Background Study for the Science Council of Canada

June 1971 Special Study No.15

Scientific Activities in Fisheries and Wildlife Resources

By D. H. Pimlott
C. J. Kerswill
J. R. Bider

Scientific Activities in Fisheries and Wildlife Resources

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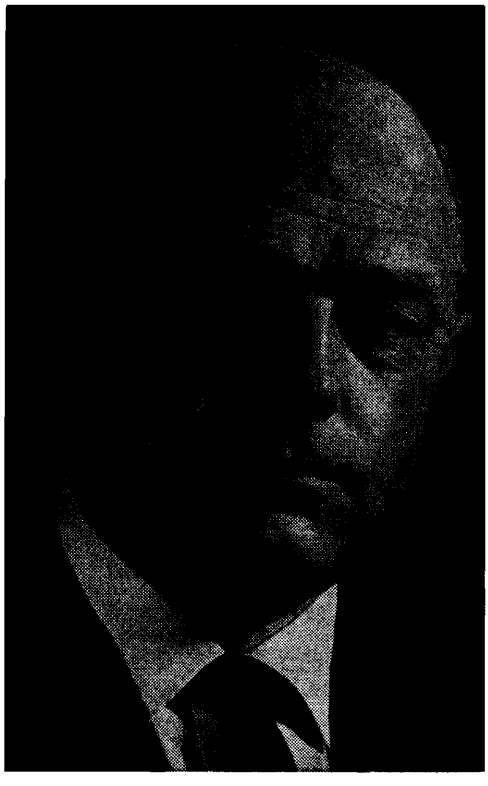


B.Sc.F., M.Sc., Ph.D.

Born: 1920
Place: Quyon, Québec

Employment
Newfoundland Government, 1950-1957: Wildlife Officer, in charge of wildlife research and management.

Ontario Department of Lands and Forests, Research Branch, 1958-1962: wolf research.

University of Toronto, 1962-present: Holds a cross appointment with the Faculty of Forestry and the Department of Zoology, and teaches in ecology, resource management and environmental studies.

Science Council of Canada, May-September 1969: Seconded to the Council to carry out this study.

Research Specialties and Major Interests
Dr. Pimlott's research since 1950 has been directed primarily at the ecology and population dynamics of large mammals. Since 1958, his studies have centred on the interrelationships of wolves and their prey, theories of population control, and principles of mammalian predation.

He also has an active involvement in the areas of ecology, resource management and environmental studies as a member of citizens' organizations.

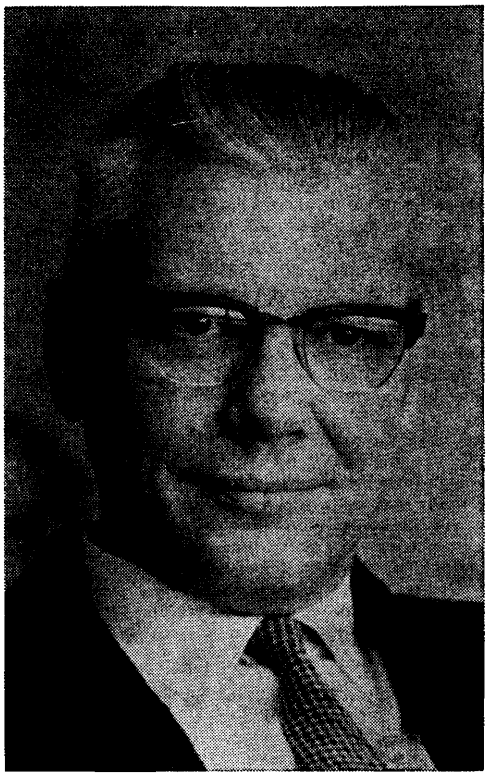
Publications
Dr. Pimlott is best known for his research and writing on the ecology and management of big-game animals and wolves.

He is the author of some 17 papers on various aspects of ecological research, and another 17 in his area of research and on the preservation of animal species and natural areas.

Awards and Distinctions
Conservation Award–Federation of Ontario Naturalists, 1967
Centennial Medal–Government of Canada, 1967

Other Responsibilities
American Society of Mammalogists
Canadian Institute of Foresters
Canadian Society of Wildlife and Fishery Biologists–Post Director
Wildlife Society–Member of Advisory Board
Canadian Audubon Society–Member of the Board of Directors
Federation of Ontario Naturalists
National and Provincial Parks Association of Canada–Member of Advisory Board

Kerswill, C. James



B.A., M.A., Ph.D.

Born: September 20, 1912
Place: Toronto, Ontario

Employment
University of Toronto, assistant in biology, 1937-1940.

Fisheries Research Board of Canada, scientific assistant, 1941-1946, in charge of P.E.I. Biological Station, Ellerslie, P.E.I., and of FRB oyster culture investigations.

University of Western Ontario, assistant professor of zoology, 1946-1949.

Fisheries Research Board of Canada: 1949-1963, scientist in charge of Atlantic salmon investigations; 1950-1952, seconded to Headquarters, Ottawa, as scientific assistant to Chairman; 1963-1964, assistant director, Biological Station, St. Andrews, N.B.; 1965-July 1970, director, Arctic Biological Station, Ste. Anne de Bellevue, Que.; May-September 1969, seconded to Science Council of Canada to carry out this study; July 1970-present, Program Co-ordinator, Commercial and Recreational Fisheries, Fisheries Research Board of Canada Headquarters, Ottawa.

Research Specialties and Major Interests
Biology and management of salmonids; effects of pesticides on fisheries; limnology; Atlantic shellfish.

Representative Publications
The management of Atlantic salmon. Background paper, "Resources for Tomorrow" conference, Montreal, October 23-28, 1961. Vol. 2: 823-831.

Studies on effects of forest sprayings with insecticides, 1952-63, on fish and aquatic invertebrates in New Brunswick streams: Introduction and Summary. 1967. J. Fish. Res. Bd. Canada 24: 701-708.

Fish losses after forest sprayings with insecticides in New Brunswick, 1952-62, as shown by caged specimens and other observations. 1967. J. Fish. Res. Bd. Canada 24: 709-729.

Bider, John Roger

B.Sc.(Hon.), M.Sc., Ph.D.

Born: November 23, 1932
Place: Lachine, Québec

Employment
1953-1957: Directed, managed, and co-owned a trout hatchery at Lac Carré, P.Q.

1956-1958: Owned and operated Laurentide Lake Management Ltd.

1961-1963: Taught General Biology and Invertebrate Zoology at Loyola College, Montreal, and Ecology at the Université de Montréal.

1963-1965: Junior Lecturer at Université de Montréal. Developed new course in Vertebrate Zoology and was responsible for comparative anatomy labs.

June, 1965: Appointed Assistant Professor in Wildlife Biology, Department of Woodlot Management, Macdonald College, McGill University.

July-August 1965: Received a U.S. National Science Foundation award to study Desert Biology at Arizona State University.

May-September 1969: Seconded to the Science Council of Canada to carry out this study.

September 1969-present: Appointed Associate Professor in Wildlife Biology, Department of Woodlot Management, Macdonald College, McGill University.

Research Specialties and Major Interests
Studies in terrestrial community ecology with particular interest in the temporal and spatial utilization of the environment, the factors which cause dynamic animal activity, and the relations which exist between the numbers of animals and their activity.

The largest part of his research is based on data derived from the sand transect technique which he has developed over the last 10 years.

Publications
Some 14 papers in his field.

Other Responsibilities
In addition to his teaching and research work he is very active in several professional, scientific and para-scientific organizations, as follows:

Secretary, Quebec Chapter, and Director of Canadian Society of Wildlife and Fisheries Biologists.

Voting delegate to Canadian Wildlife Federation.

Director (Montreal Region) Quebec Wildlife Federation.

Second Vice-President, Montreal Anglers Inc.

Director Canadian Audubon Society.

Member, Superior Wildlife Advisory Council to Quebec's Minister of Tourism, Fish and Game.

The Wildlife Society of America.

The American Society of Mammalogists.

Canadian Society of Wildlife and Fishery Biologists.

Canadian Society of Zoologists.

The Ecological Society of America.

Sigma Xi.

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Chapter I

Perspective on the Study

I.1 Philosophy and Approach to the Report

Fish and wildlife, when expressed in cash income terms, provide only a modest portion of the national income of Canadians; yet, if their full value is considered, they constitute one of the most valuable resources of the country. They should not be sacrificed on the altar of short-term economic gain, nor should the diversity of species be destroyed in a questionable quest to feed 50 billion people in an overcrowded world which would be unfit to live in.

We introduced the report as we have because we consider it important to establish that although we have attempted to be objective, we are not unbiased observers. We feel very strongly that the perpetuation of fish and wildlife is important to man and to the world; we make an unabashed attempt to make this the outstanding aspect of our report because we consider that the maintenance of high-quality environments throughout the world is vital to man's continuing survival.

A second aspect of the report is that we have aimed at writing it for the layman as well as for scientists. Reports written by scientists for scientists usually take a lot of background knowledge for granted. We have tried to avoid this, so the discussion of the nature of ecosystems (Chapter II); the discussion of the economic theory of fisheries (Chapter IV); the background on the constitutional aspects of the Migratory Birds Treaty (Chapter VI); and the reviews of the nature and effects of water pollution caused by the mining and the pulp and paper industries (Chapter X) are examples of material written to provide background knowledge to help make our conclusions, proposals and suggestions understandable. Professionals who find it to be "old hat" can escape boredom by simply skipping parts of the report that deal with things long understood by them.

Although the report was prepared and written primarily by three individuals, our philosophy has been to write as the representatives of the community of fishery and wildlife scientists in Canada. To achieve this objective, we have attempted to draw on "the most profound creative idealistic and practical minds that exist in the twin disciplines today".[1] We have done this by inviting many individuals to write us about the problems, needs and advances in their areas of specialty. In addition, we have searched the literature for relevant descriptive or analytical material written by Canadians. We have used this material freely, frequently quoting directly rather than attempting to paraphrase it. We did it in this way because we wanted to introduce other members of the profession directly, to change the pace and tone of the report, and because we felt rather strongly that we should not attempt to restate things that had already been well written by other Canadians.

Finally, we have sought the ability to state our cases with candour but without acrimony. It is our conviction that one of the greatest errors made by scientists today is to avoid frank discussion of situations and issues which pertain to the environment. We believe that people best understand "what things are all about" when they see them in terms of specifics; we have tried to come down to specific cases as often as possible and have attempted to be candid in our discussion and appraisal of them.

I.2 The Science Council of Canada

Many people who read this report will be reading a Science Council report for the first time. Because of this, we considered that the introduction should tell about the Council, why it was brought into being and what role it is attempting to play in Canadian society.

[1]From a memorandum to Dr. P.A. Larkin in which we discussed our approach to obtaining the information for the study. April 18, 1969.

The Science Council consists of 25 members, having a specialized interest in science and technology, chosen from among people in universities, industry and government, and 4 associate members from such agencies as Treasury Board, Economic Council of Canada and the Science Secretariat of the Privy Council.[1] The Science Council is thus concerned with national science, not just federal government science. In April 1969, the Science Council became a Crown Corporation with a "permanent" instead of a "borrowed" staff. The move enhanced objective examination of federal government programs and removed the conflict of interest between the Science Council's need to publicize its results and the federal Cabinet's need to make timely announcements of policy. Before the Science Council became a Crown Corporation, the services required in carrying out its duties were provided by the Science Secretariat of the Privy Council Office. Now the services required are provided by a small professional staff, some of whom serve on term appointments, and by contractors who provide services for special projects.

The duties of the Science Council are to assess in a comprehensive manner Canada's scientific and technological resources, requirements and potentialities, and to make recommendations thereon to the Prime Minister. The main function therefore is advisory. The Science Council has no authority over the expenditures of any government or its agencies. In particular, it is the duty of the Council to give consideration to, and make recommendations on, the adequacy of the scientific and technological research and development being carried on in Canada. Consideration must also be given to the priorities that should be assigned to specific areas of scientific and technological research, the effectiveness, development and use of scientific manpower and the long-term planning for research and development. Consideration must be given to the factors involved in Canada's participation in international scientific affairs, the responsibilities of departments and agencies of the Government of Canada in relation to those of other organizations in developing and maintaining co-operation and the exchange of information concerned with science and technology, economic or social aspects of life.

The present interests of the Science Council are essentially threefold. The Council attempts to develop a strategic policy for the use and application of science and technology by Canada as the nation seeks to attain its social and economic goals. Evidence of the Council's main effort to date in pursuit of that objective is Science Council Report No. 4, *Towards a National Science Policy for Canada.*[2] An important component of the science policy proposed by the Science Council is the concept of "major programs" defined as "large multidisciplinary mission-oriented projects having as a goal the solution of some important economic or social problem and in which all sectors of the scientific community must participate on an equal footing". Examples of major programs, such as atomic weapon development, the space race and so on, tend to have some war-time or cold war motivations. The challenge to Canada is to develop major programs with peace-time objectives. The Science Council is already considering ways and means of initiating programs on urban development and on transportation.

The other major area of interest of the Science Council is in studies of specific disciplines and areas of science and technology. The Science Council is conducting studies of disciplinary areas such as fisheries and wildlife to inquire into the "health" of those scientific areas and to ascertain the extent that the needs of society are reflected in the levels of activity in them.

[1] *See* Science Council of Canada. Annual Reports 1966 to 1968. Ottawa, Queen's Printer.

[2] Science Council of Canada. Towards a national science policy for Canada. Report No. 4. Ottawa, Queen's Printer, 1968.

Water resources research in Canada[1] was the first study of direct interest to people concerned with matters of the environment. Studies on agriculture, earth sciences, basic biology, forestry, and marine sciences and technology have been or will be published in the near future. Other studies published have a wide relationship to science in general. These include *Background Studies in Science Policy*, *The Role of the Federal Government in Support of Research in Canadian Universities*, and *Scientific and Technical Information in Canada.*[2]

I.3 The Committee on Fisheries and Wildlife

In the conduct of its special studies, the most common approach used by the Science Council has been to appoint a committee of scientists and other professionals to develop terms of reference and to recommend on the appointment of a Study Group.

The Science Council Committee on Fisheries and Wildlife Resources comprises Dr. P.A. Larkin, Chairman, Dr. T.M.R. Beveridge, Dr. E.S. Deevey, Mr. I. Langlands, Mr. K.H. Loftus, Professor C.E. Law, Dr. A. Labrie, Mr. W.W. Mair, Mr. D.F. Miller, Dr. A.W. H. Needler and Mr. R.C. Passmore.

In the general discussion on the scope and aims of the Special Study on Fisheries and Wildlife, the Committee concluded that the study should be future oriented and should seek to highlight needs and opportunities for the next 10 and 20 years. Statistical material collected were to show important trends. Timeliness and cost-utility of collecting data were to be given consideration overriding 100 per cent completeness. Timeliness was related to the need for correlation with other contemporary studies of the Science Council mentioned previously. In the terms of reference[3] and discussions, the Committee charged the Study Group to conduct a study of the application of science in fisheries and wildlife; to consider factors which bear directly and indirectly on the management of fisheries and wildlife; to consider the way agencies and members of the profession relate to the affairs of society. In addition, strong direction was given by the Committee to determine the goals of fisheries and wildlife activities and relate them to the national goals as outlined in Report No. 4 of the Science Council.[4]

I.4 Principal Sources of Information

The timing of the Fisheries and Wildlife Study was very fortunate. When we were beginning our work, the proceedings of the Special Committee on Science Policy of the Senate had just been published.[5] These proceedings contained detailed accounts of the scientific activities of all the federal agencies in which we were interested. Similarly we benefited from data obtained from questionnaires which had been sent to project leaders in various aspects of biology in research institutions throughout Canada.[6] The data from these two sources provided considerable understanding to our area of interest. Similarly the background papers on fisheries and wildlife, prepared for the Resources for Tomorrow Conference in 1961, were valuable sources of information.[7] Although written nine years earlier, they contained much that was timely. The summaries of the discus-

[1]Science Council of Canada. Special Study No. 5, Water resources research in Canada, by J.P. Bruce and D.E.L. Maasland. Ottawa, Queen's Printer, 1968.

[2]Science Council of Canada. Special Studies Nos. 6, 7 and 8 respectively. Ottawa, Queen's Printer, 1969.

[3]The terms of reference of the Study Group are given in the Appendix.

[4]Science Council, Report No. 4, *op. cit.*

[5]The Senate of Canada. Proceedings of the Special Committee on Science Policy, particularly Reports Nos. 10, 15, 17 and 31. 1968 and 1969.

[6]The data were obtained primarily for the Special Studies of the Science Council and Basic Biology Study. However, fisheries and wildlife scientists and organizations were included.

[7]Resources for Tomorrow Conference. Background Papers, Vols. 1 and 2. 1961.

sions at the conference also helped us to gain focus quickly after we began our work, because they brought principal areas of interest or concern immediately to mind.[1]

Early in the study, as mentioned before, we contacted a great many organizations and individuals by letter to inform them of the study and to invite their assistance. In many instances, this was followed by another letter which requested help of a specific nature.

Finally, we spent six weeks travelling across the country. This trip was of a "brain-storming" nature and in the course of it we held meetings at Vancouver, Winnipeg, Ottawa, Quebec City, Sackville, St. Andrews and St. John's. At each meeting, we dealt with a series of topics and usually concluded with a statement of consensus prepared by the discussants. During this trip we spent much time in impromptu discussions, with individuals or small groups, of topics where expertise was available. We found the meetings and the impromptu sessions informative and stimulating. In fact, if the Science Council of Canada allowed its special studies to be dedicated, we would dedicate this "to all the people who encouraged and spurred us on by offering helpful ideas and material". It is our hope that the results of the study will warrant the support they gave us.

We are very appreciative also of the help given us by many individuals in organizing the meetings. We are particularly aware of the debt we owe to Dr. P.A. Larkin, Chairman of our Committee, and Drs. A.H. McPherson and W.J.D. Stephen who, while serving as Science Advisers to the Science Council, were our project officers. In addition to their direct help, we were speeded by their capable use of the carrot and the club. Mr. D. Hunka, Chief Administration Officer of the Science Council, also did much to assist by always responding to our requests for support or help of one kind or another.

During the summer months, we had four young people on our staff. Ann Innis as secretary, Gerry Finn, who directed a program of data collection for us, and Wendy Stewart and Doug Nesbitt who worked under his direction. They were an inspiring, hard-working group of young people and we thoroughly appreciated them and their efforts.

[1]Resources for Tomorrow Conference. Proceedings of the Conference, Vol. 3. 1962.

Chapter II

Goals as a Guide to Resource Policies and Programs

II.1 Focus on National Goals

The achievement of specific goals in the area of fisheries and wildlife resources is completely dependent on the existence of national goals that reflect a strong sense of environmental awareness. Although it is not generally recognized by Canadians, we consider it unlikely that the National Goals defined by the Science Council[1] can be achieved over the long-term unless they adequately reflect this growing awareness of man's total dependence on the natural environment. As Senator John Nichol, in an address to the Senate of Canada, stated:

"The fight to save the natural environment will only be won if we are capable of a major and drastic change in the thought patterns which have governed man's existence on this planet until now. We have all been brought up to think that man owns nature, and we are now finding out that man and the natural world are part of the same interdependent total mix of life...."[2]

The attention of our Study Group was specifically directed to confront the National Goals and goals for fisheries and wildlife resources by our terms of reference, which stated:

"Determine the relationship of the goals of fisheries and wildlife science and technology to the national goals as outlined in Science Council of Canada Report No. 4, *Towards a National Science Policy for Canada.* If necessary these should be expanded and extended to incorporate the views of fisheries and wildlife scientists as to the nature of these national goals. In particular, the Study Group should define those elements of the national goals which specifically relate to fisheries and wildlife."

The six National Goals chosen by the Science Council to provide the focus for discussions of policy are:

"National prosperity;

Physical and mental health and high life expectancy;

A high and rising standard of education, readily available to all;

Personal freedom, justice and security for all in a united Canada;

Increasing availability of leisure and enhancement of the opportunities for personal development;

World peace, based on a fair distribution of the world's existing and potential wealth."[3]

The identification of the goals by the Science Council, and the direct requirement of our terms of reference, led us to consider the importance of goals and as a result, to inquire into the extent to which policies and programs in the field of fisheries and wildlife science have developed as a result of the existence of specific goals.

There must, of course, be an integral relationship between the primary goals of a nation and goals of a secondary nature as defined for any specific area of science. It became evident that the two sets of goals are so intertwined and so mutually dependent that it is virtually impossible to discuss one set without reference to the other. However, until it is more widely recognized that national goals and environmental goals are inseparable, it serves a useful purpose to provide them with separate identities for purposes of discussion.

II.2 National Goals and Environmental Quality

Fishery and wildlife ecologists, naturalists, anglers and hunters in Canada have perhaps been most acutely aware of and concerned about the degradation of the environment. This awareness is probably the result of their better position than

[1]Science Council of Canada, Towards a national science policy for Canada. Report No. 4. Ottawa, Queen's Printer, 1968.

[2]Debates of the Senate, Vol. 117, No. 95, p. 1827, 14 October 1969.

[3]Science Council, Report No. 4, *op. cit.*

most in seeing some of the effects of degradation, for example:

"The fish fauna of the Great Lakes has been completely altered in a decade. The famous fishery on Lake Erie for blue pike, whitefish and cisco is gone. The blue walleye, unique to Lakes Erie and Ontario is apparently extinct."[1]

"At present, six species (of birds) and one group–birds of prey–are considered to be vanishing.... The second class of vanishing vertebrate...is mammals. There are nine larger forms and a number of smaller species...."[2]

Their awareness of environmental problems was further evidenced by the responses we received to a letter in which we asked for opinions about the adequacy of national goals as defined by the Science Council. The first is from a letter received from a provincial natural history organization, while the second and third are from letters written by Canadian fisheries and wildlife scientists.

"We believe that omission of the maintenance of a healthy environment as a national goal was a fundamental error and needs careful reconsideration."

"As far as the national goals go, the obvious omission is of any mention of environmental quality. If the present rates of pollution continue to increase faster than do rates of pollution abatement, no national goals of any kind will be achievable for the presently settled parts of Canada 20 years from now."

"...I believe the goals as listed are inadequate. In particular, I was disappointed not to see listed as a goal, a stable and healthy environment.... As long as we regard environmental faults as merely faults to be corrected while we pursue goals which do not include environmental quality, we shall continue to pile up new problems that may be insoluble before long. Indeed, it might be appropriate to set as the main goal *survival*, because that would focus attention on the need for stability...a healthy environment in perpetuity. It might also suggest that, at least in the methods of their achievement, some aspects of the other goals may require a major redirection of emphasis if we are to maintain a healthy environment."

Although we were aware that concern existed among fishery and wildlife scientists, we were nevertheless surprised by the way it often predominated over considerations concerning the application of science in the management of fish and wildlife. The first letter received from one scientist, who is chief of a resource management program and who might have been expected to be preoccupied with needs for more money and bigger and better research programs, dealt almost entirely with this aspect of the terms of reference of the Study Group.

Similarly, a group of Atlantic biologists who met with the Study Group requested that the meeting deal entirely with the discussion of national goals and with a proposal that a Canadian Council of Ecology be established by the federal government. The concept stated by this group of biologists was that if we are to maintain a healthy environment, there must be a completely integrated approach to human and resource management.

Ecology is such an integrating science "concerned with the study of living things in their relationships with their environments. In particular it is concerned with populations and communities of living organisms.Their environment includes both other living things and the physical environment of energy, atmosphere, water, soil and rocks. Since the conservation and rational use of

[1]Scott, W.B. Freshwater fishes of eastern Canada. Toronto, University of Toronto Press, 1967.

[2]Tener, J.S. Vanishing species in Canada. Proceedings of the Fifty-Seventh Convention of the International Association of Game, Fish and Conservation Commissioners. 1967.

biotic resources requires an understanding of their environmental relationships, ecology forms a scientific basis for these human activities. Since man must coexist with and is himself an integral part of a physical and biotic environment, ecology forms one kind of scientific basis for understanding man's role on earth."[1]

The questions that loom largest to the ecologists of the world are those associated with the apparent need for perpetual growth of the economy and with the growth of human populations. In the public mind, questions about human numbers are almost always centred around the problem of whether or not enough food can be produced to feed the people of the world. However, to the ecologist, the vital question is: Can a stable and healthy world environment be maintained if it is subjected to the stresses that will be imposed by an economy that is in a perpetual state of growth?

The world environment is being subjected to a variety of insults by technological man. As molecular ecologist Dr. Charles Wurster wrote:

"We are, in a sense, conducting a biological experiment of truly colossal proportions, using the entire world's biota as experimental organisms. How will it all come out? No one knows! Clearly some parts of the experiment have gone sour, and the flow of bad news seems to increase as the data come in."[2]

An article by a Canadian ecologist on the importance of preserving undisturbed elements of natural environments contains a section on ecological systems and the way the world's ecosystems are being influenced by contemporary man.[3] The questions it poses warrant consideration as Canadians seek to identify the way in which science and technology can contribute to the attainment of national goals and in particular to the goal of National Prosperity. A portion of the article follows:

"Ecosystems appear to be relatively stable, that is they resist change in a number of ways. Over long periods of time inorganic resources and organic production remain at about the same levels. This is because most materials taken up by organisms are eventually returned to the environment from which they were drawn. The same species continue to live together and even the numbers of each species appear to be controlled within limits. Complex communities in which many species interact seem to be the most stable. Invaders most often disrupt the simpler natural communities such as occur on islands or those modified by human activities. Also, violent fluctuations in the numbers of single species usually take place in simple northern communities or human crops.

"Let me briefly recapitulate. A long period of evolution has given rise to a diversity of species, each of which is uniquely adapted to its environment. These species are grouped in communities and ecosystems having a high degree of stability. This is implied in the popular phrase 'the balance of nature'. Stability exists with respect to the use of resources, species composition and the numbers of each species. It is brought about by a system of checks and balances, the workings of which we only dimly perceive. In the past, changes have occurred slowly so that evolutionary adjustment was possible and, although over long periods of time species appeared and disappeared and re-groupings gradually took place, there was continuity in the organized structure of the living world.

"Let us turn our attention to man. In the stone age he was largely a nomadic predator exerting his influence over a

[1]UNESCO. Conservation and rational use of the environment. Report submitted by UNESCO and FAO, E/4458, 1968.

[2]Wurster, Charles. Chlorinated hydrocarbons and the world ecosystem. Biological Conservation, Vol. 1. 1969.

[3]Falls, J.B. The meaning of wilderness to science. The Ontario Naturalist, Vol. 5. 1967.

limited range of prey species. But, as his culture developed and new tools increased his impact on the environment, he became an ecological dominant. He now exerts unprecedented influence on the environment and hence exercises power over other species. Today, man is changing the world at an ever increasing rate as his population and technology grow. As he preempts more and more of the world's space and resources to himself, many other species are driven to the verge of extinction. Complex natural ecosystems are replaced by simpler, less stable ones in the form of crops, pastures and habitations. Exotic species are introduced to these altered environments. Erosion is speeded up and nutrients are flushed into rivers, lakes and the sea instead of being recycled through natural ecosystems. They are replaced by fertilizers mined from rocks, thus speeding up the use of capital resources. Radioactive materials, poisons and the by-products of industry are distributed over the landscape confronting living systems with challenges new to their evolutionary experience. The rate of change is so fast as to preclude the possibility of adaptation for many species. Thus, the richness and stability of the natural world are being lost and man may even render his environment unsuited to his own survival.

"If man is to survive he must learn to manage his environment more wisely. The way things are going, he may do irreversible damage to the natural world which will lead at least to a severe restriction in the choices open to future generations. Among the possibilities of permanent damage are the extinction of species and the destruction of complex ecosystems. These in their enormous variety are priceless resources. The significance of any species is largely unknown. We do not fully understand its role in the ecosystem of which it is a part and we cannot foresee the potential value of its genetic material for our own use. Many species have contributed therapeutic chemicals for medicine or inherited qualities to our crops. We can be sure, however, that, if we allow a species to become extinct, it has no further value. The only way we can prevent extinction is to preserve the ecosystems in which species live.

"Complex ecosystems with their natural stability are valuable buffers against too drastic change of environment–insurance against our mistakes. At the very least they provide a measure of protection for the landscape they cover. Moreover, if we can understand their workings we may be able to manage better the systems which we have altered to our own purposes. Thus, ecosystems as well as species are repositories of valuable information. There is a real fear that before this information is turned to knowledge, the systems themselves may be destroyed."

Canadians are becoming deeply concerned over the fact that the environment in which they live is being rapidly degraded. This mounting concern is evident in the dramatic increase of press, radio and television coverage of environmental questions, and by the fact that politicians at high levels are saying and doing things about polluters and pollution. Examples are the ban on DDT, first by Ontario, and then by the federal government; the Canada Water Act, which makes pollution a criminal offence; and the threat by the federal government, to make those responsible for oil spills pay the costs of the clean-up. During the past year, intense public debates have developed over resource development programs which would have received little attention, or perhaps might even have been hailed as major advances, even a few years ago.

The breadth of public concern is indicated by four topics which received national coverage in 1968 and 1969. They were strip mining for coal in British Columbia, the diversion of the Churchill River at Southern Indian Lake in Manitoba, continuation of intensive logging programs in Algonquin Park

(classified as a Natural Environment Park) in Ontario, and the pollution of Long Harbour in Newfoundland by a plant which produces phosphorus. In each instance, the public debate reached such an intense level that Ministers of the Crown were forced to make public statements and in some cases to take action to change or modify existing situations.

The maintenance of a quality environment should be given a primary listing in the definition of national goals for Canada. Listing it first would serve, not only to indicate its relative importance, but would also symbolize the concern of contemporary society for the future. It would affirm that the attainment of immediate economic goals must be rigorously appraised to ensure that their attainment will not leave a legacy of catastrophic environmental problems.

It is difficult, however, to foresee how socio-economic and environmental goals can be brought into harmony in contemporary and future societies unless there is a dramatic change in outlook. One of the respondents stated the case this way:

"As a practising resource manager with wide interests in preserving and enhancing the opportunities for outdoor recreation, I question whether the first two of the six goals chosen in Report No. 4 of the Science Council–national prosperity, and physical and mental health and high life expectancy–are not mutually exclusive. Certainly, I see no hope for the second if prosperity continues to be defined as it is generally in our society today and if it continues to be assumed that prosperity must increase indefinitely. As defined today this assumes an infinite increase in material possessions, use of energy and increasingly massive use of resources to supply these demands. Such demands are impossible to sustain indefinitely. Sooner or later this will become obvious but probably not before our very large Canadian resources of fish and wildlife have been massively damaged together with their capacity to supply outdoor recreation and perhaps even more fundamental human values and needs which are ill understood today.

"There is much evidence that the present great movement of people to cities, the increase of material possessions and the rising capability for more or less aimless mobility are not leading to the good life and a successful society. Indeed there is much evidence to suggest that present trends will lead to the breakdown of all the institutions of our society. On the other hand, there is a rising tide of ill-defined public concern with the continuing degradation of our natural environment and an increasing feeling that a world unfit for wildlife will ultimately be a hostile environment for ourselves. I suspect also that these ill-defined feelings are based on a fundamental need of humans for space and room and escape terrain. It is significant that in a recent Gallup Poll in the United States, the very great majority of people indicated that, if they had a choice, they would not live in a large city. It may well be that people in our society will be the first in history to have wealth enough to make this choice if we learn quickly enough to understand ourselves and our fundamental needs so that we can make an intelligent choice."

Balance between the goals of national prosperity, health, leisure and personal development and a quality environment can only be achieved if there exists in society an adequate understanding of the consequences of actions which influence the environment. Presently there are many forces which prevent the development of such understanding in Canada–the strongest has been the way in which the public is prevented from participating in the process of decision making.

There are many differences between the handling of resource and environmental questions in Canada and the United States. Part of the difference is due to the way basic responsibilities

were defined in the Constitutions; however, an equally important part is the difference in the philosophy of approach. In the United States, the citizens have become much more involved in debates on resource and environmental matters, due in part to the many public hearings held by Congressional and Senate Committees, and can, consequently, become better informed. In modern parlance, participatory democracy is more of a reality in the United States than it is in Canada. More ways for the public to participate are needed here.

The higher level of citizen participation in the United States is evidenced by the degree to which fishery and wildlife agencies are related to advisory boards comprising an amalgam of citizens, ranging from scientists to businessmen, naturalists and sportsmen. Although arrangements of this nature have many disadvantages from the point of view of public servants, the advantages associated with them far outweigh any disadvantages. They are important because they are an excellent means of developing public knowledge and of honouring the basic "right to know" that citizens in a democracy must have if the system is to work effectively. For as R. Gordon Robertson said:

"I could shelter behind the dictum so solemnly delivered from editorial pages and professorial podia that politicians, and not civil servants, make policy while civil servants and not politicians, apply it. It is unfortunate that so clear and helpful a distinction should have so little truth about it. Both halves of the proposition are shaky, if not positively false. Politicians are, to their sorrow, as responsible for the application as for the selection of policies. On the other hand, civil servants, like myself, contribute as constantly to the development of policy as to its application."[1]

The case for involvement was stated succinctly at the Resources for Tomorrow Conference:

"Wildlife is a public resource and thus a government responsibility. It is no criticism of government agencies to say that they cannot move far in advance of public thinking, that they cannot properly place before the public thoughts essential to the formulation of progressive policies and government action, that they cannot speak for themselves respecting hostile pressures nor solicit support from favourable quarters."[2]

He spoke of the value of private organizations, which are woefully weak in Canada, then went on to state:

"If our future in wildlife conservation is to prove a social gain, stimulated by those who satisfy them, and guided by social and governmental processes, we cannot too soon take those steps that will provide the public with facts and ideas upon which they may base adequate value judgements."[3]

There is a need in Canada for a highly credible, non-political organization, sponsored and funded by government, which will have as its basic role that of providing the public with facts on the environment, "upon which they may base adequate value judgements". A suitable name for such an organization might be the Environmental Council of Canada, or simply Environment Canada.

II.2.1 Definition of Environmental Quality

Discussions about environmental quality a decade ago were most commonly associated with features of the environment related to the physical well-being of individuals. However, in common with definitions of human health in the 1960s, it was rather generally broadened to include many different aspects which relate to mental and social well-being and

[1]Robertson, R.G. The coming crisis in the North. Journal of Canadian Studies, Vol. 2. 1967.

[2]Mair, W.W. Elements of a Wildlife Policy. Resources for Tomorrow Conference, Vol. 2. 1961.

[3]*Ibid.*

to the maintenance of the diversity of environments and of natural populations for the enjoyment of future generations.

The U.S. Public Health Service has suggested that the maintenance of environmental quality is achieved when the following conditions prevail:

1. The health of even sensitive or susceptible segments of the population would not be adversely affected;
2. Concentrations of pollutants would not cause an annoyance, such as the sensation of unpleasant tastes or odors;
3. Damage to animals, ornamental plants, forests, and agricultural crops would not occur;
4. Visibility would not be significantly reduced;
5. Metals would not be corroded and other materials would not be damaged;
6. Fabrics would not be corroded and other materials would not be damaged;
7. Natural scenery would not be obscured.

Although the definition is fairly broad, we consider that it should also include:

8. The diversity of natural communities would not be lost in either remote areas or in the localities where human populations are concentrated;
9. The harvestable productivity of land, freshwater and marine environments would not be reduced significantly over large areas of the world.

II.3 Proposed Additions to National Goals[1]

We propose that the restoration and maintenance of a stable and healthy environment over the long term be defined as a major national goal.

Elements of the Goal

–Education and information programs to achieve a high level of public understanding of environmental relationships.

–Development of a greater sense of social responsibility among natural scientists.

–Support for world birth control programs.

–Pollution control based on recycling of materials and the establishment of national and international standards.

–More intensive regulations of chemical, biocides and fertilizers used in the manipulation of the 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 restoration of as complete a range as possible of the natural communities, landscapes and geological features of the world.

–Conservation and improvement of the harvestable productivity of land, freshwater and marine environments.

Contributions of Science and Technology

–Increased participation by scientists in the day-to-day affairs of society.

–An increasing awareness among the medical profession of the need to balance advances in controlling mortality with advances in birth control.

–Development of ways and means of making resource management programs relevant to citizens of less-developed countries.

–Development of efficient and economic systems of recycling and using waste products.

–Classification and ecological analysis of the major ecosystems of the world.

II.4 Reflections on Existing Goals[2]

Goal 1: National Prosperity

This goal, and some of the elements associated with it, should be qualified so that it is clearly understood to mean national prosperity over the long term and to include environmental considerations and tangible aesthetic values as well as Gross National Product (GNP).

[1] A group of biologists from the Atlantic Provinces assisted in the preparation of this section.

[2] *Ibid.*

Revision should reflect awareness that natural resources are finite, and the ability of the biosphere to contain waste products is limited. It should be listed as goal 7 to establish a better sense of perspective of its importance to Canadians.

Goal 2: Health
The health of the population, which according to the World Health Organization should include "a state of complete physical, mental and social well-being, not merely the absence of disease or infirmity", should be a primary consideration. Methods of reducing the deleterious genes in the population should be actively considered, and socio-ecological studies should be made to determine the characteristics of optimum human environments.

Goal 5: Leisure and Personal Development
A number of ecologists suggested that this goal should be stated as "The Opportunity for Personal Development". They reasoned that the need is for more leisure time that is rewarding but less destructive to the environment.

II.5 Relationship of Fisheries and Wildlife to National Goals[1]

Goal 1: National Prosperity
Wildlife and fisheries contributes, albeit insufficiently under present management, to the economic growth and prosperity of regional economies. With adequate development, fisheries and wildlife, based upon the production of food or recreation or both, may help significantly to reduce regional economic disparities. Moreover, a significant number of Canadians choose to live in towns, villages and rural settings in order to maintain a high level of contact with the out-of-doors and with the wildlife resource. Adequate inputs into fisheries, wildlife and recreational fields will help to maintain a dispersion of workers throughout the country, and add to the diversity of opportunity and to the prosperity of society in Canada.

Goal 2: Health
With a burgeoning human population, increased urbanization, increasing levels of stress in a competitive market system and increasing leisure time, the provision of all kinds of outdoor recreation is essential to the health of Canadians. Fish and wildlife are one of our most important recreational resources in Canada.

Goal 3: Education
There are few subjects in elementary and higher education today which treat holistically the natural environment of man. However, in spite of advances in computer technology, fisheries and wildlife management must be based upon a total environmental outlook, including the human element. For this reason, the teaching of ecology is extremely important throughout educational systems, not only for fisheries and wildlife specialists, but for engineers, foresters, agriculturalists and many other disciplines. It is a complex subject which draws together the technological specialization of almost all professions into living reality. Thus fisheries and wildlife ecology does play and should play an increasingly important role in education. This subject is discussed in some detail in Chapter IX.

Goal 4: Freedom, Security and Unity
Although the elements of this stated goal do not deal specifically with freedom, it is contended that freedom of choice is essential. Canada is a new country in comparison with Great Britain, China or Europe. We have a prosperity which has been denied all other countries in a similar state of development, and consequently, we have choices available to us which no others have had. In terms of fisheries, wildlife and outdoor recreations, this choice or freedom is one which cannot long be deferred. Do we plan now to

[1]Dr. John Bandy of the British Columbia Department of Recreation and Conservation provided he major effort in the preparation of this section.

incorporate outdoor recreation of the type we now know as a part of our culture or do we ignore this aspect and continue to develop all our land and water for other purposes?

Goal 5: Leisure and Personal Development
Both consumptive and non-consumptive uses of fish and wildlife play significant roles in leisure and personal development as indicated in the discussion of goals 1 and 2 and in Chapter III where social values are discussed.

Goal 6: World Peace
The elimination of poverty and world hunger is essential to world peace. It is peculiar, however, that attempts to alleviate hunger in particular have been based upon attempts to introduce agricultural methods developed in specific portions of the world such as the United States. Indeed one could even imagine attempts to convert northern Eskimos and Indians to agriculturalists who would be required to produce new breeds of cattle and corn. Instead, improvements and the development of methods suited to the production of indigenous food supplies seem much more logical and appropriate. Whatever the case may be, the management of indigenous species for food and recreation may well contribute, in this and other countries, to national and regional prosperity, alleviation of poverty and hunger, and indirectly assist in bringing about world peace.

II.6 Goals for Fisheries and Wildlife Programs[1]

The attempt to determine the goals of fisheries and wildlife indicated that few individuals or agencies have thought of their programs in terms of overall goals or objectives. Research problem areas could be described by many scientists, but to what end they should be pursued and for how long was seldom evident. Such aimlessness seems to give rise to resignation on the part of many scientists to managing the resource into mediocrity, if not to oblivion. We considered that the situation described by the Science Council represented one that is not uncommon in the fisheries and wildlife field.

"Yet another problem in the development of science in Canada is the tendency of organizations whose missions have been realized, or which have demonstrably failed to reach their objectives, to follow programs which are diffuse and self-perpetuating. There is often a marked reluctance to terminate such programs, even when they are of little priority, as long as the least justification can be found."[2]

Most of the scientists employed by fisheries and wildlife administrative agencies had their fundamental training in the life sciences. They find, however, that many, if not most, current and near-future resource management questions lie in the fields of physical and social sciences. Then lacking clear direction and facing a full range of problems, the intelligent, well-trained, industrious persons with life science orientation may answer questions that management is not asking or may become frustrated because they are unable to provide solutions to the problems at hand.

Science is not magic, but it is a method for improving the probability of achieving a desired outcome from a given set of events. Science is thus a part of the decision-making process, but it is not the only device. By merely tossing coins one could expect to be "right" half of the time.

Some scientists admittedly do not achieve a 50 per cent score on desirability of solutions. That situation may result from working through a rear-view mirror; i.e. looking to the past instead of the present and future. Results of research must be timely as well as providing

[1]Dr. W.J.D. Stephen assisted with the preparation of this section.

[2]Science Council, Report No. 4, *op. cit.*

answers to relevant questions. There are many reasons of course for low scores on "desirable outcomes".

The most probable cause of an "undesirable event" is lack of clear definition of what is wanted. Then anything that happens can be undesirable. Science and technology can contribute to administration of fisheries and wildlife resources but responsibilities lie with three groups of people: the project leader, the research manager and the executive.[1] There must be clear understanding among those groups of the continuous and interlocking responsibilities for planning scientific activities. Goals must be set and kept under constant review so that planning is based on realities and not on illusions. There must be patience and consistency, tempered by common sense, to pursue the goals despite setbacks inherent in research. Finally, but most important, there must be courage to make decisions clearly and cleanly.

Fishery and wildlife scientists have spent a lot of time pondering the question of how to develop and use resources fully, while at the same time maintaining a wide diversity of species, natural populations and animal communities. Society generally is coming to realize that it faces the dilemma of living in the world and using its resources, while at the same time, attempting to live in harmony with the environment over the long term. Ecologists and biologists generally could be particularly valuable at a time when society has begun to fear that environmental malfunctions could result in the destruction of civilization. Their contribution could conceivably be a much more important one if they act quickly to clarify their goals, establish objectives, and then work for the establishment of policies and programs that will allow them to be achieved.

Although the following list of goals is set in a narrower framework, they have the same aim as those identified by the Science Council; that is, to provide focus for this discussion of scientific activities in the fisheries and wildlife field.

II.6.1 Specific Goals for Fisheries and Wildlife

Ecological Conscience

Development of an ecological conscience in society.

Elements of the goal

–Awareness of man as part of, not independent of, nature.

–Recognition of "rights" and non-economic "values" of non-human organisms.

–Creation of desire to leave the biosphere in healthy condition for future generations.

Contributions of science and technology

–Introduction of ecological concepts at all levels of education.

–Introduction of more broadly based education for biologists, particularly in the social sciences and humanities.

–Promotion of greater level of participation in and discussion of environmental questions.

–Greater participation of scientists in the day-to-day affairs of society.

–Recognition of responsibility by industry and government of need to base decisions on long-term considerations which are related to the environment.

Natural Populations

Maintenance of natural populations and communities of fish and wildlife widely distributed throughout the world.

Elements of the goal

–Provision of technical services of adequate quality.

–Maintenance of elements of natural environments widely distributed throughout areas of human settlement.

–Preservation of natural communities in an unexploited state throughout the world.

[1]Werner, J. Effective planning for research. *In* Management of scientific talent. *Edited by* J.W. Blood. American Management Association Report No. 76, American Management Assoc., N.Y. pp. 53-59. 1963.

Contributions of science and technology
–The development of new techniques of maintaining and restoring natural environments.

–The development of new techniques in the husbandry of wild animals so as to maintain species in danger of becoming extinct and to utilize the productive capacity of wild species for food.

–The development of knowledge on the distribution, status and ecological characteristics of species, populations and communities.

–Utilization of modern methods of data handling so that knowledge is readily available and usable in planning and developmental processes.

–The development of priorities in research so as to better deal with potential problem areas and to provide more effective support for management.

–Contribution by the wealthy nations of the world for the preservation and maintenance of the natural communities in less affluent countries.

–The development and improvement of industrial practices so that they can exist in harmony with natural environments.

Aesthetic Use
Promotion of aesthetic uses and cultural appreciation of fish and wildlife.

Elements of the goal
–Provision of increased opportunity to see and study animals for all strata of society.

Contributions of science and technology
–Development of new ways for humans to enter natural environments unobtrusively.

–Increase availability of facilities to see and study animals in captive situations.

–Presentation of materials on biotic communities that can be related to specific areas.

–Development of human communities so they are better environments for wild animals.

Effective Management
Development of effective methods for maintaining and managing fish and wildlife populations for man's use and enjoyment.

Elements of the goal
–Increased level of aplication of science.

–Continued growth of relevant knowledge.

–Improved environment for applied scientists.

Contributions of science and technology
–Establishment of priorities and increasing development of mission-oriented research programs.

–More effective co-ordination of research, development and management through improved communication and better organizational arrangements.

–Development of better means of recognizing contributions of applied scientists.

–Application of advanced methods of systems simulation and of data processing to improve efficiency and level of understanding of natural processes.

II.7 Achieving Environmental Goals

Dr. C.H. Douglas Clarke, Chief of the Fish and Wildlife Branch of the Ontario Department of Lands and Forests, recently put national goals, environmental quality, fish and wildlife in terms that speak for every biologist:

"Let me suggest to you again that it is not possible to find a simpler measure of a good environment than whether fish and wildlife can thrive in it. There are societies older than ours in years that have every right to claim that they are younger and healthier because they have been able to preserve some of the freshness of youth. This happened because people had the will to do it. In the fish and wildlife business we know only too well that man was given dominion over the beasts of the field and the fowls of the

air, and we are constantly reminded that he was not given dominion over himself. That is something he has to achieve."[1]

With poisons contaminating soils, with industrial wastes filling rivers and the sky, with radioactive materials in food, with electrical plants pouring hot water into our waterways, and with the very oxygen content of our air declining, our environment is deteriorating, and in more ways than we are aware of. Most problems are discovered only after they are mature and entrenched. The DDT crisis is an example.

Man shares this earth with a variety of other life. All use the same general environment as man, and are influenced variously by man's modification and frequent degradation of that environment. If these other animals are influenced by man's activities, their numbers, and their health, must reflect the state of the environment.

There is not likely to be any "fiscal profit" in retaining or restoring environmental quality; Canada will just be a better place in which to live. Environmental problems will not be solved easily by "grand" solutions or by simply applying the "systems approach". Although existing knowledge is still primitive about how to solve environmental problems, the understanding of low-level, long-term detrimental effects is nevertheless adequate to permit great "advances" or recoveries now. The crucial requirement is that sufficient energy and support be devoted to the job.

[1]Clarke, C.H.D. Fish and wildlife values in pollution. The Ontario Pollution Control Conference. 1967.

Chapter III

Social Values of Fish and Wildlife

III.1 The Nature of the Values[1]

"It seems clear that the world has never needed natural history as it does now. It needs it as the background of the thinking of all citizens about the world they live in, it needs it for the most practical job of preserving the world in a state fit to live in. Not less important, it needs it also as an element, perhaps the core, of a personal joy in order, proportion, and beauty, which is a necessity of a full and seemly culture."[2]

Fish and wildlife have other values besides those that are economic. These are the values that are recreational, therapeutic, artistic, educational, and ecological, which do have economic facets, but basically have little to do with economic evaluations.

These values we might group under the term "social values". They are not easy to write about, especially for an account largely involved with the precisions of science. At the same time, they are far too important to ignore. They have to do with what we are, not merely with prices in the market place.

III.2 Recreational Values

People are complex. Man's recreation comes in a confusion of forms, and even within one person the motivation for it may be a complex blend of several drives. The chaos becomes impressive after even superficial consideration of the variation of opinion on what constitutes recreation. One man's recreation can even be another man's labour.

Most Canadians associate the best kinds of recreation with the outdoors. A substantial portion of outdoor recreation is focussed directly at fish and wildlife, while in most of the other outdoor pursuits, wildlife values are either part of the attraction or are an enjoyable incidental bonus when good luck happens to present wildlife. The most intensely interested of these people we label as "Naturalists". But as R.Y. Edwards pointed out:

"...to assume that these naturalists possess most of man's interest in the untamed world is an astonishingly uninformed viewpoint. Naturalists are a tiny minority lost in the millions of people who are less intensive, and less well organized in their approach, but who still obtain joy and satisfaction, and enrich their lives, from the beauty and from the fascinating details of their untamed surroundings.

"When the Government of Canada counted the hunters in this country in 1961, it defined a hunter as anyone who had hunted for at least an hour during that year. Any survey of naturalists in Canada, based on the same sort of broad definition, would turn up almost as many naturalists as there are Canadians. And this would be the truth, except that most of them would not consider themselves to be naturalists."[3]

By far the majority of outdoor users consider wildlife to be the most interesting element in the landscape. The following demonstration of public interest illustrates the Canadian attraction to wildlife:

"In 1963 the first official wolf howl was held as a part of the interpretive program of the Algonquin Park Museum. We were uncertain about the number (of people) that might attend but thought that there might be 25 cars in the cavalcade as we searched for wolves. Instead, every campground emptied; 168 cars–an estimated 800 people–created the biggest traffic jam that had ever been witnessed in the Park."[4]

[1]R.Y. Edwards of the Canadian Wildlife Service provided the major effort in the preparation of this chapter.

[2]Coventry, A.F. The naturalist in modern society. *In* Fish and wildlife. Toronto, Longman's, pp. 19-27. 1964.

[3]Edwards, R.Y. The nature of naturalists. The Ontario Naturalist, Vol. 7. 1969.

[4]Rutter, R.J., and D.H. Pimlott. The world of the wolf. Philadelphia, Lippincott, 1968.

The value of recreation in the public mind is mainly the value of pleasure. In short, it is fun. In our affluent society the popular concept of value as opposed to price is largely an evaluation of kinds and intensities of pleasure.

The recreation associated with fish and wildlife appears to be a typically pleasurable set of recreational pursuits and a number of Canadian authors have reflected on the fact that the naturalist, the hunter, and even the scientist, can enjoy his associations with other living things:

"I can only wish for all my readers the many happy hours spent in watching birds that I have had."[1]

"The pleasure of hunting is, I believe, a perfectly legitimate purpose. It is a compound pleasure, deeply emotional, set in a valid tradition..."[2]

"We study living things for the pleasure it gives, from curiosity about how animals and plants live and interact, or from a desire to understand how the plants and animals with which we share the world come to be as they are."[3]

The enjoyment of wildlife appears to be of three kinds. All three are related and not always separate one from another. These are the excitement of the chase, the pleasure of sensory enjoyment, and the satisfaction of obtaining trophies.

The chase, or the hunt, is an exciting activity to man, the traditional examples being hunting and fishing. These gun and fishing-rod recreations are often referred to as primitive activity rooted in man's past. Of course, this is true. What in man is otherwise? However, a study by the Canadian Wildlife Service has shown that hunting and fishing can be just as accurately described as widespread modern activities which add zest to the lives of over 1.5 million Canadians.[4] Roderick Haig-Brown has probably done more thinking on these matters than any other Canadian. Of fishing, he states: "The appeal is more nearly that of hidden treasure, except that this treasure has life and movement and uncertainty beyond anything inanimate."[5] And of hunting he says: "I still love hunting as a supreme sport, infinitely more challenging and exciting than any of the artificial contests between men that are commonly called sport."[6]

However, these pursuit activities aimed at possessing animals do not stand alone. A number of other pursuit activities, not aimed at possession, nevertheless have fish and wildlife as their goals, and the number of participants in these other activities is destined to exceed those adhering to the traditional pursuit forms.

For example, C.H.D. Clarke reported to the Resources for Tomorrow Conference:

"...one of the most striking things reported from all provinces is the multiplication in the last few years of nature students, bird watchers, nature photographers and the like. Once a handful, they are now legion. Because they are as much lone wolves as the hunters but do not buy licenses, we learn only by accidental illuminating flashes just how numerous they are."[7]

The naturalist activity of searching out and watching animals is widespread and growing and is not confined to terrestrial wildlife. Increasing numbers of people are even entering the aquatic environments equipped for leisurely

[1]Symons, R.D. Hours and the birds. Toronto, University of Toronto Press, 1967.

[2]Haig-Brown, R. Measure of the year. Toronto, Collins, 1950.

[3]Myres, M.T. The study of natural history. *In* Alberta: a natural history. Edmonton, Hurtig, 1967.

[4]Benson, D.A. Hunting and fishing in Canada. Ottawa, Queen's Printer, 1963.

[5]Haig-Brown, R. Fisherman's fall. Toronto, Collins, 1964.

[6]Haig-Brown, R. Measure of the year, *op. cit.*

[7]Clarke, C.H.D. Wildlife in perspective. Resources for Tomorrow Conference, Vol. 2. Ottawa, Queen's Printer, 1961.

exploration and observation. Haig-Brown, who has become one of the devotees, gave his impressions in one of his books on fishing:

"When I ask myself why I have taken to the mask and snorkel with such enthusiasm after all these years, the first answer that comes to my mind is: curiosity. To that I must add: love of the fish and love of the water. But I had no idea it would be so beautiful."[1]

Man the inventor continues to take an old pleasure, the chase, and to mould it into new forms of adventure. These lookers and watchers of all kinds are just as much hunters as the gun-shooting type. They seek adventure, get pleasure from perfected skills, aim at the achievement of reaching the objective sought, and through it all they experience escape and often relaxation.

Sensory enjoyment in man is usually the pleasure of looking at things. People are fascinated by animals. Bruce Hutchison has caught the spirit of this interest in his book, *Western Windows.*

"A hoarse croak from nowhere, a whisper of strong wings, a great V scrawled across the sunset in big, black type produced fierce excitement and wild surmise on our country lane.... Only a Canadian could understand the meaning of the geese."[2]

National parks are often wild areas protecting landscapes in natural conditions. Park users, like zoo users, demonstrate clearly by their behaviour that the most interesting wild elements preserved in such parks are wild animals.

"The users of most national, state, and provincial parks are wildlife users. Any park in which at least part of the attraction is wildness is offering wildlife to be used.... some of the heaviest use of wildlife in the world takes place every year in those parks of Canada...in which there is no gunpowder hunting."[3]

It is an increasingly common hobby to attract wildlife–mainly birds–near our homes. By growing plants attractive to birds, and more commonly by attracting birds in winter to our windows by using food in bird feeders, we demonstrate the value we place on seeing attractive wild animals. These have all been more or less premeditated ways in which people see and enjoy wildlife. The chance encounter, however, can give just as much pleasure, and perhaps represents the most common way that people find wildlife to enjoy.

"While the general interest in wildlife is impressive, it is even more surprising to look closely at the specialized users. Most numerous of all are the people who take an interest in the birds that happen to cross their paths. Some cannot name the birds that they know and enjoy, but they have put up feeders, or nesting boxes, or they let plants go to seed to attract birds. Millions of North Americans enjoy seeing birds, and to some extent have become birdwatchers. The pastime, along with golf, is a favorite target for the cartoonist, sure evidence of its firm entrenchment in our culture."[4]

While the goal of much of the pursuit of fish and wildlife is sensory enjoyment, sometimes the goal is something more tangible. Traditionally, the trophy is permanent proof of a successful pursuit. Professor Miller described this tangible goal in fishing, the goal which when achieved becomes a trophy:

"I know men who will cheerfully fish all day long for one trout. Obviously they don't really care too much about getting

[1]Haig-Brown, R. Measure of the year, *op. cit.*
[2]Hutchinson, B. Western windows. Toronto, Longman's, 1967.
[3]Edwards, R.Y. Wildlife management in parks. Occasional Papers No. 1, Canadian Society of Wildlife and Fishery Biologists. 1965.
[4]*Ibid.*

fish; but they would not go unless fish were there."[1]

The trophy may take the form not only of the familiar deer's head or fish on an oval wall plaque, but may be instead a photograph, a list of birds seen, an entry in a diary, or even just an experience to display in conversations. The trophies may multiply into collections, whether of deer heads, different kinds of game heads, butterflies or photographs of the species attracted to a bird feeder. Trophies and collections are usually part of the goals of the people having a good time pursuing fish and wildlife.

