PESTICIDE SECTION

CANADIAN WILDLIFE SERVICE

MANUSCRIPT REPORTS

No. 14

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P.A. Pearce

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Effects on Bird Populations of Phosphamidon and Sumithion used for Spruce Budworm Control in New Brunswick and Hemlock Looper Control in Newfoundland in 1968: A Summary Statement

by

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For Interdepartmental Committee on Forest Spraying Operations, November 1968.

INTRODUCTION

Chemicals were first used for control of spruce budworm in New Brunswick in the northwest of the province in 1952. With the exception of 1959, operations have been conducted each year since. In 1960 the scene of activities shifted to central parts of the province. For several years DDT was used exclusively. In 1962 an organophosphate (phosphamidon) was first employed, on a trial basis, as a potential DDT-replacement insecticide. In 1964 the Canadian Wildlife Service, fulfilling its responsibilities under the Migratory Birds Convention Act, became involved in studies of the side effects on forest birds. Studies have mostly been conducted within a framework in which operational considerations, dictated by larval development, have assumed paramount importance. Wildlife monitoring has also been conducted in plots experimentally sprayed with a variety of chemicals by the Chemical Control Research Institute. "Operational experiments" have been concerned with variations of dosage, concentration, and timing of application. In 1966 a second organophosphate, sumithion (fenitrothion), was first used. A new factor, finer droplet size (fine calibration), was introduced for the first time in 1968. This year also, the areas treated with organophosphates exceeded for the first time those sprayed with DDT. A chemical control operation was launched against the hemlock looper in Newfoundland in 1968.

The following report summarizes the results of monitoring the effects on bird populations of phosphamidon and sumithion used for spruce budworm control in New Brunswick in June, and for hemlock looper control in Newfoundland in July, 1968. The latter operation is covered more fully in a separate report to this committee.

METHOD

The 1968 field season was to have been partly devoted to refining our census methods so that small post-spray depressions of bird populations might be more meaningfully assessed than has so far been possible in our monitoring program. This plan was disrupted when two treatments made early in this year's spray operation caused an unexpectedly high hazard to birds. Thereafter, and largely at our request, frequent changes were made to the schedule of block treatments as originally planned. Day-to-day decisions were made as to where and how we might best direct our monitoring activities and a great amount of time was spent travelling to spray blocks to search for sick birds.

Bird counting in the manner previously described to this committee was carried out in three areas (Block 25, Block 29, and control) in New Brunswick, and in two areas in Newfoundland (Area 24-25, and control). Two straight, parallel lines one-quarter of one mile apart and one mile in length were marked in the centre of Block 25 (Dungarvon River). They were oriented in an east-west direction, that is at right angles to flight lines of spray aircraft, to minimize the effect of overlapping of or gaps between spray swaths. The lines were designated as "A" and "B". Two straight, parallel lines one-third of one mile apart and one mile long were marked in the northeast corner of Block 29 (Big Hole Lake). They were oriented in a northeast-southwest direction, straddled the lake, and were designated as "A" and "B". This part of the block was the only area

which we believed would contain a sufficiently varied avifauna. These two blocks were scheduled for treatments in which we were most interested and were chosen for reasons of accessibility and relative proximity to field camp. A similar route, composed of two legs each one mile in length, was marked in a very homogeneous stand on the Grand Lake road south of Doaktown, and used as a control. In Newfoundland, a route two miles long was marked in the middle of Area 24-25 and followed a logging road. A route of the same length was flagged along a logging road near Black Duck and used as a control.

An observer walked slowly along the "A" and "B" lines keeping a tally of all birds seen and heard. A count was made of the number of songs heard. Rough population indices were obtained by dividing the time (in minutes) taken to cover the route into the total number of songs heard and the total number of individual birds noted, respectively. Counts were made early in the morning when birds are most active. One observer was assigned the route in Block 25, another the route in Block 29. Both observers were assigned to cover the control route, thus obviating the "human factor" of any identification ability or hearing differentials. "A" and "B" tallies were kept separate. We felt that, with uniform spray coverage, any significant population depression should mainfest itself equally on each leg.

On either side of the "A" line, parallel lines were marked at a distance of two and one-half chains from it. Trees at each chain interval were labelled. An attenuated, 40-acre plot (80 x 5 chains) was thus demarcated. Within this plot, two observers in radio contact plotted the location of singing males and other birds seen. Territories were defined and later

mapped. This kind of census taking was abandoned in Block 25 because of an insufficiency of time and suitably-qualified observers. In the New Brunswick control area, territory-mapping was conducted in three superimposed 40-acre plots of different configuration. The dimensions of these plots were as follows: 80 x 5 chains (as in Blocks 25 and 29), 40 x 10 chains, and 20 x 20 chains. Within the plots, lines two chains apart were flagged and trees were numbered at each chain mark. Work in the 40 x 10 and 20 x 20 chain plots was done by a biologist in pursuit of a separate project with different objectives. Our aim was to measure breeding populations in terms of the number of territorial males per 100 acres and to be able to pin-point territories vacated as the result of spraying. Another goal was to equate an estimation of the number of breeding pairs on a long, attenuated plot (containing many fractional territories) with an estimate of the number on a plot of more square configuration (perhaps embracing more whole territories). This phase of the study is not yet complete and is not reported on here.

Spraying was followed by searching for evidence of "bird effect" in 22 of the New Brunswick and three of the Newfoundland spray blocks. The following phenomena were considered to be indicative of poisoning to a greater or lesser degree:

(a) dead birds found;

(b) sick birds captured by hand;

(c) birds seen to be incapacitated to a lesser extent but poisoning evidenced by tremoring, loss of equilibium, erratic flight (e.g. ruffed grouse crashing into bole of tree), constant blinking and bill wiping (we have

noted captive birds experimentally dosed with organophosphates to indulge in this activity. Increased lachrymation and salivation are reported to be symptoms of anticholinesterase poisoning in man);

(d) abnormally tame birds seen;

(e) birds seen out of their normal habitat (e.g. Cape May warblers on the ground, bay-breasted warblers foraging in slash);

(f) depression of population indices in areas where bird counts were made (in this regard, counts in control, or unsprayed areas are important as apparent population fluctuations occur from day to day which can be attributed to factors other than the application of poisons); and sprayed areas).

RESULTS

The results of census and search activities are presented under four headings—phosphamidon, sumithion, mixtures, and others. Within the first three categories, findings are presented block by block in order of decreasing dosage.

A Phosphamidon Blocks

Block 2

Treatment: phosphamidon, 3/8 lb., 1/5 USG, coarse calibration. June 11, morning.

Searched by 4 observers, 4:00 to 5:30 p.m., 8:15 to 8:45 p.m.,

sick birds captured	sick birds seen
1 eastern wood pewee	3 Tennessee warbler
1 magnolia warbler	2 myrtle warbler
1 myrtle warbler	1 purple finch
	1 chipping sparrow
	4 white-throated sparrow

During both search periods, all observers noted that birds had been virtually silenced. One observer heard only two partial songs from white-throated sparrows during a 30-minute period in an area of heavy slash which should have supported a large number of this species. During two hours of searching, another observer heard occasional songs from 11 birds of eight species scattered through the block. Song counts were made at six stations in an unsprayed area outside but near the block from 7:30 to 7:45 p.m. These counts gave 6, 7, 15, 18, 22, and 23 songs/minute, contrasting strongly with the silence inside the block. The two warblers died during the evening of the same day. The flycatcher was released.

Searched by 3 observers (1 inexperienced), 9:30 to 10:30 a.m., June 12

sick birds captured	sick birds seen
none	none

Song counts were 17/minute (mostly thrushes and Tennessee warblers), 2/minute (from 1 bay-breasted warbler), 4/minute (from 1 Blackburnian warbler), 4/minute (from 1 mourning warbler), and 3/minute (from 1 white-throated sparrow). A count made in a nearby unsprayed area gave 33 songs/minute from a variety of species, but mostly Tennessee warblers and purple finches.

Block 25

Treatment: phosphamidon, 3/8 lb., 1/5 USG, fine calibration. June 7, morning.

Searched by 3 observers, 4:00 to 5:30 p.m., June 7.
2 observers, 7:00 to 8:15 p.m., June 7.

sick birds captured	sick birds seen
1 yellow-bellied flycatcher	1 sparrow hawk
1 robin	4 Empidonax flycatcher
1 Swainson's thrush	2 robin
2 Tennessee warbler (one dead)	1 Swainson's thrush
2 Cape May warbler	1 Hylocichla thrush
1 myrtle warbler	1 Cape May warbler
1 Blackburnian warbler	1 myrtle warbler
1 bay-breasted warbler	1 bay-breasted warbler
1 American redstart	1 white-throated sparrow
2 shipping sparrow	

The yellow-bellied flycatcher was found motionless on a road carrying light motor traffic. One dead Tennessee warbler was also found in such a location. Both birds could have been traffic victims but appeared to be uninjured. All observers reported that the forest was virtually silent at all locations. Song counts varied from nil to 1.3/minute (3 individuals of 3 species), to 1.7/minute (1 thrush). Counts were made at two stations in an unsprayed area to the south of the block and gave 32 songs/minute (10 individuals of 5 species), and 41/minute (13 individuals of 8 species). The first sick birds were picked up at 4:30 p.m. The first one (a Cape May warbler) died in captivity at 6:00 p.m. Most died during the evening or during the following night. A Blackburnian warbler survived until the next morning and a chipping sparrow survived until 4:00 p.m. of June 8. One observer reported that sick birds became progressively more difficult to find, as they were on the ground and moved very little.

