PROCEEDINGS
OF
WORKSHOP

FATE AND EFFECTS OF FOREST PESTICIDES
.....the Newfoundland experience

NORTHWEST ATLANTIC FISHERIES CENTRE
DEPARTMENT OF FISHERIES AND OCEANS
ST. JOHN'S, NEWFOUNDLAND

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Workshop Proceedings

FATE AND EFFECTS OF FOREST PESTICIDES
(the Newfoundland experience)

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Oceans

n/c
from Coady
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Executive Boardroom
Northwest Atlantic Fisheries Centre
Wednesday, May 14, 1986

October, 1986

AGENDA

Fate and Effects of Forest Pesticides (the Newfoundland experience)

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List of Participants

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On May 14, 1986 the Fisheries Research Branch, Department of Fisheries and Oceans sponsored an informal workshop on the "fate and effects of forest pesticides" as part of an ongoing series of seminars at the Northwest Atlantic Fisheries Centre. These proceedings reflect discussions.

1. Opening remarks — L. Coady (Chair)

Mr. Coady welcomed the group. He referenced a one-page Notice to Participants which had been circulated in advance of the meeting. Given the diversity of the group, it proved necessary to develop very general terms of reference for the workshop. It was felt that general emphasis should be given to key research findings over the past nine years of experimental/operational spraying in Newfoundland. In Mr. Coady's view, the session provided a excellent opportunity for federal, provincial and public groups to exchange views on the fate and effects of forest pesticides and related issues.

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2. Overviews

Nine groups made presentations (see agenda). Speakers provided brief summaries for inclusion in these proceedings.

- Environment — S. Bonnyman

Ms. Bonnyman provided a review of spruce budworm environmental monitoring programs conducted by the Government of Newfoundland and Labrador since 1977 and a summary of studies and results:

> "The Department of Forest Resources and Lands conducted its first chemical aerial spray program against spruce budworm in 1977. The program was directed at forest areas with a large infestation of budworm, and was experimental in nature. Several different pesticides were utilized, and environmental monitoring was conducted on the major experimental spray regimes.
>
> An operational campaign using primarily matacil, with some *Bacillus thuringiensis* (*B.t.*) was mounted in 1978, 1981, 1982, 1983, 1984, and 1985 with associated monitoring programs. In 1979 and 1980 small hectarages were sprayed with *B.t.* In these two years, monitoring was continued at sites sprayed previously with matacil to examine long-term persistence in the environment.
>
> Experimental and control blocks established in 1980 have been maintained for environmental monitoring activities. Permanent designation has proven much more satisfactory than earlier attempts to "follow around" operational

blocks, which made the collection of prespray data difficult, if not impossible.

A wide variety of studies (Table 1) was undertaken in the early years of the program, including studies on terrestrial insects, soil arthropods, aquatic invertebrates, small mammals, fish and song birds. In late 1982 an overall review led to a more directed approach in the established experimental and control sites. Song-bird field studies continued until 1983. In 1984 a comprehensive analysis of the data collected since 1979 was carried out. Aquatic invertebrate populations were monitoring until 1985. The first year of a 2-year pollinator study was also conducted in 1985.

Early results are generally not conclusive. The major lessons from the program concern aquatic invertebrates and song-birds. Results from drift sampling and artificial substrates indicate no impact from matacil at operational doses, in a direct overspray scenario. These results are derived from spraying a control block following collection of two years' data. The comprehensive analysis of song-bird data revealed no major differences in experimental and control populations. However, sprayed areas differed from non-sprayed areas in their bird community characteristics.

All results indicate that matacil sprayed at operational doses results in:

1. immediate knock down of terrestrial insects (short term) and may possibly affect soil arthropods;
2. non-detectable impacts on aquatic invertebrates; and
3. a very small change in song bird diversity, but not numbers."

- Forest Resources and Lands — J. Hudak (for H. Crummey)

Mr. Crummey was unable to attend as he was involved in preparations for the forthcoming field season. He nevertheless forwarded a report on the efficacy of forest protection programs against insect pests in Newfoundland and a summary of various spray regimes used in spruce budworm control 1977-1985. His report:

"These comments address the question of what we have learned about the efficacy of spray programs carried out by the provincial Department of Forest Resources and Lands over the past nine years. Programs were initiated mainly against the spruce budworm although a new infestation of hemlock looper is threatening Newfoundland forests and a spray program was carried out in 1985. Areas sprayed

Table 1. Biological Sampling Programs; 1977-85.

	1977		1978		1979		1980		1981		1982		1983		1984		1985	
Sampling Method	CHEM	B.t.	CHEM	B.t.	CHEM	B.t.	CHEM	B.t.	CHEM	B.t.	CHEM	B.t.	CHEM	B.t.	CHEM	B.t.	CHEM	B.t.
A. Terrestrial Arthropods																		
Sweepnetting	X		X	X														
Beating of trees	X																	
Pitfall traps	X	X																
Night Sweeping	X	X																
Deadfall traps	X	X									X							
Soildwelling			X		X	X	X	X										
Plantdwelling					X	X	X	X			X							
Malaise trap			X															
Pollinators																	X	
B. Aquatic Invertebrates																		
Artificial Substrates									X		X		X		X		X	
Drift Sampling	X	X	X						X		X		X		X		X	
Surber Sampling	X	X	X						X		X							
C. Bird Communities																		
Song Census	X	X	X		X		X		X		X							
Mist Netting	X	X	X		X		X		X		X		X					
Adult: Immature ratio			X		X		X		X		X		X					

during the past nine years, including aircraft used and products, are listed in Tables 2 and 3.

Effectiveness monitoring usually involves intensive surveys of prespray larval, post-spray larval/pupal and defoliation in treated and untreated plots. The main objective of spray operations against insects is to protect the softwood trees from defoliation and not to eradicate the pest. In any one year, only a portion of the total area infested is actually treated to minimize risk to non-target organisms, including man.

In essence, it can be said that the objectives of the programs have been met i.e. foliage and trees have been protected and the resource, where treated, has been preserved. Annual reports and summaries on the programs have verified that spray programs generally are efficacious although certainly there are instances where, for a variety of reasons, the results are less than ideal, the most common problems being:

- the timing of application which might be delayed because of "bad" weather;
- the number of applications;
- the development of the insect;
- the location of sample plots used to evaluate success which, in some cases, may have been better situated; and
- the atmospheric conditions during spraying and immediately afterwards.

One cannot expect 100% success all of the time.

The most obvious evidence of efficacy is the degree of defoliation in treated versus untreated areas. This has been well documented in Newfoundland when comparing within years and from year to year. Simply put, treated areas are less defoliated than untreated. Also, it has been seen within years that where buffers have been left, eg. along Noel Paul's Brook in central Newfoundland, defoliation occurs and pockets of infestation continue to the detriment of the resource.

We can now turn our attention to the types of products used and how they affect efficacy. Generally, the use of chemical insecticides has resulted in better crop protection in Newfoundland than the use of the biological insecticide Bacillus thuringiensis (B.t.). That is not to say that B.t. does not work; there are instances where B.t. works as well as chemicals, but there has been no consistency in its efficacy. In recent years, B.t. manufacturers have improved their formulations and increased the potency of their products as well as becoming

TABLE 2

Summary of Various Spray Regimes Used for Spruce Budworm Control (Including Environmental Spraying) in Newfoundland 1977 - 1985

Year	Spray Regime[a]	Area (Ha) Treated Single-Engine[c]	Multi-Engine[d]	Total
1977	1.[b] 2 appl. 210g Sum/1.46L/ha+ 1 appl. 88g Mat/1.46L/ha	-	16 180	
	2.[b] 3 appl. 88g Mat/1.46L/ha	-	16 180	
	3.[b] 2 appl. 210g Sum/1.46L/ha	-	16 180	
	4.[b] 2 appl. 88g Mat/1.46L/ha	9 600	-	
	5.[b] 3 appl. 70g Mat/1.46L/ha	-	16 180	
	6.[b] 1 appl. 20BIU Th16B + 56g Ort/5.84L/ha+ 1 appl. 20BIU Th16B/5.84L/ha	-	2 590	
	Annual Sub-Total	9 600	67 310	76 910
1978	1. 2 appl. 70g Mat/1.46L/ha	9 929	340 003	
	2. 1 appl. 70g Mat/1.46L/ha	102	26 570	
	Annual Sub-Total	10 031	366 573	376 604
1979	1. 1 appl. 20BIU Th16B/5.84L/ha	5 650	-	
	2.[b] 1 appl. 20BIU Th24B/5.84L/ha	140	-	
	3.[b] 1 appl. 20BIU N45/5.84L/ha	80	-	
	Annual Sub-Total	5 870	-	5 870
1980	1.[b] 1 appl. 20BIU Th16B/5.84L/ha	7 345	-	
	2.[b] 1 appl. 20BIU Th24B/4.67L/ha	400	-	
	3.[b] 1 appl. 20BIU Th32B/2.34L/ha	400	-	
	4.[b] 1 appl. 20BIU N45B/4.67L/ha	400	-	
	5.[b] 1 appl. 20BIU N3/4.67L/ha	1 820	-	
	6.[b] 1 appl. 20BIU D88/4.67L/ha	600	-	
	7.[b] 2 appl. 20BIU Th16B/5.84L/ha	96	-	
	8.[b] 2 appl. 20BIU D88/4.67L/ha	700	-	
	Annual Sub-Total	11 761	-	11 761
1981	1. 1 appl. 70g Mat/1.46L/ha	-	17 990	
	2. 1 appl. 86g Mat/1.46L/ha	3 200	70 478	
	3. 2 appl. 70g Mat/1.46L/ha	2 180	51 943	
	4. 2 appl. 86g Mat/1.46L/ha	-	13 208	
	5. 1 appl. 70g Mat/1.46L/ha+ 86g Mat/1.46L/ha	-	79 064	

