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CANADIAN RESEARCH REPORT, 1986

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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 1986 totalled 2,995 t similar to the 3,053 t in 1985.

2. Other species. No other species of fish or invertebrates were landed by Canada from these Subareas in 1986.

B. Special Research Studies

1. Environmental Studies

a) Atlantic Oceanographic Laboratory (Bedford Institute). Analysis of samples collected from PISCES IV at the natural seep of petroleum off Scott Inlet, Baffin Island, were carried out. Measurements of heterotrophic production suggest that this is a significant fraction of the total annual benthic productivity.

Freon profiles from Baffin Bay show considerable structure in near surface layers, reflecting different source waters and mixing between them. Freons were first introduced into the atmosphere about forty years ago and have been increasing in concentration ever since. Because seawater obtains freons from the atmosphere, the low, near zero, concentrations found in the deep water relative to the surface water indicate that the deep water was formed at least many decades ago.

Recovered four current meter moorings and set four more in a continuing exploratory program to map the velocity and hydrographic fields of Baffin Bay/Davis Strait. A number of CTD stations were occupied and special sampling was carried out with the West Greenland Current to see if raised levels of radioactive Cs isotopes might indicate the arrival of waters from the Irish Sea and Bay of Biscay nuclear fuel reprocessing plant discharges.

Geochemical studies on the contamination of sediment, SPM and biota in a Greenland fjord system (71°07'N/51°16'W) by mine wastes was completed in 1986.

Baseline levels of heavy metals were determined for the coastal sediments of south and east Greenland shelves.

Collected large volume water samples for Cs-134 and Tc-99 analyses in the West Greenland Current and Labrador Sea in 1986 to study the movement of Sellafield tracers into Baffin Bay (Subareas 1 and 2).

2. Biological Studies

a) Groundfish. A stratified random survey was conducted in SA0+1 in depths of 200-1250 m in August-September, 1986. A total of 203 successful tows was made. The collected data are now being analyzed . The survey was directed primarily towards Greenland halibut and grenadier and involved extensive chartwork in advance of the cruise.

b) Atlantic salmon. A total of 3,608 salmon was sampled at the fish plant in Sisimiut; 6,443 in Nuuk, 5,948 from Paamiut, and 4,425 from Narssaq in centimeter length groups; including detailed measurements of fork length, gutted weight, and of these 3,509 were scale-sampled. This project provides an annual assessment of the proportion of North American and European fish caught at West Greenland. Also, 70 salmon were detected with micro tags. Microtags were from Canada, USA, Scotland, Ireland, Iceland, and England.

In total, 555 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 1986. All trips were on foreign vessels chartered to fish the Canadian allocation except for ten days fished in 1A&1B. A total of 341 fishing days and 1,812 sets was observed, with a total of some 204,127 shrimp measured.

SUBAREA 2

A. Status of the Fisheries

1. Cod. Canadian landings were 16,900 t, compared to 11,900 t in 1985 and 23,400 t in 1984. Landings were almost entirely from Div. 2J, with only 350 t from Div. 2G and 2H. Landings from the inshore sector were 12,600 t, up from 10,200 t in 1985 and offshore landings were 4,300 t compared to only 1,600 t in 1985.

2. Redfish. Canadian landings were 2,570 t, compared to 980 t in 1985 and only 180 t in 1984. These landings were primarily from Div. 2J, with only 40 t landed from Div. 2H.

3. Greenland halibut. Canadian landings were 2,300 t down from 7,800 t in 1985. Division 2J landings comprised 2,220 t with only 80 t landed from Div. 2H. The inshore fishery accounted for 46% of the landings in this Subarea.

4. Other groundfish. Canadian landings of other groundfish species amounted to only 100 t in 1986.

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 1986 were 383 t, compared to 211 t in 1985. Landings of large salmon (263 t) increased by 93% over 1985. The recreational harvest totalled 5.6 t.

8. Arctic charr. Landings of Arctic charr in Subarea 2 during 1986 were 114 t, a decrease of 19% from 1985. The continued decrease in fishing effort is a major factor associated with reduced landings again in 1986. 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 5,750 t in 1986, 3,400 t of which were in the Hopedale Channel. Total landings in 1986 were approximately 4,700 t. A total of 156 fishing days and 776 sets was handled by observers with 44,538 shrimp measured.