Searched by 2 observers, 9:30 to 11:00 a.m., June 8.

sick birds captured	sick birds seen
1 yellow-bellied flycatcher	1 yellow-bellied flycatcher
1 robin	1 robin
1 hermit thrush	2 Swainson's thrush
2 Swainson's thrush	1 bay-breasted warbler
1 Tennessee warbler	2 evening grosbeak
1 myrtle warbler	3 slate-colored junco
2 bay-breasted warbler	1 unidentified
1 evening grosbeak	

Eleven species were heard singing while a bird count was being made prior to the search period. Both observers reported the near absence of bird songs at most places within the block. At one station, however, a high song count was obtained, possibly in an area that spray had not reached. Most of the captured birds died in captivity. The thrushes were released in the middle of a field during the afternoon. Both Swainson's thrushes flew strongly to the nearest cover about 100 yards away; the hermit thrush flew uncertainly, with one stop, to the same cover; the robin was able to fly only a few yards.

Searched by 1 observer while bird count was being made, June 9 a.m.

Sick birds captured	sick birds seen
2 Swainson's thrush	1 ruffed grouse
2 evening grosbeak	1 Swainson's thrush
	1 bay-breasted warbler
	1 white-throated sparrow

Vocal activity was very low. The observer reported that most of the singing on the "A" leg of the census route was by winter wrens, and by Tennessee warblers, ovenbirds, and slate-colored juncos on the "B" line.

Seven bird counts were made before spraying and another seven after spraying. Results are shown in Table 1. Population indices are shown in Table 2. Nearly all species were reduced in numbers. Ruby-crowned kinglets and most warblers were virtually eliminated. Ovenbirds, followed by Tennessee warblers, seemed less hard hit than other warblers. The spray effect was equally great on both legs of the census route. There was apparently little recovery of the most severely depleted species even 25 days later.

Table 1. - Bird count results, Line A, Block 25, N.B.

Species*	Number of birds recorded														
	May							June						July	
	22	24	25	27	31	3	5	8	9	13	19	24	27	2	
Yellow-bellied sapsucker	8	10	12	11	8	6	8	9	4	6	9	6	10	10	
Winter wren	8	9	9	10	7	6	9	6	5	5	6	4	4	4	
Robin	8	2	3	4	4	0	3	2	0	3	3	1	2	0	
Swainson's thrush	0	7	4	4	7	5	6	3	1	3	4	2	8	9	
Ruby-crowned kinglet	4	5	1	3	2	3	2	0	0	0	0	0	0	0	
Tennessee warbler	1	8	12	3	21	9	10	1	0	2	2	2	3	6	
Parula warbler	1	0	1	1	3	2	2	0	0	0	0	1	0	1	
Magnolia warbler	1	10	10	11	8	7	10	1	1	1	2	1	3	4	
Cape May warbler	8	7	5	3	7	4	4	0	0	0	0	0	0	0	
Black-throated blue warbler	3	4	4	3	7	4	4	0	0	0	0	0	0	1	
Myrtle warbler	4	5	6	9	4	1	2	0	0	0	0	0	1	0	
Black-throated green warbler	3	5	5	4	6	5	6	0	0	0	0	0	0	0	
Blackburnian warbler	0	6	5	4	7	6	4	0	0	1	1	1	1	2	
Bay-breasted warbler	2	9	9	11	13	9	13	2	2	2	5	1	4	3	
Ovenbird	9	10	11	16	14	9	11	3	1	2	4	5	5	3	
Canada warbler	0	2	3	3	7	1	3	0	0	0	0	0	0	0	
American redstart	0	0	2	1	2	4	4	0	0	0	0	0	0	0	
Rose-breasted grosbeak	2	8	5	5	4	4	7	0	1	0	0	0	0	1	
Purple finch	7	6	3	6	5	4	4	2	1	3	3	5	6	2	
Pine grosbeak	1	2	4	5	8	2	4	4	0	2	4	2	4	2	
Slate-colored junco	5	8	5	0	2	1	3	1	2	1	1	0	1	2	
White-throated sparrow	15	17	15	20	20	18	15	8	8	4	8	5	8	7	

Sprayed on morning of June 7

Line B, Block 25, N.B.

Ruffed grouse	2	4	2	3	1	0	1	0	1	0	0	0	0	0	
Yellow-bellied spasucker	7	11	5	13	6	2	5	6	2	1	8	7	6	6	

Table 1. — Cont'd.

Species*	Number of birds recorded														
	May							June							July
	22	24	25	27	31	3	5	8	9	13	19	24	27	2
Yellow-bellied flycatcher	0	0	0	0	0	2	3	0	0	1	1	0	0	1
Red-breasted nuthatch	1	3	0	1	4	2	5	0	0	3	3	2	7	2
Winter wren	7	9	6	10	7	3	5	2	1	3	3	2	3	5
Robin	3	5	4	2	5	1	2	2	2	0	5	3	2	3
Swainson's thrush	0	3	2	3	2	2	4	2	1	1	6	5	5	8
Ruby-crowned kinglet	2	1	2	7	1	4	2	0	0	0	0	0	0	0
Solitary vireo	1	3	3	2	1	0	1	0	0	0	0	0	0	0
Tennessee warbler	1	11	7	2	11	2	12	0	3	3	4	4	5	7
Parula warbler	2	3	1	3	1	2	0	0	0	0	0	0	0	0
Magnolia warbler	0	3	3	6	3	5	4	0	0	0	1	1	1	2
Cape May warbler	8	8	3	4	1	1	3	0	0	0	2	0	0	0
Black-throated blue warbler	2	2	1	3	1	0	1	0	0	1	1	0	0	1
Myrtle warbler	6	4	6	4	5	2	4	0	0	0	1	0	0	0
Black-throated green warbler	0	6	4	5	1	3	3	0	0	0	0	0	0	0
Blackburnian warbler	0	5	1	1	5	2	4	0	0	1	0	2	1	1
Bay-breasted warbler	5	10	10	14	12	9	13	1	2	1	2	3	4	1
Ovenbird	5	14	12	17	13	7	10	4	5	3	7	3	3	5
American redstart	0	2	1	2	3	1	3	0	0	0	0	0	0	0
Rose-breasted grosbeak	2	5	4	4	4	1	4	0	1	0	0	0	1	0
Purple finch	5	6	5	7	3	0	3	1	1	0	2	4	3	1
Pine grosbeak	5	6	1	1	6	2	4	1	1	2	4	4	4	1
White-throated sparrow	11	19	12	19	15	15	14	5	4	7	7	7	7	6

Sprayed on morning of June 7

* Includes only those species seen or heard, after first arrival on the block, on at least six of the seven pre-spray counts. Evening grosbeak has been excluded.

Table 2. - Count totals and population indices, Line A, Block 25, N.B.

Count number	Date	Total birds recorded	Time (minutes)	Birds/ minute	Total songs recorded	Songs/ minute	Total species
1	May 22	129	63	2.0	719	11.4	32
2	May 24	183	67	2.7	915	13.6	38
3	May 25	168	63	2.7	768	12.2	38
4	May 27	157	60	2.6	617	10.3	30
5	May 31	186	69	2.7	1037	15.0	31
6	June 3	128	61	2.1	552	9.0	27
7	June 5	165	60	2.8	818	13.6	31
		Sprayed on morning of June 7					
8	June 8	50	53	0.9	139	2.6	17
9	June 9	33	49	0.7	98	2.0	14
10	June 13	44	45	1.0	187	4.2	20
11	June 19	74	47	1.6	331	7.0	24
12	June 24	66	44	1.5	250	5.7	27
13	June 27	89	47	1.9	354	7.5	24
14	July 2	75	41	1.8	400	9.8	24
					Line B, Block 25, N.B.		
1	May 22	102	54	1.9	475	8.8	30
2	May 24	181	63	2.9	740	11.8	37
3	May 25	116	53	2.2	498	9.4	32
4	May 27	155	62	2.5	672	10.8	35
5	May 31	124	52	2.4	511	9.8	28
6	June 3	75	39	1.9	218	5.6	22
7	June 5	122	54	2.3	500	9.3	30
		Sprayed on morning of June 7					
8	June 8	31	47	0.7	72	1.5	13
9	June 9	41	45	0.9	76	1.7	22
10	June 13	37	34	1.1	224	6.6	19
11	June 19	76	45	1.7	309	6.9	24
12	June 24	62	38	1.6	257	6.8	25
13	June 27	77	43	1.8	321	7.5	26
14	July 2	58	35	1.7	235	6.7	21

The elimination of birds is reflected in the depression of the population indices. A slow recovery is suggested. Tables 1 and 2 are to be compared with Tables 7 and 8. Counts made in the control area show no significant decline of the numbers of any species, though they do of course indicate the small day-to-day changes which we expect and which we attribute to the influence of several weather variables on bird behaviour. Birds/minute indices in the control area remain remarkably constant.

Block 45

Treatment: phosphamidon, 1/4 lb., 1/5 USG, fine calibration.

June 27, morning.

Searched by 1 observer, 6:45 to 8:45 p.m., June 27.

sick birds captured	sick birds seen
none	none

No evidence of birds in distress was detected. Vocal activity was thought to be normal.

Searched by 3 observers (1 inexperienced), 9:45 to 12:00 a.m.

June 28.

1 observer, 12:00 a.m. to 2:00 p.m., June 28.

sick birds captured	sick birds seen
2 Swainson's thrush	1 Tennessee warbler
2 Tennessee warbler	1 blackpoll warbler
1 Cape May warbler	1 American redstart
1 myrtle warbler	1 slate-colored junco
1 bay-breasted warbler	
1 blackpoll warbler	
1 pine siskin	
1 white-throated sparrow	

Observers ranged throughout the central parts of the block. Old

logging roads were few: it was along such a road that most of the incapacitated birds were seen and captured. Although this was grown up in bracken and spruce in places it probably represented the best searching "habitat". Song counts were made at several stations in the block. They were as follows: nil (in open coniferous stand), 1/minute (from 1 bay-breasted warbler along a stream edge), 16/minute (from 4 individuals of 3 species, in open conifers), 17/minute (in open conifers), 32/minute (along a road edge), and 33 (along a stream edge). All counts were made in the middle of the morning. None was made in an unsprayed area. A swamp sparrow's nest containing three apparently healthy nestlings was also found.

