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A PRELIMINARY REPORT ON THE EFFECTS OF NRDC-143 ON AQUATIC FAUNA

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A report to Chipman Chemicals Limited and FMC on field studies carried out in 1976.

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INTRODUCTION

During May and June of 1976 personnel of the Chemical Control Research Institute (CCRI) conducted field trials to test the synthetic pyrethroid NRDC-143 (Permethrin) against the spruce budworm, *Choristoneura fumiferana* Clem. In conjunction with the efficacy trials, it was decided to initiate field trials to determine the effects of NRDC-143 on aquatic fauna because laboratory studies had shown this chemical to be highly toxic to fish and some aquatic invertebrates. These studies were carried out in co-operation and with support from Chipman Chemicals Limited and FMC.

A lake and stretch of stream within the Petawawa Forest Experimental Station (PFES) and a lake in Pontiac county, Quebec, were treated with aerial applications of NRDC-143 at various application rates during late May and early June. Assessment of the impact of the chemical treatments on these aquatic systems will be continued throughout the summer months and a detailed report of these impact studies will be prepared by the early fall. In the meantime, because of the immediate need for field data on the effects of NRDC-143 on aquatic fauna in order to make decisions with regard to the desirability of proceeding with further development of this chemical, this preliminary report has been prepared presenting data collected and analysed to date.

The author would like to stress the preliminary nature of the report and point out that some inaccuracies may be present in the data presented because the desire to present as much of the results as quickly as possible, precluded checking counts and identifications made in the field.

Thomas Lake - PFES - 35 gm AI/hectare

Thomas Lake, a small (approx. 10 hectare) shallow (max. depth 3 m) lake within PFES was treated with an application of 35 gm AI/hectare at 7:10pm on 25 May 1976. Prespray monitoring activities had shown this lake to have a very large minnow population made up of abundant numbers of several species of cyprinid, large numbers of small sunfish, and smaller populations of bullheads, sticklebacks and darters. Larger fish in the lake as revealed by pre-treatment gill netting included large numbers of suckers and bullheads and smaller numbers of large sunfish. Youngs Lake, the untreated control lake located about 6 km from Thomas Lake, contained a similar fish fauna but also supported a large perch population.

Observations made at Thomas Lake immediately following treatment indicated a heavy deposit of the emmitted spray onto the surface of the lake. The carrier oil was easily seen on the surface of the lake and strands of dye were clumped along the windward shoreline. Blackflies showed an immediate reaction and could be seen to fall distressed into the lake minutes after the plane passed over. No other distressed organisms were observed the evening the lake was treated but the following day one distressed minnow and several distressed aquatic Coleoptera (predaceous diving beetles and whirligig beetles) and Hemiptera (predaceous diving bugs and water scorpions) were found. A few dead aquatic insects were found the second day after treatment but no more dead or distressed organisms were found during the remainder of the daily monitoring period. Numerous healthy minnows and sunfish were observed every day before and after treatment. Many larger suckers and bullheads were caught in gill

nets in Thomas Lake four and twelve days after it was treated.

Prior to treatment minnows caught in Thomas and Youngs lakes were caged at various depths in these lakes to look for mortality caused by the treatment. Survival in the cages during the period from caging until treatment (8 to 12 days in duration) was excellent but all the darters caged escaped due to their small size. Mortality after the treatment date among the caged fish from the treatment and control lakes is recorded on Table I. This data indicates an effect on caged fish held near the surface of the treatment lake.

Five minnow traps were set in both the treatment and control lakes and emptied daily throughout the study period (Table II). The daily catch of minnows in the treatment lake was consistently high throughout this period except for immediately after the treatment when it dropped off somewhat due to a sharp decrease in the numbers of cyprinids caught. No comparable decrease was observed in the control lake indicating that the decrease in the treatment lake was caused by the insecticide application. The large numbers of minnows trapped from the third day after treatment on, indicate this was a short lasting behavioural effect.