B. Special Research Studies

1. Environmental Studies

a) Oceanographic studies. The Seal Island section in 2J was occupied in August. Temperature profiles were taken at each fishing station occupied during 1986.

b) Atlantic Oceanographic Laboratory (Bedford Institute). The $s^{18}O$ studies in Hudson Strait examine the distribution and fluxes of freshwater derived from sea ice meltwater in Hudson Strait by the stable oxygen isotope method. The isotopic analysis of the water samples is substantially completed and the interpretation of the data is underway.

The results of a study of the background levels of petroleum residues in the waters and surficial bottom sediments of the Labrador Shelf were published.

Carbon isotopes have been used to study the deglaciation history of paleoenvironmental changes in the Lake Melville area (Labrador).

A study of the relation of tidal mixing to summer density stratification, nutrient and chlorophyll distributions in Hudson Strait was completed and submitted for publication.

Current meter array across Hamilton Bank was recovered and reset (ninth year). Additional pressure gauges were set in order to look at the propagation of dynamical features along the Labrador Shelf. Hydrographic measurements were carried out on the Labrador Shelf and slope in connection with this program.

The second year of the Labrador Ice Buoy Program was completed with ten ice beacons being placed on the ice off Nain and Hopedale in January and February and tracked by satellite as they moved southward. Additional estimates of the drift of sea ice were made using high resolution satellite imagery.

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.

b) Flatfish. Data on distribution and abundance of American plaice, Greenland halibut, and witch were collected during a regular fall survey of Div. 2J. This is part of a regular survey program that began in 1977. Researchers are utilizing data from shrimp surveys in efforts to develop a recruitment index for G. halibut.

c) Capelin. An acoustic survey in Div. 2J3K in October 1986 located capelin mainly in Div. 2J. Total capelin biomass was estimated to be about 430,000 t.

d) Atlantic salmon. A total of 3,034 Atlantic salmon caught in the commercial fisheries was sampled for size and age distribution.

e) Arctic charr. A total of 2,416 samples were obtained for age determination of Arctic charr in commercial landings from twelve northern Labrador fishing areas. Approximately 21,000 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-August, 1986 completed a biomass survey using a Sputnik 1600 shrimp trawl in the major areas where commercial concentrations occur. A total of 136 sets was made with the greatest catch (564 kg) being obtained in the Hopedale Channel. Catches in the Cartwright Channel ranged to 244 kg. Information from this survey was used to estimate shrimp abundance which, in turn, will be used to update CAFSAC advice on total allowable catches for 1987.

SUBAREA 3

A. Status of the Fisheries

1. Cod. Canadian landings were 237,000 t, compared to 245,000 t in 1985 and 228,000 t in 1984. The inshore sector accounted for 36% of these landings at 84,500 t, down from 102,000 t in 1985. Landings from Div. 3K and 3L accounted for 73% of all cod landings in this Subarea. Inshore landings from Div. 3K and 3L were 59,800 t down from 71,000 t in 1985, while offshore landings remained at 113,000 t, which was about the same as in 1985.

2. Redfish. Canadian landings were 27,900 t, compared to 29,100 t landed in 1985 and 23,100 t in 1984. Division 3K landings accounted for 58% of the total landings, with 16,100 t landed compared to 22,900 t in 1985. Landings form Div. 3L were 4,800 t, up from 2,100 t in 1985, with landings from Subdiv. 3Pn and 3Ps at 6,800 t up from 3,700 t in 1985.

3. Flatfish. Canadian landings of the combined flatfish species were 66,900 t compared to 72,000 t in 1985. American plaice dominated these landings with 40,600 t, down from 44,600 t in 1985. Yellowtail landings were 14,200 t compared to 13,500 t landed in 1985. Greenland halibut landings were 5,700 t down from 7,500 t in 1985. Landings of greysole were 5,700 t about the same as in 1985. About 1,700 t of Atlantic halibut were landed in this Subarea in 1986. Landings from the inshore sector amounted to only 17% of total flatfish landings. About 88% of all Greenland halibut landings were landed inshore.

4. Other groundfish. Canadian landings were around 20,800 t, comprised primarily of haddock (8,400 t), pollock (5,500 t), white hake (3,800 t), wolffish (1,500 t), and winter flounder (1,500 t). Haddock landings increased from 2,500 t in 1984 and 5,900 t in 1985. These haddock landings were mainly from Div. 3O (6,000 t) and Subdiv. 3Ps (1,600 t). Pollock landings increased from only 1,400 t in 1985, with most of the landings coming from Subdiv. 3Ps (5,200 t).

