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RESOURCE DEVELOPMENT BRANCH

MANUSCRIPT REPORT

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In
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On
Aquatic Insects in a Small Stream

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INTRODUCTION

In 1971, Fundy National Park was sprayed from the air with two applications of the organophosphate insecticide Fenitrothion, to control the spruce budworm (Choristoneura fumiferana). The first spray application was applied in mid June at the rate of 3/16 lb./acre of active ingredient contained in a water emulsion formulation. The second spray application was applied about two weeks later at the rate of 1/8 lb./acre. Fenitrothion is a trade name for an insecticide which is also called Accothion, Folithion, Novathion, and Sumithion.

This is the second assessment; the first being in 1970, to determine the effects of Fenitrothion spraying in Fundy National Park on aquatic insects, and presents four groups of data.

First, populations of aquatic insects were determined before and after spraying.

Second, Fenitrothion residue analyses were done on samples of mayfly nymphs (Ephemeroptera) that were collected before and after spraying.

Third, records were kept of water temperatures and water level fluctuations during the period of aquatic insect population sampling.

Fourth, water samples were collected periodically throughout the aquatic insect population sampling period, and analyzed for general water quality parameters.

METHODS

AQUATIC INSECT POPULATION SAMPLING

A "Surber" one foot-square sampler was used to collect aquatic stream bottom invertebrates for population determinations. Five one square-foot samples were taken once each week for three weeks before the first spray application, five samples once each week for two weeks between the first and second spray applications, and five samples on each of three sampling dates over a three and one half week period following spraying.

Insects were preserved in an approximately 5% formalin solution at the time of collection. The samples were cleaned at a later date by separating insects from sample debris and the cleaned sample was preserved in a 70% solution of isopropyl alcohol. Insects were subsequently sorted according to the four major orders that are utilized as food by young salmon (Keenleyside 1967), and counted. Total biomass of all orders of insects found was determined by displacement, for the composite five one-square foot samples taken on each sampling date.

The sample stream was a small tributary known as Hueston Brook, which flows into the Point Wolfe Resivor.

FENITROTHION RESIDUE ANALYSES ON MAYFLY NYMPHS (EPHEMEROPTERA)

Mayfly nymphs were collected from Hueston Brook and analyzed collectively for Fenitrothion residues. Mayfly nymphs were taken live from stones, with forceps, preserved in ethyl acetate and delivered to Dr. J.R. Duffy at the University of Prince Edward Island, where they were analyzed. One pre-spray sample, three samples between the first and second spray applications, and four samples following the second spray application were analyzed. The last sample was taken 14 days after the second spray application. Mean sample weight expressed as wet weight of insects was 2.2 grams. The mayfly nymphs collected for Fenitrothion analyses were collected outside the area used for insect population sampling.

WATER TEMPERATURE AND WATER LEVEL FLUCTUATIONS

Water temperatures and water levels were recorded in the insect population sample area, on the average of about every two days from May 21, 1971, to August 18, 1971. Water temperatures were determined with a pocket thermometer, and a recording thermograph was also in operation. Changes in water levels were measured by reading the water level on a stationary measuring stick.

WATER SAMPLE ANALYSES

Water samples were collected from Hueston Brook periodically from May 21, 1971, to August 2, 1971, and delivered to the Department of the Environment, East Water Quality Station Laboratory at Moncton, New Brunswick, where they were analyzed for the following water quality parameters: alkalinity, calcium, chloride, color (Hazen Units), copper, fluoride, hardness, iron, lead, magnesium, manganese, nitrogen, pH, phosphate, potassium, silica (Si O_2), sodium, specific conductance, sulphate, turbidity, and zinc.

RESULTS

(a) AQUATIC INSECT POPULATIONS

Populations of the four orders of aquatic insects that are known to be the major food supplies of juvenile salmon (Keenleyside, 1967) are identified. The effects of the double Fenitrothion spray on numbers of insects in each of these four orders and on the total biomass of all orders of aquatic insects collected is assessed.

Numbers of caddis larvae (Fig. 1) were not reduced following spraying. Mean numbers of caddis larvae found per square-foot in the sampling program which followed spraying were greater (27%), than the mean numbers found per square-foot in the sampling program before spraying.

Numbers of dipterans (Fig. 2) were highest in the period between the first and second spray applications. Mean numbers of dipterans found per square-foot before spray were considerably less than the mean numbers found per square-foot following spraying. By the end of the sampling program dipteran populations were about the same as they were before spraying.

Numbers of mayfly nymphs (Fig. 3) per square-foot, were on the average greater (18%) in the post-spray sampling period than they were in the pre-spray sampling period.