Year	Spray Regime[a]	Area (Ha) Treated: Single-Engine[c]	Multi-Engine[d]	Total
1981	6. 2 appl. 20BIU Th16B/7L/ha	720	-	
	7. 1 appl. 20BIU D88/7L/ha	1 200	-	
	Annual Sub-Total	7 300	232 683	239 983
1982	1. 1 appl. 70g Mat/1.46L/ha	1 293	-	
	2. 2 appl. 70g Mat/1.46L/ha	41 816	-	
	3. 1 appl. 20BIU Th16B/7L/ha	4 725	-	
	Annual Sub-Total	47 834	-	47 834
1983	1. 1 appl. 70g Mat/1.46L/ha	-	622	
	2. 2 appl. 70g Mat/1.46L/ha	15 749	50 183	
	3. 2 appl. 70g MatF/1.46L/ha	2 591	3 615	
	Annual Sub-Total	18 340	54 420	72 760
1984	1. 1 appl. 70g Mat/1.46L/ha	1 250	-	
	2. 2 appl. 70g Mat/1.46L/ha	21 816	-	
	3. 1 appl. 20BIU Th16B/7L/ha	720	-	
	4. 1 appl. 20BIU D132/1.57L/ha	1 680	-	
	5. 2 appl. 20BIU D132/1.57L/ha	710	-	
	Annual Sub-Total	26 336	-	26 336
1985	1. 1 appl. 20BIU D132/1.57L/ha	3 450	-	
	2. 2 appl. 70g Mat/1.46L/ha (environment only)	2 945	-	
	Annual Sub-Total	6 395	-	6 395

a) Fol = Folithion[R] (Fenitrothion)
Mat = Matacil[R] (Aminocarb)
Mat F = Matacil Flowable[R] (Aminocarb)
Ort = Orthene[R] (Acephate)
Sum = Sumithion (Fenitrothion)
Th = Thuricide[R] (*Bacillus thuringiensis*)
N = Novabac[R] (*Bacillus thuringiensis*)
D = Dipel[R] (*Bacillus thuringiensis*)

b) Includes experimental as well as operational spraying.

c) Includes: Piper Pawnee; Cessna AgTruck; Cessna AgWagon; Grumman AgCat

d) Includes: Douglas DC-6B (1977, 1978, 1983, 1985); Douglas DC-4 (1981); Super Constellation (1981).

TABLE 3

Summary of Spray Regimes Used For Hamlock Looper Control in Newfoundland 1985

Year	Spray Regime[a]	Area (Ha) Treated Single-Engine[b]	Multi-Engine[c]	Combination[d]	Total
1985	1. 1 appl. 210g Fol/1.5L/ha	4 864	10 382	3 964	
	2. 1 appl. 280g Fol/1.5L/ha	2 920	36 894	-	
	3. 2 appl. 210g Fol/1.5L/ha	12 889	33 232	17 583	
	4. 1 appl. 30BIU D132/2.36L/ha	2 365	-	-	
	Annual Sub-Total	23 038	80 508	21 547	125 093

a) Fol = Folithion[R] (Fenitrothion)
D = Dipel[R] (*Bacillus thuringiensis*)

b) Grumman AgCat

c) DC-6B

d) Large aircraft applied the first application; AgCats applied the second application.

more competitive with chemicals price-wise. For these reasons, more is being used and with greater success than in the past.

The decision to protect a crop must come early in the infestation before extensive damage is allowed to occur. Late decisions mean that the crop is subjected to defoliation and hence growth loss and decreased vigor which lessens its ability to withstand subsequent attack by insects and disease.

One final comment should be made. Insecticides would not be used if they were not efficacious and if they caused any long lasting significant impact on non-target organisms. The decision to use this management tool is made only after serious evaluation and consideration of all implications and concerns."

- Fisheries and Oceans R. McCubbin/P. Ryan

Mr. McCubbin's presentation focused on monitoring experiences and a number of Department of Fisheries and Oceans (DFO) involvements.

"Since 1980, pesticide research in Canada has departed from environmental impact type studies, which attempted to determine potential impacts from aerial pesticide application at an ecosystem level. Several comprehensive studies have been mounted by spray researchers intent on taking a holistic approach to pesticide impacts only to find that their results were, at best, inconclusive. It can be concluded that it would require practically a catastrophic impact to the aquatic ecosystem to determine, in a scientifically valid manner, that a pesticide application had an impact distinguishable from naturally induced variability.

Forest insect pest researchers are often quick to point out, that adverse weather (e.g. cold damp conditions) at a critical instar larval phase will do more to knock down forest pest levels than the most efficient of pesticide spray operations.

Natural ecosystems are perhaps more resilient from an environmental impact perspective than expected. This may explain why results of laboratory toxicity tests on stream biota are rarely collaborated in field study research. When one considers that in an acute lethality toxicity test, fish are often exposed to a constant concentration of a pesticide in stagnant water that has little to no dissolved particulates, this is hardly surprising. How comparable are these tests to natural ecosystems where fish are only exposed to relatively brief spats of pesticide concentrations, often in the low parts per billion range, in an environment where the pesticide is immediately subjected to various degradation pathways such as photolysis, hydrolysis, adsorption or absorption to organic or inorganic particles or microbial breakdown?

More and more in the 1980's, spray researchers have focused on specific aspects of sublethal effects monitoring. Recent reductions in both manpower and budgets demand that any research be highly goal specific. For this reason the concept of "comfort monitoring" is becoming more common. Comfort monitoring is designed to provide information on a specific concern that government or the general public might have.

In 1985, with a forecast of moderate to severe defoliation in 270,000 ha of forest in Newfoundland, the provincial government mounted an aerial spray program against the hemlock looper using fenitrothion. For the first time a decision was made to spray portions of the Avalon Peninsula. Of specific concern to DFO was the Colinet spray block, due to the fact that this river is the main recipient of Atlantic salmon fry transferred from the spawning channel at North Harbour. Concerns were also expressed by the Salmon Association of Eastern Newfoundland that fenitrothion could be detrimental to young salmon fry transferred to the Colinet River. SAEN contended that transferred fry, which are metabolically very active at that stage of their life history and which are highly stressed from the fry transfer operation, could be adversely affected from fenitrothion spray operations.

Protection of Colinet River from inadvertent spraying was complicated by the morphology of the upper watershed as the river follows a dendritic pattern in this area making the appropriation of a 400 m no spray buffer zone somewhat difficult.

In response to public concern, the Department of Fisheries and Oceans initiated sublethal toxicity effects monitoring on the Colinet River. The specific criterion chosen as an indicator of fenitrothion exposure was acetylcholinesterase inhibition in the brains of young salmonids.

Two spray blocks were monitored. The first was in Colinet River (above Colinet Pond) with a control on the North Harbour River. The second environmental sampling site was located off the Avalon on Frenchmen's Brook (near Grand Falls) with a control on an unnamed tributary of the Exploits River just above Grand Falls. The latter sampling location was selected due to the fact that the Environmental Protection Service was conducting environmental monitoring in this spray block including determinations of pesticide concentration levels in water. Fenitrothion was applied twice at an application rate of 210 g ai/ha with a 400-meter no-spray buffer zone designated to protect aquatic environments.

Samples of Atlantic salmon parr and juvenile brook trout ranging in size from 4 to 15 cm in length were collected using electroshocking equipment, both pre-spray and 24-hours post spray for the Grand Falls location and pre-spray and 48 hours and 96 hours post-spray for the Colinet site. Sample sizes ranged from 20 - 30 fish for the Colinet site to 45-75 fish for the Grand Falls site.

Once caught, fish were frozen on dry ice while in the field, transported to the laboratory and held at -70°C until analysis. Brain tissues were pooled from five fish of similar length, and assayed for acetylcholinesterase. With maximum fenitrothion exposures (in water) of 21 ppb (which occurred 10 minutes post spray), no significant differences in enzyme activity were obtained in tissue preparations of fish from the Grand Falls experimental site when compared to controls which showed no acetylcholinesterase depression. Similarly no acetylcholinesterase inhibition could be detected in salmon taken from the Colinet spray block. Department of Forest Resources and Land spray personnel confirmed that both experimental spray blocks had been sprayed. Since the inhibition of acetylcholinesterase is a sensitive indicator of fenitrothion poisoning, it would appear that the 1985 Hemlock Looper Spray Program in Newfoundland did not have any direct effects on fish populations in the area.

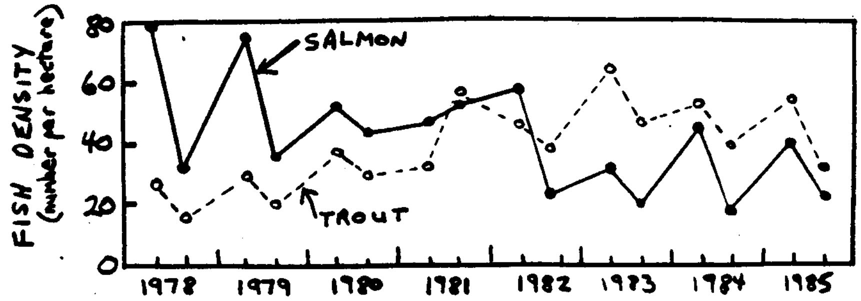
Unfortunately, no corresponding chemical assay was taken for the Colinet site, so although we can say that Colinet River fish did not experience any acetylcholinesterase inhibition, we cannot judge the level of exposure. The sampling did, however, prove that fish in the fry transfer area did not exhibit any sign of fenitrothion poisoning."

