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BIENNIAL REPORT - 1978-80,
WESTERN REGION,
DEPARTMENT OF FISHERIES AND OCEANS

Edited by
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This is the 142nd Technical Report
from the Western Region, Winnipeg

EDITOR'S PREAMBLE

This is the third 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 two reports, 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.) 1982. Biennial report - 1978-80, Western Region, Department of Fisheries and Oceans. Can. Tech. Rep. Fish. Aquat. Sci. 1068: vi + 42 p.

This report is a record of the accomplishments of Regional Programs during the period April 1, 1978 to March 31, 1980. It is the second of a series of biennial reports of the Region's activities.

Key words: Freshwater Institute.

LIST OF ACRONYMS

ALUR	Arctic Land Use Research
AOSERP	Alberta Oil Sands Environmental Research Program
ATP	Adenosine triphosphate
BKD	bacterial kidney disease
CAN/OLE	Canadian On-Line Enquiry
CAN/SDI	Canadian Selective Dissemination of Information
CIDA	Canadian International Development Agency
CISTI	Canadian Institute for Scientific and Technical Information
COPE	Committee for Original People's Entitlement
DFO	Department of Fisheries and Oceans
DIAND	Department of Indian Affairs and Northern Development
DOE	Department of the Environment
DPW	Department of Public Works
DREE	Department of Regional Economic Expansion
EARP	Environmental Assessment and Review Process
ELA	Experimental Lakes Area
FAO	Food and Agricultural Organization
FDA	Federal Drug Administration (USA)
FFMC	Freshwater Fish Marketing Corporation
FHB	Fish Habitat Branch
FIS	Fishing and Industry Services
FLIP	Federal Labour Intensive Program
FRB	Fisheries Resources Branch
FSB	Fishing Services Branch
FVAP	Fishing Vessel Assistance Plan
FVIP	Fishing Vessel Insurance Plan
FWI	Freshwater Institute
F/Y	fiscal/year
GNWT	Government of Northwest Territories
IJC	International Joint Commission
ISB	Industry Services Branch
LB	Limnology Branch
LDH	lactate dehydrogenase
LRTAP	Long-Range Transport of Atmospheric Pollutants
MS	Management Services
NTIS	National Technical Information Service
NWT	Northwest Territories
OECD	Organization for Economic Cooperation and Development
OPMS	Operational Performance Measurement Systems
PCB	polychlorinated biphenyls
ppb	parts per billion ($1:10^9$)
ppm	parts per million ($1:10^6$)
PUSH	Purchase and Use of Solar Heating Equipment Program
RAPP	Review and Planning Process
RRS	Research and Resource Services
SCHB	Small Craft Harbours Branch
SCUBA	Self-contained Underwater Breathing Apparatus
SPC	Standard plate counts
TAC	Total allowable catch
UNESCO	United Nations Educational, Scientific and Cultural Organization
USFDA	Food and Drug Administration

DIRECTOR GENERAL'S OFFICE

SUMMARY

Direct Federal Government involvement in the Prairie fisheries began in 1944. For a short history of the period to 1976, see the Biennial Report for 1974-76, Fisheries and Marine Service Technical Report No. 813, 1978. For the period 1976-78, see the Biennial Report for 1976-78, Canadian Technical Report of Fisheries and Aquatic Science No. 1019, 1981.

The present review period, April 1, 1978, to March 31, 1980, was another period of considerable turmoil, owing to the effects of the splitting of the former Department of Fisheries and the Environment into two new Departments, namely, Fisheries and Oceans, and Environment. The new departments were proclaimed on April 2, 1979. Essentially, our Department of Fisheries and Oceans (DFO) comprised the former Fisheries and Marine Service, together with some elements of former departmental management, personnel, computing and applied statistics, and information branches.

During the review period, much departmental reorganization has taken place, with changes in regional reporting relationships and headquarters structure. As a result, much effort was expended by various Western Region staff in planning and reorganizing the Region to fit in with new Departmental goals and mandates. Such work was by no means finished at the end of the review period. Internally, the former Environmental Secretariat attached to the Director-General's Office was absorbed into the Fish Habitat Branch, Research and Resource Services (RSS), on January 1, 1979, when R. J. Paterson, Director of the Secretariat, transferred to DFO Headquarters in Ottawa.

As in the previous review periods, much "extra-curricular" activity was undertaken by Regional staff, such as memberships on committees, task forces, boards, advisors to commissions, membership on Environmental Assessment and Review Panels, etc. As in previous years, the strain of such necessary activities made it difficult to carry out regular duties; load sharing among the staff has been extensive and highly commendable.

Regional problems such as acid rain, nuclear waste disposal, oil and gas exploration in the north, and fisheries and marine mammal management in the Northwest Territories (NWT), continue to occupy the forefront of our priorities. More emphasis is now being placed on the economic aspects of the fisheries, especially the viability of small operations and hobby fish farming.

The following Biennial Report for 1978-80 summarizes Regional accomplishments, together with descriptions and comments on ongoing programs and services.

INFORMATION BRANCH

After a period of four years, the region's information branch was revived in October, 1978. The function of the branch is to plan and implement both the immediate and long-term generation and dissemination of public information to support regional and national personnel, projects, programs and policies of the department.

During its first 18 months of operation the branch satisfied approximately 1 200 telephone inquiries, 400 written and 300 direct personal requests from the general public. It guided more than 1 000 people on tours of the laboratory facilities of the Freshwater Institute. It provided a referral service to more than 200 requests for specific scientific and technical information from other government agencies, universities and fishery workers provincially, nationally and internationally.

It either coordinated or provided assistance, items, and articles to internal and external media. A number of individual interviews were arranged as a result of requests from the media; all were aired or published regionally, and some nationally. The branch initiated and assisted in the production of two half-hour television shows - one on the inland commercial fishery and one on the scientific research of the Western Region.

The branch also established a communications resource file in anticipation of future comprehensive release and display of information to the public.

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 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.

Four members representing four basic scientific disciplines are appointed by senior management. They serve for two years on the Council; to provide continuity, only two members are appointed 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, if necessary, external experts. The Council then drafts its comments. This confidential information is sent only to the scientist concerned, who is invited to meet with the Council to answer questions, and, perhaps, to defend the project. The draft comments may or may not be changed as a result of this consultative process. The final comments are composed and forwarded to regional management. A complete copy of all descriptions of scientific activities 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 merits of the research projects, together with the evaluations of 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, 1978 to March 31, 1980, the PRC handled 86 manuscripts destined for scientific journals. In addition, 93 manuscripts destined for the DFO 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 1978-79 and 1979-80, regarding publication of results of various scientific and technical investigations by Regional Staff.

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 continues to gather economic data and to monitor trends in the commercial fishery of the Western Region and the recreational fisheries of the NWT. In this regard, a transport model has been developed for application in the Freshwater Fish Marketing Corporation's (FFMC) area of operation. The model has application for measuring the least cost flows of fisheries production from lake to market and for assessing investment incentives. In addition, the FSB has developed the capability to analyse 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. The FSB also provides a perspective of the economic requirements for managing public fisheries resources.

Activities in the ISB have been primarily concerned with enforcement of the Fish Inspection Act and Regulations; however, staff have served as the Departmental contacts with fishermen regarding a number of service programs, including 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 were 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 "Golden Caviar" for the industry;
b) Conducting investigations regarding various aspects of fish quality, and
c) Initiating innovative fisheries development projects such as the "Saputit" charr fishery and the Beaufort Sea test fishery.

NWT District management programs are primarily designed to ensure compliance with provisions of the Fisheries Act and the Whale Protection Regulations. The conservation of both the fishery and marine mammal resources in the NWT was achieved through the activities of the District enforcement staff located in Hay River, Yellowknife, Inuvik and Frobisher Bay. 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 as 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

Table 1. Western Region fisheries - landings, landed value and marketed value. (Landings in thousand pounds round equivalent weight - values in thousand dollars)

	1977-78[1]			1978-79[1]		
	Landings	Landed Value[2]	Market Value	Landings	Landed Value[2]	Market Value
Whitefish	16 716	4 632	8 524	16 558	6 763	10 687
Lake trout	1 815	517	1 215	1 216	455	964
Pickerel	10 079	6 702	10 986	8 310	5 862	8 460
Northern pike	8 143	1 034	3 420	8 187	1 638	4 028
Sauger	3 333	1 423	3 066	3 082	1 209	1 505
Inconnu	200	27	60	368	52	148
Arctic char	282	403	549	167	239	284
Others	6 523	521	1 429	7 068	719	2 016
Total	47 091	15 259	29 249	44 956	16 937	28 092

[1] Fiscal period May to April

[2] Landed value includes initial and final payments

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) (Table 1); 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 (Table 2). 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 lead 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 managment 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 public expenditures on fisheries management. From this perspective, the FSB is interested in economic efficiency in the fishing industry and in the public management of fisheries resources.

Table 2. Number of persons employed in Western Region primary fishing operations, 1977-78 and 1978-79.

	1977-78	1978-79
Self-employed	3 255	3 174
Crew	2 153	2 204
Total	5 408	5 378

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

1. The Valuation of Recreational Fisheries. To be published in the August 1980 issue of the Canadian Journal of Fisheries and Aquatic Sciences.
2. Inland and Arctic Fisheries Potential for the 80's. Departmental document concerning investment opportunities for the Western Region.

Fishing Industry Section

The Fishing Industry section provides the capacity to analyze the economic structure and performance of the fishing industry (both commercial and recreational) from an aggregate point of view.

A linear programming transportation model has been developed to examine the efficiency of commercial fisheries distribution in the area of operations of the FFMC. During the review period, the model has been applied to several problems in the Western Region. The problems examined include the continuing debate as to whether increased field processing would be beneficial relative to the highly centralized processing arrangement now in place. Work completed by the Fishing Industry section on Saskatchewan processing alternatives has hopefully contributed to the resolution of this problem. While this study suggested that termination of processing operations at certain sites within Saskatchewan would enhance the performance of the secondary fishing industry, the feasibility of consolidating processing capacity within Saskatchewan was found to be conditional on whether this capacity would complement rather than duplicate existing FFMC capacity at Transcona, Manitoba. This matter is now being evaluated by the FFMC and the Province of Saskatchewan. At the request of the fishing industry, additional work was initiated, such as the evaluation of a proposed reinvestment in packing plant capacity by the Matheson Island Fishermen's Cooperative on Lake Winnipeg. Currently, discussion is under way as to whether or not the Fishing Industry section will participate in the assessment of proposed investments in the Windigo Lake area in Northwestern Ontario.

During the review period, the Fishing Industry section was charged with the responsibility of evaluating the potential investments in harbour capacity in the Western Region. Benefit-cost analysis of the proposed investments was done for the Small Craft Harbours Branch (SCHB), Western Region. The results of the evaluation suggest that, on efficiency grounds, neither the investment program as a whole nor any individual project would be considered economically feasible. Insofar as the rationale for public investment in harbour capacity depends on income redistribution, equity, and regional development concerns, these objectives need to be made more explicit in the future planning for harbour capacity.

Finally, the Fishing Industry section has initiated a review of issues in the recreational fisheries and current techniques in the economics of outdoor recreation. Recreational fisheries are assuming increasing importance in the utilization of the fisheries resources in the Western Region. The need for economic analysis is necessary for a variety of reasons, including the rationalization of resource management budgets, assessments of the incremental benefits and costs of resource enhancement initiatives and the resolution of resource use conflicts between recreation and other competing uses. In this regard, a background paper is being prepared outlining issues and opportunities in the management of the recreational fisheries. The initial focus is the Northwest Territories, but it is hoped this work will be relevant to other jurisdictions within the Western Region.

Fishing Enterprises Section

Whereas the Fishing Industry section is concerned with a macroview of the fishing industry, the Fishing Enterprises section is concerned with a microview. 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 managment by assessing returns to labor 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 labor 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 the development and economic analysis of its database on commercial fishing enterprises in the Western Region. The database contains information on fishing effort, landings, revenues, expenses, net revenues, cash flows and capital equipment for three sampled fishing technologies in use. A draft paper has been prepared detailing the economic viability of the aggregate skiff fishery in Western Canada. On the basis of an analysis of over 400 skiff enterprises of a total population of more than 2 400 enterprises, it is thought that less than 50% earned cash flows sufficient to provide long-run returns to labour and capital. Understanding of the factors contributing to the viability of fisheries is essential in achieving an economically healthy fishing industry. This analysis has been used to provide annual viability estimates for the

Saskatchewan and Manitoba fisheries, as well as to assess public fisheries resource allocation for the Pinehouse Lake fishery.

INDUSTRY SERVICES BRANCH

The ISB enforces mandatory legislative requirements for national inspection programs relating to the certification of domestic and import fish and fish products and the inspection of fishing vessels and processing plants. In addition, the Branch provides developmental, engineering and technological advice and guidance to the primary sector of the industry and administers various national assistance programs such as the Vessel Subsidy and Vessel Insurance programs.

Administration Section

In 1978-79 and 1979-80, this Section provided direction to a staff of 44.0 PY's and 43.0 PY's respectively, including scientific and professional, technical and administrative support personnel in Manitoba, Saskatchewan, Alberta and functional supervision to Industry Services programs in the NWT.

