CREDIBILITY OF THE NRCC REPORT (AUGUST 1977) ON "*FENITHROTHION*: THE LONG-TERM EFFECTS OF ITS USE IN FOREST ECOSYSTEMS: CURRENT STATUS"

A critical review

by

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ABSTRACT

This critique challenges some of the opinions recently published by the National Research Council of Canada, concerning the scientific investigation of environmental and health issues stemming from forest spray operations. These opinions, stated by an Expert Panel reviewing a recent symposium on the long-term effects of the insecticide fenitrothion, were directly critical of the quality of scientific surveillance of effects in ecosystems, and indirectly critical of research managers and spray proponents.

Some of these NRC judgments are acceptable and welcomed by the author. Others are considered to be superficial, pretentious or invalid, raising doubts as to the competence or representativeness of the Panel. It is shown that the Panel has not adhered to its mandate to concern itself only with scientific criteria for environmental quality. The critique explains and defends descriptive field monitoring and various classes of research activity. It appeals for advice on how to apply systems modelling to the problem of assessing ecosystem disturbance. It disputes the Panel's claim that perennial spraying assures the de facto persistence of insecticide in the environment. It questions the practicability of the Panel's recommendation that new central authorities be established to regulate spray operations and to fund research.

RESUME

Cette critique désavoue certaines des opinions émises récemment, par le Conseil National de Recherche du Canada, qui portaient sur les études scientifiques cherchant à faire la lumière sur certaines questions de santé publique et de détérioration de l'environnment qu'ont suscitées les pulvérisations forestières aériennes. Ces opinions, exprimées par un Comité de spécialistes lors de l'analyse des délibérations d'un récent colloque sur les effets à longue échéance de l'insecticide fénitrothion, mettaient directement en question la qualité scientifique de la surveillance des effets éprouvés au sein des divers systèmes écologiques affectés.

De façon plus indirecte, elles étaient également critiques des gestionnaires de recherche et des supporteurs des pulvérisations.

Certains de ces jugements portés par le CNR sont acceptables et même reçus avec enthousiasme de la part de l'auteur. D'autres par contre sont considérés superficiels, prétentieux ou non-justifiables, laissant planer des doutes sur la compétence ou la représentativité du Comité même. On y démontre que celui-ci n'a pas tenu compte du mandat qui lui avait été confié de s'intéresser seulement aux critères scientifiques portant sur la qualité de l'environnement. La critique explique et justifie le sondage descriptif fait sur le terrain ainsi que le bien-fondé des diverses activitée de recherche. Elle solicite des propositions sur la meilleure façon d'employer les modèles mathématiques pour évaluer les perturbations dans les écosystèmes. Elle conteste la prétention du Comité qu'un programme de pulvérisation sans cesse renouvelé assure du fait même la persistance d'insecticide dans l'environnement. Elle met en doute la valeur pratique de sa recommandation suggérant que de nouvelles autorités centrales soient mises sur pied en vue de réglementer les pulvérisations et fournir les subventions nécessaires aux recherches.

FOREWORD

As never before, Canada is faced with problems of resource and environmental management requiring planning and vision into future uncertainties. Not least among these problems is the current spruce budworm outbreak across millions of hectares of eastern Canada, threatening the wood supply in several regions. Some provinces have to make strategic decisions on whether to hold onto mature forests by resort to repeated use of chemical insecticides, or to lose parts of the standing crop to destruction by the pest.

A conspicuous dimension of the problem is the general reluctance to continue to rely on the broadcast use of toxic chemicals. It is to the credit of the National Research Council of Canada that a continuing review of the environmental aspects of pesticide usage was initiated in the early 1970's. The recent NRC report on fenitrothion is the latest attempt to bring scientific focus to the environmental and health implications of forest insecticide use. It is unfortunate that a potentially useful document has been seriously flawed by over-statement and lack of objectivity.

