuliidae	larvae	1.25	0.25	-	2.50	-	-
	Chironomidae	larvae	14.25 ab	5.00 a	13.00 ab	42.75 ab	36.00 b	140.00 c
		pupae	-	-	-	0.25	0.75	0.25
	Heleidae	larvae	-	-	0.25	-	0.25	-
		pupae	-	-	-	-	0.50	-
	Rhagionidae	larvae	0.25	0.50	-	0.25	0.25	0.50
	Empididae	larvae	-	-	0.75	0.25	-	-
Total Aquatic Invertebrates			30.25 a	34.25 a	33.75 a	91.00 ab	75.25 ab	188.00 b

*mean numbers of organisms collected from four rocks
numbers followed by the same character are not significantly different at the 5% significance level (a Student-Newman-Keuls test was
used after transforming the data to log (x + 1.0))

**application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980

Table 9
Aquatic invertebrates collected from rocks*,
Middle Brook Treatment Station B
Gloucester County, New Brunswick
2 June - 1 August 1980

Days before or after first (second) application of 0.280 kg AI/ha SEVIN-2-OIL [®] AA			-9	-5	+2	+10 (+4)	+16 (+10)	+51 (+45)
Nematoda			-	-	-	-	-	0.25
Nematomorpha			-	-	-	-	-	0.25
Hydracarina			14.75 a	6.25 ab	3.25 ab	5.00 ab	5.00 ab	0.50 b
Plecoptera		nymphs	-	0.25	0.75	0.50	0.50	0.25
Ephemeroptera	Baetidae	nymphs	0.25	-	0.75	0.50	2.25	8.50 a
	Heptageniidae	nymphs	-	-	1.00	-	1.25	0.25
	Leptophlebiidae	nymphs	-	-	1.00	-	0.25	-
	Ephemereilidae	nymphs	0.25 a	1.25 ab	5.25 b	3.75 b	3.00 b	6.00 b
Trichoptera	Glossosomatidae	larvae	0.25	-	-	-	1.25	0.25
	Hydropsychidae	larvae	-	-	-	-	-	0.25
	Hydroptilidae	larvae	-	0.50	-	-	-	0.75
	Lepidostomatidae	larvae	-	-	-	-	1.00	-
	Leptoceridae	larvae	0.50	0.50	-	-	0.50	0.50
	Limnephilidae	larvae	5.50	1.00	2.75	5.00	1.25	1.50
	Philopotamidae	larvae	-	-	0.25	-	-	-
	Polycentropodidae	larvae	-	0.25	-	0.25	0.25	-
	Rhyacophilidae	larvae	-	-	-	0.25	-	-
	Unidentified	pupae	0.75	2.50 a	0.25	0.50	-	-
Coleoptera	Elmidae	larvae	-	1.50	0.50	-	1.25	2.50
		adults	-	0.25	1.00	0.50	1.75	0.25
Diptera	Tipulidae	larvae	0.50	1.00	-	0.75	-	0.25
	Simuliidae	larvae	-	-	-	0.75	0.50	-
		pupae	-	0.75	0.25	-	-	-
	Chironomidae	larvae	9.50	20.75	14.25	9.50	48.25	115.50 a
		pupae	0.25 ab	- a	- a	- a	1.25 b	0.25 ab
	Heleidae	larvae	0.75	0.75	0.25	0.25	-	-
	Rhagtonidae	larvae	0.50	1.00	0.50	-	-	-
	Empididae	larvae	-	-	0.25	0.25	-	-
Total Aquatic Invertebrates			33.75	38.50	32.25	27.75	69.50	138.00 a

*mean numbers of organisms collected from four rocks
numbers followed by the same character are not significantly different at the 5% significance level (a Student-Newman Keuls test
was used after transforming the data to log ($\chi + 1.0$))

**application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980

Table 10
Aquatic invertebrates collected from rocks*,
Bass Brook Control Station,
Gloucester County, New Brunswick
31 May - 1 August 1980

