



Environmental Monitoring by CCRI in  
Lac Ste - Anne, Quebec Spruce  
Budworm Spray Block 305, 1977

by

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## ENVIRONMENTAL MONITORING BY CCRI\* IN LAC STE - ANNE

QUEBEC SPRUCE BUDWORM SPRAY BLOCK 305, 1977

### INTRODUCTION

A severe spruce budworm, *Choristoneura fumiferana* Clem., outbreak in the Gaspé region of Quebec has presented a substantial hazard to the fir-spruce forests of the area in recent years. In the fall of 1976, budworm egg-mass surveys indicated an extremely high larval population would be present in the spring of 1977 within forests which had already been weakened by severe defoliation in the previous year. Entomologists at the Chemical Control Research Institute were consulted by the provincial agency responsible for forest protection and asked to recommend an insecticide application program which would reduce budworm populations sufficiently to protect the infested forests from severe defoliation. The recommendations given proposed that applications of insecticides at dosage rates above the levels currently registered for spruce budworm control would be required to protect the areas with the highest density of budworm egg-masses (greater than 2000 egg masses/10 m<sup>2</sup> of foliage). On the basis of this recommendation, the proposed Quebec 1977 spruce budworm spray program included treatment of a 120,960 hectare (298,900 acre) block of the most heavily infested forest with two successive applications of 0.280 kg fenitrothion/ha (4.0 oz/acre) followed by 0.088 kg aminocarb/ha (1.25 oz/acre). This exceeds the registered maximum total dosage rate for fenitrothion of 2 x 0.21 kg/ha by 0.14 kg/ha.

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The proposed application of above registered dosages of insecticides was approved by a working group of the Federal Interdepartmental Committee on Pesticides (FICP) under the procedures set out in Trade Memorandum T-104 established under the Pest Control Products Act. In agreeing to allow the use of the proposed applications, the FICP strongly recommended that complete monitoring studies be carried out within the spray areas to determine the effects on aquatic organisms. An extensive aquatic monitoring program was subsequently organized with direct input from three provincial and two federal agencies: Quebec Department of Tourism, Fish and Game, Quebec Department of Natural Resources, Quebec Environmental Protection Service, Inland Waters Division of Fisheries and Environment Canada and the Chemical Control Research Institute. The monitoring program was carried out within a number of rivers and streams and a single lake, Lac Ste - Anne, located within spray block 305 treated with two 0.280 kg/ha applications of fenitrothion followed by 0.088 kg/ha aminocarb. The lake study incorporated monitoring of water chemistry, insecticide residues, primary production and fertility, zooplankton, benthic fauna and fish populations, with different participating agencies responsible for different aspects. This report incorporates the preliminary results of studies on zooplankton, benthic fauna and fish carried out by the Chemical Control Research Institute. Studies of fenitrothion residues in fish from Lac Ste. Anne and monitoring activities of CCRI in streams and rivers will be presented in subsequent reports.

Support for this work provided by the Sumitomo Chemical Company, Osaka, Japan is greatly acknowledged.

## METHODS

### Zooplankton:

Zooplankton populations in Lac Ste -Anne were sampled with a Schindler-Patalas plankton trap (Schindler 1969) with a 154 mesh to the centimeter straining net, which captured all the zooplankton present in 12 litre water samples. On each sampling occasion, samples were taken from the surface, 4 m and 8 m at a 9 m deep station in the north basin of Lac Ste -Anne. The samples were preserved immediately with formaldehyde and later counted and identified in the laboratory by viewing them in a gridded dish under a dissecting microscope.

### Benthic fauna:

Bottom fauna populations were sampled from a shallow (1 to 3 m) area of Lac Ste -Anne in the narrow neck of the lake connecting the north and south basins. Samples were taken with an Ekman grab which sampled a 232 cm<sup>2</sup> (36 in<sup>2</sup>) area of bottom. The bottom type sampled consisted of fine silt over a hard base of stones and rocks. Four grab samples were taken on each sampling date and each was immediately preserved in its entirety with formaldehyde. Benthic organisms were later separated from the substrate in the laboratory with the aid of a "bubbler" (Kingsbury and Beveridge, in press) and then counted and identified to order or family.

