Progress Notes

Aussi disponible en français

No. 62, March 1976

Impact on forest birds of the 1975 spruce budworm spray operation in New Brunswick

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Abstract

The impact on breeding birds of a forest spray operation against spruce budworm in New Brunswick in 1975 is assessed by two independent methods: intensive surveys of singing males along walked transects and extensive surveys along motored transects. Extrapolation of data derived from those studies indicates that several million singing male birds, mostly canopy feeders, were killed. Birds feeding on or near the ground were not significantly affected. It seems likely that phosphamidon caused the major portion of the mortality but that fenitrothion was also involved. The application of aminocarb, in a spray format which included fenitrothion, also resulted in significant mortality to canopy feeders. Inadvertent overdosing, resulting from imprecise positioning of spray aircraft, may have contributed locally to the hazard to birds. Spray regimes were more complex and phosphamidon played a greater role in the 1975 operation than in spray programs conducted in the province in preceding years. For those reasons, songbird mortality in 1975 is judged to have been exceptionally and atypically high.

Introduction

Current attempts to protect eastern Canadian spruce–fir forests against severe defoliation by spruce budworm (*Choristoneura fumiferana*) have resulted in an annual aerial spraying of forest with insecticide, the largest such operation in the world. The area sprayed in New Brunswick alone amounted to about 2.7 million ha in 1975 (Figure 1). In 1976 spraying in that province will probably take place over about 4 million ha. Spray operations in Quebec are of similar magnitude. Protection programs against the current outbreak of spruce budworm in New Brunswick began in 1952 and, with the exception of 1959, have continued every year since. In that period about 5.7 million kg of DDT and 3.5 million kg of organophosphate insecticides were released over the New Brunswick forest. Fenitrothion has been the major insecticide used since 1968.

In 1975 spray operations in New Brunswick were characterized by complex combinations of insecticidal treatments (Table 1). The effects of some of those spray regimes on forest birds are reported here.

Method

Field activities were conducted in the context of aerial spraying by two organizations representing the public and private sectors, the two spray plans being superimposed. Insecticide was sprayed from either (*a*) Grumman Avenger (TBM) aircraft fitted with standard boom and nozzle equipment, or from (*b*) Thrush Commander aircraft fitted with rotary atomizers. Phosphamidon and trichlorfon were applied in water solution, fenitrothion as an emulsion, and aminocarb in oil solution.

Bird responses were assessed from two independent sets of data. The first set consisted of counts of singing male birds made by Canadian Wildlife Service personnel on line transects before and after spray treatment. Transects were oriented across the flight paths of spray aircraft in order to allow for the better interpretation of possible uneven application of spray. Four transects, each of 2–3 km, were run 12–18 times in each area studied. Spray regimes representing 70% of the total area sprayed were monitored (Table 1). Post-spray searches were made for avian carcasses and birds displaying symptoms of cholinesterase inhibition. The second set of data came from annually-conducted Breeding Bird Surveys on which point counts of birds were made every 0.8 km over a 40 km driven transect (Robbins and Van Velzen, 1967). The transects in New Brunswick were all made on dates after spraying had started, and comparisons were made between surveys done in 1974 and 1975 in sprayed and unsprayed areas. Those counts were made by volunteer ornithologists with no knowledge of the spray regimes.

Results and discussion

Line transects

The counts of birds in the area sprayed under regime A (Table 2) showed a significant decrease of Ruby-crowned Kinglets and Cape May Warblers following the first spray (fenitrothion) and a much more marked reduction following spraying with phosphamidon. The changes in numbers of Tennessee Warblers are masked by the low figures from the pre-spray period which was before the bulk of the population had arrived on the breeding ground.

Two transects were made in the area sprayed under regime E (Table 3). On both transects Tennessee Warblers virtually disappeared, although on one transect the major reduction was after the last spray (phosphamidon) and on the other, after the first spray (fenitrothion). The major reduction in numbers of Ruby-crowned Kinglets occurred after application of phosphamidon, whereas that of Cape May Warblers occurred after fenitrothion spraying.

The data from the area sprayed under the triple regime aminocarb-fenitrothion-aminocarb (regime F, Table 4) show no effect following the first spraying, some effect following the second, and a marked decrease of birds following the third. As the first and last aminocarb sprays were at the same dosage, those findings suggest an impact due to accumulative effects from multiple spray applications.

