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BIENNIAL REPORT - 1976-78,
WESTERN REGION, FISHERIES AND MARINE SERVICE,
DEPARTMENT OF FISHERIES AND THE ENVIRONMENT

Edited by

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This is the 136th Technical Report
from the Western Region, Winnipeg

EDITOR'S PREAMBLE

This is the second of a series of Biennial Reports concerning activities and changes in the Western Region of what is now the Department of Fisheries and Oceans, from 1974-76 onward. These reports are presented to ensure that an accurate record of the Region's activities is readily available when needed. Please note that the Research component of the Region (the former Freshwater Institute of the Fisheries Research Board of Canada) did not issue any annual reports between 1966 and 1970, when it was incorporated into the regular Department structure. This new Biennial Report series covers the region's recent history, beginning with the amalgamation of Operations and Research Directorates into a cohesive structure. As in the first report, we have chosen fiscal years, April 1 to March 31, rather than calendar years, as being more closely related to the realities of budgets and planning processes.

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ABSTRACT

Scott, D. P. (ed.) 1981. Biennial report - 1976-78, Western Region, Fisheries and Marine Service, Department of Fisheries and the Environment. Can. Tech. Rep. Fish. Aquat. Sci. 1019: vi + 36 p.

This report is a record of the accomplishments of Regional Programs during the period April 1, 1976 to March 31, 1978. It is the second of a series of biennial reports of the Region's activities.

Key words: Freshwater Institute.

LIST OF ACRONYMS

AES	Atmospheric Environment Service
AESC	Arctic Environmental Steering Committee
AFTRC	Aquatic Fauna Technical Research Committee
ALUR	Arctic Land Use Research
AOSERP	Alberta Oil Sands Environmental Research Project
BSDT	Bureau of Staff Development and Training
CAN/OLE	Canadian On-line Enquiry
CAN/SDI	Canadian Selective Dissemination of Information
CCIW	Canada Centre for Inland Waters
CIDA	Canadian International Development Agency
CWS	Canadian Wildlife Service
DFE	Department of Fisheries and the Environment
DINA	Department of Indian and Northern Affairs
DOE	Department of the Environment
DPW	Department of Public Works
EDP	Electronic Data Processing
EIS	Environmental Impact Statement
ELA	Experimental Lakes Area
FAB	Financial and Administration Branch
FFMC	Freshwater Fish Marketing Corporation
FIS	Fishing and Industry Services
FLIP	Federal Labour Intensive Program
FMS	Fisheries and Marine Service
FRB	Fisheries Resources Branch
FRBC	Fisheries Research Board of Canada
FSB	Fishing Services Branch
FVAP	Fishing Vessel Assistance Plan
FVIP	Fishing Vessel Insurance Plan
FWI	Freshwater Institute
ICES	International Council for the Exploration of the Sea
IJC	International Joint Commission
ISB	Industry Services Branch
IWD	Inland Waters Directorate
MF	Membrane Filtration
MPN	Most Probable Number
MS	Management Services
NWT	Northwest Territories
OAS	Ocean and Aquatic Sciences
OECD	Organization for Economic Cooperation and Development
OPMS	Operational Performance Measurement Systems
PCB	Polychlorinated Biphenyl
PRC	Publications Review Committee
PRE	Program Review and Evaluation
RRS	Research and Resources Services
RSCC	Regional Screening and Coordinating Committee
TSB	Technical Services Branch
USFDA	U. S. Food and Drug Administration
WNRB	Western and Northern Regional Board

DIRECTOR-GENERAL'S OFFICE

SUMMARY

Direct Federal Government involvement in the prairie fisheries began in 1944 with the establishment of inspection systems and a small research unit. For a short history of the period to 1976, see the Biennial Report for 1974-76, Western Region, Fisheries and Marine Service Technical Report No. 813, 1978.

The present review period, April 1, 1976, to March 31, 1978, was a period of reasonable organizational stability within the Region, although the reorganization of the previous period was still having some unsettling effects. However, the period also saw a number of Headquarters-inspired reviews of various Regional mandates, programs, planning structures, priorities, etc., all of which were quite time-consuming for the Regional staff. These reviews did serve to focus Regional awareness on internal inconsistencies, as well as apparent conflicts between our goals and those of the Fisheries and Marine Service (FMS) nationally. We believe most of these inconsistencies have been explained and rationalized.

In general, staff of the Region have continued to be involved in a very broad variety of work. Not only have the regular tasks such as inspection, regulation, enforcement, fisheries and environmental research been carried out, but many of the staff are members of a variety of committees, task forces, advisors to commissions, members of Environmental Assessment and Review Panels, etc. Such involvement in what might perhaps be called "extra-curricular" activities, puts considerable strain on the individuals involved, since there is no provision for extra help for their regular duties. It speaks well for the staff that there have been no complaints about the load; all feel that the tasks are essential to the well-being of prairie fisheries and the aquatic environment.

In any dynamic, responsive organization, some changes of direction are inevitable. Much of the research work associated with lake eutrophication is complete, but new dangers to the aquatic ecosystem such as acid rain and nuclear power wastes, require practical research. Thus, the Experimental Lakes Area research program is shifting emphasis to these problems. Likewise, new developments in the North in the searches for gas and oil require that our knowledge of northern fisheries and ecosystems be upgraded substantially. Several new research and management programs are under way.

Man's effects on the fish and their environments through contamination by municipal and industrial effluents continues to be a problem, and probably will continue to be for the foreseeable future. The Western Region is deeply involved through both research and inspection components.

The following Biennial Report for 1976-78 summarizes highlights of Regional accomplishments, together with descriptions of ongoing programs and objectives of various groups. We continue to emphasize development of innovative technology and research for the protection of

fish, fisheries, fishermen, the aquatic environment, and the consumer of fish products.

ADVISORY COUNCIL

The Advisory Council reports to the Director-General and the Directors of this region. It evaluates the scientific research activities of the Region and reports its findings, together with a numerical rating, to regional senior management. It is specifically instructed to avoid resource allocation issues as far as possible, and concentrates on the scientific merit of the research projects. It normally meets once a year for 4-8 weeks but can be convened to consider special questions as required.

Except for the Chairman, who is appointed by senior management, members are elected by Regional staff through a secret ballot so as to represent four basic scientific disciplines, one member per discipline. Elected members serve for two years on the Council; to provide continuity, only two members are elected each year. The chairmanship is a continuing appointment, subject to review by the Director-General and Directors.

The project review process begins with receipt by the Council of detailed descriptions of each research activity of the Region. These descriptions are reviewed by the members of the Council and external experts, if necessary. The Council then drafts its comments and assigns a rating. This confidential information is then sent only to the scientist concerned, who is invited to meet with the Council to answer questions as well as to defend the project, if necessary. The draft comments may or may not be changed as a result of this consultative process. The final comments are drafted and a final rating is assigned. All the comments are packaged and forwarded to regional management. A complete copy of all descriptions of scientific activities (with ratings deleted) is placed in the Library, thus providing access to the information to anyone in the Region and the public.

The ratings and general evaluations of the projects are used by management as part of the input to decision-making on program enhancements, reductions, cuts, additions, etc. The merit of the research projects, together with the evaluation of the performance and progress of the projects, permit more efficient resource allocation by management.

PUBLICATIONS REVIEW COMMITTEE

The Publications Review Committee (PRC) was created in October, 1975, and came into full operation on January 1, 1976. Its basic mandate is to ensure that all material from the Region destined for publication in any forum undergoes thorough internal review prior to being submitted for publication. The Committee consists of five members, including the Chairman, and a Secretary.

During the present review period, April 1, 1976 to March 31, 1978, the PRC handled 89 manuscripts destined for scientific journals. In addition, 80 manuscripts destined for the FMS

Report Series and other publications were processed and cleared. The PRC also furnished some input to the deliberations of the Advisory Council in each of 1976-77 and 1977-78, regarding publication of results of various scientific and technical investigations by Regional Staff.

ENVIRONMENTAL SECRETARIAT

The functions of the Environmental Secretariat are:

1. To represent FMS on the Regional Screening and Coordinating Committee (RSCC);
2. To act as a Regional focal point on environmental issues for contact with Headquarters and other agencies, both in and out of the Department, and
3. To provide advice related to environmental programs and priorities to the Regional Director-General.

The unit consists of a Director, a Coordinator, and a Biological Advisor. The latter position was staffed in 1977.

RSCC commitments occupied a substantial proportion of the Secretariat's time. The Director was Chairman of the RSCC until December, 1976, and assumed the role of Acting Chairman in December, 1977, when the Chairman left the Federal Public Service. At the request of the Western and Northern Regional Board (WNRB), this role was continued in 1978.

Offshore drilling in the Beaufort Sea and in the Arctic Archipelago demanded particular attention. The Secretariat prepared an assessment of the impacts of artificial islands in the Beaufort Sea, and was the FMS focal point for contributions to the development of terms and conditions for offshore drilling permits and for the annual review of drilling operations. A proposal was submitted to the WNRB to develop a plan to provide a scientific response to oil spills in the Beaufort Sea. The proposal was supported, and, with the cooperation of Ocean and Aquatic Sciences (OAS) Victoria, a preliminary plan was prepared by means of a contract. The plan was refined and a submission to Treasury Board for funding is in preparation. The Secretariat acted as the scientific authority for a study on resource use under the Arctic Islands Pipeline Program.

The Secretariat contributed to a workshop, held in Winnipeg in April, 1976, to establish a departmental position on the Mackenzie Valley Pipeline proposal and on the mechanisms necessary for surveillance and monitoring during construction and operation of a pipeline. The Secretariat visited the site of construction of the Alyeska (Trans-Alaska) Pipeline in June, 1976; many environmental problems were observed and informative discussions were held with the surveillance and monitoring agency. A special report was prepared.

The Secretariat organized an offshore drilling technology seminar for Department of Fisheries and the Environment (DFE) staff in November, 1977, and organized a workshop for DFE, Alaskan State and U.S. federal agencies to

discuss problems of mutual concern. The workshop was held in Whitehorse, Yukon Territory, in April, 1978.

Mining was another major area in which the Secretariat was involved. It represented FMS on the RSCC's Mining Committee, whose main tasks were associated with the licensing of NWT mines. It reviewed FMS Western Region involvement with mining activities, with special reference to the NWT, and it assisted in the planning and conduct of the Arctic Environmental Steering Committee's (AESC) Mining Workshop held in Winnipeg, March, 1978.

Other activities of the Secretariat included: 1) participation in the review of the role of AESC for the WNRB; 2) contributions to the DFE Mackenzie Basin Committee; 3) a major role in the preparation of a background paper and a regional policy on chemical blackfly control; 4) representing FMS on Federal-Provincial-Industrial task forces concerned with the development of liquid effluent regulations, specifically for the alkali and associated products industries, the metal finishing industry and the organic chemical industry; 5) summarizing Western Region's involvement with water quality objectives; 6) involvement with the Peace-Athabasca Delta Monitoring Program, and 7) presentation of a paper at the 65th Statutory Meeting of the International Council for the Exploration of the Sea (ICES) in Reykjavik, Iceland, October, 1977.

Together with the Environmental Impact Section of the Research and Resource Services Directorate, the Secretariat initiated and produced a bimonthly Environmental Bulletin which summarized committee and research activities relating to the Region's environmental concerns.

FISHING AND INDUSTRY SERVICES

DIRECTOR'S SUMMARY

Staff of the Fishing and Industry Services (FIS) Directorate, composed of the Fishing Services Branch (FSB), the Industry Services Branch (ISB), and the Northwest Territories (NWT) District Office, were engaged in a broad range of activities from the primary fishing industry through to final consumer.

The FSB has continued to gather economic data and to monitor trends in the commercial fishery. A transport model has been developed for application in the Freshwater Fish Marketing Corporation's (FFMC) area of operation. In addition, a capability has been developed for analysing the economic performance of fishing enterprises. This has resulted in development of a database of owning and operating costs of commercial fishing enterprises that will permit analysis of the economic performance of fishing vessels in the various fisheries throughout the Western Region.

Activities in the ISB have been primarily concerned with enforcement of the Fish Inspection Act and Regulations; however, staff have served as the Departmental contact with fishermen regarding a number of service programs, including the Federal Labour Intensive Program

(FLIP), ice harvests and fisheries development projects. Contaminant levels in fish, fish products and marine mammals were analysed to monitor the safety of fish and fish products as food for human consumption. In addition, fish and fish products were inspected for compliance with requirements of the Fish Inspection, Food and Drug, Consumer Packaging and Labelling, and the Net Weights and Measures Acts and Regulations. Technical expertise and information was provided regarding improvement of processing facilities, quality control programs and proposed legislation regarding fish processing establishments. Vessel programs, including Vessel Insurance, Vessel Certification and Vessel Assistance, were provided to the primary industry. Research and development projects in support of various segments of the industry were provided by:

- a) Developing processing methods for whitefish roe;
- b) Conducting investigations regarding various aspects of fish quality, and
- c) Assisting in plant design for processing specialty products.

NWT District management programs are primarily designed to ensure compliance with provisions of the Fisheries Act and the Fish Inspection Regulations. Enforcement programs were reviewed and efforts made to quantify effectiveness and efficiency. In addition to the enforcement role carried out by District staff, a significant input was made by serving as the major Departmental link for providing information to the general public.

FISHING SERVICES BRANCH

The activities of the FSB involve the application of economics to the management of fisheries resources. Economics is concerned with the allocation of scarce resources among alternative uses to satisfy the desires or requirements of society. From this point of view, the FSB is interested in economic efficiency in the public management of fisheries resources for commercial fisheries production and for the provision of recreational benefits. Since the public management of fisheries resources is intimately related to the economic viability of the private sector, the FSB is also interested in the structure, conduct and performance of the commercial and recreational fishing industries. To pursue these interests, work is divided into four interrelated Sections:

- 1. Economic Intelligence;
- 2. Public Resource Management;
- 3. Fishing Industry; and
- 4. Fishing Enterprises.

Economic Intelligence Section

The single desk arrangement for selling fisheries production, which was created by the formation of the FFMC, puts the Western Region in a unique position to monitor the Region's fishing industry. The economic intelligence capability of the Region has largely come about through a cooperative arrangement with the FFMC to develop computerized statistical reporting systems. The ability to monitor trends in the commercial fisheries and to undertake economic

analyses of the fisheries is contingent on an adequate database. Information currently available from the database includes: a) fisheries production (primary level of production and its landed value); b) conversion of primary fisheries production into intermediate and final product mix (secondary level of production), and c) marketing of fisheries production (tertiary level of production and its final value). This information system provides a perspective of the flow and "value" of fisheries production in the Western Region for use by the FFMC, fisheries management agencies, statistical reporting agencies, and economic analyses conducted by the FSB. Such analyses are essential to the evolution of wise management policies.