In Chapter IV we discuss the problems of economists and wildlife managers in assigning figures in equations to represent the recreational use of fisheries and wildlife. Although it seems increasingly important that this be done to meet the needs of treasury boards and cost accountants, one can only wonder if fabricated figures representing human use can have any hope of measuring value. Many biologists still argue that there is no need for such manipulations because value, after all, is simply a judgement of people. No one knows the value, in terms of human pleasure, of paintings by Kreighoff or Tom Thompson, but their values are recognized as large and worth preserving. Their price in dollars is of concern to only a possessive few.

In the final analysis, the value of anything to human society is simply a matter of human opinion. This opinion can seldom be expressed clearly, for there is no clear way to evaluate such things. But human response, considering both its volume and its intensity, seems to be a fair approximation of value. The volume of favourable Canadian response to fish and wildlife is impressive, and the intensity of this response in many people is sustained at high levels. Although it needs no more than this to make it an important subject, recreational and aesthetic values have always received short shift when men were zealfully rolling back frontiers.

III.3 Therapeutic Values

Among the major benefits of wildlife are the healthy exercise given to men who need it, along with the change of pace and surroundings that contribute to health in a stress-ridden society. Such matters are difficult to measure, but the observations of men who have experienced them are perhaps the best evaluations possible. To thousands of people, avocations like fishing and hunting are not only pleasant, but they are considered essential to health.

"The sport of fishing is an important part of life to many thousands of people, perhaps several millions of people, on this continent alone. But it is also something more than a sport. It is intimate exploration of a part of the world hidden from the eyes and minds of ordinary people. It is a way of thinking and doing, a way of renewing the mind and body, that men have been following with growing intensity for hundreds of years."[2]

Clarke[3], referring to Marchionini[4], notes that those who live close to nature have less coronary thrombosis, cancer and diabetes. These are diseases of modern living. In his famous book, *The Western Angler*, Haig-Brown sums up the matter well:

"I think no one could deny that it is thoroughly desirable that man should go out along the streams and into the woods and fields, or that he should get to know something of the ways of animals. In doing so he improves his health, relaxes his mind, gains immeasurably in depth of experience and breadth of knowledge."[5]

[1]Miller, R.B. A cool curving world. Toronto, Longman's, 1962.
[2]Haig-Brown, R. Measure of the year, *op. cit.*
[3]Clarke, C.H.D. *op. cit.*
[4]Marchionini, A. Gesundheit Freizeit und Naturpark. Naturschutzparke, Vol. 17. 1960.
[5]Haig-Brown, R. The western angler. New York, Morrow, 1947.

III.4 Artistic Values

People are attracted to animals. Their prominence in man's recreation is proof of this. Animals in painting and sculpture, in literature, in creative photography, all have a popular following.

But mostly artistic interest is an in-turning of man upon man and upon the man-made; so the experts on such cultural achievements are often the most in-turned of all.

There are great animal stories in our literature and great animal art in our galleries. Animals are, perhaps, better material for the factual interest than the artistic. The camera, the detailed and accurate illustration, the factual story–these are the contributions to art and literature inspired by animals; and these are increasingly popular every year, if one can judge from the books, movies, art prints, and other commercial evidence of the public interest and demand.

It was suggested recently[1] that Nature could have painted the Mona Lisa with her left hand, blindfolded. Certainly, as human accomplishments, the objects in our art galleries can be impressive and beautiful; they complement, but do not really compete with the real things in nature. Even nature's abstractions in simple two-dimensional design, as made by algae in a pool or by a zebra's pattern, far transcend man's abstract art.

The skill in the human hand is a result of accumulated successful experiment. The same process, through evolution, has produced living things which surely are the most beautiful and wonderfully improbable things on earth. Here is the "art of the ages" and man too is in the artistic display. Unfortunately, like most art, appreciation comes only with experience. But the rewards are great.

"The wonder of the world, the beauty and the power, the shapes of things, their colours, lights and shades; these I saw. Look ye also while life lasts."[2]

[1]Russel, J., and R. Russel. On the loose. Sierra Club. San Francisco, Ballantine Book, 1967.

III.5 Educational Values

The recorded history of man enhances our understanding of man's ecological place in the landscape. Fish and game animals, predators and competitors, were important environmental elements as man progressed onward from stone-age levels. Man's role in the landscape has changed through history, and in modern times it has become obscured. The history of man is not very meaningful unless it has a major content of this historical human ecology. Fish and wildlife are primary elements of any such human history. This is especially true of Canada. Fish and wildlife sustained the native people that Europeans found in Canada, and fish, fur and whales brought European man in numbers to Canada's shores.[3]

The more one understands the world of which we are a part, the better equipped one is to lead a satisfying life. Most men, even most educated men, are long on man's studies of himself, short on the disciplines that reveal the place of man in his world. But this condition is changing rapidly in a time when a world's fair took the theme "Man and His World", and when the news media daily show concern for the quality of the landscape. Man has a rapidly deepening interest in animals and in the environments that moulded and now sustain them.

Darwin opened man's eyes to evolution's magnificent parade of life through time, and gave new meaning to life. If man is to understand himself and his place in the countryside, he must know something of these origins.

[2]Murie, Mrs. O.J. Personal communication; stated as being from an old tombstone in Cumberland, England.

[3]Whitehead, W. One hundred years of national wealth. Canadian Audubon, 29: 144-159. 1967.

Morse, E.W. Fur trade routes of Canada, then and now. Ottawa, Queen's Printer, 1969.

Ormsby, M.A. British Columbia: a history. Vancouver, MacMillan, 1958.

Innis, H.A. The fur trade in Canada. Toronto, University of Toronto Press, 1956.

"Each living organism is seen as the repository of a unique assortment of biological information gained through the eras via the process of evolution. Each offers a potential enrichment of human knowledge and enjoyment that is limited only by our capacity to appreciate."[1]

Animals are essential to the understanding of man himself. The human being as a type of machine has designs, functions and behaviour best understood through the study of other animals. Science continues today its great tradition of studying animals to reveal knowledge of man, not only in the long-established fields of anatomy and physiology, but in the relatively new fields of behaviour, which perhaps can help solve the pressing problem of evolving a harmonious global community.

Animals in variety are essential to teaching ecology, and this subject is the foundation of teaching man's role in the functioning of the earth's surface. Whether a landscape is wild or is dominated by man, there can be no understanding it, hence no intelligent management of it, or proper harvesting from it, without the understanding of its ecological functions. Herein is the knowledge of how to grow man on the land, and the understanding of how population explosion results in human degradation.

The education of people takes place on many levels. Most of our knowledge and ability comes from experiences outside of schools. Interest in the outdoors, and particularly in fish, wildlife, and the other things found there, is an easily acquired avocation. Birds, undoubtedly, have proved to be the most attractive and popular focus of outdoor-oriented people. Birdwatchers are everywhere.

Our senses are our contact with the surrounding world. To the extent that these senses transmit messages to our brains, we are in touch with our immediate world. The extent of our "aliveness" is perhaps measured by the awareness of our surroundings. Children are very aware, and very alive. Adults can lose much of this ability. A hobby that involves sharpening the senses and improving powers of observation–like the hobby of finding and watching birds–increases one's enjoyment of one's surroundings. An interesting life comes of appreciating the interesting things that touch our lives. Awareness must precede appreciation. Since urban living tends to narrow the awareness of man, any counteracting force has value. Fish and wildlife are the foci of avocations that promote such awareness.

III.6 Ecological Values

Man, for all his technology, still lives in an ecological web of life. The other life of earth sustains him, and he in turn influences that other life.

Most obviously, fish and wildlife feed man. The value here has its economic aspects, but these are artificial. Food has primarily biological values for sustaining life. In Canada the necessity of fish and wildlife as food varies from those having nothing else but caribou, or seals, or codfish, to those who use grouse or venison as an occasional welcome relief from constant beef and turkey.

The most frightening threat of our time is man's tremendous capacity to change or even erase the landscape, coupled with his widespread ignorance of what he is really doing. One authority predicts that the collapse of the living world as we know it will take place in this century. Experience in education has clearly demonstrated that man's innate interest in wildlife provides an effective route to capturing the interest of people, then to building their understanding of the environment that makes their life possible. R.Y. Edwards is convinced that:

"Once a child has held a wild bird for banding, has measured and identified

[1]Cowan, I. McT. Conservation and man's environment. Nature, 5016. 1965.

trees, has understood the needs of a wild plant, and has helped to put life on land that had no such life before, that child is more aware of the scope of nature, and is equipped to begin his understanding of his role in this living world."[1]

Perhaps the greatest value of wild animals to man is just emerging–man's evaluation of his own survival. Man's exploding population contains within it a technological explosion. These together are making demands on the environment that threaten to make the world uninhabitable. The problem of multiplying people is a chronic one; that of technology is critical. Much of the technological problem is really the disastrous side effects resulting from man's intensifying use of the countryside.

Canada's surface is large and constant monitoring of the total landscape by scientists guarding against dangerous situations is probably unwieldy or even impossible. With study, it is probable that other life can be our monitors of earth-surface quality. Such indicators are voluntary and should have accuracy. The idea, of course, is neither new nor untried. Much of what we know of the DDT disaster came from the study of fish and wildlife.[2]

Wildlife and wildlands afford man the opportunity of being attuned to the continuous miracle of nature, away from the artificialities of modern life. "We need the tonic of wildness", wrote Thoreau. "We need to witness our own limits transgressed, and some life pasturing freely where we never wander."

[1]Edwards, R.Y. Educational measures dealing with the conservation of the natural environment. Address to the International Federation of Landscape Architects. Mimeograph. 1968.

[2]The topic of fish and wildlife and DDT is discussed in Chapters VII and X.

Chapter IV

Economic Aspects of Fisheries and Wildlife

IV.1 The Spectrum of Economic Values

"The fishery on the Atlantic Coast has been well documented from the early 16th century when fishermen from Portugal, the Basque country of Spain, Normandy and Brittany in France and Devonshire in England were taking fish from the rich fishing banks off Newfoundland."[1]

"The organized fur trade in Canada was started in the latter half of the 16th century by the French along the lower St. Lawrence. The British, with the formation of the Hudson's Bay Company in 1670, established trading posts on the shores of Hudson Bay and James Bay. The latter half of the 17th and 18th century was a period of rapid expansion of the fur trade and explorations were made to the west and north."[2]

Commercial fisheries and the fur trade are Canada's two oldest industries. They have been clearly visible threads in the economic fabric since the colonization of the country, and they continue to be recognizable components of the food and fibre industries.

Man's interaction with fish and wildlife include a rather broad spectrum of activities such as angling, hunting and various forms of non-consumptive recreational uses; however, classic economic concepts, analyses and terminology have been applied mainly to commercial fisheries and the fur trade. These fit easily into the scheme of normal market-place activities, translate readily into Gross National Product (GNP) and, as such, are readily understandable to economists and treasury boards.

In the course of the chapter, we will discuss the economic impact of the traditional commercial fisheries and fur trade, and attempt to show that analytical approaches are either lacking or are still very rudimentary when it comes to placing recreational and other social values in economic perspective.

IV.2 Commercial Fisheries

The products of commercial fisheries are mainly components of the food industry. The objectives of the enterprise are thus to provide a uniform stream of high-quality commodities in competition with other sources of food. There are limitations to cultural practices which can be applied to affect production, and to quality-control measures which can be exercised to guarantee a high-quality product. In addition, the commercial fisherman faces a high degree of variation, both in amount and kind of products that are returned for a unit of effort.

Freshwater and marine commercial fisheries are significantly different only in scale of production and in jurisdictional properties of the fishery. The same economic and ecological principles apply to both fisheries, so they will be considered together.

Canada is among the top 10 fishing nations of the world.[3] It is favourably located to harvest from the Atlantic, Pacific and Arctic Oceans and to sell into the large North American market. In 1968 the combined marine and freshwater commercial fishing enterprises landed approximately 2.6 billion pounds of products with landed values of approximately $190 million (Tables IV.1 & IV.2).

The landed values of products in freshwater fisheries was approximately $1.5 million in 1966 (Table IV.2) and represents approximately 1 per cent of the value of Canadian fisheries.

"More than 150 species of fish and shellfish are harvested by Canadian fishermen. The most important species of the sea fisheries include groundfish,

[1]Dominion Bureau of Statistics. Fisheries and furs. *In* Canada Year Book, Chapter XIV. Ottawa, Queen's Printer, 1969.

[2]Loughrey, A.G. The economics of the fur industry in Canada. Resources for Tomorrow Conference, Vol. 2. 1961.

[3]Jackson, R.I. Current developments in international fishery arrangements. *In* The future of the fishing industry of the United States. University of Washington, Publications in Fisheries, New Series Vol. IV. 1968.

Table IV.1–Landed Weight and Value of Sea Products[1]

	May-April 1967-68		May-April 1968-69	
	Landings	Value	Landings	Value
	'000 lb.	$'000	'000 lb.	$'000
Canada–Total	**2 449 939**	**152 087**	**2 817 923**	**174 000**
Atlantic Coast–Total	**2 204 302**	**106 084**	**2 557 025**	**126 935**
Demersal:				
Cod	558 932	24 606	571 820	24 127
Haddock	97 950	6 581	101 472	7 822
Redfish	169 925	4 400	213 757	5 520
Other	341 103	12 864	330 561	12 700
Pelagic:				
Herring & Sardines	900 816	9 530	1 196 363	12 367
Swordfish	8 134	3 381	7 199	3 645
Other	24 725	994	30 913	2 072
Anadromous:				
Salmon	6 202	3 343	4 777	2 308
Other	21 269	900	22 028	982
Invertebrates:				
Lobsters	35 818	24 049	38 593	25 591
Scallops	13 047	8 384	15 406	13 067
Other	26 381	1 695	24 136	2 650
Other Sea Products	–	5 407	–	4 084
Pacific Coast–Total	**245 637**	**46 003**	**260 898**	**57 065**
Demersal:				
Pacific Cods	18 892	1 524	16 225	1 400
Halibut[2]	24 605	6 216	29 630	7 468
Soles and Other Flatfishes	8 828	560	10 697	663
Pelagic:				
Herring	38 242	668	3 289	204
Anadromous:				
Salmon	129 735	34 856	176 151	44 854
Other Fish	9 570	413	9 794	716
Invertebrates:				
Shellfish	15 765	1 757	15 112	1 760
Misc. Items	–	9	–	–

[1]Adapted from tables in *Fisheries of Canada* July 1968 and June 1969, by adding to the latter data for April 1969 (provided by Economics Section, Dept. of Fisheries and Forestry) since system and presentation changed in the July 1969 issue.
[2]Includes halibut landed in U.S. ports by Canadian fishermen.

Table IV.2–Freshwater Fisheries: Landings and Values by Species in 1966

	Landings	Landed Value
	'000 lb.	$'000
Yellow Pickerel	11 189	3 995
Whitefish	20 510	3 506
Perch	22 374	1 990
Sauger	4 833	1 461
Tullibee	10 893	579
Trout	2 948	539
Pike	7 866	487
Carp	9 957	276
Sturgeon	311	197
Catfish	985	193
Other	29 741	2 353
Total	**121 607**	**15 576**

Source: From tables in *Canadian Fisherman*, June 1968.

such as cod, haddock, pollock, hake, etc., herring, halibut, salmon and lobsters. More than $200,000,000 is represented in fishing boats and catching gear and investment in shore facilities is also well over $100,000,000. A work force of above 80,000 persons is employed in fishing operations and of these 30,000 depend solely on the catching of fish for their livelihood and 20,000 are employed in processing plants."[1]

The value of the fishing industry ranks low on the national scale, contributing about 0.6 per cent of the GNP. However, its value to the regional economy is high in many parts of the Maritimes, including the Gaspé and the north shore of the Gulf of St. Lawrence, Newfoundland and British Columbia. As Crutchfield stated, in a significant number of instances, the fishery "is a measure of the welfare of entire communities".[2]

In discussing the place of fisheries, it is often pointed out that the industry has declined steadily in its contribution to employment and GNP. This does not, however, signify poor performance on the part of the fisheries because "one of the most stable relationships in economics is the decline in the proportion of food to total consumer good purchases with rising real incomes".[3] In addition, the relative position of the industry in the economy has been influenced by changing patterns of resource development and the attainment of harvestable limits of a number of key species.

The production of the fisheries of the world has expanded rapidly since World War II:

"In 1948, the total world production of fish was about 18 million metric tons or about 40 billion pounds, which was at about the same level as in 1938 just before the beginning of World War II. By 1957, total production had grown to 27.4 million metric tons or something over 60 billion pounds, a growth that represented an annual rate of increase of about 4.5 per cent over the ten years from 1948 to 1957. After 1958 the rate of increase in world catch almost doubled to an annual average of better than 8 per cent through 1966, when the total world production was 52.6 million metric tons, or better than 115 billion pounds."[4]

United States production has remained relatively constant during the past 30 years at between 4 and 5 billion pounds annually. Canadian production, however, has kept pace and has almost tripled since 1938. The approximate landed weights for the years ending 1938, 48, 58, and 68 were 1.1, 1.5, 2.0 and 2.9 billion pounds respectively.[5] During the past war period, a number of European countries began to fish actively in the western Atlantic, and Japan and U.S.S.R. greatly increased the intensity of their fishing in the eastern Pacific.

The productive capacity of Canadian fisheries was reviewed by Ricker in a background paper for the Resources for Tomorrow Conference.[6] His data suggested potential for increases in production ranging from a few per cent to more than 200 per cent.

[1]Dominion Bureau of Statistics. Fisheries and furs. *In* Canada Year Book, Chapter XIV. Ottawa, Queen's Printer, 1969.

[2]Crutchfield, J.A. The role of fisheries in the Canadian economy. Resources for Tomorrow Conference, Vol. 2. 1961.

[3]*Ibid.*

[4]Van Cleve, R. The conference objectives and the way of their seeking. *In* The future of the fishing industry of the United States. University of Washington. 1968.

[5]Data provided by Economic Service, Department of Fisheries and Forestry.

[6]Ricker, W.E. Productive capacity of the Canadian fisheries–an outline. Resources for Tomorrow Conference, Vol. 2. 1961.

IV.2.1 Fisheries–The Problem of a Common-property Resource[1]

A serious aspect of the operation of a fishery, or any similar common-property enterprise in which there is no limitation of entry, is that there is usually no net yield[2] to the economy from it.[3] The way in which this ill has afflicted Canadian fisheries is vividly illustrated by comparing total costs with the gross value of the resources. In a discussion of the British Columbia fishery, Crutchfield stated, "The Pacific Coast salmon and halibut fisheries are classic cases of excessive entry in response to relatively favourable prices, the end result of which is to tie up more than the required inputs with no self correcting tendency." He pointed out that although the real output of the primary fishery on the Pacific Coast had been barely maintained, capital investment had grown rapidly from $22 million annually in 1946 to $54 million in 1958.[4]

A recent report on fisheries in the Atlantic Provinces details a similar story for the lobster industry which dominates the inshore fisheries in all provinces except Newfoundland.[5] The report, drawing on reports by Department of Fisheries and Forestry scientists,[6] traces the various aspects of the fishery: the number of fishing units, landings, landed value and income to fishermen. The latter is reviewed in detail in this paragraph from the report: "Income of lobster fishermen in Western Nova Scotia, which had the highest total income from the lobster fishery, reached only 57 per cent of the provincial average and 50 per cent of the Canadian average. In Southern New Brunswick the lobster fisheries income was 67 per cent of the provincial average and 51 per cent of Canada. The worst situation was in Newfoundland where income in the lobster fishery was 37 per cent of the provincial average and 32 of the Canadian. In Prince Edward Island, which had the best experience, the Northumberland Strait fisherman's income was 85 per cent of the provincial average, and 58 per cent of the Canadian average."

It pointed out the dependence of the regions on transfer payments and unemployment insurance to maintain even the low income level of those participating in the fishery. One statement summed up the situation rather dramatically: "It is clear that the inshore fishery throughout the Atlantic Provinces is an instrument of poverty. Far too many men, boats and equipment are being applied to a basically limited resource."[7]

Recent developments in the Atlantic herring fishery provide an example which suggests that in spite of the recognition of inherent problems in common-property fisheries, contemporary fishery management is still not capable of developing fisheries to the point of providing a net yield to the economy. The halibut, salmon and lobster fisheries

[1]The problems associated with Common-property resources are brilliantly illustrated in an essay, "The tragedy of the Commons" (Science, Vol. 162, No. 3859, Dec. 13, 1968) by Garret Hardin with an example of herdsmen who pasture their cattle on a commons which is open to all. "As a rational being, each herdsman seeks to maximize his gain by adding one more animal to his herd." The utility of adding an animal has a positive component, the proceeds from the sale of the additional animal, and a negative component, the overgrazing caused the animal. However, since, to the individual, the positive component is greatest, he adds the animal and other rational herdsmen do likewise. "Each man is locked into a system that compels him to increase his herd without limit–in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all." As an analogy, it describes many commercial fisheries.

See also Crave, Beryl L. The tragedy of the Commons revisited. Science, Vol. 166, No. 3909, Nov. 28, 1969.

[2]Net yield equals gross value of the harvest over total production costs.

[3]The economic theory was developed from studies of the Canadian fisheries by H.S. Gordon, The economic theory of a common-property resource; the fishery. The Journal of Political Economy, Vol. LXII. 1954.

[4]Crutchfield, *op. cit.*

[5]Atlantic Development Board. Fisheries in the Atlantic Provinces. Background Study No. 3. Ottawa, Queen's Printer, 1969.

[6]Rutherford, J.B., D.G. Wilder, and H.C. Frick. An economic appraisal of the Canadian lobster fishery. Bulletin 157. Fisheries Research Board of Canada. Ottawa, Queen's Printer, 1967.

[7]Atlantic Development Board, *op. cit.*

were established during a period when considerations for regulation dealt only with the conservation of species. However, the offshore fishery for herring in the Atlantic has developed within this decade. It seems reasonable to have expected that management of the fishery would have profited from past experiences and been regulated so as to sustain the herring stock and optimize the economic yield. Our investigations have, however, raised doubts on both scores.[1]

A brief recapitulation of the history of the Atlantic herring fishery will indicate the uncertainty about the long-term effects of recent developments.

The commercial fishery for herring on the east coast has been established for over 150 years.[2] For the greater part of this period, it was conducted as an inshore fishery with weirs, gill nets or small inshore seiners. New Brunswick was the major producer of herring which to a large extent were canned or smoked. A greatly increased demand for fish meal, for use as livestock and poultry food, has developed during the past 10 years and this has greatly influenced the demand for herring for reduction purposes. In response to the demand, the nature of the fishery changed rapidly, beginning in 1964, from an inshore to an offshore fishery conducted primarily by purse-seiners.

From 1940 to 1964, herring landings on the east coast were most commonly within the range of 200 million to 300 million pounds annually. Between 1965 and 1968, the catch increased from approximately 400 million to 1 200 million pounds annually (Fig. IV.2). The potential to catch and to process herring also increased with equal rapidity. The build-up of the fleet of herring seiners was accelerated when seiners were transferred to the east coast after the crash of the Pacific herring fishery between 1965 and 1967. The decline of the Pacific fishery is shown in Figure IV.1. It was suggested to us by fishery scientists and members of the industry that the potential that now exists in fleet and plants can more than double current production on the east coast. In short, it appears that the new offshore herring fishery may even now have reached the point where, like the great majority of traditional fisheries, it makes no net yield to the economy. It is also possible that the stocks are already being overfished although the fishery is continuing to expand.

The fundamental nature of the problem is evidenced by the Canadian Atlantic Herring Fishery Conference held in May 1966 at Fredericton, New Brunswick. The conference was called on quite short notice by the Federal-Provincial Atlantic Fisheries Committee[3], because of "...the ferment which is evident in the herring fishery of the Atlantic coast, the growing interest on the part of the fishing industry in making full use of the great herring stocks at our doors, the expansion already initiated and the obvious need for better knowledge of the resource and of how to exploit it to the best advantage of our people."[4] It comprised six sessions: herring resources, fishing gear and techniques, fishing vessels, trends in utilization, current Canadian developments in the industry and industry's approach to development. The only paper which dealt with regulation of the fishery was presented by a representative of the

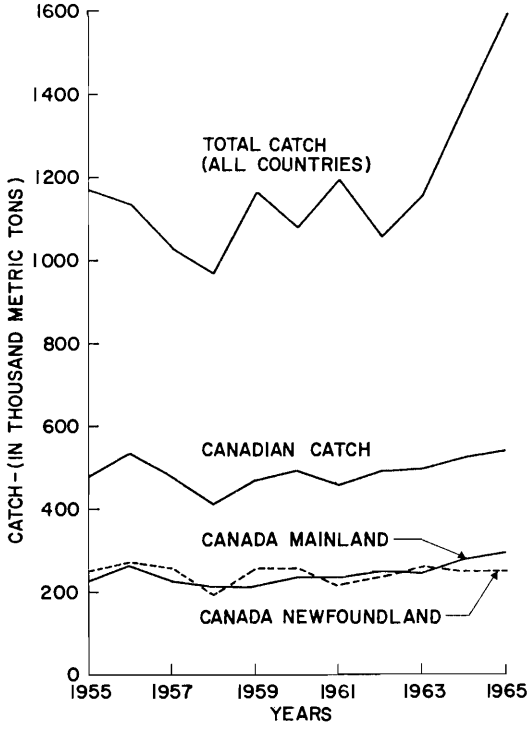
[1]The potential biological and economic problems faced by the fishery were detailed to us by scientists in the course of a series of meetings and personal interviews which we conducted in the Maritime Provinces. Later we attempted to obtain details on: a) the chain of events, including sources of capital, which had brought about the rapid expansion of the industry and b) the size, and potential, of the fleet and the industry to catch and process herring. We learned that such data are difficult to obtain and we did not have the resources to conduct an independent investigation to obtain all the data needed to understand what might be required to exercise control in the development of future fisheries.

[2]This review is based primarily on papers in the proceedings of the Canadian Atlantic Herring Fishery Conference. Canadian Fisheries Reports No. 8. Ottawa, Queen's Printer, 1966.

[3]The committee comprises the deputy ministers of fisheries of the five Atlantic coast provinces and the federal Department of Fisheries.

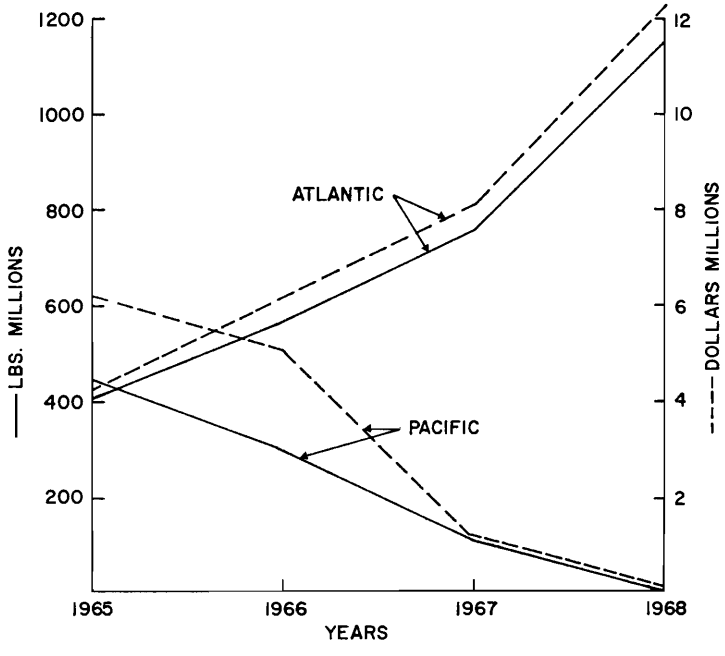
[4]From the introductory remarks by Dr. A.W.H. Needler, Deputy Minister of Fisheries, at the Canadian Atlantic Herring Fishery Conference.

Figure IV.1–Total North Atlantic Groundfish Catch and Canadian Catch in Subareas 3, 4 and 5, for Species Fished by Canada, 1955-65[1]



[1]*Source:* ICNAF Statistical Bulletins. From Atlantic Development Board, Study No. 3.

Figure IV.2–Herring Catch Statistics, 1965 to 1968



sardine industry, which is located primarily in New Brunswick. It proposed consideration of four "general conservation methods" and appealed to the Department of Fisheries "...to establish immediate and extensive facilities for proper research into fishing for herring to ensure that proper conservation measures are instigated and strictly enforced".[1] Apart from this paper, and a few comments in the discussion sessions, limitation of entry into the fishery and regulation of exploitation of the herring stocks were not discussed. We were not able to obtain any information to indicate whether these questions have been seriously considered as the fishery expanded during the past three years.

During the build-up of the fishery, no foreign countries participated in the fishery, so it could have been subject to regulation on a national (Canadian) basis. Regulation may now pose somewhat greater problems because an international fishery has started. We were advised that in the winter of 1968-69 German vessels fished one stock off Newfoundland all winter. To sum up, we believe that the lack of regulation imposes a threat to the industry and to the herring stocks. We consider that the matter warrants immediate consideration and suggest that it be assigned to a task force comprised of federal and provincial governments and industry.

IV.2.2 Economics and the Exploitation of Fish Stocks

Although a fishery is an economic pursuit, maintenance of fish stocks is generally considered to be a biological aspect of the question and one which can be achieved by regulatory actions based primarily on biological knowledge. Reflecting on this, Gordon stated:

"The most vivid thread that runs through the biological literature is the effort to determine the effect of fishing on the stock of fish in the sea. This discussion has had a very distinct practical orientation, being part of the effort to design regulative policies of a 'conservation' nature."[2]

Gordon did not, however, concede that the primary considerations in regulative policies were of a conservation nature, and in the introduction to his paper, stated:

"It will appear, I hope, that most of the problems associated with the words 'conservation' or 'depletion' in the fishery are, in reality, manifestations of the fact that the natural resources of the sea yield no economic rent."[3]

While it is possible to question the validity of the conservation aspects of Gordon's theory, few would argue that regulations should not be based on socio-economic as well as biological considerations.

The degree to which decreased catches or the crash of fish stocks can be attributed to overfishing has probably been discussed more intensely during the past 100 years than any other question relating to commercial fisheries. Some of the most eminent biologists of the last century argued that the fishery resources of the sea were inexhaustible and did not require any restrictive measures to protect them.[4] This was probably a reasonable argument at the time because of the relatively primitive technology being applied in the exploitation of the majority of the fisheries of the world. However, technological innovations have changed fishing methods and capability dramatically in this century, and there is now little doubt that overfishing must be considered as a threat when fisheries are developed on an unlimited entry basis. One of the most quoted discussions of the overfishing question was presented

[1] McLean, D.A., Jr. Our future supply of herring in the Bay of Fundy. Proceedings of Canadian Atlantic Herring Fishery Conference. Canadian Fisheries Reports No. 8. Ottawa, Queen's Printer, 1966.

[2] Gordon, H.S., *op. cit.*

[3] Gordon, H.S., *op. cit.*

[4] Gordon reviewed aspects of this debate.

as a series of five lectures just prior to World War II by E.S. Russell.[1] He reviewed a number of fisheries, including the Pacific halibut fishery, and showed how the maintenance of the catch "...was achieved only by extension of fishing grounds, and hid successive depletion of the older banks". However, he dealt only with ground, or demersal, fish and not with pelagic fish "...for the problem of depletion seems hardly to arise with it, so large are the stocks".

Since Russell presented his lectures, the technology of capturing pelagic fish has improved markedly; we are now faced with the histories of major fisheries, the Pacific pilchard and herring fisheries and the North Sea herring fishery are examples, which crashed while undergoing intensive exploitation.[2] Although the relationship between cause and effect is never very clear when a stock disappears, the fact that those fisheries mentioned had been subjected to progressively heavier fishing before their crash cannot be disregarded.

The cause of the decline of the west coast herring fishery has been strongly debated among the members of the B.C. Fisheries Council. A review of the fishery, written in 1964 prior to its decline, pointed out that "Year-to-year variations in oceanographic conditions, and particularly the abundance of the right kind of food, have a profound effect on the survival of herring larvae."[3] Referring to the demand for herring, the review stated:

"Mainly in response to market conditions, the herring fishery has shown a steady expansion within the past 50 years, both in respect to size of catch and to number of stock exploited. The most important influences have been the development and loss of the oriental market for dry-salt herring, and the development of the reduction industry for herring meal and oil."

In regulating the harvest of fishery stocks, catch per unit of effort is watched to determine the maximum intensity of fishing which the stock can tolerate. However, during development of the herring fishery in recent years, new technology, such as the use of echo sounders, and new fishing methods, such as the use of lights in night fishing, had been adopted in a relatively short space of time. It is possible that these had so improved the fishing efficiency that the catch-effort statistics did not portray what was happening to the various stocks.

In summation, although it is difficult to conceive of eight different stocks of herring crashing simultaneously as the result of overfishing, it remains suspect as a major factor in the decline of the fishery. As an example, it at least suggests the need for care in the exploitation of Atlantic herring stocks for the reduction and the fish protein concentrate industries.

IV.3 The Fur Industry

"Fur holds a special significance for Canada. It was the principal motive for early settlement and provided the lure to the adventurers who explored the vast hinterlands beyond the Great Lakes. Jacques Cartier found fur of high quality, but the rapid expansion of the fur trade took place only after the increase in the demand for the beaver hat in Europe during the latter part of the seventeenth century.

"The beaver hat was an expensive luxury to which only a few could aspire, but the trade was sufficiently profitable to produce a complex organization of transportation and exploration which stretched eventually 'a mari usque ad mare'. During Canada's early years the fur trade stood as a major moulding influence, and the industrious beaver

[1]Russell, E.S. The overfishing problem. Cambridge University Press, 1942.

[2]Based on discussions with fishery scientists.

[3]Larkin, P.A., and W.E. Ricker. Canada's Pacific marine fisheries–past performance and future prospects. Fifteenth British Columbia Natural Resources Conference. 1964.

can rightly lay claim to be included among the country's significant national symbols."[1]

The fur industry in Canada is no longer based simply on pelts trapped in the wild. Currently fur farms account for one-third of the pelts and two-thirds of the value of production, the latter having climbed steadily to gain that share from about one-third of the total at the beginning of the post-war period.

Mink contributes about 99 per cent of the production from fur farms, while beaver makes up more than one-third of the value of the wild catch. Muskrat, wild mink and seals contribute another third, and 22 species make up the remainder. About three-quarters of the wild fur production comes, not from the Northwest Territories and the Yukon as many people suppose, but from the Central and Prairie Provinces.

Except for muskrat, the production of wild furs has been maintained since the end of World War II. The production of beaver, the most important species, increased from 135 629 pelts in 1947-48 to 420 437 in 1967-68; however, the increase in total value of beaver was much less, $4.4 to $6.3 million. Over the 20-year period, overall value of wild fur production declined from approximately $22 million to $12 million. During the same period, the value of pelts (99% mink) produced on fur farms increased from approximately $12 million to $23 million.[2]

The decline in the primary fur industry has resulted from a complex of social and economic factors rather than biological ones. As indicated earlier, the prices for raw furs have not kept pace with increases in the cost of living so it is becoming more difficult to make an adequate living by trapping.

In a background paper for the Resources for Tomorrow Conference, Loughrey suggested that there had been far too great a tendency for wildlife biologists, enforcement agencies and administrators to view the fur resource from "the narrow views of inventory, conservation of resource, and resource management". He stated: "These agencies must become more aware of and sympathetic to the problems of primary producers; they must accept the significance of demand for fur on the international market. They can use their influence to strengthen and solidify the diverse segments of the industry from producer to consumer."[3]

It is of interest that he was, in fact, making the same point about the fur industry that Gordon made about fisheries, i.e. that a poor balance exists between biological and socio-economic considerations in the regulation of the resource. Although it is difficult to argue against the point Loughrey made, it should be noted that government agencies have been giving some consideration to the socio-economic side of the industry. For example, British Columbia, Quebec, Ontario and Manitoba have established trapline systems over large areas and, by so doing, have in fact made trapping a private-property rather than a common-property resource. Ontario provided support, for a number of years, to the Ontario Trappers Association and brought about the establishment of a viable, trapper-operated fur auction house in North Bay. Saskatchewan developed a fur marketing service which has assisted the trappers to develop more orderly and economic methods of marketing their pelts. Following the lead of the Hudson's Bay Company, Quebec has established 12 beaver preserves for Indian trappers. These now include a total area of over 300 000 square miles.

Most of these steps to help the primary fur industry to develop in a more orderly way were inaugurated either before or

[1]Canadian Imperial Bank of Commerce. The fur trade. Commercial Letter, February, 1963.

[2]Dominion Bureau of Statistics. Fisheries and furs. *In* Canada Year Book. Ottawa, Queen's Printer, 1969.

[3]Loughrey, A.G. The economics of the fur industry in Canada. Resources for Tomorrow Conference, Vol. 2. 1961.

Table IV.3–Pelts of Fur-bearing Animals Produced and Percentage Sold from Fur Farms, Years Ended June 30, 1948-68

Year Ended June 30	Pelts		Percentage of Value Sold from Fur Farms
	number	value	
1948	7 952 146	32 232 992	37
1949	9 902 790	22 899 882	33
1950	7 377 491	23 184 033	34
1951	7 479 272	31 134 400	36
1952	7 931 742	24 215 061	42
1953	7 568 865	23 349 680	43
1954	6 274 727	19 287 522	49
1955	9 670 796	30 509 515	43
1956	7 727 264	28 051 746	56
1957	6 919 724	25 592 130	57
1958	6 440 319	26 335 109	60
1959	5 370 531	25 836 617	62
1960	5 999 414	31 186 078	60
1961	6 237 360	28 737 087	59
1962	5 771 129	28 971 077	64
1963	5 123 395	31 943 418	62
1964[1]	4 572 594	35 412 822	63
1965[1]	5 609 025	36 534 609	58
1966[1]	5 507 199	45 622 852	63
1967[1]	5 221 750	35 103 371	65
1968[1]	6 098 408	36 577 871	63

[1]Includes seal pelts.

soon after World War II; however, since the industry has declined steadily, it is obvious that its problems have not been solved. Among other things, the industry has come under increasing pressure as a result of competition from European countries and from the synthetic fur industry.

This subject was discussed at the Resources for Tomorrow Conference in 1961.[1] The participants in the Wildlife Workshops agreed that the hope for improving the status of the industry lay primarily in this area, and made the following recommendation to the Steering Committee:

"Economics of the Fur Industry
It is recommended that a board or commission be established which is truly representative of the fur industry of Canada, responsible for domestic and foreign market research, product development and quality and product promotion on a vigorous continuing basis."

Although the Wildlife Workshop dealt primarily with marketing and production aspects of the fur industry, there is much to be said for the establishment of programs to determine the extent to which trapping can be maintained, or restored, as a viable independent way of life for people living in remote areas and for native people. In referring to the latter Loughrey wrote:

"It is thus imperative that governments formulate a policy by which Indians and Eskimos will derive the greatest benefit from the fur resources. Government wildlife research and management agencies must concern themselves not only with the proper harvesting of the resource, but also with the capabilities of the people who are harvesting that resource.... The formation and support of trappers' councils to foster concepts and responsibilities associated with group ownership and management must be encouraged. Trapper education programs should be increased in scope and function in order to teach improved trapping

[1]Wildlife Workshop B and Joint Meeting of Wildlife Workshops A and B. Resources for Tomorrow Conference, Vol. 3. 1962.

and fur handling techniques.... In all these fields the assistance of social anthropologists should be engaged."[1]

Events which have transpired since the Resources for Tomorrow Conference suggest that there is an even greater need to consider the desirability for such action than there was a decade ago.

Some of the problems in the management of fisheries and wildlife result from the complexities introduced by divided responsibilities between the federal and provincial governments. The fur industry in Canada is one of the resource areas which requires joint consideration if its problems are to be solved. The management of the resource is a matter of provincial jurisdiction; however, the questions of market research, product development and promotion, and the place of trapping in the economy of native people obviously require federal support and initiative if they are to be of maximum benefit to the country as a whole.

The federal government took an initial step by developing the Canadian Fur Council. However, as Malaher stated at the Resources for Tomorrow Conference: "At present levels, this promotion (by the Council) is like an annual shot in the arm to an invalid in urgent need of repeated medication. So far, the patient has managed to survive but little more."[2]

In summation, the primary fur industry in Canada appears to be gradually declining. At the very least, the industry, which played such an important role in the development of the country, warrants a thorough socio-economic study to determine whether it is dying because of changing times or because of factors which could be controlled. The industry has been almost completely unsupported by government subsidies throughout its history. But in many areas it now appears to be in trouble. At the very least, joint government action is warranted to seek out its areas of strength and weakness and determine if anything can be done to give it a new lease on life. A thorough discussion of the topic at a Federal-Provincial Wildlife Conference would be a good way to determine if there is agreement that the problems of the fur industry warrant joint action.

IV.4 Recreational Values

"In North America, outdoor recreational resources are often owned by governments and provided by them free, or almost free of charge to all users. Such freedom of access to public lands and wildlife resources has become part of our tradition and is one of our society's distinguishing marks. As naturalists and outdoorsmen, politicians and public all give vigorous endorsation to free public access to non-commercial natural resources it is reasonable to expect this situation to prevail for some time to come.

"Freedom of access means, of course, that these recreation resources have been deliberately withheld from the usual market environment (such as that prevailing for timber and mineral resources). This situation poses a particular problem for governments and their officials who make decisions about management and development of these resources. Normally, we depend upon the market to demonstrate the worth society places on products, services, and resources, but where facilities are provided free, such information is not available. The result is that people making decisions about recreational resources must work almost entirely without the usual economic indicators of the values of those resources to the consumers.

"Yet decisions must be made and in fact are made every day about the management and development of recreational resources. Competing demands on limited public funds must be weighed against each other, and wherever there

[1]Loughrey, *op. cit.*

[2]Malaher, A.G. Wildlife Workshop B. Resources for Tomorrow Conference, Vol. 3. 1962.

are competing uses for the same resource base (such as competing demands of agriculture and recreation for rural land) their relative values must be assessed in some way. Decisions about priorities are of necessity based on some conception of the values to be gained from spending more public funds on one area at the expense of another. The more information we can give decision-makers about the economic characteristics of competing demands on scarce funds, the more rational their decisions are likely to be."[1]

This quotation is important because it indicates why the managers of recreational resources are now more inclined to turn to economists for help in stating the value of recreation in its various forms; it also describes the nature of the dilemma that the economist faces in trying to provide answers; and finally it points out the unique place that recreational resources have in North American society. Economic evaluations of recreational resources require that net economic yield[2] be estimated so that direct comparison can be made of the costs and benefits of, for example: a) developing programs of a similar nature; b) utilizing resources in different ways, e.g. angling versus commercial fishing; c) retaining resources of a particular kind while obtaining services of an entirely different nature, e.g. the production of hydroelectricity versus the maintenance of salmon runs in a river.

It is this requirement of economic theory that has caused great gyrations among economists as they have sought to come to terms with the problem of defining values in outdoor recreation.[3] In Chapter III, the question was asked, Is placing a price tag on values which are social and cultural always a valid exercise? This question has, however, no validity to an economist as the following statement by Crutchfield indicates:

"The idea that sport fishing (or for that matter, outdoor recreation in general) should not be valued in money terms even in theory must be rejected. To argue that there are intangible values associated with fishing which cannot be registered by the pricing mechanism reveals fundamental misunderstanding of the role of prices in a market economy as an aggregate measure of human choices. The common denominator is the satisfaction which consumers expect to derive from additional amounts of the various commodities and services available to them, and it is measured in a simple and direct way: willingness to buy at a price. To endue sport fishing or mountain climbing with some kind of 'extra' values, incapable of being measured in willingness to pay is to deny the rationale of our entire organization."[4]

Non-economists have suggested that there are aspects of recreation to which no monetary value can be attached. They have also suggested that the minimum value of recreation is indicated by what people are willing to pay for it (the expenditures method of evaluation).[5] This has, however, been described as an invalid technique by Pearse and Bowden who stated:

"...it has often been incorrectly assumed that the value of hunting and fishing can be assessed in terms of what people spend in pursuit of these activities. But adding up the costs incurred in hunting is no more a reflection of the real worth of the game than is the cost of

[1]Pearse, P.H., and Gary Bowden. Big game hunting in the East Kooteway. Copyright by P.H. Pearse. 1966.

[2]Net yield equals gross value of the harvest over total production costs.

[3]*See for example:*

Clawson, M. Economics aspects of sport fishing. 1965.

Scott, A. The valuation of game resources; some theoretical aspects. Canadian Fisheries Reports No. 4. Ottawa, Queen's Printer, 1965.

Crutchfield, J.A. The valuation of a fishery. Land Economics, Vol. 38. 1962.

[4]Crutchfield, *op. cit.*

[5]This method was the basis of the survey reported by: Benson, D.A. Fishing and hunting in Canada–1961. Ottawa, Queen's Printer, 1963.

logging a reflection of the value of the timber."[1]

Another method proposed was to determine the value of recreational time.

"In one version the value per man-day of fishing is established by assuming that leisure time is a specific factor in real production necessary for performance of the tasks which eventuate in the nation's gross national product. A portion of GNP proportionate to the rates of non-working to working time is imputed as the produce of leisure and is then converted to a daily basis."[2]

Crutchfield gave a number of reasons for repudiating the approach and stated, "At the very least, this (method) would preclude sensible comparison of different fisheries or of fisheries with other competing recreation." He concluded: "It would seem that we cannot beg the difficult job of estimating the net yield from sport fishing on the same economic basis that we apply to all other valuable resources."[3] This conclusion has also been stated by three Canadian economists, all of whom agree with Crutchfield that there is no alternative to the calculation of the net economic yield of recreational resources.[4]

Several approaches have been proposed to obtaining an estimate of net economic yield. The most prominent group are based on determining how much would be paid if direct charges were made for the use of the resources. Several economists have proposed methods of simulating demand for recreation based on differential travel costs. Another approach has been to determine net economic yield where quasi market-place situations have been established, such as the leasing of salmon streams in New Brunswick or the requirement for non-residents to hire guides in British Columbia.

The results of these attempts have not been considered very successful even by economists. This fact is witnessed by a statement in a recent paper by Brown and Crutchfield:

"The economic evaluation of various forms of outdoor recreation has been a subject of intense interest to American and Canadian economists in recent years.... Regrettably it cannot be said that the usefulness of the resulting output is noteworthy. Perhaps the main accomplishment to date has been a significant reduction in the number of grossly incorrect estimates of the economic contributions of particular types of fish, parks and other sources of recreation and aesthetic enjoyment. Much less has been accomplished in establishing useful operational procedures through which analytically correct estimates can be made."[5]

However, it appears to us that this paper brings the search for means of evaluating recreational resources full cycle, for the authors do in fact recommend the use in East Africa of a modified form of the expenditures method of evaluation.

Scott discussed the theoretical aspects of the valuation of game resources at a symposium on the Economic Aspects of Sport Fishing which was sponsored by the Department of Fisheries in 1965. He examined "some of the theory lying behind" the travel-cost method of evaluating economic resources and stated that the success of the method depends on the use of a "huge number of questionnaires" to determine the "opportunity cost of travel". He suggested that in the absence of these, "this problem of valuation can only be resolved by the actual imposition of 'a toll'." He reached the same con-

[1]Pearse and Bowden, *op. cit.*
[2]Crutchfield, *op. cit.*
[3]Crutchfield, *op. cit.*
[4]Pearse and Bowden, *op. cit.*
Scott, *op. cit.*
[5]Brown, G., and J.A. Crutchfield. A money-flows approach to investment in game management. Special Issue, East African Agricultural and Forestry Journal. 1968.

clusion from an examination of the problems for evaluation of the existence of alternative game areas that are "free".[1]

The summary of the panel discussion indicated the interest that Scott's proposal had created:

"Some of the advantages of tolls were cited as the possible levelling off of peak periods in the utilization of the resource and the assurance that once the appropriate toll is imposed a proper exploitation of the resource ensues.

"Objections were raised to the use of tolls solely as a means of testing public reaction. Another objection consisted in the inability of a toll on one specific site to be considered in isolation from other fishing sites or other recreational facilities. It also raises the question of income redistribution. It was further pointed out that the imposition of a toll on readily-accessible facilities defeats its purpose in that it discourages the use of the facilities by the people for whom they were intended. An exception to this last objection was cited as in the case of inaccessible resources used by the wealthy.

"It was noted that the objections to tolls rested upon the assumption that recreational facilities should be free. However, it was suggested that the evaluation of recreational facilities cannot be considered free unless the value of these assets in alternative use has been determined as zero."

Although there obviously were differences of opinion on the means of evaluating sport fishing resources:

"A general consensus evolved on a definite need for evaluating sport fishing for policy decisions especially where there are conflicts in the use of the resource, where there is a need to consider appropriate levels of investment in sport fishing facilities as well as the consideration of alternative uses of such investment in competing recreational facilities such as museums, historic sites, etc."[2]

Our inquiries indicate that fishery and wildlife administrations in Canada generally agree with the consensus reached by the symposium on the need for making economic evaluations of recreational resources. It was, however, evident to us that they have, on the other hand, done relatively little to stimulate studies in Canada by providing direct financial support.

A recent series of papers on hunting in British Columbia were based on research principally supported by Resources for the Future, Inc. of Washington, D.C.[3] This work represents the only important investigation of economic aspects of hunting since the study of fishing and hunting was published in 1961 by the Canadian Wildlife Service.

On the fisheries side, some specific investigations are being conducted by the Economics Service of the Department of Fisheries and Forestry;[4] however, neither the Department, nor the Fisheries Research Board has played an important role in providing support for studies which would make important contributions to the solution of the problem of how to evaluate recreational resources so that they can be adequately related to other resources. It is vital that this be done–otherwise the value of the fisheries of Canada will continue to be equated with the contribution of the commercial fisheries of Canada to GNP, a method which represents a gross under-evaluation of the total resource. The results of such a situation are even more serious on the wildlife side for there, with the exception

[1]Scott, *op. cit.*

[2]*From* Summary of discussions–panel 1a. The basis for an economic approach. Canadian Fisheries Reports No. 4. Ottawa, Queen's Printer, 1965.

[3]Pearse and Bowden, *op. cit.*

See also Bowden, G., and P.N. Pearse. Non-resident big game hunting and the guiding industry in British Columbia; an economic study. Department of Recreation and Conservation. Victoria, B.C. 1968.

[4]Economics Service. A review of studies on the economic and statistical aspects of salmon sport fishing in British Columbia–1968. Department of Fisheries and Forestry. Mimeograph. 1969.

of the fur industry, no data exist which even represent under-evaluations of the resource.

IV.4.1 Angling and Hunting

The economic impact from angling and hunting takes two forms. One is derived from providing fibre and food for people and food for dogs in remote areas; the second, from expenditures on recreational hunting and angling.

The outstanding use of wildlife as "country food" is found with the caribou. That use declined as herds were decimated, as restrictions were placed on hunting, and as residents of northern Canada became less dependent on them. Under primitive conditions an Eskimo family required 250 caribou per year, and even under present conditions, living on the land requires 100 to 150 caribou per year.[1] Nevertheless, a currently allowable harvest of an estimated 15 000 caribou of mean weight 180 pounds dressed at 60 per cent would yield $1.92 million if given a nominal value of one dollar per pound, the estimated alternative cost of meat transported to a remote area. The value added through use of hides and bones would not be included in that total. No current statistics are available on the total kill and use of caribou for domestic food and fibre. Similarly no current measures are available for use of whitefish, char, lake trout, or other animals such as moose, elk, bison, deer, seal, walrus and muskox. As the dependence on "country food" diminishes, the need for data on stocks, exploitation and recruitment rates for those commodities to measure man's survival capabilities will be replaced by a need to measure fish and wildlife values for resource allocations among primary industries.

The angler or recreational hunter has little interest in the price per pound of his harvest. In most instances, if he calculated it, he would be subjected to ridicule or condescension of his wife or friends when he revealed the figure. The economic aspects therefore lie in the number of fish or other animals taken and the total expenditures of the angler or hunter in exploring for, producing, storing, transporting, processing and distributing fish and wildlife.

Angling or hunting allows a great deal of elasticity of substitution in the production of "commodities". Many people just go fishing or hunting and are perfectly satisfied whether they take a smallmouthed black bass or a great northern pike, a cottontail rabbit or a ruffed grouse. Since each species occupies a distinct niche within a habitat, and as a great deal of discrimination is frequently exercised by a consumer whether he knows it or not, there is economic merit in considering each species as a separate commodity.

As mentioned earlier, the only national economic survey of hunting and angling in Canada was made in 1961. There still is not a complete register of hunters and anglers in Canada. As an example, salt-water angling, which was imputed as an activity to over 150 000 persons in 1961, does not yet require a licence or other registration of the participants, although salt-water fishermen might represent about one-fifth of the registered fishermen. There are many serious arguments under way which warrant much more knowledge than is available about the actual and potential numbers of salt-water anglers and about their contribution to the economy. The arguments include the importance of the economic competition between anglers and commercial fishermen; the long-term benefits of maintaining a salmon fishery versus converting rivers into energy sources for hydro power; and the advantage of converting capital-intensive commercial fisheries into the labour-intensive service industries associated with salt-water angling.

Similarly criticism can be directed against hunting statistics which can be separated only as far as big game, small game and waterfowl are concerned. The

[1]Kelsall, J.P. The migratory barren-ground caribou of Canada. Ottawa, Queen's Printer, 1968.

data are in fact incomplete even in these areas, since not all persons who hunt are required to buy a licence or even to register (Tables IV.4 and IV.5).

With very few exceptions, e.g. fishing for salmon in certain streams or parts of streams in New Brunswick, the cost of a licence is recognized as a token payment which is little more than a registration fee. This becomes evident when one examines the basis for hunting in European countries, where, in addition to a licence fee, the hunter is required to pay the landowner for the privilege of hunting and sometimes an additional amount if he keeps the meat of the animal he shoots.[1] However, in spite of the fact that free angling and hunting in North America is in fact a form of social benefit, dispensed through a special form of common-property use, state and provincial legislatures fail to recognize the need to support them adequately and seldom appropriate more money than that which is obtained through revenue from licences. This has not permitted an orderly development of investments in those areas in the past, and is not likely to in the foreseeable future. Considering

[1]Pimlott, D.H. Moose harvests in Newfoundland and Fennoscandian countries. Transactions of the 24th North American Wildlife Conference. 1959.

Table IV.4–Non-tidal Angling Licence Sales by Province

Province	1938	1948	1958	1968
Newfoundland	X	X	9	17 (4)
P.E.I.	X	4 (1)	7 (2)	8.6[1]
Nova Scotia	N	N	N	71 (3)
New Brunswick	.5 (2)	1 (5)	5 (6)	59 (11)
Quebec	N	72 (25)	252 (59)	398 (89)
Ontario	N	N	N (380)	83[3] (635)
Manitoba	N	N	83 (13)	97 (23)
Saskatchewan	6[2]	17 (4)	98 (8)	120 (10)
Alberta	5	16	129	137[4]
British Columbia	28 (6)	76 (21)	120	209 (81)
Total	**39.5 (15)**	**186 (56)**	**703 (468)**	**1 200 (856)**

Note: ( ): foreign sales; N: not required; X: not available.
[1]Not required by farmers or fishermen.
[2]1940.
[3]Licence instituted January 1, 1969.
[4]1967.

Table IV.5–Hunting Licence Sales by Province

Province	1938	1948	1958	1968
Newfoundland	.3[1]	5	24	46 (34)
P.E.I.	X	X	3[2]	3.5[2]
Nova Scotia	17	37[3]	49[2,4]	87 (1)
New Brunswick	26 (1)	43 (3)	53 (3)	77 (3)
Quebec	6 (1)	102 (2)	215 (5)	337 (9)
Ontario	133	203[5]	436	547 ( )
Manitoba	12[6]	43[6]	58 (3)	90 ( )
Saskatchewan	11[7]	46 (.5)	114 (4.5)	158 (8)
Alberta	18[8]	37[9]	143 (2.2)	201 (12)[12]
British Columbia	44 (9)	159[10]	115[11] (3.4)	419 (7)
Total	**267 (2)**	**781 (5.5)**	**1 210 (21.1)**	**1 546 (42)**

Note: ( ): foreign sales; N: not required; X: not available.
[1]1943.
[2]Not required by farmers or fishermen.
[3]1947.
[4]1957.
[5]1946.
[6]Not required by farmers.
[7]1940.
[8]1941.
[9]Deer only.
[10]1950.
[11]No big game required.
[12]1967-68.

resource allocations that must occur in Canada over the next 20 years, we can only repeat that the collection and analysis of more comprehensive economic data related to angling and hunting are imperative if wise investments are to be made.