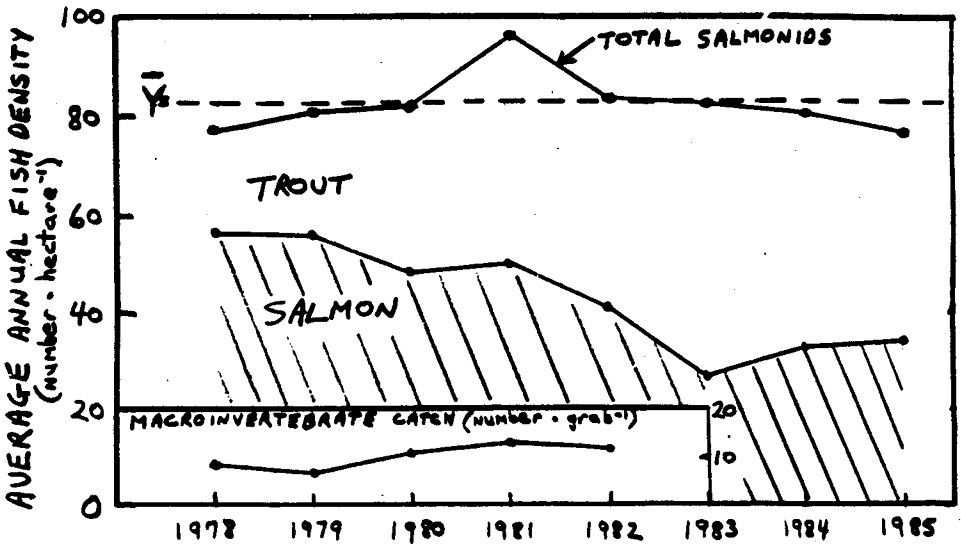
Mr. Ryan outlined DFO research activities in the Experimental Ponds Area in central Newfoundland. He questioned Mr. McCubbin's comments on the applicability of data from the Experimental Ponds Area to demonstrate impacts and felt that they were incorrect. He offered a diagram (Fig. 1) as a direct rebuttal. The EPA project consists of ecological research contributing to the understanding of freshwater salmonid ecosystems. Research has been ongoing since 1977 and information has been collected on habitat requirements, food and feeding,

Figure 1.

P.M. Ryan - May 1986

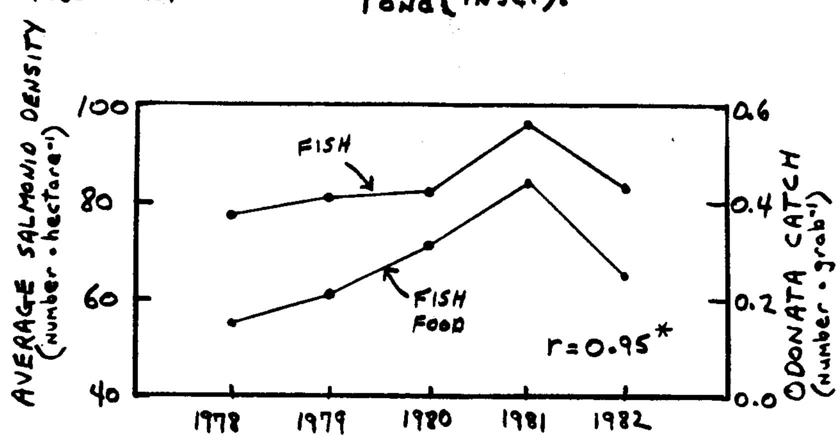
(A) Salmon and trout populations vary seasonally and annually in Spruce Pond with an inverse relationship between the numbers of the two.

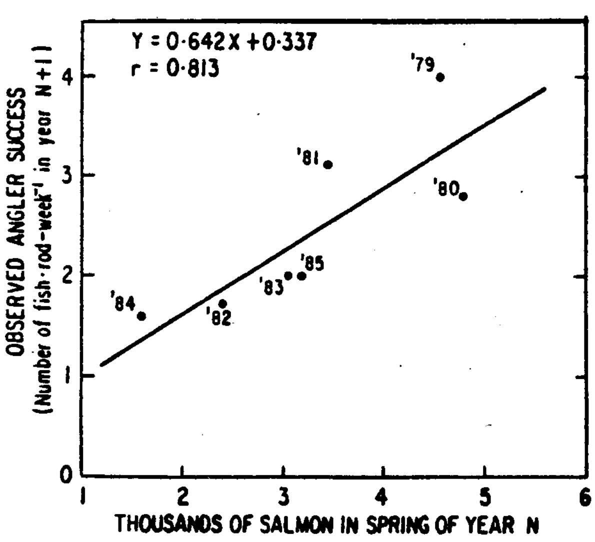




(B) The average annual density of the two species in Spruce Pond has been relatively constant. Some of the variation in average annual salmonid density is related to the abundance of invertebrates in Spruce Pond (inset).

(C) Most of the variation in average annual salmonid density in Spruce Pond is related to variation in the abundance of dragonfly larvae, the main food item of salmon and trout in Spruce Pond.





(C) Reductions in salmonid food supply in the Experimental Ponds Area may reduce the production of young salmon in the lakes and, subsequently, catches in the recreational and commercial salmon fisheries.

productivity and carrying capacity, fish species interactions and capacity of natural lakes for producing Atlantic salmon smolts (see Figure 1).

Mr. Coady noted that the Experimental Ponds project was originally established as a pesticide spray impact study with specific emphasis on long-term (cf. short-term) effects. In a review of selected freshwater projects in 1983, it was concluded that a determination of the long-term effects of forest pesticides was unattainable. It was also concluded by the review group that it was not possible to document either gross production or mortality for any level in the system and prospects of detecting pesticide impacts from invertebrate data therefore appeared improbable.

- Environmental Protection Service J. Osborne/W. Pierce

EPS interests have included aquatic monitoring, contingency planning and emergency response. Mr. Osborne provided the following summary of EPS involvement, lessons learned and future work. An update on aquatic field monitoring of the 1985 hemlock looper spray with fenitrothion was also supplied.

"EPS has been very closely associated with all major pesticide uses in the province over the past 15 years. Our first experiences were with the use of abate and methoxychlor for blackfly control in Labrador. Since then we have taken part in or been advisors to most monitoring programs undertaken in the province. As a member of the Newfoundland Pesticides Advisory Board we feel it is our responsibility to ensure that the federal view on each application for pesticide use in the Province is voiced to the Board. We achieve this through direct consultation with DFO in Newfoundland and consultation with ARPAC (Atlantic Region Pesticides Advisory Committee) in the region.

In 1977 an experimental spray against the spruce budworm was proposed and EPS accepted the responsibility for monitoring the aquatic non-target effects. The resulting report (Coady, 1978) indicated that fenitrothion had a considerably greater impact on aquatic species than did matacil. Although these results generated considerable argument in the scientific community it was one of many reasons used to select matacil for future budworm spraying in the province.

In 1978 the first operational spray (with matacil) against budworm took place and EPS again undertook the aquatic monitoring. A draft report was prepared and included in the provincial report for that year. The basic conclusions of that report were that significant reductions occurred in benthos immediately post-spray, but as in the 1977 work, the stream recovered from this effect.

During the next five years EPS supported the provincial monitoring program, providing advice on study design and some chemical analysis. Our field efforts were directed to the control and containment of pesticides on the mixing sites and storage areas. Some work was performed on barrel washing operations in an effort to reduce the residual pesticide in the barrels and utilization of the washings in the spray.

When the 1986 fenitrothion spray against the hemlock looper was announced EPS was adamant that aquatic monitoring be conducted considering the effects recorded in 1977. Neither the proponents nor Newfoundland Department of Environment (NDOE) were willing to allocate resources to aquatic monitoring. EPS re-allocated resources from other projects to perform the work. Although the data are not yet completely analyzed it appears that the effect was similar to matacil and more in line with results obtained in New Brunswick.

We have also been involved with a number of other spray programs during the 1977-85 period including the CN-Rail herbiciding, MOT airport and Terra Nova Park Golf course programs as well as the Baygon spray in Goose Bay. The majority of our work in these areas has been the provision of advice and no field monitoring of effects has been conducted.

We have learned the obvious. Chemical spraying will affect non-target species. The extent of that effect will be dependent upon a number of conditions. Double swathing, as occurred in 1977, is a significant factor in the overall impact of the spray on aquatic invertebrate populations. Heavy rain soon after spraying will result in increased concentrations of pesticide in the water and thus more dramatic reductions in aquatic invertebrates.

The concentration of pesticide in water varies also with the system. A long river traversing the entire block will produce initial high pesticide concentrations over the first 6-12 hours and then levels will return to background or non-detectable over the next day or so. Highest concentrations recorded are in the 35-45 ppb range. A system with a number of steadies or small ponds will produce a lower initial level but it will be maintained over a greater period. The flow rate of the stream and the overhanging cover will also have an effect on pesticide concentrations in the water over time.

Concentrations of pesticide in the surface water are likely to be higher than in the water column, at least for the immediate post-spray period (6 hours).

Buffer zones, if strictly enforced, can afford some protection to major rivers and ponds but are an ineffective method for small rivers (<5m) or ponds >25 acres.

The detection of jettisoned loads of pesticide presents problems and it is an area which has not been fully investigated. The two loads dumped in 1977 were located easily because pilot reports were accurate and the pesticide was dyed. The load dumped from the DC-3 in 1981 was never found and reports of people being sprayed that year were common. The use of dyed chemical would help locate dumps and authenticate over sprays of people.

A study was undertaken by the Newfoundland District Office of EPS to determine if the fenitrothion treatments of the 1985 Hemlock Looper control program were having significant impacts on stream aquatic invertebrates.

A treated and control stream were monitored after two operational operational sprays (direct overspray of streams) of fenitrothion (Folithion-11%; Cyclosol 63-40%, 585 diluent-45%) at 210 g ai/ha. Parameters sampled included: water quality, stream flow, temperature, aquatic insect drift, aquatic insect colonization of artificial substrates and pesticide concentrations in water.

Preliminary results indicate that a significant increase in aquatic insect drift occurred after the first spray on July 22 in the treated stream while drift after the second spray was less than that observed pre-spray. However, drift data for the control stream followed a similar pattern.

Water quality data indicated fenitrothion levels in the treated stream reached a maximum concentration of 4 ppb 10 minutes after the first spray and 21 ppb 30 minutes after the second. Fenitrothion levels in the control stream remained non-detectable after the first spray but reached a maximum of 2 ppb 2 hours after the second.