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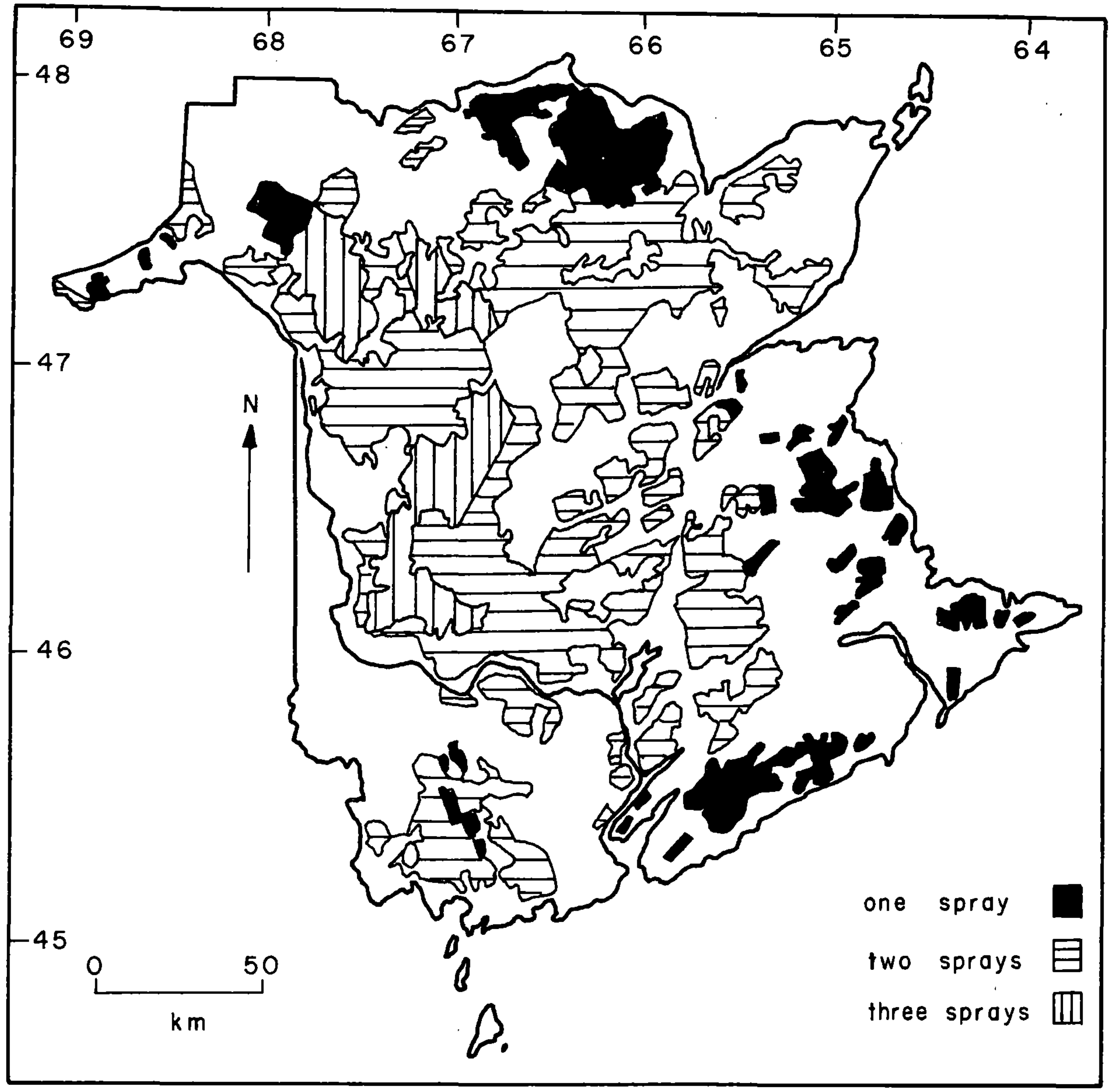
Figure 1
Map of New Brunswick showing area sprayed during 1975 larviciding operations against spruce budworm.



Our results indicate that a major portion of the kill of songbirds was due to exposure to phosphamidon. Fowle (1965) found very striking reductions following spraying with phosphamidon but the dosage used in those operations was 500 g/ha. Fowle (1972) concluded that, at an emitted dosage greater than 280 g/ha, phosphamidon may be hazardous to birds. Some losses in 1975 were, however, attributable to fenitrothion. The findings were in line with the National Research Council report (1975) which indicates that mortality of songbirds can be expected to start in the 140–280 g/ha range of application of that pesticide.

Two biases of the transect method of determining mortality favour the under-estimation of mortality. The first bias is the tendency to record a greater proportion of singing birds when fewer birds are present, thus masking any decline of song. The second bias is that a population reduction caused by early spraying may be offset by returning migrants.