Branch management was continually involved in financial management and resource planning activities and program justification exercises during the review period. Management information systems such as Review and Planning Process (RAPP), Operational Performance Measurement Systems (OPMS) and computerized data systems, such as a national contaminants data retrieval program and regional quality, parasite infestation and contaminants detection programs, were maintained and reviewed on an ongoing basis.

During the review period, Branch management served on various committees, including a Regional Management Committee, Tri-Partite Mercury Committee, Field and Laboratory Activities Coordinating Committee and National Inspection Committee. Staff also liaised with other national and international agencies such as the Department of Consumer and Corporate Affairs, the Health Protection and Medical Services of the Department of National Health and Welfare, the Environmental Protection and Environmental Management Services of the Department of the Environment and the U.S. Food and Drug Administration (USFDA).

Regional Inspection Section

Inspection Chemistry: During the review period the Chemistry group carried out 36 000 analyses for organochlorine pesticide residues, polychlorinated biphenyls (PCB), mercury, selenium, arsenic, a number of heavy metals (lead, copper, cadmium, zinc, etc.), species identification by electrophoresis, proximate composition, sodium chloride, paralytic shellfish poison extractions, histamine, phosphate, trichlorobenzene, and formaldehyde. The majority of the sample types analyzed were fish tissues, although others such as clams, molluscs, marine mammals, bird tissues, and algae were examined. Studies were conducted to establish baseline contaminant data; to ensure that fish being sold commercially was in compliance with established regulations and regulatory guidelines; to assess the safety of fish as food for selected domestic native fisheries, and to determine if there were changes in contaminant levels with time.

In addition to 14 000 mercury analyses completed during the review period, the section was involved in a number of other projects. The Northwest Territories Contaminants Survey was completed with the analysis of an additional 760 samples for eight metals and a number of organochlorine pesticide residues and PCB's. Survey samples from a number of commercially important lakes in the prairie provinces were also analyzed for metals, pesticide residues and PCB's. A total of 239 samples were analyzed electrophoretically for species identification. Salt determinations and paralytic shellfish poison extractions were conducted on a number of fish products to ascertain their compliance with regulation. The laboratory also provided assistance to the Process and Product Development group with the analysis of some 300 samples to determine the effect of length of frozen storage on extractable protein; samples were also analyzed for lipid, moisture, and salt (Table 3).

Assistance was provided to two other groups in the Institute. Metal determinations were conducted on samples submitted by the Fish Habitat Branch (FHB) which is involved in investigations in the Arctic. In addition, a number of samples of rainbow trout were analyzed for moisture, lipid and protein at the request of the Aquaculture Section, Fisheries Resources Branch (FRB), to determine if the nutritive quality of the fish could be improved as a result of genetic selection.

Other federal and provincial departments were also assisted during the review period. The Department of the Environment (DOE), specifically Environmental Management and Environmental Protection Services requested analyses of about 450 samples, primarily for metal determinations related to pollution studies in Saskatchewan, northern Manitoba and the Northwest Territories. Mercury analyses were conducted for Health and Welfare Canada, Medical Services Branch, to determine mercury levels in fish being eaten by a family near Cambridge Bay. Samples were also received from the Saskatchewan Department of Environment from selected areas of the Saskatchewan and Qu'Appelle River systems for metal, pesticide residue and PCB scans. Laboratory work began on a project for the Department of Indian Affairs and Northern Development (DIAND) to determine heavy metals in eastern Arctic ecosystems, namely, in the area of the Nanisivek mine in the NWT. A variety of sample types (fish tissue, molluscs, algae, sea urchins, clams) were analyzed for six metals.

The Mercury Quality Assurance Program was ongoing during the review period. Five sets of canned fish samples were distributed to some 26 participating laboratories in Canada and the United States. In addition, the laboratory participated in six other collaborative studies, thereby enabling us to assess the accuracy and precision of the various analyses we perform.

Table 3. Summary of analyses: April 1, 1978 to March 31, 1980.

Sample Source	Sample Material	ANALYSES																						
		As	Cd	Cr	Cu	Fe	Pb	Mg	Mn	Hg	Met-Hg	Mo	Ni	Se	Sn	Tl	Zn	Pest.	PCB's	Salt	EP[1]	Pr.An.[2]	PSP	Hist.[3]	Form.[4]
Commercial Inspections	Fresh, frozen fish and fish products		3				3			5196										24	152		15	2	1
Survey Samples	Frozen fish tissue	852	852	852	852		852			9911	70			892	3		852	961	961						
Product Development Station	Fish tissue																			21		328			
Fish Habitat Branch	Marine mammal tissue	39	39	39	39		39			39	39	39	39				35								
	Molluscs	39	39		39	39	39			39							39								
Aquaculture Section	Fish tissue																					258			
DOE Environmental Protection	Clam, fish and crayfish tissue	477	477	477	477	477	477	411	477	517			411	477			477	215	223						
DOE Environmental Protection	Fish tissue	23	23	23	111	88	23			111				23		23	111								
National Health and Welfare	Marine mammal tissue									18	18														
Ontario Ministry of National Resources	Fish tissue																				114				
Sask. Dep. of Environment	Fish tissue	150		150	150		150			150			150	150			150	150	150						
Sask. Power Corporation	Fish tissue									69															
DIAND	Molluscs	100	100				100			100				100			100								

[1]EP = Electrophoresis [2]Pr.An. = Proximate Analyses [3]Hist. = Histamine [4]Form. = Formaldehyde

Table 4. - Bacteriological analyses, Western Region, 1978 and 1979 (domestic and import products).

Laboratory	SPC's	Coliforms	Faecal Coliforms	E.coli	Staphylococci	Sterility	Salmonellae	Swabs	Others	Total
Edmonton	844	153	1 566	228	213	97	-	-	6	3 107
Hay River	264	524	249	11	-	-	-	90	-	1 138
Prince Albert	232	534	389	30	-	-	-	-	18	1 203
Manitoba	893	353	2 206	365	441	480	-	262	209	5 209
Regional Headquarters	35	-	202	175	54	-	61	110	-	637
TOTAL	2 268	1 564	4 612	809	708	577	61	462	233	11 294

These studies were conducted by the International Atomic Energy Agency, Canada Centre for Inland Waters, Federal Interdepartmental Committee on Pesticides, and the Vancouver Inspection Laboratory.

Technical assistance was provided to Ontario Ministry of Agriculture, Beak Consultants in Toronto, and the Vancouver Fish Inspection Laboratory related to difficulties with analyses for a number of metals.

The Chemistry group developed the capability to analyze for methyl mercury, trichlorobenzene, histamine, Allura Red (a prohibited food color), and formaldehyde. A new procedure was adopted for selenium and arsenic, permitting the analysis of both elements from one sample digest in half the time required for the old procedures. Developmental work was conducted on the methyl mercury procedure in an attempt to replace the gas chromatographic portion of the analysis with atomic absorption, thereby making the procedure more rapid and rugged. Also, some time was spent investigating combined digestions for arsenic, selenium and mercury.

The Chemistry group hosted an Interservice Chemists Workshop on Mercury at the Institute in April of 1979. In addition, staff attended a number of meetings during the review period: the International Conference on Hydrocarbons and Chlorinated Hydrocarbons; the Chemical Institute of Canada Meeting; the Annual Meeting of the Spectroscopy Society; the Annual Meeting of the Association of Official Analytical Chemists, and an Analytical Chemists Meeting on Quality Assurance.

Inspection Microbiology: During the review period, Regional field laboratories in Manitoba, Saskatchewan, Alberta and the Northwest Territories carried out 11 294 routine microbiological analyses of representative samples from approximately 40 million pounds of domestic and imported fish and fish products (Table 4).

Three 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 and uniformity in analytical microbiological techniques. Under the quality assurance program a variety of bacteriological media were tested for performance. Other aspects of the quality assurance program were also investigated. The Regional laboratory also received and analysed an international quality assurance sample in 1978 and again in 1979 - prepared by USFDA, Cincinnati, Ohio, U.S.A.

The Regional laboratory completed a comparison study between membrane filtration versus the most probable number tube methodology for enumerating total and/or fecal coliforms in water/ice samples. In addition, studies were completed on data interpretation for Standard Plate counts (SPC) on imported shrimp products with the result that SPC analyses are no longer required on imported products except for molluscs and crustaceans. A contract project was completed with the University of Manitoba to determine the incidence of Clostridium botulinum in smoked freshwater products and a rapid identification technique was completed during the review period which would significantly reduce the time required for faecal coliform confirmation. The new technique was submitted to Ottawa for their review and possible inclusion in the National Standard Methods manual.

Product Services: Regional Product Services programs were designed to coordinate and monitor district inspection activities to ensure that inter-provincial, export and import trade shipments comply with applicable requirements of the Fish Inspection, Food and Drug, and Consumer Packaging and Labelling Acts and Regulations.

Data were processed and analyzed by computer to evaluate the efficiency and accuracy of inspections, to ensure problem areas were controlled and to ensure policies and programs were being enforced consistently.

A Lake Classification and Inspection Procedures Manual was revised (annually) to concentrate inspection and sampling activity on problem areas, particularly for the whitefish infestation inspection and mercury control programs. The manual also contains standard procedures to be employed in the sampling and inspection of freshwater fish.

In addition to coordinating and monitoring inspection activities, information regarding equipment problems with imported or inter-regional shipments was relayed to Ottawa or other Regions. Inspection results from the whitefish and mercury control programs were summarized in appropriate formats and routinely forwarded to provincial and FFMC authorities to facilitate the operation and management of commercial fisheries in Ontario, NWT and the prairie provinces.

Special projects carried out in 1978-79 and 1979-80 to ensure the effectiveness of product inspection activities included: a contaminants survey in the NWT; a mercury surveillence program resulting in a published data report for the South Indian and Rat River area affected by the flooding program resulting from diversion of the Churchill River to the Nelson River to create hydro-electric energy; a quality survey of fisheries products from retail outlets in Winnipeg and Edmonton, and a grade standards pilot project to assess applicability of proposed freshwater fish grade standards.

Plant Services: Regional Plant Services programs were designed to coordinate and monitor district plant inspection activities to ensure that the plant inspection and certification program was being uniformly enforced under the Fish Inspection Act and Regulations and that fish were being processed under good manufacturing practices in sanitary establishments.

A Plant Inspection Procedures Manual was developed during the review period to be used to classify plants and cold storages and to provide advice and guidance to District staff in carrying out their plant inspection activities.

Technical expertise and information was provided to industry, provincial and other federal agencies on improving plant processing facilities and interpretation of existing and proposed legislation dealing with fish processing establishments.

Team surveys consisting of regional and district personnel were maintained, resulting in a uniform approach to certification requirements. In 1978-79, 15 such surveys were completed in Manitoba. In 1979-80, 24 surveys were completed, nine in Manitoba, 10 in Saskatchewan, and five in the NWT. Three new Certificates of Registration were issued.

Forty-eight registered processing establishments were allowed to export their products during the review period.

Fisheries Development Section

Process and Product Development: This group conducted development projects and activities in support of the commercial fishing industry through technology transfer, consumer education, public relations and interdepartmental research.

The development of whitefish roe production and processing in the Western Region inland fishery has led to the foundation of a roe processing industry, substantially increasing the returns to the producer fisherman. The increase in 1979 amounted to approximately 34% to the incomes of participating whitefish fishermen. Apart from direct supervision of this operation by project staff, the work included the development of improved processing equipment to upgrade efficiency and product quality, and the training of industry personnel to support an operational expansion, resulting in the production of 12 metric tonnes of product.

This group also established specifications and supervised the commercial processing of a pasteurized whitefish roe caviar product introduced to the North American market in 1979.

Development of various products from the roe of several freshwater species other than whitefish was also undertaken during the review period.

Assistance and guidance were provided to a commercial fishermen's organization in product and process development, processing equipment specificaton, processing plant design, analysis of end-of-line product costs and supervision of pilot plant processing of products from underutilized freshwater fish for market testing.

Other support of the commercial sector through technology transfer included:

> Product and process development at the request of the NWT government for the development of a smoked Arctic charr lox-type product to be processed at Rankin Inlet, NWT, and the supervision of processing for test marketing purposes. This product is designed to compete in the cold-smoked salmon fillet market.
>
> Technical assistance and guidance requested by the FFMC consisted of the development of formulations for a frozen minced fish consumer product; the application of chemical and sensory testing procedures to identify flavor problems in a minced fish kosher product; processing and supply of samples of "surimi", and intermediate minced fish product for the further manufacture of Japanese kamaboko sausage and a canned whitefish product for buyer appraisal; recipe development in both official languages for a variety of FFMC products; and the processing and supervision of commercial processing of various roe product samples, provision of technical advice, and participation in discussions with buyers to assist in the introduction and development of markets for FFMC products.

Studies initiated during the review period included the preliminary evaluation of a chemical test to assess rancidity in stored salt-cured whitefish eggs; the preparation and analysis of laboratory samples of liquified fish waste as a potential plant fertilizer; and the preparation and preliminary assessment of the quality of test samples of "surimi" processed from whitefish infested with Triaenophorus crassus.

Consumer education and public relations included: participation in National Fish and Seafood month media receptions in Winnipeg, Yellowknife, Calgary and Regina; preparation of species-specific informational material for media release; seminars to a fisheries technologists' organization, and university food science department and a foods and nutrition department on roe processing techniques and various aspects of fish processing and nutrition, and responses to over 100 consumer requests for information relating to fish handling and preparation concerns.