In addition, the Economic Intelligence Section is responsible for the processing of sales of recreational fishing licences in the NWT to provide information for fisheries management in that part of the Region.

Public Resource Management Section

Fisheries resources may be regarded as a valuable form of wealth which is capable of enhancing the welfare of Canadian society. This wealth can readily be dissipated in the exploitation of the resource by the private sector and in the management of the resource by the public sector. The failure or inability of management agencies to control fishing effort is generally acknowledged as a contributing factor in the decline of fish stocks and in the emergence of an industry characterized by costs of production which exceed the value of production. This situation has led to eroded profits, stranded labour and capital, and social and economic hardships. In addition, Canadian citizens, who may be regarded as fisheries resources stockholders, have not only foregone a direct dividend in the form of a resource rent, but have incurred enormous management costs through taxation. To the extent that public management costs exceed the rent that the resource is capable of generating, there is a danger that the resource wealth will be eroded by the public sector. From this perspective, the FSB is interested in economic efficiency in the fishing industry and in the public management of fisheries resources.

During the review period, the FSB has attempted to contribute an economic perspective to public resource management through the following papers and projects:

- 1. Economic Alternatives for Great Slave Lake. Internal document for the management of Great Slave lake fisheries. 1977.
- 2. The Allocation of Resources in Fisheries: An Economic Perspective. Proceedings of a Symposium on Selected Cool-water Fishes of North America, held in St. Paul, Minnesota, March 7-9, 1978.
- 3. Regulating Access to Canada's Inland Fisheries. To be published in the Proceedings of a Symposium on Policies for Economic Rationalization of Commercial Fisheries, held in Powell River, B.C., August 23-29, 1978.
- 4. The Valuation of Recreational Fisheries. Presented at 1978 Sports Fish Conference, held in Fredericton, N.B., October 2-4, 1978.

Fishing Industry Section

The Fishing Industry Section provides the capacity to analyze the economic structure and performance of the fishing industry (commercial and recreational) from an aggregate point of view. The focus of this section during the review period was on the refinement and application of a transportation model to the commercial fisheries in the area of operations of the FPMC. The model comprises three sub-models in the following functions:

1. The linear programming model maximizes the difference between revenues from the sale of products and the costs of packing, processing and transporting of fish;
2. The pooling model uses the results of the linear programming model and distributes the revenues and costs according to a system of accounts referred to as "species pooling", and
3. The cash flow model uses the results of the linear programming model and cost of production information to estimate the revenue and expenses incurred at plants to handle the volumes received.

The model has been applied to a cross-sectional analysis of the fishery for the period of May, 1976, to April, 1977, and the results, conclusions, and recommendations from this analysis have been prepared for the consideration of the Federal-Provincial Freshwater Fisheries Committee. In addition to this study, two formal studies were initiated to examine investment decisions in fish processing capacity and handling facilities for the Savage Island fishery in northern Manitoba and the field processing capacity in Saskatchewan (La Ronge, Reindeer Lake, Wollaston Lake, Beaver Lake and Buffalo Narrows). These studies will also be presented to the Federal-Provincial Freshwater Fisheries Committee. Related analyses were also conducted in cooperation with the FPMC to examine revisions in the packing allowances to agents for the coming 1978-79 fiscal year and packing plant reinvestments at McBeth Point and Berens River on Lake Winnipeg. Further expansion of this work awaits consideration of these studies by the participating agencies.

Due to the priority placed on the transportation analysis, work initiated in the prior review period (i.e. 1974-76) did not proceed to completion. Nevertheless, data compiled in this study was in part intended to satisfy the information needs of the Recreational Fisheries Branch at Headquarters for their national survey of anglers, and this service has been completed.

Fishing Enterprises Section

Whereas the Fishing Industry Section is concerned with a macro-view of the fishing industry, the Fishing Enterprises Section is concerned with a micro-view. That is, this section provides a capability for the analysis of the economic performance of fishing enterprises (vessels, handling and processing facilities, fish farming, etc.). This activity encompasses that body of economic analysis which deals with the "theory of the firm"; it is concerned with the financial viability of individual enterprises.

Many of the commercial fishing enterprises in the Western Region are very unsophisticated with respect to measuring profitability. Further, many enterprises do not generate sufficient cash flow to achieve long-run viability which will permit reinvestment in gear and equipment. From this perspective, the Fishing Enterprises Section is capable of providing a major contribution to fisheries management by assessing returns to labour and capital currently engaged in the fisheries, and by providing a perspective of the production required by fishing enterprises to achieve long-run viability. This work has important implications for public resource management in controlling the aggregate level of fishing effort on a given fisheries resource to permit a return to labour and capital employed in exploiting the resource. Of equal importance are the implications for public resource management to provide a net return from the resource to the public sector.

During the review period, the major thrust of the Fishing Enterprises Section has been to prepare a database detailing the costs of owning and operating commercial fishing enterprises, so that the FSB could analyze the economic performance of fishing vessels in a wide cross-section of commercial fisheries within the Western Region, especially those in northern and remote areas. This study canvassed approximately 400 and 650 commercial fishermen respectively, on their 1976-77 and 1977-78 annual fishing costs. Correlated with data on primary fisheries production produced by the Economic Intelligence Section, the database consists of information on fishing effort, production, gross revenues, variable costs, fixed costs, net revenues, cash flows and capital equipment. The information will be used to assess the requirements for annual and long-run profitability of fishing vessels in the inland fishery. This work is essential in achieving an economically healthy fishing industry. The work is currently being used to assess public resource management programs for the Great Slave Lake and Pinehouse Lake commercial fisheries. In addition, the work has been used to assess lake-side fish prices output from the transportation model of the Fishing Industry Section.

The Fishing Enterprises Section also completed an economic analysis of rainbow trout farming. The study provided a perspective of the financial requirements and the annual production requirements for returns to labour and capital engaged in this form of extensive aquaculture. The study concluded that, given the mean level of production experienced in non-algal collapse lakes prior to 1977, commercial extensive aquaculture was not economically viable, and that the variability of recovery of stocked fingerlings would have to improve before economic viability could result.

INDUSTRY SERVICES BRANCH

The present organization of the Western Region was implemented in 1975, including, as a functional successor to the Operations Directorate's Inspections Branch, the formation of an Industry Services Branch. This Branch incorporated mandatory legislative requirements for national inspection programs, technology and fishery development activities, and fishing vessel

assistance and fishing vessel insurance programs serving the primary commercial fishing industry.

The major activity of the Branch and its District offices has been the enforcement of the Fish Inspection Act and Regulations. However, field staff, who are the only FMS contact at the fisherman level in the Western Region, have also brought to the fishermen the benefits of Fishing Vessel Insurance, Fishing Vessel Assistance and Fish Chilling Assistance programs. These staff members have also managed fishermen-oriented federal grant programs such as FLIP, ice harvest and fisheries development projects.

Administration Section

In 1976-78, this Section provided guidance, direction and managerial administration to a staff of 44 indeterminate scientific and professional, technical and administrative support personnel in Manitoba, Saskatchewan and Alberta, and functional supervision to Industry Services programs in the NWT.

Program and resource matters were continually reviewed, including Zero-base budget preparation, make-or-buy/contracting out/revenue and cost recovery/review projects, all of which were related to program and person-year justifications.

Management information systems, including Operational Performance Measurement Systems (OPMS) and Database systems, were developed on a national scale in 1976-77, and, in 1977-78, were implemented in the Region. This resulted in time-accounts and work activities being recorded and reviewed as management tools in the Western Region for plant, product and vessel programs.

In 1976-78, Section staff served on various committees, including Regional Management Committee, Tri-Partite Mercury Committee, Field and Laboratory Activities Coordinating Committee, and National Inspection Committees. Staff also liaised with other national and international regulatory agencies such as the Department of Consumer and Corporate Affairs, the Health Protection and Medical Services Branches of the Department of National Health and Welfare, the Environmental Protection and Environmental Management Services of the Department of Fisheries and the Environment, and the U. S. Food and Drug Administration.

Regional Inspection Section

Inspection chemistry: During the review period, the chemistry laboratory staff carried out 39,000 analyses of fish, fish products, marine mammals and other inland freshwater sample sources to obtain data used to establish baseline contaminant levels for species and size in specific locations. These analyses also: a) determined whether commercially harvested fish were in compliance with established guidelines; b) assessed the safety of fish as food for selected domestic native fisheries, and c) identified species and determined whether there were significant differences in contaminant levels in fish or fish products over time in different areas.

The Winnipeg laboratory continued to coordinate the International Mercury Quality

Assurance Program in 1977-78. During the year, three different sets of canned samples were distributed to the 24 participating laboratories, two of which were new to the program. Two special studies were conducted on aqueous standards for the regional laboratories within the Branch, and special assistance was provided to Domtar Research Centre in Quebec and Beak Consultants in Toronto. Both laboratories were having difficulties with mercury analyses during the course of the year. In addition, the chemistry group participated in a number of other collaborative studies: a metals study on dried oyster conducted by the U.S. Food and Drug Administration, a mercury study on sediments conducted by the Canada Centre for Inland Waters, a pesticide study in fish sponsored by the Federal Interdepartmental Committee on Pesticides, and a national branch study on heavy metals and pesticides in fish tissue conducted by the Montreal Fish Inspection Laboratory. A survey for polychlorinated biphenyls (PCBs) in 1100 samples of commercial species from the Great Lakes and Prairie Provinces was completed by Toronto, Winnipeg, Montreal and Halifax laboratories, providing adequate baseline data to the Department to allow proper management of affected species. The Winnipeg laboratory analysed 425 of these samples in 1976-77, and 200 in 1977-78.

In 1977-78, a large project was conducted at the request of the Environmental Impact Branch, Research and Resource Services (RRS), to determine baseline levels of contaminants in Eastern Arctic species. Approximately 400 samples of sculpin, narwhal, fish livers and other tissues, sediment, sea urchins and seaweed, were analysed for 11 metals, with an additional 163 being analysed for mercury alone.

Approximately 700 samples were analysed as part of a NWT Contaminants Survey, to obtain information on levels of arsenic, selenium, cadmium, copper, zinc, lead, organochlorine residues and PCBs. Samples of fish and marine mammals were collected from areas where permanent human settlements exist. Approximately half of the samples have been analysed.

Approximately 120 samples of bird breast tissue, liver, and brain were analysed for B. Kemper, CWS, to determine baseline levels of zinc, lead, cadmium, arsenic, and mercury in seabirds in the Strathcona Sound, NWT, area, where a lead-zinc mine is being developed.

Moisture and lipid determinations were performed on approximately 300 samples of rainbow trout for B. Ayles, Fisheries Resources Branch (FRB). This experiment was conducted to determine whether the nutritive quality of trout could be improved as a result of genetic selection.

The Inspection Chemistry group was represented on two committees: the Mercury Sampling and Analyses Review Committee, whose task was to review and recommend on procedures for determination of mercury in all substrates, and the Organizing Committee for the 12th Annual Western Pesticide Residue Analysts Workshop.

Inspection microbiology: During the review period, Regional field laboratories in Manitoba, Saskatchewan, Alberta and the NWT were

Table 1. Bacteriological Analyses, Western Region, 1976 and 1977 (domestic & import products).

Laboratory	SPC's	Coliforms	Faecal Coliforms	<u>E.coli</u>	Staphylo-cocci	Sterility	Sal-monellae	Swabs	Others	Total
Edmonton	546	197	543	29	220	65	-	-	-	1600
Hay River	136	492	111	20	-	-	-	90	-	849
Prince Albert	717	614	732	76	18	-	-	32	273	2462
Regional Headquarters	30	-	28	10	20	12	12	30	30	172
Thompson (1977)	-	148	-	-	-	-	-	-	-	148
Toronto (6 mos, 1976)	204	12	537	117	85	474	115	-	84	1628
Wheatley (6 mos, 1976)	109	24	109	3	37	-	-	-	-	282
Winnipeg	685	339	1327	98	304	1907	70	283	174	5187
TOTAL	2427	1826	3387	353	684	2458	197	435	561	12,328

responsible for routine microbiological analyses on representative samples from approximately 40 million pounds of commercially produced domestic and imported fish and fish products. As shown in Table 2, a total of 12,328 tests were carried out. (Ontario is included until mid-1976, when it became a separate region.)

Two sets of check samples per year, under the Regional Quality Assurance Program, were prepared at Regional headquarters (Winnipeg), and sent to the District laboratories for analyses to assess competency in analytical techniques. The Regional laboratory also received and analysed an international quality assurance sample in 1976 and again in 1977, prepared by the USDA, Cincinnati, Ohio. Under the quality assurance program, a variety of bacteriological media were tested on a comparative basis for their growth supportive properties.

In addition, the Regional laboratory carried out investigative studies including in-plant microbiological surveys to determine sources of plant and product contamination; comparison studies between Membrane Filtration (MF) and Most Probable Number (MPN) methods to promote the MF as a method approved by the Minister; isolation of *Clostridium botulinum* (the botulism organism) in freshwater smoked fish; rapid methods to identify bacteria of public health significance, and a prototype core sampler designed to obtain samples for microbiological analyses without destructive sampling.

Product services: The Regional Product Services Programs are designed to organize, coordinate, and monitor district inspection activities to ensure that all fish and fish products involved in inter-provincial, export, and import trade comply with all the applicable requirements of the Fish Inspection, Food and Drug, Consumer Packaging and Labelling, and the Net Weights and Measures Acts and Regulations.

Data are computer analysed to evaluate the efficiency and adequacy of inspections, to ensure problem areas are under control with policies and programs being enforced consistently. Further, inspection effort is concentrated on problem areas according to procedures outlined in a Lake Classification and Inspection Procedures Manual.

To enhance the effectiveness of Product Services programs in response to specific problems, the section:

- Developed contaminant survey programs for inhabited areas of the NWT, the Rat-Burntwood River system in Manitoba, and the Qu'Appelle-South Saskatchewan River system in Saskatchewan;
- Maintained and revised the Lake Classification and Inspection Procedures Manual in 1977 and 1978;
- Revised mercury classification and control procedures to take advantage of the raising of the allowable mercury tolerance from 0.5 to 1.0 ppm in the U.S.A;
- Refined the lake inspection and consumer complaint reporting and data processing procedures to provide more meaningful information at field and regional levels;
- Provided input and initial file designs for a National Contaminants Database Computer Program;
- Developed and implemented an OPMS data collections and summary program to monitor the efficiency and effectiveness of Inspection programs, and
- Reformatted the Domestic Quality monthly report to facilitate follow-up on rejected shipments and detentions at the field and Regional levels.