Artificial substrate data indicate that the aquatic insect biomass decreased in both the control and treated streams to approximately the same degree during the summer. However, a dramatic increase in biomass (followed by a corresponding decrease, probably indicating a large emergence) occurred in the control stream during late July early August which did not appear in the treated stream until late August early September, the significance of which is unclear.

Water and biota data collected during 1985 have been processed in the laboratory and writing of a first draft is underway. A cross-section of drift samples has been submitted to the Freshwater and Anadromous Fisheries section of DFO for identification of individual insects. Artificial substrates still remain in both the control and treated streams and will be recovered in late May or early June, 1986. Until these data are available no conclusions can be made regarding the recovery of insect populations in the treated stream or the long term effects of fenitrothion aerial spraying on aquatic insect populations. Completion of this first draft is scheduled for the end of June, with a final report by the end of August, 1986."

In future we see EPS involved in providing advice and auditing future programs rather than taking an active role in monitoring. Where new chemicals are involved we will advocate monitoring programs to assess impact. Based on the Polluter Pay Principle we believe that it is the responsibility of the proponent to conduct monitoring.

- Canadian Forestry Service J. Hudak

Dr. Hudak detailed Canadian Forestry Service research on spruce budworm and hemlock looper outbreaks in Newfoundland with particular reference to an experimental program in 1985 which tested *Bacillus thuringiensis* (*B. t*), matacil, a new formulation of sumithion/dimilin and an insect growth regulator on hemlock looper. A sound-on-slide presentation on the 1985 research program was also presented. His report:

"The recent outbreak of the spruce budworm in Newfoundland lasted from 1971 to 1985. The CFS, in addition to conducting research on various aspects of the problem, forecast and monitored population levels and subsequent defoliation and assessed tree mortality. The severity of the outbreak peaked in 1976-77 when moderate and severe defoliation occurred on about 1.3 million ha of productive forests (Figure 2). Balsam fir mortality commenced in 1975 and reached about 40 million m^3 by 1982 and it levelled off

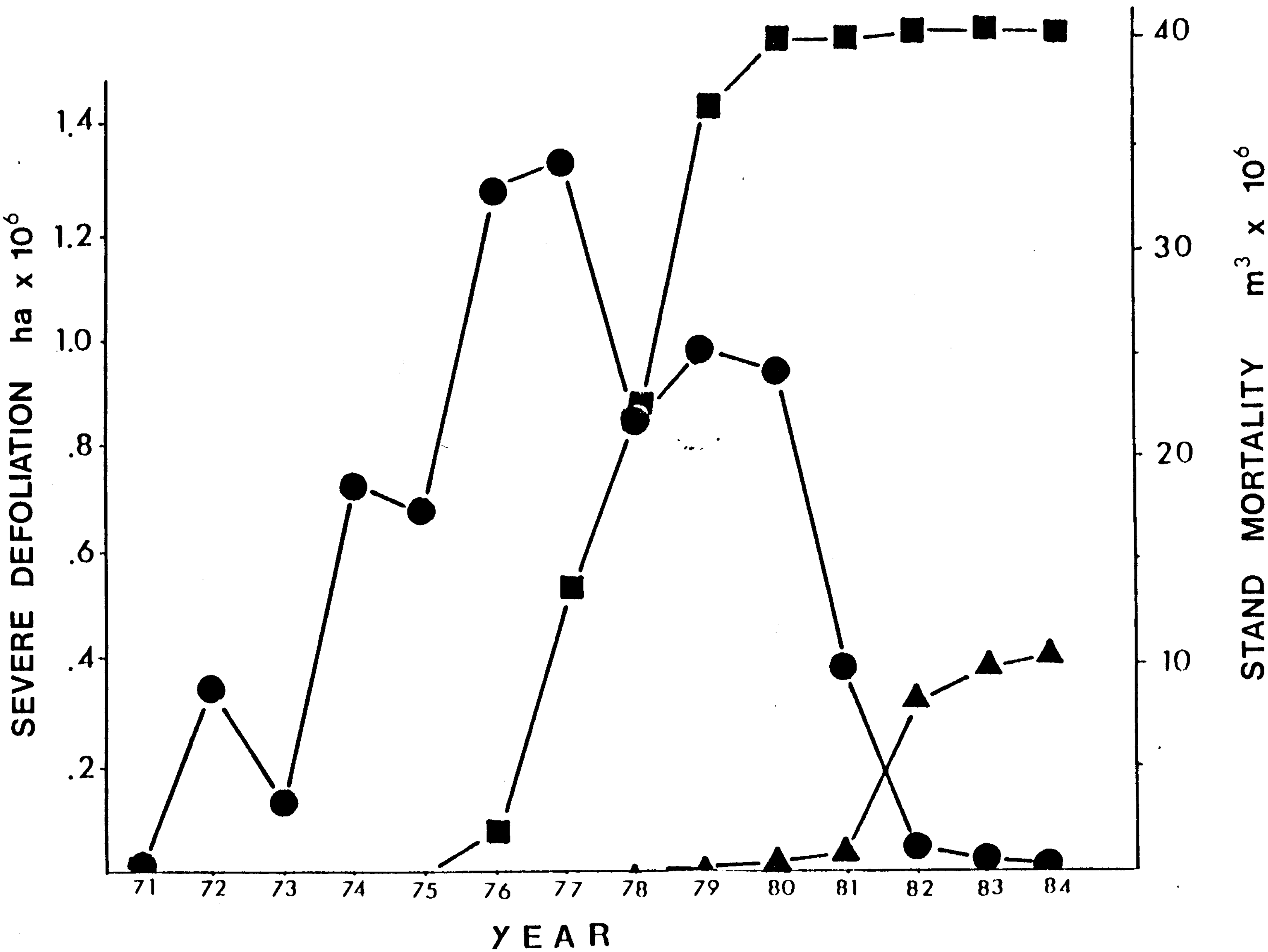


Figure 2. DEFOLIATION BY THE SPRUCE BUDWORM AND BUDWORM-CAUSED MORTALITY IN NEWFOUNDLAND FROM 1971 TO 1984. ● = DEFOLIATION ■ = FIR MORTALITY ▲ = SPRUCE MORTALITY

since that time. Black spruce mortality began in 1979 and reached about 10 million m^3 by 1984. The total fir-spruce mortality was about 50 million m^3 or about 30% of the total softwood inventory of the Island.

The CFS was actively involved in insecticide application in 1979 when a joint CANUSA program was designed to test the effectiveness of B.t. 30 km north of Gander. The Provincial Government requested the relocation of the experiment because of public concern, but it was too late in the season and the experiments were cancelled.

In addition to the above activities the CFS negotiated and awarded several contracts to Dr. J. R. Finney-Crawley of MUN to test and develop methods for using nematodes as biocontrol agents against the spruce budworm and other major forest insect pests. The laboratory results are promising including the isolation of a local, cold tolerant nematode. Present research must be continued before these nematodes may be tested in the field.

Moderate and severe defoliation by the hemlock looper in 1985 was forecast to occur on about 270,000 ha of fir-spruce for the Island. Considering the weakened condition of the forests following the spruce budworm outbreak together with the probable severe damage by the looper in 1985 the Department of Forest Resources and Lands decided to conduct an aerial operational control program. However only one insecticide, fenitrothion, is registered for use against the hemlock looper and it is desirable that other insecticides, possibly biological insecticides, be registered and made available for operational use. To satisfy this requirement the Canadian Forestry Service on the request of and in cooperation with the Department of Forest Resources and Lands conducted an experimental program in 1985 to test the effectiveness of B.t., Matacil, a new formulation of Sumithion and Dimilin, and an insect growth regulator. This research project was approved by Agriculture Canada and the Provincial Department of Environment following the recommendation of the Pesticide Advisory Board.

The dosages and formulations of the insecticides tested were as follows:

1. Bacillus thuringiensis

Thuricide 64B	2 x 30 BIU/ha;[1]	1.78 ℓ/ha
Thuricide 48LV	2 x 30 BIU/ha;	2.36 ℓ/ha
Futura	2 x 20 BIU/ha;	1.4 ℓ/ha
	2 x 30 BIU/ha;	2.1 ℓ/ha

2.	Dimilin	1 x 30 g ai/ha[2]	2.0 ℓ/ha
		1 x 35 g ai/ha	4.7 ℓ/ha
		1 x 70 g ai/ha	
		2 x 70 g ai/ha	
3.	Matacil 180 F	2 x 90 g ai/ha	1.5 ℓ/ha
		2 x 135 g ai/ha	
		2 x 180 g ai/ha	
4.	Sumithion	2 x 210 g ai/ha	1.5 ℓ/ha
		2 x 140 g ai/ha	
		2 x 210 g ai/ha	

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[1]BIU = billions of international units.

[2]g ai = grams of active ingredients.

All 14 sprays were water base formulations. Each treatment was applied to a 15 ha plot located near Bay d'Espoir. Thuricide 64B at 30 BIU gave excellent control at a very high population level. Thuricide 48LV and Futura at 30 BIU gave reasonable control at a lower population level, but there was no reduction when Futura was sprayed at 20 BIU.

Dimilin gave excellent control when applied twice at 70 g ai/ha, even at a very high population level. Looper larvae were abundant in trees adjacent to the spray plot shortly after the post-spray sample was taken in the treated plot. One application of 70 g ai/ha did not affect larval numbers but decreased the number of pupae. Lower dosages of Dimilin applied once at 30 and 35 g ai/ha gave little or no control.

Matacil gave no control at two applications of 90 and 135 g ai/ha but it provided about 50% population reduction at 2 x 180 g ai/ha, double the maximum dosage in the use against the spruce budworm. Sumithion provided only partial control; a population reduction of about 50-80% at pupation occurred in two of the three treatment plots. Results with Sumithion must be considered inconclusive as the emulsifier was inadvertently omitted from the formulation.

