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Canadian Research Report, 1989

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Section I. Newfoundland Region

by

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SUBAREAS 0 AND 1

A. Status of the Fisheries

1. Groundfish. Only 128 t of Greenland halibut were landed from Subarea 0 in 1989.

2. Shrimp. Canadian landings of shrimp from Division 0A in 1989 totaled 7,216 t (preliminary), 1,300 t more than 1988 landings. The new fishery in Division 0B produced about 3,200 t, compared to 2,800 t in 1988.

B. Special Research Studies

1. Environmental Studies

Baffin Bay/Davis Strait (Bedford Institute). Five moorings with fourteen current meters and three pressure gauges in a line across Davis Strait at 66°15'N that were deployed in the summer of 1988 were recovered. Five replacement moorings were deployed. Nine stations were occupied at the mooring locations.

2. Biological Studies

a) Atlantic salmon. A total of 3,529 salmon was sampled at the fish plant in Nuuk, 2,787 in Sisimiut; and 3,138 from Paamiut, in centimeter length groups; including detailed measurements of fork length, gutted weight, and of these 2,187 were scale-sampled. This project provides an annual assessment of the proportion of North American and European fish caught at West Greenland. Also, 101 salmon were detected with micro tags. Microtags were from Canada, USA, Scotland, Ireland, Iceland, and England.

In total, 216 tissue samples were collected for electrophoretic analysis. The results of this analysis will be used to develop a database of known-origin salmon for discriminant analysis.

b) Observer Program. Canadian observers participated in 25 trips fishing shrimp in Davis Strait (0+1) during 1989. A total of 863 fishing days and 4,262 sets was observed, with a total of some 386,721 shrimp measured.

c) Scott Inlet (Bedford Institute). Sediment traps deployed at Scott Inlet in 1988 were recovered in 1989 and measurements were made of benthic production.

SUBAREA 2

A. Status of the Fisheries

1. Cod. Canadian landings were 56,000 t, compared to 59,000 t landed in 1988. Most of these landings were from Div. 2J with less than 500 t landed from Div. 2H and no landings from Div. 2G. Landings from the inshore sector accounted for 22,200 t, up from just over 17,000 t landed from this sector in 1988. Offshore landings were 33,800 t compared to 41,900 t in 1988.

2. Redfish. Canadian landings were low, with less than 70 t landed, compared to 400 t landed in 1988. Landings in recent years have been almost exclusively from Div. 2J.

3. Greenland halibut. Canadian landings were 2,500 t, compared to 1,800 t landed in 1988. Landings were primarily from Div. 2J with less than 200 t landed from Div. 2H. The inshore fixed-gear fishery accounted for 92% of all landings in this Subarea.

4. American plaice. Canadian landings of American plaice were up substantially at 3,200 t, compared to only 100 t landed in 1988 and 140 t in 1987. These landings were almost entirely by the offshore fishery in Div. 2J.

5. Other groundfish. Canadian landings of all other groundfish species totaled only 115 t in 1989.

6. Capelin. Landings of capelin remained at a low level.

7. Herring. Landings of herring remained at a low level.

8. Atlantic salmon. Commercial landings of Atlantic salmon in Subarea 2 during 1989 were 330 t, compared to 357 t in 1988. Landings of large salmon (222 t) increased by 5% over 1988. The recreational harvest totaled 8.2 t.

9. Arctic charr. Landings of Arctic charr in Subarea 2 during 1989 were 100 t, an increase of 12% from 1988. While effort declined again in comparison with 1988, catch rates and overall abundance of charr appeared higher than in the past several years.

10. Shrimp. The Subarea 2 shrimp fishery was subject to a total quota restriction of 11,080 t in 1989/90 (season May 1 to April 30), 4,400 t of which were in the Hopedale Channel. Total landings were approximately 11,000 t.

B. Special Research Studies

1. Environmental Studies

Oceanographic studies. The NAFC current meter program on Hamilton Bank was continued. Temperature profiles were taken at each fishing station occupied in the subarea.

2. Biological Studies

a) Cod. Biological sampling of the commercial fishery included observations from both the inshore and offshore sectors. From research vessels, distribution and abundance studies were carried out and detailed biological sampling was conducted. Stomachs were collected from Div. 2J in autumn. A second complete stratified-random survey was conducted in Divisions 2GH (August 16-September 9) and provided samples and biomass estimates.

b) Flatfish. Data on distribution and abundance of American plaice, Greenland halibut, and witch were collected during groundfish surveys of NAFO Div. 2J in 1989. Due to design changes, the shrimp surveys in Div. 2H and 2J are no longer useful in the development of a recruitment index for Greenland halibut.

c) Capelin. An acoustic survey in Div. 2J3K in October 1989 resulted in a biomass estimate of 1,745,000 t.

d) Atlantic salmon. A total of 4,224 Atlantic salmon caught in the commercial fisheries was sampled for size and age distribution.

e) Arctic charr. A total of 181 samples was obtained for age determination of Arctic charr in commercial landings from thirteen northern Labrador fishing areas. Approximately 23,000 fish were sampled for length distribution from the same areas. Information on sex distribution of charr caught in the fishery was obtained and stomach samples obtained for evaluation of food and feeding habits.

f) Shrimp. A research vessel survey which was conducted in July, 1988 completed a biomass survey in Hawke Channel using a Sputnik 1600 shrimp trawl. A total of 120 sets was made with the greatest catch (789 kg) being obtained in the Hopedale Channel. Areas of shrimp concentration were sampled throughout the Subarea, as well as in Div. 3K and 0B. The data obtained will be analyzed to investigate the possible relationships between shrimp concentrations in the Northwest Atlantic. In addition, Canadian observers participated in 43 commercial trips fishing shrimp off Labrador and northeast Newfoundland (Subarea 2 and Div. 3K) during 1989. A total of 1,098 fishing days and 5,542 sets was observed, with a total of some 474,000 shrimp measured.

g) Exploratory surveys.

- shrimp and scallop

Two 65-foot vessels were contracted to carry out a 30 sea day charter each for shrimp and scallop in the deep-water fjords along the Labrador coast north of Nain. Both vessels spent several days in Nachvak, Saglek, Hebron, and Okak fjords. Results indicate that no potential exists for a viable shrimp or scallop fishery in the areas surveyed.

- crab

A 65-foot vessel was contracted to carry out a 30 sea day charter for snow crab from Black Tickle to Makkovik, Labrador. The area surveyed covered 8,000 square miles around the Hamilton Bank. A fleet of 35 crab pots were set in each 100 square miles. Thirty-six percent of the crab fleets hauled contained commercial quantities of crab (over 15 lb/pot). This is a northward extension of currently exploited crab stocks in Labrador.

SUBAREA 3

A. *Status of the Fisheries*

1. Cod. Canadian landings were 204,100 t, down from 235,200 t landed in 1988. Landings by division were: 3K - 57,200 t, 3L - 98,700 t, 3N - 6,100 t, 3Ø - 7,500 5, 3Ps - 27,500 t, and 3Pn - 7,200 t. The inshore sector accounted for 50% of these landings, at 101,800 t, compared to 108,200 t landed inshore in 1988. Inshore landings from Div. 3K and 3L were 76,600 t, down from 83,100 t landed inshore in 1988, while offshore landings were 79,300 t, also down from 98,000 t landed in 1988. Inshore landings from Subdiv. 3Ps were 22,300, up from 19,600 t in 1988, while offshore landings were 79,300 t, also down from 98,000 t landed in 1988. Inshore landings from Subdiv. 3Ps were 22,300 t, up from 19,600 t in 1988, while offshore landings were 5,300 t, compared to 6,000 t landed offshore in 1988.

2. Redfish. Canadian landings were 13,200 t, down from 1987 and 1988 levels of around 21,000 t. Div. 3K and 3L landings were 3,700 t, down from 11,500 t in 1988. Combined landings from Subdiv. 3Pn and 3Ps were 9,500 t, compared to 9,200 t in 1988. Landings from other Divisions remained low.

3. Flatfish. Canadian landings of the combined flatfish species were 54,200 t, compared to 56,200 t in 1988. American plaice dominated these landings at 32,000 t, compared to 31,400 t in 1988. Yellowtail landings were 5,400 t, down substantially from 10,700 t landed in 1988. Greenland halibut landings were 9,300 t, up from 6,700 t in 1988, while greysole landings were 6,200 t, compared to 5,800 t in 1988. Other flatfish landings included 500 t of winter flounder and 850 t of Atlantic halibut. While landings from the inshore sector amounted to only 25% of all flatfish landings, about 91% of all Greenland halibut were landed by the inshore fixed-gear fishery.

4. Other groundfish. Canadian landings of other groundfish species were: haddock - 8,800 t, white hake - 2,700 t, pollock - 2,700 t, and wolffish - 1,100 t. Some 2,400 t of lumpfish roe were also landed inshore in this Subarea during 1989.

5. Capelin. Approximately 50,000 t of capelin were landed inshore in Div. 3L, 27,000 t in Div. 3K, and 2,400 t in Div. 3Ps in 1989. The inshore catches were taken during the inshore spawning migration. Female capelin are preferred to satisfy the Japanese roe market. The offshore catch in Div. 2J3KL was 23,000 t.

6. Herring. Herring landings from Newfoundland were approximately 6,200 t, 5,700 t from Div. 3KL and 500 t from Div. 3P. The commercial fishery did not catch the quotas, primarily due to poor market conditions and the presence in most areas of small fish, not of marketable size, mixed with the larger, commercial size fish.