Stonefly nymphs (Fig. 4) were obviously reduced in numbers following spraying. Mean numbers of stonefly nymphs per square-foot in the sampling period after the first spray application to the end of sampling were 67% less than the numbers found per square-foot before spraying.

The average biomass, which consists of all orders of aquatic stream insects that was determined following spraying was slightly higher than before spraying.

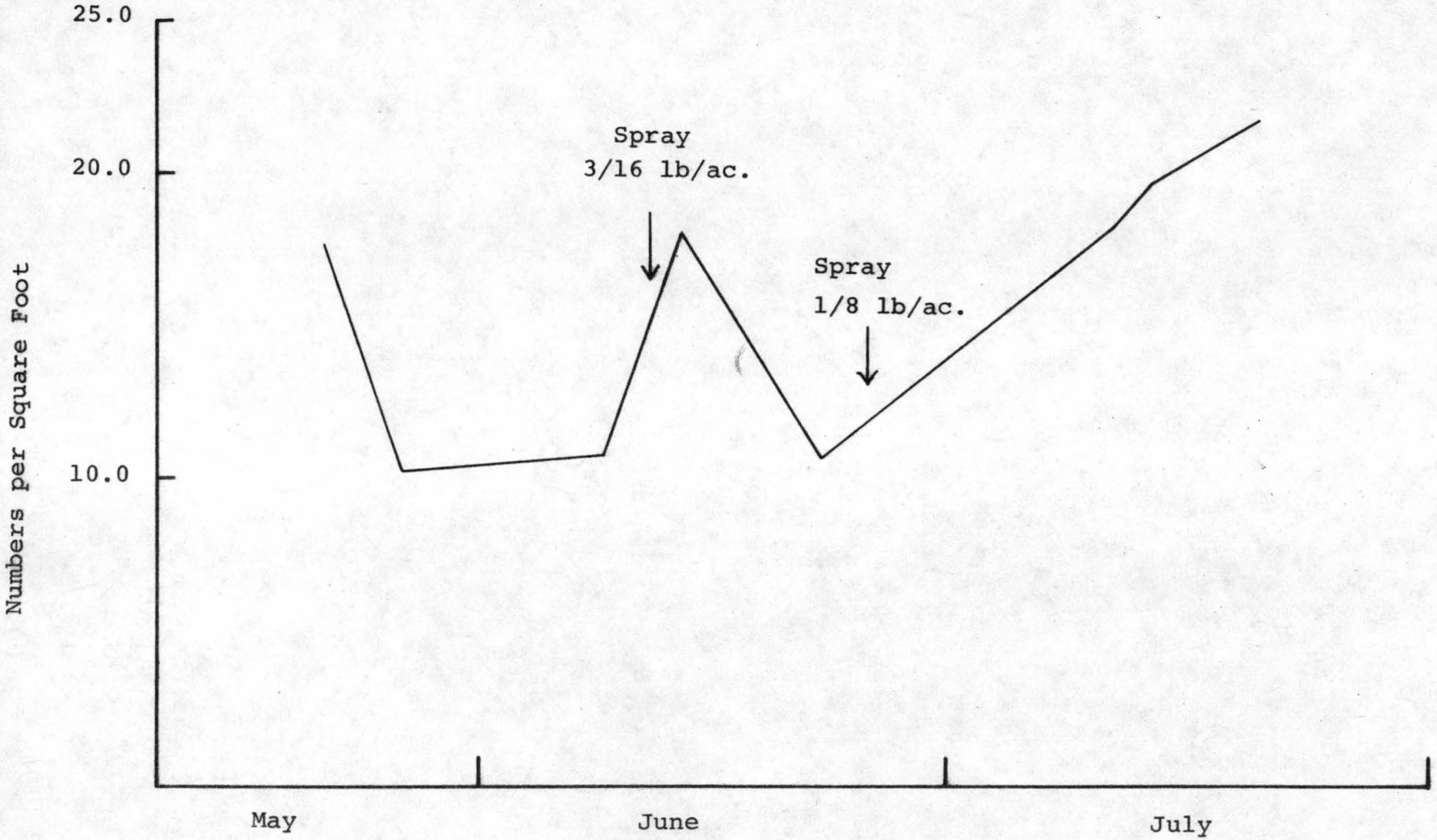

Figure 1. Populations of caddis larvae (Tricoptera) found in Hueston Brook which was sprayed with two applications of Fenitrothion at the rates of 3/16 lb/acre and 1/8 lb/acre respectively.

