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Science Council
of Canada

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1970
Report No.9

This Land
is their Land...

ANALYSES

**This Land
is their Land...**

**A Report
on Fisheries and
Wildlife Research
in Canada**

ANALYZED

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The Rt. Hon. Pierre Elliott Trudeau,
P.C., M.P.,
Prime Minister of Canada,
House of Commons,
Ottawa 4, Ontario.

Dear Mr. Prime Minister:
In accordance with sections eleven and thirteen of the Science Council Act, I take pleasure in forwarding to you the views and recommendations of the Council as they concern policies on fisheries and wildlife research in Canada, in the form of a report entitled "Science Council Report No. 9—This Land is their Land...".

Yours sincerely,

O.M. Solandt,
Chairman,
Science Council of Canada

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What To Do at the Top

Set a New National Goal

Fish and wildlife are important in Canada's future. As resources of economic value, they will contribute significantly to the national income of Canada. As vertebrate animals, they are man's closest biological relatives, which brings a feeling of kinship and affection for them. As barometers of environment, they will reflect the virtues and evils of good and bad management of air, land and water resources. The interdependence of human and animal populations and the mutual need for appropriately rewarding places to carry on their daily lives require consideration of fish and wildlife populations in the context of the environment aspired to by mankind. Thus, for economic, social and aesthetic reasons, the protection and enhancement of fish and wildlife are synonymous with the development of our environment.

In this spirit, a stable and healthy environment of high ecological quality, maintained over the long term, should be defined as a new national goal. The six national goals, chosen by the Science Council to provide the focus for discussion of policy, were:

1. national prosperity;
2. a high and rising standard of education, readily available to all;
3. physical and mental health and high life expectancy;
4. personal freedom, justice and security for all in a united Canada;
5. increasing availability of leisure and enhancement of the opportunities for personal development;
6. world peace, based on a fair distribution of the world's existing and potential wealth.

It is obvious that these goals cannot be achieved without the development and maintenance of a healthy environment. The conviction must become widespread that Canadians are, in part, the products of their environment—the nature of their countryside; that it is the responsibility of successive generations of Canadians to pass on a better natural resource than

they inherited; that wildlife and undisturbed natural areas are necessary repositories of a natural diversity that has not yet been utilized. National prosperity, health, leisure and personal development depend upon an adequate understanding of the consequences of actions which influence the environment. There is at present a substantial knowledge of the first-order effects of human activity on natural environments. There is a rapidly developing knowledge of the properties of complex biological, social and economic systems, but the techniques of optimization are still far from providing a handbook for the engineering of environments to achieve health, wealth and happiness. Until that day, it is vital to preserve options for the future, and to build into each resource-use decision an effort to produce a high-quality environment. This aim can best be achieved by its recognition in a national goal.

The elements of the national goal of environmental improvement would be:

—maintenance, improvement and restoration of the harvestable productivity of high-quality land, freshwater and marine environments;

—education and information programs to achieve a high level of public understanding of environmental relationships;

—pollution control based on recycling of materials and the establishment of national and international standards;

—more intensive regulation of chemicals, biocides and fertilizers used in the manipulation of environment; intensive research to anticipate the effects of new chemicals on ecosystems;

—integrated management of land and water, based on classification and comprehensive planning;

—preservation, maintenance and management of as complete a range as possible of natural communities, landscapes and geological features of Canada.

The contributions of science and technology to the goal would be:

—classification and thorough analysis of the major kinds of natural environments in Canada;

–development of adequate knowledge of resource interactions to permit proper environmental use planning;

–development of techniques for increasing the harvestable productivity of land, freshwater and marine environments;

–development of methods of recycling nutrients and of more efficient and economic means of re-using waste products;

–research to evaluate and predict the effects of chemicals, biocides and fertilizers on plant and animal communities.

Create an Environmental Council of Canada

The achievement of specific goals in fisheries and wildlife is completely dependent on the existence of national goals which reflect a strong component of environmental awareness. In large measure, all other aspects of fisheries and wildlife science are subordinate to this central theme. In consequence, a major step in planning for the future would be the creation of a non-political organization sponsored by the government which would have, as its basic role, the provision to the public of facts about their environment, upon which they may base adequate value judgements. The cost of sacrificing even immediate material welfare for a quality environment may not be high, but if it is, Canadians deserve to have the facts and a chance to make their choice.

The structure of the organization is a prerogative of the government; however an independent Crown Corporation, with a directorate representative of environmental interests and a small professional staff, is suggested. A suitable name for such an organization might be the Environmental Council of Canada.¹ It would conduct, and publish, studies and forecasts of environmental problems in Canada, and make analytical reviews of

¹The United States has already established an Environmental Council which has the President of the United States as its Chairman.

environmental questions which are the subject of public interest. It should strive to become a major source of informed opinion on environmental problems.

The Council should be a valuable adviser to government. Ideally, it should stimulate particular ministries to an appreciation of the interrelationship between resource uses and the necessity for considering problems in a larger context; it should draw attention to gaps in the support for environmentally oriented research; it should provide the inspiration and leverage for new kinds of activities in government departments.

Create a Department of Renewable Resources

In their early stages, developments of Canadian resources were pioneering in character—essentially operations that “mined” resources and that were largely conducted without reference to each other. Increasingly, particularly in the last two decades, the gathering intensity of resource use has led to conflicts of interest. The prospect must be for even more intense interaction between resource uses. To achieve sustainable high productivity in a quality environment, major advances must be made in the integration of resource development. Multiple-purpose use of resources, designed to maximize sustained benefits, must become the reality that modern technologies can attain; the Science Council will examine administration of all resources in the near future. Despite a wealth of intergovernmental and interdepartmental activity, there are only a few examples of effective multiple-purpose use of resources in Canada.

From the viewpoint of managing fish and wildlife populations and without prejudice to any future Science Council recommendations, there is an obvious necessity for modification of administrative arrangements and for blending ecological, social and economic factors of resource management in more realistic and meaningful ways. What is needed is

a sufficiently large administrative group of resource scientists, sociologists and economists to enable a unified and rational approach to the problems of managing renewable resources. Failure to do this will result in perpetuation of competitive compartmentalization, duplication of effort, conflicting spheres of activity, frustrations and inefficient use of national resources.

A step in this direction should be the synthesis of a federal Department of Renewable Resources comprising the present federal groups concerned with fisheries, forestry, parks and wildlife. The department would inherit the emphasis on sustaining yields of fish, wildlife and trees, and would provide the necessary focal point for a federal emphasis on the rapidly growing use of fish, game and forests for outdoor recreation. A more comprehensive department that embraced all land and water resource uses might seem more ideal from the resource management viewpoint. Intensive study should therefore be given to devices by which a more limited department might work with the Department of Agriculture and water resources agencies to provide an integrated approach to resource use. A structure might then be evolved that would operate efficiently but would retain its various components in identifiable form. A similar trend should be developed in provincial governments, though it is notable that the provinces have tended to move more rapidly than the federal government in the development of integrated renewable resource departments.

