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Canadian Research Report, 1987

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Section I. Newfoundland Region

by

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**SUBAREAS 0 AND 1**

**A. Status of the Fisheries**

1. Shrimp. Canadian landings of shrimp from Subarea 0 in 1987 totalled 6,035 t (preliminary), more than double the 1986 landings.
2. Other species. There were scallop landings from Cumberland Sound, Subarea 0. No other species of fish or invertebrates were landed by Canada from these Subareas in 1987.

**B. Special Research Studies**

**1. Environmental Studies**

- a) Ocean Circulation Division (Bedford Institute). Four current meter moorings that had been set in summer 1986 on the Greenland continental slope in eastern Baffin Bay near 75 N and 71 N (12 meters in all) were recovered and 5 moorings were deployed in a line across Davis Strait at 66 15 N during early September, 1987. 130 CTD stations were occupied, mostly in Davis Strait and along the eastern side of Baffin Bay as far north as 76 N. Davis Strait moorings will be replaced annually for a total of three years deployment.

**2. Biological Studies**

- a) Groundfish. A technical report was prepared on the distribution and abundance of Greenland halibut, deepwater redfish, golden redfish, roundnose grenadier and roughhead grenadier in Davis Strait. The report summarized the results of a stratified random survey conducted in SAO+1 in depths of 200-1250 m in August-September, 1986.

- b) Atlantic salmon. A total of 2,791 salmon was sampled at the fish plant in Sisimiut; 3,788 in Nuuk, 4,156 from Paamiut, and 2,191 from Narssaq in centimeter length groups; including detailed measurements of fork length, gutted weight, and of these 2,960 were scale-sampled. This project provides an annual assessment of the proportion of North American and European fish caught at West Greenland. Also, 146 salmon were detected with micro tags. Microtags were from Canada, USA, Scotland, Ireland, Iceland, and England.

In total, 377 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.

- c) Observer Program. Canadian observers participated in several trips fishing shrimp in Davis Strait (0+1) during 1987. A total of 276 fishing days and 1,086 sets was observed, with a total of some 240,752 shrimp measured.

## SUBAREA 2

### A. Status of the Fisheries

1. Cod. Canadian landings were 54,400 t, up substantially from 19,700 t landed in 1986 and 11,900 t in 1985. These landings were almost entirely from Div. 2J, with only 11 t recorded from Div. 2H. Landings from the inshore sector were 16,200 t, up from 13,300 t in 1986 and offshore landings were 38,200 t, compared to only 6,400 t landed in 1986.
2. Redfish. Canadian landings were 2,600 t, compared to 2,900 t landed in 1986 and 980 t landed in 1985. These landings were entirely from Div. 2J.
3. Greenland halibut. Canadian landings were 7,600 t, compared to 5,700 t landed in 1986 and 7,800 t in 1985. Landings were primarily from Div. 2J, with only 60 t landed from Div. 2H. The inshore fixed gear fishery accounted for 3,100 t or 41% of the landings in this Subarea.
4. Other groundfish. Canadian landings of other groundfish species totalled only 580 t in 1987, including 350 t of greyscale and 150 t of American plaice.
5. Capelin. Landings of capelin remained at a low level.
6. Herring. Landings of herring remained at a low level.
7. Atlantic salmon. Commercial landings of Atlantic salmon in Subarea 2 during 1987 were 448 t, compared to 397 t in 1986. Landings of large salmon (306 t) increased by 13% over 1986. The recreational harvest totalled 8.2 t.
8. Arctic charr. Landings of Arctic charr in Subarea 2 during 1987 were 107 t, a decrease of 6% from 1986. The continued decrease in fishing effort is a major factor associated with reduced landings again in 1987. Assessments were carried out on three major stock units representing ten subareas.
9. Shrimp. The Subarea 2 shrimp fishery was subject to a total quota restriction of 6,800 t in 1987, 4,000 t of which were in the Hopedale Channel. Total landings were approximately 7,240 t. A total of 232 fishing days and 1,396 sets was handled by observers with 147,499 shrimp measured.

### B. Special Research Studies

#### 1. Environmental Studies

- a) Oceanographic studies. The Seal Island section in 2J was occupied in August and again in November in 1987. Temperature profiles were taken at each fishing station occupied in the subarea.

- b) Ocean Circulation Division (Bedford Institute). Studies of the ice growth/decay and the movement of the Labrador Ice Pack continued during January-April, 1987. Ice beacons were deployed on the ice and ice movement was monitored using both these beacons and satellite imagery.

A total of 12 current meter moorings or bottom pressure installations that had been set on the Labrador Shelf in summer 1986 were recovered in July 1987 and an additional 5 current meter moorings and 4 bottom pressure gauges were laid. The majority of these moorings were set in a line across the shelf and slope at Hamilton Bank but some were set off Nain. In addition, 46 CTD stations were occupied on the shelf and slope and the Labrador Current was mapped during four days of BATFISH towing.

## 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. The first complete stratified-random survey was conducted in Divisions 2GH in 1987 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. 2G, 2H and 2J in 1987. Researchers continue to use data from shrimp surveys in Div. 2H and 2J in efforts to develop a recruitment index for Greenland halibut.
- c) Capelin. An acoustic survey in Div. 2J3K in October 1987 located capelin mainly in Div. 2J. Total capelin biomass appeared to be lower than in 1986 although a final estimate was not calculated due to calibration problems.
- d) Atlantic salmon. A total of 2,969 Atlantic salmon caught in the commercial fisheries was sampled for size and age distribution.
- e) Arctic charr. A total of 2,484 samples was obtained for age determination of Arctic charr in commercial landings from twelve northern Labrador fishing areas. Approximately 19,000 fish were sampled for length distribution from the same areas. Tagging studies were continued to clarify the extent of seasonal and annual movements and to determine the degree of annual commercial exploitation. Stomach samples were obtained from four areas for evaluation of food and feeding habits.
- f) Shrimp. A research vessel survey which was conducted in July, 1987 completed a biomass survey using a Sputnik 1600 shrimp trawl in the major areas where commercial concentrations occur. A total of 120 sets was made with the greatest catch (531 kg) being obtained in the Hopedale Channel. Catches in the Cartwright Channel ranged to 507 kg. Information from this survey was used to estimate shrimp abundance which, in turn, will be used to update CAPSAC advice on total allowable catches for 1988.
- g) Iceland scallop. Observer participation was provided to an exploratory cruise looking for Iceland scallops on the offshore banks along the Labrador coast. Commercial concentrations were not found.

### SUBAREA 3

#### A. Status of the Fisheries

1. Cod. Canadian landings were 210,000 t, compared to 253,500 t landed in 1986 and 245,000 t in 1985. The inshore sector accounted for 96,400 t, compared to 91,600 t landed inshore in 1986. Landings from Div. 3K and 3L accounted for 69% of all cod landings in this Subarea. Inshore landings from Div. 3K and 3L were 62,700 t, up slightly from 60,400 t in 1986, while offshore landings were 82,200 t, down substantially from 126,100 t landed offshore in 1986.

2. Redfish. Canadian landings were 21,700 t, compared to 31,100 t landed in 1986 and 29,100 t landed in 1985. Division 3K landings were 10,600 t, down from 19,200 t in 1986, while Div. 3L landings were about the same as in 1986 at 4,500 t. Combined landings from Subdiv. 3Pn and 3Ps were 6,300 t, compared to 6,900 t in 1986. Landings from other Divisions remained low.
3. Flatfish. Canadian landings of the combined flatfish species were 70,800 t compared to 68,800 t in 1986. American plaice dominated these landings with 39,500 t, compared to 40,800 t in 1986. Yellowtail landings were 13,700 t, compared to 14,200 t in 1986. Greenland halibut landings were 9,400 t, up from 5,800 t in 1986, while greysole landings were 4,900 t about the same as in 1986. Other flatfish landings in this Subarea included some 2,450 t of winter flounder and 900 t of Atlantic halibut. While landings from the inshore sector amounted to only 24% of overall flatfish landings, about 95% of all Greenland halibut landings were landed inshore.
4. Other groundfish. Canadian landings of other groundfish species were about 13,900 t, comprised primarily of haddock (5,100 t), white hake (4,500 t), pollock (2,700 t), and wolffish (1,500 t). Some 3,100 t of lumpfish roe were also landed in this Subarea during 1987.
5. Capelin. Approximately 22,000 t of capelin were landed inshore in Div. 3L and 11,000 t in Div. 3K in 1987. Landings in other Divisions in Subarea 3 were low. 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 30,000 t.
6. Herring. Herring landings from Newfoundland were approximately 22,800 t, 22,400 t from Div. 3KL and 400 t from Div. 3P. The commercial fishery did not catch the quota primarily due to poor market conditions.
7. Mackerel. Mackerel landings in Subarea 3 were about 10,000 t, compared to 11,000 t landed in 1986.
8. Squid. Total reported catch of squid in 1987 was 162 t (preliminary data). Early season catch rates on the southern Grand Bank were relatively high, suggesting a higher inshore resource level for the upcoming summer/fall fishery than in recent years. However, the fishery was again poor, the low catch being due to a natural absence of squid from commercial fishing areas.
9. Atlantic salmon. Landings were 784 t in the commercial fishery and 21 t in the recreational fishery. The commercial catch of large salmon (356 t) increased by 26% over 1986.
10. Scallops. Approximately 54 t sea scallop meats were landed from offshore 3P (St. Pierre Bank), down from 147 t in 1986. A single year class will continue to be the mainstay of the fishery in this area. The first excursion of the offshore fleet into the Grand Banks (Div. 3L) directing for Iceland scallops took place in 1987 with 8.7 t of meats landed.