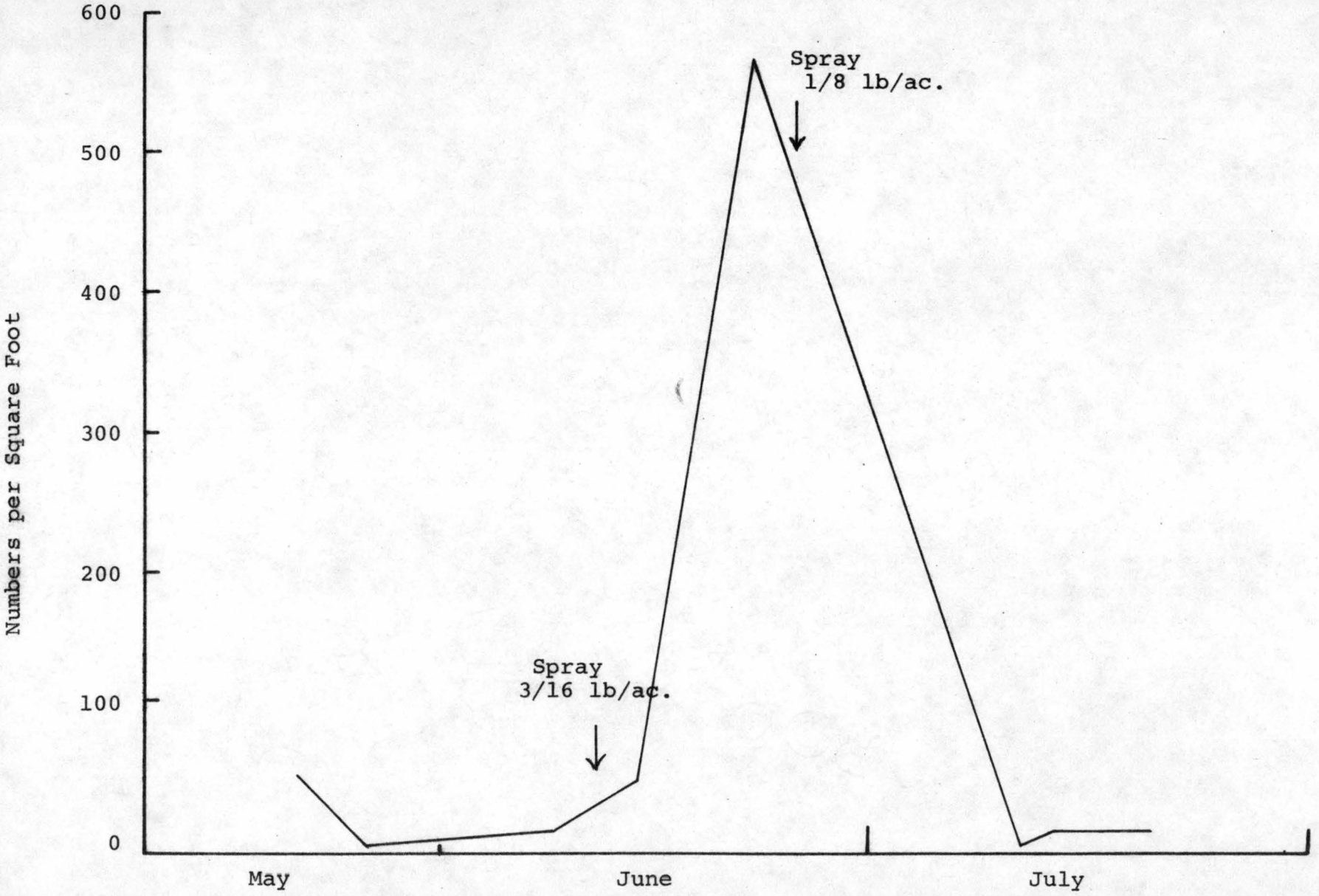

Figure 2. Populations of (Diptera) found in Hueston Brook which was sprayed with two applications of Fenitrothion at the rates of 3/16 lb/acre and 1/8 lb/acre respectively.