Plot 1 (CCRI program)

Treatment: phosphamidon, 1/4 lb. average dosage, graduated across plot, east to west light to heavy, boom and nozzle application. June 3, evening.

The plot was searched for short periods during the two days following treatment. There was little evidence of birds in distress. A dead white-throated sparrow was found at station B4 at 3:00 p.m. on June 5. Song counts were made at several stations inside and outside the plot. Counts were low 48 hours after spraying, but were made in rather windy conditions.

Plot 2 (CCRI program)

Treatment: phosphamidon, 1/4 lb. average dosage, graduated across plot, east to west light to heavy, ULV application. May 23, evening.

Searched by 2 observers, 2:20 to 4:20 p.m., May 24.

sick birds captured	sick birds seen
1 myrtle warbler	2 white-throated sparrow

The myrtle warbler died about 7:00 p.m. of the same day, approximately 24 hours after spraying. All three birds were found near the road forming the western boundary of the plot. Very little song was heard.

Searched by 3 observers, 7:10 to 8:00 p.m., May 24.

sick birds captured	sick birds seen
1 hermit thrush	1 slate-colored uunco
	2 white-throated sparrow

The junco was seen to constantly twitch its tail and wipe its bill. The whitethroat was constantly bill wiping and flew erratically. Song counts were nil in 7 minutes, and 3 in 17 minutes (all from 1 bay-breasted warbler). Counts in a control area to the west of the road forming the western boundary of the plot were 18, 21, 20, and 17 songs/minute.

Searched by 2 observers from 8:45 a.m. on, May 25.

sick birds captured	sick birds seen
none	1 bay-breasted warbler
	2 ovenbird
	1 white-throated sparrow

The whitethroat was nearly caught, the two ovenbirds allowed very close approach, and the bay-breasted warbler was nearly touched. Song counts were 2, 1, and 1/minute. In a nearby control area they were 18, 16, and 19/minute.

Searched by 3 observers from 9:25 a.m. on May 26. Song counts were 1, 0, and 0/minute. In a control area they were 9, 11, and 26/minute. An observer walked along the "A" line as far as the 22-chain mark during

the early afternoon of May 27 and in 34 minutes heard 22 songs, 10 of which were from one black-throated green warbler. The same observer then walked along the "B" line of Plot 1 being used as a control and in 29 minutes heard 115 songs.

Block 32

Treatment: phosphamidon, 1/8 lb., 1/5 USG, fine calibration.

June 16, evening.

Searched by 2 observers, 3:30 to 5:00 p.m., 6:30 to 7:30 p.m.

June 17.

sick birds captured	sick birds seen
none	1 myrtle warbler
	1 American redstart
	1 white-throated sparrow

During the afternoon search, three song counts were made. These were 5, 10, and 20/minute, mostly from Swainson's thrushes and white-throated sparrows. A Canada warbler and a white-throated sparrow were found incubating. A dragonfly was picked quivering from a twig. There was little bird song in the evening. At one station only 3 songs/minute were heard--from two distant white-throated sparrows. In one dense coniferous area no ruby-crowned kinglets or bay-breasted warblers were heard. In another similar area, however, bay-breasts were singing normally. Two purple finches and several whitethroats were seen to be constantly bill wiping.

Area 32 (Newfoundland)

Treatment: phosphamidon, 1/8 lb., 1/5 USG, fine calibration.

July 14, morning.

Searched by 1 observer, 1:45 to 3:15 p.m., July 14.

The observer was flown by helicopter into this remote area, During a five-minute period in a stand of black spruce and balsam fir, one pine grosbeak was heard singing and a small flock of crossbills was heard flying over. There was no other vocal activity. In another stand of balsam fir no bird song was heard. In a third location, a bog surrounded by alders, one Tennessee warbler sang once and several Lincoln's sparrows were busy wiping their bills. In places sheltered from the breeze, there were clouds of mosquitoes--much to the discomfort of the observer. Along the bank of the river (Lloyd's) a spotted sandpiper, two greater yellowlegs, and a northern waterthrush all behaved normally. An active osprey nest was found.

B. Sumithion Blocks

Block 9

Treatment: sumithion, 1/2 lb., 1/5 USG, fine calibration.
June 16, evening.

Searched by 4 observers (3 inexperienced), 4 different parts of the block, 5:00 to 7:45 p.m., June 17.

sick birds captured	sick birds seen
1 magnolia warbler	1 myrtle warbler
1 black-throated green warbler	1 slate-colored junco
1 Blackburnina warbler	
1 chipping sparrow	

All of the sick birds were seen on roadsides. Song counts were made in three of the locations searched and were as follows: 17/minute (mostly thrushes, no warblers), 30/minute (all expected species, thrushes

particularly vocal), and 8/minute (no warblers). The song count was 27/ minute in a nearby unsprayed area. Several dead dragonflies were found at one station. A redwinged blackbird's nest containing four active nestlings was also found. The latter part of the search was conducted in rain, at times heavy.

Block 16

Treatment: sumithion, 1/2 lb., 1/2 USG, coarse calibration.
June 5, morning (eastern three-quarters).
June 6, morning (western quarter).

Searched by 4 observers (1 inexperienced), 4:00 to 6:00 p.m., June 5.

sick birds captured	sick birds seen
1 Blackburnian warbler	(see below)

Searching was confined to the central and eastern parts of the block. Most of the area had been cut over and was laced with a network of wood roads which greatly facilitated search operations. For a hot, windy afternoon birds were thought to be quite vocal, particularly Swainson's thrushes and white-throated sparrows. Many bay-breasted warblers were seen on the ground or near the ground foraging in the omnipresent slash.

Searched by 4 observers, 9:30 to 11:00 a.m., June 6.

sick birds captured	sick birds seen
2 bay-breasted warbler	1 purple finch

No song counts were made, but song intensity was felt to be normal. Several bay-breasts were again seen near the ground foraging in slash piles. Several barn swallow nests were found in old camp buildings. Adult birds were behaving normally.

Block 28

Treatment: sumithion, 1/2 lb., 1/5 USG, fine calibration.

June 4, evening.

Searched by 3 observers (1 inexperienced), 10:30 to 12:00 a.m.

June 5.

sick birds captured	sick birds seen
none	none

Song counts at different stations gave 12, 6, and 10 songs/minute from a variety of species. There was nothing to suggest any serious effect on birds.

Block 6

Treatment: sumithion, 3/8 lb., 1/5 USG, coarse calibration.

June 16, morning.

Searched by 2 observers (1 inexperienced), 3:40 to 6:05 p.m.

June 16.

sick birds captured	sick birds seen
none	2 American redstart

Singing activity was thought to be normal although there were noticeably quiet areas. Few ruby-crowned kinglets were heard.

Searched by 2 observers (1 inexperienced), 7:20 to 8:30 p.m.

June 16.

sick birds captured	sick birds seen
1 American redstart	1 white-throated sparrow

Three nests were found (2 white-throated sparrow and 1 Tennessee warbler), all with adults incubating.

Searched by 2 observers, 2:00 to 3:00 p.m., June 17.

sick birds captured	sick birds seen
1 chipping sparrow	none

A white-throated sparrow was found incubating. Vocal activity seemed normal, and there were no noticeably quiet areas. The area searched was the same as on the preceding day. More ruby-crowned kinglets were heard singing.

Block 7

Treatment: sumithion, 3/8 lb., 1/5 USG, fine calibration.

June 6, morning.

Searched by 1 observer, 8:30 to 11:30 a.m., June 8.

sick birds captured	sick birds seen
none	1 magnolia warbler
	1 myrtle warbler
	1 American redstart

Due to a communications breakdown this block was searched 48 hours after treatment instead of one day later as planned. The sick birds were found in central and western parts of the block where no warbler or kinglet songs were heard. In eastern parts of the block there was no evidence of birds in distress and kinglet and warbler song was thought to be normal. The observer reported as follows: "At about 9:50 spray planes were finishing Block 8, immediately to the west, and they appeared to overlap Block 7 by as much as 1/4 mile. This resulted in Forestry sampling station #15 (and presumably #16) receiving a second treatment. This overlap included the area where sick birds were found."

Block 8

Treatment: sumithion, 3/8 lb., 1/5 USG, fine calibration.

June 8, morning.

Searched by 1 observer (inexperienced), 3:30 to 4:50 p.m., June 9.

sick birds captured	sick birds seen
1 magnolia warbler	none
2 Blackburnian warbler	

Searching was done in fine weather. Apart from the incapacitated birds which he caught, the observer saw only a few rose-breasted grosbeaks and white-throated sparrows. He was particularly struck by the silence in the block.

Block 29

Treatment: sumithion, 3/8 lb., 1/5 USG, fine calibration.

June 9, morning.

Searched by 3 observers, 6:10 to 8:10 p.m., June 9.

sick birds captured	sick birds seen
1 yellow-bellied flycatcher	1 ruffed grouse
2 Swainson's thrush	1 yellow-bellied flycatcher
2 Tennessee warbler	1 Empidonax flycatcher
2 magnolia warbler	1 robin
2 Cape May warbler	4 Swainson's thrush
1 chipping sparrow	1 Tennessee warbler
	1 parula warbler
	1 Cape May warbler
	2 myrtle warbler
	2 black-throated green warbler
	3 bay-breasted warbler
	1 yellowthroat
	1 scarlet tanager
	3 slate-colored junco
	7 white-throated sparrow
	1 unidentified

Song counts were made at various places in the block. They were as follows: nil, nil, 1/minute (1 ovenbird), 3/minute (3 individuals of 3 species), 25/minute (25 individuals of 15 species), and 30/minute (many individuals of 12 species). Quiet areas seemed to alternate with active

areas in fairly well marked zones. The sick grouse was approached very closely. When it flushed it crashed into the trunk of a tree, fell to the ground, and then continued its flight. Casual searching was continued the following morning while the bird count was being made. No birds were captured but the following sick ones were seen: 1 ruffed grouse, 2 Swainson's thrush, 1 yellowthroat, 4 white-throated sparrow. A dead Blackburnian warbler was found near the census line 19 days after spraying.