## B. Special Research Studies

### 1. Environmental Studies

- a) Oceanographic studies. Most of the standard sections in Subarea 3 were occupied but due to operational problems the Flemish Cap section was occupied only from 47°15'W westward. Seasonal survey data from the northern Grand Bank were analyzed for the development of an operational fisheries oceanography product. The time series of Station 27 (4 km east of Cape Spear) was continued, the station being occupied 33 times in 1987.

- b) Plankton studies. Data were collected during August and September in Conception Bay, Newfoundland, to discern vertical distribution of the ichthyoplankton (particularly herring and capelin larvae) and zooplankton community. Also data were collected to examine diel variability in ichthyoplankton catches from standard oblique Bongo tows. Data from both these investigations will be used to aid in the analysis and interpretation of data collected during ichthyoplankton surveys carried out from 1982 to 1986.
- c) Coastal Oceanography Division (Bedford Institute). An array of bottom pressure gauges and near-bottom current meters were recovered from the northern Grand Bank and northeast Newfoundland Shelf during the summer of 1987. These data are being analyzed to determine the effects of local and upstream forcing on the currents over the Grand Banks.

An array of three current meter moorings, two thermograph moorings and one sea surface temperature buoy was recovered from Southeast Shoal during the fall of 1987. Hydrographic and Doppler current profiles were also obtained in the region. The project is investigating circulation, mixing, heat and salt budgets of the waters over the Shoal.

An array of seven moorings was recovered from the Newfoundland Basin after an eighteen month deployment. Hydrographic surveys and chemical tracer (primarily freon) sampling were carried out on two cruises. The circulation and eddy activity in the region are being investigated.

Twelve satellite-tracked ice beacons were launched north of the Subarea and tracked throughout the region as they drifted south. This project which attempts to address problems associated with the ice field motions also involved modelling and analysis of satellite imagery.

A field program examining the dynamics and thermodynamics of the advancing ice edge was carried out in the region. It involved current meter and acoustic Doppler measurements, hydrographic surveys, and the tracking of ice beacons.

- d) Ocean Circulation Division (Bedford Institute). Five current meter moorings were deployed on the Southeast Shoal Grand Bank, from April to October, 1987 to investigate the processes by which the waters over this shoal underwent their annual heating cycle. A total of 66 CTD stations were occupied over the shoals in April, 1987 and 116 stations in October. Some 57 hr of batfish towing was obtained along the edges of the Grand Banks in April, 70 hrs in October. Velocity profiles using the Acoustic Doppler Profiler were obtained throughout both cruises.

Thirty full depth CTD stations with nutrients, oxygen, total carbonate and alkalinity and freon measurements were obtained in the Newfoundland Basin (Divisions 3N, 3M) during March, 1987. A three hour BATFISH tow was also taken across the southern end of Flemish Pass. A further 62 CTD stations with the same suite of tracers were occupied in October, 1987. Approximately five days of BATFISH mapping (CTD to 200 m) of the North Atlantic Current and Mixed water regime was also accomplished. Six current meter moorings set in the North Atlantic Current in April, 1986 were recovered in October, 1987. One other mooring set at the same time was recovered in May, 1987.

- e) The oil industry continued ongoing oceanography observations on the Grand Banks (at a reduced level) in support of offshore exploratory drilling operations. Additional activities included ice and iceberg surveillance, geophysical site surveys, spill response field exercises.
- f) Plankton studies. Plankton samples for squid larvae were taken south of the Grand Bank (Gulf Stream) in February-March using midwater trawl and BONGO nets.

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

There were several projects undertaken in 1987:

- LIMEX Cruise 1987

The Labrador Ice Margin Experiment took place in March 1987 on the Grand Banks of Newfoundland. It was divided into two distinct activities, remote sensing and ice and oceanography. The C-CORE activity included the measurements of ice motions induced by wave penetration into the ice field, the measurement of strength and conditions of the ice, and aerial photography of the pack ice.

- Cappahayden Ship Detection Experiment

A ground wave radar experiment was conducted at Cappahayden, Newfoundland, to confirm the over-the-horizon monitoring capabilities of the radar system for ocean vessels. The system will eventually monitor vessels out to the limits of the Canadian economic zone.

- Offshore Rig Data Collection

A data set for the rig mounted ice hazard detection program was collected during May to October, 1987 using the rig, Bow Drill III as an experimental platform.

## 2. Biological Studies

- a) Cod. Sampling of the landings from the commercial fishery both inshore and offshore was continued in 1987. Using research vessels, surveys were carried out in all NAFO Divisions (except 3M) to determine the distribution and abundance of cod. Biological sampling was extensive during these surveys and several thousand cod were tagged, inshore and offshore.

A comparative tow experiment between the Canadian and French vessels conducting surveys in Subdiv. 3Ps, was completed.

Cod from St. Pierre Bank, Burgeo Bank and Rose Blanche Bank (Subdiv. 3Pn) were compared for meristic characteristics, growth rates and prevalence of parasite nematodes.

The cod stock that occupies NAFO Subdivision 3Ps was assessed at a bilateral meeting that included Canadian and French scientists. A single estimate of stock size was obtained for the first time in three years.

Acoustic tracking of cod on their inshore migration provided observations on their diurnal behaviour in relation to feeding and temperature. Combined trawl and acoustic surveys were used to determine the distribution of cod off the east coast of Newfoundland during the shoreward migration in June.

- b) Redfish. Several research cruises throughout Subarea 3 (except Div. 3NO) 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 attempted in Div. 3P during July. Due to equipment malfunctions it was not completed.