7. Mackerel. Mackerel landings in Subarea 3 were about 1,900 t, compared to 4,300 t landed in 1988.

8. Squid. Total reported catch of squid in 1989 was 2,200 t (preliminary data). Early season catch rates on the southern Grand Bank were moderate. The poor fishery, for the seventh consecutive year, was due to a natural low abundance of squid in commercial fishing areas.

9. Atlantic salmon. Landings were 448 t in the commercial fishery and 21 t in the recreational fishery. The commercial catch of large salmon (189 t) was the same as in 1988.

10. Shrimp. The Div. 3K shrimp fishery located in the St. Anthony Basin was subject to a TAC of 1,600 t from May 1, 1989, to April 30, 1990. Catches to date from this area exceeded 800 t. An additional TAC of 2,000 t was set for other areas within Div. 3K. Catches to date were less than 500 t.

11. Scallops. Landings in 1989, again based predominantly on the 1982 year-class, receded to 305 t meats, down from 1,027 t the previous year. Average as-landed meat count was 26.9/500 g.

12. Clams. An experimental offshore fishery for Stimpson's surf clam (Spisula solidissima) commenced on the Grand Banks. Two experimental licenses had been issued for Eastern Grand Banks (3LNO) for 7,500 t each. A significant by-catch of the Greenland cockle, Serripes groenlandicus is reported from some areas.

8. Special Research Studies

1. Environmental Studies

a) Oceanographic studies. All of the standard sections in Subarea 3 (White Bay Line, Bonavista Triangle, Flemish Cap Section) were occupied in July 1989. The time series of Station 27 (4 km east of Cape Spear) was continued, the station being occupied 33 times in 1989. Current measurements were taken using moored instruments at two locations on the Bonavista Line.

b) Ocean Circulation (Bedford Institute).

- (3N) Southeast Shoal (Grand Bank):

A current meter mooring and a sea surface temperature buoy were deployed on the southern Grand Bank in late April, but went adrift in July and May respectively. A limited hydrographic survey was conducted on the deployment cruise.

- (3L) Labrador/Newfoundland ice margin:

A field study of wave/ice interaction and ice remote sensing was carried out on the southern edge of the Labrador/Newfoundland ice margin. Data on ice motion were collected using five ice motion sensing packages along with in situ anemometers and over flights of the Canadian Synthetic Aperature Radar System. The main program extended through March 1989, but some CTD data were collected during February and March using a helicopter-mounted system to work through the marginal zone ice.

c) Oil industry (Environmental Studies Revolving Fund). Four studies dealing with both the physical and biological environment are currently underway. The projects focus on the Grand Banks, a frontier oil and gas development area.

- Tainting of commercial species of Grand Banks flatfish:

The risk of tainting commercial fish species will always be an issue in the event of an oil spill affecting major fishing grounds. This particular study deals with species of Grand Banks flatfish that could be tainted through exposure to hydrocarbons resulting from a spill on the Grand Banks of Newfoundland. The study includes a review of existing information and the development of a computer model that will determine the likelihood of oil actually coming in contact with commercial flatfish that live close to the seafloor on the Grand Banks.

- Sensitivity of eggs and larvae of Grand Banks fish to petroleum hydrocarbons:

This study involves the development of a numerical model that will estimate the potential for translation of toxic effects in eggs and larvae to populations of adult cod and plaice. The project includes a review of existing data on the spatial and temporal distribution of eggs and larvae of Grand Banks cod and plaice; investigations into the behavior and toxicity of typical Grand Banks crudes, and the development of oil spill scenarios for the area. All of this information will be incorporated into a computer model that has been used successfully in other offshore areas.

- Monitoring of a recent iceberg scour:

Recent work has documented the formation of three iceberg scours and an iceberg pit on the northeastern Grand Banks. These features, of recent and known age, provide an opportunity for study. The objective of this project is to design a study program by which rates of change in these four iceberg-related seabed features may be characterized and quantified. The project will include measuring changes in dimensions, rates of infilling, rates of degradation, and biological repopulation of the subject iceberg scours. This will allow the dating of additional scours in the region.

- Documentation and archiving of marine radar data sets:

The detection and management of icebergs is a key concern associated with oil and gas development on the Grand Banks. For this reason, digital radar signal data and associated documentation have been collected during three previous ESRF studies (Reports 008, 035, 091). To ensure accessibility for both government and industry, these data are being converted into a common, easily-read format. The resulting records will be archived at the Canada-Newfoundland Offshore Petroleum Board. In addition, the Canada-Newfoundland Offshore Petroleum Board commissioned a report 'Review of Environmental Effects Monitoring Techniques Appropriate to Offshore Hydrocarbon Development Projects'.

d) Temperature-guided fishery project. A working system involving three trawlers was tested at sea for the first quarter of 1989 (data and reports concerned 3K mostly). It was demonstrated that only a few sea-bottom temperature observations were required to establish the pattern of anomalies over a large area. The 'data poor' maps so generated were compared to 'data rich' maps from the

November groundfish survey and showed good agreement. Despite excellent results, the service has been terminated for want of interest from industry.

e) Conception Bay remote sensing. An extensive moored current meter array and program of CTD transects (by Memorial University) was extended by two weeks of CODAR (surface velocity maps from HF radar), 12 SAR transects, drifters, and a CASI (imaging spectroplotometer) flight. This interesting and complex data set is expected to reveal much of the physical dynamics of Conception Bay, as well as technical information on the calibration and limitations of the instruments involved.

f) Centre for Cold Ocean Resources Engineering (C-Core), Memorial University.

- The sea ice environment:

  The LIMEX (Labrador Ice Margin Experiment) Program is directed to advance the knowledge of physical environment associated with the ice-covered ocean. LIMEX '89 was the second major field program; LIMEX '87 was the previous one. This year's program showed that when dealing with the ocean environment, aircraft programs are severely limited in range and by weather. Future programs will include satellite platforms such as ERS-1 and RADARSAT.

  Data using the motion sensor packages were collected during the 1989 program. The results of this work are expected to further the knowledge of waves at the ice margin, ice conditions within the ice margin, and remote sensing of waves in ice and to contribute to ocean wave remote sensing.

- Geophysical/geotechnical sediment property correlation:

  Relationships have been established between acoustic properties (velocity and attenuation) and geotechnical properties (density, porosity, shear modulus, and damping) of selected sediments in support of the Acoustic Sub-seabed Interrogator (ASI) and its associated developments.

- Innovations in acoustic technology offshore:

  A CO-ASI (Conventional Optimization Acoustic Sub-seabed Interrogator), based on the ASI concept, is being designed and fabricated. It will include advanced design, multi-tip acoustic transmitters designed and fabricated at C-CORE. The CO-ASI is being engineered to perform layer-by-layer interrogation of a complex sub-seabed to a depth of 30 m. High-resolution acoustic information will be acquired and related to physical and geotechnical soil properties.

- Ice/seabed interaction:

  Ice scour research, supported by an NSERC strategic grant, continues to provide information on the mechanics of the scour process and its effects on the soils both above and below maximum scour depth.

- Geographical Information Systems (GIS) - new program:

  The new program is developing a GIS-based system which will examine multivariate spatial relationships between ocean-related variables and seabed features and properties. The spatial model for iceberg scouring on the Grand Banks will synthesize iceberg information, sea ice coverage data, wave and current regimes, iceberg scour data, surficial geology, bathymetry and other complementary environmental data.

- Remote sensing of ocean wave conditions:

  The interpretation of wave spectra from Ground Wave radar technology has been applied to the estimation of the ocean wave spectrum. Basic analytical modeling of the ocean surface return, interpretation of measured data using the models and signal processing and data analysis techniques were undertaken. This program was carried out cooperatively with researchers from the Bedford Institute of Oceanography which provided information on ocean surface modeling and identified user requirements in the oceanographic community. This program developed specifications for a Ground Wave radar system for ocean wave observations to be incorporated into shore-based or rig and vessel-based radar systems.

2. Biological Studies

a) Cod. Sampling of the landings from the commercial fishery both inshore and offshore was continued in 1989. Using research vessels, surveys were carried out in all NAFO Divisions (except 3 M) to determine the distribution and abundance of cod. Biological sampling was extensive during these surveys and several thousand cod were tagged, inshore and offshore. Stomachs were collected from Div. 3LNO during spring and from Div. 3KL during autumn. Samples were collected from meristic studies in Div. 2J3K during winter and Div. 3L and Subdiv. 3Ps during spring.

b) Redfish. Several research cruises throughout Subarea 3 were conducted yielding information on abundance and distribution. The collection and subsequent ageing of otoliths from both research and commercial catches, and the application of these to respective length frequencies yielded information about commercial catch at age as well as population structure. An acoustic cruise for redfish was carried out in Div. 3P/4V during July-August.

c) Flatfish. Distribution and abundance of flatfish were studied during fall random stratified surveys in the following NAFO Divisions and times in 1989: Div. 3K - fall survey; Div. 3L - spring and fall surveys; Div. 3N, 3O - spring survey; and Subdiv. 3Ps - winter survey. These surveys provide a major source of information for continued biological studies of flatfish. In addition, the following surveys provided valuable data on flatfish:

- New studies into the behavioral ecology of A. plaice were continued, largely through laboratory experiments in controlled environments.
- As a result of joint research efforts from the Newfoundland Region and Scotia-Fundy region scientific advice was provided through CAFSAC for the management plan for Atlantic halibut.
- A juvenile flatfish survey was conducted in Div. 3LNO in the fall of 1989. This survey is part of a time series directed at establishing a pre-recruit index for yellowtail aged 1-3 years. Information was also collected on the distribution and abundance of juvenile American plaice.

d) Capelin. Data from acoustic surveys conducted in the offshore areas of Div. 3L were used to provide TAC advice, through NAFO, for 1990. The inshore fishery was monitored by a comprehensive logbook survey and an aerial survey was conducted during the inshore spawning migration.