Days before or after first (second) application of 0.280 kg AI/ha SEVIN-2-011:0**			-11	-5	+2	+10 (+4)	+15 (+9)	+51 (45)
Nematoda			-	-	-	0.25	-	-
Oligochaeta			-	-	-	-	-	0.75
Hydracarina			0.75	3.00	1.00	1.25	5.75 a	-
Plecoptera		nymphs	- a	0.50 ab	0.50 ab	1.00 ab	2.75 b	0.75 ab
Ephemeroptera	Baetidae	nymphs	0.50	0.50	1.50	1.25	2.00	13.25 a
	Heptageniidae	nymphs	0.50	-	0.50	-	0.25	-
	Leptophlebiidae	nymphs	-	0.25	-	-	0.75	0.25
	Ephemerellidae	nymphs	1.00	1.25	-	0.25	4.25	1.00
Trichoptera	Brachycentridae	larvae	0.25	-	-	-	-	4.00
	Hydropsychidae	larvae	-	-	-	-	-	0.50
	Hydroptilidae	larvae	-	0.50	0.75	-	-	-
	Lepidostomatidae	larvae	-	-	-	0.50	-	-
	Limanephilidae	larvae	-	0.50	1.00	0.25	0.25	-
	Odontoceridae	larvae	-	0.75	-	-	-	-
	Polycentropodidae	larvae	-	0.25	-	-	0.25	-
	Rhyacophilidae	larvae	-	0.50	-	-	-	1.25
	Unidentified	larvae	0.25	-	-	-	-	-
		pupae	-	1.00	-	0.25	0.25	0.25
Lepidoptera		larvae	-	-	-	-	-	0.25
Coleoptera	Elmidae	larvae	0.25	6.00	1.50	0.50	1.75	22.75 a
		adults	1.00	3.00	2.75	0.25	3.00	4.75
Diptera	Tipulidae	larvae	-	0.75	-	-	-	-
	Simuliidae	larvae	0.25	0.75	0.50	-	-	-
	Chironomidae	larvae	10.00	19.00	15.25	11.75	19.25	28.00
		pupae	0.50	0.50	0.50	-	-	0.25
	Heleidae	larvae	-	0.25	0.25	0.25	-	-
	Rhagionidae	larvae	-	-	-	-	-	0.75
	Empididae	larvae	-	-	0.25	-	-	-
Total Aquatic Invertebrates			15.25 a	39.25 ab	26.25 ab	17.75 ab	40.50 ab	80.00 b

*mean numbers of organisms collected from four rocks
numbers followed by the same character are not significantly different at the 5% significance level (a Student-Newman-Keuls test
was used after transforming the data to $\log(x + 1.0)$)

**application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980

APPENDIX V

Stomach content analyses for brook trout and slimy sculpins collected from the treatment and control streams, Gloucester County, New Brunswick.

Table 1. Brook trout sampled for stomach content analysis, Middle Brook Treatment, Gloucester County, New Brunswick.

Date	31 May- 1 June	12 June	20 June	26 June	3 August
Number of fish sampled	10	10	13	10	5
Mean fork length (mm)	121.30	121.00	119.46	127.80	123.00
Range	103-193	93-146	83-143	85-183	88-168
Mean weight (g)	30.06	22.00	21.97	30.21	27.16
Range	13.5-84.4	9.6-36.1	7.6-34.9	7.9-78.9	8.0-59.1
Mean volume of stomach contents (ml)	1.23	0.91	0.65	0.90	0.40
Range	0.2-5.7	0.2-3.1	0.2-2.0	<0.1-3.5	<0.1-0.8
Mean (volume of stomach contents/body weight)	0.036	0.050	0.025	0.033	0.016
Range	0.018-0.068	0.009-0.140	0.011-0.105	0.001-0.071	0.006-0.030
Fulton's coefficient of condition (K)*	1.17	1.19	1.21	1.26	1.22
Range	1.01-1.33	1.07-1.28	1.11-1.33	1.16-1.35	1.17-1.26

* $K = w/l^3 \times 10^5$ where w = weight (g)
 l = fork length (mm)

Table 2. Sculpins sampled for stomach content analysis, Middle Brook Treatment, Gloucester County, New Brunswick.