5. Capelin. Approximately 48,000 t of capelin were landed inshore in Div. 3L and 15,000 t in Div. 3K in 1986. 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 17,000 t.

6. Herring. Herring landings from Newfoundland were approximately 4,800 t, 4,600 t from Div. 3KL and 200 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 11,000 t, compared to 15,000 t landed in 1985.

8. Squid. Total catch of squid in 1986 was 1 t (preliminary data). Early season catch rates on the southern Grand Bank indicated a very low inshore resource level for the summer/autumn fishery. The low catch was due to a natural absence of squid from commercial fishing areas.

9. Atlantic salmon. Landings were 668 t in the commercial fishery and 39 t in the recreational fishery. The catch of large salmon (278 t) increased by 15% over 1985.

10. Scallops. Approximately 147 t meats were landed from offshore 3P (St. Pierre Bank), up from 53 t in 1985. Increased landings resulted from a new year class of sea scallops recruiting to the fishery.

B. Special Research Studies

1. Environmental Studies

a) Oceanographic studies. Most of the standard sections in Subarea 3 were occupied. In addition, data were collected south of the Grand Banks during squid surveys. Seasonal survey data from the northern Grand Bank were analysed to produce sea-bottom temperature maps. An increase of about 0.7°C was demonstrated from winter 1985 to 1986. In Trinity Bay, three CTD transects were occupied six times, covering all seasons. The time series of Station 27 (4 km east of Cape Spear) was continued.

In cooperation with the Bedford Institute, a series of east-west transects across the Southeast Shoal was occupied repeatedly by NAFC vessels. These data, supplemented by BIO transects and a moorings program will be used in a study of water exchange in this area.

b) Atlantic Oceanographic Laboratory (Bedford Institute). A pilot field study was carried out with moorings, Batfish, and CTD's on S.E. Shoal to investigate the processes leading to the anomalously warm water found here. All equipment successfully survived the spring and summer period after which it was recovered.

An extensive field program east of the Grand Banks was carried out with the purposes of (a) determining the transport of the North Atlantic Current, (b) investigating the deep water circulation, and (c) investigating the mixing of upper waters between the Labrador and North Atlantic Current from the Tail of the Bank to Flemish Cap. Program involves moorings, CTD's, chemical tracers, and Batfish mapping.

Coastal temperature monitoring program was maintained throughout the year at about 30 sites in cooperation with NAFC.

An array of nine moorings was recovered for the outer Grand Bank and Flemish Pass area in a joint project with Petro Canada, Mobil, Husky-Bow Valley, and ESSO Resources. Data recovery was about 43% overall with heavy losses due to fishing activity.

An array of three moorings measuring current and hydrographic properties was placed in the Hibernia area from April to October to examine the mixed layer dynamics in the region. Data return was about 90%.

Temperature, salinity, and acoustic Doppler current profiles were taken on the Grand Bank during April and October cruises, covering the outer region from the 100 m to 1000 m isobath, 48°N-43°N. More complete coverage was given to Southeast Shoal.

Tidal modelling of the five principal components for the Grand Banks was completed.

A report dealing with oceanographic conditions on the Grand Banks and Northeast Newfoundland Shelf for 1975-86 was completed for the CAFSAC groundfish committee.

Current modelling studies for the Strait of Belle Isle were completed. An array of bottom pressure gauges was moored on the northern Grand Bank and Northeast Newfoundland Shelf and are due to be recovered in mid-1987. They are the observational phase of an examination of the influence of upstream conditions on Grand Banks currents.

c) The oil industry continued ongoing oceanographic observations on the Grand Banks (at a reduced level) in support of offshore exploratory drilling operations.

d) Plankton studies. Plankton samples for squid larvae were taken south of the Grand Bank (Gulf Stream) in February-March.

e) Other environmental studies. Tissue samples were taken at various locations within Subarea 3 for use in multi-variate monitoring of the biological effects of offshore hydrocarbon exploration and development. Field studies were conducted at the site of an 1982 spill of No. 2 fuel oil (inshore site).

f) In two experimental rivers the production of juvenile Atlantic salmon was measured by analyzing the effects of abiotic and biotic variables on biomass, growth rate and survival.

2. Biological Studies

a) Cod. Sampling of the landings from the commercial fishery both inshore and offshore was continued in 1986. Using research vessels, surveys were carried out in all NAFO Divisions to determine the distribution and abundance of cod. Biological sampling was extensive during these surveys and several thousand cod were tagged, inshore and offshore.