Plant inspections: During the review period, the plant registration program was enforced under authority of the Fish Inspection Act and

Table 2. Summary of Analyses: April 1, 1976 to March 31, 1978.

Sample Source	Sample Material	A N A L Y S E S																		
		Hg	Pb	Cd	Cr	Cu	Zn	As	Se	Fe	Ni	Mn	Sn	V	Mg	OCP	PCB	EP ¹	Salt	PrC ²
Internal	Fish and marine mammal tissue	16220	483	481	481	481	481	481	538				2			968	968	91	80	47
Fish for Food	Fish tissue	4940														95	95			
CWS	Fish tissue	342																		
	Bird tissue	124	124	124			124	113												
AOSERP	Fish tissue	476	464	464	464	464	464		377		464			464		44	44			
Province of Manitoba	Fish tissue	205	253	253	48	253	253	253		205		205		205		48	48			
Environment Impact	Fish tissues, sediment, sea urchins	517	354			354	354	354		354	354	354			354					
CCIW	Sediments		25			25	25			25	25			25						
Chemical Methodology	Fish tissue															35	35			
Aqua-culture	Fish tissue																			270
Montreal Inspection Lab.	Fish tissue								86											
Province of Saskatchewan	Fish tissue					5		5	5											

¹ EP = Electrophoresis

² PrC = Proximate Composition

Regulations to ensure that fish were processed under good manufacturing practices in sanitary establishments.

Provincial agencies were advised on application of complementary provincial legislation to promote voluntary compliance by industry on minimum construction and sanitary requirements in unregistered fish plants. In early 1977, the Province of Ontario promulgated complementary Fish Inspection Regulations and federal primary products inspectors were gazetted under these regulations.

Technical expertise and information were provided to industry, provincial and other federal agencies on improved plant processing facilities, quality control problems, and interpretation of existing and proposed legislation dealing with fish processing establishments. In 1976, the Province of Saskatchewan enacted shoreland pollution control regulations which were used in connection with new plant construction.

Team surveys consisting of regional and district personnel were maintained, resulting in a uniform approach to certification requirements. In 1976, eight such surveys were completed in Ontario and two in Manitoba. In 1977-78, 55 surveys were completed, 22 in Manitoba, 18 in Saskatchewan, 6 in Alberta, and 9 in the NWT. Eleven new Certificates of Registration were issued.

Eighty registered processing establishments were allowed to export their products during the review period.

Regional Vessel Programs Section

Section activities for the review period were as follows:

1. The Fishing Vessel Insurance Plan (FVIP) provided vessel insurance to fishermen in the Western Region at a reasonable cost while attempting to have the Plan self-sustaining.
2. The Fishing Vessel Assistance Plan (FVAP) provided improvements to the fishing fleet in the Western Region to develop a better and more productive fishery. The Plan encouraged the use of new fishing technology at the primary commercial fisherman level; also, the use of better life saving equipment and navigational aids on board vessels was encouraged.
3. The Vessel Certification Program involved an ongoing voluntary vessel inspection program to upgrade construction aimed at ensuring that fish are stored and handled in such a way that there is a minimum loss of quality.

Table 3 provides statistics for the review period.

Technical and Scientific Services Section

Fish products and process development: The fish products and process development group conducted research and development projects in support of the primary commercial fishing industry through technology transfer, consumer educa-

Table 3. Statistical Information for the Review Period.

Fishing Vessel Insurance Plan

<u>Fiscal Year</u>	<u>No. of Policies</u>	<u>Insured Value</u>	<u>Premiums</u>
1976/77	278	1,592,765	30,704
1977/78	472	2,627,091	35,903

Fishing Vessel Assistance Plan

<u>Fiscal Year</u>	<u>No. Vessels Approved</u>	<u>Const. Cost.</u>	<u>Subsidy</u>
1976/77	60	338,202	140,654
1977/78	121	828,321	258,999

Vessel Certification Program

<u>Fiscal Year</u>	<u>No. Vessels Inspected</u>	<u>Vessels Failed</u>	<u>Vessels Passed</u>
1976/77	604	466	138
1977/78	837	599	238

education, public relations, and interdepartmental research.

Processing equipment was designed and developed, and processing methods initiated for the commercial production of salted whitefish roe from the Western Region inland fishery. Direct supervision of the fishery was provided by staff of the group. Based on the 1978 selling price of the product, the result was a greater than 20% increase in the value of export whitefish to the producer and fishermen.

The group advised and assisted a commercial fishermen's organization in plant design, process development, and processing, to promote the marketability of underutilized freshwater fish.

During the review period, various studies were carried out, including:

1. An evaluation of the effects of antioxidant systems in extending the frozen storage life of minced flesh of mixed species of freshwater fish;
2. Determining and instituting measures to correct the cause of substandard quality of whitefish from a Saskatchewan source, and
3. A study of the kinetics of salt uptake and equilibrium to standardize brining methods so as to meet residual NaCl requirements of USFDA hot-smoked fish processing requirements.

Support of the commercial sector through technology transfer resulted in:

1. Specification of processing equipment and process development for a commercial fish-smoking operation in Saskatchewan;

2. A report prepared at the request of the NWT government and the Hay River town council that examined the prospect of and the costs associated with conversion of the existing Hay River fish plant from a total fresh and frozen processing operation to a primarily canned fish plant;
3. Technical advice and processing assistance to a Wheatley, Ontario, processor in canning alewife as a sardine-type product for in-plant evaluation and market testing, and
4. Technical assistance on behalf of or at the request of the FPMC included the development of process specifications for a canned minced mullet product, an evaluation of acceptability of dry-salted split mullet, preparation of salt/acid cured samples of several species for market trials, and provision of other technical assistance in relation to fish quality, packaging, product formulation, etc.

Consumer education and public relations included participating as an exhibitor at nutrition fairs in Winnipeg and Edmonton; media presentation on fish quality and preparation, and seminars to fishermen's organizations, government, and non-government organizations on product development, various aspects of fish processing, nutrition and flavour profiling.

Assistance was given to the aquaculture group of the FRB, RRS, by developing methods for conducting field and laboratory sensory techniques for the evaluation of various quality characteristics of cultured fish. Assistance was also provided to a visiting scientist with work on properties of certain off-flavours in fish through sensory studies in model and real systems.

Freezing processes and equipment: A prototype high-velocity air blast freezer was fitted with an electronic fan speed control to allow investigation of the effect of variation of air velocity on freezing rates and dehydration. An automatic hot gas bypass system was incorporated to allow precise selection and maintenance of freezing air temperature.

The water re-use system originally designed for aquaculture and reported earlier was redesigned to incorporate improved make-up water filtration and control. A high efficiency hydro-cyclone prefilter was added, together with a new type of biological filtration medium consisting of 40-mm diameter cylindrical plastic bio-rings. Three systems were built to evaluate different media efficiencies.

An automated lift gate mechanism for controlled release of walleye through culverts into Lake Winnipegosis was designed for installation at Pacheta Lake near Duck Bay, Manitoba. The design incorporated a mechanical worm gear mechanism, portable battery pack, solid state relays, and an integrated circuit logic controller.

Field Engineering and Fisheries Development Section

During the review period, this Section provided field engineering support to ensure that

fish plant construction or modification, process equipment, refrigeration, etc., complied with the Fish Inspection Regulations. It assisted industry in arriving at satisfactory design and equipment specifications, and maintained responsibility for industrial development of the commercial fish industry.

The Section provided technical assistance to other Regional programs such as Vessel Subsidy, laboratory services, and Economic Intelligence. The inspection program included design and modification of plants in the Region as well as extensive planning of future construction, utilizing the FMS transportation model to analyse the fishery. The Section assisted the FSB in developing a physical inventory of all the plants considered as delivery points under FPMC jurisdiction.

Schedules A and B of the Fish Inspection Regulations were rewritten to clarify sections and add new features.

Administration of the FLIP resulted in fish plant renovations and ice-house construction. A total expenditure of \$91,000 produced 69 person-months of work. Administration of the Ice Harvest program resulted on harvesting 10,205 tons of ice and expenditure of \$119,000. The Fish Chilling Assistance program continued with grants totalling \$112,000. A five-year monitoring program was continued for new and previous grant installations.

The report on the physical feasibility of mobile fish plants was published and a \$135,000 prototype was constructed. The first year of a three-year test schedule was completed in 1978 with promising results. A prototype aluminum vessel for use in the small skiff fishery was constructed, tested, and demonstrated throughout the Western Region. The vessel incorporated the features required under the voluntary inspection programs.

A Rotational Pulse Fishing project was undertaken to assess the economic and physical feasibility of deleting the biological quota on small-quota fly-in freshwater lakes and allowing the fishermen to fish until the operation was no longer viable. A prototype fly-in fish packing shore facility was established on each site to ensure a quality product.

A project to demonstrate the feasibility of and to determine the techniques necessary for harvesting, processing, and marketing whitefish roe was conducted. The roe were successfully sold on the Japanese market.

Utilizing a scanning sonar unit, the Section attempted to determine the locations of fish populations beneath the winter ice of lakes. This technique, if successful, would eliminate the unproductive and tedious trial and error methods of finding fish in winter fisheries. The Section has also conducted tests utilizing an electric pair seine to trap stocked rainbow trout to keep them alive and allow for purging of muddy flavours often present in trout reared in small lakes.

The Section purchased a can-filling machine as part of an experimental canning line

for deboned mullet to satisfy the potential market.

District Programs

Field inspection programs: In 1976-78, all fish and fish products in Manitoba, Saskatchewan, Alberta, and the NWT which entered into inter-provincial, export and import trade were inspected for compliance with the Fish Inspection Act and Regulations. These specify labelling, quality, levels of bacteria of public health significance, parasites, toxins and other contaminants as part of a national program of quality standards for fish and fish products. Guidance and technical assistance were provided to industry in the processing of safe, sanitary, good quality products.

All fish processing plants in Manitoba, Saskatchewan, Alberta, and the NWT involved in exporting fish and fish products were inspected under registration requirements to meet construction, equipment, and operating requirements of the above-mentioned regulations; such inspection is a requirement for holding a valid registration certificate. Tables 4-6 summarize the district product inspection data for the calendar years 1976 and 1977.

Field vessel programs: During the review period, under the Fishing Vessel Insurance Plan, field officers checked that applicants were eligible for insurance, established insured value, and calculated rates according to established guidelines. They collected premiums, issued official receipts and forwarded the premiums to the Regional Office; they were also responsible for investigation of accident claims and reporting on results thereof.

Under the Fishing Vessel Assistance Plan, field officers checked construction progress and recommended progress payments. They ensured that the vessel was properly insured before final payments were made, and audited the vessels to ensure that these were engaged in fishing for a five-year period in accordance with FVA Regulations.

Field officers promoted voluntary up-grading of fishing vessels to improve construction standards; they promoted up-grading of operating methods on board to improve landed quality.

The Western Region combined field activities at the District level so that ISB personnel carried out diverse mandatory inspection activities together with duties associated with Vessel Insurance, Vessel Assistance, Fisheries Development, Fish Chilling Assistance, Ice Harvest and other non-inspection duties. Field officers continued to be the only FMS contact at the fishermen level.

NWT TERRITORIES MANAGEMENT DISTRICT

The NWT District office represents the FMS in the NWT, and, together with assistance from the Regional headquarters office in Winnipeg, provides all services within the responsibilities of the Service to the public. The three main functions of the office are: Conservation and

Protection (Enforcement), Inspection, and Environment Protection.

During the review period, 76 prosecutions for various offences, and 15 cases involving search and rescue were successfully executed by the officers. This period also saw a change in the management philosophy for Great Slave Lake, and the formation of the Great Slave Lake Advisory Committee. The legal gillnet mesh size for the lake was lowered to increase the efficiency of and the incentive to a declining commercial fishing industry.

Some adjustments were made in the District to accommodate changes in the NWT. The Fort Simpson office was closed and a Baffin office was proposed, to reflect the shift in resource use and in industrial activity. Also, in response to increased hunting pressure, several regulations under the Fisheries Act (Beluga, Narwhal, and Walrus regulations) were redrafted and submitted for consultation in the local communities and for approval to Ottawa.

RESEARCH AND RESOURCE SERVICES

DIRECTOR'S SUMMARY

The review period 1976-78 produced a plethora of review processes conducted by various agencies for various purposes. At times it seemed to some of us that responding to reviews was the major aspect of our jobs. However, one of these processes - the Program Review and Evaluation (PRE) exercise - was aimed at science in government and was therefore welcomed by this Directorate. It seemed a logical extension of our own long-standing internal evaluation process, and, while the initial PRE exercise seemed to fall a bit short of the mark, the process should be given time to mature.

Science productivity in the Region continued to be high during the review period and the output dealt with an incredibly wide variety of issues. As usual, it is difficult to select highlights, but a few examples are outlined below. The interested reader is referred to the body of the Report for details, and, of course, we are willing to address any and all requests for additional information.

1. The involvement of the Region in the Garrison Diversion issue provides a good single example of the role we play in national, international and interprovincial affairs. In this case, a specific threat was identified, and then defended in various arenas. It subsequently became the major issue that External Affairs had at their disposal in negotiations with the proponents of this scheme, and continues to be a concern for the Province of Manitoba.
2. The Region was also involved in the Alberta Oil Sands Environmental Research Program (AOSERP) in a number of areas. Toxicological studies were conducted on a variety of compounds expected to be discharged by this energy-related project. In addition,

Table 4. Product Services - Domestic Quality Program Statistics .

Province	Year	Product Type	Inspection		Rejection	
			No.	Tonnes	No.	Tonnes
Alberta	1976	Bulk	1366	1148	9*	1
		Packaged	18	84	0	0
	1977	Bulk	1778	1415	75	156
		Packaged	13	76	5	35
Saskatchewan	1976	Bulk	2370	2862	112*	92
		Packaged	204	749	31	157
	1977	Bulk	2421	3169	129	107
		Packaged	181	626	14	58
Manitoba	1976	Bulk	3726	11443	170*	157
		Packaged	144	1089	6	71
	1977	Canned	32	23	3	2
		Bulk	3853	14577	344	160
	1977	Packaged	111	1009	0	0
		Canned	30	29	9	6
Northwest Territories	1976	Bulk	188	981	0	0
	1977	Bulk	222	1223	0	0
All	1976	Bulk	7650	16434	291	250
		Packaged	366	1922	37	228
	1977	Canned	32	23	5	2
		Bulk	7002	20384	548	422
	1977	Packaged	305	1833	19	93
		Canned	30	29	9	6

* The 1977 and 1978 rejections include whitefish rejections for excessive cysts but 1976 does not.