Finally, it is desirable that federal-provincial collaboration in resource use problems should be strengthened. A Canadian Council of Resource Ministers has convened since 1963, and while it has had some effect on public understanding through conferences and seminars, it has not had success in solving resource problems. To come to grips with resource problems, it is desirable that provincial agencies should be strengthened. Attention should be given to devices for federal funding, by contract, of proposals by

provinces for long-term study of resource problems. Similar devices should be used in such specific areas of resource management as land acquisition. Federal intent to conclude agreements with provinces desiring to participate in acquisition or management of waterfowl habitat has been clearly stated. No serious attempt, though, has been made to fulfil the statement of intentions. With federal review of progress of such studies, it might be expected that a closer liaison would be achieved between provincial and federal planners.

Resolve Jurisdictional Problems

An irritation and an inconvenience in fisheries and wildlife science in Canada is the clumsiness of existing jurisdictional arrangements. Many arguments favour the amendment of the BNA Act to give the provinces jurisdiction over inland fisheries, except for international boundary waters and migratory fish (anadromous) species, and the federal government jurisdiction, except for proprietary rights, over all migratory birds. The former change would regularize many existing working arrangements; the latter change would enable more effective management than that presently provided by the Migratory Birds Convention Act. The problems have persisted for so long that many devices have been invented to get on with the job in spite of the jurisdictions.

Nevertheless, jurisdictional problems remain at the heart of some confused and conflicting management. At present the Migratory Birds Convention Act is inadequate as a statutory base from which to manage migratory birds. It would be desirable if Canada were to negotiate a new migratory bird treaty with the United States and Mexico. The new treaty should establish a framework in which substantive matters, such as habitat maintenance, research, distribution of annual kill and regulations, can be considered on an international basis. This chain of activities pivots on amendment

of the BNA Act or the invention of some jurisdictional device to circumvent the constitutional problems.

The jurisdictional arrangements for fisheries have largely been surmounted by the virtual delegation to provinces of responsibility for management of fisheries. The only potential problem here is that Quebec assumes administrative control over the marine fisheries of the province. Bearing in mind the complexity that this could introduce into the management of the modern Gulf of St. Lawrence fisheries, it would seem desirable to have the fisheries arrangement with Quebec made similar to those between the other Atlantic provinces and the federal government.

Amendment of the BNA Act is now under active discussion between the federal government and the provinces. Fisheries and wildlife problems should be included in their study. Of course, revision of the Act involves much wider considerations than fish and wildlife and may perforce be long delayed. Meanwhile, it will be important to extend efforts to develop modes of collaboration that will surmount any formal jurisdictional problems in resource use and encourage federal-provincial joint activities.

Enact a Canadian Wildlife Act

Particular problems exist in the fields of regulation of both fish and wildlife. Rather surprisingly, there is as yet no Canadian Wildlife Act. The statutory base for federal participation in the wildlife sector is narrow; it does not establish a base for national initiative when national interests are clearly at stake. The failure to carry out the intent of the 1966 statement of national wildlife policy is indicative. The Canadian Wildlife Service has not played an active role in stimulating or supporting desirable scientific activities.

In 1961 specific recommendation for the enactment of a Canadian Wildlife Act was made to the Steering Com-

mittee for the Resources for Tomorrow Conference. It was worded:

“It is recommended that: a Canadian Wildlife Act, comparable to the Canadian Forestry Act, be enacted, under which the Canadian government can most effectively participate in the closest co-operation with provincial governments in wildlife research and management, including the initiation, conduct, correlation and dissemination of research and its findings and the provision of funds for research.”

That recommendation does not require rewording. The enactment of a Canadian Wildlife Act should receive high priority.

Plan for Future International Fisheries Problems

In the fisheries sector it is notable that international agreements and the accepted practices of the international Law of the Sea may be quite inadequate for regulation and protection of Canada's marine fisheries. In a rapidly changing world it will be necessary for Canada to develop international fisheries policies and to anticipate the large scientific inputs that are required for effective international negotiation.

A special task force should be struck to consider Canada's international fisheries problems, both marine and freshwater, and the policy and research needs they generate. The task force should be predominantly fisheries oriented but should, of necessity, involve participation by the Department of External Affairs. It should develop a Canadian attitude to international fisheries problems that would serve the needs of Canada, while considering the collective interests of the community of nations that harvest the sea. It should specifically attempt to anticipate research and information needs that will enable management of international fisheries on a rational basis.

The problems of international fisheries cannot be considered entirely out of con-

text of other marine resource uses that have international elements. A separate study should perhaps be conducted that would generate a Canadian policy on the use of marine resources. An exercise of this kind has recently been conducted in the United States and would appear to have the merit of crystallizing a national attitude toward the future use of the world's oceans by the world community of nations.

International fisheries regulation is currently going through a rapid stage of transition which reflects the increasing tempo of harvesting the living resources of the sea. Canada has traditionally played an active role in international reviews of the arrangements for managing world fisheries; this role should be encouraged as an important Canadian contribution to world affairs.

What To Do at Middle Levels of Administration

In broad perspective, Canadian fish and wildlife science has been world leading in calibre; but, in recent years, the sum of the various activities has not covered the sum of the national needs. As the pace of resource use has quickened, it has become clear that sharply defined national objectives are needed if the limited number of things we can afford are to be those that are most relevant. Relevance will stem chiefly from better understanding of the social and economic aspects of human uses of fish and wildlife, and better basic development of environmental science. Better performance can be achieved meanwhile, and sustained in the future, if there is better integration of research, management and development, and a much wider use of advisory boards broadly representative of the various sectors of public interest.

Integrate Research, Management and Development

Organization for research, management and development within fisheries and wildlife agencies is in need of internal review. The relationship between the Fisheries Research Board and the Services of the Department of Fisheries is not as effective as it could be; there are problems where overlapping functions have been difficult to resolve. The development of a large biology group in the Resource Development Service, for example, is at least in part due to the fact that the Service considers that the Board does not provide the research it needs to support its activities. Similarly, it is apparent that there are areas where much can be done to improve co-ordination between activities of the Fisheries Research Board and the Industrial Development Service.

In recent years, growth of the Atlantic herring fishery has followed a pattern which was disorderly in the synthesis of research, management and development. Necessary biological information for regulation of stocks was not available even though the rapid growth of the in-

dustry was encouraged by government. The fishery may well follow a "boom or bust" pattern that might have been avoided by more careful planning.

In the wildlife area, the handling of wetland resources provides a similar example of disconnected bits of research, management and development. The acquisition of wetlands and easements is not adequately guided by knowledge of the requirements of the hunters. For that matter, the preferences of the hunters are not adequately understood. Moreover, research on waterfowl is largely unrelated to the understanding of the dynamics of production or harvest. In brief, the present activity in waterfowl is a prime example of largely unrelated research, management and development.

These two examples of Atlantic herring and wetlands acquisition are only two from a wide field of examples in fish and wildlife science in Canada. It is neither necessary nor desirable to mix an assortment of research and management objectives in single projects, not to mix research and development in single projects. Rather, the emphasis must be given to devices which will interface the gaps between research knowledge and application to development or management.