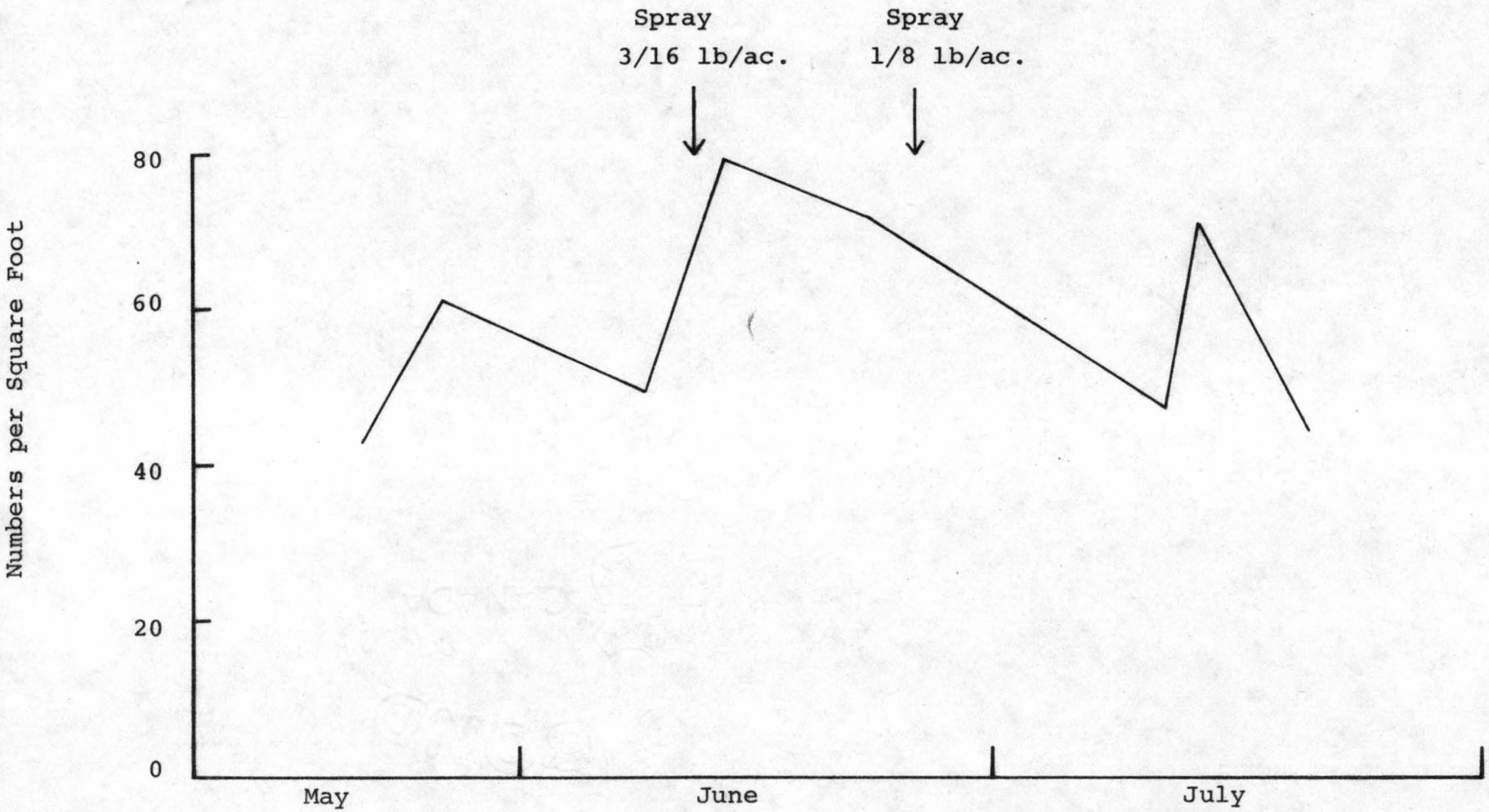

Figure 3. Populations of mayfly nymphs (Ephemeroptera) found in Hueston Brook which was sprayed with two applications of Fenitrothion at the rates of 3/16 lb/acre and 1/8 lb/acre respectively.