Six pre- and five post-spray bird counts were made. Results are shown in Tables 3 and 4. All the warbler species apparently suffered a decline in numbers, particularly black-throated greens, Blackburnians, and bay-breasts. Unaccountably, ruby-crowned kinglets were reduced in number on the "B" line but not on the "A". Two flycatcher species were heard for the first time on the first post-spray count. Winter wrens were apparently unaffected on both lines as were yellow-bellied sapsuckers. Swainson's thrushes sustained a loss. Thirteen days after spraying, there had been a noticeable recovery or replacement. This is reflected in near pre-spray levels of the population indices. Tables 3 and 4 are to be compared with Tables 9 and 10. Counts made in the control area show no significant decreases in the numbers of any species and population indices remained constant.

Chignecto campground, Fundy National Park

Treatment: sumithion, 3/8 lb., 1/3 USG, medium calibration.
June 7, evening.

Three bird counts were made by the park naturalist. Results are shown in Tables 5 and 6. Unfortunately, the only post-spray count

Table 3. - Bird count results, Line A, Block 29, N.B.

Species*	Number of birds recorded										
	May						June				July
	22	23	26	28	29	5	10	13	22	28	3
Yellow-shafted flicker	2	1	1	1	1	0	0	0	1	1	0
Yellow-bellied sapsucker	11	7	11	10	6	9	7	5	7	10	10
Yellow-bellied flycatcher	0	0	0	0	0	3	0	1	2	1	0
Least flycatcher	0	0	0	0	1	0	0	0	0	0	0
Eastern wood pewee	0	0	0	0	0	0	2	2	2	2	2
Olive-sided flycatcher	0	0	0	0	0	2	1	0	2	0	0
Barn swallow	1	5	2	3	3	2	0	2	0	0	1
Blue jay	1	3	2	4	2	0	2	0	1	0	0
Boreal chickadee	3	3	3	2	2	0	0	1	0	1	1
Red-breasted nuthatch	3	3	1	2	4	4	3	3	6	5	8
Winter wren	4	3	4	2	2	4	4	4	4	3	3
Robin	6	6	4	3	2	3	5	2	3	2	5
Swainson's thrush	1	8	7	4	8	10	3	3	11	11	8
Ruby-crowned kinglet	4	5	3	5	3	3	3	4	1	2	0
Solitary vireo	0	1	1	1	2	1	0	0	1	0	0
Tennessee warbler	0	5	8	8	17	17	2	9	13	14	10
Magnolia warbler	0	2	2	4	3	2	1	0	0	0	1
Cape May warbler	10	11	8	9	6	3	2	2	1	3	2
Myrtle warbler	12	7	3	4	2	5	1	1	3	4	1
Blackburnian warbler	0	2	7	7	5	2	0	0	0	0	0
Bay-breasted warbler	1	3	10	12	12	11	0	0	2	4	5
Ovenbird	4	11	8	7	11	9	2	3	5	3	5
Yellowthroat	1	1	2	1	0	1	0	1	0	0	0
Redwinged blackbird	1	2	3	1	0	1	2	1	1	1	3
Rose-breasted grosbeak	0	0	5	2	6	2	1	0	1	0	0
Purple finch	10	8	9	10	7	7	4	3	8	7	6
Pine grosbeak	4	2	1	1	2	2	1	1	0	2	0
Slate-colored junco	1	2	1	1	2	2	2	3	3	3	5
White-throated sparrow	10	6	7	7	7	4	1	2	4	3	6

Sprayed on morning of June 6

Table 3. — Cont'd. Line B, Block 29, N.B.

Species*	Number of birds recorded										
	May						June				July
	22	23	26	28	29	5	10	13	22	28	3
Yellow-bellied sapsucker	7	6	4	8	6	6	7	4	7	6	10
Eastern wood pewee	0	0	0	0	0	0	2	0	2	1	2
Olive-sided flycatcher	0	0	0	0	0	0	2	1	0	0	1
Blue jay	1	2	2	2	3	1	1	0	1	2	1
Winter wren	3	4	3	4	3	4	3	6	5	3	4
Robin	3	6	3	4	2	3	2	3	4	4	1
Swainson's thrush	1	4	4	7	11	4	2	3	11	9	8
Ruby-crowned kinglet	9	7	7	8	6	3	2	0	2	0	1
Solitary vireo	1	2	1	1	3	6	1	1	0	0	0
Tennessee warbler	0	4	10	15	20	14	4	4	11	8	5
Parula warbler	0	1	2	1	0	1	0	0	0	0	0
Magnolia warbler	1	7	3	11	4	7	1	0	1	1	2
Cape May warbler	9	10	9	7	6	7	1	1	0	1	1
Myrtle warbler	8	7	8	8	5	3	0	0	1	0	1
Black-throated green warbler	0	2	5	4	2	2	0	0	0	0	0
Blackburnian warbler	0	2	3	4	2	3	0	0	1	2	1
Bay-breasted warbler	0	3	11	6	6	8	0	0	2	2	5
Ovenbird	2	7	8	7	4	5	0	0	2	1	2
Yellowthroat	2	0	1	1	2	2	0	0	1	2	1
Redwinged blackbird	1	3	1	2	2	1	1	1	2	2	1
Purple finch	6	7	8	10	5	7	3	2	5	5	2
Slate-colored junco	2	1	2	3	3	2	1	0	1	2	4
White-throated sparrow	7	6	9	13	9	9	4	1	9	8	4

Sprayed on morning of June 9

* Includes only those species seen or heard, after first arrival on the block, on at least five of the six pre-spray counts. Evening grosbeak has been excluded.

Table 4. - Count totals and population indices, Line A, Block 29, N.B.

Count number	Date	Total birds recorded	Time (minutes)	Birds/ minute	Total songs recorded	Songs/ minute	Total species
1	May 22	103	80	1.3	757	9.5	28
2	May 23	129	84	1.5	1126	13.4	36
3	May 26	130	75	1.7	968	12.9	32
4	May 28	117	64	1.8	954	14.9	29
5	May 29	128	61	2.1	990	16.2	35
6	June 5	121	61	2.0	982	16.1	32
		Sprayed on morning of June 9					
7	June 10	52	52	1.0	165	3.2	24
8	June 13	60	49	1.2	401	8.2	26
9	June 22	92	56	1.6	762	13.6	27
10	June 28	96	60	1.6	706	11.8	27
11	July 3	95	50	1.9	483	9.7	25
					Line B, Block 29, N.B.		
1	May 22	83	64	1.3	387	6.0	24
2	May 23	114	60	1.9	735	12.2	31
3	May 26	118	60	2.0	730	12.2	31
4	May 28	139	65	2.1	1010	15.5	31
5	May 29	119	54	2.2	909	16.8	31
6	June 5	120	60	2.0	883	14.7	34
		Sprayed on morning of June 9					
7	June 10	48	47	1.0	161	3.4	23
8	June 13	37	40	0.9	216	5.4	20
9	June 22	89	47	1.9	759	16.1	28
10	June 28	80	53	1.5	611	11.5	26
11	July 3	76	40	1.9	509	12.7	27

was made several days after treatment. Results indicate no substantial population changes. A C.W.S. observer made several three-minute song counts both within and well outside the campground on June 8.

	Station	Time	Songs/minute	Time	Songs/minute
Control	1	6:30 a.m.	23	1:00 p.m.	25
Control	2	6:45 a.m.	19		21
Control	3	6:55 a.m.	19		24
Campground	4	7:20 a.m.	13		15
Campground	5	7:45 a.m.	25		
Campground	6	8:00 a.m.	25		
Campground	7	8:15 a.m.	17	2:00 p.m.	17
Campground	8	8:30 a.m.	18	2:10 p.m.	15
Campground	9	8:45 a.m.	19	2:20 p.m.	8

At 2:30 p.m. the observer found a Cape May warbler perching on a branch about six feet from the ground. It allowed very close approach, its feathers were ruffled and it was closing its eyes periodically. When he reached out for it, it flew to a higher branch a few yards away. A few minutes later a black-throated green warbler was seen low down in a spruce and allowed the observer to approach within 10 feet before it flew off strongly. The observer reported "It seems likely that if there is to be any effect on birds it is just beginning to show up."

Block 14

Treatment: sumithion, 1/4 lb., 1/5 USG, extra fine calibration. June 19 morning.

Searched by 2 observers (1 inexperienced), 4:00 to 6:30 p.m., June 19.

Searched again by the same observers, 10:30 a.m. to 1:30 p.m. June 20.

Table 5. - Bird count results, Fundy National Park

Species	Number of individuals noted June 5	June 6	June 11
Yellow-shafted flicker	1	0	0
Yellow-bellied sapsucker	3	1	1
Yellow-bellied flycatcher	0	1	1
Eastern wood pewee	0	4	1
Olive-sided flycatcher	1	0	0
Barn swallow	6	0	1
Gay jay	0	1	0
Common crow	2	1	1
Boreal chickadee	1	2	2
Red-breasted nuthatch	1	1	1
Winter wren	1	0	0
Robin	15	13	16
Hermit thrush	2	1	0
Swainson's thrush	5	2	5
Ruby-crowned kinglet	3	3	3
Red-eyed vireo	4	0	2
Tennessee warbler	8	5	9
Nashville warbler	1	0	1
Magnolia warbler	7	11	10
Cape May warbler	4	5	2
Myrtle warbler	5	2	5
Black-throated green warbler	8	4	4
Bay-breasted warbler	20	18	17
Ovenbird	5	2	3
Mourning warbler	0	1	0
Yellowthroat	2	2	1
Canada warbler	0	1	0
American redstart	6	12	4
Brown-headed cowbird	4	1	1
Evening grosbeak	11	13	7
Purple finch	5	1	2
Pine siskin	8	2	6
American goldfinch	2	1	0
Slate-colored junco	10	8	12
Chipping sparrow	7	3	6
White-throated sparrow	21	18	16
Song sparrow	1	1	1
Unidentified	9	6	2

Sprayed on evening of June 7

Table 6. - Count totals and population indices, Fundy National Park, N.B.