Table 5. Import Analyses 1976 - 1978 .

District	Year	Container Type	No. Shipments	Tonnes Received	No. Shipments Sampled	Tonnes Represented	No. Rejections	Tonnes Rejected
Alberta	1976	packaged	242	301	175	103	5	5
		canned	132	104	84	29	9	1
	1977	packaged	377	482	151	185	4	16
		canned	100	155	52	87	0	0
Manitoba	1976	packaged	821	1103	238	141	50	26
		canned	214	308	132	82	26	1
	1977	packaged	899	1066	186	217	34	19
		canned	254	342	119	131	3	2
TOTAL	1976	packaged	1063	1404	413	244	55	31
		canned	346	412	216	111	35	2
	1977	packaged	1276	1548	337	402	38	35
		canned	354	497	171	218	3	2

Table 6A. Consumer Complaint Program.

Year	No. Consumer Complaints Received from Districts	No. Complaints Confirmed	No. Complaints Forwarded	No. Control Actions Taken
1977	51	46	32	2
1978	78	57	64	2

Table 6B. Label Evaluation Program - 1978

Type	No. Received	No. Approved	No. Requiring Amendments at Next Printing	No. Rejected
Domestic	147	106	22	19
Import	119	36	74	9
Ottawa	<u>21</u> 287	<u>7</u> 149	<u>6</u> 102	<u>8</u> 36

the Region's Experimental Lakes Area (ELA) project assisted AOSERP in assessing the risk posed by acid rain due to their sulphur dioxide emissions. Surveys were conducted of lakes in the AOSERP area and a deliberate experimental acidification of a lake in the ELA was begun.

3. A mid-Arctic research station was established near Chesterfield Inlet on the western shore of Hudson Bay. Its purpose was to provide a bridge between biological/fisheries studies in southern Canada and similar studies in the high Arctic, the idea being to reach resource decisions in a cost-effective manner. A simulated gas pipeline rupture was conducted with great difficulty under winter ice, resulting in a recommendation to the proponent (Department of Indian and Northern Affairs) that such an event constituted only a remote threat to fish. Therefore, more economical submerged stream and lake crossings were a viable consideration.
4. In cooperation with local fishermen, and with input from RRS together with the FSB, a novel management scheme for Great Slave Lake was instituted. Results are presently being monitored and will probably be applied elsewhere in northern commercial fisheries.
5. Percid fisheries are potentially very valuable. This is especially true of the commercial fishery for walleye, yet this fishery is in a declining phase, and conventional restocking techniques do not seem to be effective. Western Region, in cooperation with the Province of Manitoba, investigated the use of rearing ponds wherein the fry, normally stocked directly, can be reared for a summer in a rich environment, free from predation prior to release. This technique seems proven to be remarkably effective and is accomplished with little capital investment. Further studies are being pursued at present.

6. The Region became involved in a number of energy-related projects with particular reference to their potential effects on fisheries. Acid rain concerns were extended beyond the minimal involvement with AOSERP to include issues relating to any fisheries in lakes on the Canadian Precambrian Shield. Apparently, lakes in this vast area of Canada are especially vulnerable to this threat as are certain areas in maritime Canada. In addition to these studies, research was initiated into the impact that radionuclides may have upon the fishery. The concern here is that the mining of uranium ore and the disposal of spent fuel might result in the introduction of radioactive materials into the aquatic environment. The Department must be prepared to present government and the public with solid, factual information regarding these matters in the very near future. In the case of hydroelectric power, we assessed the first reservoir to be established in a permafrost area. Unique disbenefits were established but it is also clear that hydroelectric impoundments constitute a very clear opportunity for the deliberate enhancement and management of sport and commercial fisheries. These opportunities are presently being explored.

7. Continuing research into the impact of toxic chemicals upon Canadian fisheries involved work upon pesticides, acid rain, heavy metals and industrial effluents. In addition, numerous bioassays were developed and released for assessment by other agencies. In particular, remedial measures for mercury pollution were explored at Clay Lake, Ontario, by means of a joint Federal/Provincial agreement under the Canada Water Act. Also, joint studies with federal and provincial agriculture agencies were pursued with regard to the

use of methoxychlor as a blackfly control agent. Base metal smelting operations were investigated with regard to their ability to contribute to heavy metal and acidification problems. Many other industries were assessed with regard to the Federal Effluent Regulations Program.

FISHERIES RESOURCES BRANCH

The objectives of this Branch are:

- a) To develop management strategies for existing and future north temperate fisheries, and
- b) To develop operational procedures for commercial fish culture in Canadian fresh waters.

The Branch is organized into a number of Sections, the activities of which are as follows:

Fishery Management Section

The Fishery Management Section is responsible for the development, operation, and maintenance of a management program controlling the exploitation of fish and marine mammal populations in the fresh and marine waters of the NWT. The legislation required to carry out the management program is embodied in the Northwest Territories Fishery Regulations, and various marine mammal regulations which are promulgated from time to time under Section 34 of the Fisheries Act.

Activities involve fishery studies of a monitoring, assessment, and inventory nature. Controls are effected by changes in the appropriate Regulations and attendant Variation Orders regarding commercial quotas, angling catch and possession limits, seasons, gear restrictions, etc. In setting these regulations, close liaison is maintained with the NWT District Enforcement Division to ensure that management objectives are understood and can be effectively enforced.

In addition to biological investigations, considerable information concerning use of the resource is obtained from direct communication with various departments of the NWT Government, local fishermen and their associations, Hunters and Trappers Associations, Settlement Councils, sport fishing lodges, the NWT Tourist Association, and local Fish and Game Associations. Such liaison takes place in communities throughout the NWT. This dialogue is very important in arriving at solutions to resource-use conflicts and the formulation of regulatory controls.

The projects engaged in by the Section remained essentially the same in 1976-78 as in previous years except that the priority activity became the implementation and monitoring of a management scheme for the commercial fishery on Great Slave Lake. This emphasis is a direct result of the work of Dr. M. C. Healey, a former member of the Branch, now at the Pacific Biological Station, Nanaimo, B. C. A new activity involved the participation of a staff biologist on the Biology Committee of the International Joint Commission study of the Poplar River. Projects

for the review period involved:

1. Monitoring and assessment of the Great Slave Lake commercial fishery;
2. A study of the summer and fall spawning runs of lake whitefish in streams adjacent to Great Slave Lake;
3. Monitoring and assessment of the commercial walleye fishery in the NWT;
4. Monitoring and assessment of sport fisheries in the NWT, including the lake trout fisheries on Great Slave and Great Bear Lakes, the Arctic char fisheries at Tree River and Albert Edward Bay, and the Arctic grayling and northern pike fisheries in the west Great Slave Lake area, and
5. Monitoring and assessment of the commercial Arctic char fisheries at Cambridge Bay, Nettilling Lake, and Sylvia Grinnell River.

Arctic Char Research Section

This work of this Section was initiated in 1974 with the establishment of a research facility at Nauyuk Lake, located 160 km west-southwest of Cambridge Bay, Victoria Island. The objective of the project was to study the life history, population dynamics and production potential of an anadromous and a landlocked population of Arctic char. The study was designed to operate for five years of intensive investigation, followed by three years at a monitoring level.

This investigation has continued to discover important facets of the extremely complex life history and population dynamics of the char. Preliminary estimates of production, based on counts of the entire population and measurements of individual fish have been made. A total biomass of 28,045 kg produced an increment of 32% during summer growth. However, 40% of this was lost due to a decline in individual weight over winter. The population has declined slightly from just over 11,000 individuals over 400 mm in length in 1974 to 9,000 in 1976. Mortality has been extremely low, as demonstrated by a tag recovery of 75% over a span of two years. The only known natural mortality occurred in the post-spawning period before fish were able to regain the sea and resume feeding. A considerable degree of straying has been recorded with tagged individuals being recovered by anglers in such diverse locations as the head of Elu Inlet (100 km), Ellice River (400 km), Albert Edward Bay on Victoria Island (290 km), and Bathurst Lake at the Bathurst Inlet settlement (130 km). It is presumed on this evidence that a considerable interchange of individuals with other systems occurs, especially on a local scale.

The observed spawning pattern of the Nauyuk Lake char population is complex and quite variable. Some tagged fish have been found to spawn in alternate years, the greatest frequency possible in the circumstances, but this is not considered to be a regular feature of the population. Great variation (about an order of magnitude) has also been observed in the incidence of annual production of young-of-the-year.

The Inuit population of two families at Nauyuk has imposed considerable fishing

pressure on the char population. The domestic catch was 3,346 kg in 1975 and 2,959 kg in 1976, representing 12.3% and 18.0%, respectively, of the total upstream migration in the Fall. This rate of exploitation appears to be in excess of the productive capacity of the system in view of the very low rate of recruitment that has been observed.

The Inuit have been considerably involved in the project, particularly with regard to recording and examining the domestic catch, and in making freely available their local knowledge and experience. Without their help and cooperation, this work could not have proceeded in such a satisfactory manner.

Percid Experimental Management Research Section

Within Canada's inland waters, the walleye, *Stizostedion vitreum*, is an extremely valuable sport and commercial fish species. An understanding of the physiological and biological mechanisms which regulate and control the production capacity of this species is most important to both federal and provincial fisheries agencies. In late 1976, this section began investigations focussed on these aspects in order to define the limits and characteristics of biological compensation in walleye populations experiencing exploitation stress, and to improve the understanding of the interrelations which occur between walleye and other species in the fish community.

As a first step toward developing alternative management schemes for this species, an experimental approach was developed, based on controlled selective harvesting in several small lakes located in northern Manitoba. In the summer of 1977, the Heming Lake fisheries research camp was reactivated, and six lakes in the vicinity were identified as having unexploited walleye populations. Information on these populations was collected to establish the steady state or preharvesting conditions prior to the actual cropping which will occur in 1979. It is expected that the walleye populations will compensate for exploitation through changes in growth rate, rate of maturation, reproductive potential, mortality rate and recruitment. The actual magnitude of these responses will be examined as a function of fishing intensity. During the review period, considerable effort was expended in selecting capture methods and tagging techniques which would have a minimal effect on the population structures of these walleye. Because of problems experienced in determining the ages of older walleye, a study was initiated to develop a new aging technique, using bony structures other than scales. As a result of this study, it was found that sections of dorsal fin spines allow a more accurate determination of the ages of walleye in unexploited populations.

Another activity of this section has been an investigation into the use of rearing ponds as a method of enhancing the survival of stocked juvenile walleye. Since 1971, a number of experimental rearing ponds have been developed from small, shallow lakes situated near the shores of Lake Winnipegosis, Manitoba. Just prior to the onset of first feeding, hatchery-produced walleye fry were released into the rearing ponds where they utilized natural food during the summer

period. The ponds are devoid of fish predators due to the phenomenon of winter kill, and, at stocking rates of 1700-1900 fry/ha, the survival of walleye fry remains between 40% and 60% of those initially stocked (versus less than 1% in the natural situation). Growth of walleye fry in the rearing ponds was as good as or better than growth of fry in Lake Winnipegosis over the same period. It is suggested that the rearing ponds could make a substantial contribution to the commercial and sport fisheries of Lake Winnipegosis, and this technique may have application in other areas where rehabilitation of walleye stocks is required.

Biochemical Genetics Research Section

The objectives of this Section are to maintain familiarity with current molecular biological research and to assist in the transfer of new ideas and techniques from this field to other Sections of the FRB. These objectives are achieved by a combination of active study and communication, as well as by the conduct of appropriate research projects designed to illustrate the application of current molecular biological practice and thought to fisheries management situations. Some highlights from the review period include:

1. Publication of the final results of a study concerning the survival of walleye fry and fingerlings introduced into a lake with a depleted native walleye stock. The introduction was very successful in terms of augmenting the depleted population. The accurate measurement of the survival of the introduced fish was entirely dependent upon the application of a biochemical genetic technique.
2. A long-term investigation of lake whitefish in western Canada has shown conclusively through the application of biochemical genetic expertise that the lake whitefish of the Yukon Territory have been isolated from other North American whitefish for millions of years. It seems quite possible that similar evolutionary distances may also separate populations of other northern fishes. Any northern development such as dam construction, which could disrupt waterways, should thus be studied in some detail to estimate the effects of possible mixing of these stocks of fish.
3. Several theses were also completed by graduate students under the supervision of the Section head, as follows:
 - a) A study at the M. Sc. level of lake Whitefish in Lake Winnipeg showed the existence of multiple breeding stocks, using biochemical techniques. Fisheries management measures designed to maintain or enhance fish stocks must take these sub-populations into account to ensure the long-term viability of the fisheries.
 - b) A similar, more extensive study has demonstrated that a number of lakes in the Yukon Territory hold two distinct species of what was formerly assumed to be lake whitefish. The results have

implications yet to be fully realized in terms of present evolutionary theory. The entire investigation was published as a University of Manitoba Ph. D. thesis, and a journal paper discussing the evolutionary implications of this work is currently in preparation.

- c) A third study described the occurrence and translocation of mercury in environmentally contaminated fish and was published as a U. of Manitoba Ph. D. thesis. The central hypothesis of this work concerning the way in which mercury moves through the biosphere was drawn from basic molecular biological theory and represents the most significant new idea regarding mercury pollution to have been put forward in many years.

Fish Pathobiology Section

In the summer of 1977, this Section was re-organized into a diagnostic and a research subsection. Complete diagnostic services were provided for regional facilities engaged in the interprovincial and international export of live fish and eggs. In addition, diagnostic services were extended to private facilities in Ontario, under the provisions of the Fish Health Protection Regulations.

Fish Pathobiology personnel were involved in implementation of the Regulations in western Canada. Disease occurrences in aquaculture operations were also investigated. Diseases were routinely monitored in fish used for research, for toxicological assessment, and for industrial effluent studies.

Research and consultation with provincial officials established procedures for the disinfection of regional hatchery facilities. Research work involved the development and application of new techniques for improving diagnosis methodology, the study of the etiology and epizootiology of diseases of walleye, and investigation of cellular defence mechanisms in fish.