Emerging insects were trapped from both Thomas and Youngs lakes for a three week period around the treatment date. Ten traps set in the treatment lake and five traps in the control lake were emptied daily and the number of emerging insects caught were recorded (Table III). The catch from both lakes consisted almost entirely of emerging midges (Diptera: Chironomidae). Very few emerging insects were trapped from the treatment lake but the data collected indicates no effect on insect emergence after treatment. Far more insects were caught in the control lake than in the treatment lake over the entire period.

Table I

Mortality among caged fish in Thomas and Youngs Lakes, PFES, 25 May to 4 June, 1976

	No. in cage on treatment day	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10	Total Mortality
THOMAS LAKE												
Surface												
Cyprinids	2	-	-	X	-	-	X	-	-	-	-	2
Bullheads	2	-	-	-	XX	-	-	-	-	-	-	2
Sunfish	3	-	-	-	-	-	-	-	-	XX	-	2
1 meter												
Cyprinids	2	-	-	-	-	-	-	-	-	X	-	1
Bullheads	1	-	-	-	-	-	-	-	-	X	-	1
Sunfish	2	-	-	-	-	-	-	-	X	-	-	1
Sticklebacks	2	-	-	-	-	-	-	-	-	-	X	1
2 meter												
Cyprinids	2	-	-	-	-	-	-	-	-	-	-	0
Bullheads	1	-	-	-	-	-	-	-	-	-	-	0
Sunfish	2	-	-	-	-	-	-	-	-	-	-	0
Sticklebacks	2	-	-	-	X	-	-	-	-	-	-	1
3 meter												
Cyprinids	2	-	-	-	-	-	-	-	All fish died due			
Bullheads	1	-	-	-	-	-	-	-	to cage being			
Sunfish	2	-	-	-	-	-	-	-	pulled into oxygen			
Sticklebacks	2	-	-	-	-	-	-	-	depleted silt.			
YOUNGS LAKE												
Surface												
Cyprinids	3	-	-	-	-	-	-	-	All fish escaped			
Bullheads	1	-	-	-	-	-	-	-	due to cage			
Sunfish	2	-	-	-	-	-	-	-	falling open.			
Perch	2	-	-	-	-	-	-	-				

Continued ...

Table I Cont'd

	No. in cage on treatment day	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10	Total Mortality
YOUNGS LAKE Cont'd												
2 meter												
Cyprinids	3	-	-	-	-	-	-	-	-	-	-	0
Bullheads	1	-	-	-	-	-	-	-	-	-	-	0
Perch	2	-	-	-	-	-	-	-	-	-	-	0
4 meter												
Cyprinids	3	-	-	-	-	-	-	-	-	-	-	0
Bullheads	1	-	-	-	-	-	-	-	-	-	-	0
Sunfish	1	-	-	-	-	-	-	X	-	-	-	1
Perch	2	-	-	-	-	-	-	-	-	-	-	0

Table II

Minnow trap catches in Thomas and Youngs Lakes, PFES, 15 May to 4 June, 1976

Number of days before or after treatment	Cyprinids		Bullheads		Sunfish		Darters		Perch		Sticklebacks		Totals	
	Thomas	Youngs	Thomas	Youngs	Thomas	Youngs	Thomas	Youngs	Thomas	Youngs	Thomas	Youngs	Thomas	Youngs
-10	171	1		8	27			4	40				198	53
-9	104	5	1	8	51	1			22				156	36
-8	271	2	2	3			1		54	1			275	59
-7	260	12		45	15				49				275	106
-6	131	10	2	22	4				29	5			142	61
-5	210			22	7		2	1		1	2		220	27
-4					TRAPS	NOT	EMPTIED							
-3	291			10	5		1		1	1			298	11
-2	288	4		22	2				6	1			301	32
-1	285	6	1	23	3			1	4				289	34
-0*	298			6	1		5						304	6
+1	158	1	1	20	6	2			4				165	27
+2	83			22	8		1	1					92	25
+3	197			18	43					1			241	18
+4	220			5	45		1		1	1			267	6
+5	264			3	24		1		4				289	7
+6	200		1	1	22	1	1		1				224	4
+7	235			3	22				5				257	9
+8	280		1		7				1				288	1
+9	185	2		4	3				5				188	11
+10	128	4		3	52				2				180	9

* Traps emptied before lake was treated.