Although many North American economists deny the validity of the expenditures method to indicate the value of recreational pursuits, the data in the report on fishing and hunting in Canada provide some interesting insight into the degree to which Canadians participate in these activities.[1] It was found that 12.6 per cent of the populace over the age of 14, fished, hunted or did both; 10.8 per cent fished, while 6.5 per cent hunted. "Fishermen spent a total of $188 million on their sport in 1961, for an average of $143 per fisherman." Hunters spent a total of $87 million for an average expenditure of $110. The average expenditure per day was $9.50 for sport fishing and $8.16 for hunting.

IV.4.2 Non-consumptive Use: Birdwatching, Nature Photography

Recreational appreciation of wildlife in its natural habitat has widely acknowledged economic benefit which fundamentally has two forms: those who actually observe or appreciate and those that take pleasure in the thought of its possibility. The economic value which is related to the knowledge of the existence of wildlife populations is intangible, but nevertheless it is real.

Canadians who contribute to such appeals as the World Wildlife Fund, whose objectives include preservation of the rhinoceros in Borneo or other "endangered" species throughout the world, belong in that class. Their number is substantial, but the "hard-core market" is not known in breadth or depth. The magnitude of economic impact is also unknown for persons whose primary motivations are observation or photography of wildlife or fish. Their economic profile is, however, better known.

A loose definition of the "hard-core market" would include, but certainly not be restricted to, those persons who belong to naturalists clubs. Participants in this form of recreation, labelled "birdwatchers" or "naturalists", adhere to the broad definition of wildlife proposed by the Resources for Tomorrow Conference as "all species of mammals, birds, reptiles, amphibians and fish". In fact, the concept may include invertebrates and floral aspects; in short, the total environment. A distinction need only be made between those people who enjoy wildlife when they see it and those who actively seek to see, photograph, listen to or record sounds, or undertake other appreciative activity short of attempting to capture wildlife. A valid economic distinction can be made between the highway traveller who enjoys wildlife when he sees it along the road, and the person who enjoys the scenery along the highway while he is seeking birds. In the first instance, birds have an intangible consumer utility, but in the second instance they are a commodity in the economic sense. The intangible consumer utility of birds should be recognized and accounted for in economics associated with highways, but should not cloud the economics associated with the use of wildlife made by naturalists.

The trappings of the naturalist are binoculars, cameras, identification guides, "bird lists", bird feeders and food, and so on. Birdwatching appears to be the predominant interest and apparently forms the largest component of the economic impact of naturalists; however, there are no definitive data available which are referable to Canada. Virtually the only information available is from a small study made by Dr. M.T. Myres based on the expenditures of members of the Calgary Bird Club (now the Calgary Field Naturalists). He estimated there to be 800 000 naturalists in Canada in 1966 but less than a 2 per cent membership in organized clubs; he

[1]Benson, *op. cit.*

estimated that capital expenditures of $155 and operating expenditures of $202 were made per capita of club membership in 1966. It is useful to extrapolate to a total annual expenditure exceeding $162 million, not out of consideration for its reliability, but to indicate the need for more exact information. If the extrapolation were correct, the amount would be about half the market value of commercial fisheries in Canada. Thus any problems associated with recreational appreciation of wildlife, if the "pay-offs" for solutions were equal, might be reckoned to deserve about half the scientific attention devoted to commercial fisheries. But economists suggest that such a comparison is about as valid as stating that a P.E.I. potato and a California grapefruit are equal, so it brings us back to the fact that birdwatching has value and to the question of whether or not it can be valued in dollar terms which have any real meaning.[1]

IV.5 Proposals for Future Action

The study of the development of the Atlantic herring fishery, as well as some other aspects of our investigations, suggested to us that there is a great need in the Department of Fisheries and Forestry for some kind of forward-planning unit that would help the Department to identify potential biological, economic and social problems in fisheries before they develop. Such a unit could conceivably also give leadership in the development of new fisheries and in suggesting new approaches to old problems.

We propose that a task force[2] make an immediate appraisal of the herring fishery; however, there is an obvious need for a long-term approach which will solve problems before they reach a stage where the attention of a task force is required.

In the case of the fur industry, we consider that there is a need for a socio-economic study to determine the potential of the industry, and to determine what role it can play in establishing an economic base to the economy of northern, particularly native, communities.

Thirty years ago the establishment of trapline systems gave the industry a new lease on life in many areas; recently the use of snowmobiles has also helped to revive the industry in some areas by giving trappers greater mobility, thus making it possible for them to go home more frequently and to trap larger areas. It is possible that a deliberate study of the industry would identify other "simple" things that would give new life to the industry and a better socio-economic base, rather than welfare payments, to small northern communities.

In the field of recreation, we gained the impression that Canadian resource managers are eager to have economists develop ways of evaluating the resources *but* few are willing to pay anything for the service. We suggest that both federal and provincial agencies should support socio-economic studies of recreational resources by:

a) contracting to have specific studies undertaken;

b) making major grants to one or two Canadian universities to encourage the development of centres for socio-economic research on recreational questions.

But on the other side of the question, we suggest that the relative lack of success in ascribing values to recreational resources indicates that the approaches taken by economists have been too orthodox in nature. A demand of the times surely is for intensification of the search to find ways of ascribing values to valuable things which cannot be readily sold in the market places of the world[3].

[1]Myres, M.T. A sample survey of the expenditures of naturalists. Canadian Audubon, Vol. 30. 1968.

[2]The use of task forces is discussed in more detail in Chapter XI.

[3]It has been suggested by P.H. Pearse (Toward a theory of multiple use: the case of recreation versus agriculture. Natural Resources Journal, Vol. 9. 1969) that "These problems suggest a wide scope for interesting research bringing together the combined expertise of biologists and economists."

Chapter V

Organization for Research Management and Development

V.1 Historical Developments

"Jurisdiction over the various groups of wildlife is not clearly stated in the Canadian constitution and is characterized by divided responsibilities based on interpretation and *ad hoc* arrangements arising from sometime convenience."[1]

The "mission" of government departments with responsibilities for fish and wildlife management began before Confederation with laws regulating the harvest of fish and game. The proclamation of the British North America Act (BNA Act) led to divided jurisdiction over domestic fish and wildlife resources. In 1902, with the first of the international treaties, Canada undertook commitments for research to better manage international marine resources. With the passage of the Migratory Birds Treaty in 1916, waterfowl and certain other birds became a federal responsibility. Then, jurisdiction over domestic and international fish and wildlife resources was divided between the federal and provincial governments.

Fish and wildlife did not receive equal consideration under the BNA Act although both were common-property resources. Section 91 (12) gave the federal government exclusive legislative authority over seacoast and inland fisheries but did not mention wildlife. Considering the importance of the fur trade to the early development of Canada, it is strange that the Fathers of Confederation did not specifically classify game animals as a matter of either federal or provincial responsibility. As a result, wildlife was subsequently considered to be a matter of a merely local nature, and hence fell under the exclusive powers of provincial legislatures (Section 92 (16)). Each province established its own legislation for regulating the exploitation and use of game species.

The relatively simple jurisdictional framework for the management of fisheries and wildlife began to be modified soon after Confederation. The first modification came in 1898 as the result of the claim of Quebec and Ontario for proprietary rights over inland fisheries.[2] The Privy Council ruled that proprietary rights should remain with the province unless it had been transferred to Canada by specific reference in the Act. The ruling introduced many complexities:

1. It gave the province the power to legislate on all matters of property and civil rights, but
2. reaffirmed that the enactment of fishery regulation was the exclusive right of the federal parliament, and
3. it ruled that the federal parliament had the power to restrict the free exercise of provincial rights if it was necessary to do so to regulate the fisheries.

One of the most important ramifications of this part of the ruling was that federal fishery laws could have a direct bearing on provincial powers to regulate the use of water resources. After the 1898 decision, proprietary rights to inland fisheries were assumed by Quebec and Ontario, and federal fishery officers were replaced by provincial officers.

Over the years the administration of freshwater fisheries was delegated to the provinces that wished to undertake the responsibility. The federal government now administers only the freshwater fishery in the Atlantic Provinces, the Territories and National Parks. Each year, regulations for inland fisheries are drafted by provincial officials who pass them on to federal officials for legislative and executive action.

The favourable ruling on proprietary rights over inland fisheries whetted the appetite of the provinces, and subsequently, British Columbia (1913) and Quebec (1920) claimed rights over tidal water fisheries. Privy Council denied this claim, but, in spite of this, the administration of coastal fisheries was turned over to Quebec by two Orders-in-Council

[1]Munro, D.A. Legislative and administrative limitations on wildlife management. Resources for Tomorrow Conference, Vol. 2. 1961.

[2]Ozere, S.V. Survey of legislation and treaties affecting fisheries. Resources for Tomorrow Conference, Vol. 2. 1961.

(1922 and 1943). In the second Order-in-Council, the administration of the fisheries of the Magdalen Islands was added, as was the administration of regulations under the Fish Inspection Act and the Meat and Canned Foods Act. The latter two were returned to the federal government in 1959.

Wildlife remained a matter of merely local or private concern until the Migratory Bird Treaty was negotiated with the United States in 1916. The proprietary right of the province was never questioned, so that the Treaty and the Act in fact established a major area of divided responsibility.

V.2 Fishery and Wildlife Organizations in Canada

Fish and wildlife are a mobile, common-property resource. They cannot be managed like agricultural or forest resources, where the man who sows the seeds or manages the forests has a reasonable assurance that he will reap the benefits. Because of this, private enterprise has shown little interest in or support for related scientific activities. A little support, however, is given to development related to the recreational use of fisheries and wildlife.

Not more than three Canadian consulting firms are known to have a capability for undertaking fisheries or wildlife management projects. Engineering, economic or management consulting firms in Canada are unlikely to be able to undertake a fisheries or wildlife project without large amounts of technical advice from government or university scientists.

A few private Canadian-based organizations employ scientists. They are the British Columbia Wildlife Federation, which is an organization of hunters and anglers, the Northeastern Wildlife Station, Delta Waterfowl Research Station, and Ducks Unlimited. The latter three are funded primarily from the United States. Their relative contribution to the total scientific effort is small when compared to the portion funded by government.

Science, as applied to fisheries and wildlife management, is dominated by mission-oriented government agencies which are concerned almost exclusively with controlling the harvest of the resource. These agencies also tend to support research conducted at universities on species of economic importance. The National Research Council (NRC) tends to support more basic wildlife and fishery research programs but careful wording of project proposals is required so that projects concerning species of economic importance are not considered as applied research–a category which is not popular with the Council.

A fisheries ministry has been a continuing part of the federal government since 1867.[1] Activities of a scientific nature are carried out by the Industrial Development Service, Economic Research and Intelligence Service, Resource Development Service, Inspection Service, and the Fisheries Research Board of the Department of Fisheries and Forestry.

The statutory basis for the activities of the Department of Fisheries is broad and includes the Department of Fisheries Act (R.S.C., 1952, Chapter 69), the Fisheries Act (R.S.C., 1952, Chapter 119), the Fish Inspection Act (R.S.C., 1952, Chapter 118), and the Fisheries Development Act (R.S.C., 1952, Chapter 18). In addition, there are several acts which give statutory basis for the involvement of the government in conventions relating to international fisheries.

The Industrial Development Service concerns itself with production techniques and the improvement of methods, procedures and equipment. The Economic Research and Intelligence Service provides the government and industry with commercial information, including statistics, and undertakes studies on the various economic problems of fisheries. The Resource Development Service con-

[1]Department of Fisheries. Thirty-Seventh Annual Report–1966. Ottawa, Queen's Printer, 1968.

centrates on the improvement of the reproduction environment and fish stocks. The Inspection Service is nearer the marketing stage and has a large number of laboratories and inspection stations throughout the country. The Fisheries Research Board is responsible for the research programs of the Department.

The Fisheries Research Board (FRB) prides itself on being the first national research organization to be managed by an independent scientific board. In matters of research, it is autonomous and is unique in government. The small agency, set up originally in 1898, became the Biological Board of Canada in 1912 and the Fisheries Research Board in 1937. It has a full-time chairman, appointed by and directly responsible to the Ministry of Fisheries and Forestry, and a board of 18 members appointed for five-year terms by the Minister who serve in honorary capacities.[1] The Board's membership reflects the desire to balance the influence of civil servants and independent scientists. The Fisheries Research Board Act requires that a majority of board members be scientists and that the others be representatives of the Department of Fisheries and Forestry and the fishing industry. The Board's general task is to conduct basic and applied research on aquatic fauna and flora, their environment and conditions of utilization.[2]

The Fisheries Research Board has an eastern, a central and arctic and a western advisory committee. These committees offer advice on the various research programs conducted by the Board. Their reports and recommendations form the basis of the agenda for the Board's annual meetings. In addition to these regular committees, the Board sets up special committees to consider specific questions.

Interest in wildlife at the national level developed very slowly in Canada. For 30 years after the enactment of the Migratory Birds Convention Act, management of migratory birds was the responsibility of the Migratory Bird Section of the National Parks Branch. In 1947 the Section became the Dominion Wildlife Service, and three years later was renamed the Canadian Wildlife Service (CWS). The new Service became responsible for wildlife and fishery research in parks and for wildlife research in the territories.

In the last 20 years, the Canadian Wildlife Service underwent marked expansion. Its professional staff increased from 7 in 1947 to 90 in 1968-69; in 1962 the Service decentralized into eastern and western regions, with headquarters at Ottawa and Edmonton. In recent years the Service assumed responsibility for the effect of pesticides on wildlife, the hazards of birds to aircraft, and is developing interpretation and information services. Throughout its history, activities relating to migratory birds have received the major share of attention and budget. In 1968-69, more than 50 per cent of its expenditures were in this area of activity.

The responsibility for the fishery and wildlife activities of provincial governments is exercised by organizations which, though generally similar in function, vary considerably in name, in organization and in their relationship to other resource agencies. In British Columbia and Quebec, the fish and wildlife agency is associated with a parks branch; in all other provinces they are in multi-resource departments, associated in varying combinations with forestry, mines, parks and Crownlands. All provinces, with the exception of Newfoundland, Nova Scotia, New Brunswick and Quebec, have wildlife and both aspects of fisheries (sport and commercial) in the same department. Quebec and Alberta have all aspects of the management and research of sport fisheries and wildlife under the same branch, while Ontario separates

[1]Fisheries Research Board. The Fisheries Research Board of Canada–what it is and what it does. Ottawa, Queen's Printer, 1968.

[2]The Senate of Canada. Proceedings of the Special Committee on Science Policy, No. 17. Ottawa, Queen's Printer, 1969.

the two functions under a Fish and Wildlife Branch and a Research Branch, respectively. The Manitoba Department of Mines and Natural Resources is undergoing a reorganization, and it appears that it will, in the future, develop its central organization more on the basis of function than on specific areas of responsibility. The activities of all provincial agencies are based on acts which provide the basis for the regulation of fishing and hunting. In Nova Scotia, a separate portion of the Lands and Forest Act deals with game.

The involvement of Canadian universities has been entirely in the area of research. However, university scientists also played an important role in the establishment of the Fisheries Research Board (and in the development of some of its stations) and in the development of fishery and wildlife programs in some provinces. The place of universities in the spectrum of scientific activities in Canada was described by a recent Science Council report in these terms:

"Universities occupy a unique position as part of Canada's resources for research. They have special responsibilities not shared significantly by other institutions. Traditionally and historically, they saw their research role as that of generating new knowledge *per se* and research of a basic nature was favoured."[1]

A review of NRC grants for 1968-69 showed that there were 72 research scientists in 31 universities whose programs could be classified as either fisheries or wildlife (Table V.1). In addition, there were a number of others who were doing research in parasitology and other fields relevant to fish and wildlife. In virtually all cases, the scientists were staff members of departments of biology or zoology. Fishery scientists at four universities also received grants from the Fisheries Research Board, and during the past five years, a number of wildlife scientists have conducted research under contract with the Canadian Wildlife Service.

V.2.1 Distribution of Manpower and Expenditures

Details on the distribution of manpower and expenditures in fisheries and wildlife are given in Tables V.1 and V.2. Total expenditures on scientific activities in the two areas in 1968-69 were approximately $33.5 million, with 77 per cent expended on fisheries and 23 per cent on wildlife. The data show that 76 per cent of fishery and 34 per cent of wildlife scientists were employed by the federal government. The concentration of expenditures in the federal sector was somewhat higher with 85 and 41 per cent of the funds expended by federal fishery and wildlife agencies respectively. A further examination of the fishery data shows that approximately 80 per cent of the federal expenditures was evenly divided between the east and west coasts, 13 per cent was expended on freshwater and 7 per cent on arctic fisheries and marine mammals. A comparison of the data for wildlife and the freshwater fisheries shows that there was approximately the same distribution of manpower and expenditures between the two sectors (Tables V.1 and V.2). In the case of wildlife, 7 per cent of the manpower and 5 per cent of the expenditures were in the private sector; the fisheries sector was completely deficient in this area.

Over the next 20 years, we consider a redistribution of activity in fisheries particularly desirable. We suggest that by 1990 federal fisheries should represent approximately 45 per cent of the total effort (Table V.3) and federal wildlife 30 per cent (Table V.4). Also proposed is a strengthening of the university sector in both fisheries (2 to 10 per cent) and wildlife (4 to 12 per cent) and strengthening of private sectors. We suggest that the fisheries industries should represent 15 per cent of the total expenditures, and private interests in the wildlife area, 10 per cent (Tables V.3 and

[1]Macdonald, J.B., *et al.* The role of the federal government in support of research in Canadian universities. Special Study No. 7, Science Council of Canada. Ottawa, Queen's Printer, 1969.

Table V.1–Manpower and Gross Expenditures on Scientific Activities Applied to Fish and Wildlife Resources (1968-1969)

Section of Performance	Fisheries				Wildlife			
	Scientific Manpower	%	$'000	%	Scientific Manpower	%	$'000	%
Federal[1]	424	76	21 741	85	90	34	3 119	41
Provincial[2]	107	19	3 444	13	117	43	3 876	50
University[3]	27	5	605	2	45	16	269	4
Other Private[4]	–		–		17	7	410	5
Total	**558**		**25 790**		**269**		**7 674**	

[1]Sources of data were the administration of the Canada Department of Fisheries and Forestry, Fisheries Research Board, and the Canadian Wildlife Service.
[2]Data were developed from reports and correspondence from the provinces to the Study Group.
[3]Grant support only. Data developed from *Annual Report on Support of University Research*, National Research Council, 1967-68.
[4]Data extrapolated from the expenditures reported to the Study Group by Delta Wildlife Research Foundation and Ducks Unlimited.

Table V.2–Manpower and Gross Expenditures on Scientific Activities Applied to Freshwater Fisheries (1968-1969)

Sector of Performance	Scientific Manpower	%	$'000	%
Federal	85[2]	39	2 898[3]	42
Provincial[1]	107	49	3 444	49
University[1]	27	12	605	9
Other	–		–	
Total	**219**		**6 947**	

[1]Manpower and dollar data from Table V.1.
[2]Scientific manpower calculated by dividing the per capita costs of scientists at Fisheries Research Board Winnipeg lab (see FRB 10-year plan) into total federal expenditures.
[3]Data based on the Senate of Canada, 1969. Proceedings of the Special Committee on Science Policy, No. 17.

Table V.3–Distribution of Scientific Performance Applied to Fisheries Resources in 1990 by Geographic Problem Area

Sector of Performance	Freshwater	Anadromous	Inshore Shellfish	Pelagic & Groundfish	Total
	%	%	%	%	%
Federal	7	11	5	22	45
Provincial	20	5	5	0	30
University	3	4	2	1	10
Other	2	5	3	5	15
Total	**32**	**25**	**15**	**28**	**100**

Table V.4–Distribution of Scientific Performance Applied to Wildlife Resources Proposed for 1990 by Major Habitat Areas

Sector of Performance	Wetlands	Improved Forage Cropland	Native Forage and 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**

Table V.5–Distribution of Scientific Effort Applied to Fisheries Resources Proposed for 1990, by Subject Area, Geographic Problem Area and Sector of Performance

Problem Area	Bio-Science	Chemistry (Technology) & Biocides	Environment Oceanog. Limnology	Engineering	Sociology	Economics	Statistics	Total
Freshwater:								
Federal	2.45	1.05	2.10	+	.70	.70	+	7
Provincial	5.00	3.00	2.00	2.00	3.00	3.00	2.00	20
University	.50	.25	.50	.25	.75	.75	–	3
Industry	.50	.25	–	1.00	–	.25	+	2
	8.45	**4.55**	**4.60**	**3.25**	**4.45**	**4.70**	**2.00**	**32**
Anadromous:								
Federal	4.00	.36	2.21	2.21	.74	.74	.74	11
Provincial	1.00	.50	1.00	.50	1.00	1.00	–	5
University	1.69	.33	.33	.33	.66	.66	–	4
Industry	.62	1.25	–	1.88	–	1.25	+	5
	7.31	**2.44**	**3.54**	**4.92**	**2.40**	**3.65**	**.74**	**25**
Inshore, Invertebrates and Seaweeds:								
Federal	2.13	1.50	.63	.50	.12	.12	+	5
Provincial	2.00	1.25	–	.50	.25	1.00	+	5
University	1.00	.50	–	.12	.13	.25	–	2
Industry	1.12	.38	–	1.12	–	.38	+	3
	6.25	**3.63**	**.63**	**2.24**	**.50**	**1.75**	+	**15**
Pelagic and Groundfish:								
Federal	7.70	.55	6.05	6.05	.55	1.10	+	22
Provincial	–	–	–	–	–	–	–	0
University	.25	.12	.25	.12	.13	.13	–	1
Industry	–	1.25	.42	2.08	–	1.25	–	5
	7.95	**1.92**	**6.72**	**8.25**	**.68**	**2.48**	+	**28**
Total	**29.96**	**12.54**	**15.49**	**18.66**	**8.03**	**12.58**	**2.74**	**100**
Present	(52)	(16)	(7)	(22)	(1)	(1)	(+)	

V.4). In the preparation of Tables V.5 and V.6, we made a breakdown of specific areas to show the extent that various sectors might be represented in the specific areas of activity. The proposed redistribution of scientific effort would represent dramatic changes in emphasis; such changes would be consistent with the need for strengthening socio-economic and environmental areas of the two fields.

The proposed strengthening of the freshwater sector from 16 to 32 per cent of total expenditures is based on the anticipated increase of scientific activities as appreciation of recreational values grows and as studies associated with the maintenance of a quality environment are intensified. In wildlife a major area of need is associated with animals in urban environments, and we suggest that 10 per cent of total expenditures should be associated with scientific activities in densely populated areas. In this sector we also suggest that the forest industries should make a considerable contribution –this is represented by the 5 per cent shown under native forage and wildland in Table V.4. The maintenance of a high level of expenditures on anadromous fish is based on the anticipated needs in this area associated with:

a) the demands on water resources for energy sources and for other purposes;

b) continuing high commercial value of the resource; and

c) increasing recreational values.

V.3 Jurisdictional and Organizational Complexities

The introductory review on the development of jurisdictional responsibilities in Canada for fish and wildlife brought out that an apparently simply system (i.e. federal government had clear jurisdiction over fisheries while provincial governments took over wildlife on a local basis), was gradually modified by jurisdictional interpretations by the assumption of treaty responsibilities and by administrative decisions. Eventually both fields contained considerable areas of divided responsibility.

In fisheries, the major area of divided responsibility was with the inland, or freshwater, fishery. Many potential problems have been avoided by the federal government's decision to allow provinces to administer their fisheries if they wished to do so. Also, long-standing federal-provincial committees (Atlantic Provinces, Quebec, Ontario, Prairies and British Columbia) provide the opportunity for discussion and resolution of problems. Although aligned on a regional rather than on a national basis, these committees have served as the counterpart to the Federal-Provincial Wildlife Conference.

The unrealistic combination of *de jure* status and *de facto* administration of the inland fishery is, however, cumbersome.[1] An example is that provincial fisheries regulations must be enacted by the federal government. A logical step would be to transfer jurisdiction of freshwater fisheries to the provinces by amending the BNA Act. It would not necessarily influence the role of a federal research agency since the Canada Forestry Act clearly established the principle that the conduct of research on resource questions is not strictly a matter of provincial or federal responsibility.

The acceptance of partial or complete responsibility for the administration of the inland fishery by some provinces has resulted in inequities in the distribution of federal support of research, management and development. The Department of Fisheries and Forestry assumes complete responsibility for fisheries in the Atlantic Provinces, does some research in the Prairie Provinces, but does not participate in any way in Quebec, Ontario or in the inland waters of British Columbia. Except for industrial development, federal support is normally in the form of "doing the work". This is at variance with federal policy on forestry and agri-

[1]Munro, D.A. Legislative and administrative limitations on wildlife management. Resources for Tomorrow Conference, Vol. 2. 1961.

Table V.6–Distribution of Scientific Effort Applied to Wildlife Resources Proposed for 1990, by Subject Area, Geographic Problem Area and Sector of Performance

Problem Area	Bio-Science	Chemistry (Biocides)	Environment Habitat and Land Use	Engineering	Sociology	Economics	Statistics	Total
Wetlands:								
Federal	5.50	1.00	2.00	1.00	1.00	2.00	1.00	14
Provincial	1.00	.50	1.00	.50	.50	1.00	.50	5
University	1.00	.13	.62	.13	.12	1.00	–	3
Industry	.50	.50	.50	.25	.25	–	–	2
	8.00	**2.13**	**4.62**	**1.88**	**1.87**	**4.00**	**1.50**	**24**
Improved Forage and Cropland:								
Federal	1.00	2.00	2.00	.13	.37	.50	1.00	7
Provincial	8.00	3.00	3.00	.25	1.00	1.75	3.00	20
University	1.00	.25	.25	.12	.38	1.00	–	3
Industry	.25	.25	.25	–	.75	.50	–	2
	10.25	**5.50**	**5.50**	**.50**	**2.50**	**3.75**	**4.00**	**32**
Native Forage and Wildland:								
Federal	2.00	2.00	1.00	.25	.25	1.00	.50	7
Provincial	8.00	4.75	4.00	.25	1.00	1.00	1.00	20
University	1.00	1.00	.50	.13	.12	.25	–	3
Industry	1.00	.75	1.00	.25	1.00	1.00	–	5
	12.00	**8.50**	**6.50**	**.88**	**2.37**	**3.25**	**1.50**	**35**
Urban:								
Federal	.25	.25	.75	.25	.25	.25	–	2
Provincial	.50	.50	.50	.50	.25	.25	.50	3
University	.50	.50	.50	.50	.50	.50	–	3
Industry	.25	.25	.25	.25	–	–	–	1
	1.50	**1.50**	**2.00**	**1.50**	**1.00**	**1.00**	**.50**	**9**
Total	**31.75**	**17.63**	**18.62**	**4.76**	**7.74**	**12.00**	**7.50**	
Present	(93)[1]	(3)	–	–	–	–	(4)	

[1]Includes environment, habitat and land use studies.

culture where many programs conducted by the provinces receive federal support. In the latter case federal support has contributed to the increasing expertise at the provincial level.

The Resource Development Service of the Department of Fisheries and Forestry has considerable engineering strength. The expertise in this area has been used in development projects such as the removal of barriers in salmon rivers, the stabilization of the seasonal flow of rivers and the construction of spawning channels. With the withdrawal of the federal government from inland fisheries this expertise became concentrated in coastal areas. Yet no province has developed comparable strength in this field. It has been suggested that spawning channels might play a role in the development of the kokanee fishery in the Great Lakes. Potential opportunity for such development appears to exist along the Ontario side of Lake Huron. It is unfortunate that the best expertise cannot be used for such inland projects.

In the marine fishery, complexities exist as a result of the interaction of many countries in some important international fishing waters (Chapter VI). A further complication arose when the federal government agreed that Quebec assume administrative control over the marine fishery of the province. The wisdom of that agreement, considering the complexity it introduced to the regulation and management of fisheries in the Gulf of St. Lawrence, is open to question and should be reconsidered since there is now a need to manage the Gulf fisheries on a unitary basis. At the time the delegation of authority took place, the Quebec fishery was essentially an inshore fishery conducted by small boats; however, now boats from the five provinces bordering on the Gulf are found fishing in the same areas. In addition, a considerable need exists to regulate some of the fisheries, e.g. herring and queen crab, on the basis of quotas. This could be done more effectively by a single administration. It would also appear logical for Quebec to withdraw from research on the marine fishery. It appears to us that the research effort in the marine fishery in Quebec has been afflicted by many of the problems that beset organizations too small to be truly viable and which, as a result, have great problems in securing and retaining qualified staff and in developing and completing worthwhile research programs.[1]

In wildlife, migratory waterfowl constitutes the only important area of divided jurisdictional responsibility. Because of their retention of the property rights relating to migratory birds, the provinces retained some responsibility for their management. For many years, however, the provinces did not participate in research or management programs. During this decade there has been a decided trend among the provinces to reverse this tendency. This trend, combined with a greatly increased level of activity, has resulted in areas of overlap and of at least potential competition between agencies. In Ontario, for example, both the Canadian Wildlife Service and the Fish and Wildlife Branch of the Ontario Department of Lands and Forests are engaged in acquiring waterfowl habitat and presumably will duplicate efforts in managing them.

In the interests of efficiency and of maintaining harmonious relationships between the Canadian Wildlife Service and provincial wildlife agencies, it is vital that detailed consideration be given to co-ordination of efforts. It seems to us that one of the most logical places to start is in the area of habitat acquisition and management.

A statement made in the House of Commons on April 6, 1966, by the Honourable A. Laing dealt with migratory birds. One section referred to the main-

[1]An imaginative program of research for the Gulf of St. Lawrence has been proposed: Le Groupe de Travail en biologie des pêches de Grande-Rivière, 1966. (La recherche en biologie des pêches en Gaspésie et aux Iles de la Madeleine. Actualité Marines, Vol. 10, Nos. 1, 2 and 3.) However, there is little evidence that it is being undertaken by the province.

tenance and management of migratory bird habitat and stated an important principle:

"Agreements may be concluded with provinces desiring to participate in acquisition or management of habitat, the terms of agreement to be compatible with the national objective of maintaining desired populations and distribution of migratory birds and to provide security for the federal investment."[1]

Although this seems to establish clearly the federal intent, or at least willingness, to enter into agreements with the provinces regarding the acquisition and management of habitat, there is considerable evidence to suggest that no serious attempt has been made to make management of habitat clearly a provincial responsibility. Considering the property right of the provinces in both land and migratory birds, it should be.

A second area of complexity related to wildlife exists between the federal government and the Yukon and Northwest Territories Councils. The "National Wildlife Policy" contains a major section on territorial wildlife which states the basic principle of the interrelationship:

"The federal responsibility for territorial wildlife is to provide research support for management services as may be agreed upon between the Federal and Territorial governments, except that there is complete federal responsibility for migratory birds. There is also residual authority that may be exercised to safeguard species in danger of extinction."[2]

This basic arrangement has been in existence since the role of the Wildlife Service was established in the late 1940s; however, the Northwest Territories Council in particular has not had much sympathy for management recommendations made by the Wildlife Service and it appears that the majority have been disregarded.[3] In other instances, regulations appear to have been made on wildlife matters without reference to the advisory role of the Wildlife Service.

A recent example of this type of action is found in proposed regulations which will effectively permit market hunting of caribou by residents of the Northwest Territories who hold Resident Hunting Licenses.[4] The history of the decline of caribou herds in the Territories, documented by Kelsall[5] and Symington[6], raises many questions about the ability of the caribou to withstand the additional stress of commercial hunting at present. Since the future of caribou is uncertain and since they migrate into Manitoba and Saskatchewan, very close co-ordination of the federal and territorial functions was warranted, but it appears was not forthcoming.

The Yukon and the Northwest Territories are important frontiers of the country. It is essential that national as well as territorial interests be reflected in wildlife research and management programs. For this reason, there should be continuing programs of research by the federal agencies throughout the Territories. Because of the nature and cost of operations, it also seems desirable that the Canadian Wildlife Service provide the research support required as background to establishing allowable kills of big-game species in the Territories.

In view of the problems that have developed between the Canadian Wildlife Service and the Territorial Councils, the *modus operandi* of federal-territorial interrelationships on wildlife questions

[1]Laing, Hon. Arthur. Canada's national wildlife policy and program. Hansard, April 6, 1966.

[2]Laing, *op. cit.*

[3]We held discussions with a number of individuals on this topic and we attempted to gain more understanding of it through a study of pertinent documents in the files of the Department of Indian Affairs and Northern Development. However, we were not permitted to examine them.

[4]*See* Record of 36, 37, 38, 39 Sessions of the Northwest Territories Council.

[5]Kelsall, J.P. The migratory barren-ground caribou of Canada. Ottawa, Queen's Printer, 1968.

[6]Symington, F. Tuktu. Ottawa, Queen's Printer, 1965.

should be subjected to immediate study. It should be followed by decisions on the various aspects of administrative arrangements. 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 partisan rivalries and of managing wildlife in a way that would be compatible with both national and territorial interests.

V.4 On Effective Organizational Structures

Canadian authorities have not yet reached agreement on the type of organizational structure that will be most effective in relating the functions of research, management, development and administration in natural resource agencies. The subject was discussed in some detail by Munro at the Resources for Tomorrow Conference in 1961.[1]

Although Munro pointed out the difficulties of making an objective evaluation of the merits of line and staff organizations because of the relative abilities of personnel, he did state some of the advantages and disadvantages of the two types of organization.

"The sort of field work which a game agency must carry out–enforcement of game laws, extension work with trappers, making censuses of fish and wildlife, are but a few examples–certainly calls for specialists, persons suited by aptitude and training to their work. It is also true that if field work in the fish and game field is to be carried on effectively it should be able to compete effectively with the administrative demands of other resources for man-power and equipment. These would seem to be good arguments for a line organization providing for full-time, trained fish and wildlife officers at the field level.

"On the other hand, it is equally obvious that there are benefits to be derived from close association between fish and wildlife administration and the administration of other renewable resources, particularly at the regional and central office level. Such association will not be of much benefit unless the various resources are represented by officials of equivalent status. Some provinces have organizations which provide for this in part. While provision for integration of administration of all renewable resources is desirable up to a point, it should not extend to the point where senior game officials, specialists in the problem of game administration, are hampered in the exercise of effective supervision over fish and game field staff."[2]

These remarks reflect the uncertainty about the type of organization which can be most effective in promoting the application of science to the management of resources. However, at the end of our six-week tour, we were deeply impressed with the extent to which administrative "hang-ups" are limiting the application of knowledge to the management and development of resources.

The maintenance of a close relationship between research, management and development functions is imperative. However, there is little evidence that fish and wildlife agencies have yet considered it important. It is also apparent that some organizational schemes, which appear ideal from an administrative point of view, may limit effective communication between individuals and agencies in different functional capacities. Some examples might serve to illustrate the lack of co-operation and the need for closer relations.

There are also organizational anomalies which do little to increase co-operation between the Fisheries Research Board and the Services of the Department of Fisheries and Forestry. Activities of the Fisheries Research Board in various

[1]Wildlife Workshop B. Resources for Tomorrow Conference, Vol. 3, pp. 121-126; and Munro, *op. cit.*
[2]Munro, *op. cit.*

regions are developed, at least in part, as a result of recommendations made by regional advisory committees. But these advisory groups do not serve the same function to the Development Services nor do any members of the Services sit as members of any of the advisory boards.

Other examples can be drawn from the provincial level. The Ontario Department of Lands and Forests is a multi-resource agency which is decentralized. Decentralization has been gradual and is still proceeding at the district level where personnel in all branches are being brought under subdistricts called "Chief Ranger Divisions". There is much difference of opinion among fishery and wildlife specialists about whether decentralization resulted in a reasonable level of efficiency in the integration of scientific activities. This uncertainty can be illustrated with the following example.

In the case of the Great Lakes, there are four research units which have line relationships with head office. On the management side, there are a number of staff specialists, but at the field level, management activities are undertaken by biologists whose supervisors report to the district forester.

It has been evident that there are many difficulties in developing satisfactory communication between research and management and even between management specialists at head office and in the districts. It has, for example, been difficult to get similar work, such as lake surveys and sampling of fish catches, done with enough uniformity so that the results are readily comparable from district to district.

To promote better management programs, a number of fishery management units have been established to deal with important fisheries on major lakes including the Great Lakes. However, problems in making decentralization work are still evident when the Great Lakes are being considered.

The Lake Huron Unit will probably be associated with the Parry Sound Forest District; however, Lake Huron borders on five different forest districts. To co-ordinate activities, say, in obtaining catch statistics, the unit leader will have to stimulate the interest of and invite assistance, through the district foresters, from the fish and wildlife staff of all the districts. To obtain usable data, he will also have to ensure that methodology and levels of sampling are comparable throughout. Some argue strongly that it is virtually impossible in such a situation to overcome all obstacles and that the fishery units, at least in the case of the Great Lakes, should have a line relationship with the central office of the Fish and Wildlife Branch.

There are two notable cases of successful interdepartmental relationships. The first concerns the Department of Fisheries and Forestry.

The International Fisheries Service is a relatively small agency which serves an important role in negotiating regulations for international fisheries and marine mammals. Its director serves on some of the commissions established to implement the provisions and attends the meetings of the various commissions. He is generally accompanied by scientific advisers from the Fisheries Research Board, who are usually key investigators on species to be discussed at the meetings. Members of the Fisheries Research Board frequently present background papers and serve on working committees which develop recommendations for consideration.

The teamwork of the International Service and the Fisheries Research Board is respected by commissions around the world. The arrangement between the two organizations appears to be very effective and would be difficult to improve. In considering the success of the relationship, two factors seem to stand out. There is a personality factor in that the present director is a former member of the Fisheries Research Board and has a high regard for it. Secondly, the International Service is small and is located at headquarters.

The second successful case concerns

the Wildlife Division of the Department of Agriculture, Mines and Resources of Newfoundland. This Department undertook wildlife research in 1950, and since that time, has been the most productive provincial wildlife agency in the publication of scientific papers. It has also been very productive in implementing its research through management and development programs. Its achievements have included restoration of caribou and beaver in a number of areas where they had been extirpated, the establishment of moose in southern Labrador, management of ptarmigan on the basis of the status of the population, and the use of intensive, local predator control programs to limit lynx where they were restricting the survival of caribou calves. Few provinces have approached Newfoundland's record of accomplishments.

Although it is difficult to evaluate the interacting factors which produce a successful unit, both examples have common features. The International Fisheries Service and the Wildlife Division in Newfoundland are relatively small organizations. Both have had excellent leadership and personnel. Both have well-defined missions and know that the "buck stops" in their division.

Large, and particularly multidisciplinary or multi-resource branches or departments, need a much more thorough study of organization to render management more effective.

A thoughtful attempt to break down the barriers that exist between functional units and between specific resource areas within a multi-resource organization is being made by the Department of Mines and Natural Resources in Manitoba. It appears to be the first concerted effort to develop an approach and a plan for integrated resource management in Canada. The philosophy of the scheme is to develop an organization which will bring about the integration of the use of resources, while at the same time, establish workable relationships between functional areas. It is being adopted as a pilot-plan approach and warrants close examination by resource agencies throughout the country.

V.4.1 Personnel, Job Specifications and Performance Evaluation

As the number of scientists increases, a substantial amount of literature is developing on the management of scientific personnel. To review the whole subject is beyond the scope of this report, but it is relevant to discuss one of the major problems that commonly develops in government laboratories.

As an employer of scientists, government commonly seeks to achieve "mission-oriented" objectives. The appropriate employee is an informed expert concerned with solving problems that may be relatively straightforward in concept. By contrast, the young scientist, fresh from university, is often motivated by the desire to make a name for himself in his discipline. He may seek the maximum opportunity to do research, become a leader in his field *and to publish.* Thus a common "situation" in government laboratories is created in which the opposing selfish interests of employer and employee are not in harmony. At its worst, a charade is conducted in which the scientist pretends to be doing "mission-oriented" work by constructing a plausible link between what he is doing and some area of government concern (say pollution), and his administrators pretend to believe him and convey the myth to senior levels and the public. At its best, the scientist makes a genuine attempt to be both a scientist and a professional and his administrators try to encourage him to do so. This situation is perpetrated through typically ambiguous and vague definitions of responsibilities and assessment of performance. If a man does his work with vigour and vitality, then he has greater opportunity for promotion, regardless of whether his work is relevant to the problem that prompted his hiring.

If clear definitions of responsibilities accompanied by specific job titles were

established by employers, universities might produce a more heterogeneous product than their present basic-research-oriented graduates. We feel five kinds of jobs are usually involved:

1. Resource managers: to collect and analyse statistics, perform public relations functions, prepare information for external use.

2. Resource management scientists: to supervise large-scale management programs, be responsible for the analysis of information as well as the scientific activities related to inter- or intra-disciplinary negotiations (i.e. international commissions or multi-resource programs).

3. Applied scientists: to solve specific and often urgent problems either alone or by being part of small task forces which might be multidisciplinary (e.g. determine cause of mortality, and develop a particular pollution abatement procedure).

4. Research scientists: to embark on research programs concerning major biological questions which might be uncovered by applied scientists. These programs may, in the long run, be valuable both to employer and to those in other areas of biological research.

5. Government research professorships: to experiment with new procedures or to recast thinking in strikingly new ways without restraint.

A scheme such as the above would realistically recognize the variety of jobs that are done by government scientists. It would allow employees to know what was expected of them. It would make evaluation of their performance far more straightforward than it presently is.

V.4.2 Integration of Resource Organizations

It was pointed out that the provinces have moved much more rapidly than the federal government in the development of integrated renewable resource departments. In 1968, fisheries and forestry were brought together under a single department; however, National Parks and Wildlife and Water Resources, which frequently occur under the same roof, still exist in two different departments (Department of Indian Affairs and Northern Development and Department of Energy, Mines and Resources). The Royal Commission on Government Organization recommended that: "The Wildlife Service, with the addition of the Zoology Unit from the National Museum, be transferred to the Department of Fisheries".[1] It did not, however, make any other recommendation that would have resulted in a single Department of Renewable Resources, which many resource scientists consider to be a desirable development.

There seems to be only one major reservation about the desirability of large multi-resource departments. While recognizing the advantage for co-ordination of activity between the basic resource groups, many argue that wildlife interests, which represent an area where conservation aspects often appear to be anti-progress, should have direct Cabinet representation.

There is a need for integration and co-ordination of activities in areas where common interests are involved, and for communication and direct interaction when one resource impinges on others. **We conclude that any advantages of direct Cabinet representation of wildlife interests are counterbalanced by the need to have a strong multi-resource department whose minister is among the leaders in Cabinet.** We consider this is the best possibility of achieving integrated resource programs in either federal or provincial governments.

Report No. 4 of the Science Council laid "...stress on the value of comprehensive mission-oriented programs as necessary parts of the development of Canadian science".[2] A great deal of sympathy to this concept was expressed to

[1]The Royal Commission on Government Organization. Scientific Research and Development, Report 13, Volume 4. Ottawa, Queen's Printer, 1963.

[2]Science Council of Canada. Towards a national science policy for Canada. Report No. 4. Ottawa, Queen's Printer, 1969.

us during the study tour, and we directed our thinking to how mission-oriented programs can best be achieved. We concluded that many fisheries and wildlife programs conducted by government agencies reflect to too strong a degree the personal inclination of the principal investigators. The need to ensure that programs are responsive to the needs of society justifies a wider use of advisory boards which recommend desirable programs and evaluate programs. We suggest that such boards require the services of full-time staff to aid in the evaluative function; we consider that their staffs should comprise individuals who are appointed for limited periods, possibly in many cases as a result of secondment from other organizations.

On the wildlife and forestry side, both the Canadian Wildlife Service and the various forestry branches of Fisheries and Forestry are deeply involved in considering research and (or) management programs for resources over which they have no proprietary right. The existence of such situations indicates the need to find ways in which the development of programs can be influenced by the proprietary agencies and by the interest of the public at large. An extension of the use of advisory boards could conceivably meet this need. In unified Departments of Renewable Resources it would be possible to develop advisory boards, and their supporting staff, in ways which would contribute to the integration of programs and to more effective communication between resource scientists.[1]

V.5 The Statutory Basis of Wildlife Activities

In a paper prepared for the Resources for Tomorrow Conference, W.W. Mair suggested that:

"Data on revenue and expenditure of game administration...suggest that, in financing sport fish and wildlife management, it is common practice to strike a rough balance between direct revenue and expenditure. This practice fails completely to recognize the actual contribution of the resource to the economy, and the stake of every citizen in it. It places the burden almost entirely upon the *special users* who represent less than 20 per cent of the Canadian population. It fails also to direct proportionately to the resource the taxes paid by those whose businesses depend on it. As a consequence management of sport fish and wildlife receives inadequate financial support."[2]

Mair made three proposals for policy consideration:

1. Programs to support non-consumptive uses of wildlife should be financed from general revenue.
2. Programs to support consumptive uses of wildlife should be financed through taxes on special users and persons who benefit directly therefrom.
3. In recognition of national interests and direct legislative responsibilities, the federal government should contribute to the support of wildlife management.

Mair's statement on the balance of revenue and expenditures in provincial game agencies is still applicable in 1969; it indicates that provincial legislators do not recognize the non-consumptive values of fisheries and wildlife.

In the United States, funds for state fish and wildlife agencies come almost entirely from two sources. The first is earmarked funds derived from licence revenue which provides a financial base, roughly equivalent to that of our Canadian system. The second source is from federal support programs, the funds for which are collected from surtaxes on arms, ammunition and fishing tackle. The federal support has had a strong influence on the development of research, management and development programs

[1]The proposal for a Natural Resources Council, which was made by the Agricultural Study Group, evokes sympathy with us. It would not need to conflict with an expanded Department of Renewable Resources or with the greater use of advisory boards.

[2]Mair, W.W. Elements of a wildlife policy. Resources for Tomorrow Conference, Vol. 2. 1961.

and on the acquisition of habitat for management activities of various kinds.

Since the end of World War II, there have been several proposals that the federal government should accept a broader responsibility for wildlife research in Canada. The first was made at the National Conference on Reconstruction in 1945 when the establishment of a wildlife research board with associated research stations was recommended by the wildlife section of the resource subcommittee. Ten years later, in 1955, and for a number of years subsequently, the Federal-Provincial Wildlife Conference passed a recommendation urging federal assistance to provinces "in wildlife research and other activities". The recommendation suggested that the assistance should be given on the same basis as that given in forestry, fisheries and agriculture.[1] The reference to forestry was indicative of the feelings of wildlife specialists who generally considered that national interests in wildlife should be recognized in a *Canada Wildlife Act*, just as they had been recognized in forestry through the *Canada Forestry Act* passed by Parliament in 1949. They considered that the passage of that Act established a precedent for similar action in the wildlife sphere, since Section 92 (5) of the BNA Act had clearly established that the management and sale of forests was the exclusive right of provincial governments yet, in the national interest, the federal government assumed a broad initiative in research and in supporting national forestry programs.

In 1961 specific recommendations for the enactment of a Canada Wildlife Act were made to the Steering Committee for the Resources for Tomorrow Conference. It was worded as follows:

"It is recommended that: a Canada Wildlife Act, comparable to the Canada 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 these purposes."[2]

That recommendation does not require rewording. In terms of the national interest, the statutory basis for participation in wildlife is much too narrow. A broadening of the base is an urgent requirement and very important to the development of scientific activity in wildlife in Canada.

With regard to resource planning, wildlife scientists have recognized the potential value of the Canada Land Inventory supported through the Agricultural and Rural Development Act (ARDA). It has represented a unique form of federal support to resources planning. The principle of that program should be studied in detail to determine if there are other ways it can be applied in the future to assist in establishing a national framework for planning, managing and developing Canada's resources.

V.6 As Things Are– As They Might Be

Jurisdiction and administration of fisheries and wildlife is characterized by divided responsibilities and *ad hoc* arrangements arising from sometime convenience. This sentence, adapted from the opening quotation of this chapter, describes the Canadian way of overseeing resources. We discussed how this situation developed, reviewed present organizations and the way that manpower and expenditures used in scientific activities are distributed among governments and private organizations. While recognizing that there are some advantages in having different resource areas represented by separate ministers of government, we suggest that integrated agencies offer the

[1]Thorpe, F.J. Historical perspective on the Resources for Tomorrow Conference. Vol. I. 1961.

[2]Joint Meeting, Wildlife Workshops A and B. Resources for Tomorrow Conference, Vol. 3. Ottawa, Queen's Printer, 1962.

best possibility of achieving integrated resource management–a pressing demand on our time. Existing Canadian agencies offered us a wide opportunity to draw comparisons, and as a result of observation and discussion, we consider that the interrelationships of research and management within and between agencies, the effective use of advisory boards, the development of task forces to provide a rapid overview of problem situations, the development of resource philosophies rather than disciplinary jealousies, the provision of joint services and the regulation of the use of chemicals in the environment, all work out better over the long-term when integration exists. As a result, we suggest that fisheries, forestry, parks, recreation, and wildlife should occur within the same department of government.

We are concerned about the problem of wildlife management in the Yukon and Northwest Territories; we do not feel that present arrangements are satisfactory. We believe that some method of management which adequately reflects national and territorial interests should be developed. We suggest that a Wildlife Management Commission might be worthy of consideration; on further reflection we have wondered if it should not be a Fisheries and Wildlife Commission. In fisheries, we consider that the "one-time" convenience of Quebec's having jurisdiction over marine fisheries in parts of the Gulf of St. Lawrence is no longer a satisfactory arrangement, and we suggest that responsibility be returned to the federal government. On the other hand, we consider that the *de facto* jurisdiction of the provinces over freshwater fisheries should be made *de jure* by an amendment of the BNA Act.

Our review of the distribution of expenditures leads us to believe that proportionately greater amounts should be spent on freshwater fisheries and wildlife. We have gone into some detail in a tabular breakdown to show how this might be accomplished. It has long been argued that the common-property nature of fisheries is the factor that discouraged participation of industry in scientific activities. However, we consider that this argument has many weaknesses; it cannot be argued very logically, for example, in the case of product research, an area in which industry should play a much greater role. Elsewhere (Chapter VII) we suggest consideration of an industry-supported institute, similar in concept to the Pulp and Paper Research Institute of Canada, as a means by which industry could assume a significant role in the scientific area. We reviewed in some detail the statutory basis for wildlife management in Canada, and we suggest that a pressing need exists for a *Canada Wildlife Act* which would recognize national interest in wildlife resources, just as the *Canada Forestry Act* recognized national interest in forestry. This proposal also relates to one made in Chapter VI, where we suggest that migratory birds should be recognized as primarily an area of national concern by an amendment of the BNA Act.

At the level of agencies and individuals, we suggest that the use of advisory boards should be developed to a greater extent by government agencies. These boards could work more effectively if they have full-time supporting staff to assist them, but we propose that such staff would serve for limited periods and would be obtained by secondment or simply through contractual arrangements. We consider that clearer definition of the responsibilities of individual scientists could be obtained through more specific job titles. We suggest five classes which seem to describe the kinds of jobs most commonly involved in the research-management complex that exists in resource departments.

Chapter VI

Organization to Manage International Resources

VI.1 Focus on International Questions

"The principal commercial fisheries in Canada are found along the seacoasts... in many instances,...resources harvested by Canadian fishermen in or out of Canadian territorial waters are also exploited by fishermen of other countries in the high seas adjacent to Canadian territorial waters. In such instances, regulation for conservation purposes would be difficult to undertake without the agreement and cooperation of the countries to which the fishermen belong.

"The same problem exists in the inland boundary waters between Canada and the United States, for instance, in the Great Lakes region....

"To meet the problems of conservation in these fisheries, a number of treaties have been negotiated with those countries interested in participating in these particular fisheries."[1]

Fisheries and wildlife programs are characterized by a marked involvement in international arrangements for the regulation and use of the resources. Therefore, a great many complexities and problems are introduced which do not arise in other resource fields (e.g. forestry, where the provinces hold clear priority rights to the resource).

Examples of fisheries requiring international legislation are those for the several species of groundfish on which the commercial fishery of the Atlantic coast is based. These species, including cod, haddock, redfish, etc., roam over wide areas of the ocean in the territorial waters of Canada, as well as hundreds of miles to the edge of the continental shelf. They have been exploited for several centuries by fishermen from Europe, as well as from North America. Similarly, the fishery resources on the Pacific coast of Canada, on which the Canadian industry depends, are accessible to foreign fishermen beyond Canadian territorial waters. A similar situation exists in the inland boundary waters between Canada and the United States; for example, in the Great Lakes region. Finally, seals, whales and migratory birds either live entirely in international waters or travel back and forth across international boundaries and so also require consideration.

VI.2 Canada's International Commitments

The complexities introduced by international conventions do not apply simply to the regulation and management of the resource, but also have a profound effect on the nature of research programs and on expenditures for research. For example, in 1952, Canada, Japan and the United States signed the International Convention for the High Seas Fisheries. The Convention contains a formula, known as *the abstention principle*, which reserves the harvesting of marine resources to the nations who have contributed to their development and maintenance. The workings of the principle were described in one of the background papers of the Resources for Tomorrow Conference:

"The essence of the abstention principle is that where a stock of fish is being fully utilized and is under such scientific investigation, management and regulation as is required to make possible the maximum sustainable yield, then States, whose nationals have not in the past participated in the fishery, shall abstain from fishing the stock.

"To determine whether any stock qualifies for abstention, a commission, composed of four representatives from each contracting government, reviews on an annual basis the fisheries involved and makes recommendations to the contracting governments accordingly.

"The commission may also recommend to any of the contracting parties joint conservation measures in regard to any stock of fish in the North Pacific

[1]Ozere, S.V. Survey of legislation and treaties affecting fisheries. Resources for Tomorrow Conference, Vol. 2. 1961.

Ocean and Bering Sea, which is under substantial exploitation by two or more of the contracting parties."[1]

The determination of whether or not "any stock qualifies for abstention" requires a great deal of research to determine the status and population dynamics of the stock. In addition, there must be long-term continuous research programs to determine the measures needed to conserve fish stocks and (or) to determine the levels of exploitation that can be tolerated by a particular stock.

The scientific investigations to meet Canada's commitments to the International North Pacific Fisheries Commission and to the International Commission for the Northwest Atlantic Fisheries are largely conducted by the Stations at Nanaimo, St. John's, Newfoundland and St. Andrews, New Brunswick. These investigations are expensive because they require ships that can operate far out at sea and sophisticated laboratories ashore. They also pose problems to the development of cost-benefit evaluations of research since much of the benefit relates to maintaining Canada's international prestige and to retaining our right to marine resources for the future.

Canada is a signatory to eleven treaties which relate to fishery and wildlife resources. Six deal entirely with fisheries, one deals with fisheries and wildlife (seals), three deal with wildlife (fur seals, whales and migratory birds), and one deals with research and investigations on the living resources of the Atlantic Ocean and adjacent seas.

Legislation to enable Canada to implement the various conventions is usually contained in special acts. In cases where there is no special act, all the powers required to give effect to the terms of a convention are contained in existing Canadian legislation, such as the Fisheries Act.

Nine international commissions and one international council involved with marine resources have been established under the provisions of formal conventions. Generally these commissions are responsible for compiling scientific data on which to base recommendations to the member governments or on management of specific resources in specific areas of the world. A senior official of the Department of Fisheries and Forestry serves on the executive body of each organization. Only three of the ten organizations employ scientific staff to undertake investigations; in all other cases the organizations merely plan and co-ordinate scientific work which is cooperatively undertaken by the appropriate national scientific bodies.

The Migratory Birds Convention, which will be discussed in detail later, does not have a commission to implement the provisions of the treaty. However, in 1961, an International Technical Committee was established by Canada and the United States: "...to review problems of common concern in respect of migratory birds, particularly populations of ducks that breed in Canada and winter in the United States."

Table VI.1 summarizes the number of member nations included in each of the international organizations, the number of staff involved in carrying out the work, the total 1969-70 budget of each organization and the Canadian share of the budget.