Assistance was provided to the aquaculture group of the FRB in supervising field and laboratory sensory analysis of various quality characteristics of extensively and intensively cultured fish.

Freezing Processes and Equipment Design: A technique was developed for fabricating simulated fish for use in measuring freezing rates in a prototype high velocity blast freezer. The prototype freezer was designed to obtain fundamental information on freezing rates and heat transfer properties in various types of fish products. The method consisted of filling various sized polyethylene tubes with a specially formulated artificial freezing substance, using a sausage stuffing machine. The freezing substance consisted of 77% water, 23% methylethyl cellulose, and a trace of preservative. The physical and chemical properties of this mixture closely approximate those of actual fish flesh so that almost identical freezing curves can be obtained. The advantage of the artificial fish was repeated use without change of properties, thus permitting more accurate evaluation of different freezing regimes and procedures.

Work continued on a water reuse system which will be used for holding fish for research purposes, including toxicity studies, where clean water is required to be provided and a continuous flow-through system would be much more expensive to maintain. The first test used 40 mm plastic bio-rings and was operated in the Freshwater Institute wet lab. A six foot circular tank was stocked with 90 g fish and the make-up water rate set at 4.5 to 6.0 $L.m^{-1}$. Fish grew well, water quality was excellent and chemical tests satisfactory over the 23-week experiment. The second test used three 6.5' square tanks with three different media: 40 mm plastic bio-rings, 1/2" ceramic beryl saddles and 5/8" Raschig rings. All three systems were set up at the Rockwood Hatchery, and stocked with 1.8 g fish. Make-up water rate was set at 3.0 $L.m^{-1}$. Fish grew well - average weight 65.7 g after 24-weeks - water and chemistry quality was not as good but improved after flow pattern and backwash regimes were redesigned. The polypropylene bio-rings proved to be the best media; the ceramic types plugged up quickly and required frequent backwashing.

An alternate design of an automated 30" lift-gate mechanism was developed using a hydraulic system instead of a mechanical worm gear train. The lift-gate mechanism project was designed to be used by the Province of Manitoba in the walleye enhancement program in small pothole rearing lakes. The system uses an automatic programmable lift-gate mechanism which ensures pre-arranged release of walleye stock during periods of low water levels. Benefits include conservation of water outflow during periods of low water levels, and, because a manual system is no longer required, a significant decrease in manpower. The new design was much more rugged and compact and incorporated a digital clock to trigger the raising and lowering of the gate. The new unit will be installed at Arpin Lake at the north end of Lake Winnipegosis.

A design was developed for a small scale portable continuous air blast freezer capable of freezing 800 lb of fish fillets/h. All major components were specified for a prototype freezer to be used in remote locations. This project will progress to completion within the next two years.

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 also 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.

Administration of Phase II of the Federal Labour Intensive Program (FLIP) resulted in the expenditure of $235 000 and produced 223 person-months of work. Administration of the Ice Harvest program resulted in harvesting 21 123 tons of ice and expenditure of $252 000. The Fish Chilling Assistance program continued with grants totalling $57 402.64. A five-year monitoring program was continued for new and previous grant installations.

An in-depth report was completed on the feasibility of a fish cannery proposal in the Hay River plant in the Northwest Territories.

A three-year test schedule to assess the physical and economic feasibility of a prototype mobile fish plant was completed in 1980.

A prototype aluminum vessel for use in the small skiff fishery completed its demonstration schedule in the Western Region with a final trip to the Northwest Territories. The vessel incorporated the features required under the voluntary inspection programs.

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

Table 5. Fishing Vessel Insurance Plan.

F/Y	Prov.	No. of Policies	Insr. Value	Prem.	No. of Claims	Amt. Paid
1978-79	Man.	492	2 572 187	35 402	23	18 334
	Sask.	49	169 620	2 636	1	930
	Alta	30	83 550	1 363	-	-
	N.W.T.	45	744 105	9 954	4	14 284
		616	3 569 462	49 355	28	33 548
1979-80	Man.	598	3 083 036	41 960	50	28 037
	Sask.	48	155 135	2 580	-	-
	Alta	30	103 378	1 782	-	-
	N.W.T.	44	767 735	9 349	4	1 744
		720	4 109 284	55 671	54	29 781

A continuing project to demonstrate the feasibility of and to determine the techniques necessary for harvesting, processing, and marketing whitefish roe was conducted. The Section endeavored to obtain extensive participation from the fishing industry for this project.

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 flavors often present in trout reared in small lakes.

A project to design and construct gear necessary to help automate the winter fishery was undertaken. A ski-mounted aluminum shed complete with a hydraulically operated net hauling drum and a ski-mounted aluminum insulated fish holding shed were constructed and tested. The following year, an improved duplicate set of equipment was built. The basic objectives of the project are to increase efficiency, enhance working conditions, and improve product quality.

A project to develop and demonstrate a method to utilize offal from fish heading and gutting operations for the production of concentrated fish fertilizer was undertaken. The component layout and a general specification list of equipment has been completed.

A project entitled "Saputit (Fish Weir) Charr Fishing" was initiated in the Northwest Territories. The objective was to enhance the economic viability of the anadromous Arctic charr fisheries in that area by using a fish weir form of exploitation for harvesting this species as opposed to the netting techniques now in use. This project will continue in the future.

Regional Vessel Programs Section

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.

Table 6. Fishing Vessel Assistance Plan.

F/Y	1978-79		1979-80	
Prov.	No. Approved	Amt Paid	No. Approved	Amt Paid
Man.	147	284 126	117	139 814.53
Sask.	29	30 867	6	14 190.40
Alta	9	11 930	6	7 675.85
N.W.T.	3	24 829	1	4 468.52
	188	351 752	130	166 149.30

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 and improved lifesaving equipment and navigational aids at the primary commercial fisherman level.

The Vessel Certification Program involved an ongoing vessel inspection program to upgrade construction and operating procedures aimed at ensuring that fish are stored and handled in such a way that there is a minimum loss of quality.

Tables 5 and 6 provide statistics for the review period.

NORTHWEST TERRITORIES MANAGEMENT DISTRICT

The NWT District Office represents the Department of Fisheries and Oceans in the Northwest Territories and, together with assistance from the regional headquarters office, provides all services within the responsibilities of the Department to the public. The three main functions of the office are: conservation and protection (enforcement), inspection, and environment protection.

During the review period, several regulations under the Fisheries Act (beluga,

narwhal and walrus) were amended in response to the increase hunting pressure on marine mammals. A subdistrict office in Frobisher Bay was established and a new Rankin Inlet office was proposed to enhance our capability to protect the marine mammals and other responsibilities under the Act.

This period also saw the fishermen's proposal to restrict entry to Great Slave Lake commercial fishing. A two-year moratorium was being planned to enable the Department, in conjunction with the Great Slave Lake advisory committee, to work out the proper policies and regulations to control the total fishing effort on Great Slave Lake.

RESEARCH AND RESOURCE SERVICES

DIRECTOR'S SUMMARY

While the productivity of Research and Resource Services (RRS) was high by any standard, it is difficult to select highlights from an operation as diverse as that of RRS and the reader's attention is directed to the body of this report.

The directorate continued in its pursuit of scientific excellence but became more involved in research planning than in previous years. This planning process, together with a redirection of internal resources, lead to reassessment of some regional priorities and areas of activity.

1. Garrison Diversion - Staff participated in several U.S./Canada talks, and kept officials in the Department of External Affairs current with developments. The plan prepared for the International Joint Commission (IJC) was reviewed by regional scientists.
2. AOSERP - Participation in the Alberta Oil Sands Environmental Research Program (AOSERP) ended after three years. Some very valuable short-term habitat assessment was completed during this time.
3. Arctic Research - The directorate's research program in the Arctic was expanded slightly during this period. Studies were continued in fish and habitat management, and the first phase - five years - of a major research project on Arctic charr was completed. A habitat monitoring and assessment study of the Mackenzie Delta/Beaufort Sea area was initiated. Increased activity in the Arctic is expected for the future.
4. Inland Fisheries Enhancement - Informal negotiations were begun with the three prairie provinces, particularly Manitoba, with regard to enhancing recreational and commercial fisheries.
5. Acid Rain - The region continued its work at the Experimental Lakes Area on the effect of acid rain on aquatic ecosystems. Lakes are being experimentally acidified at rates which allows comprehensive studies of pH on early species changes, heavy metal releases from lake sediments, increases in sulfate reduction, changes in the physiology and reproduction of organisms and various other factors. Future negotiations between the United States and Canada on transboundary air pollution will be delicate and require sound scientific information.
6. Toxic Chemicals - Efforts continued into determining how toxic chemicals affect aquatic organisms. Several reports and papers were published but perhaps a better measure of the expertise within the region and the need for toxicological information is the number of inquiries from industry, government and other national and international agencies for formal and informal advice.
7. Fish Habitat - The program in the Northwest Territories was expanded by redirecting internal resources and using external resources at the disposal of the region. Industrial developments at the Nanisivik mine and in other areas of the Arctic received attention. Fisheries habitat in the Arctic is being threatened by major industrial developments, largely hydrocarbon exploration and development related, and if present plans are pursued, the pressures on the resource will be significant throughout the Arctic.

FISHERIES RESOURCES BRANCH

The objectives of this Branch are to develop management strategies for the exploitation of north temperate fishes (freshwater and marine) and marine mammal populations in the Canadian Arctic, and to develop operational procedures for commercial fish culture in Canadian fresh waters. To achieve these goals, the Branch is organized into a number of sections which carry out activities in support of the Region's management responsibility for fish and marine mammals in the Northwest Territories, and the national program for fish health. In addition, the research activities of the Branch are important to provincial governments within the Region who receive the benefit of the results to support their delegated management authority and to enhance fish production from the various aquaculture experimental and cropping experiments.

Fish and Marine Mammal Management Section

This section is responsible for the development, implementation, maintenance and assessment of management programs designed to control exploitation (for subsistence, commercial and recreational purposes) of the fish and marine mammal resources of the Northwest Territories and adjacent waters including Hudson and James Bays. Controls are effected under the Authority of the Fisheries Act, Section 34, and are embodied in various regulations such as the Northwest Territories Fishery Regulations and the Beluga, Narwhal, Seal and Walrus Protection Regulations. The general objective of the management program is to ensure that these resources are exploited to derive a maximum long-term

benefit for residents of the NWT in particular and Canadians in general.

The section's activities include field studies of an inventory, assessment and monitoring nature. Information from these studies culminates in the formulation, recommendation (to Regional Directors/Director-General) and implementation of management controls (commercial quotas, catch possession limits etc.) for the exploitation, conservation and protection of the fish and marine mammal resources. On setting these controls close liasion is maintained with the DFO-NWT District Enforcement Section. Also considerable time is spent communicating and consulting with the Government of the NWT (GNWT) and resource users such as local fishermen and their associations, hunters and trappers associations, settlement councils, sport-fishing lodge owners, tourism associations and local fish and game associations.

Activities during 1978-80 included:

1. Experimental Management, Great Slave Lake Commercial Fishery - Efforts were directed towards measuring the effects of the reduced gillnet mesh size on lake whitefish, the major exploited species. Also harvest data from the subsistence fishery, together with the catch/effort and cullage data from the commercial fishery, will be used as a basis for a management program based on a "total allowable catch" (TAC). Preliminary results from the migration (tagging) and biochemical genetics studies indicate that different stocks may exist in Great Slave Lake and TAC's will have to be based on this biological information.
2. Lake Trout Sport Fishery - As a result of several years of monitoring the sports catch, the lake trout stocks in Great Bear and Great Slave (east arm only) lakes will be managed on a trophy basis. It is hoped that reduced catch possession limits will sustain this unique sports fishery based on large, slow growing trout.
3. Central Arctic - Arctic charr Commercial Fisheries - Assessment studies on anadromous populations were carried out in the Wellington Bay (Cambridge Bay) area and the commercial fishery was closely monitored. In addition, a survey of charr runs to assess the potential for further fisheries development in the Gjoa Haven - Pelly Bay area was completed. The survey was a joint DFO-GNWT effort funded through the General Development agreement of Department of Regional Economic Expansion (DREE).
4. Monitoring of Small-Scale Sport and Commercial fisheries was carried out on a rotational basis at various sites within the inland and coastal areas of the NWT including walleye at Hay River, grayling at Kakisa River, and Arctic charr at Paulatuk, Tree River, Robertson River, and Rankin Inlet. Information gathered is used to set or modify quotas and catch limits which are reviewed annually.
5. Marine Mammal Studies - Studies of beluga and bowhead whales in the Mackenzie Delta/Beaufort Sea area were completed through contract and the results published. In addition, subsistence beluga hunts in the Mackenzie Delta and Cumberland Sound areas, and narwhal hunts at Pond Inlet and Arctic Bay were monitored through a combined effort of government, industry (eg. Petro Canada), consultants and local people. Results show a high rate of loss of killed animals because of "sinking". To overcome this problem, a different harpoon technology was field tested.

Besides field activities section staff were involved in various native claim negotiations such as the Committee for Original People's Entitlement (COPE) land claims and the Inuit Tapirisat of Canada Nunavut proposal.

Fish and Marine Mammal Research Section

Since the last Biennial Report, the Arctic charr, Percid Experimental Management and Biochemical Genetics Research groups have been amalgamated into a single section for reporting purposes. It is anticipated that with new resources an additional group dedicated to research into the biology and population dynamics of marine mammals in the Canadian Arctic in support of the Fish and Marine Mammal Management Section will also be included. The activities of this Section over the review period are described under the three project titles which follow.