- c) Flatfish. Distribution and abundance of flatfish were studied during fall random stratified surveys in the following NAFO Divisions and times in 1987: Div. 3K - fall survey; Div. 3L - spring, summer, 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:
- A line transect survey was conducted in March on the tail of the Grand Bank to compare species composition and abundance in the area around the 200-mile limit and to determine if catches of groundfish were higher on average from sets inside the 200-mile limit. This survey followed the same procedures and design as the one conducted in April 1986.
  - A gear trials/experimental survey conducted in April found unusually large concentrations of American plaice in depths of about 520 m in the northeastern slope of the Grand Bank (Div. 3L). Some biological samples were collected and further research is planned in this area in conjunction with the 1988 spring groundfish survey on the Grand Bank.
  - A juvenile flatfish survey was conducted in Div. 3LNO in the fall of 1987. 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 1988. The 1983 year class appeared strong in surveys in Div. 3L and Div. 3NO and was an important contributor to the spawning biomass in these areas in 1987. The inshore capelin fishery was monitored by a comprehensive logbook survey and an aerial survey was conducted during the inshore spawning migration. Capelin were tagged during the inshore phase of their life cycle to describe migration patterns.
- Two cruises to the Southeast Shoal were completed in 1987. On the first trip (DAWSON, August 15, 1987 completed) seventy-one stations were sampled with MINIBIONESS and attached optical plankton counter. An additional 56 stations were occupied on an opportunistic basis. In a November trip (LADY HAMMOND) detailed information was collected on the vertical and horizontal distribution of capelin larvae relative to oceanographic features.
- e) Herring. Surveys to determine vertical distribution and abundance of herring and capelin larvae were conducted in Trinity Bay in August and September. An acoustic survey was conducted to estimate herring abundance in bays of northeastern Newfoundland during October-December.
- f) Scallops. A research survey was undertaken to assess the state of sea scallop stocks on St. Pierre Bank (Subdiv. 3Ps) from April 30 - May 12, 1987. Two hundred and eighty-five one-mile survey sets were completed in two target areas.
- g) Squid. In February-March a survey was conducted by the Nfld. Region to study the distribution of larval and juvenile squid in the Gulf Stream system between 55°W and 60°W longitude. A predictive index of squid abundance for the commercial fishery was also developed. From a pre-recruit survey in June on the Grand Bank a predictive index of inshore abundance was determined. At Holyrood, catch and effort data were collected using squid traps, ageing studies were continued using chemical time-markers in conjunction with mark-recapture methods, and water temperature was monitored.
- 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 photographic survey for snow crab was 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) 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 survey of about 75 commercial salmon fishermen was conducted to assess local sales and effort expenditure. A total of 2,260 Atlantic salmon caught in the commercial fisheries was sampled for size and age distribution.
- k) Multispecies. Laboratory experiments were undertaken into the influence of variations in food availability on the susceptibility of larval fish to predation. Additional work was undertaken to establish the sensitivity of 0-group cod growth rates to variations in food availability in an attempt to make inference about the relative importance of each factor in the field. In addition, a simple model has been developed to investigate model stability and optimal management strategies of predator-prey systems under different assumptions about the abundance and variability of a non-exploited alternative prey species fed upon by the predator. A stochastic simulation model was also developed of larval growth and mortality under variable conditions of larval food availability and predator abundance.
- l) Newfoundland Institute for Cold Ocean Science (Memorial University). Field investigations were undertaken on primary productivity in coastal bays (primarily Conception Bay with comparative studies of other large bays along the NE Newfoundland coast). There were further studies of the movement of adult capelin in relation to the upwelling/downwelling cycle and related predator interactions. Earlier studies on spring blooms have turned to details of microbial decomposition.

#### 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.

Standard oceanographic transects (ie. Seal Island, White Bay, Bonavista Triangle, Flemish Cap) were occupied in August. Temperature profiles were taken at each research fishing station occupied during 1987. Six month temperature recorders were provided to researchers in conjunction with the DFO long-term Temperature Monitoring Program. Fifty-six sites were occupied in the Newfoundland Region, three sites in that Gulf Region. Field trials of the Applied Microsystems STD-12 on the groundfish ottertrawl were also undertaken in 1987.

- b) Hydrography. The C.S.S. MAXWELL and a team of hydrographers have been transferred (April 1, 1987) from Halifax to St. John's in support of coastal mapping. Detailed information will be provided for the production of nautical charts, tide and current tables and sailing directions.

#### 2. Biological Studies

- a) Assessments. Assessments of some 25 groundfish stocks presently under catch quota regulations were conducted and in some cases refined and advice on TACs for the 1987 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 Nfld., Labrador, Quebec and Maritime rivers, three Arctic charr stock complexes and other commercial and potentially commercial species.

- b) Research vessel cruises. Fifty research vessel cruises were undertaken in 1987 utilizing DFO-owned vessels (WILFRED TEMPLEMAN, MARINUS, SHAMOOK, ALFRED NEEDLER, MAXWELL), the GADUS ATLANTICA (on long-term charter) and four other vessels on short-term charters.
- c) Commercial sampling. Sampling of foreign and Canadian offshore catches by the Canadian Observer Program continued in 1987. A total of 4,530 samples representing some 1,009,706 length measurements and approximately 14,426 otolith pairs were collected from the catches of foreign and Canadian offshore fisheries. A total of 7,488 days and 32,231 sets was observed. Coverage in 1987 was 100% 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 RSPF 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. Some experimental work was conducted to examine the differences in the retention of cod in nets using diamond and square mesh codends.
- e) Cod-capelin interactions. A Cod-Capelin Working Group was formed in 1986. Collaborative projects have commenced on qualifying interrelationships between the two species. A comprehensive review of potential research projects has been completed and priorities assigned. Two workshops were held in 1987.
- f) Parasitology. An extensive survey of nematode parasites in about 12,500 cod from Newfoundland is now completed. Results are being compared with survey data available from the 1950s. In addition, a total of 440 harp seal stomachs was examined and about 325,000 nematodes recovered, of which less than 1% were sealworms (Pseudoterranova decipiens).

### 3. Other

- a) Shell hardness gauges for snow crab. Five devices for measuring meat yield or shell hardness of snow crab claws were evaluated. There were (1) an ultrasound unit. (2) an Ametek force gauge. (3) & (4) two durometers (Shore and Pacific Transducer). (5) a specifically designed deformation gauge (hardness calipers). The ultrasound unit, Ametek gauge, and Shore gauge all proved unsatisfactory. On the other hand, accurate shell hardness measurements with the Pacific Transducer (PT) durometer and the hardness calipers were possible. With the PT durometer, there was a significant positive relationship between durometer units (related to hardness) and claw meat yield ( $p > 0.001$ ,  $r^2 = 0.53$ ,  $n = 17$ ). With the hardness calipers, there was a significant negative regression between claw deformation (inversely related to hardness) versus claw meat yield ( $p > 0.001$ ,  $r^2 = 0.17$ ,  $n = 79$ ). These results demonstrate that shell hardness is a valid predictor of meat content. The PT durometer is recommended over the hardness calipers since the durometer is easier to use, is commercially available, and produces better regression statistics.

Section II. Scotia-Fundy Region

by

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Subarea 4: Divisions 4V-W-X

A. STATUS OF THE FISHERIES

1. Groundfish General

Total nominal catches decreased by 13.0% to 174,893 MT. The decrease was due to reduced catches of haddock and cod, only partly compensated for by increased catches of redfish and minor species.

2. Cod

Total landings decreased by 21% to 71,953 MT, 41% of total groundfish catches in the area. The decrease was spread over the whole of the Scotian Shelf but mainly in Div. 4V.

3. Haddock

Nominal landings decreased 46% to 16,482 MT. Catches from Div. 4X remained at near the same level as in 1986 but catches from Div. 4W and 4Vs fell drastically.

4. Flatfish

Flatfish catches rose by 18% with increased landings of all species except Greenland halibut, a minor component.

5. Redfish

Catches rose by 43% to 16,593 MT due to increases in catches from Sub-divs. 4Vs and 4Vn which counteracted a minor decrease in Div. 4X.

6. Pollock

Pollock catches decreased by 2% to 40,279 MT. A reduction in catches from Div. 4V was compensated for by increased catches from the southwest Scotian Shelf, mainly Div. 4X.

7. Other Groundfish

Total landings from the area were up 15% from the 1986 level at 15,031 MT mainly due to increased catches of white hake and cusk which showed increases of 15% and 86%, respectively.

8. Scallop (*Placopecten magellanicus*)

Landings totalled almost 11,000 MT round weight, maintaining the level reached in 1986.

9. Herring

Total nominal catches were 130,309 mt. This is up about 21% from 1986, wholly due to increased catches from Div. 4X where they amounted to about 118,680 MT, 26% above last year, constituting 91% of the total catch from the Scotia-Fundy region.

10. Mackerel

Nominal landings increased by about 10% from 1986 to 5,256 MT, 58% from Div. 4X.

11. Tuna

No information available.

12. Swordfish

Thirty-four longline vessels reported landings totalling 591 MT, 82.7% below the 1986 landings. A further 88 MT was taken by harpoon. The average weight of fish was considerably lower than in 1985 at 69.3 kg compared with 43.7 kg the previous year.

13. Atlantic Salmon

Total nominal landings for Scotia-Fundy (Divs. 4X-W-Vn and Nova Scotia portion of Div. 4T) were 20.7 MT, a decrease of 8% from 1986. This was a grilse-only retained sports fishery; there was no licensed commercial fishing for salmon in 1987.

14. Squid (*Illex illecebrosus*)

Both catch and effort in the international fishery remained low with a nominal catch of only 1663 MT for Subareas 2 to 4. This represents a continuation of the very low levels seen since 1982.