The attached report by Dr. I.W. Varty, an ecologist with the Canadian Forestry Service, takes issue with some of the findings of the NRC panel and with the attitude displayed by panel members as regards forest management and ecological studies. Dr. Varty's critique is welcome because it places in perspective some of the statements of the NRC panel which reflect a lack of balance and understanding. The author suggests that the deployment of scientific expertise on the fenitrothion problem has been a reasonably logical response to the needs for information and priorities of the issue. He fully recognizes that much further research is urgently required.

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The National Research Council's Associate Committee Scientific Criteria for Environmental Quality renders a commendable service to Canadian science and resource management by its ongoing series[a] of publications on pesticides. The first NRC report on fenitrothion (NRCC 14104, Dec 1975) reviewed its chemistry and use, and noted that issues of long-term ecological impact were unresolved. Next, in April 1977, NRC and Agriculture Canada jointly promoted a Symposium to bring into perspective the health and environmental aspects of fenitrothion use. Finally, the latest paper (NRCC 15389), "Fenitrothion: the long-term effects of its use in forest ecosystems: Current Status", published in August 1977, is the overview of an "Expert Panel" reporting on the symposium.

Insecticide practice around the world has come under fire from scientists and the press as a result of abuses and misuses in crop husbandry and disease vector control, while the major material benefits from normal use are universally taken for granted. The controversy has included chemical control tactics to protect eastern Canadian forests from spruce budworm, particularly the use of fenitrothion over millions of acres. Doubts on the effectiveness of treatment and on its safety to human health and to environmental integrity have troubled the public, scientists and resource managers. The initiative of the National Research Council, that rock of scientific integrity in Canada, to assess long-term effects of fenitrothion was therefore welcome to people looking for responsible judgment.

The result - the "Current Status" report - is disappointing. It brings a measure of hasty judgment to the public debate on pesticide use, while elements of rhetoric and innuendo lower the credibility of the entire publication. The press has already reached happily for certain intemperate statements which make bold headlines, and public

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[a] NRCC report nos. 13684 (Picloram), 14094 (Chlordane), 14098 (Endosulfan), 14102 (Methoxychlor) 14104 (Fenitrothion) and 15385 (Bacillus thuringiensis) available from Environmental Secretariat, Publications NRCC, Ottawa, Ont. K1A OR6.

trust in provincial resource protection policies and federal environmental surveillance has been unfairly damaged. My critique is intended to examine some of the strengths and weaknesses of the Current Status report, and to temper its impact by explaining the rationale for the current environmental monitoring approach.

I must also note that the Expert Panel, although composed of eminent scientists and professionals, incorporates little practical field experience of forest pest control operations, environmental surveillance, and resource management. The Panel failed to recognize the limitations of its own competence or to enrich its experience by consultation with provincial resource departments and federal research agencies. Nonetheless, some useful advice can be drawn from the Panel's various recommendations.

Role of science in the protection strategy

The Panel Report summarizes the role of science in the decision-making processes as: (1) to identify the risks and benefits, (2) to assess the adequacy of knowledge, (3) to advise on modifications of the control program to facilitate acquisition of knowledge, and (4) to advise how to optimize the benefit-risk relationship. The Report then claims that these roles have not been fulfilled by the scientists examining the spruce budworm control program.

That claim is unbelievable in its stark simplicity. Volumes of reports on defoliation prevention and the state of the forest estate attest the short-term benefit of spray tactics. The development of a simulation model for the New Brunswick situation seeks to put those benefits in the perspective of long-term wood supply. Similarly, the various reports on responses of the fauna of target and non-target areas identify the overt deleterious consequences in short-term, and recognize the inadequacies of long-term surveillance. Gaps in knowledge of environmental toxicology and insecticide chemistry have been recognized long before NRC explored the topic, and substantial progress in acquiring new knowledge has been made every year. How else could fenitrothion have

merited NRC recognition that it has one of the better data bases available in comparison with other pesticides?