In summary the results showed that Thuricide 64B at 30 BIU/ha and Dimilin at 2 x 70 g ai/ha may be considered as potential practical alternatives to fenitrothion against the hemlock looper. However, these two insecticides will have to be registered before their large scale operational use.

In 1986 the CFS plans to test jointly with the DFRL the effectiveness of Sumithion R, Sumithion F, a new water base formulation on about 30 ha blocks and Dimilin on about 150-175 ha block in western Newfoundland."

In addition to the above the CFS negotiated and awarded a research contract to Drs. Bridson and Larson of MUN for determining the fate and impact of Dimilin in lentic and soil habitats of Newfoundland."

- Memorial University

Memorial University has participated in provincial monitoring programs since 1977. Initial involvements were voluntary; more recently MUN researchers have been contracted by NDOE. The Canadian Forestry Service has also funded research at Memorial on the use of nematodes as biological control agents for forest pests.

Three presentations were made by Memorial researchers. Dr. Knoechel reviewed aquatic research findings, Ms. Woodworth-Lynas the effects of matacil spraying on bird communities and Dr. Finney-Crawley the potential for biological control of forest insect pests with steinernematid nematodes. Their reports follow in that order.

Aquatic monitoring R. Knoechel

"A four-year program (1982-85) to monitor spruce budworm spray impact on non-target organisms in streams focused on the macroinvertebrate fauna (largely insect larvae) and on attached algae. Data on macroinvertebrates were obtained in the form of dry weight biomass estimates of organisms living on artificial substrates (bags of rocks) and drifting in the water while algal populations were measured on ceramic tile substrates placed in the streams. The employment of artificial substrates reduced the high level of variance associated with unit area samples taken from natural streams while measurement of organisms as biomass provided a variable that was readily interpretable as food supply potentially available to fish. Drift samples provided an indication of immediate short term spray impact in the form of dead insects falling into the stream as well as lethal and sublethal behavioural effects on the insects living in the stream. Rock bags provided a means to evaluate intermediate range spray effects in the form of reduced invertebrate biomass. The algal data permitted a measure of spray impact on the primary producers in the streams which constituted part of the food supply for insects.

The study sites were four streams which drain into the Gander River and Gander Bay: Jonathan's Brook, Island Pond Brook, Weir's Brook and Gander Bay Brook. The watersheds of Weir's and Island Pond

Brooks were first sprayed in the summer of 1981, prior to the commencement of the current study. This spray regime was maintained in 1982 and 1983 with Jonathan's Brook and Gander Bay Brook serving as controls. The spray regime was altered in 1984 and 1985 with Gander Bay Brook becoming a spray site and Island Pond Brook being designated a control while the other two streams remained unchanged. This switch was designed to look for more subtle, low-level effects of spraying or release from spraying which could be evaluated from comparison with the first two years' data.

The general results of the monitoring program were as follows:

1. Matacil residue levels in water samples were always reduced below the limit of detection within 48 hours of the spray at experimental sites. The bulk of the residue was observed in the streams during the first few hours post-spray.

2. Monitoring drift in the form of biomass rather than numerical abundance of taxonomic groups successfully removed much of the "noise" present in previous studies. There were no noticeable spray effects on either the magnitude or the seasonal pattern of drift in any of the sprayed streams.

3. A three week colonization period was usually sufficient for the establishment of steady state macroinvertebrate biomass levels on artificial substrates (rock bags) in all streams. It was noted in 1982 and 1983 that both spray streams had lower benthic macroinvertebrate biomass than either control stream. One spray and one control stream were switched in 1984 to provide an experimental test of the hypothesis that the lower biomass was the result of the previous spray history rather than a pre-existing condition. There was no evidence of a change in seasonal pattern of biomass in the two streams that were not switched while the two that were showed strong indications of a departure from the previous years' patterns. Gander Bay Brook, which was sprayed for the first time in 1984, showed unusually low biomass during and following the spray period. Island Pond Brook, not sprayed for the first time that year, showed unusually high biomass following the spray period. These departures from the expected pattern were of short duration, however, and were not at all corroborated in 1985 despite the continued switch in spray regime. It seems reasonable, therefore, to accept the null hypothesis that generally lower macroinvertebrate levels observed in Weir's and Island Pond Brooks were due to a pre-existing condition and did not result form the spruce budworm spray program.

4. A three week colonization period was usually sufficient for the establishment of a steady state attached algae community on artificial substrates (ceramic tiles) in three of the four streams. There was no apparent effect of the spray program on the algal biomass in the sprayed streams."

"Data as a set of 1-year studies will not show patterns which become evident in a study over a 5-year period. Long term utilization of the same study areas and methodologies permit the acquisition of baseline data which in turn provide a stronger basis for the evaluation of both the short and long term effects of pesticide on specific communities. In an avian study there are so many sources of variation, simple analyses will not suffice. For example, bird abundances may vary from year to year because of environmental differences between the years and/or chance. Also vegetation is not identical at all sites within each year nor identical at the same site among the years.

The variability of the Newfoundland climate has meant that spray programs have usually occurred in late June and early July at a time in the bird reproductive season when singing has largely ceased or at least become an unreliable indicator of anything other than massive impact. Aural and visual detection methods such as line transect and circular plot methods for estimating bird densities may therefore produce results which are determined solely by the timing of the spray. The bird study methodology of choice therefore was mist-netting.

Our initial postulate was that vegetationally similar net sites should capture similar birds. We therefore wished to 1) distinguish differences in bird communities caused by differences in site vegetation from differences caused by other factors and 2) with systematic vegetation differences accounted for, identify relationships among the bird abundances. It was decided to consider all bird species together because 1) there was a lack of adequate criteria for identifying species as informative (therefore by default abundant species would be used) and 2) abundant species might be particularly poor for looking at spray effects because with large numbers available for repopulation, masking of spray effects could occur and/or abundant species may also be species which are not affected by spray treatment.

From the analyses of each single year's data no strong linear relationships were observed, therefore pairwise distances (a measure of dissimilarity) between each of the net sites on both vegetation and bird ordinations were determined to give single measures of the ordination sources. Results were then tabulated by spray treatment, by year and by vegetation to be tested by standard analyses of frequencies. Results:

1. Multiple regression plots of bird distance against vegetation distance showed no linear or polynominal relationships.

2. In 3 of 5 years there were interactions between treatment, birds and vegetation. We know that treatment wouldn't affect vegetation and it seems unlikely given the site structure involved that vegetation would affect bird and treatment interaction. Therefore, although the 3-way interaction was significant, any consistencies in the 2-way interactions would be useful.

3. Except for 1981 there was no interaction between birds and vegetation. In all years except for 1981 a significant interaction was evident between treatment and birds indicating the spray was affecting the bird communities.

4. Plots of bird distances derived from log-linear modelling (Figure 3) showed: Categories 1 and 2 (low distances) were consistently larger in SS as compared to SU or UU indicating sprayed areas have many net sites which are similar in their birds. This is not an effect of vegetation because bird-vegetation relationships were not significant for 4 out of 5 years. Category 3 (mid-distance) was consistently smaller in SS and consistently bigger in UU.

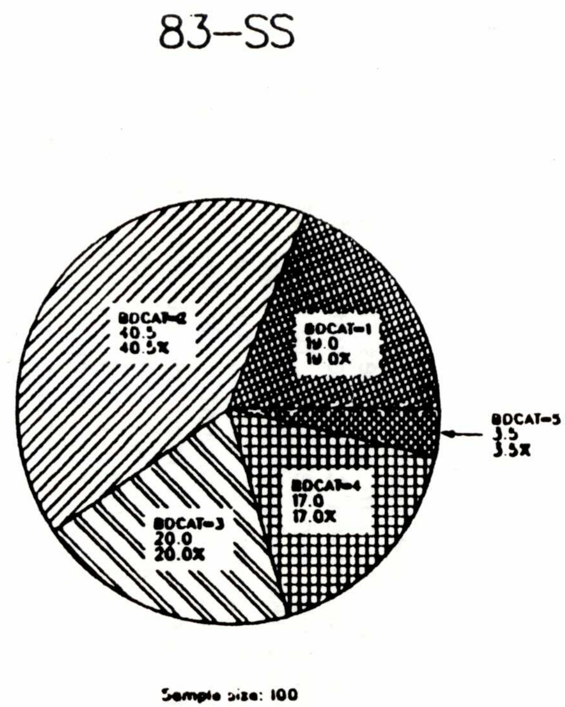
Areas that have been sprayed differ from areas which have not been sprayed in their bird community characteristics. In sprayed areas they have become similar. The most likely explanation is a change in the relative dominance of individual species."

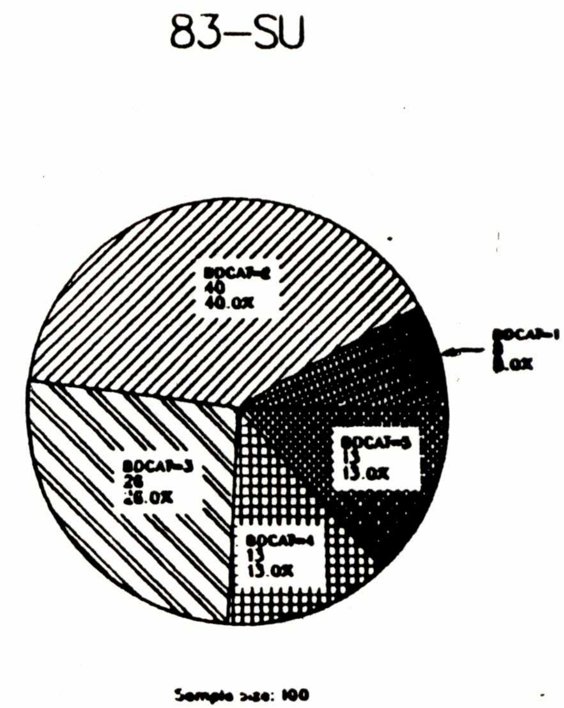
Biological controls; nematodes J. Finney-Crawley

"Although a number of chemical pesticides have proved useful in the control of forest insect pests growing antagonism by the public to the use of such pesticides, both from the public health and environmental points of view, plus the resistance of pest insects to chemical pesticides, has intensified the search for alternative, less environmentally damaging biological control agents.