Aquaculture Section

The objective of this Section is to develop methods for the enhancement of commercial and recreational fish farming. This is accomplished through studies involving fish nutrition, fish biology, aquatic food chains, water chemistry and hatchery experiments and operations. An information and extension service is also maintained to pass on the practical results of studies to fish farmers.

For the review period, the major efforts of the Section were directed toward the solution of problems associated with extensive trout culture in Canadian prairie lakes, and intensive culture in controlled hatchery environments. Other significant activities included: 1) provision of aquaculture information to the public; 2) training and education of fisheries students from Thailand, Jamaica, and the University of Manitoba; 3) cooperative studies with other government and

university groups, and 4) provision of fish culture support to groups working on fish habitat protection.

Approximately 3500-4000 farmers are involved in extensive trout culture in prairie pot-holes. Experimental studies on this culture system were carried out at the Aquaculture Field Station at Erickson, Manitoba, 275 km northwest of Winnipeg. Significant accomplishment over the review period were:

1. The completion of genetic studies which included estimates of heritabilities of growth and survival of trout;
2. The evaluation and identification of superior strains of trout for commercial use;
3. The completion of water chemistry studies encompassing the development of a model incorporating meteorological as well as limnological variables to predict summer and winter fish kills;
4. A study of the use of copper sulphate (CuSO_4) as an algicide in fish farms;
5. The establishment of basic criteria for the operation of an extensive trout culture operation, and
6. Studies on the relationships between trout stocking and other components of the pond ecosystem, including primary production, zooplankton, amphipod and salamander production.

Intensive fish culture studies were carried out at the Rockwood Experimental Hatchery, 60 km north of Winnipeg. Located on the site are a large (70 m x 30 m) hatchery building, a smaller (15 m x 15 m) broodstock building, and 10 ha of earthen ponds, as well as residences for the hatchery staff and small service buildings. Significant accomplishments in intensive culture studies were:

1. Installation of Canada's first practical solar energy system, with assistance from the Department of Energy, Mines and Resources, for operation of a fish hatchery. The system supplied the 3.6 tonnes of heated water per hour needed for the broodstock building;
2. The development of a new compact water reuse system which cuts new water use in a 1700 L fish tank by 90% to only 4.5 Lpm;
3. The development of new fish foods, using regionally-produced agricultural products such as field peas, faba beans, sunflowers, soybeans and rapeseed, as well as other protein oils;
4. Continuation of studies on the genetics and selective breeding of trout in intensive culture, and
5. The initiation of experiments on the pond culture of trout.

Also of significance during the review period was the establishment of a public display at the Aquaculture Field Station.

ENVIRONMENTAL IMPACT BRANCH

Branch activities were carried out by a multi-disciplinary, permanent staff of 22. There

were three main Sections within the Branch: Environmental Impact Assessment, Environmental Impact Research, and Alberta Oil Sands Environmental Research. All of these involved activities directed at: 1) understanding how various types of industrial developments can affect living aquatic resources and how these impacts can be mitigated, and 2) ensuring protection of regional living aquatic resources and habitats from such impacts. Although the Region includes the prairie provinces and the NWT, most of the Branch's efforts were directed at the NWT.

Branch objectives and strategies were:

1. To ensure the protection of fish resources and habitats from man-made disturbances by performing impact assessments and reviews of proposed industrial developments, and
2. To obtain predictive impact data on how industrial development activities are likely to affect Arctic aquatic ecosystems.

Environmental Impact Assessment Section

1976-77: The mining sub-projects included continuation of aquatic resource surveys and metal contamination studies in the vicinity of Arvik and Nanisivik mines. Considerable advice was provided to the NWT Water Board and DFE on effects of mining wastes on living aquatic resources.

The fishery resource mapping sub-contract continued with mapping of Banks Island and the Coppermine-Kent Peninsula portion of the Arctic coast. Final maps were developed by the Arctic Land Use Research Program (ALUR).

The fish passage study on the Redknife River showed that baffles were successful in reducing water velocities to levels which are expected to enable fish to pass through the highway culverts. Experimental methods for providing fish access through the turbulence at the culvert outlets are now being reviewed. Advice was also provided to the Manitoba government on problems associated with fish blockages (e.g. Goose Creek).

Aquatic resource inventories were conducted for the portion of the Arctic Islands Pipeline extending from the NWT boundary to Baker Lake. Inventories included resource usage as well as biological information. Hydrocarbon exploratory drilling applications were reviewed for Canmar, Norlands, Hudson's Bay Oil and Gas, and Imperial Oil Ltd.

The third year of the Mackenzie Highway Monitoring Study was completed as was an interim report for 1975-76. Construction did not proceed at these crossings but more predevelopment data were collected.

Aquatic resource surveys were continued on the upper Snare River (Indin Lake) to provide further knowledge on the impacts of impoundment on this system.

Upon requests from the Department of Public Works (DPW) and the Department of Indian and Northern Affairs (DINA), advice was

provided on various dredging problems in the Region.

The Section also participated in the International Joint Commission (IJC) study of the effects of the Garrison Diversion on Canada. One of the staff members served as Canadian chairman of the Biology Committee; this committee's report had a major influence on the IJC's recommendations to the Canadian and U.S. governments with respect to the potential for and effects of introduction of foreign biota. The IJC recommended that there be no construction until this problem is solved.

1977-78: The mining sub-project has been terminated and write-up of reports has commenced. The Section reviewed Environmental Impact Statements (EISs) for a uranium mine at Cluff Lake, Saskatchewan, and two mines in the NWT (Canada Tungsten, and Arvik).

The fishery resource mapping sub-project continued with mapping of the Coppermine-Bathurst Inlet area. Formal reports describing survey techniques and catalogues of lake and river systems in 1975, -76 and -77 were published.

The Redknife fish passage study was completed and a report prepared; similarly, a hydraulic model study of the use of weirs to overcome problems associated with turbulence and culvert access was completed.

The third and final year of the Arctic Islands Pipeline Program - Aquatic Resource Inventory, was completed with an inventory being done on the Murchison River system. A final comprehensive report covering eight watersheds along the proposed pipeline route has been completed.

The final year of the Mackenzie Highway Monitoring Study was completed and a report written. Highway construction was stopped and no further construction is anticipated. During the course of the four-year study, considerable information was gathered on the fisheries resources of the various streams crossed by the highway. As well, a good understanding was gained of the kinds of impacts caused by stream crossings and how to mitigate them.

Fisheries resource surveys were completed in the Indin Lake - Snare River area in anticipation of hydroelectric development of the Snare River. Additional information was also compiled from other potential hydroelectric sites: Great Bear River and Lac la Martre.

Environmental Impact Research Section

1976-77: In 1976-77, the Stanwell-Fletcher Lake study was completed and a report submitted. In general, it was found that the limnology of this lake is similar to that of other high Arctic lakes such as Char Lake. This provides some confidence in speaking in general terms of the effects of disturbances on such lake systems. This year the Region also decided to mount a long-term research thrust into the Arctic by committing funds for construction of a field camp north of Chesterfield Inlet; this will permit long-term environmental impact research to be conducted on site in the Arctic.

Recruitment of staff commenced with the hiring of a project leader, Dr. H. E. Welch.

1977-78: A field camp was set up at Saqvaquac, 40 km north of Chesterfield Inlet on the northwest coast of Hudson Bay. The camp was built in such a way that year-round aquatic research can be conducted. While much of the summer of 1977 was devoted to construction of the facility, some research was carried out, as follows:

1. A series of lakes was designated for future experimental purposes. Routine baseline limnological and fisheries data were collected for background purposes;
2. Some detailed life history studies commenced for a number of aquatic species;
3. A stone weir was constructed in the Saqvaquac River to enable enumeration of the fall run of anadromous Arctic char. 11,000 char were counted from August 1 - September 30, and
4. Preliminary work was done on determining the swimming speed of Arctic char - these data will be useful in designing fish passage facilities in stream crossings.

The major piece of research conducted in 1977-78 was the methane addition experiment. A study was conducted to simulate a natural gas pipeline rupture under river/lake ice, and to determine the effects of such a rupture on downstream lakes and their biota. In spite of harsh Arctic winter conditions, the elaborate experiment was conducted from January to June, 1978. The working hypothesis was that certain methane oxidizing bacteria in the lakes would metabolize the methane released, and this would cause an oxygen depletion in the lake, to the detriment of fish populations therein. The experiment was completed and there was no evidence of oxygen depletion, possibly as a result of low nutrient supply. A report has been completed on this study.

Alberta Oil Sands Environmental Research Project

This project commenced in May, 1975, with FMS involvement planned to 1978-79. However, there are annual budgets and reviews, and specific research projects and subprojects that may expand, cease or change direction. Although funding was available for FY 1975-76, management and planning were not fully established until December, 1975, which prevented a full program from being conducted that fiscal year. FMS received \$600,000 and 15 person-years (PYs) to fund and staff aquatic biological studies. Fiscal year 1976-77 was the first comprehensive year of research.

1976-77: A large number of studies commenced; these included: fish toxicology inventory; literature review and bibliography of the impact of saline waters upon freshwater; survey of contaminants in biota in the AOSERP area; life cycles of some common aquatic insects of the Athabasca River, Alberta; synopsis of physical and biological limnology and fisheries programs in the AOSERP area; walleye and goldeye fisheries investigations in the Peace-Athabasca Delta - 1975; apparatus development - sonic fish tags; industrial effluents - chemical characterizations;

invertebrate studies; lake acidification - heavy metals cycling in lakes; aquatic environmental research (toxicology); acute and chronic toxicity of vanadium; multiple toxicity of nickel (Ni), vanadium (Va) and phenols; sampling and tagging of fish in the Athabasca River; intensive fisheries study of the Muskeg River drainage, and recreational uses of fish and wildlife. A number of interim and final reports were filed.

1977-78: While most of the 1976-77 studies continued, FMS staff focussed their interests on fisheries resource inventories in the Athabasca, Steepbank and Muskeg rivers, aquatic invertebrate studies (baseline and experimental), and aquatic bacterial - algal studies. A number of interim and final reports were filed.

LIMNOLOGY BRANCH

The Limnology Branch carries out practical research on the structure (e.g. species composition, trophic organization) and function (e.g. energy flow, geochemical cycling) of the freshwater environment. The studies conducted are concerned with the impact of man's culture on the natural freshwater environment, the objective of Limnology Branch projects being to develop sound freshwater habitat and fisheries management strategies. Two fundamentally different approaches to investigating limnological problems are reflected by the two Branch Sections, Experimental Limnology and Regional Limnology.

The Experimental Limnology Section uses experimental manipulation as its prime investigative tool, focussing primarily on small-lake experiments. Historically, Experimental Limnology's job was to determine the most likely causes of eutrophication of lakes. However, many of the major questions related to eutrophication are now resolved, and 1976 was a year of major redirection. Emphasis was placed on studies of the ecological importance of the contamination of natural freshwater systems by heavy metals, radionuclides, and acid precipitation.

The basic approach taken in carrying out work of the Regional Limnology Section is a comparative one. Comparative analyses are used both in space and time in exploring the responses of the natural system to man's impact. During 1976 and 1977, the emphasis of research by the Regional Limnology Section continued at Southern Indian Lake towards determining and understanding of the impacts attributable to the diversion of the Churchill River and the impoundment of the lake. Southern Indian Lake was the first North American lake situated in permafrost to be impounded; it is Manitoba's fourth largest lake and supports northern Manitoba's largest commercial fishery. On-site studies currently being conducted will be used to formulate models which may be used to predict the environmental consequences of future reservoir developments of this sort. First post-impoundment observations (impoundment began in July, 1976) were made in 1976. Concentrations of suspended sediment in the lake increased dramatically; preliminary estimates have been made of the effect on erosion of the first year of impoundment.

Together, studies by the Experimental Limnology and Regional Limnology Sections include

many aspects of the environmental problems expected from the major energy-generating alternatives: fossil fuel burning, nuclear energy, and hydroelectric power.

Experimental Limnology Section

Much less emphasis was placed on eutrophication research during 1976 and 1977 compared with previous years. However, key studies continued on the effects of long-term fertilization on eutrophication. Total phosphorus, nitrogen and carbon budgets were worked out, and a model of sediment return and saturation constructed on Lake 227, fertilized since 1969. Fertilization of Lake 226 (two basins) was also continued to determine the long-term effects of loading of N and C but not P, and to evaluate the magnitude of possible compensation by N-fixation as a result of loading with N-deficient fertilizer. In 1977, an overview of C, N and P cycling was published in *Science*, stressing the extent to which lakes are able to compensate for nitrogen and carbon deficiencies.

The program begun in 1975 to obtain information on the fate and food chain effects of heavy metals and reactor waste products in the aquatic environment is now well under way. Lamont-Doherty Geological Observatory is a co-investigator in the project. In 1976, a whole-lake experiment was carried out in Lake 224 with ^{65}Zn , ^{60}Co , ^{134}Cs , ^{203}Hg , ^{59}Fe , ^{51}Cr , ^{226}Ra , ^{14}C and ^{75}Se . Monitoring of this spike was continued in 1977. All isotopes disappeared into bottom sediments with a half-time of 10-46 days. The fastest to disappear were isotopes which bound to suspended particulates, such as ^{59}Fe , ^{51}Cr , and ^{60}Co . Slowest were those that remained in ionic form: ^{134}Cs , ^{65}Zn , and ^{75}Se . Experiments were also carried out in limnocorrals in 1977, using 13 isotopes. Both basins of Lake 226 were spiked in order to compare the effects of oligotrophic and eutrophic conditions. Four tube experiments were done in Lake 226 to test the importance of sediment-water exchange. Samples of water, sediment and biota were monitored with a lithium-drifted germanium detector.

Acidification of fresh water by air-borne contaminants, particularly SO_2 , was recognized as a major Canadian and international problem. In 1976, a study was begun to document changes in fish populations (growth, fitness, and physiology), benthos and plankton, nutrient and heavy metal chemistry during acidification. Lake 223 was acidified at the rate of 0.25 pH units per year with H_2SO_4 , and compared to control Lake 224. By the end of 1977, the lake pH had dropped to 6.0. Enclosures containing metal isotopes were used to examine H^+ -heavy metal interactions. Physiological studies of H^+ on water and calcium balance in crayfish were completed and similar experiments were begun on *Mysis*. The effects of cadmium at concentrations of 0, 3, 10, and 30 $\mu\text{g L}^{-1}$ on plant and animal communities were investigated. Initial population estimates for trout, sucker and crayfish in Lake 223 were completed; initial hydrological and elemental budgets were also completed. Preliminary experiments showed that survival of lake trout eggs fertilized at pH 4-5 was poorer than at pH > 6.