Use More Advisory Boards

Many fisheries and wildlife research programs conducted by federal and provincial government agencies reflect, to too strong a degree, the personal inclinations of principal investigators. Programs of the Fisheries Research Board, although not perfect, appear to exhibit an effective degree of responsiveness to needs greater than many fish and wildlife research agencies. This responsiveness has, in large part, been attributable to their use of advisory boards which recommend desirable programs and which evaluate programs. The example of the Fisheries Research Board should be widely copied by renewable resource departments. A Canadian Waterfowl Advisory Board,

reporting to the Minister of the federal department which administers the Canadian Wildlife Service, is especially recommended. Moreover, advisory boards should be widely representative of society, more so than in the Fisheries Research Board which, for example, lacks representation of individuals whose primary interest is in the sport fishery or the non-exploitative use of resources.

Particular attention should be given to making the advisory board concept a success. Advisory boards are only effective when their members are active. When boards are organized, thought should be given to ways of making their members work efficiently. Where necessary, boards should be provided supporting staff for administrative matters. Moreover, they should freely exercise powers to co-opt specialists on particular problems. Finally, it is important that advisory boards should not confuse their functions by acting as boards of management. Their main function should be to evaluate programs independently, commenting on their relevance, assessing the degree of duplication of effort, recommending termination of unproductive lines of work, stimulating the development of new activities. A good advisory board is a valuable senate on matters of policy and priority. A poor advisory board is often a nuisance or, worse, a farce.

The proposed Department of Renewable Resources should vigorously pursue the concept of advisory boards here outlined.

Move Scientists Around

Equally important is the development of devices that would increase mobility of scientists, not only within government agencies, but also between federal and provincial governments and between government, university and industry. In present conditions there is rather little interchange between scientists, say, in federal government laboratories of forestry, fisheries, agriculture and water resources. This kind of compartmen-

alization is equally common in provincial government branches and in universities. Consequently, specializations are duplicated, interests are parochial and reactions to new ideas are defensive. Movements between government, university and industry sectors are virtually non-existent, underlining the personal sacrifices such moves entail and the prejudices that each group accumulates from being too isolated. Integration of research, management and development is largely a matter of people who know more than one point of view. A special effort should thus be made to devise methods of increasing the mobility of Canada's work force of fish and wildlife scientists.

To get on with this job immediately, it would be desirable if there were an immediate vigorous practice of secondment of scientists, such as is developed in the activities in the Science Council. It would be desirable, for example, for limited time periods and specific projects, for the Fisheries Research Board to second scientists to fishing companies; for the Canadian Wildlife Service to second scientists to provincial governments; for the Canadian Wildlife Service to request secondments of some university professors. All types of interchange should be vigorously encouraged. Those that prove profitable should soon be evident.

Recognize and Reward various kinds of Achievements

As by far the largest employer of fish and wildlife scientists, the federal government should consider carefully the various kinds of roles scientists may fill in the government service. Scientists may be used in relatively routine data-collecting jobs, or as resource managers, applied researchers, basic researchers, or as government-sponsored professors. Recognizing these varied jobs with appropriately broad job specifications and evaluating performance in them by differing and appropriate criteria would substantially improve the technique of managing scientific person-

nel. Good science deserves intellectual freedom and appropriate financial rewards. At present there is a tendency for scientists and their employers to pretend that all scientists are a uniform shade of “mission-oriented” grey, when, in fact, they are not and should not be. Differing specific tasks should be identified against which performance should be measured.

In provincial government agencies, and to some degree in the Canadian Wildlife Service, the small size of staff and the diversified work load allow for retaining a considerable degree of flexibility in performance evaluations. But, again, some greater degree of clarification would be desirable.

What To Do as Scientific Activities

Develop Environmental Science

In the recent past man has achieved unprecedented power to influence his environment. He is exercising that power at a rapidly increasing rate as his populations and technologies grow, frequently without sufficient understanding of the consequences. Mankind as a whole, and Canadians in particular, must perforce develop an environmental science as well as an environmental conscience. Present scientific activities in Canada collectively comprise a substantial and important contribution to science, but not necessarily to problems of national interest. In large measure scientific activities in fisheries and wildlife are fragmentary and seem to be done largely in the hope that someday someone will put all the pieces together in a meaningful synthesis. The lack of conceptual focus is the most outstanding characteristic of those scientific activities that one would ordinarily associate with environmental science. The biggest thrust in scientific activities should be to reorganize whole groups of activities to more specific social objectives.

Develop Social and Economic Research related to Fisheries and Wildlife

One of the very substantial gaps in present knowledge, and one of the very substantial difficulties in fisheries and wildlife development, is the uncertainty about social and economic values. For many Canadians, opportunities for angling and hunting are intangible necessities. Attempts by economists to come to grips with this situation have not been considered as very successful, even by economists. When the questions are placed in a broader context, one might question whether the basic issues are really as simple as the dollars and cents of angling, hunting and tourism. Environmental quality is not necessarily synonymous with opportunity for outdoor recreation. The explosive growth of outdoor activity has underlined that what

nobody owns, nobody cares for, and the country is increasingly blighted by a new kind of city-bred garbage spreader. This is only one of many social dimensions in environmental science—in angling and hunting per se, in commercial fisheries and in the total fabric of national life. In any event, neither federal nor provincial agencies have provided sufficient support for studies which would make important contributions to the solution of the problem of how to evaluate renewable resources in this general context, so that they can be adequately related to other resources. Considering resource allocations that must occur in Canada over the next 20 years, substantial expenditures in this type of research activity are imperative if wise investments are to be made.

Federal and provincial agencies should not only undertake socio-economic studies themselves, but should make major grants to one or two Canadian universities to encourage the development of socio-economic research on recreational questions.

The commercial fisheries provide substantial statistical information for more conventional kinds of cost-benefit analysis. The best elements of Canadian fishing fleets are highly efficient: with no subsidy, they compete successfully against highly subsidized foreign competition. But a major social and economic problem for virtually all fisheries arises from their common property nature. Since nobody owns them, everybody can use them. Few prosper, so the government is asked to help. The more help is given, the more who go fishing to get help. Rather quickly, fisheries become instruments of social welfare. The recent developments of licence limitation schemes for salmon on the west coast and lobsters on the east coast are a direct effort to cope with this problem in an orderly and humane way. It is notable, however, that these programs were not started with, nor are they continuing with, a sufficient background of social and economic research. Additionally, much of the research that has been

done is not being applied. There is no reassurance that the day-to-day tactics of the licence limitation schemes are part of a well-reasoned strategy. A similar situation exists in the present efforts to rationalize the freshwater fishing industry.

Increase Research on Chemicals and Biocides

The recent widespread attention to the effects of DDT on fish, birds and mammals (including man) should teach us the lesson that no chemical panacea should be taken without clear appreciation of its consequences. Quite obviously, chemical treatments and biocides will be immensely valuable to us in the future; but, in a technology that develops thousands of new unnatural chemical compounds every year, it is obvious that man's very survival depends upon a large investment of research that evaluates chemicals, so that they will be used wisely before they are used widely. The usual criteria of bioassay are obviously not sufficient; an entire new catalogue of questions of an ecological nature require answering before new chemicals are sanctioned for release. It is now obvious that sublethal concentrations of environmental contaminants have insidious ecological and physiological consequences. Until research is greatly intensified in this area, the establishment of tolerance levels lacks realism. Similarly, research to develop less complicated methods of monitoring levels of contaminants in the environment should be given high priority. Increasingly, this type of research has involved a high degree of sophistication. Accurate chemical analysis is fraught with technological difficulties. Techniques of pathology and toxicology are relatively new and in the process of rapid development. Accordingly, the greatest investment in this type of activity should be at universities or in large centralized government laboratories with clearly designated missions.