Several reports were finalized respecting a study of factors influencing the availability of cod inshore (Conception Bay). Field work was undertaken by NORDCO Ltd., in the 1985 fishing season to obtain additional evidence to test hypothesis relating cod distribution to water temperature. The project monitored catch and effort in the trap fishery in selected areas and extensive monitoring of oceanographic conditions was undertaken. Climatological conditions which might be anticipated to modify oceanographic conditions were also monitored.

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 conducted in Div. 3P during July. The data collected will yield information concerning stock biomass as well as diel movements and spatial distributions of redfish.

The size, number and weight of juvenile redfish of ages 1-4 in stomachs of cod caught on Flemish Cap during the winters of 1978-84 were described. These data were used in a sequential population analysis to estimate the number of redfish at age during each year.

c) Flatfish. Distribution and abundance of flatfish were studied during fall random stratified surveys during the fall in 3K, and spring in 3NO and 3Ps. Information from these surveys additionally provided data on year-class strengths of pre-recruited flatfish. These surveys are a major source of information for continued biological studies on the various flatfish species. A juvenile flatfish survey, year 2 of a time series, was conducted on the Grand Banks NAFO Div. 3LNO inside the 50 fathom contour. Emphasis is on establishing a pre-recruit index for age 1-3 year old yellowtail. An 80/104 Yankee shrimp trawl with modified groundgear was used. Biological information was also obtained for juvenile A. plaice.

Part of the 1986 surveys (Jan.-Feb.) was devoted to line surveys on the "nose" of the Grand Bank to address questions of foreign trawler catches in that area. Data were also used to answer questions regarding the seasonal distribution and abundance of Greenland halibut in the NAFO regulatory area on the "nose" of the Bank.

Line surveys on the "tail" of the Bank were conducted in April to determine if differences in distribution and abundance of groundfish existed in the area around the 200 mile limit.

d) Capelin. Data from acoustic surveys conducted in the offshore areas of Div. 3L were used to provide TAC advice, through NAFO, for 1987. 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 1986. 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.

Detailed information on the vertical and horizontal distribution of capelin larvae relative to hydrographic features characteristic of the Southwest Shoal of the Grand Banks was obtained during a research cruise in September aboard CSS DAWSON (in conjunction with personnel from Marine Ecology Laboratory, Bedford Institute). A concurrent physical oceanographic program was in place from May to October, providing the necessary background for linking the age structure and spatial distribution of capelin larvae to physical processes. Data analyses is in progress.

The occurrence of capelin in stomachs of cod and plaice, and catches of capelin during bottom trawl surveys were used to describe in broad terms the distribution of capelin in Div. 3L.

e) Herring. Surveys to determine distribution and abundance of herring larvae were conducted in Trinity Bay in June, August, September and October. The goal of the project is to determine at which stage in the early life history recruitment of a particular year-class can be reliably predicted. Sonar surveys were conducted to estimate herring abundance in bays of southeastern Newfoundland during Feb.-March and Nov.-Dec. in northeastern Newfoundland.

f) Scallops. A research survey was undertaken to assess the state of sea scallop stocks on St. Pierre Bank (Subdiv. 3Ps).

g) Shrimp. Only one of nine sets made in St. Anthony Channel in 1986 was productive for shrimp (188 kg.). No extensive survey of this area was carried out.

h) 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.

i) Crabs. Studies on biological aspects of a shallow-water spring breeding migration of snow crabs were continued. Studies investigating the effect of water temperature on yearly recruitment were continued.

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

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 survey of about 80 commercial salmon fishermen was conducted to assess local sales and effort expenditure. A total of 1,571 Atlantic salmon caught in the commercial fisheries was sampled for size and age distribution.

l) Multispecies. Investigations of multispecies relationships are progressing using stability studies of computer models of marine tropic webs. Work is focusing on role of early life history stages in ecosystem dynamics and of specific linkages for higher stages. Experimental work has commenced on the role of predation and food supplies in the survival of cod and capelin larvae.

m) Ichthyoplankton. Ichthyoplankton sampling in Conception Bay in 1986 completed field work for a study of larval fish succession, feeding and niche overlap that was begun in 1985. The sampling was intensive in time but did not attempt to resolve spatial patterns. Extensive analysis of morphometrics and feeding are underway. Several diurnal studies were completed.

n) Newfoundland Institute for Cold Ocean Science (Memorial University). Field investigations were mounted in the large bays along the NE Newfoundland coast (White, Notre Dame, Trinity, Conception Bays) as part of investigations on circulation and exchange between large bays and the continental shelf and biological productivity in the area. Studies included CTD measurements, plankton and water sampling and sediment studies.