It is perhaps true that science has not much influenced spray operations to make them amenable to research investigation. Those operations take place within a demanding time frame; they are at the mercy of the weather and are bounded by the requirement that they kill budworm to save foliage at high efficacy. Each unit of work, a 5000 ha block, has a price tag of around $25,000 and has to pay its way. The forest cannot be rented like a farmer's potato field and modified as experimental strips with a range of treatments. Forest spray operations do not lend themselves readily to research manipulation, and it cannot be expected that operators can subordinate their prime responsibility to serving research needs. The spray airstrip has a pressing schedule in May-June, and it is costly to set aside spray planes, pilots, mechanics, mixing tanks and materials to await the design of the experimenter and the whim of the weather. These are the facts of life.

The Panel Report infers that scientists have not advised provincial authorities how to maximize the advantages and minimize the risks of insecticide tactics. That charge is patently untrue. How other than by science could a whole range of candidate insecticides have been explored for their target efficacy? How else were low volume spraying and new guidance systems tested? How were the defects of DDT, phosphamidon, and Bt identified? How were the dosage tolerances of wildlife to fenitrothion and aminocarb established? Scientists have long advised decision-makers through the Forest Pest Control Forum, the regional committees administering the Pest Control Products Act, various provincial resource and environmental committees, and the spray operators in direct consultation.

NRC should be well aware of the varied indispensable inputs by scientists into decision-making in spray tactics and strategies. These inputs might be fairly criticized on grounds of quantity and quality, but the bald statement that scientific roles have not been fulfilled is misleading to everyone.

Operational Programs

The Panel Chairman has presented an unfavourable rating of spray operators and resource managers. I quote "Operationally, the use of pesticides in Canada for the control of spruce budworm must be described as involving brute force and educated ignorance ..... The actual operational control program is so complex and chaotic .... the stupidities, deliberate and otherwise, which have plagued the use of fenitrothion ..." (p. iii-iv).

These intemperate outbursts suggest a profound ignorance of the problems of provincial resource management, and of the realities of the spray tactics and conduct. The Panel would have been better served by the inclusion of at least one member with a practical grasp of protection strategy. In any case, this kind of commentary oversteps its mandate for scientific criteria.

The statement "brute force and educated ignorance" carries innuendo but no explicit message. Perhaps the writer was suggesting that spraying is a blunt weapon used without environmental sensitivity over a very large area by indifferent technicians. That view is contrary to my personal experience in New Brunswick and elsewhere. I could argue that operational control based on phenology of the target pest discriminates more heavily against budworm than other faunal components of comparable sensitivity. The sprayers show intelligent willingness to modify target areas, regimes, formulations, delivery systems, and timings to minimize the exposure of wildlife, beneficial insects, and people. The major defect - unpredictable drift of the spray cloud - is itself the product of efforts to avoid large-drop contamination along the midline of a spray swath, and to achieve uniformity of deposit with smaller quantities of insecticide. The state of the art is somewhat intermediate between routine, heavy, repeated, preventive sprays used in some agricultural and public health practices, and the fine-honed integrated control practiced in a few high-value crop regions. No one has yet devised a pesticide delivery system that does not contaminate non-target habitats, and science is only beginning to devise prophylactic

methods of control specific to a single target pest.

From the inside, spray operations do not appear "complex and chaotic". The spray map and regimes followed in any one year are the logical product of the distribution, value and age class of the susceptible forest, the history of defoliation, the density and phenology of the pest, the proximity and sensitivity of non-target ecosystems, the facilities at air strips, needs for operational testing of delivery systems, and candidate insecticides, and recently the voices of landowners. It is true, however, that the needs of the sprayers for new technical knowledge often outstrip the capacity of ecologists to monitor the consequences.

The Panel notes that novel approaches to budworm and resource management have been proposed, and suggests that these options be examined (p. 13). Since these approaches are *already* being examined, and were proposed on the initiatives of the Province of New Brunswick and of Fisheries and Environment Canada, the Panel's wisdom is late and superfluous. Again, it should confine itself to its mandate for scientific criteria.

The chairman's statement about "deliberate stupidities" is untrue, and sullies the integrity of operators, managers, and scientists at large. It is unworthy of an NRC document and unworthy of further comment.

