AQUATIC IMPACT STUDIES ON EXPERIMENTAL AQUEOUS FORMULATIONS OF SPRUCE BUDWORM CONTROL AGENTS CONTAINING TRITON® X-100, NEW BRUNSWICK, 1982

File Report No. 38. November 1982.

S. B. Holmes

Forest Pest Management Institute
Canadian Forestry Service
Sault Ste. Marie, Ontario

INTRODUCTION

On 28 April, 1982, the New Brunswick Task Force on the Environment and Reye's Syndrome chaired by Walter O. Spitzer released its report to the New Brunswick government. One of the key recommendations made by the Task Force was that the use of Atlox 3409F in forest spraying to control spruce budworm be discontinued and replaced by another emulsifier. The major objection to the use of Atlox 3409F was that it has shown viral-enhancing properties in the laboratory and is currently being investigated as a possible cofactor in the pathogenesis of Reye's Syndrome in children. As a result of decisions reached following this report, and availability of materials, the fenitrothion water-based formulation was dropped from the 1982 New Brunswick spray program and fenitrothion was applied dissolved in the solvents Dowanol TPM or Cyclosol 63. In addition, a 'crash' program was initiated, involving several cooperating agencies, aimed at generating, in one year, all the data required to register new water-based formulations of fenitrothion and aminocarb which do not contain viral-enhancing emulsifiers. As part of this 'action plan' environmental impact studies were conducted in three experimental spray blocks treated with the candidate fenitrothion and aminocarb formulations. The preliminary results of the aquatic impact studies are reported here. Concurrent terrestrial impact studies are reported elsewhere (McLeod, 1982).

SITE DESCRIPTION

Aquatic impact studies were conducted in 4 streams in the Nepisiguit River watershed near Popple Depot, New Brunswick (Figure 1). Popple Depot is in Northumberland County approximately 65 km WSW of Bathurst at 47°23'50" N latitude, 66°30'40" W longitude. The Lower West Branch of Portage Brook (subsequently referred to simply as Portage Brook) and Sixty-three Mile Brook were within experimental spray blocks I and III respectively. Ransom Brook was outside of spray block II, but was sprayed with the same formulation. White Birch Brook served as an untreated check. Portage Brook was the largest of the four streams with a measured discharge on 5 July 1982 of 178.6 L/sec, White Birch Brook was next with a discharge of 138.9 L/sec, then Ransom Brook with a discharge of 58.3 L/sec and finally Sixty-three Mile Brook with a discharge of 22.8 L/sec. All four streams supported similar communities of aquatic invertebrates and had resident brook trout *(Salvelinus fontinalis)* populations.

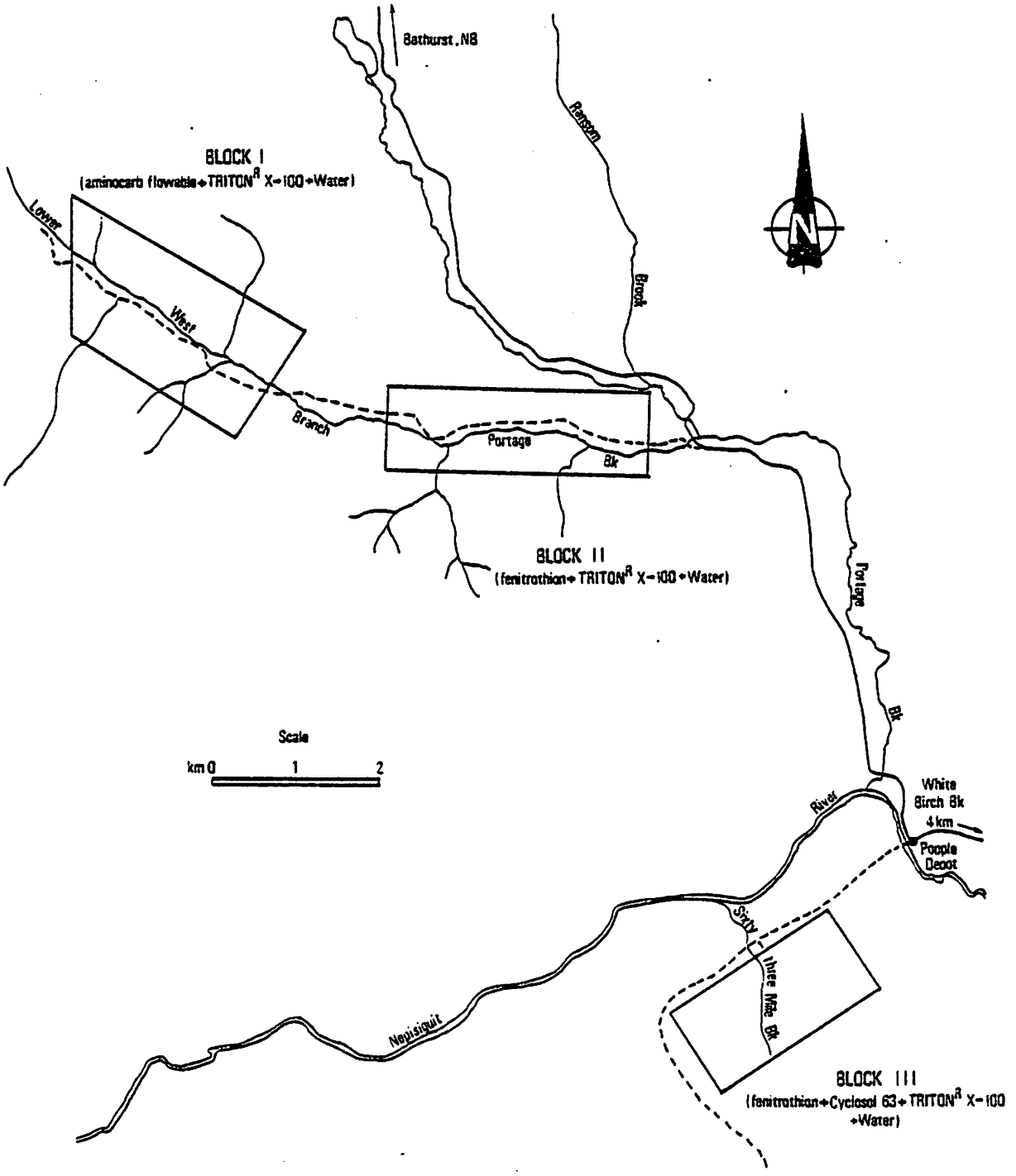


Figure 1

LOCATION OF EXPERIMENTAL SPRAY BLOCKS NEAR POPPLE DEPOT, NB (1982)

INSECTICIDE FORMULATIONS AND APPLICATIONS

Aerial Applications

Aerial applications were conducted by Forest Protection Limited, the crown corporation responsible for budworm spraying in New Brunswick. Portage Brook and Sixty-three Mile Brook were treated by spraying blocks I and III respectively. Ransom Brook was treated separately from block II by spraying a double swath down the stream from its headwaters to its confluence with Portage Brook. Spotters were used to ensure that spray lines were followed and streams and sampling sites received good coverage. Details of the insecticide formulations and applications are summarized in Tables 1 and 2 respectively.

Ground Applications

Portage Brook, Ransom Brook and Sixty-three Mile Brook were retreated by hand on 7 July, 1982. Insecticide formulations for these tests were obtained by grab sampling from the tank mixes applied to blocks I, II and III. The test materials were applied approximately 100 m upstream from biological sampling sites using a Micron 'ULVA' Sprayer[7]. According to the manufacturer's specifications, this ultra low volume applicator is capable of producing a relatively narrow spectrum of droplet sizes centering around 70 μ diameter. Dosage rates were adjusted by diluting the tank mixes with water and were intended to produce residue levels in the streams in excess of those achieved following aerial application. Details of the insecticide formulations and applications are summarized in Table 3.

METHODS

Insecticide Residues

Water samples were collected periodically before and after each application for insecticide residue analysis. Details of the sampling procedure and analytical methods will be presented in a separate report (Sundaram, in prep.).

---

[7] Micron Sprayers Ltd., Herefordshire, England.

Table 1. Insecticide formulations used to treat experimental spray blocks near Popple Depot, New Brunswick (1982).

Block I	MATACIL® 180F (aminocarb flowable)[1]	26.7% (vol)
	TRITON® X-100[2]	3.0% (vol)
	Water	70.3% (vol)
Block II	NOVATHION® Technical (fenitrothion)[3]	10.9% (vol)
	TRITON® X-100	10.7% (vol)
	Water	78.4% (vol)
Block III	NOVATHION® Technical (fenitrothion)	10.9% (vol)
	Cyclosol 63[4]	24.0% (vol)
	TRITON® X-100	3.0% (vol)
	Water	62.1% (vol)

[1] Chemagro Ltd., Mississauga, Ontario.
[2] Rohm and Haas, Canada Inc., West Hill, Ontario.
[3] Cheminova, Lemvig, Denmark.
[4] Shell Canada Chemical Co., Toronto, Ontario.

Table 2. Details of aerial applications to experimental spray blocks near Popple Depot, New Brunswick (1982).

		Date	Time (ADT)	Aircraft Type	Emission System	Emission rate (L/ha)	Dosage rate (g AI/ha)
Block I	First application	17 June 1982	0650	Gruman AgCat	Micronair[5]	1.46	70
	Second application	25 June 1982	0610	Cessna AgTruck	Micronair	1.46	70
Block II[6]	First application	17 June 1982	0700	Gruman AgCat	Micronair	1.46	210
	Second application	24 June 1982	2030	Cessna AgTruck	Micronair	1.46	210
Block III	First application	22 June 1982	1955	Cessna AgTruck	Micronair	1.46	210
	Second application	28 June 1982	1940	Cessna AgTruck	Micronair	1.46	210

[5] Micronair (Aerial) Ltd., Sandown, England.
[6] Ransom Brook was sprayed at the same time as Block II.

Table 3. Details of ground applications to experimental streams near Popple Depot, New Brunswick (1982).

				Formulation	
	Time (ADT)	Duration (sec)	Stream discharge (L/sec)	Tank mix (ml)	Diluent water (ml)
Sixty-three Mile Brook	0745	290	19.6	30[8]	620
Ransom Brook	0845	285	57.4	75[9]	575
Lower West Branch Portage Brook	0955	600	128.9	650[10]	-

[8] NOVATHION® Technical + Cyclosol 63 + TRITON® X-100 + water.
[9] NOVATHION® Technical + TRITON® X-100 + water.
[10] MATACIL® 180F + TRITON® X-100 + water.

Aquatic Invertebrate Drift

Wildco drift nets[11] with No. 54 (363 μ) mesh were used to sample drift. Drift nets were placed in the stream for 10-15 minutes to sample a column of water from the surface to the bottom, including the surface film. Current speed was measured at the opening to each drift net half-way between the surface and bottom with a Teledyne Gurley No. 625 Pygmy Current Meter[12]. Drift Samples were hand sorted in the field to remove extraneous material and the organisms collected were preserved in a solution of 65% methanol, 5% glycerin and 30% water. Organisms were later identified in the laboratory using the keys of Merritt and Cummins (1978), Pennak (1978), Ward and Wipple (1959) and Wiggins (1977).

Drift was monitored hourly on 2 mornings and 2 evenings prior to treatment to document the normal diel drift pattern for each study stream. On spray days drift samples were taken before and at regular intervals after each application. Drift stations for the aerial applications were located near the downstream edges of spray blocks I and III on Portage Brook and Sixty-three Mile Brook respectively, and just downstream from the road on Ransom Brook and White Birch Brook (Figure 1). Drift was monitored at two locations on each stream for the ground applications: a treated site approximately 100 m below the application site (corresponding to the drift station for aerial applications), and a check site approximately 10 m above the application site.

Benthic Invertebrate Populations

Benthic invertebrates were collected before and after treatment by Surber sampling near the drift stations at the treated and check sites. Nine samples were collected on each sampling date for the aerial applications and 5 on each date for the ground applications. Aquatic organisms were separated from other materials in the samples by hand sorting in the field and preserved in a solution of 65% methanol, 5% glycerin and 30% water. Organisms were later identified in the laboratory.

Differences in the mean numbers of organisms collected on each sampling date were compared at the $P < 0.05$ significance level within each stream using oneway analysis of variance and Tukey's multiple comparison test. A $\log_{10} (X + 1)$ transformation of the data was used to help meet the assumptions for analysis of variance (Elliott, 1977).

---

[11] Wildlife Supply Co., Saginaw, Michigan.
[12] W & L.E. Gurley Co., Troy, New York.

Caged Invertebrates

On 15 June, 1982, an upwelling box containing approximately 50 mayfly nymphs of the genus *Ephemerella* was placed near the drift station in each stream. The nymphs were collected from moss covered rocks in Portage Brook approximately 300 m above its confluence with the Nepisiguit River. The boxes were removed from Portage Brook and Ransom Brook on 27 June, 1982, and from Sixty-three Mile Brook and White Birch Brook on 30 June, 1982, at which time mortality was recorded. The difference in mortality between treated and check cages was estimated by the following approximate 95% condifence interval (Dixon and Massey, 1969):

$$X_1-X_2-1.96\sqrt{\frac{X_1-(1-X_1)}{N_1}+\frac{X_2-(1-X_2)}{N_2}} < p_1-p_2 < X_1-X_2+1.96\sqrt{\frac{X_1(1-X_1)}{N_1}+\frac{X_2(1-X_2)}{N_2}}$$

where N_1 and N_2 = number of nymphs in treated and check cages
X_1 and X_2 = proportion of dead nymphs in treated and check cages
p_1 and p_2 = mortality in treated and check cages

The null hypothesis $H_o: p_1-p_2 = 0$ (equal mortality) was rejected at the $P<0.05$ significance level if the above confidence limits for p_1-p_2 did not include 0.