The use of steinernematid nematodes for biological control under Canadian conditions was initially pioneered by Welch in 1961. Since that time some 33 species and strains of these nematodes have been shown to be effective against a variety of insect pests. Steinernematid nematodes fulfill the criteria necessary for a parasite to be a good biological control agent, in particular they can be easily and economically mass produced, cause mortality in the host (either feeding or non-feeding stage) within 48 hr, are applicable by current conventional methods and are safe to

1983 BIRD DISTANCES





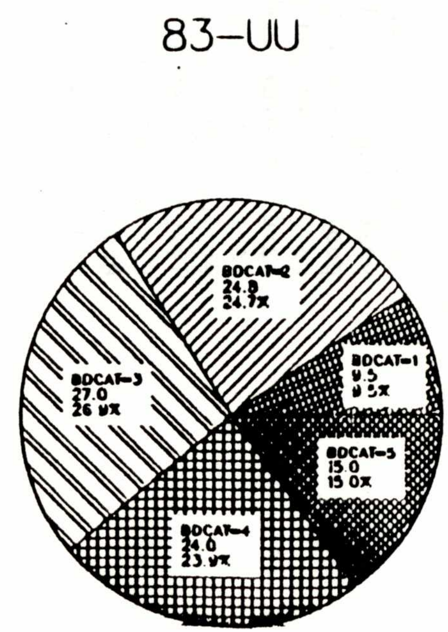


Figure 3. Distribution of pairwise distance categories from similarity matrix of bird abundance per netsite of capture. Categories are in descending order of similarity from 1-5.

SS- sprayed site-sprayed site pairs
SU- sprayed site-unsprayed site pairs
UU- unsprayed site-unsprayed site pairs

most non-target organisms including all vertebrates. In addition, in contrast to chemical and microbial agents, which must rely on chance contact, steinernematid nematodes can actively search for hosts, permitting their use against even well hidden target pests. The infective stages are also resistent to most chemical insecticides and so could be implemented in integrated control methodologies.

Steinernematid nematodes, adapted to specific environments, are already in operational use in various parts of the world for control of economically important pests. They have been tested in the laboratory here against a number of forest insect pests including spruce budworm (Finney et al. 1982, Finney and Bennett, 1984a), larch, pine, mountain ash and birch sawflies (Finney and Bennett, 1983), the birch casebearer and hemlock looper (Finney and Bennett, 1984b). Although all insects proved susceptible to the nematodes when the temperature regime imposed ranged from 17-25°C, their effectiveness was drastically reduced at temperatures normally encountered in Newfoundland and boreal Canada. This prompted the search for a suitable strain for use in Canadian forested regions. A soil survey carried out in 1983 resulted in the isolation of three candidate nematode species which showed particular promise as biocontrol agents in the temperature range 5-20°C (Finney, 1984). The development of these biological control agents would add a unique and environmentally safe methodology to forest management practices in Canada."

- Wilderness Society J. Rice

The Wilderness Society of Newfoundland and Labrador was represented by Dr. J. Rice. His report:

"In a workshop on what we have learned over the past 9-10 years what should the role be for a representative of a public interest group? We haven't conducted original research, we don't have our own new data to present. In a larger context, what is the role of public interest groups in the entire process of planning, conducting and evaluating such uses of our environment? We feel it is at least in part to fill the gap outlined by Sue Bonnyman and Carla Woodworth-Lynas - to help establish values. When environmental impact X is detected, it is the people's place to decide whether the impact is acceptable or not. To the extent that public interest groups are often special interest groups, of course we can't claim our voice is the only voice to listen to - but we are one voice. Especially if we are well-informed, responsible, and constructive, we have a prominant role to play, a role in two parts (at least). First the watchdog role of ensuring that adequate precautions are taken in conducting any pesticide programme; that environmental assessments are done, that monitoring be conducted sensitively and thoroughly, that the public is completely informed of what is planned, what the consequences will be, and what the alternatives are. Our second role is to evaluate the information provided by scientists (as best we can - and by being well informed we can probably do it as well as any other public segment), and provide feedback on how well the values of society are translated into the practices of government and industry.

We have many reasons to be pessimistic about past practices. Too often the forest products industry presents itself as viewing the forests of the land as a single crop garden. At least by appearance, the belief is often translated into forest practices which are single use rather than multi-use in nature.

To open up the practices, and the decisions used in selecting the practices, the Wilderness Society has tried to use the provincial Environmental Assessment Act. The Act provides for a full review of forestry practices, and a consideration of alternatives. It is a good forum for airing differences of attitude and opinion. It is extremely discouraging when the provisions of the Act are circumvented, as with the decision to spray fenitrothion in response to the hemlock looper outbreak. By the 21st of May, 1985 when the spray program was announced, there was inadequate time for an assessment. However, it is beyond comprehension why it was necessary to wait that long before discussing the use of fenitrothion with interested members of the public. From as early as January 1985, the Wilderness Society was trying to establish a dialogue with forestry officials on the matter. The department was completely closed to all overtures. We stress that we have engaged in constructive dialogue when given the opportunity. The involvement of the founders of the Wilderness Society with the Departments of Environment and Forestry, when the matacil spray program was initiated in the mid-1970's was reasoned and constructive. We feel our input was directly related to some of the improvements in the design of the monitoring studies, and in some of the pressure for improvements on techniques of spray application. We were responsible, rational, and we accepted with good conscience the final program against the spruce budworm (despite numerous approaches from media and individuals trying to get the Wilderness Society to stir up trouble about the matacil spray campaign). As long as the spray was administered carefully, and careful monitoring was done, we accepted the compromise.

Having accepted the use of matacil for control of the spruce budworm, we were nonetheless very alarmed to hear the province was considering the use of fenitrothion for hemlock looper control. We feel there is a great deal of scientific evidence questioning the environmental safety of fenitrothion. We agree the chemical is not uniformly damned in all studies, but there is enough conflicting evidence to cause disquiet. The spring of 1985 was a long chronology of rebuffed attempts to open an avenue for dialogue on these concerns. We were assured of a monitoring study, but even had difficulty inputting constructively on the design and execution of the monitoring study.

Design of monitoring studies is not easy. We are well aware of that problem. We are also well aware that a poorly designed or otherwise inadequate monitoring study is most likely to conclude there are no differences between sprayed and unsprayed areas: weak studies (either poorly designed or simply inadequately supported) can't detect anything less than a catastrophy. We feel the forest industry ought not have so much leeway that environmental catastrophies become the only way to stop things. Note we are not accusing anyone of causing - or even contemplating causing - an environmental catastrophy. But we want the evidence that monitoring studies can detect changes of much lesser magnitude. From the sketchy terms of reference for the fenitrothion spray monitoring study we had little confidence in the sensitivity of the monitoring study. We had no choice, however, but to wait for the results of the first year. We felt it was extremely important to see the results of the monitoring of the first year of the monitoring program, so we could have constructive and meaningful input into decisions regarding spray for the current year. We will present an appalling chronology of refusals and excuses, which have meant that as of 14 May 1986, no one in the public has been allowed to see any of the results of the monitoring programme in 1985. This has completely shut the public off from any ability to participate in decisions about the use of their forested lands; at least any useful and informed participation. We feel this is completely unacceptable, and it certainly looks self serving and politically motivated by a few vested interests (even if in fact it was not). We feel the general public deserves more consideration for its legitimate interests and concerns. We feel we as an organization deserve more consideration from our record of constructive involvement, given the opportunity to participate meaningfully. It is well documented that the public is unsure the spray programmes are effective and necessary. More alarmingly, the public does not feel confidence in the scientists and managers who are responsible for their forests. This lack of confidence has serious implications, and should (but hasn't) lead to responses by the scientists and managers. The Wilderness Society hopes that the "closed shop - we're the experts" mentality is replaced by an attitude which allows for more legitimate public involvement in the uses of our natural resources."

- Salmon Association of Eastern Newfoundland D. Whitaker

Mr. Whitaker offered the following notes:

1. "The proponents of spraying tend to argue along "farming" lines and apply single crop logic. The objectives of such programs are short-term usually; the effects are long-term, widespread and often unpredictable and not easily measured due to complex interactions. Of major concern are the multiple effects in the food web. We should be concerned about our own meagre spectrum of species which has little or no buffering capacity. We should also be aware that the effects of forest spraying here may be felt as far away as Greenland (migratory salmon) and South American forests (migrating birds) i.e. a 6400 + km spread.

2. Aerial Spraying. Nearly all such programs are aerial in nature and as such have problems of control and risk related to drift or dumping in emergencies. The obvious concerns are poor control over precision in space and time. Nfld. weather tends to be very changeable which affects timing and effectiveness. If we spray at the right time, even small amounts of wind causes drift and deposition on small feeder streams. There are accidents or emergencies where controlled or uncontrolled dumping occurs usually over bogs or water both of which must eventually affect downstream watersheds. Containment within jettissonable compartmentalized field tested tanks (with parachutes) may be a feasible alternative.

3. Pesticides. Very few are species specific. All are poisonous. Regulations do not permit an apparently less harmful pesticide for looper because of approval procedures. Carriers may be as toxic as the pesticide itself. Predatory insects are affected and may impact on non target species of importance. Predatory birds and mammals are also affected. Fish are affected either directly or by loss of food source. Aquatic insects have long life cycles generally 1 year plus most of which is in the water. They are niche

specific and also not easily recolonized. They are the main food source for young fish. Other arthropods (e.g. terrestrial) are also vulnerable. Spraying upstream may affect the full watershed.