Two cruises to the Southeast Shoal were completed in 1989. Both surveys were restricted by vessel breakdown and bad weather.

e) Scallops. A 13-day cruise (245 sets) to St. Pierre Bank pointed to a residual biomass of between 300-600 t meats A quota of 400 t and an EA regime was initiated in 1989. The fishery will continue to depend on the 1982 year-class. No large-scale settlement and/or recruitment of newer year-classes was evident.

f) Clams. In 1989, observers were deployed on three experimental surf clam trips in Div. 3LNO (155 fishing days, 111 samples, 26,828 lengths). Also, some frozen samples were returned to DFO. Observer participation allowed compilation of data on fishery performance and the collection of limited biological data, particularly on size-frequency distributions.

g) Squid. At one inshore locality (Holyrood), water temperature was monitored and commercial squid samples were acquired, whenever available.

h) Crabs. Studies on biological aspects of a shallow-water spring breeding migration of snow crabs were continued at Bonne Bay in western Newfoundland. Studies investigating the effect of water temperature on yearly recruitment were continued. A bottom-trawl survey for snow crab was successfully carried out during May in Conception Bay.

i) Lobster. Long-term monitoring of the fishery of various aspects of population biology and dynamics were continued at three inshore Newfoundland sites.

j) Iceland scallops. A random-stratified survey (196 sets) was completed in 3N. Catch rates were low throughout the areas surveyed. Only two areas near Lilly Canyon produced moderate-to-good catches. No live sea scallops were encountered, but several disarticulated values were taken.

k) Atlantic salmon. Long-term research studies continued to develop a model which could be used to estimate salmon production capacities of streams, optimal egg deposition and stock and recruitment relationships. A total of 1,834 Atlantic salmon caught in the commercial fisheries was sampled for size and age distribution.

l) Seals. A total of 574 jaws, 528 stomachs, 189 ovaries and uteri, 32 foeti, 97 penises and testes, and 164 tissue samples were collected in 1989. Age data for a total of 16,159 animals were edited and updated.

A document has been prepared on the results of experiments on the determination of optimal photographic conditions for aerial surveys of harp and hooded seals. A major aerial survey (2J3K and Gulf of St. Lawrence) is planned for March 1990.

An experimental by-catch monitoring program was established for the 1989 fishing season. Preliminary data indicate very low levels of seal catches among our collectors. Program has been modified and expanded to include more fishermen covering a greater area and different gear types.

All harp and hooded seal tagging data have been updated and verified. A study of the precision of age determinations of hooded seals has been completed.

A study of seal patches/ice floe habitat through remote sensing was completed in March 1989.

m) Whales. Biological information and tissue samples were obtained from stranded and incidentally trapped cetaceans. A total of 12 individuals from 7 species was examined.

Studies were continued of ice entrapments of blue whales, entanglements of whales in fishing gear, detectability of fishing gear by cetaceans, photo-identification of cetaceans, food selection using stable isotope analysis, population modeling, aromatic hydrocarbon pollutants.

n) Multispecies. Laboratory experiments on the susceptibility of larval fish to predation were conducted to assess size-related differences between species. The use of otolith micro-element composition to assess environmental temperature was assessed. A review of studies on early life history characteristics in fish assessing the sensitivity of fish eggs and larvae to fluctuations in biotic and abiotic features of the environment was completed. A comparison of life history characteristics and recruitment variability demonstrated a strong link to the early life.

o) Larval fish. Work on nearshore production processes in relation to larval fish survival, particularly capelin, was initiated.

p) Benthic ecology. A new method for extracting viable dinoflagellate cysts from sediment was developed and cultures of Alexandrium tambourines, the PSP-causing dinoflagellate, were established from cysts taken from bottom sediments.

SUBAREAS 2 AND 3

A. Special Research Studies

1. Environmental Studies

a) Oceanographic and related studies. Ships of opportunity XBT programs were continued using the vessels CAPE ROGER and the LEONARD J. COWLEY. Temperature profiles were taken at each research fishing station occupied during 1989. Six-month temperature recorders were provided to researchers in conjunction with the DFO long-term Temperature Monitoring Program. CTD data were collected using a SeaBird SeaCat Profiler on the groundfish ottertrawl.

b) Hydrography. The CSS MAXWELL and hydrographic staff were involved in inshore sounding surveys from May 8 to November 3. Detailed information for the updating of navigation charts was collected along the northeastern Newfoundland coast.

c) Bedford Institute.

- Labrador and Newfoundland Shelves:

A helicopter-supported field survey was carried out March 5-10, 1989, off the Labrador Coast after an early survey in January was canceled due to unsafe ice conditions. Thin ice conditions occurred along the coast as heavy pack ice was pushed offshore due to predominantly westerly winds. In early March, the thicker ice was closer to the coast and five CTD profiles were obtained at locations where five satellite-tracked ice beacons were deployed. The CTD profiles showed that the surface mixed layer with near-freezing temperatures extended to over the total water column (200 m), verifying the above-normal local ice growth over the inner shelf. The five ice beacons provided an average 38 days of data, traveled a distance ranging from 320 to 625 km at a mean drift rate of 15 cm/sec, but reaching 3-hr max rate of 130 cm/sec.

- Labrador Slope-mid Labrador Sea:

Fifteen full-depth CTD stations were obtained along a line running from the edge of the Labrador Shelf at approximately 50°N, toward the northeast to approximately 39°W. The remainder of the planned work in the central Labrador Sea was canceled due to ice-damage to the ship.

2. Biological Studies

a) Assessments. Assessments of some 25 groundfish stocks presently under catch quota regulations were conducted and refined and advice on TACs for the 1989 fishing season was provided either through CAFSAC or NAFO. Further assessments were conducted of 17 pelagic-shellfish-marine mammal stocks, the marine phase of mixed Atlantic salmon stocks originating from Newfoundland, Labrador, Quebec and Maritime rivers, three Arctic charr stock complexes and other commercial and potentially commercial species.

b) Research vessel cruises. Fifty-four offshore and inshore research vessel cruises were undertaken in 1989 utilizing DFO-owned vessels (WILFRED TEMPLEMAN, MARINUS, SHAMOOK, LADY HAMMOND) and the GADUS ATLANTICA (on long-term charter) (Table 1).

c) Commercial sampling. Sampling of foreign and Canadian offshore catches by the Canadian Observer Program continued in 1989. A total of 5,841 samples representing some 1,379,367 length measurements and approximately 13,540 otolith pairs were collected from the catches of foreign and Canadian offshore fisheries. A total of 7,627 days and 33,115 sets was observed. Coverage in 1988 was high for 2J3KL cod, whereas in other areas approximately 20% coverage of Canadian vessels was maintained. The foreign activity inside the 200 mile limit was completely covered. High levels of coverage were also maintained on RSPP and other types of charter trips. Analysis of production on factory and wetfish trawlers was continued and the study of discarding practices for the domestic offshore fleet was examined closely.

d) Cod. Combined trawl and acoustic survey was undertaken to determine the distribution of cod off the east coast of Newfoundland and during the shoreward migration in June. Also, to determine the depth and temperature of cod concentrations near the coast prior to and during the inshore migration of cod.

Adult cod were tagged in inshore areas during the summer-autumn and also the winter to determine migration patterns of summer feeding concentrations and of overwintering concentrations.

Completed initial installation/testing of new 120 KHz Biosonics Dual Beam Echosounding System (with integration and in situ target strength capabilities), including recalibration of discriminant function for cod and capelin acoustic signals as a precursor to new studies of cod distribution inshore.

e) Cod-capelin interactions. A bilateral workshop between Canada and Norway was held with additional participation from Iceland. Five days of talks were held, covering the main components of cod-capelin-marine mammal-oceanography in both areas and approaches to quantifying and modeling the interactions. Six specific follow-up activities were identified, each to be ready by a second meeting, in Bergen, in April 1990.

f) Parasitology. Stomachs of 489 harp seals collected off Labrador, northeast and southern Newfoundland were examined for nematodes. Over 400,000 specimens were recovered; most were Contracaecum osculatum and Phocascaris phocae. Sealworms (Pseudoterranova decipiens) were rare (<1% infected) and most specimens of sealworm were third or fourth stage larvae. Small numbers of larval Anisakis were also found.

Various species of fish commonly found in the stomachs of grey seals were collected (off southern Newfoundland) and examined for larval sealworm. Atlantic cod, Greenland cod, and sculpins were the most heavily infected; pelagic species such as capelin and herring were uninfected, as were skate and lumpfish. Hake and turbot had small numbers of sealworms.