B. SPECIES RESEARCH STUDIES

1. Environmental Studies

(a) Hydrography

A study of the mixing near the Shelf break due to the generation and dissipation of solitons was carried out on the Scotian Shelf near the Gully (Div. 4W). Observations were made using CTD's deployed in the single cast, multiple YO-YO cast and BATFISH modes, high frequency acoustic backscatter surveys, acoustic doppler velocity profilers and ocean turbulence measuring probes.

Coastal temperature monitoring program was maintained throughout the year at approximately 90 sites in the Gulf of St. Lawrence, Gulf of Maine and on the Scotian Shelf.

Studies of the oceanic response to winter storms on the Scotian Shelf using observations from the CASP experiment, January-March 1986, produced new insights into the nature of the low-frequency circulation and of near-inertial waves driven by wind. The extensive surface wave data set was analyzed and used to improve the BIO wave model. Results of an aircraft survey of the marine planetary boundary layer were also published.

Monitoring radioactive and thermal releases from the Point Lepreau Nuclear Generating Station, located in New Brunswick on the Bay of Fundy, continued to show that the only radionuclide that is derived from the nuclear reactor which is present in detectable concentrations in the environment is tritium. In the wide range of environmental samples analyzed during 1987, including atmospheric, terrestrial and marine samples, only weapons fallout, Chernobyl and naturally-occurring radionuclides are measurable in addition to tritium.

Temperature-salinity soundings as well as dissolved oxygen and nutrient data were obtained from over 40 stations in the Gulf of St. Lawrence in aid of continuing climatological studies. This data set now extends over almost three decades and is being used to define how the Gulf responds to local and oceanic forcing on these longer time scales.

A bottom-mounted doppler current profiler was deployed on the Magdalen Shallows to monitor ice motion.

Further oxygen isotope samples were obtained from the Gulf of St. Lawrence to help delineate sources of freshwater in the Gulf and to examine the attenuation of the isotopic signature of Gulf water along the Scotian Shelf.

Water column Ra isotope and Mn profiles as well as various bottom cores were obtained from the Gulf of St. Lawrence to characterize sedimentary inputs and exchange at the sediment-water interface.

Examination of relation of groundfish distributions and bottom environmental conditions on Scotian Shelf (Divs. 4V-W-X).

(b) Plankton Studies

Field research continued on the influence of physical factors on the vertical distribution of haddock eggs and larvae and their prey. The time series of determinations of haddock eggs and larval abundance and ctenophore abundance was maintained.

A 7-day patch study was carried out off southwest Nova Scotia (DW-4X) to investigate (1) causes and correlates of vertical movement, (2) scale of horizontal patchiness, (3) predators and prey of larval herring, (4) effects of vertical migration and patchiness in standard bongo survey results.

Sorting, identification and counting of larvae from collections for the Scotian Shelf Ichthyoplankton Program (SSIP) continued with incorporation into the extensive database.

(c) Benthic Studies

Research cruises were carried out in the Bay of Fundy, on the Scotian Shelf and on Georges Bank to inventory commercial-size stocks. A survey for larval scallops was carried out in October on Georges Bank and the western Scotian Shelf.

2. Biological Studies

(a) General. The annual groundfish research survey program on the Scotian Shelf continued with the regular summer (July) survey. The annual Canada/U.S.S.R. silver hake survey (Subareas 4 and 5) was completed in November. Two annual herring larval surveys (March-October) were carried out in the Bay of Fundy (Div. 4X). An annual midwater trawl juvenile gadoid survey was carried out in June.

Monitoring and biological sampling of commercial catches both at sea (International Observer Program) and landing places continued.

A study of fish production and commercial potential of fish resources along the edge of the continental shelf and adjacent oceanic waters continued.

Studies were continued on the mechanisms and factors producing observed groundfish distribution patterns and on utilization of inshore habitat by juveniles of important commercial species.

(b) Cod. Determination of survey areas of late larval and juvenile cod were continued in coastal areas of Nova Scotia (Div. 4W-X).

Microstructural analysis of inshore and offshore otoliths for comparison of birthdate distributions continued.

(c) Haddock. Establishment of locations of survey areas of late larval and juvenile stages of haddock in relation to tidal fronts off southwest Nova Scotia (Div. 4X).

Application of histological and biochemical methods of determining larval condition in both laboratory reared and 'wild' fish was carried out.

Analyses of zooplankton and stomach content were made on juvenile gadids.

(d) Pollock. Meristic analysis for stock discrimination was completed. Results indicate separation of the Gulf of Maine-Georges Bank fish from those of the Scotian Shelf but there is a large degree of overlap.

(e) Herring. Samples of spawning herring from several grounds were examined by a variety of techniques in stock discrimination studies.

Analysis continued of factors affecting the weir fishery, including historical weir performance and interaction with aquaculture.

The study of the transboundary nature of herring along the coasts of New Brunswick (Div. 4X) and Maine (Div. 5Y) continued.

The 5th annual acoustic survey of overwintering herring in Chedabucto Bay (Div. 4W) was carried out to estimate size, composition and abundance.

(f) Redfish. Measurements of the naturally-occurring radionuclides, Pb-210 and Ra-226, have been undertaken on ocean perch as a means of determining fish ages based on a time scale established by the radioactive decay of these radionuclides. The analytical results of this experiment are presently being studied in an effort to resolve a long standing controversy regarding the maximum ages attained by these fish.

(g) Atlantic halibut. Experimental longline gear was used to capture halibut for biological information and for stock for laboratory rearing in association with aquaculture development.

Comparative mortality experiments using longlines and bottom trawls were carried out.

(h) Scallop (Placopecten magellanicus)

Research cruises were carried out in the Bay of Fundy (Div. 4X) and on the Scotian Shelf (Div. 4V-W-X) and Georges Bank (Div. 5Ze) to inventory commercial-size stocks.

A survey for larval scallops took place in October on Georges Bank (Div. 5Ze) and the western Scotian Shelf (Div. 4X).

(i) Tagging. Approx. 3300 haddock were tagged and released in the eastern part of the Scotian Shelf (Div. 4W-Vs).

### 3. Gear and Technology

Demonstration acoustics cruises for pollock and regular groundfish cruises were used to develop protocol for control of systematic sampling for pollock.

## Subareas 5 and 6

### A. STATUS OF THE FISHERIES

#### 1. Groundfish General

Total nominal landings increased by 23% from the 1986 level to 21,124 MT, about 91% of which was from Georges Bank (Div. 5Zc). Landings of all major species increased. Cod and haddock together constituted 81% of the landings.

#### 2. Cod

Landings increased by 34% to 12,345 MT of which 96% was from Georges Bank (Div. 5Zc).

#### 3. Haddock

Landings increased by 32% from the 1986 level to 4,793 MT, reversing the general downward trend since 1980. Closure of Scotian Shelf areas probably increased effort on Georges Bank.

#### 4. Pollock

Nominal landings increased by 48% to 3,234 MT, 65% of which were taken on Georges Bank (5Zc).

5. Other Groundfish

These constituted only 10% of the total groundfish landings.

Flatfish landings were down 36% from 1986 at 295 MT but all other species showed minor increases.

6. Scallop (*Placopecten magellanicus*)

Landings totalled 56,000 MT round weight, up 40% from the 1986 level, continuing the increase since 1985.

7. Herring

No herring were landed from Subarea 5.

B. SPECIAL RESEARCH STUDIES

Subarea 5

Turbulence and moored current meter measurements from Georges Bank were used to estimate vertical mixing and horizontal exchange rates. A detailed field study of exchange in the tidal front on northern Georges Bank is planned for 1988.

A method for determining the age of sea scallops from stable oxygen isotope samples of the exterior shell has been developed and applied in aging scallops from Browns Bank. Future work will be directed toward aging of Georges Bank scallops.

Complete coverage of Georges Bank (Div. 5Zc) continued as a routine part of Scotia-Fundy groundfish research trawl surveys, in March 1987.

A joint Canada/U.S. cruise was conducted in July on Georges Bank involving one Canadian and two U.S. vessels and a submersible to compare visual and trawling estimates of gadid abundance and prey types and comparison of U.S. and Canadian sampling gear.

Gadid larvae were collected on Georges Bank in association with studies of larval condition.

Harp Seals

Experiments on aerial photographic survey techniques were carried out in Newfoundland.

