



RESEARCH ON IMPACT OF PESTICIDES
ON NON-TARGET FAUNA

by

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Research on Impact of Pesticides on Non-target Fauna:

A. Introduction

The applications of pesticides on a large scale have caused from time to time adverse side effects on various fauna in the forest environment, more particularly fish, aquatic fish-food organisms, birds and parasites and predators of pests. As a consequence, studies have been conducted on the susceptibility of various species of fish and birds to insecticides, and on effects of aerial application on captive and free living populations of non-target species, with the objective of establishing guidelines or criteria that will minimize losses to forest and related aquatic fauna. Some research and monitoring programs have been carried out by fish and game departments of provincial governments. More extensive programs along these lines have been conducted by several agencies of ^{the} Department of Fisheries and Environment (D.F.E.) that administer federal statutory responsibilities relating to the fish, migrating bird and water resources of Canada, along with the Regional Centers of C.F.S. and the Environment Impact Section of the Chemical Control Research Institute (C.C.R.I.) as mentioned above.

B. Organization

The several services and their principal research activities related to aerial spraying operations are described below:

1. Fisheries and Marine Service

- (a) Research on the biology of fish and other aquatic organisms, and their habitat relationships.
- (b) Studies on the influence of insecticides on fish behaviour and survival.
- (c) Establishment of acute and sub-lethal tolerance limits to insecticide concentrations, of the more important fish species inhabiting

forest streams and lakes, either as permanent residents or for part of their life cycle.

2. Canadian Wildlife Service.

(a) Research on the biology and ecology of migratory birds.

(b) Studies of the effects of insecticides on behaviour, survival and reproductive capacity of birds and other animals.

(c) Monitoring the effects of aerial application of pesticide on field populations of migratory birds.

3. Environmental Protection Service

(a) Studies of concentrations of insecticides in forest streams and lakes, in relation to tolerance limits for fish.

(b) Monitoring the effects of aerial application of insecticides on fish populations and fish-food organisms.

4. Canadian Forestry Service

As mentioned in the organization of the C.F.S., the Environment Impact Section of C.C.R.I. and some of the Regional Forest Research Centres also carry out research on the impact of newly developed pesticides on various components of forest ecosystem before recommending for operational field trials. The various impact studies are as follows:

(a) Chemical Control Research Institute (Environment Impact Section)

(i) Short and long term effects of insecticides on forest vertebrates and invertebrates eg., 6 years study of fenitrothion conducted in the Larose Forest, Ontario. The Larose Forest Project is an example of a long-term research study to evaluate the short-and long-term consequences of prolonged pesticide usage on the forest ecosystem. The study, now in its seventh year adopts a total system approach, with

emphasis on both terrestrial and aquatic compartments. Repeated treatments of Fenitrothion at simulated operational levels have been followed by studies on the vertebrate and invertebrate fauna to determine any lethal and sub-lethal effects, including the possible disruption of food webs. Ecological data on the population dynamics of the various ecosystem components have been supported and interpreted using chemical residue analyses on the various important biotic and mineral substrates. Conclusions derived from the study indicate a minimal effect of prolonged usage of this material on the forest integrity.

(ii) Research into methodology for assessing impact of insecticides on birds, mammals, fish, pollinators, and aquatic and terrestrial invertebrates with emphasis on territorial surveys of birds, reproduction of small mammals, use of domestic honey bees to assess effects on wild pollinators and effects on fish food organisms.

(iii) Insecticide residues in forest environments, their accumulation and persistence in non-target organisms.

(iv) Fate and ecological effects of insecticides in small lakes.

(b) Maritimes and Pacific Forest Research Centre

(i) Effect of insecticides on non-target insects especially parasites and predators.

C. Research on Selected Components of the Forest Ecosystem by Various Services of D.F.E.

1. Birds

Studies were carried out to develop methodologies for looking at pesticide effects on forest songbirds through territorial and singing-male surveys.