Monitoring continued in 1976 to evaluate

effects on water quality of clearcutting and related activities, the 1973 hurricane and the forest fire of 1974. Rainfall-runoff relationships for peak flow and base flow events were developed for further analysis on a comparative basis between the burnt and unburnt areas. A manuscript on the hydrology and chemistry (P, N and K) in the first three years after the windstorm and fire was completed in 1977. Clearcutting studies were terminated in the autumn of 1976 due to the withdrawal of the Canadian Forestry Service from active participation.

Regional Limnology Section

Studies continued on the possible effects of hydroelectric development-related diversion of the Churchill River and impoundment of Southern Indian Lake. Algal nutrient bioassays in Southern Indian Lake, based on defined physiological parameters, indicated that phosphorus is the nutrient most likely to become limiting to primary production, and clearly limited algal growth in July and August before impoundment. After impoundment in 1976, light limitation of algal growth has become increasingly dominant because of high turbidities. However, in the recently flooded Notigi Reservoir, nitrogen limitation occurs after mid-summer for most algae, but it is overcome by the nitrogen fixing *Aphanizomenon flos-aquae* which blooms at that time. Flooded soils may release relatively more P than N, and may account for the usual predominance of cyanophyte species in newly flooded reservoirs. A technical report on ATP concentrations in Southern Indian Lake in 1975 and 1976 was published. In 1977, whole lake surveys of zooplankton and zoobenthos were carried out in order to determine initial effects of impoundment on these communities.

Description of the stream conditions necessary for successful walleye spawning continues in preparation for documentation of the effect of flooding and river diversion on their spawning success and migratory behaviour. 2,859 fish were tagged in 1976 and approximately 3,100 in 1977. Muscle tissue in whitefish exhibited enzymatic differences, indicating two whitefish populations in Southern Indian Lake. Changes in the distribution of these sub-populations are expected because of lake impoundment and river diversion. In 1977, fishing by fine mesh gill nets was done in South Bay areas known to support young-of-the-year whitefish. Approximately 200 young-of-the-year whitefish were caught. A sub-sample of scales is being read to confirm ages. Stomach contents have not yet been examined. Evaluation of new whitefish spawning sites was also begun in 1977. In conjunction with the University of Manitoba, surveys of pre-impoundment levels of parasite infestation of fish (in particular, whitefish) have been completed. After impoundment in July, 1976, concentrations of sediment increased in Southern Indian Lake to 8-10 times the natural level by September, when the lake reached its new controlled level. Optical interference by the fine clay fraction of these sediments has required modification of sample preparation prior to nutrient analyses. The feasibility study on the utility of LANDSAT-satellite imagery to estimate relative quantities of suspended sediments in Southern Indian Lake has been completed, and satellite imagery will be used to follow sediment transport and deposition through time. In 1977, initial rates of shoreline

erosion were reported. An intensive study was initiated in Long Bay in 1976. The goal is to link production of all trophic levels to the extent of inundation of terrain units which are mappable in the pre-impoundment condition. Realization of these objectives would permit quantitative assessment of impact of proposed northern boreal reservoirs on water quality and fish production. The Long Bay study plan is to: 1) identify rates of nutrient supply from flooded terrain (sub-divided into key units); 2) compare rate relative roles of physicochemical and biochemical processes in producing these rates; 3) create mass budgets for the Bay to assess relative significance of flooded materials; 4) estimate utilization of nutrient mass by biological organisms, and 5) to assess effects on population dynamics of the top aquatic predator in the Bay (northern pike).

Manuscripts on Lake Winnipeg limnology are near completion. Based upon estimated rates of supply of N and P, it is expected that Lake Winnipeg would show characteristics of an eutrophic lake. However, chlorophyll concentrations were low in proportion to P concentration, annual supply rates of P, water flushing time, mean depth and surface area of the lake. The biomass and species composition of phytoplankton in most of Lake Winnipeg were found to have characteristics of a shallow prairie lake or pond. In smaller areas of the lake, receiving dilute nutrient-poor runoff from Shield watersheds, phytoplankton species assemblages were similar to those found in oligotrophic lakes. Zoobenthos and planktonic crustacea were not typical of the usual eutrophic lake fauna. Oxygen depletion was not observed, due to shallowness of the lake and frequent strong prairie winds which vertically mixed the lake waters continuously. It is likely that the flora and fauna of Lake Winnipeg are more strongly influenced by the lake's shallowness and turbidity than by rates of nutrient supply. Reports were also written for IJC technical committees concerning environmental effects of the Garrison Diversion project on present and future limnology of Lake Winnipeg and Lake Manitoba.

In 1976 and 1977, a sampling program was carried out on six lakes near Erickson, Manitoba, to study the effect on zooplankton of periodic anoxic conditions and different patterns of fish survival. The study was carried out in cooperation with the Aquaculture Section and the CIDA Training Program. Comparisons of phytoplankton and protozoan abundance and seasonal distribution were carried out on these lakes in an effort to assess their relative importance in the food chain. Sampling and analyses of 10 lakes were continued in the Riding Mountain area, to study stability of zooplankton communities. A paper on *Limnocalanus macrurus* in Great Slave Lake was presented at the SIL Congress in Copenhagen in 1977. Benthic invertebrate studies continued with three comprehensive manuscripts on the taxonomy, morphology and phylogeny of the Chironomidae being completed.

Analysis of data collected during primary productivity studies on Lake Tanganyika is complete and technical reports are in draft form. The results of the research are forcing a new view of the metabolism of the lake. Respiration rates exceed production rates by a significant margin. It is inferred that heterotrophic

production is extremely high. This heterotrophic production, based on upwelling of hypolimnetic waters rich in reduced substrates, may be more important to the productivity of the pelagic food chain than primary production *per se*. This hypothesis would explain the enigma of Lake Tanganyika, i.e. oligotrophic (in terms of algal production) but with a very high fish production rivaling pond culture.

TOXICOLOGY BRANCH

The three general responsibilities of the Toxicology Branch were as follows during the review period:

1. To advise on aquatic toxic chemical problems and policy;
2. To conduct interdisciplinary fundamental and applied research on the harmful effects of chemicals on fish, other aquatic species and whole ecosystems, with the emphasis on bioassay development pertinent to protocols for environmental contaminants, and
3. To conduct fundamental and applied research into analytical methods for heavy metals, pesticides and other toxic compounds in aquatic systems.

This Branch had 49 PY, with an annual operating budget in the range of \$250,000-\$300,000. In 1976-77, these responsibilities were met by the Branch Management and Administration, and three functional sections, namely, Biological Methodology, Chemical Methodology, and Industrial Toxicology. At the end of FY 1976-77, these sections were regrouped under the following three titles: Industrial Toxicology, Protocol Development, and Organic Chemicals Toxicology. The basic responsibilities and accomplishments of these sections follow.

1976-77

Branch Administration: Branch Management and Administration provided advice and guidance to the Branch by participation in the AOSERP as a member of the Aquatic Fauna Technical Committee. A review of aquatic environmental research for the Fisheries Research Board of Canada (FRBC) was carried out in consultation with the Organization for Economic Cooperation and Development (OECD). Frequent advice was provided to the Director and Director-General, and to federal, provincial, industrial and foreign groups.

Through the research interests of the Branch Head, bacterial responses to heavy metals were investigated as a method of assessing the effects of heavy metals on aquatic ecosystems. An investigation of the methylation of heavy metals by bacteria and its effect on the accumulation of heavy metals by sport and commercial fish was initiated. Work continued on nitrogen fixation, a problem associated with eutrophication research.

Biological Methodology Section: This section was organized:

1. To provide advice and conduct research on the effects of, and

2. To develop test methods for use in assessing the effects of pollutants upon fish and aquatic invertebrates.

When the test development is complete, the methods will be available for use in pollution control programs such as the Environmental Contaminants Program and the National Effluent Regulations Program.

The responsibilities of the Biological Methodology Section were met by the following accomplishments:

Advice on toxicological problems was given to other scientists at the FWI, Federal and Provincial Departments, Industry and University staff. Members of this Section served on several committees, including the Ontario/DFE Sudbury Environmental Task Force, DFE Committee on Long Range Transport of Atmospheric Pollutants, Alberta Blackfly Coordination Committee, and the Prairie Farm Rehabilitation Act Herbicide Committee.

The invertebrate culture subproject defined the culture technique for the amphipod, *Hyalella azteca*, for inclusion in the manual for culture of selected freshwater invertebrates for use in routine toxicity tests. In collaboration with the invertebrate biology subgroup, parthenogenesis in the burrowing mayfly, *Hexagenia rigida*, was investigated. The latter group reported the life cycles of some Athabasca River (Alberta) insects, and completed the design of a drift sampler.

The microbial communities/food chain subproject modified an algal-protozoan medium for use with heavy metals and stressed the system with cadmium.

The pesticides group adapted a cholinesterase assay and used it to assess the effects of an organophosphorus insecticide, fenitrothion, on fish. This group continued the laboratory experiments on starvation and methoxychlor kinetics. Methods were developed for analysing methoxychlor and two other insecticides in water and tissues.

The sublethal-bioassay group developed a new approach for recording the locomotor activity of fish and continued work in preference/avoidance testing and optomotor response. Prototype facilities for testing swimming performance and buoyancy regulation were constructed.

The chemosensory bioassay groups emphasized the study of the toxicity of heavy metals to the olfactory system of fish. They provided further evidence to support a model for stimulant molecule-receptor binding in fish olfaction. Histochemical methods were developed to localize phospholipids in the olfactory system and acetylcholinesterase in brain tissue of fish.

Field research and survey projects were also undertaken by the Biological Methodology Section to verify the predictability of laboratory tests and to establish realistic conditions to be included in such tests. Preliminary results suggest that aerial emissions from smelters have adverse effects on the growth and reproduction of commercial fish species (whitefish, walleye) and

rough fish species (suckers), and may result in the extinction of populations of these species. The results will be of use in developing regulations to control aerial emissions from smelters and in studies and control of the long range transport of aerial pollutants, a growing environmental problem in Canada. Studies in conjunction with the use of methoxychlor to control the blackfly, a serious pest of man and livestock in some areas, showed that this pesticide has severe effects on non-target organisms. The results were used by the WNRB in developing a DFE policy paper on the use of methoxychlor to control the blackfly.

Industrial Toxicology Section: This section was organized:

1. To provide FMS input to the EPS for the National Effluent Regulations Program;
2. To contribute in a major way to the Western Region's response to specific problem areas, e.g. to assess the toxicity of saline groundwater and its components from the Athabasca Oil Sands to fish and aquatic invertebrates, and
3. To provide advice and conduct research into the effects of specific pollutants of concern to the Region.

Section staff participated in the joint Federal-Provincial-Industrial Task Forces which developed effluent regulations for alkali and associated industries, the metal finishing industry, and the organic chemical industry, by providing advice on the deleterious effects to fish and aquatic life of these effluents and their components, by providing advice on toxicity testing procedures, and by recommending permissible levels of pollutants. There was lesser involvement with effluent regulations for the meat and poultry industry, and for the smelting and refining industry. As part of interdepartmental or Federal-Provincial groups of experts, water quality criteria and objectives were developed to protect the fish and aquatic life of the Yukon and NWT, and of the Souris, Red and Roseau Rivers of Manitoba. The resultant documents were forwarded to senior management for acceptance. Advice was given on protecting fish, aquatic life, and sport and commercial fisheries of the Qu'Appelle River by serving on the Qu'Appelle River Advisory Committee.

Avoidance-preference and olfaction tests were performed with various mine effluents and their components. The results will be used in the Mining Effluent Regulations Program. A protocol of several toxicity tests showed that municipal wastes produced harmful effects on important commercial and sport fish, and on fish food organisms. Chlorination of municipal wastes increased their toxicity. These results will be used in developing effluent regulations for municipal wastes, and have already been used to provide information to Manitoba and Winnipeg on the implications of Manitoba's proposed disinfection policy.

Members of the Industrial Toxicology Section were very active in a toxicology project for the AOSERP. Lethal and sublethal physiological, biochemical, embryological, behavioural and histological responses of fish and aquatic

invertebrates were used to assess the toxicity of saline groundwater, and of copper and vanadium, two components of the groundwater. Results have enabled identification of the dilution necessary to protect the fish and aquatic organisms from these particular stresses. Results indicate that the toxicity and composition of the effluent varies greatly in time and with locality, indicating that further work with the components is necessary. The results will be used by the AOSERP to set effluent criteria and to establish "guidelines for the socially acceptable limits of damage to present and potential uses of the biotic and abiotic resources" of the AOSERP area, as outlined in the Canada-Alberta Agreement for AOSERP.

A protocol of several toxicity tests was used to assess the toxicity of fenitrothion and acephate, organophosphorus insecticides used to control spruce budworm, a severe pest in many regions of Canada. The results showed that acephate was three orders of magnitude less toxic to fish than was fenitrothion. These results will be used to provide advice on spruce budworm control.

The uptake and distribution of radio-nuclides in fish was studied. The work will provide data of use in regulations for atomic energy plants, and in any pollution problems involving heavy metals.

Chemical Methodology Section: The major role of this Section was research in the fields of environmental chemistry and analytical methodology. It had, in addition, an important service and advisory function related to the chemistry requirements of the entire Region. Its responsibilities were:

1. To develop analytical methods for pollutants of concern, and
2. To conduct surveys to determine pollutant concentrations for estimates of present dangers and establishment of baseline data.

Methods were developed for the analysis of mercury, arsenic, selenium, aluminum, vanadium, manganese, copper, cadmium, iron, nickel, zinc, methoxychlor, glyphosphate, dimilin, mirex, esters and/or ethers from humic acid lipids, a new herbicide (=glycine methylphosphonic acid), acetone, ethanol, phenols and triaryl phosphates in water, sediments and tissues.

Surveys of the English-Wabigoon River system have shown that mercury pollution remains serious and is unlikely to improve of itself in the foreseeable future. Joint studies with the Arctic Biological Station on mercury levels in seals at Holman Island, NWT, have identified a potential danger to native people; the work has been extended to other areas. Cooperative work with Health and Welfare Canada on feeding mercury-contaminated fish to cats have shown what dietary levels are harmful, and how the metal accumulates in various organs.

Metal and pesticide concentrations in fish from Lakes Huron and Superior were surveyed for the IJC. A study of arsenic in the Yellowknife, NWT, area shows some contamination of biota by mining operations. All these results

will be used in the protection of fish and humans.