Develop Long-term Ecosystem Studies

It is equally important that special emphasis should be given to development of greater understanding of natural ecosystems. Even if a chemical treatment is selective in eliminating only one species with no adverse side effects on any other living organisms, there may be many ecological consequences. While there is much to be learned about ecosystem dynamics, the recent emphasis provided by the International Biological Program studies has clearly indicated the consequences of resource uses on ecosystems and the potential for intentional large-scale ecosystem manipulation.

At this moment ecologists do not understand how ecosystems work. The first-order effects of adding a pollutant or a fertilizer, of harvesting a particular species, or of controlling a particular pest, are usually familiar. What is known to occur, but which is as yet unpredictable, is the chain of repercussions to secondary and tertiary levels, the resilience and stability of natural associations, the patterns of adjustment to changes in the natural flow of nutrients and energy—in brief, the responses of a dynamic natural system to external change.

The research required to solve these problems must be large scale and long term. In general, natural systems are open ended. To assess the relevant physical and chemical processes, as well as their biological consequences, requires a large team of scientists from different disciplines and a large investment in equipment. Because of the slow responses of natural systems, typically tuned to annual rhythms, studies must be long term to be rewarding.

At present, neither universities nor government provides the appropriate milieu for large-scale, long-term studies, the one preoccupied with its educational function, the other periodically reoriented to more immediate missions. Studies that are concerned with analysis of ecosystems should perhaps be stimulated through

long-term granting commitments to consortia of universities and government agencies (especially through a Department of Renewable Resources). Considerable thought should be given to ways to combine the logistic wherewithal and administrative machinery of government with the specialized talents and educational functions of universities. The Canadian Committee for the International Biological Program (IBP) should take the necessary initiative in proposing sequels to the IBP that would exploit the momentum that they have recently given to ecosystem studies in Canada. The Fisheries Research Board should be given encouragement to continue the important marine ecosystem studies that have been started on both coasts, and the freshwater ecosystem studies at the Freshwater Institute in Winnipeg.

It is to be especially emphasized that there is a close relation between ecosystem studies, the assessment of the effects of chemicals and biocides and the study of large resource-use projects. These are not mutually exclusive activities and they share the common requirement for large field operations and facilities for experiment on a natural scale.

Study Large Resource-Use Projects

Similarly, it is necessary to find new ways to conduct large-scale research experiments that are concerned with multiple-purpose use of resources, particularly those that are anticipated in the years ahead. There has long been a need, for example, to understand and document the influence of mechanized logging operations on run off, stream quality, nutrient leaching, ecological succession, and a host of effects on fish and wildlife. For very large resource projects it will be obvious that there are potentially tremendous dislocations on environment, and perhaps tremendous potential benefits for fish and wildlife. Large-scale water resource projects in Canada have not received adequate preliminary study, nor is there a well-established practice of

exploiting projects for their research potential. Ideally, the principle should be established that resource developers should bear, either directly or indirectly, part of the responsibility for and part of the costs of environmental studies which would assess the potential effects of their projects *before they were undertaken*. Because this principle would be a departure from past government-entrepreneur relationships, it would require substantial study before implementation.

Make a Special Effort Now in the Arctic

It seems likely that Arctic resources will soon be vigorously exploited without adequate background study of the natural environment. In consequence, there is every prospect that northern development will be accompanied by the creation of a new set of environmental problems which would have been far easier to avoid than to rectify. Because of its high costs, the current prospect is for curtailment of Arctic ecological studies, even though the present pace is too slow. Yet here is a chance for Canada to try to steer the development of a great natural area on an ideal path, a course based on thoughtful prior analysis of the consequences of various policies.

In association with the various aspects of oil and mineral exploration and transport in the Arctic, it is strongly recommended that there be an intensive program of environmental research. The first priority should be given to renewable resource inventories that would enable classification of Arctic ecosystems and define the distribution of various kinds of frozen ground water. These studies should be initiated immediately. Equally important is study of the productivity of Arctic ecosystems, particularly the tundra and the taiga. The omission of a tundra ecosystem study in the Canadian proposals for the International Biological Program is much to be regretted. Research is greatly needed on the effects of a modern technology on the slowly re-

newable resources of the Arctic to which a native culture is adapted.

The sparse human population of the Arctic makes it unlikely that development will be associated with strong public reaction. In these circumstances a more positive governmental policy and action are appropriate.

Review some Particular Wildlife Programs

The great diversity of species and environments that comprise the Canadian wildlife scene create great difficulties for scientific work. Each principle of management must be explored repeatedly, if it is to be applied successfully to a particular species in a particular habitat. In consequence, the characteristic of wildlife research is the duplication of feeble levels of effort, repeated rediscovery of essentially the same basic principles, and diffusion of research into unrelated fragments. To develop vigorously, wildlife science needs a major infusion of effort and a sharp focussing on problems of high priority.

It is apparent, for example, that an appraisal of scientific activities is of particular importance for waterfowl. Federal waterfowl research programs, although small, have expanded substantially during the past decade. Efforts have been diffuse and would appear to lack any real sense of direction. The most immediate need is not for particular research, but for development of a thorough understanding of the interrelated aspects of wetlands reclamation programs and waterfowl habitat.

The scientific activities of provincial wildlife agencies have developed rather fixed patterns centred around the enforcement of game regulations, studies of sex or age characteristics of populations, and the damaging of habitat conditions of big game wintering areas. Hunter impact, environmental factors and land management programs need emphasis. There is a particular need to develop detailed understanding of habitat requirements so

that realistic cutting prescriptions can be provided to forest industries. Provincial agencies should also develop more diversified programs related to non-game species. In short, fish and game departments have not tended to keep up with the times, either in the quantity of research in relation to the need, or in the relevance of research to the problems of the day. Their present research patterns tend to reflect "starvation budgets" and social attitudes of a decade ago rather than those of the decade ahead.

A particularly good example of the backwardness of many wildlife programs is their failure to come to grips with the implications of increasing urbanization of Canada. A greater proportion of Canadians live in cities and suburbs and are increasingly less exposed to natural wildlife. To enhance and enrich the lives of city dwellers, much more emphasis should be given to the provision of zoos and wildlife parks close to urban centres. More emphasis should be given to considering ways in which cities may encourage a resident summer population of songbirds. The wildlife "pests" of urban areas such as starlings and pigeons, the wildlife scavengers such as seagulls and rats, and the subsidized "wildlife" such as cats and dogs, are well worth research study from the viewpoint of modern urban man.

The fur industry warrants a thorough socio-economic study to determine whether it is dying because of changing times or because of factors which could be controlled. At the very least, joint government action is warranted to seek out its areas of strength and weakness and determine what would give it a new lease on life. Studies of the fur trade could be usefully handled by federal contracts to provinces.

There should be continuing programs of research by the federal agencies in the Northwest and Yukon Territories. It would seem desirable though for the territorial councils to employ wildlife management personnel who report directly to them on specific management

questions. Also some arrangements should be worked out so that Canadian Wildlife Service biologists work very closely with the game administration. Some form of a wildlife management commission, if comprised of individuals representing both national and territorial interests, might be worthy of consideration as a means of overcoming the partisan rivalries and of managing wildlife in a way that would be compatible with both national and territorial interests.