Operational applications of fenitrothion, phosphamidon and MATACIL[®] have been found to occasionally cause reductions in populations of specific groups of forest songbirds depending on dosage rate and application conditions. Species inhabiting open areas appear to be the most susceptible to applications of these insecticides, the warblers (family Parulidae), kinglets (family Sylviidae) and finches (family Fringilidae) comprised the groups which suffered the greatest impact. Applications of fenitrothion within research areas at dosage rates six times those used in forest protection programs have been documented as causing population reductions and reproductive failures among warblers and finches. Studies into the long term effects of operational dosages of fenitrothion on small song bird populations are presently being carried out in a research area near Ottawa. Populations have been intensely monitored on plots receiving from one to five yearly applications. Extensive chemical sampling has been conducted on these plots to study the persistence of fenitrothion residues in foliage, soil, water and animal tissue. No serious or long-term effect could be identified.

2. Aquatic fauna

Research is conducted into the effects of pesticide usage on fish and fish food organisms. Forest insecticides currently in use have been shown to have little or no impact on fish, but sometimes affect fish food populations. The extent to which fish growth may be affected has not been identified. Recent research has looked into the effects of chemical insecticides introduced into lakes during multi-million acre forest protection programs. Fenitrothion has been found to have little effect on lake fauna at operational dosages (ie, 2-4 oz/acre). Damage and recovery of lake biota has been studied by exposing a lake to insecticide treatment

at a very high dosage level. Considerable research on lethal and sub-lethal effects of pesticides on fish and aquatic invertebrates has been conducted under laboratory conditions. The effects of sublethal exposure of fish to pesticides has also been studied with respect to behavior, vulnerability to predation, locomotory prowess and other parameters. Bioassays have been conducted to establish pesticide concentrations lethal to native Canadian fish and fish food organisms. Other research has studied effects of organochlorine and organophosphate insecticides on fish physiology.

3. Pollinators

Wild pollinators are essential components of forest ecosystems. In order to assess the impact of forest pest control programs on this important group of non-target insects, research is conducted into the effects of pesticide applications on domestic honey bees. Studies of this nature have been conducted in areas treated with fenitrothion, phosphamidon, MATACIL[®], ZECTRAN[®], Orthene[®], methoxychlor, dimethoate, Bacillus thuringiensis, Dimilin[®] and the nuclear polyhedrosis virus of spruce budworm. Impact is measured by monitoring mortality at the hive, pollen collection, flight activity, hive growth and production and development of brood. Applications of chemical insecticides have been shown to sometimes cause increases in adult mortality immediately following treatment and in some instances pollen collection and colony behavior have also been affected. Even when initial adult mortality is apparently high, the effects of these insecticide applications have been short-lived and overall colony strength and hive vigor has not appeared to be seriously damaged. No impact on honey bee colonies has been measured in areas treated with biological insecticides.

4. Insect predators and parasites

Research was carried out for the effects of forest pest control operations on parasite and predators of some pest species. Phosphamidon can cause severe immediate kill of spruce budworm parasitoids but this has not adversely affected the percentage of parasitism in the next generation of budworm. Mortality of budworm predators was found to be minor. Recurrent applications of fenitrothion do not reduce the effectiveness of biotic control by parasites and predators. Also B.t. formulations had no significant impact on budworm parasites or other non-target insects.

5. Small mammals

Investigations on the impact, on small forest mammals, of experimental and operational applications of several chemical and biological insecticides, viz. Matacil[®] (New Brunswick, Quebec), phosphamidon (New Brunswick), Zectran[®] (Quebec), Sevin[®] (Manitoba), fenitrothion (New Brunswick, Quebec, Ontario, Manitoba, British Columbia), Bacillus thuringiensis (Ontario, Manitoba), a juvenile hormone analog (Quebec), and the entomopoxvirus and the nuclear polyhedrosis virus of the spruce budworm (Ontario) were carried out. At recommended rates of application these materials have no adverse effects on small mammal populations.

6. Amphibians

Research has established the safe levels of several insecticides towards frog larva in the laboratory and shown that operational dosages of these insecticides have no significant effects on native frog and toad populations. Field research has confirmed this in areas treated under operational conditions.