The relative effectiveness and efficiency of the two types of commission, those which conduct their own research programs and those which have supporting research conducted by member nations, warrants consideration. We were not, however, capable of making an evaluation and could not find any evidence that such evaluations have ever been attempted. We consider that they should be undertaken. Canada played a major role in promoting the concept, adopted in the post-war conventions, of member nations conducting the supporting research programs. Canada could well take the initiative in promoting an evaluation of the effectiveness of that approach. An

[1]Ozere, S.V., *op. cit.*

Table VI.1–International Fisheries and Wildlife Organizations in which Canada Maintains Membership

Name and Date Treaty First Signed	No. of Member Nations	Current No. of Staff	Budget 1969-70	Canadian Share of Budget
			dollars	dollars
International Whaling Commission (1946)	16	2 part-time	5 600	350
North Pacific Fur Seal Commission (1911)	4	1 plus part-time assistance	16 000 (U.S.)	4 000 (U.S.)
International North Pacific Fisheries Commission (1952)	3	3 plus part-time assistance	72 000 (Can.)	24 000 (Can.)
International Commission for the Northwest Atlantic Fisheries (1949)	14	6 plus part-time assistance	107 700 (Can.)	10 500 (Can.)
Inter-American Tropical Tuna Commission	5	29 plus seasonals	564 735 (U.S.)	4 800 (U.S.)
Great Lakes Fishery Commission (1954)	2	4	1 510 000 (U.S.)	480 000 (U.S.)
International Pacific Salmon Fisheries Commission (1930-1937)	2	49 plus 20 seasonal	841 400 (Can.)	420 700 (Can.)
International Pacific Halibut Commission (1923)	2	22 plus 25 seasonal	504 000 (U.S.)	252 000 (U.S.)
Atlantic Tuna Commission (1968)	17 signatures (organizational meeting to be held in December, 1969)			
International Council for the Exploration of the Sea	17	13 plus part-time assistance	1 025 000 Danish Kroner	75 000 Danish Kroner
Migratory Birds Convention (1917)	2	no agency	Nil	Nil

evaluation would not be simple to make because it would involve the consideration of bilaterial versus multilateral conventions. A good place to start might be with a comparison of the effectiveness of the contemporary Great Lakes Fisheries Commission and two old-type organizations, the Pacific Halibut Commission and the International Pacific Salmon Fisheries Commission. The fact that they are all bilateral commissions would make the evaluation work easier. However, the solution of the many complexities involved could offer guidelines that might be applied to the more complex situation of the multilateral commissions.

VI.3 Effectiveness of International Management Programs

The signing of a treaty and the formation of an international commission does not ensure that the fish or wildlife species mentioned in the convention will never be endangered. The countries who sign conventions are as much, or more, concerned with gaining their share of the resource as they are in protecting it. The convention and the commission establish the framework in which nations can work to bring about a reasonable balance between exploitation and conservation; there are examples of both success and failure in achieving these dual goals.

An evaluation of international fisheries management was made by the Commission on Marine Science, Engineering and Resources, Washington, D.C., January, 1969. The report includes the following statement:

"Any international legal-political framework for exploiting the living resources of the oceans must be judged by the extent to which it achieves the following objectives:

"It must encourage the development of the vast food reserves of the sea at the lowest possible cost in order to combat world hunger and malnutrition.

"It must promote the orderly and economically efficient exploitation of these living resources, with adequate regard for their conservation.

"It must not provoke international conflict but rather contribute positively to international order, welfare, and equity.

"The Commission concludes that the existing framework is seriously deficient when judged by these standards."[1]

The Commission further contended that each coastal nation, unless limited by treaty, has the right of permanent, exclusive access to the living resources found in its internal or territorial waters and contiguous fishing zone, as recognized in international law. Yet this freedom to fish is beclouded by extravagant claims by a few nations with respect to the breadth of the territorial sea and exclusive fisheries zone. The freedom is also limited by bilateral and multilateral treaties and agreements, and is restricted by the coastal nation's right to exclusive access to the living, sedentary species on the continental shelf.

Several alternatives to the existing framework have been considered, but the Commission rejected them. These are:

"To give each coastal nation permanent exclusive access to the living resources of the waters superjacent to its Continental Shelf;

"To give the United Nations in the name of the international community, title to the living resources of the high seas beyond the 12-mile fisheries limit so that it may either operate the high seas fisheries itself or auction to the highest bidders exclusive right to exploit specified stocks of fish or specified areas of the high seas."[2]

It is interesting that the Commission concluded that United States objectives

[1]Commission on Marine Science, Engineering and Resources. Our nation and the sea. Washington, D.C., U.S. Government Printing Office, 1969.
[2]*Ibid.*

regarding the living resources of the high seas could best be obtained by improving and extending *existing* international arrangements. Although it rejected the idea that the United Nations be given title to the living resources of the high seas, its ideas about extending existing arrangements seemed to lead in that direction. A participant in the Law of the Sea Conference stated:

"...the Commission itself recommends that existing regional fishery organizations in the northwest Atlantic (ICNAF) and the northeast Atlantic (NEAFC) pool their competence, their geographical area of operation and their regulations for what it considers practical conservation and economic reasons. This pooling already involves eighteen to twenty important countries, a substantial fraction of the full international community. It may be that such an 'acceptable' suggestion by the Commission itself may have a 'spilling over' value that could lead to even greater consolidation."[1]

Similarly, referring to the two proposals that the Commission rejected, P.A. Larkin stated:

"It is most unfortunate that the Commission did not consider these and similar proposals at great length, even if only to shoot them down as impractical. In my view, there are variants of these schemes that might lead to a successful pattern in management of marine fisheries resources."[2]

The Commission also recommended that national catch quotas be established for the North Atlantic cod and haddock fisheries. It concluded that fixing national catch quotas is a promising way to improve the profitability of the operations of participating nations in certain important fishing areas of the world. It emphasized, however, that such a system should not be instituted immediately in every high seas fishery, but might be attempted first where it is most likely to succeed and where its effects could be assessed before it is more widely used. Further, the Commission recommended that the United States seek agreement in ICNAF to collaborate with NEAFC to which thirteen nations, but not the United States, belong. The reason is that adoption of national catch quotas for the ICNAF area alone could increase fishing pressure on the NEAFC area, which also faces a grave situation, and vice versa, thus nullifying any potential economic gain from national catch quotas for fleets operating in both areas. The Commission suggested, based on data from a study by the Organisation for Economic Co-operation and Development, that if steps are not taken to reduce the fishing effort in the North Atlantic, it may increase by as much as 15 to 30 per cent by 1970.

The idea of national catch quotas is not a new one. They have been used in a variety of forms by the United States and Canada in the regulation of Pacific salmon fisheries and between Canada, Japan, the U.S., and the U.S.S.R. in the management of fur seals in the North Pacific. They have not, however, ever been used to regulate the catch in any of the major fisheries where there is multinational participation. There even appears to be reluctance to introduce a quota system in the regulation of sealing off the coast of Newfoundland and Labrador (in the area referred to as the "Front") where Canada and Norway are the only participating nations.[3] Available data indicate that seals in this area have been overexploited for at least the past decade and more precise methods of regulating the kill are badly needed. The same thing appears to be true of some of the pelagic fisheries, and as mentioned in Chapter

[1]Kask, J.L. Review of international fisheries management. *In* Our nation and the sea. Chapter 4. Law of the Sea Conference. University of Rhode Island. Prepublication typescript. 1969.

[2]Larkin, P.A. Comments on international fisheries management. *In* Our nation and the sea. Chapter 4. Law of the Sea Conference. University of Rhode Island. Prepublication typescript. 1969.

[3]Sealing came under the jurisdiction of ICNAF in 1966 by the addition of a protocol to the convention.

IV, herring particularly appears to be in danger of being overexploited.[1] Although methods of regulating the catch of marine fish are required, some scientists doubt that national catch quotas can be achieved under existing arrangements.[2]

A pertinent recommendation of the Commission is that international fishery organizations should be strengthened. Many of the existing conventions do not encompass all the waters in which the resources in question are to be found. Further, they seek to regulate designated species of fish, while the increasing sophistication, range and flexibility of modern high seas fishing equipment tend to make species regulation unrealistic. Also, the existing conventions cover only a small part of the actual catch from the world fisheries, and even a smaller part of the potential catch.

The Commission recommended that one of the existing international organizations be entrusted with the tasks of:

1. Evaluating the operations of existing fisheries conventions,
2. Suggesting measures to improve and co-ordinate their activities, and
3. Recommending establishment of new conventions.

In view of the urgency of the need to maintain marine resources at a high level of productivity, Canada should consider joining with the United States to promote the international review proposed by the U.S. Commission on Marine Science, Engineering and Resources. Even though criticisms of a number of specific recommendations made by the Commission seem to be valid, it does not detract from the fact that an international review of arrangements is badly needed. It is possible that this decade of environmental awareness could give rise to serious, perhaps even less nationalistic, considerations of how world fisheries can best be managed. Canada could play an important role in promoting a review. It is in our, as well as in world, interest that the world fisheries be well-managed to maintain their productivity, qualitatively and quantitatively.

VI.4 The Migratory Birds Convention–A Special Problem

The Fathers of Confederation left a legacy of problems when they failed to include migratory birds in Section 91 of the BNA Act, which lists items under the exclusive Legislative Authority of the Parliament of Canada. The signing of the Migratory Birds Convention in 1916, and the subsequent enactment of the Migratory Birds Convention Act a year later, appeared to resolve the problem by making migratory birds a federal responsibility. However, changes in Canada's position in the Commonwealth (and consequently its position vis-à-vis foreign states) and subsequent judicial decisions have resulted in a situation in which it has apparently become impossible to modify the treaty without giving complete jurisdiction over the resource to the individual provinces. Many scientists believe that this would result in a chaotic situation in waterfowl management.

In 1916 when the Migratory Birds Convention was signed, Canada did not have treaty-making powers; consequently, the treaty was signed for Canada by the British Ambassador to Washington. Under the powers conveyed by Section 132 of the BNA Act, jurisdiction over migratory birds became the responsibility of the federal government. However, Section 132 specifically refers "...to the obligations of Canada or of any Province thereof as part of the British Empire, towards Foreign Countries, arising under Treaties between the Empire and such Foreign Countries". After the enactment of the *Statute of Westminster*, 1931, by which Canada acquired full treaty-making powers, a Supreme Court decision on a labour conventions case ruled several federal acts *ultra vires*. This ruling established the principle that while Canada could enter into conventions regarding matters which were within

[1]The history of herring fishery is discussed in more detail in Chapter IV.

[2]For example, see Kask and Larkin, *op. cit.*

the exclusive jurisdiction of the provinces, it could not enact legislation to implement such treaties.[1]

This decision meant that Section 132 applied only to treaties signed before the *Statute of Westminster* was passed and, hence, appeared to make it impossible to renegotiate the Migratory Birds Treaty without returning the jurisdiction to individual provinces. This interpretation was confirmed in an appeal against a conviction under the Migratory Birds Regulations where it was stated:

"There would seem to be no doubt that statutes which implement treaties made before the *Statute of Westminster* remain valid legislation even though the subject matter of the treaty is one which falls exclusively under Section 92, so long, of course, as those treaties have not been denounced."[2]

The Migratory Birds Convention and its enabling Act no longer provide an adequate basis for the management and protection of migratory birds. The Convention provides for the establishment of legislation which protects birds, but does not allow for the establishment of a commission with power to recommend on the regulation of the kill, to acquire habitat, or to transfer funds from one country or another. Nor does it make any provision for research or for an equitable distribution of the harvest between Canada and the United States. On this latter point, there is some disaffection in Canada over the fact that 80 per cent of the waterfowl are shot in the United States, while more than that are raised in Canada.[3]

There are a number of aspects of the treaty which are cited as being unreasonable from a Canadian point of view. For example:

1. It does not permit any open seasons on waterfowl before September 1; by that time many birds have left northern areas and some ducks, pintails in particular, may often have begun their migration and are in the United States.

2. It does not permit any legal hunting by Indians and Eskimos during the spring and summer.

3. It contains a classification of migratory game and migratory non-game birds under which it would be possible to establish hunting seasons on whooping cranes, but does not permit the establishment of regulations that permit Newfoundlanders to kill murres, or other seabirds, unless they are residents of a rural area and are in need of the murres for food.

4. It does not provide for protection of raptors even though some of these, such as peregrine falcons and bald eagles, have become endangered species.

5. It does not provide any means by which foreign governments can participate in payment for crop losses which occur in Canada as a result of waterfowl depredations.

The desirability of overcoming many of these problems by renegotiating the Migratory Birds Treaty has been subject to considerable debate during the past 15 years. The focus of discussion has been the International Association of Fish, Game and Conservation Commissioners. Professor A.T. Cringan of the University of Guelph was an active exponent of the idea. In 1960, using the Great Lakes Fisheries Convention as a model, he prepared a draft of a convention on waterfowl management between Canada, Mexico, and the United States.[4] Presumably because of the constitutional problems, the International Association dis-

[1] *Attorney-General for Canada* v. *Attorney-General for Ontario*, [1937] A.C. 326 (P.C.)

[2] *Regina* v. *Sikyea*, [1964] 46 W.W.R. 65, 77 (N.W.T.C.A. per J.A. Johnson).

[3] Smith, S.B. Critique of waterfowl management in Canada. Federal-Provincial Wildlife Conference, Edmonton. Prepublication copy. 1969.

[4] Bue, I.G. Waterfowl-Wetlands Committee Report. Proceedings, 49th Conference. 1969.

Evans, T.I. Report of the Waterfowl Study Committee. Proceedings, 49th and 50th Conventions of the International Association of Fish, Game and Conservation Commissioners. 1960.

Bue, I.G., T.I. Evans, and A.T. Cringan. Should we have an International Waterfowl Commission? Proceedings, 27th Annual Meeting, Midwest Fish and Game Commissioners. 1960.

continued its discussion on an International Waterfowl Commission and is now considering the adoption of a proposal for an International Wildlife Management Policy.

It is evident that jurisdictional arrangements for the management of migratory birds are archaic and will continue to pose problems until a more satisfactory convention is negotiated. The logical solution would be to amend the BNA Act and place the jurisdiction of migratory birds, except for proprietary rights, under Section 91 of the Act. If this were accomplished, Canada could logically take the initiative to bring about a renegotiation of the treaty and the establishment of an International Commission for the Management of Waterfowl. A commission could develop reasonable arrangements for the transfer of funds for the leasing and acquisition of habitat, for regulating the kill and for alleviating problems caused by the depredations on crops by waterfowl. Such action is long overdue.

VI.5 Focus on Future Needs

One of our principal proposals is that Canada should assume the initiative and take specific action to promote a review of existing conventions which provide the legal basis for managing the international fisheries of the world. A proposal of this nature can be compared with proposals to change Canada's constitution–everybody is likely to favour it, but for so many different reasons that the chances of anything worthwhile resulting are remote. Would such an exercise then be worth the effort as far as international agreements are concerned? We think so, because we consider that important world, and Canadian, interests are at stake.

In Chapter IV we quoted statistics showing that world production of fish tripled between 1948 and 1968. The estimates of potential production vary from an estimate by the Food and Agriculture Organization of 55 million metric tons (slightly above present production) to as high as 2 000 million metric tons. However, 100 to 200 million tons is most commonly quoted as the range which could be reached with existing technology. But in Chapter IV we also expressed fear about the possibility that a very productive Atlantic species, herring, could be lost (economically at least) as a result of overfishing. Also, we pointed out that the loss of herring and pilchard in the Pacific may have been the result of overexploitation. There is also some evidence that the anchovy of the South Pacific is also being overexploited and could be lost as one of the most productive species of the world's oceans.

The problem of overexploitation also looms over the groundfish stocks of the Northwest Atlantic. This includes the fisheries of the Grand Banks which have been of primary importance to Nova Scotia and Newfoundland. The offshore fishery grew steadily after World War II and has almost doubled since the Russian fleet first began fishing in the Northwest Atlantic in 1956; it is believed that the stocks are presently being fished at a level close to their sustainable limit. The following excerpts from a recent report focusses on the future prospects of the fisheries.

"In the years 1962 to 1966, some 2,388,000 metric tons of groundfish were caught in the ICNAF area. Maximum sustainable yield was estimated to be 3,068,000. This level of catch, on the basis of past experience, in the ICNAF area will be reached in 1970. Moderate over-fishing will have been reached in 1972 and high over-fishing will have been reached in 1975. As mentioned earlier, maximum sustainable yield for cod was reached in 1968 and the moderate overfishing level will be reached in 1971...."

"The biologists are unwilling to express a view in hard quantitative terms as to the levels at which the peak and decline will actually occur. It seems rather certain however that, on the basis of the pressures presently exerted, the groundfishery will experience a peak and sub-

sequent decline before 1976 or 1977. In other words, it is expected that over the next few years, more and more vessels will be committed to the Atlantic coast groundfishery by Poland, the U.S.S.R. and probably Canada, and that the groundfishery will be pushed beyond the maximum sustainable yield level. Given the assumption of increasing vessel commitment, the peak and subsequent downturn in groundfish catch will probably occur between 1972 and 1977. Because of the uncertainty expressed by the biologists, it is impossible to say either in biological or economic terms exactly what will actually happen. It is only reasonable, however, to expect that the results, particularly from the economic standpoint, will be catastrophic...."[1]

ICNAF came into being in 1949 because of concern for the future of the Northwest Atlantic fisheries. Each year it holds meetings at which the status of the fisheries is considered. But in 1969, after 20 years of ICNAF operations, a group of economic consultants suggested that a downturn in groundfish catch will occur between 1972 and 1977 and that the results, from an economic standpoint, will be catastrophic.

These considerations about the groundfisheries, the uncertainty about the future of the harp seals and Atlantic salmon stocks suggest that ICNAF is not doing a very dynamic job of managing the fisheries of the Northwest Atlantic. We consider that this illustrates why Canada should place more importance during the next decade on attempts to develop international agreements and organizations, which will allow world fisheries to develop rationally rather than on a "boom or bust" basis.

We suggest that the Department of Fisheries and Forestry and the Department of External Affairs should develop an integrated approach in promoting the reviews of international agreements and organizations that we have proposed. It would be desirable that they have the benefit of the efforts of an advisory committee of individuals from provincial governments, industry, private organizations and universities, as well as from federal agencies. However, if it becomes evident that adequate control of offshore fisheries cannot be achieved through international agreements, Canada should exercise its prerogatives and undertake the vegetation of specific stocks through the establishment of a system of national quotas.

We suggest that the Migratory Birds Treaty is inadequate to the needs and will be of even more limited value in the future. The cost of managing the resource and the distribution of the waterfowl kill between Canada and the United States are matters that should be the subject of agreements between Canada and the United States. Agreements covering both of these matters have been worked out between Canada and the United States in the case of Pacific salmon; we consider that they will constitute major problems in waterfowl management within the next 20 years if they are not resolved.

It is unfortunate that the pros and cons of amending the BNA Act and renegotiating the Migratory Birds Convention have never been thoroughly discussed in Canada. Partly, this has been due to the fact that federal officers have been discouraged from getting involved in such discussions. We consider that this is an undesirable state of affairs and suggest that, at the very least, a thorough debate of the subject is warranted. We suggest that the Canadian Wildlife Service (through the Federal-Provincial Wildlife Conference), Ducks Unlimited, the Canadian Wildlife Federation and the Canadian Audubon Society should co-operate in promoting thorough consideration of the proposals we have made about the BNA Act and the Migratory Birds Treaty.

[1]Lagace, B.G., *et al.* The past, present and expected future supply for Atlantic Coast groundfish. Hedlin-Menzies. Report to the Department of Fisheries and Forestry. 1969.

Chapter VII

Scientific Activities in Fisheries

VII.1 Perspective on Research and Management

"Canada is entering a new era in fisheries research. Investigations began with a survey of species, their distribution and the foods they consume, and were afterwards extended to estimates of the size of fish populations. When pressure on the stocks increased, following intensification of fishing and changes in environmental conditions, there were often extreme fluctuations in fish populations. Management measures had to be devised, and these measures were often taken in haste and without the benefit of factual information.

"Knowledge of the dynamic interrelations between the fish and its environment will greatly help the fishery biologist in predicting the results to be expected in certain specified circumstances. In these days of changing environmental conditions, the need for research in this field is pressing. For very few of the commercial or sport fishes in Canada is all the required information available to make the wisest management decisions."[1]

Fisheries research in Canada extends back for 70 years when the Biological Board of Canada (the original name of the Fisheries Research Board) was created. University professors played a prominent role in the establishment of the Board, and for a quarter of a century its research programs were carried out primarily by university professors and their students. A major change occurred after World War I when the Board employed its first full-time scientific staff. However, the close relationship which existed at the time was evidenced by the fact that the first full-time scientist was the Director of the St. Andrews Laboratory. The Director spent his winters at the University of Toronto where he supervised graduate students whose research programs were often conducted at St. Andrews. Without any formal declaration of policy, the arrangement gradually dissolved; by the 1940s the operations of the Fisheries Research Board (FRB) and of university research had to a large extent been separated.[2] In the intervening years, the role of FRB has grown rapidly, while research activities in fisheries at universities has developed slowly.

The slow development of fisheries research at universities is in part attributable to the high costs of seagoing operations, and the necessities for year-round observations in comprehensive population studies. Consequently, university work on marine fisheries has been largely in systematics, physiology and behaviour, other laboratory sciences, and theoretical studies. In university research, it is difficult to disentangle that which stems from marine fisheries problems and that which is done on marine organisms because of their ready availability. The total contribution of marine research from the coastal universities is considerable, especially from Dalhousie and McGill on the east coast, and U.B.C., Simon Fraser and the University of Victoria on the west coast. By comparison, though, with their United States counterparts, Canadian universities have not developed substantial marine fisheries research programs, nor have they acquired the same seagoing capabilities. In recent years, FRB has tried to encourage marine fisheries research by university people by providing facilities for graduate student research at their coastal stations and by encouraging their staff members to participate in graduate training programs.

The Fisheries Research Board has gained a worldwide reputation for its contributions to fisheries science and technology, made known through its own *Journal*, through scientific papers by its staff in outside publications, and contributions by its scientists to international commissions and societies. The

[1]Clemens, W.A. Requirements in fisheries research. Resources for Tomorrow Conference, Vol. 2. 1961.

[2]The relationships between FRB and universities is reviewed in the statement made to the Special Committee of the Senate on Science Policy, No. 17, 1969. It also suggests how FRB considers that future relationships should be developed with universities.

overall objective of fisheries research programs in Canada, as seen by FRB, is to maintain, develop and effectively use all available aquatic renewable resources.[1] A necessary component is to maintain and improve as necessary the biological fitness of the aquatic environment. Sub-objectives of the program may be described as:

a) to develop effective methods of managing the aquatic renewable resources for the maximum long-term benefit of commercial and sport fisheries;

b) to increase the utilization of these resources by developing new and improved harvesting techniques and products, with accompanying improvement of handling, storage and processing methods;

c) to understand, maintain and enhance all biological aspects of the aquatic environment;

d) to encourage excellence in education of personnel involved in all phases of the scientific activities.

In 1965, the Fisheries Research Board began to develop a 10-year plan of its activities and development. It was published in 1968.[2] It included an ambitious plan for expansion of its activities which is unlikely to be realized under the current austerity policy of the federal government.

The Resource Development Service of the Department of Fisheries and Forestry is the primary agency of the federal government charged with relating research to the management of Canadian marine fisheries. Since the offshore fisheries to a large extent come under international agreement, the activities of the Service have mainly been related to freshwater (Atlantic Provinces), anadromous and invertebrate fisheries. The development of the scientific activities of the Service has occurred primarily during the past 20 years. It now has an establishment of 95 professional positions in biology and engineering.

Fisheries research and management work by provincial agencies is, like wildlife, primarily a post World War II phenomenon and is almost entirely centred round freshwater fisheries. As in the case of FRB, Canadian universities played a major role in getting things started. In 1920, the Ontario Fisheries Research Laboratory was formed within the Biology Department of the University of Toronto; its field laboratories were gradually taken over by the Department of Lands and Forests after the war. Fisheries research programs at the Universities of Alberta, British Columbia, Saskatchewan, Manitoba, Western Ontario, Queen's, McGill, Montreal, New Brunswick and Dalhousie were under way prior to World War II and played a role in stimulating provincial programs.[3]

Scientific investigations of living aquatic resources is the domain of the fishery biologist and involves a broad spectrum of research on various species of animals and plants up to the time when some reach the harvestable stage. A review of the scientific investigations conducted is difficult because of the large number of papers published by Canadian scientists. The problem is illustrated by the recent publication of an *Index and List of Titles* of publications between 1900 and 1964; it contains 649 pages.[4] The annual index and list for 1968 is approximately 100 pages long.[5] Because of the large volume of publications, we will refer primarily to publications of a review nature. We drew heavily on such works for overview on the resource. The papers pre-

[1]Based on the latest description of Fisheries Research Board of Canada activities; personal communication from Dr. G.I. Pritchard, September, 1969.

[2]The Fisheries Research Board of Canada and its place in Canada's scientific development. Ottawa, 1968. *See also* Report No. 17 of the Special Committee of the Senate on Science Policy. Ottawa, Queen's Printer, 1969.

[3]Clemens, W.A. A brief history of the development of limnological and freshwater fisheries research in Canada. The Canadian Fish Culturist, Issue 12. 1952.

[4]Carter, N.M. Bulletin 164, Fisheries Research Board. Ottawa, Queen's Printer, 1968. Lists all publications by FRB staff and publications by others in the FRB Journal.

[5]Carter, N.M. Index to publications for 1968. Journal of the Fisheries Research Board of Canada, Vol. 25, No. 12. 1968.

pared for a Federal-Provincial Conference on Fisheries Development in 1964 were also valuable since they touched on virtually all aspects of the resource.[1]

VII.2 Marine Fisheries

Commercial sea fisheries occur primarily off the Atlantic and Pacific coasts. Those in the Arctic are of a very limited nature. This review follows a commonly used breakdown based on the general habits of the fishes, which broadly establish the practical methods of conducting the fisheries:

–*demersal* fisheries, for groundfish occurring on or near the bottom, including cod, haddock, redfish, flounder, etc.;

–*pelagic* fisheries, for herring, mackerel, tuna, swordfish, etc. that can be fished at or near the surface;

–fisheries for *anadromous* species that reproduce in fresh water but migrate to sea where they mature and may be taken commercially; mainly for salmon, but also for smelts, alewives, arctic char, etc.;

–*invertebrate* fisheries, for oysters, clams, squid, lobsters, crabs, shrimps, etc.

Two recent publications give considerable perspective on the fisheries on the two coasts,[2] and a review paper of catches from 1945 to 1960 prepared for the Resources for Tomorrow Conference discusses the factors affecting catches and estimates of stock sizes. It also includes projection of catches of individual species up to 1980.[3]

VII.2.1 Demersal (Groundfish)

Groundfish research in the Atlantic area, practically all by the Fisheries Research Board of Canada at St. Andrews, New Brunswick, and at St. John's, Newfoundland, emphasizes biology and population dynamics of all presently exploited species. Recent studies by fish assessment groups of the International Commission for the Northwest Atlantic Fisheries (ICNAF) show that data available from many years of research are barely adequate for even the roughest assessment of basic population parameters. Strong demands are thus made on the two stations to provide population data. The uncertainty about the future of these fisheries (Chapter VI), makes it imperative that high priority be given 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.[4]

Most of the Pacific coastline has a narrow continental shelf rarely over 50 miles and sometimes only 1 or 2 miles wide, in contrast with the great expanse of productive Atlantic shelf. The only exception is the Bering Sea, where the shelf extends several hundred miles from shore. A great variety of groundfish–halibut, cod and flatfishes–are caught, but annual total landings have about $10 million value, one-fifth of the value of Atlantic groundfish.[5]

Halibut is the most valuable species with annual landed value of $6 to $7 million. Practically all research has been carried out and reported by the International Pacific Halibut Commission, established by a treaty between the United States and Canada.[6] Management policy, begun in 1932, limits the annual catch

[1]Department of Fisheries. Canadian Fisheries Reports No. 4. Ottawa, Queen's Printer, 1964.

[2]Templeman, W. Marine resources of Newfoundland. Bulletin 154, FRB. Queen's Printer, 1966; and Larkin, P.A. and W.E. Ricker. Canada's Pacific marine fisheries. Past performance and future prospects. Fifteenth B.C. Natural Resources Conference. 1964.

[3]Ricker, W.E. Productive capacity of Canadian fisheries–an outline. Resources for Tomorrow Conference, Vol. 2. 1961. *For the detailed report see* Circular No. 4, FRB Biological Station, Nanaimo, B.C. 1962.

[4]The publication by Templeman contains a concise statement on the groundfisheries and on the problems associated with multinational participation in the fisheries.

[5]A publication by D.L. Alverson, A.T. Pruter, and L.L. Ronholt (A study of demersal fishes and fisheries of the northwestern Pacific Ocean, Institute of Fisheries, U.B.C., 1964) of the U.S. Bureau of Commercial Fisheries, contains much detail on the Pacific fisheries.

[6]The annual reports of the International Pacific Halibut Commission review the research and management programs conducted by the Commission and include a list of publications.

by area, supplemented by special regional adjustment of fishing seasons. Marked increase in abundance has resulted; it constitutes one of the important success stories in the international management of fisheries.[1] Some research on other groundfish has been carried out by the FRB Nanaimo Station. Recently, particular attention has been directed to taxonomy of rockfish, and factors controlling development and survival of various groundfish species.

VII.2.2 Pelagic

There has been a great deal of research on Atlantic herring, and it has resulted in more than 300 publications.[2] As a result, "scientists can advise that available herring resources are grossly underexploited. They can offer general advice on where, when and how herring are concentrated for capture. They can answer many questions concerning stocks and migrations, fish sizes and ages. But they do not have enough information to provide the quantitative advice required to make best use of our herring resource."[3]

In 1961, Ricker postulated that the herring fishery could at least be doubled.[4] However, as discussed in Chapter IV, it is believed that the fishery has already exceeded maximum sustainable yield, at least in two fishing areas: a) the Gulf of St. Lawrence and west and south coasts of Newfoundland, and b) the Bay of Fundy and George's Bank.

The problems associated with the herring fishery point to the need for: a) flexibility in research programs, so that priorities can be established where important and obvious needs exist; and b) management to be willing, in the early stages of development, to accept "ball park" estimates as a basis for regulation of fisheries. In the case of the herring fishery, because exact quantitative data considered to be necessary to regulate the fishery are lacking, no action was taken on the basis of Ricker's estimations of the productivity of the fishery. The problems of the herring fishery are discussed in more detail in Chapter IV.

The most important needs for research on all Atlantic pelagic species are to determine the distribution, size and productivity of specific stocks. The research is expensive because it requires a considerable allocation of ship time. In the past, there has not been a willingness to meet these needs, and this has been a factor in the failure to conduct the kind of research considered necessary to regulate the fishery. Because of the great variation in the success of particular year classes, apparently as the result of environmental factors, the research should include more effort on studies of the environment including biological and physical monitoring as a long-term operation.

As mentioned in Chapter IV, both the sardine and herring fisheries have collapsed in the Pacific. The apparent cause in both cases is overfishing; however, the extent to which environmental factors may have interacted is unknown. In an attempt to identify the factors that contributed to the decline more specifically, research on pelagic fisheries at the Nanaimo station is concentrated on herring. It includes analysis of all available data and population dynamics and on environmental conditions which existed over a considerable time span.

Other species contribute in variable amounts to the pelagic fisheries. Albacore, abundant in sub-tropical waters, comes north in varying numbers and sometimes provides around 2 million pounds. Since 1962, bluefin and skipjack tuna have been taken by Canadian fishermen. Since 1960, Canadian purse-seiners have fished tuna for the first time; previously fishing was entirely by trolling with artificial lures. Larkin and Ricker

[1]Bell, F.H. The Pacific halibut fishery. *In* The future of the fishing industry of the United States. University of Washington, Publications in Fisheries, New Series Vol. IV. 1968.

[2]A bibliography of herring in the Northwest Atlantic. ICNAF, Document 4, Serial 1289.

[3]Martin, W.R. Herring resources research needs. *In* Proceedings, Canadian Atlantic Herring Fishery Conference, Canadian Fishery Conference. Canadian Fisheries Reports No. 8. Ottawa, Queen's Printer, 1967.

[4]Ricker, *op. cit.*

have suggested that there is no definite prospect of catching many tuna north of California, unless it becomes economically practical for Canadian vessels to go southward to the mid-Pacific between 25° N. and 40° N. and participate in an international fishery for bigeye tuna and other species.[1]

VII.2.3 Anadromous

Present research on anadromous species in the Atlantic area is largely done by the Fisheries Research Board and is directed to Atlantic salmon; St. John's, Newfoundland, is mainly responsible for investigating the marine phase and St. Andrews, New Brunswick, the freshwater stages.[2] Forest spraying with pesticides, release of improperly treated mining effluents, and other man-caused deterioration of the freshwater environment, upon which reproduction depends, probably threatens salmon more than overfishing.

Research effort on the marine phase has increased recently because of the development since 1964 of intensive fishing off Greenland. Recaptures of adult fish that were tagged as young fish leaving their home streams have shown that this fishery takes salmon produced in Canadian and European rivers. Included in the program is a detailed study of the physical characteristics of Canadian smolts to determine if they can be used to identify fish originating in Canadian rivers, a useful adjunct to expensive tagging that can only be applied to relatively few fish.

Research toward improved salmon management could include:

a) methods of substituting for losses of natural production caused by environmental deterioration;

b) identification of pollutants and development of countermeasures, including effect of marine pollution on behaviour of returning adults, and comparative research on behaviour under polluted and non-polluted conditions;

c) selection and development of stocks suitable for intensive management through selective breeding.

Of these, probably top priority, as far as the Atlantic salmon investigation is concerned, should be assigned to (a), and it should involve extensive co-operative effort between the Fisheries Research Board and the Resource Development Service. Pollution studies should be included as a component of the Department's antipollution program. Work on selective breeding should involve mainly the Resource Development Service, probably in consultation with FRB geneticists.

During the past two decades, considerable work has been done in the Atlantic Provinces, particularly in Newfoundland, to improve salmon production by the removal of barriers or by provision of salmon ladders of one kind or another. Evidence is lacking about the degree to which this work has paid off. We suggest that a program to evaluate this work should be undertaken by the Resource Development Service; we further suggest that, in future, a strong evaluative component should be included as part of the planning of every project.

The Resource Development Service constructed a controlled flow spawning channel on the Noel Paul's Brook of the Exploits River in 1965, as part of a program to establish sea-run salmon in the 1 400 square miles of the drainage system that lies below a (presently) impassable dam at the outlet of Red Indian Lake. The need for, or value of, spawning channels for Atlantic salmon has not, in our estimation, been demonstrated; we caution against the adoption of this west coast technique of producing salmon, until that has been done. We suggest that consideration be given to use of the Noel Paul's Channel in experiments in which productivity of that stream is compared with that of streams in which

[1] Larkin and Ricker, *op. cit.*

[2] A review of investigations in progress was presented by P.F. Elson and C.J. Kerswill (Studies on Canadian Atlantic Salmon. Transactions, Twentieth North American Wildlife Conference, 1955) and a comprehensive bibliography was prepared by J.L. Bergeron (Bibliographie du saumon de l'Atlantique. Contribution Ministère Chasse et Pêche).

runs are established by simpler methods of transplantation of spawning stock.

Commercial fisheries for the five species of Pacific salmon (sockeye, pink, chum, coho and chinook) are the most valuable along the Pacific coast. Over the past 50 years, total Canadian production has shown only a slight decline. The success of the rehabilitation of sockeye and pink salmon runs on the Fraser River during the period from 1945 to 1965 is perhaps the most important success story in North American salmon fisheries. The rehabilitation was accomplished partly by a new pattern of regulation of the fishery, and partly as the result of conservation of fishways in Hell's Gate Canyon where a major obstruction had occurred in 1913 from a landslide caused by railway construction. Restorative work on the Fraser and the success in regulation has been done through the International Pacific Salmon Fisheries Commission (IPSFC) which was established by Canada and the United States. The efficiency with which the harvest of the various stocks of salmon is regulated by the Commission is an outstanding example of the way one aspect of management has developed on the basis of mission-oriented research. We consider that the example has much that is worthy of consideration in the management of other fisheries on both coasts.

Research on Pacific salmon has been very extensive and now comprises thousands of titles. It has been brought together in a number of recent reviews published by the International North Pacific Fisheries Commission (INPFC) and in a major review on sockeye salmon.[1] Two INPFC bulletins give a concise review of the effectiveness of salmon management up to the end of the 1950s; one was prepared by Canada (FRB) and the other by the United States.[2]

Research is conducted by several agencies, the most important of which are IPSFC, the U.S. Bureau of Commercial Fisheries and FRB. However, high seas research on salmon for the purposes of INPFC is conducted by the three countries involved–Japan, the United States and Canada–for the Commission. The observations made by them have provided quite a comprehensive understanding of the high seas distribution of most of the major salmon stocks of the northern Pacific, and these studies "brought knowledge of salmon life history to a new stage of comprehensiveness".[3] Research by FRB has also contributed much knowledge on factors affecting production and survival during the early stages when the young salmon are in fresh water. A major contribution to the management of Pacific salmon was made by W.E. Ricker, an FRB scientist, through the analysis of the data on stock-recruit relationships. His analysis suggested that maximum sustained yield is associated with spawning populations of intermediate size. This work underlies much of the current practice by which attempts are made to subdivide the escapement so that each stock in major river systems is harvested to an optimum degree.

The realization that Pacific salmon return to their "home stream" to spawn was one of the first steps toward management. Partly because of mounting information which could not be explained otherwise, the home stream theory became the central theme in management of Pacific salmon. It is still the cornerstone of management practice. With the conviction that salmon would return to their natal stream, and with the early appreciation that salmon eggs are easy to fertilize and culture, it was inevitable that there would be many enthusiasts for salmon hatcheries. A substantial practical experience in salmon culture was

[1]Forester, R.E. The sockeye salmon. Bulletin 136, FRB. Ottawa, Queen's Printer, 1968.

[2]Report on salmon stocks of the Pacific coast of Canada with reference to Articles III(1)a and IV of the International Convention for the High Seas Fisheries of the North Pacific Ocean. INPFC Bulletin 9 and Report of the U.S.A. concerning the managing of certain North Pacific salmon stocks with reference to Article III(1)a, etc.

[3]Larkin, P.A. Major advances in the management of Pacific salmon. Ms. for publication in centennial volume of American Fisheries Society, 1970.

quickly accumulated, and in a largely undocumented activity, many hundreds of millions of eggs and fry were manipulated through a variety of rearing procedures. By the 1930s, a growing number of studies on the biology of Pacific salmon had raised questions both about hatcheries and the techniques of regulation of salmon fisheries. At the end of the 1935 season, salmon hatcheries for production purposes were closed in British Columbia. Similar developments in Alaska led to abandonment of hatcheries there.

Faced with increasing encroachment on the habitat of salmon by other uses of rivers, authorities in the United States and Canada have come back to hatcheries and have intensified efforts to make them more than the "poor substitutes for natural reproduction" that they seemed to be. Since 1950 the techniques of salmon culture have been substantially improved, and there is evidence that some kinds of hatchery practice can be made to pay off. Additional encouragement for salmon culture has come from the development of artificial spawning channels which ostensibly combine protection from environmental extremes with preservation of sufficient naturalness.

We suggest that the Department of Fisheries and Forestry should make a thorough evaluation of the use of hatcheries and spawning channels to determine their potential and to locate areas where they may contribute to productivity.

In 1969, Fisheries Research Board scientists at Nanaimo prepared a series of reports on research required to provide a basis for the enhancement of the salmon resource.[1] We consider that the recommendations for research based on field trials, or experiments, to test hypotheses on predicted increases in growth and survival are particularly relevant. For example, the potential of predator control as a device for increasing salmon production has never been exploited, although studies almost 30 years ago suggested that it was a profitable area for management. We suggest an expanded program of research in this area and suggest a reallocation of priorities to achieve it.

The transplanting of Pacific salmon to the east coast of Canada warrants special comment. Pink salmon, with their two-year life cycle and short period of freshwater residence, have potential for an extremely valuable Atlantic fishery. The U.S.S.R. has undertaken transplants to their Arctic Atlantic coast with some indications of success, and following this example, a transplant was made by the FRB from the Pacific coast to North Harbor River in Newfoundland. To date, returns have been encouraging, and further development of these potentials seems to be a fruitful line for the future.

VII.2.4 Invertebrates

Total landed value of all species of invertebrates on the east coast was $41 million in 1968-69, largely from lobster and scallop catches. The lobster is the most valuable individual fisheries species in Canada, with current landed value over $25 million.[2] Inshore areas are exploited by 25 000 fishermen (over half of all persons classified as fishermen are on the Atlantic coast) using 17 000 boats and 2¼ million traps. Offshore stocks on the continental slope are fished profitably by the United States but present policy does not permit Canadian participation. Canadian landings reached a peak of 52 million pounds in 1956, but fell to 35 million pounds by 1967.

The cause of catch fluctuations is not understood, in spite of thorough long-term biological studies of recruitment

[1]Larkin, P.A., J. McDonald, R.R. Parker, F. Neave, H. Godfrey, and W.E. Ricker. Research programs concerned with methods of increasing salmon populations. FRB Manuscript Report Series 1015. Nanaimo, B.C. 1969.

[2]There are many popular and technical publications on the fishery:

Wilder, D.G. Canada's lobster fishery. Canadian Geographical Journal, Vol. 55. 1957.

Rutherford, J.B., D.G. Wilder, and H.C. Frick. An economical appraisal of the Canadian lobster fishery. Bulletin 157, FRB. Ottawa, Queen's Printer, 1967.

and careful evaluation of effects of regulations such as season, size limits and protection of egg-bearing females. Present research interests by FRB, including St. Andrews, St. John's, and Halifax laboratories, include general biology and special studies on effects of temperature, crowding, photo-periodicity, moulting glands, moult hormones, disease control, nutrition and selective breeding. The importance of improved handling after first capture is indicated by an average annual loss of about 3 million pounds (8 per cent of present production). A promising possibility for increasing production is to provide suitable cover for lobsters on the sea bottom, since lobsters are known to be plentiful in rocky areas where they occupy solitary burrows. Possibly the greatest need is to encourage fishermen and fishing companies to put into practice information now available on proper handling which has resulted from past research.

Three species of crab (queen or snow, red, and northern stone) offer best prospects for development. There is negligible information on any crab species, and 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. Biologists urge that a well-planned and co-ordinated exploratory program be initiated for all species, because fishermen are constantly requesting information on new grounds. Studies on all aspects of care and handling of the product before processing are essential if fishermen are to bring these delicate products in healthy condition to the plants. Studies on gear design are desirable to allow crabs of unsuitable sizes to escape.

Oysters have been investigated and experimentally cultivated in the Maritime Provinces by the Fisheries Research Board and the federal Department of Fisheries since 1930, with considerable success. But a severe setback in production in the 1950s resulted from a disease that attacked Nova Scotia and New Brunswick stocks, similar to the attack that wiped out all fishable oysters on Prince Edward Island in 1918.[1] The problem of erratic production of young is being investigated through experimental oyster hatcheries, recently developed through joint efforts of FRB and the federal Department's Resource Development Service.

In the mid-1960s, the federal Industrial Development Service and provincial surveys aroused interest in exploiting two species of shrimp. In 1967, 1 million pounds, and in 1968, 2 million pounds were landed, over half in Charlotte County, New Brunswick; good catches were also made off Gaspé, Quebec. The life history of the shrimp is fairly well understood from exploratory work by FRB and by agencies of other countries, but there is little knowledge of movements, population sizes and rates of exploitation. Urgent consideration should be given to determine how more effort can be achieved in this area under current restrictions on overall increases in expenditures.

An important point regarding invertebrate fisheries is that, with one exception, all are confined to our territorial waters where Canadians can exercise resource management and derive exclusive benefits. Further, in the oyster fisheries resource, renewal can be controlled by culture methods and probably by selective breeding. The potential exists of being able to expand the oyster fishery to virtually any desired level, and this can be said for no other commercial fishery, either for vertebrates or invertebrates.

The total landed value of Pacific invertebrates is just under $2 million annually. The crustacean group includes one species of crab and six species of shrimps; molluscs include the Pacific oyster and various kinds of clams. The annual catch of crabs increased to a record 5 million pounds in 1967, mostly taken by traps, the balance by trawlers incidental to the capture of groundfish. Since 1964 there has been no field work on crabs by FRB Nanaimo; however, records of catch are watched for

[1]Medcof, J.C. Oyster farming in the Maritimes. Bulletin 131, FRB. Ottawa, Queen's Printer, 1961.

evidence of overexploitation. From 1 million to 2 million pounds of shrimps have been landed in British Columbia in recent years; little is known about their biology and there is no active management program or regulation of the catch.

Among edible molluscs, the Pacific oyster, introduced from Japan, is now the most important shellfish, with annual yields exceeding 100 000 U.S. gallons, most of the production coming from inter-tidal leased grounds in the Strait of Georgia. Extensive research work is carried out by FRB Nanaimo on spatfall forecasts, culture methods, pollution purification, etc., in co-operation with the Industrial Development Service of the federal Department of Fisheries and Forestry and the British Columbia Research Council. It is an example of an effective mission-oriented program that is a credit to FRB and participating agencies. It is also an area where the stage has been set for a rapid development program; consideration is needed to determine how it can be achieved.

In 1965, the experimental introduction of Atlantic lobsters into Pacific waters was started by FRB Nanaimo, in co-operation with FRB St. Andrews, and offers great hope for development. Adults introduced into Fatty Basin, Vancouver Island, have reproduced in an experimental hatchery and survived well, except for some predation by mink and otters. Only evidence of natural reproduction of the offspring is still lacking. These investigations warrant careful follow-through, so that the project can be pushed to application or terminated quickly if it does not show real potential for development.

VII.2.5 Marine Sport Fisheries

The increasing demands for recreation in North America have resulted in a rapid growth of marine sport fisheries. On the west coast, a small boat fleet and the marinas which serve it have mushroomed in the last decade as evidence of a major recreational industry. Sport fishing for salmon is the major attraction, but other kinds of fishing and scuba diving are increasingly popular. Additionally, "beachcombing" for oysters, clams and other shellfish are popular family pastimes. Similar recreational marine fishing activities are developing on the east coast.

Embodied in this new industry are a number of social and economic research problems, for which there is a paucity of reliable statistics and a notable lack of relevant biological research. Certainly it is the marine sport fishery for coho and chinook salmon that largely prompts current plans for hatcheries, and it will be necessary to greatly expand management research if the hatchery investments are to be put to best use. At present, the Resource Development Service of the Department of Fisheries and Forestry conducts only limited research on recreational fishing, although fielding inquiries and representations of anglers is a particularly time-consuming summer activity.

Revenues to offset research expenditures should be obtained from licensing of salt-water angling. A particular sore point with many Canadians is the substantial sport fishery by United States residents sailing in Canadian waters, which yields a very small return as a tourist industry but extracts a considerable harvest of sport fish and invertebrates.

VII.3 Freshwater Fisheries

Compared to marine fisheries, the value of the commercial catches of freshwater fisheries is low. However, they provide employment for 16 000 people in the primary industry, they are the main source of fish in the diets of many Canadians, and they are of uncalculated (but high) value to the sport fishery. In 1961 the survey of fishing and hunting in Canada showed that 1¼ million fishermen generated approximately $174 million in gross business activity.[1] In 1967 the sale of non-resident licences (primarily to U.S. citizens) was 814 208 and the sale of resident licences was over a million, so in

[1]Benson, D.H. Fishing and hunting in Canada. Ottawa, Queen's Printer, 1963.

that year at least 2.5 million people participated in the sport fishery.[1] However, because of the problem of expressing recreational values in economic terms (Chapter IV), there is still no meaningful method for comparing the value of the sport and commercial, or of freshwater and marine fisheries. It has, however, become obvious that the real value of the freshwater fisheries should not be expressed only in terms of commercial products, and that the expenditures on research, management and development related to the sport fishery should be commensurate with its real value.

The neglect of the sport fishery is evidenced in many ways besides inadequate appropriations for research and management. For example, the *Canada Year Book*, 1968, devotes 15 pages to federal input into administration, economics and scientific activities in the commercial fisheries, but sport fishing is only mentioned in a few brief paragraphs under fisheries activities by provincial governments. Hopefully, growing consideration of sport fishing in the Canadian economy is indicated by the three-day symposium sponsored by the Department of Fisheries in January 1965, on economic aspects and research requirements for the sport fishery.[2]

There is a great deal of overlap between the commercial and sport fisheries. Both are carried out in the large lakes such as the Great Lakes, Great Slave Lake and Lake Winnipeg, and they overlap to varying degrees in smaller lakes depending on existing policies in the various provinces and territories. There are often problems associated with management where overlap occurs.[3] In some instances, fisheries regulations have tended to circumscribe the activities of the commercial fishermen while, at the same time, research programs have been primarily oriented towards commercial fisheries.

Freshwater fish break down rather naturally into two broad categories, those which inhabit cold water (principally trout and whitefish) and those which live in warm water (walleye, northern pike and bass are well-known examples). Rather distinct biological characteristics are associated with the two groups and these are reflected in the nature of management practices that are necessary to maintain viable fisheries.

Canadian research on sport fisheries is shared by the federal and provincial governments. On the Atlantic coast, the Fisheries Research Board has conducted extensive life history and population studies especially on the freshwater stages of the Atlantic salmon and brook trout. Some work has been done on arctic char and lake trout in the Northwest Territories. One FRB laboratory is concerned entirely with freshwater fishery resources –the Freshwater Fisheries Institute established at Winnipeg, 1966. An important element of its research is on fish population studies, aimed at understanding the basic principles involved in production of fish in lakes, to develop improved management methods. Present activities include examination of commercial catches combined with regional surveys; field experiments designed to foster production of desirable species; fundamental investigation of metabolism and reproduction of fish species in both natural and polluted waters; development of fish farming in a co-operative program with the western provincial governments including work with rainbow trout, whitefish and walleye. A new statistical group has been established to develop methods and techniques for data collection and rapid analysis, with wide application in fisheries management, as in predicting population trends and estimating quotas.

[1]Data on sport fishery from a report by R.H. Strand and R.G. Martin (Fish conservation highlights 1963-67, Sport Fishing Institute, 1968). The number of fishermen is considerably higher than the sale of licences because fishermen are not required to have a licence in every circumstance where they can fish.

[2]Northcote, T.G. Some research requirements in freshwater sport fishing. *In* Canadian Fisheries Reports No. 4. Ottawa, Queen's Printer, 1965.

[3]For example, Christie, W.J. Angling–commercial fishing relationships in the Great Lakes. Ontario Department of Lands and Forests. Mimeograph. 1965.

Since 1966, the Department of Fisheries and Forestry has operated a laboratory at Sault Ste. Marie responsible for Canadian lamprey control operations in the Great Lakes. Before then, the lamprey control program was part of a combined biological and technological program conducted from an FRB laboratory at London, Ontario. This is an example of desirable transfer of responsibility from research to management after attainment of original research objectives. Elsewhere federal scientific activities in freshwater fisheries are mainly concerned with species valuable for sport fishing, usually anadromous species like Atlantic salmon which are not fished commercially in fresh water, or the brook trout which can be taken only by angling.

Fisheries statistics show commercial catches for only six provinces and the Northwest Territories; New Brunswick and Quebec with only a few hundred persons employed in the primary industry, Ontario and the three Prairie Provinces with from two to six thousand people employed, and the Northwest Territories with about 450 persons engaged in the primary industry. The following is an abbreviated description of scientific activities conducted by the provinces.

Newfoundland and New Brunswick undertake no scientific activity concerning the limited inland fisheries which, with tidal fisheries, are under federal jurisdiction.

Prince Edward Island Department of Fisheries, Fish and Wildlife Division, co-operates with the Fisheries Research Board in investigating production of brook trout for angling at various sites, including reconstructing dams on former pond sites to increase public angling.

The Nova Scotia Wildlife Division of the Department of Lands and Forests operates a system of rearing-ponds for brook trout, develops farm-ponds and produces rainbow trout and small-mouth bass.

Quebec's freshwater fisheries, mainly in the St. Lawrence drainage, take perch, carp, pickerel, sturgeon, etc., and pertinent biological studies are carried out at a laboratory in Quebec City. The Department of Tourism, Fish and Game maintains four hatcheries for stocking public waters with brook, brown, rainbow and lake trout, splake, salmon and maskinonge. The Fish and Wildlife Service of the Department contains a Biological Research Section and has fishery biologists located in eight districts. The province has established a pioneering program in parks of regulating the sport fishery for trout on the basis of the estimated productivity of individual lakes. Under this system, fishing in a lake is stopped when a specified quota has been reached.

Ontario, bordering on four of the Great Lakes with extensive fisheries, has the largest provincial research and management staff of the provinces. The provincial and federal governments recently completed a revised agreement on fisheries research. Important terms were that:

a) in 1967, the province would again assume responsibility for fisheries research on Lake Superior, a federal charge for the previous 10 years;

b) the Fisheries Research Board of Canada would assume responsibility for a major program of research on eutrophication in the Great Lakes.

Research under the Fisheries Section of the Research Branch of the Department of Lands and Forests includes: *on Lake Ontario*, intensive long-term studies of whitefish to provide guidelines for future management in all Great Lakes; and continuing studies on the American eel, white perch and kokanee (lake form of sockeye salmon); *on Lake Erie*, new research into the causes of the decline of walleye and studies of food habits, distribution, and factors affecting production of strong and weak year classes of smelts; *on Lake Huron*, rehabilitation studies using splake (lake trout x brook trout hybrids) coincident with lamprey control; experimental introduction of kokanee; *in South Bay*, survival studies on young-of-the-year whitefish; *on Lake Superior*, particular attention to the recovery of various sub-populations of lake trout aided by an extensive planting program.

At the management level, the province has a number of fishery management units and general duty biologists (many of whom do both fish and wildlife work) in 22 "Forest Districts", in addition to a number of staff positions at head office. Sixteen fish hatcheries and rearing stations are operated by the Forest Districts.[1]

In Manitoba, the main species fished are pickerel, whitefish, sauger and pike. The Fisheries Branch of the Manitoba Department of Mines and Natural Resources conducts scientific studies to provide a basis for developing sound policies and management practices. A recent reorganization places increased emphasis on development programs. Population studies on Lake Winnipeg whitefish have indicated overfishing, e.g. high annual mortality rates and decrease in average weight of fish caught. The fish-producing potential of lakes involved in flooding for hydroelectric purposes has been examined. Potential annual catch quotas have been evaluated for a number of the larger northern lakes, based mainly on total dissolved solids, mean depths and percentage of marketable species caught in test nets. New experimental zoning on a number of northern lakes involves grouping lakes in designated blocks to be operated under single commercial fishing licences. In these activities close liaison is maintained with the federal Department of Fisheries and Forestry and with the Fisheries Research Board. Fish culture activities include replenishing the commercial fishing waters with hatchery-reared pickerel and whitefish.

In Saskatchewan, the Fish Research Division, Fisheries Branch, Department of Natural Resources, develops policies and programs in fisheries from scientific investigations aimed at determining productivity of water bodies, assessing abundance and relationship of species, investigating ecology and assessing environmental factors affecting fish, achieving maximum harvest of populations on a sustainable basis, and facilitating rehabilitation and stocking of small bodies of water. Examples of recent investigations are management of northern pike at Lac la Ronge, where a commercial fishery yields about one-tenth the production of the pike-angling fishery; a study on Tobin Lake indicating that goldeye could be harvested commercially; studies of whitefish, pike, walleye and other species in Dore Lake to evaluate management procedures. It also has a continuing program of biological surveys and a number of fish hatcheries.

In Alberta, lake whitefish is the most valuable commercial fish, followed by tullibee, walleye, northern pike, perch, turbot, lake trout and suckers. Of 9 million pounds landed in 1966, 21 per cent were marketed outside the province, 90 per cent of this in the United States. There are six biological districts where surveys and research projects are carried out; in one recent project the commercial and sport fisheries potential of waters north of 55° N. was estimated.

In British Columbia, commercial freshwater operations are extremely small by comparison with sport fishing. About 2 000 lakes in British Columbia are the backbone of the present fishery by 200 000 anglers, and it supports a large resort industry in the summer months. Research on this resource developed rapidly in the early 1950s and has been sustained at a vigorous level chiefly by the research division of the Fish and Game Branch of the Department of Recreation and Conservation. The division has operated as a co-operative research unit with the Institute of Fisheries (now the Institute of Animal Resource Ecology) at the University of British Columbia. The total research output of the group has been large and the record of publication better than in most provinces. The regional limnology of the province is well documented, and hatchery activities are handled effectively, but noticeably there has been little effort to assess anglers' habits,

[1]Reviews of research and management programs are contained in the Annual Report of Research Branch (1968) and in the Annual Report of the Minister of Lands and Forests. For the purpose of this review, the Minister's report for 1968 was used.

or to direct research activities to clearly defined management objectives based on user's requirements.