Resource Ecology and Energy Flow Project: This group has been working primarily on Arctic charr in the central Canadian arctic. A research facility was established in 1974 at Nauyuk Lake on the Kent Peninsula, approximately 120 km west-southwest of Cambridge Bay, where a study of both anadromous and landlocked populations was initiated. The objectives of the study have been to obtain information on the population dynamics and life history of Arctic charr so that better management strategy may be planned. In addition, studies involving population manipulation within landlocked lakes has led to a much better understanding of energy flow within arctic lakes in particular and freshwater systems in general.

Some of the findings that influence the management of Arctic charr stocks are:

1. Many anadromous stocks are not discrete and a great deal of mixing occurs during the brief summer feeding season in the sea;
2. Homing is much less precise than originally thought. In some cases as little as 60% of the individuals that leave a freshwater system in the spring, return to that system in the fall;

3. Charr will frequently migrate great distances while at sea. Tagged individuals are often caught 100 - 150 km from where they were tagged and returns from as far away as 250 km have been recorded, and
4. Recruitment of juveniles to the adult population has been found to be sporadic. Smoltification can occur anywhere from 4 to 8 years of age and appears to be at least partially dependent on climatic conditions.

The studies that have been conducted on landlocked populations have led to the formulation of a new concept of how energy moves through aquatic systems. Further field work in this area is still under way but preliminary indications are that the theory may have major implications in the way fisheries biology is approached in the future.

At present the results from the Arctic charr investigation are being assembled for publication as a bulletin and should be completed within two years.

The Resource Ecology and Energy Flow group has also taken over responsibility for the Experimental Cropping of Lakes investigation that has started in 1971. Four lakes located 35 km north of Yellowknife in the Northwest Territories are being monitored to determine the effects of an experimental exploitation of lake whitefish and lake trout that took place in 1973-74. Each of three of the lakes was harvested at a different intensity and one was held as a control. The initial results of the experiment have been published by Dr M.C. Healey (Pacific Biological Station, Nanaimo) and show that lake whitefish respond to exploitation with an increase in growth rate and perhaps also an increase in fecundity. The present monitoring is to determine the long term effects of the cropping.

Experimental Resource Management Project: The objective of this group is to assist in developing and/or refining fisheries management strategies through experimentation which will allow for the rational utilization of fisheries resources in inland waters. An experimental and manipulative approach was developed to provide information which will assist in defining the limits and characteristics of biological compensation in fish stocks which are undergoing exploitation stress due to commercial and/or recreational fisheries. Controlled selective harvesting experiments were initiated in 1979 and continued in 1980 whereby unexploited walleye stocks in three small lakes (100-300 ha) in northern Manitoba were cropped at the rate of 50, 25 and 10% of their estimated biomass. Three other lakes were allowed to remain relatively untouched so that a control could be maintained to allow for annual environmental variation. Northern pike, lake whitefish, yellow perch and white suckers were harvested as well, and information collected on all species in the fish community will improve the understanding or interrelations among them.

During the actual cropping program 13.3, 6.7 and 4.0 kg/ha of fish were removed each year from Wapun, Home and Demarch lakes respectively, of which 3.4, 1.6 and 1.4 kg/ha were walleye. Evidence already exists that some of the components in the most heavily exploited fish community are responding to the imposed perturbation, namely:

- a substantial decline in the strengths of recent walleye year classes;
- an increased abundance of forage species (i.e. yellow perch, trout-perch, white sucker), and
- an increase in seasonal growth rate of younger walleye.

Some other activities which were undertaken during the review period include:

1. Aging techniques using bony structures of walleye in the Heming Lake study area have been validated, using both previously aged and released walleye, and those injected in 1978 with tetracycline;
2. The recovery of whitefish stocks in Heming Lake is being monitored following a heavy exploitation program between 1950 and 1960. Of special interest is the quality (export grade) of the whitefish, when historically the stocks showed high levels of infestation with the parasite Triaenophorus crassus;
3. Studies evaluating the fish communities and the parasitofauna of each species were initiated using lakes in the Heming Lake area. This work is proceeding with the cooperation of the University of Manitoba Faculty of Graduate Studies, and
4. Work on the development and initiation of a major Federal/Provincial program leading to the eventual enhancement of selected walleye and whitefish stocks in inland lakes is continuing with the cooperation of personnel in the Aquaculture Section.

Resource Assessment and Biosystematics Project: The objectives of this group are to maintain familiarity with current population genetics research with emphasis on the molecular and biochemical aspects of population genetics and to assist in the transfer of new ideas and techniques from this field to other Sections of the Branch. These objectives are achieved by a combination of active study and communication, as well as by the conduct of appropriate research investigation designed to illustrate the application of current population genetics practice and thought to fisheries management situations.

Some highlights from the review period include:

1. White muscle lactate dehydrogenase (LDH) variants in lake whitefish, rainbow trout, brook trout and chum salmon have been characterized and the material was presented at the 1978 Isozyme Conference, December 1978. Subsequently, these data were organized into a manuscript which has been accepted

for publication by Biochemical Genetics. Fundamental studies of this sort continue to be necessary to provide a firm molecular and biological basis for our population genetics work.

2. An investigation of a cell culture derived from walleye, conducted in collaboration with the Fish Pathobiology Program, showed that these cells could be distinguished from other fish cells in culture by isozyme methods. These data have been published in Canadian Journal of Fisheries and Aquatic Science.
3. Samples of lake whitefish were collected from Great Slave Lake for the purpose of investigating the population structure of this important, commercially exploited stock. Some preliminary analyses have also been completed. This project represents a collaborative effort with the Fish and Marine Mammal Management Division.
4. A graduate student at the University of Manitoba successfully completed a M.Sc. thesis under the supervision of the program head. The results of this investigation provide evidence for the isolation of lake whitefish in a Nahanni glacial refuge, distinct from the other better-known Bering and Missouri-Mississippi glacial refuges. These results suggest that disruption and rearrangement of existing barriers to fish migration such as now exist in the Nahanni and Liard River regions should be viewed with some concern for the continued survival of these fish stocks.
5. A cooperative investigation with the Manitoba Department of Natural Resources revealed that large sauger from the north basin of Lake Winnipeg were, in fact, sauger according to their isozyme phenotype, and not walleye-sauger hybrid fishes, as their large size had suggested. Further investigation also revealed that these comparatively large sauger were, on average, much older than the smaller fishes characteristic of the heavily exploited sauger stock of the south basin of Lake Winnipeg. These results have been published in a Manitoba Department of Natural Resources Research Report.

Fish Pathobiology Section

The objectives of this section are to investigate the etiology and epidemiology of infectious diseases of fish and to provide diagnostic pathology services under the provisions of the Federal Fish Health Protection Regulations. During the review period hatcheries were certified in Ontario, Manitoba, Saskatchewan, and Alberta and in addition fish kills in the Beaufort Sea and elsewhere in the NWT were investigated. The thorough diagnostic examination of an isolated population of Arctic charr at Nauyuk Lake in the NWT enabled scientists to select a disease-free stock for use in aquaculture programs. In cooperation with Provincial Fisheries Departments, a preliminary environmental survey was conducted to determine the incidence of bacterial kidney disease (BKD) in wild and stocked salmonids in western Canada.

Working in cooperation with fisheries personnel in Ontario and Saskatchewan, section personnel investigated infectious diseases of walleye. A new herpes virus was isolated from this species and the preliminary biological characterization of the agent was completed.

Tagging studies at Wapun Lake in Manitoba established that dermal sarcoma is unlikely to be a significant cause of mortality in adult walleye in the wild. In cooperation with other investigators, a detailed survey was conducted on the epizootic distribution of skin tumors in walleye in western Canada. The information from this survey is important for the future evaluation of comparative studies concerned with environmental carcinogenesis.

Laboratory studies were initiated to determine the immunogenicity of inactivated preparations of infectious hematopoietic necrosis virus in rainbow trout. Methods of enhancing the production of neutralizing antibodies are currently under investigation.

Aquaculture Section

The objective of this section is to investigate, improve and develop methods which will result in increased fish production in central Canada from both commercial and private fish farms. The pathways investigated include fish biology, fish nutrition, pilot-scale production, water chemistry, invertebrate biology and computer modeling. Several project staff are involved in preparing "extension" material (pamphlets, etc.) and delivering presentations.

For the review period, the major efforts of the Section were aimed at habitat manipulation and control, and fish nutrition. Investigation of the utilization of waste heat in northern climates was a prominant activity as was the setup and operation of a pilot-scale fish production facility. The activities carried forward during or in this period included: 1) provision of fish culture information to fish farmers, both private and commercial; 2) training and education of fisheries students from China, Turkey, Thailand and the University of Manitoba; 3) cooperative students with other government and industry groups, and 4) acquisition of two disease-free stocks of Arctic charr from remote northern river systems.

Approximately 4 000 farmers are involved in extensive trout culture in the Canadian prairies. Their distribution ranges from southeast Manitoba to the Peace River district in British Columbia. Experimental studies on this type of culture were carried out at Rockwood Experimental Hatchery and at the Erickson Field Station. Accomplishments in extensive culture included:

1. Impact of pre-release caging of fish on growth and survival, as well as advantage conferred by early feeding during this pre-release period;
2. Completion of major phases of extensive fish culture, and preparation of short pamphlets on specific aspects of fish farming;
3. Development and publication of a model to evaluate and predict the oxygen regime in lakes in both summer and winter;

4. Studies on predator displacement using crop depredation control devices;
5. In situ field strength measurements of an array of voltage/pulse combinations for the high salinity conditions in the prairie lakes to assess the potential for electrofishing at harvest, and
6. Publication of a system to help predict fish yield based on water chemistry variables.

Investigations into intensive culture were carried out at Rockwood Experimental Hatchery and at the Freshwater Institute. These included:

1. Setup of Canada's first pilot-scale fish production system based on the utilization of low-grade (solar) heat;
2. The evaluation of rainbow trout, Arctic charr and brook charr species for intensive production-scale culture;
3. Evaluation of taste effects of rearing rainbow trout on feed manufactured from domestic grains;
4. Development of a mathematical model predicting fish growth in tanks and outdoor ponds;
5. Investigations into the harvest and utilization of freshwater shrimp (Gammarus lacustris) as a fish food for intensive culture systems;
6. Evaluation of the feasibility of fish farming in the vicinity of Hay River, Northwest Territories, and
7. An evaluation of the suitability of the giant freshwater prawn (Macrobrachium rosenbergii) for fish culture, and a summary of all published information on its culture.

In addition a five-day course on intensive and extensive fish culture is being developed for delivery early in 1981.

FISH HABITAT BRANCH

Activities of the Fish Habitat Branch were carried out by a multi-disciplinary, permanent staff of 19 in 1978-79 and of 21 in 1979-80. The Branch now contains two main sections, the Resource Impact Section and the Fish Habitat Research Section; the Alberta Oil Sands Environmental Research Project terminated at the end of 1978-79 although the writing of reports continued. In 1979, two biologists joined the branch from the Region's disbanded Environmental Secretariat.

The objectives and strategies of the Branch are:

a) to ensure the protection of fish resources and habitat from man-made disturbances by performing resource inventories and reviews of impact assessments filed by industrial proponents, and by stipulating biological requirements for said protection, and
b) to obtain predictive impact data on the likely effects of industrial developments on arctic aquatic ecosystems by conducting short and medium-term research at an arctic based field camp.

Although the Western Region consists of the Prairie Provinces and the NWT, most activities were directed at the NWT with the notable exception of Garrison Diversion.

Resource Impact Section

Staff of the Resource Impact section, and of the Branch Chief, represented Western Region in 1978-79 and 1979-80 on several committees to provide advice on the effects of industrial developments on fish and fish habitat. These committees included the Regional Dredging, Hydrocarbon, Hydropower and Transportation Committees, the Interdepartmental Dredging Committee, the DOE Mackenzie Basin Committee, the Slave Delta Task Force, Qu'Appelle Advisory Committee, the Federal Fisheries Management Task Force on Fish Screening, the DOE/DFO Garrison Committee, and the IJC Poplar River Biology Committee. In addition, in 1979-80 staff served on the Regional Screening and Coordinating Committee, the Regional Mining Committee, the Working Group for the Lancaster Sound Regional Study, and the Beaufort Sea Production Environmental Advisory Committee.

1978-79: Reviews were conducted on the environmental impact statements for the South Davis Strait and Lancaster Sound drilling projects, and the Banff Highway Twinning and the Mackenzie River Dredging projects; all these were panel projects under the Federal Environmental Assessment and Review Process (EARP). Staff participated at the public hearings for the first three projects. Other major reviews were of the proposed Slave River hydroelectric scheme and of several proposed dredging operations.

Designs for the Liard Highway continued to be reviewed, and some agreement was reached with DIAND and Department of Public Works (DPW) on appropriate stream crossing design criteria. Designs for several reaches of the Qu'Appelle River were completed, and a temporary fishway was constructed at Katepwa Lake. Designs were prepared for fishways for the Jackhead River and Orr Creek, Manitoba. Fish passage requirements were assessed at Tungsten, NWT, and South Reindeer Lake Causeway, Saskatchewan.

The U.S. Department of Interior's Modified Plan for the Garrison Diversion was reviewed.