### Fish:

Fish populations in Lac Ste -Anne were sampled periodically by leaving gill nets set in the lake overnight. Gangs of gill nets with 30 m sections of various mesh size ranging from 1.3 to 5.1 cm<sup>2</sup> were run out from

points of attachment along the shoreline towards the centre of the lake in the evening, and pulled the following morning. Fish caught in the net were removed and their total length, fork length, weight and sex recorded. A number of different organs and tissue types were then dissected out and frozen for later analysis for fenitrothion residues. The stomach with its contents was bottled separately and preserved with formaldehyde. Back in the laboratory the volume of the stomach contents was measured and their composition determined under a dissecting microscope.

## RESULTS

### Zooplankton:

Zooplankton populations were present at very low densities in Lac Ste -Anne in the spring of 1977 (Table-1). Calanoid and cyclopoid copepods were the only groups of zooplankters present in any kind of numbers throughout May and June. Very few cladocerans or rotifers were found in any of the samples taken except for the final samples taken in early July. The paupacity of zooplankton populations in Lac Ste-Anne early in the summer has been previously noted during inventories of the lake carried out by the Quebec Service de la Faune (Laperle, 1964).

Zooplankton populations in Lac Ste-Anne remained fairly constant over the period of insecticide applications (Fig. 1). Twelve hours after the first fenitrothion application (May 20, AM) numbers sampled were about twice as high as in pre-spray samples, but these dropped to low numbers two days after treatment and then levelled out at close to pre-spray numbers. Fluctuations of a similar magnitude were found following the second fenitrothion treatment (May 29 PM). These fluctuations are well within the normal variability found when sampling zooplankton numbers

in lakes and can not be attributed to effects of the insecticide applications. Zooplankton numbers showed a substantial increase in numbers following the aminocarb application (June 16, PM). This was characterized not only by a build up of copepod populations, but by the appearance of a number of types of cladocerans and moderately large numbers of rotifers in early July. This buildup of zooplankton populations was probably a response to turnover of the lake waters and resulting increases in phytoplankton populations. It indicates that normal conditions prevailed among the zooplankton community in spite of exposure to the insecticide applications.

#### Benthic Fauna:

The shallow portion of Lac Ste-Anne from which Ekman grab samples were taken supported a very rich benthic fauna (Table 2) consisting primarily of midge larvae (Diptera: Chironomidae), amphipods (Amphipoda) and fingernail clams (Gastropoda: Sphaeriidae). Other aquatic insect groups consistently present in small numbers were alderfly larvae, *Sialis* sp., (Megaloptera: Sialidae) and biting midge larvae, *Culicoides* sp., (Diptera: Heleidae). Baetid mayfly nymphs (Ephemeroptera: Baetidae) were consistently found in moderate numbers until early June when they disappeared completely from samples.

Bottom fauna populations in Lac Ste-Anne showed a general increase in numbers over the treatment period with large increases and declines superimposed over this general trend (Fig. 2). These short term fluctuations resulted from large differences in the numbers of midge larvae collected in different samples and can be primarily attributed to normal sampling variability associated with sampling very dense populations of tiny organisms. The only group of benthic organisms showing a consistent

decline in numbers at the time of the insecticide applications was baetid mayfly nymphs. These were present at about pre-spray levels three days after the first fenitrothion application but had declined noticeably by the time of the second fenitrothion application and disappeared completely one week later. Scuba searches following the first and second fenitrothion application did not reveal any dead aquatic invertebrates but considerable activity was noted among mayfly nymphs and caddisfly larvae.

Fish:

Variable fishing success was achieved with gill nets set in Lac Ste-Anne over the period of insecticide treatment. Gill nets were first set on the evening of May 5 when only a very small portion of the north basin was free of ice. Over the prespray period, ten overnite gill net sets and two all day sets captured only ten brook trout, *Salvelinus fontinalis* Mitchell, and five lake trout, *Salvelinus namaycush* (Walbaum) (Table 3). Between the first and second fenitrothion sprays eight brook trout and thirteen lake trout were caught in five overnite and five all day gill net sets. During this period the lake became free of ice and gill netting activities were moved into the south basin of the lake. This resulted in an increase in the catch of lake trout but less success in capturing brook trout. Twenty-seven lake trout and only five brook trout were caught in four overnite and three all day gill net sets following the second fenitrothion application.