SPECIAL SEALS - RESEARCH STUDIES

Grey Seals

Total cohort tagging of the 1987 Sable Island production resulted in 6,900 pups being tagged. Total production for 1987 was 7391. In addition, 400 female and 100 male pups were branded as part of the continuing programme of fecundity and survival. Approximately 500 individually branded adults were resighted, as returning adults from branding programmes conducted between 1969-1974. Detailed pup growth was obtained from 40 mother/pup pairs from birth to ten days post-weaning.

Harbour Seals

Total pup production was once again marked on Sable Island resulting in 556 pups being tagged from a production of 581. A programme to study the energetics of pup rearing was initiated using stable isotopes. Good results were obtained on 30 mother/pup pairs with multiple re-captures from birth to weaning.

Section III. Gulf Region

by

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**A. STATUS OF THE FISHERIES:**

**1. Southern Gulf Cod (41VN):**

The total allowable catch was 45,200 tonnes which represented a decrease of 14,800 tonnes from 1976. Provisional catches totalled 51,000 tonnes. The 1987 fishery was notable in that the proportion of the catch taken in the winter fishery decreased from approximately one quarter of the total to 18% due largely to the reduction of the allocation to France from 7,000 to 1,200 tonnes. The standardized otter trawl catch rate series has been increasing since 1984 and was the highest in the series that began in 1966. The estimated population biomass in 1987 was considered to have been lower than the high levels recorded in the 1984-1986 period because of reduced growth of individual cod and because most recent year-classes, while large, have been smaller than those contributing to high biomass in 1984-1986. The decline in the 1987 biomass would not be reflected in catch rates since the biomass of age classes being exploited by the fishery has been increasing. The increase in the estimate of biomass is less than the increase in the numbers of cod because of the decline in average weights at age.

**2. Southern Gulf American Plaice (4I):**

The total allowable catch for this fishery has been 10,000 tonnes annually since 1977. Provisional catches in 1987 totalled 8,000 tonnes which was comparable to catches in recent years of 6,000-10,000 tonnes. Catches have primarily been made incidentally to other fisheries until recently. The proportion of the total catch that has been taken by directed effort has increased from 21% in the early 1980's to over 50% at present. The abundance index from research vessel surveys suggest that the stock has been stable since 1984.

**3. Southern Gulf White Hake (4I):**

The total allowable catch for 1987 was 9,400 tonnes with provisional catches totalling 6,200 tonnes. Precautionary TAC's of 12,000 tonnes were set annually since 1982. Concerns that precautionary TAC's allowed the stock to be exploited at about twice the  $F_{0.1}$  level in recent years was confirmed, thus the TAC was reduced for 1987. The biomass declined as the fishery developed until 1981 but this was reversed as a result of the strong 1982 and 1983 year classes which contributed to population numbers increasing more rapidly than biomass. Population numbers and biomass declined in 1987 in response to heavy fishing.

**4. Southern Gulf Herring (4I):**

The total allowable catch by gillnet and purse seine fisheries was 60,300 tonnes in 1987 with provisional catches totalling 76,500 tonnes. The presence of above average year classes (2-5 times the average since 1983) have allowed the biomass of age 5 and older fish to increase rapidly from an estimated level of 20,000 tonnes in 1980 to 227,000 tonnes in 1987. This increased biomass has supposed increased catches since 1981. The catch per unit effort in the fall gillnet fishery, stratified by geographical and seasonal patterns, has shown an increasing CPUE index since 1980. The total catch varied between 21,000-31,000 tonnes from 1981-1985, then increased to 59,000 tonnes in 1986 before reaching 76,500 tonnes in 1987. The increase in catch between 1985 and 1987 was mainly due to increased effort in the fall fisheries and both increased effort and catch rates in the spring fisheries. The spawning biomass has increased since 1981 in response to better recruitment and catch controls, but is still low relative to the mid 1960's although now similar to levels in the mid 1970's.

**5. Atlantic Bluefin Tuna (SA 3-6):**

The total allowable catch for 1987 was 573 tonnes as in 1986. 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 466 fish (80 tonnes) as compare to 1986 landings of 439 fish (160 tonnes). The traditional fishery by Canadian rod and reel plus tended line landed 30% of the fish while an experimental offshore longline fishery landed 366 fish. The Canadian rod and reel plus the tended line catch rate series are used for calibrating the older fish (16 + years) in the stock assessment.

**6. Atlantic Salmon:**

Returns of multi-sea-winter (MSW) salmon in 1987 to most rivers tributary to the Gulf of St. Lawrence were much below predicted values which suggests that an annual event affected returns on a wide geographical scale particularly since the success of the West Greenland fishery in 1986 indicated that 1987 should be a year of good returns of MSW salmon to Canadian rivers. Estimated total returns to the Miramichi River were much less (13,500 fish) for MSW salmon than had been forecast (54,200 fish) whereas the estimated returns (97,100 fish) of one-sea-winter (1SW) salmon were much better than average (48,500 fish). Estimated total returns (11,300 fish) of MSW salmon to the Restigouch River in 1987 were only half the number (21,900 fish) predicted while the returns (10,500 fish) 1SW salmon were similar to 1986 and in both years were 25% higher than the 1981-1985 average. Along the Gulf shore of Nova Scotia, counting fence observations indicated that MSW salmon returns in 1987 were below 1986 levels while 1SW returns were similar or higher. Estimated 1987 returns of salmon to rivers in western Newfoundland and southern Labrador, based upon index counting facilities, suggests that the MSW component is decreasing in comparison to 1986 levels while returns of the 1SW is comparable. Interpretation of escapements to western Newfoundland rivers could be impacted by the commercial fishery and low water levels. Commercial landings of large (MSW) salmon (18,900 fish) were the highest since 1983 and landings of small (1SW) salmon (56,100 fish) were the highest since 1976.

**7. Gaspereau (4T):**

Gaspereau are intensively harvested in the Miramichi River, New Brunswick, and in the Margaree River, Nova Scotia. Catches in 1987 were the highest recorded in the Miramichi River (2,145 tonnes) since 1980 and in the Margaree River (1,259 tonnes) since 1982. The present level of fishing effort in the Miramichi River is much in excess of what is required to harvest the resource at the  $F_{0.1}$  mortality level. The fishery in the Margaree River harvests the resource at a high level as evidenced by the heavy reliance on younger age classes in comparison to previous years.

**8. Gulf Lobster (4RT)**

Overall landings in 1987 were 20,283 tonnes; the highest recorded in the last 30-35 years. Landings in the previous three years were, as follows: 1986-15,449t, 1985-17,721t, 1984-14,085t. The relative stability of landings since 1975 has occurred without changes in fishing effort (the number of fishermen, traps, licences and length of season). Stability of landings is attributable to favourable recruitment. The Gulf Lobster fishery has been traditionally a recruitment based fishery which should be viewed as stable with existing catches and effort.

**9. Southern Gulf Snow Crab (4T):**

The main snow crab fishery is conducted in the southwestern Gulf of St. Lawrence with smaller fisheries occurring off the western coast of Cape Breton and off the eastern coast of Prince Edward Island.

The southwestern Gulf began in 1966 with nominal landings increasing rapidly to a high of 31,585 tonnes in 1982 followed by annual landings ranging from 24,267 to 26,062 tonnes until 1987. Provisional total landings in 1987 (11,782 tonnes) were about half of those recorded in the 1983-1986 period. Catch rates (kg/trap haul) in the 1987 fishery were about half of those recorded in the previous two years, as follows: 57.3 in 1985, 55.7 in 1986, 26.2 in 1987. A reference total allowable catch of 26,000 tonnes was introduced in 1984 which was in the range of harvest in the previous two



years. The TAC was increased to 28,000 tonnes in 1985 and was replaced by a season for 1986 and 1987 subject to reference TAC's of 26,000 tonnes. Data from the 1987 fishery suggests that recruitment between 1986-1987 was about equal to losses due to natural mortality and consequently the biomass was similar at the beginning of the 1987 fishery to the level at the end of the 1986 fishery. This situation is in marked contrast to earlier years when the relatively constant catch rates indicated that the biomass at the beginning of each season had rebuilt to levels similar to those at the beginning of the previous season, i.e., that recruitment and growth had replaced the amount that had been caught in the previous season. The 1987 total allowable catches for the Gulf coast of Cape Breton fisheries in the two management areas (Area 18 and 19) was 626 and 1,150 tonnes respectively. Provisional landings for Area 18 and 19 were 624 and 1,116 tonnes respectively. Current levels of fishing effort appear to be harvesting these resources at a target exploitation rate of 50-60 percent.