The IJC Poplar River Biology Committee advised the IJC on the probable effects of the coal-fired power plant in Saskatchewan on the aquatic biota of the Poplar River in Manitoba.

A three-year investigation was initiated in the Beaufort Sea-Mackenzie Delta area to assess the sensitivity of fish resources and fish habitat to the increased industrial activity in the area. Data were collected on the numbers of migrating fish in some streams, the movement of anadromous fish along the coast, the distribution of marine and anadromous fish, growth rates of coregonids, spawning habitats, and the description of fish habitat in coastal bays, especially Parlaiyut Bay, along the Tuktoyaktuk Peninsula.

Studies were initiated on five Liard River tributaries that will be crossed by the Liard

Highway. The studies will determine the effectiveness of the fish-passage requirements.

Contracts were administered for the mapping of aquatic resources in the Kazan Uplands for the Arctic Land Use Research Program (ALUR), a fisheries study of the Slave River Delta, and the impact of the Liard Highway crossing of the Poplar River, NWT, on fish resources.

1979-80: Reviews were conducted on the environmental impact statements for the Arctic Pilot Project and for Eldorado Nuclear's Saskatchewan uranium refinery; both are Federal EARP panel projects. Other major reviews were of Alaska Highway Gas Pipeline, Baffin Bay drilling, Liard Highway, harbour and other land use developments along the Beaufort Sea coast, Alsands and Cold Lake heavy oil plants, the Slave River hydroelectric scheme, and Saskatchewan uranium mines.

As a result of an Environmental Assessment Panel recommendation, a regional planning exercise was initiated for Lancaster Sound. A summary of the marine biology of the area was provided to the working group.

Staff assisted in writing a report on fish screening, and in establishing a mechanism for the design and review of fishways in Alberta and Manitoba. Advice was provided on 16 provincial fishways which were inspected.

The review of the Garrison Diversion was completed. Staff participated in Canada-USA discussions on Garrison, and monitored all events related to the project.

The IJC Poplar River Biology Committee completed its report.

The Beaufort Sea Production Environmental Advisory Committee, formed to provide operators in the Beaufort with advice on the regulatory requirements that they must follow, reviewed considerable production and environmental information.

Staff participated in the development of DFO's oil spill response plans and scientific research response plans.

Advice was given to DFO, Pacific Region, on the effects of radionuclides from uranium mining and milling operations on fish resources and fish habitat.

The second year of the Beaufort Sea-Mackenzie Delta study was completed. The distribution and relative abundance of marine and anadromous fish was assessed along the coast from Parlaiyut Bay to Liverpool Bay. More detailed and diverse studies occurred in Parlaiyut Bay. The movements of coregonids in the Mackenzie Delta between Toker Point and Holmes Creek were investigated. The importance was established of the Parlaiyut drainage basin as summer feeding habitat for anadromous fish and as spawning and overwintering habitat. Sizeable runs of various whitefish species were enumerated from several small streams draining the Tuktoyaktuk Peninsula lakes. The importance of these lakes for biomass production was apparent.

Information was collected on the migration, habitat use and relative numbers of fish species and on flow conditions for four watersheds along the Liard Highway.

A contract was administered to survey the fish resources of the Back River Lowlands for ALUR.

Fish Habitat Research Section

1978-79: The construction of an all weather research camp at Saqvaqjuac, 40 km north of Chesterfield Inlet, NWT, was completed. The following studies occurred there:

The study of Arctic charr swimming performance was completed, resulting in the establishment of parameters for use in the design of culverts to permit the passage of Arctic charr.

The baseline phase was completed of the nitrogen and phosphorus addition study to simulate eutrophication of a mid-Arctic lake.

Baseline limnological and fisheries data were collected for the area including the collection of information for the continental data base on acid rain, and on the anadromous arctic charr migration.

1979-80: The nitrogen and phosphorus addition study proceeded with the addition of nitrogen and phosphorus to one lake and of phosphorus to a second lake. Data were collected from these two lakes and a control lake on nutrient budgets, hydrology, physical limnology, zooplankton, benthos, and fish populations.

The migration of Arctic charr was monitored again. The size of the run was similar to those of the past two years.

Experimental hydrology studies and radionuclide studies were initiated at Saqvaqjuac.

LIMNOLOGY BRANCH

The Limnology Branch (LB) 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 LB projects is to develop sound freshwater habitat and fisheries management strategies. Together, studies by the two branch sections include many aspects of the environmental problems expected from the major energy-generating alternatives: fossil fuel burning, nuclear energy, and hydroelectric power. The two branch sections, Experimental Limnology and Regional Limnology, reflect two fundamentally different approaches to investigating limnological problems.

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 and solutions for eutrophication of lakes. However, by the mid 1970's, many of the major questions related to eutrophication were resolved and a major redirection was begun. Emphasis was placed on studies of the ecological importance of the contamination of natural freshwater systems by acid precipitation, heavy metals and radionuclides. Preliminary results of these studies were included in a special issue of the Canadian Journal of Fisheries and Aquatic Sciences published in March of 1980.

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 1978-79 and 1979-80, the emphasis of research by the Regional Limnology section continued at Southern Indian Lake towards determining and understanding the impacts attributable to the hydroelectricity-related diversion of the Churchill River and 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. A series of manuscripts is in preparation which will describe the initial effects since impoundment in July of 1976.

Experimental Limnology Section

Emphasis on eutrophication research during 1978-79 and 1979-80 was further reduced. However, two key studies continued on the effects of long-term fertilization on eutrophication. A ^{32}P spike in Lake 227 allowed calculation of fluxes of phosphorus to and from the sediments and assessment of the roles of various molecular weight fractions. As a result, a complex multi-box model was completed to examine trends in relationships between epilimnion, hypolimnion and the sediments of those compartments over the years. Zooplankton counting was completed and a manuscript is under review. It should be noted that, since the commencement of the Lake 227 project in 1969, nearly 100 manuscripts have been published or are near completion which have incorporated data collected from this lake. 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. An analysis of the effects of eutrophication on whitefish population structure is currently under review.

Monitoring of the Lakes 223, 224 and 226 radioisotope experiments, aimed at obtaining information on the fate and food chain effects of heavy metals and waste products from uranium mining and nuclear reactors in the aquatic environment, was continued in 1978-79. In cooperation with personnel from Argonne National Laboratory, water, plankton, sediments, fish and macrophytes were sampled for concentration, distribution and speciation of plutonium. Lake 224 field work was completed in 1979-80. In 1978-79, a laboratory was set up in Winnipeg capable of measuring low level activities of emitting nuclides including ^{238}U, ^{234}U, ^{230}Th, ^{234}Th, ^{228}Ra, ^{226}Ra, ^{222}Rn, ^{210}Po, ^{238}Pu, and ^{241}Am. That same year, this laboratory was key to performing analyses and the provision of advice relative to the Cosmos 954 incident. In 1979-80, a seasonal sampling program was begun in order to determine annual budgets of uranium series nuclides in a variety of watersheds. Estimates of selected radionuclides in runoff in the Experimental Lakes Area (ELA) north-west subbasin and the Saqvaqjuac Meadow basin were completed; further, a number of cores were taken from Saqvaqjuac lakes and preliminary analyses carried out.

Recognizing that acidification of fresh waters due to SO_2 emissions is probably the environmental problem of greatest significance in Canada today, the study begun in Lake 223, in 1976-77, was continued through 1978-79 and 1979-80. Changes in fish populations, benthos and plankton, nutrient and heavy metal chemistry during acidification are being documented. By the end of 1979, the pH of the lake had been reduced to 5.5 from the initial 6.7. Changes observed to date include increased concentrations of aluminum and zinc (due to mobilization from the sediments), disappearance of Mysis relicta (a major food of lake trout), disappearance of the fathead minnow, Pimephales promelas, a sharp decline in the population of slimy sculpin, Cottus cognatus, and a greater incidence of embryo malformation in lake trout which will likely eventually lead to the total disappearance of that species. In 1979-80, a second whole lake acidification experiment was begun on Lake 114, a small, shallow, headwater lake of extremely low alkalinity and typical of the small lakes used for commercial bait-fishing in eastern Canada. Efficiency of acidification will be compared to Lake 223, where sulfate reduction in an anoxic hypolimnion helps buffer the system. Since poorly buffered lakes, of the sort studied at ELA, are likely to be affected more rapidly than others by acid precipitation, they perhaps may be used to serve as "early warning" indicators of problems likely to occur in deeper, better buffered lakes.

Evaluation of the effects on water quality of the 1973 hurricane and the forest fire of 1974 has been completed and the results published in the March 1980 special issue of the Canadian Journal of Fisheries and Aquatic Sciences. Both runoff flow and the concentrations of the nutrients studied therein increased. As expected, the largest increases in yield occurred in the first year after the burn - for example, as high as nine times for nitrate when compared with pre-impact means. However, pre-impact yields were reestablished within three years. It was concluded there is little likelihood that these sorts of fire-caused losses of nutrients will significantly affect the regrowth of forests; nor will they likely result in significant adverse effects on receiving waters.

Regional Limnology Section

Studies continued aimed at determining the effects of hydroelectric development-related diversion of the Churchill River and impoundment of Southern Indian Lake.

In 1978, monthly monitoring of light extinction, adenosine triphosphate (ATP), primary production and alkaline phosphatase activity was performed at 13 stations in the lake. Stations receiving substantial amounts of suspended sediments from shoreline erosion showed no signs of phosphorus limitations, while bay stations and lake areas with low concentrations of sediments in suspension showed phosphatase activity and significant increases in areal primary production. Stations which had substantial increases in turbidity had similar or lower rates of primary production than before impoundment. ATP at all stations was signficantly higher than before impoundment and diversion. Light enrichment bioassays showed nitrogen debt developing before phosphorus limitation at turbid stations, but light limitation was probably the main controlling factor at all turbid stations.

In 1978 and 1979, mid-summer whole-lake zooplankton surveys were continued at 58 stations. Preliminary analyses of 1972 and 1975 pre-impoundment and 1977, 1978, 1979 post-impoundment data are currently underway. All aspects of the zoobenthos subproject progressed as planned. A post-diversion survey of Southern Indian Lake, the diversion route lakes and the Lower Churchill River lakes was done in 1979. The 1977, 1978 and 1979 emergence trap collections were identified; reared chironomid species have been mounted, and most of the artificial substrate samples have also been processed. In August 1979, a paper on the sampling of emerging Chironomidae by means of submerged funnel traps was presented at the 7th International Symposium on Chironomidae in Dublin, Ireland.

The routine physical-chemical observations which began in 1974 at 13 stations were terminated at the end of 1978. Emphasis in 1979 was shifted to whole-lake surveys in order to refine putative water mass boundaries and their temporal variability using physical and chemical tags. In 1979, a two-volume report was published which contains all physical data collected on Southern Indian Lake from 1974 through 1978.

The walleye spawning study was continued in 1978-79. The two spawning streams were reoccupied and over 1 000 additional fish were tagged. A search for walleye eggs by a SCUBA-diver-operated suction device was not successful in showing much evidence of spawning in either flooded or unflooded stream areas. Further, there was little success in catching young-of-the-year walleye either as newly hatched larvae drifting downstream from spawning beds or as free swimming fish in Sandhill Bay. It was concluded that flooding was having little impact on the spawning success of stream spawning walleye populations. As a result, the field aspects of this subproject were not continued in 1979-80. Experiments designed to assess the impact of sedimentation on spawning success of whitefish showed a deposition of approximately 20 mm of sediment on spawning beds over the winter of 1978-79. Egg mortality, however, was found to be high in both control and experimental chambers. Eggs were placed in redesigned traps in the fall of 1979.

By the end of 1978, some dramatic changes in the commercial fishery of the lake became obvious. Commercial whitefish catches, since flooding, have been composed of increased proportions of "dark" fish which are, on average, more heavily infested with the muscle parasite, Triaenophorus crassus. As a result, the grade and value of the fishery has declined. In addition, there has also been concern about likely post-impoundment increases in mercury concentrations in Southern Indian Lake commercial fish species. In order to document the underlying causes of these changes in 1979-80, a major fishing survey in the commercially important areas of the lake was conducted and an interview program covering commercial fishing activities was carried out. The data collected in these initial surveys are currently being analysed.

The Long Bay field program was completed as planned in 1978-79 and 1979-80. Responses to the flooding of Long Bay, to date, have been qualitatively similar to observations in other reservoirs. Because shoreline erosion was negligible in this bay, turbidity declined, light penetration improved, nutrient conditions for algal growth improved, areal primary production increased and nannoplankton biomass increased. Two years after flooding, the new littoral of flooded vegetation supported an abundant and diverse fauna of macrozoobenthos of which the Chironomidae are the most prominent constituents. Chironomidae accounted for 50% of the diet of early season pike young of the year. There has been, generally, an increase in the abundance of most small fish species, but young-of-the-year pike abundance, as estimated by seining success and cannibalism, was greatly reduced. The adult pike population appears to be responding to post-flooding increases in food resources. The percent of adult pike stomachs which contained food increased from 1977 to 1978 largely due to increases in feeding on large invertebrates, e.g. mayfly nymphs and crayfish. The condition regression for fish caught in 1978 was significantly different than the 1976 or 1977 regressions. Growth of tagged fish during 1977-78 was significantly faster than for 1976-77, the immediate post-flooding year. Catch per unit effort for adult pike with various fishing gear has either increased or remained unchanged. Estimates for biomass of flooded vegetation and its nutrient content are now available for the bay and were the subject of a paper presented at the Canadian Botanical Association in August 1978.