RESULTS

Insecticide Residues

The results of insecticide residue analyses are summarized in Table 4. Most of the water samples from the aminocarb treated stream (Portage Brook) also contained detectable levels ($\geq$ 0.01 ppb) of fenitrothion. Since the interference in GLC chromatograms obtained from these samples was high due to the presence of co-extractive impurities, no attempt was made to quantify the residue levels of fenitrothion, and the values are given with some caution (Sundaram, pers. comm.).

Aquatic Invertebrate Drift (Aerial Applications)

Strong diel drift patterns were evident in all study streams on 8 and 12-13 June 1982 with peak drifts occurring just before dawn and after dark (Appendix I, Tables 1-4). Simuliidae and Chironomidae (Diptera), *Baetis*, *Ephemerella*, *Cinygmula*, *Epeorus* and *Paraleptophlebia* (Ephemeroptera) and *Leuctra* and *Nemoura* (Plecoptera) were generally the most abundant organisms in morning and evening drifts. Most other taxa drifted in more or less constant numbers at all times of the day.

The normal morning drift pattern in Portage Brook was slightly disrupted as a result of the two aminocarb applications to block I. A small peak in drift occurred around 0750 h on 17 June 1982 (1 hr after the first application), and another larger peak around 0710 h on 25 June 1982 (1 hr after the second application) (Figure 2; Appendix I, Table 1). Although no taxa clearly predominated in the first peak, Chironomidae and Hydracarina were the most abundant organisms in the second peak. No similar peaks were seen at the check station in White Birch Brook (Appendix I, Table 4).

The first fenitrothion application to block II does not appear to have had any significant effect on aquatic invertebrate drift in Ransom Brook. Drift patterns for the two pre-spray and the post-spray I time periods were very similar (Figure 3). There was, however, an unusual peak in drift activity centered around 2200 h on 24 June, 1.5 hr after the second fenitrothion application (Figure 4). Simuliidae and Chironomidae both drifted in larger than normal numbers at this time (Appendix I, Table 2). Unfortunately there is no data from the check stream for this date.

Drift activity in Sixty-three Mile Brook peaked at 2200 h on 8 and 12 June 1982 (Figure 5). These peaks were made up primarily of caddis pupae, or 'pharate adults' (Hinton, 1971), coming to the surface for

Table 4. Insecticide residues found in streams following aerial and ground applications of aminocarb and fenitrothion near Popple Depot, New Brunswick (1982).

	Application Type and No.	Insecticide sprayed	Insecticide Residues (ppb)							
			Pre-spray	+½h	+ 1 h	+ 3 h	+ 5 h	+ 6 h	+ 12 h	+ 24 h
Portage Brook	Aerial, 1	aminocarb	-	-	2.26 (0.04)*	0.38 (0.01)	-	0.06	0.03	ND
	Aerial, 2		-	-	0.53 (0.01)	0.06	-	ND	ND	ND
	Ground		(0.01)	6.15 (0.05)	2.98 (0.04)	1.01 (0.03)	0.75 (0.04)	-	-	-
Ransom Brook	Aerial, 1	fenitrothion	-	-	0.17	0.13	-	0.09	0.07	0.03
	Aerial, 2		-	-	0.25	0.15	-	0.12	0.09	0.11
	Ground		0.04	4.06	1.33	0.16	0.04	-	-	-
Sixty-three Mile Brook	Aerial, 1	fenitrothion	-	-	0.10	0.03	-	0.01	0.01	0.09
	Aerial, 2		-	-	1.84	0.61	-	0.40	0.15	0.33
	Ground		0.07	21.45	4.06	0.32	0.14	-	-	-

* values in parentheses show fenitrothion found in aminocarb treated streams.
ND = not detectable (<0.01 ppb).

Figure 2

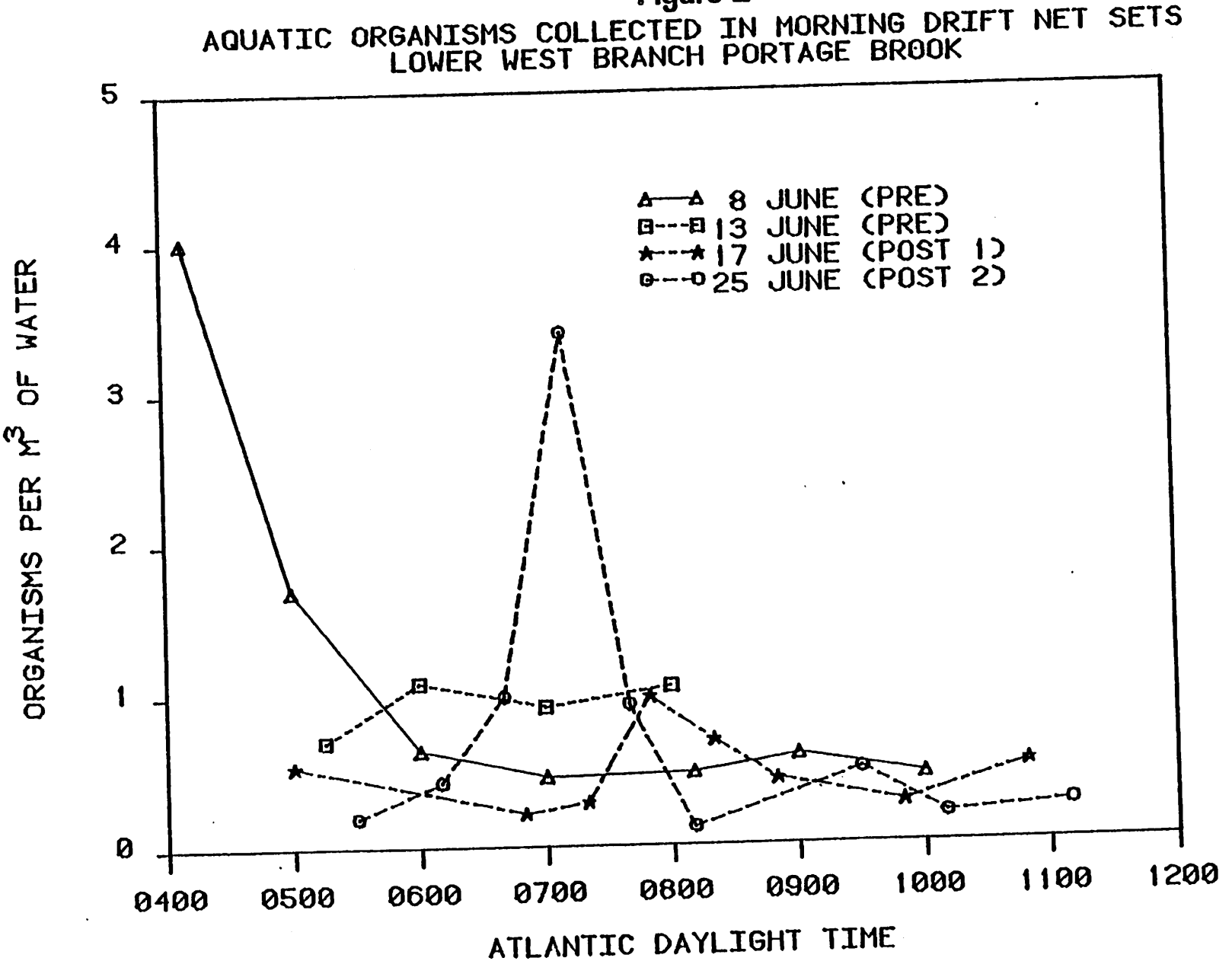

AQUATIC ORGANISMS COLLECTED IN MORNING DRIFT NET SETS
LOWER WEST BRANCH PORTAGE BROOK
8 JUNE (PRE)
13 JUNE (PRE)
17 JUNE (POST 1)
25 JUNE (POST 2)
ORGANISMS PER M3 OF WATER
0
1
2
3
4
5
0400
0500
0600
0700
0800
0900
1000
1100
1200
ATLANTIC DAYLIGHT TIME