Table III

Numbers of emerging insects caught in ten traps set in Thomas Lake and five traps set in Youngs Lake, PFES, 14 May to 3 June, 1976

Number of days before or after treatment	Thomas Lake	Youngs Lake
-11	1	26
-10	11	52
-9	2	13
-8	0	23
-7	0	11
-6	Traps not emptied	
-5	2	9
-4	Traps not emptied	
-3	1	11
-2	1	2
-1	0	3
-0 *	1	13
+1	2	10
+2	1	5
+3	2	13
+4	2	9
+5	2	22
+6	0	30
+7	1	17
+8	1	16
+9	1	16

* Traps emptied before lake was treated.

Youngs Creek - PFES - 70 gm AI/hectare

An approximately 5 km stretch of Youngs Creek between Race Horse Road and Meridian Road was treated with NRDC-143 in the evening of 2 June 1976. Two identical swaths were flown along this section of the creek emitting 35 gm AI/hectare each time to give a total emission rate of 70 gm AI/hectare. The portion of Youngs Creek treated flows through an open valley approximately 50 to 100 meters wide with no overhead forest canopy. The creek varies from about 3 to 10 meters in width and from about 30 cm to 1.5 meters in depth. The bottom is primarily sand with silt and aquatic plants in some sections. Pre-treatment sampling and observations revealed that the creek supported a diverse fauna of fish, aquatic insects and invertebrates including water mites, crayfish, clams, leeches, blackfly larva, burrowing mayfly nymphs, sticklebacks, mudminnows, suckers and several species of minnows.

As soon as treatment of the creek began knocked down terrestrial organisms were observed on the surface and minnows were seen feeding on them. A heavy deposit of oil was noticeable on the surface for about an hour after treatment after which only traces of oil and dye were seen. The morning after treatment, two minnows were found swimming belly-up in distress in front of a seine set across the creek below the treatment area. No other affected fish were seen after this time.

A number of cyprinids and mudminnows caught in the creek before it was treated were held in a cage at the downstream end of the treated portion and checked twice daily for mortality. There was no effect among these caged fish up to four days after treatment. Two minnow traps were set at this same station and checked in the morning and evening for

a seven day period over the treatment date. The number of minnows caught fluctuated considerably (Table IV) making it difficult to draw conclusions as to whether there was any effect on the catch caused by the insecticide treatment. Relatively large catches on the second to forth day after treatment show that any effect on minnows was of short duration and not significant in terms of the minnow population.

A drift net was set in the creek twice daily over the treatment period to sample drifting aquatic and terrestrial organisms. The net was set in mid-stream so as to sample the drift from throughout a 45.8 cm (18 inch) wide portion of the creek including the surface film. The net was left in place for 30 minutes each sampling period and the organisms captured were identified and counted (Table V). Immediately after the treatment significant increases in the numbers of drifting aquatic insects and terrestrial organisms were apparent. The aquatic insects showing large increases in drifting populations were midge larvae and pupae (Diptera : Chironomidae), blackfly larvae (Diptera : Simuliidae) and caddisfly larvae (Trichoptera). A great variety of terrestrial organisms were knocked down by the treatment and sampled by the drift net including adult dipterans of numerous families, hymenopterans, beetles, mayflies, caddisflies, lepidoptera larvae and spiders. Numbers of drifting aquatic and terrestrial organisms dropped back to pretreatment levels by the second day after treatment. Only a small number of aquatic invertebrates were caught in drift net samples with a few amphipods and water mites showing up after treatment. Similar numbers of larval fish were caught in drift net sets before and after treatment.