Date	31 May- 1 June	12 June	20 June	26 June	3 August
Number of fish sampled	10	11	11	10	10
Mean total length (mm)	65.70	63.55	60.91	68.20	59.50
Range	42-113	45-88	50-82	48-85	48-82
Mean weight (g)	3.90	3.70	3.46	4.27	3.28
Range	0.9-14.2	1.7-7.2	2.1-6.8	1.6-8.5	1.2-10.4
Mean volume of stomach contents (ml)	0.15	0.19	0.05	0.08	0.08
Range	<0.1-0.4	<0.1-0.3	0-0.1	<0.1-0.2	0-0.2
Mean (volume of stomach contents/ body weight)	0.05	0.05	0.02	0.02	0.02
Range	0.03-0.09	0.01-0.12	0-0.04	0.01-0.03	0-0.04

Table 3. Brook trout sampled for stomach content analysis, Little Brook Control, Gloucester County, New Brunswick.

Date	2 June	14 June	19 June	25 June	2 Aug.
Number of fish sampled	10	10	11	11	10
Mean fork length (mm)	124.10	135.10	129.45	115.36	122.30
Range	93-169	107-185	93-168	85-150	89-153
Mean weight (g)	22.90	32.65	28.93	19.70	25.08
Range	9.9-50.4	16.2-76.3	7.8-58.9	7.6-42.3	10.1-43.9
Mean volume of stomach contents (ml)	1.24	1.16	0.96	1.09	0.86
Range	<0.1-4.5	0.5-2.1	<0.1-2.8	0.2-2.6	0.1-2.7
Mean (volume of stomach contents/body weight)	0.050	0.043	0.033	0.054	0.46
Range	0.002-0.095	0.011-0.093	0.005-0.066	0.013-0.097	0.010-0.223
Fulton's coefficient of condition (K)*	1.15	1.23	1.16	1.20	1.26
Range	1.04-1.23	1.10-1.32	0.97-1.31	1.09-1.34	1.13-1.43

*K = $w/\ell^3 \times 10^5$ where w = weight (g)
 ℓ = fork length (mm)

Table 4. Sculpins sampled for stomach content analysis, Little Brook Control, Gloucester County, New Brunswick.

Date	2 June	14 June	19 June	25 June	2 August
Number of fish sampled	10	12	10	10	10
Mean total length (mm)	63.10	65.08	66.40	71.50	60.20
Range	50-80	50-93	50-82	56-87	55-68
Mean weight (g)	2.39	3.50	3.71	5.14	3.52
Range	1.1-4.2	1.9-7.7	1.8-7.1	2.9-8.5	2.4-5.5
Mean volume of stomach contents (ml)	0.15	0.11	0.13	0.13	0.08
Range	<0.1-0.4	0-0.2	<0.1-0.3	<0.1-0.5	<0.1-0.2
Mean (volume of stomach contents/ body weight)	0.06	0.03	0.03	0.03	0.02
Range	0.02-0.16	0-0.06	0.01-0.06	0.01-0.10	0.01-0.06

Table 5. Brook trout sampled for stomach content analysis, Bass Brook Control, Gloucester County, New Brunswick.

Date	1 June	12 June	19 June	25 June
Number of fish sampled	15	11	12	13
Mean fork length (mm)	90.80	98.82	97.42	103.54
Range	60-135	71-122	72-137	73-165
Mean weight (g)	10.15	12.28	12.28	15.39
Range	2.4-28.4	3.9-20.2	5.0-27.4	4.8-52.5
Mean volume of stomach contents (ml)	0.33	0.86	0.41	0.65
Range	0.1-1.1	0.2-2.6	0.1-1.1	0.1-4.0
Mean (volume of stomach contents/body weight)	0.034	0.075	0.40	0.034
Range	0.021-0.052	0.025-0.160	0.011-0.090	0.012-0.076
Fulton's coefficient of condition (K)*	1.13	1.17	1.22	1.21
Range	1.02-1.23	1.06-1.27	1.07-1.40	1.07-1.39

* $K = w/\ell^3 \times 10^5$ where w = weight (g)
 ℓ = fork length (mm)

Table 6. Stomach contents of brook trout, Middle Brook Treatment, Gloucester County, New Brunswick.