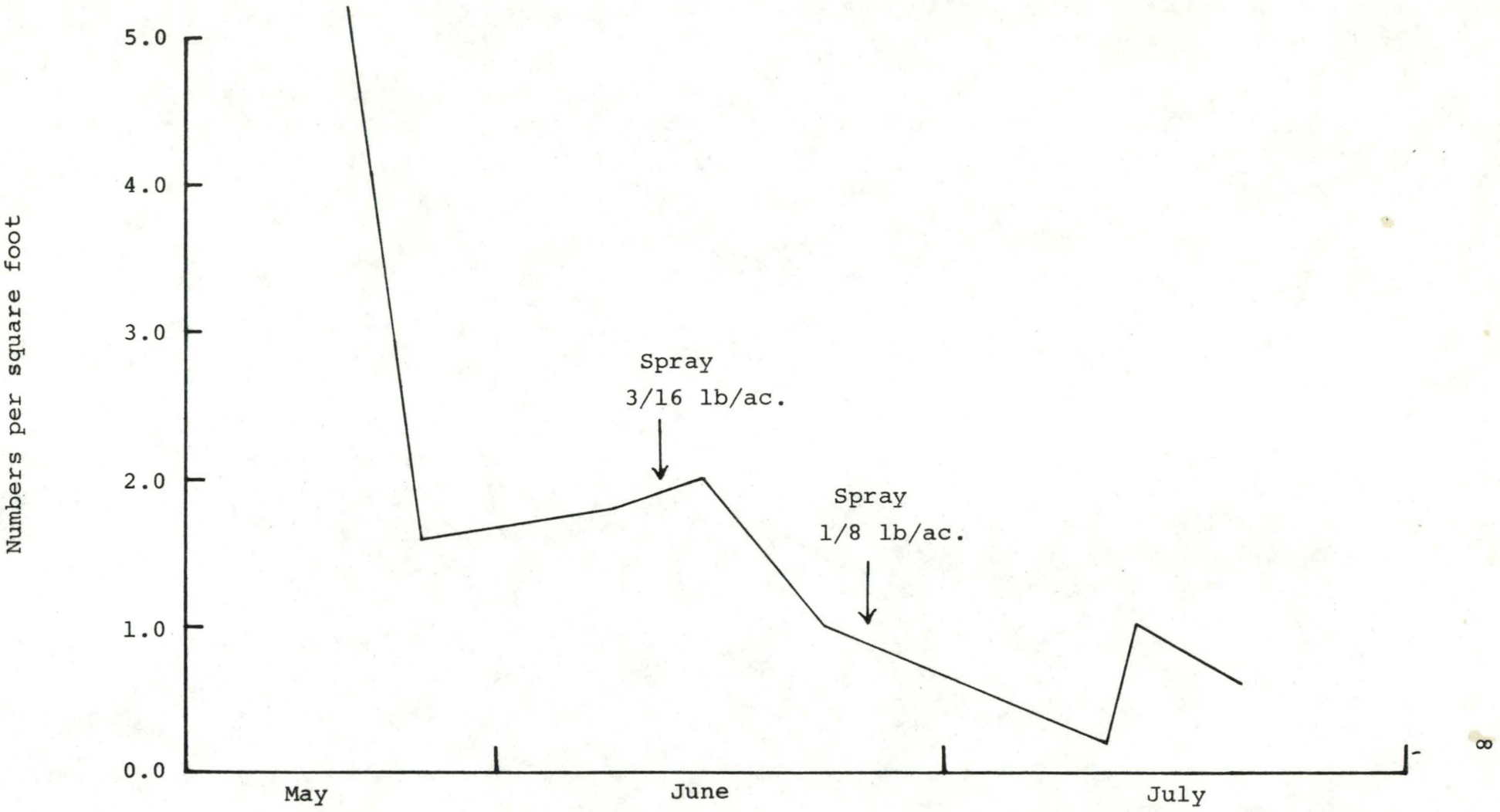

Figure 4. Populations of stonefly nymphs (Plecoptera) found in Hueston Brook which was sprayed with two applications of Fenitrothion at the rates of 3/16 lb/acre and 1/8 lb/acre respectively.