In the Territories, whitefish is the most valuable commercial freshwater species, taken in many lakes along with ciscoes and other species. Usually the fisheries are under management by the Department of Indian Affairs and Northern Development, which gets biological advice from the Fisheries Research Board.

Research on various aspects of freshwater fish and fisheries is also conducted at a number of Canadian universities. The programs at the University of British Columbia, the University of Manitoba and the University of Toronto have been the most prominent in recent years. In 1968, FRB made major development grants to all three institutions. The grant to Manitoba was to support the Aquatic Biology Research Unit ($100 000), the one to Toronto ($150 000) was for research on aquatic ecosystems and the one to British Columbia ($50 000) for fish physiology and mathematical ecology.

VII.3.1 Research, Management and Development Programs and Needs in Freshwater Fisheries

A review of research, management and development programs in freshwater fisheries in Canada leaves one with the strong impression of inadequacy and underdevelopment. For example, "in British Columbia absolutely no information is available for 81 per cent of a total of at least 22 000 lakes in the province, and less than one quarter of about 2 000 lakes known to contain sport fish receive any management whatsoever even of the crudest form".[1] The situation with respect to basic data on lakes, which is considered to be one of the first steps in fisheries investigations, does not appear to be much more advanced in other parts of Canada.

In Chapter X it is pointed out that water resources are being developed rapidly throughout the country. In some provinces, the majority of the rivers which have economic potential have already been developed. This has resulted in a considerable number of artificial lakes which each year are subject to marked fluctuations in the water level. However, there have only been a few limnological studies of these reservoirs, none of which could be considered to be thorough. Considering the extent of the development of water resources in Canada, this area should not be left in such a neglected state. The financing of such studies should be included as part of the costs of developing and operating water resources facilities (see Chapter X).

"The European work on reservoirs can be used to suggest general effects on impoundments on Canadian lakes and rivers, but differences in character of the lakes and rivers and their fisheries before alteration as well as differences in water level change and fluctuation thereafter make it imperative to conduct more extensive studies here."[2]

"Most sport fish stocks are 'managed' with an almost ludicrous lack of knowledge of their population dynamics, especially when compared to the information available and used in management of many commercial species."[3]

Even in the case of commercial fisheries, it was impressed on us by the Study Group that there is a great need for study of the large lakes "to examine the underlying behaviour of fish populations."[4] The importance of this recommendation is evidenced by a recent study of walleye in Lake Erie which suggests that the lack, or inadequate analysis, of population data led management to adopt extremely liberal regulations which, in the presence of a seriously deteriorating environment,

[1]Northcote, T.G., *op. cit.*
See also An inventory and evaluation of the lakes of British Columbia with special reference to sport fish production. Transactions of 15th British Columbia Natural Resources Conference. 1964.
[2]Northcote, T.G., *op. cit.*
[3]Northcote, T.G., *op. cit.*
[4]From the recommendations of the Study Group on Commercial Fisheries, Winnipeg, June, 1969.

contributed to the collapse of walleye populations in the western basin of the lake.[1]

Our investigation brought out that fish culture techniques are of as great concern to freshwater biologists as they are to scientists who deal with anadromous species. Many consider that they can play a very important role in the maintenance and development of freshwater fisheries. However, it was pointed out to us on many occasions that they are frequently used in an inadequate way, and like those associated with anadromous species, the level of critical evaluation of the results of planting hatchery stock is very low. The conclusion was unavoidable that millions of fish are still being planted under circumstances (e.g. trout fry or fingerlings in lakes which already contain trout or mixed populations of fish) where it is clear that they make no contribution to the fishery.[2]

The misuse of hatchery production is more than an academic question because of the large amounts of money expended on the various activities associated with them. Ontario, with the largest number of hatcheries, lists 16 in the 1968 Annual Report of the Department of Lands and Forests. It planted approximately 63 million fish in 1967. The cost of production and planting was not available to us; however, we estimate that it was in excess of $2 million, perhaps as much as 20 to 30 per cent of the budget of the Fish and Wildlife Branch of the Department.

In some circumstances hatcheries can be used very effectively as a tool of management. In British Columbia the present sport fishery on trout is largely based on lakes that were barren of fish 50 years ago, and which have since been stocked from hatcheries. Lakes which do not have natural spawning facilities are most cheaply maintained for fishing by annual plantings with fry. The restocking of lakes that have been chemically treated for removal of "trash fish" species is another hatchery function. Finally, hatcheries are economical operations for "put and take" plantings of catchable sized trout in urban recreational fisheries for youngsters and old age pensioners.

While the above are particularly useful hatchery activities, in a great many instances there is questionable wisdom in planting fish in natural waters that contain a resident population of sport species as well as perhaps other species of fish. We suggest that all agencies in Canada which operate fish hatcheries consider the desirability of conducting stringent evaluations of the biological and economic effectiveness of their fish-planting programs, and consider ways and means of redirecting ineffective aspects of such programs.

Associated with hatcheries and the culturing of both freshwater and marine fish, there is the recurring problem of fish disease. As a service to provincial agencies, and for appropriate backup of salmon cultural work, the establishment of fish disease research units on both coasts would be desirable. Their work would also relate to pollution problems, for the study of fish pathology is still in its infancy. In the words of a United States specialist, "we call our state the wonder land of lakes, because whenever we find a dead fish we can only wonder what it died of". Recognition of the major problems in fish disease and pathology by the establishment of service and research centres would be extremely popular with federal and provincial agencies as well as the general public.

The introduction of exotic species has come to be used very widely in the management of freshwater fisheries. The present trend is toward the accentuation of this activity because changes in the fauna, the fisheries and the physical environ-

[1]Regier, H.A., V.C. Applegate, and R.A. Ryder. The ecology and management of the walleye in western Lake Erie. Great Lakes Fishery Commission, 1969.

[2]For example, *See* Miller, R.B. Comparative survival of wild and hatchery-reared cutthroat trout in a stream. Transactions of the American Fisheries Society, Vol. 83. 1954; and Fraser, J.M. Brook trout lakes and the role of hatchery fish. Ontario Department of Lands and Forests, Research Information Paper (Fisheries), No. 22. 1962.

ment have often made the management of important endemic species impossible or, at least, difficult. The important question on which fisheries scientists have not always been able to reach a consensus is when, and under what circumstances, should management resort to the introduction of exotic species.[1]

The question is being asked now for the Great Lakes and, in our opinion, it is being answered in an unsatisfactory way –unsatisfactory because unilateral action is being taken by management agencies in making introductions with little prior investigation, with little consultation between jurisdictions and even between research and management scientists. The case in point is the introduction of coho salmon in Lake Michigan[2] and more recently in Lake Ontario. The introduction has often been cited as a dynamic attempt by fisheries management to come to terms with the problems of the Great Lakes; however we see it as an example of an introduction without a reasonable evaluation of the possible courses of action and of the potential consequences to fisheries management in the Great Lakes. An aspect of that problem is likely to be that once the "appetite" for coho salmon is developed among fishermen, the option of terminating the program, which biologically can be done at any time, may be lost because of political factors. Another aspect is the complications which could develop in obtaining stock for the continuous program of introductions.

The steps, as we see them, that should have been followed are:

1. completion of the program of investigation to determine if self-perpetuating populations of lake trout or splake can be established;

2. multijurisdictional consideration through the Great Lakes Fisheries Commission to select exotic species for introduction;

3. an intensive program to introduce and evaluate the success of introductions.

Recent activities in the Great Lakes are worthy of special attention because they demonstrate fisheries research and management efforts in a complex international situation, efforts which are both commendable and reprehensible.

The experiment to control sea lamprey was based on the results of research conducted in South Bay (Lake Huron) and on other supporting evidence from both Canadian and U.S. studies.[3] The coordination of the control program through the various agencies and the Great Lakes Fisheries Commission has been excellent; in addition the turning over of the program from research to the management agencies (in Canada, the Resource Development Service of the Department of Fisheries and Forestry) was timely. An economic evaluation of the program was conducted on the basis of the lake trout fishery in Lake Superior.[4] The annual cost of this program (shared on a 65:35 ratio between the United States and Canada) for 1969 was $1.6 million. It was suggested to us by one authority that the present level of expenditure is inadequate and may result in inconclusive results. We suggest that the Great Lakes Fisheries Commission should clarify this matter. Too much money is being committed to the program to continue it in an inadequate manner.

Research on the lakes is co-ordinated through the Commission. The contribution of the adjacent states has been small or nonexistent and the U.S. federal program has varied in intensity from lake to lake. Ontario has made the major effort on the Canadian side with programs that started on Lake Huron in 1947, Lake

[1]For example, *See* Loftus, K.H. *(Editor)* A symposium on introductions of exotic species. Ontario Department of Lands and Forests, Research Report No. 82. 1968.

[2]Tody, W.H., and H.A. Tanner. Coho salmon in the Great Lakes. Michigan Department of Conservation. 1966.

[3]Budd, J.C., F.E.J. Fry, and P.S.M. Pearlstone. Final observations on the survival of planted lake trout in South Bay, Lake Huron. Canadian Fish Culturist. 1968.

[4]Brinser, A., L.L. Smith, Jr., J.C. Frick, and F.E.J. Fry. Economic evaluation of sea lamprey control and lake trout restoration in Lake Superior. Great Lakes Fishery Commission. 1968.

Erie in 1953 and Lake Ontario in 1957; both Ontario and the Fisheries Research Board began research on Lake Superior in 1955. We gained the impression that major problems in co-ordination are developing as a result of the entry of the Department of Energy, Mines and Resources in the general area of pollution and environmental studies. The proposed program of investigation is very large, in terms of work by existing agencies, and it appears that the latter tend to be ignored.

In concluding this discussion of freshwater fisheries, we suggest that the introduction of exotic species to new environments should not be the primary response of fisheries managers in meeting the problems of freshwater fisheries in the future. To respond in this way would be to suggest that the science has little more to offer to management than the panaceas of the hatchery advocates of the 19th century.

In registering a negative response to the course of action which has been followed in the introduction of coho salmon to the Great Lakes, we are not suggesting that there should not be a strong effort made to undertake purposeful action on the part of management. To a considerable extent, there has been very little real management of sport fisheries in Canada up to the present time. But as the frontier recedes it is going to become increasingly important that such programs be undertaken. We suggest that every agency involved with fish management should have a portion of its programs related to the deliberate management of fish populations and their environment, in order to gradually build up expertise and understanding of manipulative processes. We urge that such action programs be carefully planned, conducted and reported.

In the area of administration, there has been a tendency in the United States to separate the research and management activities related to the sport and commercial fisheries (for example, the Bureau of Commercial Fisheries and the Bureau of Sports Fisheries and Wildlife); however, in Canada this has not been as common a trend. Although recognizing the relatively inferior status that the sport fishery has had in the past, we do not consider that compartmentalization of the activities would assure more adequate consideration in the future. In this respect, we are in accord with our panel on commercial fish which urged that sport and commercial fisheries be considered together as part of the process of maximization of the fishery resource.

VII.4 Marine Mammals

The Fisheries Research Board laboratory at Ste. Anne de Bellevue, Quebec, is responsible for all scientific investigations in Canada on sea mammals, comprising whales and seals in Pacific, Arctic and Atlantic waters. The results of investigations on population ecology of Atlantic whales, Pacific fur seals, and Atlantic harp and hood seals are needed by three international commissions–The International Whaling Commission, the North Pacific Fur Seal Commission and the International Commission for the Northwest Atlantic Fisheries. Other mammal investigations include life history and population studies on white whale (beluga), walrus, narwhal, ringed seal, and other species that, if exploited wisely, could benefit northern native communities. Similar studies are also made on the gray seal of the Atlantic coast, which is often considered to be a nuisance because it damages fishing gear and is a vector for the codworm.

Damage to the inshore fisheries by harbour and gray seals has been particularly serious to mackerel and herring fisheries in eastern areas of Cape Breton Island. Situations have existed where fishermen will no longer put their gill nets in the water. The damage is of two forms: the destruction of nets, and the loss of fish resulting from the seals literally "grazing" fish enmeshed in the gill nets in the Gulf of St. Lawrence. The gray seal is "considered" to be the principal vector of the codworm which, be-

cause it encysts in muscle tissue, causes marketing problems with cod or additional processing costs when fillets must be candled and the cysts removed.

Some years ago, in an attempt to alleviate the problems, the Department of Fisheries (as it was called at the time) instituted a bounty on harbour seals. However, the gray seal was not included because of the dangers of exterminating the species which is relatively rare off the east coast of North America.[1]

In 1966, the Department instituted a control program through which a specified number of gray seal pups were killed on Basque Island, where many of the seals which cause the problems off Cape Breton are believed to originate. The control program has been gradually intensified since that time and is currently being conducted through a contract with Karlsen Sea Products of Halifax.

A number of important areas of seal ecology, of the interrelationships of seals with the fisheries and with the transmission of the codworm, are still poorly understood. We suggest that specific investigations be undertaken to:

a) ensure that no colonies of gray seals are extirpated;

b) determine much more exactly the role of the species as a vector of the codworm;

c) determine if the problem of damage to the inshore fishery can be alleviated by any means other than by direct reduction of the seal population.

Investigations on harp seals have been in progress since 1949 and are aimed at providing a basis for managing two herds (the Gulf of St. Lawrence and the Labrador "Front" herds). In recent years annual catches in the Gulf have been only slightly below the estimated maximum sustained yield of 90 000 young seals. The catch on the Front has appeared to be excessive since the sustainable catch is estimated at between 75 000 and 90 000 and around twice this number have been harvested.[2] Public opinion against the killing of baby seals (whitecoats) has resulted in restricting future catches until the pups have moulted and acquired a mottled coat. A major accomplishment in the management of harp seals in the North Atlantic was the establishment of annual kill quotas in the Gulf of St. Lawrence by the Department of Fisheries and Forestry in 1966. These are based on population data obtained by FRB and constitute the direct application of the results of research in developing a workable quota system.

We suggest that Canada should press hard, through the International Commission for the Northwest Atlantic Fisheries, for regulation of the kill of seals in the "Front" herd on a similar quota system. The overexploitation of the herd is an international disgrace and regulation of kill, rather than of the season, is overdue.

The history of seals in Canada is an example of lagging development which has worked against east coast fishermen and Eskimos. The sealing industry has been going for 200 years but has never moved beyond the stage of export of a semi-raw product to Europe, particularly Norway. The result has been that prices are undoubtedly lower and subject to greater fluctuations than is necessary. Also, the lack of adequate fur treatment facilities has tended to hinder the development of fur product industries in northern Canada where the ringed seal is widely hunted, and where processed pelts of harp seals could be utilized.

The North Atlantic Whale Investigations are important because of the revival of whaling since 1964 off Nova Scotia and Newfoundland, mainly for the fin whale. Population estimates based on systematic sightings and tagging are used to establish annual quotas for this species; data are obtained and processed on other species (sei, blue, humpback, sperm, minke, etc.) because interest may

[1]Mansfield, A.W. The gray seal in eastern Canadian waters. Canadian Audubon, Vol. 38. 1966.

[2]Several publications, e.g. Sergeant, D.E. Exploitation and conservation of harp and hood seals. Polar Record, Vol. 12. 1965.

shift to other species in future. In the past, whales have generally been over-exploited in various parts of the world and the most recent example is the North Pacific where the Canadian Whaling Fleet ceased operations in 1967. Hopefully the research program will contribute to proper management of the stocks, since it was started early and data on the stocks are being obtained rapidly. The annual quota for fin whales was 800 in 1967, reduced to 700 in 1968, and to 600 in 1969.

The need for careful management of marine mammals is illustrated by the rise and fall of a pothead (or pilot) whale industry in Newfoundland. A research program was undertaken by Fisheries Research Board soon after the industry began; it resulted in considerable knowledge of the ecology and population dynamics of the stock. However, the knowledge was not applied through regulation of the kill and, it appears that by the mid-1960s the stock which came into Conception Bay was virtually extirpated by the industry.

There is increasing evidence that the bowhead whale is becoming more numerous in the Canadian Arctic and is gradually reoccupying its former range. In terms of their potential value to Eskimos in such areas as Banks Island, a research program to determine their abundance, and investigations to determine how they can be hunted, stored, and utilized by the Eskimos, are warranted.

Some Arctic sea mammals, e.g. walrus, narwhal, beluga, have been quite thoroughly studied but need continuing checks on their status. The ringed seal has been investigated only in the eastern Arctic, and investigation for several years is planned for the western part of its range to round out population studies over the full range of environmental conditions. In view of the importance of this species throughout the north, and of exploration and development work under way in the western Arctic, this work should be undertaken at an early date.

On the Pacific coast, research on the northern fur seal includes distribution studies and sampling to provide information on feeding habits, reproduction and mortality rates which are needed annually for meetings with the U.S.S.R., U.S.A. and Japan under the Interim Convention on Conservation of North Pacific Fur Seals. The industry is conducted entirely by the U.S.S.R. and U.S.A. on Northern Pacific Islands, but Canada and Japan receive 15 per cent of the annual take of skins. It amounts to about $1½ million annually to Canada. There does not appear to be any pressing need for an extension of research on this species.

VII.5 Harvesting and Utilizing the Resource

Government research in Canada on fishing gear is infinitesimal at present. Activities by the Fisheries Research Board are centred at St. Andrews, New Brunswick, where one engineer with several technicians and limited facilities are engaged mainly with an engineering study of otter trawls. In addition, the St. Andrews station has been assigned responsibility for research and development on fishing gear for the Atlantic coast with the plan of developing a centre of excellence on this subject, co-ordinating the work of fish behaviour biologists and engineers.

The Industrial Development Service of the Department of Fisheries and Forestry was created in 1955 to help effect the modernization of the fishing industry. Much of the work of the service on fishing gear is done through contractual arrangements and by chartering commercial fishing vessels.[1]

The future of fishing gear technology in Canada is dim if the present level of activity continues. We will lag behind other nations in knowledge and use of

[1]The report of the Department of Fisheries and Forestry to the Special Committee of the Senate on Science Policy, No. 17, includes a review of the work of the Industrial Development Service.

modern fishing gear, and our fishing activities will be less competent than those of competing nations. Probably the greatest gain for the least effort would result from assimilating information already available in the literature from other nations. Foreign technical literature varies greatly in quality; therefore, it should be culled, translated into Canadian terminology and units and restated in a co-ordinated manner. Those engaged in fish gear technology in Canada should be trained at the university level in mathematics, fluid mechanics, stress analysis, etc., in order to apply the foreign knowledge to problems in the Canadian fishing industry. Canada must contribute her share to the total knowledge if the flow of information from other nations is to continue and accelerate. In addition, a long-term series of rather routine investigations is needed here to take into account environmental conditions which are peculiar to Canada and which affect changes in the properties of materials and operating efficiency.

In 1968, Fisheries Research Board published a list of highlights of its achievements over the years, with emphasis on those bearing directly on the fishing industry. Forty of the seventy items listed are in the field often referred to as "fisheries technology", and they include various activities concerning care and handling of fish from capture through to various end-products. Examples are preservation of chilled fish with antibiotics; freeze-drying of fish steaks; invention of a mechanical salt-fish washer which was widely accepted by industry; a method for extracting fat from fish, now in worldwide laboratory use; development of a process producing fish protein concentrate (FPC), superior in quality to that produced by parallel research in other countries; in co-operation with industry, invention of rapid, non-damaging pumps for larger fish like salmon; brine-spray freezing, an engineering achievement adopted by industry in tuna vessels.

In the category of fisheries resource utilization, the most useful recent developments appear to have been in fish preservation and handling techniques, improvements in products such as fish oils and meals, and to a lesser extent, the introduction of tests for fish quality. Numerous attempts to introduce new edible products have achieved little success, sometimes through lack of appeal, but often because of lack of demand through competition with foreign imports. Fisheries Research Board scientists have suggested a need for continued efforts to improve fish quality through comprehensive studies on the control of bacterial spoilage and undesirable alterations in frozen fish such as oxidative and hydrolytic rancidity, and protein denaturation. They also suggest that high priority be given to research on factors that predetermine how fish must be handled. This involves altering the processing, storage and other conditions to take into account the particular condition of the living animal at the time of capture. Special technology is needed for inland freshwater fisheries, and since relatively little work has been done on frozen or processed products or on transporting live fish, we consider that research in this area should be accelerated.

Improvements are needed in handling fish on Canada's comparatively small vessels. Research should involve engineering studies in applied and developmental work, for example on applications of insulating materials, particularly where fish are held in refrigerated sea water or in ice; also in loading, transferring, distributing and unloading devices to overcome laborious and often undesirable handling methods.

Currently interest in non-edible marine products is largely in the pharmaceutical field. A recent survey showed that over 47 per cent of all new prescriptions filled contain a drug of natural origin as the sole ingredient or as one of two or more ingredients. In August 1969, over 200 specialists in several sciences met at the University of Rhode Island for a conference on the progress and problems connected with mining the seas for drugs.

Emphasis was placed on the fact that the vast majority of all known forms of animal life are found in the sea, which it is expected will yield a proportionately rich harvest of medically useful chemicals. Well-known products now in use are alginic acid from algae and seaweeds and its salts (alginates), with a wide variety of medicinal properties.

Fisheries Research Board, Halifax is investigating marine products that have other than pharmaceutical uses; for example, attempts to discover new underwater glues by analysis of the secretions by which molluscs are anchored to stones, etc.

In Canada, as in other countries, there is little research input by companies engaged in fish processing. Either they conduct no laboratory work or simply maintain a small control laboratory. The industry has depended largely on research conducted by government and university laboratories and on research connected with other food industries such as dairies, egg and fruit processing. A similar situation, as far as research is concerned, exists in virtually every aspect of the industry. The argument that has prevailed is that the status of fish as a common-property resource essentially places the initiative on government to finance and conduct the research needed to support the industry and to maintain the resource. We consider that, in terms of the subjects discussed in this sector, the argument is quite illogical and should be thoroughly re-examined. We consider that, at the very least, co-operative arrangements should be involved, with the industry assuming primary responsibility for direction and operation of research establishments.

We suggest that the establishment of a *Fish Products Research Institute of Canada*, modelled after the Pulp and Paper Research Institute of Canada, be considered; we further suggest that consideration be given to transferring the Halifax and Vancouver laboratories to the proposed Institute.

VII.6 The Environment

Among fisheries agencies in Canada, expertise on the environmental effects of industrial programs on fish populations exists mainly in Fisheries Research Board and in the Resource Development Service of the Department of Fisheries and Forestry.[1] The Resource Development Service has been forced to build its expertise quickly because of the rapid expansion of the pulp and paper industry in British Columbia during the past six years. During this period, four large pulp mills were constructed on the Fraser River system and discharged their wastes into the system. A detailed report by RDS on the potential effects of the wastes was used as the basis for negotiations with the companies and "culminated in the installation of suitable effluent treatment facilities in all instances, establishing an important precedent for the future".[2]

The Resource Development Service and FRB have also gained considerable expertise in pesticide investigations as a result of studies of large-scale programs to control spruce budworm in New Brunswick and of lesser programs in other areas of the country. The New Brunswick control program began in 1952 and has been conducted continuously since that time. Studies on aquatic invertebrates, fish and wildlife have provided the knowledge on which negotiations for modification of the program have been based.[3]

The capability of the staffs of FRB and RDS to handle investigations asso-

[1]The range of activities in environmental studies is indicated by the reports of the RDS listed in the submission of the Ministry of Fisheries to the Special Committee of the Senate on Science Policy, No. 17, Ottawa, Queen's Printer, 1969.

[2]*Ibid.*

[3]Jackson, K. The role of the Department of Fisheries of Canada in dealing with problems presented by the use of pesticides in B.C. Canadian Fish Culturist, No. 38. 1968.

Kerswill, C.J., and H.R. Edwards. Fish losses after forest spraying with insecticides in New Brunswick, 1952-62, as shown by caged specimens and other observations. Journal Fisheries Research Board, Vol. 24. 1967.

ciated with pollution problems was demonstrated when the two agencies combined forces and showed that fish losses in Long Harbour and Placentia Bay had resulted from the discharge of elemental phosphorus from the Electric Reduction Company (ERCO) plant on Long Harbour.[1] The study included both chemical and oceanographic studies. Bioassays on cod, sticklebacks and herring demonstrated that the effluent from the plant was toxic and produced haemolysis of red blood cells. Studies also demonstrated that fish could not survive if mud from the floor of Long Harbour, near ERCO outfall, was placed on the bottom of aquaria. Analysis of the mud indicated the presence of elemental phosphorus and gave strong circumstantial evidence on the cause of the fish kills. Subsequently the contaminated mud over an area of approximately 160 acres was removed by suction dredge.

The ERCO plant returned to a full production schedule after remedial action in the treatment of effluents and completion of the dredging operation.

The most specific program of environmental studies being conducted by FRB at present is the one associated with the eutrophication of the Great Lakes. The investigations are being conducted by the Freshwater Fisheries Institute, which was established at Winnipeg in 1966. However, a proposed program, entitled *Pollution Control in the Fisheries Environment*, was distributed by the Department of Fisheries and Forestry to other agencies concerned on September 15, 1969. The recommended program also involves the Department of National Health and Welfare and the Department of Energy, Mines and Resources. Scientific activity in this field could become a much more significant part of research programs, since the report states:

"It is the responsibility of the Fisheries Research Board to provide knowledge and develop procedures that may be used by the Fisheries Service to accomplish its missions. The Board is primarily concerned with determining the efforts of developments, wastes and substances on fish and aquatic biota, defining pollutants and limits of tolerance, assessing and forecasting the distribution and concentration of pollutants, seeking counter measures to pollution and means of restoring impaired FISHERIES ENVIRONMENTS."

It is pointed out that efforts of the Fisheries and Forestry Ministry must be complementary to related work of other agencies (federal, provincial, university and private). When implemented, such a program should contribute to the maintenance of a quality environment. The whole program, as a federal anti-pollution package, would amount to $30 million annually. The implementation of this program would require a dynamic review of existing programs, since federal agencies have been instructed to give pollution and environmental studies high priority while maintaining expenditures at the 1968 level. If effective co-ordination is achieved between the three departments involved, the adjustments would be less traumatic than might otherwise be necessary.

At the provincial level, no fishery agency is actively engaged in environmental studies that are related to pollution problems. An increasingly strong effort is being made, however, by provincial fishery agencies to gain a more prominent role in regional planning, and in other decision-making processes which result in changes to aquatic environments through industrial developments or through the generation of energy from thermal or hydro sources. The demand is a reasonable one.

VII.7 High Points on Fisheries

Canada has gained a wide reputation for fisheries science; it is perhaps in this

[1]Divers engaged by the Department estimated that there were 15 million (± 50 per cent) dead fish, mostly cod, in an area of approximately 15 square miles in Long Harbour Inlet.

field of biology that we are best known. The reputation is largely based on the work of the Fisheries Research Board which dominates the total scientific pattern of activity. With increasing levels of use of fisheries resources both nationally and internationally, the emphasis in fisheries research has shifted from background biology to population dynamics and recently to awareness of social and economic factors in management. Similarly, the demands of modern food technology have shifted research from the simple essentials of canning and preserving to the complex biochemistry of marine products. The increasing tempo of use of other resources in Canada has created needs for knowledge of mechanisms of natural productivity and the effects of a multitude of natural and unnatural materials on the physiology and behaviour of aquatic organisms. The total picture of current fisheries research is thus very broad, and reflects a diversity of species, environments, technologies and resource use problems.

In these exploding circumstances, the necessity for clearmindedness about priorities has become widely recognized and has been brought into sharp focus by some particular problems such as herring management on both coasts and the decline of the Great Lakes fisheries. At the same time, it has become clear that research has opened up possibilities for developing particular fisheries for which Canada has a good competitive market base. Pacific salmon are the prime example, for which there is a good sale, and production of which can be artificially enhanced at favourable cost-benefit ratios. Provided that favourable international arrangements can be maintained, research and management expenditures on salmon should be adequately rewarding. There are similar opportunities for oyster culture on both coasts. The market is good, the techniques are largely known, the environments are satisfactory. Expenditures in development should pay off.

Otherwise, marine fisheries are largely maintenance operations for which Canadian scientific activity is at present largely justifiable as the necessary price for domestic management and (or) joint management in competitive international fisheries.

Freshwater fisheries have an apparent potential in Canada because of the great reservoirs of fresh water in the country and because of the occurrence of unique high-quality species. Consequently, scientific activities are not undertaken for reasons of lack of substantial commercial productivity. In recent years, the chief justifications of research and management have been the growing sport fisheries and the problems of maintaining quality aquatic environments. In this direction, the present levels of effort are inadequate to meet current problems. It is notable that hatcheries continue to provide consolation to management and anglers, even though there is abundant evidence that in a large number of cases the plantings of fish are an expensive but useless ritual in terms of providing fish for anglers to catch. Extensive evaluations are needed.

The major exception to the general freshwater pattern is the Great Lakes, where size and accessibility to large markets compensate for the low natural productivity of northern waters. The story of the Great Lakes is sufficiently familiar that it requires no documentation to be labelled as an epic case of man's mismanagement of natural environments. The opening of the upper lakes to lamprey, the acceleration of eutrophication, overfishing, and the inadequacy of fisheries research and management programs have resulted in a fishing industry in a depressed and chaotic state. It is scarcely surprising that the present situation is distressing and that Canada may well be committed to an ill-advised pattern of scientific activity. An extensive review is very much needed.

In the field of fisheries technology, Canada is notably deficient in work on gear for catching fish, and notably pro-

ficient in sophisticated modern biochemistry. The deficiency in gear research should not be cause for alarm–there is an abundant literature on which we can profitably draw. There is also a substantial record of FRB achievement in fish handling and good product research. The biggest needs are for industry to get into this kind of research work themselves and get on with the implementation of modern methods of putting high-quality products on consumers' dinner plates. The modern biochemical work at FRB laboratories could be profitably expanded to give Canada a jump in the competitive field of the exploitation of new chemical products from the sea. To bring maximum efficiency to the food technology aspects of Canadian fisheries, the formation of a Fish Products Research Institute of Canada, which would combine government and industry contributions, is suggested.

Chapter VIII

Scientific Activities in Wildlife

VIII.1 Perspective on Research and Management

Wildlife research in Canada is of much more recent origin than fisheries research. Virtually no scientific studies of wildlife were conducted by government agencies before World War II. Game departments and commissions began a slow transition to broader management programs which recognized the need to understand the ecology of the animals to be managed, besides enforcing laws and controlling predators. Research was recognized as the means to provide the knowledge for management. But, not many agencies gave much consideration to exactly what knowledge was needed or what kind of programs should be undertaken.

In the immediate post-war days, when the Canadian Wildlife Service (CWS) existed as the Migratory Bird Section of the National Parks Branch, its field staff consisted of five officers who administered all federal responsibility in the Maritimes, Quebec and Ontario, the Prairies and British Columbia. They were a group of keen, hard-working individuals who contributed a great deal to our knowledge of the occurrence and distribution of the wildlife of Canada. After their retirement, the Wildlife Service replaced them with men who were trained along more formal lines; in addition, the Service began to build up a small force of staff specialists in birds and mammals.

During the late 1940s, there was a great deal of uncertainty about the status of barren-ground caribou; it resulted in the Wildlife Service playing a leading role in the development of a co-operative federal-provincial research and management program for this species. This was a mission-oriented program which was pursued actively for many years.[1]

The majority of the programs conducted by the Canadian Wildlife Service were studies on the ecology of particular species and were not oriented to provide information of immediate importance to management. A number of the studies have provided important base line data on the ecology of particular species.[2] Since most studies were conducted in the Arctic or sub-Arctic, they served an important secondary function of developing staff who knew Canada well, particularly the North, and who were capable of serving the federal government in many different capacities.

Staff increases in the 1960s made the need for new approaches apparent; somewhat different emphasis on the role and nature of research during the past five years gives evidence of adaptation to changing needs. The decentralization of the Service put both research and management arms under regional supervisors for the eastern and western regions. The change appears to be gradually resulting in programs which are more strongly oriented to provide answers to questions of immediate concern to management.

The development of wildlife research and management programs in Ontario approximately paralleled the rate of development in the Canadian Wildlife Service. The development was slower in the other provinces, with the main surge coming in the 1950s and early 1960s. Ontario is the only province which separates its research staff (Research Branch) from its management staff (Fish and Wildlife Branch). In all other instances, they are a part of the game or wildlife agency.[3] In some cases, as for example Newfoundland, Nova Scotia and New Brunswick, the wildlife biologists serve in multiple capacities and are not listed as research or management biologists.

[1]The most recent publication by J.P. Kelsall (The migratory barren-ground caribou of Canada. Ottawa, Queen's Printer, 1968) includes a complete bibliography of the published and unpublished reports of work associated with this program.

[2]Two prominent examples are by L.M. Tuck (The Murres, their distribution, populations and biology, 1960) and J.S. Tener (Muskoxen in Canada, a biological and taxonomic review, 1965). Both published by the Queen's Printer, Ottawa.

[3]Dymond, J.R. The organization of wildlife and fisheries research in Canada. Resources for Tomorrow Conference, Vol. 2. Ottawa, Queen's Printer, 1961.

VIII.1.1 Research Needs and Relationships

"The knowledge and understanding demanded for the successful management of any species increases directly with the pressure of human induced circumstances on it.

"In a rapidly developing country such as Canada, where the use pattern is proceeding directly from the primal nomadic hunter culture through the agrarian to the urban industrial culture, a much greater understanding is paramount. The interference with native habitats and wildlife species, destruction and creation of wildlife habitats, the growing demands on wildlife to supply recreation rather than food and clothing, have presented a constantly increasing demand for information of an ever more sophisticated nature in order merely to meet the day to day needs of designing management practices."[1]

The fundamental objectives of wildlife research are to determine the kind, number and nature of the factors which affect the numbers of wild animals. Although "wildlife" is quite frequently interpreted so broadly that even reptiles and amphibians are included, in practice it has generally meant birds and mammals. The present status of research on wildlife has been influenced by the large number of species and by the variety of habitats in which they live. Only rarely has research provided an adequate basis for precise management predictions.

Wildlife has interested man in many ways. In various times and places the same animal has been classed as: a) a game animal, b) a non-game species, c) a pest. The objectives of scientific activity dealing with the three classes of wildlife are obviously quite different. Research on game animals and pests begins by considering factors which control the size of populations and then diverges to a variety of programs designed to provide the basis for the management of the species. In the case of a pest, the goal is usually to decrease numbers or to influence patterns of behaviour. In the case of wildlife which serves primarily as a recreational resource, scientific activity centres around three fairly specific areas:

a) ensuring adequate-sized populations to produce the desired "spectacle";

b) assessing the impact of man's activity on the environment;

c) satisfying curiosity about animals and their way of life and thus enhancing awareness and enjoyment of the environment.

Wildlife research is potentially a large area of scientific activity, involving studies with a variety of objectives, on a large number of species in a wide range of habitats. The common theme is the enhancement of knowledge of a resource which has both economic and aesthetic values.

VIII.2 Determining Species and their Distribution

Before any resource planning can be undertaken, it is essential to know what species are present. We now have first approximations of the kinds of animals likely to be found in any part of Canada, but much more precise data are needed, particularly for areas where the environment may be modified. It is important that we acquire adequate background of all species which are, or could be, endangered by human activity. More thorough knowledge is also needed on the distribution of species, their habitat requirements, and their relations to other species found in the same habitat.

Faunal surveys have a longer history than any other aspect of wildlife activity in Canada. They have provided much of the background knowledge on the occurrence and distribution of species in the remote areas of the country. They have been conducted primarily by the National Museum (which has done

[1]Cowan, I. McT. A review of wildlife research in Canada. Resources for Tomorrow Conference, Vol. 2. Ottawa, Queen's Printer, 1961.

much of the survey work in the Territories) and by provincial museums, of which the British Columbia Museum and the Royal Ontario Museum have been most active.

In the more accessible areas of the country, knowledge of the fauna has been greatly increased by the recording of "casual" observations of amateur and professional naturalists and by more intensive zoogeographic studies which often involve live or dead trapping methods. The results of these observations and studies are frequently published in the *Canadian Field Naturalist*, *The Blue Jay* or *le Naturaliste Canadien* but also as museum, wildlife service publications and scientific papers in North American journals.

The data from all these sources are often published as faunal catalogues[1] and as major faunal surveys of the country or of specific regions or provinces. Canada is fortunate in having scientists working in this field who are devoted to the concept of publication. Within the last two decades, a number of major works, such as *The Birds of Canada*[2] and *The Mammals of Eastern Canada*[3] have appeared, as well as many books on the birds and mammals of provinces and regions.

However adequate the level of publication by individual scientists, the total effort for the nation has been pitifully small. The support of scientific activity of museums has always been at a bare subsistence level, and it would be very difficult to find an area of the country where either survey data or museum reference collections are adequate. The history of the National Museum written for the Senate Special Committee on Science Policy by A.W.F. Banfield[4] is a shocking record of the lack of regard that Canada has shown for the need to acquire detailed knowledge of its fauna and flora. The folly of the course that has been pursued is perhaps best exemplified by the North where we are entering a period of intensive exploration and development of resources with a very inadequate knowledge of the fauna and ecology of the region.

The scientific activities of provincial museums and of the National Museum, in particular, should be more adequately supported. We consider that the National Museum should assume the role of conducting and promoting comprehensive faunal surveys and should maintain national collections of an adequate nature for both fauna and flora. We consider that field investigations should extend to the level of the community and that the densities of various species should be determined, over at least a 10-year period, for "type" habitats in various areas of the country.

VIII.3 Estimating the Size of Populations

During the course of discussions in various parts of the country, wildlife biologists often mentioned the need for better methods of estimating wildlife populations. The same point was seldom raised by fishery biologists who, having to deal with organisms living in an opaque medium, settle for ways of determining the effect of exploitation on the population and are less inclined to attempt to learn the exact number of animals in a population.

On the wildlife side, there are many levels of management which do not require a knowledge of absolute numbers. We suggest that considerable attention should be given to this matter, so that money is not spent unnecessarily on intensive studies of species where priority ratings are not warranted. Knowledge of population density in terms of absolute numbers is often desirable and some-

[1]For example, Anderson, R.M. A catalogue of Canadian recent mammals. National Museum. Ottawa, King's Printer, 1946.

[2]Godfrey, W.E. The birds of Canada. Ottawa, Queen's Printer, 1966.

[3]Peterson, R.L. The mammals of eastern Canada. Toronto, Oxford University Press, 1966.

[4]Report No. 40. The scientific policies and programs of the National Museum of Natural Sciences, Ottawa, Canada. 1969.

times basic to three major areas of activity:

a) the protection of endangered species;

b) the management of species which are being intensively exploited;

c) the development of models which deal with the interaction of the various components of communities.

The enumeration of rare or endangered species encompasses all degrees of difficulty from very simple to extremely difficult. Examples are the whooping crane and cougar. The number of whooping cranes can be exactly determined on their nesting grounds in Wood Buffalo Park, on migration and on their wintering grounds on the Gulf of Mexico. The cougar has been extant in New Brunswick for over 20 years, but little is known about the size of the population and it is unlikely that the information will be gained in the near future. Direct counts can also be made of birds of prey such as hawks, owls, osprey and eagle, but since they occur over such a wide area, government agencies alone cannot possibly maintain data on changes in their numbers. Naturalists, through an annual Christmas bird count, are maintaining an extensive monitoring program on the relative numbers of a large variety of birds of prey and other non-game species. Many naturalist organizations in Canada participate in this "census".

Counts, or even estimates, are not usually feasible for other non-game forms of mammals, reptiles or amphibians and new methodology is greatly needed. One of the most promising approaches was developed in a graduate program at the University of Montreal. It involves the determination of relative numbers based on the movements of animals across a specially prepared sand transect.[1] The method also has considerable potential for community studies and will be referred to later in this respect.

Aerial surveys have been used extensively in Canada to obtain data on populations of big-game animals, waterfowl and fur-bearers. Since the end of World War II, much use has been made of this technique to conduct waterfowl production surveys in May and June and post-hunting season counts on wintering grounds. In spite of almost 25 years experience with aerial censusing of waterfowl, the estimates produced are quite inexact.

The problems of conducting surveys on the principal prairie breeding grounds in western Canada are not as complex, but results are influenced by a vast array of variables. A review paper and subsequent discussion of it, at a wetlands seminar in Saskatoon in 1968, makes it very evident that considerable attention should be given to the problem of developing satisfactory census methods in western as well as eastern Canada.[2]

Aerial censuses of big-game have been conducted almost entirely when animals are on their winter range. Pioneer studies on methodology have been conducted in Canada on caribou and moose, both in the use of direct visual methods and in combination with the use of aerial photographs.[3] From direct aerial observations, later combined with aerial photography, wildlife censusing is now moving into studies of the possibility of utilizing remote sensing. The pioneering work in this area in Canada is being undertaken by the Research Branch of the Ontario Department of Lands and Forests which is testing an infrared line scanner for the censusing of big game.[4] The Ontario work is valuable in that it serves to keep the wildlife field abreast of the potential of new equipment.

[1]Bider, J.R. Animal activity in uncontrolled terrestrial communities as determined by a sand transect technique. Ecological Monographs 38. 1968.

[2]Canadian Wildlife Series, Saskatoon Wetlands Seminar. Ottawa, Queen's Printer, 1969.

[3]Several studies are listed in the publications. Thomas, D.C. Population estimates of barren-ground caribou, March to May 1967. Ottawa, Queen's Printer, 1969.

[4]Wildlife Section Report. *In* Annual Project Report of Research Branch. Ontario Department of Lands and Forests. 1969.

VIII.4 Determining the Factors which Affect Numbers

"Wildlife management is the manipulation of populations of animals and men. It follows, therefore, that an understanding of the nature and mode of action of all the forces that interact to build, destroy, and maintain an animal population is fundamental to the task.

"More studies are needed which attempt the analysis of all forces acting on and within a population to influence its size."[1]

Animals are born and eventually they die. Since only by these "occurrences" can the numbers of animals be established, biologists spend a great deal of time and effort on studies aimed at determining what factors influence the birth rate and death rate of animal populations. Once understanding is gained of the way regulating factors operate, there are several management activities which can be undertaken to increase or decrease numbers, or simply to make available more animals to hunters while maintaining populations in a relatively stable state.

VIII.4.1 Productivity and Predation

Studies of the reproduction of a species can be undertaken simply to learn what the birth rate (gross productivity) is for the species in some geographic area; they are also used to give an indication of the environmental forces acting on a population. Knowledge from any of the three areas of study may be of considerable value to management.

Through productivity studies, Newfoundland learned that a prevalent North American belief that moose populations always contain a high incidence of barren cows was fallacious. It was demonstrated that it was possible to shoot as high as 25 per cent of the population each year.[2] The knowledge on productivity rates and interrelated understanding of range conditions resulted in the establishment of regulations under which the annual kill of moose was increased from less than 3 000 in 1950 to over 7 000 in 1968.

The Newfoundland research, and studies of a similar nature in British Columbia and Ontario, made a considerable contribution to the establishment of more liberalized hunting regulations for moose in North America. The result has been continent-wide increases in kill which have been of comparable magnitude to those achieved in Newfoundland.

In the case of caribou which can be more readily observed, and where adequate samples of mandibles are often difficult to obtain, the data on productivity are usually based on adult:fawn or doe:fawn ratios obtained from aerial observations often complemented by aerial photographs. The Canadian Wildlife Service, Newfoundland and Quebec, has been most active in the conduct of productivity studies by these means.

Ontario's studies of productivity in deer, based on the age structure of animals in the kill, showed that very heavy mortality of fawns occurred during winters when snowfall was above average.[3] The influence of predators on the productivity of big-game animals has also been studied in Ontario[4] where the principal prey species of wolves were deer, beaver and moose, and in Newfoundland, where lynx were preying on caribou calves on the calving ground. Wolf predation on caribou was also studied in the Northwest Territories but, unfortunately, not until the wolf population had been subjected to intensive control during the 1950s.

Through productivity studies conducted on the calving grounds and by means of

[1]Cowan, I. McT., *op. cit.*

[2]Pimlott, D.H. Reproduction and productivity of Newfoundland moose. Journal of Wildlife Management, Vol. 23. 1959.

[3]These data have been issued annually either as mimeographed or multilithed reports by the Fish and Wildlife Branch, e.g. Cumming, H.G. Deer hunt in Ontario. Department of Lands and Forests. 1968.

[4]Pimlott, D.H., J.A. Shannon, and G.B. Kolensky. The ecology of the timber wolf in Algonquin Provincial Park. Ontario Department Lands and Forests Res. Rep. (Wildlife) No. 87. 1969.

aerial surveys and assessment of mandible collections, Newfoundland determined that the interior herds of caribou were being limited by low calf production. Investigations traced the following sequence of events:

"A lynx stalks a young calf and bites it on the neck; frequently the doe drives the lynx off. If the calf escapes it develops an abscess on the neck from an infection of *Pasteurella multocida* that is present in the mouth of lynx. Calves usually die from the infection within 7 days after being bitten."

An experiment was devised to test a hypothesis that low calf survival was caused by lynx predation:

"To determine if a reduction of the lynx population on the calving grounds could improve calf survival, a winter lynx trapping program was carried out at Middle Ridge. A total of 44 lynx were killed by four trappers. Only three lynx were taken in the last month of the program.... Approximately 90 per cent of the calves were still alive at three weeks of age at Middle Ridge while on the Pot Hill calving grounds, where trapping was not carried out, 50 per cent of the does lost their calves to the lynx predation-disease syndrome by three weeks of age."[1]

Lynx have been controlled on the calving grounds for the past five years. The interior herds have increased steadily and the total population was estimated in 1968 at 12 000 animals, up from approximately 7 500 in 1965. The increase was attributed to the removal of lynx predation as a primary limiting factor on the increase of the herds.

Many studies of the factors which influence the productivity of ducks and geese have been conducted in Canada during the past 25 years. In the case of ducks, the U.S. Fish and Wildlife Service[2], staff and students of the Delta Waterfowl Research Station[3] and graduate students of various universities[4] have been most active. The Canadian Wildlife Service and provincial agencies have played a relatively minor role.

The reproductive success of waterfowl is particularly prone to the influence of climatic factors (drought is particularly significant) and possibly to predation. Mortality from predation results from the interaction of many different species. However, its effect as a population depressant has only been clearly demonstrated in one study in the United States.[5]

Dr. A.H. Hochbaum (Delta Waterfowl Research Station) believes that hunting of ducks in drought years, when reproduction has been poor, is a particularly significant force in the limitation of surface feeding ducks which breed in the Prairie Provinces. He advocates intensive restriction of hunting in dry years as a means of maintaining waterfowl at high levels of population.[6]

VIII.4.2 Basic Population Studies

A group of "wildlife" studies being conducted in Canada can be classified under the broad category of basic population studies. Some cannot be readily separated from mission-oriented productivity and predation studies that have, as a primary

[1]Bergerud, A.T., *et al.* Wildlife management. *In* Annual Report of the Newfoundland Department of Mines, Agriculture and Resources, 1965.

[2]Very little of this work is available in published form.

[3]Hochbaum, A.H. The canvasback on a prairie marsh. The American Wildlife Institute. 1944. Travels and traditions of waterfowl. University of Minnesota Press, 1955. *Also* Sowles, L.K. Prairie ducks. Wildlife Management Institute. 1955.

[4]The work by L.B. Keith (A study of waterfowl ecology on small impoundments in southeastern Alberta. Wildlife Monograph No. 6. 1961) was mentioned most frequently as one of the best recent examples of a population study.

[5]The subject of predation on waterfowl is reviewed in: Pimlott, D.H. Predation and productivity of game populations in North America. Proceedings of the IX Congress of the International Union of Game Biologists. In press.

[6]Hochbaum, A.H. Delta Waterfowl Research Station. Conservation Catalyst. Vol. I. No. 2. 1966; *and* The effect of concentrated hunting pressure on waterfowl breeding stock. Transactions of the 12th North American Wildlife Conference. 1949. *Also* personal communications.

objective, the production of more game for hunters.

Snowshoe or varying hare, lynx, arctic and red foxes, lemming, snowy owls, ptarmigan and ruffed grouse are some of the best examples of species whose populations fluctuate in a cyclic fashion. Since they all occur over wide areas of Canada, their presence has generated considerable enthusiasm among Canadians for research, in the nature and periodicity of cyclic phenomena and on the factors which cause the fluctuations.

Although the fur trade had been aware of the 10-year cycle for over 100 years, the interest of biologists was sparked in 1924 by a British ecologist, Charles Elton, who studied the fur returns of the Hudson's Bay Company. Much of the subsequent work was done during the 1930s and 1940s in Canada, much of it by Canadian scientists. Studies on the cycle of ruffed grouse and varying hare were conducted as Ph.D. studies at the University of Toronto in the 1930s, and at the University of Alberta by W. Rowan, a zoologist who was particularly well known for his studies of bird migration. Rowan's work developed the interest of a student, L.B. Keith, who later wrote a comprehensive review on the 10-year cycle.[1]

The fluctuations of small mammals, lemmings in particular, have also been the subject of research in Alaska and northern Canada. In common with the studies of the 10-year cycle, research on small mammals has reached the stage where investigations are seeking to determine the mechanisms which cause the fluctuations. The most comprehensive work on small mammal populations is being done at the University of British Columbia and at the University of Alberta.

Two species of upland game birds, blue grouse and ptarmigan, are being studied in long-term research programs in Canada; a study of blue grouse in British Columbia is being conducted by university scientists whose primary objective is to elucidate the action of population mechanisms.[2] The primary objective of the ptarmigan study in Newfoundland was to obtain the knowledge on which management programs could be based.

In big-game, studies intensive and long-term enough to warrant classification as population studies are the barren-ground caribou studies of the Canadian Wildlife Service, the moose and caribou studies of the Newfoundland Wildlife Division and the white-tailed deer work of the Ontario Department of Lands and Forests.[3]

During the past 18 years, goose populations which nest in the Canadian Arctic have been studied quite thoroughly. The program of research was described to the Senate Committee in these terms:

"This program began in 1952 and is continuing. It consisted of studies of the greater snow goose, lesser snow goose, blue goose, Ross' goose, white fronted goose, Atlantic brant, black brant and two races of Canada geese. This is a coordinated program which for each species listed above has moved from basic to applied to developmental research. For all species listed, the basic research has nearly been completed. The core of the eleven man team who attacked this problem was provided by three Canadian Wildlife Service Scientists and by five contractural scientists. A total of eight Ph.D. theses will have resulted by 1969-70, as well as 80 publications. Major contributions in basic research have been in the areas of popu-

[1]The book by L.B. Keith (Wildlife's 10-year cycle. University of Wisconsin Press, 1963) includes a complete listing of the literature on animal cycles in America.

[2]The report by J.F.S. Bendell and P.W. Elliott (Behaviour and the regulation of numbers on blue grouse. Canadian Wildlife Service. Ottawa, Queen's Printer, 1967) reviews some of the pertinent theory and work in this field.

[3]A number of the publications which have resulted from the Canadian Wildlife Service and the Newfoundland programs have been cited elsewhere. There have been no major publications on the Ontario work, although studies have been in progress for almost 20 years.

lation genetics, mortality tables, environmental control and reproductive success, physiology of migration, nutrition."[1]

VIII.4.3 Diseases and Parasites

"The study of wildlife diseases continues to be one of the most fruitful and potentially important areas for research. As yet we have only the most superficial knowledge of parasites and diseases of wild animal species and know almost nothing about the epizootology of diseases in wildlife. Discoveries in this area are a vital prerequisite to the final elucidation of the mechanisms underlying the quantitative behaviour of animal populations".[2]

Among government wildlife agencies, research on diseases and parasites has been conducted primarily by the Canadian Wildlife Service (Pathology Unit) and by the Ontario Department of Lands and Forests (Wildlife Section of the Research Branch). Research on wildlife parasites is, however, also being conducted in several universities.[3]

The Canadian Wildlife Service has current studies on the diseases and parasites of arctic fox, bison, wolf and beaver.[4] There was evidence in 1962 of the truth of Cowan's statement that "we have only the most superficial knowledge of parasites and diseases of wild 'animals' when anthrax occurred in bison in the Northwest Territories." It was the first recognized occurrence of the disease in Canada and resulted in the known deaths of 281 bison in 1962. The Canadian Wildlife Service has now established a control program.

The Ontario program has included an intensive survey to determine the status of the kidney worm in wild mammals in Ontario, periodic reassessment of the diseases and parasites of beaver from a specific area of the province and research on rabies in foxes.[5]

The most significant program of research on wildlife parasites in the post World War II period has been conducted by members of the Department of Parasitology of the Ontario Research Foundation. The Department, which has now become part of the School of Hygiene of the University of Toronto, conducted field aspects of its research programs primarily in Algonquin Park. Major areas of research included protozoan life cycles and epizootology, the biology of pharyngeal botflies, hippoboscid flies, trematode parasites and of the meningeal worm of white-tailed deer and moose. Among wildlife circles, the group is best known for studies of protozoan parasites[6] and of the meningeal worm.

VIII.5 The Environment

Over the long term, the greatest challenge to wildlife management specialists is to maintain the places where animals live and to control hazards to the environment.[7] The wildlife field has not responded in a very dynamic way in the conduct of research or in development of programs of habitat management. The latter has not been easy to bring about because: a) wildlife usually live on land primarily used for agriculture or forestry and b) management of habitat is expensive. But the problems faced by management should have stimulated research on the influence of environmental factors and on other environmental questions, because they established the need for biologists to be able to offer advice on ways and means of ameliorating the impact of development programs on wildlife.

[1]Proceedings of the Senate Special Committee on Science Policy. No. 31. Ottawa, Queen's Printer, 1969.

[2]Cowan, I. McT., *op. cit.*

[3]The National Research Council's annual report on support of university research for 1968-69 lists programs at U.B.C., University of Alberta, McMaster University and Memorial University. In addition, programs exist at the University of Guelph and at the University of Toronto.

[4]Pathology Unit Report. *In* Canadian Wildlife Service, 1966. Ottawa, Queen's Printer, 1967.

[5]Wildlife Section Report, *op. cit.*

[6]Some of the studies are reviewed in: Fallis, A.M. Protozoan life cycles. American Zoologist, Vol. 5. 1965.

[7]Fuller, W.A. Emerging problems in wildlife management. Resources for Tomorrow Conference, Vol. 2, 1961. *See also* Chapter IX. The influence of resource development on fisheries and wildlife. 1961.

VIII.5.1 Climatic Factors

A country which has the range of climatic conditions that exists in Canada, and the number of species which are at either the northern or the southern limit of their ranges, should have a deep awareness of the way climate influences the distribution and abundance of animals. In Canada, conditions in winter appear to be of particular significance to big-game animals and studies have been conducted in five provinces and the Northwest Territories.[1]

The Canadian Wildlife Service has also conducted studies on the influence of adverse weather on the survival of caribou calves.

VIII.5.2 Habitat Investigations

Until this decade, studies of wildlife habitat in Canada have been of a short-term nature, conducted as peripheral aspects of population programs. Some of the earlier studies of this nature were conducted in Ontario, the Northwest Territories and Newfoundland.

Waterfowl habitat programs conducted by the Canadian Wildlife Service were reviewed in 1966.[2] The two of greatest significance were: a) a wetlands habitat investigation program conducted in Saskatchewan in co-operation with the Saskatchewan Research Council between 1962 and 1966[3] and b) a study of the delta marsh complex conducted by the Canadian Wildlife Service in co-operation with the Manitoba Wildlife Branch and Delta Waterfowl Research Station. The project also included an engineering study by a consulting firm. A report was made in 1967; however, no action has been taken to implement it.

Major big-game habitat investigations are now being conducted in a number of areas in Canada. They include studies by the Canadian Wildlife Service on barren-ground caribou and big horn sheep, and by Ontario and Quebec on deer and moose. The Ontario work is perhaps the most comprehensive. It is being conducted by the Fish and Wildlife Branch of the Department of Lands and Forests and is being done by a team of scientists including a wildlife biologist, a forester and a plant ecologist.

Knowledge of the availability and distribution of habitat for big-game (ungulates) and waterfowl in the relatively accessible areas of Canada is being advanced by the Canada Land Inventory program which is discussed in the next section.