Lake trout in Lac Ste-Anne were feeding almost exclusively on fish (brook trout) and amphipods prior to the first insecticide application (Table 4). Their diet changed progressively to one primarily consisting of a variety of aquatic insects (chironomid larvae and pupae, caddisfly

larvae, mayfly nymphs and alderfly larvae) over the period of the two fenitrothion applications. The mean volume of food present per lake trout stomach remained fairly constant over the sampling period (Table 3) indicating no abnormal increases or decreases in feeding. Brook trout fed primarily on amphipods over the sampling period except following the first fenitrothion application when feeding on baetid mayfly nymphs and caddisfly larvae increased sharply (Table 5). This was reflected in a substantial increase in the mean volume of food present per brook trout stomach at this time (Table 3). This indicates that mayfly nymphs and caddisfly larvae were affected to some extent by the fenitrothion treatment and rendered more susceptible to predation by fish as a result. This conclusion is supported by the observations of high levels of activity after fenitrothion spraying among these groups. The subsequent disappearance of baetid mayfly nymphs from bottom samples and decrease in their occurrence in brook trout stomachs to low levels following the second fenitrothion application suggests that the effect on this group was significant. Despite this, they showed increased occurrence and importance in the diet of lake trout at this time. This may be because lake trout were beginning to feed deeper in the lake than brook trout and were feeding on deeper dwelling populations of baetid mayfly nymphs which hadn't been affected by the insecticide applications to the extent of the shallow dwelling populations fed on by brook trout. The presence of such a deep dwelling mayfly nymph population is confirmed by scuba observations of large numbers of individuals on the bottom of the north basin of Lac Ste-Anne at depths of up to 10 m.



### CONCLUSIONS

It is apparent from the biological sampling reported that the insecticide applications did not have dramatic adverse effects on the zooplankton, benthos or fish populations of Lac Ste-Anne. A significant effect on shallow dwelling baetid mayfly nymphs is indicated as is opportunistic feeding on affected mayfly nymphs and caddisfly larvae by resident fish populations.

Table 1

Combined zooplankton catches from surface, 4 m and 8 m samples\*  
taken from Lac Ste-Anne, Block 305, Gaspé, 6 May to 2 July, 1977

Date	May 6	May 11	May 17	May 20	May 22	May 24	May 30	June 1	June 2	June 6	June 11	June 15	June 17	June 19	June 26	July 2
Leptodora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Daphnia	1	-	-	-	-	1	1	-	1	1	1	2	1	2	3	28
Bosmina	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Diaphanosoma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15
Holopedium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
Unknown	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Total Clodocera	1	-	-	-	-	1	1	-	1	1	2	2	1	2	3	61
Calanoid copepods	20	6	11	35	8	10	15	44	13	10	11	12	32	41	17	141
Cyclopoid copepods	13	27	16	38	2	10	20	41	25	11	16	11	14	38	34	50
Nauplii	20	5	19	31	11	33	15	16	42	18	26	61	65	93	93	186
Total Copepoda	53	38	46	104	21	53	50	101	80	39	53	84	111	172	144	377
Kellicotia	-	-	-	-	-	2	1	-	-	-	-	-	-	-	-	-
Asplanchna	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	21
Total Rotifera	-	-	-	-	-	2	1	-	-	-	-	-	-	1	-	21
Acari	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Total zooplankton	54	38	46	104	21	56	52	101	81	40	55	86	112	176	147	459

\* 122 samples taken with a Schindler-Patalas plankton trap.