4. Multiple crop. The forest is certainly not a mono culture or one crop farm. It supports a diversity of plants and wildlife not to mention user groups. . The tendency to monoculture with crops of same age is a bad combination (unserved biology). Biologists who argue for monoculture are betraying the general principles of ecology.

5. Alternatives. The keys to best options lie in nature. Ask a wheat farmer about rust. Some plants are more resistent than others. Predator cultures may be a real option especially insects. Sterile male technology is well known. The use of pheromones is possible. Multiple croping may be an answer and alternate harvesting strategies may be possible."

- Natural History Society W. Montevecchi/ J. Gibson

The Newfoundland Natural History Society argued that long-term environmental poisoning approaches to terrestrial ecology were illogical. Drs. Montevecchi and Gibson both offered comments. Their subsequent report:

"Major concerns of the Natural History Society of Newfoundland and Labrador regarding pesticide spraying are: (1) the effects on (i) non-target insects, (ii) insect communities, (iii) birds and fish, (2) the long-term resiliency of target organisms to ecotoxin programs, and (3) the serious illogic involved in prolonged environmental poisoning approaches (pesticides and herbicides) to terrestrial ecology.

The Society is particularly concerned about the renewed use of fenitrothion, which has catastrophic effects on insects, and which persists for over a year in the environment. No serious studies have yet been devised that could be used to predict suspected long-term effects on non-target species. For example, studies have shown that with the recommended applications, fish are not directly killed (R. McCubbin, pers. comm), but aquatic and terrestrial invertebrates may be severely affected (e.g. Coady, 1978). Studies in Newfoundland and Quebec have shown that fish production is food limited (Ryan, pers. comm.; Gibson et al. 1984). The major growth of trout and young salmon occurs in the early summer, over the time of spray application. Aquatic insects are the dominant prey at that time, with terrestrial insects becoming more important later in the summer. Study results presented by the Environmental Protection Service (1986b) at the present workshop indicate that aquatic insect emergence was delayed by one month in a sprayed stream. Such effects on the temporal distribution and availability of food resources for fish carry potentially highly significant biological consequences that need to be studied. Age at maturity and fecundity are affected by food supplies. Another vital consideration is that about half the population of juvenile salmon and trout normally die over winter, the proportion depending on numbers and condition of the fish. Any substantial decrease in food would increase this density-dependent mortality. It was noted in the Environmental Protection Service presentation that buffer zones are ineffective for small rivers and ponds. Such second and third order rivers are, in general, more productive per unit area than larger rivers, and are the major spawning and rearing habitat for trout and salmon.

Montevecchi and Tuck (1986) have reviewed the data on pesticide/avifaunal interactions in Atlantic Canada, and we draw upon the information in that review here. Spruce budworm outbreaks are part of the natural cycle of North American boreal forests, occurring at about 25-year intervals (Hall, 1981). It was noted by one of the members of the Society (R. J. Gibson) who was working in Quebec at the time that the severe infestation of budworm in Newfoundland in the mid-70s also occurred along the North Shore, but the infestation subsided without spraying and with no great effect on the forest. Warblers and other budworm predators also show 'outbreaks' during infestations (e.g. Morris et al. 1958; Erskine, 1977). In New Brunswick a 25-year program of annual toxin spraying has held budworm populations at an intermediate partially destructive level, and the budworm's population cycle is no longer observed. The environmental poisoning programs have forced a naturally cyclic phenomenon into an artificially static and persistent state. The serious ramification of this forest management approach is that the 'managers' are locked into a program of having to spray poisons every year to maintain the static, unnatural situation they have created. Couple this pesticide approach with a herbicide strategy to maintain artificial forest monocultures that are unnaturally prone to insect infestation and destruction, and the problem is compounded and magnified. The forest managers lock themselves into greater dependencies on ecotoxins and into longer-term poisoning of the ecosystem.

It was noted in reply from the Canadian Forestry Service that Newfoundland will not get locked into a continuous spray program as has occurred in New Brunswick, because the weather in this province evidently controls the insect pests as effectively as the sprays in some years. Toxin sprays have been applied in eight out of the past ten years, and fenitrothion is again being used in the summer of 1986.

In the early 1980s, the government of Newfoundland and Labrador initiated experimental spray programs of the herbicide 2,4-D. They have more recently solicited a forestry industry sponsored 'impact study' of herbicides and have given notice of intention to support a herbicide program if the 'impact study' can justify it. Such justification will undoubtedly be evaluated primarily in economic rather than in ecological currency. Deciduous trees are more productive of wildlife than conifers. They support more insects and more birds, and are the preferred food of moose. Streams are generally heterotrophic, and input from deciduous trees is more productive than that from coniferous trees. Alders fix atmospheric nitrogen and they and other deciduous species are important in nutrient cycling. Since deciduous trees form a relatively small part of our forests, it may not be advisable to reduce them. Mixed forests are less vulnerable to insect infestation. Government officials expect herbicide spraying to be very limited and confined to areas already clear cut, to give conifers an advantage over other plants. Such browse is important food for moose and other land mammals and provides foraging habitat for diversity of land birds.

Another major environmental problem with pesticides and herbicides is that while they are aimed at a single organism, they often kill a variety of non-target species, that can include natural biological controlling agents, such as predators and parasites (NRCC 1975; Hall 1981). Non-target insect pollinators can also be hit hard by chemical spray programs (Kevan and Collins 1974; see also Rendall et al. 1977). Such impact on pollinating insects carries deep implications for the reproduction and fruiting of many plants, including berry bearers that are important for human and nonhuman consumption. Up until 1972, it was estimated that New Brunswick lost $1,000,000 in blueberry crop returns, as a result of off-target spraying (Kevan and Collins 1974). Spray programs usually result in substantial amounts of toxins falling outside the target areas (e.g. NRCC 1975; Pearce et al. 1979a) and to complicate matters, the mode of spray applications also influences impacts on the avian community (Pearce and Peakall 1977; Pearce et al. 1979b; Busby et al. 1983).

Payne's "invited provocation" at the workshop, which was critical of "environmentalist groups" had little bearing on the present discussions. In Newfoundland there is still sufficient unspoiled wilderness that it is available to everybody, near at hand, and used in many ways by the majority of the population, without regard to income. It is highly improbable in Newfoundland that environmental concerns with responsible responses will cause recessions, and even less likely deaths attributable to such recessions.

In conclusion, we have little confidence that there is enough sincere discussion or concern about environmental issues by governmental and industrial agencies intimately linked to the natural environment. While some presentations at the symposium indicated potential avenues for furthering environmental protection, e.g. dyeing sprays or comprehensive scientific studies of spray effects, many simply touted what agencies would no longer do or glossed over major environmental concerns and issues (Environmental Protection Service; Newfoundland and Labrador Department of Environment). We concur with other speakers that well-planned scientific experiments would do much to answer the important questions, and if publicly discussed, help bring about public confidence in cooperation amongst the various agencies and the wise use of the **many** forest resources. In view of the (a) resiliency of insect pests in the face of chemical poisons, (b) roles of natural controlling agents and the cyclic nature of 'pest' populations, (c) obvious consequences of dumping toxins into the environment and (d) inevitable progression that follows from toxic approaches to ecological phenomena, we conclude that chemical spray programs are biologically insane and economically unjustifiable.

We thank Dr. D. Steele of the Natural History Society of Newfoundland and Labrador for comments on this manuscript. Literature cited appears at the end of the proceedings.

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3. Invited paper

During the afternoon session, Dr. Jerry Payne, Habitat Research, Fisheries Research Branch provided personal views (with slides) on the forest pesticide issue. The presentation (Pesticides and Enviromentalism: Notes of a Pollution Watcher) dealt with the reasonableness of public and research views of toxicity. A point summary of his presentation:

- Pesticides are generally used for two purposes - to improve the health and well-being of humans or to grapple with human starvation. Not [illegible]

- More than a billion human beings are chronically hungry and from 500 to 700 people die of starvation on any day while we are at coffee break.

- All major regulatory actions should consider unemployment since it has such devastating effects on human health and welfare. Contrary to myth, only a small component of health (yet vast and disproportionate sums of money) has to do with doctors and medicine. It has been estimated by one analyst that the 1984 recession in the U.S. killed thousands of people and made thousands more seriously ill.

- It is not uncommon for dozens of agencies throughout the world to be involved in determining whether such and such a pesticide or chemical may be responsible for a few extra cancers per year, while in Newfoundland alone there are probably dozens or hundreds of premature deaths per year from cancer (or related diseases) whose cause is rooted in poverty and malnutrition.

- Pesticide applicators should adopt all recommended safety precautions, since they are at special risk from high doses of pesticides.

- It has been stated that "it is safe to predict that, by appropriate choice of dose, concentration of solution and frequency of administration, any chemical agent can be shown to be a carcinogen."

- Unlike the consumption of meats, fats or even eggs (which have recently been associated with three times the normal uterine cancer rates in women), there is no evidence that pesticide usage is an important factor in human carcinogenesis.

- There is considerable evidence that the use of pesticides has had a significant and positive impact on human welfare.

- Statements to the effect that pesticides may cause malformations in human babies can be mischievous. For instance, a number of conditions reported to induce malformations in baby rats include air-transport, fasting, vitamin-excess, fright and restriction of movement.

- Pesticides must be rigorously screened for harmful effects to humans and the environment, but reason has to be invoked, since no expert is ever at a loss for more tests that he thinks could be done to define the toxicity of a chemical.

- It is true "we can never do one thing, we must always ask: and then what?" However, the what about humans (should a policy against use of pesticides lead to the demise of a major industry) must be given equal billing to the what about birds.

- Perceptions can be all powerful in politics (which is understandable) but also in the halls of legal justice (which is less understandable). For instance, a court in the U.S. has recently ruled that regulators have to weigh psychic-costs for perceptual or imagined effects, even if not substantiated by scientific analysis. In other words the creation of false perceptions can be an enterprising activity.