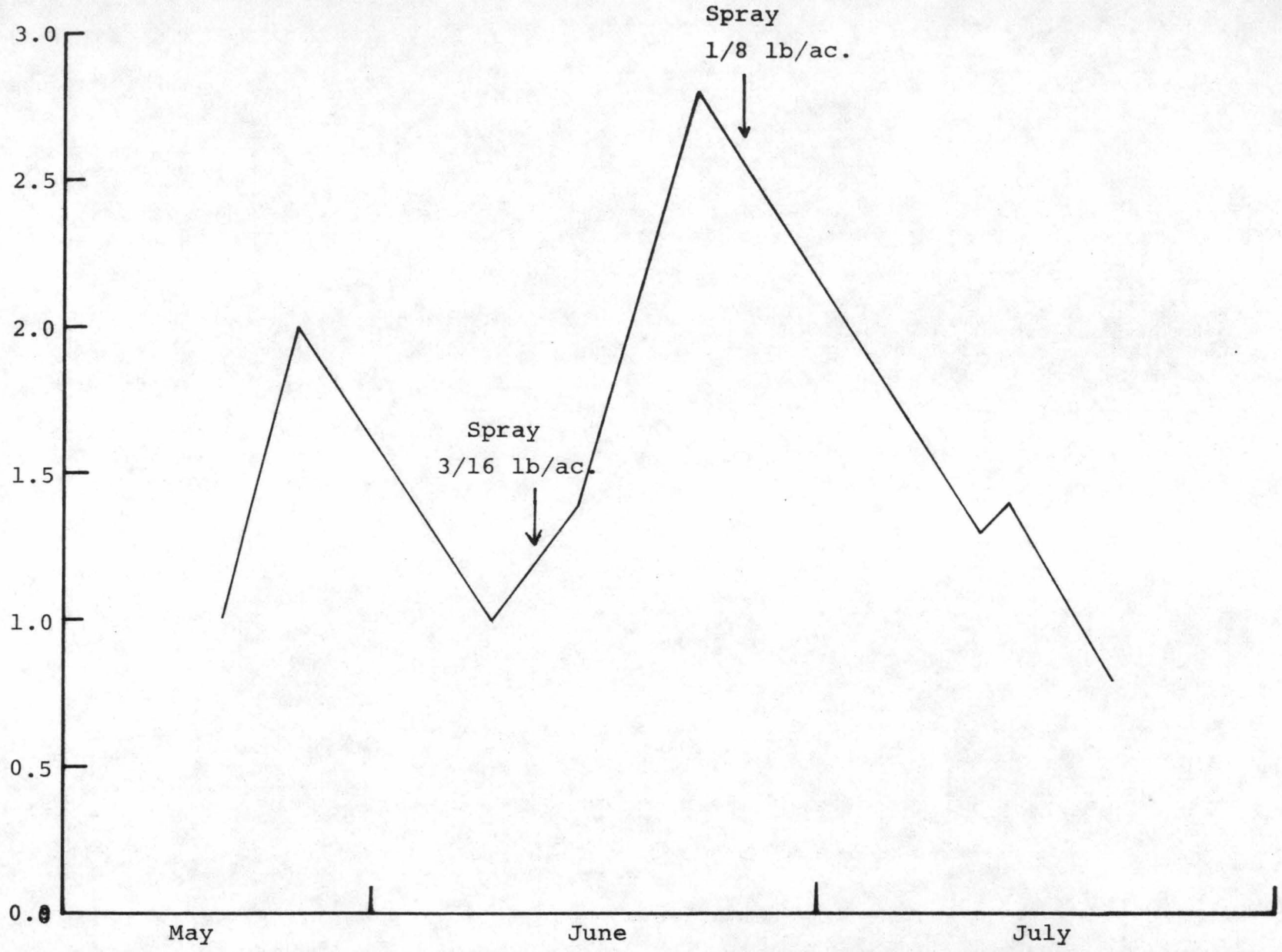

Figure 5. Biomass of aquatic stream invertebrates found in Hueston Brook which was sprayed with two applications of Fenitrothion at the rates of 3/16 lb/acre and 1/8 lb/acre respectively.

(b) FENITROTHION RESIDUE ANALYSES ON MAYFLY NYMPHS (EPHEMEROPTERA)

Mayflies were collected for analyses as an indication of the amount of Fenitrothion reaching these organisms and to relate any adverse short term effects of spraying on aquatic stream insects. Results of analyses of mayflies for Fenitrothion (Table 1) show that neither Fenitrothion or its breakdown product (Fenioxon) were detected in any of the samples analyzed.

Date Sampled	Sample Weight (Grams)	Fenitrothion ppm	TLC* Confirmation	Fenioxon ppm	TLC Confirmation
May 26	7.43	0.0	ND*	0.0	ND
→June 11	1.85	0.0	ND	0.0	ND
June 12	1.91	0.0	ND	0.0	ND
June 14	1.80	0.0	ND	0.0	ND
→June 25	1.44	0.0	ND	0.0	ND
June 26	1.27	0.0	ND	0.0	ND
June 28	1.53	0.0	ND	0.0	ND
July 9	0.71	0.0	ND	0.0	ND

*TLC = Thin Layer Chromotograph Confirmation
*ND = None Detected
→ First Spray Application (3/16 lb/acre) Applied on June 11.
→ Second Spray Application (1/8 lb/acre) Applied on June 25.

Table 1. Results of analyses for Fenitrothion and its breakdown product; Fenioxon, in mayfly nymphs (Ephemeroptera) collected from Hueston Brook.

(c) WATER TEMPERATURE AND WATER LEVEL FLUCTUATIONS

Resords that were kept of water temperatures and water levels in Hueston Brook are presented graphically in Figure 6. Water levels show a maximum fluctuation of only three inches from May 25 to August 18, 1971. Water temperatures ranged from 8 to 16°C from May 19 to August 18, 1971, as determined by a pocket thermometer and a recording thermograph showed a water temperature range of 7 to 16.5°C.