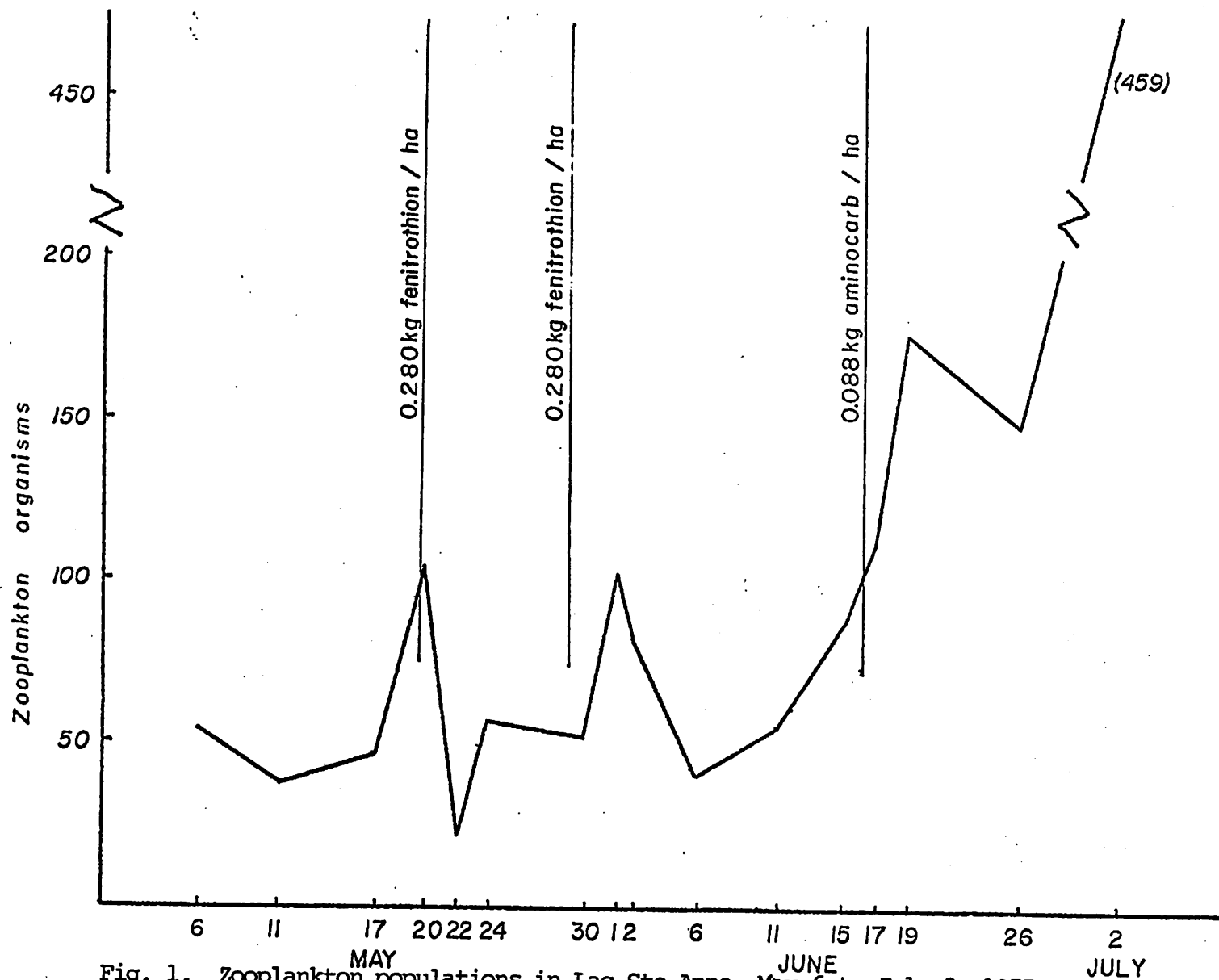


Fig. 1. Zooplankton populations in Lac Ste-Anne, May 6 to July 2, 1977

Table 2

Bottom fauna populations\* in Lac Ste-Anne, Block 305  
Gaspé, May 5 to July 2, 1977

Date	May 5	May 11	May 17	May 23	May 29	June 2	June 6	June 11	June 15	June 19	June 26	July 2
Mean depth (m)	1.46	1.00	1.31	2.75	1.85	1.80	2.00	1.80	1.75	1.15	1.20	1.20
Ephemeroptera: Baetidae	2.8	6.2	1.2	3.0	0.5	0.8	-	-	-	-	-	-
Odonata: Libellulidae	0.2	-	-	-	-	-	-	-	-	-	-	-
: Aeshnidae	-	0.2	-	-	-	-	-	-	-	-	-	-
Plecoptera	-	1.0	-	-	-	-	-	-	-	-	-	-
Megaloptera: Sialidae	1.0	1.0	1.0	1.0	5.5	4.8	1.2	4.8	3.2	4.0	5.8	4.2
Trichoptera	-	0.2	0.2	0.2	0.2	-	-	1.0	-	0.2	1.0	0.2
Diptera: Chironomidae larvae	72.2	17.0	30.5	70.0	278.0	203.8	69.0	139.5	121.8	77.2	124.2	145.2
: Chironomidae pupae	-	-	0.2	-	-	-	-	1.0	0.5	0.5	43.0	11.8
: Heleiididae	-	0.2	-	-	1.0	1.0	0.8	1.5	1.0	1.5	4.2	12.0
Nematoda	-	-	-	-	-	-	-	-	-	-	-	0.2
Oligochaeta	-	-	-	-	-	0.2	-	-	-	0.2	2.2	1.8
Amphipoda	13.8	19.0	19.0	18.5	50.0	38.5	23.2	25.8	45.8	24.2	37.5	24.2
Hydracarina	-	-	-	-	-	0.2	-	-	-	-	-	-
Gastropoda: Sphaeridae	13.5	10.2	30.2	24.8	49.8	54.8	20.0	21.2	26.8	11.8	46.2	83.0
Total	103.5	55.2	82.5	117.0	385.0	304.0	114.2	194.8	199.0	119.8	264.2	282.8