Count number	Date	Total birds recorded	Time (minutes)	Birds/minute	Total species
1	June 5	189	65	2.9	32
2	June 6	147	65	2.3	31
		Sprayed on evening of June 7			
3	June 11	143	60	2.4	29

Both searches were repeatedly interrupted by heavy rain. There was no evidence of bird intoxication.

Block 15

Treatment: sumithion 1/4 lb., 1/5 USG, fine calibration.

June 11, morning.

Searched by 2 observers (1 inexperienced), 5:30 to 8:00 p.m.,

June 11.

sick birds captured	sick birds seen (some only slightly affected--see below)
none	1 ruffed grouse
	1 magnolia warbler
	1 bay-breasted warbler
	1 yellowthroat
	1 pine grosbeak
	2 pine siskin

The ruffed grouse was seen at the roadside and allowed the observer to approach to within a few feet. It then jumped into a dtich and the observer followed. The bird then flew off through the woods, crashing into the branches of several trees before it was lost from view. The magnolia warbler was on the ground and very slow to move, as were the bay-breasted warbler and the yellowthroat. The pine grosbeak was seen to have difficulty maintaining its balance while perching. The two siskins were feeding at the roadside and when approached flew up into a nearby shrub where they obviously experienced difficulty retaining their balance. The observer was able to approach to three feet. In one very quiet area juncos and whitethroats were perching quietly in trees and constantly wiping their bills.

Song counts were made at a few forestry sampling stations as follows:

N10 2 songs/minute (from 1 distant white-throated sparrow)

N8 4 songs/minute (from 1 myrtle warbler, 2 Tennessee warblers, 1 white-throated sparrow)

N12 25 songs/minute (several thrush and warbler species)

A control count gave 30 songs/minute (10 individuals of 6 species).

Most of the searching was done along and from a road bisecting the block and running roughly northeast to southwest. There was an apparent zonation of bird activity along this road.

Searched by 2 observers (1 inexperienced), 9:30 to 10:30 a.m. June 12.

sick birds captured	sick birds seen
none	none

Song counts were again made at forestry sampling stations and were as follows:

N10 21 songs minute (8 individuals of 5 species)

N8 33 songs/minute (9 species)

N 12 10 songs/minute (5 species)

A control count gave 36 songs/minute (10 individuals of 8 species).

Block 20

Treatment: sumithion, 1/4 lb., 1/5 USG, fine calibration. 2 applications. June 16, morning.

Searched by 2 observers 2:45 to 3:45 p.m., by 1 observer 4:30 to 5:00 p.m., by 2 observers 6:15 to 7:15 p.m., and by 1 observer 7:30 to 8:00 p.m., June 16.

sick birds captured	sick birds seen
2 American redstart	4 American redstart

Song counts were made at four widely separated points in the block:

(a) 38, 31, and 34 songs/minute.

(b) 9 songs/minute (mostly thrushes).

(c) 19, 23 songs/minute (most expected species but no warblers: it was in this vicinity that the six sick redstarts were encountered).

(d) 21, 23 songs/minute (second count consisting mostly of warbler song).

Searched by 4 observers (3 inexperienced), 2:30 to 4:30 p.m.

June 17.

sick birds captured	sick birds seen
1 Blackburnian warbler (found dead on road)	none
3 American redstart	

All four birds were found on logging roads. A few dead and dying dragonflies were found at several locations. Many individuals of an unidentified fly species were found to be in distress throughout the block.

Block 30

Treatment: fenitrothion (CIBA), 1/4 lb., 1/5 USG, fine calibration.

June 16, a.m.

Searched by 1 observer (inexperienced), 3:00 to 8:00 p.m.

June 16.

sick birds captured	sick birds seen
none	none

The observer reported no evidence of birds in difficulties. Two broods of ruffed grouse looked healthy and behaved normally. Song level was thought to be normal.

Block 34

Treatment: sumithion, 1/8 lb., 1/5 USG, fine calibration.
2 applications: noon and evening, June 23.

Searched by 3 observers, 3:00 to 5:00 p.m., 6:00 to 6:20 p.m. June 24.

sick birds captured	sick birds seen
1 American redstart	1 myrtle warbler
1 American redstart found dead	3 American redstart
	2 White-throated sparrow

We had hoped this block treatment would have been a "dress rehearsal" of one of the treatments proposed for the hemlock looper control program in Newfoundland in which sumithion was to be applied twice, at 1/8 lb./acre, with a four or six day interval. Song counts were made at several stations in the block. In one hardwood area on the flanks of and at the crown of a hill birds had been silenced. One ovenbird sang once in five minutes. There was no other bird song. It was in this vicinity that three of the five redstarts were found. An employee of Forest Protection Limited was in the block during the afternoon of June 25. He reported seeing several birds (of unknown species) "wobbling on their perches." The redstarts were held in captivity and fed readily enough on insects that were presented to them but died during the night of June 25/26.

Area 24-25 (Newfoundland)

Treatment: sumithion, 1/8 lb., 1/5 USG, fine calibration.
Two applications: on morning of July 9 and on morning of July 15.

Searched by 2 observers, 3:30 to 6:30 p.m., July 9.

sick birds captured	sick birds seen
none	none

A few birds were seen to be constantly wiping their bills. A yellow-bellied flycatcher flew down to within a few feet of one observer. It retained its equilibrium and appeared to be in no distress. Searching was continued for a short while the following day but nothing untoward was noted.

Searched by 2 observers, 3:30 to 6:30 p.m., July 15.

sick birds captured	sick birds seen
none	(see below)

At the brow of a hill near the end of the census route, several birds were seen constantly bill wiping. While the bird count was being made on July 16, two incapacitated adult slate-colored juncos were seen, one of which was nearly taken in the hand. On the morning of July 18, one ruby-crowned kinglet, one junco and one whitethroat were very tame. All were on the ground and reacted very slowly when approached. Vocal utterances of young birds were not to be considerably diminished over the preceding days.

It was not known until a very late hour if the looper population in this area was of sufficient size to warrant chemical control. Consequently there was time to make only one pre-spray bird count. A total of eight counts was made. Results are shown in Table 1 and population indices are shown in Table 2 of a separate report to this committee. The results of counts in a control area at Black Duck are shown in Table 3 and control population indices are shown in Table 4 of the same report. There was

apparently no population depression after the first treatment. After the second treatment, however, there was a decrease in the numbers of black-throated green and blackpoll warblers. The number of the latter species remained low three days later.

Block 26

Treatment: sumithion, 1/8 lb., 1/5 USG, fine calibration.
June 16, morning.

Searched by 2 observers (1 inexperienced), 3:15 to 6:15 p.m.
June 16.

sick birds captured	sick birds seen
none	none

No evidence of birds in distress.

Block 31

Treatment: sumithion, 1/8 lb., 1/5 USG, fine calibration.
June 14, evening.

Searched by 3 observers (1 inexperienced), 4:00 to 5:00 p.m., 6:15 to 7:15 p.m., June 15.

sick birds captured	sick birds seen
none	none

Area 14 (Newfoundland)

Treatment: sumithion, 1/8 lb., 1/5 USG, fine calibration.
Two applications, morning of July 7 and 14.

The area was searched by one observer from 5:15 to 8:15 p.m. on July 14 during which time nothing untoward was noted.

C. Mixtures

Block 1

Treatment: phosphamidon, 1/4 lb., + sumithion, 1/8 lb., 1/5 USG, fine calibration. June 11, a.m.

Searched by 4 observers (1 inexperienced), 7:00 to 7:30 p.m., June 11.

sick birds captured	sick birds seen
1 myrtle warbler	1 robin
1 bay-breasted warbler	2 bay-breasted warbler
1 slate-colored junco	1 slate-colored junco
2 chipping sparrow	1 white-throated sparrow
	1 unidentified

Birds were almost completely silenced in the areas searched. One of the chipping sparrows died at 9:00 p.m. The myrtle warbler appeared to have revived and was released.

Searched by 3 observers (1 inexperienced), 10:45 to 11:15 a.m., June 12.

sick birds captured	sick birds seen
1 rose-breasted grosbeak	1 robin
1 chipping sparrow	1 Tennessee warbler
	1 slate-colored junco
	1 chipping sparrow

Two song counts were made, at two widely separated locations. They were nil and 0.3 songs/minute (from 1 ovenbird). A control count was made at Catamaran Brook about a mile outside the block and gave 33 songs/minute (mostly Tennessee warblers and purple finches).

Block 33

Treatment: sumithion, 1/8 lb., + DDT, 1/10 lb., 1/5 USG, fine calibration. Two applications. June 22, morning.

Searched by 1 observer, 4:30 to 6:30 p.m., June 22.

No evidence of any effect on birds.

D. Others

Plot 3 (CCRI Program)

Part of the plot was sprayed with DDT during the evening of June 1, treatment being interrupted by problems of a mechanical nature. The rest of the plot was sprayed early the following morning. Average dosage was 1/4 lb./acre. At 5:00 a.m. on June 2 a robin was found at the side of the highway forming the southern boundary of the plot. Although it displayed some of the symptoms of poisoning (tremoring and loss of balance) it doubtless had been struck by a passing car, though no injury was apparent. An observer ranged widely through the plot for about one hour late in the morning of June 2. There was no evidence of bird poisoning.

Plot 8 (CCRI Program)

Bird census taking by a rolling-station method was begun in this plot but was discontinued owing to the demands of other commitments. The plot was sprayed with baygon at an unknown dosage on the morning of June 22. Three observers searched for evidence of bird poisoning from 2:30 to 4:00 p.m. of the same day. They found none.