Extrapolation from short transects to large areas involves the assumption that the sample areas studied were representative both in terms of habitat and patterns of application of spray. Uneven spatial distribution of changes of bird numbers along transects, together with observed overlapping of and gaps between swaths from spray aircraft, suggest that distribution and effects of spraying were far from uniform, but we have no measurement of deposit of insecticide in the areas studied. Nevertheless, there is no reason to suppose that the transect areas were atypical. With such vast areas involved in the spray operations, estimates of bird mortality can inevitably only be made by extrapolation from very small samples.

Direct spray mortality was observed in two of the three regimes monitored (A and E) and reports of dead and intoxicated birds were received from 15 widely-scattered localities, chiefly in the more heavily settled southern regions of the province and all in the zone subjected to spray regime A. In several cases, carcasses were obtained during on-site investigations. Later examination of spray schedules revealed that, in all reported instances, casualties were noted on days immediately following insecticide application. Bird mortality is deemed to have been fairly light in fenitrothion-treated areas. A heavier mortality apparently occurred in phosphamidon spray zones, many bird deaths being reported, for example, in the upper Tobique River valley (Christie, 1975). Dead birds representing twenty species in six families were found during the spray operation. Not surprisingly, the Parulidae were well represented on tallies of dead birds, since warblers numerically comprise 50–65% of the avifauna complex in the forest stands sprayed.

Breeding Bird Surveys

Table 5 gives the changes in populations of migratory forest birds from 1974 to 1975 for seven Breeding Bird Surveys made along routes lying completely or partially in zones sprayed under regime A (Table 1) and for eight surveys conducted in largely unsprayed areas in 1975. For those 15 surveys, comparisons were considered valid since, for any given route, the observer was the same and timing of the survey and weather during the survey were comparable in the two years. Two of the seven sprayed routes were surveyed before the second spray (phosphamidon) application. In the spray zone there were significant reductions of Least Flycatcher, Hermit Thrush, Ruby-crowned Kinglet, Red-eyed Vireo, Tennessee Warbler and Chestnut-sided Warbler: those species increased, though not significantly, in unsprayed areas. Significant decreases in Winter Wren, Nashville Warbler and Canada Warbler occurred in the spray zone, lesser declines occurring in untreated areas. An additional five species showed changes in the same direction but these were not significant. These data generally support the thesis that songbird populations were adversely affected in areas sprayed.

Kill estimates

If our figures of percentage reduction are typical of the spray regime as a whole, then using the data presented in Tables 1–4 it is possible to make some estimate of the total number of birds killed by the spray program. Regime A (fenitrothion followed by phosphamidon) was used over an area of 1.753 million ha, nearly two-thirds of the total area sprayed. Erskine (1968, 1969) gives bird population density values of 318–336 singing males/100 ha for species that we have called mid-crown to canopy, 96–121 for wide-ranging and 244–247 for ground to mid-canopy species. These density values were derived from a plot on which the forest composition was both very similar to the composition on the line transects in spray regime A and representative of a large proportion of the sprayed area. Bird densities on this plot fall roughly in the middle of a range of densities recorded for budworm areas in New Brunswick. Applying the percentage reductions for those classifications noted in regime A (Table 2), the calculated kills are 1.6 million in the mid-crown to canopy and 0.9 million for the wide-ranging species. Calculations for the other two spray regimes monitored add much smaller numbers of casualties. The total casualties for all three regimes are estimated at 2.0 million for mid-crown to canopy and 0.9 million for wide-ranging species. These estimated losses represent about one-fifth of the total number of singing males at risk in the mid-crown to canopy strata of the forest. In a further three spray regimes D, I and J (Table 1), totalling 212 thousand ha, phosphamidon was used at dosages which would be expected to cause mortality. These regimes were not monitored and are not considered in these calculations.

The birds recorded in this study were singing males. In the spring and early summer, singing males of these species may be reliably taken to represent breeding pairs. In addition, a certain proportion of the adults present in any one year do not breed (Stewart and Aldrich, 1951). If breeding females and non-breeders are not much less susceptible to forest spraying than are singing males, the adult casualties in the three regimes monitored considerably exceeded three million.

Acknowledgements

We are indebted to N. Garrity for assistance in bird census taking and to J.V. Dobell for drafting Figure 1.