Ecological monitoring and research

The Panel reserved its unkindest cuts for ecologists. Certainly, the published ecological research is vulnerable to criticism, but what is now needed is a *constructive* appraisal of what needs to be done; that appraisal should stem from a good understanding of the goals, circumstances, and resources constraining ecological surveillance of spray programs.

According to the Chairman ... "most of the scientific work done to date lacks rigor, planning, and control, and one wonders whether there has been more concern with appearing busy than with shedding light..." (p. iii).

It is regrettable that a valid criticism of publications should be coupled with a thoughtless disparagement of an unspecified group of researchers. This is the more galling because in my own experience most of those scientists are dedicated to their mission, and their busy appearance derives from a courageous attempt to match a surveillance problem that is too big for the resources available to them.

The Expert Panel "was appalled by the generally poor quality of ecological research ... the majority of the research is pedestrian and is concerned more with data collection than with relevant experimentation." (p. 11).

There was no need for any expert to be suddenly appalled. The evidence has been available for years. Scientists who conduct ecological surveillance have long been frustrated by their commitment to descriptive survey of field events rather than to the more rewarding exploration of hypotheses, cause-effect relationships and deductive reasoning in the traditional scientific method.

Four kinds of scientific activity are needed to cope with the ecology of ongoing spray programs. They are (1) field monitoring, (2) field experiments, (3) laboratory experiments, and (4) systems modelling.

Most field ecologists have been committed to monitoring; this is only the first step in science, that is, observation and description. Their mandate, in their several disciplines of wildlife, fisheries, invertebrate ecology and environmental pollution, is to maintain an overview of the responses of the entire fauna in target forests and adjacent systems. Their mission is to stay in broad perspective, keeping alert to drastic kill or population shifts of important organisms in a mosaic of ecosystems. These field monitors have to dissipate their efforts across the evolving and disparate techniques of insecticide practice, and contend with amoeboid patterns of budworm infestation and target area. They must cope with the complexities of spray operations and the infinite variability of natural systems; it is not their role to simplify operations for experimental purposes. This variability includes

the following factors: (1) insecticide classes (carbamate, organophosphate, plant derivative, biological insecticide), (2) different proprietary versions of a single insecticide (isomerization), (3) spray regime, (4) spray formulation (adjuvents, diluents), (5) variability of deposit on receptors, (6) variability of spray cloud drift, (7) diurnal timing, (8) seasonal timing, (9) delivery system, (10) past spray history, (11) ecosystems, stand characteristics, and heterogeneity within habitats, (12) weather events, and (13) background information and baselines.

Contrary to the Panel assertion that "research scientists appear to have failed to recognize the complex nature of the varied formulations and spray regimes used in the field" (p. 5), these sources of variability have been glaringly evident to them. In monitoring practice, pre-treatment description and calibration with detailed precision are pipe dreams. The most practical expectation is that gross short-term changes may be detected by territorial survey. Sampling problems are severe. Most monitoring has been confined to pre- and post-treatment sampling to estimate survival of indicator species or groups. There are two options. One is to concentrate the observations in one or very few plots and gather enough samples to produce a statistically valid statement of the unique event that happened. That statement may have rigor and precision, but it lacks generality. The other option is to extend scanty sampling resources over a large territorial area and over major regimes and ecosystems. This has the generality of a survey but lacks statistical soundness. It is this dilemma that makes monitors hesitant of publication and reluctant to advise on particular regimes. In practice, ecologists have tended to favour extensive rather than intensive monitoring because they are required to report on the spray operations as a whole rather than probe single components. Monitoring - factual verification of effects in the spray block - will always be needed by the resource manager and the public no matter how sophisticated or predictive modelling may become. Monitors are quite properly concerned with data collection rather than with relevant experimentation; that concern should not be denigrated (p. 11).

In the second activity class, field experimentation, it is imperative that ecologists try to relate spray delivery and faunal responses. The Panel correctly states that it is impossible to predict realistically the environmental impact without information on a) the chemical nature of the material deposited in the field, and b) the uniformity of the deposition patterns (p. 5). It is untrue that little progress on these requirements has been made in 20 years, but it is true that the problems have not yet been solved; and solutions are urgent. In reiterating this need, the NRC Panel does offer a constructive comment. These are research problems in which input from agencies such as NRC is truly needed.

