FISHERIES RESEARCH PROGRAM REVIEW

1981/82 NATIONAL SUMMARY

Canada

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CHAPTER I

INTRODUCTION

This is the fourth National Summary of the Fisheries Research Program Review in the Department of Fisheries and Oceans (DFO). The first summary for 1978/79, was not based on the present Program Activity Structure; a different set of definitions were used to define the scope and components of the Fisheries Research Program. Thus, the resources and programs in the National Summaries are comparable starting with 1979/80, the present document being the third one based on the same definitions.

The purpose of the present report is to:

1. Provide a national perspective of fisheries research programs/achievements for 1981;
2. Summarize the fisheries research expenditures of dollars and person years (PY) for FY 1981/82;
3. Describe the regional Program Review, Evaluation and Planning (PREP) process;
4. Summarize and reference special reviews for fisheries research programs that were done in a national perspective in 1981;
5. Provide an audit trail of organizational changes and of interpretation of programs by PAS categories;
6. Combine relevant material into a single report to serve as a database for subsequent analyses and responses to information requests.

Fisheries research programs in DFO are conducted largely by the Fisheries Research Branches (FRBs) in the Fisheries Management (FM) side of DFO. In FY 1981/82 there were six (6) FM regions with Fisheries Research Branches. The Great Lakes Biolimnology Laboratory at Burlington, Ontario, became part of the FM Ontario Region this fiscal year. In the Atlantic provinces a new Fisheries Management region (Gulf Region) was created to increase focus on the Gulf of St. Lawrence fisheries. The new region is based on the former Quebec Region and parts of the Maritimes and Newfoundland Regions. The reduced former Maritimes Region became the Scotia-Fundy Region. In 1981/82 the Gulf Region was still in a start-up phase and its Fisheries Research expenditures were in fact almost entirely those of Québec. In addition to the regional Fisheries Research Branches with program delivery responsibilities, there is a Fisheries Research Directorate (FRD) at Headquarters in Ottawa that has a coordination/advisory/policy role. The FM regions and the Fisheries Research Branches (1981 titles) with their research establishments are identified in Table I-1.

Fisheries Research can be defined in several ways. The broadest definition normally used includes all activities of the Fisheries Research Branches, plus any PAS 1.4 activities (see Appendix B) outside the FRBs, plus relevant vessel costs; this excludes any similar activities in OSS and in Fisheries Development. Another definition includes

all activities in FRBs plus relevant vessel costs; this encompasses some support functions (i.e. at the St. Andrews Biological Station, and at the Arctic Biological Station in St. Anne de Bellevue) and some operational ones (e.g. hatchery operations and habitat protection in the Atlantic Regions). Still another definition includes all PAS 1.4 activities (including those outside of FRBs) plus relevant vessel costs. The resource tables in Chapter III are arranged so that PY and $ data can be extracted for any of the above definitions.

The present document is organized into five chapters and four appendices. Chapter I provides the general framework, including notes on the organization and definition of fisheries research in DFO; Table I - 2 lists various reports/reviews that include descriptions of fisheries research programs at various levels of detail, both nationally and regionally. Chapter II provides an overall view of the highlights of the achievements of fisheries research during 1981.

Chapter III summarizes the PY and $ expenditures. Chapter IV summarizes achievements and thrusts in FRBs for each PAS 1.4 category. Chapter V references special reviews of fisheries research programs that were done in a national perspective in 1981.

Appendix A describes the FRB Program Review, Evaluation and Planning processes used in each region. Appendix B gives the definitions for all PAS categories, with additional detail for the PAS 1.4 activities, to the level of the fourth digit. Appendix C provides the audit trail of the PAS categories to which programs/projects are assigned. Appendix D lists the research publications for 1981 in three categories: primary, uncategorized, and secondary.

Table I-1. List of Fisheries Research Branches and their main research laboratories, by region. In the newly formed Gulf Region the research programs in PY 1981 were entirely those of Québec.

Region	1981 Branch Title	Establishment and Location
Newfoundland	Research and Resources Services Branch	- in NW Atlantic Fisheries Centre, St. John's Nfld.
Scotia-Fundy	Resource Branch	- parts of three divisions and the Director's office are in Regional HQ, Halifax, N.S. - Marine Fish Division, in Bedford Institute of Oceanography, Dartmouth, N.S. - Biological Station, St. Andrews, N.B.
Gulf (Québec)	Fisheries Research Branch	- Moncton Laboratory, Moncton, N.B. (No resources in 81/82) - Quebec Laboratory, Quebec, Que. - Arctic Biological Station, Ste. Anne de Bellevue, Quebec
HQ (NCR)	Resource Services Directorate	- (coordinating/advisory group in Ottawa)
Ontario	Great Lakes Biolimnology Laboratory	- in Canada Centre for Inland Waters, Burlington, Ontario
Western	Research and Resource Services Branch	- in Freshwater Institute, Winnipeg, Manitoba
Pacific	Resource Services Branch	- Biological Station, Nanaimo, B.C. - West Vancouver Laboratory, West Vancouver, B.C.

Table I-2. Annual Reviews and plans for fisheries research programs, at various levels of aggregation. The zero symbol (0) means that the report at the particular level is not produced for the particular region.

TYPE OF REPORT	REGION					
	PACIFIC	WESTERN	ONTARIO	GULF(1)	SCOTIA-FUNDY	NFLD.
1. DFO Annual Report	--In the FY 1981/82 report Fisheries Research is covered in 6 pages.					
2. National Plan For Fisheries Research 1981-1985 (Internal planning document)	--The plan contains 46 pages (plus 25 page appendix) in a national perspective.					
3. Fisheries Research Program Review, 1981 National Summary	--Annual summary (since 1979) of regional programs					
4. DG-level FM Regional Annual Reviews(2)	0	In prepar. (biennial)	0	3 pages on FRB	5 pages on FRB	13 pages on FRB
5. FRB Annual Reviews*	In prepar. 1981-82 (combined)	0	99 pages	0	(produces quarterly reports)	0

(1) In the newly formed Gulf Region the rsearch programs in FY 1981 were in fact those of Québec.

(2) Regular Annual Reviews (formerly called Annual Reports) for most fisheries research establishments ceased after 1975.

CHAPTER II

HIGHLIGHTS 1981

Activities in the field of Fisheries Research covered a broad spectrum of scientific investigations related to the Canadian marine and freshwater fishery resources and habitats, and the provision of biological advice required for their management. The main objectives were to develop and maintain a knowledge of the fisheries resources, including species interactions; to assess the effects of environmental factors and fishing on the resource base; to develop and maintain a knowledge base on the effects of contaminants and habitat alterations on aquatic resources; to investigate methods for the enhancement of those resources, including aquaculture; and to provide biological advice and professional services in the above areas.

Biological advice was provided directly to departmental resource managers in the Pacific and Freshwater sector, while in the Atlantic the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) continued to play a major role in the provision of biological advice. Staff were also actively involved in the scientific deliberations of international fisheries commissions on both coasts and the Great Lakes and in the scientific support of bilateral and multilateral negotiations.

Scientific data from Departmental fisheries research programs were used in the establishment of catch quotas, development of regulations, negotiation of intergovernmental agreements, design of enforcement programs and other areas of decision making within fisheries management. In addition, information and advice on the resource base were provided directly to the fishing industry and related enterprises. The biological monitoring of fishery species, population survey cruises, associated data analyses and population modelling of fishery resources constituted three quarters of the research effort in the three Atlantic regions. Advice was also provided to competing users of aquatic habitats on the potential effects of their activities on the aquatic environment.

The Fisheries Research Directorate in Ottawa functions as a coordinating/advisory/conceptual centre with a national perspective. It encourages innovation and emphasizes cost-effectiveness in evaluating ongoing and future fisheries research programs. The Directorate provided committee chairmen for the Canadian Atlantic Fisheries Scientific Advisory Council (CAFSAC), and the International Commission for the Conservation of Atlantic Tunas (ICCAT), and commissioners to the International Whaling and the Inter-American Tropical Tuna Commissions; organized a departmental workshop on trawl surveys; coordinated technology transfer to the private sector; coordinated and drafted a vessel acquisition strategy plan; conducted analyses supporting introduction of enterprise allocations for the Atlantic offshore groundfish industry, and was involved in planning the department's role in aquaculture development.

In the Newfoundland Region approximately 80 per cent of the research budget was committed to resource assessment activities, including population surveys, biological monitoring of fishery species, and modelling. Resulting stock assessments constituted the basis for scientific advice in managing the fisheries from coastal Newfoundland and the Grand Banks in the south, to the Labrador Sea and Davis Strait in the north.

An analysis of juvenile redfish recovered from stomachs of cod collected on the Flemish Cap over four years demonstrated the potential for determining, from predator stomach contents, the juvenile distribution and relative year-class success of major prey. For the first time significant numbers of juvenile flatfish were captured with the small-mesh shrimp trawl, enabling the standardization of gear and commencement of a time series for recruitment estimation. The 1981 herring sampling data indicated a change in the spawning type composition of herring stocks along the southeast coast of Newfoundland, possibly resulting from the reduction in stock size of spring spawners. Aerial surveys showed some potential for estimating capelin distribution in inshore waters. Research at the Comfort Cove experimental area provided the first documentation of annual fluctuations in standing stock, recruitment and growth in an American lobster population. An analysis of optimum substrate volume in monofilament and polyethylene collectors for use in scallop culture was completed. Various refinements were realized in the development of a harp seal population model and a systematic aerial survey of whales was carried out in the Newfoundland-Labrador area for the second consecutive season.

A major inventory and review of the sensitivity of headwater lakes in Newfoundland to acid rain was initiated. Several options were developed for reducing, by 20-60 per cent, the interception of salmon of non-Newfoundland and Labrador origin in the Newfoundland commercial fisheries. Winter temperature and egg deposition were used successfully to predict Atlantic salmon smolt year-class strength. An improved helicopter transport system for salmon fry was tested and proved to be extremely effective. Planning was completed for an enhancement program to more than double production of Atlantic salmon in Newfoundland. Sea trials of the hydroacoustic data-acquisition system (HYDAS) to permit computer analysis of fish echoes proved highly successful.

The two-ship survey on the Flemish Cap in 1981 represented a significant step towards testing specific study designs of standard ichthyoplankton surveys. Histopathological changes were discovered in the liver and gills of fish exposed to very low (i.e. 50 ppb) levels of Hibernia crude oil; it was also found that various lipids are changed by chronic oil exposure. The usefulness of MFO (mixed function oxidase) as a biological monitor was established. Newfoundland researchers collaborated in various national and international research advances in microbial chemistry and fish disease.

In the Scotia-Fundy Region the principal research thrust was directed toward stock assessment, habitat protection and resource enhancement, including aquaculture. Biological advice on various marine freshwater and diadromous species was provided to fisheries managers, management agencies, and various international fisheries organizations.

Salmonid investigations in New Brunswick were conducted on the Miramichi, Restigouche, and Saint John Rivers. Four major enhancement projects in Nova Scotia were carried out on the Liscomb, La Have, East (Sheet Harbour) and Medway River. Cooperative trout studies with other agencies were maintained and expanded. Catch-and-effort data collection for Atlantic salmon and gaspereau was expanded;electronic storage and analysis of this data were improved.

Updated advice on the management of the crustacean, molluscan, and marine plant resources was provided. This included a recommendation for an increased minimum legal size for lobster in certain districts. A survey of lobster fecundity and parasitism around the Maritimes was continued. The offshore lobster fishery was monitored. Production, distribution, and marketing data on Maritime lobsters were compiled in a discussion paper on the management of the fishery. Snow crab stock assessments, sampling technique development, and stock discrimination studies were continued. Baseline surveys for deep-sea red crab and Jonah crab along the Scotian Shelf between Browns Bank and Banquereau Bank were completed. Marine plants research included Irish Moss and kelp biomass estimates, harvesting strategy studies, and assessment of the importance of macrophytes to commercial animal species. A massive sea urchin die-off was surveyed and control methods for the species investigated. Scallop population studies were conducted on Georges Bank, on the Scotian Shelf, in the Bay of Fundy and in Northumberland Strait. Biological data on squid (Illex illecebrosus) were collected through domestic research cruises, and through joint cruises with France and the U.S.S.R. New approaches to data analysis were developed which promise an improved understanding of squid population dynamics. Exploratory surveys of underexploited molluscan species identified concentrations of ocean quahog and hard shell clam. An assessment of the important oyster population of Caraquet Bay, New Brunswick, was completed; federal-provincial cooperation on the Caraquet Bay Oyster Development Project was continued. Blue mussel and oyster spat settlements were monitored and studied to provide scientific advice to the aquaculture industry.

A large body of biological and statistical data collected by DFO research vessels, by the International Observers Program, and by observers deployed aboard domestic vessels was used to prepare stock assessments of groundfish and pelagic species. A juvenile silver hake survey on the Scotian Shelf involving the R.V. Lady Hammond and the U.S.S.R. vessel Ekliptika was completed. The Scotian Shelf Ichthyoplankton Program (SSIP) provided data on the early life history stages of the major commercial species. Grey seal migration patterns and population structure and trends were studied as a basis for management advice. Applied fisheries ecology research included a study of the origin of the Fundy Basin shad stock, positive identification of Pacific coho salmon in the Bay of Fundy, investigation of herring behaviour and the effects of Miramichi dredging on fish populations and fishing success. Studies on lobster biology focussed on larval survival, egg predation, nutrition, long-term growth and reproduction. Research was also conducted on salmon aquaculture, and the effects of low pH on survival and recruitment of Atlantic salmon.

In the newly-formed Gulf Region the year was marked by reorganization and establishment of new programs to meet the needs of the Region while at the same time continuing ongoing research programs in Québec. In effect, research achievements for the year can be attributed to Québec, while other relevant work was still not transferred from the Newfoundland and Scotia-Fundy Regions. Management advice was provided on the basis of impact studies and population assessments; longer-term studies yielded improvements in stock assessment methodology, and increased understanding of certain marine communities. Emphasis was on improved herring abundance estimates and recovery prediction, discrimination of capelin stocks, and determination of the possible impact of cod abundance on snow crab production. Studies of 200 lakes and 30 salmon rivers were conducted as part of a 3-year program on determining the chemical and biological impact of acid rain. The effects of acidification on vital processes, such as egg and fry development of speckled trout, were also studied. The environmental impact of marsh reclamation structures (aboiteau) on the flats of the St. Lawrence, and dredging in the Grande Entrée lagoon of the Magdalen Islands were also investigated. Local benthic communities on the lower north shore of the Magdalen Islands were studied in anticipation of ecological changes resulting from hydroelectric developments in the local rivers. Gross assessment of lobster production in the lagoons of the Magdalen Islands was completed and studies of larval drifting and depth preference were initiated. Analysis of data from observations on cetacean strandings, particularly in the northwest Atlantic and around New Zealand, were completed. The conclusion that mass mortalities serve as a population-regulation mechanism was prepared for presentation in a scientific report of the Whales Research Institute, Tokyo. A detailed history of whaling on Canada's east coast was completed. A study of the depletion of beluga whale populations in Hudson's Bay and Ungava Bay suggested that these populations are threatened if whaling operations continue at present levels. A detailed study of northwest Atlantic commercial whaling catch/effort data was completed.A number of papers and working documents relevant to Canadian and international whaling concerns were prepared for the International Whaling Commission meetings and other seminars and workshops.

In the Ontario Region an exploratory fishing survey was conducted in Lake Superior to assess the feasibility of a commercial fishery for the pink salmon, an accidental introduction to the Great Lakes. Further investigations on the biology of the pink salmon, size of stocks and effectiveness of alternative harvesting techniques were initiated. The primary focus of the Great Lakes Fisheries Research Branch was the understanding and amelioration of problems of habitat deterioration through chemical contamination. Research was directed at assessing the distribution of chemical pollutants in fish and identifying the sources of contamination. Confirmation of the presence of the highly toxic dioxin in fish from Lake Ontario further emphasized the need for improved control of chemical dump sites in the Niagara River area. Surveillance studies were conducted to measure the health of lakes. Laboratory toxicology studies contributed to an overall understanding of the effects of chemical substances on fish health and reproductive success. Extensive studies were done on the impact of acid rain on fish populations in Ontario, the data contributing significantly to Canada-U.S. negotiations on air borne contaminants.

In the Western Region studies were conducted on certain experimental lakes toward understanding the ecological implications of the contamination of natural freshwater systems by acid precipitation, heavy metals and radionuclides. As a result, the early stages of the lake acidification process, in both stratified and unstratified systems, were documented in detail and concomitant key organisms and processes were identified. At South Indian Lake in northern Manitoba the effects on the fishery of the impoundment of Southern Indian Lake and the diversion of the Churchill River for hydroelectric development were studied. Limnocorral experiments were continued toward determining key sources, processes and organisms in the post-impoundment mercury contamination of the lake system. Pollutant research continued on synthetic pyrethroid insecticides, on a dioxin compound associated with the widely-used herbicide 2,4-D, the forestry pesticide fenitrothion, and a series of aromatic hydrocarbons, nuclear reactor coolant and oil-dispersant mixtures. A major review of organic and inorganic pollutants in Arctic marine mammals was prepared for the International Council for the Exploration of the Sea (ICES). Long-term investigations on arctic charr ecology and productivity, lake whitefish population genetics, nutrition of hatchery-reared fish, water chemistry and pothole lake culture entered their final phase. The fish pathology unit continued research and diagnostic investigation of diseases of trout, lake whitefish and walleye. Fisheries resource inventories and habitat assessments continued along the southern coast of the Beaufort Sea in anticipation of increased industrial activity in the area. The second year of a monitoring program in the vicinity of Nanisivik Mine (Baffin Island) was completed. The Research Branch continued its involvement in Departmental and inter-departmental policy coordination on northern resource development projects and environmental regulations.

The Western Region has begun a redirection of its activities and a reorganization aimed to increase emphasis on the Arctic. Significant components of research in aquaculture, freshwater fisheries ecology and toxicology were phased out.

Highlights of Pacific Region Fisheries Research Branch activities included significant advances in non-linear estimations which have led to a revised growth model for fish. The separation of chum salmon stocks in a mixed gauntlet fishery was developed using a combination of morphometric and electrophoretic discriminators. Sockeye salmon stocks within the Barkley Sound fishery were identified and traced through the examination of test fishery samples for internal parasite tags. The method was refined to provide real-time stock analysis as a basis for fisheries management decisions.

Studies continued on the size and timing of release for juvenile hatchery-reared chinook and coho salmon. Results indicate that with control of these two factors the rate of return can be increased three to ten times. A further refinement has the added advantage of limiting the percentage of precocious males or "jacks", which are virtually worthless to the fishery and genetically damaging to the brood stock. A survey of fleet dynamics of the west coast troll fishery was initiated. Data collected from on-board observers were complemented by time-lapse

photography of radar images. Data on fleet movements and fishing success are now being analyzed in relation to oceanographic conditions, especially thermal fronts as determined by satellite imagery analysis.

The first year of a three-year project to study the feasibility of impounding herring for the roe fishery was highly successful. Herring captured and transported to floating sea pens some months before the onset of natural spawning were held with great success; mortalities were low and spawning was inhibited. Mature herring with a high roe-to body weight ratio were maintained in peak condition for a six week period. The results from this year's work already point the way towards an alternative harvesting strategy for this most valuable fishery.

PAS 1.4 Activities Outside FRBs

In the Pacific Region two groups are identified as doing fisheries research (PAS 1.4) outside the Fisheries Research Branches. Some salmon Enhancement Program (SEP) Research was financed by SEP but carried out through the Fisheries Research Branch. The research done within SEP is not covered in this report.

In the Pacific Region's Field Services Branch three Management Biology Units do local assessments of salmon and herring runs, and shellfish stocks. They also provide short-term management advice for regulating the salmon and herring, and shellfish fisheries. A fourth biology unit carries out work in habitat protection.

CAFSAC

The role of the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) can be summarized as follows:

- to provide scientific advice on fisheries management, taking into account all stocks of interest to Atlantic coast fishermen;
- to serve as a focus for the development of fisheries resource management science; and
- to serve as a partial forum for development of proposals for cooperative research and scientific monitoring of foreign fishing in the NW Atlantic.

The eight sub-committees of CAFSAC are Groundfish; Pelagic; Marine Mammals; Invertebrates and Marine Plants; Anadromous, Catadromous, and Freshwater Fisheries; Statistics, Sampling and Surveys; Marine Environmental and Ecosystems; and Aquaculture. These sub-committees convened on 24 occasions during 1981.

The Activities and outputs of CAFSAC for 1981 are described in the CAFSAC Annual Report, Vol. 4, 1981. A list of stocks for which CAFSAC provided scientific advice to management in 1981 is given in Table II-1.

A special Joint Meeting of CAFSAC Subcommittees was held in March on Standardization of Assessment Techniques. The purpose was to comment on the advantages and shortcomings of particular assessment methodologies, and to provide guidance on the most appropriate input parameters and techniques for various types of analyses. It was decided to capitalize on this initiative, and planning has begun for the production of a CAFSAC stock assessment manual.

Table II-1. List of stocks for which CAFSAC reviewed the status or provided scientific advice in 1981.

Species	No. of stocks*	
Altantic salmon -Labrador	?	
-Newfoundland	?	
-Maritimes	3	
Alewife/Blueback Herring	2	
Freshwater and Diadromous		7+
Cod	10	
Haddock	2	
Pollock	1	
Redfish	7	
American Plaice	5	
Witch	4	
Greenland Halibut	3	
Yellowtail	1	
Flatfish	1	
Roundnose Grenadier	2	
Silver Hake	1	
White Hake	1	
Argentine	1	
Groundfish		39
Herring	8	
Mackerel	1	
Capelin	1	
Bluefin Tuna	1	
Swordfish	1	
Pelagics		12
Harp Seal**	?	
Hooded Seal**	1	
Whales	2	
Grey Seal	1	
Marine Mammals		5+
Scallops	2	
Lobster	1	
Shrimp	5	
Snow Crab	4	
Irish Moss	2	
Oysters	1	
Bar Clams	1	
Invertebrates and Marine Plants		16
TOTAL*		79+

* This represents a minimum, since in some cases a number of separate sub-stocks are assessed as part of one stock complex.

** Ultimately the scientific advice for harp seals and hooded seals was provided through the North Atlantic Fisheries Organization (NAFO).

CHAPTER III

FY 1981/82 EXPENDITURES

This chapter summarizes the PY-$ expenditures for the Fisheries Research Branches (FRBs) in six regions and for the Fisheries Research Directorate (FRD) at Headquarters in Ottawa. In addition it displays PAS 1.4 (see definitions in Appendx II) activities and fisheries research vessel expenditures in DFO units outside FRBs. Excluded are some research activities in Fish Inspection and Technology and in Fisheries Development programs, and fisheries research activities performed by the Ocean Science and Surveys (OSS) side of the Department. Resource data are for the fiscal year (April 1 to March 31), while achievements (in Chapters IV and V) are for the calendar year (January 1 to to December 31).

In FY 1981/82 the PAS was used in the DFO financial reporting for the first time. Some reinterpretation of what activities are assigned to what PAS categories has been done beyond what is shown in the 1981/82 financial coding manual.

The overall fisheries research expenditures as per the above statement of inclusions, are summarized in Table III-1, below.

Table III-1 National fisheries research expenditures in FY 1981/82. The numbers in brackets are for the previous FY (1980/81); % is the percentage increase between the two years.

PAS	DESCRIPTION	PY		%	$('000)		%
Fisheries Research Branches							
1.4.0	Research Management	(48)	59	23	(2,570)	3,464	35
1.4.1	Resource Assessment	(434)	482	11	(20,040)	23,179	16
1.4.2	Aquaculture/Enhancement	(143)	122	-15	(5,187)	5,332	3
1.4.3	Fish Habitat Research	(170)	201	18	(7,308)	10,554	44
1.4 Total in FRBs		(795)	864	9	(35,105)	42,529	21
Other PAS in FRBs		(146)	153	5	(11,051)	13,158	19
FRB TOTAL		**(941)**	**1,016**	**8**	**(46,156)**	**55,687**	**20**
1.4 Outside FRBs		(51)	52	2	(3,190)	3,359	5
Research Vessels external to FRBs		(77)	99	29	(15,475)	10,621	-31
TOTAL FISHERIES RESEARCH		**(1,069)**	**1,167**	**9**	**(64,821)**	**59,667**	**7**

The total fisheries research resources in FY 1981/82 show an increase of 98 PY (9%) and $4.8 million (7%) over the previous year. Of the PY increase, 41 represent the Fisheries Research Branch in the Ontario Region which in previous years was not costed as part of fisheries research. Other substantial increases were 17 PY in the Scotia-Fundy and Quebec regions representing an increased fisheries focus on the Gulf of St. Lawrence; 12 PY in the Pacific Region representing mainly an increased focus on resource assessments; and 22 PY in vessel support in the Scotia-Fundy and the hitherto-uncounted Ontario Region. The dollar resources (and program achievements) for the Fisheries Research Branches are described in greater detail in Chapter IV.