Table 7. — Bird count results, Line A, Control, N.B. (Observer X)

Species*	Number of birds recorded							
	May			June			July	
	24	25	27	2	4	8	27	2
Ruffed grouse	1	1	2	1	0	0	0	0
Yellow-bellied sapsucker	11	9	9	12	10	11	16	13
Yellow-bellied flycatcher	0	0	0	10	10	10	8	3
Red-breasted nuthatch	6	3	3	3	4	4	8	2
Winter wren	1	2	2	1	1	1	2	1
Robin	3	1	2	1	3	2	5	3
Swainson's thrush	8	11	9	5	8	10	15	15
Ruby-crowned kinglet	8	7	8	8	6	5	3	1
Solitary vireo	0	0	1	1	1	1	1	1
Tennessee warbler	15	15	10	16	15	14	19	12
Parula warbler	1	1	1	0	1	2	1	1
Magnolia warbler	5	5	12	8	6	6	9	3
Cape May warbler	5	4	4	2	1	2	4	0
Black-throated blue warbler	3	1	1	2	0	1	2	1
Myrtle warbler	5	9	5	4	3	4	2	4
Black-throated green warbler	7	2	4	3	3	1	2	1
Blackburnian warbler	1	3	3	5	4	2	4	4
Bay-breasted warbler	6	3	7	6	5	10	7	8
Ovenbird	14	13	14	12	13	16	13	16
Canada warbler	1	0	0	2	2	1	1	1
American redstart	0	0	0	1	0	0	0	0
Rose-breasted grosbeak	2	1	1	1	0	1	1	0
Purple finch	7	9	10	5	7	7	6	11
Pine grosbeak	0	0	0	0	0	0	1	4
Slate-colored junco	2	2	3	3	2	3	5	2
White-throated sparrow	11	8	12	10	9	8	16	13

Line B, Control, N.B. (Observer X)

Ruffed grouse	1	1	1	0	0	0	0	0
Yellow-bellied sapsucker	8	8	6	7	6	6	11	7
Yellow-bellied flycatcher	0	0	1	5	4	3	4	0
Red-breasted nuthatch	0	2	1	0	5	3	3	5
Winter wren	2	0	2	0	3	1	0	2

Table 7. — Cont'd.

Species*	Number of birds recorded							
	May			June			July	
	24	25	27	2	4	8	27	2
Robin	7	9	4	6	6	6	6	5
Swainson's thrush	2	6	5	7	4	5	8	11
Ruby-crowned kinglet	7	7	13	6	8	6	7	3
Solitary vireo	0	1	0	0	0	0	0	0
Tennessee warbler	16	14	11	13	10	15	12	14
Parula warbler	2	1	2	2	1	0	1	1
Magnolia warbler	8	8	7	9	5	5	5	0
Cape May warbler	0	2	5	1	4	3	0	3
Black-throated blue warbler	1	0	0	0	0	0	0	0
Myrtle warbler	6	7	4	5	3	3	5	1
Black-throated green warbler	4	5	2	0	0	0	1	0
Blackburnian warbler	1	0	0	0	0	1	1	0
Bay-breasted warbler	3	4	10	6	6	6	8	4
Ovenbird	9	9	10	11	13	8	9	11
Canada warbler	0	0	0	2	2	3	2	0
American redstart	0	0	0	0	1	1	0	0
Rose-breasted grosbeak	1	0	0	0	1	0	2	1
Purple finch	6	5	9	8	9	2	8	7
Pine grosbeak	0	0	0	0	1	2	3	0
Slate-colored junco	1	1	0	0	1	1	1	0
White-throated sparrow	8	9	9	11	10	9	11	16

Table 8. - Count totals and population indices, Line A, Control, N.B. (Observer X)

Count number	Date	Total birds recorded	Time (minutes)	Birds/ minute	Total songs recorded	Songs/ minute	Total species
1	May 24	157	89	1.8	1317	14.8	39
2	May 25	131	62	2.1	1076	17.4	31
4	May 27	136	68	2.0	1148	16.9	29
7	June 2	137	58	2.4	1042	18.0	34
8	June 4	131	59	2.2	1060	18.0	31
10	June 8	142	60	2.4	1213	20.2	37
14	June 27	172	55	3.1	1029	18.7	37
15	July 2	141	59	2.4	1166	19.8	33
					Line B, Control, N.B. (Observer X		
1	May 24	117	57	2.0	624	10.9	31
2	May 25	117	61	1.9	826	13.5	27
4	May 27	118	64	1.8	836	13.1	28
7	June 2	114	50	2.3	703	14.1	27
8	June 4	125	56	2.2	710	12.7	36
10	June 8	104	50	2.1	922	18.4	29
14	June 27	126	56	2.2	894	16.0	32
15	July 2	108	52	2.1	887	17.0	29

Table 9. - Bird count results, Line A, Control, N.B. (Observer Y)

Species*	Number of birds recorded								
	May			June				July	
	26	28	29	6	10	14	21	3	10
Yellow-shafted flicker	1	1	0	0	0	0	1	0	0
Yellow-bellied sapsucker	14	13	13	6	9	3	8	16	10
Yellow-bellied flycatcher	3	3	4	3	4	4	5	6	3
Least flycatcher	2	2	2	0	0	1	1	0	0
Eastern wood pewee	0	0	0	1	3	1	1	2	1
Olive-sided flycatcher	0	0	0	0	0	0	0	0	0
Barn swallow	0	0	0	0	0	0	0	0	0
Blue jay	3	4	1	1	1	0	0	0	2
Boreal chickadee	0	1	3	1	0	0	3	1	5
Red-breasted nuthatch	1	4	2	4	6	2	3	2	3
Winter wren	1	1	1	1	0	2	1	2	0
Robin	5	8	4	1	5	1	2	3	3
Swainson's thrush	6	6	7	10	9	10	9	10	11
Ruby-crowned kinglet	7	8	8	5	5	4	4	1	1
Solitary vireo	0	1	0	1	1	0	0	2	0
Tennessee warbler	12	17	14	16	17	17	17	16	8
Parula warbler	2	1	2	1	1	0	0	0	2
Magnolia warbler	7	12	10	7	4	7	5	6	6
Cape May warbler	5	4	1	2	2	1	2	1	0
Myrtle warbler	4	7	6	4	2	1	3	1	3
Black-throated green warbler	3	5	4	3	2	2	2	2	1
Blackburnian warbler	1	2	2	3	1	3	3	1	0
Bay-breasted warbler	9	5	9	7	11	9	8	11	7
Ovenbird	13	13	11	16	16	9	11	13	14
Yellowthroat	0	0	0	0	0	0	0	0	0
Redwinged blackbird	0	0	0	0	0	0	0	0	0
Rose-breasted grosbeak	2	0	0	0	0	0	0	0	0
Purple finch	7	7	7	3	6	2	4	5	0
Pine grosbeak	0	0	0	0	0	2	0	1	1
Slate-colored junco	7	4	3	4	3	1	2	3	2
White-throated sparrow	24	19	21	19	21	14	16	16	17
	Line B, Control, N.B. (Observer Y)								
Yellow-shafted flicker	0	0	0	2	1	1		1	2
Yellow-bellied sapsucker	13	11	12	3	11	2		14	11

Table 9. -- Cont'd.

Species*	Number of birds recorded								
	May			June				July	
	26	28	29	6	10	14	21	3	10
Yellow-bellied flycatcher	3	3	3	1	2	3		0	2
Least flycatcher	2	2	2	1	2	1		0	0
Eastern wood pewee	0	0	0	0	0	0		1	0
Olive-sided flycatcher	0	0	1	1	1	0		0	0
Barn swallow	0	0	0	0	0	0		0	0
Blue jay	1	3	1	1	3	2		0	0
Boreal chickadee	0	3	1	3	1	0		0	6
Red-breasted nuthatch	1	2	4	0	5	2		5	4
Winter wren	1	2	1	1	1	0		1	0
Robin	6	6	8	2	7	4		4	3
Swainson's thrush	7	5	4	1	6	9		12	16
Ruby-crowned kinglet	14	12	12	8	9	5		5	2
Solitary vireo	0	0	1	0	1	1		1	0
Tennessee warbler	15	17	16	14	14	13		9	7
Parula warbler	0	2	2	0	0	0		1	1
Magnolia warbler	7	8	10	6	8	7		4	6
Cape May warbler	4	3	1	4	2	5		1	0
Myrtle warbler	11	8	8	3	3	1		7	4
Black-throated green warbler	2	3	0	0	0	0		1	1
Blackburnian warbler	1	2	1	1	1	0		0	1
Bay-breasted warbler	14	10	9	8	13	6		7	7
Ovenbird	10	11	11	14	13	7		12	14
Yellowthroat	0	1	1	0	1	1		0	0
Redwinged blackbird	0	0	0	0	0	0		0	0
Rose-breasted grosbeak	0	0	0	0	2	0		3	0
Purple finch	8	7	5	5	4	3		5	3
Pine grosbeak	0	2	0	1	2	0		2	0
Slate-colored junco	0	0	4	0	3	0		0	3
White-throated sparrow	20	17	22	18	27	15		18	16

rained out

* Those species listed in Table 2.