Figure 3

AQUATIC ORGANISMS COLLECTED IN MORNING DRIFT NET SETS
RANSOM BROOK

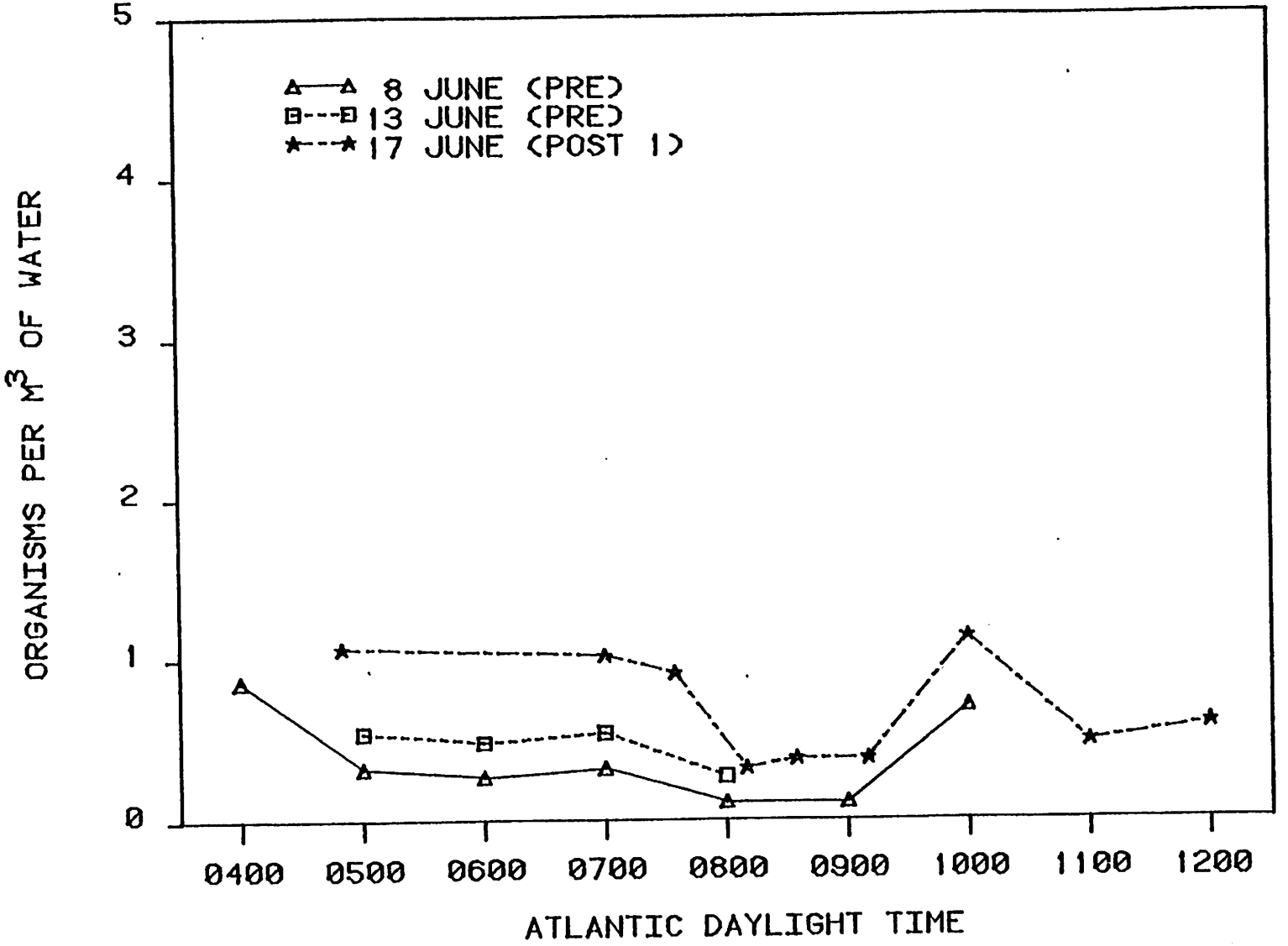


Figure 4

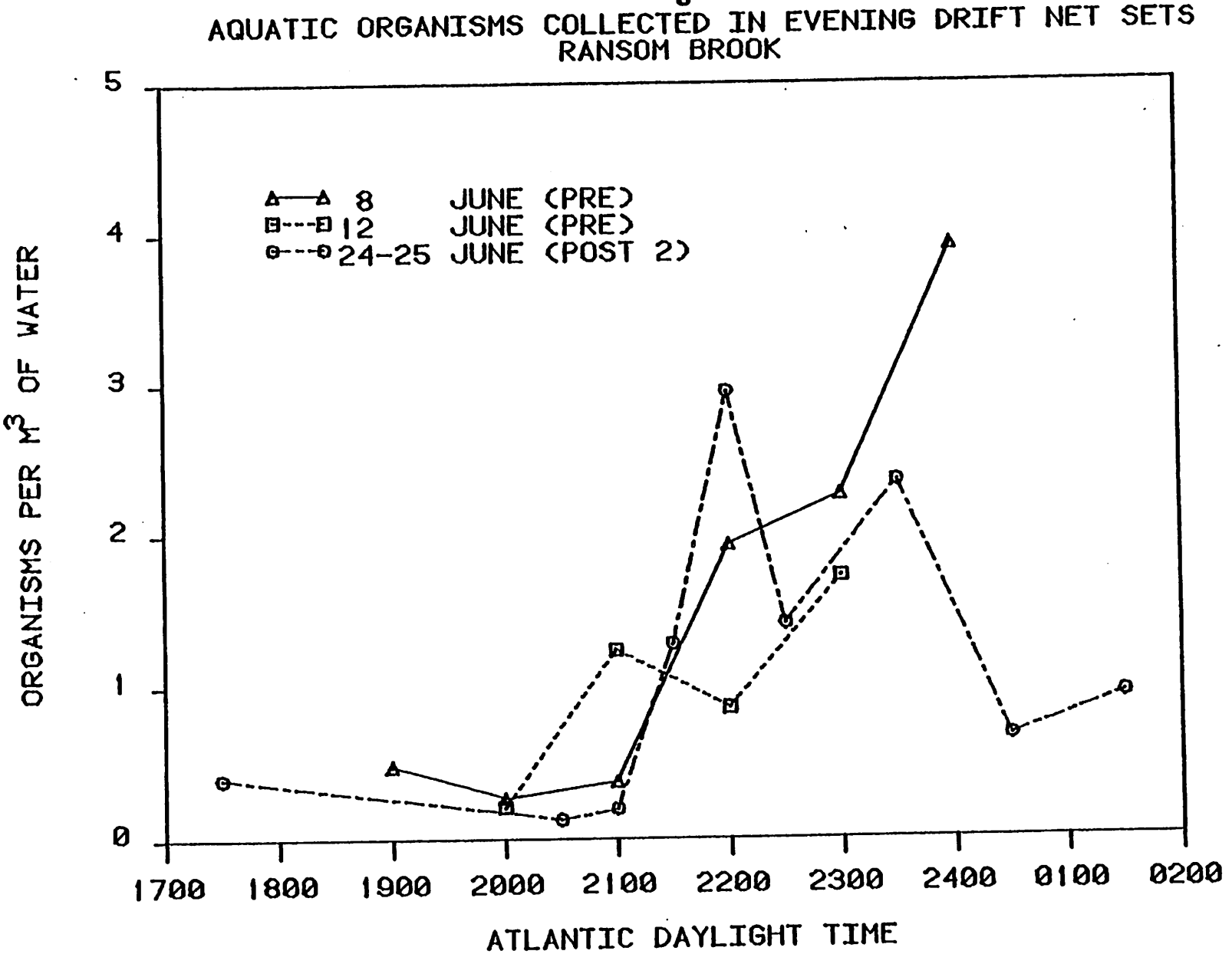
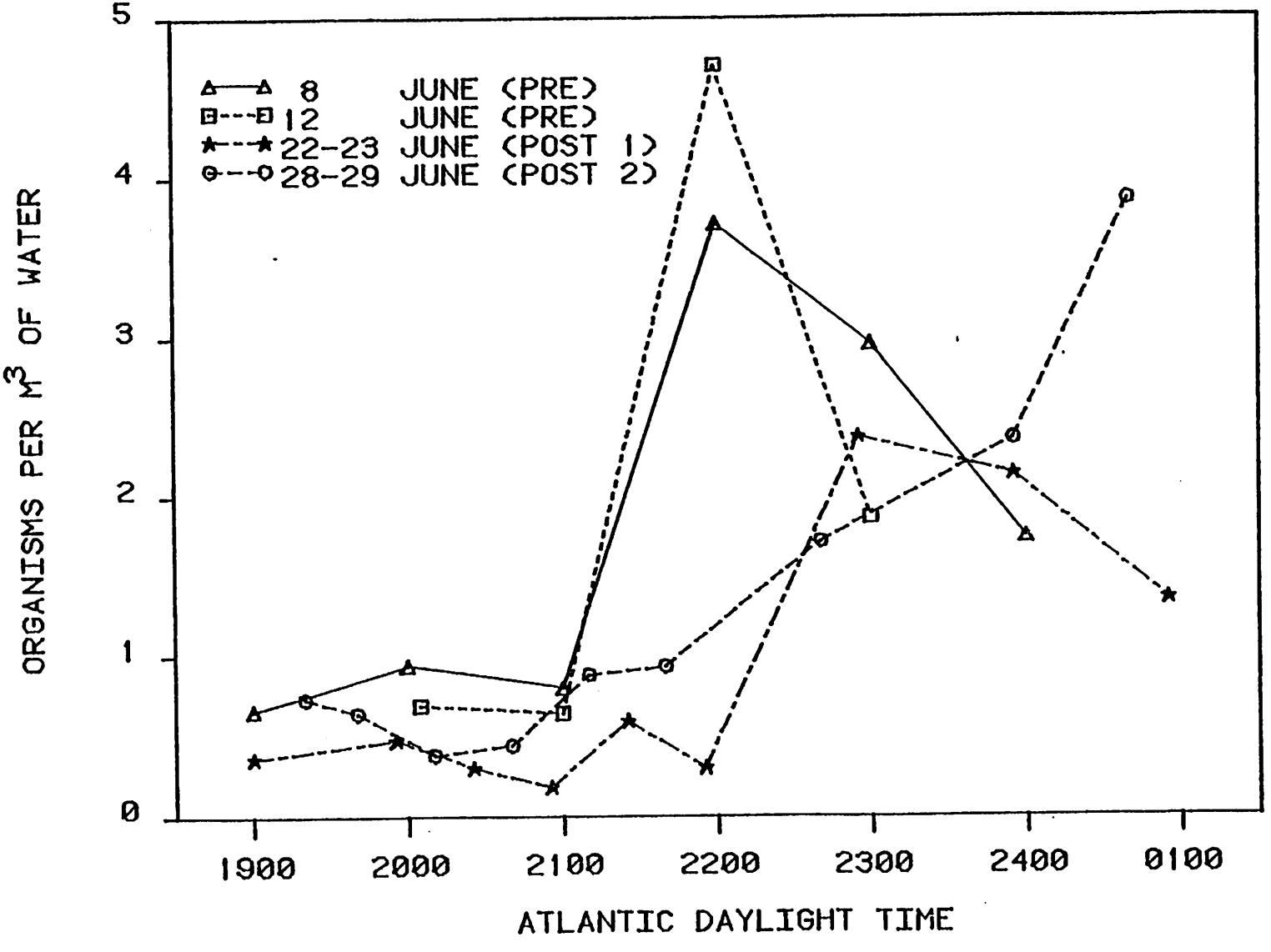

AQUATIC ORGANISMS COLLECTED IN EVENING DRIFT NET SETS
RANSOM BROOK
8 JUNE (PRE)
12 JUNE (PRE)
24-25 JUNE (POST 2)
ORGANISMS PER M3 OF WATER
0
1
2
3
4
5
1700
1800
1900
2000
2100
2200
2300
2400
0100
0200
ATLANTIC DAYLIGHT TIME

Figure 5

AQUATIC ORGANISMS COLLECTED IN EVENING DRIFT NET SETS
SIXTY-THREE MILE BROOK



emergence, and did not recur on later sampling dates (Appendix I, Table 3). Large numbers of 'pharate adult' caddisflies also drifted at 2200 h on 8 June 1982 in Ransom Brook (Appendix I, Table 2). Other than these peaks, drift patterns in Sixty-three Mile Brook on 8 and 12 June 1982 (pre-spray) and 22-23 June 1982 (post-spray I) were very similar. Drift activity on 28-29 June 1982 (post-spray II) also followed pre-spray patterns fairly closely, except that *Epeorus* nymphs continued to drift in large numbers even after midnight (Figure 5; Appendix I, Table 3).

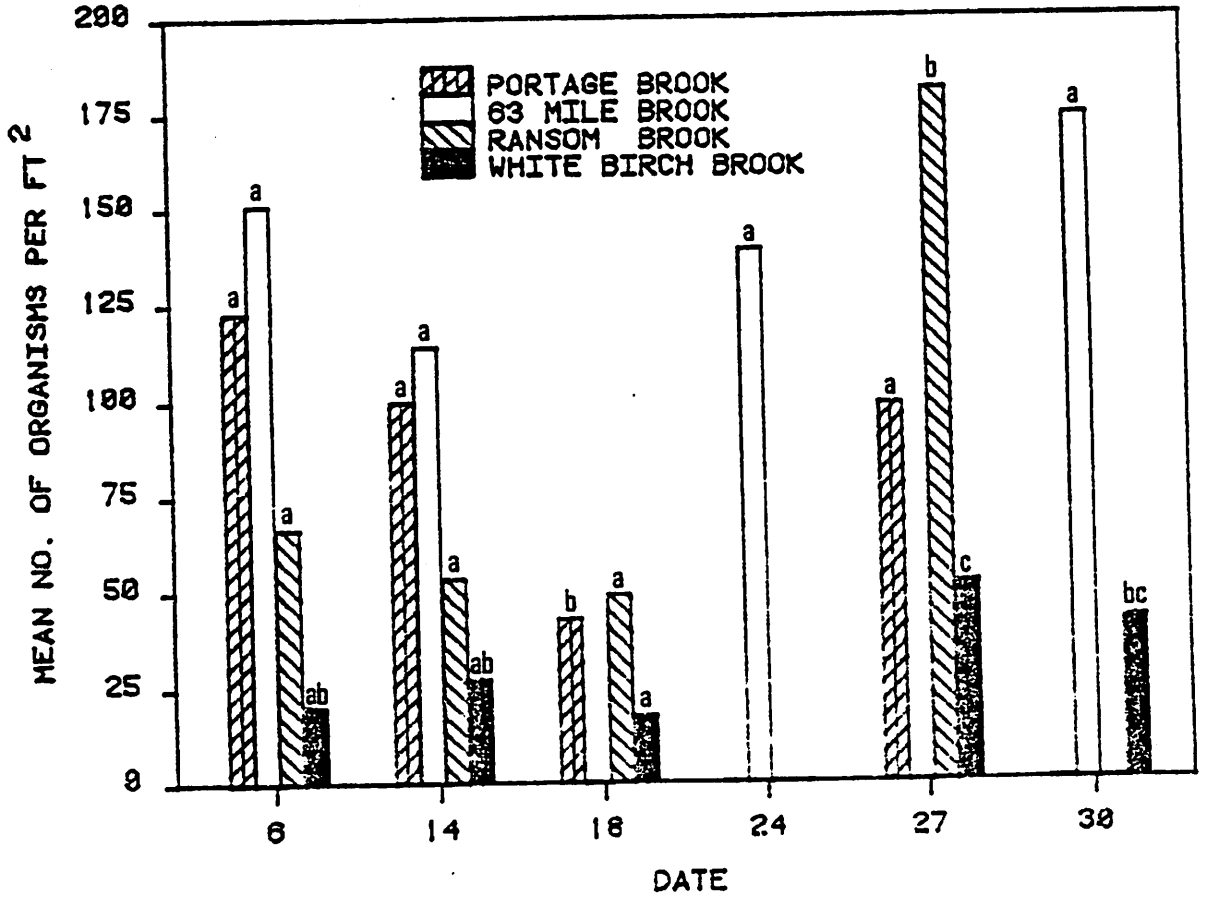
Benthic Invertebrate Populations (Aerial Applications)

There was a significant decrease in the total standing crop of benthic invertebrates in Portage Brook on 18 June 1982 (1 day after the first aminocarb application) (Figure 6; Appendix II, Table 1). *Baetis* and *Epeorus* were significantly reduced in numbers on this date. *Ephemerella, Paraleptophlebia* and *Rhyacophila* (Trichoptera) were also reduced in numbers, but not significantly. By 27 June, two days after the second aminocarb application, total standing crop and numbers of *Epeorus* and *Paraleptophlebia* had recovered to pre-spray levels, but numbers of *Baetis, Ephemerella* and *Rhyacophila* were still depressed. *Baetis* were also reduced in numbers in the check stream on 18 June, but by 27 June numbers were back to pre-spray levels (Appendix II, Table 4). None of the other taxa mentioned above, except *Paraleptophlebia,* decreased in numbers in the check stream over this period. *Paraleptophlebia* were not found in check stream samples.

There were no significant decreases in numbers within any taxa following either fenitrothion application to Ransom Brook (Appendix II, Table 2). Total standing crop remained statistically unchanged between 6 and 18 June and then increased significantly on 27 June (3 days after the second fenitrothion application) (Figure 6). This increase was largely the result of significant increases in numbers of Chironomidae, Simuliidae, *Epeorus* and *Nemoura.*

Total standing crop did not change significantly over the course of the study in Sixty-three Mile Brook (Figure 6). Numbers of *Cinygmula* (Ephemeroptera) were significantly reduced on 24 June, two days after the first fenitrothion application and were still depressed on 30 June two days after the second fenitrothion application (Appendix II, Table 3). The same was true for *Alloperla* (Plecoptera), *Neophylax* (Trichoptera) and Heleidae (Diptera), but these reductions were not significant. *Cinygmula* and *Alloperla* were not reduced in numbers in the check stream, *Neophylax* were not present and Heleidae were collected in very small numbers on only one of the five sampling dates.