VIII.5.3 Land Capacity Inventories

At the Resources for Tomorrow Conference in 1961, a program of land capability studies was recommended by the workshops on agriculture, forestry, wildlife and recreation. The recommendations resulted in a joint statement by the research co-ordinators:

"The Conference affirmed the following needs:

"1. To complete a country-wide assessment of resource supplies which may be set against long-term assessment of resource needs.

"2. To make possible systematic studies of:

"(a) Problems of resource management and development in all fields; and

"(b) Economic potentials and social needs in all regions."[4]

Two years later the federal government approved the proposal for a comprehensive inventory of the land resource. Under this program the land capability for agriculture, forestry, recreation and wildlife are recorded along with aspects of present land use.

In general, areas which are particularly suitable for non-consumptive use of wild-

[1]For example, Pruitt, W.O., Jr. Snow as a factor in the winter ecology of barren ground caribou. Arctic, Vol. 3. 1959; and Desmeules, P. The influence of snow on the behaviour of moose. *In* Travaux en cours en 1963. Rapport n° 3. Ministère du tourisme, de la chasse et de la pêche, Province du Québec. 1964.

[2]Land management and wildlife. *In* Canadian Wildlife Service, 1966. Ottawa, Queen's Printer, 1967.

[3]*See papers by* Miller, J.B. *In* Saskatoon Wetlands Seminar. Ottawa, Queen's Printer, 1969.

[4]Statements by Research Co-ordinators. Resources for Tomorrow Conference, Vol. 3, Appendix II. 1962.

life are mapped on recreation maps. These include important seasonal concentrations of animals in rookeries or nesting sites, such as the many gannet, puffin, and auk island nesting grounds along the Atlantic coast.

The Land Inventory could herald a new era of rational land-use policies since they will help to bring to public attention areas which are of particular value for the survival of wildlife or for scientific or aesthetic uses. An example of this sort exists in the Prince George area map where there is only 1 square mile of prime waterfowl habitat in the 4 000 miles covered by the map. Recognition of the scarce nature of waterfowl habitat should enable land-use planners to protect the area from development.

The need for an inventory method which can be utilized quickly and economically to appraise large areas has been recognized in the development of the Biophysical Land Inventory. We consider that opportunities to test its value should be sought to determine its usefulness for appraising land capabilities in remote areas of the country.

VIII.5.4 Habitat Acquisition and Easement Programs

In 1963 the Canadian Wildlife Service began a four-year pilot program to determine the feasibility of maintaining wetlands habitat by entering into agreements with landowners and through a limited program of acquisition. Two years later, in May 1965, the Canadian Council of Resource Ministers discussed and approved a National Wildlife Program. At the Federal-Provincial Wildlife Conference a month later, the Honourable Arthur Laing, Minister of the Department of Northern Affairs and National Resources, announced that the federal government would spend $5.1 million for 10 years on the easement program and $400 000 for 5 years on acquisitions.[1]

The objective of the easement program was to maintain at least two-thirds of the 6 million ponds on the prairies as waterfowl breeding habitat. By 1969, after two years of the program, $469 640 had been spent on the easement program, approximately 5 per cent of the money that was to have been allocated for that period. The acquisition program was at a somewhat higher level than the one proposed, and totalled approximately $2.6 million for the first three years of the program; it is estimated that it will reach $10 million over a 10-year period.[2]

Our investigations indicated that the reduction in the land easement program was caused by several developments of which the austerity program was most important. It resulted in a freeze on expenditures for new programs and new staff. Additional factors were rigid Treasury Board requirements on the description of land to be taken and escalation of land values. The latter necessitated a review of objectives, particularly those related to obtaining easements on a total of 4 million potholes. One analysis suggested that it would cost in excess of $33 million if the land easement program was to be extended to cover the original area proposed.[3]

The Canadian Wildlife Service has developed a revised program to preserve wetlands. It will be based on information from the Canada Land Inventory. The program recognizes the problems of preventing drainage of the most productive agricultural lands (C.L.I. Class 1) and will be concentrated on Class 2, 3 and 4 agricultural lands which are in the greatest danger of being drained. The interaction of agriculture and waterfowl is discussed further in Section X.5.2.

The acquisition of land for other forms of wildlife is not very common in Canada. It has, however, become a necessity in British Columbia where the Fish and

[1]Laing, Hon. A. Wildlife is for people. Transactions of the 29th Federal-Provincial Wildlife Conference. 1965. The program was described to landowners in a leaflet published by the Canadian Wildlife Service and titled *Dollars from Wetlands*.

[2]Perret, N.G. The federal wildlife land easement and acquisition program. Transactions of the 33rd Federal-Provincial Wildlife Conference. In press.

[3]Stephen, W.J.D. Research requirements for the establishment of wetlands preservations objectives. Canadian Wildlife Service. Mimeograph. 1969.

Wildlife Branch of the Department of Recreation and Conservation and the Okanagan-Similkameen Parks Association have begun to purchase land in two areas where the winter range of California big horn sheep is seriously overgrazed. (See also Section X.5.2.)

VIII.5.5 Pesticides

Research on the effects of pesticides on wildlife is an area which has been left almost entirely to the Canadian Wildlife Service. In 1968-69 the National Research Council made two grants totalling $11 070 to university scientists; their work represented the only non-federal studies of the effects of pesticides on wildlife.[1]

The Wildlife Service began to study the effects of wildlife in the early 1960s, and in 1962 a Pesticide Section was created. There are now four scientists in the section. From 1966 to 1968, the pesticide operating budget increased by 300 per cent to $192 000; approximately half of the 1968-69 pesticide budget was for extramural contracts, mostly for testing for residues in wildlife species; approximately one-fifth of the 1968-69 budget was spent on studies related to the New Brunswick budworm project. An account of the activity of the section was given in *Canadian Wildlife Service, 1966.* The Division of Wildlife Research of the United States Fish and Wildlife Service has a limited program of research on pesticide-wildlife relations which complements programs of research undertaken in Canada.[2]

We consider that the support of research on effects of pesticides on wildlife is inadequate and should be greatly expanded. A paragraph in a recent editorial in the *Canadian Field Naturalist* referred to the effectiveness of research on environmental effects of pesticides and other forms of pollution during the past 20 years, and urged consideration of dynamic approaches in the future. It stated the case in terms which we support:

"The central significance of environmental pollution research is that it has hopelessly failed. For these decisive studies showing critical DDT effects in Europe and North America come after twenty years of large-scale DDT use and small-scale side effect research, and at the point where, in these countries, DDT use is declining anyway and ironically for different reasons, principally the development of resistant strains of insects. If environmental pollution research cannot be supported to a much greater and more coherent extent in the future, and so achieve results in time spans that have any relevance to the problems, then this research is merely a sop to the conscience of the scientific community, a pretense with no real function in resource management."[3]

We deal again with aspects of pesticide questions in the next chapter.

VIII.6 Other Areas of Interest

VIII.6.1 Community and Ecosystem Studies and the Systems Analysis Approach

Community and ecosystem studies are aimed at understanding the factors which affect population fluctuations and the interrelations between components. Two Canadian field groups are making significant contributions in this relatively new approach to wildlife research. The Rochester Field Station in Alberta, which was previously mentioned, is privately owned and is supported by the University of Wisconsin, the Government of Alberta, and research grants from American funding agencies. The only Canadian support is by the Alberta government. The Lac Carré field station in Quebec is also privately owned and all major projects have been supported through National Research Council operating grants. A

[1]Annual report on support of university research, 1968-69. NRC of Canada. 1969.

[2]The research is summarized each year in: Wildlife research problems programs progress. U.S. Dept. of Interior, Superintendent of Documents, Washington, D.C.

[3]Keith, J.A. The DDT affair. Canadian Field Naturalist, Vol. 83. 1969.

laboratory was donated to the station by Montreal Anglers, Inc., through Macdonald College. At this station the "sand transect technique" was developed. It was designed to study the role of biotic and physical factors which affect all components of the community. The greatest asset of the technique is that data on all species (beetles to moose) are gathered simultaneously and expressed in the same unit of measurement.[1] Recent work using the technique is providing new insights into old problems by testing many assumptions about animals which were previously taken for granted.

Computers and systems analysis techniques bring a new power of gaining insight and making predictions. Essentially the computer allows empirical study of complex systems that are as yet beyond the techniques of formal analysis. A simple example is the riddle of how best to harvest a population which is exposed to varying climatic factors that influence production. The answer (obtained from computer simulation studies) is always to harvest the surplus above that which would give maximum reproduction in average conditions. Thus the wildlife manager should every year aim to crop a surplus above a fixed figure.

The extension of these techniques to many fields of wildlife management is much to be desired. The rigour necessary to formulate such a system forces a conceptual focus, indicates missing areas of study, and frequently underlines the futility of fragmentary studies. It is inconceivable for example that the present pattern of research on waterfowl could have come from any attempt to formulate a model system of waterfowl production. Given the economic, social and biological components of the total system, it seems likely that any realistic model designed to show the paths of national interest would have suggested much more study of hunters and farmers, less study of ducks, a more thorough study of the effect of water conservation and drainage schemes and less emphasis on the wetlands easement program.

The development of modelling in wildlife biology is considerably behind that in fisheries and economic entomology. A growing tendency to treat wildlife, fisheries and entomological problems in a common language of yield, predation, reproduction and so on is encouraging.

VIII.6.2 Damage Caused by Wildlife

"It is obvious that the increasing human population in Canada is a dynamic force that is creating and will continue to create wildlife problems. The first category of wildlife problems includes those where wildlife endangers man or damages his interests. No doubt his first example of this sort coincides with Champlain's settlement in 1608. After the first crop was planted there were undoubtedly birds and perhaps mammals as well on hand to share in the harvest. As settlement progressed and agriculture gained in importance, problems of damage arose more and more frequently. They remain with us today."[2]

The problems in pest control are broad and affect many Canadians directly or indirectly. Historically, problems of predation were considered to be the primary ones; however, as agriculture moved towards monoculture and large areas came under cultivation, damage to cereal and fruit crops became of paramount importance. The species most commonly involved in North America are blackbirds and starlings; however, ducks, geese, sandhill cranes and rodents also cause crop losses in many areas. In urban areas there is an increasing demand to control many forms of wildlife, often not because of damage but simply because people are not used to wild animals and do not know how to live with them.

In Canada the most important agricultural losses are caused by birds feeding on cereal grains and fruits. The problem has been the subject of much discussion at Federal-Provincial and North American Wildlife Conferences, and has been re-

[1]Bider, J.R., *op. cit.*
[2]Fuller, W.A., *op. cit.*

viewed in three major studies, one conducted in Manitoba, one in Saskatchewan and one in Ontario.[1] The studies illustrate clearly that there are no simplistic solutions to crop damage problems. The study on sandhill cranes showed that while "wildlife damage to crops may occur on farms of low or high capability, the economic effects of damage are much more severe on farms of low production capability". It suggested that "wildlife has an economic value which may be considered an alternative to grain production. Where the margin or grain production is low, the value of wildlife need not be high to be a more suitable alternative." It is suggested that the immediate problem could be alleviated by the use of acetylene exploders and "lure" crops. The Ontario study showed that much of the damage was occurring on first-class agricultural lands, but no ways of alleviating the damage were found.

The unknown aspects related to the influence of birds and mammals on forestry are even greater. Both mammals and birds can exert a significant influence on forest plantations by eating buds and girdling stems, but little is known of the effect that seed-eating mammals and birds have on forest regeneration through the consumption of seeds.

In 1957, the Ontario Department of Lands and Forests began a program to assess the effects of some mammals on forest regeneration; however, the program has now been discontinued and results have not been published. The Canadian Wildlife Service has one investigator studying the effect of small mammals on the regeneration of cutover areas in western Alberta, and Newfoundland has conducted two studies to determine the influence of moose on forest regeneration in cutover areas in various parts of the main island.[2]

For centuries, the greatest hazards to human life from wildlife were the ones associated with diseases transmitted by wildlife. Now the highest hazard probably results from the impact of automobiles and aircraft with birds and mammals. Virtually no work has been done to alleviate problems associated with automobiles. Canada has, however, led in studies that pertain to aircraft-bird problems.[3]

The program began in 1963 when, at the request of the Department of Transport, the National Research Council set up the Associate Committee on Bird Hazards to Aircraft. The Committee included members from the Department of Transport, National Research Council and the Canadian Wildlife Service.

The program was given a strong biological orientation when it was learned that it would be very difficult to eliminate hazards by using engineering methods. Two principal biological approaches were used: studies at a number of airports to learn about the bird species involved, the reasons why they were present on airports and what could be done to disperse them. Radar was also used to study bird migration. The use of radar has developed into a study of the migratory movements of large birds capable of causing serious damage to aircraft in flight. When complete, it will permit the development of forecast techniques which will provide bird migration forecasts, somewhat similar to weather forecasts. The study of the ecology of airports has proved to be valuable. It has resulted in many changes which have made airports less attractive to birds and consequently has reduced the number of bird strikes made during landings and take-offs.

It appears that the things which have

[1]Bossenmaier, E.F., and W.H. Marshall. Field feeding by waterfowl in southwestern Manitoba. Wildlife Monograph No. 1. The Wildlife Society. 1953.

Stephen, W.J.D. Bionomics of the sandhill crane. Ottawa, Queen's Printer, 1967.

Dyer, M.I. Blackbird and starling research program, 1964-68. Ontario Dept. Agriculture and Food. 1968.

[2]The work in Newfoundland is reported in a paper by: Bergerud, A.T. and F. Manuel. Moose damage to balsam fir-white birch forests in central Newfoundland. Journal of Wildlife Management, Vol. 32. 1968.

[3]Solman, V.E.F. Bird control and air safety. Transactions of the 33rd North American Wildlife and Resources Conference. 1968.

been done, such as the modification of the environment around airports, have been those which are relatively easy to do. Further reduction in hazards will require more intensive research and a more sophisticated approach to application. An example of a lag in application is evidenced by the development of an aircraft radar system to avoid collisions with flocks of birds by the National Research Council, which was adopted for use in France but not in Canada.

Since the highest hazards often exist when birds are in migration, one of the greatest needs, on the biological side, is to determine what climatic patterns trigger migration flight routes that are followed, and conditions and heights at which various species fly.

We consider that the approach to the solution of aircraft-bird problems has been imaginative and dynamic. We hope that programs of the same calibre will be developed to solve the more prosaic, but nonetheless, important problems where the loss of human life is not involved.

Problems of wildlife damage to agriculture and forestry are of this nature. Their implications range all the way from local to international interests. We agree that: "Failure to solve the problems by techniques that discourage damage without eliminating the animals will lead to the destruction of valuable and interesting wildlife."[1]

We suggest that consideration and study of the problem has been inadequate and should be increased significantly. We further suggest that the Canadian Wildlife Service should accept a primary role in the development of research programs on the basic aspects of the problem and on means of alleviating wildlife damage problems throughout Canada. We suggest that programs of study should involve the co-operation of the National Research Council and of federal and provincial agriculture, forestry and wildlife agencies.

We also suggest that provincial agencies should give more attention to problems caused by individual or by small numbers of animals. One of the most immediate needs is for a series of pamphlets which would give information on animals that are often considered to be pests, and advise on how to cope with specific problems. A co-operative approach to meeting this need could be developed through a committee of the Federal-Provincial Wildlife Conference.

VIII.6.3 Introduction and Transplantation of Wildlife

In 1850 the English sparrow was introduced to the North American continent. It was followed by introductions of the starling in eastern America and the crested myna in the Fraser Valley around 1890. The former is now a pest which causes a great deal of damage to crops, while the latter has never been more than a local curiosity. Several gallinaceous birds have also been introduced with varying degrees of success. Pheasant and gray partridge have been successful in all provinces but Newfoundland; California quail, mountain quail and chukar partridge have had some success in British Columbia. Other birds such as the black grouse and capercaillie have been introduced but have not become established.

Accidental or purposeful introductions of exotic mammals are relatively rare and include the Norway rat, the European hare in southern Ontario, and reindeer in the Mackenzie Delta of the Northwest Territories.

The introduction of native species to habitats from which they have been extirpated, or in which they have not been able to colonize because of physical barriers, has been particularly common in eastern Canada. Some of the earliest introductions were made to Anticosti Island and Newfoundland. The introductions to Anticosti included white-tailed deer, moose, beaver, muskrat, elk and bison. The deer have become very abundant, while a number of the other species have not persisted or are rare.

[1]Cowan, I. McT., *op. cit.*

Varying hare were introduced to Newfoundland about 1850 and moose in 1879 and 1904. Both have become very important game animals. Since beginning game management work in 1950, Newfoundland has developed an active program of introducing North American species. The introductions have included moose to Labrador, ruffed grouse and spruce grouse to several areas of the island and bison to Brunette Island off the south coast. Also, the federal Department of Forestry introduced shrews in 1958 in an attempt to control larch sawfly. Caribou have been re-established in several areas of the main island and in a number of offshore islands where they had been extirpated by hunting. Of the animals introduced, ruffed grouse and shrews have been widely established and the introduction of spruce grouse appears to be succeeding.

Elsewhere less intensive programs are also under way. Nova Scotia is attempting to re-establish caribou and to introduce ptarmigan and sharp-tailed grouse; Quebec is attempting to re-establish a caribou herd in the Laurentide Park, Ontario is seeking to re-establish the Giant Canada Goose in southern Ontario, and the Canadian Wildlife Service has undertaken a program to re-introduce caribou on Southampton Island.

In Newfoundland, where there has been the most activity, considerable attention is given to the possible ramifications of introductions. For example, the introduction of white-tailed deer was considered[1] and subsequently rejected. Squirrels were introduced to an island to determine the impact they would have on the supply of conifer seeds before being introduced to the main island. The factors which were weighed before introducing an animal to Newfoundland were stated in 1963 as:

"1. What will the animal ultimately mean to the Newfoundlanders in terms of increased pleasure and dollars and cents?

"2. Will the new species cause extensive damage to the vegetation of Newfoundland?

"3. What, if any, new animal diseases can be expected from the new introduction?

"4. Will the new species adversely affect any native species and conversely will the new animal benefit our existing species?

"5. What are the biological chances of the species surviving and multiplying?"[2]

While recognizing the potential benefits that may be derived from introductions of species, we urge that all agencies continue to give very careful consideration to the use of this form of wildlife management.[3] Although problems have been rare, a single major one could offset the beneficial aspects of many favourable ones.

VIII.7 Science and Wildlife– Past, Present and Future

The discussion of mission orientation in research in Science Council Report No. 4[4] caused us to think and talk a great deal about the subject during our study. The emphasis in Report No. 4 was "given to economically oriented science and technology" so we reasoned that the concept of mission orientation in fisheries and wildlife might be quite different. To develop our thinking, we often attempted to analyse the research and management programs of Canadian fish and wildlife agencies. It was rather a fruitful area of exploration because there is much diversity in programs and approaches among, even within, existing agencies.

Earlier we reviewed the history of the

[1]Pimlott, D.H. Should white-tailed deer be introduced into Newfoundland? Transactions of the Federal-Provincial Wildlife Conference. 1955.

[2]Bergerud, A.T. Newfoundland wildlife management. Annual Report, 1962-63. *In* Annual Report, Department of Mines, Agriculture and Resources, 1963.

[3]A paper written on "Introduced Mammals and their Influence on Native Biota" by A. DeVos *et al.* (Zoologica, Vol. 41, 1956) serves as a valuable reminder of the inherent danger of introducing exotic animals.

[4]Science Council of Canada. Towards a national science policy for Canada. Report No. 4. Ottawa, Queen's Printer, 1968.

development of the Canadian Wildlife Service (Chapter V) and we pointed out that, even extending through the 1950s, its need for staff members who understood the Canadian environment was as great as its need for detailed knowledge of particular animals. The programs of research that developed under this regime were quite variable. We think of them as having fallen into three rather distinct categories of mission orientation: toward production of base line data, toward long-term management, and toward immediate or short-term aspects of management.

In the report prepared for the Senate Special Committee on Science Policy, the Canadian Wildlife Service described its goose research program in some detail. We think of these studies as being in the "base line group" because they were designed to provide basic understanding of the "breeding, ecology, taxonomy and population dynamics of Arctic nesting geese". We consider the approach of the Canadian Wildlife Service to these studies to be sound. On the whole, North American goose populations are still relatively secure, so there were no pressing management needs, but there was an obvious need to gain a thorough knowledge of the distribution and ecology of the various species and populations as a basis for future action. The studies were developed, conducted and, in most cases, the results published when they were completed.

"The impetus for large-scale scientific study of caribou was given in February, 1947. At that time the Eleventh Federal-Provincial Wildlife Conference, meeting in Ottawa, resolved that a thorough investigation should be made of the status and human use of the barren-ground caribou between Hudson Bay and the Mackenzie River Valley. Full co-operation between agencies of both federal and provincial governments was stressed from the outset. In 1948 a scientific advisory committee was established and field work began..."[1]

We think of this study as being in the second category, i.e. mission orientation toward the long-term management of the species. Again, we have been favourably impressed by the way the studies were conceived and conducted. The use of contractual studies to cover specific areas where information was needed, such as the influence of snow conditions on the use of habitat, represents an approach to a problem which we consider warrants continued use by the Canadian Wildlife Service and more use by other fisheries and wildlife agencies. The principal weaknesses that existed in the caribou program were not in biological research but in socio-political areas. They have constituted severe limitations to the application of the knowledge gained through the biological research program. They point, as do many other things in fisheries and wildlife, to the need for much greater socio-economic components in research and management programs.

For many years waterfowl investigations had the primary role of providing knowledge of numbers of ducks and of breeding success. The information was collected because it was considered to be important for establishing hunting seasons and bag limits (aspects of short-term management). But as pointed out in Section X.5.2, a great deal of uncertainty exists about the future of a number of species of ducks; like the caribou, there has existed a considerable need for a co-ordinated program of research to determine what factor or combination of factors limit waterfowl populations. But no co-ordinated program has ever been developed; those of the Canadian Wildlife Service have the appearance of a jumble of individual *ad hoc* programs which are unlikely to provide very much of the understanding needed as a basis for managing waterfowl. We asked Dr. H.A. Hochbaum, Director of Delta Waterfowl Research Station, to offer a critique on waterfowl research and management for us. We came to have considerable sympathy for

[1]Kelsall, *op. cit.*

his viewpoint that much irrelevant work is being done in the waterfowl field. In part he stated:

"*How Well are We Doing:* In 1946 there were four federal biologists dealing part-time with waterfowl in Canada, perhaps one provincial waterfowl biologist. In the United States there were no more than six federal waterfowl biologists and three state waterfowl biologists. From 1946 through 1963 the U.S. Fish and Wildlife Service spent $215,854,297 on waterfowl management, research and enforcement, at the same time expanding its staff of waterfowl biologists to more than one hundred men. During the same period, the number of state waterfowl biologists grew to over one hundred and the States now spend nobody knows how many millions of dollars each year on waterfowl. We cannot say how much the federal and provincial governments of Canada have spent on waterfowl during these same years, but it is considerable, and the number of federal and provincial waterfowl biologists is now impressive (about fifty). The Canadian Wildlife Service has built a fine waterfowl research station at Saskatoon, while another waterfowl research station has been established by the United States Government at Jamestown, North Dakota, at the cost of $3,000,000. Ducks Unlimited, in the meanwhile, has been spending around $1,000,000 a year on ducks in recent years; and the Delta Waterfowl Research Station enlarged its budget from $5,000 to over $100,000 a year. I give figures where they are known to me because they are impressive. Ducks have not lacked the attention of trained men nor of money. And yet while spending went rapidly upward and the force of trained men increased, the resource steadily declined, with the low point reached in 1968. (A "low" below that naturally enforced by drought.) We are spending great sums of money but hardly using it effectively in waterfowl management. In short, we are not doing very well."[1]

We suggest that a complete reappraisal of the Canadian approach to waterfowl research and management is required and we offer some suggestions later in this section.

An overall survey of the Canadian Wildlife Service shows that, except for ducks, many of the programs conducted in the 1950s and early 1960s were closest to the base line on long-term management categories of studies. They have included murres, Wilson's snipe, muskoxen, arctic fox, grizzly bear, polar bear, wolf and wood bison. A study on sandhill cranes had a short-term orientation and was aimed at finding solutions to crop damage problems caused by cranes and ducks. The proposed solution to depredations caused by sandhill cranes has not been put into practice.

Most of the wildlife programs conducted by the provinces have had a short-term management orientation; they have involved surveys of one kind or another but not much work that can be considered to be research. Most provinces have had very small staffs and they have largely been engaged in day-to-day jobs that left little time to conduct specific programs related to either research or to management.

Newfoundland has been the most significant exception to this rule. With a small staff and small budget, it has conducted worthwhile programs whose orientation has ranged from base line to short-term management; many of them were mentioned in earlier sections. They have included studies of caribou (both in Newfoundland and Labrador), lynx, moose, ptarmigan and varying hare. The research has been closely related to management needs and has been applied in many ways.

Ontario has had a Wildlife Section in its Research Branch for almost 20 years, and together with the management staff in the Fish and Wildlife Branch, has had the largest wildlife organization in Canada. It is, however, a program which has

[1]Letter to the Study Group.

not shown many dynamic accomplishments. The research programs have not had much relationship to management needs; the management staff has been dispersed among the 22 forest districts and have rarely succeeded in getting beyond the day-to-day routine of the districts. Perhaps the most important achievement has been in the management of moose where knowledge gained from aerial surveys has been applied in the establishment of hunting seasons throughout the province.

To sum up, our review of wildlife research and management indicates that, up to the present, the bulk of wildlife research in Canada has not been done in support of management and, in some cases at least, this has not been illogical because the need primarily was to gain basic understanding of species. Murre populations, for example, are not much used by people; however, they inhabit the ocean where they could be greatly influenced by future developments.[1] The base line study showed that most of the murre populations are concentrated on the Grand Banks in winter. The murre report makes it obvious that oil exploration and developments on the Grand Banks could threaten almost the entire population of the two species, so if it is undertaken, it will need to be carefully regulated.

We consider that there is a need for the Canadian Wildlife Service to accept a broad mandate to continue and expand the program of base line studies to support Canadian work on the preservation and long-term management of species. The mutual neglect of this area by the provinces suggests that there would be little in the way of jurisdictional problems to be worked out with the provinces. Specific reference to this area of responsibility should be included in a *Canada Wildlife Act*. We do not suggest, however, that the provinces should continue to neglect this area entirely, but rather that efforts should be concentrated in areas where needs are more immediate; for example, studies that are related particularly to the development of water resources or to use of chemicals in the environment.

Research as a basis for long-term management programs is an area in which we recognize areas of continuing overlap between provincial agencies and the Canadian Wildlife Service. We do not think of it as undesirable but suggest that there is a particular need to find ways and means of integrating programs. The national policy and program for wildlife tabled in the House of Commons in 1966 stated that the Canadian Wildlife Service would "provide research services to the provinces on request". This seems to us to be a reasonable avenue of co-operation, particularly between the smaller provinces and the federal government. We consider it of some importance that the Canadian Wildlife Service should continue to undertake studies of this category in the Territories.

In the waterfowl field, it is absolutely vital that federal-provincial-private programs be co-ordinated, and in some cases integrated, much more closely than they have been in the past. A recent paper on this topic discussed some of the background work that is required in preparation to defining the roles of various agencies.[2] We suggest that the divided jurisdictional responsibilities that exist (see Chapters V and VI) require a more tightly woven co-ordinating structure than has existed or is being considered. We suggest that the formation of a body, which might be called the National Waterfowl Advisory Board, representative of federal, provincial and private interests, is worthy of consideration. We suggest that its functions might be to:

1. Suggest approaches on international affairs.

2. Set goals based on a solid foundation of socio-economic as well as biological considerations.

[1]Tuck, *op. cit.*
[2]Cowan, I. McT., *op. cit.*

3. Recommend priorities on the types and nature of scientific investigations and management programs.

4. Recommend priorities for habitat acquisitions and provide guidelines for land easement programs.

5. Act as an independent critic in evaluating new and old programs which concern waterfowl.

We suggest that a thorough reappraisal of the type of investigation necessary to support immediate aspects of management is warranted. In our opinion, these have generally not been well thought out and have had too great a tendency to mimic activities from one area to another. This type of activity has generally included studies of sex and age, composition of the kill, browse studies, dead-deer surveys, aerial surveys, etc. Many are necessary activities but it is important to ask questions about the purpose of the data collection in terms of management objectives.

We consider that more attention should be paid to publishing the results of research and of management programs. Except for Newfoundland, the work of provincial agencies has not been reported in an adequate manner. The review of wildlife research in Canada prepared for the Resources for Tomorrow Conference contained 89 titles[1]; only 5 were by members of provincial agencies. Little change in the rate of publication has been evident since that time. Although there have been some significant gaps, the Canadian Wildlife Service has gradually developed a good approach to publications by combining papers in research journals with its own report series. Two of three major monographs, murres and caribou, won the North American Award (1961 and 1969) for wildlife publications.[2]

We consider that scientists should have an absolute mandate to publish the results of their research and that the responsibility is largely an individual one. We consider that failure to publish the results of management work has been a disservice to the profession; it has resulted in unnecessary expenditures from duplication of effort; it has also resulted in the repetition of studies, which the analysis of data and writing of reports would have shown to be ill-conceived. In the case of managers, we consider that there are two significant obstacles beyond that of personal apathy; they are lack of publication sources and failure of administrations to allow managers to devote an adequate portion of their time to analysis of data and to report writing. We consider that a Canadian publication devoted to wildlife management would provide a valuable function, and we suggest that it is an area of co-operation that could be fruitfully explored by federal and provincial agencies. It is perhaps one of the services in the national interest that could be provided by the Canadian Wildlife Service.

An important area of need for research, management and development is related to urban environments.[3] In Chapter V, we suggested that by 1990, 10 per cent of the expenditures on scientific activities in wildlife should be made in urbanized areas where at least 90 per cent or more of the people will be living. A primary objective of the expenditure would be to increase wildlife recreational opportunities; the secondary objective would be to develop understanding and appreciation of wildlife by society at large. This latter objective is closely related to discussions of information and education programs in the next chapter. Action programs in urban areas would be an important part of education programs and would help to create an atmosphere in which public education programs could be successfully conducted. Recreational use of wildlife has

[1]Cowan, I. McT., *op. cit.*

[2]Tuck and Kelsall, *op. cit.*

[3]This subject was recently discussed at two conferences, the proceedings of which have now been published:

Bureau of Sport Fisheries and Wildlife. Man and nature in the city. Superintendent of Documents, Washington. 1968.

The Wildlife Society. Wildlife resources in a changing world. The Conservation Foundation. 1968.

been given little attention by wildlife agencies in Canada. The Canadian Wildlife Service is in the process of developing a program and now has a nature centre on the Wye Marsh near Midland, Ontario. However, there is no evidence that the Canadian Wildlife Service conception involves programs in major areas where people live. We suggest that a major extension of the program into urban areas should be considered.

We consider it important that an approach to urban wildlife be developed which will afford the possibility of a national program. We have not been able to develop a clear conception of how such a program could be developed to avoid jurisdictional and administrative jealousies which impose limitations on national efforts. We think, however, that some of the aspects to be considered should be:

1. The need that exists for such programs to be developed while urban areas are in relatively early stages of growth.

2. The void that exists in this area and the lack of activity by provincial wildlife agencies at the present time.

3. The need for a major research program to: a) determine the kind of approaches which would have the greatest potential of providing recreational and educational opportunities for people, b) obtain base line data on wildlife in urban environments.

We suggest that, like many other things we have proposed, the program should be developed through a federal-provincial-municipal co-ordinating committee which might be called the *Canadian Committee on Urban Wildlife*. The Committee would act through provincial subcommittees which would get down to the level of action programs. We suggest, for example, that programs might be started in Stanley Park in Vancouver, the Morgan Arboretum on the Island of Montreal, the Albion Hills Conservation Area near Toronto, and Bowring Park in St. John's. The initiative of programs at such locations would be done at the invitation of local authorities or organizations. In some cases, the approach might be to use natural centres, comparable to the Wye Marsh facility, and in such cases the land for the centre would be rented or leased at a nominal fee. Other approaches might be that:

a) the federal government would offer financial and other support through research and through the developmental stages, or

b) the Canadian Wildlife Service might establish and run the programs for an establishment period, or

c) it might be one of the ways in which the presence of the federal government would be of a continuing nature.

Thinking partly in terms of the need for flexibility at the upper level of government and of development of local initiative, we tend to favour the first or second proposal.

In rural areas, we also consider that much more attention should be given to recreational aspects of wildlife, particularly related to observing and studying wildlife. The interest of people in such activities has been amply demonstrated in many parks and other areas in Canada where wildlife "spectacles" have been available to the public. We consider that this area of activity would require exploratory work to develop approaches, development of pilot programs, and development of action programs and possibly of advisory services to tourist operators, youth camps, etc. We consider that the major effort in this area should logically be undertaken at provincial and municipal levels; however, we also suggest that this is one of the areas in which considerable development could be undertaken by the private sector, particularly tourist operators.

Chapter IX

Education and the Use of Resources

IX.1 The Nature of Resources Management

"...a technocrat tackling resources-for-tomorrow problems might be inclined to believe that the solutions should be derived wholly from technological knowledge. The job of legislators and administrators should be merely to fashion their instruments in accordance with the facts.

"However, such a belief would be mistaken for the very simple reason that laws and administrations must embrace the *whole* reality of which natural resources are only a part. The whole reality includes demographic, cultural and moral data, political requirements, economic factors, historical conditions and what not.

"Whence then must progress come? It must come from a united front of all the experts on a scientific and technological basis. The experts must forego their vested interests and their political conflicts, and warn the Canadian public that there exist certain objective data which cannot be ignored without danger to everyone's health and welfare."[1]

It is often argued that the management of fisheries and wildlife is more of an art than a science. The argument has much logic behind it since successful management requires an intricate blend of biological knowledge, social understanding, political realism, legal appreciation and economic and financial acumen. Unfortunately, the education of biologists has not usually taken them much beyond things biological.

IX.2 Reflections on the Education of Fisheries and Wildlife Scientists[2]

"We are at the point in fishery research where the classical concept of the fishery scientist must be scrapped. Fishery research is ecological research of the very broadest kind–in today's jargon fishery research and development is a 'system', which includes a balanced mixture of all the aquatic sciences, meteorology, engineering, law and social-political sciences."[3]

The world that fishery and wildlife scientists survey today is very different from the one 25 years ago. During this time, the framework of management has changed from one that was considered to be almost purely biological to one that is now recognized as being infinitely more complex. During the same period, however, the approach to the education of scientists has changed very little in Canada. There is an urgent need for a rapid evolution in education; particularly in the education of those who will be engaged in "people-oriented" aspects (management and development) of the resources, as contrasted with "organism-oriented" aspects of fisheries and wildlife.

The education of scientists who manage the plant and the animal components of the environment has been quite different. On the plant side, distinct professions developed in agronomy, horticulture, range management (usually all associated with agricultural colleges) and forestry.

The pioneering developments in all of these areas occurred primarily in Europe. However, the United States and Canada both recognized similar needs many years ago. In the case of forestry, which is the closest parallel to fisheries and wildlife, faculties have been established at four Canadian universities for almost half a century.

There has only been one attempt in Canada to develop a specific undergraduate program for fishery and wildlife biologists with an orientation towards management. It was established in 1952 as the "Wildlife Management Option"

[1]Trudeau, Pierre Elliott. Speaking at Plenary Sessions. Resources for Tomorrow Conference, Vol. 3. 1962.

[2]Reference is entirely to biological science.

[3]McHugh, J.L. Education and training of fishery scientists and administrators. *In* The future of the fishing industry in the United States. University of Washington, Publications in Fisheries, New Series, Vol. IV. 1968.

at the Ontario Agriculture College, now a college of the University of Guelph. The course was listed in the undergraduate calendar as a B.Sc. (Agr.) and was described in the 1969-70 calendar as the "Fisheries and Wildlife Biology Major, Resources Area, Bachelor of Science in Agriculture". The Department of Zoology initiated an honours zoology program in 1958 and now lists "Honours Fish and Wildlife Biology" as one of five options in the department. Approval to discontinue the "Fisheries and Wildlife Resources" program (B.Sc.-Agr.) was recently given by the Senate of the University.

The complete change-over from a B.Sc. (Agr.) to a B.Sc. (Honours) program appears to be of both philosophical and practical significance. In the past, the Guelph program has attracted many students who were interested in fishery and wildlife management. However, its appeal in the future to such individuals is uncertain, since it will not be very different from honours biology programs which are available at a number of other universities in southern Ontario. It is, however, expected that the University of Guelph will offer diploma programs, beginning in 1970, in both fishery and wildlife management so it is possible that these will compensate for the withdrawal of the undergraduate management option.

Apart from this program at Guelph, there has not been an evolution in education for fishery and wildlife biology similar to the developments in the United States where many departments or colleges of fisheries and (or) wildlife have developed. The general approach in Canada has been for students to take undergraduate degrees in biology or forestry. Then, if they were inclined toward fisheries or wildlife work, they could undertake graduate studies in one of six or seven Canadian universities or enter a graduate school in the United States or Great Britain.

Weaknesses in the approach seem to lie primarily in two areas: a) the need for applied biologists has been almost completely neglected, and b) it has produced scientists who have virtually no background in social, economic and political sciences.

A group of fisheries and wildlife scientists discussed the subject of the education of biologists at one of the meetings we held. They summed up their impressions with this statement: "We submit that the products of Canadian universities are often ill-trained to handle ecological problems inasmuch as they are unable to relate their academic training to ecological situations in the field."

They made the following suggestions:

a) in educational and training processes there should be more direct contact with ecological situations;

b) there is a need to create an awareness in students of the need to continually and critically reassess current ideas and methodology;

c) encouragement should be given to integrating natural science departments in Canadian universities.[1]

The director of a provincial fishery and wildlife department (who has a Ph.D. in Zoology) stated the case this way:

"If I could begin my career over again, I would certainly do it differently. At university I would attach considerable importance to sociology, psychology and economics.

"Our young biologists going into management today are ill-equipped, in my opinion, to manage common property resources. For the most part, they are too much animal oriented or technocentric and this presents real problems in our dealings with the people to obtain support."

Besides their problems in dealing with the social side of resource questions, fish and wildlife management biologists have had noticeable weaknesses in developing and planning management programs. For example, big-game animals and their

[1]From a summary statement prepared at one of the meetings convened by the Study Group.

use of habitat have been actively studied since the end of World War II. The studies have not, however, resulted in knowledge that could be applied in the preparation of cutting prescriptions to provide optimum combinations of food and cover for animals in winter. To overcome the deficiencies which exist, both Ontario and Quebec have recently had to initiate crash research programs.

IX.2.1 Education of Graduates and Undergraduates

To gain insight into the capability of Canadian universities to produce fishery and wildlife biologists, we reviewed the National Research Council's *Annual Report on Support of University Research* for 1967-68 and 1968-69. Our objective was to determine the distribution and number of scientists conducting fishery and wildlife research programs. We identified 73 research scientists in 31 institutions who we considered fitted logically into this classification. Sixty-two were in 22 institutions which offered programs of graduate studies. More than half of the universities had no more than two staff members in fisheries or wildlife. Only the University of British Columbia, Alberta, Toronto, McGill and Memorial had more than five faculty members, and only four of the five universities mentioned had a balance between fishery and wildlife staff. The review indicated that universities with a nucleus of more than three staff members in either fishery or wildlife areas is a rare phenomenon.

We also reviewed the undergraduate curricula of the 31 universities to determine the availability of 24 courses we considered to be most relevant to students interested in fish and wildlife biology. The courses selected included 14 courses in biology and 10 courses in other disciplines. Seven of the biology courses were available at 70 per cent of the institutions and 12 were available in 60 per cent. In most cases, there were no serious barriers established, in the form of prerequisites, etc., to students taking the available courses. In our review of the "other" courses, we were limited to 19 universities because calendars did not give explicit enough detail to allow us to determine which courses were available to biology students. In these we found, for example, that economics, sociology and political science or public administration were available at all 19, but because of restrictive "core course" requirements, biology students could take them at only 25 per cent or less of the institutions. We conclude that there is a wide capability among Canadian universities to provide the undergraduate education for resource biologists, but that the capability is being limited by requirements for too great a degree of specialization in biology. This results in a situation in which there is little opportunity for biologists who wish to develop careers in applied areas. The tendency to require too high a degree of specialization in biology appears to be gradually breaking down, and at the University of Toronto, for example, students in honours programs now have much more latitude in the individual course of study. We consider that this development could be valuable to the education of research, as well as applied, scientists in the fishery and wildlife area.

Mathematical aspects of biology and methods of systems analyses are rapidly coming into their own. To take advantage of these new developments, it is important that an increasing number of "budding" mathematicians have the opportunity to explore the challenges which exist in biological areas. It is much more likely that they can be attracted if the study programs are not too rigidly oriented to the traditional approach of honours students having to cover "everything" in biology and consequently having little time to develop in other areas. Whenever possible, the use of mathematics should be developed and practised in the same courses in which ecological information and theories are transmitted to students. Newer approaches, such as the use of team teaching, makes this goal possible to achieve.

Biological research has had chronic problems in coping with large quantities of data and from paralysis in analyses caused by the sheer complexity of biological systems. With the advent of computers, problems of data reduction have been greatly lessened and problems of analysis are no longer limited by the wealth of calculations required. The whole new world of mathematical experimentation has been opened up. Much more activity is needed in this area in educational institutions so that biological research can benefit to the same degree as has research in the physical sciences.

We suggest that mathematical ecology is one area which warrants support. It would benefit both management and research activities in fisheries and wildlife. We also consider that there is a need for the development of programs in applied ecology in Canada at the post-graduate level. We think that these could be most effectively developed if fish and wildlife specialists were educated in a broad program in which there is a great deal of interaction between individuals who are specializing as agriculturists, foresters, planners, etc. To meet the need which exists for applied biologists we suggest that:

a) graduate programs of applied ecology should be established at two or three universities where an adequate association of disciplines exists;

b) biology or zoology departments recognize the needs that exist for ecologists to develop in related disciplines, and establish graduate programs which permit students to concentrate their academic work in areas which are only indirectly related to biology, e.g. economics, sociology and geography;

c) graduate programs be developed which are based entirely on academic studies.

The development of such programs of applied studies will require that the watertight compartments, which commonly exist between faculties of arts and science, agriculture, forestry and engineering, be punctured.

In Section IX.1 we quoted part of a statement prepared by a panel of scientists at one of our meetings. They stated that young ecologists "are unable to relate their academic training to ecological situations in the field". Practical experience, of course, will help to alleviate this problem. But it is becoming harder for biologists to gain experience during their undergraduate days.

The Director (Dr. John Anderson) of the Fisheries Research Board Biological Station at St. Andrews, N.B. and Dr. K. Ronald of the Department of Zoology of the University of Guelph have played leading roles in making the facilities of the St. Andrews station available to university classes and in the development of the Huntsman Marine Laboratory Inc. on a property adiacent to the station. The laboratory will provide living accommodations, library facilities and eventually additional laboratory space for professors and students who come to St. Andrews. The development constitutes an excellent example of co-operation between a government agency and university departments to provide students with experience beyond the classroom and graduate students and professors the opportunity to conduct off-campus laboratory and field research programs. More co-operation of this nature is desirable.

One of the principal ways of gaining practical experience has been through summer employment in government laboratories or in field studies. With the advent of more technical support staff and of austerity programs, summer employment is becoming much more difficult to obtain. We suggest that there is a need for agencies to adopt a policy of making summer employment available to students, partly as a contribution towards the education of members of the fishery and wildlife profession.

IX.3 Information and Education Programs

"Many of society's current problems are

essentially ecological problems. Whether one considers the world population explosion, pollution of water and air, mass applications of pesticides whose long-term effects are only partially known, or juvenile delinquency in the asphalt jungles of large urban areas–the one common denominator is an unharmonious relationship between man and his environment. Solution of many modern problems, in order to permit a high quality of life to be maintained, will require application of ecological principles of varying degrees of complexity. But application of these principles is likely to have to wait until the man on the street–the average citizen–has developed the attitudes which result from ecological understanding."[1]

"The most important thing I can think of is to inform the public. We already have far more knowledge than we are making use of. Nothing that has happened since I was an undergraduate had not been foreseen, at least in principle. The only surprise has been the rapidity of the deterioration of our environment; we just did not anticipate the Great Lakes fisheries being wiped out and Lake Erie becoming a cesspool. So my No. 1 priority would be a massive educational campaign."[2]

The prime objectives of public information and education (I & E) programs should be:

a) to create public understanding of the environment;

b) to provide accurate information on the chemical and technological threats to the environment;

c) to increase awareness of the individual and a sense of social responsibility necessary to maintain the quality of the environment.

Information and education programs in Canada were the subject of a number of background papers at the Resources for Tomorrow Conference in 1961 and were discussed at two workshops. One speaker, who had conducted a study of activities, warned that programs in the conservation field were inadequate to meet the needs that exist in Canada.[3]

A lead-off speaker at the workshop suggested that the information and education field in Canada was beset by eight major deficiencies or problems: four were classed as organizational and four as functional deficiencies.[4] The organizational category included general lack of status and definition, obscure definition of jurisdictional responsibilities, meagre budgetary provisions and a lack of professionally skilled personnel. Included in the functional group were lack of means of assessing effectiveness, refusal of administrations to allow information and education programs to function adequately, the persistence of outdated publicity approaches and a lack of liaison with universities and scientists.[5]

The workshops agreed on 10 guidelines for I & E programs: five dealt with those "feasible at present or capable of early development" and five with those which had "first priority in long-term importance". In the intervening period, the only action taken to implement the proposals is that by the Canadian Wildlife Federation to examine courses of study in schools and universities in Canada.

"The Workshops provided considerable evidence that improved information-education programs are essential to improved resource management" and in Workshop B, "it was stressed that non-government agencies were essential. Effective information and education required dissemination of unpleasant as well as pleasant facts".[6]

[1]Conservation education in Canadian schools. The Centennial Project of the Canadian Wildlife Federation. CWF News Release. 1966.

[2]From a letter to the Study Group by a Canadian ecologist.

[3]Symington, D.F. The renewable resources. Information and Education in Canada. Resources for Tomorrow Conference, Vol. 2. 1961.

[4]Monk, D.R. Lead-off speaker at Information-Education Workshop B. Resources for Tomorrow Conference, Vol. 3. 1962.

[5]*Ibid.*

[6]Workshop B. Discussion. Resources for Tomorrow Conference, Vol. 3. 1962.

The need to have both public and private agencies represented in information and education programs was emphasized by the director of a conservation education program who stated it this way:

"Information is an essential part of the democratic process and since governments are congenitally indisposed to telling the whole truth it is essential that private conservation agencies get more heavily involved in all phases of conservation education rather than only on a crisis basis. The dearth of citizens groups in Canada is itself perhaps a reflection on the effectiveness of I and E programs. Hopefully this shortage will be overcome and strong local, regional and national conservation organizations will develop over the next decade or two. One of their prime objectives should be to educate in broad terms and to bring to public attention the side of the story not told by government information programs."[1]

The importance of the dual roles of private and public agencies in information and education, which is so well-stated in the quotation, is the principal theme of this section. There are important weaknesses in both sectors; we consider that developing ways and means of overcoming them should be accorded a high priority.

A second theme is that the area of greatest importance is to develop broad concepts of environmental education as the basis for all I & E programs of resource agencies in Canada.

The importance of the development of broad programs in environmental education is gradually being recognized over the world. But in spite of the fact that the concept was discussed at length at a world conference on the biosphere[2], no government in the world has yet taken the initiative to develop an integrated program. We suggest that Canada should take this initiative.

Commission II of the Biosphere Conference prepared five basic statements on environmental education (Appendix C) and presented one which established a framework for consideration of the concept. The statement follows:

"Concept of Environmental Education

"1. The critical problems and immediate opportunities urgently require the development of environmental education

-to form an attitude of man and his society towards the biosphere–the natural resources and the landscape as a unit–in the sense of wise rational use and conservation of them.

"2. The basic principles of environmental education interpreted according to the level and purpose should be

-to maintain and wherever possible to enhance the economical capital of the biosphere;

-to provide an integrated scientific approach to the planning, management and development of the environment as a unity in space and time;

-to seek man's personal fulfilment in partnership with nature through and with natural forces;

-to develop a policy of trusteeship for posterity.

"3. Environmental education is required in different depths according to the level of education being provided and the objectives being pursued:

-children and young people in order to enable them to use the environment wisely and to enjoy it considering the environmental education as part of a scientific and liberal education;

-adults in order to guide children and young people, to develop criteria by which they can judge policies and practices affecting their lives;

-specialists in different occupations dealing with both biosphere management and education in order to fulfil effectively the principles set out above.

[1]Letter to the Study Group.

[2]Intergovernmental Conference of Experts on the Scientific Basis for Rational Use and Conservation of the Resources of the Biosphere. UNESCO, Paris, 1968.

"4. All available media of education and information must be employed in a continuous and sustained program of environmental education. Each country should have a council, centre or similar institutions for environmental education and these activities should be co-ordinated also on an international scale."

IX.3.1 Environmental Education Programs in Educational Institutions

Undoubtedly one of the most praiseworthy attempts to encourage the development of environmental (or conservation) education programs in educational institutions has been made by the Canadian Wildlife Federation. The program began as a centennial project in the summer of 1966 and was "designed to foster ecological understanding amongst students progressing through the elementary and secondary school programs of the provinces and territories".[1]

The Canadian Wildlife Federation study indicated that relatively little was being done in Canadian schools on environmental education. In two provinces, Saskatchewan and Nova Scotia, the secondary school biology program in approximately half the schools was based on *High School Biology*, produced by the American Institute of Biological Sciences, Biological Sciences Curriculum Study. The "BSCS Green Version" is an excellent biology textbook with an ecological orientation. Prince Edward Island was the only other province that required the "BSCS Green Version" in the biology course. Since that time, Ontario has introduced a strong ecology component into its Grade 10 science course, and a natural science program, including outdoor study, into its Grade 6 course; however, the situation has not changed much in other provinces. At present, the interest of many teachers is running ahead of the curriculum in virtually every school system in Canada. Under these circumstances the adequacy of the self-generated programs depends on the background of the teachers. In many cases they involve the presentation of interesting facts, but do not deal adequately with interrelationships and environmental influences.[2] Because of the obvious need that exists, the Canadian Wildlife Federation is continuing to place major emphasis on the program. It discussed the need and the concept in these terms:

"Though lack of attention to ecology is apparent at both elementary and secondary levels of education, correction of these inadequacies appears to us to require different approaches for the two levels. At the secondary level, where subject areas are more clearly defined and where teachers have advanced training in their subject field, giving greater emphasis to ecological studies is largely a matter of adjustment of curriculum.

"At the elementary level, where curricula already include material relating to natural history, natural science and resource uses such as forestry, fisheries and agriculture, the major requirement is for teachers to receive training in the fundamentals of ecology. There is an urgent need to establish schools at which practising teachers and teachers-in-training can receive instruction which will fit them for teaching the ecological viewpoint and participating in outdoor education."

Outdoor education programs for students is one aspect of environmental education which has developed very rapidly during the past five years. A pioneer effort in outdoor education was the Island Natural Science School established by the Toronto Board of Education. The school accommodates two Grade 6 classes each week–pupils and teachers living-in at the school. There are daily outdoor classes–bird-banding, meteorology, astronomy, ecology–supplemented by indoor sessions with slides

[1]Schools of natural history. A prospectus. Canadian Wildlife Federation. Nov. 4, 1968.

[2]Based on information provided by R.C. Passmore, Executive Director of the Canadian Wildlife Federation.

and films. Recently a number of other Ontario Boards have started outdoor science schools. Another successful program is conducted by the Metropolitan Toronto and Region Conservation Authority (MTRCA) in co-operation with the secondary schools in the regions which it serves. The "Authority" now has two conservation schools, each with a full-time teaching staff, and are operated the year round.

It is vital to the success of outdoor education programs that those who staff them be well trained; so the rapid development in the area highlights the need for teacher-training programs of the type advocated by the Canadian Wildlife Federation.

At the university level, there is a great opportunity for biology departments to create ecological awareness among students. Biology is listed as an optional science for arts students at virtually every Canadian university. In addition, faculties of education in some provinces send some or all of their students to departments of biology. A number of biology departments (McMaster, Manitoba, U.B.C. and U. of T. have been particularly called to our attention) take these outstanding opportunities to present an ecological viewpoint to students.

IX.3.2 Information and Education and Private Organizations

It is noteworthy that the two individuals, quoted earlier who stressed the importance of the role of private agencies, were both men in government service. Both recognized the strictures that are placed on information and education programs by political systems, which inevitably are committed to telling "the public good news about conservation but not bad news...." Both of them reflected on the dearth of strong citizens groups in Canada and expressed the need for strength in this area.

The citizens groups which have the greatest influence on policies in fisheries and wildlife, and which also take action on matters of a more general nature, are those which represent anglers, hunters and naturalists. After the Resources for Tomorrow Conference, provincial angler and hunter organizations started the Canadian Wildlife Federation (CWF). The Federation has a strong ecological outlook and has tackled such problems as the banning of DDT, native hunting rights and northern development. It publishes *Wildlife News*; however its coverage of resource or conservation matters is limited since it consists of only four pages and includes both French and English versions of subject material. It also sends out periodic newsletters for the information and use of its affiliates.

Two naturalists organizations, the Canadian Audubon Society and the Federation of Ontario Naturalists, publish magazines which include original articles. During the past decade, *Canadian Audubon* has contained a series of ecological articles on wildlife species. Some of the species have been caribou, grizzly bears, wolves, harp seals, trumpeter swans and polar bears. The article on polar bears was republished in the *U.S. Congressional Record* and may have had some influence on the development of co-operative research programs between the United States, the U.S.S.R. and Canada. The magazine has also contained articles of a more general appeal including philosophical and factual articles on parks and other environmental questions.

There are a number of other closely related organizations which also play a direct role in raising environmental questions and in telling some of the "bad news" about conservation. Of the provincial organizations, the British Columbia Wildlife Federation has probably been the most dynamic in its approach. It informs its members by means of a newsletter which deals with topical issues.

The Conservation Council of Ontario has served in bringing organizations and individuals of somewhat different persuasions together to discuss conservation issues. However, because of the many "points of view" it is sometimes impos-

sible for the Council to reach a consensus. It has produced a number of good publications, such as the one on the subject of water pollution in Ontario.[1] It also publishes *The Bulletin* (of the Conservation Council of Ontario). Apart from a page or two of Council news and comments, it is comprised of reprinted articles on environmental and resource topics.

In the area of parks, the National and Provincial Parks Association of Canada and the Algonquin Wildlands League (Ontario) have both brought questions on the maintenance of environmental quality to public attention. The rapid evolution of parks policy in Ontario seems in no small measure to be the result of the activities of the Algonquin Wildlands League which had centred attention on specific parks and on parks policies. The League's publication is a simple mimeograph called *Wildland News.*

The universal characteristic of the operation of all these organizations, except the Conservation Council of Ontario, is that they are continually fighting for their financial lives. Support of publications, particularly, requires the development of a critical mass in membership; almost invariably this has been difficult to achieve. Consequently, the permanent staff has spent a considerable portion of available time on fund-raising activities. Publishing is vital to their survival and to their role in society, but it usually poses a heavy financial burden, and the staff seldom has enough time to devote to it and little or no money to pay for articles written for it. Consequently, publications are often months behind their publication dates, inadequately edited and lacking the variety of articles that would make them appealing to persons with only a general interest in environmental matters.

We consider that there is a need for financial support by governments of this aspect of the activities of private organizations. There has been some assistance in the past; however, it does not appear to be a firmly established matter of policy and presumably could be discontinued at any time without notice.

We suggest that both federal and provincial governments consider the possibility of establishing grants to support the information and education activities of resource-oriented organizations. The basis for considerations should centre on the need of society to have agencies which help to develop public understanding of resource and environmental matters.

IX.3.3 Information and Education Programs in Fisheries and Wildlife Agencies

"Of all the myriad factors involved in resource administration in a modern democratic setting, the most crucial by far is the communication factor."[2]

The information and education programs of the renewable resource agencies, other than agriculture, in Canada are all "shoe string" operations.

A survey of provincial departments shows that Alberta, Manitoba, Nova Scotia and Saskatchewan have accorded their I & E agencies the status of operating branches. Ontario has a Conservation Information Section in its Operations Branch, while I & E work in Quebec is done by the Publicity Service of the Director-General of Tourism. The rest of the provinces conduct their public relations programs as minor aspects of the work of various divisions or branches. In the federal government, the Department of Fisheries and Forestry conducts its programs through an Information and Consumer Service. The Department of Indian Affairs and Northern Development has an Information Services Division and the Canadian Wildlife Service has a small editorial and information staff.