Four reports on Lake Winnipeg limnology were published in 1979-80. They included: treatment of the light environment of the system; other routine physical chemical data, including major ions, nutrients, temperature, oxygen and conductance; the morphometry and hydrology of the lake, and watershed and characterization of the offshore sediments. Several notes on the taxonomy of Lake Winnipeg zoobenthos were also published. Papers on the limnology and the

limnetic zooplankton of Yukon lakes are progressing well. The results of the zooplankton part of the study on the effect of periodic anoxia in Erickson lakes is in the first draft stage. The study of zooplankton community stability, being conducted in six lakes in the Riding Mountain area, continued throughout 1978-79 and 1979-80. Production studies in Lake Tanganyika were completed in 1979 with publication of one technical report, a poster presentation at the 1978 annual meeting of the American Society of Limnology and Oceanography and the submission of three manuscripts to Limnology and Oceanography.

TOXICOLOGY BRANCH

This branch had three general responsibilities during the review period, namely:

1. To conduct fundamental and applied research on the behavior and effects of chemical contaminants on fish and aquatic ecosystems;
2. To conduct methodology research to find ways to measure responses of aquatic organisms to chemical contaminants, and ways to measure chemical substances in fish and environmental samples, and
3. To provide advice on chemical pollution issues as they affect fisheries and aquatic resources.

During the review period these responsibilities were met by the successful completion of several research projects, with publication of results in various reports and journals. Methodology work made possible the evaluation and measurement of several chemical pollutants. A series of bioassay procedures was described in a special Departmental publication, the demand for which has been such as to require a second printing. Advice and unpublished data were provided to headquarters staff on numerous occasions, and to other government and private agencies and individuals. A number of committee obligations were discharged. During the review period the Branch hosted the 6th Annual Aquatic Toxicity Workshop for over 100 delegates and the 3rd International Congress on Ephemeroptera. Each of these events required substantial effort for organizational details and for preparation of "Proceedings" volumes.

During the review period a new building was completed except for a final water purification system, and some Branch projects moved their laboratories to the new building. A prototype water purification system was designed, tested, and installed in the new building, and it may form the basis for permanent water purification.

The Branch was organized into three sections until the end of the review period. These were Industrial Toxicology, Organic Chemicals Toxicology, and Protocol Development.

Industrial Toxicology Section

This group focussed research on metal pollution issues both in laboratory and field studies.

The dynamics of mercury in a freshwater lake (Clay Lake) in northwestern Ontario was completed with support from a joint federal/provincial agreement to study mercury in the Wabigoon River system, under terms of the Canada Water Act.

For the mercury studies, a field camp was established at Quibell, Ontario, and operated for two years. A number of large 6-10 meter diameter and 3-4 meter diameter tubes were installed inside a breakwater built across a bay of Clay Lake, and these tubes were used for experimental additions of trace quantities of radiolabelled mercury. Hydrological sampling was initiated and these samples allowed the calculation of water and mercury budgets for the lake. Field studies were integrated with a series of laboratory experiments to detect microbiological transformations of inorganic mercury to methyl mercury.

The results of these investigations have shown generally that Clay Lake is retaining about 75% of the mercury it receives from inflowing water, and that mercury in the water column is mainly responsible for maintenance of high levels of mercury in the fish. While the great majority of mercury in the lake is associated with bottom sediments, that mercury contributes very little directly to the fishery problem. An isotopic method was developed to allow detection for the first time of mercury methylation within the water column, and also of mercury methylation by fish intestinal contents. The effects of three concentrations of selenium (1, 10, 100 $\mu g.L^{-1}$) on rates of mercury bioaccumulation were investigated in a series of lake tubes. Selenium reduced the rate of mercury bioaccumulation and was, at the same time, itself accumulated to a degree that would be expected to reduce toxicity to consumers of methyl mercury in fish.

Since both mercury and selenium can be transported to water bodies by air in the manner of acid in rain, the results obtained can be applied to situations of mercury contamination by that mechanism in addition to the better understood cases of point sources.

The acidification issue is difficult to separate from several others. It has frequently been observed that acidification of lakes results in elevated concentrations of metals in those lakes, even if the metals were not added with the acid. The reason for this is that certain metals present as insoluble materials become more soluble with increasing acidity. Similarly, the forms of carbon are sensitive to acidity, and an acid lake might be expected to lose mineral carbon as carbon dioxide. Questions of metal dynamics and toxicity, and of carbon cycling, are important aspects of the acidification phenomenon, and they have been included in the project. An important fisheries question associated with any habitat change, including acidification, is the issue of tolerance of fish to the change. Studies are underway to investigate the importance of adaptive changes in tolerance of fish to certain metals.

A method was developed to analyse fish tissues for metallothionein, a low molecular weight protein synthesized by fish. This pro-

tein has the ability to bind with several metals and protect the fish from poisoning by those metals. High levels of metallothionein are synthesized as adaptive responses to exposure to sub-lethal concentrations of metals. This adaptive response was quantified in white suckers exposed to selenium, mercury, cadmium and zinc. In addition, the effects of acidification on early life stages of fish have been investigated, using fertilized fish eggs maintained in incubators suspended in acidified and non-acidified lakes. Preliminary results indicate that development of lake trout embryos is less sensitive to acidification than some earlier studies have suggested. Most of the results of a 2½ year study of fishes and fish habitat in the vicinity of the base metal smelter at Flin Flon, Manitoba, were published during this period. Amounts of several metals deposited on lakes as a result of atmospheric emissions were documented, as were the effects of the metals on water chemistry of ice-covered lakes during snow-melt; plant metal concentrations, fish metal accumulation, and fish population effects were analyzed and reported. Also, a compilation of all precipitation and lake water chemical analyses was published. A summary was presented at the Norwegian SNSF International Conference on Acid Precipitation. A total of eight scientific papers have been published on the Flin Flon work with additional material in various stages of preparation.

In May, 1978, a bay on ELA Lake 382 was curtained off from the main basin of the lake for purposes of maintaining a "wild" lake ecosystem of manageable size for toxicological experimentation. During the summer of 1978, white suckers were marked and tagged in both the bay and lake to estimate population sizes, growth rates of individuals, age distribution etc. At the same time, three species of minnows were studied, primarily in the bay, to determine similar population parameters, and also to determine feeding ecology in connection with other studies on insect and plankton faunas. In 1979, the experiment was curtailed and operations were limited to four monthly sampling trips to the bay-lake system. At these times, population samples were obtained for the suckers and minnows but no further tagging was carried out. Minnow stomach samples were obtained from both bay and lake populations at each sampling time. In addition to the populations and feeding studies, water, sediment, plants and various other biota were sampled for chemical analyses to determine background levels of a number of metals. Originally, it was anticipated that this bay on Lake 382 would be used for an experimental whole-lake addition of cadmium, but more recent information has indicated greater need for acidification research. In any case, the population basics will provide necessary background information for any future manipulations.

Laboratory studies defined lethality of cadmium to juvenile rainbow trout over a range of pH and water hardness values and these results were related to sub-lethal physiological studies. The effects of pH on acute lethality and histopathology of vanadium poisoning in trout were also determined. Refinement of a rapid bioassay technique, "Residual oxygen bioassay", was completed. This technique is easily applied in field situations and takes only about six hours to complete. For reasons not clearly understood, results from this test correlate well with more conventional bioassay procedures.

The effects of exposure to low concentrations (3.0 to 5.0 $\mu g.L^{-1}$) of cadmium on growth and various biochemical processes associated with growth in fish were examined over a pH range of 6.0 to 8.0. Statistical treatment of the data failed to demonstrate any effect of cadmium exposure on either growth or the biochemical parameters during the three-week exposure period. Further studies, however, demonstrated significant sublethal aberrations in cardiovascular and respiratory function and plasma electrolyte balance in fish exposed to 6.4 $\mu g.L^{-1}$ over a 178-day period. No such effects were observed in fish exposed to 3.6 $\mu g.L^{-1}$ cadmium over the same time interval, although tissue levels of cadmium in gill, kidney and liver were similar in both groups of fish. The results may have application to natural lake systems since cadmium levels in the range used in these investigations are present in some North American and European lake systems. A significant result of the studies was the lack of correlation between tissue concentration of cadmium, and toxicological response of fish. This suggests that the degree of stress of fish in cadmium-polluted lakes cannot be estimated from surveys of tissue cadmium concentrations.

A major activity of this group has been the design and testing of a water supply system to serve the new bioassay building. In order to facilitate research on toxicity and dynamics of metals, and research on acidification it was necessary to purify and dechlorinate city water without using sodium thiosulfate. A treatment system based on activated charcoal and high intensity ultraviolet irradiation was designed and tested on a laboratory scale. Based on that experience, a temporary system was designed and installed in the new building. If this system proves adequate, it will provide the basis for a permanent water system which will allow control of the pH and CO_2 content of water, and be free of chelators which have been a problem for our research on the biological uptake of metals.

Analytical laboratories, in this project, provided extensive support to several scientists within the project and to other projects throughout the Institute, primarily in studies of inorganic chemical pollution. The ability to identify and measure contaminants has required analytical methodology research and those results have been fundamental to a number of research and monitoring programs.

Project staff performed some 16 500 chemical analyses on various samples in support of other research projects. As an example, this project provided the mercury and selenium analyses reported as part of a federal/provincial study of mercury in the Wabigoon River. Methodology was fundamental to that study and a method was developed to enable routine determination of mercury at nanogram per litre concentrations in natural waters. Similarly, a corresponding effort made possible measurement of methyl mercury at low levels in natural waters.

ation of cadmium in water at microgram per litre concentrations.

In cooperation with DIAND, data on the levels of six metals in tissues of narwhals were obtained. The whales were obtained from the Canadian Arctic and samples of liver, kidney, muscle and blubber were analysed for lead, copper, cadmium, mercury, selenium and zinc. Results were submitted to DIAND and will provide a basis for assessing the state of metal pollution of these whales in northern Canada.

In conjunction with the Limnology Branch, chemical work was initiated in 1976 on metals in Lake 223 of the ELA . It is well established in the literature that elevated concentrations of certain metals occur in lakes undergoing acidification. To some extent metals may reach lakes by the same aerial processes transporting the acid, but in some instances the metals appear to originate within the lake. In the case of the experimental acidification of Lake 223, the concentrations of iron, manganese, zinc, and aluminum have increased, and these elements were not introduced with the acid used to acidify the lake. These increases in metal concentration resulted from leaching of sources within the lake, namely, the lake basin itself and sediments. The biological significance of these elevated metal concentrations is the subject of research in other projects.

Metals in natural waters are known to occur in a variety of chemical forms or "species", depending upon conditions in the water. A computer program to calculate the abundance of various chemical species has been generalized to the point where concentrations of 200 different chemical species can be calculated simultaneously from the analytically determined concentrations of total dissolved elements. The program presently encompasses 22 different elements but can be extended to any number of elements provided the pertinent thermodynamic data are available. The program can perform the calculations to give metal species concentrations in the presence of varying types (up to 30) of minerals (calcite, dolomite, etc.) in equilibrium with the water. Practical confirmation of the free metal ion concentration has sometimes been obtained through measurements with the ion-specific electrode. In this connection, investigations were carried out with the cupric ion-selective electrode. It was found that in alkaline solutions (waters) a true measure of the free metal ion concentration was not obtained with such an electrode without the necessary correction for pH effects.

Toxicity studies have shown that metal toxicity relates not generally to the total amount of metal as determined analytically, but rather to specific species present. In fact, the total metal concentration can be a misleading indicator of an element's toxicity. Information in this area bears substantially on the formulation of allowable concentration levels in natural aquatic systems.

Organic Chemicals Toxicology Section

This section concentrated on the environmental dynamics and some toxic effects of organic chemical pollutants. The number of such organic pollutants is enormous, and the group has focussed mainly on those still in experimental stages of development, especially pesticides and organics related to the energy industry. Emphasis has been given to research on methodology for the measurement and identification of organics and some of their metabolites in water, sediments and biological samples, to research on processes responsible for movement of organics among components of aquatic ecosystems, and to effects of exposures to organics on aquatic animals and plants.

Laboratory and field trials were carried out to evaluate the persistence of two experimental herbicides for control of aquatic vegetation, fluridone and terbutryn. Both these compounds were more persistent than had been expected, particularly in sediments. It was possible to identify some of the major metabolic products formed from the original herbicides, using radioactive herbicides as starting materials. A third aquatic herbicide, hexazinone, was found to be lost rapidly from the water column after it was used in a tube study of mercury dynamics at Clay Lake, Ontario, as part of the study reported earlier. Laboratory studies were carried out to examine uptake and loss of another experimental herbicide, ethalfluralin, by fish and aquatic plants. This compound was taken up by fish with remarkable efficiency but it was cleared from fish with a half-time of about one week.