As experimental fishery off eastern Prince Edward Island was initiated in 1985 with the issuance of 16 permits. An additional 14 permits were issued in 1986 and the original permits were converted to licences in 1987. Four hundred and fifty seven tonnes were landed in 1987 as compared to 1,239 tonnes in 1986 and 802 tonnes in 1985. Catch rates (kg/trap haul) have decreased since 1985, as follows: 53 in 1985, 33 in 1986 and 18 in 1987. The continued decline in catch rates clearly shows that the resource is subjected to high fishing pressure and that catches exceed the biomass being replaced by annual recruitment.

#### **10. Southern Gulf Scallop (4I):**

Landings of giant scallop have ranged from 500 to 300 tonnes from 1967-1972, and fluctuated between 200 and 350 tonnes from 1972-1986. Total landings for 1987 are unavailable but are estimated to be approximately 250 tonnes as in the previous three years.

#### **B. SPECIAL RESEARCH STUDIES:**

##### **1. Environmental Studies:**

Temperature profiles were collected at 166 stations during the fall groundfish cruise and 183 cod stations during June 1987.

##### **2. Biological Studies:**

- a) Cod: Commercial fishery data (catch and weight at age, catch per unit effort, and research survey data were used for the assessment of the 4Ivn cod stock. A workshop to establish consistency in the age reading for this stock was conducted and otoliths from previous years were read again. A juvenile gadoid survey was conducted in the southern Gulf of St. Lawrence using IYGPT gear. Stomachs were collected for food content study.
- b) Plaice: The input data for the assessment of American plaice in area 4I came from commercial fisheries data and research vessels. Commercial catch rates of stern and side otter trawlers. Danish seiners, and Scottish seiners were standardized from 1977 to 1987 for the directed fishery and 1966 to 1987 for the by-catch fishery using a multiplicative model. Research vessel mean catch per tow and the commercial catch rates showed similar trends. Both indices have declined since 1979. Stabilized catch rates and mean catch per tow have been observed in the last three years.
- c) White Hake: The input data for the assessment of the white hake in area 4I came from age composition of the catch, commercial catch rate and research surveys. This is an inshore stock; the assessment of which has been hampered by lack of a valid abundance index. To begin collecting the data for such an index, inshore cruises were completed throughout the summer and fall of 1984. These data have been edited and will be used in the next assessment.

d) Herring: A revised abundance index was calculated using a multiplicative model which accounted for seasonal variation in gillnet catch rates. The high catch rates in 1987 were corroborated by a survey of 22 index fishermen. The new catch rate indicated that the stock size was two fold greater than previously estimated. The major research activities included the completion of the fourth annual acoustic survey in the Gulf of St. Lawrence. This survey also indicated that the stock biomass has increased. Surveys of smelt and mackerel fishermen were initiated to develop an index of juvenile herring abundance. The third consecutive spawning bed survey was also completed using an underwater video camera.

An analytical assessment of both spring and fall spawning groups was made utilizing commercial fisheries data. In order to determine the abundance index, gillnet fishery catch rates and index fishermen were used.

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. However, in 1987, an offshore longline fishery was begun using chartered Japanese vessels. This new data source will be utilized in the 1988 assessment.

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, native and commercial fisheries, and summarizing all catch and effort data. In addition to biological assessments, specific research was conducted on the following: morphometric and meristic studies for stock discrimination; oocyte development research; the use of estuarine habitat by juvenile salmon; comparison of freshwater production of salmon and brown trout; density-dependent factors and density-independent factors effecting production; and field census techniques for monitoring juvenile populations. Research on the effect of water levels on juvenile production was initiated.

g) Gaspereau: Assessments of the 1987 fisheries for the Margaree and Miramichi rivers were completed using samples from commercial traps, weighted by daily catches estimated from logbooks, to generate a catch-at-age matrix used in sequential population analysis. A mark-recapture experiment was completed on the Margaree River to estimate speed of migration and to confirm rates of harvest. In addition, research was conducted on the stock-recruitment relationship for gaspereau in South River.

h) Lobster: Extensive monitoring of the lobster fishery in the experimental minimum carapace increase zone of Cape Breton was made. The programs involved sea sampling of commercial lobster catches to obtain biological and fisheries related parameters, and tagging lobsters at three sites to determine growth parameters and movement pattern. The experimental carapace increase program is in the second year of a four year incremental minimum legal carapace increase which will be evaluated for biological effects during and after the increase.

Sea sampling of commercial lobster catches is conducted from Baie des Chaleurs to the Labrador coast. The

information is used for providing management advice for local adjustments to fishery regulations.

Data has been collected on comparative lobster fecundity in various areas of the Gulf of St. Lawrence. This information will be used to further compare geographic differences in lobster recruitment and landings.

i) Snow Crab:

Catch and effort trends for the Gulf of St. Lawrence inshore fisheries off western Newfoundland; western Cape Breton Island; northern Prince Edward Island; and the offshore fishery in the southwestern Gulf were monitored and used in Leslie analyses to determine biomass and exploitation levels for each area. Sea sampling programs were supplemented by trawl surveys to estimate distributions and other biological parameters of the Gulf's snow crab populations. All of the Gulf fisheries appear to have reached or exceeded their maximum sustainable levels of fishing effort. Especially in southwestern Gulf and Prince Edward Island fisheries. An unexplainable decline in catch to 50% compared to the previous seasons was observed.

Studies were conducted on growth at molt based on observations in aquaria and also on molt stages based on integumental development. Tagging surveys, using T-bar tags, were continued in the Prince Edward Island fishery and the southwestern Gulf to determine movement of crabs in these areas. Monitoring of short-term movements of crabs were continued in Bonne Bay by using biotelemetry. Observations on mating behavior, molting and the reproductive cycle for both male and female crabs were continued in the laboratory. A geostatistical technique for biomass analyses was developed.

j) Scallop:

The assessment of the giant sea scallop stock was done by analysing data from logbooks, landing statistics, and sea sampling on board commercial fishing vessels. The southern Gulf was divided into sub-areas for the analysis with results showing considerable variation from one sub-area to another. A study of the maturation cycle was completed.

The northeastern Gulf of St. Lawrence Iceland scallop stock assessment was done by analysing data from an experimental survey, logbooks, landing statistics, port samplings and a questionnaire. The results suggest an overall stable population structure and a decrease in the exploitable biomass.

Section IV - Quebec Region

by

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This report summarizes the research of several laboratories in Quebec, which are identified as follows:

- ABS - Arctic Biological Station, Ste-Anne de Belevue (DFO)  
 MLI - Maurice-Lamontagne Institute, Mont-Joli (DFO)  
 MAPAQ - Direction de la Recherche Scientifique et Technique,  
 Quebec Provincial Government.

SUBAREA 4

A. Status of the Fisheries

DFO Nominal landings and TAC ('000 t) since 1983 for stocks currently being assessed in the Quebec region are as follows:

Species	Division	Nominal Landings (TAC)			
		1984	1985	1986 <sub>1</sub>	1987 <sub>2</sub>
Cod	4RS, 3Pn	93 (100)	87 (100)	80 (92.1)	N.A. (80.3)
Greenland Halibut	4RST	1.8 (5)	2.4 (5)	6.5 (5)	N.A. (8.9)
Atlantic Halibut	4RST	0.176	0.163	0.273	N.A. (0.3)
Redfish	4RST	36 (50.6)	28 (50.6)	33 (55.6)	N.A. (50)
Herring	4R	10.4 (10)	14.4 (10)	21.4 (17)	N.A. (30.6)
	4S	1.0 (1)	0.5 (1)	0.6 (1)	N.A. (1)
Mackerel	3-6	40.6	70.8	63	N.A.
Capelin	4R	1.9 (20)	2.2 (20)	3.3 (20)	N.A. (5)
	4ST	0.2 (5)	0.5 (5)	0.7 (5)	N.A. (2)
Snow crab	4S, 4Tpq	5.1	5.8	5.3	5.0
Shrimp	4RST	7.5 (16.3)	8.8 (14.5)	9.5 (12.1)	12.0 (13.1)
Lobster	4S, 4T <sub>3</sub>	1.9	2.1	2.3	2.7
Scallop <sub>4</sub>	4S, 4T <sub>3</sub>	1.1	1.3	1.2	2.0

- 1 Preliminary values.  
 2 Preliminary values when available.  
 3 Except 4Tghij.  
 4 Round weight.