A further breakdown of the FY 1981/82 expenditures is given in the 12 tables (table III-2 to III-13), as follows:

Table III-2 - Overall fisheries research, by region;
Table III-3 - Fisheries Research Branch totals, by region;
Table III-4 - PAS 1.4 expenditures, by region;
Table III-5 - Fisheries research vessels, by region;
Table III-6 - National fisheries research, by PAS;
Tables III-7 to III-13 - Fisheries research for each region, by PAS.

In these tables the Support Services (PAS 1.1.2) functions are shown variously; this reflects different administrative arrangements in different regions. In general the administrative services (finance, personnel, purchasing, maintenance) and libraries are costed to accounts outside the FRBs (except at the St. Andrews Biological Station and the Arctic Biological Station, and the fisheries library in Newfoundland). Some other support functions such as electronic data processing (EDP) and secretarial support are administered differently in different regions. Research vessel expenditures are described in greater detail in Table III-5.

Data on resources from sources outside DFO are incomplete; where available they are shown at the end of the regional tables (table III-7 to III-13).

Resource expenditures and narratives on achievements by program area (PAS) are presented in Chapter IV.

Table III-2 Overall fisheries research expenditures in FY 1981/82, by region. This includes all expenditures in the Fisheries Research Branches, all PAS 1.4 items external to FRBs, and all fisheries research vessel expenditures external to FRBs. Dollars are expressed in thousands.

REGION	PY	SAL	O&M	CAP	TOTAL$
Newfoundland	239	6,979	10,232	368	17,579
Scotia-Fundy	409	11,481	9,248	973	21,702
Gulf (Québec)	55	1,661	1,752	94	3,507
Headquarters	18	629	690	3,650	4,969
Ontario	56	1,716	1,046	104	2,866
Western	153	4,489	2,136	229	6,854
Pacific	237	7,349	4,293	548	12,190
TOTAL FISHERIES RESEARCH	**1,167**	**34,304**	**29,397**	**5,966**	**69,667**

These data exclude the cost of buildings/grounds and their maintenance (except maintenance at the St. Andrews Biological Station and the Arctic Biological Station). The data do include expenditures for fisheries research vessels (including major capital for vessel construction). Other support services are accounted for variously. The St. Andrews Biological Station and the Arctic Biological Station each maintains its own workshop, library and financial/personnel/ purchasing services. FRB in the Newfoundland Region operates a library and an in-house computing facility. At other locations such in-house services, where available within DFO, are provided by the regional Support Services Branches.

Table III-3 Fisheries Research Branch expenditures in FY 1981/82, by region. Dollars are expressed in thousands.

REGION	PY	SAL	O&M	CAP	TOTAL$
Newfoundland	203	5,926	9,335	365	15,626
Scotia-Fundy	387	10,769	6,486(a)	965	18,220(a)
Gulf	55	1,661	1,752	94	3,507
Headquarters	18	629	690	0	1,319
Ontario	41	1,302	816	104	2,222
Western	153	4,489	2,136	229	6,854
Pacific(b)	159	5,225	2,399	315	7,939
TOTAL in FRB(c)	**1,016**	**30,001**	**23,614**	**2,072**	**55,687**

(a) The Scotia-Fundy expenditures do not include $2,437 K for charter of vessels paid from accounts external to FRB. In addition, all regions, except Gulf and Western, had use of DFO-owned vessels costed in accounts external to FRB (see Table III-5).

(b) In the Pacific Region the SEP Research (including biological evaluation of lake enrichment) and the Biology Units in the Field Services Branch are excluded from this table.

(c) Aside from (a) and (b), the difference between this table and Table III-2 is in the research vessel expenditures costed outside the FRBs.

Table III-4 PAS 1.4 expenditures in FY 1981/82, by region. Dollars are expressed in thousands.

REGION	PY	SAL	O&M	CAP	TOTAL $
Fisheries Research Branch					
Newfoundland	198	5,817	3,723	363	9,903
Scotia-Fundy	267	7,745	4,344	589	12,678
Gulf	48	1,499	1,191	94	2,784
Headquarters	16	549	650	0	1,199
Ontario	39	1,266	723	103	2,092
Western	137	3,956	1,793	185	5,934
Pacific	159	5,225	2,399	315	7,939
PAS 1.4 Total in FRBs	**864**	**26,057**	**14,823**	**1,649**	**42,529**
PAS 1.4 External to FRBs(1)					
SEP Research	10	235	250	15	500
Lake Enrichment	6	145	433	20	598
Biol. Units in Field Services Branch	36	1,116	952	193	2,261
PAS 1.4 External Total	**52**	**1,496**	**1,635**	**228**	**3,359**
TOTAL PAS 1.4	**912**	**27,553**	**16,458**	**1,877**	**45,888**

(1) All the rsources PAS 1.4 external to FRBs are in the Pacific Region.

Table III-5 Fisheries Research Vessel expenditures in FY 1981/82.

REGION	PY	SAL	O&M	CAP	TOTAL $
Newfoundland					
DFO (FRB)	0	0	0	0	0
DFO (ext.)	36.0	1,053	897	3	1,953
Charters (FRB)*	0	0	5,750	0	5,750
Charters (ext.)	0	0	0	0	0
TOTAL	**36.0**	**1,053**	**6,647**	**3**	**7,703**
Scotia-Fundy					
DFO (FRB)	6.3	197	80	0	277
DFO (ext.)	22.3	712	325	8	1,045
Charters (FRB)*	0	0	840	0	840
Charters (ext.)	0	0	2,437	0	2,437
TOTAL	**28.6**	**909**	**3,682**	**8**	**4,599**
Gulf (Québec)					
DFO (FRB)	0	0	10	0	10
DFO (ext.)	0	0	0	0	0
Charters (FRB)*	0	0	360	0	360
Charters (ext.)	0	0	0	0	0
TOTAL	**0**	**0**	**370**	**0**	**370**
Ships Branch (HQ)					
Vessel Construction	**0**	**0**	**0**	**3,650**	**3,650**
Ontario					
DFO (ext.)**	**14.2**	**414**	**230**	**0**	**644**
Western	--------- no vessel expenditures --------				
Pacific					
DFO (FRB)	0	0	0	0	0
DFO (ext.)	26.6	628	259	5	892
Charters (FRB)*	0	0	455	0	455
Charters (ext.)	0	0	0	0	0
TOTAL	**26.6**	**628**	**714**	**5**	**1,347**
Vessel Construction	0	0	0	3,650	3,650
DFO-owned (FRB)	6.3	197	80	0	277
DFO-owned (ext.)	99.1	2,807	1,711	16	4,534
Charters (FRB)	0	0	7,405	0	7,405
Charters (ext.)	0	0	2,437	0	2,437
TOTAL VESSELS	**105.4**	**3,004**	**11,633**	**3,666**	**18,803**

* This includes $1,530K short-term charters ($235K in Nfld; $840K in S-F, $455K in Pacific) that, in the regional tables, are shown within the PAS 1.4 program costs.

** The vessel resources shown for Ontario are provided by and costed in OSS.

Table III-6 NATIONAL FY 1981/82 expenditures, by PAS

PAS		PY	SAL	O&M	CAP	TOTAL $
Fisheries Research Branches - PAS 1.4						
1.4.0.0	Management	59.3	1,838	1,313	313	3 464
1.4.1.0	Assessment	13.0	271	243	47	561
1.4.1.1	Diadr. & F.W.	110.7	2,995	1,247	167	4,409
1.4.1.2	Groundfish	125.0	3,763	1,427	70	5,260
1.4.1.3	Invertebrates	77.9	2,181	1,123	103	3,407
1.4.1.4	Marine Mammals	27.1	875	1,055	8	1,938
1.4.1.5	Marine Plants	5.0	167	259	24	450
1.4.1.6	Pelagic Fish	73.3	2,376	1,388	105	3,869
1.4.1.7	Ecology	49.6	1,649	1,559	77	3,285
1.4.1 Subtotal		481.6	14,277	8,301	601	23,179
1.4.2.0	Aquac./Enh.	3.5	129	29	0	158
1.4.2.1	Aquaculture	37.2	1,245	387	37	1,669
1.4.2.2	Enhancement	81.5	2,500	919	86	3,505
1.4.2 Subtotal		122.2	3,874	1,335	123	5,332
1.4.3.0	Habitat	7.0	182	86	25	293
1.4.3.1	Aquatic Impact	58.6	1,647	744	67	2,458
1.4.3.2	Toxicol./Poll.	134.9	4,239	3,044	520	7,803
1.4.3 Subtotal		200.5	6,068	3,874	612	10,554
PAS 1.4 Total in FRBs		**863.6**	**26,057**	**14,823**	**1,649**	**42,529**
Fisheries Research Branches - other PAS						
FRD (HQ) Dir.Gen.(PAS 1.1.1)		2.4	80	40	0	120
Support Services (PAS 1.1.2)		46.7	1,096	1,261	179	2,536
Research Vessels (PAS 1.1.3.3)						
DFO owned		6.3	197	566	8	771
Charters		0	0	5,875	0	5,875
Shellfish Leasing (PAS 1.5.1)		3.0	76	32	0	108
Habitat Management (PAS 1.5.2)		33.4	1,057	476	87	1,620
Resource Rehabilitation and Enhancement (PAS 1.5.3)		61.0	1,438	541	149	2,128
FRB TOTAL		**1,016.4**	**30,001(a)**	**23,614**	**2,072**	**55,687**

NATIONAL (cont'd)

PAS	PY	SAL	O&M	CAP	TOTAL $
PAS 1.4 outside FRBs					
SEP Research(b)	16.0	380	683	35	1,098
Field Services Branch(c)	35.9	1,116	952	193	2,261
Research Vessels external to FRB accounts (PAS 1.1.3.3)					
Vessel construction	0	0	0	3,650	3,650
DFO Owned	99.1	2,807	1,711	16	4,534
Charters	0	0	2,437	0	2,437
TOTAL FISHERIES RESEARCH	**1,167.4**	**34,304**	**29,397**	**5,966**	**69,667**

(a) COSEP salaries are included within programs.

(b) SEP Research in the Pacific Region (includes biological evaluation of Lake Enrichment) comprises 0.5 PY, 12 SAL, 13 O&M and 1 CAP in PAS 1.4.1.1, and 15.5 PY, 368 SAL, 670 O&M 34 CAP in PAS 1.4.2.2.

(c) The Pacific Field Services Branch biological activities are assigned to PAS 1.4.1.1, 1.4.1.3 and 1.4.1.6 in the ratio of 80:5:15.

Table III-7 NEWFOUNDLAND: FY 1981/82 expenditures by PAS

PAS		PY	SAL(a)	O&M	CAP	TOTAL $
Fisheries Research Branch - PAS 1.4						
1.4.0	Management(a)	21.4	639	557	65	1,261
1.4.1.	Resource Assessment and Related Research	137.6	4,133	2,166(c)	205	6,504
1.4.2	Aquaculture & Resource Dev't Research	24.0	625	400	61	1,086
1.4.3	Habitat Assessment and Related Research	15.2	420	600	32	1,052
PAS 1.4 Total in FRB		**198.2**	**5,817**	**3,723**	**363**	**9,903**
Fisheries Research Branch - other PAS						
Library (PAS 1.1.2)		5.0	109	97	2	208
Research Vessels (PAS 1.1.3)						
Charters (d)		0	0	5,515	0	5,515
FRB TOTAL		**203.2**	**5,926**	**9,335**	**365**	**15,626**
PAS 1.4 outside FRB		0	0	0	0	0
Research Vessels external to FRB accounts (PAS 1.1.3.3)						
DFO-owned		36.0	1,053	897	3	1,953
TOTAL FISHERIES RESEARCH		**239.2**	**6,979**	**10,232**	**368**	**17,579**
Resources from outside DFO						
COSEP(b)		14.5	0	0	0	0

(a) Includes the Branch Director, Scientific Program Coordinator, Executive Assistant, secretarial staff, scientific computing and technical services.

(b) COSEP dollars are included in the salary of recipient projects.

(c) 58K O&M is from Student Employment Program (45K in PAS 1.4.1.1 and 13K in PAS 1.4.2.2.).

(d) Additional small charters, totalling $235K, are included as part of the program expenditures under PAS 1.4.

Table III-8 SCOTIA-FUNDY: FY 1981/82 expenditures, by PAS

PAS		PY	SAL	O&M	CAP	TOTAL $
Fisheries Research Branches - PAS 1.4						
1.4.0	Management(a)	12.7	379	153	80	612
1.4.1	Resource Assessment and Related Research	175.9(b)	4,829(c)	2,641	194	7,664
1.4.2	Aqaculture & Resource Dev't Research	39.6	1,312	604	24	1,961
1.4.3	Habitat Assessment and Related Research(d)	38.4	1,163	946	291	2,441
PAS 1.4 Total in FRB		**266.6**	**7,745**	**4,344**	**589**	**12,678**
Fisheries Research Branch - other PAS						
Support Services (PAS 1.1.2)						
	St. Andrews(e)	32.7	789	880	66	1,735
	Solar-heat installation(f)	0	0	0	110	110
Research Vessels (PAS 1.1.3.3)(g)						
	DFO-owned	6.3	197	556(k)	8	761
Shellfish Leasing (PAS 1.5.1)		3.0	76	32	0	108
Habitat Management (PAS 1.5.2)		17.4	524	133	43	700
Resource Rehabilitation & Enhancement (PAS 1.5.3)		61.0	1,438	541	149	2,128
FRB TOTAL		**387.0**	**10,769**	**6,486**	**965**	**18,220**
PAS 1.4 outside FRB		0	0	0	0	0
Research Vessels external to FRB accounts (PAS 1.1.3.3)						
DFO-owned(h)		22.3	712	325	8	1,045
Charters(i)		0	0	2,437	0	2,437
TOTAL FISHERIES RESEARCH		**409.3**	**11,481**	**9,248**	**973**	**21,702**
Resources from outside DFO						
COSEP		21.0	0	0	0	0
Provincial Employment Program		9.8	66	13	0	79
Nova Scotia Department of Fisheries		6.4	39	29	0	68
Nova Scotia Energy Research Council		0.5	6	0	0	6
Prince Edward Island Employment Program		0.3	5	0	0	0

SCOTIA-FUNDY (Cont'd)

PAS	PY	SAL	O&M	CAP	TOTAL $
Resources from outside DFO (cont'd)					
Post Doctoral Fellowships(j)	2.0	-	-	-	-
CANUSA	0	0	21	0	21
Moncton University	1.0	13	2	0	15
Tidal Power Co.	0	0	25	0	25
Energy Conservation Program	0	0	0	6	6
Polycyclic Aromatic Hydrocarbons Emergency	0	0	23	25	48

(a) Includes Office of the Branch Director (6.0 PY), Freshwater and Anadromous Division administration (6.7 PY) and the financial resources for the Director FES at St. Andrews. The 1 PY for the Director of FES is prorated into 1.4.1, 1.4.2 and 1.4.3.

(b) Includes 7.5 PY for the Marine Fish Division and 2 PY for CAFSAC, Salaries for CAFSAC are prorated into Marine Fish Division Activities.

(c) PAS 1.4.1.3 and PAS 1.4.1.7 includes $39K and $5K O&M Summer Student Employment resources respectively.

(d) This includes acid rain studies (5 PY, 120 SAL, 537 O&M and 120 CAP).

(e) Includes station administration, finance, personnel, purchasing, word processing, registry, all secretaries, workshops (including electronics and plumbing), maintenance, marine technology, library, graphics and computing. Excludes research vessels.

(f) Installation of solar heating system to heat sea water for fish holding was paid for by special energy funds.

(g) Short-term charters ($840K) are included under FRB program costs, mostly under PAS 1.4.1.2, 1.4.1.3, 1.4.1.6, 1.4.1.7, 1.4.3.1, and 1.4.3.2.

(h) Includes 7.3 PY and $248K SAL for R.V. ALFRED NEEDLER.

(i) Charter cost for R.V. LADY HAMMOND.

(j) Salary costs are included in program O&M budget.

(k) $476K of this is for short-term charters.

Table III-9 GULF (Québec): FY 1981/82 expenditures by PAS

PAS		PY	SAL	O&M	CAP	TOTAL $
Fisheries Research Branch - PAS 1.4						
1.4.0	Management(a)	6.0	213	135	46	394
1.4.1	Resource Assessment and Related Research	33.9	1,095	679	0	1,774
1.4.2	Aquaculture & Resource Dev't Research	0	0	0	0	0
1.4.3	Habitat Assessment and Related Research	7.7	191	377	48	616
PAS 1.4 Total in FRB		**47.6**	**1,499**	**1,191**	**94**	**2,784**
Fisheries Research Branch - other PAS						
Support Services at ABS (PAS 1.1.2)		7.0	162	191	0	353
Research Vessels (PAS 1.1.3.3)						
DFO-owned		0	0	10	0	10
Charters		0	0	360	0	360
FRB TOTAL		**54.6**	**1,661**	**1,752**	**94**	**3,507**
PAS 1.4 outside FRB		0	0	0	0	0
Research Vessels external to FRB accounts (PAS 1.1.3.3)		0	0	0	0	0
TOTAL FISHERIES RESEARCH		**54.6**	**1,661**	**1,752**	**94**	**3,507**
Resources from outside DFO						
COSEP		10.1	-	-	-	-
Other(b)		0	0	71	0	71

(a) Includes office of the Branch Director (4PY) and Director of the Arctic Biological station (2PY).

(b) Support to Arctic Biological Station: $9K from EAMES and $62K from Mobil Oil.

Table III-10 HEADQUARTERS: FY 1981/82 expenditures by PAS

PAS		PY	SAL	O&M	CAP	TOTAL $
Fisheries Research Directorate - PAS 1.4						
1.4.0	Management(a)	5.2(a)	153	176(b)	0	329
1.4.1	Resource Assessment and Related Research	7.0	267	445(c)	0	712
1.4.2	Aquaculture & Resource Dev't Research	3.5	129	29	0	158
1.4.3	Habitat Assessment and Related Research	0	0	0	0	0
PAS 1.4 Total IN FRD		**15.7**	**549**	**650**	**0**	**1,199**
Fisheries Research Directorate - other PAS						
Office of the Director General (PAS 1.1.1)		2.4	80	40	0	120
FRD TOTAL		**18.1**	**629**	**690**	**0**	**1,319**
PAS 1.4 outside FRB		0	0	0	0	0
Research Vessels external to FRD accounts (PAS 1.1.3.3)						
Vessel Construction		0	0	0	3,650	3,650
TOTAL FISHERIES RESEARCH		**18.1**	**629**	**690**	**3,650**	**4,969**
Resources from outside DFO						
COSEP(d)		.3	-	-	-	-

(a) Includes the Director and secretary of Resource Research Branch (2.0 PY) and the Research Planning and Analysis Group (3.2 PY).

(b) Includes $150K grant to the Marine Science Research Laboratory in Newfoundland.

(c) Includes $100K contribution to the Committee on Seals and Sealing.

(d) COSEP salary included within program.

Table III-11 ONTARIO: FY 1981/82 expenditures by PAS

PAS		PY	SAL	O&M	CAP	TOTAL $
Fisheries Research Branch - PAS 1.4						
1.4.0	Management(a)	4.0	153	27	0	180
1.4.1	Resource Assessment and Related Research	11.2	339	228	31	598
1.4.2	Aquaculture & Resource Dev't Research	0	0	0	0	0
1.4.3	Habitat Assessment and Related Research	24.3	774	468	72	1,314
PAS 1.4 Total in FRB		**39.5**	**1,266**	**723**	**103**	**2,092**
Fisheries Research Branch - other PAS						
Support Services (PAS 1.1.2)		2.0	36	93	1	130
FRB TOTAL		**41.5**	**1,302**	**816**	**104**	**2,222**
PAS 1.4 outside FRB		0	0	0	0	0
Research Vessels external to FRB accounts (PAS 1.1.3.3)						
DFO-owned (OSS)		14.2	414	230	0	644
TOTAL FISHERIES RESEARCH		**55.7**	**1,716**	**1,046**	**104**	**2,866**
Resources from outside DFO						
DOE (GLWQA) (b)		0	0	64	22	86
COSEP(c)		5.0	-	-	-	-

(a) This includes the Director, Senior Scientist, and two secretaries.

(b) Of the Great Lakes Water Quality Agreement funding, 10K CAP is in PAS 1.4.0.0; the remainder in PAS 1.4.3.2.

(c) COSEP salaries are included within recipient programs.

Table III-12 WESTERN: FY 1981/82 expenditures by PAS

PAS		PY	SAL	O&M	CAP	TOTAL $
Fisheries Research Branch - PAS 1.4						
1.4.0	Management[a]	3.0	103	32	23	158
1.4.1	Resource Assessment and Related Research	23.0	609	379	14	1,002
1.4.2	Aquaculture & Resource Dev't Research	17.1	473	146	0	619
1.4.3	Habitat Assessment and Related Research	93.9	2,771	1,236	148	4,155
PAS 1.4 Total in FRB[b]		**137.0**	**3,956**	**1,793**	**185**	**5,934**
Fisheries Research Branch - other PAS						
Habitat Management (PAS 1.5.2)		16.0	533	343	44	920
FRB TOTAL		**153.0**	**4,489**	**2,136**	**229**	**6,854**
PAS 1.4 outside FRB		0	0	0	0	0
Research Vessels external to FRB accounts (PAS 1.1.3.3)		0	0	0	0	0
TOTAL FISHERIES RESEARCH		**153.0**	**4,489**	**2,136**	**229**	**6,854**

(a) Includes 1 PY for the Director of FRB and 2 PY for Fisheries Resources Administration.

(b) All Support Services are outside of FRB accounts. No crewed research vessels or chartered vessels were used.

Table III-13 PACIFIC: FY 1981/82 expenditures by PAS

PAS		PY	SAL	O&M	CAP	TOTAL $
Fisheries Research Branch - PAS 1.4						
1.4.0	Management[a]	7.0	198	233	99	530
1.4.1	Resource Assessment and Related Research	93.0	3,005	1,763	157	4,925
1.4.2	Aquaculture & Resource Devel. Research	38.0	1,314	156	38	1,508
1.4.3	Habitat Assessment and Related Research	21.0	708	247	21	976
PAS 1.4 Total in FRB		**159.0**	**5,225**	**2,399**	**315**	**7,939**
Fisheries Research Branch - other PAS		0	0	0	0	0
FRB TOTAL[b]		**159.0**	**5,225**	**2,399**	**315**	**7,939**
PAS 1.4 outside FRB						
SEP Research						
5% PAS 1.4.1		0.5	12	13	1	26
95% PAS 1.4.2		9.5	223	237	14	474
Lake Enrichment 1.4.2		6.0	145	433	20	598
SEP Research Total		16.0	380	683	35	1,098
Field Services Branch[c]		35.9	1,116	952	193	2,261
Research Vessels external to FRB accounts (PAS 1.1.3.3)[d]						
DFO-owned		26.6	628	259	5	892
TOTAL FISHERIES RESEARCH		**237.5**	**7,349**	**4,293**	**548**	**12,190**

(a) Includes the Branch Director, Science Coordinator, Associate Director, Information Officer, 2 Illustrators, 2 Secretaries.

(b) Support Services are outside FRB accounts and not included here.

(c) The resources for the five biological units (Management Biology Support Units for North Coast Sub-Region, South Coast Sub-Region, Fraser River Yukon Sub-Region, Salmon Coordinator and Herring Coordinator are assigned to PAS 1.4.1.1, 1.4.1.3 and 1.4.1.6 in the ratio of 80:5:15.

(d) Short term charters under $50K (totalling $455K) are included under program costs.

CHAPTER IV

PROGRAMS AND RESOURCES

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INTRODUCTION

This chapter provides an overview of Fisheries Research programs in a national perspective. It summarizes program achievements in 1981 and identifies changes in thrusts. This is based largely on the regional Program Review, Evaluation and Planning (PREP) documents and specialist input of Senior Policy/Program Advisors at Headquarters.

A. RESEARCH MANAGEMENT (PAS 1.4.0.0)

This category is intended for Research Management functions at the level of the Office of the FRB Director, and for HQ staff functions not specific to any 3rd-digit PAS category. Other services provided to the Branch at large, as well as expenditures of Division Chiefs and Section Heads, should ideally be prorated among appropriate project PASs.

Fisheries Research Management
(PAS 1.4.0) FY 1981/82

		Expenditures ($ x1000)				
REGION	PY	O&M	CAP	O&M+CAP	SAL	O&M+CAP +SAL
Newfoundland	21.4	557	65	622		
Scotia-Fundy	12.7	153	80	233		
Gulf (Québec)	6.0	135	46	181		
Headquarters	5.2	176(a)	0	176		
Ontario	4.0	27	0	27		
Western	3.0	32	23	55		
Pacific	7.0	233	99	332		
TOTAL	59.3	1,313	313	1,626	1,838	3,464

(a) Includes $150K grant in support of the Marine Sciences Research Laboratory at Logy Bay, Newfoundland.

The considerable variation in PY and $ expenditures for PAS 1.4.0 in the table above reflects variability in the usage of this PAS category in the regions. Some management functions at the Division level are included in PAS 1.4.0 (e.g. Anadromous Division in Scotia-Fundy). Other Division-management and cross-discipline functions are shown under 1.4.1.0, 1.4.2.0 and 1.4.3.0, e.g. 1.4.1.0 in Scotia-Fundy and 1.4.3.0 in the Western Region. The preferred approach is to prorate these expenditures into relevant programs.