FIGURE 6
MEAN POOLED STANDING CROP COLLECTED BY 9 SURBER SAMPLES
6 - 30 JUNE 1982



BARS OF THE SAME TYPE WITH DIFFERENT LETTERS ARE SIGNIFICANTLY DIFFERENT ($P<0.05$) AS DETERMINED BY AN ANALYSIS OF VARIANCE

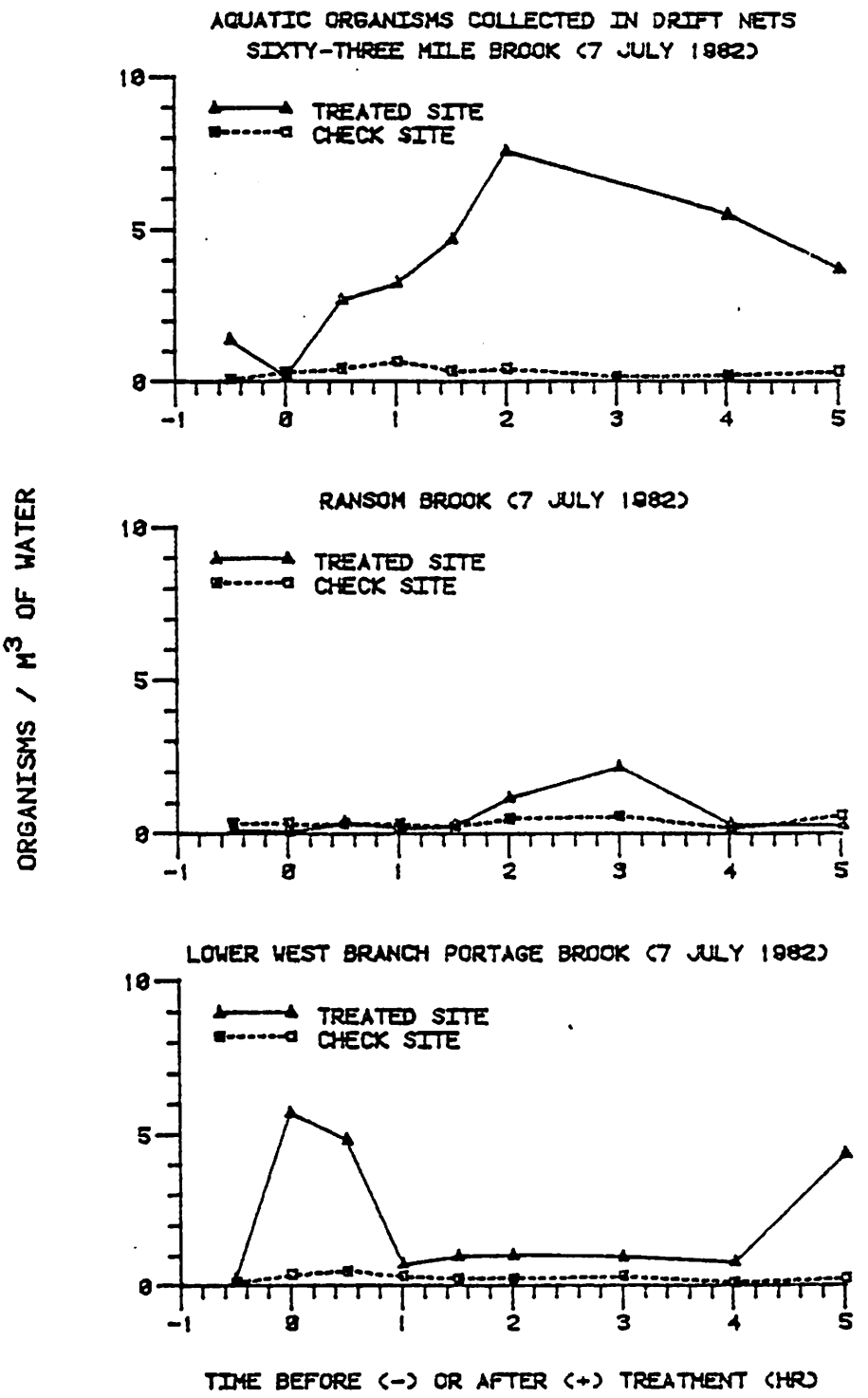
Aquatic Invertebrate Drift (Ground Applications)

Post-spray increases in drift occurred at the treated sites in all three study streams (Figure 7). Drift increases in Sixty-three Mile Brook were composed primarily of *Nemoura, Epeorus, Wormaldia* (Trichoptera) and Chironomidae, with peak drifts occurring 2 hours after the fenitrothion application, but increases still evident 3 hours later (Appendix III, Table 1). No similar increases occurred at the upstream check site (Appendix III, Table 2). *Nemoura,* Chironomidae and Simuliidae all drifted in increased numbers at the treated site in Ransom Brook 2-3 hours after the fenitrothion application (Appendix III, Table 3). Increased drifts of *Nemoura* and Chironomidae also occurred at the check site 3 hours after application, however (Appendix III, Table 4). Peak drifts at the treated site in Portage Brook occurred immediately after the aminocarb application and 5 hours later. The first peak was composed primarily of Simuliidae (Appendix III, Table 5). The second peak, composed primarily of Chironomidae, may have resulted from mechanical disturbance of the bottom, since someone walked down the stream just a few minutes before this sample was taken. Chironomidae dislodged from the bottom may still have been drifting at the time of this sample because of their small size and poor swimming ability, while the larger and the more active insects, such as the Trichoptera and Ephemeroptera, would tend to re-attach to the bottom more quickly. Rhyacophila also drifted in slightly elevated numbers ½–2 hours after application (Appendix III, Table 5). There were no similar increases at the check site (Appendix III, Tables 6).

Benthic Invertebrate Populations (Ground Applications)

The total standing crops of benthic invertebrates in Sixty-three Mile Brook, Ransom Brook and Portage Brook did not change significantly between 6 and 8 July (from 1 day before to 1 day after the insecticide applications) (Appendix IV, Tables 1-3). *Ephemerella, Neophylax* and *Rhyacophila* were significantly reduced in numbers in Ransom Brook following the fenitrothion application and *Rhyacophila* were significantly reduced in numbers in Portage Brook following the aminocarb application, however. There were no significant reductions in any taxa in Sixty-three Mile Brook.

FIGURE 7


AQUATIC ORGANISMS COLLECTED IN DRIFT NETS
SIXTY-THREE MILE BROOK (7 JULY 1982)
TREATED SITE
CHECK SITE
10
5
0
-1
0
1
2
3
4
5
RANSOM BROOK (7 JULY 1982)
TREATED SITE
CHECK SITE
LOWER WEST BRANCH PORTAGE BROOK (7 JULY 1982)
TREATED SITE
CHECK SITE
ORGANISMS / M3 OF WATER
TIME BEFORE (-) OR AFTER (+) TREATMENT (HR)

Caged Invertebrates

The results of the invertebrate caging study are summarized below:

	No. Caged	No. Dead	Statistic
White Birch Brook	49	0	NA
Portage Brook	53	0	$0 < p_1 - p_2 < 0$
Ransom Brook	46	0	$0 < p_1 - p_2 < 0$
Sixty three Mile Brook	43	4	$-0.180 < p_1 - p_2 < -0.006$

The proportion of dead nymphs in Sixty-three Mile Brook was significantly greater than the proportion of dead nymphs in White Birch Brook ($P<0.05$).

DISCUSSION

Impacts associated with the aerial and ground applications of the MATACIL® 180F + TRITON® X-100 + water formulation were greater than expected based on studies conducted by the Forest Pest Management Institute on the MATACIL® 180F + Atlox 3409F + water formulation near Searchmont, Ontario in 1981 (Holmes, 1982) and Fredericton, New Brunswick in 1982 (Kreutzweiser, 1982). In the Searchmont study, a ground application of the MATACIL® 180F + Atlox 3409F + water formulation, which resulted in a peak aminocarb concentration in stream water of 29.2 ppb, had no apparent effect on either drift activity or benthic invertebrate populations. A second application at a much higher dosage rate, which resulted in a peak amino carb concentration in stream water of 256.1 ppb, resulted in increased drifts of Simuliidae, Leuctridae (Plecoptera), Baetidae (Ephemeroptera) and Philopotamidae and Hydroptilidae (Trichoptera). In the Fredericton study, peak aminocarb concentrations of 22.64 and 9.18 ppb were measured in stream water following aerial applications of the MATACIL® 180F + Atlox 3409F + water formulation (Sundaram, pers. comm.), with no evidence of increased drifts or reductions of stream benthos (Kreutzweiser, 1982). Although peak residue levels were much lower in our study (2.26-6.15 ppb), both increased drifts (Hydracarina, Chironomidae, Simuliidae and *Rhyacophila)* and reduced benthic invertebrate populations *(Baetis, Epeorus, Ephemerella, Paraleptophlebia* and *Rhyacophila)* were documented. The reasons for this apparent discrepancy are unclear, but it is possible that differences in formulation may have been at least partly responsible.

Other monitoring studies in Quebec and Newfoundland have documented impacts associated with experimental and operational applications of the MATACIL® 180D oil formulation. Holmes (1979) noted a small increase in the number of drifting Simuliidae in a Quebec stream in which the peak aminocarb concentration was 3.34 ppb. Populations of Baetidae and Heptageniidae (Ephemeroptera) were reduced in another stream for which residue data were not available. Holmes and Kingsbury (1980) reported impacts on a number of aquatic invertebrate groups (Baetidae, Simuliidae, Chironomidae, Elmidae (Coleoptera) and Trichoptera) in 2 streams in Quebec treated with MATACIL® at the seasonal maximum allowable dosage rate, in which peak aminocarb concentrations were 13.7 and 24.2 ppb. Increased drifts of aquatic insects were observed following operational spraying with MATACIL® in Newfoundland in 1978, although there were no reductions attributable to spraying in numbers or diversity of bottom dwelling insects (Anon, 1979). Aminocarb levels in stream water as high as 34 ppb were recorded in this study. Coady (1978) on the other hand, found that aminocarb levels in stream water reached 24 ppb following operational MATACIL® applications in Newfoundland in 1977, with no observable effects on stream fauna. From the above, it appears that the effects of aminocarb on aquatic fauna can be quite variable and are not necessarily correlated with the peak aminocarb concentrations measured in stream water.

Most of the water samples analysed from the aminocarb treated stream (Portage Brook) contained detectable levels of fenitrothion. There are several possible sources of this contamination, the most likely being improper flushing of aircraft spray tanks prior to loading, operational spraying in the headwater areas of Portage Brook and drift of spray products from adjacent operational spray blocks. The amount of contamination was generally quite small (0.01-0.05 ppb), however, and probably did not have any significant effect on the benthos of Portage Brook.

Effects of the fenitrothion applications on the invertebrate fauna of Ransom and Sixty-three Mile Brooks were relatively small when compared to impacts observed following operational fenitrothion applications in New Brunswick and Newfoundland. Eidt (1975) reported a large kill of aquatic insects but no noticeable depletion of benthos in a New Brunswick stream containing fenitrothion up to 5.25 ppb. Coady (1978) noted a substantial depletion in total numbers of benthic invertebrates and marked alterations in invertebrate drift patterns in a Newfoundland stream following an operational fenitrothion application where the level of fenitrothion in stream water was 39 ppb. (Holmes 1979) described an operational application of fenitrothion in Quebec, in which the peak concentration of fenitrothion measured in stream water was 1.74 ppb, which had very little effect on aquatic invertebrates. In our study, drift increases were relatively small and there were no significant reductions in total benthos following aerial and ground applications of the fenitrothion formulations. The largest drift increase occurred after the ground application to Sixty-three Mile Brook, and this corresponded to the highest fenitrothion concentration measured in the study (21.45 ppb).

In general, impacts associated with the experimental aerial and ground applications of aminocarb and fenitrothion formulations containing TRITON® X-100 were moderate, and are considered to be comparable to, or less than, those documented following previous operational aminocarb and fenitrothion applications for spruce budworm control in eastern Canada.

REFERENCES

Anonymous. 1979. 1978 Environmental monitoring of the spruce budworm spray program in Newfoundland - Final report of the Environmental Monitoring Committee. Information Report RA-79-2. Government of Newfoundland and Labrador, Department of Consumer Affairs and Environment, Research and Assessment Branch.

Coady, L.W. 1978. Immediate chemical and toxicological influences of aerially applied fenitrothion and aminocarb in selected Newfoundland streams - Summary report on 1977 field monitoring. Surveillance Report EPS-5-AR-78-1. Environment Canada, Environmental Protection Service, Atlantic Region.

Dixon, W.J. and F.J. Massey, Jr. 1969. Introduction to statistical analysis. McGraw-Hill Book Co., Toronto, Canada.

Eidt, D.C. 1975. The effect of fenitrothion from large-scale forest spraying on benthos in New Brunswick headwaters streams. Can. Ent. 107:743-760.

Elliott, J.M. 1977. Some methods for the statistical analysis of samples of benthic invertebrates. Scientific Publication No. 25. Freshwater Biological Association, Ambleside, Cumbria, U.K.

Holmes, S.B. 1979. Aquatic impact studies of a spruce budworm (*Choristoneura fumiferana* Clemens) control program in the lower St. Lawrence region of Quebec in 1978. Information Report FPM-X-26, Environment Canada, Canadian Forestry Service, Forest Pest Management Institute.

Holmes, S.B. 1982. Comparative effects of three MATACIL® field formulations on stream benthos and fish. Information Report FPM-X-55. Environment Canada, Canadian Forestry Service, Forest Pest Management Institute.

Holmes, S.B. and P.D. Kingsbury. 1980. The environmental impact of nonyl phenol and the MATACIL® formulation. Part 1: Aquatic ecosystems. Information Report FPM-X-35. Environment Canada, Canadian Forestry Service, Forest Pest Management Institute.

Kreutzweiser, D.P. 1982. Aquatic impact studies in New Brunswick forests treated with semi-operational applications of MATACIL® flowable formulations in 1982. File Report No. 40. Environment Canada, Canadian Forestry Service, Forest Pest Management Institute.

McLeod, B.B. Terrestrial impact studies on experimental aqueous formulations of spruce budworm control agents containing TRITON® X-100, New Brunswick, 1982. File Report No. 37. Environment Canada, Canadian Forestry Service, Forest Pest Management Institute.

Merritt, R.W., and K.W. Cummins (ed.). 1978. An introduction to the aquatic insects of North America. Kendall/Hunt Publishing Co., Dubuque, Iowa, U.S.A.

Pennak, R.W. 1978. Fresh-water invertebrates of the United States. John Wiley and Sons, Toronto, Canada.

Ward, H.B., and G.C. Whipple. 1959. Fresh-water biology. John Wiley and Sons, New York, N.Y., U.S.A.

Wiggins, G.B. 1977. Larvae of the North American caddisfly genera (Trichoptera). University of Toronto Press, Toronto, Canada.