## B. Special Research Studies.

### 1. Environmental studies

#### a) Hydrographic studies

*MLI* In collaboration with the Bedford Institute of Oceanography, a number of thermographs were installed in the coastal regions between Rivière-du-Loup and Chaleurs Bay. This project aims to obtain a temporal series of water temperatures.

#### b) Plankton studies (including eggs and larvae)

*MLI* An analysis of the ichthyoplanktonic communities of NAFO division 4T was made. Spatial and temporal variability of the ichthyoplankton present along the St. Lawrence estuary were investigated. Results from the survey should provide information on associations of eggs and larvae and the effects of physical and biological factors on the structure of the communities.

#### c) Benthic studies

*MLI* The preferred scallop habitat in the Magdalen Island area (NAFO division 4T) was identified with the use of a bottom dredge. Maps of the spatial distribution of substrate types and benthic organisms were drawn.

#### d) Observations on ice conditions in Subareas 0 to 4

#### e) Other environmental studies

*MAPAQ* A survey of environmental conditions initiated in 1984 and continued in 1987 on the lower North Shore (NAFO division 4Sv,w) of the Gulf of St. Lawrence. It included the use of 9 bathythermometers in six shallow water locations near the coast. Data were also taken each week or two, from June through October in 5 areas for the determination of temperature, salinity, chlorophyll a, particulate inorganic and organic material in the upper 14 meters of water.

### 2. Biological studies by species

*MLI* General: In order to provide information for the various stocks being assessed, sampling of commercial species was undertaken by the sampling and observer groups. Close to 20,000 otoliths from 7 finfish species were read. This group also coordinates the returns (and publicity) of all tags received in MLI and insures that the reward and information is forwarded to the appropriate group. An observer program was carried out in order to provide information from the national fleet as well as vessels from St. Pierre and Miquelon fishing for cod in the Gulf of St. Lawrence. Three stratified-random research surveys (Subdivision 3Pn, divisions 4R, 4S and 4T) and one larval survey were done and used as independent indices of abundance for various stock assessments.

The Gulf redfish (divisions 4RST) and Atlantic halibut (Divisions 4RST) have been added to the list of stocks assessed in the Quebec Region. In the first case, this was a result of a transfer of responsibility from the Gulf region while the second is a stock for which a TAC has been implemented for the first time in 1988.

A reference collection of available biological specimens has been created and should cover all animal taxa found in the St. Lawrence river as well as in the Gulf.

#### 2.1 Demersal fish

##### 2.1.1 Cod

*MLI* An ongoing project on the role of cod as a predator in the North of the Gulf of St. Lawrence was made from the analysis of the stomach contents and rate of digestion. Results from tagging programs were analyzed in order to answer questions regarding the northern Gulf stock identity as well as the existence of local populations. A posteriori analysis of results from the winter surveys in the Gulf of St. Lawrence was undertaken in order to determine any possible influence of the ice edge to variations in catchability of cod. An analytical assessment is performed on a yearly basis and presented through CAFSAC.

### 2.1.2 Redfish

*MLI* The Gulf of St. Lawrence stock was assessed using a non-equilibrium general production model and presented at CAFSAC. Results from various groundfish surveys and commercial sampling were presented in order to provide information on stock structure.

### 2.1.3 Greenland Halibut

*MLI* Results of commercial sampling and research vessel surveys were done on the 4RST Greenland halibut stock. Results were presented at CAFSAC.

### 2.1.4 Atlantic Halibut

*MLI* In order to provide information to management on the stock status of this resource in the Northwest Atlantic, a review of available biological information within the Gulf of St. Lawrence was collected and presented to CAFSAC.

## 2.2 Pelagic fish

### 2.2.1 Herring

*MLI* Stock assessments of herring in NAFO divisions 4R and 4S were made and included improvements to the collection and analysis of catch and effort data as well as the interpretation of maturity status of specimens of spring and autumn spawners. Herring present at a spawning bed in the St. Lawrence estuary were monitored with the use of telemetry in order to delimit the spawning area and factors that influence the timing of the spawning were also investigated. The population dynamics and genetic differentiation of various influxes of herring into a particular spawning site were investigated as part of a master's degree.

### 2.2.2 Mackerel

*MLI* An analytical assessment of the mackerel stock (S.A. 3 to 6) was made and included results from an ongoing larval survey in the southern part of the Gulf (NAFO division 4T).

### 2.2.3 Capelin

*MLI* A stock identification based on morphometric characteristics of the NAFO division 4RST populations was done and included in the stock assessment presented to CAFSAC.

## 2.3 Invertebrates

### 2.3.1 Snow Crab

*MLI* Stock assessment of the snow crab resource in the Estuary and lower North Shore (NAFO division 4Tp,q and 4Sv,w) was done. Estimates of biomass and catch and effort information were used. Results were presented to CAFSAC. Another study investigated the spatial distribution and the type of habitat utilized by juvenile and adult crabs along the North Shore of the Gulf of St. Lawrence. Field work concerning the hypothesis of a terminal molt was undertaken on the lower north shore with the use of electronically encoded micro tags.

### 2.3.2 Shrimp

*MLI* A predictive model on the effect of environmental variables on the spatial distribution of shrimp is under study. This involves the use of a submarine video camera and acoustics for the study of vertical and horizontal distributions. A biological update of the status of the resource in various fishing areas was done and presented to CAFSAC.

### 2.3.3 Lobster

*MAPAQ* A project which aimed to get additional data on the relationship between gastrolith growth and molt stage in lobster was done in the Bay of Gaspé (NAFO division 4Tn).

*MLI* Stock assessments was made for the lobster of Anticosti. Data were collected to assess any variation in catchability due to variation in water temperature.

#### 2.3.4 Scallop

**MAPAQ** Magdalen Islands (NAFO division 4Tf). In order to develop an efficient method for artificial production of Giant Scallop spats on a large scale, a research program was initiated in 1987. During this first year of experiments, a total of 80,000 spats of 1 mm in size have been produced. In the next year, the efforts will be focused on hatchery production and the growth of spats in nursery until they reach 10 mm in size.

Lower North Shore (NAFO division 4Sv,w). Collection of spat was made, and some aspects of the hanging methods of culture were studied. The survey of growing juveniles was continued and a transfer of spat from the experimental hatchery of M.A.P.A. in the Magdalen Islands was made.

**MLI** A stock identification based on enzymatic heterozygosity of various Gulf populations was undertaken. Stock assessment of the Magdalen Island scallop resource was presented to CAFSAC. A field survey aiming the identification of particular areas commercially exploitable along the lower north shore was maintained in 1987.

#### 2.3.5 Mussels

**MAPAQ** A study in cooperation with the "Institut National de la Recherche Scientifique en Océanologie" was initiated to determine the carrying capacity of the Magdalen Islands (NAFO division 4Tf) lagoons for mussel culture. There was also a first attempt to develop mussel culture in open waters around the Magdalen Islands.

Experimental data on reproduction, recruitment, growth and yield of mussels have been collected from Carleton (Chaleur Bay, NAFO division 4Tm) in order to evaluate the suitability of this site for commercial mussel farming operations. Oceanographic parameters such as temperature, salinity, ice conditions, food supplies (suspended particulate matter, phytoplankton biomass), condition indices, fouling, sanitary status and heavy metal concentration were also evaluated as obligate selection criteria.

Rates of intoxication and detoxification of wild and cultured mussels regarding the toxin-producing algae Protogonyaulax tamarensis were monitored in Bay of Gaspé (NAFO division 4Tn) in order to study the possibility of commercial use of this toxic area for mussel culture.

Collection of spat was made, and some aspects of the methods of culture were studied in order to transfer and adapt the methods used in the Magdalen Islands to the lower North Shore.

**MLI** A project concerning the inter-cohort competition among mussels was made in order to test the hypothesis that the settlement of spat inhibits the growth of adults. An optimisation of the spatial distribution of mussel rearing apparatus to gain maximum efficiency of the phytoplankton was made. A thesis on the validation of the technique of ageing based on shell microstructure was done.

#### 2.3.6 Soft shell clams

**MLI** Following the development of a clam fishery in Havre Saint Pierre (NAFO division 4S) collection of biological data was undertaken in order to provide information on growth, production, biomass and yield. A follow up of the commercial fishery catch and effort was done.