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Table 1
Synopsis of major insecticidal treatments during the 1975 aerial spray operation against spruce budworm larvae in New Brunswick

Spray regime	Insecticide (emitted dosage in g/ha)*	Area sprayed (10^3 ha)
A	fenitrothion (175) + phosphamidon (175)†	1753
B	fenitrothion (175)	310
C	fenitrothion (280)	207
D	phosphamidon (140) + fenitrothion (175) + phosphamidon (175)	164
E	fenitrothion (280) + fenitrothion (175) + phosphamidon (175)†	87
F	aminocarb (52) + fenitrothion (175) + aminocarb (52)†	61
G	trichlorfon (280) + trichlorfon (280)	49
H	fenitrothion (175) + trichlorfon (280)	43
I	phosphamidon (175) + phosphamidon (175)	24
J	phosphamidon (280)	24
	miscellaneous	18
	Total	2740

*In terms of technical material. 1 oz/acre = 70 g/ha.
†Spray regimes monitored for impact on birds.

Table 2
Effect of spray regime A on number of singing males (mean, standard deviation) recorded on transect

Foraging habitat	Pre-spray Three counts May 18–20	Post-fenitrothion (175 g/ha) Six counts May 22–June 4	Post-phosphamidon (175 g/ha) Six counts June 6–24	% overall change
Mid-crown to canopy	118.3 ± 10.4	128.5 ± 20.5	84.3 ± 8.6*	-29†
Wide-ranging	53.7 ± 17.9	33.2 ± 8.8*	29.0 ± 5.5	-46†
Ground to mid-crown	134.7 ± 11.7	145.7 ± 20.5	127.7 ± 11.0	-5
Selected species				
Ruby-crowned Kinglet	13.3 ± 2.3	9.7 ± 2.4	2.6 ± 1.7*	-80†
Cape May Warbler	14.3 ± 3.3	6.2 ± 3.7*	1.3 ± 0.7*	-91†
Tennessee Warbler	11.3 ± 6.1	32.5 ± 9.5*	13.7 ± 4.8*	-58†‡
Ovenbird	51.0 ± 3.7	48.7 ± 10.5	46.7 ± 3.7	-8
White-throated Sparrow	22.0 ± 4.2	18.7 ± 3.4	18.1 ± 3.4	-20

*Change from previous series of counts is significant at 95% level.
†Significant at 95% level.
‡Based on second period against third as Tennessee Warbler numbers were very low pre-spray, indicating that much of the population had not yet arrived.

Table 3
Effects of spray regime E on number of singing males (mean, standard deviation) recorded on transects

1st transect

Foraging habitat	Pre-spray Five counts May 25–June 2	Post first fenitrothion (280 g/ha) Three counts June 4–6	Post second fenitrothion (175 g/ha) Six counts June 11–18	Post-phosphamidon (175 g/ha) Four counts June 22–25	% overall change
Mid-crown to canopy	80.8 ± 11.8	68.7 ± 4.0	55.1 ± 3.6*	15.5 ± 2.7*	-81†
Wide-ranging	12.0 ± 4.8	7.7 ± 4.0	10.0 ± 3.1	12.5 ± 2.7	+4
Ground to mid-crown	35.2 ± 8.0	24.6 ± 6.4	23.0 ± 3.3	16.5 ± 6.1	-53†
Selected species‡					
Ruby-crowned Kinglet	12.0 ± 3.8	10.3 ± 2.3	8.0 ± 0.9	2.3 ± 1.1*	-81†
Cape May Warbler	11.6 ± 2.7	4.3 ± 1.2*	6.2 ± 2.0	4.5 ± 0.5	-61†
Tennessee Warbler	43.6 ± 5.3	38.0 ± 4.0	23.2 ± 3.4*	3.0 ± 0.7*	-93†
White-throated Sparrow	7.0 ± 4.3	3.3 ± 1.5	6.0 ± 2.2	3.3 ± 1.5	-53

2nd transect§

Foraging habitat			Six counts June 11–22	Three counts June 23–25	
Mid-crown to canopy	44.4 ± 10.4	49.6 ± 5.8	41.8 ± 4.6	36.5 ± 6.8	-18
Wide-ranging	8.4 ± 4.3	7.7 ± 1.2	7.6 ± 1.7	4.3 ± 0.8*	-50†
Ground to mid-crown	63.8 ± 14.2	69.7 ± 5.9	66.4 ± 9.8	58.0 ± 5.6	-9
Selected species‖					
Tennessee Warbler	4.6 ± 2.4	0.3 ± 0.5*	0.0 ± 0.0	0.0 ± 0.0	-100†
Ovenbird	7.6 ± 3.2	6.7 ± 1.1	4.7 ± 1.4	4.7 ± 1.5	-38
White-throated Sparrow	7.4 ± 4.4	4.7 ± 2.1	6.2 ± 1.7	3.3 ± 2.5	-55

*Change from previous series of counts is significant at 95% level.
†Significant at 95% level.
‡Ovenbird data insufficient for analysis.
§There is evidence that not all the area covered by transect was sprayed.
‖Ruby-crowned Kinglet and Cape May Warbler data insufficient for analysis.