Sample date		Percent Occurrence					Mean Percent Contribution to Volume					Mean Number of Organisms per Stomach				
		31 May	12 June	20 June	26 June	3 August	31 May	12 June	20 June	26 June	3 August	31 May	12 June	20 June	26 June	3 August
No food present		0	0	0	0	0										
Aquatic Insects																
Plecoptera	N	20	80	69	70	40	0.9	27.3	5.8	7.9	3.0	2.0	53.0	2.8	5.4	1.0
Ephemeroptera																
Heptageniidae	N	10	20	-	-	-	0.5	0.2	-	-	-	5.0	1.5	-	-	-
Other	N	30	60	23	30	100	1.0	3.4	1.2	0.9	9.2	1.3	9.3	2.0	1.3	3.6
Odonata																
Anisoptera	N	-	-	-	10	20	-	-	-	0.5	1.0	-	-	-	2.0	1.0
Hemiptera																
Gerridae		-	-	-	10	20	-	-	-	1.0	0.2	-	-	-	1.0	1.0
Megaloptera																
Sialidae	L	-	-	8	-	-	-	-	0.1	-	-	-	-	1.0	-	-
Trichoptera	L	100	100	77	70	80	43.8	45.4	17.8	6.5	10.0	12.9	20.2	4.1	3.4	4.8
	P	-	-	23	20	60	-	-	0.7	0.4	18.0	-	-	1.3	1.0	4.0
Coleoptera	L	40	10	31	20	20	1.8	0.1	1.2	0.7	1.0	1.0	1.0	1.8	1.0	1.0
	A	60	40	54	50	-	5.3	3.1	5.7	5.5	-	1.7	2.5	2.6	2.2	-
Diptera																
Tipulidae	L	-	20	23	40	40	-	0.2	0.2	11.0	0.4	-	1.0	1.0	5.0	1.0
	P	-	-	-	10	-	-	-	-	0.2	-	-	-	-	1.0	-
Simuliidae	L	60	70	23	-	20	5.0	8.0	0.7	-	0.2	2.2	22.4	2.7	-	1.0
	P	-	10	-	-	-	-	0.1	-	-	-	-	1.0	-	-	-
Chironomidae	L	40	70	54	80	20	1.2	1.8	1.8	2.4	3.8	1.5	5.3	2.7	2.9	4.0
Heleidae	L	-	-	-	30	-	-	-	-	2.1	-	-	-	-	3.3	-
	P	-	10	-	20	-	-	0.1	-	2.4	-	-	1.0	-	2.0	-
Rhagionidae	L	10	-	-	10	-	0.3	-	-	0.5	-	1.0	-	-	1.0	-
Empididae	L	10	-	-	-	20	0.2	-	-	-	0.8	1.0	-	-	-	1.0
Other aquatic invertebrates																
Hydracarina		50	30	23	-	40	1.0	1.2	0.4	-	3.2	2.0	2.7	1.0	-	2.0
Pelecypoda		-	-	-	10	-	-	-	-	3.0	-	-	-	-	1.0	-
Terrestrial arthropods																
Arachnida		20	-	23	20	100	0.5	-	0.6	3.2	5.4	1.0	-	1.0	1.0	1.6
Collembola		-	-	-	10	20	-	-	-	0.2	2.8	-	-	-	1.0	1.0
Ephemeroptera	A	-	30	-	-	-	-	0.4	-	-	-	-	2.3	-	-	-
Plecoptera	A	10	10	-	-	-	0.5	0.2	-	-	-	2.0	2.0	-	-	-
Hemiptera		-	-	8	40	60	-	-	0.4	3.0	2.2	-	-	1.0	1.5	2.0
Homoptera		40	10	31	10	60	1.3	0.2	0.7	0.5	1.0	1.0	3.0	1.5	4.0	2.0
Coleoptera	L	-	-	-	-	20	-	-	-	-	1.0	-	-	-	-	1.0
	A	50	40	77	50	40	4.0	0.9	10.1	4.7	2.6	2.2	1.3	3.3	2.4	2.5
Trichoptera	A	-	10	15	30	-	-	0.1	0.5	3.0	-	-	1.0	1.0	3.3	-
Lepidoptera	L	60	40	46	40	40	10.6	1.5	6.2	6.0	16.4	2.7	1.5	4.2	3.0	2.5
Diptera	L	-	-	-	-	60	-	-	-	-	2.0	-	-	-	-	1.3
	A	70	40	92	100	100	15.1	4.0	42.4	33.0	12.0	13.7	4.5	9.7	6.5	4.2
Hymenoptera																
Formicidae		30	10	-	-	-	1.2	1.5	-	-	-	1.0	1.0	-	-	-
Other	L	-	-	-	-	20	-	-	-	-	0.8	-	-	-	-	1.0
	A	50	20	62	20	20	4.8	0.3	3.6	1.4	3.0	2.2	1.5	2.0	1.5	1.0
Fish		10	-	-	-	-	1.0	-	-	-	-	2.0	-	-	-	-