\* mean numbers collected in four 232 cm<sup>2</sup> Ekman grab samples.

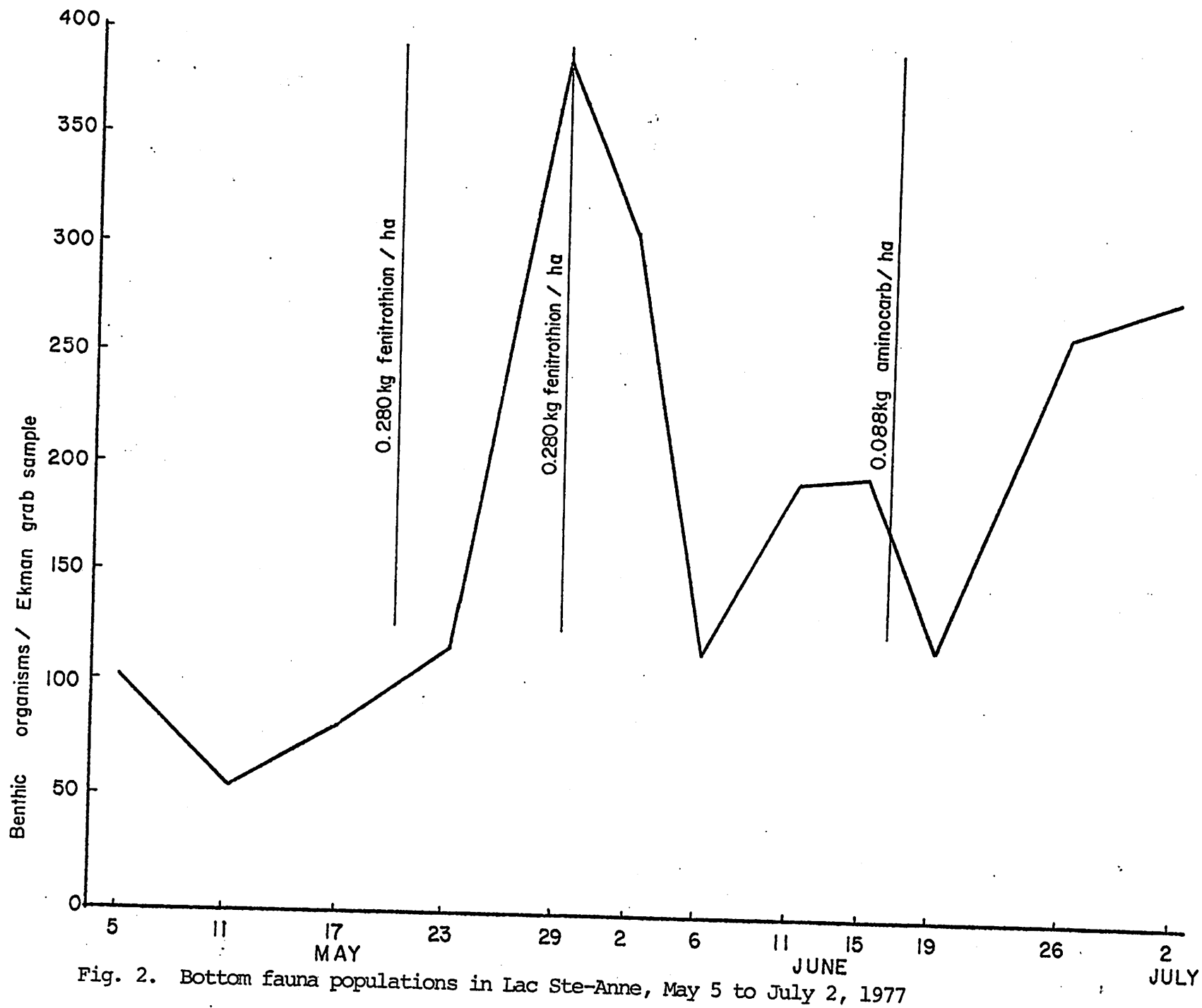


Table 3

Fish sampled from Lac Ste-Anne, Block 305, Gaspé  
May 7 to June 9, 1977

## Lake Trout

Period	Prespray (May 9-12)	Post first spray (May 20-29)	Post second spray (May 30 - June 9)
Number of fish sampled	5	13	27
Mean total length (mm)	606.2	533.2	530.6
Range	548-665	294-680	268-635
Mean fork length (mm)	558.0	487.6	485.1
Range	504-614	268-625	245-580
Mean weight (gm)	1968.0	1351.0	1347.6
Range	1437-2718	202-2872	122-2280
Sex ratio (male: female: immature)	0:5:0	3:6:4	8:14:5
Mean volume of food present/stomach (ml)	9.42	5.66	10.89
Range	0.0-25.0	0.2-28.0	0.0-120.0

## Brook Trout

Period	Prespray (May 7-18)	Post first spray (May 21-26)	Post second spray (May 31)
Number of fish sampled	10	8	5
Mean total length (mm)	299.4	294.1	321.6
Range	225-524	221-440	260-375
Mean fork length (mm)	287.9	281.9	312.0
Range	215-509	209-421	250-370
Mean weight (gm)	407.3	304.2	340.4
Range	100-1846	106-841	120-582
Sex ratio (male: female)	3:7	4:4	1:4
Mean volume of food present/stomach (ml)	2.92	5.49	1.56
Range	0.3-10.6	0.1-16.0	0.1-6.0

Table 4

Fish food items found in the stomachs of lake trout from Lac Ste-Anne  
Block 305, Gaspé, May 9 to June 9, 1977

	Percent occurrence			Mean percent contribution to total Volume of stomach contents			Average Number/Stomach		