The functions included under PAS 1.4.0 in each region are tabulated below.

Newfoundland Region:
- FRB Director's Office (7.6 PY) (Director, Scientific Program Coordinator, Executive Assistant and Office Support Staff)
- Scientific Computing unit (9.9 PY) (computer services for the Branch, advice on statistics and experimental design, and research into statistical methodology related to fisheries)
- Technical Services (6.9 PY) (photography/drafting services, curatorship of the specimen museum, scientific records maintenance, and support to the Research Vessel Committee)

Scotia-Fundy Region: -FRB Director's Office (6 PY) (Director, Executive Assistant, Statistician, and Office Support Staff)
Freshwater and Anadromous Division administration and secretaries (6.7 PY)

Gulf (Québec) Region: -FRB Director's Office (4 PY) (Director, Executive Assistant and Office Support Staff)

Headquarters: -Director of Resource Research Branch (2.0 PY)
-Research Planning and Analysis (3.2 PY)

Ontario Region: -FRB Director (1 PY)
-Senior Scientist (1 PY)
-Secretaries to the above (2 PY)

Western Region: -FRB Director (1 PY)
-Head of Fisheries Resources Administration and
-secretary (2 PY)

Pacific Region: -FRB Director (1 PY)
-Associate Director (1 PY)
-Scientific Program Coordinator (1 PY)
-Information Officer)
-Illustrators) (4 PY)
-Secretaries)

B. DIADROMOUS AND FRESHWATER FISH (PAS 1.4.1.1)

The following summary of research activities on freshwater and diadromous fish in 1981 covers five of the six DFO Fisheries Management regions outside of HQ. In the Ontario region all relevant activities are included under Fisheries Ecology (PAS 1.4.1.7). In the newly-created Gulf Region, except for some research on eels and salmon in Québec, PAS 1.4.1.1 activities continued to be carried out by the Scotia-Fundy Region. These activities will be formally transferred to the Gulf Region in the coming year.

The principal PAS 1.4.1.1 activities in all regions relate to stock assessment methodology, monitoring of catch and escapement, provision of advice on stock status, and provision of advice on definition of and potential for managing the commercial, recreational and native food fisheries based on the diadromous and freshwater fish

Diadromous and Freshwater Fish (PAS 1.4.1.1) FY 1981/82

		Expenditures ($ x1000)				
REGION	PY	O&M	CAP	O&M+CAP	SAL	O&M+CAP +SAL
Newfoundland	26.8	447	44	491		
Scotia-Fundy	31.9	145	28	173		
Gulf (Québec)	2.9	69	0	69		
Headquarters	0.7	37	0	37		
Ontario	0	0	0	0		
Western	15.5	229	9	238		
Pacific	32.9	320	86	406		
TOTAL in FRBs	110.7	1,247	167	1,414	2,995	4,409

DIADROMOUS FISH

Fish species under this heading include salmons, trouts, chars, shads, lampreys, eels, smelts, eulachons, sturgeons and striped bass.

Highlights for 1981 are outlined below, by region.

Newfoundland Region

Atlantic salmon research continued on stocks originating in Newfoundland and Labrador watersheds and on stocks originating in rivers of other provinces which are caught in the Newfoundland commercial fisheries and at West Greenland. Options were developed to reduce interception of non-Newfoundland-Labrador-origin salmon in the Newfoundland commercial fisheries. Progress was made with a salmon assessment model

which pointed out the need for long-term studies on salmonid biomass, production, spawning requirements and exploitation patterns in the sea. Significant insights into factors controlling salmon production were gained from ongoing studies on Western Arm Brookand Highlands River. To study interactions among various salmonid species, an experimental-stream tank was constructed at the Fisheries Center in St. John's. Salmon tagging studies at sea continued, this year in the Bay of Exploits, to assess the manageability of the enhanced Exploits River salmon run. Commercial fisheries within this Bay appeared not to harvest distant river stocks but, nevertheless, to harvest local stocks in addition to Exploits River fish. Studies at West Greenland and contributions to the ICES Working Group on North Atlantic Salmon by Newfoundland Region staff continued to provide advice related to the origins of salmon stocks at West Greenland.

Arctic charr research in the Hebron Fiord area of Labrador was intitiated to obtain information on biological characteristics, population dynamics, and stock and recruitment relationships. This project was conducted in cooperation with Industrial Development Branch to assess the potential for a commercial fishery in this area. Also, 80,000 Arctic charr eggs collected from the Fraser River (Labrador) were transferred to the Freshwater Institute (Winnipeg) for growth and other aquaculture related studies.

Scotia-Fundy Region

Atlantic Salmon continued to be the most important responsibility in PAS 1.4.1.1 in this region. As indicated above, for this fiscal year most PAS 1.4.1.1 responsibilities in the newly-created Gulf Region were still carried by the Scotia-Fundy Region (formerly Maritimes Region). Enumeration and monitoring of adult and juvenile salmon were continued on the three major New Brunswick rivers - Restigouche, Miramichi and Saint John. Assessments and forecasts for the 1982 returns were prepared and vetted through CAFSAC, and provided to ICES. Salmon counts were conducted at several rivers in Nova Scotia and biological sampling was conducted at several sites. Extensive electroseining for juveniles was done to provide population estimates as a basis for recommendations to management. A salmon logbook for commercial fishermen was introduced to evaluate the accuracy of the landings data. Catch and effort statistics for 1981 were compiled for both the commercial and sport fisheries. Progress was made on assessing the feasibility of photo-geometric methods with some ground control as an efficient alternative to traditional stream survey methods for the quantification of salmonid spawning and rearing habitat. The draft regional salmon management plan was expanded into an Atlantic-wide document in cooperation with Headquarters and the other Atlantic regions.

For alewives, detailed records were compiled of returns, harvest and life history trends for Mactaquac on the Saint John River. A tagging program was initiated to provide better information on the mixing of stocks in the Lower St. John basin. Logbooks were introduced for commercial fisheries in N.B., N.S. and P.E.I. The response varied from good in N.B. to, poor in N.S. and P.E.I.

Striped bass in the Annapolis River failed to reproduce from 1975 to 1981. Some viable eggs were collected and reared for three months in an effort to provide some juvenile fish for release back to the river and to assess the feasibility of a fish-culture solution to the problem.

Gulf (Québec) Region

Studies were initiated on the effects of acid rain in four Quebec - North Shore salmon rivers and on the behaviour of salmon smolts upon leaving the estuary of the Grand Trinité River. Studies on the sea-run Brook trout were started on Quebec's North Shore, concentrating on environmental parameters, such as salinity, which seem to limit the distribution of this species at sea.

Arrival dates of elvers (young of the eel) to several rivers of the North Shore were determined. In addition, studies on subsequent juvenile stages have determined their distribution and movements in the estuaries. Diet studies were conducted on potential estuarine predators to determine their impact on juvenile eels and salmon. Mass mortalities of eels again this year in the Saint Lawrence estuary necessitated investigations requiring analyses of blood and muscle samples from eels provided by commercial fishermen in the Quebec and Kamouraska areas.

Western Region

Studies to assess stocks of Arctic charr were undertaken in Cambridge Bay for commercial fisheries and in Lake Hazen for sport fisheries. An International Symposium on Arctic charr was organized and held in Winnipeg in May 1981.

Pacific Region

Only a portion of the total research effort on Pacific anadromous fishes is reported under PAS 1.4.1.1. Research activities related to cultured stocks and to assessing the Salmonid Enhancement Program are reported under PAS 1.4.2.

With regard to the Canada/U.S. Salmon Interception Limitation negotiations, much of the information provided by the mark-recovery program was analysed and reported, including analysis of age-composition and length-at-age data for coho salmon caught in B.C. commercial fisheries between 1961-1979, and a summary of the incidental catch of salmon in midwater trawl fisheries in Canadian waters (1977-1980). Length-weight relationships for coho and chinook salmon were estimated from fish caught in 1981. A summary of 1974-78 coded wiretag recoveries was completed, and 1979 and 1980 recoveries were collated.

In the field of stock identification, a number of studies were initiated utilizing electrophoresis techniques. Activities centered on northern B.C. sockeye salmon, Tlupana Inlet chum salmon, Nanaimo River

chinook salmon and Johnstone and Georgia Strait chum salmon. Results of these studies should assist in the management of these species on a discrete-stock basis.

A feasibility study of acoustic estimating methods for salmon was carried out for sockeye, pink and chum salmon; result were encouraging Abundance estimates were best when sounding at an oblique angle at night.

Intensive modelling expertise was applied to the chinook salmon resource in Alberni Inlet to resource managers.

Studies of west coast lamprey led to identification of a new species. Abundance estimates of the large Pacific lamprey in Babine Lake were completed. Further refinement of these estimates may identify the potential for a commercial lamprey fishery in this area.

FRESHWATER FISH

Due to increased involvement in acid rain studies, only limited investigations were performed on the freshwater fisheries in the Atlantic zone. Some work was done on ageing and diet of brook trout in the Newfoundland Region. A report on the Smallwood Reservoir (Labrador) was written, detailing species composition, catch by size for the major species, and catch per unit effort for lake whitefish.

In the Western Region, biochemical studies were performed in attempts to unravel the complex genetics of two enzyme systems in lake whitefish. It is anticipated that this genetic variation will be useful for stock identification purposes. Studies of the population dynamics of whitefish were conducted in Lake Winnipeg, Yukon Lakes and Great Slave Lake for the provision of advice to resource managers.

Following the termination of the actual cropping program at Heming Lake, the mode and rate of recovery of the overexploited fish communities continued to be monitored. Data pertaining to walleye are of particular concern due to their depleted status.

C. GROUNDFISH (PAS 1.4.1.2)

In general, the objectives of this program are to provide reliable real-time advice for national and international management of both the commercial and potentially commercially important groundfish species. This includes advice not only on TACs, but also on the implications of alternative management strategies.

The achievement of this requires:

- the design and conduct of research vessel surveys to provide biological information and abundance indices;
- the investigation of new survey techniques (e.g. hydro-acoustics);
- the collection and analysis of commercial fisheries catch and effort data;
- the sampling of commercial catches for biological information sufficient to determine the year-class structure of catches;
- biological studies to assess stock discreteness, stock interaction and factors (such as growth) affecting population dynamics;
- mathematical analyses of the data, refinement of mathematical procedures, the construction of models, and the critical review of investigative procedures such as research survey methods.

The meeting of these objectives requires very substantial ongoing efforts. The workload can be expressed as number of research vessel days, number of fish tagged, number of fish for age determination, etc. While such figures may represent significant achievements for individual groups, they are not reported quantitatively in this analysis. The number of stocks assessed amounts to some 34 in the Atlantic Region and 30 in the Pacific. Fisheries Management frequently requires more than one assessment per year.

Groundfish
(PAS 1.4.1.2) PY 1981/82

		Expenditures ($ x1000)				
REGION	PY	O&M	CAP	O&M+CAP	SAL	O&M+CAP +SAL
Newfoundland	59.8	508	20	528		
Scotia-Fundy	37.5	333	25	358		
Gulf	0	0	0	0		
Headquarters	0.7	18	0	18		
Ontario	0	0	0	0		
Western	0	0	0	0		
Pacific	27.0	568	25	593		
TOTAL	125.0	1,427	70	1,497	3,763	5,260

Newfoundland Region

The major data collection for assessment of some 25 stocks annually has continued through operations of large research vessels and extensive biological sampling of commercial catches. Studies on food and feeding were continued for the purposes of determining trophic relationships, the significance of changes of food organisms to population abundance, and the role of predation in the mortality of juvenile stages of commercial species (redfish). The incidence of redfish in predator stomachs may in fact be an indicator of year-class strength. Work continued on stock and species discrimination using a number of techniques; the existence of a third redfish species was confirmed. Various studies associated with improving the quality of the stock assessment data were continued, including development of better sampling gear (allowing effective sampling of juvenile flatfish for the first time), examination of the bias and precision of various techniques of sampling, and the improvement of acoustic techniques including trials to estimate abundance of groundfish. Studies were initiated on the by-catch in groundfish fisheries, on the seasonality of inshore cod abundance in relation to biological and oceanographic parameters, and on the by-catch of cod in small-mesh gear set for capelin (the mortality of cod was negligible).

Scotia-Fundy Region

Assessment of all groundfish stocks currently under management was carried out. A number of special analyses were conducted on the implications of alternative management measures, such as variable mesh size. Research included comparison of selectivities of cod-end mesh size for silver hake; tagging, particularly of cod and pollock; and ageing studies. White hake can now be aged, enhancing the capability to assess this species. Pending the delivery of a new research vessel, comparative fishing was carried out between the interim replacement and the previous main vessel. Commercial sampling design was examined critically and comparisons undertaken between sampling catches in port and at sea. Research survey work was carried out, particularly for juvenile fishes in the vicinity of Sable Island and for silver hake.

Pacific Region

Extensive work on age determination of various species was continued, it being found that many species commonly have a longer life span than thought previously; various techniques were initiated to verify these determinations. Stock assessment for advice on catch levels was carried out for all species subject to such management measures. Results of extensive tagging studies continued partly to support age determinations. A long-term tag was developed for spiny dogfish. Mathematical models were examined critically for appropriateness in assessing different species, e.g. accounting for the longevity of rockfish and black cod. The direct use of length frequencyinformation in age-structured models was studied. Considerable effort was put into preparing reports on the biology of a number of species. Studies were

initiated on discards in commercial fisheries and on the validation of programs carried out by observers. Attention to hydroacoustic methods was continued although comparison between hydroacoustic biomass surveys and trawl and echo-sounder surveys showed serious discrepancies for groundfish.

D. INVERTEBRATES (PAS 1.4.1.3)

The primary objective of research programs on invertebrates is to provide scientifically sound biological advice for the management of these fishery resources. This includes the development of a comprehensive understanding of stock boundaries and relationships, of dynamic changes in populations in response to harvesting, and of recruitment changes and growth. Specifically, the programs involve stock assessments as well as the associated biological and fisheries research on various species of scallops, lobsters, crabs, shrimps, squids, oysters, clams and others. In 1981 crustaceans and mollusks constituted 32% of the landed value of fisheries resources in Canada, and in terms of individual species, the Atlantic scallop and the Atlantic lobster fisheries ranked second and third of all species. These fisheries are labour-intensive and have significant impact on regional economies.

In 1981 the major fisheries were monitored for catch composition, catch, effort and catch rates. These programs provided biological and fishery-related input for the Canada/U.S.A. boundary dispute (Georges Bank) in preparation for Canada's submission to the World Court, served as a basis for management advice on numerous fisheries, and provided input to international fisheries agencies such as NAFO and ICES. Participation in various ad-hoc meetings is a continuing role of the researchers.

Responsibility for snow crab studies was originally vested in the Maritimes Region but, in the summer of 1979, was transferred to the Quebec Region, where it became fully operational in 1980. In 1981 it was decided that the newly created Gulf (Québec) Region will have the responsibility for snowcrabs in the Gulf of St. Lawrence.

The Maritimes Region, which became the Scotia-Fundy Region in 1981, augmented its staff in areas such as squid population dynamics, electronic data processing, port sampling, mathematical biology and modelling. In 1981 a number of research mandates were also transferred to the Gulf Region.

Responsibility for the Strait of Belle Isle scallop stock and for the Esquiman Channel shrimp stock, held by the Newfoundland Region in 1981, will be transferred to the Gulf Region in 1982.

Invertebrates
(PAS 1.4.1.3) FY 1981/82

REGION	PY	Expenditures ($ x1000) O&M	CAP	O&M+CAP	SAL	O&M+CAP +SAL
Newfoundland	18.0	251	30	281		
Scotia-Fundy	48.7	708	70	778		
Gulf (Québec)	2.2	45	0	45		
Headquarters	0	0	0	0		
Ontario	0	0	0	0		
Western	0	0	0	0		
Pacific	9.0	119	3	122		
TOTAL in FRBs	77.9	1,123	103	1,226	2,181	3,407

Newfoundland Region

Research investigations were undertaken on lobsters, crabs, scallops, shrimp and squid. Close liaison was maintained with the industries and with management through committees and advisory groups. Priority areas in 1981 included:

i) for lobster:

Successful field application of laboratory-developed techniques for prediction of moulting and of egg extrusion in lobsters provided a new method of determining annual growth, and a basis for expressing maturity as a function of size.

Research at the Comfort Cove experimental area provided the first documentation in an American lobster population of annual fluctuations in standing stock, recruitment, growth, etc.

ii) for scallop:

An analysis of optimum substrate volume in monofilament and polyethylene collectors for use in scallop culture was completed. A detailed analysis of cruise data collected in 1980 was undertaken to assess the status of the Strait of Belle Isle scallop fishery. A new, simplified logbook was introduced in this fishery to obtain better estimates of catch and effort data. Spatfall was also monitored in Garden Cove and Port au Port Bay.

iii) for crab:

A positive highlight in the crab research program was the recovery of successfully molted snow crabs that had retained "T-bar" tags. This is a significant advance in the determination of growth parameters in this species. Data related to the abundance and distribution of crabs were analyzed and recommendations were made for the establishment of a crab fishery in previously unexploited areas.

iv) for shrimp:

Application of a computerized statistical procedure for mode analysis to the interpretation of age data for shrimp off Labrador proved successful. Investigations into the predator-prey relationships between shrimp and Greenland halibut off Labrador were initiated. A research survey was successfully completed off Labrador.

v) for squid:

A random stratified survey on the Grand Banks was completed in June to provide information on the relationship of catch rate and inshore abundance of squid and to attempt to forecast their availability inshore. Inshore studies included tagging studies, sampling of commercial landings, and the analysis of environmental data as a determinant of availability.

Scotia-Fundy Region

The program involves a variety of stock assessment research and associated biological research which serve as the basis for the management of lobster, crab, shrimp, scallop, clam, oyster and squid stocks.

In 1981 research staff were involved in the conduct of large cooperative research projects with the USSR and France to investigate the seasonal distribution and migration patterns of larval and juvenile squid. The Maritimes shrimp fishery, lobster landings in various inshore and offshore fisheries, and the Cape Breton snow crab fisheries were monitored. Surveys of red crab and Jonah crab resources on the Scotian Shelf were completed.

The general distribution of lobsters between Browns Bank and inshore areas off Southwest Nova Scotia was determined; an assessment of the 1980 fisheries was provided for CAFSAC. The lobster research group contributed to a major review paper on lobster management in the Maritimes. A three-year laboratory study of lobster, comprising more than 3000 molts of lobsters ranging from first hatching to market size, has given the first data on long-term growth of individual animals; maximum growth rate was 40% greater than any previously reported.

Oyster resource enhancement, spatfall monitoring and prediction services were carried out in various areas. Research on scallops on Georges Bank remains a high priority. Scallop surveys were conducted in

the northern part of Georges Bank, on the Scotian Shelf, in the Bay of Fundy near Digby, and near Grand Manan, as well as in Northumberland Strait. Scientific advice was provided to a number of management committees and scientific advisory committees.

Significant progress was made towards program objectives despite the termination of a number of research initiatives due to the creation of the Gulf Region. Twenty-one positions in the Invertebrate and Marine Plants Division were identified for transfer to the Gulf Region. As a consequence of these changes, a major reorganization of the Invertebrates and Marine Plants Division was carried out. Concurrently, the decision was made to reorganize the Crustaceans Section by transferring three PYs from St. Andrews to Halifax. As of October 1, 1981, responsibility for the Ellerslie Research and Operational Support Facility was transferred to the Gulf Region.

Gulf (Québec) Region

Surveys were carried out on snow crabs in the southwestern Gulf and the St. Lawrence Estuary. Commercial catches from the New Brunswick fleet were sampled both at sea and in port, and logbooks were collected and analyzed. In 1980 this program on snow crabs was the only research on invertebrates conducted by the Quebec Region. In 1981 the Centre de Recherches en Biologie Marine was created in Moncton. It will conduct research jointly with personnel from the University of Moncton. The Centre has yet to be fully staffed.

Pacific Region

Major emphasis in the Pacific Region was on biological research and continued assessment of invertebrate resources with the aim of providing the management information necessary for optimum utilization of these resources. Species studied included Dungeness crab, shrimp, prawns, oysters, mussels, scallops, abalone, sea urchins, geoduck and squid. The research group provided advice to the general public, industry and other Government agencies on various issues.

The status of important Dungeness crab fisheries was assessed by analysis of catch and effort data, by resource surveys to determine size frequencies and shell condition, by experimental fishing and sampling in closed areas, and by tagging to determine migration patterns and total biomass. A study was initiated to investigate Cancer crab predation on commercial mollusc species.

A shrimp resource survey was undertaken off the west coast of Vancouver Island for quota determination purposes. A biological study of the Knight and Kingcome Inlet prawn population was carried out to provide data for the initial development of a spawner escapement management plan and for the design of optimal-size trap escape ports.

Assessments of clam biomass and recruitment were conducted on selected beaches in the Strait of Georgia and along the north coast of British Columbia. Assistance was also provided to the Field Services Branch to determine clam abundance on exploited areas on the west coast of Vancouver Island and in Queen Charlotte Strait, and to assess the long-term impact of mechanical harvesters on clam beds. The continuing spread of Manilla clams in British Columbia was monitored.

The Department's long-term involvement with Pacific oyster breeding studies and the spatfall prediction service, mostly in Pendrell Sound, was terminated during 1981; this responsibility was turned over to the Provincial Marine Resources Branch. An attempt was made to collect natural seed of weathervane scallops in the Gulf Islands region; a laboratory facility was constructed to study breeding and to develop seed production methods. Personnel and much of the funding for this project came from the Provincial Marine Resource Branch. The purpose of the present study is to determine the feasibility of scallop culture in British Columbia using both native and exotic species.

Abalone were tagged for growth measurement and transferred from an area of low growth to one of high growth. Subtidal geoduck stocks were sampled at the market in 1981 to determine their age structure; sampling of harvested and unharvested clams to determine age structure was contracted out.

Surveys of population density and size structure of red sea urchins were conducted in various statistical areas. The distribution and abundance of squid in British Columbia were investigated to determine the feasibility of establishing a commercial fishery on several species in nearshore and offshore waters. Further studies are required to investigate the implications of the frequent major fluctuations in abundance and to test the potential for commercial exploitation in various locations.

E. MARINE MAMMALS (PAS 1.4.1.4)

Expenditures for salaries and O&M for marine mammal programs have increased from (16.4 PY and $1,142m FY 1980/81, largely as a result of program expansion in the Western Region (where PY utilization increased from 1.0 to 7.5) and the Gulf Region (from 6.5 to 9.5 PY).

Marine Mammals
(PAS 1.4.1.4) FY 1981/82

		Expenditures ($ x1000)				
REGION	PY	O&M	CAP	O&M+CAP	SAL	O&M+CAP +SAL
Newfoundland	6.0	276	1	277		
Scotia-Fundy	1.0	38	0	38		
Gulf (Québec)	9.5	207	0	207		
Headquarters	1.1	307*	0	307		
Ontario	0	0	0	0		
Western	7.5	150	5	155		
Pacific	2.0	77	2	79		
TOTAL	27.1	1,055	8	1,063	875	1,938

* Includes contribution to COSS and COWW and funds for research contracts.

Newfoundland Region

Continuing stock assessment work on marine mammals in the Laborador/Newfoundland area included various advances in the development of a harp seal model to investigate historical trends in population size and vital rates, and a systematic aerial census of whales. Detailed sampling of age distribution of harp and hooded seals in the commercial harvest was continued.

Scotia-Fundy Region

The marine mammals program centered around tagging studies and analysis of bounty information to determine migratory patterns, assess population size and the contribution to gear damage. Approximately 95% of grey seal pup production and 98% of the harbour seal pup production on Sable Island was tagged. Approximately 1,000 grey seal jaws were verified for bounty payment.

Gulf (Québec) Region

A survey of wintering white whales in western Hudson Bay was carried out under contract. A technical report on bearded seal biology was prepared. Analysis of data was completed for a monograph on ringed seal population biology. Other work on seals included analysis of 1981 harp seal samples for CAFSAC and NAFO meetings. Other work on whales included a detailed study of NW Atlantic commercial whaling catch/effort data and collection of biological information from stranded whales in the Gulf of St. Lawrence.

Headquarters

Program delivery with respect to marine mammal research was limited to the supervision of contracts.

Western Region

The marine mammal program centered around monitoring studies of marine mammal harvest including narwhal at Pond Inlet and Arctic Bay and walrus at Igloolik and Hall Beach. Considerable effort was devoted to the development of management strategies (quotas, seasons, etc), in consultation with various government agencies and resource users.

Pacific Region

Fur seal research reports were prepared for presentation to the Standing Scientific Committee of the North Pacific Fur Seal Commission. A report on the status of killer whale stocks was also completed.