Application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980.

N = nymphs
A = adults
L = larvae
P = pupae

Table 7. Stomach contents of slimy sculpins, Middle Brook Treatment, Gloucester County, New Brunswick.

Sample date		Percent Occurrence					Mean Percent Contribution to Volume					Mean Number of Organisms per Stomach				
		31 May- 1 June	12 June	20 June	26 June	3-4 Aug.	31 May- 1 June	12 June	20 June	26 June	3-4 Aug.	31 May- 1 June	12 June	20 June	26 June	3-4 Aug.
No food present		0	0	19	0	20										
Aquatic Insecta																
Plecoptera	N	60	91	27	80	-	14.2	19.4	15.6	41.4	-	2.5	7.9	2.0	2.1	-
Ephemeroptera																
Heptageniidae	N	10	-	-	-	-	0.5	-	-	-	-	1.0	-	-	-	-
Other	N	90	73	27	20	70	35.3	24.9	7.8	9.0	41.1	2.7	8.4	1.3	1.0	3.6
Trichoptera	L	50	82	73	50	60	26.0	23.2	59.9	25.0	46.0	3.0	6.0	2.0	2.2	7.5
	P	-	9	-	-	-	-	0.5	-	-	-	-	1.0	-	-	-
Coleoptera	L	10	-	-	10	-	0.2	-	-	3.5	-	1.0	-	-	1.0	-
	A	-	-	-	10	-	-	-	-	4.5	-	-	-	-	1.0	-
Diptera																
Tipulidae	L	40	9	-	10	-	5.1	1.8	-	8.0	-	1.0	1.0	-	1.0	-
Simuliidae	L	40	91	-	-	10	14.9	28.6	-	-	8.8	10.3	13.4	-	-	9.0
Chironomidae	L	60	36	64	70	60	2.3	1.2	16.8	4.6	4.1	2.0	3.0	4.6	4.3	4.3
	P	10	9	-	-	-	0.5	0.5	-	-	-	1.0	1.0	-	-	-
Heleidae	L	10	-	-	-	-	1.0	-	-	-	-	2.0	-	-	-	-
Terrestrial arthropods																
Lepidoptera	L	-	-	-	10	-	-	-	-	4.0	-	-	-	-	1.0	-

Application at 0631 ADT on 11 June 1980 and again at 0819 ADT on 17 June 1980

N = nymphs

A = adults

L = larvae

P = pupae

Table 8. Stomach contents of brook trout, Little Brook Control, Gloucester County, New Brunswick.