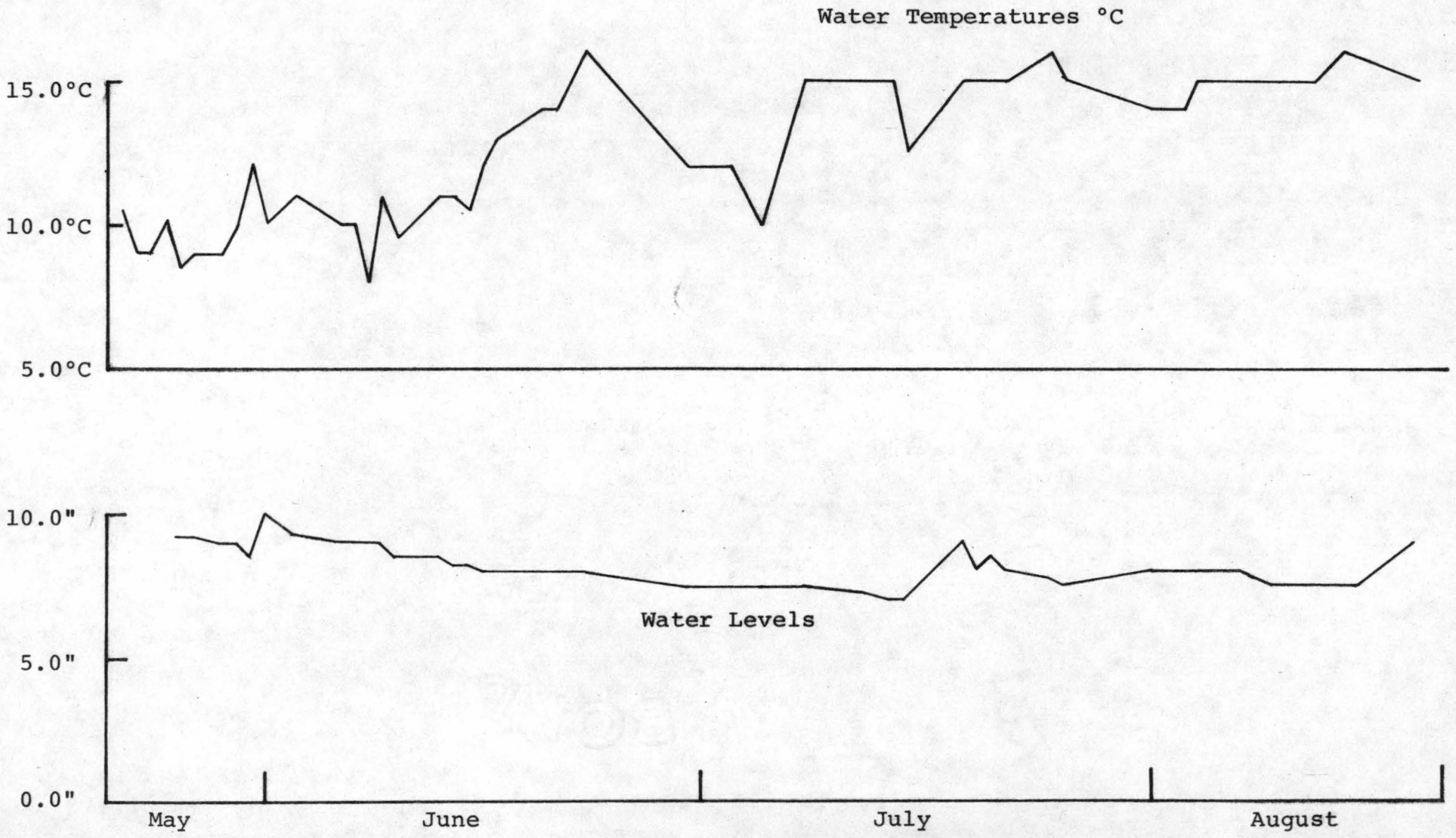

Figure 6. Water Temperature and Water Level Fluctuations in Hueston Brook.

(d) WATER SAMPLE ANALYSES

Differences in magnitude in various water quality parameters (Table 1), were found among the samples taken from Hueston Brook on different dates. Results of the analyses for the sample taken on June 11, show considerably lower than average values for alkilinity, calcium, hardness, pH, silica, specific conductance, and sulphate. The reason for these lower values is not known, but it should be noted that Hueston Brook was first subjected to spraying on June 11.