APPENDIX I

Aquatic invertebrate drift data from treated and check sites for each aminocarb and fenitrothion formulation aerial application.

Table 1. Aquatic organisms collected in drift nets set in the Lower West Branch Portage Brook* between 8 and 25 June, 1982.

		8 June													12 June				13 June			
		0410	0500	0600	0700	0810	0900	1000	1900	2000	2100	2200	2300	2400	2010	2100	2200	2300	0515	0600	0700	0800
Nematomorpha			0.07+		0.07	0.03	0.03	0.06	0.03		0.03	0.03	0.09	0.03	0.04	0.04				0.05	0.05	0.05
Oligochaeta											0.03											
Hydracarina			0.11	0.07	0.03			0.03	0.06	0.03	0.03				0.04					0.27	0.05	0.21
Collembola									0.03									0.04		0.22		0.21
Plecoptera																						
Alloperla	nymphs								0.03					0.12				0.04				
Leuctra	nymphs											0.03		0.06								
Nemoura	nymphs												0.06					0.04				
Isoperla	nymphs												0.03	0.03				0.04				
Ephemeroptera																						
Baetis	nymphs	0.90	0.14	0.03		0.06	0.03			0.03		0.03	1.53	1.34	0.04		0.04	0.25		0.11		
Ephemerella	nymphs	0.16	0.04							0.06			0.56	0.31				0.11	0.05			0.05
Cinygmula	nymphs	0.03	0.04									0.06	0.25	0.19		0.04		0.04	0.05			0.05
Epeorus	nymphs	0.25	0.07			0.03				0.06		0.03	0.09	0.25			0.04	0.11	0.16	0.05		
Paraleptophlebia	nymphs	0.06					0.03						0.34	0.41				0.04				
Ameletus	nymphs											0.06	0.09					0.07				
Megaloptera																						
Sialis	larvae											0.03										
Trichoptera																						
Parapsyche	larvae													0.03								
Lepidostoma	larvae							0.03										0.04	0.05			
Neophylax	larvae													0.03								
Onocosmoecus	larvae	0.03		0.07	0.13		0.09	0.03	0.03				0.06	0.12	0.04	0.04	0.04	0.07			0.11	0.05
Psychoglypha	larvae			0.10	0.03				0.16		0.03						0.04	0.07		0.05	0.05	
Rhyacophila	larvae	0.03						0.03						0.03	0.04			0.04		0.05		
Unidentified	pupae	0.03							0.03			0.42	0.16	0.09			0.07					0.10
Coleoptera																						
Chrysomelidae	adults																				0.05	
Dytiscidae	adults								0.03	0.03	0.03		0.03				0.04					
Elmidae	adults																					0.05
Haliplidae	adults								0.03													
Diptera																						
Chironomidae	larvae	0.62	0.65	0.14	0.10	0.29	0.16	0.16	0.74	0.10	0.06	0.45	1.18	1.50		0.04	0.07	0.65	0.11	0.16	0.05	0.05
	pupae	0.06	0.07			0.03	0.16	0.03			0.10	0.03	0.19	0.12				0.07				
Dixidae	larvae												0.03					0.04				
Muscidae	larvae																	0.04				
Simuliidae	larvae	1.84	0.50	0.24	0.10	0.03	0.09	0.06	0.16	0.06	0.06	0.51	7.23	4.89	0.12	0.04	0.11	1.56	0.27	0.49	0.49	0.21
	pupae															0.04						
Tipulidae	larvae								0.03													
	pupae													0.03								
Total		4.02	1.69	0.64	0.46	0.48	0.59	0.45	1.38	0.38	0.38	1.70	11.94	9.60	0.31	0.23	0.43	3.35	0.70	1.08	0.92	1.05

* the Lower West Branch of Portage Brook was treated with MATACIL® 180F + TRITON® X-100 + water by aerial application at 0650 ADT on 17 June, 1982, and again at 0610 ADT on 25 June, 1982.

+ number of organisms per m^3 of water passing through the drift net.

Table 1. (cont'd.)

		17 June									25 June								
		0500	0650	0720	0750	0820	0850	0950	1050	1150	0530	0610	0640	0710	0740	0810	0930	1010	1110
Nematomorpha			0.05		0.06	0.06	0.05	0.11					0.06		0.06				
Oligochaeta					0.06														
Hydracarina			0.05	0.06	0.06	0.12	0.11	0.11	0.23	0.06				0.43	0.06		0.06	0.06	
Collembola						0.06								0.06					
Plecoptera																			
Alloperla	nymphs			0.06					0.06										
Leuctra	nymphs																		
Nemoura	nymphs				0.06		0.05							0.12					0.06
Isoperla	nymphs																		
Ephemeroptera																			
Baetis	nymphs			0.06		0.06			0.06				0.06					0.06	
Ephemerella	nymphs	0.05			0.06	0.06			0.06						0.06				
Cinygmula	nymphs	0.05								0.06			0.06						
Epeorus	nymphs	0.05			0.12	0.06	0.05								0.06	0.06	0.06		
Paraleptophlebia	nymphs												0.06	0.06					
Amelotus	nymphs																		
Megaloptera																			
Sialis	larvae																		
Trichoptera																			
Parapsyche	larvae																		
Lepidostoma	larvae																		
Neophylax	larvae																		
Onocosmoecus	larvae					0.06							0.06						0.12
Psychoglypha	larvae						0.05					0.06	0.06	0.06	0.19	0.06		0.06	
Rhyacophila	larvae														0.12				
Unidentified	pupae		0.05						0.06	0.06									
Coleoptera																			
Chrysomelidae	adults																		
Dytiscidae	adults																		
Elmidae	adults									0.06									
Haliplidae	adults																		
Diptera																			
Chironomidae	larvae				0.29	0.06	0.11			0.06		0.12	0.25	2.41	0.19		0.19		0.06
	pupae	0.05							0.06								0.06		
Dixidae	larvae																		
Holeidae	larvae				0.12														
Simuliidae	larvae	0.32	0.05	0.12	0.17	0.17		0.05			0.20	0.25	0.37	0.19	0.12		0.12		
	pupae																		
Tipulidae	larvae													0.06					
	pupae																		
Total		0.54	0.22	0.29	0.98	0.69	0.43	0.27	0.52	0.29	0.20	0.43	0.99	3.40	0.93	0.12	0.49	0.19	0.25

Table 2. Aquatic organisms collected in drift nets set in Ransom Brook* between 8 and 25 June, 1982.

		8 June													12 June				13 June						
		0400	0500	0600	0700	0800	0900	1000	1900	2000	2100	2200	2300	2400	2000	2100	2200	2300	0500	0600	0700	0800			
Oligochaeta																				0.05†					
Hydracarina					0.11			0.11	0.05	0.05						0.11									
Collembola																0.21				0.11	0.11				
Plecoptera																									
Alloperla	nymphs	0.05							0.05				0.05	0.11			0.05	0.05							
Leuctra	nymphs	0.11									0.05		0.21	1.18	0.05		0.05	0.32							
Nemoura	nymphs	0.05	0.05					0.11	0.05			0.27	0.11	0.48	0.05	0.16	0.05	0.21							
Isogenus	nymphs												0.05												
Ephemeroptera																									
Baetis	nymphs	0.11											0.05	0.05											
Ephemerella	nymphs								0.05				0.27	0.59				0.11							
Cinygmula	nymphs						0.05					0.05	0.05	0.05											
Epeorus	nymphs				0.05			0.05				0.05	0.70	0.16			0.05	0.32	0.05			0.05			
Paraleptophlebia	nymphs			0.05																					
Ameletus	nymphs											0.05					0.05	0.05							
Trichoptera																									
Glossosoma	larvae																		0.11						
Parapsyche	larvae													0.05											
Lepidostoma	larvae						0.05	0.05											0.11						
Onocosmoecus	larvae					0.11		0.05		0.05		0.05	0.05				0.05					0.11			
Psychoglypha	larvae			0.05				0.05							0.11	0.05		0.11	0.11	0.16	0.21				
Rhyacophila	larvae							0.05		0.05	0.05			0.11											
Unidentified	pupae											1.07	0.05												
Coleoptera																									
Haliplidae	adults								0.05																
Helodidae	adults																								
Dytiscidae	larvae																	0.05							
	adults											0.21						0.16							
Diptera																									
Chironomidae	larvae	0.27	0.11	0.11	0.05			0.21	0.11	0.11	0.27	0.05	0.21	0.70		0.38	0.16	0.27	0.11			0.11			
	pupae	0.05							0.05					0.05							0.05				
Dixidae	larvae				0.05							0.05					0.05								
Heleidae	larvae																0.05								
Simuliidae	larvae	0.21	0.11	0.05	0.05				0.05			0.05	0.43	0.38		0.32	0.27		0.05	0.16	0.11		0.54	0.81	0.54
Tipulidae	larvae		0.05															0.05							
Total		0.86	0.32	0.27	0.32	0.11	0.11	0.70	0.48	0.27	0.38	1.93	2.26	3.92	0.21	1.24	0.86	1.72	0.54	0.48	0.54	0.27	1.07	1.02	0.91

* Ransom Brook was treated with NOVATHION® Technical + TRITON® X-100 + water by aerial application at 0700 ADT on 17 June, 1982, and again at 2030 ADT on 24 June, 1982.

† number of organisms per m^3 of water passing through the drift net.

Table 2. (cont'd.)

		17 June									24-25 June								
		0450	0700	0735	0810	0835	0910	1000	1100	1200	1730	2030	2100	2130	2200	2230	2330	0030	0130
Oligochaeta																			
Hydracarina		0.05		0.11			0.16	0.27	0.05	0.11	0.13								
Collembola		0.05	0.11						0.11	0.05									
Plecoptera																			
Alloperla	nymphs																0.07	0.07	
Leuctra	nymphs	0.05														0.07	0.34		0.07
Nemoura	nymphs							0.11	0.05						0.13	0.27	0.27	0.20	
Isogenus	nymphs																		
Ephemeroptera																			
Baetis	nymphs															0.07			0.07
Ephemerella	nymphs	0.05	0.05	0.05				0.05								0.07			
Cinygmula	nymphs																		
Epeorus	nymphs								0.05						0.13				0.07
Paraleptophlebia	nymphs																		
Ameletus	nymphs															0.07			
Trichoptera																			
Glossosoma	larvae																		
Parapsyche	larvae																		
Lepidostoma	larvae																		
Onocosmoecus	larvae					0.05				0.05									
Psychoglypha	larvae		0.05	0.11		0.05		0.11	0.05	0.05									0.11
Rhyacophila	larvae	0.05			0.11			0.05							0.07				
Unidentified	pupae																		
Coleoptera																			
Haliplidae	adults																		
Hydrodidae	adults									0.05									
Dytiscidae	larvae																		
	adults								0.05						0.07				0.11
Diptera																			
Chironomidae	larvae	0.27		0.11		0.05	0.11	0.38	0.11	0.21	0.13		0.07	1.14	1.88	0.20	0.34	0.07	0.07
	pupae													0.07				0.07	
Dixidae	larvae																		
Heleidae	larvae							0.05											
Simuliidae	larvae	0.54	0.81	0.54	0.21	0.21	0.11	0.11		0.05	0.13	0.13	0.13	0.07	0.60	0.67	1.34	0.54	0.40
Tipulidae	larvae														0.05				
Total		1.07	1.02	0.91	0.32	0.38	0.38	1.13	0.48	0.59	0.40	0.13	0.20	1.28	2.95	1.41	2.35	0.67	0.94

Table 3. Aquatic organisms collected in drift nets set in Sixty-three Mile Brook* between 8 and 29 June, 1982.

		8 June													12 June				13 June			
		0400	0500	0600	0700	0800	0900	1000	1900	2000	2100	2200	2300	2400	2005	2100	2200	2300	0515	0600	0700	0800
Nematomorpha			0.05[+]			0.05																
Hydracarina						0.05																
Collembola				0.05				0.05		0.05	0.05				0.05					0.05	0.05	
Plecoptera																						
Alloperla	nymphs					0.05																
Leuctra	nymphs	0.05									0.05			0.09			0.10	0.05		0.05	0.10	
Nemoura	nymphs		0.09					0.05		0.05	0.05	0.05	0.09	0.19			0.05	0.05	0.05		0.10	0.05
Ephemeroptera																						
Baetis	nymphs	0.38	0.09	0.05		0.05				0.05		0.14	0.47	0.38	0.10		0.10					0.10
Ephemerella	nymphs																					
Cinygmula	nymphs		0.05									0.05	0.09	0.14		0.05					0.05	
Epeorus	nymphs	0.09	0.19	0.05	0.19		0.05	0.09	0.09	0.05		0.38	0.84	0.14	0.10	0.15	0.73	0.70	0.20	0.20	0.20	
Ameletus	nymphs																					
Trichoptera																						
Parapsyche	larvae	0.09								0.05			0.05					0.05				
Lepidostoma	larvae																	0.05				
Neophylax	larvae			0.05			0.05						0.05	0.09								
Onocosmoecus	larvae			0.05												0.05			0.05	0.05		
Psychoglypha	larvae					0.05					0.05											
Rhyacophila	larvae	0.05					0.05										0.05	0.05		0.05		
Unidentified	pupae			0.05	0.05	0.05		0.14				1.64	0.05	0.05			2.25	0.10	0.05			0.05
Coleoptera																						
Elmidae	adults															0.05						
Diptera																						
Chironomidae	larvae	0.33	0.47	0.56	0.38	0.28	0.28	0.19	0.42	0.42	0.47	0.84	0.80	0.28	0.24	0.20	0.64	0.44	0.51	0.15	0.36	0.10
	pupae		0.09					0.09	0.09	0.09	0.09		0.19	0.09	0.05	0.05	0.39	0.10	0.10		0.10	0.05
Heleidae	larvae		0.05																			
Simulidae	larvae	0.14	0.28	0.09		0.05	0.05	0.09	0.05	0.19	0.05	0.61	0.33	0.28	0.15	0.10	0.39	0.24	0.15	0.05	0.20	
	pupae																					
Tipulidae	larvae				0.05													0.05				
Total		1.13	1.36	0.94	0.66	0.61	0.47	0.70	0.66	0.94	0.80	3.71	2.96	1.74	0.69	0.64	4.70	1.86	1.13	0.61	1.18	0.36

* Sixty-three Mile Brook was treated with NOVATHION® Technical + Cyclosol 63 + TRITON® X-100 + water by aerial application at 1955 ADT on 22 June, 1982, and again at 1940 ADT on 28 June, 1982.