Electrophoretic analysis of sealworms (conducted by Professor Paggi and coworkers at the University of Rome) was continued and a manuscript prepared and submitted for publication. The manuscript indicates that there are at least three species of sealworm in the North Atlantic, rather than one, as originally thought.

g) Groundfish. Analyses will be completed to quantify the variation in biomass by size category, as compared to by species, for groundfish taken in research surveys from 1971 to the present.

h) Flatfish. Papers were prepared on minimum size limits of Atlantic halibut, biology of A. plaice in Div. 3M; spawning of witch flounder; and the response of flatfish to trawling gears.

i) New quantitative methods of relating estimates of abundance of fish to environmental attributes such as position, depth, bottom temperature, etc., will be applied to cod data from Div. 2+3.

j) Crab. A study investigating the effect of shell condition on snow crab weight-length relationships was initiated.

3. Miscellaneous

a) Shell hardness gauge for snow crab. Shell hardness studies using the Pacific Transducer (PT) durometer were published. This year 20, 7 lb gauges were purchased and tested in the field. Fishery Officers compared thumb pressure to the PT durometer. Results showed that on a scale of 0 to 100 on the durometer, a value of 68 (bottom of claw, 7 lb gauge) is recommended as a cut-off for removing soft shell crabs from the catch. The gauge will be further modified for testing again next year.

b) Parasite detection and removal. The Parasensor technology is being further developed and in-plant testing is scheduled for early 1990. It is a vision enhancement device utilizing laser for inspection of cod fillets for parasites.

c) A comparison of extended and standard gillnets for harvesting Atlantic cod. In 1989 the Fisheries Development Division of the Department of Fisheries and Oceans conducted an experiment to

determine the fishing effectiveness of extended gillnets (35 meshes deep) in comparison to the standard gillnets (25 meshes). Three commercial gillnet fishermen were provided with identical fleets of extended and standard nets set alternatively in the same fleet. Fishing effort was directed in both inshore and offshore waters.

The extended nets yielded a 96% and 58% increase on inshore and offshore fishing grounds respectively. It was observed during fishing operations that the top 10 meshes of the net accounted for 4.0-23.0% of the total catch harvested in extended nets.

d) Middle-distance vessels. The provincial Department of Fisheries published a report on the results of Newfoundland's middle-distance fleet program. In 1982, a demonstration project commenced using fixed gear, mid-size vessels to evaluate how this combination of vessel and gear technology could assist in extending the operating season of inshore processing plants, improve the quality of landed fish and serve as a technology transfer model for the emerging inshore fleet.

e) *Hydroacoustics.* Investigate potential sources of variation observed in calibration measurements of the Hydroacoustic Data Acquisition System (HYDAS). The procedure used to acquire and analyze HYDAS calibration data in 1987 and 1988 was examined. Errors and weaknesses were identified in the procedure. These problems were corrected through the development of a new data acquisition and analysis technique.

Start the development of a stern deployment/retrieval and towing system for the GADUS ATLANTIC which will allow hydroacoustic work to be conducted in ice-infested waters. The stern towing system was designed and contracts were let for the construction and installation of the system on the vessel. All equipment will be installed on the vessel in January 1990 and field testing will be conducted prior to and during the February 1990, 2J3K cod trip.

TABLE 1
NEWFOUNDLAND REGION
RESEARCH VESSEL CRUISES 1989

Vessel	Area of Operation	Type of Survey	Operating Days	Trip #
NFLD-BASED VESSELS				
WILFRED TEMPLEMAN	3LNO	Redfish	January 17-27	80
	3P	Groundfish	January 31-February 17	81
	3LNO	Groundfish	April 19-May 8	82
	3L	Groundfish	May 10-29	83
	3LNO	Juvenile flatfish	August 22-September 6	84
	3LO	Flatfish	September 7-18	85
	Labrador Sea	Salmon	September 21-October 8	86
	3L	Groundfish	October 12-November 1	87
	3L	Oceanography	November 3-7	88
	3NO	Groundfish	November 9-14	89
SHAMOOK	Off St. John's	Crab	May 1-10	149
	Conception Bay	Herring	May 16-19	150
	Conception Bay	Oceanography	May 29-June 2	151
	3L	Cod, capelin	June 5-16	152
	Conception Bay	Oceanography	June 19-24	153
	Conception Bay	Oceanography	June 27-July 14	154
	2J (inshore)	Cod sampling	July 26-August 21	155
	Conception Bay	Crab	August 30-September 2	156
	Conception Bay	Oceanography	September 5-8	157
	Conception Bay	Oceanography	September 11-28	158
	Conception Bay	Crab	October 10-13	159
MARINUS	Conception Bay	Oceanography	March 1-10	116
	Conception Bay	Benthic sampling	March 13-23	117
	Conception Bay	Oceanography	April 3-12	118
	Conception Bay	Benthic sampling	May 15-24	119
	3KL (inshore)	Capelin	May 29-June 23	120
	Placentia Bay	Toxicology	July 4-18	121
	Conception Bay	Larval studies	July 26-30	122
	Bonavista Bay	Crab	August 1-15	123
	3Ps	Cod, pollock tagging	August 17-September 8	124
	Conception Bay	Benthic sampling	September 12-22	125
	Conception Bay	Cod acoustic tagging	September 25-October 9	126
MAXWELL	Fogo Island	Hydrography	May 19-July 27	-
	Fogo Island	Hydrography	July 31-August 24	-
	Hamilton Sound	Hydrography	August 25-September 19	-
	Twillingate	Hydrography	September 22-26	-
	Dildo Run	Hydrography	September 27-November 1	-
CHARTERS (includes trips* manned by Quebec personnel)				
GADUS ATLANTICA	*4RST3Pn	Groundfish	January 12-30	162
	3KL	Cod acoustic	February 3-24	163
	3L	Acoustic trials	April 21-26	164
	3Ps	Scallops	April 27-May 9	165
	3L	Capelin acoustic	May 11-29	166
	St. John's	Acoustic calibration	May 30-June 1	167
	3KL	Cod acoustic	June 4-19	168
	3LNO	Capelin acoustic	June 21-July 4	169
	OB2GHJ3K	Shrimp	July 6-26	170
	3P4RV	Redfish acoustic	July 28-August 14	171
	3N	Scallops	August 16-28	172
	2J3K	Capelin acoustic	October 10-30	173
	2J	Groundfish	November 1-16	174
	2J3K	Groundfish	November 17-December 4	175
	3K	Groundfish	December 6-20	176
LADY HAMMOND[1]	3L	Capelin	May 2-12	196
	Conception Bay	Crab	May 12-23	197
	3L	Crab	May 24-June 3	198
AERIAL SURVEYS				
FIXED-WING AIRCRAFT	Trinity, Conception & Notre Dame Bays	Capelin	June 16-July 4	-

[1]Scotia-Fundy based long-term charter.

SECTION II. Gulf Region

by

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A. STATUS OF THE FISHERIES:

1. **Southern Gulf Cod (4TVn):**
The Total allowable catch was 54,000 tonnes. Provisional landings were 50,000 tonnes. France was allocated 1,360 tonnes and a catch of 500 tonnes was reported. The winter fishery (4Vn) represented 14% of the landings. Fixed gear landings were the lowest in the period 65-89. The winter fishery (4Vn) represented 18% of the 1988 landings. The standardized Otter trawl catch rate decreased slightly over 1988, however, it is still among the highest observed since 1966. Research survey estimates (age 3+) also declined over 1988. The mean population biomass appears to have been stable since 1984 and at the highest level since the mid 1950's. Fishing mortalities on the stock have been reduced in recent years to 0.2-0.25 from 0.3-0.7 previously.

2. **Southern Gulf American Plaice (4T):**
The annual total allowable catch for this fishery has been 10,000 tonnes since 1977. Provisional landings in 1989 totalled 5,000 tonnes representing a decline of 1,700 tonnes from 1988. The proportion of the total landings taken by directed effort has increased from 21% in the early 1980's to over 50% at present. Catch of small fish continues to be a problem with up to 50% by weight of the catch being discarded. The abundance index from research vessel surveys suggest that stock biomass has declined substantially since the late 1970's to become relatively stable since 1984. The recent catches from 5,000 to 9,000 tonnes are thought to be close to the $F_{0.1}$ level.

3. **Southern Gulf White Hake (4T):**
The total allowable catch for 1989 was 5,500 tonnes with provisional catches totalling 5,128 tonnes. Precautionary TAC's of 12,000 tonnes were set from 1982 until 1986. Concerns that precautionary TAC's allowed the stock to be exploited at about twice the $F_{0.1}$ level in recent years were confirmed, thus the TAC was reduced to 9,400 tonnes for 1987 and again to 5,500 tonnes for 1988 and 1989. This fishery has been relatively stable with a catch of 5,000-6,000 tonnes since 1965. The peak catch of 14,000 tonnes reached in 1981 was due to recruitment of several strong year classes. Population numbers and biomass have declined in recent years in response to lower recruitment and high fishing mortality.

4. **Northern Gulf Witch Flounder (4R + 4S):**
The total allowable catch for 1989 was 3,500 tonnes with provisional catches totalling 1,000 tonnes. Catches have remained stable at this level since 1982. Close to 100% of the catch is taken near Newfoundland in Division 4R. Catches are thought to be below the long term sustainable yield.

5. **Southern Gulf Herring (4T):**
The total allowable catch by gillnet and purse seine fisheries was 86,900 tonnes in 1989 with provisional catches totalling 57,600 tonnes. The fishery continues to be supported by several strong year classes. Above average recruitment since 1979 has allowed the stock to rebuild strongly from its levels in the late 1970's. CPUE's based on a fixed week model indicated a moderate rise in fall CPUE, continuing the trend since the early 1980's. Catch rates by index fishermen supplemented commercial catch rates in the catch rate model. Spring CPUE declined slightly but not significantly. Biomass of both spring and fall spawners is roughly an order of magnitude higher than at the beginning of the decade.