Sample date		Percent Occurrence					Mean Percent Contribution to Volume					Mean Number of Organisms per Stomach				
		2 June	14 June	19 June	25 June	2 August	2 June	14 June	19 June	25 June	2 August	2 June	14 June	19 June	25 June	2 August
No food present		0	0	0	0	0										
Aquatic Insecta																
Ephemeroptera	H	30	80	64	82	70	1.9	1.7	9.6	5.3	3.7	11.0	4.1	1.4	15.0	2.4
Heptageniidae	H	-	10	9	9	20	-	0.1	0.1	0.1	0.5	-	1.0	1.0	1.0	1.5
Ephemerellidae	H	20	20	9	9	-	1.8	1.1	1.6	0.5	-	1.5	1.0	1.0	1.0	-
Other	H	50	100	55	55	70	1.5	4.3	4.0	0.8	2.5	3.4	4.8	1.7	2.2	1.6
Odonata																
Anisoptera	H	-	10	-	9	-	-	5.3	-	1.6	-	-	3.0	-	1.0	-
Megaloptera																
Libellulidae	L	-	-	-	9	-	-	-	-	1.8	-	-	-	-	10.0	-
Trichoptera	L	100	100	91	73	100	28.0	15.3	25.4	19.2	19.6	7.1	7.7	5.4	8.3	5.0
Other	P	-	20	9	9	10	-	0.8	0.1	0.2	1.0	-	1.0	1.0	1.0	4.0
Coleoptera																
Eurytomidae	L	10	-	-	-	-	0.1	-	-	-	-	1.0	-	-	-	-
Other	L	-	-	9	9	-	-	-	0.1	0.1	-	-	-	1.0	1.0	-
Other	P	10	30	9	-	-	0.5	1.0	0.5	-	-	1.0	1.0	2.0	-	-
Other	A	30	40	18	9	20	0.8	1.0	0.5	0.2	1.5	1.7	1.3	1.0	1.0	1.5
Diptera																
Tipulidae	L	20	-	-	36	20	1.7	-	-	5.8	0.2	1.5	-	-	1.3	1.0
Other	P	-	-	9	9	-	-	-	0.1	2.3	-	-	-	-	1.0	-
Simuliidae	L	90	90	73	91	40	22.9	10.8	17.0	15.0	0.7	59.7	22.6	103.6	28.3	1.5
Other	P	30	10	9	45	-	0.8	0.1	0.1	1.7	-	3.0	1.0	5.0	3.4	-
Chironomidae	L	90	100	82	100	60	9.6	14.4	5.6	17.4	1.7	25.4	32.1	19.1	29.0	3.3
Other	P	30	20	18	18	10	1.5	0.3	0.2	0.2	0.1	12.0	2.0	1.5	1.5	1.0
Belontiidae	L	10	20	9	64	10	0.1	0.2	0.1	1.5	0.1	1.0	1.0	1.0	2.9	1.0
Other	P	-	50	-	-	-	-	0.7	-	-	-	-	2.6	-	-	-
Stratiomyidae	L	10	-	-	-	-	0.3	-	-	-	-	1.0	-	-	-	-
Tobaciidae	L	10	40	9	9	10	1.0	4.1	6.8	5.5	0.5	3.0	1.5	1.0	4.0	1.0
Rhyacionidae	L	10	-	-	-	-	0.3	-	-	-	-	1.0	-	-	-	-
Empididae	L	-	20	-	18	-	-	0.2	-	0.2	-	-	1.0	-	1.0	-
Other aquatic invertebrates																
Hydracarina		20	40	27	36	30	0.2	0.4	0.2	0.4	0.7	1.5	2.0	1.7	1.0	1.0
Gastropoda		-	-	9	-	10	-	-	0.1	-	0.4	-	-	1.0	-	1.0
Terrestrial arthropods																
Arachnida		20	60	36	27	90	0.7	2.3	0.3	0.6	10.5	2.0	1.8	1.0	1.3	2.2
Collembola		-	10	9	9	10	-	0.1	0.1	0.1	0.1	-	2.0	1.0	2.0	1.0
Ephemeroptera	A	-	-	-	-	20	-	-	-	-	1.3	-	-	-	-	2.5
Ephemeroptera	A	-	-	-	-	10	-	-	-	-	1.4	-	-	-	-	7.0
Hemiptera		10	20	-	18	30	0.3	0.2	-	0.3	1.4	1.0	1.0	-	1.0	2.3
Homoptera		-	20	9	-	60	-	0.4	0.1	-	1.3	-	2.5	1.0	-	3.5
Coleoptera		-	-	-	-	50	-	-	-	-	3.2	-	-	-	-	1.2
Coleoptera	L	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	P	-	10	-	-	-	-	2.0	-	-	-	-	2.0	-	-	-
A	A	30	50	55	55	70	1.0	4.0	3.8	7.0	4.0	1.7	4.2	1.3	3.3	1.9
Trichoptera	A	-	10	-	-	20	-	0.1	-	-	-	-	-	-	-	6.0
Lepidoptera	L	30	30	-	-	5	1.2	0.9	-	-	2.9	1.7	1.3	-	-	1.6
A	A	-	-	-	-	10	-	-	-	-	1.0	-	-	-	-	3.0
Diptera	L	-	20	36	9	10	-	8.0	6.7	0.2	0.7	-	50.5	24.8	1.0	1.0
A	A	60	100	73	73	100	16.4	17.1	16.7	9.5	29.8	33.5	17.3	12.5	11.8	13.3
Hymenoptera																
Formicidae		40	40	9	18	20	7.4	1.2	0.7	0.5	2.0	1.8	1.8	1.0	1.0	1.5
Other	A	10	20	-	9	20	0.1	0.2	-	0.1	0.5	1.0	1.0	-	2.0	1.5
Amphibian eggs		-	-	-	9	-	-	-	-	1.8	-	-	-	-	-	-