NICOS researchers were also involved in investigations of the spring bloom in Conception Bay and relationships to nutrient depletion and productivity in cold ocean environments.

SUBAREAS 2 AND 3

A. Special Research Studies

1. Environmental Studies

a) Oceanographic and related studies. The Bedford Institute (AOL) prepared monthly State-of-the Oceans reports (from July, 1984) on research activities throughout the NAFO Area. Ships of opportunity XBT programs have also been continued.

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 1986. Six month temperature recorders were provided to researchers in conjunction with the DFO long-term Temperature Monitoring Program. Field trials of air deployable XBTs were also undertaken.

b) Marine Ecology Laboratory (Bedford Institute). Subareas 2+3 (with Subareas 4,5,6). During the 70's and early 80's several studies at the Marine Ecology Laboratory found correlations between environmental variables and fish catch over large areas of the Northwest Atlantic. Recent studies have extended the time series and re-examined the relationships. For six of the thirteen stocks, the correlation remained high and of the same sign. The analysis suggests that future investigations of environmental effects on fisheries recruitment will require independent estimates of population abundance, or if catch data are to be used, they should be corrected for changes in fishing effort.

An investigation of the effects of Gulf Stream Rings on recruitment was started in cooperation with DFO scientists in Newfoundland. It is proposed to test the hypothesis that shelf water entrained by these rings may transport enough fish eggs and larvae to significantly reduce recruitment. An approximately 10-year time series of the number of rings, the position of the shelf/slope front and the position of the north wall of the Gulf Stream have been generated from IR satellite imagery for nine principal shelf bank regions as an initial stage in the investigation.

An overview of environmental effects in the NAFO region during 1986 was completed. Several anomalous features were observed, including colder than normal temperatures in the Labrador Sea and over the Grand Banks, high wave activity in the Labrador Sea, and heavy ice conditions on the Labrador Shelf and in the Gulf of St. Lawrence (all NAFO Subareas).

c) Centre for Cold Ocean Resources Engineering (C-Core), Memorial University. Over the last eighteen months, C-Core has concentrated on the analyses of field data collected in 1984 and 1985, (remote sensing, ice detection, seabed sediments, iceberg scouring, geophysical, geotechnical, ice dynamics). Researchers expect that 1987 will be a very active year for field work. The Oceans Engineering Information Centre (OEIC) at C-Core was awarded a Fisheries and Oceans contract to determine whether the OEIC collection could be used as an information resource for Canadian ocean technology documents for Aquatic Sciences and Fisheries Abstacts. Work also continued on the transfer of cold ocean information into the Arctic Sciences and Technology Information System.

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 1985 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, four Arctic charr stocks and other commercial and potentially commercial species.

b) Research vessel cruises. Fifty-nine research vessel cruises were undertaken in 1986 utilizing DFO-owned vessels (WILFRED TEMPLEMAN, MARINUS, SHAMOOK, ALFRED NEEDLER), 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 1986. A total of 1,284 samples representing some 367,296 length measurements and approximately 5,052 otolith pairs were collected from the catches of foreign and Canadian offshore fisheries in Subareas 2+3. A total of 3,054 days and 12,418 sets was observed. Approximate coverage in 1986 was 13% for Canadian and 93% of foreign. 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 more closely.

d) Cod. Catch and weight at age data for cod in Div. 2J3KL and 3NO were re-evaluated for time periods where there appeared to be discrepancies on where estimates had been made previously. In both cases, improvements were observed in the data base.

A retrospective analysis of Div. 2J3KL cod (projections from 1977 to 1984 using known parameters such as recruitment, partial recruitment, average weights, etc.) was carried out. Retrospective projections on the Arcto-Norwegian cod stock were also conducted to determine the effects of fishing at levels higher than $f_{0.1}$.

An examination was made of catch estimates provided by DFO's surveillance personnel including a comparison of these statistics and those reported by NAFO member countries.

Estimates were developed of the proportions of cod biomass in Div. 2J3KL, including estimates of biomass inside and outside the 200 mile Canadian fishing zone.