[+] number of organisms per m^3 of water passing through the drift net.

Table 3. (cont'd.)

		22-23 June									28-29 June								
		1900	1955	2025	2055	2125	2155	2255	2355	0055	1920	1940	2010	2040	2110	2140	2240	2355	0040
Nematomorpha														0.05					
Hydracarina															0.05	0.05			
Collembola													0.05		0.05				0.05
Plecoptera																			
Alloperla	nymphs							0.06		0.06		0.05					0.10		0.11
Leuctra	nymphs																		
Nemoura	nymphs		0.06					0.06	0.06		0.15	0.05	0.05	0.05	0.20	0.24	0.39	0.43	0.48
Ephemeroptera																			
Baetis	nymphs	0.06						0.24	0.23		0.05			0.10			0.44	0.32	0.32
Ephemerella	nymphs								0.11				0.05						
Cinygmula	nymphs							0.24	0.23									0.05	0.05
Epeorus	nymphs	0.06	0.06	0.06		0.18	0.12	1.30	1.24	0.68	0.05	0.10		0.15	0.20	0.24	0.39	0.96	1.82
Ameletus	nymphs						0.06			0.06									0.05
Trichoptera																			
Parapsyche	larvae													0.05				0.05	
Lepidostoma	larvae																		
Neophylax	larvae																		
Onocosmoecus	larvae	0.06				0.06			0.06			0.05	0.05	0.05		0.05	0.05		0.05
Psychoglypha	larvae										0.05								
Rhyacophila	larvae																		
Unidentified	pupae																		
Coleoptera																			
Elmidae	adults																		
Diptera																			
Chironomidae	larvae	0.18	0.24		0.06	0.24	0.06	0.18	0.17	0.17	0.24	0.05	0.14		0.39	0.10	0.10	0.21	0.38
	pupae		0.06	0.12	0.12	0.06		0.06		0.11		0.10	0.05			0.05		0.11	0.05
Heleidae	larvae																		
Simulidae	larvae		0.06	0.12		0.06	0.06	0.18	0.11	0.28	0.20	0.24				0.20	0.20	0.21	0.43
	pupae							0.06											
Tipulidae	larvae																0.05		0.05
Total		0.36	0.47	0.30	0.18	0.59	0.30	2.37	2.14	1.35	0.73	0.64	0.38	0.44	0.88	0.93	1.71	2.36	3.86

Table 4. Aquatic organisms collected in drift nets set in White Birch Brook between 8 and 28 June, 1982.

		8 June													12 June				13 June			
		0400	0500	0600	0700	0800	0900	1000	1900	2000	2100	2200	2300	2400	2000	2100	2200	2300	0500	0600	0700	0800
Nematoda															0.02[+]							
Nematomorpha													0.02									
Oligochaeta						0.02	0.02									0.03			0.02	0.02	0.02	0.07
Hydracarina		0.02				0.04	0.05		0.02	0.02	0.02											
Collembola				0.02							0.03				0.04	0.03	0.04	0.07	0.04	0.16	0.07	0.12
Plecoptera																	0.02		0.02			
Alloperla	nymphs	0.02					0.02															
Leuctra	nymphs	0.09	0.04						0.02			0.17	0.17	0.14			0.02	0.16	0.02			
Nemoura	nymphs	0.05	0.05		0.02		0.04				0.02	0.42	0.38	0.33	0.05		0.07	0.30	0.05	0.07	0.05	0.07
Isogenus	nymphs																					
Ephemeroptera																						
Baetis	nymphs	0.42	0.09	0.05	0.02	0.11	0.07	0.02	0.07	0.17	0.14	1.03	0.68	0.56	0.04	0.03	0.07	0.57	0.24		0.04	
Ephemerella	nymphs			0.04			0.02					0.02	0.14	0.12				0.11				
Clinygmula	nymphs												0.02			0.02		0.02		0.02		
Epeorus	nymphs	0.04		0.02	0.04		0.02		0.03			0.10	0.05	0.09			0.04	0.05	0.07	0.02	0.02	0.02
Paraleptophlebia	nymphs																					
Ameletus	nymphs	0.04											0.09						0.02			
Trichoptera																						
Glossosoma	larvae																					
Parapsyche	larvae	0.02				0.02						0.07	0.05	0.03								
Lepidostoma	larvae					0.04											0.02					
Onocosmoecus	larvae							0.02							0.04	0.05			0.02		0.05	0.05
Psychoglypha	larvae			0.02	0.02	0.11	0.04			0.03	0.03				0.02	0.02		0.04		0.02		
Rhyacophila	larvae				0.04		0.04		0.02					0.02		0.02	0.04				0.02	
Unidentified	pupae				0.04		0.05	0.02	0.02			0.21										
Coleoptera																						
Dytiscidae	larvae																					
	adults																					
Elmidae	adults																0.02					
Haliplidae	adults																					
Diptera																						
Chironomidae	larvae		0.02	0.04		0.04			0.02	0.07	0.02	0.02	0.05				0.02	0.02		0.02		0.02
	pupae	0.04				0.02	0.02				0.02	0.10						0.05			0.02	0.04
Empididae	larvae														0.02							
Heleidae	larvae										0.03											
Simuliidae	larvae	0.05	0.05	0.05			0.02	0.04	0.02	0.05	0.03	0.24	0.16	0.09	0.04	0.05	0.07	0.09	0.15	0.02	0.04	
	pupae										0.02				0.02							
Tipulidae	larvae												0.02							0.02		
	pupae																			0.02		
Gastropoda							0.02															
Total		0.79	0.26	0.24	0.16	0.38	0.42	0.09	0.21	0.35	0.37	2.38	1.83	1.37	0.27	0.26	0.41	1.48	0.64	0.37	0.33	0.39

[+] number of organisms per m^3 of water passing through the drift net.

Table 4. (Cont'd.)

		17 June					22-23 June						25 June					28 June				
		0800	0900	1000	1100	1200	2000	2100	2200	2300	2400	0100	0700	0800	0900	1000	1100	2000	2100	2200	2300	2400
Nematoda																						
Nematomorpha										0.02												
Oligochaeta									0.02											0.03		
Hydracarina		0.10	0.02	0.25	0.02	0.39	0.07	0.05			0.05							0.03	0.09			0.03
Collembola								0.12			0.05								0.03	0.03		
Plecoptera																						
Alloperla	nymphs	0.02	0.02																			
Leuctra	nymphs					0.02			0.05	0.16	0.05	0.02						0.03		0.09	0.09	0.06
Nemoura	nymphs	0.02	0.02			0.02	0.05	0.02	0.42	0.76	0.60	0.19	0.02	0.02	0.09	0.05	0.02	0.09	0.09	0.67	0.61	0.43
Ephemeroptera																						
Baetis	nymphs	0.14	0.06	0.08	0.10	0.02	0.05	0.07	0.60	0.42	0.32	0.35	0.04	0.07	0.02	0.09	0.02	0.12		0.49	0.64	0.46
Ephemerella	nymphs								0.02	0.21	0.14	0.16								0.06	0.29	0.17
Cinygmula	nymphs										0.02					0.02				0.12		0.03
Epeorus	nymphs	0.04				0.02			0.05	0.14	0.05	0.07		0.02	0.02		0.02	0.03		0.35	0.09	0.09
Paraleptophlebia	nymphs																				0.03	
Amelotus	nymphs									0.02	0.05											
Trichoptera																						
Glossosoma	larvae															0.02						
Parapsyche	larvae																					0.03
Lepidostoma	larvae																					
Onocosmoecus	larvae			0.02		0.04			0.02	0.02	0.05	0.02					0.02	0.03	0.03		0.06	0.06
Psychoglypha	larvae	0.10				0.02													0.03			0.03
Rhyacophila	larvae		0.02	0.02		0.02		0.02		0.05				0.02							0.06	
Unidentified	pupae	0.02	0.06	0.04	0.08	0.10			0.05				0.02	0.02	0.02	0.05		0.03				
Coleoptera																						
Dytiscidae	larvae											0.05										
	adults															0.02						
Elmidae	adults									0.02												
Haliplidae	adults																					
Diptera																						
Chironomidae	larvae										0.07	0.02						0.03	0.03	0.17		0.09
	pupae			0.02		0.02		0.02		0.02	0.05						0.02		0.03	0.06	0.14	0.06
Empididae	larvae																				0.03	
Heleidae	larvae																		0.03	0.03		
Simuliidae	larvae	0.02		0.06	0.12		0.02	0.02	0.05	0.09	0.09	0.02	0.07		0.07	0.07		0.09		0.06	0.06	0.03
	pupae	0.02					0.02		0.02											0.06		
Tipulidae	larvae																			0.12		
	pupae																					
Gastropoda																						
Total		0.46	0.19	0.49	0.33	0.67	0.21	0.30	1.30	1.95	1.58	0.90	0.16	0.16	0.23	0.32	0.12	0.46	0.35	2.32	2.09	1.56

APPENDIX II

Benthic invertebrate population data from treated and check sites for each aminocarb and fenitrothion formulation aerial application.

Table 1. Aquatic organisms collected in Surber samples from the Lower West Branch Portage Brook* between 6 and 27 June, 1982.

		6 June		14 June		18 June		27 June	
Nematomorpha		0.22 ±	0.44+	0.67 ±	1.00	-		0.22 ±	0.44
Oligochaeta		0.22 ±	0.44	0.11 ±	0.33	-		0.33 ±	0.50
Hydracarina		0.11 ±	0.33	0.22 ±	0.44	0.78 ±	0.83	0.22 ±	0.44
Plecoptera Alloperla	nymphs	1.22 ±	0.97	0.22 ±	0.44	0.78 ±	0.67	0.78 ±	0.67
Leuctra	nymphs	0.33 ±	0.50	0.67 ±	0.50	0.33 ±	0.71	1.22 ±	1.20
Nemoura	nymphs	-		0.22 ±	0.44	-		0.44 ±	0.73
Isogenus	nymphs	-		0.11 ±	0.33	0.11 ±	0.33	-	
Isoperla	nymphs	0.33 ±	0.71	0.56 ±	0.73	0.67 ±	1.12	0.33 ±	0.50
Ephemeroptera Baetis	nymphs	8.89 ±	8.22	9.78 ±	5.47	0.33 ±	0.50	1.44 ±	1.33
Ephemerella	nymphs	17.00 ±	6.42	14.11 ±	9.83	8.11 ±	5.21	9.78 ±	7.12
Cinygmula	nymphs	32.89 ±	13.61	7.78 ±	4.09	19.78 ±	9.97	11.78 ±	9.04
Epeorus	nymphs	25.33 ±	19.03	27.11 ±	9.96	7.22 ±	4.66	19.44 ±	12.71
Paraleptophlebia	nymphs	0.56 ±	0.73	0.67 ±	0.71	-		0.67 ±	0.87
Ameletus	nymphs	-		0.11 ±	0.33	-		-	
Trichoptera Glossosoma	larvae	0.67 ±	1.00	0.56 ±	0.73	0.11 ±	0.33	-	
Parapsyche	larvae	0.11 ±	0.33	0.22 ±	0.44	0.11 ±	0.33	0.11 ±	0.33
Lepidostoma	larvae	0.11 ±	0.33	-		-		-	
Apatania	larvae	0.11 ±	0.33	-		-		-	
Neophylax	larvae	0.33 ±	0.50	0.22 ±	0.44	0.22 ±	0.44	0.11 ±	0.33
Onocosmoecus	larvae	0.11 ±	0.33	-		-		0.11 ±	0.33
Rhyacophila	larvae	3.33 ±	3.54	3.56 ±	2.70	0.89 ±	1.54	1.11 ±	1.36
Unidentified	pupae	3.33 ±	2.50	2.22 ±	1.20	0.56 ±	0.73	1.00 ±	0.87
Coleoptera Elmidae	adults	0.22 ±	0.44	-		0.22 ±	0.67	0.22 ±	0.44
Diptera Chironomidae	larvae	16.00 ±	11.49	3.22 ±	2.17	2.22 ±	2.11	43.56 ±	17.47
	pupae	8.67 ±	4.06	-		-		3.33 ±	3.54
Empididae	larvae	0.33 ±	0.50	-		-		0.22 ±	0.67
	pupae	0.22 ±	0.44	-		-		0.11 ±	0.33
Heleidae	larvae	0.11 ±	0.33	-		-		0.22 ±	0.44
Simuliidae	larvae	0.11 ±	0.33	26.44 ±	37.69	-		1.22 ±	1.72
	pupae	0.11 ±	0.33	-		0.11 ±	0.33	0.22 ±	0.44
Tipulidae	larvae	1.67 ±	1.22	0.78 ±	0.97	0.33 ±	0.71	0.56 ±	1.01
Total		122.67 ±	33.11	99.67 ±	44.31	42.89 ±	19.10	98.78 ±	44.44

* the Lower West Branch of Portage Brook was treated with MATACIL® 180F + TRITON® X-100 + water by aerial application at 0650 ADT on 17 June, 1982, and again at 0610 ADT on 25 June, 1982.