	Prespray	Post 1	Post 2	Prespray	Post 1	Post 2	Prespray	Post 1	Post 2
Alderfly larvae (SIALIS sp.)	20	15	33	0.2	7.3	4.7	12	33	11
Amphipods	80	54	48	40.8	37.3	9.1	10	40	90
Blackfly larvae	0	0	4	0.0	0.0	0.1	0	0	1
Caddisfly larvae	20	69	26	0.5	20.2	21.0	2	5	50
Chironomid larvae	20	23	37	3.8	1.2	27.2	1	4	150
Chironomid pupae	0	31	48	0.0	2.3	17.1	0	8	115
Dragonfly nymphs	0	0	4	0.0	0.0	1.0	0	0	1
Fingernail clams	0	31	11	0.0	0.8	0.1	0	2	2
Fish	40	23	18	48.2	22.3	12.3	1	3	2
Leeches	0	15	0	0.0	3.8	0.0	0	1	0
Mayfly nymphs (Baetidae)	20	38	67	6.2	3.2	7.7	3	5	9
Stonefly nymphs	20	8	4	0.2	1.5	0.1	1	3	1
Empty stomachs	20	0	4	-	-	-	-	-	-

Table 5

Fish food items found in the stomachs of brook trout from Lac Ste-Anne,  
Block 305, Gaspé, May 7-31, 1977

	Percent Occurrence			Mean percent contribution to total Volume of stomach contents			Average Number/Stomach		
	Prespray	Post 1	Post 2	Prespray	Post 1	Post 2	Prespray	Post 1	Post 2
Alderfly larvae (SIALIS sp.)	40	12	20	22.5	1.2	0.8	24	1	1
Amphipods	90	62	80	56.0	25.2	57.0	25	10	10
Caddisfly larvae	40	88	20	11.5	35.9	7.0	3	21	25
Chironomid larvae	10	0	0	0.2	0.0	0.0	1	0	0
Chironomid pupae	10	0	0	0.3	0.0	0.0	2	0	0
Dragonfly nymphs	0	0	20	0.0	0.0	5.0	0	0	2
Fingernail clams	10	12	20	0.2	0.1	0.2	1	1	1
Fish	0	12	0	0.0	11.9	0.0	0	1	0
Mayfly nymphs (Baetidae)	60	75	20	9.3	19.8	2.0	1½	46	1
Oligochaetes	0	12	40	0.0	5.0	28.0	0	3	1



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