F. MARINE PLANTS (PAS 1.4.1.5)

Only the Scotia-Fundy Region conducted research on marine plants in 1981. However, some of the work was located within the boundaries of the new Gulf Region. The purpose of the program was:

1) to acquire a greater understanding of the biological parameters deemed important in the management of commercially important species;

2) to determine the level of yield beyond which other commercially important marine species (such as lobsters and finfish) become adversely affected;

3) to determine acceptable harvesting strategies for all commercially important marine plant species.

Advice was provided to both provincial and federal government agencies on marine plant matters. Species involved included Chondrus, Laminaria (kelp), Ascophyllum and Irish moss. The research staff were highly interactive with both fishermen and industry, through direct field contact and through active participation in government-industry advisory committees.

Marine Plants
(PAS 1.4.1.5) FY 1981/82

		Expenditures ($ x1000)				
REGION	PY	O&M	CAP	O&M+CAP	SAL	O&M+CAP +SAL
Newfoundland	0	0	0	0		
Scotia-Fundy	5.0	259	24	283		
Gulf (Québec)	0	0	0	0		
Headquarters	0	0	0	0		
Ontario	0	0	0	0		
Western	0	0	0	0		
Pacific	0	0	0	0		
TOTAL in FRBs	5.0	259	24	283	167	450

In 1981 a number of Chondrus beds were sampled in SW Nova Scotia and the southern Gulf of St. Lawrence. The study on growth and reproduction of Chondrus was completed and data were analysed and presented to CAFSAC. Other studies undertaken included assessment of the vulnerability of the Chondrus resource to handrakes (in SW Nova Scotia), evaluation of effectiveness of a roller belt harvester (in Georges Bay, SE Gulf of St. Lawrence), and assessment of Chondrus beds which may be unexploited in the Mud Island area off SW Nova Scotia. Yearly and historical analysis of crop abundance, yield and effort provided the basis for resource management recommendations.

Research on kelp (Laminaria) included a study on the feasibility of using remote sensing techniques for assessing standing crops. Also, low-light underwater television was used to survey a five-hectare bed in Lobster Bay off SW Nova Scotia. This method was found to be as accurate as direct-diver observations. A study of the growth/erosion dynamics of beds in SW Nova Scotia was initiated, as well as a study on inter-specific competition between L. digitata and L. longicruris.

The Marine Plants Botanical Station in Mimineqash, P.E.I., was open throughout 1981. During the winter months it was used for analyzing samples. During the field season the station provided support for five technicians and one biologist. Information to the general public was provided by a slide presentation and tours of the station.

G. PELAGIC FISH (PAS 1.4.1.6)

In general, the objectives of this program are to provide reliable real-time advice for national, and international management of both the commercial and potentially commercially important pelagic species. This includes not only advice on TACs, but also on the implications of alternative management strategies.

The achievement of this requires:

- the design and conduct of research vessel surveys to provide biological information and abundance indices;
- the investigation of new survey techniques (e.g. hydro-acoustics);
- the collection and analysis of commercial fisheries catch and effort data;
- the sampling of commercial catches for biological information sufficient to determine the year-class structure of catches;
- biological studies to assess stock discreteness, stock interaction and factors affecting population dynamics, such as growth;
- mathematical analyses of the data, refinement of mathematical procedures, the construction of models and the critical review of investigative procedures such as research survey methods.

Performance in meeting these objectives involves very substantial efforts of an ongoing nature. The workload can often be expressed as number of research vessel days, number of fish tagged, number of fish aged, etc. While such figures may represent significant achievements for individual groups, they are not reported quantitatively in this analysis. Advice on approximately 18 stocks is given annually, and frequently more often. In fact, many of these nominal stocks are actually stock complexes which increases the complexity of the assessment process and emphasizes the importance of many of the stock-discrimination-type studies.

Pelagic Fish
(PAS 1.4.1.6) FY 1981/82

REGION	PY	Expenditures ($ x1000) O&M	CAP	O&M+CAP	SAL	O&M+CAP +SAL
Newfoundland	21.9	317	87	404		
Scotia-Fundy	29.0	361	0	361		
Gulf (Québec)	5.1	179	0	179		
Headquarters	0.3	8	0	8		
Ontario	0	0	0	0		
Western	0	0	0	0		
Pacific	17.0	523	18	541		
TOTAL in FRBs	73.3	1,388	105	1,493	2,376	3,864

Newfoundland Region

With all seven herring stocks depressed to a greater or lesser extent, effort is being expended to improve the quality of data from commercial fisheries and to detect incoming recruitment. The program of contracting commercial fishermen to fish with experimental gillnets was expanded. Aerial surveys demonstrated some potential to locate capelin spawning beaches, to provide an index of minimum spawning biomass of capelin spawning inshore, and to estimate fishing effort. Capelin research offshore included acoustic surveys and development of analytical packages. Mackerel research included sampling of commercial catches and analysis of stomach contents.

Scotia-Fundy Region

Larval surveys on herring and mackerel were continued and the time series is now becoming significant. Acoustic methodology continued to be developed, with concentration on investigating the potential and limitations of existing systems. Data on large pelagic species from previous years were analysed. Survey methodology was reviewed critically.

Gulf (Québec) Region

Significant progress was achieved in analysing historical data and in collecting new data for assessment of the depressed herring stocks. Particular attention was paid to developing means of estimating abundance of juveniles in order to predict stock recovery. Stock discrimination studies were carried out on capelin and smelt using meristics and morphometrics, electrophoretic methods and parasite frequency and distribution.

Pacific Region

Assessments of the status of herring stocks were completed. Extensive work was undertaken to improve the understanding of factors determining the abundance of herring at all stages of the life history, and hence to provide an improved capability to predict harvest potential. Investigation of the factors required for determination of egg production from observations of area and density of spawn deposition demonstrates that an adequate system would be very complicated, but that current data do allow re-evaluation of the historical data series. Studies are being carried out on environmental factors affecting recruitment, including factors affecting age-specific growth and fecundity. The abundance and distribution of juveniles are being investigated to determine whether these can provide useful estimates for forecasting future yields. Research on adult herring biomass assessment methods involves studies on hydro-acoustic survey techniques as well as more conventional means. The offshore albacore fishery was monitored for catch/effort and biological information. Age determination on the basis of finrays was introduced. Studies were expanded on feasibility of impounding large numbers of herring prior to spawning.

H. FISHERIES ECOLOGY (PAS 1.4.1.7)

Fisheries ecology encompasses a diverse set of research activities primarily concerned with ecological and multi-species research in support of resource assessment and habitat management, including aquatic climate studies relevant to fisheries. The program includes studies on larval stages, food chains, species interactions, ocean climate, reproductive success, etc. Much research that could be included in the "fisheries ecology" category is displayed as part of assessment-oriented research, habitat research, and research in Ocean Science and Surveys.

Three major research programs are highlighted below: The Flemish Cap Project is being scaled down, and to some extent will be replaced by a project on the Southeast Shoal dealing with stock recruitment processes of yellowtail. The Scotian Shelf Ichthyoplankton Program (SSIP) data are being analyzed and it is expected that some changes in the program will occur. The ocean climate initiative, launched in 1980 as part of the National Climate Program, still remains an important objective. It represents an attempt to better understand how the physical environment affects ecosystem dynamics and the fisheries resources. In addition to the three programs above, a number of smaller projects were undertaken.

Fisheries Ecology
(PAS 1.4.1.7) FY 1981/82

		Expenditures ($ x1000)				
REGION	PY	O&M	CAP	O&M+CAP	SAL	O&M+CAP +SAL
Newfoundland	5.1	367	23	390		
Scotia-Fundy	13.3	609	0	589		
Gulf (Québec)	14.2	179	0	179		
Headquarters	0.7	20	0	20		
Ontario	11.2	228	31	259		
Western	0	0	0	0		
Pacific	5.1	156	23	179		
TOTAL in FRBs	49.6	1,559	77	1,636	1,649	3,285

Newfoundland Region

The Flemish Cap Project, continued in 1981, has produced a better understanding of the physical and biological oceanography, larval redfish dynamics and early life history, and feeding behaviour of cod on juvenile redfish. Unfortunately the high fishing mortality of cod (designated as target species) in recent years has severely depleted the spawning biomass. This has been paralleled by an almost complete absence of cod eggs and larvae in the surveys. Thus, the research gains have mostly been on the larval ecology of redfish.

Progress on ocean-climate-related activities has been mainly in modernizing the data acquisition system and the data products.

Scotia-Fundy Region

Major progress has been made in aligning of studies on the Gulf of St. Lawrence cod with those on Scotian Shelf cod, which is a component of SSIP. Studies on several aspects of 4T cod have been completed (fecundity, egg size in sequential spawning batches, historical feeding data, cod food consumption model). Some reduction in the number of SSIP surveys has occurred. All data from oblique-bongo and Isaacs-Kidd trawl samples to September 1981 have been sorted.

Routine processing of all hydrographic data was maintained in 1981.

In studies on invertebrate ecology, a taxonomic key was produced to differentiate between snow crab stocks. A study was completed on the energy content of new and well-developed eggs from various sizes of lobsters from different locations. A number of cooperative surveys were conducted with the USA and USSR to investigate methods of studying larval and juvenile squid from the edge of the continental slope off Nova Scotia and Newfoundland to the Sargasso Sea.

Significant progress was made in 1981 in determining the abundance and distribution of Gonyaulax and Gonyaulax cysts: these activities should lead eventually to the development of a predictive capability for Paralytic Shellfish Poisoning events in the Bay of Fundy.

Gulf (Québec) Region

Arctic Biological Station

A map of the Beaufort Sea was drafted and is to be used to develop distributional maps of Arctic marine and anadromous fish species.

The Frobisher Bay area still serves as a focal point for the Arctic biological oceanography program. Surveys of phytoplankton and zooplankton in relation to the physical environment were continued. Primary production and the energetics of zooplankton are being measured. A study of zooplankton association with sea ice was completed. Studies to relate detrital fallout to zoobenthic energetics continue.

Quebec Laboratory

Studies were undertaken on the survival of undersize lobsters released after trapping. Trap designs are being modified to improve escapement of undersize lobsters. Larval lobsters were sampled using a new vertical sampler. Physical and chemical oceanographic data were collected in conjunction with the larval samples.

Tidal and nearshore aquatic communities were sampled along a number of transects near Iles Mingan to determine community structure. These samples will serve as a basis to determine the impact of hydroelectric development on a nearby river.

Ontario Region

Project Quinte data, on the behaviour of an ecosystem under active management, are being analyzed in preparation for a final report.

Western Region

Ecological studies in this region are reported as an integral component of the Region's habitat and resource assessment programs.

Pacific Region

Studies of the circulus counts and spacing on scales of larval chum during their first few weeks of ocean life, indicate size-selective mortality. Additionally, comparison of the Nitinat and Nanaimo areas identified how differences in quality of estuary habitat affect the growth rate of chum and chinook in these systems.

A study was conducted on the feeding ecology of hake, pollock and dogfish in the Strait of Georgia. Analysis of ichthyoplankton catches have provided estimates of the distribution and growth of euphausids in the Strait.

A review of the oceanography of the continental shelf and slope waters off the west coast of Vancouver Island is in preparation. Past research has been reviewed and monthly anomalies of sea-surface temperatures and salinity, sea level and Ekman transport are summarized.

I. AQUACULTURE AND RESOURCE DEVELOPMENT (PAS 1.4.2)

The overriding force in the development of modern aquaculture is a perceived national economic need. Aquaculture is the culture or husbandry of aquatic organisms in fresh or saltwater, providing the means of pursuing major alternatives to traditional fisheries development strategies. It encompasses a spectrum of management inputs, ranging from complete control over the life-cycle of animals in highly artificial containment systems, to semi-intensive culture, to extensive systems with limited care of the organisms raised. Aquaculture is at present used in Canada for producing human food, increasing natural stocks through artificial recruitment and transplantation, producing sport fish, and producing industrial fish or fishery products (e.g. seaweeds for marine colloids).

The Departmental strategy in aquaculture development over the short term is to continue concentrating on the optimization of the biological and technological product processes. Interventions have been made in response to specific needs, primarily at the micro-economic scale. Other programs include those in health protection and control of communicable diseases, and introduction of exotic fish species. These relate more to preservation of future options for development, and to the protection of the wide spectrum of fish resources. There are also pressures to refine regulations and institutional guidelines which demand a response, and marketing will become more complex as aquaculture production increases.

Resource development options, primarily with the Pacific salmon species and Atlantic salmon, are being undertaken to enhance natural populations on both east and west coasts. Both public and private aquaculture have roles to play in this field, and both are based on the same technology. Research on feral and cultured stocks is frequently the same, with emphasis being placed on increasing survival and minimizing conflict between the two types of stocks.

In-house aquaculture and resource enhancement research is focussed in regional centres in St. John's Halifax, St. Andrews, Winnipeg, West Vancouver and Nanaimo. Total Resources of $5.3 million were utilized in FY 1981/82, only slightly more than in the previous year ($5.2 million) not corrected for inflation.

Aquaculture and Resource Development Research (PAS 1.4.2) FY 1981/82

REGION	PY	Expenditures ($ x1000) O&M	CAP	O&M+CAP	SAL	O&M+CAP +SAL
Newfoundland	24.0	400	61	461		
Scotia-Fundy	39.6	604	24	628		
Gulf (Québec)	0	0	0	0		
Headquarters	3.5	29	0	29		
Ontario	0	0	0	0		
Western	17.1	146	0	146		
Pacific	38.0	156	38	194		
TOTAL in FRBs	122.2	1,335	123	1,458	3,874	5,322

In 1981 the aquaculture research program in the Pacific region was reactivated. Resources from the aquaculture research program at Winnipeg have been re-directed to other priority research areas; priority in aquaculture is being given to artic charr.

Considerable progress has been achieved in aquaculture research in 1981. Some of the highlights are summarized below.

Fish Health

The Canadian Fish Health Protection Regulations, enacted in 1977 under the Fisheries Act, were designed to prevent the spread of infectious salmonid diseases through inspection of production sources of fish stocks, and through control of the movement of infected salmonid stocks. Importation of cultured salmonids into Canada and inter-provincial transportation of stocks are allowed only by permit. In 1981 stock shipments involved primarily rainbow trout (9.0 million eggs, 2.2 million fingerlings and 1.1 million kg dead cultured fish). All the live fish and eggs and most of the dead fish imported to Canada originated from the U.S.A.

A technical committee is reviewing the Manual of Compliance to the regulations, updating diagnostic protocols and clarifying procedures for application of regulations. The revised manual will be subject to peer review and scrutiny by the fish culture industry prior to publication, which is expected in 1983.

Concern has been expressed over the first report of Proliferative Kidney Disease (PKD) in North America, and its potential threat to Canadian fisheries resources. The disease agent for PKD is thought to be a haplosporidian parasite, and has caused serious economic losses in

salmonid fish culture operations where it has occurred in Europe. As an interim precaution against possible introduction of this pathogen to Canada, Local Fish Health Officers have been asked to warn importers of live fish from U.S.A. of this hazard.

Studies on the microstructure of bacterial pathogens of fish to isolate cell fractions causing virulence was continued. A mutant form of Aeromonas salmonicida unable to form A-layer protein (apparently necessary to virulence) was shown to have a deep mutation in the lipopolysaccharide (lps), suggesting that a complete lps is necessary before synthesis of the A-layer can take place. The amounts of proteolytic enzyme produced by virulent and avirulent strains of A. salmonicida were compared. Results suggested that a protease is not an important virulence factor in this micro-organism.

The uniqueness of the virus serotype of a new strain of infectious pancreatic necrosis virus (IPNV) previously isolated from Arctic charr (lower Mackenzie R. drainage basin) was confirmed. IPNV was also confirmed in wild Atlantic salmon in the Exploits River, Newfoundland. Cooperative research on fish viruses in the Western Region established that either one of two types of herpesvirus or alternatively a distinct retrovirus, can be associated with similar epidermal lesions in walleye. Investigations of other walleye diseases established that "bleach" disease is likely attributable to infection by a Flexibacter sp. (antigenically distinct from Flexibacter columnaris which causes saddleback disease in Atlantic salmon).

Further studies were undertaken on the immune response of coho salmon to A. salmonicida. There are indications from this research that some other element(s) in fish, perhaps cellular elements, are required in addition to immune serum to provide protection against this pathogen. Immunofluorescence-based diagnoses of Renibacterium salmoninarum (Bacterial Kidney Disease) could not be corroborated by culture or by stressing the fish to elicit active BKD. These results suggested that the entities being detected by the fluorescent antibody technique may be dead cells of the pathogen persisting from some previous covert BKD infection.

Parasitology studies were undertaken on a number of species including Pacific salmon, black cod, hake and herring. Investigations over a 7-year period with sockeye salmon have indicated strong possibilities of discrimination among stocks of sockeye, based on the occurrence of the myxozoan parasites Myxobolus neurobius in the brain and Henneguya salminicola in the body musculature.

Nutrition

A study was conducted in 1981 to provide an up-to-date description of the scientific, industrial, technical and regulatory framework which supports fish feed production in Canada. It is estimated that the present demand for fish feed nationally is 5,500 tonnes, of which 4,200 tonnes (76%) are required for use in commercial culture operations. By

comparison, in 1972 only 1200 tonnes were used - 520 in the public and 680 in the private sectors. 80% of the supply is at present manufactured in Canada, compared to only 10% in 1972. The remaining 20% is imported, primarily from the U.S.A.

The study concluded that the basic equipment and skills to manufacture dry fish feeds are available in Canada today. However, the demand for fish feeds is marginal compared to requirements for conventional animal and poultry feeds. Thus small mills, or those with specialty products capability, are most suited for fish feed manufacture in terms of production, scale and economics. It was recommended that government procurement of fish feeds should focus on Canadian sources.

With few exceptions, fish nutrition research and diet development have been, and will continue to be, public sector activities. Only when markets justify the investment will the private sector (feed manufacturing companies) initiate in-house research. Much of the present research involves adapting known salmonid requirements to additional species under defined conditions, evaluating new ingredients, and re-evaluating nutrient requirements in view of improved knowledge concerning manufacturing, storage and processing of feedstuffs.

Nutrition research at the Halifax Laboratory continued to focus on lobsters and salmonids. In further eye-stalk ablation trials with improved diets, 100% of eye-stalk ablated canner lobsters molted within 1.5 months of the operation, in contrast to only one in twenty intact control lobsters. The de novo synthesis of ascorbic acid from uniformly labelled C14 D-Glucose has been demonstrated. This provides substantial support for previous feeding trial results suggesting vitamin C is not a dietary requirement for lobsters. Reference protein prepared from rock crab (Cancer irroratus) was shown in lobster feeding trials to be significantly better in terms of growth and survival than the past standard reference protein, casein.

With finfish, a study designed to determine the effect of dietary trace elements on the incidence of bacterial kidney disease (BKD) in Atlantic salmon showed that modification in dietary trace element supplementation reduced the incidence of BKD lesions from 37% to 4%. An open feed formula containing 45% protein and 16% lipid was found to give superior growth, feed conversion, survival and lipid reserve compared to commercial feed. Finally, experiments showed that in commercially prepared moist feeds for Atlantic salmon, it is possible to replace gaspereau as an ingredient with cheaper, more available herring.

On the West Coast, research is being undertaken to develop and test diet formulations for Pacific salmon which might eventually replace the moist pellets used predominantly in federal hatcheries. Preliminary results of studies conducted at Quinsam and Robertson Creek hatcheries indicate that growth, food conversion and survival of salmon through the juvenile stage were equivalent in fish fed dry and moist pellet diets. Samples of smolts reared on these diets have been marked for comparison of performance through the adult stage.

Genetics and Physiology

A collaborative research program between the Department of Fisheries and Oceans and the International Atlantic Salmon Foundation is being undertaken at the North American Salmon Research Centre, St. Andrews, N.B. As well as providing opportunities for research on stock improvement and selective breeding of Atlantic salmon, the research program develops and tests models for application through technology transfer to other agencies and fish culture operations.

The primary objective of the research program is to develop strains which have been selectively bred for sea ranching. Specifically, research includes the selection of four separate strains of Atlantic salmon by introgression of favourable genes from several wild salmon stocks, and subsequent index selection from the resultant hybrid progeny. Control populations incorporating the original genetic structure of donor stocks will be reared parallel to each strain in order to measure changes in strain characteristics which can be attributed to stock selection.

Sex-reversal experiments were conducted in which Atlantic salmon fry were fed diets containing either methyltestosterone or estradiol. Steroids consumed at first feeding resulted in sex reversal, and when fed at a later date they increased the incidence of precocious parr. Induced maturation and spawning of Atlantic salmon was attempted using pituitary extract injections. Results indicated that if pituitary injections are given too soon, fertilization of ova will be variable; if injections are given very late in the season, there is no advantage. The optimum acceleration of maturation is achieved by injecting broodfish in mid-season.

The environmental control of juvenile salmon growth with particular reference to bimodal length frequency distribution was studied. Through environmental manipulation, it was shown that numbers of fish in the upper modal group (these are the first to become smolts) could be increased. Continued studies on effects of thyroid hormone on growth and salinity tolerance of salmon parr suggested that growth of small parr could be accelerated so that they reach smolt size a year earlier than normal.

New initiatives in genetic studies in the Pacific region will focus on studies related to improving hatchery efficiency through a program of selective breeding for traits such as growth efficiency, disease resistance, and marine survival in Pacific salmon; and documentation of the genetic controls of traits under artificial selection through breeding programs and determining response to selection.

Endocrinology

The major focus in endocrinology studies has been in the field of reproductive physiology of Pacific salmon. Results of these investigations have application in husbandry of wild and cultured stocks, especially as they relate to sex ratios and sexual maturity. Research

goals include production of all-female groups of smolts by hormonal and genetic means, producing 100% sterile groups of salmon smolts, developing induced ovulation techniques to increase efficiency of hatchery operations, and developing procedures of short and long term preservation of salmonid gametes.

Culture System Optimization

The research and operational support facility at Prince Edward Island was used for collaborative research with other agencies and institutions. Projects included experimental culture of the blue mussel, research into scallop/lobster interactions, investigations on Malpeque disease of oysters, introduction of the Bay scallop, and genetic engineering studies on the American oyster.

The feasibility of intensifying production of Atlantic salmon in small lakes and ponds in Newfoundland was examined. Initial results are positive, with fry to smolt survivals in three ponds varying from 2.2% to 5.8%. The design of deep substrate incubators is being assessed to determine merits of parallel discharge (new design) and serial discharge (as in old facilities). The initial tests with model incubators have confirmed that the parallel discharge incubator has an improved flow pattern relative to the serial discharge design. Eggs are now being incubated in these models to determine whether improved flow pattern translates into better fry production characteristics.

Two-sea-year salmon of the Saint John River stock are predominantly females while one-sea-year salmon are mostly males. Males are most numerous among small-grade hatchery parr while females are most abundant among large-grade parr. These differences are not as well defined in the first fall (0+ parr) as by the following spring (1+ parr). It has been estimated that the smaller 1+ Saint John smolts have about 2.1% survival to adults returning to the release site. Total survival of these smolts is about half that observed for larger 2+ smolts of the same stock.

In the Western Region in 1981/82 research on intensive aquaculture systems was significantly reduced and resources redirected to Arctic fisheries management concerns. The work that is continuing is related to the use of waste heat. Emphasis is being placed on Arctic charr culture. A one-week course on Aquaculture was run in cooperation with Alberta Agricultural College.

In British Columbia, results to date indicate that fertilization of sockeye salmon nursery lakes is a promising technique for increasing sockeye salmon production, especially in lake systems where an adequate resource is still available. Limnological surveys of sockeye-producing lakes along the British Columbia Coast have confirmed their potential for increased biological production through controlled addition of nitrogen and phosphorus. Positive responses of primary producers to nutrient additions have been clearly demonstrated in all study lakes thus far examined, and in most of those treated lakes juvenile sockeye

have attained a significantly larger size when compared to years of no treatment. Nutrient application techniques have been refined to the point where it is possible to load nutrients into the lakes at rates which will sustain production increases but avoid deterioration of lake water quality or fish habitat. Eleven lakes were fertilized in 1981; an expansion to 14 lakes is anticipated for 1982.

The number and size of sockeye smolts produced in most fertilized lakes and in some unfertilized lakes has been estimated over the past 4 years. These data have begun to yield a number of insights into interactions among lake enrichment procedures, production of zooplankton as prey, sockeye population density, stickleback population density, sockeye growth and to a lesser extent sockeye survival within coastal lakes. It is clear that:

(1) sockeye growth across a wide range of population densities is positively influenced by factors related to addition of inorganic nutrients to lakes;

(2) sockeye growth is adversely affected by high population densities of limnetic fish (3000 fish per ha) whether these are sockeye or sticklebacks;

(3) on average the larger smolts (mean approximately 4 gms) produced in coastal lakes under lake enrichment should exhibit better marine survivals than their smaller counterparts (2-3 gms) produced under non-enriched conditions;

(4) environmental variations are large enough to produce exceptions to these generalities in any given lake or in any given year.