Table 10. - Count totals and population indices, Line A, Control, N.B. (Observer Y)

Count number	Date	Total birds recorded	Time (minutes)	Birds/ minute	Total songs recorded	Songs/ minute	Total species
3	May 26	160	52	3.1	833	16.0	34
5	May 28	173	61	2.8	786	12.9	33
6	May 29	167	51	3.3	701	13.7	38
9	June 6	140	47	3.0	675	14.3	34
11	June 10	162	57	2.8	956	16.8	33
12	June 14	105	40	2.6	748	18.7	27
13	June 21	126	39	3.2	574	14.7	30
16	July 3	147	42	3.5	661	15.7	34
17	July 10	136	49	2.8	379	7.7	34
					Line B, Control, N.B. (Observer Y)		
3	May 26	156	59	2.6	605	10.2	30
5	May 28	161	60	2.7	817	13.6	35
6	May 29	165	61	2.7	742	12.2	35
9	June 6	113	49	2.3	555	11.3	29
11	June 10	154	55	2.8	683	12.4	31
12*	June 14	98	33	3.0	433	13.1	26
13	June 21	(count not made because of rain)					
16	July 3	136	46	3.0	407	8.8	32
17	July 10	139	51	2.7	430	8.4	31

* Only three-quarters of route covered because of rain.

DISCUSSION

It is important to re-state at the outset that in 1968, as in previous years, our work has involved the monitoring of a control operation. We have not been able to establish hazard levels precisely and the effects of a given treatment must always be qualified by the words "as operationally made." It would be impossible to apply insecticide from the air uniformly over a wide area even though the operator was very experienced and used the best available equipment and aircraft-guidance systems. An uneven insecticide application, or a treatment that was not quite what was intended, could result from the influence of several variables of an "operational" nature. Some of these are interacting and are as follows:

(a) Human. Pilots may be inexperienced. Aircraft may not be flown at the correct speed and altitude. Correct spacing may not be maintained. Block boundaries may be incorrectly located by the guiding aircraft. Aircraft may be improperly calibrated. Formulations may be incorrectly prepared.

(b) Physical—Chemical. Emulsions may be unstable. Chemical properties of formulations may change if the water used in mixing is too acid or too alkaline. Properties of technical materials may change after prolonged storage.

(c) Physiographic. Spraying over rugged terrain imposes special difficulties for pilots. Operation over relatively featureless terrain may make block boundary location difficult.

(d) Meteorological. Excessive wind or air temperature may prevent the spray

from reaching target areas. Drift spraying may be impossible in calm air conditions. Problems of this sort may be compounded by those caused by physiographic factors.

In operational spraying against spruce budworm, compressed as it must be into a short time span geared to larval development, some operational variables, singly or in combination, are very difficult to avoid. Their importance and effects are virtually impossible to assess.

Post-spray searching of treated areas occupied more of our time than in other years. Several factors, the following of which are important, determine whether a real effect will be detected by post-spray searching.

(a) The size of the population and the degree to which birds are poisoned.

(b) The experience of the searchers—an observer with little ability to identify birds and with no knowledge of bird behaviour will be severely handicapped.

(c) The number of persons employed searching.

(d) The time lapse between spraying and initiation of searching. The time for which searching is prolonged—it may be a considerable time before the effect of a slow-acting toxicant manifests itself.

(e) The weather during searching—rain or wind may inhibit bird activity and obscure any effect.

(f) The floristic nature of areas being searched—dense forests restrict vision, thick ground and shrub vegetation may conceal sick birds.

(g) The number of roads and trails in the search area—a good network will facilitate the finding of dead and incapacitated birds, as previous experience has shown.

(h) The extent to which sick birds are removed by predators.

For purposes of comparison it would be useful to systematize search operations and to quantify results. The above-mentioned factors point up the difficulty of such an exercise and for these reasons searches in two areas treated identically may produce markedly different results and assessment of total effect. Our experience has shown that carcasses are extremely difficult to find. Sick birds are relatively more easily found, depending on the degree of incapacitation. We may safely assume that the sick birds that are captured or seen actually represent only a small fraction of the total number affected in a given sprayed area.

A word of caution should be said concerning the usefulness of the population indices. These are based largely on the number of birds heard singing. Normally an observer will hear only those birds singing relatively close by, more distant songs being "drowned out". Following a population reduction, an observer will hear a disproportionately greater number of the birds that are singing within range. For these reasons a population depression may actually be greater than is suggested by the birds/minute and songs/minute indices. Furthermore, surviving birds may seek to expand their territories to fill the vacuum created by the removal of others. Increased competition may stimulate more vocal activity. Arrival of immigrants from outside the sprayed area may have a similar effect.

Before discussing the effects of the 1968 spray programs it would be useful briefly to review the conclusions drawn from the results of the last four years' operations in New Brunswick and to examine this year's findings in their light.

In 1964 phosphamidon applied at 1/2 lb. in 3/4 USG per acre caused substantial avian mortality in some areas. A half-strength mixture applied in the evening apparently had little effect on birds: it was not known if this could be attributed to the decreased dosage, to the relative inactivity of birds at the time of application, or to other factors. The effect of the addition of a penetrating agent was obscured by factors of an imponderable nature. Experiments with captive birds showed that it was possible for them to pick up lethal dosages through their feet from sprayed branches.

In 1965 varying degrees of population reduction and mortality were observed in all areas where 1/2 lb. of phosphamidon per acre was applied. A double application of 1/4 lb. in 4/5 USG caused some mortality. On all plots where 1/4 lb. phosphamidon per acre was applied, effects were relatively slight and it was concluded that this dosage was below the lethal level for most species except for those whose feeding habitats and behaviour made them particularly vulnerable. No effects could be attributed to dilutions of 1/5, 2/5, and 4/5 USG. Experiments with captive birds confirmed earlier observations on dermal toxicity.

Further monitoring of field applications of phosphamidon in 1966 were difficult to assess as they were made early in the season when migrants were arriving in the study areas where censuses were being taken. There was a suggestion that 1/4 lb. in 1/5 USG caused a slight reduction in the number of birds. A low volume application of technical material (1/3 lb. per acre) caused a decrease in numbers of birds and song activity, and several incapacitated birds were found.

In 1966 bird observations were made in several plots sprayed with sumithion. Cold weather, accompanied by rain and snow during post-spray censusing, made assessment of effect difficult. Navigational errors compounded the problem. It was concluded that doses of less than 1 lb. per acre of sumithion probably do not depress bird populations. Experiments with captive birds demonstrated the lower toxicity of sumithion compared with phosphamidon and that birds could pick up lethal doses of sumithion through contact with sprayed perching surfaces.

Operational experimentation with sumithion was expanded in 1967 and the effect on forest birds was monitored in 11 treatment areas. For the first time, sumithion-phosphamidon mixtures were used. All applications were made at the rate of 1/2 USG emulsion per acre. The effects on birds may be summarized as follows:

1. Sumithion applied very late in the evening at 1 lb. per acre apparently had no effect on birds, though monitoring was restricted to post-spray searching only;
2. Sumithion applied early in the evening at 1/2 lb. per acre caused incapacitation of some birds, a few of which were readily captured;
3. Sumithion applied in the morning at 1/2 lb. per acre caused a noticeable population depression, particularly of warblers. Fifteen birds were captured and many more were seen to be in distress. The effect was much more marked than in areas similarly treated in the evening. The same treatment in another spray block failed to cause any detectable effect and was ascribed to the inhibition of bird activity by excessive

wind at the time of spraying;

4. Sumithion applied in the morning at 3/8 lb. per acre failed to cause any population depression, though the area was sprayed during windy conditions and rain hindered post-spray searching;
5. Two evening applications of sumithion, three days apart, at 1/4 lb. per acre caused very little effect. Three warblers were captured in areas where it was suspected overlapping swaths had caused an increased dosage; and
6. Application of phosphamidon-sumithion mixtures (1/4 + 1/4, 1/8 + 1/4, 1/8 + 3/8 lb. per acre) caused no detectable bird-population depressions and no evidence of birds in distress was noted.

Effects of Phosphamidon, 1968

The most marked and widespread effect was in Block 25. Ruby-crowned kinglets and several of the high-foraging warbler species were apparently eliminated, there being no recovery or replacement 25 days after treatment. (Data for the control area do indicate a gradual decline in the numbers of ruby-crowns, early migrants, which may reflect a decline in breeding activity). Large birds, such as a sparrow hawk and a ruffed grouse, were also affected. Some avian mortality in Block 25 was not totally unexpected. We had had no previous experience with a 3/8 lb. dosage of phosphamidon, but this amount is 50 percent higher than the 1/4 lb. treatments made in 1965 and 1966 when, although some birds were killed, the effect was relatively slight. Total effect was probably as great as in some (Bettsburg, Nashwaak) 1/2 lb. blocks sprayed in 1964

although, for reasons already outlined, it is impossible to assess quantitatively. If dosage alone was the critical factor, the hazard level was lower than we had thought. A new variable, fine calibration, was introduced for the first time in the 1968 experiments. The same dosage (3/8 lb.) at the same dilution (1/5 USG) was applied in Block 2, treatment being made at a coarse calibration. About the same search effort was directed here as in Block 25, three sick birds being captured and another 11 seen. Birds were silenced but the effect appears not to have been as great as in Block 25. In Block 45 ten sick birds were captured and another four seen, the search effort being about the same, in man-hours, as in Block 25 and 2. Here again phosphamidon was applied at a fine calibration: mortality was greater than in areas treated with 1/4 lb. in previous years. A ULV application silenced birds throughout the plot during the two days we were active there, but only two sick birds were captured and another nine were incapacitated to a greater or lesser degree. In one of the 1/8 lb. blocks (32) sprayed during the evening, a few sick birds were seen and there was some song suppression in localized areas. In the other 1/8 lb. block (32, Newfoundland) sprayed during the morning, birds were silenced and several were noted to be constantly bill wiping. Probably the effects were just beginning to be manifested but it was not possible for us to return to the area. The possible implications for nestlings and other young birds resulting from spraying relatively late in the season have been treated more fully in a separate report concerning monitoring of the hemlock looper operation in Newfoundland.

Only one block (1) was visited that had been sprayed with a mixture of organophosphates (1/4 lb. + 1/8 lb. phosphamidon + sumithion at a fine calibration). In a little over three man-hours of searching, seven distressed birds were picked up and ten more seen. Birds had been silenced in the areas that were searched. There was no 1967 block with which to compare results but intensive censusing and post-spray searching in two blocks (I and L) treated that year with 1/4 lb. + 1/4 lb. mixture at a coarse calibration failed to reveal any effects on birds.