- Lysenkoism is inherent in the logic, "although proof of the cause and effect of pesticide pollution and harm is not established, the evidence is overwhelming.". Fortunately the [illegible] in this paper [illegible]

- Our attitudes, beliefs, and concerns are rooted in ethical systems - broadly three: (a) Benthamite (utilitarian) (b) Ralsian-Kantian (egalitarian) and (c) Nitzschean (elitism). Much support can be adduced for the charge by some intellectuals and pundits that ~~envi~~ronmentalism is a close relative of elitism. Payneism

- Who has more right to a clump of trees, a tofu-loving backpacker from St. John's or a fried-chicken loving logger from Joe Batt's Arm?

- The cry of save the earth for future generations implies that a tofu loving Jerry Payne VIII might in some unknown (Lysenkoistic) way suffer (from the use of pesticides). This "concern" must be balanced against human welfare today - in the case of the third world all those blank faces and stark rib-cages.

- It is natural that "where you stand will in large part depend on where you sit."

- It is much easier for Environment Canada, Fisheries and Oceans, or the Wilderness Society to speak in seemingly unimpeachable generalities and say no (to pesticides) than for the Department of Forestry, Agriculture, or the logger's union in Corner Brook.

- It cannot be over-stressed that pesticides have to be rigorously tested [illegible] before being permitted for widespread use in the environment.

- Likewise vigorous monitoring programmes on aquatic and terrestrial organisms must be a necessary accompaniment of all forest spray programs.

- It is naive to think that you can satisfy anti-spray or (anti-sealing) groups with science. But [illegible] scientific arguments [illegible].

- However, the weeds and underbrush of distrust must never be allowed to flower in the garden of reasonable men/women. [illegible]

- It will always be easy to speculate to the point of horribilizing - more difficult to fashion a compass for truth and social justice for all concerned.

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4. Discussion

Participants responded to overview statements in the morning and Dr. J. Payne's presentation in the afternoon. General issues, such as the use of herbicides, were also addressed. Discussions were lively!

The following views/themes/concerns (grouped for convenience) were recorded by the Chair:

Spraying operations

- Big improvements have been realized in application technology:

  a) downsizing of planes;
  b) canopy release height controls;
  c) less toxic carriers, emulsifiers, pesticide regimes;
  d) mixing, storage, contingency planning, washing, disposal procedures;
  e) analytical, detection procedures.

- Experience has led to the view that buffer zones are useless for small streams and ponds but better for larger rivers and lakes. A 400 m buffer zone seems effective for larger water bodies.

- Forestry researchers very often have only as much notice as monitoring or activitist groups in preparing for spray operations.

- Budworm infestation in Newfoundland has declined. Spraying helped in some cases and environmental/climate situations in others. The vagaries of the Nfld. climate are such that fewer options are available to forest managers than elsewhere in eastern Canada.

- Do we want to continue spraying indefinitely or are there better alternatives to long-term contamination of the forest ecosystem with pesticides? Are forest managers locked into continued large-scale spray operations? The New Brunswick experience leaves a clear impression that forest pest populations are resilient to spraying. Bird (and other) non-target groups are vulnerable to some pesticides but perhaps more resilient than expected. Better alternatives may nevertheless be available and a key question is whether spraying should be continued indefinitely.

- Several emergency situations have arisen since 1977 (jettisons, etc.) and responses have been mounted by EPS and NDOE. As the use of tracer dyes is costly, radio transmitters could be used in spray loads in the event of dumpings. These would be useful in locating jettisons.

- The 1977 experimental spray program proved of considerable value. Matacil and B.t. were found to be effective on budworm with few side effects (cf. fenitrothion) and provincial decision makers chose to avoid the use of fenitrothion from 1978 to 1984.

Environmental monitoring

- Effective monitoring should be able to pick up effects and distinguish effects from background noise/normal environmental variables. To date no monitoring studies have been able to detect anything of real value. National Research Council reports (1978 and 1984) substantiate the view that ecological monitoring procedures have been of poor quality.

- No one is addressing the need for a good monitoring study. What should a monitoring study try to achieve? Can it achieve it? What do the results mean? There are poorly designed studies that show no effect and a few that show gross effects where statistical "hand-waving" would be of no additional value. There are few standards for what constitutes a good or bad study. A one year-study has no monitoring value. If an effect is found, there are no options for avoiding them in future. Effects are portrayed as random, out-of-the ordinary. One good six year study is a far better approach than a dozen or so poor studies on a year-to-year basis. A scientific study is needed; not a better monitoring protocol. Interdisciplinary collaboration is essential.

- MUN researchers have effected several changes in monitoring protocols. Bird methodologies have changed dramatically and aquatic procedures have been refined. Concerns were nevertheless raised that the pooling of all invertebrate taxa into biomass (aquatic studies) and comparing interannual changes in biomass is inappropriate as substantial changes in ecosystems could be completely masked. The alteration of a natural prairie grassland into a forage area for beef cattle, as an analogy, may appear as no change in biomass yet represents substantial changes in species composition.

Public input

- General observations:

  a) number of individuals coming out to public meetings is low: reflects public frustration with short time frames, poor timing, technical complexities, ambiguous results and futility of intervening;

  b) public groups lack sufficient manpower to mount an effective position; concerned individuals are left to "steal time from employers" or "burn the midnight oil" to meet unreasonable schedules;

  c) government slow to move and provides little time to respond; leaves public in an unwelcome antagonistic role;

  d) public interests groups have done more and put up with more than government and industry should have expected;

  e) monitoring results not always available on request or within reasonable timeframes;

  f) funding problems; lack of technical expertise.

- Public will not accept priority use of forest areas by the forest industry. Recreational and other uses have not been given sufficient profile. The forest industry has been given free rein to manage the forest as they see fit.

- Public activist groups are often accused of misleading, inflammatory arguments and the misuse of scientific information. Legitimate, responsible questions have been posed yet no dialogue has developed. Public groups are trying to be reasonable without causing a fuss yet communications with decision makers are poor. Communications between government and public groups need improvement. A lot of bad feelings and bad publicity could be avoided.

- There is increasing concern that federal/provincial government restraint programs will reduce the level of research on fate and effects of forest pesticides.

- Pesticide Advisory Board. The Nfld. Board has been revamped and now includes public members.

- While public outcry has lead to some improvement in spray procedures, there is a big difference in being responsible to public outcry than being responsive to public concern. The public is easily mislead by so called "comfort monitoring". One-year monitoring studies serve regulatory and other watchdog functions but are, inherently, <u>useless</u> from a scientific standpoint.

- Socio-economic factors (eg. employment) are rarely given the profile they deserve in the forest pesticide debate.

- Public education programs are poorly developed and ineffectual.

<u>Hemlock looper outbreak</u>

- The re-introduction of fenitrothion (only registered pesticide available against hemlock looper) in 1985 is a major turning point in operational spraying in this Province. Over the past nine years, the public has grown complacent with forest spraying and may not realize the significance of returning to fenitrothion for operational use. Environmental effects on non-target species are far more significant with fenitrothion than matacil yet no EIS is required and terms of reference for a monitoring study have yet to be delivered. The results of monitoring studies in 1985 are still not available and public groups are concerned with the quality of information being received.

- Looper outbreaks have rarely lasted more than a couple of years. It would be extremely difficult to undertake further experimental work given the expected duration of the outbreak.

- Forestry officials should have been aware of an impending hemlock looper outbreak and yet took no action to have alternatives to fenitrothion registered. The renewed use of fenitrothion, if even a short term requirement, is extremely retrogressive given the position taken by the Province to use matacil rather than fenitrothion for budworm spraying.

Herbicides

- Herbicides (background):

  a) not used in broadcast sense;
  b) magnitude of use is limited and scattered and restricted to highly productive sites;
  c) one of several approaches;
  d) no indiscriminant use;
  e) target species not mature trees but opportunistic species that invade an area after cutting;
  f) as harvesting does not involve cutting along riparian areas, herbicides not normally required in these zones;
  g) planting is not an alternative to herbicides which are used to combat weeds and softwood plantations;
  h) 2,4-D/Agent Orange analogy considered unfair by foresters;
  i) ROUNDUP more effective in experimental trials than 2,4-D or manual clearing.

- Herbicides (concerns):

  a) continuing controversy over 2,4-D from a public health standpoint;
  b) not economical if used in limited areas i.e. no commercial gain;
  c) five years before EIS terms of reference issued;
  d) difficult for public to obtain and provide adequate reviews of technical information;
  e) no convincing answers to public concerns.

Biological controls

- Various biological control methodologies have been implemented in Canada for the control of forest insect pests. These include the use of parasitic wasps in Ontario and the parasites of the sawfly and birch casebearer in Newfoundland. Current research is focused on the use of micro-organisms including bacteria, viruses, fungi, protozoa and nematodes for regulation of populations of pest insects in forestry. Indeed Canadian scientists played a major role in research and development of the bacterium *Bacillus thuringiensis* (*B.t.*) which is widely used in this country. Presently Memorial University is focusing research on the use of nematode parasites for control of spruce budworm and hemlock looper (see "Microbial Insecticides in Canada: Present Status and Future Use"; a Report of the Entomological Society of Canada to be published in 1986).

- There is a misconception that biological control mechanisms have fewer side effects than chemical pesticides. The NRC report on the effects of *B.t.* was quick to note that the impact on aquatic insects has not been as adequately monitored as the effects of chemicals in terrestrial ecosystems. Future research should include intensive studies on short term and long term effects of these control agents on populations not only of target insects but also non-target insects and fauna.

- While there has been a lot of excellent work on alternative methods of pest control (eg. lower, safer doses), biological controls and application technology, government has been unable to alleviate public concern on the issue. Research priorities and communication should be re-evaluated along these lines.

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5. Closing comments

In closing, Mr. Coady noted that workshop discussions had been extremely wide-ranging with diverse viewpoints on many key issues. Participants agreed that proceedings should be prepared and the Chairman agreed to coordinate efforts. He further expressed his appreciation to those attending.

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