6. **Atlantic Bluefin Tuna (SA 3-6):**
Canada's share of the west Atlantic total allowable catch for 1989 was 573 tonnes. This TAC was set by ICCAT as part of an overall western Atlantic quota of 2,660 tonnes. The same allocations have been in place since 1983. The reported nominal landings for Canada was 573 tonnes as compared to 1988 landings of 440 tonnes. The Canadian rod and reel plus the tended line catch rate series have been used for age calibrations of the older fish (16+ years) in the stock assessment.

7. **Atlantic Salmon:**
The 1989 management plan for Atlantic salmon in the Gulf Region was a continuation of the five year plan initiated in 1984. Major restrictions on harvest included: the closure of commercial fisheries in New Brunswick, Nova Scotia, Prince Edward Island and in certain localized areas in southeast Newfoundland; mandatory release of all multi-sea-winter (MSW) salmon by anglers in all areas; and prohibiting the landing of salmon from non-salmon gear. In northeastern New Brunswick, total returns of 1SW salmon were 38-57% below 1988 levels and were also 17-40% lower than 1979-1988 means. MSW salmon returns also declined 21-28% from the previous year and were below previous ten year averages in Miramichi River but were similar to long term averages in Restigouche River. Angling catches of 1SW salmon generally reflected these reduced returns. Target spawning requirements were apparently met in Miramichi River in 1989, but not in Restigouche River. In Prince Edward Island there were below average returns of 1SW and MSW salmon. In Gulf Nova Scotia spawning requirements were exceeded. In western Newfoundland, adult salmon escapements in 1989 at counting fences and fishways were average or below average. Recreational and commercial landings of 1SW and MSW salmon were below 1988 landings.

8. **Gaspereau (4T):**
Gaspereau are intensively harvested in the Miramichi River, New Brunswick, and in the Margaree River, Nova Scotia. The catch of 1,924 tonnes from the Miramichi River in 1989 was approximately equal to the 1988 catch (1,888) and the average for the past five years, whereas the catch of 1,123 tonnes from the Margaree River was equal to the previous five year average. The fishing mortality rates are high in both rivers and new recruits constitute almost 60% of the catch.

9. **Gulf Lobster (4RT):**
Overall landings in 1989 were estimated at 23,057 tonnes, this marks the third consecutive year of increase in landings and is the highest annual landings in the past 35 years. Landings in the previous three years were as follows: 21,300 tonnes in 1988, 20,300 tonnes in 1987, and 15,449 tonnes in 1986. The stable and gradual increase of landings since 1975 has occurred without changes in fishing effort (number of fishermen, traps, licenses and length of season). The increases and general stability of landings are attributed to favourable recruitment. The Gulf lobster fishery has been traditionally a recruitment based fishery.

10. **Southern Gulf Snow Crab (4T):**
The southern Gulf of St. Lawrence snow crab fishery is composed of four management units: the southwestern Gulf, Prince Edward Island and two fisheries off the western coast of Cape Breton Island.

The southwestern Gulf fishery began in 1966 and expanded rapidly with landings of 31,585 tonnes in 1982. Annual landings then fluctuated between 24,000 and 26,000 tonnes until 1986. Total landings dropped to 11,782 tonnes in 1987 and increased slightly to 12,355 tonnes in 1988. In 1989, the fishery was closed after six weeks due to a high incidence of white crab in the catch. A reference total allowable catch (TAC) of 26,000 tonnes was introduced in 1984. Total landings of 7,882 tonnes were recorded for the 1989 season. Catch rates (kg/trap haul) decreased continuously from 57.3 in 1985, 55.7 in 1986, 26.2 in 1987, 23.2 in 1988 and 22.1 in 1989.

The Prince Edward Island snow crab fishery was initiated on an experimental basis in 1985 and is now composed of 30 fishermen. Catches have dropped from 1,239 tonnes in 1986 to 457 tonnes 1987 and then increased to 666 tonnes in 1988 and 747 tonnes in 1989. Catch rates declined from 53 kg/trap haul in 1985 to 32.6 in 1986 and 18.3 in 1987. Catch rates have then increased to 31.1 kg/trap haul in 1988 and to 47.5 kg/trap haul in 1989. The total exploitation rate was estimated to be between 56.6 and 75.5%.

Area19 off the western coast of Cape Breton Island was established in 1978 and is composed of 59 fishermen. In 1989, the total allowable catch for the zone was 1,338 tonnes and landings of 1,334 tonnes were recorded. Catch rates declined continuously from 96 kg/trap haul in 1982 to 30.3 kg/trap haul in 1987, but increased to 58.7 kg/trap haul in 1988. In 1989, the catch rate decreased to 44.5 kg/ trap haul.

11. **Southern Gulf Scallop (4T):**
Landings of sea scallop were estimated at approximately 250 tonnes in 1989. Annual landings since 1972 have ranged between 200 and 350 tonnes. The overall sea scallop fishery in the southern Gulf is stable except in some localized areas. The northeastern Gulf Icelandic scallop stock is also viewed as stable if current effort levels are maintained.

B. SPECIAL RESEARCH STUDIES IN 1989:

1. **Environmental Studies:**
Hydrographic studies - Temperature profiles were collected at 169 stations during the fall groundfish cruise and at 30 stations during a July juvenile cod survey in the southern Gulf of St. Lawrence.

Sediment samples (500ml/station) were collected at 150 stations in the southwestern Gulf of St. Lawrence from snow crab fishing grounds. In Bonne Bay, Newfoundland, temperature, dissolved oxygen level, and salinity were measured by CSTD probe between late April and August. Plankton sampling (surface and vertical tows) and measurements of suspended carbon were conducted at depth strata of 10m from late April to August.

2. **Biological Studies:**

a) Cod: Commercial fishery (catch and weight at age, and catch per unit effort) and research survey data were used in the assessment of the 4TVn (Jan.-Apr.) cod stock. A survey to determine juvenile cod concentrations and distribution in Miramichi Bay was conducted during July. Factors associated with a recent decrease in growth rate continue to be the main topic of study.

b) Plaice: The input data for the assessment of American plaice in area 4T came from commercial fisheries data and a research vessel survey. The discarded catch was estimated and included in the catch at age. Commercial catch at age showed more older fish than other plaice stocks. Research vessel mean number per tow showed a decline since 1979. A stable level of mean catch per tow has been observed in the last three years.

c) White Hake: Commercial catch samples, research vessel surveys, and commercial catch and effort data were used for the stock assessment. A study was completed to investigate the stock structure of white hake in the southern Gulf. Two components were identified, one stock is restricted to water less than 200m.

d) Herring: The index fisherman program, in operation since 1986, was continued for a fourth year. The annual acoustic cruise for southern Gulf herring ended prematurely because of a labour dispute. Survey coverage included only the western part of the Gulf, where estimates of acoustic backscatter were much lower than in previous years. Several studies continued on the distribution and biology of juvenile herring in the Gulf. Surveys confirmed that the Bay of Chaleur is an important area for juvenile herring throughout the year, including winter, when their presence was verified by gillnetting through the ice. Investigations on spawning of herring continued with emphasis on

application of geostatistical methods for biomass estimation and on the role of winter flounder as egg predators.

e) Atlantic Bluefin Tuna: A stock update and review was carried out at the annual ICCAT meetings. Sampling of individual fish, at local fishing ports, is the only source of biological data for tuna in the traditional Canadian fishery. In 1987, an offshore longline fishery was begun using larger vessels. This new data source will be utilized in future assessments.

f) Atlantic Salmon: Advice on the status of Atlantic salmon stocks was provided for the following rivers and areas: Restigouche and Miramichi Rivers, New Brunswick; Margaree River, Nova Scotia and western Newfoundland. Biological advice was based on monitoring adult and smolt runs at several index river sites; sampling angling, commercial and Native fisheries; summarizing all catch and effort data; and conducting electrofishing surveys throughout headwater areas. Specific research was conducted on the following topics: stock identification based on scale characteristics; run timing and exploitation rates of early versus late-running salmon; effect of sea age on the reproductive potential Atlantic salmon; spatial and temporal variability in the run-timing of anadromous stocks within the Gulf of St. Lawrence and sea survival of smolts.

g) Gaspereau: Assessments of the 1988 gaspereau fisheries of the Margaree and Miramichi rivers were completed. The catch at age was structured using samples from the fishery in the Margaree and the Miramichi Rivers, weighted by daily catch from logbook reports. Sequential population analysis was completed. Collection of biological characteristics of gaspereau from other rivers in the Gulf of St. Lawrence was continued.

h) White Flounder: The functional and numerical response of winter flounder to herring spawn were estimated at spawning grounds. Gastric evacuation times will be estimated in laboratory experiments. The overall importance of feeding on herring spawn to the production of winter flounder will be investigated.

i) Lobster: On the western coast of Cape Breton Island, a pilot study has been initiated for monitoring the effect of minimum carapace size on lobster population structure and fisheries yield. Data on life cycle and population characteristics of lobster in the area were collected from tagging and year round sea sampling.