1977-78

Industrial Toxicology Section: This Section was organized to conduct fundamental and applied research on:

1. The analyses and behaviour of industrial chemicals, e.g. studies with arsenic, cadmium, mercury and acidification processes in aquatic ecosystems, and
2. The effects of these chemicals and processes on fish and their habitat, i.e. on the adaptive processes that fish can develop when exposed to sublethal concentrations of such chemicals, and on the early (embryo-larval) life history stages of fish.

This Section also provided services in analytical inorganic chemistry and input to the Protocol Development Section.

In order to test the biological validity of the use of water quality criteria for the protection of fish and their habitat, cadmium was chosen as a model toxicant to link the laboratory bioassay approach to effects produced in the natural environment. Investigations on the toxicology and bioaccumulation of cadmium in the laboratory, and on the feasibility of partitioning a bay of approximately four ha from the rest of Lake 382 in the ELA, were conducted. Laboratory investigations on cardiovascular, respiratory, and renal systems in rainbow trout demonstrated that the gill is the target organ and can be used to assess adverse effects of cadmium on natural fish populations. Seven fish species were identified in the Lake 382 experiments, and baseline concentrations were obtained on these fish, and on the water, sediments, crayfish, clams, and three species of macrophytes. Plans include the use of small and large limnocoarals to determine the chemical behaviour of cadmium in Lake 382, and the direct and acute adverse effects on fish and other aquatic biota.

Another major effort in the Industrial Toxicology Section was the evaluation of selected amelioration measures for reducing methyl mercury production in Clay Lake, Ontario. The measures evaluated included: investigations on the role of the water column in mercury methylation, the use of sulphate to decrease methylation in the anoxic sediments, the use of a herbicide to simulate de-eutrophication, and the use of selenium to detoxify the mercury and to reduce mercury levels in the biota. The measures showing greatest promise were the removal of mercury from the inflow to the lake and the addition of selenium. Future plans include investigating the mechanisms of the mercury-reducing effects of selenium, the toxicology of selenium on aquatic organisms, and the relationship of acidification to mercury concentration in fish.

In support of these and several other studies, research was conducted in metal speciation, and in developing and improving analytical chemistry methods for heavy metals in water and associated biota. Over 6,000 chemical analyses were conducted on more than 4,500 samples as a service to the Industrial Toxicology groups and

others, such as Protocol Research and Experimental Limnology.

Protocol Development Section: This new Section for fundamental and applied research was established in October, 1977, from the biochemical, histological, physiological, behavioural, and ecological components of the former Biological Methodology and Industrial Toxicology Sections described in 1976-77. It was created to provide an integrated and directed effort toward the production of a package of toxicity tests suitable for test protocols from which to determine the harmful effects produced by known and anticipated pollutants on fish and invertebrate organisms. While additional effort was placed on organizing and prioritizing these tests, major emphasis continued to be on research and development of new test procedures to recognize and describe acute and chronic, lethal and sublethal effects of environmental contaminants on aquatic life.

In connection with the AOSERP project, two histopathological investigations on the effects of saline groundwater, and vanadium, respectively, on gills, liver, and kidney of rainbow trout were completed. The histochemical localization of phospholipids in the olfactory epithelium of fish was described. Data have been collected on the histochemical demonstration of heavy metal toxicity (Hg, Cu, Cd); also, the collection of enzyme assay data on ceruloplasmin (a blood serum protein) was initiated, to determine its possible role in fish copper metabolism.

Neurotoxicology studies focussed on the olfactory function of fish and its impairment by heavy metals. A comparative study of heavy metal (Cu, Cd, Zn, Ni) toxicity on the olfactory response in rainbow trout and Arctic char was completed. Toxic effects of Pb, Co, and Ag on the olfactory bulbar response of rainbow trout were determined. Also, synergistic and antagonistic actions of several heavy metal combinations were examined. Tissue preparations from trout olfactory rosettes were shown to contain "binding/uptake" systems specific for stimulating amino acids; sublethal concentrations of Cu and Hg impaired these systems. Acetylcholinesterase activity in the olfactory bulb proved to be low, compared to other brain areas. To characterize the nature of biological attractants and repellents pertinent to fish behaviour and mediated by olfaction, skin mucus in rainbow trout and whitefish was investigated. Stimulatory amino acid content was found to be significantly higher in males than in females in both species; exposure to heavy metals increased skin mucus cells and mucus secretion.

In studies focussed on behaviour of fish and freshwater invertebrates, several methodological developments were completed and applied to problems of behavioural ecology and toxicology. A novel technique to monitor locomotor activity of fish by sonar beams was used to determine activity changes caused by organophosphate exposure and correlated with depressed acetylcholinesterase. A field version of the same technique was successfully applied to determine natural circadian activity patterns in Yellow perch in a northern lake. In a cooperative study with the University of Manitoba, advice and assistance was provided in establishing methods for testing swimming performance and

buoyancy regulation in fish. The supervision of a M.Sc. thesis dealing with these questions was completed. To investigate the drift behaviour of stream invertebrates and possible changes due to toxicants, two laboratory stream channels with control of pertinent physical and chemical factors were designed and built. Also, a large, multi-purpose test facility for fish and invertebrates was completed and described. Tests on effects of repeated and previous exposures to methoxychlor on the preference/avoidance response of whitefish were carried out. Using the same technique, experiments on the preference/avoidance response of the freshwater crustacean Gammarus lacustris to copper and saline groundwater (AOSERP report) were carried out and described.

Conditions and procedures for holding, culturing and testing of four more species of freshwater invertebrates (two insects, two crustaceans) were established and described, as components of the planned "Manual for the Culture of Selected Freshwater Invertebrates". In a combination of laboratory and field investigations, the effects of cadmium were examined on a number of species and response parameters. A predator-prey system, consisting of the protozoan Tetrahymena vorax and the algae Chlamydomonas, was stressed with cadmium under different flow-rates and exposure schedules. Continuous-flow systems were developed for use in the field. Preliminary tests were conducted at two field sites to determine the reproductive potential of microbial populations under test conditions and for incubation of zooplankton populations. The following parameters were investigated in cadmium tests, using five different invertebrate species: uptake, accumulation, effects on embryonic development, emergence, and life cycle.

Following the main mandate given this group, a comprehensive review of protocol elements (test species, response parameters, test methods) available at the Freshwater Institute was initiated. This led to the identification of approximately 25-30 potential protocol contributors. In a series of meetings, basic aspects and problems of "protocol testing", and some preliminary guidelines for a FWI handbook of methods to assess chemical hazards to the aquatic environment were discussed. At the same time, a literature search system, using efficient computer services, was established.

Organic Chemicals Toxicology Section: This new Section for fundamental and applied research was developed from pesticide chemistry, analytical organic chemistry, biochemistry, and vertebrate and invertebrate biology activities of the Biological Methodology and Chemical Methodology Sections described in 1976-77. It was created to provide advice and new information on the behaviour and effects of pesticides and other organic chemicals as they affect fisheries. This research involved monitoring applied field uses of pesticides, laboratory toxicity tests, and experiments on mechanisms of action, and chemistry of pesticides and other organics. The Section also provided services in analytical organic chemistry, biochemical analyses in cases of suspected poisonings, benthic invertebrate identification, and related input to the Protocol Development Section.

Studies on the treatment of western rivers with methoxychlor were continued, but emphasis was shifted to laboratory experiments directed at understanding and interpreting field data. Fish were exposed to equivalent amounts of methoxychlor presented either as an emulsifiable concentrate or as a particulate, and the particulate was much less toxic. Since limited field tests with particulate formulations have been effective against blackflies in eastern Canada, it seems possible that they may offer effective pest control with reduced risk to fish.

Radioactively labelled methoxychlor was synthesized from anisole and used to estimate the amounts required to cause individual blackfly larvae to detach from their substrates. Results indicated that virtually all larvae detached and began drifting by the time they had accumulated about 20 nanograms of pesticide. Experiments with eggs of the mayfly, *Hexagenia rigida*, indicated that methoxychlor was toxic to mayfly eggs at levels below those used in blackfly larviciding. The behaviour of several experimental pesticides was investigated in small ponds. Two of these, fluridone and terbutryn, are designed for control of aquatic vegetation, and will soon be proposed for registration in Canada. Analytical techniques to measure these compounds were developed and persistence of both was measured in water and hydrosol. Persistence of these herbicides was also monitored, using a bioassay procedure with duckweed; chemical and biological estimates of herbicide decay in sediments were in agreement. Terbutryn was found to form two structures in pond water, identified as de-ethylated terbutryn and hydroxy terbutryn. Phytotoxicity and chemical residues persisted through the winter following June treatment. Fluridone was found to persist in hydrosol for periods greater than a year. Aspects of this work were presented to the annual meeting of the American Chemical Society and were selected by that Society as newsworthy items. Fish did not seem to accumulate fluridone efficiently, but studies using radioactively labelled fluridone indicated that much of the radioactivity in the fish could not be extracted using conventional solvent techniques.

A third experimental herbicide, ethalfluralin, was also investigated. Ethalfluralin exhibits striking fish toxicity; the LC₅₀ is 37 ppb. Uptake curves from water were determined for rainbow trout sac fry and fingerlings, using chromatographic and isotopic techniques. Results indicate that the parent compound is unstable in fish, and several currently unidentified products are formed. The parent compound decayed with a half-life of about eight days.

Additional experiments were conducted with several other compounds. Stonefly nymphs were found to be very sensitive to fenitrothion, an organophosphorus compound, and cholinesterase activities in their heads could be used to detect exposure history. Persistence and metabolism of bayluscide (a molluscicide used in sea lamprey control) in hydrosol was monitored in a laboratory study, and an amino metabolite was identified. Velpar, another experimental aquatic herbicide, was monitored following field application to a limnocorral.

Some limited analytical service work was

undertaken to analyse samples for haloforms for the City of Winnipeg, pesticides for CIDA, PCB's for EPS, and enzymes for the Province of Manitoba. Several papers were prepared and presented, and these are listed in the list of Regional Publications.

In addition to research and service functions, Section staff are frequently asked to review and comment on Headquarters documents on the subjects of pollution with organic compounds and pesticides, to review journal articles, and to attend meetings of committees and other groups. There is frequent communication with the Headquarters pesticide biologist on questions of pesticide registration.

Field studies on the Souris, Roseau, and Red Rivers were carried out to provide either pretreatment information on probable sites for blackfly larviciding and/or essential "natural" data on experimental animals.

MANAGEMENT SERVICES

DIRECTOR'S SUMMARY

The major objective and function of the Management Services (MS) Directorate is to provide the required support services for the Regional programs and activities of FIS and RRS. To accomplish this support, MS is divided into two distinct Branches, consisting of a Financial and Administrative Branch (FAB), and a Technical Services Branch (TSB).

The major functions of the FAB are central registry, mail, communications, shipping and receiving, accounts and budgeting. Under the scope of the TSB are the support services functions of computing services, electronics, fish holding facilities, shops, gear design and fabrication, library, publications, graphics and photography, and facility operations and management. Detailed descriptions of these functions are provided in the following Branch reports.

FINANCIAL AND ADMINISTRATIVE BRANCH

Materiel Management Section

The Materiel Management Section provided the following services to programs of the Region during the review period:

Acquisition of goods and services:	14,371 purchase orders
Receipt, distribution and warehousing of supplies and equipment:	4.3 million
Maintenance of inventory records:	1,765 line items
Vehicle administration:	100
Personal service contracts:	100
Total value of inventory:	\$5 million

Support Services Section

The Support Services Section provided the following services to the Region during the review period:

Switchboard and
receptionist services: 250,000 calls

Building security:

Support Services Section coordinates the security of the FWI and its adjacent buildings, as well as providing direction to the Region on security matters.

Occupational health and safety administration:

In an effort to promote good health and safety practices both in the FWI and the Region, the Section carries out a yearly health and safety check of the FWI and out-lying field camps and installations.

Central registry
operation: 200,000 items

Other services coordinated and controlled by this Section include issuance of I.D. cards, building passes, parking, and vehicle and other credit cards.

Financial Services Section

The Financial Services Section provides financial services for all Regional programs and for the Regional Personnel Office. These services included, during the review period:

Budgetary control: \$12,820,000/year
Budgetary control of FE-funds: 605,072

Processing of suppliers
accounts for payment: 38,800

Provision of financial analysis and reports.

Provision of management information systems.

Application of Treasury Board and Departmental Regulations and directives.

The financial reporting system has been put on-line. A review of the financial procedures and paper flow has resulted in numerous changes in the financial systems.

TECHNICAL SERVICES BRANCH

Facilities Management Services Section

During the period 1976-78, a field camp was constructed at Saqvaqujac, NWT, approximately 30 km north of Chesterfield Inlet. The camp's main programs relate to environmental impact studies on freshwater and marine fish. The camp's location was determined by the availability of both freshwater lake systems and the water in Hudson Bay. The remoteness of the site, with the only access to it being by boat, suggested a major change in construction methods for the required structures. The buildings were designed using refrigeration urethane panels and totally erected in Winnipeg. These buildings were then dismantled, packaged and transported to the site

by sea lift. This saved considerable construction time at the site, and the five buildings were erected and usable in less than two weeks. The structures have also proved to be very energy efficient.

This period also saw the advent of an intense energy conservation program throughout the Region. All aspects of energy consumption were investigated and reviewed. In many cases, energy savings of greater than 20% were obtained by changing methodology and by modifying equipment. Preliminary investigation began for the utilization of solar energy as a source of water heat for fish tanks at the Rockwood Experimental Fish Hatchery, located at Gunton, Manitoba.

The new bioassay laboratory at the FWI proceeded through the design, specification, tendering and construction phases during this period. By March, 1978, the foundation was completed and the superstructure erected. The estimated completion date for this specialized laboratory required for ecosystem toxicology programs is January, 1979.

Library and Publications Services Section

Table 7 summarizes some of the library functions over the period under review.

Table 7. Library acquisitions and interlibrary loan transactions.

	1976-77	1977-78
Books added to the library	1048	542
Interlibrary loans:		
Loans supplied to other libraries	174	163
Photocopies supplied in lieu of loan	576	1084
Total	<u>750</u>	<u>1247</u>
Requests made for material needed by FWI Staff	885	912
Total number of items received	662	772

The number of requests received from staff for material which we do not hold has increased over the figures for earlier years. The year 1976-77 was a relatively slack year for requests to lend or photocopy materials from our collections for other libraries. This is the first year in which there has been a drop in the number of requests received compared with the previous year. This may be because it was decided to introduce a nominal charge to those libraries (mostly University libraries) which charge us for photocopies. It is perhaps of interest to note that the second year under review shows a considerable increase in the number of requests satisfied. To some extent, this may reflect the closer liaison with respect to inter-lending between our Library and the University of Manitoba libraries entered into at this time.