Industrial R&D and Other Interfaces –

Modern industrial aquaculture is science intensive and science dependent. The Department of Fisheries and Oceans, for numerous years, has invested in intramural as well as extramural investigative programs that impact upon aquaculture and health requirements, some of which are continuing and others which are ready for transfer to industry through federally sponsored industrial R&D programs. A research mode is viewed as the most effective way to transfer technology, and pilot-scale operations fit federal science policy initiatives to involve industries in both the conduct and financing of the research effort. Funds from other agencies are being justified on a case-by-case basis, and several aquaculture-related operations described below are being supported by funds from the Program for Industry/Laboratory Projects (PILP) administered by the National Research Council, and the Unsolicited Proposal Program administered by the Department of Supply and Services.

Significant progress has been made in developing a commercial vaccine against enteric redmouth disease at the Connaught Laboratories, Toronto, and research was initiated to determine the feasibility of developing a vaccine against furunculosis. Experimental development of lobster culture facilities is being undertaken on Prince Edward Island

and selective breeding of Atlantic salmon and trout for commercial culture is being undertaken at a private operation in Nova Scotia. A study conducted on a large lake adjacent to the St. John River estuary in New Brunswick identified significant potential for Atlantic salmon culture through the innovative use of a salt water reservoir in the lake.

J. HABITAT ASSESSMENT AND RELATED RESEARCH (PAS 1.4.3)

The continued flow of benefits from the wild fisheries resources ultimately depends upon the quality and quantity of natural fish production systems, or habitats. These production systems include not only the water in rivers, lakes, streams and oceans, but also the total physical, chemical and biological surroundings in which plants and other life forms interact to make fish life possible. Departmental research on fish habitat is therefore directed towards ensuring that the productive capacity of natural fish habitat is protected against damage from industrial and other activities and towards restoring and developing productivity of fish habitat.

Habitat Assessment and Related Research (PAS 1.4.3) FY 1981/82

		Expenditures ($ x1000)				
REGION	PY	O&M	CAP	O&M+CAP	SAL	O&M+CAP +SAL
Newfoundland	15.2	600	32	632		
Scotia-Fundy	38.4	946	291	1,237		
Gulf (Québec)	7.7	377	48	425		
Headquarters	0	0	0	0		
Ontario	24.3	468	72	540		
Western	93.9	1,236	148	1,384		
Pacific	21.0	247	21	268		
TOTAL in FRBs	200.5	3,874	612	4,486	6,068	10,554

The following narrative of programs and achievements is organized by Region.

NEWFOUNDLAND REGION

Diadromous and Freshwater Fish

The impact on salmon production, resulting from hydroelectric development at Top Brook Pond was assessed.

The acid rain program required active involvement on two national committees, as well as overseeing several studies: to determine the susceptibility of fish and fish habitat in headwater lakes to acid rain; to survey water quality of important or potentially important Atlantic salmon enhancement rivers in insular Newfoundland and Labrador; and to gather and assemble all available water quality data for the province of Newfoundland for the years 1972-80.

The insecticide spray impact study continued in 1981 to determine the long-term effects of aerially applied pesticides on aquatic life in the Experimental Ponds Area in central Newfoundland. Another year of pre-spray data was added to the data base for Spruce and Headwater ponds, and productivity data were collected. The results obtained to date are proving to be valuable in a number of other areas such as salmon and trout management, and in planning for a salmon enhancement program for the Atlantic coast.

Groundfish

Habitat research relevant to groundfish populations was in the area of physiological ecology. Emphasis continued to be placed on hydrocarbon problems in the marine environment. Work focussed on the ability of spawning cod to detoxify hydrocarbons; the effect of chronic oil exposure on gonad maturation and gamete viability in cod; development of dose-response relationships for oil in sediment in relation to flounder feeding; and detailed statistical analyses of cod and sculpin data to develop dose-response relationships for Venezuelan and Hibernia crude.

Pelagic Fish

An evaluation of capelin larval toxicity in relation to Hibernia oil in sediments was carried out. The results indicate sediment oil concentrations of greater than 100 ppm would be required before toxicity is manifested.

Invertebrates

Habitat research relevant to invertebrate populations focussed on the hydrocarbon detoxification/degrading ability of mussels, freshwater clams and soft-shell clams, and on the potential of lobsters, clams and mussels for deactivation of chlorination-derived mutagens.

General

The presence of mutagens in offshore sediments of the Gulf of St. Lawrence was studied to determine whether long range transport can be an important vehicle for disseminating hydrocarbon mutagens, and the importance of this source of hydrocarbon compared with petroleum hydrocarbons. Also, bacterial assays for hydrocarbon-degrading bacteria were carried out on coastal sediments to evaluate the usefulness of this approach as a biological monitor around areas of oil development. Research was also initiated to address the controversial question of whether oil sinks.

SCOTIA FUNDY REGION

Diadromous and Freshwater

Research related to energy development included assessments of improvements to fish passage ways for salmon and alewives; assessment of the impact of streambed channelization on salmonid productivity; the calibration of a model for Atlantic salmon for setting maintenance flow requirements at water diversion and storage sites; and habitat inventories and population assessments of shad in the inner Bay of Fundy to provide baseline information for assessment of tidal power impacts.

Research related to forest harvesting included continuing evaluations of the long-term impacts on forest stream ecoystems and salmonid production in the Nashwaak watershed, and the effect of Matacil on pond microbiology.

Research related to acid rain included pH monitoring of salmon rivers; measuring acidification impact on stream invertebrates and salmon; mitigation by neutralization (which involved liming of lakes and post-application chemical and biological monitoring); assessments of the effects of acid precipitation on aquatic habitat in the Maritimes, specifically to ascertain the status of water chemistry and fish populations in representative lakes in New Brunswick and Nova Scotia as part of the National Lakes Survey, and to undertake studies of salmon recruitment in an acidic stream in S.W. Nova Scotia.

Groundfish

Habitat related research in support of groundfish populations centered on biochemical indicators of sublethal effects. Research included a monthly monitoring of adenylate energy charge (AEC) in gills, liver and muscle of sea raven and winter flounder. These data will provide useful baseline information and guidance for choosing suitable aquatic animals for monitoring the effect of pollutants on AEC. Additionally, research was carried out on pollution-stressed cod caught near the entrance of Halifax Harbour. Histopathological indications of chronic liver stress were noted, and evaluation of a possible cause/effect relationship with organochlorine compounds is underway.

Pelagic Fish

Habitat related research relevant to pelagic fish populations centered on the effects of persistent organochlorine pesticides and polychlorinated biphenyls (PCBs) on herring from the Trinity (SW Nova Scotia) area, to be compared with a similar study of herring from the Gulf of St. Lawrence. Investigations continued on the implications of dredging and spoil dumping for herring in the Miramichi Estuary. The first phase of a multidisciplinary field and laboratory study on the effects of silt on herring behaviour was concluded.

Invertebrates

Habitat related research relevant to invertebrate populations centered around three major areas: effects of heavy metals and polynuclear aromatic hydrocarbons (PAHs), effects of persistent organochlorine pesticides and PCB, and biochemical indicators of sublethal effects.

Research related to the effects of heavy metals included work in the Belledune area (Chaleur Bay in the western Gulf of St. Lawrence) with respect to cadmium in lobster and a baseline survey of cadmium in scallops collected from 15 commercial sites in the Maritimes.

Extensive surveys for PAH in lobsters were conducted in Sydney Harbour. Investigation into the uptake and depuration of PAH by impounded lobsters was completed.

Initial investigations on PCB levels in the hepatopancreas of lobsters from Sydney Harbour indicate that levels may exceed the Canadian tolerance guidelines.

Research continued on the use of biochemical indicators to detect sublethal effects of trace levels of pollutants in lobsters. This included work to isolate and identify in-vitro steroid hormones in an attempt to assess the effects of pollutants on steroidogenesis; a laboratory study on the adenylate energy charge (AEC) and ATPase activity in lobsters exposed to a sublethal level of zinc under flow-through conditions; investigations to determine the potential of a metallothionein-like protein (MLP) as a biochemical indicator in lobster and to determine the toxicological significance of MLP; and tissue studies from lobsters from the Miramichi area and from Sydney Harbour. The relationship of parasitic infections and granulomas to pollution levels was investigated.

Marine Plants

To determine those aspects of fisheries productivity most vulnerable to contamination and to human activity, studies were done on intertidal loss and on the extent of floating and intertidal standing crop of Ascophyllum (wrack).

General

A number of research projects were not linked directly to any particular species group. In relation to energy development, the Bay of Fundy Benthic Survey, initiated in anticipation of tidal and other energy-related developments, was completed.

The specimen collection and identification centre at St. Andrews, N.B. was successfully managed under contract for a second year. Monitoring of the L'Etang Estuary in SW New Brunswick, polluted by pulp mill effluent, was continued to develop methodology for assessing the status of aquatic ecoystems subject to anthropogenic activity.

GULF (QUÉBEC) REGION

Diadromous and Freshwater Fish

Research related to acid rain involved the launching of programs to determine whether current water quality on the North Shore of Quebec is a threat to Atlantic salmon; to determine how acidification affects fish habitats and their subsequent utilization by man; to identify the magnitude of the acidification phenomenon and the effects of other pollutants on fish and fish habitat; and to determine the nature of the damage.

Other

The majority of habitat research in the Gulf (Québec) Region can be classified as general biological oceanography designed to contribute to our understanding of marine ecosystems to enable prediction of future impacts. The work included microbiological studies at Frobisher Bay as part of the EAMES study; completion of an ice biota (flora and fauna) study at Frobisher Bay; studies on the rate of lipid and caloric energy accumulation in the Arctic under natural conditions and utilization rates under conditions of stress; completion of the Grand Banks microbiology study; completion of the first year of a microbiology study as part of the Baffin Island Oil Spill (BIOS) study; and assessment of the impact of agricultural practices on intertidal salt marshes in the St. Lawrence Estuary. As well, a bibliography of fish habitat in the St. Lawrence River and Gulf of St. Lawrence (specifically the Estuary, Saguenay Fjord, Magdalen Islands) was completed.

Marine Mammals

Habitat research related to marine mammal populations in the Arctic continued with studies on vocalizations and surface behaviour of white whales in Lancaster Sound; studies on the use of polynyas by Arctic marine mammals; and continuation of monitoring of ringed seal populations in Amundsen Gulf and the SE Beaufort Sea.

ONTARIO REGION

All habitat research in the Ontario Region related to freshwater fish populations. Studies included investigation on factors affecting phytoplankton productivity in Lake Superior (e.g. light, temperature, and phosphorus); participation in the Great Lakes international fish

contaminants surveillance program which has an overall objective to survey the concentration of contaminants in selected species of Great Lakes fish and other biota, with the specific purpose of determining environmental trends in contaminant levels and relating these, where possible, to sources of such pollution; ongoing development of methodology for a fish tissue bank as part of the contaminants surveillance program; and investigation into the effect of sediment-associated contaminants on phytoplankton (of concern due to extensive dredging operations in the Great Lakes nearshore zone).

Acid rain studies focussed on a headwater lakes survey of habitat and biota in central Ontario which aided in the selection of the Algoma calibrated watershed site. Two levels of studies are being carried out: extensive survey of lakes throughout Ontario, and process studies predominantly in a single watershed (Turkey Lakes) in the Algoma region of Ontario.

Research in environmental toxicology continued on both contaminant dynamics and their effects, to develop criteria suitable for water quality objectives for the protection of aquatic biota; to develop principles of aquatic toxicology for assessing the hazards of contaminants to aquatic biota; and to develop principles of contaminant dynamics for contaminant management in aquatic ecosystems. Work focussed on metal methylation in acidic environments, on mercury levels in exploited fish populations, on lead accumulation by fish exposed to fluctuating concentrations of waterborne lead, on surveys of lead contamination in Lake Ontario fish, on contaminant levels in fish and eggs, on uptake of contaminants by fish, on PCB dynamics in model ecosystems, and on contaminant effects.

WESTERN REGION

All habitat research in the Western Region related to freshwater fish populations. Studies continued on northern reservoir biology and fisheries with manuscripts prepared on pre-impoundment and diversion studies and on initial impacts of the hydro-electric development on South Indian Lake. Surveys and experimental studies on mercury in fish in new reservoirs were completed. As well, information and advice on the fisheries consequences of hydro developments were provided (on request) to a number of agencies, corporations and native groups.

Research continued on aquatic toxicology with emphasis on ecotoxicology, organic chemicals toxicology, pollutant indentification and measurement, and fish toxicity mechanisms. The ecotoxicology program carried out fundamental and applied research to recognize, define and provide knowledge needed to prevent deleterious effects of organic and inorganic pollutants on freshwater habitats. Effects on both fish and invertebrate food resources were studied, using a combination of field and laboratory investigations of lake and river habitats. The organic chemicals toxicology program continued to investigate the toxicology and environmental pathways of experimental pesticides, energy-related organics, priority pollutants and industrial organics in fish and aquatic systems. As well, advice on pesticide registrations was provided. The

pollutant identification and measurement program continued to conduct applied and fundamental research on acidification and pollution problems of heavy metals in aquatic systems and biota, with an emphasis on determining the relationship between results of laboratory toxicology analyses and field observations. The focus of the ongoing fish toxicity mechanisms research is the elucidation of physiological and biochemical mechanisms whereby toxicants exert their adverse effects upon fish. Much of the work in 1981 focussed on chronic acid stress.

Research continued on acidification ecotoxicology and in 1981 focussed on environmental and chemical factors controlling mercury contamination in fish; on testing to determine fish physiological and biochemical responses to acid and metal stresses, and measurement of ability of fish to adapt to those stresses; and on examination of embryological development of fish in whole-lake experiments and in controlled laboratory experiments with known inputs of pollutants.

Habitat related research on fish pathobiology (fish health) included investigations into the epizootic distribution and etiology of naturally occurring tumors and diseases of fishes to provide basic information relevant to international investigations pertaining to fish habitat deterioration and environmental carcinogenesis.

Research continued in the experimental lakes program to provide small-scale whole ecosystem tests of important environmental impacts (lake acidification, radioactive contaminants and toxic heavy metals) and to evaluate their effects on fishes, fish habitats and water quality. This work is in response to the need for such information as a basis for environmentally responsible decisions on energy developments.

PACIFIC REGION

Diadromous and Freshwater Fish

Research continued on fishing vs forestry interactions in the Carnation Creek project which is a baseline study that is providing an understanding of the physical and biological processes within the watershed and of the immediate effects of logging and forest management practices. Work included analysis of benthos samples, gravel samples, rainfall, stream flow data and stream temperature data.

Research continued on pollution ecology to generate scientific knowledge on the environmental factors affecting the survival of juvenile salmonids and other resource species. Specific work included assessment of the effects of municipal wastes discharged into the intertidal zone of the Fraser estuary; identification of contaminants in wastewaters and fish tissue; and research into the release of chloroform and methylene chloride from chlorinated organic matter.

Research continued on coastal habitat ecology as related to juvenile salmon, with investigations into the utilization of, dependency on, and significance of coastal habitats, specifically the Fraser River estuary. Work on the detritus and hyperbenthic plankton of the Fraser River delta was completed. Studies on impacted estuaries included an historic evaluation (1951-1981) on the changes in the Nanaimo River Delta due to log storage, and the evaluation of the recovery of benthic habitat following log-boom removal.

Other

An interpretation and report of the study on the effects of ocean dumping in Alberni Inlet was completed.

CHAPTER V

SPECIAL REVIEWS 1981

In addition to the Regional PREP process which provides a basic project inventory and review/evaluation of achievements against targets, a number of special reviews in a national perspective contribute to evaluation and planning of programs. The PRE National Summary is one such special review. In 1981 other special reviews were done relevant to:

- Canadian Climate Program
- Genetics Research Program at NASRC
- Fish Health Protection Regulations
- Marine Sciences Research Laboratory (in Newfoundland)
- COSS and COWW
- Revitalization of the Pacific Region Fish Habitat Management Program
- Arctic Fisheries Science Programs

CANADIAN CLIMATE PROGRAM - ANNUAL PROGRAM REVIEW

The Annual Program Review Meetings are held in conjunction with meetings of the Climate Advisory Committee. The intent of the meetings is primarily one of program appraisal, leading to definition of priorities. They also help to achieve interdepartmental program integration through communication during the meeting and through subsequent activities.

Reports on climate-related programs in various government departments in 1981 are printed in the May 1982 report of the Annual Program Review Meeting of the Climate Advisory Committee of the Canadian Climate Program. Relevant Fisheries Research programs are described on pages 46-49.

GENETICS RESEARCH PROGRAM AT NASRC

The 44-page report on the Genetics Research Program at the North American Salmon Research Centre (NASRC) in St. Andrews, N.B. is the outcome of a workshop held in St. Andrews, June 2-4, 1981. The report briefly outlines the scientific background to the genetics research program and summarizes the physical capacity of the NASRC. This is followed by discussion and recommendations on traits for selecion, donor

stocks, breeding program and schedule, control populations, effective breeding population size, and primary data collection. Six appendices cover additional background information and scientific rationales for aspects of the program.

FISH HEALTH PROTECTION REGULATIONS

Prior to undertaking a major revision of the Manual of Compliance to the Fish Health Protection Regulations (implemented in 1977), a study titled "An Evaluation of Sampling and Diagnostic Procedures in use under the Fish Health Protection Regulations" was conducted under contract to evaluate the existing sampling and diagnostic procedures described in the Manual of Compliance. In addition, some of the broader fish health issues were examined, including assessment of the impact of the regulations in Canada, need for Canadian sources of diagnostic reagents, and development of vaccines.

MARINE SCIENCES RESEARCH LABORATORY

The MSRL of the Memorial University of Newfoundland in St. John's received a DFO grant of $150 K. Their research activities and achievements are described in a report to DFO, titled Progress Report for the MSRL 1981/82. It is organized under the following headings:

- Physiological and behavioural ecology
- Physiology
- Endocrinology
- Steroidal Hormones
- Toxicology and Pathology
- Aquaculture
- Biological Oceanography

COSS and COWW

The Committee on Seals and Sealing (COSS) and the Committee on Whales and Whaling (COWW) are two independent advisory committees reporting to the Minister of DFO.

The terms of reference for COSS are to examine all aspects of the hunting of seals in the Northwest Atlantic and Arctic Oceans, and in particular to investigate the economic, sociological, ecological and humanitarian aspects of the seal hunt. The terms of reference for COWW include examination of all management and research programs related to whales in Canadian waters. Reporting for both COSS & COWW is done through correspondence and meetings with the Minister.

REVITALIZATION OF THE PACIFIC REGION FISH HABITAT MANAGEMENT PROGRAM

A full examination of the Departmental Fish Habitat Management policies and program was carried out in the Pacific Region at the request of senior management. Research on fish habitat and related issues constitutes a substantial part of this program. A 36-page report titled "Final Report on the 1980-1981 Revitalization of the Pacific Region Fish Habitat Management Program" was submitted in October 1981. It describes the process and results of the project, and offers conclusions and recommendations in the areas of policy, program, communications, organization, and co-ordination with OSS.

ARCTIC FISHERIES SCIENCE PROGRAMS

This is a summary of science activities in the Arctic conducted by the Fisheries Management side of DFO, mostly by the Fisheries Research Branches, but includes some operational activities, especially in the Western and Quebec Regions. It is based on regional PREP submissions. Oceanographic programs in the Arctic conducted by the OSS side of DFO are excluded.

This special focus on the Arctic is in keeping with developments in the north, and with the concerns of native peoples over the renewable resource and the habitat on which it depends. The material is organized by performer Region (below): Headquarters, Pacific Region (Yukon), Western Region (NWT), Quebec, and Newfoundland. A summary table of relevant resources is provided.

Headquarters (Fisheries Research Directorate)

The Resource Research Branch participates in policy development with respect to scientific issues in the Arctic, facilitates coordination of DFO's various Arctic fisheries research programs, and serves as a focal point for departmental policy advice on the protection of endangered species.

The Branch coordinated scientific input for a departmental review of the status of the bowhead whale and for development of a policy position on aboriginal hunting. Staff coordinated provision of appropriate scientific expertise for the independent review of the bowhead question conducted by the Committee on Whales and Whaling.

As part of Canada's ongoing commitment to the Scientific Committee of the International Whaling Commission, the Branch organized a departmental review of past Arctic whale research activities and future plans. A summary report is being prepared.

Staff contributed to the clarification of Canada's position on listing of species under the Convention on Internatinal Trade in Endangered Species (CITES); they also played an active role in negoti-

ations to ensure that only legitimately endangered species are listed. Input was also provided to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Pacific Region (Yukon Territory)

The Department has responsibility for managing freshwater fish as well as anadromous species in the Yukon Territory. Management is carried out by the Fraser River, Northern B.C. and Yukon Division of the Pacific Region, with the Division head office located in New Westminister, B.C. and a local office in Whitehorse. The Whitehorse office is the base for several fishery officers and a small biological unit. The biological unit undertakes stock assessment programs designed to aid in the establishment of regulations and long-term management strategies.

A salmon counting weir on the Klukshu River, a tributary of the Tatshenshini River (Alsek system), was in operation for the sixth consecutive year to enumerate the escapement of sockeye, chinook and coho to this stream. In addition, salmon were sampled for length, weight, sex and age, and a small creel census was undertaken to estimate the harvest by anglers.

The commercial catch of salmon in the vicinity of Dawson was sampled as in previous years for length, weight, sex and age. Subsistence and domestic fisheries were monitored along a 480 km stretch of the Yukon River between Dawson City and Carmacks, and also on the Pelly River between the Yukon River and Pelly Crossing.

The escapement of chinook salmon through the Whitehorse fishway was monitored again; the 1981 escapement was the second highest on record.

A survey of Yukon lakes was undertaken by FRB staff in 1981 to provide productivity estimates to assist in establishing regulations for the sport and commercial fisheries. The measure of productivity used was the morphoedaphic index (total dissolved solids divided by mean depth) and this was calculated for 52 lakes. Total dissolved solids were determined for an additional 15 lakes. The results indicated that Yukon lakes are generally of low productivity and could easily be overfished if not carefully managed.

Western Region - (Northwest Territories)

Fishery management field activities included investigations into both freshwater and anadromous fisheries. Biological data on commercial, sports and subsistence (domestic food) catches were collected.

Monitoring of the commercial fisheries were continued on Great Slave Lake, Victoria Island (Cambridge Bay area) and along the Keewatin coast as were as stock assessment studies on Great Slave Lake whitefish populations and Wellington Bay (Victoria Island) anadromous Arctic char

Table V-1 Arctic Fisheries Science Resources in DFO, FY 1981/82

Region and Program	PY	($ x100) External O&M	CAP	Sources	Total
1. Headquarters					
Policy and Programmes	2.0	-	-	-	-
2. Pacific					
Fisheries Resources	4.0	6.0	-	-	6.0
3. Western					
Arctic Marine Ecology	12.0	200.0	106.5	-	306.5
Arctic Marine Mammals	4.2	49.0	-	-	49.0
Arctic Fish	1.8	21.0	-	-	21.0
Conservation and Protection	12.5	90.5	-	-	90.5
Fishing and Industry Services	2.0	30.0	-	-	30.0
4. Quebec					
Marine Mammals	3.0	40.7	-	25.3	66.0
Marine and Anadromous Fish	3.0	4.7	-	3.0	7.7
Arctic Oceanography	10.0	74.6	10.0	35.4	120.0
5. Newfoundland					
Arctic Char	4.5	43.0	3.5	50.0	96.5
Greenland Fisheries Investigations (Atlantic Salmon)	1.7	20.0	-	-	20.0
Hudson Strait/Ungava Bay Shrimp Assessments	1.3	45.0	-	5.0	50.0
Marine Fisheries Management	3.4	16.3	-		16.3
	65.40	640.8	120.0	118.70	879.50
				Salaries in DFO	1,877.4
				Vessel Charters	375.0
				Total	**3,131.9**

populations. Preliminary work was also done on the feasibility of commercially harvesting herring for their roe in Tuktoyaktuk area. The experimental fish weir (Saputit) project at Jayco River (Victoria Island) was concluded.

Marine mammal field activities included monitoring of the Mackenzie Delta beluga hunt. Six local Inuit were contracted to observe the hunt in camps between Shingle Point and Tuktoyaktuk. Over 75% of all hunters were interviewed and data were obtained on hunting effort and on numbers of animals caught and lost. Landed whales were examined to develop population parameters.

Aerial surveys were conducted on beluga in Cumberland Sound during early August, and also along the west coast of Hudson Bay from Fort Severn (Ontario) to Rankin Inlet (NWT) in July, and from Repulse Bay (NWT) to the Nelson River (Manitoba) in August.

Fish Habitat

A number of studies were conducted with the overall objective of defining the anadromous and freshwater fisheries resources of the south Beaufort Sea area and the extent to which these resources could be affected by the development of hydrocarbon resources in the region. Hydro-acoustic (echo-sounding) techniques were used to delineate discrete pre-spawning aggregations of fish in the Mackenzie Delta and River.

Studies to describe the fish resources of Tuktoyaktuk Harbour were initiated. In addition, studies were initiated on two watersheds draining into the harbour to determine the extent to which these systems are utilized as feeding, spawning, rearing and overwintering areas by anadromous coregonids and other fish species.

Staff participated in a joint DFO-DIAND program to monitor the effects of effluent from the Nanisivik lead-zinc mine on Baffin Island. A similar monitoring program was carried out at the Polaris Mine on Little Cornwallis Island, which began operations in late 1981.