Sea sampling of commercial lobster catches was conducted throughout the Gulf of St. Lawrence from Baie des Chaleurs to

western Newfoundland in order to provide management advice for specific local adjustments of fishery regulations and resource monitoring projects.

i) Snow Crab: Biological characteristics of the snow crab populations were monitored by sea sampling aboard commercial vessels during the 1989 fishing seasons. In the southwestern Gulf of St. Lawrence, the supplementary sampling of the snow crab fishery was conducted aboard chartered vessels after the fishing season in order to monitor the incidence of postmolt crab. Stock assessments of all areas were presented based on data derived from fishermen's logbooks and processors' sales slips. Initial biomass and exploitation levels were estimated using Leslie analysis of catch/effort trends. A post-season trawl survey was conducted on all major fishing grounds in the southwestern Gulf of St. Lawrence fishery to provide information on the biomass levels and density distributions of commercially-sized terminal molt males and potential molters.

Studies were conducted: growth increment, frequency of molting at size and duration of each molt stage, factors determining normal and terminal molting, geographic distribution of crabs in relation to different biological categories; pre-recruit size composition; and abundance. Studies on reproduction were continued and focussed on: the reproductive contribution of pre-terminal and terminal molt males relative to primiparous and multiparous females, the monitoring of the reproductive cycle; and, the reproductive potential of male and female crabs. The tagging of pre-terminal and terminal molt crab as well as postmolt males was continued in order to study growth, seasonal movements, and mixing of crabs between fisheries. Studies of size composition and characteristics of snow crab couples and oceanographic parameters were conducted on a relatively unfished snow crab population in Bonne Bay, Newfoundland, by diving, trawling and experimental fishing. A study was conducted on age determination of snow crab carapaces using radioisotopic techniques.

j) Scallop: An inventory of the different types of fishing gear currently in use was completed and used in a report describing the changes in the historical catches and effort of giant scallop in the southern Gulf of St. Lawrence from 1967-1988. A survey of the Pictou Island area in the Northumberland Strait was conducted in 1989 and a tagging study for growth initiated. Analysis of survey results remains ongoing.

SECTION III. Scotia-Fundy Region

by

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Subarea 4: Divisions 4V-W-X

A. Status of the Fisheries

Provisional 1989 catches of the principal groundfish, pelagic and invertebrate species are given in Table 1, together with catches for the previous four years.

Total groundfish catches declined slightly to 163,843 MT, a decrease of only 2% from 1988, mainly due to small decreases in cod, haddock, flatfish and "other groundfish" catches.

Herring catches in 1989 decreased by 17% relative to the previous year. The herring stocks in the area are considered to be healthy and this decrease was due mainly to poor market conditions for roe herring. Bluefin tuna catches attributed to SA 4 declined, but the combined SA 4+5 catches for this fishery, which is conducted near the boundary between these Subareas, increased by 72% from 208 MT in 1988 to 357 MT in 1989. This fishery is enjoying a "boom" period, with catches increasing annually since 1985. Salmon catches in the recreational fishery remained relatively stable at 20.9 MT in 1989, up slightly from 19.1 MT in 1988.

Scallop landings were 44,818 MT round weight in 1989, the second year of unusually high landings, mainly from the western part of the Subarea. The Stimpson's Surf Clam harvest continued to increase dramatically, to 7820 MT in 1989 from 2929 MT the previous year, as this offshore fishery continues to develop.

B. Special Research Studies

1. Environmental studies

   (a) Oceanographic. Several analyses on the distribution of adult fish in relation to the physical environment were completed. The physical oceanography of the southwest Nova Scotia area as it relates to biological production was described extensively in several Fisheries Ecology Program publications.

   (b) Plankton. Analyses of cod and haddock egg and larval data collected during the Southwest Nova Scotia Fisheries Ecology Program were completed and published. Studies on secondary production in the deep basins on the Scotian Shelf continued, including juvenile fish sampling to determine the role of basins as nursery areas.

2. Biological Studies

(a) cod. Otolith shape analysis as part of a continuing cod stock structure study continued. The special spring cod survey in 4VsW was again completed. Problems were encountered using data from this series in the assessment calibration but they were used successfully to describe cod distribution in relation to oceanographic factors.

(b) haddock. A number of special studies associated with the Southwest Nova Scotia Fisheries Ecology project were completed and published. The first of a series of spring cruises was completed to simultaneously assess the abundance and distribution of pelagic and demersal juveniles in relation to a number of biological and physical factors along 5 cross-shelf transects from Brown's Bank to the Bay of Fundy. Approximately 11,000 haddock were tagged and released during May on Banquereau Bank. Meristic, morphometric and endonuclease analysis of mitochondrial DNA continued as part of the 4TVW stock discrimination study.

(c) pollock. Analysis of diel acoustic experiments determining distribution around seamounts in relation to temperature, tidal currents and ambient light continued.

(d) silver hake. The first of a 3-yr joint Canada/USSR research program was conducted from June to September, to determine the role of ocean features on commercial silver hake catch rates. Preliminary analyses suggest that silver hake aggregate within warm core rings.

(d) redfish. Work on radiochemical age-validation was completed and will be published in 1990. No future assessment activity is planned for this stock.

(e) flatfish. Analyses were initiated on material collected for a halibut spawning study. A paper was published describing the effect of a minimum size regulation on yield and value per recruit in the Canadian Atlantic halibut fishery. Another paper described the survival of juvenile halibut caught in various gear types.

(f) herring. Analyses of larval vertical distribution data and food preferences collected off southwest Nova Scotia continued and some results related to the larval retention phenomenon in the Bay of Fundy were published. Stock identification studies focussed on juvenile fish otolith shape analyses. A transboundary herring study designed to determine juvenile herring movements sampled juvenile "brit" aggregations in Penobscot and Passamaquoddy Bays.

(g) seals. The monitoring of Sable Island grey seal pup production continued - the entire cohort of 9712 pups was tagged or mortality recorded. As part of a continuing research program on grey seals, 360 specimens were taken on Sable Island to examine the dynamics of the sealworm parasite *Pseudoterranova decipiens*, in seal stomachs. A long term study of seasonal and geographic variation in the diets of grey seals, and associated studies on the incidence of sealworm in seal stomachs is continuing. Monitoring of incidence of sealworm in intermediate fish hosts is continuing with associated studies on fish and invertebrate hosts. "Population Biology of Sealworm in Relation to its Intermediate and Seal Hosts" was prepared for publication as a special research bulletin in 1990.

Studies on the cost of reproduction and lactation in harbour seals are nearing completion. Studies on their diving behaviour and activity patterns have been initiated. Harbour seal birth distribution during the breeding season and total pup production (621) continued to be monitored on Sable Island. A cohort specific branding program was initiated to provide identifiable individuals for future recruitment, survival and other studies.

(h) underutilized species. The field sampling phase of a study on the biology and ecology of mesopelagic fish species along the continental shelf edge was completed during 3 cruises, completing a series of six seasonal surveys.

(i) Survey trawl performance studies. SCANMAR gear mensuration equipment was deployed on standard sets during the 4X part of the summer groundfish survey on the Scotian Shelf. In addition, experimental sets were conducted to determine the effect of warp:depth ratios on door spread.

(j) Cooperative industry research. A special project was initiated to foster joint government/industry research, with an ultimate goal of establishing an "index fisherman" program to supplement conventional commercial abundance indices.

(k) Lobsters. An additional 800 lobsters were tagged as the final phase of the offshore lobster tagging program. About 300 lobsters obtained from Georges were also tagged and displaced to study homing behaviour.

(l) Offshore clams. Analyses of data from exploratory research cruises, a test fishery, and the current fishery continued.

Subareas 5 + 6

A. Status of the Fisheries

Total groundfish catches decreased by 36%, from 23,676 to 15,211 MT, mainly due to decreased catches in all major species, including cod, haddock and pollock. Of the main categories given in Table 1, only "other" groundfish species were taken in larger quantities, with a 35% increase from 1988. Scallop landings increased slightly, from 35,993 to 38,810 MT, an increase of 8%.

B. Special Research Studies

1. Environmental studies

   (a) Oceanographic. A physical oceanographic field study of the circulation and hydrography at the tidal front on the northeastern Georges Bank was conducted during July. It was a continuation of the tidal front project begun last year. This year's study was conducted in conjunction with a biological investigation of the distribution and drift of lobster larvae. Four drift-buoy tracking experiments were undertaken over a two week period. A total of 15 ARGOS satellite-tracked buoys and 32 Loran-C buoys were released and recovered. Five current meters were moored at one site on the Bank during the same period. A total of 140 CTD profiles were also taken. Processing of the current, hydrographic, and turbulence data collected during 1988 is proceeding and the initial analyses have begun.

   (b) Plankton. Plankton (larval lobster) studies were conducted on Georges Bank as part of the Frontal Program. Results of recent Georges Bank research were presented at the 3rd Georges Bank Workshop, at the Bedford Institute of Oceanography, Dartmouth.

2. Biological Studies

   (a) cod. Tagging data relevant to Subarea 5 were analyzed and used to redefine the Georges Bank management area.

   (b) pollock. Analysis of historic tagging data was completed. This and other biological data provided information for a new definition of management units i.e. Division 4VWX and 5Zc. Additional tagging experiments were postponed to 1990 due to problems with the scheduled research vessel. Histological examinations resulted in determinations of percent mature-at-age.

   (c) silver hake. Morphometric and distribution data suggest Gulf of Maine silver hake form a population distinct from that on the Scotian Shelf. Research results were prepared for publication in 1990.

(d) herring. A survey for both larvae and adults was conducted on Georges Bank during October-November. Larval tows were made according to a stratified random design in the area of historical spawning, and adults were taken opportunistically in groundtrawl sets. Results from previous cruises were presented in two research documents and a paper arguing that the reappearance of herring on the bank is due to resurgence of a remnant population, rather than recolonization from other populations, was completed.