It is absurd to suggest that any part of ecological methodology has remained essentially unchanged over decades (p. 12). The Panel will not make its points more effectively by exaggeration. Scientists have continued to adapt methods from other biological fields and there are good examples of problem-specific ingenuity. The weakness of methodology is not confined to spray ecology; most fields of environmental monitoring are in their infancy.

The third class of activity is laboratory experimentation. This is perhaps the weakest part of scientific inquiry. There is a general dearth of environmental toxicologists in Canada and a particular lack in spray ecology. Dosage-response studies pertinent to the Canadian fauna and operational conditions are much needed, and perhaps it is true that some of the work already conducted has lacked environmental relevance.

The fourth class, systems modelling, is discussed later.

Long-term perspective

The major ecological problem is to identify the significance of short-term effects on faunal populations in long-term resource perspective. Long-term effects present a challenge in experimental design and field pragmatism. There are three options: (1) to monitor regions or plots with their operational history of spray treatments and an unpredictable future history, (2) to specify repetitive treatments in plots where the

delivery system can be controlled, and (3) to model population responses and validate the model by field experiments over time. Some progress has been made in all three options. The Panel is right in asserting that the overall ecological program lacks a coherent framework which could serve to link management and research (p. 11). Yet there are good lines of communication. Both Quebec and New Brunswick have regional monitoring committees specifically established to link sprayers, managers, ecologists, and chemists, working effectively since 1976. The Forest Pest Control Forum puts each year's experience in a single document.

As yet, resource managers have not elucidated a long-term crop protection policy in any province. Spray operators are not yet ready to stabilize perennial treatment regimes. Ecologists - by no means an army - concentrate on seasonal events and methods. Nowhere is there a master plan for long-term surveillance and integration of effort around the resource problem. It is easy to point the finger.

For errors and weaknesses, ecologists need make no excuses. Anyone who has tried to do research should know that it is generally an inefficient form of human endeavour. The search for the unknown cannot be planned in advance with the precision of a factory assembly line. Moreover, forest spray ecology is an exceptionally difficult discipline without fiscal priming by industry or public bodies, and without a large pool of American expertise to draw upon.

If the problems of field scientists are real and understandable, should we then blame forest research administration for failure to face the challenge? The answer is No. Resource and research managers have to place value judgments on broad scientific needs and to set priorities on very different research problems and disciplines. The general expectation in the 1960's was that the budworm problem would fade naturally as it had in New Brunswick and elsewhere in the 1950's, and that research on ephemeral insecticides and changing practices might be outdated before it could be applied. Management judgment in the 1970's is that forest spraying rarely causes serious environmental stress, and that current tactics, used with care, are unlikely to induce long-term disruption

of productive processes. It would have required extraordinary clairvoyance to have predicted 6 or 7 years ago that the budworm problem would extend and intensify throughout eastern North America, that fenitrothion would remain the main insecticide, that Reye's Syndrome would become a political issue, and that public concern would become general and widely misinformed.

The Panel is hasty for results. Its Chairman asserts that neither the NRC publication on Fenitrothion (Dec 75) nor the Schneider Report on Reye's Syndrome (April 76) produced any action (p. i-ii). Surely, it is not possible for one man or one panel to know all the responses to those publications in the various hierarchies of responsibility? Both reports were persuasive and undoubtedly contributed to the continuing review of social problems and the dynamics of scientific effort, without need of headlines.

Systems ecology

The Symposium and the Panel Report touched obscurely on how systems ecology could channel scientific effort to assess the long-term risks associated with the continuing spray programs. The Report blandly says "simulation modelling of the key environmental and economic factors relevant to the forest system may provide the only tool for complex integrated analysis (of management options)" (p. 14). If indeed it is the only tool, ecologists would welcome a pointed nudge in the right direction.