[1]Water pollution in Ontario. A report by the Conservation Council of Ontario. 1964.
[2]Monk, D.R., *op. cit.*

Four of the provinces have periodicals which deal entirely or in part with fish and wildlife and occasionally with environmental aspects of animal relationships.[1] The Department of Fisheries and Forestry publishes a monthly serial, *Fisheries of Canada*. The content of the various periodicals is quite varied. Alberta probably comes closest to having an environmental orientation in its publication, as it usually includes at least one article on a subject where interrelationships are involved. Ontario's *Fish and Wildlife Review* is directed almost entirely to fishermen and hunters and usually carries semi-technical articles on fishery or wildlife studies or on some aspect of hunting or fishing. *Fisheries of Canada* provides information on various aspects of fisheries activities, licensing, research programs and occasionally includes a report on environmental problems such as pollution or overfishing.

A study of the publications makes evident the basis for some of the criticisms made at the Resources for Tomorrow Conference, i.e. "the persistence of the outdated publicity approach to I & E", "meagre budgetary provision", and a general lack of professional skill. Deficiencies in environmental content become particularly evident when the Canadian publications are compared with *The Conservationist*, a magazine published by the New York State Conservation Department. *The Conservationist* includes a broad range of material including many articles which relate the work of the Conservation Department to the areas under discussion. The broad range of material makes it particularly interesting to teachers and students.

A number of publications of the Department of Fisheries and Forestry offer a substantial ecological content. Two recent ones, *Canadian Pacific Salmon* and *Lamprey Control in the Great Lakes*, are readable and informative. The Department of Fisheries and Forestry published several papers dealing with fisheries aspects of water pollution, which were presented at the Pollution and Our Environment Conference, as a separate issue of *Canadian Fisheries Reports*. It represents a type of source document that is widely needed to provide information on environmental questions.[2]

The Canadian Wildlife Service has a pamphlet series, *Hinterland Who's Who*, on the life history and ecology of different species of animals. The pamphlets give an excellent ecological overview of the species and include reference to interactions which occur between animals and man.

Among the provinces, Saskatchewan and Manitoba have probably made the strongest effort to provide background educational material on resource topics. Saskatchewan provides a *Resource Reader*. Manitoba makes information available in bimonthly "Conservation Newsletters" and through a pamphlet series. Although impressive in appearance, the *Resource Reader* has a serious weakness in that it does not bring environmental relationships into focus in the manner of the Manitoba publications and the Canadian Wildlife Service's "Hinterland" series. The fact sheet on waterfowl for example, makes no mention of the way people influence ducks, or vice versa, nor does it discuss factors which determine the suitability of habitat for waterfowl.

To sum up, we consider that the information and education programs of fisheries and wildlife agencies in Canada suffer from many, or even all, the deficiencies that were suggested at the Resources for Tomorrow Conference. With the exception of two or three agencies, they give little evidence that administrators recognize that I & E programs can help to change the attitudes

[1]B.C.: *Wildlife Review*; Alberta: *Alberta, Lands, Forests, Parks, Wildlife*; Ontario: *Fish and Wildlife Review;* Quebec: *Bulletin, Tourism, Fish and Game.*

[2]The publications on salmon and lamprey were issued in 1968 and were by R. Haig-Brown and N. Wadden respectively. Canadian Fisheries Regions, No. 9, was published in 1967.

and behaviour of Canadians towards renewable resources. Far too much of the material distributed by some agencies is designed to propagandize rather than to inform and does little to fill the information needs of citizens. We discuss this subject further in Section IX.4.

IX.3.4 Information and Education and Public Information Media

Since more than 99 per cent of the populace undoubtedly read or hear of resource matters through press, radio or television, it would be difficult to overrate the importance of these media in developing public interest and knowledge.

One of the greatest services they could provide would be to give more adequate coverage to fish, wildlife and other resources topics on a day-to-day basis. To too great a degree, coverage has centred on "national emergencies" like DDT and pollution which have begun to command public interest. One of the areas of need is for more "analytical" reporting which will help to establish a better basis for public understanding of important questions over the long term. Television, for example, periodically has national spectaculars on resource questions, but otherwise there has not been very much done to build up appreciation of ecological relationships. Fish and wildlife topics have the potential to hold audiences and we consider that they and the other resources are not receiving the kind of priority they warrant from the broadcasting media. This may, in part, be due to the lack of imaginative and informative material from government departments and agencies.

We consider that the environmental questions of the day warrant the establishment of priorities in reporting. We consider that public information media should contribute more in-depth reporting on matters where the need of the public to know is clearly not being met. We suggest that the Canadian Broadcasting Corporation, as a government corporation, should be particularly active in meeting this need.

IX.4 Towards More Effective Means of Communication

"Nearly every individual and institution is involved in some way in the communications process. The aim of those responsible for resource use must be to ensure that key individuals and institutions understand the significance of resources in the whole pattern of society, and to encourage them to adapt their information or education programs to meet the need for better public knowledge of resource management."[1]

At a point in time when the world is being flooded with information on the environment, many "key individuals and institutions" in Canada face a lack of the kind of information they need to establish better public knowledge of resource management. The problem is a multi-dimensional one and some aspects of it have been referred to in previous sections.

The background papers and the discussions at the Resources for Tomorrow Conference focussed some attention to the "near-abdication of the field of resources information and education by the federal government" and on the fact that it was almost impossible for the average citizen to find out how to get information from the diverse information media which exist. There was considerable support for the establishment of agencies in the provinces and federal government to act as clearinghouses for information and to co-ordinate activities in this area. The Glassco Commission also discussed the subject and recommended the establishment of a central government information agency. After the recent publication of a task force report *To Know and To Be Known*, Prime Minister Trudeau announced new arrangements for the management of this area of activity. We consider that any action which helps to eliminate the

[1]Symington, D.F. Information-Education statement by research co-ordinator. Resources for Tomorrow Conference, Vol. 3. 1962.

"jungle" aspect of information services is highly desirable.

In the course of our study, we learned of a proposal made to Treasury Board by the Department of Indian Affairs and Northern Development for the production of a directory on Canadian government information services. The concept was a simple one and would result in a listing of the departments and branches which could provide information on particular topics. The directory would be inexpensive and could be widely distributed across the country. We suggest that such a directory should be established. We consider that it would be of considerable value in "opening up" federal sources of information and education material to the public.

We also suggest that resource departments of both federal and provincial governments devote a higher percentage of their funds to information and education work. Symington's survey in 1961 showed that less than 1 per cent of expenditures was made on the I & E sector.[1] There is no indication that the percentage is much higher at the present time. Ontario, for example, listed head office expenditures on I & E for 1967-68 at $238 996.68. The operating expenditures for that year were $42 807 111.

One of the priorities suggested by the Resources for Tomorrow Conference workshops on I & E was the study of means of measuring effectiveness of information-education programs. We suggest that the resource departments of every government in Canada should give such studies a high-priority rating.

We believe that one of the most important reasons for the lack of in-depth information in Canada on resource and environmental matters is that not enough specific material is being produced and the material that is available does not have wide enough circulation. We recommend that the federal government sponsor or publish a high-quality, popular magazine which would publish articles on resource and environmental matters. We recommend that the magazine be distributed free to every school and library in the country, be available by subscription and be sold through commercial news-vending sources. To avoid the problem discussed earlier, of relating only good news on conservation, we suggest that a possible approach might be to have the magazine published by the (proposed) Canadian Council of the Environment, an agency which would have the primary role of providing information on environmental matters, and which would have considerable freedom of expression.

Canadian biologists have not excelled in the art of communicating with the public. Part of the evidence exists in the problems that private organizations have had in getting scientists to write interpretive articles on environmental topics; perhaps the strongest evidence is that few have been willing to become involved in discussions of environmental problems. Some reasons for the deficiency are fairly obvious. For example, scientists employed by government agencies traditionally consider themselves bound to the policies of their department and so have limited freedom to express personal opinions. While we recognize the validity of this argument as it pertains to direct aspects of policy, we suggest that the need for professionals to write on biological matters is so wide that, in fact, no serious limitations are placed on government scientists in this area at all. Perhaps the most important limitation to the participation of Canadian scientists has been a deeply established belief that scientists must always be coldly dispassionate, never emotional on matters pertaining to science. This traditional dogma received a rather thorough review in 1969.[2] We consider that the review should extend to the roots of the scientific community.

[1]Symington, *op. cit.*

[2]For example, note "The rape of the environment", 1969, by M.T. Dunbar, prepared for the Canadian Society of Zoologists–an organization with a strongly traditional approach.

The low level of importance attributed by employing or granting agencies to "non-scientific writing" is also a factor. The National Research Council, for example, requests that scientists list publications that have appeared in refereed journals. No consideration in granting can be given under such a system to the scientist who has the desire to interpret his work to the public.

Only a sociological study of the attitudes of scientists could really do justice to this subject, so we will not attempt to pursue it to greater length. To sum up, the point we make is simply that Canada needs the knowledge of its biological scientists to gain perspective on fishery and wildlife matters and on many other aspects of the environment. We urge them to participate more in the public arena. Their efforts could bring the degree of charisma to environment and resource matters that is needed to elevate consideration of them to the level of economic, political and cultural matters.

Chapter X

Influence of Resource Development on Fisheries and Wildlife

X.1 The Nature of the Influences

"The person interested in fish and wildlife nowadays has two concerns that outweigh all others. One is the loss of habitat to industry, urbanization, and other forms of land use that destroy habitat, a loss sometimes necessary, but also sometimes unnecessary. The other is the degradation of what habitat is left by environmental pollution. In both cases there is concern that fish and wildlife resources are given nothing like the consideration that their true value in the life of the Province would warrant. In the matter of environmental pollution, the general feeling among those who work with fish and wildlife is that, quite apart from the consideration they warrant because of intrinsic importance, they should be viewed as the equivalent of the coal miner's canary. Being especially sensitive, they give early warning of changes that affect all life, and the best way to assure a good environment for all is to keep it in good shape for fish and wildlife. If it is good for high quality species of fish and wildlife, then it is a high quality environment. Keep it that way and you are building for the year 3000."[1]

In this age of science and technology, fish and wildlife have become dependent resources. Their availability for our use and enjoyment is dependent on the use of other resources, which is always considered to be primary and often to be of exclusive importance.

Sometimes the changes which result from the use of other resources are beneficial, and animals flourish. At other times, they are harmful, and animal communities are destroyed; and they may even result in the extirpation of certain species. Resource development has had a greater impact on both aquatic and terrestrial environments during the past 25 years than it had in the preceding 75 years. The changes that have occurred have been related to the main foci of resource development. Some of the more obvious ones are the reservoirs constructed for the production of electric energy, the large areas of clear-cut forests associated with modern mechanical logging, the draining of the prairie sloughs to expand grain production, and the enlargement of fields and the removal of fence rows to permit more efficient use of new equipment on agricultural lands.

The most important things have not necessarily been those that were obvious. They may well have been those associated with the introduction of the products of space-age technology, detergents and pesticides, to the environment. Fishery and wildlife scientists have had a very difficult time determining the effects of these products on animal life, and long in advance of the current interest in society, came to feel very strongly that the onus should not be to prove that they have detrimental effects *after* they have been introduced, but to prove that they will not have detrimental effects *before* they are used in the environment.[2] It is unlikely, in fact, that a quality environment can be maintained unless we adopt "the proof before use" approach to the use or disposal of chemicals in the environment.

In the last 25 years, in spite of a lot of talk about multiple-use programs involving fisheries and wildlife, resource development has continued to be done largely on a single-purpose basis. In the tour we made across the country, we were unable to find many examples where significant attention had been paid to the effect development programs would have on fisheries and wildlife or on outdoor recreation. The omission is an important one, for no amount of scientific expertise will make any difference unless the opportunity to apply it is provided in meaningful ways.

[1]Clarke, C.H.D. Fish and wildlife values in pollution. Transactions of the Ontario Pollution Control Conference. 1967.

[2]Wildlife Workshops A and B. Recommendation 5 to the Steering Committee, Resources for Tomorrow Conference, Vol. 3. 1962.

X.2 Disposal of Wastes

Waste disposal is the most important problem to be faced and solved if a national goal of maintaining a quality environment is to be achieved. Man must cease waging chemical and biological warfare against himself and his environment.

It is a problem of overwhelming importance to the maintenance of commercial and sport fisheries. It is of lesser importance to wildlife; but, there too it has many links. For example, it can exert direct influence on seabirds, waterfowl and aquatic and marine mammals.

Although the disposal of wastes frequently results in pollution, it is not an invariable rule that the changes will be undesirable ones. There are many aquatic systems in which productivity is limited by low temperatures or by shortages of nutrients. In such cases, changes of the right magnitude in the right direction may be beneficial from a human point of view. The important thing is that assessments be made in advance to determine what will happen and what the influence on organisms will be. The complexities with respect to the disposal of warm water from atomic power plants were brought out at the Ontario Conference on Pollution.

"Time and place may change everything. Warm water from the atomic power plant at Douglas Point into Lake Huron will probably make no difference to the fish. The same thing in chilly Lake Superior, if it ever comes, would probably do some good. At Nanticoke, on Lake Erie, we have our fingers crossed. The engineers came up with a calculation that sounds facetious, showing that the outflow would not be enough to affect the temperature of Lake Erie. What we want to know is the effect that the warm water is going to have on the game fish spawning areas that lie in its immediate path. Lake Erie may be moribund, but Long Point Bay has remained unchanged and supports more angling than any other area in the province–better angling too."[1]

This case highlights the need for multidisciplinary consideration of all "Grand Designs" for development that can influence the environment. Apparently the engineers from Ontario Hydro did not consult with other departments and were unaware that Long Point Bay was an important sport fishing area and that vital spawning grounds were just off the proposed site of the generating plant. Further, their calculations amortized the influence that the warm water would have on the whole of Lake Erie. Biologically, the question of whether or not cooling towers should have been included in the design should have been based on the effects of warm water on the temperature, and aquatic life, of Long Point Bay, a very much smaller area than Lake Erie.

Because of the magnitude of differences in importance, the greater part of the rest of the discussion on waste disposal will be based on its influence on aquatic ecosystems. An introduction to the nature of aquatic ecosystems in Canada and of the problems of eutrophication is provided by Dr. Clarke's paper:

"No matter how many, or how few our lakes, no sooner does one come into existence than the process of its filling in commences. In the limnological sense, when it is very young it is not much use to fish, and when it is approaching death it is not much use either.

"The aging process in a lake has been given the name eutrophication. Most of our northern lakes are called oligotrophic, which is evidently intended to mean that they cannot rear very much–certainly this is true. Rich lakes, full of nutrients and full of organisms, are called eutrophic, literally 'good rearing'....Everyone recognizes that as nutrient material accumulates in an oligotrophic lake, the lake gradually becomes eutrophic–

[1]Clarke, C.H.D., *op. cit.*

moving from youth to productive maturity. If we pour nutrients in at an accelerated rate what happens is not good, which is what the 'eu' part means. It is more like premature old age than healthy maturity. The increase of dissolved solids in one oligotrophic lake in Northern Ontario as a result of the pouring in of an industrial effluent did not make it into a eutrophic lake. Instead, it became a sterile lake. Lake Erie already was a eutrophic lake. The accession of millions of tons of raw sewage day in and day out for more than a century has not made it more eutrophic. It has had an effect on the lake comparable to what we know would happen to a farmer's field if you were to dump on it all the manure from an enormous chicken factory. Up to a point it is fertilizer, or eutrophication if you like. Beyond that it represents for the environment what athero sclerosis does for a human individual. Lake Erie is at a point now where certain organisms that tolerate a shortage of oxygen are thriving, as are the couple of species of fish that thrive on these organisms. The small creatures that depended on a good supply of oxygen in the lower levels are gone or going, and so are the fish that used to depend on them. The blue pickerel that was the most important commercial fish in the 1930's is now listed in the official U.S. roster of extinct or vanishing species, and there is nothing you can do about it because the lake it used to live in does not exist any more."[1]

The discharge of industrial wastes into aquatic ecosystems presents a bewildering array of considerations as far as fish and other aquatic organisms are concerned. Wastes from mining, pulp and paper and petrochemical industries, for example, are very different physically and chemically and consequently have very different potential effects. Although the Fisheries Act, 1932, makes it illegal to place "any substances deleterious to fish in waters frequented by fish", obtaining proof that wastes have a harmful effect is difficult. However, increased public concern about pollution has resulted in greater efforts in the detection of threats to fishes from chemical and thermal wastes.

X.2.1 The Mining Industry

"Iron ore wastes (called 'tailings') are largely finely divided, low grade material that has been separated from the richer ores, and which must be disposed of in some way. When spilled into water areas, which is where most of them finally end up, these wastes may be carried for long distances. The heavier particles settle out quite rapidly. The more finely divided material, can travel very long distances, and is kept in suspension for long periods by the action of wind and currents. The main effects of these in excessive quantities are: (i) to destroy spawning areas by siltation, (ii) to smother plant and invertebrate growth on the bottom, (iii) by reduction of light penetration, decrease general food production, and (iv) by effects on certain tissues, especially respiratory, directly decrease the ability of fish to survive.

"Tailings spilled from ore concentrators of 'heavy' metal mines have much the same physical effects as those from the iron ore operations just described, i.e. smothering, turbidity, and mechanical irritation. Chemically, and more difficult to control, these tailings also carry lead, copper, and zinc in solution.

"Zinc and copper in solution are toxic to fish life at very low concentrations. In similar waters elsewhere, 0.60 ppm of zinc or 0.48 ppm of copper are the Incipient Lethal Levels (ILL)–the concentrations at which the organism can no longer survive for an indefinite period of time. With this value known, other concentrations of these substances may be expressed as multiples of the ILL. Thus it has been shown that concentrations of dissolved zinc or copper equal to four tenths (0.4) of their ILL is the level at which, under natural conditions,

[1]Clarke, C.H.D., *op. cit.*

Atlantic salmon begin to be adversely affected."[1]

Mining is Canada's most important primary industry; much hope is placed on it for the future development of Canada. However, it is also an industry which will have an important influence on fish populations and the quality of the total environment over large areas. How do things now stand between the industry and the environment? The state of affairs, for the Atlantic Provinces, was described in 1967 as follows:

"Mining pollution has increased in recent years. In Labrador, one of two enormous iron ore developments discards about 1,000 tons of waste rock every hour, and this finely divided material may eventually affect the biology of a whole chain of lakes and rivers. There are about a dozen base metal mines in the Atlantic Provinces, some having serious effects on fisheries. Copper and zinc from mill tailings cause concern for migratory fish populations in Newfoundland's Exploits River, already affected by pulp mill wastes. Part of the Northwest Miramichi River, New Brunswick, has been spoiled for rearing young salmon because it contains fraction of parts per million of copper and zinc. This pollution by metal ions has also caused avoidance reactions by adult salmon on their annual spawning migration and has recently threatened to block migration."[2]

Ontario is the only other area of the country for which we found readily available information. A 1967 report on the Ontario Water Resources Commission gives this information on "Mining, Milling and Smelting Industries":

"...there are 107 mines and mills in this classification. Most of these discharge wastes to a natural water course and approximately one-half of this total have acceptable waste disposal practices. However, the industries with acceptable control are largely small gravel mining and ceramics (mining) operations, while the outstanding pollution problems are associated with the large metal mining and milling operations. Many of the plants in this category have improved pollution control facilities under consideration and a small number have works under construction."[3]

In summary, the limited information available to us indicates that a poor state of affairs exists with respect to the disposal of wastes from the mining industry. Relatively speaking, problems associated with the industry are undoubtedly getting worse rather than better.

X.2.2 The Pulp and Paper Industry

The wastes from the pulp and paper industry are very complex and rank as one of the most serious problems to fish in a number of regions. The following account of their character and of their effects on fish is quoted from a paper presented at The Pollution and Our Environment Conference held in Montreal in 1966:

"A full bleached kraft mill producing 1,000 tons of pulp per day discharges about sixty million gallons of effluent per day. The effluent from a modern mill has a five day BOD of 35 pounds per ton of pulp produced. Thus, the oxygen demand exerted by a 1,000 ton per day mill is equivalent to that of a city of 206,000 people. In addition to its oxygen demand which without adequate dilution, dispersion and aeration could cause the effluent to deplete the dissolved oxygen in receiving waters to a level which would not sustain fish, the wastes are

[1]Taylor, V.R. Water pollution and fish populations in the province of Newfoundland and Labrador in 1964. Canadian Fish Culturist, Vol. 35. 1965.

[2]Sprague, J.B., and C.P. Ruggles. Impact of water pollution on fisheries in the Atlantic Provinces. Pollution and Our Environment Conference. 1967.

[3]Ontario Water Resources Commission. Mining, milling and smelting industries. 1967.

toxic to fish. Various workers have demonstrated that bleached kraft wastes are pronouncedly toxic to salmonid fish, their eggs and alevins at dilution ratios of less than 20 to 1. Some of the components such as hydrogen sulfide, methyl mercaptan, sodium thiosulfate and fatty and resin acid soaps are individually lethal to fish during short exposure periods at concentrations of 5 parts per million and less. The wastes from calcium base sulfite mills and bleached kraft mills are very acidic. Those from unbleached kraft mills are highly alkaline, and salmonid fishes cannot tolerate ranges in pH much beyond the limits of 6.7 to 8.5. In addition to the dissolved substances responsible for the toxicity and oxygen demand of pulp mill wastes, they are also sources of large amounts of organic particulate matter. If hydraulic debarking of logs is practised a substantial load of very small bark particles joins the fibre lost in the screening of pulp and arrives in the mill effluent. These particles usually settle out to form sludge beds which blanket the bottom, rendering it incapable of sustaining bottom-dwelling fish food organisms, and in addition bacteria decompose the sludge deposits producing toxic hydrogen sulfide gas, methane gas and a zone of dissolved oxygen depletion."[1]

The Ontario Water Resources Commission made this statement about pulp and paper wastes:

"The manufacture of cellulose products utilizes approximately 50 per cent of the available tree. The remaining 50 per cent is discharged in almost all cases to natural watercourses. Wastes arising from chemical pulping operations are highly organic and certain appreciable concentrations of suspended solids in the form of bark and fibre."[2]

Pulp mill wastes are potentially very harmful to aquatic organisms. A test run in British Columbia to determine the effects of kraft mill wastes on young sockeye salmon found that a concentration of less than 5 per cent resulted in lethal conditions. The results of a number of laboratory studies have also demonstrated the harmful effects of different kinds of paper-mill effluents on fish.[3]

The direct impact of the pulp and paper industry on fisheries and fish populations has, however, varied a great deal. The variation is related to geographical factors rather than to differences in the way that wastes have been treated. In British Columbia and the Atlantic Provinces, the majority of pulp mills have been located on tidal waters or on large bodies of fresh water. This has resulted in a marked dilution of effluents so that serious direct effects seem to have been avoided in many cases. An example is the Irving Pulp and Paper Mill which dumps untreated effluents directly into the St. John River at Reversing Falls. In spite of this, the fishermen have continued over the years to net salmon in St. John Harbour and the salmon have continued to run up the St. John River. The Bowaters Mill at Corner Brook, Newfoundland, similarly is located about two miles from the mouth of the Humber River, perhaps the most productive salmon river in Newfoundland, but there too the dilution effect seems to have prevented a serious problem. In British Columbia, the situation is described as follows:

"...there is no evidence to suggest that commercially valuable fisheries have yet been affected significantly...tidal locations of most mills plus the fact that.... All bleached kraft mills located on inland

[1]McLaren, R.E., and K.J. Jackson. Impact of water pollution on fisheries in the Pacific area. *In* Pollution and Our Environment. Canadian Fisheries Reports, No. 9. 1967.

[2]Ontario Water Resources Commission. Status of industrial pollution in Ontario. OWRC Mimeograph. 1967.

[3]McLaren and Jackson, *op. cit.; see also* Smith, L.L., *et al.* Effects of pulpwood fibres on fathead minnows and walleye fingerlings. Journal Water Pollution Control Federation. 1965.

salmon-producing waters in British Columbia are neutralizing their wastes with lime and treating them biologically."[1]

The more serious problems are occurring on inland waters. For example, in the Atlantic Provinces:

"Some of the sixteen pulp mills in the Atlantic Provinces affect fisheries seriously. One in New Brunswick spoils 35 miles of the upper Saint John River. Its wastes will also hamper any attempt to develop resident sports fish in hydroelectric reservoirs stretching 150 miles further down stream. Pulp mill wastes can also create 'barriers' which block the migration of anadromous fish between the sea and the river. Pollution from a United States mill causes such a barrier in the Saint Croix River and prevents restoration of a salmon run. There are serious doubts about a large program to develop salmon production in the upper Exploits River because mill wastes affect a section near the mouth of this largest river on the Island of Newfoundland. Even coastal mills can create similar problems. In two of the most important salmon rivers in New Brunswick, the Restigouche and the Miramichi, there is danger that increased pulp mill pollution could cause an estuarial 'barrier' to fish migration."[2]

Ontario and Quebec are most seriously affected, since they have many mills on streams (a total of 108) which do not have a flow sufficient to dilute the wastes to levels which fish can tolerate. The Report on the Status of Industrial Pollution Control in Ontario stated: "Gross oxygen depletion effects are experienced in most of the receiving streams on which the large mills are located in the provinces."[3]

There is very little information on the effects of mill wastes on aquatic organisms in the receiving streams. The only pertinent case history of the decline of a fish population in Canada has been reported for Ontario. This developed incidentally to the study of two populations of walleye pike which were the subject of conflict between sport and commercial fishermen. Nipigon Bay, an enclosed bay on the north side of Lake Superior, was the site of important commercial fisheries for lake trout, lake whitefish and walleye, and records of production were maintained from 1945 to 1965. Until 1957 lake trout contributed the greater part of the catch. Then the species declined markedly, presumably as a result of lamprey predation, and walleye then assumed primary importance.[4]

The pulp mill at Red Rock on Nipigon Bay was changed over in 1950 from a sulphite mill with 60 tons a day production to a kraft mill producing 390 tons. The kraft machines were partially converted to semi-chemical sulphite production in 1955. By 1958 a bleach plant and new chemical recovery unit were installed, and by 1966 it had a total production of 1 275 tons per day of various pulp and paper products.

Studies by the Ontario Water Resources Commission showed high concentrations of phenols in the effluent. The surface waters of the bay had accumulations of wood fibre, high populations of sludgeworms (which are indicators of pollution) and the absence of a number of aquatic organisms that are foods of walleye.[5]

Ryder concluded that there was "...severe organic pollution in the water between the effluent outflow and Five Mile Point, and moderate pollution

[1]McLaren and Jackson, *op. cit.*

[2]Sprague and Ruggles, *op. cit.*

[3]Ontario Water Resources Commission, Status of industrial pollution in Ontario, *op. cit.*

[4]Ryder, R.A. Dynamics and exploitation of mature walleyes in the Nipigon Bay region of Lake Superior. Journal of Fisheries Research Board of Canada, Vol. 25. 1968.

[5]In January 1970, Domtar Newsprint Ltd. of Red Rock, Ontario, was convicted and fined $1000.00 under the Ontario Water Resources Commission Act for polluting a section of Nipigon Bay by the discharge of wood and chemical wastes. It was the first time a pulp and paper company had been prosecuted by the Ontario Water Resources Commission.

within a 1½ mile radius east and southeast of the discharge ditch." About the walleye population he stated:

"During the years 1955-58 the (walleye) spawners were considered to be abundant; in 1959 and 1960 they were common, ...in 1961 and especially in 1962 they were scarce; in 1963 only one walleye was observed on the spawning grounds; during the years 1964-66 inclusive, no walleyes were seen on the spawning grounds."[1]

From a biological point of view, the waste disposal problems of the pulp and paper industry are being tackled at a distressingly slow rate. Ontario has had strong pollution control legislation since 1958 when the Ontario Water Resources Commission was formed. But, with minor exceptions, the situation in the industry has not changed much since that time. The rate of progress has been much slower than in many other major industries. The following quotation from a report of the Ontario Water Resources Commission reviews the state of affairs:

"There are 44 manufacturing plants in this classification and of this total, ten dispose of wastes in a satisfactory manner. These ten plants are mainly those which have access to municipal sanitary sewerage systems, or in some cases have installed suitable waste treatment facilities. The remaining plants have unacceptable controls although plans for improved controls are under active consideration.

"The treatment of soluble organic waste materials has not been actively considered in this industry's approach to pollution control. The disposal of these wastes to natural watercourses is considered by the industry to be a legitimate use of the receiving stream."[2]

In addition to this statement on the philosophy of the industry about waste disposal being "...a legitimate use of the receiving streams", there is other evidence that the problems of waste disposal will persist for a long time unless dynamic action is taken.

In 1965 the Ontario Water Resources Commission issued a directive to industry that plans for pollution abatement were to be submitted by 1966 and that programs for pollution abatement should be instituted by 1970. The progress toward these goals has been very modest and none of the 34 mills, with inadequate treatment facilities, will meet them.

There is no doubt that pulp and paper wastes are among the most difficult industrial wastes to treat. As a result, costs of treatment facilities are high. On this subject the Ontario Water Resources Commission reported: "Information on complete treatment systems for pulp mill wastes suggests that several dollars may be added to the cost per ton of paper produced. The industry feels that this added cost will inevitably place the Ontario mills in an uncompetitive position." A statement by the Canadian Pulp and Paper Association indicated that capital costs for facilities (for the industry generally) would be $250 million and operating costs $40 million annually. It appears that the industry does not feel capable of meeting this bill for Mr. T. Ross Moore, Chairman of the Canadian Pulp and Paper Association, and General Manager of Price Company Limited of Quebec, was quoted as telling the Montreal Society of Financial Analysts that it would be economically unfeasible for the industry to clean its own wastes.[3]

X.2.3 The Need for National Action

Our review, although admittedly not an intensive one, has led us to feel very strongly that national initiative should be taken to clarify and improve the situation with respect to wastes from the two primary industries considered. We

[1]Ryder, *op. cit.*

[2]Ontario Water Resources Commission, Status of industrial pollution in Ontario, *op. cit.*

[3]Air and Water News. News item datelined Montreal and titled, "Canada's Papermills Say Cleanup Too Costly". February 24, 1969.

believe that to establish a meaningful operational framework for the Canada Water Act, a national study is needed to report on the environmental and financial aspects of the problems associated with the wastes from these two industries. The following reasons support the proposal for such a study:

1. The magnitude of the problems that are created by the wastes from the two industries.
2. The national nature of the problems.
3. The apparent reluctance of the industries to solve the problems through their own means.
4. The uncertainty that exists about the financial capability of, at least, the pulp and paper industry to provide and maintain adequate treatment facilities.
5. The need to define the major areas where advances in technology are required.
6. The need for background knowledge on which national policies can be developed.
7. The need for all citizens to be adequately informed on important environmental questions.

X.3 Control of Noxious Organisms

"Unintentional or secondarily acquired residues in the food and water of man, animals and wildlife should be the problem area of greatest concern in Canada today in defining whether or not a pollution problem exists. This possibly is an air-water-soil-plant-animal relationship that requires intensive study and evaluation."[1]

"It is painful to have to admit that, after decades of intensive research, we are far from understanding the mechanism of action of DDT. It is generally agreed now that its primary effects are virtually all upon the nervous system, both in vertebrate and invertebrates."[2]

The effect and role of biocides (pesticides, herbicides and fungicides) in the environment has been the subject of increasing debate since the late Rachel Carson wrote *Silent Spring*.[3] The debate greatly intensified in Canada in 1969. During that year Ontario virtually banned DDT and related chlorinated hydrocarbons and the government of Canada severely restricted the uses of DDT. In addition, Alberta delayed the opening of its small-game season because of the occurrence of high levels of mercury in the flesh of gamebirds.

The miasmal mists of DDT have been carried to the ends of the earth. Residues have been reported in penguins and other species in the Antarctic[4] and in polar bears in Arctic Canada.[5] Public concern is growing over the way that residues are concentrated as they move up food chains from plants to herbivores to carnivores at various levels in the food chain. The effect that has long been argued about, but only documented beyond reasonable doubt in 1967, is that where residues occur above certain levels, they cause severe losses in some species of birds and fishes.

In a recent issue of the *Canadian Field Naturalist*, J.A. Keith, Head of the Pesticides Section of the Canadian Wildlife Service, reflected on the significance of the side-effects of biocides:

"Within the past few years, a number of research leads have fallen into place to form one particular picture of biocide side effects that is unusually complete and adds new legitimacy to the long-voiced concern over the widespread distribution of low levels of residues of DDT.

[1]Hurting, H., and C.R. Harris. Nature and sources of pollution by pesticides. Pollution and Our Environment Conference. 1967.

[2]O'Brien, R.D. Insecticides action and metabolism. Academic Press, 1967.

[3]Carson, Rachel. Silent spring. Boston, Houghton Mifflin Co., 1962.

[4]George, J.L., and D.E.H. Frear. Pesticides in the Antarctic. Journal of Applied Ecology (Supplement). 1966.

[5]Jonkel, C. Polar bear research in Canada. Paper presented at Conference on Productivity and Conservation in Northern Circumpolar Lands, Edmonton. Oct. 15-17, 1969.

"The fact that a decline in eggshell weight of British Peregrines and Sparrowhawks coincided both with the widespread introduction of DDT and with a decline in their reproductive success could possibly have been called mere coincidence until the same association was shown to hold for declining populations of Peregrines, Bald Eagles and Ospreys in North America, but, most significantly, not to hold for stationary populations of Redtailed Hawks, Golden Eagles and Great Horned Owls. There is also now excellent evidence for a mechanism; DDT, its most widespread metabolite DDE, and PCB (the polychlorinated biphenyls), have all now been shown to induce enzymes in birds that degrade steroids which in turn control eggshell formation. And, finally, an inverse correlation has been established between DDE residues in individual eggs and the thickness of their shells.

"Work presently underway in Canada is documenting the now-expected patterns of universal DDE distribution at very uneven concentrations, with population declines in some populations with high residue levels. This distribution ranges from resident arctic animals and Atlantic seabirds quite out of contact with areas of DDT use, to animals in New Brunswick forests, urban areas, and open farm country, that all share some history of exposure.

"The central significance for biological research is that vertebrate populations, particularly of carnivores and even in the most remote regions, can no longer be considered without proof to have normal endocrine functions. Future studies, particularly of reproductive success and behaviour, must, to be taken seriously, include assays for DDE and similarly active materials. For some species populations with relatively high DDE concentrations, such as many bird and fish-eating birds, it will no longer be possible to find sufficiently uncontaminated control populations with which to determine either normal patterns or the degree of abnormality induced by DDE."[1]

In the case of fish populations, sublethal effects are also important as witnessed by reproductive failures that have occurred in salmon and trout. However, direct effects are also evident when careful studies are done to detect them. The following account was given at the Pollution and Our Environment Conference on the effect of DDT on salmon.

"New Brunswick forest spraying programs have had a devastating effect on Atlantic salmon production from sprayed streams. With early programs nearly all young of the year were killed and lesser proportions of older pre-migrant fish. Aquatic insects, food of young salmon, were also killed in large numbers and did not recover their original abundance of species for four or more years. Adult stocks and fisheries based on sprayed young were reduced. But the effect of a single year's spraying was spread over several years of returning adult stocks, thus being less dramatic than the reduction of young."[2]

The evidence of serious environmental contamination by the broad spectrum, chlorinated hydrocarbon pesticides, is now so strong that virtually all fishery and wildlife biologists in Canada consider that their use should be discontinued immediately. Far too much of the discussion about them has been devoted to the subject of whether or not they have had demonstrable effects on human health. They are having a serious effect on many organisms that share the planet and consequently are degrading the total environment.

We suggest that their use be discontinued without further debate about the cost or availability of alternative methods

[1]Keith, J.A. The DDT affair. Canadian Field Naturalist, Vol. 83. 1969.

[2]Elson, P.F., and C.J. Kerswill. Developing criteria for pesticide residues important to fisheries. Canadian Fisheries Reports No. 9. 1967. For a more detailed account see Elson and Kerswill, Forest spraying and salmon angling. Atlantic Salmon Journal. 1964.

of control. We feel that it is now indisputable that the cost to the environment, of retaining them, is too high.

We suggest that greatly expanded programs of research be undertaken into the use of integrated control.[1]

X.3.1 The Regulation of Toxic Chemicals

"The central significance of this DDE affair for overall resource policy in Canada is that there exists no effective mechanism for preventing such resource degradations by toxic chemicals now or in the future. In the case of pesticides, despite new legislation, there is, absurdly, no requirement that individual pesticide uses be justified ecologically, that their total benefits outweigh their environmental costs. And pesticides, at least, are formally scrutinized before being sold in the market, but what of potential industrial contaminants, such as the polychlorinated biphenyls?"[2]

The legislation for the regulation of biocides originated in 1939, and though amended since, still reflects the outdated concept that the only risk of pesticides is in direct human toxicity to user or consumer and that their use is of importance only to farmers. The environmental consequences of toxic chemicals completely outdate these concepts and require a holistic, environmental approach to regulation. It is then pertinent to review present arrangements regarding the testing and regulation of these chemicals.

To be sold in Canada, a pesticide must be registered with the Canada Department of Agriculture under the Pest Control Products Act. Registration takes the form of a review to determine: a) whether the material will do what it is claimed to do, and b) that its label defines contents and recommended procedures for use in a standardized format. The Department of Agriculture may, at its discretion, ask for advice on hazards, from federal officials in public health or in wildlife and fisheries biology. However, it is under no obligation to accept this advice, although in practice it appears that public health advice is accepted. However, responsibility for registration lies solely with the Minister of Agriculture.

There appear to be a number of defects with the present arrangements. For example, since there is no federal regulation of use, so there are no national data which record actual patterns of use. Consequently, there is no normal way of determining when and where specific pesticides have been used in Canada. This seriously hampers the study of the environmental fate of residues since the provinces do not keep records of this nature either. The primary defect of making the authorization of pesticide use a responsibility of the Canada Department of Agriculture is that it is the principal source of recommendations to farmers on the use of pesticides. Since its overriding responsibilities properly lie in improving agricultural practice, and since nowadays improvement is intrinsically connected with pesticide use, it cannot handle the regulation of pesticide use in a fashion that balances total advantages and disadvantages to the environment. However, the same argument applies to all individual agencies, since they all have a statutory responsibility to give prime attention to one particular resource or service.

An extension of the singular agency defect leads inexorably towards an interdepartmental regulatory group of some kind as the only practical way in which total advantages and disadvantages of biocides can be weighed. This approach is the one used in Great Britain and we have heard that it is generally considered to be a satisfactory arrangement.

It is possible that with dynamic leadership and a clear legislative prerogative, the present interdepartmental committee (Federal Interdepartmental Committee

[1]Integrated control is blending of biological and chemical measures based on knowledge of the ecology and population dynamics of target insects and of other predacious insects which prey on them.

[2]Keith, J.A., *op. cit.*

on Pesticides, FICP) could provide the core of a group which would have primary responsibility for recommending on the registration of biocides. We believe, however, that it should, like the Fisheries Research Board, have substantial representation from the scientific community at large. In summation, we suggest consideration of more effective, less partisan, administrative arrangements for the certification and registration of pesticides.

X.4 Production of Food and Fibre

The degree to which wildlife is dependent on other resource uses is particularly evident in the case of species which live on forested and on agricultural land. Before logging, the bird community in a hardwood forest may be comprised of 20 or more species; two or three years after clear cutting, the diversity of the community will be greatly reduced but the number of individuals of remaining species is likely to be greatly increased. On agricultural lands the diversity of wildlife is also directly dependent on the diversity of the habitat.

The trends in both agricultural and forestry practices are towards the development of conditions which are unfavourable to wildlife and often to fish as well. But the needs of society are developing towards greater use of these subsidiary resources. One of the challenges in maintaining a quality environment will be to strike a reasonable balance between the economics of mechanization of these important primary industries and the maintenance of habitat conditions suitable for fish and wildlife.

X.4.1 Agriculture

There are many interfaces between agriculture and fish and wildlife and it is not possible to make any generalized statement about the way things will work out. There are species which are virtually impossible to maintain in the face of the agricultural use of land. Buffalo is such an animal, and even if they had not been almost exterminated by hunters more than a century ago, it is doubtful that there would have been any more in Canada today. Their migrations across the vast expanse of prairies could not have been tolerated by grain farmers or cattle ranchers. But there are other species, which modern agriculture favours, and we referred to some of these, particularly blackbirds, that have become so numerous that they are now regarded as serious pests on corn and on some species of fruit. Even from the point of view of hunters or naturalists, the influence of agriculture is often neutral or beneficial; in southern Ontario, for example, where agriculture has displaced a number of native species, it has provided range for ring-necked peasants, European partridge and European hare.

The areas where agriculture is having the most serious effect on wildlife is in western Canada where livestock grazing and land drainage programs are of considerable consequence to wildlife populations. In the Prairie Provinces and British Columbia, livestock commonly graze on Crownlands. In Alberta, for example, the Department of Lands and Forests administers grazing rights, and individuals can contract for grazing rights by obtaining grazing leases and tax permits or by allotments in particular zones. Grazing leases are for a long term and give exclusive use of the range to the lessee, who has virtually complete control of the use of the land. Overgrazing is common and in many areas the capacity of the habitat to support both cattle and wildlife has been reduced. In a number of areas, the effect on the winter range of mountain sheep and elk has been serious.

In areas where grazing occurs on Crownland, there is a need to introduce new regulations which will place grazing on a more reasonable basis and allow better range management practices to be introduced. In a number of forest reserves, the Forest Service has been moving to reduce stocking rates and set

later opening dates for grazing. Where this has been accomplished, much better range conditions for both cattle and wildlife have resulted. However, the greater part of Crown grazing-lands are not in good condition and both the land and wildlife are suffering.

The most serious situations on grazing lands appear to exist in British Columbia where the California and Rocky Mountain big horn sheep range occurs on a complex blend of Crown and private lands. The winter ranges are almost universally overburdened and some bands of sheep have been decimated by die-offs which are caused by a malnutrition-parasite-pneumonia complex. The interdepartmental areas of responsibility are more complex than in Alberta, and make it difficult to resolve the problem solely by government action. It is an area in which an advisory committee, comprised of livestock interests, government officials and private citizens from other areas of interest, could conceivably help to resolve a problem on which fresh insight is badly needed.

The part of Canada enclosed by the international boundary, and lines joining it to Calgary, Edmonton, Prince Albert and Winnipeg, is approximately 165 000 square miles in area. It represents less than 10 per cent of the duck breeding grounds of North America, but at least 70 per cent of the principal species of waterfowl are produced in this prime area. In addition, the wetlands of the area represent breeding areas of the canvasback, redhead and ruddy duck. Potholes and sloughs are the most important breeding area; the larger marshes also provide breeding habitat and, along with lakes, are of primary importance for moulting birds and as staging areas for waterfowl in migration.[1]

Over the past two decades, much has been written about how the gradual drainage of the wetlands threatens the future of waterfowl hunting and of one of the great natural spectacles in North America–millions of waterfowl in migration. Many of the prime areas in the northern United States have already been lost as a result of drainage programs and Canada appears to be headed in the same direction. Referring to the trend, the Honourable Arthur Laing stated in 1965:

"Natural droughts are troublesome enough, but more and more of these high-value wetlands are being threatened by the works of man. Competing demands on wetlands for agricultural, industrial, and residential land constitute a problem that is reaching crisis proportions. We have only to look to the northern prairie states to see what will happen unless we move quickly to prevent the loss of the habitat that is vital to migratory waterfowl, one of our most beautiful and valuable renewable national resources."[2]

The drainage of the larger marshes has been undertaken for flood control, hay production and pasture development. The drainage of potholes is most commonly undertaken to provide greater efficiency and ease in the conduct of agricultural practices. The drainage of land is supported by both federal and provincial legislation. Saskatchewan, for example, has a Conservation and Development Act under which Conservation and Development Area Authorities are set up to undertake land reclamation and water development. It pays 50 per cent of the reclamation costs on projects on private land. In addition, flood irrigation schemes developed under the Prairie Farm Rehabilitation Act (PFRA), ditching for highways and grid roads, and drainage programs undertaken by individual farmers add a great deal to the area of wetlands that are drained.

PFRA was organized in 1935. Their main work consists of storing water for farm and municipal use and in the

[1]Munro, D.A. Ducks and the great plains wetlands. Canadian Audubon, Vol. 25. 1963.

[2]Laing, Hon. A.A. Wildlife in the Canadian society. Speech to the B.C. Wildlife Federation. April 30, 1965.

development of irrigation projects. However, many projects constructed during wet periods, although not registered as drainage projects, resulted in the conversion of wetlands to agricultural lands. Its programs are now integrated with those initiated under the Agricultural Rehabilitation and Development Administration (ARDA), which was enacted in 1961 and amended in 1965.

We attempted to obtain data on the rate at which wetlands are being drained in western Canada under federal government (ARDA) and PFRA subsidy programs; however, the information was impossible to obtain because few of the programs which result in drainage are registered as such. The Canadian Wildlife Service has a rule of thumb that 1 per cent of prairie wetlands are being lost each year as the result of drainage programs; however, data to substantiate it are sparse. Ducks Unlimited has periodically attempted to make assessments.[1] Their data show that large areas have been involved; however, they do not allow the calculation of rates of loss of wetlands habitat.

After the report at the Thirty-third Federal-Provincial Conference in July 1969, that the prairie wetland easement program had not developed as anticipated and would be completely reoriented, the Executive Director of the Canadian Wildlife Federation wrote to Prime Minister Trudeau on the problem of wheat production and the drainage of prairie wetlands. One paragraph of the letter brought the interrelated problems into perspective:

"It is our belief that the present quota system, relative to delivery of grain to elevators, contributes to over-production of wheat and to much uneconomic and destructive drainage of prairie wetlands. Without wishing to overemphasize the obvious, there can be no doubt that drainage of sloughs and ponds does increase acreage 'sown', for purposes of establishing delivery quotas, and hence the immediate cash return to the farmer. The productivity of the drained area is commonly so low as to be uneconomic, but it does have the short term effect of permitting the grower to obtain a larger cash return from his crop in that production year. Total acreage sown to wheat is thus increased substantially, though the resultant increase in total production may be quite modest. The longer term effect on water tables would, according to the research findings of the Department of Energy, Mines and Resources, be detrimental. For waterfowl and all of the other interesting forms of live which depend on prairie wetlands, the effect is disastrous and final."[2]

The problems associated with wheat productivity, the need to diversify prairie agriculture and the impact of drainage on waterfowl are very complex and warrant immediate consideration. In common with a number of other problem areas which we have discussed in this report, we feel certain that they cannot be solved solely by the interaction of members of the federal Departments of Agriculture and Indian Affairs and Northern Development. We suggest that it should be the subject of an integrated study in which agriculturists, economists, biologists and hydrologists join forces in a comprehensive study of the interrelated aspects of waterfowl populations, water relationships and wetland drainage programs. Because of overlapping of federal and provincial jurisdictions in all areas involved, the study should be constituted on a federal-provincial basis. We consider that it might be useful to inaugurate the fact-finding portion of the study on the basis of provincial subcommittees since there is considerable variation in provincial legislation and in the application of federal programs in the three provinces.

[1]Moulding, H. Drainage in Saskatchewan. Past, present and future. Ducks Unlimited. Typescript. 1960. Plus additional data on specific areas drained up to 1968. In correspondence.

[2]Letter to Prime Minister P.E. Trudeau from R.C. Passmore, Executive Director of the Canadian Wildlife Federation, July 24, 1969.

X.4.2 Forestry

Forestry operations interact in two important ways with fish and wildlife. They influence fish populations by modifying the aquatic environment by:

a) influencing water and temperature relationships as a result of removal of the forest;

b) modifying streams through direct action of log and drives, and by the indirect action of pollution resulting from the accumulation of bark on the bottoms of lakes and rivers, and from the use of fertilizers and other chemicals in the forest.

Aquatic wildlife may sometimes be influenced by log drives; however, the primary influence to wildlife comes as a result of the modification of the habitat by logging. Since the use of rivers for the transportation of logs is decreasing, we will deal here with the changing nature of forestry operations, which we consider to be an area of paramount importance to wildlife.

For many years forestry operations were considered to be the benefactors of wildlife management in Canada. Many wildlife species (e.g. deer, moose, grouse, varying hare) most hunted for sport in Canada are not animals of the "deep" forest but of the forest edge. That is, they do best in areas where a complex blend exists between the availability of food and of cover. Forestry operations, both for saw logs and for pulpwood, often provided conditions that were close to ideal because they left forested lands as a vast patchwork of young and old stands. The pattern of forest stands of mixed-age classes resulted from: a) a wide distribution of relatively small operating units, and b) from residual immature stands and advance reproduction which were left in the wake of logging operations.

It is now becoming clear, however, that as far as wildlife populations are concerned, the logging of forests has become a two-edged sword, sometimes beneficial to, but frequently very destructive of habitat.[1] Subtle differences are often involved. Logging practices, which may be beneficial to an area primarily used as summer range, may be quite harmful in an area used as winter range. The presence of advance reproduction and immature stands can have a considerable influence on the use that is made of an area by moose or deer during the first decade or two after logging when the area has the greatest abundance of food. When stands occur in clumps they provide shelter from wind, reduce snow depth and give escape cover from predators. But with the widespread introduction of various methods of mechanical logging during the past decade, the picture has completely changed. These methods have resulted in much larger operating units and in the elimination of the advance reproduction which is almost invariably knocked down by the mechanical equipment. Also, the use of herbicides is being introduced to eliminate non-commercial species, which are often the most important food plants of browsing animals.

In Newfoundland, where we had the opportunity to see logged areas, the methods of logging and the size of logging operations common before 1960 were ideal for the improvement of the habitat for moose, but dramatic changes have taken place. Instead of 4 000 to 8 000 cords being cut each year from a single camp, annual cuts of 30 000 cords are now common. Consequently the logged areas are much larger, and as a result of mechanical logging methods, do not appear to be in a desirable condition for moose.

In 1968 two of us were members of a team which conducted a study for the Quebec Government on a problem of a declining deer population that has been experienced in areas of the province over a six-year period. During the study we observed a large winter yard that had

[1]Telfer, E.S. The relationships between logging and big game in Eastern Canada. *In* Preprints of papers presented at the 52nd Annual Meeting of the Woodlands Section, Canadian Pulp and Paper Association. 1970.

been completely eliminated by a modern logging operation. While we concluded that habitat deterioration had not been the primary cause of the decline, we did conclude that the province could not expect to maintain a huntable deer population over considerable areas, unless logging practices were considerably modified in the areas where deer spend the winter.[1]

Although wildlife biologists generally believe that the average size of clear-cut areas has increased dramatically during the past decade, and believe that this trend will have a serious influence on populations of game animals, the arguments cannot be readily substantiated since there are no quantitative data available on trends in the size of production units or on the degree to which mechanical operations eliminate advance reproduction.

Although specific aspects of interrelationships cannot be substantiated, the potential importance of pulp and paper operations to wildlife in Canada is obvious. Pulpwood production in Canada in 1968 was of the order of 23 million cunits; of this approximately 7 million came from wood residues and 16 million came from roundwood, that is, as the result of specific pulp and paper operations. It would represent the cutting of approximately 1 million acres (1 500 square miles) of forest, much of it in areas that are most used by residents and non-residents for hunting and other recreational purposes. If the cutting results in favourable conditions for wildlife, it will be of very great importance in the future; if it results in the creation of unfavourable conditions, it will constitute a disaster. It is of considerable importance that immediate steps be taken to:

a) determine what influence modern forestry operations are having on wildlife habitat in Canada; and

b) in situations where it is deleterious, determine what can be done to modify cutting methods so that they will be more favourable to wildlife.

Consistent with the theme of this chapter, we suggest that the pulp and paper industry in Canada should accept the responsibility of conducting or supporting the research program necessary to determine answers to these questions. We consider that a logical approach would be to conduct the study through the silvicultural section of the Pulp and Paper Research Institute of Canada (PPRIC). The direction of such a program should be through a forestry-wildlife advisory committee drawn from government agencies and from the industry itself. A levy of one cent a cunit on Canadian pulpwood production would provide an annual fund of approximately $250 000, or two cents, $500 000.

X.5 Development of Water Resources

"Water is a natural resource which often has a controlling influence on economic development of other resources and, therefore, is in competitive demand by the utilizers of other resources."[2]

The development of water poses the greatest challenge in the utilization and management of resources which Canada faces. Contemporary ways of life make great demands on energy sources, and any nation which wishes to "progress" and to "keep up with the world" has no alternative but to meet them. But every source of energy contains a threat to some element of environmental quality. The challenge is to develop the capability of assessing the advantages and disadvantages in a holistic sense and the wisdom to act so that there will be adequate balance between economic and environmental factors.

In Chapter I we mentioned that the

[1]Pimlott, D.H., J.R. Bider, and R.C. Passmore. Investigation into the decline of deer in the counties north of Montreal. Report to Hon. G.E. Loubier, Ministre du Tourisme, de la Chasse et de la Pêche, Quebec. 1968.

[2]Patterson, T.M. Administrative framework for water management. Resources for Tomorrow Conference, Vol. 1. 1961.

background papers and proceedings of the Resources for Tomorrow Conference were important reference sources. The section on water brings out the feeling of intensity that exists for acceleration of the development of water resources, primarily for the production of hydroelectric energy but, secondarily, for agricultural, industrial and domestic purposes.

In discussing multi-purpose development of the Fraser River, probably the only river in Canada which supports a fishery productive enough to compete with the economic yield from power[1], it was suggested at the Resources for Tomorrow Conference that "...energy resource values will far outweigh any resource losses consequent to such development".[2] P.A. Larkin suggested that even if fish protection facilities (which would cost $300 million at 1961 prices) were integrated into the development, there is no assurance they would work. He stated: "The alternatives are, therefore, fish or power."[3] In deciding on the alternatives of fish or power, we suggest that available economic analyses are not able to cope with the relative aspects of the immediate needs for electric energy and the long-term values of salmon runs in perpetuity.

It seems likely that Canada will eventually develop the greater part of the hydro potential of its major rivers. An important but unanswered question is: Can it be accomplished without seriously unbalancing the North American environment? The proposals for a North American Water and Power Alliance (NAWAPA), the Rampart Dam in Alaska (which would be 530 feet high and 4 730 feet long and create a lake of almost 11 000 square miles), and even the complete utilization of the power potential of the Fraser, the Saskatchewan, the St. Lawrence and the Hamilton river systems are matters of great ecological significance. They warrant much more thorough consideration than simply those related to economic and engineering factors which, up to the present time, have been the only factors that have been adequately considered.

For the very large projects, the issues are quite stark. There will be tremendous dislocations of the environment if they occur. However, the projects which have been developed or started in this decade are on a much smaller scale. The chances for the accommodation of other values are greater. In terms of maintaining a quality environment, the questions: How are they being developed? How will they be developed? are of considerable importance. Will it be economically feasible to develop them in a broad, multi-purpose framework? It appears that these are questions we must ask because there seems to be a need for considerably more development of water resources in Canada. Cass-Beggs gave estimates at the Resources for Tomorrow Conference which indicated that annual water consumption in Canada would increase from approximately 13 million acre feet in 1960 to 57 million in 1990.[4] He also dispelled the illusion that the need for hydroelectric power would be greatly reduced by the development of atomic sources, by pointing to the value of water power in providing electric energy at daily and seasonal peak periods.

There was considerable discussion at the Resources for Tomorrow Conference about the need for multi-purpose development of river basins, and some speakers, like the one quoted in the introduction to this section, expressed themselves quite strongly on the point.[5]

[1]The annual wholesale value of salmon was estimated at $36 million in 1961, with a greater future potential. This does not take into account the recreational values of the sport fishing.

[2]Paget, A.F., and C.H. Clay. Multi-purpose development of the Fraser River. Resources for Tomorrow Conference, Vol. 1. 1961.

[3]Larkin, P.A. The effect of man-made changes on the environment of fisheries. Resources for Tomorrow Conference, Vol. 2. 1961.

[4]Cass-Beggs, D. Water as a basic resource. Resources for Tomorrow Conference, Vol. 1. 1961.

[5]Kristjanson, K., and W.R.D. Sewell. Water management problems and issues in Canada. Resources for Tomorrow Conference, Vol. 1. 1961.

It was, however, evident that up to the time of the Resources for Tomorrow Conference, "water projects have been developed in Canada for specific and immediate ends". Our study showed that there has been no appreciable change in the pattern of development since the Conference.