Review some Particular Fisheries Programs

In fisheries, the early establishment of programs of biological research has resulted in the development of an especially strong federal research organization. It has placed Canada among the world leaders in this area of science. It has, however, resulted in too great an emphasis on research as opposed to management and development activities, despite the use of advisory boards. There is need for considerable readjustment in fisheries biological programs to achieve a better balance, greater capability to anticipate potential problem areas, and quicker response to problems when they arise.

For the marine fisheries, first priority should be given to the scientific investigations which Canada is obliged to undertake by treaty and to investigations which anticipate forthcoming international negotiations.

High priority should be assigned to research aimed at providing adequate biological assessment of both exploited and unexploited groundfish stocks to ensure optimum utilization by Canada in the face of increasing foreign competition. The potentials of fisheries of our continental shelves, particularly on the east coast, have not been adequately explored and in many instances exploitation has preceded sufficient preliminary study. Present models for management are not sufficiently comprehensive as a guide to policy. They lack precise evaluation of the tactics of fishermen and the appro-

priate strategies for competitive users. Additionally, present model systems require inputs of data that involve long term and tedious studies if the parameters are to be estimated meaningfully. There is need for intensive theoretical study that would elucidate more efficient and more comprehensive fishing strategies.

There is negligible information on developing queen crab fisheries on the east coast; long-term studies should be carried out if management is to be on a rational basis. Information is particularly needed on stock sizes, recruitment and potential yield. A well-planned and coordinated exploratory program should be initiated for all species of crabs. Studies on all aspects of care and handling of the product before processing are essential if fishermen are to bring these delicate products to processing plants in high-quality condition. Studies on gear design are desirable to allow crabs of unsuitable sizes to escape.

In fishing gear technology, probably the greatest immediate gain for the least effort would result from assimilating information already available in the literature from other nations. The next step would be to work at the development level on methods of adapting techniques to local conditions. The Industrial Development Service has already had some success along this line. There is probably little merit in a substantial investment in fishing gear research but Canada needs the people who can exploit the existing state of the art in applications to Canadian fisheries. This is an area in which federal contracts with the fishing industry would seem appropriate.

Freshwater fisheries in Canada are increasingly important for their recreational value. In recent years the chief justifications of research and management have been the growing sport fisheries and the problems of maintaining quality environments. Research activity oriented to sport fish management is an order of magnitude too small at the present time. Provincial governments should be advised of the gross inadequacy of present programs.

There are some particular areas of scientific activity in freshwater fisheries that warrant special reviews. As every fishery biologist now knows, there are some situations in which fish hatcheries are useful and even exciting tools of management. But where hatchery stocks are planted into mixed natural communities of fishes, the economics of hatcheries are dubious, even though the annual rites of planting may console the management and the anglers. Extensive evaluations of hatchery practices are strongly recommended for both the federal and all provincial governments.

Hatchery plantings are only a part of the total complex of fisheries scientific activities in which Canadians are involved in the Great Lakes. In retrospect, it is apparent that a mediocre record of research activity and the difficulties of international co-operation in management have contributed to the sad history of fisheries in the Great Lakes. At this juncture it would be appropriate for the Canadian fisheries agencies concerned to review the total Canadian scientific activity on the lakes in light of the international problems. The focus should be on whether the present investment has a favourable cost-benefit ratio for Canada, how better to co-ordinate the activities of various agencies, and what the best course for future action would be. After this kind of review, it might be appropriate to renegotiate the international commitments.

For both marine and freshwater fisheries it is one of the burdens of life that Canadians are not generally fish eaters. To increase per capita fish consumption it would be desirable to improve the quality of fish products, chiefly by greater attention to handling and distributing methods. Research activities that are appropriate to this problem, ideally, should be jointly undertaken by industry and government. Currently there is need both for research by industry and for mechanisms through which industry requests for research can be effectively communicated to government laboratories. Eventually

it might be desirable to establish a national Fisheries Products Research Institute that would provide a collaboration of industry and government contributions on development of new and better fish products.

Meanwhile, lack of participation by the fishing industry in product research should be a matter for their deep concern. While industry at present finances some contractual research, and has been engaged in joint activities with the Industrial Development Service, the prevailing attitude has been that the common property nature of the resource makes science the government's business. There is validity in this argument as it applies to management of resources, but once the fish are caught they are a private commodity whose value can be enhanced by technology. An appropriate development of fish products research within the industry should be encouraged.

Exploit some Bright Prospects

There are bright prospects for the development of some kinds of fisheries on both coasts of Canada and in fresh water. For example, molluscan shellfish, especially oysters, on both coasts are promising prospects for much enlarged industries. Research should be aimed very specifically at developing culture techniques that would encourage entrepreneurship in the expansion of the industry. Because the techniques of oyster culture have been widely developed in other parts of the world, emphasis should be on integrated activities that follow through to management and economic return. Administrative problems relating to oyster leases and public health are a particular bottleneck and should be the focus of special federal-provincial discussions. In the case of oyster culture, we should be able to proceed directly from the application of current knowledge to a payoff in dollars.

There seems at last to have been a substantial breakthrough in the artificial culture of salmon. Cost-benefit analyses

suggest extraordinarily quick returns on investments in salmon culture such as artificial spawning channels and hatcheries. Salmon culture requires substantial inputs in engineering talent as well as biological science. Because the techniques are new, it is important that the emphasis should be placed on thorough evaluation of projects. If the payoff is not dollars, then it should be a knowledge of why the schemes were not as successful as had been anticipated. If Canadian development follows the example of the United States, somewhat less than half of the projects will be successful. It is important that these failures be documented and quickly terminated as write-offs. The present practice of hit-and-miss evaluation, and incomplete integration of research and project design, leads to a failure to capitalize on the experimental potential of expensive projects. With the high potential payoffs, there is no doubt that investment should be large in this area and that performance should be commensurate with the stakes involved.

Less well-proven but promising opportunities are suggested by recent attempts at culturing rainbow trout, salmon and sable fish in salt water enclosures and rainbow trout in prairie pot-holes. Culturing ventures of this kind are the logical aquatic sequel to the chicken factories of modern agriculture, and they entrain the same kind of needs for backup science on nutrition, disease and pathology. An investment in federal "nutrition and disease" centres on both coasts would be well advised if these promising prospects should materialize. It might be added that such centres would be very welcome by provincial agencies operating hatcheries.

Finally, in the list of bright prospects, there is an opportunity for "risk capital" in imaginative research on the use of natural biological products by various industries. For example, seaweeds, fish and marine invertebrates possess unique enzymes, sterols and hormones, useful to pharmaceutical and other industries. The research would be expensive and would

likely require collaborative effort among government, university and industry laboratories using sophisticated biochemical, pharmacological, microbiological and other research techniques. The rewards could be substantial because the sea is the richest source of animal variety and it is as yet largely unexplored biochemically.