On the basis of experience in previous years we would not have expected such a marked effect in some of these blocks. This leads us to the conclusion that, in 1968, dosage was not the sole critical factor.

Effects of Sumithion, 1968

The Block 16 treatment was the same as in Blocks A, B, D, and J sprayed in 1967—1/2 lb. in 1/2 USG at a coarse calibration. It was included in the 1968 program in the expectation that some of the conflicting evidence arising from last year's monitoring might be resolved. Three sick birds were captured and a few more seen. Bay-breasted warblers were noted to be on or near the ground feeding but otherwise appeared normal. It is not known if this was an indication of slight intoxication or if the birds' natural food source had been eliminated and they were seeking an alternative one. The effect of spraying was very similar to that in Block A and B most parts of which, however, were sprayed in the evening. The effect was much slighter than in Block D but greater than in Block J (where birds were apparently unaffected). We are really no nearer establishing

the hazard level for birds of sumithion sprayed at a coarse calibration but, under certain circumstances, 1/2 lb./ acre can kill birds.

Two blocks were sprayed with sumithion at 1/2 lb. in 1/5 USG at a fine calibration. Block 9 was sprayed in the evening and six birds were readily captured and others seen by inexperienced searchers in unfavourable searching conditions 24 hours later. This was the first time we had found sick birds after an evening spray. (A 1 lb. dosage applied coarse in Block M in 1967 apparently did not affect birds). Block 28 received exactly the same treatment but no evidence of bird intoxication was found. Observers encountered difficulty locating this block and some doubt was expressed at the time that they were within its bounds while searching.

We monitored five areas which were sprayed with 3/8 lb./acre. Birds were apparently most affected in Block 29, where the most intensive monitoring was carried out. Eleven sick birds were captured and another 38 seen. The results of searching throughout the block and a comparison of the census figures for both legs of the census route suggest that spray coverage was not very uniform. There were striking reductions in the numbers of many warblers. Winter wrens were apparently not affected but some ruffed grouse were. There had been a substantial recovery 13 days after treatment. Total effect was much less than in Block 25, confirming our belief that sumithion is less toxic to birds than phosphamidon. Effect was much greater than in Block D in 1967, suggesting that another factor, possibly calibration, was important.

The Block 29 treatment was replicated in Blocks 7 and 8. Birds were silenced in Block 8 and one inexperienced observer was able to capture

three sick warblers easily about nine hours after spraying. The treatment in Block 6 differed only in that the calibration was coarse. Here a more intensive and prolonged search revealed only five sick birds, two of which were taken in the hand. The Fundy National Park campground was sprayed by a different type of aircraft, during the evening. Dosage was again 3/8 lb. but in 1/3 USG at a medium calibration. The limited census data suggest there was no significant population depression. Some birds were apparently slightly affected but probably soon recovered. The effects of these five 3/8 lb. treatments, compared with the 1/2 lb. treatments, indicate that a factor other than dosage was important and that it was probably droplet size.

A double application of sumithion at 1/4 lb./acre in Block 20 inexplicably failed to produce the extensive mortality that was anticipated. It is difficult also to interpret our findings in the five 1/4 lb. blocks that we searched. Some sick birds were seen. Song counts made at several points in these blocks suggest that spray coverage was far from uniform. Sumithion sprayed extra fine in Block 14 produced no effect that we could detect though rain impeded our searching. In Block 34 where sumithion was sprayed twice at 1/8 lb. some sick birds were captured and others seen. Effect on birds was again quite localized. Searching in five 1/8 lb. sumithion blocks revealed little or no effect on birds. The evidence suggests that the hazard level for sumithion at a fine calibration is between 1/4 lb. and 3/8 lb./acre. Acute poisoning of birds at dosages of or below 1/4 lb. can probably be attributed to local concentration resulting from overlapping swaths or peculiarities of drift.

In summary, then, we can state that apparent inconsistencies in the effects of duplicated treatments at lower dosage levels can probably be attributed to the influence of operational variables. Assuming that these factors do not account for all the relatively greater and more widespread effects as compared with the effects of comparable dosages in previous years, which seem likely, our findings best fit the hypothesis that the finer spray is more toxic to birds than the coarser calibration. Dr. Fowle has demonstrated the ability of birds to pick up lethal amounts of insecticide through contact of the feet with sprayed plant surfaces. It is possible that birds are able to pick up relatively greater amounts when the material is distributed in a greater number of smaller droplets, though smaller droplets would probably be absorbed much faster by the plants. The possibility of entry into the bird through the respiratory system has, in the past, not been excluded. Birds may be able to inhale smaller droplets more readily than larger ones. Smaller droplets would take longer to settle and would be more easily carried about by small air currents within the forest and could prove hazardous to birds in the lower levels. More work will be needed to determine the extent to which the bird hazard is augmented by the smaller droplet size and to define the mechanism by which birds are able to pick up toxic dosages.

SUMMARY

During the 1968 control programs in New Brunswick and Newfoundland we conducted searches for evidence of harmful effects on forest birds in 24 spray areas. Intensive monitoring by censusing was carried out in

Table 11. Summary of block treatments and assessment of effect.

Block	Treatment	Effect
2	Phos. 3/8 lb., 1/5 USG, coarse, a.m.	Suppression of song. 1.4 sick birds/man-hour* searching.
25	Phos. 3/8 lb., 1/5 USG, fine, a.m.	Suppression of song, population indices. Little recovery of some species, especially warblers, 3 weeks later. 5.8 sick birds/man-hour searching.
45	Phos. 1/4 lb., 1/5 USG, fine, a.m.	Effect variable. 1.8 sick birds/man-hour searching.
32	Phos. 1/8 lb., 1/5 USG, fine, p.m.	Effect variable, slight. 0.6 sick birds/man-hour searching.
32 (Nfld.)	Phos. 1/8 lb., 1/5 USG, fine, a.m.	Birds silenced. Some bill wiping. No sick birds found.
1	Phos. + Sum. 1/4 lb. + 1/8 lb., 1/5 USG, fine a.m.	Birds silenced. 4.8 sick birds/man-hour searching.
9	Sum. 1/2 lb., 1/5 USG, fine, p.m.	Rain impeded search. Song counts suggest variable effect. 0.9 sick birds/man-hour searching.
16	Sum. 1/2 lb., 1/2 USG, coarse, a.m.	Some warblers grounded. No apparent song suppression. 0.3 sick birds/man-hour searching.
28	Sum. 1/2 lb., 1/5 USG, fine, p.m.	No apparent effect. Searched early. Some doubt as to whether correct area.
6	Sum. 3/8 lb., 1/5 USG, coarse, a.m.	Singing normal. 0.6 sick birds/man-hour searching.
7	Sum. 3/8 lb., 1/5 USG, fine, a.m.	Searching initiated over 48 hours after spray. Effect variable. 1.0 sick birds/man-hour searching.
8	Sum. 3/8 lb., 1/5 USG, fine, a.m.	Birds silenced, little activity. 2.6 sick birds/man-hour searching.
29	Sum. 3/8 lb., 1/5 USG, fine, a.m.	Marked population depression, some recovery. 6.8 sick birds/man-hour searching.

Table 11. Summary of block treatments and assessment of effect—Cont'd.

Block	Treatment	Effect
14	Sum. 1/4 lb., 1/5 USG, extra fine, a.m.	Rain impeded search but no apparent effect.
15	Sum. 1/4 lb., 1/5 USG, fine, a.m.	Localized. Some birds slightly affected.
20	Sum. 1/4 lb., 1/5 USG, fine, a.m., x 2, second treatment immediately following first.	Localized. 1.2 sick birds/man-hour searching.
30	Fen. 1/4 lb., 1/5 USG, fine, a.m.	None apparent.
34	Sum. 1/8 lb., 1/5 USG, fine, x 2, noon and evening same day.	Effect localized. 1.2 sick birds/man-hour searching.
24-25 (Nfld.)	Sum. 1/8 lb., 1/5 USG, fine, a.m., x 2, 6 days apart.	Slight effect, localized.
26	Sum. 1/8 lb., 1/5 USG, fine, a.m.	None apparent.
14 (Nfld.)	Sum. 1/8 lb., 1/5 USG, fine, a.m.	None apparent.
31	Sum. 1/8 lb., 1/5 USG, fine, a.m.	None apparent.
33	Sum. + DDT, 1/8 + 1/10 lb. 1/5 USG, fine, a.m., x 2 second treatment immediately following first.	None apparent.

* Number of sick birds includes those found dead, those captured, but not those only slightly affected. Searches by inexperienced observers abitrarily assumed to be half as effective as those by experienced ones.

only four of these as well as in two control areas which were not sprayed. Most of our work was concerned with two insecticides, phosphamidon and sumithion, applied at different dosages and calibrations. Some evidence of bird poisoning was detected in 15 of the areas sprayed. Table 11 gives a brief summary of our findings, which have been examined in the light of our experience in the past four years. Some previous conclusions have been strengthened but others remain unverified. From the effects of the 1968 programs we have drawn the following conclusions.

1. Evening spraying offers definite advantages to birds over morning spraying.
2. Phosphamidon is more toxic to birds than sumithion.
3. A fine spray-droplet spectrum augments the hazard to birds.
4. Phosphamidon probably begins to cause acute effects at a dosage of about 1/8 lb./acre when sprayed at a fine calibration.
5. Sumithion begins to cause acute effects at a dosage between 1/4 lb. and 3/8 lb./acre when sprayed at a fine calibration.
6. Phosphamidon kills birds at a 3/8 lb./acre dosage when applied at a coarse calibration. Hazard level is probably near 1/4 lb./acre.
7. Sumithion can kill birds when applied at 1/2 lb./acre at a coarse calibration.
8. Some anomalous results are ascribed to the effect of imponderable operational variables.

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