A project was initiated to prepare a fish and marine mammal inventory and habitat sensitivity maps of the Beaufort Sea area. Arctic land-use mapping surveys of various watersheds on Victoria, King, William and Prince of Wales Islands were undertaken under contract. Maps have been prepared on watershed characteristics and catch information, along with a report describing the techniques utilized.

Staff participated in the review of several major industrial projects in the region, prepared policy and guidelines concerning the use of explosives in the waters of the NWT, and prepared draft guidelines for dredging projects.

Research continued through the year on the physical, chemical and biological processes of Arctic fresh and marine waters, and on the impact of man's activities alter aquatic habitats.

The problem of the source, sinks and cycling of the natural uranium series elements in lakes, streams, and the estuary at Saqvaqjuac (40 km north of Chesterfield Inlet) were studied. Samples of freshwater fish, estuarine fish, crabs, kelps, seal, walrus, and polar bear have been obtained to determine the accumulation of uranium series elements in the food chain. Sediment cores of freshwater lakes and the Saqvaqjuac Estuary are being analyzed for natural radionuclides, bomb fallout nuclides, and fallout of lead and mercury.

Freshwater phytoplankton and zooplankton research was done at Saqvaqjuac on control lakes, nitrogen-fertilized lakes, and phosphorus-fertilized lakes. Samples of lake zooplankton from the Arctic islands and mainland NWT and Yukon are being used in zoogeographic studies.

Industry Services

Four out of five registered fish processing plants were formally surveyed in the NWT to determine their ability to maintain certification status; more than 180 inspections were carried out to monitor compliance to operational requirements. In addition, over 600 microbiological analyses were performed on fish from subsistence fisheries.

Thirty-three of approximately 80 commercial fishing vessels were inspected, and approximately 2.8 million pounds of fish products in the NWT were subject to inspection in 1981. A total of 1,683 samples of aquatic biota taken in 1980 and 1981 from a mine site in the NWT were analyzed, with 14,150 analyses completed for mercury, arsenic, selenium, lead, cadmium and zinc. Five vessels were surveyed to determine their ability to meet new vessel certification requirements under the Quality Improvement Program.

Major activities in fisheries development included:

- A project to test the feasibility of a gillnet fishery to harvest Pacific herring in the Mackenzie Delta area and to determine the time of roe maturity from that species as a potential cured roe product. The results of the roe processing were satisfactory both in terms of

- An investigation was conducted on the use of lake whitefish and broad whitefish as possible sources of caviar. Sufficient data were obtained to indicate that broad whitefish is an appropriate source of roe for a high-quality caviar product.

- A project with local Inuit fishermen was done to test the feasibility of a modified saputit (fish weir) harvesting method for Arctic char on the Jayco river on Victoria Island.

Conservation and Protection

For purposes of conservation and protection the Northwest Territories are divided into five sub-districts, with headquarters in Yellowknife. Fishery officers were involved in the enforcement of the

Fisheries Act and relevant regulations. They were also engaged in the collection of harvest data, conservation education, habitat protection, and other activities of the Department in the north. Staff participated in five interdepartmental and territorial government committees where terms and conditions were developed and incorporated into licences or permits issued by other agencies. Staff also participated in eight advisory resource-use committees.

Quebec Region

Arctic Whales

A survey of wintering beluga whales was carried out under a contract funded by the Western Region. This work complemented the study of beluga in Northern Quebec. A second year of beluga behavioral data was gathered from Cunningham Inlet. A team attempted to investigate the entrapment of narwhals in Quillham Bay, but were hampered by bad weather and ice conditions.

Arctic Seals

The analysis of data from Holman Island was completed and a monograph is being prepared on the ringed seal populations. A technical report on bearded seal biology was released. A paper was published on marine mammals on "Polynyas" in the Canadian Arctic. A study was initiated in collaboration with McGill University on predation of ringed seals by Arctic fox. Further data were collected on the biology of ringed seals in the Holman Island area.

Arctic Marine and Anadromous Fish

Data for 54 marine species of fishes has been computerized and verified, leaving only four species to be completed. Programs were prepared for a series of statistical analyses on each species, and statistics on growth and maturity have been computed where sufficient data were available. Computer maps of individual species distributions have been plotted from samples collected in the period 1955-77. Preliminary illustrations and maps have been prepared for an Atlas of Marine Fishes of Arctic Canada being produced in conjunction with NMNS, Ottawa. The text of a report on fishes of the Beaufort Sea is in the final stages for publication.

Arctic Biological Oceanography

Marine Plants

A checklist of marine phytoplankton and sea-ice microalgae from the Canadian Arctic was completed. A report n the sea-ice microalgae of Frobisher Bay is in the final stages of preparation. This program was

partially funded by the private sector. A manuscript on the in-situ growth rates of Arctic marine phytoplankton in Frobisher Bay is nearly completed.

Continuing studies on standing stock, species composition, vertical distribution, community structure, and rate of primary production of marine phytoplankton and sea-ice microalgae in relation to environmental factors were conducted in Frobisher Bay during the open water as well as ice seasons. Primary production rates of seaweed were measured, as were diurnal variations in chlorophyll and phytoplankton abundance through a full tidal cycle.

Zooplankton

A study of animals living within the sea ice was completed and has produced the first quantitative data from any Arctic locality on predatorprey relationships and the density and abundance of life within the ice. A study on the deepwater zooplankton of Eclipse Sound was conducted and the seasonal movements of a number of species were delineated.

Work on an up-to-date checklist of Canadian Arctic zooplankton was continued. A paper on the factors controlling primary productivity in the waters around the Belcher Islands was accepted for publication. Successful trials were conducted in the use of underwater television cameras for zooplankton investigations.

Zoobenthos

Studies related to detrital fallout were continued. Some progress was made in the preparation of manuscripts of zoobenthic intertidal studies, and of the structure and stability of Arctic zoobenthic communities. Progress was made in other continuing studies at Frobisher Bay, Eclipse Sound and Ungava Bay and should be completed next year. Other studies on station lists were continued in Hudson Bay, Foxe Basin, Coronation Gulf, Franklin and Darnley Bays and the Arctic Archipelago.

Marine Physiology

Studies on the four dominant macrozooplankters in Frobisher Bay were continued. As the local ecology of these species becomes better understood, emphasis will be shifted to the physiological aspects of the program. Temperature and salinity profiles and biological sampling were undertaken in Frobisher Bay. These data, coupled with those from sampling of previous years, will be presented in a data report on seasonal abundance, population structure, depth distribution and size frequency of plankton.

Biomass and energy content studies of principal macrozooplankton groups were continued, as were studies on biochemical composition of the animals. Metabolic studies designed to estimate the relative energy requirements of major Arctic zooplankton species under field and laboratory conditions were undertaken.

Marine Microbiology

The BIOS oil spill project at Cape Hatt was continued under the sponsorship of Environment Canada; a report on the 1980 data was issued early in 1981. A small project was initiated at Cape Hatt to evaluate bacterial activity in under-ice communities. The study of bacterial heterotrophy at Frobisher Bay was completed.

A cooperative program with McGill University on petroleum biodegradation was initiated in Frobisher Bay. The private sector, in conjunction with Arctic laboratories, funded a project to assess features of microbiology and biological oceanography of the McKenzie Delta.

Newfoundland Region

Freshwater and Anadromous Fisheries Management

The Arctic char project serves primarily to provide management advice on the status of northern Labrador char populations and available harvests of specific stocks for the Inuit subsistence and commercial fishery. Analysis of tag returns indicated a seasonal exploitation rate of 0.22 and 0.44 for Nain Bay and Tikkoatokak Bay respectively. Catch effort statistics for the 1981 commercial fishery show that landings increased by 38% over 1980, while effort increased by 4% as a result of the expanded fishery in the Hebron and Saglek areas. Analysis of tag return and catch/effort statistics has allowed quota reductions in areas of over-exploitation (e.g. Nain Bay) and redirection of funding into under-utilized areas such as Okak Bay. A cooperative venture between the Industrial Development Branch and the Salmon and Char Management Section permitted monitoring of the char migration on the Ikarut River.

Other selected involvements included an arrangement for electrophoretic analysis of 500 blood samples by the Freshwater Fisheries Research Institute (Drottingholm, Sweden) for stock identification in the northern Labrador char populations. A cooperative program was also undertaken with the Freshwater Institute (Winnipeg) where 80,000 char eggs were hatched to examine growth, genetics and nutritional requirements. Two papers on Arctic char stocks of northern Labrador were presented at the International Symposium on Arctic char in Winnipeg. An assessment of arctic char stocks was provided to CAFSAC.

West Greenland Fishery Investigations

This program provides an annual assessment of the proportion of North American Atlantic salmon caught at West Greenland. It also involves research to improve the quality of advice toward limiting the effects of this fishery on North American salmon stocks and fisheries. In 1981, significant contributions were made to the ICES North Atlantic Salmon Working Group, and collaborative research was carried out with Danish scientists and the Scottish Department of Agriculture. Biological sampling permitted the prediction of smaller-than-normal salmon returning to home rivers in Europe and an increase in the proportion of North American salmon at West Greenland in response to stock rebuilding efforts.

Shrimp Biology and Assessment - Hudson Strait/Ungava Bay

The objective of this project is to provide scientific advice for management of the shrimp resources in northern waters, based on an understanding of stock boundaries and relationships, on population dynamics and on ecosystem relationships. Shrimp sampled in 1980 were analysed for age distribution. Further samples were obtained in 1981. Methods of ageing and results were presented to the Shrimp Ageing Workshop. Attempts were made to correlate catch rates with diel variability; comparisons with 1979 and 1980 data indicated differences in abundance which suggests that vertical migration accounts for only part of the variability in catch rates. Results of the research/exploratory cruise by the Imapqike Fishery indicated a potential yield of 300-450 tons of shrimp from the waters off Port Burwell, and 500-700 tons from waters west of Resolution Island.

Marine Fisheries Management

With respect to the waters of northern Labrador, the main species of interest are the Arctic cod, Greenland halibut and grenadier. Samples of Arctic cod were collected from all areas of northern Labrador for length, weight, sex, maturity and age analysis. Vertebral samples were analysed for stock discrimination.

Studies on the life history and biology of the Greenland halibut were carried out to update stock assessments and delineate stock boundaries. Food, feeding, distribution, and sexual maturity relationships are also being studied. A preliminary assessment was done of the predator-prey relationship between Greenland halibut and shrimp in the northern Labrador shrimp fishery.

APPENDIX A

REGIONAL PREP PROCESSES

The Regional Program Review and Planning (PREP) process reviews and evaluates the effectiveness, relevance and priority of programs in relation to government policies and client needs. It provides a measure of accountability in the development and completion of research activities, and is an integral part of planning and budgeting.

The outputs of the 1981/82 regional PREP processes constitute a major input to the present document. The backward-looking component (Program Review and Evaluation - PRE) generates statements on the achievements against plans in the PREP of the previous year (1980/81). The forward-looking component of the process (planning, i.e. the final 'P' in PREP) generates the work plans for the next fiscal year (1982/83). The process takes place October to January, but final documentation is normally completed only after the end of the Fiscal Year. A description of the PREP process for each Region is given below.

NEWFOUNDLAND REGION

Program Review and Evaluation in 1981 centered on the following:

a) effectiveness, relevance, priority and actual effects of programs and activities, taking into account governmental and departmental objectives and client needs; and

b) identification of changes to improve program design and delivery, organizational planning and administrative effectiveness.

The six stages of the PREP in Newfoundland are described below.

1. Documentation

Standardized formats were developed for the preparation of project reports to facilitate:

- consistent quality of documentation; and
- ready access to material in planning, budgeting and other exercises throughout the year.

A list of projects was prepared by the Scientific Program Co-ordinator in consultation with Program Heads and circulated to researchers to ensure that all activities were covered.

Accomplishments during the past calendar year were evaluated on the basis of research goals for the year to determine whether these had been attained. Additional projects were also listed with relevant justification.

Researchers were asked to propose research goals for 1982 with emphasis on the establishment of clear, attainable targets to be completed within the next review period. They further contributed to the evaluation process by providing brief descriptions of long-term objectives, areas and issues of client concern, neglected areas of research and other topics of interest to the Management Committee.

2. Internal Review

Internal review varied among Programs. In general, review procedures were dictated by the requirements of program reports (Stage #3) and in-depth evaluation by Management Committee (Stages #4 & 6) outlined below.

3. Program Reports

Program reports were submitted in advance of detailed evaluation by Management Committee, and included:

a) a brief introductory statement describing in general terms the activities, responsibilities and objectives of the Program and supporting Sections as they related to the overall mandate of Research and Resource Services;

b) a summary of major review and evaluation findings and Program highlights, with particular emphasis on topics and issues requiring further attention by Management Committee; and

c) a compendium of individual project reports with preliminary review and evaluation statements by Program Heads.

4. Project Evaluation by Management Committee

Management Committee evaluated all projects on the basis of project reports and preliminary evaluations by Program managers. In the presentation of individual reports by Program Heads, project strengths and weaknesses were to be identified with sufficient information to aid the committee in evaluation.

Projects were appraised in relation to government and departmental objectives and client needs with specific attention to effectiveness, productivity, quality, relevance, priority, and effects. Evaluation comments were recorded by Management Committee, and reports and proposals were subsequently modified as appropriate.

5. Outside Review

Invitations to interested groups and individuals were forwarded a month in advance of scheduled meetings. Those indicating an interest in attending received preview information as an aid to discussion. Sessions were chaired by the Director and all were attend by Program Heads.

External Agencies (exclusive of fishing industry). A meeting was scheduled with representatives of federal and provincial government Departments, Memorial University of Newfoundland, College of Fisheries, and other academic institutions, the oil industry, consulting companies and other interested parties. Research staff were encouraged to participate in the session.

Fishing Industry. An in-camera exchange was arranged with members of the fishing industry to provide an opportunity for discussion and criticism of research programs and to identify areas and issues of industry interest.

Senior Departmental Personnel. Management Committee met with senior Fisheries and Oceans personnel (Regional and external) to assess the relevance of research programs in view of Regional activities and requirements and in relation to comments raised by the fishing industry and other groups. Personnel from outside the Region were also invited to participate. Comments, criticisms raised during this stage of the review were documented for further consideration by Management Committee.

6. Wrap-up Evaluation by Management Committee

In advance of wrap-up, an annotated list of issues identified in project evaluation, by outside agencies and by members by Management Committee were compiled by the Scientific Program Co-ordinator for in-depth examination and follow-up. The final evaluation considered major review and evaluation findings.

7. Preparation of Directorate Report

A final report was prepared by the Scientific Program Co-ordiator from combined program submissions with sufficient additional information to make it suitable for wider public circulation.

8. Presentation to Regional Director General

Program Review and Evaluation (1981) findings are presented to and reviewed with the Regional Director General, prior to budgeting for the new fiscal year.

SCOTIA-FUNDY REGION

In late November, 1981 the Division Chiefs were requested to complete the modified RAPP forms (labelled Review Process 1981/82) according to HQ guidelines. The forms were completed by project leaders and submitted via Section Heads and Division Chiefs to the Director's Office, along with the Operational Plan. This process was completed before the end of December, 1981.

The Branch Director and the four Division Chiefs reviewed the program achievements against targets and evaluated the programs for effectiveness and efficiency and for relevance to regional and national objectives (January, 1982).

Subsequently, resources tables were compiled to the fourth PAS digit as of the end of December, 1981, and revised in May when year-end data became available. Rollup statements were added by the Director's Office prior to submission of the documentation to Headquarters.

GULF (QUEBEC) REGION

A description of the PREP process was not provided by the Gulf Region. Three separate sets of meetings were held, one each in Moncton, Quebec and Ste. Anne de Bellevue.

HEADQUARTERS

The small HQ unit combined the PREP process with the staff appraisal process. Excerpts from the appraisals, on achievements for the elapsed year and goals for the coming year along with goals from the previous year, constituted the PREP documentation. The achievements and work plans were reviewed by the Directors at a meeting with their staff officers. The documentation was presented to the Director General of the Fisheries Research Directorate.

ONTARIO REGION

Documentation. PREP documentation was drafted by November 1981. It included both a review of programs and proposed plans for the coming year.

Review. Both an internal review (with the three program coordinators) and an external review (with representatives of client groups) were held. The PREP documents were revised and modifications made to proposed plans to reflect discussions taken.

Revision. When budgets were distributed in March 1982 the work plans were finalized against <u>actual</u> resources.

Annual Review. A final version of the PREP documentation was printed in September 1982.

WESTERN REGION

In the Western Region the PREP Process for the Fisheries Research Branch is integrated with the overall regional Review and Planning Process (RAPP). Every regional project (basic organizational unit, generally equivalent to a regional financial responsibility centre) participates in the RAPP and provides the following:

- inputs for work plans and multi-year operational plans;
- forecasts of support service requirements (e.g. personnel, EDP, analytical services, wet lab, etc.);
- identification of program and resource changes within A-base allotments;
- forecasts of capital and equipment requirements;
- preliminary financial planning (includes external funding);
- a mechanism for evaluation of project performance;
- the formalization of the project objective-setting exercises.

The Research Advisory Council provides the mechanism for the assessment of plans and performance of all regional research and science projects. For these activities the project RAPP documentation provides the roll-up for the planning and review of individual sub-projects which define the activities of individual scientists and biologists.

The Council's terms of reference were as follows:

1) to evaluate sub-project submissions on the basis of whether or not stated objectives were met;

2) to advise the Director of the submissions which appeared to be deficient;

3) to review in particular the activities of projects which were officially ended in 1981/82 and the plans for all new projects;

4) to advise the Director on other matters relating to the research activities of the Western Region.

The following were the steps taken in the Research Advisory Council process:

1) individual projects submitted RAPP and sub-project documentation;

2) leaders of new projects presented open seminars on their plans;

3) all submissions were discussed within the Advisory Council;

4) Council reported to the Director on the performance of individual projects and on the general state of research activities in the Region;

5) the Director reviewed the Council's comments with individual project leaders;

6) the 'Annual RAPP, Review of 1981/82 and forecast of 1982/83' was printed.

Normally the process is initiated in October and completed in January. In 1981/82, because of the reorganization of the Western Region, the review process was not started until March.

PACIFIC REGION

A call for PREP documents on a project basis was issued by the FRB Director in late September to describe achievements against targets for the calendar year elapsed and targets for the next year. During October each project officer prepared the documentation in consultation with his Division Chief. The Research Advisory Board, appointed by the Director and including external reviewers (from FRB Western, SEP and the University of B.C.), received the documents and heard verbal presentations by Section Heads and by Project Leaders at two weeks of open meetings in November.

The Board then produced a report for the Director of the Fisheries Research Branch advising him on the scientific merit of the proposals and their relevance to departmental mandates. Using this advice and tempering it with up-to-date departmental concerns the Director, with his Associate Director and the Science Coordinator, produced work plans and budget allocations for the next fiscal year.

APPENDIX B

PAS DEFINITIONS

Fiscal year 1981/82 was the first year that the new Program Activity Structure (PAS) was used for all DFO financial reporting. For Fisheries Research programs it had already been used retroactively in the 1979 and 1980 Fisheries Program Review National Summaries. The PAS was issued as DFO Management Services Bureau Directive 24-80, dated 3 November 1980, and modified 17 June, 1981 by means of a memo from the three ADMs who had science programs (i.e. AFS, PFF, OSS).

The five-page summary of the PAS for the entire Department (below) is followed by eight pages of detailed definitions for Fisheries Research (PAS 1.4).

DEPARTMENT OF FISHERIES AND OCEANS

PROGRAM ACTIVITY STRUCTURE

1.0 ACTIVITY - FISHERIES MANAGEMENT

S. Activity	S.S. Activity	S.S.S. Activity
1.1 Administration (FM)	1.1.1 Management	
	1.1.2 Support Services	1.1.2.1 Communications
		1.1.2.2 Finance
		1.1.2.3 Personnel
		1.1.2.4 Assets Management
		1.1.2.5 Information Systems
		1.1.2.6 Library
		1.1.2.7 Technical Support
	1.3.3 Ships	1.1.3.1 Surveillance & Enforcement - Offshore
		1.1.3.2 Surveillance & Enforcement - Inshore
		1.1.3.3 Research
		1.1.3.4 Search & Rescue
1.2 Economic Development	1.2.1 Marketing	1.2.1.1 Market Research & Analysis
		1.2.1.2 Market Promotion & Development
	1.2.2 Economic/Social Research & Policy Analysis	
	1.2.3 Intergovernmental Relations	1.2.3.1 International Relations
		1.2.3.2 International Trade & Development
		1.2.3.3 Federal Provincial Relations
	1.2.4 Statistics	

ACTIVITY - FISHERIES MANAGEMENT

S. Activity	S.S. Activity	S.S.S. Activity
1.3 Fisheries Development & Fishermen's Assistance Program	1.3.1 Fisheries Development Programs	1.3.1.1 Gear Development
		1.3.1.2 Vessel Development
		1.3.1.3 Exploratory Fishing
		1.3.1.4 Processing Improvement
		1.3.1.5 Quality Improvement Infrastructure
		1.3.1.6 Self Enforcement Program
	1.3.2 Fishermen's Assistance Programs	1.3.2.1 Fishing Vessel Insurance Plan
		1.3.2.2 Fishing Vessel Assistance Program
		1.3.2.3 Fisheries Prices Support Board
		1.3.2.4 Fishermen's Improvement Loan Act
	1.3.3 Special Assistance Programs	1.3.3.1 Bait Services
		1.3.3.2 Salmon Compensation
		1.3.3.3 Community Services
		1.3.3.4 Buy-back Program
1.4 Fisheries Research	1.4.1 Resource Assessment & Related Research	1.4.1.1 Anadromous, Catadromous & Freshwater Fish
		1.4.1.2 Groundfish
		1.4.1.3 Invertebrates
		1.4.1.4 Marine Mammals
		1.4.1.5 Marine Plants
		1.4.1.6 Pelagic Fish
		1.4.1.7 Fisheries Ecology
	1.4.2 Aquaculture & Resource Development Research	1.4.2.1 Aquaculture
		1.4.2.2 Resource Development, Enhancement
	1.4.3 Habitat Assessment & Related Research	1.4.3.1 Aquatic Impact Assessment
		1.4.3.2 Toxicology & Pollution

ACTIVITY - FISHERIES MANAGEMENT

S. Activity	S.S. Activity	S.S.S. Activity
1.5 Fisheries Operations	1.5.1 Resource Management	1.5.1.1 Offshore Surveillance & Enforcement
		1.5.1.2 Inshore Surveillance & Enforcement
		1.5.1.3 Inland Surveillance & Enforcement
		1.5.1.4 Allocation & Regulations Development
		1.5.1.5 Licensing
	1.5.2 Habitat Management	1.5.2.1 Habitat Protection and Operations
		1.5.2.2 Habitat Planning
		1.5.2.3 Habitat Restoration and Development
	1.5.3 Resource Rehabilitation & Enhancement	1.5.3.1 Rehabilitation & Enhancement
		1.5.3.2 Production Facilities
	1.5.4 Inspection	1.5.4.1 Field Inspection
		1.5.4.2 Laboratory
	1.5.5 Salmonid Enhancement	1.5.5.1 SEP Reconnaissance & Feasibility
		1.5.5.2 SEP Public Involvement
		1.5.5.3 SEP Design
		1.5.5.4 SEP Construction
		1.5.5.5 SEP Facility Maintenance
		1.5.5.6 SEP Facility Operations
		1.5.5.7 SEP Community Development
		1.5.5.8 SEP Assessment Evaluation and Management Studies
1.6 Small Craft Harbours	1.6.1 Harbour Management & Property Administration	
	1.6.2 Commercial Fishing Harbours	
	1.6.3 Recreational Harbours	

2.0 ACTIVITY - OCEAN SCIENCE AND SURVEYS

S. Activity	S.S. Activity	S.S.S. Activity
2.1 Administration (OSS)	2.1.1 Management	
	2.1.2 Support Services	2.1.2.1 Communications
		2.1.2.2 Finance
		2.1.2.3 Personnel
		2.1.2.4 Assets Management
		2.1.2.5 Information Systems
		2.1.2.6 Library
		2.1.2.7 Technical Support
	2.1.3 Ships	2.1.3.1 Oceanography
		2.1.3.2 Hydrography
		2.1.3.3 Support to Fisheries Management
		2.1.3.4 Search and Rescue
		2.1.3.5 Support to Other Federal Government Departments
		2.1.3.6 Support to Canadian Universities
		2.1.3.7 Support to Other Canadian Bodies
		2.1.3.8 Support to Non-Canadian Bodies
2.2 Oceanography	2.2.1 Physical Oceanography	
	2.2.2 Chemical Oceanography	
	2.2.3 Marine Ecology	
	2.2.4 Freshwater Ecology	
	2.2.5 Ocean Dumping	

ACTIVITY - OCEAN SCIENCE AND SURVEYS

S. Activity	S.S. Activity	S.S.S. Activity
	2.2.6 University Subventions	
	2.2.7 Ocean Engineering & Technology Transfer	
	2.2.8 Data Information	
2.3 Hydrography	2.3.1 Navigational Charts - Surveys	
	2.3.2 Navigational Charts - Production	
	2.3.3 Tides, Current and Water Levels	
	2.3.4 Sailing Direction	
	2.3.5 Ocean Mapping	
	2.3.6 Navigation	

1981/82 DETAILED DEFINITIONS FOR PAS 1.4

These definitions provide further detail for only the PAS 1.4 items in the preceding 5-page summary.