What Education Scientists Need

Produce Resource Scientists

The common approach in Canadian universities has been for students to take undergraduate degrees in biology, and if they were then inclined toward fisheries or wildlife work, to undertake graduate studies in one of six or seven Canadian universities, or to enter a graduate school in the United States or Great Britain. This approach appears to have resulted in several factors which bear directly on the profession and on the philosophy of the individuals who work in it. Canadians are much more inclined to think of themselves as zoologists or ecologists rather than as resource scientists. In general, there is not the sense of profession that exists among similar groups in the United States. This trend was perhaps timely in the circumstances of the last 20 years. It helped to maintain a balance between the various subdisciplines of zoology in university departments, resulted in a number of strong graduate departments, and produced scientists who were thoroughly grounded in basic principles of science. In the current circumstances, the traditional pattern is inadequate. It produces people who have virtually no background in the social, economic and political sciences and reflects an almost complete neglect of the need for applied biologists. Deficiencies in background are particularly important to biologists who are employed in management capacities in government departments. It is scarcely surprising that fish and wildlife biologists have been noticeably weak in developing or planning management programs. While the specialists in biological disciplines will always be needed, the troops of environmental scientists must be more broadly educated.

To produce the kind of resource science specialists that are required in the next two decades in Canada, it will be important to devise programs of study that provide a core of applied ecology in the biological sciences and a broad background in earth and aquatic sciences, and life and social sciences. The deliberate

emphasis at the undergraduate level should be a liberal science education and not specialization. The aim should be to puncture the water-tight envelopes that commonly enclose faculties of arts, science, agriculture, forestry and engineering. Specialties in various aspects of applied ecology should be developed at the graduate level, but again with strong emphasis on cross-faculty ties.

Mathematical aspects of biology and methods of systems analysis are rapidly coming into their own in environmentally oriented science. Characteristically, fish and wildlife management literature contains a profusion of adjectives and adverbs, reflecting the hedging necessary in coping with situations that are complex and not readily susceptible to field experiment. To this jungle of fuzziness, the development of computer techniques has brought new incentives for developing a conceptual focus and a new potential for gaining insight and making predictions. Essentially, the computer allows empirical study of complex systems that are as yet beyond the techniques of formal analysis. The development of mathematical ecology should be encouraged for it promises to provide the tools for coping with the large quantities of data and the complexities characteristic of resource management. At present there are a few developing centres of activity at Canadian universities. Their support and enlargement will be important to the rapid sophistication of resource management procedures in Canada.

What about Costs and Benefits?

In 1968-69 gross expenditure on scientific activities in fisheries and wildlife in Canada was \$33.5 million (Table 1). Expenditure on fisheries was \$25.8 million and on wildlife \$7.7 million. It is not easy to evaluate whether this is an appropriate level of expenditure. In the first place, the simple logistics of wildlife and fisheries investigations make them inherently expensive. Large geographical areas must be covered at all times of the year. The problems are not conveniently brought into the laboratory for solution. Second, it is obvious that much of the expenditure is necessary to maintain a status quo. Fisheries and wildlife resources deteriorate rapidly when they are not protected on the basis of informed scientific regulation. In a very real sense, expenditures on fisheries and wildlife science are largely maintenance costs. Third, expenditures in fisheries and wildlife science, particularly in fisheries, are in some measure a necessary charge for protection of Canada's future interests. The conduct of scientific investigations is the price of admission for participation in use of an international resource. The international agreement on fur seals is a striking example. Finally, investments in fisheries and wildlife science commonly have long delayed payoffs. For almost exactly 100 years fisheries scientists have pursued the enthusiastic arithmetic of hatcheries with no success; but, finally, from the 100 years of disenchantment and experience, there has emerged an expertise which promises to return adequately the many years of unrewarding investment. In these several circumstances there is evident justification for expenditures on fish and wildlife science in excess of the average rate in relation to gross national product.

The evaluation of benefits from investment in fish and wildlife science proceeds from the tangible to the intangible. The marketed value of the commercial fisheries catch in 1968 was \$350 million, to which salmon, lobsters and cod were the chief contributors. About one-third of the marine fishery products are processed. The fishing industry contributes 0.6 per

cent to the gross national product. Regionally, fisheries have high value, in many instances their welfare being a measure of the welfare of communities. Since 1938 Canadian production has tripled, though the industry has declined in its relative contribution to employment and gross national product. Better economic performance will ensue from limitation of the number of fishermen, boats and equipment in overcapitalized fisheries such as for salmon and lobster, and perhaps herring.

In substantial measure, the sustained values of the commercial fisheries catches reflect the research investments of the last 50 years. In like fashion, the present level of expenditure will be reflected in sustained and increased values in the future.

Added to these tangible benefits are the real but less measurable recreational values of fisheries. In 1961 expenditure by Canadians who went angling was estimated as \$188 million. What this means in terms of dollar benefits is largely conjectural. To the degree that foreign tourists are involved, who would not be involved in the absence of angling, it is obviously a source of real income to Canada. Salt water angling could become the base of a particularly remunerative tourist business, but owing to the way it is managed at present, there is a very small return to the Canadian economy. A substantial licence fee for non-Canadian anglers should be considered.

In the case of wildlife, virtually all of the benefits are in recreational terms. The total value of wild fur production was only \$12 million in 1968. By contrast, direct expenditures of hunters were \$87 million in 1961. Again, the economic significance of this expenditure is something of an enigma. It is a perhaps more revealing statistic that in 1961, more than 12 per cent of Canadians over 14 years of age went fishing or hunting, or did both. What they got out of the experience, and what others like them got from "bird-watching", is a real but, to date, unplumbed economic value of fish and wildlife. It is a reflection on our lack

of social and economic research that we cannot document the explosive growth of outdoor recreation that has occurred in the last five years. It is nevertheless quite clear that research and management activity is not keeping pace with recreational developments.

Put Proportionately Less into Federal Activity

It is somewhat simpler to comment on the relative expenditures in the different sectors of the fish and wildlife "industry". In fisheries, the federal government performed¹ 76 per cent and funded 85 per cent of the scientific activities; provincial governments did 19 per cent and funded 13 per cent (Table 1); universities made up the remainder—5 per cent of activities, 2 per cent of funding. The fisheries industry undertook no identifiable scientific activities although small quality control laboratories are maintained by some companies.

There are obvious imbalances in this distribution of effort. Federal contributions in fisheries should continue to be large, primarily because of the international considerations, but also as a means of encouraging development of provincial performance. Provincial participation in the scientific effort on fisheries for inshore marine species and anadromous fish should be substantially increased. Provincial decisions on stream basin and shoreline uses should be made with the advice of provincial employees who are experts and advocates of fisheries values. This recommendation was made at the Resources for Tomorrow Conference in 1961 and circumstances have not changed substantially since. For freshwater fisheries, the provincial contributions are at present inadequate and substantial increases seem appropriate to their provincial status.

The development of fish products research within the fishing industry should

be encouraged. There is also need for industry participation in gear research and technology and arrangements for joint activity of industry and government in exploratory fishing, and for development of techniques of culturing fish and invertebrates. In all of these fields there is sufficient prospect for return on investment that industry should be coaxed out of their traditionally passive role in research and technology.

University inputs appear to be small in the present analysis but, of course, advances in fisheries science do not occur out of the general context of growth in the biological sciences as a whole. The real basis for concern should be the lack of facilities for work related to fisheries at most universities. Much university research is opportunistic in character. By providing facilities for holding aquatic animals and making government facilities freely available, it would be expected that there would be an appropriate shift in emphasis.