A comprehensive review of factors influencing the catch by the inshore cod fishery in Labrador and Newfoundland was published (DFO Technical Report Series).

e) Marine Mammals. Our inventory of hooded seal data has been computerized. Age composition and tagging data have been updated. A comprehensive research proposal was prepared for harp and hooded seal surveys in the Gulf of St. Lawrence (Subarea 4), at the Front (Subareas 2+3), and in Davis Strait (Subareas 0+1).

Male reproductive biology analysis (harp seals) based on 736 specimens with baculum and testes measurement was carried out. From the logistic model of 92 specimens with histological examination, the male harp seal reaches sexual maturity at 4-5 years. Also, sampling design and statistical analysis for a study of bile acids from the harp seal was completed.

During March 1986 experiments were conducted to determine the accuracy and interobserver variability in classifying developmental stages of hooded seal pups. These classifications are necessary to correct aerial survey results for the distribution of births over time in a whelping patch. Also, a preliminary aerial survey estimate of hooded seals in the Gulf (Subarea 4) was made. Correcting for a missing whelping patch and the distribution of births, pup production in the Gulf was estimated to be in the order of 700-900 pups. The results of both of these studies were presented to the CAFSAC Marine Mammals meeting in November 1986.

Research on whales in the Newfoundland Region was conducted on an opportunistic basis in conjunction with Dr. J. Lien (Memorial University of Newfoundland). Whale sighting surveys were conducted on two cruises to the Grand Banks of Newfoundland during May and June. Four blue whales stranded in the Port-aux-Basques area during March 1986 were examined and a study on the early spring presence of blue whales off southern Newfoundland was initiated.

f) Turtles. A study of leatherback turtles in Newfoundland was initiated. These endangered animals commonly enter Newfoundland waters during the summer and occasionally become entangled in fishing nets. In a preliminary study conducted with Dr. J. Lien (MUN), two leatherbacks were examined and biological samples collected. A third turtle was successfully released.

g) Cod-capelin interactions. A Cod-Capelin Working Group has been formed. 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 will be held in 1987.

h) Parasitology. A comprehensive project has been established to examine the distribution, abundance, inter-annual variability, and host-parasite relationships of nematode parasites in cod from stocks in Div. 2J, 3K, 3L, 3O and Subdiv. 3Ps. Contributions will also be made to technical aspects of parasite detection and removal.

3. Other

a) Fish sorting equipment. A pilot project funded under the Atlantic Fisheries Development Program and conducted by Grove Telecommunications Ltd. of St. John's has resulted in the development of a high tech machine vision system for sorting fish and storing relevant data. The equipment provides a high degree of sorting accuracy and has application in fish processing plants, aboard fishing trawlers and on fisheries research vessels. In terms of research vessels, it is anticipated that the system will provide automatic collection and entry of base data, species landed by tow, size distribution, geographic location of catch/tow, time of catch/tow and rapid data access and communication.

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 increased by 9.3% to 200,918 MT. The decrease was due to reduced catches of redfish and cod, only partly compensated for by increased catches of haddock and minor species.

2. Cod

Total landings increased by 4.8% to 91,527 MT, 45.6% of total groundfish catches in the area. The decrease was spread over the whole of the Scotian Shelf except in Subdiv. 4Vn where there was a slight increase.

3. Haddock

Nominal landings increased 23.0% to 30,735 MT. Catches from Div. 4X remained at the same level as in 1985 but catches from Div. 4W more than doubled and there were increased catches from Subdivs. 4Vs and 4Vn, confirming the shift in the Scotian Shelf haddock fishery towards the east.

4. Flatfish

Flatfish catches rose by 10.3%, mainly due to increased landings of witch flounder and mixed species which more than compensated for a reduction in American plaice catches.

5. Redfish

Catches rose by 11.8% to abut 11,562 MT due to increases in catches from Div. 4X and 4Vs which counteracted decreases in Div. 4W and 4Vs.

6. Pollock

Pollock catches increased by 3.4% from 1985 to 41,111 MT. A 14% reduction in catches from Div. 4X, which contributed 59% of the total, was compensated for by increased catches from the remainder of the Scotian Shelf (Div. 4W-V), mainly Div. 4W.

7. Other Groundfish

Total landings from the area were up 37.1% from the 1985 level at 13,032 MT mainly due to increased catches of white hake and angler which showed increases of 39.1 and 390.0%, respectively.

8. Scallop (Placopecten magellanicus)

Landings totalled almost 11,000 MT round weight, a 25% increase from 1985.