Any ecosystem has a spectrum of tolerances to insecticide pollution, sequestering some of the poison in biologically inactive sites, allowing some to escape to other systems, and breaking down the rest to noxious and innocuous derivatives. Populations and species diversity adapt in time by greater tolerance of toxic residues. Only when the dosage, frequency, and persistence of the insecticide input exceed the capacity of the ecosystem to absorb and recycle free toxins is there any real change in the structure and function of the system. Even then, change is not necessarily deleterious. Yet we know from experience that previously stable communities under stress may suffer

sudden loss of productivity after a prolonged period of uneventful accommodation. It is remotely possible that something of the sort may occur in the mosaic of ecosystems subjected to budworm infestation and chemical protection. Mathematical models might be developed to characterize the sensitivity of a selected ecosystem to spray stress. Other models might be developed to explain perturbed processes such as predator-prey relationships. This would not be a simple or short-term undertaking because even the simplest forest systems are rich in faunal diversity and bounded obscurely by adjacent systems.

Environmental impact assessment is becoming a normal part of resource management. Ultimately, budworm management may require a systematic impact analysis, covering the mosaic of ecosystems and summarizing information within a logical pattern. The Panel evidently (Fig. 1 of the Report) has something of the sort in mind, and could serve the readers better by being more explicit.

Forest Protection Policies

The Panel states "the solution (to the budworm problem) lies not simply in finding a less publicized pesticide but in developing vigorous and sensible management policies which will permit assessment of both benefits and risks" (p. 14). The innuendo is that provinces with budworm problems do not have sensible management policies and seek alternatives merely to avoid adverse publicity.

Again "the problem of evaluating the impact ... will never be addressed properly unless consideration is first given to evaluating a range of management options" (p. 13). The inference is that provinces do not consider alternatives to their current strategy.

Such representation of the attitudes and policies of provincial resource management unfairly undermines the status of the very people who have looked hardest for other options. In practice, alternative strategies and tactics have long been introduced, argued, and discarded in provincial and federal boardrooms. In particular, it was a modelling thrust initiated by the Canadian Forestry Service, and a

review launched by the Province of New Brunswick that led to the best exposition of these options (the Baskerville Report, 1976). The Panel Report is somewhat frugal of credit.

Provinces with a current budworm problem make annual decisions on insecticidal protection on the basis of imminent damage to part of the fir-spruce crop and long-term regional disruption of pulpwood supply. The decision involves politics, employment, regional economy, capital investment, public health, and the natural environment. The risks and benefits are examined as closely as available facts and hypotheses warrant the need. But we live in a society of calculated risk where complete safety is impossible, and the aim is to optimize benefit/ risk ratio. Political decisions in an emergency context cannot wait until science knows everything about insecticide chemistry, spray physics, and environmental toxicology.

Chronic poisoning

The Panel is misguided to suggest that the present protection policy (in Quebec and New Brunswick)" assures the de facto persistence of fenitrothion in the environment as surely as if it were locked in chemically" (p. 13). The implication is that fenitrothion is not much different from DDT - ubiquitous, mobile, and in continual biological cycle.

In reality, fenitrothion is sporadic in time and space, and discriminate in its toxicity. The spray plan for any one year is a patchwork of blocks, each with a varied history of previous treatments. Of New Brunswick's 6 million hectares of forest land, none has been sprayed every year since 1968. The average annual coverage since 1968 has been 2 million hectares. Furthermore, even in a treatment year, the period of lethal persistence of fenitrothion totals no more than 2 weeks in most terrestial habitats, and less than 3 days in stream habitats. The tactics on a spray block thus deliver one to three brief periods of lethality to that portion of the fauna which is exposed and susceptible. Thereafter, populations respond to the altered community relationships

and tend to return to the carrying capacity of the habitat. Immigration from the untreated matrix assists population recovery within a few weeks, months, or years, according to species and circumstances. The main inadequacy of research is that there are no life-table studies of indicator species to explore the mechanism of population response.

The Panel's report fails to characterize adequately the incidence of insecticide over time, or to make constructive suggestions on how to measure its biological effect.