H = nymphs
 A = adults
 L = larvae
 P = pupae

Table 9. Stomach contents of slimy sculpins, Little Brook Control, Gloucester County, New Brunswick.

Sample date		Percent Occurrence					Mean Percent Contribution to Volume					Mean Number of Organisms per Stomach				
		2 June	14 June	19 June	25 June	2 August	2 June	14 June	19 June	25 June	2 August	2 June	14 June	19 June	25 June	2 August
No food present		0	8	0	0	0										
Aquatic Insects																
Plecoptera	N	30	25	10	30	20	1.0	0.5	0.1	0.5	0.3	1.3	2.7	1.0	1.3	1.0
Ephemeroptera																
Heptageniidae	N	-	-	-	-	10	-	-	-	-	0.1	-	-	-	-	1.0
Other	N	10	42	-	30	60	2.5	0.5	-	1.4	10.0	1.0	1.4	-	3.0	3.8
Trichoptera	L	50	33	20	70	60	4.9	1.9	0.8	10.2	38.7	1.2	2.3	1.5	2.1	3.0
Coleoptera	L	-	8	-	-	-	-	0.1	-	-	-	-	1.0	-	-	-
	A	10	8	-	-	-	1.5	0.1	-	-	-	3.0	1.0	-	-	-
Diptera																
Tipulidae	L	10	-	-	10	-	0.1	-	-	0.5	-	1.0	-	-	3.0	-
Simuliidae	L	70	83	80	60	50	6.1	46.1	24.0	36.6	7.1	7.0	43.8	21.9	66.8	1.4
	P	-	17	10	10	10	-	0.2	0.2	0.4	0.1	-	1.0	2.0	2.0	1.0
Chironomidae	L	100	92	100	100	100	83.4	49.5	74.9	50.4	43.7	50.4	36.1	62.2	19.7	28.0
	P	10	8	-	-	-	0.1	0.4	-	-	-	1.0	2.0	-	-	-
Heleidae	L	10	-	-	-	-	0.1	-	-	-	-	1.0	-	-	-	-
	P	-	17	-	-	-	-	0.2	-	-	-	-	1.5	-	-	-
Rhagionidae	L	10	8	-	-	-	0.2	0.1	-	-	-	1.0	1.0	-	-	-
Epididae	L	10	8	-	-	-	0.1	0.1	-	-	-	1.0	1.0	-	-	-
Other aquatic invertebrates																
Gastropoda		-	8	-	-	-	-	0.3	-	-	-	-	2.0	-	-	-
Terrestrial arthropods																
Ephemeroptera	A	-	8	-	-	-	-	0.1	-	-	-	-	1.0	-	-	-

N = nymphs

A = adults

L = larvae

P = pupae

Table 10. Stomach contents of brook trout, Bass Brook Control, Gloucester County, New Brunswick.