X.5.1 Some Recent Water Resource Projects in Canada

The damming of the Peace River at Hudson Hope was one of the recent developments under consideration by British Columbia at the time of the Resources for Tomorrow Conference. The river flows through the southern portion of Wood Buffalo National Park, so at that point, becomes a matter of federal concern because of fish and wildlife resources. Regulation of the river is also of direct federal interest because of navigation. The Water Resources Branch of the Department of Northern Affairs and National Resources prepared a report on "The Effects of Regulation of the Peace River".[1] The report considered only the effect of regulation on navigation. No members of the Canadian Wildlife Service, the National Parks Branch, or the Department of Fisheries and Forestry participated in making the study. In the report no mention was made of the potential effect of regulation of the river on fisheries and wildlife. The need for ecological consideration is now evidenced by the problems which have developed with the gold-eye and walleye fisheries in Lake Athabaska and with beaver and muskrat populations in Lake Claire.

In Saskatchewan, the Squaw Rapids Hydro Power Development is located on the main Saskatchewan River, approximately 150 miles downstream from Prince Albert.[2] It was under construction at the time of the Resources for Tomorrow Conference. A scientist, who had known the area before it was flooded, conducted a personal study of the use being made of the area and submitted an illustrated report to us.[3] Following are excerpts from it:

"There is no doubt that, from a power standpoint, Squaw Rapids was a logical place for a project. In any cost benefit analysis the value of the flooded area would have been of relatively small importance. However, the reservoir was only partially cleared before flooding and, as a consequence, the area has only a fraction of the recreational value that it could well have had. In spite of what, on the surface, appears to be a lack of any real planning for the other uses of the reservoir, it has become a significant recreational area. The local conservation officer informed me that on summer weekends about 3,000 people per day came to the power station area to fish. In the fall and early winter, Squaw Rapids serves as the gateway for many who hunt migratory birds and big game.

"I am convinced that the failure to properly clear the reservoir was a blunder of major proportions. However, and this cannot be emphasized too strongly, it is exactly the kind of blunder that industries and corporations have made and are continuing to make all across this continent. I was an undergraduate at the time the decision to flood this area was made and I recall very little public pressure to have the reservoir cleared. I am sure there would be public pressure for multiple-resource management of the area. Had the vast recreational potential of the area been pointed out in a forceful manner prior to flooding, I would like to think that the situation would be very different today."

The influence of public apathy on resource development was referred to many times at the Resources for Tomorrow Conference. It is significant that it was cited as a primary factor in the single-purpose approach taken at Squaw Rapids. In Manitoba, during late 1968 and early 1969, there were many suggestions that

[1]Interim Report No. 1, June 1962.

[2]The Squaw Rapids story. Saskatchewan Power Corporation. (An information bulletin) 1966.

[3]The Squaw Rapids power project–a view in retrospect. Typescript report. 1969. (For personal reasons, the author preferred to be anonymous.)

the public is no longer apathetic about how water resources are developed. The evidence came from the intense discussions centred around the proposal to divert the Churchill River at Southern Indian Lake into the Nelson River basin. The debate became very intense and apparently was an important factor in persuading the new government, under Premier Schreyer, to announce in the Legislature in September that the project would not be undertaken because it was "drastic in its effects on resources and highly undesirable in its effect on people".[1] Our discussion with many scientists during our study trip to western Canada had convinced us that the project was one which had not received adequate study either from environmental, engineering or social considerations. Like the Squaw Rapids project, it did not give much evidence of a multi-purpose approach to the development of water resources.

In Ontario, the production of electric energy is primarily the responsibility of the Ontario Hydro Commission. It has now developed almost every source of hydro energy that is competitive with thermal-electric sources. The lands for the majority of the head ponds were under the jurisdiction of the Department of Lands and Forests prior to flooding; in most cases a good job has been done of removing the forests before flooding. Two examples where this was not done are Bark Lake (Madawaska River in eastern Ontario) which was flooded during World War II and Lac Seul which was constructed in the late 1920s and flooded over a five-year period in the 1930s. The head ponds for recent or ongoing developments on the Madawaska River (Mountain Chute, 1967), Montreal River (Lower Notch, 1971) and Mississagi River (Hubrey Falls, 1969; Wells, 1970) have all been completely cleared and will all have considerable potential for recreational use. The Department of Lands and Forests also has work in progress to improve conditions on Bark Lake and is requiring the Great Lakes Power Corporation to undertake work to clear some of the head ponds of its developments which were flooded without the forest first being cleared. In summary, most of Ontario's hydroelectric projects are multi-purpose to the extent that they have generally been cleared of forests. However, the direct economic factors pertaining to their development have always been so overpowering that the Ontario government has never undertaken comprehensive studies related to other values or to the potential ecological consequences of the developments.

The most important question about future developments centres around the rivers which flow into James Bay, particularly the Albany, Attawapiskat, Winisk and Severn. The federal Department of Energy, Mines and Resources currently has a number of engineering surveys under way to determine the feasibility of diverting portions of their flow into the Great Lakes system. It is an example of a situation where the feasibility studies should include associated studies to determine the potential effects of:

a) impounding water without clearing the trees;

b) diversions on the downstream portions of the rivers and on James Bay;

c) the potential of the rivers for multi-purpose developments; and

d) the recreational and ecological value of retaining one or more of the rivers in an unharnessed condition. The Winisk River, for example, is said to be one of the most beautiful rivers in Ontario. It is frequently referred to as one which should be classified as a "Wild River" under Ontario's Parks classification system.

Up to the present, the majority of other hydroelectric developments in Quebec have been developed solely for power development. Many storage basins that are within easy reach of major centres of population have low recreational potential because of the presence of vast

[1]As quoted from the Ottawa Citizen, September 16, 1969. (Canadian Press Story)

areas of partially submerged or floating trees. Most of the basins were flooded when power production was in the hands of private enterprise; it remains to be seen whether the situation will change now that it has become a public one.

In the Maritimes, the major development of hydro power has been on the St. John River. Since it is an important river for Atlantic salmon, it represents an opportunity to test the Larkin "hypothesis" that where power development is based on dams on the main stems of rivers used by anadromous fish, "the alternatives are...fish or power". There have been two developments (Beechwood dam, 1956; Mactaquac dam, 1960) which block salmon migrations. In both cases the federal Department of Fisheries was involved in advance studies to find ways and means of conserving the salmon stocks in the upper reaches of the river. At Beechwood, a fishway and a hoist were developed to move salmon over the dam. The works at Mactaquac involve facilities to collect, sort and hold fish. Also involved are tanks and trucks to transfer adult salmon to various parts of the river, as well as a hatchery built by the New Brunswick Electric Power Commission as part of the effort to mitigate the effect of the development. The success of the mitigation work is uncertain at this time; pollution of the river from pulp and paper and potato-processing plants is the apparent cause of conditions which have caused kills of salmon fry in the hatchery and of unsuitable conditions for migrating salmon in the river above the Mactaquac dam. One result of the latter is that salmon have had to be transported directly from Mactaquac to subsidiary streams, bypassing Beechwood dam and thus leaving its facilities unused. In addition, the commercial fishery in St. John Harbour has been cut to three days a week to try to get adequate escapement (6 000 fish) of the early summer run to provide the needs of the hatchery. This was not achieved and the Department of Fisheries and Forestry now rents a weir to take the remainder of the fish required. The next decade will probably provide the answer on whether or not a salmon run can be maintained on the St. John River in the face of such an intensive development of the water resources. The answer may very well hinge on what happens in New Brunswick and Maine in the abatement of industrial and domestic pollution, as much as on the dams on the rivers.

We suggest that there should be quite an intensive investigation of the interaction of the limnological effects of the impoundment and of pollution on salmon and other fish in the St. John River. We also suggest that there should be periodic evaluations of the effect and value of the mitigation works. Concrete determinations in both of these areas is important to the understanding of the future of the St. John as a salmon river, and is also of considerable importance as a pilot project to the development of the water resources of other rivers which contain runs of anadromous species. We consider that a major portion of the costs of these studies should be included in the operating cost of the St. John River hydro projects.

Newfoundland did not have an interconnected electric power grid when the Newfoundland and Labrador Power Commission announced plans to undertake the Bay D'Espoir project in 1965. The project involved a drainage area of 2 500 square miles and required the diversion of parts of three watersheds into the salmon river which runs into Bay D'Espoir. The potential of the project will be approximately 600 000 kw of which approximately 40 per cent was developed in the first stage which became operative in 1967. The cost of this stage was estimated at $87 million, of which $24 million was provided as a grant by the Atlantic Development Board.[1]

[1]Newfoundland and Labrador Power Commission. A publication by the Commission on power generation and transmission. 1965.

We had the opportunity to view the entire drainage basin from the air during our trip to Newfoundland; we also sought information and data on the interrelationships of the associated resource complex in an attempt to determine to what extent it could be considered a multi-purpose development.

Two medium-sized salmon rivers (Grey and White Bear) and one large river (Exploits) were involved in the diversion. The Newfoundland and Labrador Power Commission provided facilities so that minimum flow requirements for salmon-producing areas on the Grey and the White Bear could be met. The facilities were, however, not operative on the Grey River in either 1967 or 1968 at the time they were required.

The most interesting ramification of the Bay D'Espoir project is the way it is interrelated with other factors which influence existing and potential salmon production in the Exploits River system. The production of salmon on the Exploits has been limited by the presence of natural and man-made barriers; the biggest natural one is at Grand Falls, the site of the Price Newfoundland Pulp and Paper Company Mill; a dam which prevents migration exists at the mouth of Red Indian Lake. Salmon production in the Exploits River has been maintained by the presence of hydro-generating plants at Grand Falls and Bishop's Falls, which require that a minimum flow of 5 000 CFS be maintained. This flow has diluted the pollution from the paper mill at Grand Falls so that it has not stopped the salmon run, which amounts to 8 000 to 10 000 fish a year. Since the diversion may adversely affect the generating capacity of the two existing generating stations, an agreement was worked out whereby any lost capacity is replaced by power supplied from the transmission grid. The result will be that there will no longer be an absolute need to maintain the flow in the lower river. Studies by the Resource Development Branch of the Department of Fisheries and Forestry suggest that in dry years the flow in the river may be reduced to a level at which the effluent from the paper mill will prevent salmon migrating up the river. An additional fact is that the full potential of the river for the production of salmon has been estimated at 10 to 20 times present levels. The development work would involve putting fishways in existing natural barriers and dams. It cannot, of course, be developed unless the lower river can be kept habitable for salmon, and unless the pollution of Red Indian Lake caused by the ASARCO mine (American Smelting and Refining Company) at Buchans is alleviated. The pollution of the lake from this source is also influenced by the development since the diversion of headwaters to Bay D'Espoir will reduce the dilution capability of the lake.

The recreational potential of central Newfoundland has been greatly influenced by the project since it involves a series of storage basins which incorporates approximately 20 lakes extending over a linear distance of approximately 120 miles, north and then west of Bay D'Espoir. The forest was not cleared from the basins and as a result the recreational potential of the area has been greatly reduced.

X.5.2 Water Resources Development in Retrospect

In this section we have attempted to bring out the range of considerations and influences associated with water resources developments: the Fraser River where an astute fishing scientist states the alternative to be fish or power; the Peace River where the effect of the impoundment was considered only in terms of navigation and not in terms of the potential effects on fish or wildlife in downstream lakes; the impoundments in mid-Canada where fairly straight choices are involved on whether reservoirs should be cleared to provide additional recreational opportunity for the future; the potential effect of the diversion of Southern Indian Lake and other north-flowing rivers where diversion may have

considerable impact on the ecology of major portions of "northern seas"; the St. John River and the Newfoundland projects which have ramifications for important fisheries for the development of recreation and other aspects of resource development. In making the review, we became very conscious of the diverse nature of the potential effects of water resource developments in Canada. We were also convinced that there has not been much change in the approach and policies of agencies which develop these projects since the Resources for Tomorrow Conference when there was considerable discussion of multi-purpose approaches to development. It is a simple fact that the great majority of projects are still being conceived as single-purpose developments.

We consider that there is no area where the need is greater to supplement engineering and economic studies with the social and environmental components that have been almost entirely lacking. We consider that the need of society to have access to the important facts has been seriously neglected and this has meant that democratic processes have had very little opportunity to function. We take very strong exception to the viewpoint of one of the authors of a paper on water for the Resources for Tomorrow Conference who suggested that the way to make great progress through development of water resources would be to isolate the decision-making process from political considerations. He stated: "Human nature being what it is, the financial assistance toward the construction of projects has often been provided on the basis of political considerations, overlooking the engineering and economic considerations that should have prevailed." To avoid such drawbacks he suggested that first of all, the government of Canada should consolidate its water resources development activities in one department "...to deal with water problems, and with water problems only. Engineers and economists in such a department should be effectively protected from political interference with their engineering design and cost benefit analysis."[1]

As scientists interested in the development of a holistic concept of resource management, we find this concept utterly objectionable. To a considerable extent, we believe that the lack of consideration of social and environmental factors has allowed such a situation to develop in many areas of the country, and we believe that it has resulted in the narrow approach which has prevailed.

We do not, however, pretend to know whether things would be much different if the complete spectrum of factors were considered and if the public had access to all the worthwhile facts. In the case of Newfoundland, for example, we recognize the great need that is considered to exist for electric power so that industries can be developed in the province. Part of the haste in developing the Bay D'Espoir project was related to the possibility that the Electric Reduction Company was considering establishing in the province. If the time span for the construction of the project had been 10 years instead of 5, it might have been possible to salvage much of the timber which has been destroyed and which now ruins the storage basins for recreation. Newfoundland has exported round wood to overseas pulp markets for a long time and conceivably that market could have utilized the pulpwood if the local mills could not; but the Electric Reduction Company might have been lost to the province. We were not in a position to pass judgement on the feasibility of alternatives from a short-term point of view; however, we did think a great deal about long-term consequences. As a result, we came to feel that the development of the Bay D'Espoir project epitomizes one of the greatest needs of our society–the absolute need, if we are to maintain a quality environment–to develop resources in a way that extends much beyond the

[1]Kuiper, E. The water resources of the Nelson River basin. Resources for Tomorrow Conference, Vol. 1. 1961.

immediate requirements of single industries and short-term economic considerations.

It is possible that present generations are not prepared to sacrifice immediate benefits to provide a better quality environment for themselves and for the future. But we believe that is not the case. The concern that was manifested in Manitoba over the Southern Indian Lake project indeed suggests that the public wants to be involved in the decision-making process and is willing to take long-term considerations into account.

In summation, we suggest that:

a) feasibility studies for water resources projects should include strong social and environmental components;

b) the cost for such studies and of works undertaken to mitigate the effects of the development should be charged against the cost of the project;

c) the constitution of agencies to conduct the study should be of particular concern to avoid the "singular agency defect" that is referred to in Section X.3;

d) it is vital that the results of such studies be made a matter of public record well in advance of the initiation of construction.

X.6 Northern Development

"For all of its bleak ruggedness, the Canadian Arctic is, in many ways, delicate and fragile. The growing season is exceedingly short. Total annual precipitation is less than ten inches in much of the Arctic, giving it many of the characteristics of a cold desert which produces vegetation only because of low rates of evaporation. Communities of plants and animals tend to be rather simple, composed of limited numbers of very hardy species which have adapted, through eons of time, to this inhospitable environment. Despite the deceptive suddenness with which the Arctic bursts into colourful bloom in early summer, growth is extremely slow.

"The ecology of the far north is further complicated by the presence of permafrost—frost which extends deep into the earth and which thaws to shallow depths during the brief arctic summer only to freeze solid again in early autumn. It is during this brief, unfrozen period that the surface of the ground releases moisture and nutrients to support the limited, slow-growing vegetation of the tundra."[1]

Life in the Far North exists on a restricted energy budget. Fish and wildlife exist either in small numbers or must grow very slowly or both. For example, muskoxen females are unable to breed every year. Fishes in the large cold lakes such as Great Slave Lake grow at an extremely slow rate. Given this absolute limiting factor, it is never going to be possible to take large harvests of fish or wildlife from high latitudes.

Some sections of the fauna exploit temporary abundances of energy. Migratory waterfowl are able to take advantage of a summer energy surplus in order to reproduce and pass the summer. Then they must move south for the winter. Small mammalian herbivores also probably take advantage of temporary energy surpluses which occur periodically. Since several of the important fur-bearing species are predators on these herbivorous species, their numbers reflect temporary energy excess.

Invasion of the North by technological man brought many hazards. Pollution of waters is now a well-known fact at both Yellowknife and Whitehorse. In the case of the former, the Giant Yellowknife Mine discharges effluent into Baker Creek and into the north arm of Great Slave Lake. Baker Creek formerly supported a grayling fishery. However, this species has now disappeared, undoubtedly as a result of the pollution from mine wastes. A similar situation exists in the Yellowknife River in the vicinity of Yellowknife. Additional large-scale water pollution will inevitably follow the development of Anvil mines in the Yukon

[1]Canadian Wildlife Federation. Preservation of northern landscapes. Newsletter, May 23, 1969.

unless careful precautions are taken and enforced.[1]

The search for minerals and petroleum has been damaging to the natural landscape. The large area surrounding Yellowknife that was burned off during the search for gold in the late 1930s is evidence of this statement, but there are many other examples. At Pine Point, a staking rush followed the opening of the surrounding land and the landscape is now "neatly" divided into 1500-foot squares for a distance of approximately 100 miles from the functioning mine.

The search for oil in a country underlain by permafrost is giving rise to new threats to the environment. Permafrost exists in a delicate balance that is partly maintained by its plant cover. Destruction of the plant cover, in many cases, leads to thawing of the permafrost and rapid erosion. Even where the ice content of the permafrost is low and serious erosion does not follow, compression or removal of the plant cover may give rise to scars that will persist for many decades. Some alteration of the landscape is inevitable if resources are to be extracted, but senseless destruction accompanying wasteful exploratory practices has no place in modern Canada.

Some of the problems encountered by the oil industry operating in permafrost environments were outlined at the Third Canadian Conference on Permafrost, held in January of 1969.[2] Re-examination of areas, in which oil exploration had been carried out in recent years, revealed some startling evidence of serious damage to the landscape. The scrape of a bulldozer blade along a seismic exploration line permits "thermal erosion" of permafrost to take place and, with it, subsidence of the surface level. The eventual effect is that of a trench or moat, up to six feet deep, extending the length of the seismic line. On sloping land this creates a new drainage channel, subject to normal erosion problems and, in any case, completely altering the ecology of the terrain it traverses. One observed effect of this surface subsidence is the creation of barriers which interfere with movements of caribou herds whose migrations have been deflected.

Under the proposed Land Use Regulations, all resource exploration done with power equipment will require a Land Use Permit. The conditions under which these will be granted for summer use should be carefully and explicitly defined and supervised. There is very little knowledge available on which the regulations can be based. It is apparent that research is required to determine:

1. how damage to the tundra can be minimized;
2. how the tundra surface can be restored following disturbance by tracked vehicles, seismic exploration or other types of activity.

Extraction of the petroleum resources of the Arctic also leads to other serious threats to the environment. If super tankers use the Northwest Passage, an accident is inevitable sooner or later. If drilling platforms are erected in channels filled with ice, an accident is inevitable. In fact, the question should not be considered in terms of "if an accident occurs" but "when an accident occurs". Because of the low temperatures, it is possible that oil from a major spill in the Northwest Passage may persist for decades and have a massive effect on the environment. The following account of what is known about the effect of oil in cold water was given recently in a report prepared for the Canadian Wildlife Service:

[1]On October 6, 1969, the Honourable Jean Chretien, Minister of Indian Affairs and Northern Development, announced a proposal for a Northern Water Rights and Pollution Control Act. He stated: "This bill should establish the principle that rights to the use of water...are dependent upon the user accepting responsibility for maintaining the quality of the water, or restoring its quality after use to acceptable standards, before discharging the water back to the natural environment."

However, in the case of the Yellowknife area which was cited earlier, the federal government already had the power to control pollution under the Fisheries Act because grayling have been eliminated from streams into which mine wastes were discharged.

[2]Watmore, T.G. Arctic oil play facing thermal erosion problems in permafrost environments. Canadian Petroleum. March 1969.

"In cold Arctic waters, evaporation rates of the highly toxic 'lighter fractions' of crude oil slicks are believed to be greatly slowed. The net effect is to significantly prolong the time during which sensitive marine organisms are exposed to the toxic influences of the lighter hydrocarbons. Mirinov has recently shown that such surface films of oil are especially toxic to the hyponeuston, that special marine community found in the surface layer of water (from 0 to 5 cm depth) and which is composed in part of the embryonic and larval stages of many pelagic and bottom dwelling forms. Many of the species inhabiting the hyponeuston during their early stages are of great value to commercial fisheries.

"Thus, environmental temperature plays a highly relevant role in the dynamics of marine oil pollution. Based on current knowledge, the principle effects appear to be:

(1) determination of rate of biochemical degradation;

(2) determination of rate of evaporation of toxic 'lighter fractions';

(3) ice formation with its unknown consequences.

"In arctic and subarctic environments these three determinants are acting together, each augmenting the other. The consequences of these cumulative actions are not at all well understood at present, but they are clearly of great significance to ecosystems of colder environments."[1]

Clearly the questions raised are, Will oil from major spills ever degrade in the Arctic Ocean? and What are the potential hazards to marine communities from oil? With such uncertainty about the behaviour of oil and of its potential effects, and with the almost certain knowledge that sooner or later there will be a major spill from one source or another, research should be undertaken to answer these questions.

Warner recommended that the following aspects were of greatest importance:

"1. seasonal biochemical decay rates for various types of polluting oils;

"2. physical behaviour (distribution, dispersion, mixing, etc.) of oils released in arctic and subarctic coastal environments;

"3. influence of ice on dispersion and evaporation of oil fractions;

"4. biological effects and ultimate fate of 'bleached' oils;

"5. effects of oils upon wildlife species of interest and importance, including the marine mammals, with special reference to (a) damage to food sources, (b) direct physical effects, (c) physiological or toxicological effects, (d) effects upon habitat (e.g. breeding areas) of ecological significance."[2]

On shore, containing oil at the well head will present formidable problems. Oil comes out at over 100° F. and the well heads in areas of deep unconsolidated sediments, such as the North Slope of Alaska and the Mackenzie River Delta, are anchored only to the permafrost layer. Sometimes this is done by using refrigeration plants to maintain the joint. It may, however, prove to be very difficult to prevent hot oil, issuing at rates of thousands of gallons a day, from thawing out the junctions and blowing out the well. Reassurance should be given by the oil industry that such eventualities have been adequately considered.

Exploration of the Canadian Arctic for gas, oil and minerals has increased tremendously in the last year or two. Panarctic Oil spudded wildcat wells on Melville Island; the first hole was put into Hudson Bay; and there is a frantic search for uranium near the Thelon Game Sanctuary. It is obvious that with such intensive mineral and oil exploration, the pace of ecological research is much too slow. It appears that both the Fisheries Research Board and the Cana-

[1]Warner, R.E. Environmental effects of oil pollution in Canada. A brief prepared for the Canadian Wildlife Service. 1969.

[2]Warner, *op. cit.*

dian Wildlife Service may be curtailing their programs in the Arctic because of budget restrictions and the high cost of operations. Considering the potential environmental hazards that exist, we consider this to be an intolerable situation.

We suggest that an intensive program of environmental research be undertaken and that this be associated with the various aspects of oil and mineral exploration and transport. We therefore suggest that:

a) the concept of funding this research as an aspect of the costs associated with the exploration be established; Panarctic Oil, for example, should pay for the research in its area of operation;

b) the oil companies which will be involved in oil transport through Arctic waters commission major studies of the environmental effects of oil in the Arctic and of ways and means of dealing with oil spills;

c) a task force be established to conduct an immediate investigation of the apparent effects of, at least, recent exploration and development programs. Its role would be to make recommendations of a preliminary nature on means of reducing or mitigating effects and to make recommendations on approaches to long-term investigations[1];

d) special consideration should be given to the funding of base line studies of northern species and communities by the Canadian Wildlife Service, the Fisheries Research Board and the National Museum;

e) we also suggest that action be taken to set aside a number of reserves of undisturbed biological communities throughout the north for scientific purposes and a number of areas for national parks. This action has long been delayed but is of particular importance now that exploration has become so intensive. To retain undisturbed communities, consideration should be given to reserving a number of islands from exploration; to minimize disturbance on others, consideration should be given to only allowing transport for exploration crews by means of aircraft.

X.7 Adopting New Concepts and Approaches to Environmental Problems

"The overall ecological problem will not be solved without some major economic dislocations, at least in the short term."[2]

The maintenance of a healthy environment will require the adoption of new approaches by industry and government. Of fundamental importance is the principle that the cost of environmental studies to assess the potential effects of developmental programs should be borne by the industry or agency that initiates the program. A precedent for such action was established by the petroleum industry last year when it employed a group of specialists to assess the potential effects of the proposed trans-Alaskan pipeline. However, such studies should not be initiated as last-minute programs but should be undertaken during the earliest stages of consideration of programs. It should go without saying that:

1. studies should be commissioned so that the objectivity of the conclusions cannot be challenged;
2. reports should be public documents.

We consider that public hearings should be used much more widely as a means of informing, and of allowing individuals and organizations to express their viewpoints, on environmental questions. It is particularly important that hearings be held when there are many associated values not of an economic nature. The hearings held to consider the provisional master plan for Algonquin Park and the diversion of the Churchill River at Southern Indian Lake approach the type which we consider

[1]Considerable work of this nature has recently been undertaken in Alaska. A task force could probably gain much from reviewing the Alaska experiences, before planning its program.

[2]Nichol, Sen. John A. Debates of the Senate, Vol. 117, No. 95. October 14, 1969.

should be held as a matter of routine when major decisions of the environment are to be made.

There is a need for new alliances to be formed in the study and resolution of environmental problems, particularly of pollution caused by the disposal of wastes to air and water and by oil spills in aquatic environments. Pollution from these sources poses very serious threats to fish and wildlife; finding solutions is of considerable importance to the future availability and use of these resources. The North, particularly, has problems which require definitive research, and much of it should be done in Canada.

The opportunity and the need for new alliances between industry and government is dynamically stated in the article "Social Responsibility and Business: The Challenge of Choice".[1] The author discussed the areas in which society faces growing problems. About pollution he stated:

"New alliances between government and business are needed and are beginning to form in order to approach the problem of pollution. It is too huge an undertaking for either one alone. Some of these partnerships will be voluntary on the part of business; but most, I'm afraid, will be forced by government on businesses that have their noses too buried in their standard accounting practices."

The choices which are open to business were discussed in frank terms:

"The solutions will not be simple, and the search for better answers will be incredibly frustrating. Of course, business too, has a choice–keeping itself isolated from the expanding universe of human and social aspirations, dwelling in windowless, air-conditioned computer rooms.... Or business can recognize how desperately society needs its help, skills in systematic integration, administrative technology and sense of organization. First, however, it must recognize and be willing to spend energy thinking about the problem."

In this chapter, we have touched on a few of the problems which exist and we suggest approaches to studying and resolving them. In some instances, the proposed approach departs quite radically from traditional ways of doing things. They could be rejected out of hand; however, we suggest that dynamic approaches to meeting environmental problems could well be the means by which resource-based industries could avoid being subjected to ever-increasing restraints and regulations.

[1]Hansberger, R.V. (President of Boise Cascade Corporation). Stanford Graduate School of Business Bulletin. Fall issue, 1967.

Chapter XI

Getting the Job Done

XI.1 Drawing Things Together

"It is our imperative duty to manage our renewable resources. In order to do so, we have to make plans for their use."[1]

There are many instances in this report where we touch on related matters in two, three or more chapters. In most cases, there has been a good reason for our action since the direct relationship may have been to education and the next to research; then, of course, matters pertaining to research, with a common frame of reference, may also occur in separate chapters. Because of this, we decided to try to draw things together.

In the course of the study, we spent a great deal of time thinking about what makes things happen in resource systems. Before we were on the job very long, we began to ask a somewhat different question–how can we help to get the job done? The suggestions we have made reflect the answers arrived at; the listing of priorities which follows gives an impression of how we rank them in importance.

XI.1.1 Providing the Backup for Primary Agencies

We have recommended the use of advisory boards and committees in a number of instances. We consider, however, that the role of such bodies in the past has been too perfunctory; we think that it will require very deliberate thinking and action to break away from past approaches. We "tried out" the idea of advisory boards a number of times on people in various areas, and found that the closer we got to people who would be advised, the more rapid the concept of boards became. We think of this as a rather reasonable territorial response, but also as a serious threat to the development of dynamic boards or committees. We suggested that the advisory boards of major resource departments should have an independent staff but that concept can only be applied in large-scale operations; it would not likely be a feature of the boards of agencies in some provinces, for example.

Our conception of advisory boards is partly built on the premise that there is much more than biology to fishery and wildlife problems. Advisory boards probably do the poorest job when they attempt to out-professionalize the professionals. The best job is done when they exert a strong influence on the establishment of priorities, bring focus on social, political and economic aspects of biological problems; when they attempt to assess and evaluate progress, try to discover limiting factors in the application of research; and when they insist on the development of detailed plans and on adequate reporting of research and management programs. Because of all these factors, we suggest that the ranks of advisory boards should include a liberal sprinkling of thoughtful citizens, sociologists, economists, planners and professionals from unrelated disciplines, as well as professionals who can reflect directly on the quality of the science being practised. On the other hand, we urge that advisory boards recognize that they have been constituted to act in an advisory not in a managerial capacity.

Since in our system of government the "buck stops" at ministers of the Crown, we urge them to take the initiative in the establishment and appointment of advisory bodies.

One of the problems we recognized was that often there was confusion over who should be doing what kinds of jobs, e.g. the Canadian Wildlife Service, provincial agencies, universities or private organizations. Frequently, we could not decide ourselves on what should be the primary basis for the decision. The "hang-up" frequently seems to centre around jurisdictional aspects. But in this case, purely jurisdictional consideration frequently leads to inefficiency in the

[1]Vanier, Maj. Gen. G.P. Remarks at the opening ceremonies. Resources for Tomorrow Conference, Vol. 3. 1962.

application of science. Surely, we reasoned, there must be some possibility of working out terms of reference that will lead to the optimum use of scientific resources. In Chapter VIII, we suggested the formation of a Waterfowl Advisory Board; part of the rationale for that suggestion was that since it would be broadly representative of a number of agencies, organizations and citizens, it could make impartial recommendations on who could best undertake specific jobs. It might, in one instance, suggest that behavioural studies be undertaken on contract by a university, a land management program might be undertaken by a provincial agency, Ducks Unlimited might construct an impoundment, or the Canadian Wildlife Service might undertake a job on population assessment. In such a "brave new world" capability would be the primary criterion, not jurisdictional right. The point, however, is not to suggest specific mechanisms but to urge that ways of getting jobs done be considered in a much more free-wheeling way than in the past.

Task forces are being used a great deal in governments today to make quick appraisals of problem areas. We consider that this is a good development and we recommend the establishment of such bodies to look into the herring question on the east coast (Chapter IV), into problems associated with wetlands and northern development (Chapter X). But in discussing task forces, as in the case of advisory boards, we found that there is a wide variation in the nature of the concept. We consider that task forces oriented too strongly to the interests of a single department or toward too narrow disciplinary interests are likely to be ineffective.

We suggest, for example, that it would be a mistake for a task force on the North to include only representatives of the Department of Indian Affairs and Northern Development. We do not think that a task force on herring should be comprised solely of biologists and economists from the Department of Fisheries and Forestry, or of individuals from the Department and from the fishing industry. In all these samples, relatively "pure cultures" would be involved; too many of the individuals would likely have personal, organizational or disciplinary interests too strongly in mind to do the type of job that would reflect the best interests of society.

Universities have been referred to in a number of places: in terms of the role they have played in stimulating fisheries research; the early relationships of their research in fisheries to that of the Fisheries Research Board and the gradual dissolution of the arrangement; and, of course, in terms of their past and future roles in educating fishery and wildlife scientists. But the role of universities in research, and their relationship with other agencies, has not been adequately discussed. Of all the organizations, the Fisheries Research Board appears to have come to terms most completely with its relationship to universities and it discusses past, present and future relations in a frank statement of its prejudices.[1] It describes contract arrangements (a way of getting a job done), grants (strong support to develop important areas) and states its policy on the availability of its laboratories, ship time, etc. to university scientists. It is a statement of policy that lets organizations and people know the possibilities for co-operation. We think that other agencies should think out and elucidate a similar policy; we also consider it worthwhile for graduate departments of universities to conceive the role they are willing to play in research that relates to the needs of government agencies. Virtually any university department would be willing to accept a Fisheries Research Board-type grant, but to what extent are they interested in a contract that states in quite precise terms the nature of, and the

[1]Fisheries Research Board. Past, present and future relations between the Fisheries Research Board and the universities. Proceedings of the Special Committee of the Senate on Science Policy, No. 17. 1968.

requirements for, a specific research program? We hope that the answer will not be completely negative, because we consider that there are mutual advantages to be gained through periodic contractual arrangements between university and government departments. This proposal is not new; but policy on both sides of arrangements has been of an *ad hoc* nature, particularly in the case of wildlife. Our suggestion is that it warrants being thought through, and it warrants the establishment of specific pilot projects to test how well mutual needs are satisfied.

As pointed out in Chapter II, we found that biologists in Canada do not appear to think in terms of objectives and goals. In view of this weakness, we consider it particularly important that research and management agencies establish sets of goals in quite specific terms. We suggest that they should work very closely in this process so that research is organized to meet anticipated management needs for knowledge over both the short and long term.

XI.1.2 The "People" Side of Resource Management

In several places we have referred to the importance of the social and economic components of fisheries and wildlife questions. In Chapter IV for example, we suggested that these should be the most important elements in a study related to the trapping and sale of pelts of fur-bearing animals; in Chapter IX we made a plea for much more adequate treatment of these areas in the education of biologists. However, we intended to do much more on sociological aspects than is represented by these "crumbs" of attention; we commissioned a study of a limited nature to gain perspective on how sociology might contribute to the effectiveness of scientific activities in fisheries and wildlife.[1]

The study showed, as we had believed to be the case, that sociological aspects of the use of natural resources have been almost completely neglected in Canada and the United States. The United States is beginning to undertake some work related to the field of outdoor recreation but even that has been very limited. Similarly, no sociological studies of Canadian scientists or of scientific establishments (in any field) could be cited although some were listed for the United States. The study also made evident to us the even more fundamental lack of basic sociological studies on the various races and classes of Canadian society.

Although our consultant reviewed the various ways which he considered sociology could contribute to the effectiveness of scientific activities, in the two areas to which his attention was directed, it was clear that the expertise to tackle the problems simply does not exist in Canada. There are very few sociologists who are practising their science in ways that have much relevance to resource management.

The Institute of Social and Economic Research at Memorial University of Newfoundland "...was established in 1961 to foster and undertake research into economic and social problems in Newfoundland and Labrador".[2] The Institute has produced a number of background socio-economic studies, particularly relevant to fisheries since they deal with the sociology of people, many of whom are engaged in Newfoundland fisheries[3], and with the relationship of resources to the economic viability of communities.[4] It would seem logical for resource agencies to make grants to such institutions to aid in the development of

[1]Connor, D.M. Sociology as a contribution to fisheries and wildlife research and management. Paper prepared for the Special Study on Fisheries and Wildlife. Science Council of Canada. Unpublished manuscript. 1969.

[2]From frontispiece note in reports produced by the Institute.

[3]For example, Faris, J. Cat Harbour; a Newfoundland fishing settlement. Institute of Social and Economic Research, Memorial University of Newfoundland, Report No. 3. 1966.

[4]Brox, O. Maintenance of economic dualism in Newfoundland. Institute of Social and Economic Research, Memorial University of Newfoundland, Report No. 9. 1969.

sociological studies which are both indirectly and directly related to the "people side" of fishery and wildlife questions.

The Department of Fisheries and Forestry has played an active and an enlightened role in stimulating and financing the Newfoundland studies.[1] We suggest that this part of its activities should be greatly expanded and that other federal and provincial agencies should become much more active in sponsoring work of this nature. If sociology has a contribution to make to resource management, more direct action will have to be taken by resource agencies to stimulate activities in ways directly relevant to their needs.

XI.1.3 Maintaining the Diversity of Nature

In Chapter II we suggested as an element of a national goal on the environment: "Preservation, maintenance and restoration of as complete a range as possible of the natural communities, landscapes and geological features of the world."

We also suggested that the maintenance of natural populations and communities of fish and wildlife widely distributed throughout the world warranted definition as a specific goal for fisheries and wildlife programs. In Chapter X we proposed that an active program should be undertaken to preserve natural communities in the Arctic for scientific purposes and to preserve a number of areas for national parks. We have not, however, been specific in terms of the more populated areas of the country or in terms of other parts of the world.

One section of the International Biological Program is concerned with the conservation of terrestrial communities. In Canada it is referred to as the IBP-CT program. The national committee is made up of the chairman of the 10 provincial and two northern (Tundra and Taiga) panels. The objective of the program is to establish a representative series of terrestrial communities as scientific preserves throughout the country. The International Biological Program in Canada is funded by the National Research Council, which in 1968 and 1969 gave grants of $20 000 and $85 000 for work of the CT program. The ultimate success of the program will depend primarily on the participation of federal and provincial governments in enacting legislation and in designating and establishing preserves. The CT program has been based considerably on the efforts of volunteers and has lagged behind other elements of IBP activity. In 1969 it began to develop much more rapidly; however, it seems unlikely that it will be completed by 1972, the target date for the completion of IBP. We consider that the CT program warrants a priority rating during the remainder of the IBP period; priorities are needed in the funding of background investigations and in the establishment of preserves by the federal and provincial agencies which have jurisdiction over the land to be included in preserves or which have the responsibility of acquiring areas now in private ownership.

The problems of identifying areas for preservation are particularly greater in the Northwest Territories. We suggest that the Department of Indian Affairs and Northern Development should consider providing additional grants to the two northern panels to allow them to develop their investigations at a pace commensurate with that of industrial exploration and development.

There is also a need throughout Canada for the preservation and maintenance of aquatic as well as terrestrial communities. Because of the difficulty of reserving entire watersheds and of the impossibility of reserving downstream segments as uncontaminated reserves, it is apparent that fish protection requires vigorous pollution control and intensive research on the effects of pollution and on ways of ameliorating it. However, opportunities should also be sought to

[1]The role of the Department is outlined in the general preface to Report No. 9.

maintain at least entire small streams, headwater portions of larger streams and some lakes representative of different aquatic communities in as close to an undisturbed state as possible. We consider that this should be as important a function of national and provincial parks as the protection of wildlife communities. We suggest that it should be considered a more important role of national parks than that of providing angling for visitor recreation.

In the case of the latter, we consider that far too much emphasis has been placed on providing and maintaining "good-quality angling" through "modern methods of habitat management and fish culture", particularly since these have included the poisoning of indigenous fish populations and the introduction and stocking of exotic species. We suggest that the entire policy, with respect to recreational fishing and to the maintenance of aquatic communities in national parks, should be thoroughly re-evaluated, since much of the present policy does not appear to be in harmony with the primary role of national parks.[1]

The plant and animal communities of the world are part of the heritage of every Canadian. Many statements in the report indicate that we consider preservation and maintenance of their diversity of high priority. It could well be the subject of an international convention; we also consider that ways and means should be sought by which Canada can play an increasing conservation and resource management role through external aid programs.

We consider that the work of the International Union for the Conservation of Nature and Natural Resources (IUCN) is very important and suggest that every provincial government, as well as the federal government, should consider making a grant to support its programs. Membership in IUCN is also recommended to Canadians citizens as a means of learning about and supporting world activities in the preservation of resources.[2] The World Wildlife Fund also acts in the international sphere; its work to preserve endangered species throughout the world is vital, dynamic and important. Its programs are worthy of the financial support of citizens and the business community in Canada.[3]

XI.2 Priorities and Requirements to Achieve Goals

The highest priorities of fisheries and wildlife programs for the next 10 and 20 years should be associated with maintaining, or restoring, a high-quality environment. Since previous chapters have brought out the extent to which the future of fish and wildlife depends on the way the environment is maintained, it was predictable that we should give the achievement of environmental goals the highest priority.

The second level of priorities lies in the modification of administrative arrangements and in blending ecological, social and economic factors of resource management in more realistic and meaningful ways. We agree with the subcommittee of the National Committee on Forest Lands[4], that progress in these areas is vital to the development of programs of integrated resource management.[5]

[1]The statement on the provision of quality angling is given in Section 11, *Nature in National Parks Policy*, Department of Northern Affairs and Natural Resources (now the Department of Indian Affairs and Northern Development). The preamble to the same section states "our most fundamental and important obligation in the administration of the Act is to preserve from impairment all significant objectives and features of nature in the parks."

[2]See *What is IUCN*? This pamphlet describes the activities of the organization. Individual members are known collectively as Friends of IUCN; categories of support are Life Member, Benefactor and Friend. The address of IUCN is simply, Morges, Switzerland.

[3]The Hon. Alan A. MacNaughton is Chairman of the Canadian Section of the World Wildlife Fund (635 Dorchester Boulevard West, Montreal 2, Quebec).

[4]Subcommittee of National Committee on Forest Lands. Towards integrated resource management. Report prepared for the National Committee on Forest Lands. 1969.

[5]Defined by the subcommittee as "the application of management strategies to achieve the maximum output from the optimized use of a specific area for the benefit of a reference group and its successors."

At the third level, we recognize that there is considerable need for reorientation of many research and management programs in fisheries and wildlife and for intensification of some areas of scientific activities.

XI.2.1 Priorities in Maintaining Environmental Quality

We consider that the maintenance of a quality environment should be defined as the primary national goal. The most fundamental need is for better opportunities for individuals at all levels of society to become better informed on environmental questions.

An awareness of environmental problems has developed slowly in Canada. The gradual development has been more in response to U.S. issues than to a greater understanding of problems in Canada. We consider that the activities of an Environmental Council could contribute a great deal to developing public awareness on a more rational, less crisis-oriented basis. It is important that this happen, because with the rate at which technological developments occur, society cannot afford to allow DDT-type situations to develop for 20 years before public opinion and subsequent government action catches up to them.

Although at a lower level of priority, we consider that the following recommendations are also important to the achievement of environmental goals:

1. A semi-popular journal should be provided as a medium for analytical articles on environmental questions. We consider that it should be sponsored, or at least be supported, by government and distributed free to libraries and schools throughout the country. We suggest that the publication of such a journal could be part of the role of the Environmental Council of Canada.
2. Governments should support private organizations which perform educational services in developing understanding of environmental relationships.
3. Government agencies should undertake more sophisticated and more comprehensive information and education programs.
4. Press, radio and television should devote more space and time to reviewing and appraising environmental questions.
5. Professional ecologists should become more actively engaged in relating to public education, particularly through the information media and by assisting private organizations.

We accord a very high priority to the introduction of new arrangements for the conduct and support of environmental studies related to development projects and for providing solutions to environmental problems. We feel *very* certain that the possibility of maintaining a high-quality environment will be greatly reduced unless there are dynamic achievements in this area. General acceptance of the principle that a) costs of environmental studies to assess the potential effects of development programs and b) costs to mitigate damages caused by development should be borne by the developer, could have great significance for the future.

XI.2.2 Organizations and People

We consider that integrated resource management can best be accomplished when a single department has jurisdiction over fisheries, forestry, outdoor recreation, parks and wildlife. In some circumstances, it might also be desirable to include water agencies in such a department. However, because of the relationship of water to energy production, it is difficult to generalize. The close integration of water resources with other aspects of the renewable resource spectrum is, however, mandatory. It can perhaps be achieved by means other than departmentalization.

We suggest intensive study of working arrangements between research, management and development organizations. We observed a number of examples where the various groups were separated by gaping chasms. In the case of smaller provincial departments, we suggest that

the development of the Department of Mines and Natural Resources in Manitoba should be regarded as a pilot project worthy of study. We consider that the development of ways and means of increasing the mobility of scientists should be given a high priority. We believe that it will do much to improve understanding and broaden viewpoints, and thus contribute to the development of more effective working relationships between agencies, between governments and between government departments and universities.

In our study we gained the strong impression that the strength of existing agencies lies in handling affairs of the day; seldom are they capable of adapting to unusual situations except in an *ad hoc* way that is usually unsatisfactory. We believe that this may in part be due to the incessant "busyness" of life today. (In our travels we seldom met a scientist who did not feel that he had at least two major jobs too many to do.) The busyness of people on their jobs led us to believe that the present use of task forces should be expanded to handle unusual situations and to propose fresh approaches to old problems. However, we consider that studies should be made of their successes and failures to determine the nature of the factors which contribute most to success. We consider that the use of scientists as members of task forces would also contribute to increasing mobility, since, to work effectively, the members of task forces would be released from other commitments for specified periods of time.

We suggest that research and management programs of fishery and wildlife agencies warrant closer scrutiny and more critical evaluation than they have been getting in the past. We consider that advisory boards should be used more widely, *but* that to work effectively they require the assistance of scientific staff on a full-time basis. However, such staff should not be permanent but should be based on term appointments of one to two years. There are many research and management programs in fisheries and wildlife which appear to be a jumble of *ad hoc* projects or which lack sufficient support to do the jobs that really need to be done.[1] We consider that effective advisory board relationships could go a long way in solving these types of problems.

More realistic methods of specifying roles and evaluating performance of scientists working in applied and basic areas of research should be considered. A broader classification system would aid by: a) indicating the nature of the position that particular scientists hold, and b) indicating the proportion of the manpower of an organization devoted to various aspects of scientific activities.

XI.2.3 Modification of Existing Jurisdictional Arrangements

The revision of existing jurisdictional arrangements over waterfowl and inland fisheries is a matter of some importance. There are many arguments which favour the amendment of the BNA Act to give the provinces jurisdiction over inland fisheries (except for boundary waters and anadromous species) and the federal government jurisdiction (except for proprietary rights) over migratory birds.

After amendment of the BNA Act, we consider that the federal government should take the initiative to negotiate a migratory bird treaty with Mexico, and should consider the possibility of renegotiating a treaty with the United States. A new treaty is needed to establish a framework in which substantive matter such as habitat maintenance, research, distribution, dates of annual kill and regulations can be considered on an international basis.

[1]We consider, for example, that the waterfowl research programs of the Canadian Wildlife Service were in the first category and the Atlantic herring studies of Fisheries Research Board in the second. In the case of the herring study, although more than 300 papers had been published, the scientists had not succeeded in getting priorities established that would have given them the "ship time" necessary to identify clearly the various stock and to determine their potential productivity. Aspects of the herring question are discussed in Chapters IV and VII.

The statutory base for federal participation in the wildlife sector is too narrow; it does not encourage the Canadian Wildlife Service to play an active role in stimulating or supporting desirable scientific activities, nor does it establish a base for national initiative to be taken when national interests are clearly at stake. We suggest that the enactment of a Canada Wildlife Act should receive high priority.

Many scientists suggest that the ocean has a potential productivity which is much greater than that which is now being utilized. However, if it is to be utilized, or in fact if present production is to be maintained, methods of eliminating the "boom or bust" nature of many fisheries will have to be developed. Many scientists question whether this can be achieved under existing arrangements and suggest that alternative procedures be studied.

Canada's position in world affairs, and its role as one of the top fishing nations of the world, makes it possible for it to take the initiative in proposing an international review of the arrangements for managing the world's fisheries. We suggest that it should play a dynamic role in seeking to bring about worldwide consideration of the need to develop new jurisdictional arrangements and fresh approaches to the management of international resources.

XI.2.4 Priorities in Scientific Activities

Studies on the effects of sublethal concentrations of environmental contaminants should be accorded a much higher priority than in the past. 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, and to develop integrated controls, should be given a higher rating.

Much greater consideration should be given to developing socio-economic components of management and development programs. In addition, there should be much more support of socio-economic research in commercial fisheries and wildlife programs and in recreational aspects of the use of these resources.

The education of biologists, particularly those who work in management areas, should contain greater components of the social sciences, planning and other aspects related to the application of knowledge. We suggest that sociology and economics are areas of study that are particularly relevant; few biologists have been adequately prepared by their academic experience to cope with the complexities of balancing resource utilization with the needs and desires of people. The majority of Canadian ecologists received their education in arts and science faculties and primarily at a basic science level. It is analogous to a situation in which engineering was excluded from the spectrum of education of physical scientists. Conversely, we consider that the establishment of courses in ecology for engineers, economists, geographers and planners should be given high priority.

There is a distinct need for the development of specific programs of study in applied biology in a number of universities where adequate associations exist in the life, social, earth and aquatic sciences. We consider that the emphasis at the undergraduate level should be on the production of general ecologists who have the capability of specializing in any one of a broad range of disciplines, at the level of the master's degree. We also consider that graduate biology departments should: a) develop programs of study which permit students to concentrate in areas which are only indirectly related to biology, b) develop some degree programs entirely on the basis of academic studies.

There is need for most fishery and wildlife organizations to establish clear statements of policy regarding publication of the results of scientific studies. We consider that scientists engaged in research should have an absolute mandate to publish results of their investigations

within reasonable periods of time. In the course of our study, we became aware of a number of areas where we considered that dissemination of information to the public and progress of management programs were being hampered by the failure of scientists to publish the results of their research. We also consider that management agencies should give particular regard to this problem. In this case, the failure to publish is frequently the result of the agency not allowing the scientist time for the analysis of data and for writing.

The recent work in systems analysis indicates that it will probably play a key role in the future of natural resource management. We consider that continued studies of the potential of the method should be stimulated through a series of long-term grants to universities with a capability of working in this area. We consider also that major fishery and wildlife agencies should establish a policy of developing scientists who have expertise in this area. It is important for this to be done so that developing methodology can be continually tested in the study of aquatic and terrestrial communities. We believe that there will be an additional pay-off in that it will fill a distinct need to develop scientists who are not afraid to undertake studies of multi-dimensional problems, and who thus have the capability of working in broader capacities than has been common in the past.

There is a related need for increased support of long-term studies of natural populations and communities of both fish and wildlife. In the case of the latter, this line of research has shown significant progress in Canada during this decade. The importance of studies of this nature is partly related to the need to be able to determine the effects of changing environmental forces on species, populations or communities.

In the case of wildlife, an appraisal of scientific activities is of particular importance in the waterfowl (duck) sector. Federal research programs have expanded markedly during the past decade; however, efforts have been diffuse and have appeared to lack any real sense of direction. It is suggested that an advisory board could be of particular value in the evolution of mission-oriented programs. Undoubtedly the most immediate need is not in research, but in the development of a thorough understanding of the interrelated aspects of agricultural land reclamation programs and waterfowl habitat. The attention of an interdisciplinary task force should be directed toward this problem.

The scientific activities of provincial wildlife agencies have developed rather fixed patterns centred around the enforcement of game regulations, the study of sex and age characteristics of populations and the determination of habitat conditions of big-game wintering areas. In the case of big-game, there is a particular need to develop detailed understanding of habitat requirements so that realistic cutting prescriptions can be provided to forest industries.

There is a need to establish the influence of mechanized logging operations on big-game populations. These operations are resulting in much larger areas of clear cut and may have a profound effect on future availability of big game. It is proposed that an evaluation of the influence of mechanized logging on big game should be undertaken by the Pulp and Paper Research Institute of Canada.

In view of the non-consumptive recreational values of wildlife, there is a need for provincial agencies to develop more diversified programs related to non-game species. Studies that pertain to the maintenance of a wide diversity of species in urban regions would be of particular relevance. We suggest that the formation of urban wildlife committees at provincial and local levels could conceivably help to foster such developments.

The early establishment of programs of biological research in fisheries has resulted in the development of a strong federal research organization, the Fisheries Research Board. It has placed

Canada among the world leaders in this area. It has, however, resulted in a lack of balance between research, management and development activities. For example, the problems associated with the utilization of herring stocks suggest that inadequacies exist in research, management and development programs. In research, the flexibility to allow the establishment of priorities that would permit evaluation of the most vital factor (the potential productivity of the stocks) was lacking. Management failed to come to terms with ways of regulating the fisheries, and development was unable to influence the rate of build-up of the industry. We conclude that there is need for considerable readjustment in fisheries biological programs to develop:

a) more flexibility with specific areas of activity;

b) better balance between research, management and development sectors;

c) greater capability to anticipate potential problem areas.

Molluscan shellfish, especially oysters on both coasts, are highly suitable for investigations aimed at developing culture techniques to encourage entrepreneurship in the expansion of the industry. These activities should be actively encouraged. We suggest that, since some of the most promising pay-offs and some of the greater environmental problems are associated with salmon stocks, there should not be any reduction in the intensity of efforts associated with anadromous species.

It appears that in the case of both freshwater and anadromous species, hatcheries and spawning channels can play an important role. However, the use of hatchery stock has tended to be a particularly wasteful way of getting fish in the angler's creel or on the consumer's dinner plate. Because of this and because of the large amounts of money being expended on fish culture, we suggest that it is most important that all aspects of this work be subject to a continuous program of valuation.

We consider it important that provisions be made for Canada to continue to fulfill the obligations to international commissions in providing necessary scientific information on groundfish, salmon, pelagic fish, seal and whales.

Priority should be assigned to investigations aimed at improving the quality of fish reaching the consumer; this applies both to marine fisheries and the freshwater fisheries of central and northern Canada where special problems exist. We suggest that the formation of a Fish Products Research Institute would be a desirable development, and we consider that the fishing industry should play a primary role in directing and eventually financing it.

Appendices

Study Group on Scientific Activities in Fisheries and Wildlife: Terms of Reference

Working Definitions

Canada is a sparsely populated country whose primary resources are not fully explored and in which secondary industry is only beginning to gather momentum. Canada's fish and wildlife support important industries whose aims include the production of commercial products and provision of recreation. They also supply food and other products to Canadians living in remote areas.

The national fisheries and wildlife research effort is therefore concerned with the generation and application of knowledge which results in greater productivity, innovations to improve competitive positions of the industries, increased efficiency in production of food, fibre and recreation and in the most effective use of fisheries and wildlife resources for society through development of sound programs for use and replenishing of resources. Fisheries and wildlife science and technology includes support of producing, managing, harvesting, utilizing, processing and marketing of goods and services derived from these resources and research on the maintenance of the resources in a state of abundance consistent with the needs and expectations of society, for prosperity, health, education, freedom, increased availability of leisure and enhancement of the opportunity for personal development.

1. Determine the relationship of the goals of fisheries and wildlife science and technology to the national goals as outlined in Science Council of Canada Report No. 4, *Towards a National Science Policy for Canada.* If necessary these should be expanded and extended to incorporate the views of fisheries and wildlife scientists as to the nature of these national goals. In particular, the Study Group should define those elements of the national goals which specifically relate to fisheries and wildlife.

2. Indicate the desirable future development of fisheries and wildlife research and management by:

a) Projecting the major needs and trends for fisheries and wildlife research and management in Canada and within an international context over the next ten and twenty years.

b) Considering criteria and guidelines for setting priorities to meet these needs.

c) Identifying the means for integrating social and economic research with the planning, conduct, and appraisal of research towards improving the production of goods and services from fisheries and wildlife resources for the better satisfaction of needs of society.

d) Identifying the organization structure, management system and distribution of effort best suited to meet the needs and to shift research emphasis, when necessary, in order to ensure effective research management and effective co-ordination among all areas of research impinging on or affected by fisheries and wildlife resource-based activities.

3. Determine the current status of fisheries and wildlife research by:

a) Assembling a composite picture of the organization for fisheries and wildlife research and management within and among the government, universities, and private organizations concerned.

b) Surveying the distribution of man-years and financial effort among these organizations and among the various aspects of fisheries and wildlife research and management.

c) Assembling a composite picture of the organization for the education and training of scientists and supporting staff for fisheries and wildlife management and research.

d) Considering and comparing the organization and management of fisheries and wildlife research in Canada and other countries.

4. Appraise the adequacy of fisheries and wildlife research by:

a) Evaluating available data on the costs and benefits of fisheries and wildlife research to Canada.

b) Appraising the adequacy of the current research effort to meet Canada's present needs, including international interests and obligations.

c) Appraising the appropriateness of the current distribution of effort among various resource areas.

d) Appraising the pertinence and quality of research for meeting the problems and realizing the potentialities of Canadian fisheries and wildlife resource-based activities.

e) Describing the distribution of research resources (funds and manpower) among the government, industry and university sectors of the economy: (i) by sector of performance and (ii) by source of funds.

f) Appraising the adequacy of current methods for ensuring the integration and utilization of research by the resource management agencies and industries.

g) Appraising adequacy of current methods of communication of results and implications of fisheries and wildlife research to the general public.

h) Evaluating the education and training of fisheries and wildlife managers and scientists, and the adequacy of this education with reference to fisheries and wildlife research and development.

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