Table 4
Effect of spray regime F on number of singing males (mean, standard deviation) recorded on transect

Foraging habitat	Pre-spray Five counts May 30–June 10	Post first aminocarb (52 g/ha) One count June 12	Post-fenitrothion (175 g/ha) Three counts June 19–21	Post second aminocarb (52 g/ha) Three counts June 27–29	% overall change
Mid-crown to canopy	91.6 ± 10.8	88	73.3 ± 2.1	53.7 ± 3.7*	-41†
Wide-ranging	11.2 ± 2.7	13	13.7 ± 2.5	11.7 ± 3.7	+4
Ground to mid-crown	51.0 ± 12.1	46	47.4 ± 7.6	59.7 ± 4.7	+14
Selected species‡					
Ruby-crowned Kinglet	9.8 ± 2.0	11	5.0 ± 1.7	4.7 ± 0.9	-52†
Cape May Warbler	9.8 ± 2.1	9	7.7 ± 1.1	10.7 ± 1.7	+9
Tennessee Warbler	40.8 ± 11.3	38	29.3 ± 2.3	2.6 ± 0.5*	-94†
White-throated Sparrow	10.8 ± 1.4	11	8.3 ± 3.2	14.6 ± 1.5	+35

*Change from previous series of counts is significant at 95% level.
†Significant at 95% level.
‡Ovenbird data insufficient for analysis.

Table 5
Changes from 1974 to 1975 in populations of migratory forest birds for comparable routes in areas sprayed against spruce budworm and in unsprayed areas of New Brunswick (adapted from Erskine 1976, plus unpublished data)

Species (foraging habitat code)*	% change and 95% confidence limits: Sprayed routes (7)	% change and 95% confidence limits: Unsprayed routes (8)
Yellow-bellied Sapsucker (W)	+48 ± 63	+37 ± 113
Least Flycatcher (L)	-31 ± 30†	+18 ± 44
Eastern Wood Pewee (H)	-41 ± 28†	-55 ± 32†
Winter Wren (L)	-38 ± 18†	-3 ± 23
Hermit Thrush (L)	-23 ± 16†	+44 ± 109
Swainson's Thrush (L)	-4 ± 32	+26 ± 42
Veery (L)	-22 ± 37	-1 ± 41
Ruby-crowned Kinglet (H)	-17 ± 10†	+17 ± 28
Solitary Vireo (H)	+95 ± 72†	+414 ± 807
Red-eyed Vireo (H)	-36 ± 14†	+18 ± 52
Black-and-white Warbler (W)	-58 ± 59	+39 ± 97
Tennessee Warbler (H)	-27 ± 13†	+13 ± 56
Nashville Warbler (H)	-40 ± 18†	-15 ± 46
Parula Warbler (H)	-3 ± 57	+97 ± 120
Magnolia Warbler (L)	+13 ± 38	+32 ± 34
Yellow-rumped Warbler (W)	+39 ± 130	+36 ± 198
Black-throated Green Warbler (H)	+69 ± 208	+12 ± 54
Blackburnian Warbler (H)	-49 ± 80	-32 ± 67
Chestnut-sided Warbler (L)	-48 ± 39†	+32 ± 39
Bay-breasted Warbler (H)	+23 ± 29	+6 ± 46
Ovenbird (L)	-34 ± 27†	-20 ± 19†
Northern Waterthrush (L)	-21 ± 39	-32 ± 6†
Mourning Warbler (L)	-31 ± 21†	-59 ± 25†
Canada Warbler (L)	-41 ± 34†	-6 ± 65
American Redstart (H)	-4 ± 14	-4 ± 43
Rose-breasted Grosbeak (H)	+29 ± 134	+14 ± 31
Evening Grosbeak (H)	+45 ± 42	+290 ± 720
Purple Finch (H)	+12 ± 8	-11 ± 48
Dark-eyed Junco (L)	-9 ± 11	+10 ± 77
White-throated Sparrow (L)	-2 ± 6	-2 ± 16

*W, wide-ranging; L, low (ground to mid-crown); H, high (mid-crown to canopy).
†Change at least 95% significant.