Table IV

Minnow trap catches in Youngs Creek, PFES,
1 June to 6 June, 1976

Number of days before or after treatment	Cyprinids	Mudminnows	Sticklebacks	Totals
-1 am	129	0	1	130
-1 pm	0	0	0	0
-0 am	3	1	0	4
-0 pm*	8	0	0	8
+1 am	3	0	0	3
+1 pm	2	0	0	2
+2 am	4	0	0	4
+2 pm	13	0	3	16
+3 am	6	1	0	7
+3 pm		Traps not emptied		
+4 am	31	0	0	31

* Traps emptied before creek was treated.

Table V

Numbers of organisms caught in thirty minute drift net sets in Youngs Creek, PFES, 1 May to 6 June, 1976

Number of days before or after treatment	Pre-treatment					Post-treatment							
	-2pm	-1am	-1pm	-0am	-0pm	+0pm	+1am	+1pm	+2am	+2pm	+3am	+3pm	+4am
Aquatic insects	45	68	30	25	21	147	194	77	23	25	4	1	5
Other aquatic invertebrates	0	0	0	0	1	2	2	6	1	0	1	0	0
Terrestrial organisms	2	2	10	5	1	140	69	34	24	4	14	7	0
Fish	1	2	0	2	1	0	4	0	2	0	2	1	0

Lac Tassel - Quebec, 140 gm AI/hectare

Lac Tassel, a fairly small (32 hectare) relatively deep (14 m) lake located in Perche township, Pontiac County, Quebec, was treated with 140 gm AI/hectare of NRDC-143 at 6:00 am on 31 May 1976. This lake was known to support sizeable populations of smallmouth bass, white suckers, brown bullheads, perch and fallfish with a minnow fauna consisting primarily of dace and darters. The shoreline of the lake varies from rocks and gravel to fine sand and silt and supports an abundant invertebrate fauna with large populations of clams, water mites, snails, dragonfly nymphs, mayfly nymphs and caddisfly larvae being most noticeable before treatment.

The lake was treated under conditions of absolute calm and examination of the deposit samples indicated a very heavy deposit of spray products. Large numbers of knocked down terrestrial insects were observed and collected from the surface of the lake shortly after treatment. Six hours after treatment, underwater inspection of the shoreline revealed large numbers of distressed and dying aquatic insects and amphipods and one distressed minnow. About twelve hours after treatment, a number of distressed fish became noticeable splashing about on the surface and eight were collected before it became too dark to continue. Subsequent searches of the shoreline and bottom turned up a number of dead fish of various species (Table VI). In addition, very large numbers of planktonic non-biting mosquito larvae (Diptera : Culicidae, *Chaoborus* sp.) and one giant water bug were found dead.

Prior to treatment of the lake, hatchery raised brook trout and native suckers and perch were caged in the lake. Six brook trout and ten

Table VI

Numbers of dead and distressed native fish found in Lac Tassel, Quebec following aerial treatment with NRDC-143

Number of days after treatment	+½	+1	+2	+3	+7	+9	Totals by group
Smallmouth bass	-	3	4	2	-	1	10
Cyprinids	7	4	4	2	7	2	26
Perch	-	2	3	-	-	-	5
Darters	-	2	1	-	-	-	3
White suckers	2	1	-	-	-	-	3
Bullheads	-	1	-	-	-	-	1
Totals by day	9	13	12	4	7	3	48

suckers were held in cages right along the shoreline. Two of the brook trout were distressed twelve hours after the lake was treated and had died by the following morning. One sucker was found dead a week after treatment. The rest of these fish remained healthy until released eighteen days after treatment. There was no mortality among groups of brook trout held in the centre of the lake in cages at the surface and 4 meters deep or among suckers held at the surface and 2 meters deep in the same location. Two perch held at 6 meters at this station died the day after treatment but may have been affected more by handling and temperature change than by exposure to the insecticide.

Five minnow traps and a trap net were set in Lac Tassel and their catch was recorded daily throughout the treatment period (Table VII). Minnow catches were relatively small throughout this period but show some indications of being depressed following treatment of the lake. Large numbers of white suckers were caught in the trap net both before and after treatment.