Gathering these various considerations, the target for 1988 should be a distribution of effort that is 54 per cent federal, 23 per cent provincial, 13 per cent industry and 10 per cent university—a sharp shift away from the present domination by the federal government (Figure 1). Funding might remain more predominantly federal because of the national scope of many of the problems, but increased provincial support, and at least token industry participation, would reflect a healthier distribution of involvement.

Fisheries activities can be further treated by sector: 1. freshwater; 2. anadromous; 3. inshore fisheries, invertebrates and seaweeds; and 4. pelagic, groundfish and other, and by subject area: 1. biological science; 2. technology and engineering regarding gear and products; 3. chemical and biocide effects; 4. environmental limnology and oceanography, land use; 5. engineering services regarding culture and land use; 6. socio-economic studies; 7. statistics and routine data inputs.

¹ Scientific manpower is here used as a measure of performance of R & D.

The recommended distribution of scientific effort would favour developing an emphasis on freshwater fisheries and maintaining emphasis on anadromous, pelagic and groundfish fisheries (Table 2). By subject area (Figure 1) the great need in fisheries is for diversification away from the traditional stress on biological studies. Notable is the recommendation for increased socio-economic research that would lead to improvement of performance, better enable assessment of values, and relate fisheries considerations to multiple-purpose use of resources. Increased relative expenditures on environmental research would reflect the tempo of development. Additional emphasis on chemical and biocide research and on environmental studies is consistent with the main theme of this report.

Of the total activity directed toward wildlife, the federal government performed 34 per cent and funded 41 per cent; provincial governments did 43 per cent and funded 50 per cent; universities did 16 per cent and funded 4 per cent. While there is no wildlife industry per se, consumer organizations, most of them supported by U.S. funds, did 7 per cent of the activities and funded 5 per cent (Table 1).

This distribution of effort and funding is fairly well balanced except for the small performance by Canadian "industry"—the consumer groups such as fish and game associations, professional guides, and so on. The federal involvement should be aimed principally at the migratory bird and wetlands management sector because of the interprovincial and international character of the resource use (Table 3). The provincial activities should be obviously centred largely where problems with wildlife will occur—where people are and where there are alternative uses of land—on improved forage and cropland, and in native forage and wildland where grazing and logging activities relate to wildlife.

By subject area (Figure 2) expenditures on wildlife, like those in fisheries, should shift from the dominant emphasis on

biological science and environmental studies to a better balance with social and economic studies. Without a clear notion of the customers' preferences and habits, wildlife research lacks the guidelines it needs to be responsive to the needs of society.

Table 1—Gross 1968-69 Expenditures on Scientific Activities Applied to Fish and Wildlife Resources

Sector of Performance	Fisheries				Wildlife			
	Scientific Manpower	%	\$'000	%	Scientific Manpower	%	\$'000	%
Federal	424	76	21 741	85	90	34	3 119	41
Provincial	107	19	3 444	13	117	43	3 876	50
University ^a	27	5	605	2	45	16	269	4
Industry	—	—	—	—	17	7	410	5
Total	558		25 790		269		7 674	

^aGrant support only.

Table 2—Distribution of Scientific Performance Applied to Fisheries Resources Proposed for 1988 by Geographic Problem Area

Sector of Performance	Freshwater	Anadromous	Inshore (Shellfish)	Pelagic and Groundfish	1988 Total	1968 Total
	%	%	%	%	%	%
Federal	8	16	9	21	54	76
Provincial	11	8	4	0	23	19
University	4	3	1	2	10	5
Industry	1	4	3	5	13	—
Total	24%	31%	17%	28%	100%	100%

Table 3—Distribution of Scientific Performance Applied to Wildlife Resources Proposed for 1988 by Geographic Problem Area

Sector of Performance	Wetlands	Improved Forage Cropland	Native Forage & Wildland	Urban	Total
	%	%	%	%	%
Federal	14	7	7	2	30
Provincial	5	20	20	3	48
University	3	3	3	3	12
Industry	2	2	5	1	10
Total	24%	32%	35%	9%	100%

Figure 1-Performance of Scientific Activities: Fisheries

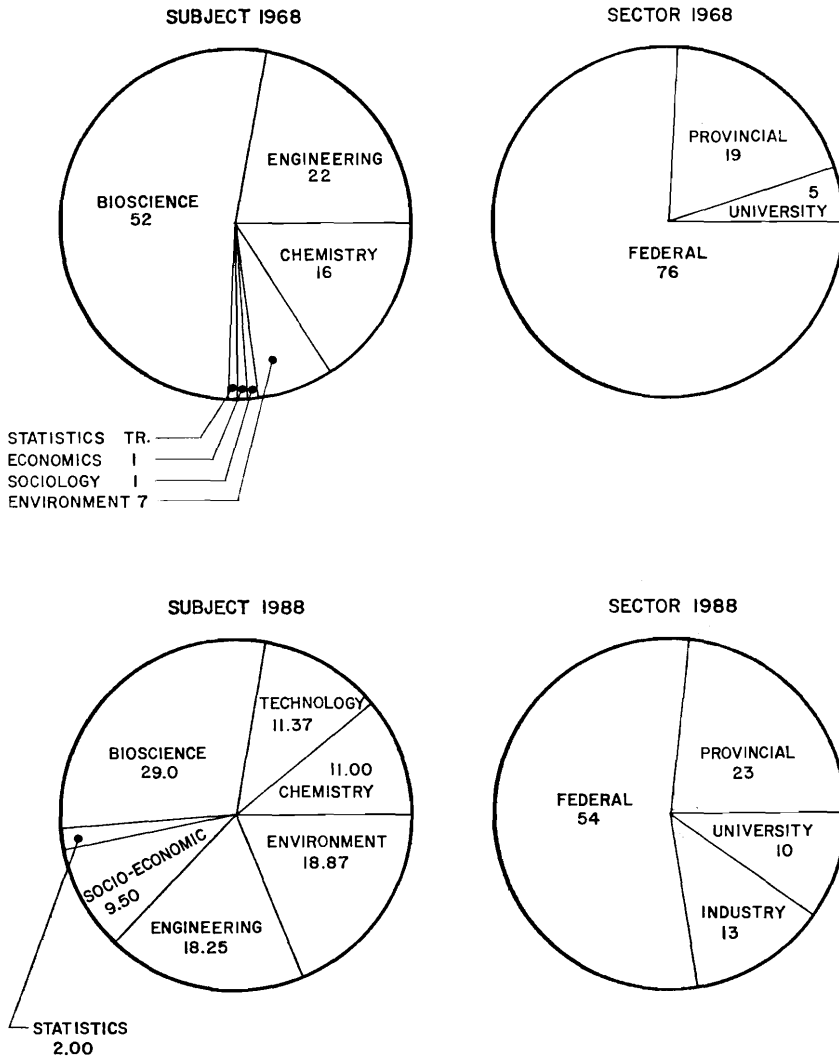
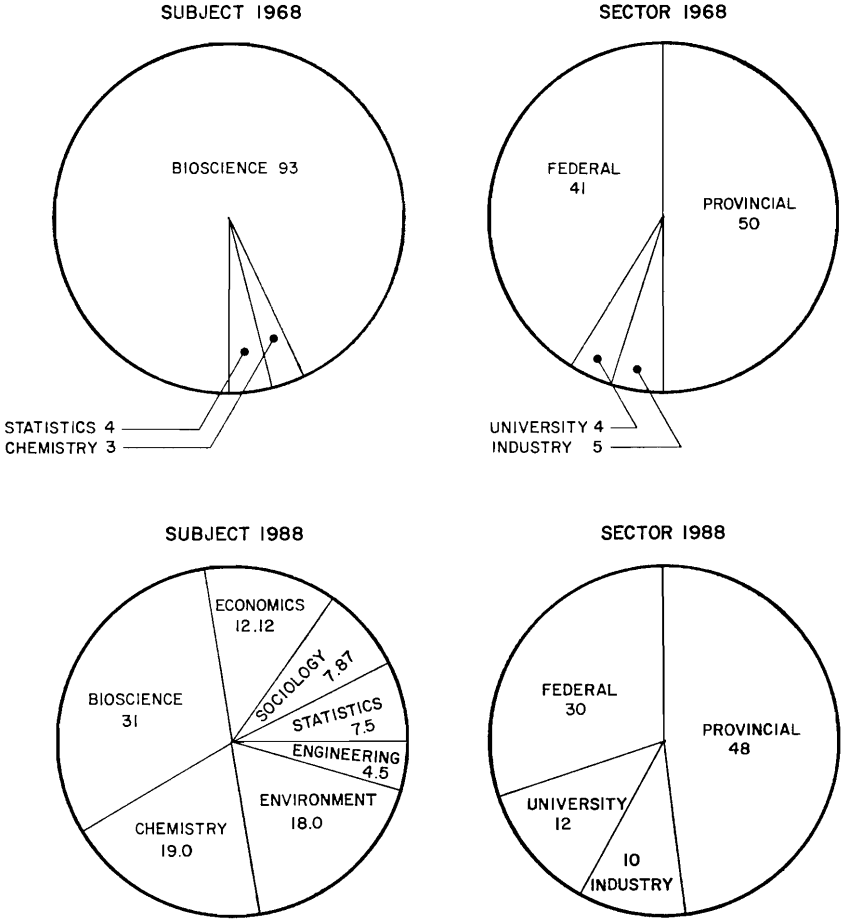