(e) large pelagics. A new program was initiated and a research program developed. One cruise was completed during the review period to observe the swordfish and tuna fisheries and collect size data. Another cruise is planned for 1990. Liver and blood samples were also collected for genetic analyses of stock structure.

(f) scallops. Investigations on the distribution and ecology of larval scallops continued. A research vessel cruise was conducted to investigate aspects of juvenile scallop ecology. Morphometrics and genetic techniques are being used to study population structure.

Table 1. Canadian catches in Subdivisions 4 VWX and Subarea 5, 1985-89

species	Subdiv. 4VWX					SA 5+6				
	1985	1986	1987	1988	1989	1985	1986	1987	1988	1989
cod	96608	91484	80747	74468	72316	11885	9308	12345	12743	7897
haddock	26065	31262	16759	14927	13814	4275	3640	4793	5943	3061
redfish	12829	11687	21246	17159	17236	118	139	74	101	9
pollock	41536	41058	42084	39420	39756	1764	2192	3234	2404	1409
flatfish	12496	11717	13749	12483	11337	494	493	318	538	210
other groundfish	9563	14605	15068	9826	9384	2673	1538	1792	1947	2625
total groundfish	199097	201813	189653	168283	163843	21209	17310	22556	23676	15211
herring	143363	108167	130309	166842	138539	0	0	0	0	0
mackerel	6265	4805	5256	6063	4813	0	0	0	0	0
bluefin tuna	14	35	41	188	30	0	0	0	20	327
swordfish	419	829	691	802	741	145	223	248	113	183
scallops	8461	10940	11456	29392	44818	31963	39050	56518	35993	38810
lobster	11337	12309	15072	15032	15928	309	274	263	212	133
illex	11	67	16	12	22	0	0	0	0	0
S. surf clam	0	21	0	2929	7820	0	0	0	0	0

SECTION IV. Quebec Region

by

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1 Research report, 1989.

SUBAREA 4

A. Status of the Fisheries

DFO Nominal landings and TAC ('000 t) since 1986 for stocks currently being assessed in the Quebec region are as follows:

Species	Division	Nominal Landings (TAC)			
		1986	1987	1988 [1]	1989 [1]
Cod	4RS,3Pn	80 (92.1)	66 (80.3)	48 (73.9)	47 (76.5)
Greenland Halibut	4RST	6.5 (5)	11 (8.9)	7.5 (10.8)	5.0 (10.5)
Atlantic Halibut	4RST	0.273	0.3 (0.3)	0.3 (0.3)	0.2 (0.3)
Redfish	4RST	33 (55.6)	35 (50)	36 (56)	45 (57)
Herring	4R	21.4 (17)	12 (30.6)	18 (30.6)	16 (34)
	4S	0.6 (1)	0.8 (1)	0.9 (3.5)	0.5 (3.5)
Mackerel	S.A.2-6	63	76.6	79.3	71.7
Capelin	4R	3.3 (20)	0.8 (5)	1.4	7.8 (7.0)
	4ST	0.7 (5)	0.1 (2)	0.2	1.3 (3.0)
Snow crab	4S,4Tpq	5.3	5.0	4.0	2.6
Shrimp	4RST	9.5 (12.1)	12.0 (13.1)	13.8 (14.1)	15.4 (15.1)
Lobster	4S,4T[2]	2.3	2.7	2.5	3.2
Scallop[3]	4S,4T[2]	1.2	2.0	1.4	2.4

[1] Preliminary values.
[2] Except 4Tghij.
[3] Round weight.

B. Special Research Studies.

1. Environmental studies

a) Hydrographic studies

MLI The variability of nutrients (mainly nitrate) in an upwelling ecosystem was investigated as it relates to phytoplankton cells. This was done in the Escoumins area. An estimation of primary production in coastal environments was done using fluorescence measurements with an airborne LIDAR system.

An analysis of the spatial and temporal variability of the geographical distribution of the toxic dinoflagellates in the St. Lawrence estuary and the Gulf was undertaken. Their genetic variability was also studied in order to determine any population structure. Various methods were used: plate morphology, comparison of various toxins using high pressure liquid chromatography (HPLC), electrophoretic separation of enzymes and sequencing of the ribosomal DNA. The rate of intake and disintoxication of paralytic toxins were investigated in soft shell clams. A laboratory experiment was conducted to study the sensitivity of larvae of commercial species such as cod, capelin, herring, mackerel, american plaice and lobster to intoxication caused by dinoflagellates.

b) Plankton studies (including eggs and larvae)

MLI An examination of the mechanisms that synchronize egg-laying in marine invertebrates was done in relation to phytoplankton blooms. Species-specific responses to food concentrations and food quality on the feeding, growth, and reproduction of planktonic copepods were tested.

See sections 2.1.2 and 2.2.2.

c) Benthic studies

MLI An exploratory survey was conducted in the Saguenay fjord in the summer of 1989 to identify various benthic species. This survey should be repeated in 1990 with the use of an underwater video camera.

d) Observations on ice conditions in Subareas 0 to 4

MLI Annual research surveys aboard the research vessel Gadus Atlantica have been conducted since 1978 during the month of January in the Gulf of St. Lawrence (NAFO divisions 4RST, 3Pn). Observations made during the 1990 survey indicate that the onset of the ice cover in the Gulf was no different than previous years but the progression and area covered by ice was more rapid and extensive than in the past. Incursions of ice into Subdivision 3Pn from mid-January to the end of February was such that it hampered the important winter fishery for cod in that area. Cod were distributed in depths of over 200 fathoms and the inshore fixed gear fishery, usually prosecuted in depths less than 100 fathoms, was a complete failure.

e) Other environmental studies

2. Biological studies by species

2.1 Demersal fish

2.1.1 Cod

MLI The assessment of the 3Pn, 4RS cod stock was done and presented within the CAFSAC forum. Results indicate a decline of close to 30% of the biomass in the last 6 years. Although commercial catch rates remain relatively constant, the survey results in the last four years are the lowest in the time series. As a follow up on the research relating higher catches of cod to the marginal ice

zone based on the surveys, analysis of the behavior and performance of the commercial fishery (St. Pierre and Miquelon and metropolitan France) was undertaken and presented to the June session of the scientific council of NAFO.

2.1.2 Redfish

MLI The NAFO divisions 4RST redfish stock was assessed in CAFSAC. Data from the commercial fishery (size composition, catch rates) as well as results from two annual groundfish surveys were used. Results indicate that as strong recruitment from the early 80's are being recruited to the fishery, yield should increase. The stock management units are being revised on an interregional basis and involves a number of stock identification techniques.

Based on gonads collected during groundfish surveys as well as commercial sampling of the commercial fishery, information on the timing and location of spawning was determined. A dedicated survey off the east tip of Anticosti Island in August, 1989, allowed the identification of larval redfish patches and measured their dispersion.

The discrimination of two redfish species (Sebastes mentella and S. fasciatus) based on the insertion of swimbladder muscle was proven to be inefficient. However, anal fin counts were proven to be usefull.

An analysis of the impact of changes in environmental conditions on redfish distribution was done by relating time of day, bottom water temperatures, and size of fish to the catch during groundfish surveys.

2.1.3 Greenland Halibut

MLI Studies on genetic discrimination of greenland halibut populations along the Atlantic coast are ongoing. Sampling of the fish present in the Gulf of St. Lawrence was done in January, 1990. Sampling of specimens from the 2J,3KL stock will be done in July, 1990. Some samples will be collected in Frobisher Bay, Hudson Strait and Cumberland Sound. Results should be available in 1990.

2.2 Pelagic fish

2.2.1 Herring

MLI Assessment of the 4R herring resource was done and presented to CAFSAC. Biomass estimates were done for the first time during an acoustic survey (Datasonic equipment) that took place in November, 1989. When aggregations of fish were detected, trawl sets were made to confirm species composition.

An analysis by visual and microscopic techniques was done to determine the stage of maturity. This allowed one to discriminate between spring and fall spawning fish. Finally, otolith shape was compared for both spawning types, as derived from these maturity stages.

2.2.2 Mackerel

MLI The stock assessment of the mackerel resource of Atlantic Canada was undertaken and presented to CAFSAC. This assessment is based on results from a larval fish survey in Magdalen Shallows (NAFO division 4T). A discrimination of the two contingents of mackerel was attempted using the shape of the first annuli of mackerel otoliths. In order to provide a new index of abundance for the assessment of mackerel, an acoustic survey aboard the ferry linking Sydney to Port aux Basques was done. This allowed the estimation of peak migration time into the Gulf of St. Lawrence. The migration would follow a thermal gradient along the Cape Breton shores.

The relationship between juvenile (age 0) growth rate and natural mortality was investigated as a factor affecting year class strength in mackerel. It was also found that cannibalism was important and the spatial characteristics of this process was examined.

Variation in catch rates of mackerel in Chaleurs Bay (NAFO division 4Tm,n) will be associated with along-shore and cross-shore wind stress. Preliminary results indicate that favorable conditions for one shore are unfavorable along the other.

2.2.3 Capelin

MLI An update of biological characteristics of the 4RST capelin resource was presented to CAFSAC. Stock discrimination studies were undertaken; these involved multivariate, morphometric analysis, truss analysis as well as genetic characterization based on biochemical polymorphism.