Sample Date	May 21	May 28	June 7	June 11	June 22	July 13	Aug. 2
Alkalinity: Phenolphatalein ($CaCO_3$)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alkalinity: Total ($CaCO_3$)	12.0	14.0	14.7	4.3	17.2	20.3	18.3
Calcium: Dissolved (Ca)	5.5	6.0	6.2	2.7	6.1	6.6	71.0
Chloride: Dissolved (C)	4.2	4.5	4.4	4.5	4.6	-	4.8
Color: Hazen Units	5.0	5.0	5.0	5.0	10.0	5.0	5.0
Copper: Total (Cu)	0.004	0.017	0.005	0.007	0.05	0.002	0.004
Fluoride: Dissolved (F)	0.08	0.09	-	0.11	-	-	-
Hardness: Total ($CaCO_3$)	17.4	18.7	19.6	10.0	19.3	21.0	181.7
Iron: Total (Fe)	0.03	0.03	0.05	0.02	0.17	0.05	0.07
Iron: Dissolved (Fe)	<0.02	<0.02	-	0.02	-	-	-
Lead: Total (Pb)	0.008	0.008	-	0.002	-	-	-
Magnesium: Dissolved (Mg)	0.9	0.9	1.0	0.8	1.0	1.1	1.1
Manganese: Total (Mn)	<0.01	0.01	-	0.01	-	-	-
Manganese: Dissolved (Mn)	<0.01	<0.01	-	0.01	-	-	-

(cont'd)

Nitrogen: Nitrate + Nitrite (Dissolved) (N)	0.71	0.71	-	1.05	-	-	-
Nigrogen: Dissolved Ammonia (N)	<0.1	<0.1	-	0.1	-	-	-
pH (Laboratory Determination)	7.0	7.1	7.1	6.7	7.1	7.3	7.2
Phosphate: Dissolved, Inorganic (PO_4)	0.05	0.05	-	0.02	-	-	-
Potassium: Dissolved (K)	0.5	0.5	-	0.4	-	-	-
Silica: Reactive (SiO_2)	4.2	4.8	4.8	3.6	5.6	6.5	5.6
Sodium: Dissolved (Na)	3.4	3.6	3.7	3.0	-	-	-
Specific Conductance (umho/cm.)	53.5	58.2	56.4	42.8	64.8	67.8	75.2
Sulphate: Dissolved	5.9	5.4	5.9	2.9	5.1	-	-
Turbidity	0.24	0.17	0.10	0.10	0.23	0.1	0.10
Zinc: Total (Zn)	0.02	0.05	0.006	0.04	0.004	0.006	0.002

Table 2. Results of analyses of water samples collected from Hueston Brook.
ppm

SUMMARY AND DISCUSSION

Numbers of caddis larvae, dipteran larvae and mayfly nymphs in Hueston Brook were not reduced following Fenitrothion spraying. Numbers of stonefly nymphs found following spraying were about 1/3 the numbers found before spraying. The biomass of aquatic insects was not reduced following spraying.

Fenitrothion residues were not detected in mayfly nymphs collected from Hueston Brook.

Water levels in Hueston Brook fluctuated very little and the highest water temperature recorded was 16.5°C.

Results of the analysis of the water sample collected on June 11; the date of the first spray application, vary from the results of water samples collected before and after June 11.

The results obtained in the 1971 study in Fundy National Park do not show significant short-term effects of Fenitrothion spraying on aquatic insect biomass. The 1971 results are generally consistent with those found in Fundy National Park in 1970, Penney (1970), when Fenitrothion was sprayed in two applications at the rate of 1/8 lb/acre each.

It is recommended, however, that a more thorough study be conducted in Hueston Brook if it is to be sprayed again, to more precisely determine any effects of Fenitrothion spraying on the different orders and biomass of aquatic insects. The study period should be greater before as well as after spraying which would indicate the degree of natural variation.

ACKNOWLEDGEMENTS

Arrangements were made through the superintendent and chief warden of Fundy National Park for park warden, G.R. MacLean to collect and clean aquatic insect samples and to collect water samples and deliver them to Moncton. Personnel of the East Water Quality Station Laboratory at Moncton analyzed the water samples. Dr. J. R. Duffy of the University of Prince Edward Island provided analytical services for Fenitrothion determinations in mayfly nymphs. F.M. Hiltz (technician) identified and counted the aquatic insects and D.B. Banks (graduate student) collected most of the mayfly nymphs for Fenitrothion analyses.

REFERENCES

Keenleyside, Miles H.A. 1967. Effects of Forest Spraying with DDT in New Brunswick on Food of Young Atlantic Salmon. Jour. Fish. Res. Bd. Can., 24(4): 807-822.

Penney, G.H. 1970. Report on the Effects of the 1970 New Brunswick Forest Spraying on Juvenile Salmon and Their Food Organisms. Manuscript Report No. 71-13, Resource Development Branch, Can. Dept. of Fisheries and Forestry, Fisheries Service, Halifax, 41 pp.