#### 2.3.7 Surf clam

**MLI** In Magdalen Islands, the impact of surf clam exploitation has been examined in relation to the unexploited stocks demographic structure.

#### 2.3.8 Whelks

**MLI** A follow up of the commercial whelk fishery in NAFO divisions 4S and 4T was made. Work included sampling of commercial catches for analysis of growth, sex-ratio and maturity.

2.4 Marine mammals

2.4.1 Seals

SAB The energetics of free ranging seals around Bic island was studied by telemetry.

2.4.2 Whales

SAB A study of Blue, Fin and Minke whale behaviour and trophic ecology was continued. Estimates of local abundance and seasonality of occurrence and documentation of whale/vessel interactions were made.

2.5 Marine plants

2.5.1 Laminaria

MLI Examination of gear efficiency to harvest laminaria in the Baie des Chaleurs (NAFO division 4T) was undertaken. This project also examined the demographic structure and biomass of the exploited stock.

2.5.2 Ascophyllum

MLI Criteria for optimum exploitation of Ascophyllum based on timing, frequency and height of the cutting of the plants was examined.

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

MLI The "DIGBY" scallop dredge efficiency was tested by direct observation using a video camera. The gear was towed on various substrates, results should enhance biomass estimates for assessment purposes.

4. Miscellaneous studies.

MLI A new research group has been created at MLI. Its activities have been to equip and organize the experimental facilities and to elaborate a long term research plan. The group will work on marine fish and crustacean. Specific projects will be initiated on the essential requirements of selected species. The preferred growing conditions will be tested for their consequences on stress and pathology control.



SECTION V - Physical Oceanographic Studies

by

Canada

Report of Physical Oceanographic Studies in NAFO Subareas by Ocean Circulation  
Division, Physical and Chemical Sciences Branch, Scotia-Fundy Region

SUBAREAS 0/1

**Baffin Bay/Davis Strait**

Four current meter moorings that had been set in summer 1986 on the Greenland continental slope in eastern Baffin Bay near 75 N and 71 N (12 meters in all) were recovered and 5 moorings were deployed in a line across Davis Strait at 66 15 N during early September, 1987. 130 CTD stations were occupied, mostly in Davis Strait and along the eastern side of Baffin Bay as far north as 76 N. Davis Strait moorings will be replaced annually for a total of three years deployment.

SUBAREA 2

**(2J) Labrador Shelf (Hamilton Bank)**

Studies of the ice growth / decay and the movement of the Labrador Ice Pack continued during January - April, 1987. Ice beacons were deployed on the ice and ice movement was monitored using both these beacons and satellite imagery.

A total of 12 current meter moorings or bottom pressure installations that had been set on the Labrador Shelf in summer 1986 were recovered in July 1987 and an additional 5 current meter moorings and 4 bottom pressure gauges were laid. The majority of these moorings were set in a line across the shelf and slope at Hamilton Bank but some were set off Nain. In addition, 46 CTD stations were occupied on the shelf and slope and the Labrador current was mapped during four days of BATFISH towing.

SUBAREA 3

**(3N) Southeast Shoals**

Five current meter moorings were deployed on Southeast Shoals from April to October, 1987 in investigate the processes by which the waters over this shoal underwent their annual heating cycle. A total of 66 CTD stations were occupied over the shoals in April, 1987 and 116 stations in October. Some 57 hrs of BATFISH towing was obtained along the edges of the Grand Banks in April, 70 hrs in October. Velocity profiles using the Acoustic Doppler Profiler were obtained throughout both cruises.

**(3N/3M) Newfoundland Basin**

30 full depth CTD stations with nutrients, oxygen, total carbonate and alkalinity and freon measurements were obtained in the Newfoundland Basin during March, 1987. A 3 hour BATFISH tow was also taken across the southern end of Flemish Pass. A further 62 CTD stations with the same suite of tracers were occupied in October, 1987. Approximately 5 days of BATFISH mapping (CTD to 200m) of the North Atlantic Current and Mixed Water regime was also accomplished. Six current meter moorings set in the North Atlantic Current in April, 1986 were recovered in October, 1987. One other mooring set at the same time was recovered in May, 1987.

#### SUBAREA 4

##### Scotian Shelf

A study of the mixing near the shelf break due to the generation and dissipation of solitons was carried out on the Scotian Shelf near the Gully. Observations were made using CTD's deployed in the single cast, multiple YO-YO cast and BATHY modes, High Frequency Acoustic Backscatter surveys, Acoustic Doppler Velocity Profilers and ocean turbulence measuring probes.

Report of Physical Oceanographic Studies in NAFO Subareas by Coastal Oceanography  
Division, Physical and Chemical Sciences Branch, Scotia-Fundy Region

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#### SUBAREA 3

An array of bottom pressure gauges and near-bottom current meters were recovered from the northern Grand Bank and northeast Newfoundland Shelf during the summer of 1987. These data are being analyzed to determine the effects of local and upstream forcing on the currents over the Grand Banks.

An array of three current meter moorings, 2 thermograph moorings and one sea surface temperature buoy was recovered from Southeast Shoal during the fall of 1987. Hydrographic and Doppler current profiles were also obtained in the region. The project is investigating circulation, mixing, heat and salt budgets of the waters over the Shoal.

An array of seven moorings was recovered from the Newfoundland Basin after an eighteen-month deployment. Hydrographic surveys and chemical tracer (primarily freon) sampling were carried out on two cruises. The circulation and eddy activity in the region are being investigated.

Twelve satellite-tracked ice beacons were launched north of the Subarea and tracked throughout the region as they drifted south. This project which attempts to address problems associated with the ice field motions also involved modelling and analysis of satellite imagery.

A field program examining the dynamics and thermodynamics of the advancing ice edge was carried out in the region. It involved current meter and acoustic Doppler measurements, hydrographic surveys, and the tracking of ice beacons.

#### SUBAREA 4

Coastal temperature monitoring program was maintained throughout the year at approximately 90 sites in the Gulf of St. Lawrence, Gulf of Maine and on the Scotian Shelf.

Results of several field experiments and modelling studies in the eastern Gulf of Maine and Scotian Shelf were published including investigations of the three-dimensional tidal residual circulation and circulation and dispersion on Browns Bank.

Studies of the oceanic response to winter storms on the Scotian Shelf using observations from the CASP experiment, January-March 1986, produced new insights into the nature of the low-frequency circulation and of near-inertial waves driven by wind. The extensive surface wave data set was analyzed and

used to improve the BIO wave model. Results of an aircraft survey of the marine planetary boundary layer were also published.

Measurements of the naturally-occurring radionuclides, Pb-210 and Ra-226, have been undertaken in ocean perch as a means of determining fish ages based on a time scale established by the radioactive decay of these radionuclides. The analytical results of this experiment are presently being studied in an effort to resolve a long standing controversy regarding the maximum ages attained by these fish.

Monitoring of radioactive and thermal releases from the Point Lepreau Nuclear Generating Station, located in New Brunswick on the Bay of Fundy, continued to show that the only radionuclide that is derived from the nuclear reactor which is present in detectable concentrations in the environment is tritium. In the wide range of environmental samples analysed during 1987, including atmospheric, terrestrial and marine samples, only weapons fallout, Chernobyl and naturally-occurring radionuclides are measurable in addition to tritium.

Temperature-salinity soundings as well as dissolved oxygen and nutrient data were obtained from over 40 stations in the Gulf of St. Lawrence in aid of continuing climatological studies. This data set now extends over almost three decades and is being used to define how the Gulf responds to local and oceanic forcing on these longer time scales.

A bottom-mounted doppler current profiler was deployed on the Magdalen Shallows to monitor ice motion.

Further oxygen isotope samples were obtained from the Gulf of St. Lawrence to help delineate sources of freshwater in the Gulf and to examine the attenuation of the isotopic signature of Gulf water along the Scotian Shelf.

Water column Ra isotope and Mn profiles as well as various bottom cores were obtained from the Gulf of St. Lawrence to characterize sedimentary inputs and exchange at the sediment-water interface.

#### SUBAREA 5

Turbulence and moored current meter measurements from Georges Bank were used to estimate vertical mixing and horizontal exchange rates. A detailed field study of exchange in the tidal front on northern Georges Bank is planned for 1988.

A method for determining the age of sea scallops from stable oxygen isotope samples of the exterior shell has been developed and applied in aging scallops from Browns Bank. Future work will be directed toward aging of Georges Bank scallops.