Observations were made on the behaviour and success of nesting bass in Lac Tassel by marking nests along the shoreline and inspecting them throughout a three week period. Daily inspection of each marked nest was made for the four days following treatment of the lake. Each time, the presence or absence of the guarding male, eggs and bass fry was recorded (Table VIII). Bass first began spawning two days before the lake was treated and by the treatment date eighteen nests containing eggs had been located. In the first four days following treatment of the lake guarding males disappeared from ten nests containing eggs and four nests without eggs while eggs were laid in twelve nests

Table VII

Daily minnow trap and trap net catches in Lac Tassel, Quebec before and after treatment with NRDC-143

Number of days before or after treatment	-4	-3	-2	-1	-0*	+1	+2	+3	+4	+7	+8
Minnow traps											
Darters	16	1	2	2	3	2	-	1	2	1	7
Cyrinids	-	-	-	2	4	-	-	-	-	-	-
Smallmouth bass	1	-	-	-	-	-	-	-	-	-	-
White suckers	-	-	-	-	-	-	-	-	-	-	1
Perch	-	-	-	-	-	-	-	-	-	1	-
Newts	1	-	2	3	-	2	-	-	-	2	-
Tadpoles	4	6	-	-	-	4	-	-	-	1	-
Trap net											
White suckers	Net	60	79	6	14	30	97	82	43		
Brown bullheads	not	-	-	-	-	-	2	1	-		Net
Perch	set	2	-	-	-	-	-	-	-		not
Smallmouth bass		-	-	-	-	1	-	-	-		set

* Traps emptied before lake was treated.

Table VIII

Condition of forty-seven marked bass nests in Lac Tassel, Quebec from 30 May to 17 June, 1976

Number of days before or after treatment	Number of nests with :								
	No male, eggs or fry	Male but no eggs or fry	Male with eggs	No male or eggs on nest which previously had male	Eggs only on nest which previously had male and eggs	Male with fry	Male only on nest which previously had male and fry	Fry only on nest which previously had male and fry	No male or fry on nest which previously had male and fry
-1	22	7	18	0	0	0	0	0	0
+½	16	1	25	3	2	0	0	0	0
+1	14	0	23	4	6	0	0	0	0
+2	14	0	21	4	8	0	0	0	0
+3	13	0	20	4	10	0	0	0	0
+9	0	2	6	4	19	15	0	1	0
+17	0	0	0	4	23	6	2	4	8

which previously had no eggs in them (Table IX). Of the forty-seven active nests studied, forty-three produced eggs and fry were hatched from twenty of these. Observations made three weeks after the treatment date when bass nesting had been completed, revealed large numbers of free swimming bass fry along portions of the shoreline.

Throughout the bass nesting survey observations were made on affected aquatic insects. Mortality among dragonfly nymphs, damselfly nymphs, mayfly nymphs, caddisfly larvae and amphipods along the shoreline of the lake appeared to be complete and none of these organisms have been found alive during underwater searches three and six weeks after treatment. Freshwater sponges, bryozoans, flatworms, water mites, snails and clams were found in abundance during these searches and a few larval and adult aquatic beetles were also seen. Many bass were observed as well as some fallfish, perch and darters.

Table IX

Numbers of bass nests in Lac Tassel on which spawning activity was terminated or initiated following treatment with NRDC-143

Number of days after treatment	Male disappearing from nest without eggs	Male disappearing from nest with eggs	Eggs being laid in nest previously occupied by a male	Eggs being laid in previously unoccupied nest
+½	3	2	3	6
+1	1	4	0	2
+2	0	2	0	0
+3	0	2	1	0
+9	0	10	0	12
+17	0	1	0	0

Results yet to be reported -

In addition to the results presented in this preliminary report, samples have been collected from the treated aquatic systems to study changes in plankton populations, bottom fauna populations and fish diets related to the NRDC-143 applications. The results of these studies will be included in a later report.