1.4 Fisheries Research

Provision of scientific advice relative to the management and enhancement of fisheries, habitat and related research.

1.4.1 Resource Assessment and Related Research:

1.4.1.1 to 1.4.1.6 Included under these headings are the following assessment studies and biological research on wild stocks:

Biological studies including:

- life history
- food and growth of wild fish
- distribution
- migration
- ageing
- physiology, including spawning and reproduction
- mortality and fecundity of wild fish
- diseases and parasites of wild fish.

excluding:

- nutrition and growth of hatchery fish and fish raised in enclosures
- diseases of hatchery fish and fish raised in enclosures
- bioenergetics, foodchain
- mechanisms of factors influencing reproduction
- ichthyoplankton studies
- studies of the impact of human intervention on habitat of fish species.

Population dynamics studies including:

- stock status and stock dynamics
- stock structure/discrimination including tagging, parasite indicators, genetic markers
- effects of and management advice for commercial fisheries
- effects of and management advice for recreational fisheries
- multi-species relationships

excluding:

effects of human intervention of fish habitat
effects of enhancement on natural production
climate and natural environmental variation on wild stocks.

Mathematical studies including:

modelling dynamics of wild stocks
field survey design
development of statistical methodology for projects in this sub-sub-activity
multi-species models

Data collection and analysis including:

catch sampling
abundance surveys of wild stocks, including acoustic work
collection and analyses of fishing log books
sampling discards and by-catch
definition and monitoring of fishing effort

Gear studies including:

selectivity
efficiency

Provision of information and advice to clients and public, including:

explanation of scientific data
preparation of public information documents
advice to Canadian commissioners on multi-lateral commissions
provision of management advice
development of policies concerning harvesting, etc.

1.4.1.1 Anadromous, catadromous and freshwater fish:

Included under this heading are resource assessment studies and biological research on wild stocks of anadromous, catadromous and freshwater fish.

Species under this heading include:

salmons
trouts
gaspereau
eels
smelt
oolichan
sturgeon
white fish
others

1.4.1.2 Groundfish:

Included under this heading are resource assessment studies and biological research on wild stocks of groundfish species.

Species under this heading include:

gray cod
cod
haddock
redfish
ocean perch
rock fishes
silver hake
other hakes
pollock
sablefish
grenadier
halibut
flatfishes
cusk
sand eels
wolffish
skates
dogfish
conger eels
argentine
other groundfish.

1.4.1.3 Invertebrates:

Included under this heading are resource assessment studies and biological research on wild stocks of invertebrates.

Species under this heading include:

lobsters
crabs
shrimps, prawns
oysters
clams
geoducks
mussels
scallops
squid
octopus
others

but excludes studies on fish disease and paralytic shellfish disease.

1.4.1.4 Marine Mammals:

Included under this heading are resource assessment studies and biological research on wild stocks of marine mammals.

Species under this heading include:

harp seal
hooded seal
grey seal
harbour seal
ringed seal
fur seal
walrus
narwhal
beluga
humpback whale
killer whale
sei whale
porpoise
dolphin
other

also includes physiological studies on

humane killing
feeding

The following types of studies are excluded:

Research related to impact assessment of site-specific development proposals
Enhancement of marine mammal stocks through human intervention
Physiological studies related to keeping animals in captivity

1.4.1.5 Marine Plants:

Included under this heading are resource assessment studies and biological research on wild stocks of marine plants.

Species under this heading include:

Irish moss
laver
other reds
kelps
laminaria
others

Studies of wild marine plant populations are included in this category.

growth and productivity studies
research for optimum harvesting strategies
impact of harvesting techniques on the resource
research and development on new and/or improved harvesting techniques
studies of the impact of human intervention on marine plant habitats
studies of culture of marine plants
studies of the role of marine plants in marine ecosystems

1.4.1.6 Pelagic Fish:

Included under this heading are resource assessment studies and biological research on wild stocks of pelagic fish.

Species under this heading include:

herring
mackerel
tunas
swordfish
sharks
capelin
other pelagics

1.4.1.7 Fisheries Ecology:

This heading includes ecological and multi-species studies in support of resource assessment and aquatic climate studies relevant to fisheries.

Subheadings include:

species interaction and food chain studies (e.g., predator/prey relationships)
studies on larval stages: ichthyoplankton studies, including migration and spatial distribution of phyto and zooplankton and nutrients
studies of mechanisms of factors influencing reproductive success
primary, secondary and other production studies
climate studies of the impact of natural fluctuations in environment on food chains and on fish populations
ecosystems modelling
bioenergetics of wild stocks
immunology and physiology studies in support of fisheries ecology
studies on paralytic shellfish disease

The following types of studies are excluded:

assessment of impact of human interventions on fish and their habitat, for example:
studies on man-made reservoirs, including studies on species succession, ecology of reservoirs and impact assessments
effects of pollutants, ocean dumping, dredging, etc. on fish species
stock discrimination studies and studies on parasite/prey relationships
life histories of commercially important species
studies on geographical distribution and migration patterns of commercially important fish species
studies on year-class fluctuations.

1.4.2 Aquaculture and Resource Development Research:

Included under this heading are the following studies concerning fish health research, nutritional research and biological studies:

Fish health research and advice for hatchery fish and fish raised in enclosures, including:

infectious diseases and immunology (bacterial, viral, parasitological)
environmental diseases (stress, genetic abnormalities, neoplasia, fouling, wastes, blooms)
diagnostic surveys and services, inspection, certification
other

excluding:

diseases and parasites of wild fish (e.g., paralytic shellfish disease).
Nutritional research and advice, including: feedstuff evaluation, diet formulation and listing
environmental and physiological manipulation, rearing strategies and techniques

Reproduction supply research and advice, including:

reproductive physiology, endocrinology and behaviour
genetics and selection programs
predictive surveys
environmental and behavioural manipulation
rearing strategies and techniques

excluding:

reproduction of wild stocks.

1.4.2.1 Aquaculture:

Included under this heading are fish health research, nutritional research, biological studies and systems research related to fish (finfish, invertebrates, aquatic plants) raised in enclosures from young to marketable stage. Systems research and advice includes:

polyculture, experimental ecosystems, production systems support technology, engineering research and their transfer
planning, zoning
licence and permit systems criteria

excluded are studies related to rearing or manipulation leading to release to the wild.

1.4.2.2 Resource Development, Enhancement:

Includes manipulation leading to augmentation or restoration of common property resources, or resources harvested in the wild, for finfish, invertebrates and marine plants.

Includes studies related to fish health research, nutritional research and biological studies, as described above, and the following systems research and advice:

ecosystems manipulation (lakes, streams, shorelines, nearshore areas)
production systems, including harvest/manageability
support technology, new and improved harvesting techniques, engineering research

excludes research and advice related to fish raised in enclosures from young to marketable stage.

1.4.3 Habitat Assessment and Related Research:

Includes research carried out in support of Departmental management and protection of fish and fish habitat, generally on the impact of human disruptive activities. The research includes work on physical alterations to habitat and investigations related to toxicology and pollution affecting fish and their habitat. Also included is research leading to restoration and improvement of habitat.

1.4.3.1 Aquatic Impact Assessment:

Includes research on the implications to fisheries of physical alterations of habitat such as those posed by:

altered stream flows
reservoir construction and operation
stream obstructions

forest harvesting and log storage
alteration of foreshore and estuaries areas
dredging and dumping
tidal barriers
temperature changes

1.4.3.2 Toxicology and Pollution:

Includes investigation of the effects of man-induced chemical changes on fish and fish habitat such as:

acid rain
forest spraying
pesticides, heavy metals and radionuclides
industrial chemicals
industrial, municipal, agricultural and other effluents
leachates from industrial processes and landfill
hydrocarbons
test methodology and protocol development for hazard assessment

Includes fish hatchery and similar wastewater assessment, but excludes chemical considerations in recycling of water for fish culture.

APPENDIX C

PROGRAM-TO-PAS CONVERSION

The list of regional PREP documents, showing PAS categories for each, constitutes a conversion table from the regional programs and responsibility centers at several levels, to the national Program Activity Structure categories. This provides the audit trail of how project costs are distributed to the PAS categories.

In FY 1981/82 the PAS was used for the first time for financial reporting. Each Branch provided its own conversion of financial collators to PAS categories. At the end of FY 1981/82 some coding adjustments were made as a result of consultations between HQ and each Fisheries Research Branch. The resulting PAS coding for 1981 is shown below alongside the retroactively introduced coding for 1980.

In the Newfoundland Region there are only two minor changes in coding from 1980 to 1981. In the Scotia-Fundy Region three of the four Divisions in FRB submitted PREP documents that were rolled up to the level of the 4th PAS digit in each Division, hence the major differences in coding between 1980 and 1981. The fourth Division (IMP) introduced some regrouping of projects to more clearly reflect the various PAS categories. The Quebec Laboratory and the Arctic Biological Station in the Gulf Region show several new programs as a result of added mandates due to the establishment of the Gulf Region. In Headquarters two new activities were undertaken, i.e. Anadromous Fish and Mathematical Statistics. The Ontario Region was transferred from the OSS side of DFO (PAS 2) to Fisheries Research (PAS 1.4) as a result of organizational changes. In the Western Region there were minor readjustments. In the Pacific Region there was considerable reorganization of projects/programs, including changes in program titles. These changes are indicated by means of of the letter codes.

NEWFOUNDLAND REGION

Program Title	PAS	
	1980	1981
Director's Office	1400	1400
Regional Library	112	112
Marine Fisheries Mgmt., Groundfish		
Gadoids	1412	1412
Flatfish	1412	1412
Redfish	1412	1412
Commercial Sampling	1412	1412
Foreign Co-operative Research	1412	1412
Population Mechanisms	1412	1412
Special Projects	-	1412
Pelagic, Shellfish and Marine Mammal Research		
Pelagic Fish	1416	1416
Shellfish	1413	1413
Marine Mammals	1414	1414
Freshwater and Anadromous Fisheries Management	-	-
Salmon and Char Management	1411	1411
Freshwater Ecosystems	1432	1432
Inland Fisheries	75% 1411 + 25% 1432	50% 1411 + 50% 1432
Resource Development	1422	1422
Experimental Ecology	-	-
Fisheries Ecosystems	1417	1417
Microbial Chemistry	1421	1421
Habitat Research and Management	33% 1431 + 67% 1432	33% 1431 + 67% 1432
Biochemical Systematics	1412	disbanded in 81/82
Electronics Development	1416	1416
Statistics and Computing	1400	1400
Technical Services	1400	1400

GULF (QUÉBEC) REGION

Laboratoire de Québec		
Bureau du directeur	1400	1400
Ecologie appliquée-Scientifique principal	-	1414
Ecosystèmes marins	50% 1417 + 50% 1431	1417
Habitat du poisson/Pluies acides	-	85% 1432 + 15% 1431
Pélagiques	90% 1416 + 10% 1417	1416
Crabes	-	1413
Mammifères St-Laurent	-	1414
Poissons anadromes et catadromes	80% 1417 + 20% 1431	80% 1411 + 20% 1431
Invertébrés	1413	-

GULF (QUÉBEC) REGION (Cont'd)

Program Title	PAS 1980	PAS 1981
Arctic Biological Station		
Administration	1400	1400
Support Services	112	112
Vessel Operation	113	113
Arctic Biological Oceanography	70% 1417 + 20% 1432+ 10% 1431	70% 1417 + 20% 1432+ 10% 1431
Arctic Marine Mammals	50% 1414 + 40% 1431+ 10% 1432	50% 1414 + 40% 1431+ 10% 1432
Arctic Marine & Anadromous	1417	1417
Gulf Mammals-Harp and Hooded Seals	-	1414
North Atlantic Whales	-	1414
Atlantic Marine Mammals	1414	-
Moncton		

In FY 1981/82 this unit did not have a budget separate from that of the office of the Regional Director General. The research unit consisted of a research director and planning staff only. Thus, for year-to-year trending, the Gulf Region FRB in 1981 was in effect, still the former Québec region.

SCOTIA-FUNDY REGION

Branch Director's Office	1400	1400
Invertebrates and Marine Plants Division		
Admin. and Support (Div. Chief)	1413	-
EDP and Port Sampling	1413	1413
Crustaceans	1413	70% 1413 + 30% 1417
Marine Plants	70% 1415 + 30% 1417	1415
Molluscan Section Admin.	1413	-
Molluscs Research and assmt.	1413	1413
Moncton Unit	1413	1413
Ellerslie Facility	112	1413
Shellfish Lease Administration	151	151
Admin. and Support and Ecology Modelling	-	60% 1413 + 20% 1415 10% 1417 + 10% 1422
Fisheries Ecology-Crustacean Shellfish	-	1417
Species Interaction	-	1417
Molluscs/Fisheries Ecology	-	1417
Molluscs/Developmental Research and Assessment	-	1413
Kelp Resource Model	-	1415
Short-Term Charters	-	1133

SCOTIA-FUNDY REGION (Cont'd)

Program Title	PAS	
	1980	1981
Marine Fish Division		
Division Administration	1410	1410
Groundfish	-	1412
Commercial Sampling & Support Serv.	1412	-
Res. Vessel Surveys & Gear Studies	1412	-
International Research & Sampling	1412	-
Biology and Assessment	1412	-
Pelagics	-	1416
Commercial Sampling & Support Serv.	1416	-
Surveys and Acoustics	1416	-
Herring Biology	1416	-
Stock Assessment	1416	-
Large Pelagics	1416	-
Fisheries Ecology	-	1417
Oceanographic Surveys and and Computing Support	1417	-
Scotian Shelf Ichthyoplankton	1417	-
Species Interactions	1417	-
Marine Mammals	1414	1414
Fisheries and Environmental Sciences Division		
Division Management	1400	-
Fisheries Environmental Coordination	152	-
Fisheries Environmental Research		
Marine Toxicology	1417	-
Marine Biological Effects	1432	-
Environmental Chemistry	1432	-
Environmental Chemistry and Toxicology	1432	-
Biochemical Toxicology	1432	-
Marine Environmental Quality Studies	1432	-
Contaminants in Commercial Species	1432	-
Endocrinology and Sublethal Effects Detection	1432	-
Applied Ecology		
Analysis and Assessment	1431	-
Fisheries Ecology	1431	-
Marine & Estuarine Studies	1431	-
Freshwater	1431	-
Applied Physiology		
Invertebrate Physiology	1413	-
Fish Physiology	1421	-
Salmon Genetics	1422	-
Environmental	1431	-

SCOTIA-FUNDY REGION (Cont'd)

Program Title	PAS 1980	PAS 1981
Disease & Nutrition		
Crustacean Diseases	1421	-
Molluscan Diseases	1421	-
Fish Diseases	1421	-
Invertebrate Nutrition	1421	-
Finfish Nutrition	1421	-
Experimental Biology	1422	-
Aquaculture Coordination	1421	-
Fish Health Unit	1421	-
Histology	1421	-
Fish Habitat Mgmt.	1431	-
Resource Related Res. + 30% PSP	-	70% 1413 + 30% 1417
Aquaculture Research	-	1421
Enhancement Research	-	1422
Aquatic Habitat Research	-	1431
Toxicology & Pollution Research	-	1432
St. Andrews Administration		
Administration Services		
General	112	-
Research Vessels	113	113
Scientific Support Services	112	-
Administration-Support Services	-	112
Freshwater and Anadromous Division		
Freshwater Division Administration	1400	1400
Resource Assessment and Related Research		
Analysis and Assessment	1411	-
Gulf Salmon Management	1411	-
Saint John River Salmon Mgmt.	1411	-
Non-Salmon Diadromous	1411	-
Mainland Nova Scotia Salmon Management	1411	-
Scientific Liaison and Tech. Support	1411	1410
Graphics and Editing	1411	1410
Aquaculture and Resource Dev. Research		
Fish Culture Biology	1422	-
Salmon Development	1422	-
Freshwater Resources	1422	-
Mainland Nova Scotia Development	1422	-
Habitat Assessment and Related Research		
Environmental Assessment	1431	-
Fish Passage Evaluation	1431	-
Habitat Management		
Watercourse Alterations	152	-
Fish Passage Engineering	152	-

SCOTIA-FUNDY REGION (Cont'd)

Program Title	PAS	
	1980	1981
Resource Rehabilitation and Enhancement		
Fish Culture Operations	153	-
Fish Culture Engineering	153	-
Special Projects Engineering	153	-
Salmon Enhancement Planning	153	-
Freshwater and Anadromous Division		
Anadromous, Catadr. + FW Fish	-	1411
Enhancement (includes Hatchery Studies)	-	1422
Aquatic Habitats (FW Habitat Res.)	-	1431
Toxicology and Pollution (Acid Rain)	-	1432
Habitat Protection (Watercourse Alter.)	-	152
Habitat Restoration (Fish Passage Eng.)	-	152
Rehabilitation and Enhancement	-	153
Production Facilities	-	153

HEADQUARTERS

Director-General	111	111
Contribution to MSRL	1400	1400
Director		
Resource Res. Br. Mgmt.	1400	1400
Sealing Contracts, COSS, COWW	1414	1414
Associate Dir., Resource Assess.	1410	1410
Anadromous Fish	-	1411
Marine Mammals	1414	1414
Marine Fish	70% 1412 + 30% 1416	70% 1412 + 30% 1416
Resource Eval. & Computing	1410	1410
Northern and Inland Fisheries	1411	50% 1411 + 50% 1414
Fisheries Ecology	1417	1417
Mathematical Statistics	-	1410
Assoc. Dir., Res. Plan. & Anal.	1400	1400
Aquac. and Resource Devel.Res.Br.	1420	1420

ONTARIO REGION

Program Title	PAS	
	1980	1981
Director's Office	(This Branch	1400
Finance and Administration	was part	112
Surveillance	of OSS	20% 1417 + 80% 1432
Environmental Toxicology	in 1980)	1432
Ecosystem Studies		60% 1417 + 40% 1432

WESTERN REGION

Director FRB	80% 1400 + 20% 150	1400
Aquatic Ecosystems Res. Admin.	1430	1430
Experimental Limnology	1432	1432
Analytical Services	1430	1430
Northern Reservoir Biol. & Fishes	1431	1431
Toxicology Section Admin.	1432	1432
Acidification Ecotoxicology	1432	1432
Fish Toxicity Mechanisms	1432	1432
Ecotoxicology	1432	1432
Pollutant Identif./Measurement	1432	1432
Organic Chemicals Toxicology	1432	1432
Fisheries Resources Admin.	1400	1400
Fish and Marine Mammal Mgt.	75% 1411 + 20% 1514+ 5% 1414	50% 1411 + 50% 1414
Fish & Marine Research	45% 1410 + 30% 1417+ 20% 1422 + 5% 1414	1411
Fish Pathobiology	65% 1421 + 20% 1422+ 15% 1432	65% 1421 + 20% 1422+ 15% 1432
Aquaculture	75% 1421 + 25% 1422	75% 1421 + 25% 1422
Fish Habitat Section Admin.	75% 1520 + 25% 1430	75% 1520 + 25% 1430
Resource Impact	50% 1431 + 40% 1521+ 5% 1432 + 5% 1422	1521
Fish Habitat Research	50% 1431 + 50% 1432	50% 1431 + 50% 1432

PACIFIC REGION

Program Title	PAS	
	1980	1981
Branch Management	1400	-
Fish Culture Research		
Division Management	1420	-
Program Support	1422	-
Stream Enhancement		
Incubation and Water Quality	1422	a
Juvenile Release Strategies	1422	an
Chum Production Requirements (Pilot Chum Hatchery)	1422	b
Hatchery Biology II	1422	-
Applied Endocrinology	1422	-
NAE herring impoundment research	1422	c
Fish Nutrition	1422	am
Stock Establishment	1422	-
Lake Enhancement		
Research and Surveys	1422	d
Lake Enrichment Treatment	1422	e
Juvenile Salmon Ecology	1422	f
Adult Salmon Ecology	1422	g
Masset Inlet Enrichment	1422	-
Aquaculture	1421	h
Chinook Temperature Requirements	1422	-
Microbiology - Salmon	1422	-
Microbiology - Herring	1422	-
Diagnostic Services	1422	i
Histological Services	1422	j
Disease Control Research	1422	k
Parasitology	1422	l
Parasite - Stock I.D.	1422	al
Fish Health and Parasitology		
Section Management and INPFC	-	1422
Disease Control Research	k	1422
Diagnostic Service	i	1422
Histological Services	J	1422
Parasitology	l	1422
Parasite - Stock I.D.	al	1422

Letter code indicates projects under the same or similar title but in different Sections in the two years.

PACIFIC REGION (Cont'd)

Program Title	PAS	
	1980	1981
Fish Culture Research		
Salmon Aquaculture	h	1421
Incubation/Water Quality	a	1422
Incubation/Basic Studies	a	1422
Fish Culture Research Station	-	1422
Controlled Reproduction	-	1422
Fish Nutrition/Smolt Quality	am	1422
Stress and Histophysiology Evaluation	-	1422
Time and Size Release Studies	am	1422
Smolting Requirements	-	1422
Enrichment Research		
Lake Enrichment	-	1422
Lake Enrichment Administration	-	1422
Juvenile Salmon Ecology	f	1422
Adult Salmon Ecology	g	1422
Research and Surveys	d	1422
Lake Enrichment Treatment	e	1422
Monitoring	-	1422
Fraser River Baseline Studies	-	1422
Stream Enhancement	-	1422
Herring Division		
Division Management	1416	m
Offshore Herring Assmt.	1416	n
Population Dynamics (summary)		
Stock Assessment	1416	o
Stock Identification	1416	o
Spawn Assessment		
Methodology Review	1416	p
Diving Surveys	1416	p
Spawn Distribution on kelp	1416	p
Spawning Ground Veg. Mapping	1416	p
External Review of Mapping	1416	p
Gear Impact		
Effects on Spawning Grounds	1416	-
Effects on Fish	1416	-
Effects of Dropout	1416	-
Life History		
Larval Ecology	1416	q
Larval Feeding	1416	q
Completion of Current Projects	1416	-
Maturation	1416	r
Species Interaction	1416	-
Herring Distribution	1416	-
Juvenile Biology	1416	r

PACIFIC REGION (Cont'd)

Program Title	PAS	
	1980	1981
Herring Section		
Section Management	m	1416
Herring Population Dynamics	o	1416
Herring Spawning Dynamics	p	1416
Herring Early Growth	q	1416
Herring Biology	r	1416
Spawn Surveys	-	1416
Stock Identification (Tagging)	-	1416
Offshore Herring Stock Assessment Surveys	n	1416
Herring Impoundment Studies	c	1416
Lamprey	aa	1411
Salmon Fisheries Biology		
Division Management	1410*	-
Early Ocean Survival	1411	-
Population Dynamics		
West Coast Coho & Chinook	1411	-
Ocean Climate	1411	-
Fisheries Oceanography	1411	-
Pop. Dyn. International	1411	s
Chum Assessment and Ecology	1411	t
Fishery Modelling	1411	u
Population Biometrics	1411	u
Chinook assess. and Ecology	1411	-
Stock Identification	1411	v
Genetics	1411	w
Habitat Research and Mgmt.	1430*	x
Watershed Ecology	1431	-
Pollution Ecology Program	1432	y
Marine Pollution	1432	-
Coastal Habitat Ecology	1431	z
Estuarine Ecology	1431	-
Lamprey	1411	aa
Salmon Biology Section		
Section Management	-	1411
Marine Mammals-Fur Seals	ab	1414
Marine Mammals-Large Whales	-	1414
Marine Mammals-Killer Whales	-	1414
Babine Sockeye	-	1411
Salmon Genetics	w	1411
International Salmon	s	1411
Stock definition in chinook salmon	-	1411
Salmon Genetics - Selective Breeding	-	1411
Salmon Behaviour	-	1411

PACIFIC REGION (Cont'd)

Program Title	PAS	
	1980	1981
Salmon Behaviour - Parasitology	-	1411
Salmon Ecology	-	1417
Professional Development	-	1411
Salmon Population Section		
Section Management	-	1411
Chum Production Requirements	b	1411
Stock Id.	v	1411
Stock Abundance Estimation	-	1411
Chum Salmon	t	1411
Modelling and Biometrics	u	1411
West Coast Troll Survey	-	1411
Salmon Habitat Section		
Management	x	1431
Pollution Ecology	y	1432
Placer Mining - Salmon Interaction	-	1431
Fisheries Forestry Interactions		
Carnation Creek	-	1431
Coastal Habitat Ecology	z	1431
Northern Fish Habitat Research	-	1431
Marine Fisheries Biology		
Division Management	1410*	-
Fur Seals	1414	ab
Seal and Sea Lion Predation	1414	ac
Groundfish		
Program Management	1412	ad
Species Interactions	1412	-
Age Determination Unit	1412	ae
Stock Assmnt. & Biology I	1412	af
Stock Assmnt. & Biology II	1412	-
Stock Assmnt. & Biology III	1412	-
Statistics and Sampling	1412	ag
Stock Assmnt. & Rockfish Biology IV	1412	ah
Stock Assmnt. & Biology V	1412	-
Stock Assmnt. & Biology VI	1412	-
Stock Assmnt. & Biology VII	1412	-
Stock Assmnt. & Biology VIII	1412	-

PACIFIC REGION (Cont'd)

Program Title	PAS 1980	PAS 1981
Crustacea	1413	-
Abalone	1413	ai
Clams and Oysters	1413	aj
Zooplankton Harvest	1413	-
Plankton Test Fishing	1413	-
Geoduck Population	1413	-
Squid	1413	ak
Mussel Culture	1413	-
Fish Holdings		
Rosewall Creek	1411	-
West Vancouver	1411	-
Nanaimo	1411	-
Ecology (was called Egg & Larval Fish Survey in 1979)	1417	-
Groundfish Section		
Section Management	ad	1412
Stock Assessment & Biology I	af	1412
Rockfish Research	ah	1412
Pacific cod-Flatfish Lingcod	-	1412
Analytical Methods	-	1412
Statistics and Sampling	ag	1412
Age Determination Unit	ae	1412
Albacore and other studies	-	1412
Hydroacoustics	-	1412
Shellfish Section		
Section Management	-	1413
Crab Biology	-	1413
Shrimp	-	1413
Abalone, etc.	ai	1413
Clams	aj	1413
Oysters and mussels	aj	1413
Invertebrates		1413
Squid	ak	1413
Fisheries Ecology		
Marine Fisheries Ecology	-	1417
Oceanographic Information Service	-	1417
Ocean Climate - Fisheries	-	1417

* In the Pacific Region the three activities identified with an asterisk had no expenditures against them, since the management functions were prorated into 4th PAS-digit categories. This is the preferred way of displaying Section and Division management expenditures.