Sample date		Percent Occurrence				Mean Percent Contribution to Volume				Mean Number of Organisms per Stomach			
		1 June	12 June	19 June	25 June	1 June	12 June	19 June	25 June	1 June	12 June	19 June	25 June
No food present		0	0	0	0								
Aquatic Insecta													
Plecoptera	N	47	18	42	23	1.5	0.2	0.9	0.3	2.1	1.0	1.2	1.3
Ephemeroptera													
Heptageniidae	N	-	9	-	-	-	0.1	-	-	-	2.0	-	-
Ephemeridae	N	20	18	-	-	0.4	0.3	-	-	1.0	1.0	-	-
Other	N	93	100	75	23	24.9	66.1	13.8	1.8	4.4	82.4	3.1	3.9
Odonata													
Anisoptera	N	-	-	8	8	-	-	7.4	3.8	-	-	4.0	1.0
Trichoptera	L	73	73	75	38	12.0	5.6	17.2	1.8	5.3	3.1	3.0	2.8
	P	-	-	8	-	-	-	4.0	-	-	-	4.0	-
Coleoptera	L	47	18	8	-	4.3	0.3	0.2	-	3.0	1.5	2.0	-
	A	33	64	50	-	0.5	1.8	1.9	-	1.2	1.7	1.7	-
Diptera													
Tipulidae	L	7	9	-	15	0.1	0.1	-	6.6	1.0	1.0	-	2.0
Simuliidae	L	60	36	33	8	1.5	0.4	0.8	0.3	2.7	1.0	2.0	1.0
	P	20	-	-	8	0.3	-	-	0.2	3.7	-	-	2.0
Chironomidae	L	100	45	50	23	1.7	0.5	0.9	0.2	3.8	1.8	2.2	1.7
	P	7	9	8	-	0.1	0.1	0.1	-	2.0	1.0	1.0	-
Heleidae	L	40	9	17	23	0.4	0.1	0.2	0.3	1.3	1.0	1.5	1.3
Other aquatic invertebrates													
Hydracarina		33	64	58	23	0.3	0.6	0.6	0.2	1.2	1.6	1.6	1.7
Gastropoda		13	-	17	-	0.1	-	0.4	-	1.0	-	1.5	-
Terrestrial arthropoda													
Arachnida		20	36	42	38	0.5	0.5	0.8	0.7	1.7	2.0	1.4	1.4
Collembola		7	9	-	15	0.1	0.1	-	0.2	2.0	1.0	-	1.0
Ephemeroptera	A	20	-	8	-	2.5	-	0.1	-	2.7	-	0.1	-
Plecoptera	A	7	9	-	-	0.8	0.5	-	-	2.0	7.0	-	-
Hemiptera		7	-	8	23	0.1	-	0.2	1.1	1.0	-	1.0	1.3
Homoptera		20	9	8	23	0.2	0.1	0.1	0.8	1.0	1.0	2.0	2.7
Coleoptera	L	7	9	-	-	0.1	0.5	-	-	2.0	1.0	-	-
	A	40	27	33	69	1.1	0.4	0.6	17.8	1.7	1.0	1.3	20.1
Trichoptera	A	20	36	-	-	0.3	0.6	-	-	1.0	1.5	-	-
Lepidoptera	L	13	9	25	85	0.1	0.2	4.5	16.2	1.0	1.0	1.3	18.9
Diptera	A	100	91	100	100	46.0	20.4	39.6	45.6	53.8	41.4	12.5	22.5
Hymenoptera													
Formicidae		7	9	58	54	0.1	0.3	5.5	1.8	1.0	4.0	1.0	1.7
Other	A	7	45	-	31	0.1	0.5	-	0.4	1.0	1.2	-	1.5

N = nymphs

A = adults

L = larvae

P = pupae