During 1977, a survey of the use of our periodicals was carried out. As a result, some titles were cancelled as changes in the direction of research had rendered these titles of little relevance to current studies.

Ten CAN/SDI literature search profiles have continued to be run during the review period. Revisions have been made to many of these profiles.

The use of the on-line literature-searching facilities, which first became available in 1974, was expanded in 1976 by obtaining access through Infomart to the Systems Development Corporation ORBIT system. In 1977, arrangements were made to access the Lockheed DIALOG system also. Thus, at the end of the period under review, we had access to over 100 different databases on four systems. In February, 1977, the old IBM terminal, which had been requiring frequent maintenance, was replaced by a Decwriter II terminal which has given excellent service. Table 8 summarizes the use of this facility in making searches for staff.

Table 8. Online searching in the Freshwater Institute Library.

	1976-77	1977-78
System Use:		
CAN/OLE	30	91
Infomart/SDC ORBIT	18	31
QL Systems	12	32
Lockheed DIALOG	-	32
Total	60	186
Data Base Use:		
BIOSIS Previews	23	87
Chemical Abstracts	4	32
Canada Water	7	23
NTIS	11	8
Pollution Abstracts	10	6
Food Science & Technol. Abstr.	-	4
Enviroline	-	3
Commonwealth Agric. Bureau	-	2
Agricola	1	-
Delft	1	-
GeoRef	1	2
Selected Water Resources Abstr.	1	1
Smithsonian Science Information Exch.	1	-
SciSearch	-	3
Aquatic Sciences Fish. Abstr.	-	2
Boreal Northern Titles	-	4
Engineering Index	-	3
ERIC	-	1
Inspec	-	1
IEC	-	1
SocialSciSearch	-	1
Solid Wastes	-	1
Library Inform. Sci. Abstr.	-	1

The use of the online searching facility for making bibliographic searches has gradually

increased. A seminar has been given on this facility each year, and a gradually increasing clientele is being built up as staff realize how this service can help them.

An index to the publications of Regional staff, both reports and articles in scientific journals, covering the calendar years 1976 and 1977, was prepared early in 1978, and was published as Technical Report No. 764 in April, 1978.

Lists of publications available for distribution have been mailed out every six months, and the numbers of requests generated by this mailing and from other sources has resulted in about 1000 requests being handled each year. These requests are in addition to the regular mailing lists for the Report Series.

In 1977, the report series issued by the FMS was reorganized into four series: Technical, Industry, Manuscript, and Data Reports. New covers were designed in Ottawa and provided for our use. The provision of the Data Report Series filled a gap in our publications which had long been felt, and which now allows specialized data collections to be made available in an economic way.

Computer Analysis Section

Data processing services were provided for research scientists, operating groups and administrative support staff within the Region. Continued interest in information on fisheries contaminants provided the impetus for the design and subsequent development of a National Contaminants Database system in Winnipeg. The database contains 15 million characters of operational data on heavy metal and pesticide contaminants recorded for fresh and saltwater fish caught within Canadian waters. Regional System 2000 databases are available for the Pacific, Western, Quebec, Maritimes, and Newfoundland regions. Information concerning lake/area fished, date, biological parameters (species, size, age, etc.), and the concentration of various contaminants is available via natural language inquiry for both commercial and survey species. The database is maintained on an IBM 3033 at Manitoba Data Services in Winnipeg.

In conjunction with this project, the Computer Analysis Section participated in the construction and compilation of the data dictionary and coding manual for the Fisheries and Marine Service. Begun in June of 1977, this thesaurus of fishing terminology is primarily intended to assist those involved in collecting, coding, programming and using fish data. The only known thesaurus in existence, it is vital to the future of database, and is proving vital in such areas as the Deputy-Minister's office, the legal services, and many provincial governments and universities.

In the two years under review, several projects undertaken by the Computer Analysis Section have gained particular attention. Two of these were:

1. A generalized Edit and Maintenance system. This system was designed to validate incoming data and to update

master data files. It has been successfully developed and applied against several data collection procedures, and has now become the standard for all formalized data gathering and reduction systems maintained by the Computer Analysis Section. A Technical Report, documenting its features and method of use, is forthcoming.

2. A system of programs to find the solutions to equations representing equilibria among chemical species in experimental lakes was successfully implemented on the University of Manitoba's IBM 370/168. The programs were used to calculate from experimental data the rates of disappearance of copper from six different prairie pothole lakes treated with copper sulphate for nuisance algal growth. Chemical speciation calculations which had implications for toxicology were performed for the same lakes. This work is now In Press.

Recently, a proposal was submitted to management recommending that the existing remote job entry terminal (RECOM 2780) be upgraded and the present keypunch machines (three IBM 129s and one IBM 029) be replaced by a more up-to-date data entry system.

Graphic Arts and Photography Section

The Graphic Arts and Photography Section at the FWI has been mainly involved with the production and layout of scientific and technical material for visual presentations at seminars, lectures and final reports. Standardizing the methods of production of jobs submitted has been used as much as possible in order to facilitate the meeting of deadlines, while keeping costs down and quality up.

A new procedure for requisitioning services was introduced whereby a job sheet is filled out in the Graphic Arts office; personal explanations and instructions can be discussed at that time. This procedure has been working successfully in cutting out much unnecessary time formerly required through the standard requisition procedure.

One major undertaking by the Section consists of the responsibility for the display decor in the central halls of the FWI. The present photo decor has been outdated by the many recent changes in programs in the Region; in addition, there has been some deterioration in the photo material itself. New ideas for layouts, and materials, are being gathered for this greatly needed change.

AREA PERSONNEL OFFICE

The Area Personnel Office was responsible for the planning, coordinating, directing, and administering of a fully decentralized and delegated Personnel Administration Program for the Western Region. The person-year (PY) allocation for the entire region was over 1000, encompassing all of the occupational categories and approximately 60 groups and subgroups. Specializations in the Personnel unit include Staffing and Manpower Planning, Staff Development, Staff

Relations and Compensation, Classification, and Pay and Benefits.

There are three personnel offices located in different geographic locations which administer the Personnel programs effectively in the Region. One office, located in Regina, serves the Inland Waters Directorate employees within the Region. A second office, located in Winnipeg, is responsible for the Atmospheric Environment Service and Water Management Service in the Region. The third office, which is located in Winnipeg at the FWI, handles the various personnel functions for the FMS.

One activity of the FMS Personnel unit includes staffing of all delegated groups within the Region, and assisting the Public Service Commission with staffing of non-delegated positions. Employment counselling is also provided both for employees and for general public enquiries. Personnel courses are offered to managers and supervisors to enhance their personnel management skills. During the period April 1, 1976, to March 31, 1978, approximately 170 indeterminate and 330 term positions were staffed for the FMS Western Region.

The Manpower Planning and Development Program involves training and development of FMS employees. Close liaison occurs among the Personnel Office, the Bureau of Staff Development and Training, and FMS Headquarters to ensure efficient operation of the program for employee training requirements. Identification of yearly training needs takes place and in-house courses are provided as well as BSDT and out-service training programs.

The Classification unit provides classification and organization services, as well as special projects such as winter works. Training sessions on job description writing, point rating, and job evaluation advice are available on a regional level.

Staff Relations activities included providing advice and assistance on all matters involving staff relations such as grievance procedures, collective bargaining, disciplinary and non-disciplinary measures, and the Employee Assistance Program. This service was provided for AES, FMS and IWD.

The Pay and Benefits function is responsible for administering a full pay and employee benefits program within the Region. The Section provides advice, direction, and guidance to personnel regarding Treasury Board policies, regulations and procedures. Information on topics such as Pre-Retirement Planning are provided for Regional DFE employees.

SMALL CRAFT HARBOURS

The freshwater fishermen have, for many years, built and maintained wharves and other fishery structures without financial support from governments. These facilities are now in a state of general disrepair, and the fishermen can no longer provide for their upkeep. As a consequence, Small Craft Harbours, which assumed much of the responsibility for these facilities in recent years, has received many applications

Manitoba District - Manager

M. Heck
C. Barrett
J. Morphy

D. Olson
E. Burke
R. Schindle
T. Stubbington

R. Lewandiwsky
L. Gambrel
C. Creamer

D. Kowal

Saskatchewan District - Manager

P. Nelson
T. E. Walker

J. W. Lovett
C. Oliver

L. A. Yaremko
R. Semchuk
J. Pryznyk

H. A. Nordlund

Alberta District - Manager

G. A. Parrott

E. L. Ball

J. Lloyd

R. Garnett

NWT Management District

Manager

District Biological Advisor

Secretary

Administrative Officer

W. Weselowski

R. V. Grimsrud

Inspection

P. Bobinski

J. K. Hunt

J. K. Hunt

Enforcement

R. Barnes
D. Desjardins

K. Roberts
O. Archibald
J. W. Caudron

W. Ralf
B. Taylor
D. Moshenko

D. Dowler

Research and Resource Services:

Director

Scientific Advisor

Secretary

R. D. Hamilton
J. R. Vallentyne
G. Porth

Fisheries Resources Branch:

Head

Secretary

R. F. Peet
M. Smith

Fishery Management - Head

M. R. Falk
D. V. Gillman
G. Low

L. W. Dahlke
D.K. McGowan
G. Carder

C. Read
A. Kristofferson
J. Hoban

R. W. Moshenko

Arctic Char - Head

E. Gyselman

K. Kroeker

L. Johnson

Percid Population Dynamics - Head

J. Babaluk

K. D. Rows

J. S. Campbell

Biochemical Genetics - Head

D. Tretiak

J. W. Clayton

Fish Pathobiology - Head

B. W. Souter

H. R. Miller
O. Nielson

K. Knight
A. Dwillow

R. K. Kelly

Aquaculture - Head

J. Barica
J. A. Mathias
M. Yurkowski
J. A. Tabachek
M. Foster

J. A. K. Lark
G. Curry
J. Gibson
J. Martin
D. Gerber

R. Olson
M. Papst
R. Hanson
D. Spriggs

G. B. Ayles

Environmental Impact Branch:

Head

Secretary

J. S. Loch
B. Cohen
L. Davenport

Environmental Impact Assessment - Head

C. Katopodis
E. Jessop
S. Davies

B. W. Fallis
K. T. J. Chang-Kue
S. Harbicht

B. G. Sutherland
M. Lawrence
G. A. McKinnon
F. Hnytko

J. N. Stein

Impact Research - Head

B. G. E. de March

G. M. McRae
G. LawsonR. R. Wallace
L. de March

H. E. Welch

Limnology Branch:

Head

Secretary

P. Campbell
C. Anderson

Experimental Limnology - Leader

E. J. Fee
J. A. Shearer
R. Schade
I. J. Davies
D. F. Malley
J. PennyB. W. Hauser
M. P. Stainton
K. H. Mills
T. Ruszczynski
J. Beaty
S. ChalanchukD. L. Findlay
M. J. Capel
J. Prokopowich
G. J. Brunskill
S. E. M. Elliott
D. DeClercq
G. Regehr

D. W. Schindler

Regional Limnology - Leader

K. Patalas
F. P. Healey
A. P. Wiens
K. G. Beaty
S. Ryland
J. DaltonA. Salki
L. L. Hendzel
H. J. Kling
R. A. Bodaly
D. Mense
G. McCullochH. A. Ayles
D. M. Rosenberg
R. W. Newbury
S. J. Guildford
C. Anema
P. S. S. Chang

R. E. Hecky

Toxicology Branch:*

Head

Secretary

J. F. Klaverkamp
G. Decterow

Biological Methodology - Leader

T. J. Hara
B. E. Thompson
J. F. Flannagan
D. A. Metner
B. E. TownsendS. B. Brown
E. Scherer
W. G. Franzin
S. G. Lawrence
S. L. LeonhardJ. Solomon
M. P. McLean
G. A. McFarlane
M. Holoka
M. R. Friesen
A. Furutani

W. L. Lockhart

Chemical Methodology - Leader

R. Wagemann
D. Povoledo
A. Lutz
A. YakimischakN. Grift
D. A. J. Murray
M. Pitze
K. SupeeneK. C. Tam
D. C. G. Muir
R. Hunt

F. A. J. Armstrong

Industrial Toxicology - Leader

W. A. Macdonald
M. A. Giles
W. LillieB. R. Hobden
S. Harrison
R. E. Evans
D. HodginsA. Blouw
H. S. Majewski
H. D. Maciorowski
R. Danell

J. F. Klaverkamp

* 1976-77; organization changed in 1977-78,
but all staff listed above remained in Branch.

Management Services:

Director

S. E. Schick

Financial and Administrative Branch - Head

S. Bubbs

Support Services - Head

H. E. Goshlak

J. Hinkelman
L. MillerB. Macdonell
J. Moar

J. A. Olivier

Financial Services - Head

N. Moran

C. Rybczuk
B. RodgerG. Laing
Y. Fiola

J. P. St. Onge

Materiel Management - Head

R. I. Taite

A. Belanger
C. EcclesB. Conley
M. Blais

W. H. McKay

Technical Branch - Head
Secretary

W. J. Nicholson
O. Pelser

Facilities Management

Fabrication - Supervisor

W. Cox

W. Chisholm

W. Burton

C. Jones

Maintenance - Chief

R. Skaritko

E. Woods

B. van der Veen

M. Zacharkiw

Fish Culture (Wet Lab)

L. Allard

J. Czwarno

A. Rybak

Library and Publications Services - Head

M. Kays

K. E. Marshall

Computer Analysis - Head

D. Abrams

J. Kinash

V. Johnson

D. Costin

Graphic Arts and Photography - Head

C. Royal

L. Taite

S. T. Zettler

Area Personnel Office:

Manager
Secretary

B. Pow
P. Cassidy

Classification - Head

A. Arnold

J. Flynn

Staffing/Training - Head

B. Marchbank

I. Hildebrand

Pay and Benefits - Head

J. Sankew

L. Yana

J. Jutras

C. Watkins

J. Prokopchuk

L. Demyen

Staffing/Staff Relations - Head

S. Swaffer

D. Boehmer

Small Craft Harbours:

Head

C. MacEwen

STAFF PUBLICATIONS - PAPERS

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