9. Herring

Total nominal catches were 108,167 MT. This is down about 25% from 1985, mainly due to reduced catches from Div. 4X where they amounted to about 94,400 MT, 27.5% below last year, but still constituting 72% of the total catch from the Scotia-Fundy region.

10. Mackerel

Nominal landings decreased by 23% from 1985 to 4800 MT, almost all from Div. 4X.

11. Tuna

No information available.

12. Swordfish

Thirty-one longline vessels reported landings totalling 714 MT, 82.6% above the 1985 landings. A further 30.9 MT was taken by harpoon. The average weight of fish was considerably lower than in 1985 at 43.7 kg compared with 46.8 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 22.5 MT, a decrease of 16.4% from 1985. This was a grilse-only retained sports fishery; there was no licensed commercial fishing for salmon in 1986.

14. Squid (Illex illecebrosus)

Both catch and effort in the international fishery remained low with a nominal catch of only 41 MT for Subareas 2 to 4. This is the 4th consecutive year with catches of under 1,000 MT.

Squid (Loligo pealei)

No fishery existed historically for this species in Subarea 4. However, Loligo was unusually abundant in 1986 and it is probable that most of the 67 MT of unspecified squid reported were of this species.

Subarea 4: Divisions 4V-W-X

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

(a) Hydrography. Analyses of CTD and current meter data has led to improved understanding of large frontal processes in the Gulf Stream.

A barotropic tidal current model for the Scotian Shelf was completed as a result of studies of current surges and large-amplitude internal waves.

Oceanic response to severe winter storms was studied on the Scotian Shelf during January-March 1986. Measurements were made of current, temperature, salinity and bottom pressure at 11 sites, coastal sea level, surface waves, surface currents (via HF radar) and marine winds.

Analyses of residual currents in the Scotian Shelf-Bay of Fundy (Div. 4X) are continued in relation to larval herring distributions.

Extension and re-examination of relationships between environmental variables and fish catches confirmed earlier findings of correlations in six of thirteen stocks.

An investigation into the effect of gulf stream rings on recruitment was started to test the hypothesis that Shelf water entrained by these rings may transport enough fish eggs and larvae to reduce recruitment significantly.

(b) Plankton Studies. Micro-, meso- and macrozooplankton samples, CTD profiles and acoustic data were collected on the Scotian Shelf during September as part of a study of the influence of different water masses on zooplankton production and community structures.

Vertical distribution of lobster larvae was studied over Browns (Div. 4X) and Georges (Div. 5Zc) Banks to evaluate the importance of offshore lobsters in general recruitment to the area, both inshore and offshore.

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

Distribution of squid (Illex illecebrosus) larvae was surveyed in the area of the slope water between the Scotian Shelf (Div. 4V-W-X) and the Gulf Stream.

(c) Benthic Studies. Isotopic analysis of sea scallop (Placopecten magellanicus) samples from Browns Bank (Div. 4X) and Georges Bank (Div. 5Zc) was made for comparison of growth rates.

Scallop aggregations in the Bay of Fundy (Div. 4X), Scotian Shelf (Divs. 4W-X) were surveyed for assessment purposes.

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). Two squid cruises were carried out (Subareas 4, 5, 6), one in the Cape Hatteras-Straits of Florida area and the other in the Gulf Stream area between 69° and 58°W, for examination of distribution of different life stages and related environmental factors. 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. Electrophoretic analysis of cod tissues for stock differentiation was carried out. A study of utility of various indicators of larval condition was initiated.

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

(c) Haddock. Study of vertical distribution of juveniles (midwater phase) in two contrasting hydrographic sites in relation to the thermal structure of the water column and distribution of zooplankton continued, with special reference to the occurrence of Caligus sp. ectoparasites on young cod and haddock.

(d) Pollock. Meristic analysis was continued for stock discrimination. Meristic counts were made on juvenile pollock to investigate the relationship between inshore areas and offshore spawning areas.

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

An experiment to test a variety of tags for use on juvenile herring was completed. A miniature verison of the Floy fine plastic tag and coded microwire (imbedded at the base of the skull) proved best marking methods.

A study of the transboundary nature of herring along the coasts of New Brunswick (Div. 4X) and Maine (Div. 5Y) was initiated with an extensive larval survey.

An acoustic survey was carried out in the Chedabucto Bay area (Div. 4W) to estimate size, composition and abundance of overwintering concentrations.