Operational regulation and coordination of research

The Panel concluded "that a single central authority should be designated to specify and govern the formulation, delivery, and distribution techniques for all large-scale pest control operations" (p. 14).

That recommendation is a political one - the classic response to centralize in the face of regional variability - and goes beyond the mandate of NRC to define scientific criteria for assessing environmental quality.

In any case, provinces are responsible for their own resources and management options. The concept of a central authority regulating the pursuit of those options runs counter to the prevailing mood for regional self-reliance and responsibility. Nor is there convincing likelihood that such a federal body would show more wisdom or act more decisively than the Provinces of New Brunswick and Quebec (together with Agriculture Canada) already do in regulating their spray programs.

It should be recognized that the multiplicity of insecticides, formulations, delivery systems and regimes arose from perceived regional needs to deal with varying conditions of budworm density, tree hazard distribution and the state of the art. The need to experiment - to vary regimes and run operational tests - will continue no matter what body is responsible for regulation.

The real problem is that the variation and changeability of spray materials and methods taxes the capacity of monitors to describe ecological effects and compare merits. Even then, the process of ecological

assessment can hardly be described as "more a matter of personal opinion than of fact"; that kind of careless statement blemishes the Panel's reporting. The monitor covering many spray regimes assembles an array of assessments weak in conventional statistical values and without cause-effect validation. He must then make a personal judgement based on the available facts and intuitive experience. But that is not to imply that personal bias outweighs the evidence.

The Chairman of the Panel went a step further "the allocation of funds (for research) should be channelled through a central coordinating group ... the National Research Council's Associate Committee on Scientific Criteria for Environmental Quality is the logical choice for this role."

The suggestion has some merit; there is indeed a need for better coordination of research. Yet there are severe institutional difficulties in establishing central funding authority. Funds for environmental monitoring, toxicology, health, biological assessment and spray technology come from a variety of agencies: several federal departments, the provinces, industry, universities and foreign institutions. There is no conceivable mechanism whereby a central authority could allocate all these funds. Even federal funding is largely controlled regionally on the principle of decentralization. Yet there is some need to channel future work within a suitable framework so that knowledge builds and synergizes. It would be premature to suggest what body might undertake that task, but is is essential that any such authority should have cognizance of crop protection strategies and the facts of life in spray operations, as well as a general expertise in research.

Caveat lector

Every NRC report has the starting advantage of the reputation and impartiality of that prestigious body. Yet to err is human, and its authors can be subject to normal myopia, bias and fallible judgement even after NRC's multistage review procedure. Let the reader beware.

The "Current Status" report raps scientific knuckles and that

is acceptable. It faults the planning and rigor of research and identifies some areas of ignorance. In some ways the report is a spoonful of good but distasteful physic. But in places the prescription seems more intended to scourge than to purge. What is not acceptable is the choice of words and the use of innuendo derogatory to resource managers, spray operators and environmental researchers. Some ill-considered statements have already given ammunition to political opponents of insecticide practice in the emotionally-changed public debate.

The report itself is open to faint praise. On almost every page there are interpretations or suggestions which are superficial, impracticable or at least debatable. I have not attempted to discuss the minutae of every paragraph, but rather to exemplify the fallibility of an expert Panel which responded too hastily to its mandate. Perhaps the Panel is qualified to probe the weaknesses of spray surveillance, but it has not demonstrated constructive leadership towards better research organization and performance in the future. When panel selection is inadequately representative for its terms of reference, its pronouncements will be pretentious or superficial in places.

Rethinking the surveillance of spray operations is needed, and not withstanding the Report's defects, I welcome NRC review. It would be productive to science and resource management to place environmental studies in a long-term framework rather than respond with annual ad hoc initiatives. Such planning and coordination faces institutional, operational, fiscal, political, and intellectual roadblocks. In our ardour for better science, let us not ignore the cooler assessment that the research effort should be commensurate with the problem. No one has yet shown that ecological effects from spray operations are as hazardous as the Panel's attitude implies.