+ mean number ± standard deviation of organisms collected in 9 Surber samples.

Table 2. Aquatic organisms collected in Surber samples from Ransom Brook* between 6 and 27 June, 1982.

		6 June	14 June	18 June	27 June
Nematomorpha		-	-	-	0.11 ± 0.22+
Oligochaeta		0.11 ± 0.33	0.22 ± 0.44	0.44 ± 1.33	-
Hydracarina		0.11 ± 0.33	0.11 ± 0.33	0.22 ± 0.44	-
Plecoptera Alloperla	nymphs	0.56 ± 0.53	9.33 ± 4.36	1.56 ± 1.74	3.00 ± 3.00
Leuctra	nymphs	0.22 ± 0.67	1.44 ± 1.67	0.56 ± 1.33	0.89 ± 1.69
Nemoura	nymphs	2.33 ± 1.87	0.89 ± 1.36	1.78 ± 2.86	10.67 ± 8.97
Isogenus	nymphs	0.44 ± 0.73	0.89 ± 0.93	0.22 ± 0.44	-
Isoperla	nymphs	-	-	0.11 ± 0.33	-
Ephemeroptera Baetis	nymphs	0.56 ± 0.53	-	0.56 ± 1.33	0.11 ± 0.22
Ephemerella	nymphs	13.67 ± 7.71	5.22 ± 3.35	8.11 ± 6.72	12.00 ± 4.47
Clnygmula	nymphs	9.89 ± 9.10	12.33 ± 7.26	14.22 ± 11.54	9.89 ± 6.88
Epeorus	nymphs	20.78 ± 6.92	15.67 ± 6.34	10.56 ± 5.75	47.56 ± 15.52
Ameletus	nymphs	-	-	0.11 ± 0.22	-
Trichoptera Glossosoma	larvae	1.11 ± 1.27	0.67 ± 0.87	0.56 ± 0.73	0.78 ± 0.83
Parapsyche	larvae	0.11 ± 0.33	0.11 ± 0.33	0.11 ± 0.22	-
Lepidostoma	larvae	0.11 ± 0.33	-	0.44 ± 0.73	-
Neophylax	larvae	0.22 ± 0.44	-	0.11 ± 0.22	-
Onocosmoecus	larvae	0.11 ± 0.33	0.11 ± 0.33	-	0.33 ± 0.71
Psychoglypha	larvae	-	-	1.33 ± 2.06	0.11 ± 0.22
Rhyacophila	larvae	2.56 ± 1.24	1.11 ± 1.36	0.89 ± 1.05	1.78 ± 1.56
Unidentified	pupae	5.22 ± 3.83	0.89 ± 0.78	1.33 ± 1.22	1.33 ± 1.41
Coleoptera Elmidae	adults	-	0.11 ± 0.33	-	-
Diptera Chironomidae	larvae	5.11 ± 3.66	1.78 ± 1.39	4.44 ± 8.68	73.22 ± 61.58
	pupae	0.22 ± 0.44	-	0.33 ± 1.00	-
Empididae	larvae	-	0.11 ± 0.33	0.11 ± 0.22	0.11 ± 0.22
	pupae	-	0.11 ± 0.33	0.11 ± 0.22	-
Heleidae	larvae	-	0.22 ± 0.67	-	0.11 ± 0.22
Simuliidae	larvae	1.22 ± 2.64	1.22 ± 1.79	0.44 ± 1.01	17.89 ± 10.96
	pupae	-	-	-	0.56 ± 1.33
Tipulidae	larvae	1.89 ± 1.83	0.78 ± 1.30	0.67 ± 0.71	0.56 ± 0.73
Gastropoda		-	0.11 ± 0.33	-	-
Total		66.56 ± 25.72	53.44 ± 19.40	49.33 ± 22.32	181.00 ± 85.46

* Ransom Brook was treated with NOVATHION® Technical + TRITON® X-100 + water by aerial application at 0700 ADT on 17 June, 1982, and again at 2030 ADT on 24 June, 1982.

+ mean number ± standard deviation of organisms collected in 9 Surber samples.

Table 3. Aquatic organisms collected in Surber samples from Sixty-three Mile Brook* between 6 and 30 June, 1982.

		6 June	14 June	24 June	30 June
Nematomorpha		0.11 ± 0.33+	0.11 ± 0.33	-	0.11 ± 0.33
Oligochaeta		0.33 ± 0.71	-	-	-
Hydracarina		0.11 ± 0.33	0.67 ± 0.87	-	-
Plecoptera Alloperla	nymphs	1.44 ± 2.07	4.33 ± 3.97	0.22 ± 0.44	0.44 ± 1.01
Leuctra	nymphs	4.78 ± 6.89	21.89 ± 10.72	6.33 ± 4.85	4.67 ± 2.50
Nemoura	nymphs	2.44 ± 2.01	7.44 ± 8.40	4.78 ± 2.77	4.56 ± 3.88
Isogenus	nymphs	1.11 ± 0.60	0.56 ± 0.73	0.67 ± 0.50	0.44 ± 0.73
Ephemeroptera Baetis	nymphs	3.67 ± 3.04	1.00 ± 1.41	1.22 ± 1.09	3.22 ± 2.22
Ephemerella	nymphs	0.33 ± 0.71	0.44 ± 0.73	0.44 ± 1.01	0.11 ± 0.33
Cinygmula	nymphs	10.89 ± 4.54	7.78 ± 4.89	4.56 ± 4.72	4.56 ± 3.17
Epeorus	nymphs	50.44 ± 24.64	41.56 ± 24.07	100.78 ± 52.73	112.33 ± 59.72
Paraleptophlebia	nymphs	0.11 ± 0.33	0.22 ± 0.44	-	0.11 ± 0.33
Ameletus	nymphs	-	0.78 ± 1.72	-	-
Trichoptera Glossosoma	larvae	0.56 ± 0.53	0.11 ± 0.33	-	0.22 ± 0.44
Parapsyche	larvae	0.67 ± 1.12	0.67 ± 0.71	0.89 ± 1.62	0.78 ± 0.97
Lepidostoma	larvae	0.11 ± 0.33	-	-	0.11 ± 0.33
Neophylax	larvae	1.33 ± 1.32	2.33 ± 4.50	0.11 ± 0.33	-
Onocosmoecus	larvae	-	0.22 ± 0.44	0.11 ± 0.33	0.11 ± 0.33
Psychoglypha	larvae	0.11 ± 0.33	0.56 ± 1.01	0.11 ± 0.33	-
Rhyacophila	larvae	3.33 ± 2.12	3.89 ± 3.26	2.33 ± 2.87	3.56 ± 2.70
Unidentified	pupae	26.89 ± 18.72	1.00 ± 1.00	1.67 ± 1.50	1.56 ± 2.24
Diptera Chironomidae	larvae	24.33 ± 19.14	14.56 ± 9.34	10.22 ± 8.78	32.44 ± 31.40
	pupae	6.33 ± 3.64	0.89 ± 1.05	0.67 ± 1.66	0.78 ± 0.83
Dixidae	larvae	-	0.11 ± 0.33	-	-
Dolichopodidae	larvae	-	0.11 ± 0.33	0.11 ± 0.33	-
Empididae	larvae	0.78 ± 0.83	0.22 ± 0.44	0.44 ± 1.01	0.44 ± 0.73
Heleidae	larvae	1.78 ± 1.39	1.11 ± 1.54	0.22 ± 0.44	0.44 ± 0.73
Simuliidae	larvae	1.11 ± 1.45	0.33 ± 0.71	0.89 ± 1.69	1.78 ± 3.03
	pupae	1.22 ± 1.79	0.11 ± 0.33	0.33 ± 0.71	0.11 ± 0.33
Tipulidae	larvae	1.11 ± 1.36	0.56 ± 0.53	0.78 ± 0.97	1.00 ± 1.12
Total		151.00 ± 50.38	113.89 ± 51.82	139.00 ± 71.35	174.22 ± 88.53

* Sixty-three Mile Brook was treated with NOVATHION® Technical + Cyclosol 63 + TRITON® X-100 + water by aerial application at 1955 ADT on 22 June, 1982, and again at 1940 ADT on 28 June, 1982.

+ mean number ± standard deviation of organisms collected in 9 Surber samples.

Table 4. Aquatic organisms collected in Surber samples from White Birch Brook between 6 and 30 June, 1982.

		6 June	14 June	18 June	27 June	30 June
Nematomorpha		-	0.33 ± 0.50[+]	0.11 ± 0.22	-	0.11 ± 0.22
Oligochaeta		0.11 ± 0.22	0.11 ± 0.22	0.22 ± 0.67	0.11 ± 0.22	0.33 ± 0.50
Hydracarina		0.11 ± 0.22	0.22 ± 0.67	-	-	-
Plecoptera Alloperla	nymphs	-	0.44 ± 0.53	0.22 ± 0.67	0.56 ± 0.53	0.67 + 0.87
Leuctra	nymphs	0.22 ± 0.44	1.89 ± 1.96	-	0.44 ± 0.73	0.67 + 1.00
Nemoura	nymphs	-	0.89 ± 1.05	0.33 ± 0.71	2.89 ± 4.91	3.22 + 3.31
Isogenus	nymphs	0.44 ± 0.53	0.33 ± 0.71	0.22 ± 0.44	1.78 ± 3.03	0.11 + 0.22
Ephemeroptera Baetis	nymphs	2.33 ± 1.94	4.11 ± 5.78	0.78 ± 1.30	4.00 ± 3.94	4.00 + 2.55
Ephemerella	nymphs	2.89 ± 1.96	1.44 ± 2.19	1.44 ± 1.13	2.89 ± 2.62	1.44 + 1.13
Cinygmula	nymphs	2.44 ± 2.60	1.33 ± 2.96	3.22 ± 5.78	5.22 ± 3.38	3.67 + 3.43
Epeorus	nymphs	7.44 ± 5.53	9.22 ± 5.74	8.11 ± 4.34	27.11 ± 13.37	21.22 + 8.71
Hemiptera Hebridae		0.11 ± 0.22	-	-	-	-
Mesoveliidae		0.11 ± 0.22	-	-	-	
Trichoptera Glossosoma	larvae	0.11 ± 0.22	0.56 ± 0.88	-	0.11 ± 0.22	0.11 ± 0.22
Parapsyche	larvae	0.67 ± 0.50	0.11 ± 0.22	0.67 ± 1.12	0.11 ± 0.22	0.33 ± 0.50
Onocosmoecus	larvae	-	-	0.11 ± 0.22	-	-
Psychoglypha	larvae	0.11 ± 0.22	-	0.11 ± 0.22	-	-
Rhyacophila	larvae	0.78 ± 0.97	1.11 ± 0.78	0.33 ± 0.50	2.78 ± 1.92	0.78 ± 0.67
Unidentified	pupae	0.22 ± 0.44	0.22 ± 0.44	0.56 ± 1.33	-	0.56 ± 0.88
Coleoptera Dytiscidae	larvae	-	-	-	-	0.11 ± 0.22
Elmidae	adults	0.11 ± 0.22	-	0.11 ± 0.22	-	-
Diptera Chironomidae	larvae	1.00 ± 0.87	0.78 ± 0.83	0.33 ± 1.00	2.33 ± 1.12	2.00 ± 2.12
	pupae	0.22 ± 0.44	0.11 ± 0.22	-	-	-
Empididae	larvae	-	0.22 ± 0.44	0.33 ± 0.71	0.22 ± 0.67	0.33 ± 0.71
Heleidae	larvae	-	-	0.22 ± 0.44	-	-
Simuliidae	larvae	0.67 ± 0.87	4.11 ± 6.41	0.44 ± 1.01	0.78 ± 1.64	2.44 ± 1.81
	pupae	0.33 ± 0.50	0.11 ± 0.22	-	0.56 ± 1.01	0.11 ± 0.22
Tipulidae	larvae	0.11 ± 0.22	0.11 ± 0.22	-	0.11 ± 0.22	0.11 ± 0.22
Gastropoda		-	-	-	-	0.11 ± 0.22
Total		20.56 ± 8.49	27.78 ± 14.77	17.89 ± 11.17	52.00 ± 17.58	42.44 ± 15.36

[+] mean number ± standard deviation of organisms collected in 9 Surber samples.

APPENDIX III

Aquatic invertebrate drift data from treated and check sites for each aminocarb and fenitrothion formulation ground application.

Table 1. Aquatic organisms collected in drift nets set at the treated site in Sixty-three Mile Brook* on 7 July, 1982.

		Time before (-) or after (+) treatment								
		-½h	0	+½h	+1h	+1½h	+2h	+3h	+4h	+5h
Oligochaeta				0.08+				s		
Collembola		0.16						a		
Plecoptera Leuctra	nymphs	0.08		0.16	0.08	0.08	0.08	m		
Nemoura	nymphs	0.16	0.08	1.04	1.21	3.05	5.71	p	3.48	2.01
Ephemeroptera Baetis	nymphs	0.16		0.08				l	0.08	
Cinygmula	nymphs		0.08	0.08				e		
Epeorus	nymphs	0.08		0.24	0.40	0.08	0.08		0.30	0.32
Trichoptera Lepidostoma	larvae			0.08				d		
Onocosmoecus	larvae			0.08	0.08			e	0.08	
Wormaldia	larvae						0.24	s		0.08
Rhyacophila	larvae				0.08			t		
Unidentified	pupae						0.08	r		
Diptera Chironomidae	larvae	0.24		0.32	1.04	1.13	1.21	o	0.98	1.21
	pupae	0.08				0.08		y		
Simuliidae	larvae	0.40		0.48	0.32	0.24	0.16	e	0.45	0.08
Tipulidae	larvae							d	0.08	
Total		1.37	0.16	2.65	3.22	4.66	7.56		5.45	3.70

* Sixty-three Mile Brook was treated by hand with NOVATHION® Technical + Cyclosol 63 + TRITON® X-100 + Water at 0745 ADT on 7 July, 1982.