Other work was continued in studies to understand the role of water chemistry in regulating the biological availability of organics. Compounds investigated in these studies have included the herbicides listed above as well as permethrin, 2,4-D, DDT, methoxychlor, krenite, hexachlorobiphenyl, aroclor 1252 (PCB), triphenyl phosphate, niclosamide, and ethylhexyldiphenyl phosphate. Freshwater organisms used included fish (rainbow trout), insects (blackfly, stonefly and midge larvae), and aquatic plants (duckweed and eurasian water milfoil). Results indicated that water chemistry played a distinct role in regulating the biological availability of organics, and that the effect could be predicted using the physical properties of the compounds tested and the properties of suspended solids in the water. Suspended solids in water tended to reduce the availability of organics to organisms apparently by adsorbing compounds. In the case of filter-feeding organisms, this could be exploited and tests were carried out with methoxychlor intentionally adsorbed to celite particles of a size retained by blackfly larvae. Blackfly larvae accumulated particulate methoxychlor and were killed by it, whereas other non-filter-feeding organisms did not take up particulate methoxychlor nearly as efficiently as emulsified methoxychlor. This offered a plausible explanation for field results showing different reactions to different pesticide formulations.

The section has necessarily devoted considerable effort to analytical methodology for determination of new organics in fish, water, sediments, and aquatic plants. A method for the determination of part-per-billion (ppb) levels of niclosamide (a chemical used for control of the sea lamprey) in water and sediment samples was

published. Methods were developed for the analysis of terbutryn and several of its degradation products in fish, sediment, plant and water samples. Several methods for the extraction of triaryl phosphate from sediment and fish were evaluated, using ^{14}C-labelled triphenyl phosphate to determine absolute extraction efficiencies.

A chromatographic cleanup and concentration apparatus was developed and has provided significant savings in solvents and staff time in our analyses of a number of trace organics in fish and water. Similarly, a new extraction flask was built to allow efficient extraction of water samples with very small amounts of solvent and it was also described in a publication. Some of the compounds under study are not readily available with radiocarbon labels, and the section has relied heavily upon tracer methodology. Project staff have synthesized radioactively labelled samples of methoxychlor, triphenylphosphate, ethylhexyl-diphenyl phosphate and other metabolites for use in a variety of experiments. In a more biological context, a technique to bioassay water and sediments for herbicides was described and applied to field studies of persistence of fluridone and terbutryn. The technique depends on growth analyses of duckweed cultures and is sensitive to most herbicides in the concentration range of about 3-300 ppb.

Additional field studies were carried out to describe the persistence of new insect growth regulators, methoprene and diflubenzuron, and of an organophosphorus insecticide, fenitrothion. None of these compounds showed great persistence under outdoor conditions. The mechanism of disappearance of fenitrothion was investigated and it appeared, from studies with shaded and non-shaded pools, that photochemical degradation was involved.

After an organism has taken a pollutant in, interest shifts to question what the organism does next. With sub-lethal accumulations, the rate of clearance of the pollutant has been investigated by exposing fish to the pollutant until measurable levels have been obtained and by then transferring the fish to clean flowing water. From estimates of uptake and clearance rates, it is possible to construct at least crude models of the likelihood that a pollutant may accumulate to toxic or unacceptable concentrations in fish. This tendency also appears to be predictable from physical properties of the compounds in question. Generally, compounds of high water solubility have the least likelihood of accumulating in fish.

Additional work was undertaken to develop ways to extract and characterize humic acids, and to define their suspected role in binding organic pollutants and hence reducing their availability to aquatic organisms.

Fish samples from a Canadian International Development Agency (CIDA) project in El Salvador were analysed for a number of pesticides and, somewhat surprisingly, parathion and methyl parathion were found in some samples.

A number of blood serum parameters were measured as background information on Arctic cod and Arctic charr.

Experimental exposures in these projects have demanded a continuous supply of organisms, and section staff maintained cultures of common duckweed (Lemna minor), eurasian water milfoil (Myriophyllum spicatum) and the freshwater midge (Chironomus tentans). Efforts were initiated jointly with Wet Lab staff to establish a recirculating marine aquarium for the culture of Arctic species. Fish were obtained from the Freshwater Institute's hatchery and Wet Lab, and other organisms were field collected as needed.

Program staff hosted the Third International Conference on Ephemeroptera, and edited the several hundred page "Proceedings" volume which appeared in March, 1980.

Protocol Development Section

This section concentrated on the responses of aquatic organisms to pollutants and used chemicals under study in other projects to define criteria for sublethal impairment in fish and invertebrates. Several such criteria based on histology, physiology and behavior were utilized for the development of toxicity testing procedures.

Substantial research effort was given to understanding the basic functioning of the sense of smell in fish. This sense is fundamental to the ability of migratory fish to "home" to their spawning grounds, ability to locate food, and ability to avoid predators. Fish modify their behavior in response to chemicals they detect in the water; some chemicals attract fish, some repel them, and some poison the sensory apparatus so that fish no longer detect chemicals at all. The olfactory system of rainbow trout was examined biochemically and physiologically by measuring the inhibition of binding of radiolabelled stimulants and the inhibition of olfactory nervous electrical activity in response to a standard stimulant. Stimulant binding and nerve electrical activity were strongly correlated. Effects of several heavy metals (copper, cadmium, mercury and silver) on the olfactory system were defined. Copper actually destroyed the peripheral nerve cells in the sensory organs, as indicated by histology, biochemistry and neurophysiology. The other metals were also active in depressing nerve electrical activity, but mercury and cadmium were less inhibitory than copper. Mercury acted on the central as well as the peripheral nervous system. Other metals tested included zinc, lead, vanadium, chromium, cobalt and nickel and these were relatively ineffective against olfactory sensory perception.

At the whole animal level, exposure to 0.01 $mg.L^{-1}$ of inorganic mercury abolished food preferences normally characteristic of lake whitefish.

Some compounds showed striking ability to attract whitefish. For example, whitefish preferred to remain in concentrations of sodium dodecyl sulfate and other household detergents. At the same time, these chemicals depressed olfactory responses. They were attracted, indeed, to lethal concentrations of copper. Certain natural compounds (some amino acids, amines, perhaps bile salts) attract fish and this

research is being applied to development of attractants to lure fish into nets and traps.

Histological work has continued over several years, both as a pathology tool in assessing effects of contaminants and diseases on fish and as a research effort to understand the fundamental histology and histochemistry of fish. These studies, at both light and electron microscopy levels, have been applied to a variety of fisheries issues. For example, a study made jointly with the FRB allowed histological assessment of rapeseed protein in diets for rainbow trout. The results showed that certain components of the rapeseed protein (glycosynolates, etc.) caused hyperplasia of the thyroid tissue that eventually would lead to fish mortality. The histology data also revealed that the morphology of the thyroid tissue was not indicative of the thyroxin levels in fish sera (normal hormone levels were determined even in very hyperplastic thyroid fish). A level of rapeseed protein in the fish diet, with no apparent effect on thyroid, was determined so that this protein source might be utilized in fish aquaculture without detrimental effects to the fish.

Histological work was included in a variety of toxicological studies, including the effects of heavy metals (copper, cadmium, mercury) on the olfactory system of fish. A method that detects olfactory neurons by their phospholipid staining properties was standardized and used to detect deleterious effects of the metals. The histological changes observed in these neurons were reflected in the electrophysiological and biochemical studies. Each metal was found to destroy or alter olfactory neurons at a certain rate. The period for reconstitution of neurons in the olfactory epithelium was also determined once the metals were removed from the water supply. This method, therefore proved to be a highly sensitive and economical test to monitor olfactory ability in fish. The potential to determine olfactory alterations due to toxicants other than metals seems promising.

Histopathology was carried out on tissues from fish that were exposed to vanadium, cadmium, and copper under bioassay conditions. The methods detected pathological changes in tissues when fish were exposed to toxicant levels well below lethal levels. Gill tissue alterations, liver glycogen depletion, intracellular changes in kidney tubule cells, and intestinal epithelial deterioration were observed in metal-exposed fish. The type of lesions observed in the metal-exposed fish were consistent with observed physiological changes. Kidney pathology was related to impairment of ionic resorption mechanisms, loss of nutrients generally absorbed in proximal tubules (glucose), dysfunction of the active transport processes of the cells, and impaired ATP production. Gill pathology was consistent with osmoregulatory stress and related to the observed cardiovascular-respiratory changes observed by the physiologists. The histopathology also indicated the extreme sensitivity and changes in toxicity of metals to fish at different pH levels.

The histology lab has supplemented Fish Health efforts to provide analyses of fish tissue pathology for other Federal government groups, provincial and NWT governments, hatcheries and others, in an effort to understand fish mortalities and fish disease conditions in Canada.

Flowing water, in general, provides a different habitat from standing water, and typically is inhabited by different kinds of organisms. In western and northern Canada, pollutants are frequently found in both rivers and lakes, and effects are very poorly understood in rivers in particular, in part because of lack of research on river biology and lack of proven river sampling methodology.

Section staff have accumulated data on effects of a variety of pollutants (cadmium, copper, methoxychlor, permethrin, fenitrothion etc.) on aquatic organisms in laboratory tests. The need to confirm these results has resulted in a search for a suitable site to manipulate real flowing waters and to determine effects of pollutant-induced disturbances on the whole aquatic ecosystem from water chemistry variables through invertebrates and plants to fish populations. Two streams were selected from a number of potential lake and stream sites, and work was begun to characterize the streams in chemical, hydrological, and biological terms. Laboratory stream channels were designed.

A series of laboratory tests was carried out to quantify a number of behavioral responses sensitive to toxicant action. Creek chub (Semotilus atromaculatus), rainbow trout and lake whitefish were tested in a locomotor response apparatus; creek chub were most consistent in response. Short-term ("spike") exposure of whitefish to 1.5-2.0 $mg.L^{-1}$ fenitrothion caused significance reductions of locomotor activity and changes of circadian activity patterns, including apparent shifts from predominantly day-active to night-active. Work on avoidance testing procedures was continued, using methoxychlor as toxicant. Concentrations above 0.5 $mg.L^{-1}$ elicited a dose-dependent avoidance response, very similar for naive and pre-exposed whitefish.

Investigations of effects of metals on fish and invertebrates were extended. For example, the effects of copper on swimming and avoidance behavior of Gammarus lacustris (a freshwater amphipod) were shown to be different for different "species" of the metal. $Cu(OH)_2$ and $(CuOH)^+$ were strongly avoided, whereas free cupric ion $(Cu)^{++}$ was only weakly avoided.

Methods were developed to compare laboratory and field results, especially with regard to effects of metals and acidification on zooplankton communities. Basic tools here have been the laboratory culture of micro-organisms and invertebrates, and impounded communities of similar organisms suspended in lake water. By conducting these experiments under conditions similar to those in a lake undergoing acidification, and by conducting the field study in the lake itself, the results can be compared with those for the actual whole-lake population. Toxicity of cadmium in conjunction with acidification was studied in this way at ELA Lake 223. The zooplankton community of Lake 223 has been shown to be changed in diversity and density

(biomass) by 3.0 $\mu g.L^{-1}$ cadmium in waters of increasing acidity. In addition, the dynamics of calcium uptake by crayfish have been found sensitive to acidification.

A major accomplishment of this section was preparation of a book compiling methods for conducting some 30 different kinds of toxicity test with freshwater organisms. These tests were developed over a period of several years by a number of Institute scientists, and information on them was supplemented with literature searches yielding over 12 000 pertinent references. A reprint library was established with over 800 papers, and the literature information was tabulated into a separate bibliographic publication. The test manual itself was published in 1979 as a Canadian Special Publication of Fisheries and Aquatic Sciences, Number 44.

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 Fishing and Industry Services, Research and Resource Services and Small Craft Harbours. To accomplish this support, Management services is divided into the following Branches: Finance, Adminstration, Materiel Management, Library, Technical Services and Facility Operations. Detailed descriptions of Branch functions are provided in the following Branch reports.

FINANCE BRANCH

The Finance Branch provides financial services for all Regional programs and for the Regional Personnel office. These services included during the review period:

- account payment
- accounts receivable
- travel
- statement preparation
- financial analyses
- advice

A full set of internal procedures for finance, administration and materiel management have been developed and implemented.

Steps are being taken to design and implement a performance measurement system.

Summary of Finance Branch Activity

Budget control:	$12 996 000/year
Budgetary control of financial encumbent funds:	$533 882/year
Processing of suppliers accounts for payment: (number)	38 800/year
Provision of financial analysis and reports	
Provision of management information systems	
Application of Treasury Board and Departmental Regulations and directives	

The Financial Allottment Control System (FACS) has been put on-line. A review of the financial procedures and paper flow has resulted in numerous changes in the financial systems.

ADMINISTRATION BRANCH

The Administration Branch provided the following services to the Region during the review period:

Switchboard and receptionist services: 230 000 calls

Building security:
Administration 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 Branch carries out a yearly health and safety check of the FWI and outlying field camps and installations.

Central Registry and Mail Room operation: 338 593 items

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

MATERIEL MANAGEMENT BRANCH

The Materiel Management Branch provided the following services to programs of the Region during the review period 1978-79 to 1979-80:

Acquisition of goods and services	15 243 purchase orders
Receipt, distribution and warehousing of supplies and equipment	$5.1 million cost of items
Maintenance of inventory records	3 360 line items
Vehicle administration	102 units
Personal service contracts processed	138
Total value of inventory controlled	$6.0 million

LIBRARY AND PUBLICATIONS BRANCH

Table 7 summarizes major activities during the period under review. The most significant happening is that the number of serials currently being received has dropped by some 20 titles during 1979-80. This trend also will be seen in the figures for 1980-81. Continuing increases in subscription rates without a corresponding increase in budget forced the cancellation of some of the lesser used titles. A survey was made in

Table 7. Library services.