Figure 2—Performance of Scientific Activities: Wildlife



Priorities for Action

The foregoing presentation, organized by levels of management, is obviously not a useful timetable for action. Many of the specifics can be implemented immediately; many of the policies imply the slow development of states of mind.

High priority should be given to the formation of an Environmental Council of Canada. It would give immediate tangible evidence that a growing public concern was being recognized in government. It would ensure an early start on assessment of environmental problems before they become a major national backache.

Equally high priority should be given to the creation of a federal Department of Renewable Resources. The federal government has already lagged behind the more progressive provinces in the integration of resource departments. The increasing tempo of Canadian development makes the example of federal leadership even more imperative.

Changes to the BNA Act and the enactment of a Canadian Wildlife Act may be held up by the slowness of constitutional reform, but no time should be lost in putting these items on the agenda for study and meanwhile getting on with the job despite the jurisdictional problems.

International fisheries problems are here now. An immediate policy stock-taking evaluation of scientific needs will be invaluable to the protection and development of Canadian fisheries in the next two decades.

Integration of research, management and development can proceed at once with appropriate in-house reviews. Advisory boards can be organized and employed with only trivial expense, and their formation should not be delayed. Similarly straightforward and inexpensive are devices for increasing mobility of scientists and providing better performance evaluation for scientists.

An important step could be taken by the immediate specification at both federal and provincial levels that projects involving major environmental alteration should include as essential elements of

feasibility and planning studies, assessment of the ecological consequences and proposals for amelioration of harmful effects or augmentation of beneficial effects.

The development of environmental science will, of course, be slow but an immediate investment in some of the scientific activities which are here recommended would enable a start in many deficient subject areas. Given this seeding, it might be expected that four or five years hence the ground would be ready for some major increases in expenditure on projects that are better conceived from the point of view of a measured national interest. Contractual expenditures on socio-economic studies and grants to universities for development of socio-economic research should begin as soon as possible. Encouragement of resource management graduate programs should similarly pay off by training specialists who think in terms of optimizing multiple-purpose use of resources.

Studies on biocides and ecosystem dynamics are imperative and should be undertaken if necessary at the expense of other biological research. Arctic research is as urgent as the pace of Arctic development. Investments in oyster and salmon culture have substantial payoff potentials. The sooner they are started, the sooner benefits will accrue.

In broadest perspective, the present pace of expenditure on Canadian fisheries and wildlife science seems to be at an appropriate level. The investment in science for commercial fisheries is readily justified, but the total evaluation is, perforce, subjective because of the difficulties of assessing the recreational benefits of fish and wildlife to Canadians. If the level of public participation is a reliable indicator, increases in expenditures in the last decade have been justified.

The best course for future expenditures largely depends on more rigorous economic analyses of recreational and social values of fish and wildlife in particular, and quality environments in general. By 1988 the appropriate level of expenditure

might well be at least triple that of 1968, but this is a matter of almost silly conjecture. For the next five years it would be useful to raise expenditures by a sufficient amount to start new activities, while older patterns of activity are held at a steady level, phasing out those that are least relevant and building those of promise.

Appendix

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The Committee is grateful to its Secretary, Mr. J. Mullin; to its advisers, Dr. A.H. Macpherson (who served until April 1969) and Dr. W.J.D. Stephen (who served after that date); and to the Study Group comprising Dr. D.H. Pimlott (leader), University of Toronto, Dr. C.J. Kerswill, Fisheries Research Board, and Dr. J.R. Bider, Macdonald College, Ste Anne de Bellevue, Quebec. A Special Study Report of Fisheries and Wildlife Research, by Drs. Pimlott, Kerswill and Bider, is in press.

*Member of the Science Council of Canada.

Publications of the Science Council of Canada

Annual Reports

First Annual Report, 1966-67 (SS1-1967).

Second Annual Report, 1967-68 (SS1-1968).

Third Annual Report, 1968-69 (SS1-1969).

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Reports

Report No. 1, A Space Program for Canada (SS22-1967/1, \$0.75).

Report No. 2, The Proposal for an Intense Neutron Generator: Initial Assessment and Recommendations (SS22-1967/2, \$0.25).

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Report No. 7, Earth Sciences Serving the Nation—Recommendations (SS22-1970/7, \$0.75).

Report No. 8, Seeing the Forest and the Trees (SS22-1970/8, \$0.75).

Special Studies

The first five of the series were published under the auspices of the Science Secretariat.

Special Study No. 1, Upper Atmosphere and Space Programs in Canada, by J.H. Chapman, P.A. Forsyth, P.A. Lapp, G.N. Patterson (SS22-1-1, \$2.50).

Special Study No. 2, Physics in Canada: Survey and Outlook, by a Study Group of the Association of Physicists headed by D.C. Rose (SS21-1/2, \$2.50).

Special Study No. 3, Psychology in Canada, by M.H. Appley and Jean Rickwood (SS21-1/3, \$2.50).

Special Study No. 4, The Proposal for an Intense Neutron Generator: Scientific and Economic Evaluation, by a Committee of the Science Council of Canada (SS21-1/4, \$2.00).

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