APPENDIX D

1981 FISHERIES RESEARCH BRANCH PUBLICATIONS

The three lists of publications for 1981 represent the scientific publication output of the six regional Fisheries Research Branches and the Fisheries Research Directorate in Ottawa.

Publications were grouped into three categories: primary (p. 2-14), uncategorized (p. 15-20) and secondary (p. 21-50). The criteria for inclusion as primary publications are first disclosure of original data in refereed journals of wide circulation; this includes significant syntheses and critical reviews. Secondary publications include DFO Technical Reports, Manuscript Reports and Data Reports, as well as most research documents published by organizations such as NAFO, ICES, CAFSAC, ICCAT, IWC, etc. Those that could not readily be categorized into the above two groups were labelled 'uncategorized'. Contributions to symposia publications and chapters in books were generally put in the 'uncategorized' group. Published abstracts and book reviews are in the 'secondary' group.

Each reference is identified by a letter code in the right hand margin denoting the Fisheries Management Region, as follows:

N - Newfoundland
S - Scotia Fundy
G - Gulf (excludes Québec)
Q - Québec
H - Headquarters (Ottawa)
O - Ontario
W - Western
P - Pacific

In cases of joint authorship involving different regions, each region is identified in the sequence of authors, e.g. SG, PW, HNO, etc.

PRIMARY PUBLICATIONS - 1981

Ackman, R.G., C.A. Eaton, J.C. Cipos and N.F. Crewe. 1981. Origin of cis-9, trans-11 and trans-9 trans-11 - octadecadienoic acids in depot fat of primates fed a diet rich in lard and corn oil and implications for the human diet. Can. Inst. Food Sci. Technol. J. 14: 103-107. S

Aiken, D.E. and W.W. Young-Lai. 1981. Dactylotomy, chelotomy and dactylostasis: methods for enhancing survival and growth of small lobsters (Homarus americanus) in communal conditions. Aquaculture 22: 45-52. S

Anderson, J.T. and S.A. Akenhead. 1981. Distribution and abundance of redfish and cod larvae on Flemish Cap in 1978 and 1979. NAFO Sci. Coun. Studies 1: 57-63. N

Anderson, J.T., J.C. Roff and J. Gerrath. 1981. The diatoms and dinoflagellates of Hudson Bay. Can. J. Bot. 59: 1793-1810. N

Antia, N.J. and M.E. Klut. 1981. Fluoride addition effects on euryhaline phytoplankton growth in nutrient-enriched seawater at an estuarine level of salinity. Bot. Mar. 24: 147-152. P

Appy, R.G. and M.J. Dadswell. 1981. Marine and estuarine piscicolid leeches (Hirudinea) of the Bay of Fundy and adjacent waters with a key to species. Can. J. Zool. 59: 183-192. S

Arnason, A.N. and K.H. Mills. 1981. Bias and loss of precision due to tag loss in Jolly-Seber estimates for mark-recapture experiments. Can. J. Fish. Aquat. Sci. 38: 1077-1095. W

Atkinson, D.B. 1981. Partial length as a replacement for total length in measuring grenadiers. J. Northw. Atl. Fish. Sci. 2: 53-56. N

Banoub, J.H. 1981. Structural investigations on the core oligosaccharide Aeromonas hydrophila (Chemotype III) lipopolysaccharide. Carbohydr. Res. 98: 93-103. N

Banoub, J.H. and D.H. Shaw. 1981. Isolation and characterization of 3-acetamido-3, 6-dideoxy-L-glucose from the core oligosaccharides obtained from the aquatic gram negative bacteria Aeromonas hydrophila and Vibrio anguillarum. Can. J. Biochem. 59: 877-879. N

Beamish, R.J. and D.A. Fournier. 1981. A method for comparing the precision of a set of age determinations. Can. J. Fish. Aquat. Sci. 38: 982-983. P

Beland, K.F., F.L. Roberts and R.L. Saunders. 1981. Evidence of Salmo salar x Salmo trutta hybridization in a North American river. Can. J. Fish. Aquat. Sci. 38: 552-554. S

Berland, B. 1981. An anisakid nematode larva with aberrant appendix. Sarsia 66: 317-318. P

PRIMARY PUBLICATIONS - 1981

Borgmann, U. 1981. Determination of free metal ion concentrations using bioassays. Can. J. Fish. Aquat. Sci. 38: 999-1002. N

Bowen, W.D., C.K. Capstick and D.E. Sergeant. 1981. Temporal changes in the reproductive potential of female harp seals (Pagophilus groenlandicus). Can. J. Fish. Aquat. Sci. 38: 495-503. N Q

Breiwick, J.M., E.D. Mitchell and D.G. Chapman. 1981. Estimated initial population size of the Bering Sea stock of bowhead whale, Balaena mysticetus: an iterative method. Fish. Bull. 78: 843-853. Q

Brett, J.R. and J.M. Blackburn. 1981. Oxygen requirements for growth of young coho (Oncorhynchus kisutch) and sockeye (O. nerka) salmon at 15°C. Can. J. Fish. Aquat. Sci. 38: 399-404. P

Brown, S.B. and T.J. Hara. 1981. Accumulation of chemostimulatory amino acids by a sedimentable fraction isolated from olfactory rosettes of rainbow trout (Salmo gairdneri). Biochem. Biophys. Acta 675: 149-162. W

Burns, B.G., C.J. Musial and J.F. Uthe. 1981. Novel cleanup method for quantitative gas chromatographic determination of trace amounts of di(2-ethylhexyl) phthalate in fish lipid. J. Assoc. Off. Anal. Chem. 64: 282-286. S

Castagnolli, N. and E.M. Donaldson. 1981. Induced ovulation and rearing of the pacu (Colossoma mitrei). Aquaculture 25: 275-279. P

Chadwick, E.M.P. and W.J. Bruce. 1981. Range extension of steelhead trout (Salmo gairdneri) in Newfoundland. Nat. Can. 108: 301-303. N

Clarke, W.C., J.E. Shelbourn and J.R. Brett. 1981. Effect of artificial photoperiod cycles, temperature, and salinity on growth and smolting in underyearling coho (Oncorhynchus kisutch), chinook (O. tshawytscha), and sockeye (O. nerka) salmon. Aquaculture 22: 105-116 P

Clayton, J.W. 1981. The stock concept and the uncoupling of organismal and molecular evolution. Can. J. Fish. Aquat. Sci. 38: 1515-1522. W

Cone, D.K. 1981. Gyrodactylus pleuronecti n. sp. (Monogenea) from winter flounder (Pseudopleuronectes americanus) in Newfoundland, Canada. Can. J. Zool. 59: 2241-2243. N

Cone, D.K. and M. Beverley-Burton. 1981. The surface topography of Benedenia sp. (Monogenea: Capsalidae). Can. J. Zool. 59: 1941-1946. N

Cone, D.K. and M.D.B. Burt. 1981. The invasion route of the gill parasite Urocleidus adspectus Mueller, 1936 (Monogenea: Ancyrocephalinae). Can. J. Zool. 59: 2166-2171. N

Dawe, E.G. 1981. Development of the Newfoundland squid (Illex illecebrosus) fishery and management of the resource. J. Shellfish Res. 1: 137-142. N

PRIMARY PUBLICATIONS - 1981

Dawe, E.G. 1981. Overview of recent progress toward aging short-finned squid (Illex illecebrosus) using statoliths. J. Shellfish Res. 1: 193-195. N

Dawe, E.G., P.C. Beck, H.J. Drew and G.H. Winters. 1981. Long-distance migration of a short-finned squid, Illex illecebrosus. J. Northw. Atl. Fish. Sci. 2: 75-76. N

Dawe, E.G. and H.J. Drew. 1981. Record of a mature female short-finned squid, Illex illecebrosus, captured inshore at Newfoundland and previous captures of mature females in the Northwest Atlantic. J. Northw. Atl. Fish. Sci. 2: 61-65. N

Dermott, R. 1981. Ingestion rate of the burrowing mayfly Hexagenia limbata as determined with ^{14}C. Hydrobiologia 83: 499-503. O

Dey, A.C., S. Rahal, R.L. Rimsay and I.R. Senciall. 1981. A simple procedure for the solubilization of NADH-cytochrome b_5 reductase. Anal. Biochem. 110: 373-379. N

Dixon, D.G. and J.W. Hilton. 1981. Influence of available dietary carbohydrate content on tolerance of waterborne copper by rainbow trout, Salmo gairdneri Richardson. J. Fish. Biol. 19: 509-517. O

Donaldson, E.M., G.A. Hunter and H.M. Dye. 1981. Induced ovulation in coho salmon (Oncorhynchus kisutch) II. Preliminary study of the usage of LH-RH and two high potency LH-RH analogues. Aquaculture 26: 129-141. P

Donaldson, E.M., G.A. Hunter, and H.M. Dye. 1981. Induced ovulation in coho salmon (Oncorhynchus kisutch) III. Preliminary study on the use of the anti-estrogen tamoxifen. Aquaculture 26: 143-154. P

Elner, R.W. 1981. Diet of green crab Carcinus maenas (L.) from Port Hebert, southwestern Nova Scotia. J. Shell. Res. 1: 89-94. S

Elner, R.W. and A. Campbell. 1981. Force, function, and mechanical advantage in the chelae of the American lobster, Homarus americanus (Decapoda:Crustacea). J. Zool., London 193: 269-286. S

Elner J.K., D.J. Wildish and D.W. Johnston. 1981. Fate of sprayed formulated aminocarb in fresh water. Chemosphere 10: 1025-1034. S

Ennis, G.P. 1981. Fecundity of the lobster, Homarus americanus, in Newfoundland waters. Fish. Bull. 79: 796-800. N

Evelyn, T. P. T., J. E. Ketcheson and L. Prosperi-Porta. 1981. The clinical significance of immunofuorescence-based diagnoses of the bacterial kidney disease carrier. Fish Pathology 15: 293-300. P

Fagerlund, U.H.M., J.R. McBride and E.T. Stone. 1981. Stress-related effects of hatchery rearing density on coho salmon. Trans. Am. Fish. Soc. 110: 644-649. P

PRIMARY PUBLICATIONS - 1981

Fairbairn, D.J. 1981. Which witch is which? A study of the stock structure of witch flounder (Glyptocephalus cynoglossus) in the Newfoundland region. Can. J. Fish. Aquat. Sci. 38: 782-794. N

Fairbairn, D.J. 1981. Biochemical genetic analysis of population differentiation in Greenland halibut (Reinhardtius hippoglossoides) from the Northwest Atlantic, Gulf of St. Lawrence, and Bering Sea. Can. J. Fish. Aquat. Sci. 38: 669-677. N

Fairfull, R.W., L.E. Haley and J.D. Castell. 1981. The early growth of artificially reared American lobsters. Theor. Appl. Genet. 60: 269-273. S

Fitzgerald, G.J. and J.D. Dutil. 1981. Evidence for differential predation on an estuarine stickleback community. Can. J. Zool 59: 2394-2395. Q

Fitzsimons, J. 1981. Occurrence of Mysis relicta Lovén in the western basin of Lake Erie (Mysidacea). Crustaceana 41: 217-219. O

Flannagan, J.F., W.L. Lockhart, D.G. Cobb and D. Metner. 1981. Stonefly (Plecoptera) head cholinesterase as an indicator of exposure to fenitrothion. Manit. Entomol. 12: 42-48. W

Fletcher, G.L., J.W. Kiceniuk and U.P. Williams. 1981. Effects of oiled sediments on mortality, feeding and growth of winter flounder Pseudopleuronectes americanus. Mar. Ecol. Prog. Ser. 4: 91-96. N

Frank, R., R.L. Thomas, H.E. Braun, D.L. Gross and T.T. Davies. 1981. Organochlorine insecticides and PCB in surficial sediments of Lake Michigan (1975). J. Great Lakes Res. 7: 42-50. O

Frank, R., R.L. Thomas, M. Holdrinet, R.K. McMillan, H.E. Braun and R. Dawson. 1981. Organochlorine residues in suspended solids collected from the mouths of Canadian streams flowing into the Great Lakes. J. Great Lakes Res. 7: 363-381. O

Franzin, W.G. and G.A. McFarlane. 1981. Elevated Zn, Cd and Pb concentrations in waters of ice-covered lakes near a base metal smelter during the snow melt. April 1977. Environ. Pollut. Ser. B 2: 11-19. W P

Godin, J.-G. J. 1981. Daily patterns of feeding behaviour, daily rations, and diets of juvenile pink salmon (Oncorhynchus gorbuscha) in two marine bays of British Columbia. Can. J. Fish. Aquat. Sci. 38: 10-15. P

Griffiths, D.K., R.D. Pingree and M. Sinclair. 1981. Summer tidal fronts in the near-arctic regions of Foxe Basin and Hudson Bay. Deep-Sea Research 28A: 865-873. S

PRIMARY PUBLICATIONS - 1981

Haegele, C.W., R.D. Humphreys and A.S. Hourston. 1981. Distribution of eggs by depth and vegetation type in Pacific herring (Clupea harengus pallasi) spawnings in southern British Columbia. Can. J. Fish. Aquat. Sci. 38: 381-386. P

Hallett, D.J., H. Shear, D.V. Weseloh and P. Mineau. 1981. Surveillance of wildlife contaminants on the Great Lakes. Int. Ver. Theor. Angew. Limnol. Verh. 21: 1734-1740. O

Haya, K. and B.A. Waiwood. 1981. Acid pH and chorionase activity of Atlantic salmon (Salmo salar) eggs. Bull Environm. Contam. Toxicol. 27: 7-12. S

Healey, M.C. 1981. Reply to comment on size of exploited lake whitefish. Can. J. Fish. Aquat. Sci. 38: 375-376. P

Hecky, R.E. and E.J. Fee, H.J. Kling and J.W.M. Rudd. 1981. Relationships between primary production and fish production in Lake Tanganyika. Trans. Am. Fish. Soc. 110: 336-345. W

Hecky, R.E. and E.J. Fee. 1981. Primary production and rates of algal growth in Lake Tanganyika. Limnol. Oceanogr. 26: 535-547. W

Hecky, R.E. and H.J. Kling. 1981. The phytoplankton and protozooplankton of the euphotic zone of Lake Tanganyika: species composition, biomass, chlorophyll content, and spatio-temporal distribution. Limnol. Oceanogr. 26: 548-564. W

Hodson, P.V. and B.R. Blunt. 1981. Temperature-induced changes in pentachlorophenol chronic toxicity to early life stages of rainbow trout. Aquat. Toxicol. 1: 113-127. O

Hughes, S.E. and N. Bourne. 1981. Stock assessment and life history of a newly discovered Alaska surf clam (Spisula polynyura) resource in the southeastern Bering Sea. Can. J. Fish. Aquat. Sci. 38: 1173-1181. P

Hughes, S.E. and N. Bourne. 1981. Stock assessment and life history of a newly discovered Alaska surf clam resource in the southeastern Bering Sea. The Eastern Bering Sea Shelf. Oceanography & Resources 67: 1205-1214. P

Hunter G.A., E.M. Donaldson and H.M. Dye. 1981. Induced ovulation in coho salmon (Oncorhynchus kisutch). I. Further studies in the use of salmon pituitary preparations. Aquaculture 26: 117-127. P

Idler, D.R., S.J. Hwang, L.W. Crim and D. Reddin. 1981. Determination of sexual maturation stages of Atlantic salmon (Salmo salar) captured at sea. Can. J. Fish. Aquat. Sci. 38: 405-413. N

Ihssen, P.E., H.E. Brooke, J.M. Casselman, J.B. McGlade, N.R. Payne and F.M. Utter. 1981. Stock identification: Materials and methods. Can. J. Fish Aquat. Sci. 38: 1838-1855. S

PRIMARY PUBLICATIONS - 1981

Jensen, J.O.T., W.E. McLean and D.F. Alderdice. 1981. Effects of accessory factors on survival of newly fertilized salmonid eggs treated with an antibiotic. Aquaculture 23: 295-307. P

Johnson, L. 1981. The thermodynamic origin of ecosystems. Can. J. Fish. Aquat. Sci. 38: 571-590. W

Johnston, C.E. and R.L. Saunders. 1981. Parr-smolt transformation of yearling Atlantic salmon (Salmo salar) at several rearing temperatures. Can. J. Fish. Aquat. Sci. 38: 1189-1198. S

Johnston, D.W. and D.J. Wildish. 1981. Avoidance of dredge spoil by herring (Clupea harengus harengus). Bull. Environm. Contam. Toxicol. 26: 307-314. S

Kabata, Z. 1981. Copepods (Crustacea) parasitic on fishes: Problems and perspectives. Adv. Parasitology 19: 1-71. P

Kabata, Z. 1981. Crucisoma bernardi gen. et sp. nov. (Crustacea:Copepoda) parasitic on a deep-sea mollusc, Cuspidaria filatovae Bernard, 1979 (Bivalvia: Anomalodesmata). Syst. Parasitol. 3: 91-96. P

Kabata, Z. 1981. Relegation of Hatschekia acuta Barnard, 1948, to synonymy with Hatschekia conifera Yamaguti, 1939 (Copepoda: Siphonostomotoida). Can. J. Zool. 59: 2080-2084. P

Kabata, Z. and D.J. Whitaker. 1981. Two species of Kudoa (Myxosporea: Multivalvulida) parasitic in the flesh of Merluccius productus (Ayres 1855) (Pisces: Teleostei) in the Canadian Pacific. Can. J. Zool. 59: 2085-2091. P

Kabata, Z. and I.U. Tareen. 1981. A new species of Thysanote Kroyer, 1863 (Copepoda: Lernaeopodidae) from the Persian Gulf, with comments on the genus. Syst. Parasitol. 3: 97-103. P

Kabata, Z. and Ju-Shey Ho. 1981. The origin and dispersal of hake (genus Merluccius: Pisces: Teleostei) as indicated by its copepod parasites. Oceanog. Mar. Biol. Ann. Rev. 19: 381-404. P

Kelly, C.A. and D.P. Chynoweth. 1981. The contributions of temperature and of the input of organic matter in controlling rates of sediment methanogenesis. Limnol. Oceanogr. 26: 891-897. W

Kelso, J.R.M. and G.S. Milburn. 1981. Response to Scott-Nasilk, et al. J. Great Lakes Res. 7: 495-497. O

Khan, R.A., J. Campbell and H. Lear. 1981. Mortality in captive Atlantic cod, Gadus morhua, associated with fin rot disease. J. Wildl. Dis. 17: 521-527. N

PRIMARY PUBLICATIONS - 1981

Kling, H.J. 1981. Chrysochromulina laurentiana: an electron microscopic study of a new species of Prymnesiophyceae from Canadian Shield lakes. Nord. J. Bot. 1: 551-555. W

Kling, H.J. 1981. Lobocystis dichotoma var. mucosa Bourelly and Quadricoccus ellipticus Hortobagyi: new records for Lake Tanganyika. Arch. Hydrobiol. Suppl. 60: 220-225. W

Klut, M.E., T. Bisalputra and N.J. Antia. 1981. Abnormal ultrastructure features of a marine dinoflagellate adapted to grow successfully in the presence of inhibitory fluoride concentration. J. Protozool. 28: 406-414. P

Lapi, L.A. and T.J. Mulligan. 1981. Salmon stock identification using a microanalytical technique to measure elements present in the freshwater growth region of scales. Can. J. Fish. Aquat. Sci. 38: 744-751. P

Leaney, A.J. and S. Morris. 1981. The Bella Coola River Estuary - Status of Environmental Knowledge to 1981. Fisheries and Oceans Canada and Environment Canada, Special Estuary Series No. 10. P

Lear, W.H., R. Wells and W. Templeman. 1981. Variation in vertebral averages for year-classes of Atlantic cod, Gadus morhua, on Flemish Cap. Can. J. Northw. Atl. Fish. Sci. 2: 57-60. N

Leslie, H.A., A. Campbell and G.R. Daborn. 1981. Nectonema (Nematomorpha: Nectonematoidea) a parasite of decapod crustacea in the Bay of Fundy. Can. J. Zool. 59: 1193-1196. S

Li, M.F., R. Zwicker and V. Marryatt. 1981. Toxicity of Matacil, an insecticide assessed on cultivated cells. In Vitro 17: p. 202. S

Lock, M.A., R.R. Wallace, D.R. Barton and S. Charlton. 1981. The effects of synthetic crude oil on microbial and macroinvertebrate benthic river communities. Part I. Colonisation of synthetic crude oil contaminated substrata. Environ. Pollut. Ser. A 24: 207-217. W

Lock, M.A., R.R. Wallace, D.R. Barton and S. Charlton 1981. The effects of synthetic crude oil on microbial and macroinvertebrate benthic river communities. Part II. The response of an established community to contamination by synthetic crude oil. Environ. Pollut. Ser. A 24: 263-275. W

Mahon, R. and M. Ferguson. 1981. Invasion of a new reservoir by fishes: species composition, growth and condition. Can. Field.-Nat. 95: 272-275. S

Majewski, H.S. and M.A. Giles. 1981. Cardiovascular-respiratory responses of rainbow trout (Salmo gairdneri) during chronic exposure to sublethal concentrations of cadmium. Water Res. 15: 1211-1217. W

PRIMARY PUBLICATIONS - 1981

Majkowski, J. 1981. Application of a multi-species approach for assessing the population abundance and the age-structure of fish stocks. Can. J. Fish. Aquat. Sci. 38: 424-431. S

Majkowski, J. and K.C. Waiwood. 1981. A procedure for evaluating the food biomass consumed by a fish population. Can. J. Fish. Aquat. Sci. 38: 1199-1208. S

Margolis, L. 1981. In memoriam. Thomas Wright Moir Cameron 1894-1980. J. Parasitol. 67(1): 113-115. P

Margolis, L., T.E. McDonald and G.E. Hoskins. 1981. Absence of the protozoan Myxosoma cerebralis (Myxozoa: Myxosporea), the cause of whirling disease, in a survey of salmonids from British Columbia. Can. J. Fish. Aquat. Sci. 38: 996-998. P

Marshall, J.S., J.E. Parker, D.L. Mellinger and S.G. Lawrence. 1981. An in situ study of cadmium and mercury stress in the plankton community of Lake 382, Experimental Lakes Area, northwestern Ontario. Can. J. Fish. Aquat. Sci. 38: 1209-1214. W

McAllister, D.E., M.E. Anderson and J.G. Hunter. 1981. Deep-water eelpouts, Zoarcidae, from Arctic Canada and Alaska. Can. J. Fish. Aquat. Sci. 38: 821-839. Q

McBride, J.R., H.M. Dye and E.M. Donaldson. 1981. Stress response of juvenile sockeye salmon (Oncorhynchus nerka) to the butoxethanol ester of 24-Dichlor phenoxyacetic acid. Bull. Environm. Contam. Toxicol. 27: 877-884. P

McDonald, J. 1981. The stock concept and its application to British Columbia salmon fisheries. Can. J. Fish. Aquat. Sci. 38: 1657-1664. P

McLeese, D.W. 1981. Cadmium and marine invertebrates. Wat. Sci. Tech. 13: 1085-1086. S

McLeese, D.W., S. Ray and L.E. Burridge. 1981. Lack of cadmium excretion by lobsters. Chemosphere 10: 775-778. S

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