		1979-80	1978-79	1977-78
TECHNICAL SERVICES				
Acquisitions:				
Orders typed:	for serials	609	542	532
	for non-serials	778	630	657
Items received:	new serial titles	47	91	51
	non-serials	567	928	655
Serial titles no longer received		66	93	55
Cataloguing:				
No. records typed		2 852	3 398	4 456
No. records withdrawn		134	153	93
No. volumes bound		529	659	621
No. volumes added to collections		1 117	1 197	2 044
READERS SERVICES				
Circulation:	to regional staff	2 509	2 771	3 319
	to other DFO libraries	41	39	28
	to others*	504	696	823
Photocopies supplied in lieu of loans:				
	to DFO libraries	259	264	340
	to other libraries	1 090	1 007	744
Interlibrary loan requests made		1 852	1 003	912
	items received	1 487	648	-
Reference questions dealt with:				
	simple directional queries	1 729	963	829
	reference queries	1 705	1 932	2 450
	on-line searches queries	204	228	150
Accession lists issued		5	5	6
Periodical contents lists circulated & items routed		1 200	1 203	1 418
CAN/SDI Profiles:	new	1	0	1
	revisions	9	11	10
	cancelled	3	0	1
Translations requested (of library material)		4	3	3
PUBLICATIONS SERVICE				
No. new technical reports mailed (mailing list c.200)		6	10	
No. MS & data reports mailed (mailing list c.15)		16	15	
No. requests for reports/reprints answered		1 421	935	

*this includes local users in person and items sent on interlibrary loan.

Table 8. Interlibrary loan activities, 1979-80.

Library Group	For our staff: Items received No.	%	Requests made No.	%	For other libraries: Items supplied No.	%
Manitoba	668	44.9	819	44.2	897	60.9
Department of Fisheries and Oceans	200	13.5	230	12.4	286	19.4
Other Canadian	570	38.3	742	40.1	269	18.3
U.S. / U.K.	49	3.3	61	3.3	20	1.4
TOTAL	1 487	100.0	1 852	100.0	1 472	100.0
Cancelled requests			59		c.200	

1979 to determine the level of use of current serials and those dropped were selected from those found to be little used. There is also a drop in the number of volumes being bound. Most of these are back volumes of periodicals and the drop is related to drop in the number of current subscriptions.

The number of items being borrowed by staff has shown a decrease over the past three years. The number of interlibrary loan requests from staff has increased over the same period. It might be argued that these are correlated and indicate that our stock is less able to meet staff needs now than in the past. However, it is suggested that the increase in interlibrary loan activity is due to the increasing use of on-line bibliographic retrieval services.

Table 8 gives a breakdown of the interlibrary loan activities in 1979-80, the first year that the information given has been collected. Some 45% of our loan and photocopy requests are met locally. In contrast 60% of the requests from other libraries that we filled are from local libraries. Note that almost the same number of items were received as we sent to other libraries.

Table 9. Online searching in the Freshwater Institute Library.

	1979-80	1978-79
No. searches made	228	204
No. library uses	9	8
System Use (sign-ons):		
CAN/OLE	301	181
DIALOG	99	115
QL	77	36
ORBIT	5	28
Univ.Alberta	3	-
TOTAL	485	360
Data Base Use (sign-ons):		
BIOSIS Previews	271	148
Chemical Abstracts	34	32
Canada Environment	33	18
Aquatic Sci.Fish.Abstr.	25	4
SciSearch	22	21
NTIS	16	17
Comp.Dissertation Abstr.	10	9
Selected Wat.Res.Abstr.	10	4
Commonw.Agric.Bureaux	7	12
OON (CISTI Catalogue)	7	8
OONL (Canadiana)	6	2
Pollution Abstracts	4	7
Enviroline	4	9
Agricola	4	6
Boreal Northern Titles	3	2
Envirobib.	3	2
Excerpta Medica	3	6
News	0	3

Some 20 other data bases were also used once or twice each year.

Table 7 indicates the general trends in the on-line search services carried out in the library and Table 9 gives more detailed data. The term "search" used in Table 9 is defined as the whole operation needed to satisfy a request from a user for material on a single topic. This topic may be a simple search for papers by an author published in the last two years, or it may be to find all references available on a broad topic such as "Ephemeroptera and pollution". A single search may involve the use of one or many data bases.

System use follows much the same pattern in both years. CAN/OLE is the most heavily used service with DIALOG and QL being second and third. The use of ORBIT has dropped, being only used in the last year when its special characteristics or data bases were needed. Access to data bases on the University of Alberta computer was gained in 1979 as this system has two bases dealing with the North which may be of value to our staff.

Although the number of searches made increased by only 10% from 1978-79 to 1979-80 the number of data base sign-ons increased by over 30%. This is due to the fact that in 1979 CAN/OLE split the BIOSIS Previews data base into two parts when it became too large for efficient searching. This is our most heavily used system/data base combination and now, in many cases, both parts of the data base are searched in order to answer users' queries. This search counts as two data base sign-ons.

The demand for staff publications continues to increase. We receive requests regularly from individuals and institutions wishing to be placed on our mailing lists. Copies of all our reports are now being sent to Micromedia Limited, a company in Toronto which puts government documents on microfiche, indexes them and offers them for sale along with an index. Their service includes subscriptions to all documents on a specific subject area as well as an on-demand service for single copies of a report, either in fiche form or as a photocopy. It is anticipated that by being able to refer requesters to this service agency, those who really need a report will be able to get one even after our printed copies have all been distributed. It is no longer possible for us to maintain stocks of all of our reports nor do we have staff to make on-demand photocopies of those which are out-of-print. The library receives a fiche copy of our reports from Micromedia.

TECHNICAL SERVICES AND FACULTY OPERATIONS BRANCH

Facilities Operations Section

Solar energy came to the Western Region as the first application of solar heated fish tank water came on line in January, 1979. This small installation, funded by the Purchase and Use of Solar Heating Equipment Program (PUSH), is supplying heated water to twelve tanks located in the brood stock building at the Rockwood Experimental Fish Hatchery located near Gunton, Manitoba. The water supply from wells is being heated from 6°C to 12°C by solar collectors

which also provide the minimal building heat required. To date, other than some minor mechanical problems, the system is proving to be efficient and economical.

A second solar installation to provide building heat and domestic hot water for a Crown residence at the hatchery site was also under construction. The main hatchery building was the subject of a feasibility study for conversion to solar heating.

The bioassay laboratory at the Freshwater Institute was completed during this time period and was occupied and operational by March, 1980. The opening of this building initiated a total space review at the Freshwater Institute to ensure the most efficient utilization of available space for the varied programs at the Institute.

Energy conservation continued to be practised extensively in regard to building management and operations. Minor modifications to building mechanical systems have provided heat from waste heat and the lighting systems and parking receptacles have been placed on timers. Fish tank water in many cases is being recycled which reduces the requirement for heating and cooling the supply water. An investigation was initiated to determine the availability of well water which, if successful, could supply all cooling required for water and building cooling.

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 2 000 databases are available for the Pacific, Western, Quebec, Maritimes, and Newfoundland regions. However, considerable difficulty has been experienced in data clean-up owing to differences in coding methods between 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.

During the review period, most of the Section's effort have been expended in routine EDP services, and in planning for a new system to be implemented in fiscal year 1980-81.

Graphic Arts and Photography

Graphic Arts and Photography has been involved in the visual interpretation of virtually all the activities at the Freshwater Institute. The customizing of requirement to production method has increased efficiency and effectively met the needs of extremely varied requests. A slide inventory, indexing and storage system has been implemented, wherein a specified subject matter can be retrieved on short notice. Photographic inventory has been updated to ensure the active involvement of media personnel in scientific endeavors.

AREA PERSONNEL OFFICE

The Winnipeg based Area Personnel Office was responsible for all Personnel activities required by Managers in the Atmospheric Environment Service, Inland Waters Directorate and Fisheries and Marine Service which were encompassed in the Department of Fisheries and Environment. This mandate was carried out for the period April 1, 1978 to April 1, 1979.

The Department of Fisheries and Oceans was created on April 2, 1979. The Personnel Branch, assigned to the new Department for the Western Region was located in the Freshwater Institute Building.

The geographical responsibility of the Regional Personnel Office includes Manitoba, Saskatchewan, Alberta, Northwest Territories and part of Ontario. The Departmental management and employee expertise which is located in such a diverse area of Canada requires an effective communication network to ensure all staff members are kept well informed of changing personnel policies.

The personnel management process in the Western Region is ongoing; however, within this process, there are disciplines of Classification, Staffing, Staff Relations and Compensation, and Training, which occur in relation to the preparation of specific Management plans.

The Regional Personnel Manager and Staff provide personnel advice to the Regional Director-General and his staff concerning the implications of Central agency decisions and provide them with personnel services to assist them in meeting well established Regional goals and objectives.

To achieve these objectives a Regional Director-General needs information which can be obtained in many way. Some vehicles through which information can be acquired include personnel, financial and performance measurement systems, meetings, committees and status reports.

The Personnel Systems for the Western Region are firmly in place and progress reports are given to Directors and Managers. These reports, the reactions to them, and the decisions flowing from them, form an essential part of the functions required of a Personnel Manager.

The Deputy Minister is responsible for Classification delegation and Managers in the Western Region carry out this delegation in committee forum under the direction of the Regional Classification Officer. The Classification assistant handles the administrative functions required in this area of responsibility.

The Staffing discipline and related delegated requirements are carried out by the Staffing/Training Officer and Assistant. The

training requirements of the Department fall under the jurisdiction of the Staffing/Training Officer.

Compensation responsibilities are handled by a Pay Supervisor and two Pay Assistants. Employee benefit counselling and Contract interpretations form a major part of the duties effectively accomplished by this group.

Staff Relations during the past year has been administered jointly by the Regional Personnel Manager and Classification Officer.

SMALL CRAFT HARBOURS BRANCH

General

Small Craft Harbours Branch was formed in 1973, and Western Region operations commenced in 1974 when jurisdiction and responsibility for some seventy facilities was transferred to the Branch from the Ministry of Transport.

The geographic area of jurisdiction for Small Craft Harbours (Western) encompasses the Province of Manitoba, Saskatchewan, Alberta, and the Northwest Territories. The regional office is located in Winnipeg, and is staffed with two continuing employees.

The activities of the Branch are confined to, and in support of, the provisions of the Fishing and Recreational Harbour Act, October, 1978, and the pertinent Regulations.

While directly responsible to the Director-General, Western Region, Pacific and Freshwater Fisheries, funding, and a significant degree of operational direction and control are provided by the Director-General, Small Craft Harbours Directorate, Ottawa.

Operations During the Period

In keeping with priorities established in earlier years, the emphasis on restoration and renewal of facilities in our inventory was maintained during the period under review. As a result, all required major maintenance work was either completed, or scheduled for designated future years, by the end of the period. Increasing attention was devoted to planning for expanding our operation to include the provision of new fishing and recreational harbours in accordance with our mandate.

To provide the basic data required to formulate long range plans for Small Craft Harbours development, separate Regional studies were commissioned and funded by the Small Craft Harbours Directorate, Ottawa. In Western Region two studies were undertaken, one concerned specifically with the commercial fishery and its requirements, and the second on the recreational boating aspect of our operation. These studies were completed in September, 1979, and have provided the information required for the development and priorization of projects for future year programs.

In spite of the necessary emphasis placed upon restoration and renewal of facilities in our inventory during this period, limited progress was possible in the provision of new or enhanced facilities for both the commercial fishery and recreational clients. Two completely new harbours for joint fishery/recreational use were installed; work in a multi-year marina development was started; two Tourist Wharf/Launch Ramp installations were completed, and a replacement Fishermans Wharf installed.

Future Operations

With the virtual completion of our rehabilitation programs, and the consequent shift to more capital intensive works, a five year forecast of activities has been developed. This forecast, based upon data available to us from the commercial fishery and recreational boating studies conducted in 1979, is updated on an annual basis.

Dependant upon budgetary allocations, we anticipate completion of all commercial fishery facilities identified in our study by F/Y 1985-86.

The recreational requirement is expected to continue well beyond that time frame. Initial contacts have been made with Provincial Government authorities to advise them of our programs. Through expansion of these contacts we hope to develop specific projects and timetables to at least partially meet the immediate and growing requirement for recreational boating facilities that can be accomodated within our progress.

STAFF LIST

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Director				N.W. Falkner
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Fishing Services Branch:				
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Alberta Region - Manager				R. Garnett
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NWT Management District
- Manager — Vacant
- District Biological Advisor — B. Wong
- Secretary — Vacant
- Administrative Officer — A. Demeule
  - P. Lalonde
  - L. Ralston

- Maintenance - Supervisor — R. Grimsrud
  - W. Weselowski

- Enforcement - Chief — D. Dowler
  - R. Barnes
  - K. Roberts
  - E. Fast
  - J. Caudron
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  - N. Robinson
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  - G. Williams
  - W. Ferguson
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K. Mills	D. Findlay	I. Davies	
T. Ruszczynski	G. Brunskill	S. Elliott	
P. Wilkinson	D. Malley	P. Chang	
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Regional Limnology - Leader			R. Hecky
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C. Anema	S. Guildford	R. Bodaly	
R. Fudge	P. Healey	L. Hendzel	
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