2.3 Invertebrates

2.3.1 Rock crab

MLI Samples of rock crab were collected in Chaleurs bay (NAFO division 4Tn,m) for laboratory study of the moulting cycle.

2.3.2 Snow Crab

MLI Stock assessment of the snow crab resource along the Quebec north shore was presented to CAFSAC. Genetic variations between populations found in the Saguenay fjord and the St. Lawrence estuary have been analyzed based on morphometric characters and enzyme polymorphism.

2.3.3 Shrimp

MLI Stock assessment of the various concentrations of shrimp in the Gulf of St. Lawrence was done and presented to CAFSAC.

A multivariate approach to study the variability of length frequency structures was applied to the Gulf of St. Lawrence shrimps. Aging of pre-recruits has resulted in the identification of an additionnal age class in the stock structure of Gulf shrimp.

2.3.4 Lobster

MLI A tagging survey was conducted in southern Anticosti (NAFO division 4Ss) from mid-July to mid-August. A total of 4,500 Sphyrion tags were applied (NAFO Circ. 90/28). The purpose of this tagging was to estimate growth between molts, moulting frequency, as well as population abundance.

MAPAQ A study of molt induction by unilateral eyestalk ablation was carried out in the Gaspé region in the summer of 1989. Canner-sized male American lobsters were individually housed in holding tanks in open, natural seawater, land-based tank systems. Two techniques of unilateral eyestalk ablation were compared. The objectives were to increase the molt rate, as compared to that in the natural population, as well as post-smolt survival and to maximize growth. Size and weight increase, mortality and conditions of lobsters were studied. A total molt rate of 15% was achieved. Molt size progression is related to the water temperature. A weight gain of 33.6% and a length increase of 10.9% was obtained. Mortality was 8%. Meat content 50 to 60 days following ecdysis approached that of nonmolted animals.

2.3.5 Scallop

MLI The assessment of the scallop resources of NAFO divisions 4S and 4T was presented to CAFSAC. The analysis was based on a dredge survey done in Magdalen Islands as well as data from the commercial fishery. Landings of scallops along the lower north

shore have increased in the last years, primarily as a result of an increase in effort. The biomass of scallops at the Magdalen Islands has been estimated directly and shows an increase.

The genetic structure of four concentrations of scallops in the Gulf of St. Lawrence has been undertaken. The effect of variations of heterozygosity with age should be taken into account. Measurement of the inter-individual distance that optimizes reproductive success of laboratory reared scallops was done and later compared to the spatial distributions observed at the Magdalen Islands.

MAPAQ Experiments on spat production of the sea scallop (Placopecten magellanicus) at the Magdalen Islands hatchery were maintained in 1989. From the 5 trials, a total of 625,000 post-larvae of over 250 microns were produced. Improvements have been obtained on growth rates and on survival rates after metamorphosis. The best growth rate obtained in 1989 was 4.35 microns a day during larval development and the best survival rate after metamorphosis reached 19%. Trials to test the efficiency of brood stock conditioning indicate that the gametes from natural spawners give better growth and survival results than those from conditioned spawners. Methods to collect pediveliger larvae were also improved. For one trial, 31% of the pediveliger larvae were collected and went through metamorphosis.

In 1989, experiments were maintained at the nursery. On June 6th, 50,000 post-larvae of 1 mm produced from a hatching that occured in May, were used for the first experiment. On the 6th of July, survival rate was 33% and 6000 scallops of 2.1 mm were transferred to sea. A second transfer of 5000 scallops of 3.9 mm was done on the 20th of July. The survival rate at sea on the 5th of October was 85.5% with an average size of 19 mm and 76.4% at a size of 23.2 mm on the 16th of November. A second experiment was undertaken at the nursery in mid-July and produced 250,000 post-larvae of 300 microns; survival rate was 13.2% and 33,000 scallops of 3.6 mm were returned to sea in mid-November. The rearing at sea of spat from the 1987 and 1988 seasons are ongoing. Scallops are being reared on lantern nets, overlayed rigid boxes, as well as by ear-hagning culture. An experimental bottom-rearing method should begin in 1990.

2.3.6 Mussels

MLI The impact of the unloading of sediments on the energetics and growth of cultured mussels was investigated in Chaleurs Bay (NAFO division 4Tm). This involved measures of filtration and excretion rates as well as assimilation efficiencies.

In-situ experiments were conducted to verify density-dependent growth in mussels. Results are currently being analysed. The optimization of growth of mussels by separating the racks was modeled.

MAPAQ In 1989, the field work in collaboration with INRS (Institut National de Recherche Scientifique) - océanologie on the carrying capacity of the Magdalen Island lagoons ended. Study was continued on the use of the "Swedish culture technique" in Magdalen Islands. This method is characterized by the use of a unique substrate for the spat collection and their subsequent growth. Finally, a preliminary experiment was undertaken to investigate stock-site interactions in the Magdalen Islands in order to find the best combination for mussel culture in terms of growth and survival.

In order to evaluate the impact of toxicity caused by Alexandrium exclavatum (Protogonyolax tamarensis) on mussel culture in Quebec, the dynamics of intoxication and detoxification of mussels cultures was studied for a third year in the Bay of Gaspé (NAFO Div. 4Tn). The origin of the mussels, the distance from shore, intertidal emersion, depth into water column as well as prior contacts with A. exclavatum were deemed important factors that explain the toxicity profile.

2.3.7 Whelks

MLI The gear selectivity and sexual maturity of whelks was estimated in order to determine the minimum size of the catch to protect the reproductive potential of the populations of the gulf. A model of the area of attraction of whelks to bait allowed one to estimate the abundance.

2.4 Marine mammals

2.4.1 Seals

MLI Research was conducted on the distribution, abundance, population dynamics, behaviour and ecology of pinnipeds in the estuary and Gulf of St. Lawrence, and on their interactions, both predatory and parasitological, with commercial fisheries. An aerial photographic survey was undertaken in January, 1989. Four grey seals were caught in the estuary, one was fitted with an ultrasonic transmitter which gave data on position and depth of dives. It allowed the recording of 65 hours of information over a period of three weeks.

2.4.2. Porpoise

MLI A system to gather information on the porpoise by-catch in the Gulf of St. Lawrence was established. This involved collection and analysis of biological samples from porpoises taken in fishing gear. A survey to estimate numbers, distribution and movements of porpoises in the estuary and Gulf was undertaken.

2.4.3 Beluga whales

MLI A volume containing some 20 articles on beluga biology was prepared. Autopsy of some 21 stranded beluga was done to estimate age, cause of death and pollutant loadings. Aerial surveys for distribution and movements of beluga herds were done every month from September 1989 to March 1990. Low level aerial surveys allowed the estimation of the length distribution of the populations. A genetic analysis was undertaken to determine relations of the St. Lawrence population with others and to compare intra-population genetic variability.

2.4.4 Large whales

MLI Stock identification of fin whales, based on length-weight relationships, external morphometrics and other parameters was attempted. A study of biological specimens of east coast killer whales was undertaken. Morphological and biological samples of stranded whales was done whenever they were reported.

2.5 Marine plants

2.5.1 *Ascophyllum*

MLI The harvesting strategy that optimizes the long term yield of ascophyllum was studied by measuring the effect of the height and frequency of the cut on subsequent production.

2.6 Parasitology

MLI Samples of benthic invertebrates were taken from the Scotian shelf, the Mingan Islands, the Brador lakes and the Sable Island shelf for studies on the prevalence and transmission dynamics of codworm. Live adult nematodes were collected from grey seal stomachs in January 1990 for the supply of eggs, and live cultures of larval nematodes were successfully established. Nematodes present in seal stomachs were sorted, identified, and counted.

3. Gear and Selectivity Studies, including studies of fishing operations.

MLI A study of the efficiency and selectivity of seven types of crab traps was undertaken.

A video monitoring of the Digby scallop dredge allowed one to measure mortality due to the gear as well as gear efficiency as it serves as an abundance indicator.

The YURI 81-114 shrimp trawl was placed aboard the research vessel Alfred Needler for trial. This will be the regular groundfish/shrimp gear to be used in future summer surveys. The adjustment of the gear was done with the use of SCANMAR wing spread and net height probes. On board were fishing gear specialists from Grande Rivière and a commercial shrimp-fishing skipper.

MAPAQ A recuperation of snow crab traps was attempted in NAFO division 4T in July, 1989 by dregging with two fishing boats. No traps were found.

4. Miscellaneous studies.

MLI A reference collection of organisms encountered in the St. Lawrence estuary and the Gulf is available. It includes references to distribution, taxonomy and biology of the species. Access to the descriptive information can now be done via a computerized system. Two new records of species were made. A slender snipe eel (Nemichthys scolopaceus, Richardson, 1948) was caught by a shrimp otter trawl in the northern part of the Gulf and a northern wolffish (Anarhichas denticulatus, Krøyer, 1844) was caught in the Saguenay fjord.

MAPAQ Semi-artificial baits for the lobster fishery and for the cod longlining fisheries have been tested in Chaleurs Bay (NAFO division 4Tn) in the summer of 1989. Results were encouraging specially for the lobster fishery with about 70% yield from the natural bait.

Information about tood crab, an unexploited species, has been collected near Grande Rivière (NAFO division 4Tn), in Chaleurs Bay. Results showed a promising commercial potential for this species in the area studied.

2. Environmental data for 1988 and Preceding years.

All available information will be forwarded directly to MEDS this year.

3. Tagging Activities.

See NAFO Circ. 90/28.