+ number of organisms per m^3 of water passing through the drift net

Table 2. Aquatic organisms collected in drift nets set at the check site in Sixty-three Mile Brook* on 7 July, 1982.

		Time before (-) or after (+) treatment								
		-½h	0	+½h	+1h	+1½h	+2h	+3h	+4h	+5h
Nematomorpha					0.05+					
Oligochaeta			0.04		0.14			0.06		
Hydracarina					0.05	0.05				
Plecoptera Alloperla	nymphs						0.05			
Leuctra	nymphs		0.04							0.05
Nemoura	nymphs		0.09	0.10	0.05		0.11	0.06		0.11
Ephemeroptera Baetis	nymphs							0.06	0.06	
Epeorus	nymphs			0.05			0.05			
Paraleptophlebia	nymphs			0.05						
Trichoptera Onocosmoecus	larvae	0.04			0.05					
Psychoglypha	larvae		0.04							
Diptera Chironomidae	larvae			0.10	0.05	0.10	0.11			0.05
	pupae				0.05					0.05
Simuliidae	larvae	0.04	0.09	0.14	0.19	0.19	0.11		0.18	0.05
	pupae		0.04							
Tipulidae	larvae					0.05				
Gastropoda					0.05					
Total		0.09	0.34	0.43	0.67	0.38	0.43	0.18	0.24	0.32

* Sixty-three Mile Brook was treated by hand with NOVATHION® Technical + Cyclosol 63 + TRITON® X-100. + water at 0745 ADT on 7 July, 1982.

+ number of organisms per m^3 of water passing through the drift net

Table 3. Aquatic organisms collected in drift nets set at the treated site in Ransom Brook* on 7 July, 1982.

		Time before (-) or after (+) treatment								
		-½h	0	+½h	+1h	+1½h	+2h	+3h	+4h	+5h
Nematomorpha							0.05+			
Hydracarina		0.05								
Collembola								0.05		
Plecoptera Leuctra	nymphs							0.05		
Nemoura	nymphs			0.05	0.05	0.10	0.10	0.30		
Ephemeroptera Baetis	nymphs						0.05			
Ephemerella	nymphs							0.05		
Epeorus	nymphs							0.05		
Trichoptera Wormaldia	larvae						0.05	0.05		
Unidentified	pupae							0.05		
Diptera Chironomidae	larvae			0.10		0.05	0.65	0.50	0.25	0.10
	pupae						0.05	0.05		0.05
Heleidae	larvae								0.05	0.05
Simuliidae	larvae	0.05	0.05	0.20	0.10	0.10	0.20	1.00		0.05
Total		0.10	0.05	0.35	0.15	0.25	1.15	2.15	0.30	0.25

* Ransom Brook was treated by hand with NOVATHION® Technical + TRITON® X-100 + water at 0845 ADT on 7 July, 1982.

+ number of organisms per m^3 of water passing through the drift net

Table 4. Aquatic organisms collected in drift nets set at the check site in Ransom Brook* on 7 July, 1982.

		Time before (-) or after (+) treatment								
		-½h	0	+½h	+1h	+1½h	+2h	+3h	+4h	+5h
Nematomorpha						0.05+	0.05	0.05		0.05
Hydracarina								0.05		
Plecoptera Nemoura	nymphs	0.19	0.05	0.09	0.05		0.05	0.19		0.09
Ephemeroptera Ephemerella	nymphs			0.05			0.05			
Cinygmula	nymphs						0.05			
Trichoptera Rhyacophila	larvae						0.05			
Diptera Chironomidae	larvae	0.09	0.09		0.14		0.05	0.28	0.05	0.09
	pupae					0.05				0.05
Dolichopodidae	larvae									0.05
Heleidae	larvae				0.05					
Simuliidae	larvae	0.09	0.23	0.19	0.09	0.19	0.23		0.14	0.28
Total		0.37	0.37	0.33	0.33	0.28	0.51	0.56	0.19	0.61

* Ransom Brook was treated by hand with NOVATHION® Technical + TRITON® X-100 + water at 0845 ADT on 7 July, 1982.

+ number of organisms per m^3 of water passing through the drift net

Table 5. Aquatic organisms collected in drift nets set at the treated site in the Lower West Branch Portage Brook* on 7 July, 1982.

		Time before (-) or after (+) treatment								
		-½h	0	+½h	+1h	+1½h	+2h	+3h	+4h	+5h
Hydracarina			0.05+							
Collembola			0.15	0.05						
Plecoptera Leuctra	nymphs									0.19
Nemoura	nymphs			0.05		0.05	0.05		0.05	0.05
Ephemeroptera Baetis	nymphs		0.05	0.15					0.05	
Ephemerella	nymphs								0.05	0.09
Epeorus	nymphs	0.05					0.05		0.05	
Ameletus	nymphs									0.09
Trichoptera Agapetus	larvae				0.05					
Wormaldia	larvae			0.05						
Rhyacophila	larvae			0.10	0.05	0.25	0.10			
Unidentified	pupae						0.05			
Coleoptera Hydrophilidae	adults		0.05							
Haliplidae	adults						0.05			
Diptera Chironomidae	larvae	0.10	0.25	0.54	0.30	0.54	0.59	0.52	0.43	3.13
	pupae		0.20	0.10	0.05				0.05	0.14
Simuliidae	larvae	0.05	4.80	3.76	0.30	0.15	0.15	0.43	0.14	0.57
Total		0.20	5.69	4.80	0.74	0.99	1.04	0.95	0.81	4.32

* Lower West Branch Portage Brook was treated by hand with MATACIL® 180F + TRITON® X-100 + water at 0955 ADT on 7 July, 1982.

+ number of organisms per m^3 of water passing through the drift net

Table 6. Aquatic organisms collected in drift nets set at the check site in the Lower West Branch Portage Brook* on 7 July, 1982.

		Time before (-) or after (+) treatment								
		-½h	0	+½h	+1h	+1½h	+2h	+3h	+4h	+5h
Nematomorpha					0.05+		0.05			
Hydracarina				0.05			0.09	0.09		0.05
Ephemeroptera Baetis	nymphs			0.05						
Ephemerella	nymphs							0.05		
Trichoptera Onocosmoecus	larvae		0.05	0.05	0.05					
Rhyacophila	larvae								0.05	
Coleoptera Dytiscidae	adults			0.05						
Diptera Chironomidae	larvae	0.09	0.32	0.23	0.09	0.09	0.14	0.18	0.09	0.18
Simuliidae	larvae	0.05	0.05	0.09	0.14	0.18				0.05
Total		0.14	0.41	0.51	0.32	0.28	0.28	0.32	0.14	0.28

* Lower West Branch Portage Brook was treated by hand with MATACIL® 180F + TRITON® X-100 + water at 0955 ADT on 7 July, 1982.

+ number of organisms per m^3 of water passing through the drift net

APPENDIX IV

Benthic invertebrate population data from treated and check sites for each aminocarb and fenitrothion formulation ground application

Table 1. Aquatic organisms collected in Surber samples from the treated site in Sixty-three Mile Brook* on 6 and 8 July, 1982.

		6 July		8 July	
Nematomorpha		0.20 ±	0.45+	0.20 ±	0.45
Plecoptera Alloperla	nymphs	1.40 ±	1.67	0.80 ±	1.30
Leuctra	nymphs	2.80 ±	2.17	2.40 ±	2.51
Nemoura	nymphs	11.00 ±	14.88	15.00 ±	15.98
Isogenus	nymphs	0.20 ±	0.45	0.20 ±	0.45
Ephemeroptera Baetis	nymphs	3.80 ±	3.83	6.60 ±	4.28
Ephemerella	nymphs	0.20 ±	0.45	0.40 ±	0.55
Cinygmula	nymphs	8.00 ±	8.89	4.00 ±	3.54
Epeorus	nymphs	97.60 ±	51.94	160.60 ±	42.66
Trichoptera Glossosoma	larvae	0.20 ±	0.45	-	
Parapsyche	larvae	-		0.80 ±	0.84
Lepidostoma	larvae	0.20 ±	0.45	-	
Onocosmoecus	larvae	0.40 ±	0.89	-	
Psychoglypha	larvae	0.40 ±	0.89	-	
Rhyacophila	larvae	4.20 ±	3.56	6.40 ±	3.44
Unidentified	pupae	0.60 ±	0.55	0.80 ±	0.84
Diptera Chironomidae	larvae	50.00 ±	60.96	17.80 ±	14.52
	pupae	1.20 ±	1.64	-	
Dolichopodidae	larvae	-		0.20 ±	0.45
Empididae	larvae	-		0.20 ±	0.45
	pupae	0.20 ±	0.45	-	
Heleidae	larvae	0.20 ±	0.45	0.60 ±	0.89
Simuliidae	larvae	1.00 ±	1.22	3.40 ±	2.07
	pupae	-		0.20 ±	0.45
Tipulidae	larvae	1.20 ±	1.30	1.00 ±	1.00
Total		185.20 ±	123.65	222.20 ±	80.15

* Sixty-three Mile Brook was treated by hand with NOVATHION® Technical + Cyclosol 63 + TRITON® X-100 + water at 0745 ADT on 7 July, 1982.

+ mean number ± standard deviation of organisms collected in 5 Surber samples.

Table 2. Aquatic organisms collected in Surber samples from the treated site in Ransom Brook* on 6 and 8 July, 1982.

		6 July		8 July	
Nematomorpha		0.60 ±	0.55+	0.40 ±	0.89
Plecoptera Alloperla	nymphs	1.00 ±	1.00	1.20 ±	1.30
Leuctra	nymphs	0.80 ±	1.30	0.60 ±	0.89
Nemoura	nymphs	2.20 ±	1.48	1.40 ±	1.14
Isogenus	nymphs	-		0.20 ±	0.45
Ephemeroptera Ephemerella	nymphs	9.20 ±	6.69	1.40 ±	1.52
Cinygmula	nymphs	1.00 ±	1.41	-	
Epeorus	nymphs	27.80 ±	21.46	7.40 ±	8.20
Trichoptera Glossosoma	larvae	0.20 ±	0.45	-	
Parapsyche	larvae	0.20 ±	0.45	-	
Wormaldia	larvae	0.20 ±	0.45	-	
Lepidostoma	larvae	0.40 ±	0.55	0.20 ±	0.45
Neophylax	larvae	1.80 ±	1.30	-	
Onocosmoecus	larvae	0.20 ±	0.45	-	
Pycnopsyche	larvae	-		0.20 ±	0.45
Rhyacophila	larvae	1.80 ±	1.30	0.20 ±	0.45
Unidentified	pupae	1.80 ±	1.92	0.20 ±	0.45
Coleoptera Dytiscidae	larvae	-		0.20 ±	0.45
Diptera Chironomidae	larvae	4.80 ±	3.56	2.80 ±	2.77
Empididae	larvae	0.20 ±	0.45	-	
Simuliidae	larvae	10.40 ±	10.45	2.80 ±	5.17
	pupae	0.40 ±	0.55	-	
Tipulidae	larvae	1.00 ±	1.22	2.40 ±	2.41
Total		66.40 ±	43.02	21.60 ±	20.79

* Ransom Brook was treated by hand with NOVATHION® Technical + TRITON® X-100 + water at 0845 ADT on 7 July, 1982.

+ mean number ± standard deviation of organisms collected in 5 Surber samples.

Table 3. Aquatic organisms collected in Surber samples from the treated site in Lower West Branch Portage Brook* on 6 and 8 July, 1982.

		6 July		8 July	
Nematomorpha		-		0.20 ±	0.45+
Oligochaeta		0.60 ±	1.34	-	
Hydracarina		0.40 ±	0.55	0.40 ±	0.89
Plecoptera Alloperla	nymphs	0.40 ±	0.89	0.60 ±	0.89
Leuctra	nymphs	0.40 ±	0.89	0.60 ±	0.55
Nemoura	nymphs	0.40 ±	0.89	0.20 ±	0.45
Isoperla	nymphs	0.20 ±	0.45	-	
Ephemeroptera Baetis	nymphs	0.20 ±	0.45	0.40 ±	0.89
Ephemerella	nymphs	10.00 ±	5.57	7.20 ±	2.59
Cinygmula	nymphs	3.20 ±	2.17	3.40 ±	2.07
Epeorus	nymphs	34.00 ±	15.95	18.40 ±	13.18
Paraleptophlebia	nymphs	0.40 ±	0.55	-	
Trichoptera Neophylax	larvae	-		0.20 ±	0.45
Onocosmoecus	larvae	-		0.40 ±	0.55
Rhyacophila	larvae	2.00 ±	1.22	0.60 ±	0.89
Unidentified	pupae	0.80 ±	1.30	1.40 ±	1.52
Coleoptera Elmidae	adults	0.20 ±	0.45	-	
Diptera Chironomidae	larvae	18.40 ±	14.03	12.40 ±	11.72
	pupae	1.80 ±	1.64	0.20 ±	0.45
Empididae	pupae	0.20 ±	0.45	0.20 ±	0.45
Heleidae	larvae	1.40 ±	1.95	-	
Simuliidae	larvae	0.60 ±	0.55	0.60 ±	0.55
	pupae	0.60 ±	0.89	-	
Tipulidae	larvae	1.40 ±	3.13	0.80 ±	0.84
Total		77.60 ±	34.96	48.40 ±	19.03

* Lower West Branch Portage Brook was treated by hand with MATACIL® 180F + TRITON® X-100 + water at 0955 ADT on 7 July, 1982.

+ mean number ± standard deviation of organisms collected in 5 Surber samples.