(f) Redfish. A survey of redfish stocks on the Scotian Shelf edge (Divs. 4X-W-V) was completed. Studies of redfish parasites for use in stock discrimination were completed.

(g) Silver hake. A study of feeding relationships of silver hake on the Scotian Shelf (Divs. 4X-W) was completed.

(h) Squid (Illex illecebrosus). Studies of oceanic factors associated with distribution and abundance continued.

(i) Spiny dogfish. A study of feeding and fecundity continued.

(j) Tagging. No tagging experiments were conducted in 1986.

3. Gear and Technology

Target-strength measurements on fish and development of theoretical concepts of acoustic measurement for estimation of fish concentrations. Development and commercial production of "Ecolog" dual beam acoustic system.

Subareas 5 and 6

A. STATUS OF THE FISHERIES

1. Groundfish General

Total nominal landings decreased by 18.9% from the 1985 level to 17,208 MT, about 82% of which was from Georges Bank (Div. 5Zc). Landings of all major species except pollock fell. Cod and haddock together constituted 75% of the landings.

2. Cod

Landings decreased by 22.5% to 9,211 MT of which 91% was from Georges Bank (Div. 5Zc).

3. Haddock

Landings decreased by 15% from the 1985 level to 3640 MT, continuing the general downward trend since 1980.

4. Pollock

Nominal landings decreased by 24.2% to 2191 MT, 70% of which were taken on Georges Bank (5Zc).

5. Other Groundfish

These constituted only 12.6% of the total groundfish landings, flatfish being the main contributor, with landings up by 5.2% from 1985 at 461 MT.

6. Scallop (Placopecten magellanicus)

Landings totalled 40,000 MT round weight, up 25% from the 1985 level.

7. Herring

No herring were landed from Subarea 5.

B. SPECIAL RESEARCH STUDIES

Complete coverage of Georges Bank (Div. 5Zc) was introduced for the first time as a routine part of Scotia-Fundy groundfish research trawl surveys, in March 1986.

A comparative fishing experiment (Canada/U.S.) was carried out to investigate horizontal distribution of juvenile haddock and cod in relation to current patterns, water masses, ocean fronts and plankton communities.

Observations of juvenile haddock behaviour were made from a submersible on Georges Bank (Div. 5Zc) with the cooperation of U.S. scientists.

SEALS

Subareas 2, 3 and 4

A. STATUS OF THE FISHERIES

Harp Seals

The total catch including the Gulf of St. Lawrence and the "Front" was 24,608, 28% above the 1985 level of which almost all were taken by landsmen. The "Front" yielded 19,544, 79% of the Northwest Atlantic catch.

Hooded Seals

The total catch was 33, only 4% of the 1985 catch.

Grey Seals

The total catch was 2,522, down 21.5% from 1985.

B. SPECIAL RESEARCH STUDIES

Harp Seals

From a catch in the estuary of the St. Lawrence, studies were continued on age composition of the Gulf harp seal population.

A book on the biology of harp seals and history of sealing was prepared, to be finalized in 1989.

Hooded Seals

Studies were made on the population of hooded seals whelping in the Gulf and on the frequency of growth stages of pups at various dates.

Grey Seals

Total pup production on Sable Island was enumerated. Total production - 6283; live escapement - 5800. All were tagged with Jumbo Rototags. Preweaning mortality to February 13th was 483 i.e. 7.7%.

A cohort of 500 newly weaned pups was branded, comprising 400 females and 100 males. Sixty yearlings were sampled and data on growth and tag loss obtained.

The presence of several hundred branded adults, marked as pups in 1969 and 1974, was recorded.

Data on annual fluctuations in sealworm burdens were analyzed and reported.

Harbour Seals

Total pup production on Sable Island was enumerated and tagged. Pup production was 531 of which 22 were killed by sharks by June 5th. One-hundred pups were weighed at birth and thereafter at 3-day intervals. Data on pup growth were obtained to weaning.

Section III. Gulf Region

by

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A. STATUS OF THE FISHERIES:

1. Southern Gulf Cod (4TVn):

The total allowable catch was 60,000 tonnes including 7,000 tonnes for french fleet. Preliminary data indicate that the domestic fleet took approximately 102% of their allowance, and France took 100%, for total landings of 61,000 tonnes. Assessment of the resource will be conducted in September 1987. No definite statement on catch rates can be made until this assessment is complete, although it appears that catch rates were in the range observed in recent years. Higher proportions of small cod (less than 43 cm) were observed in the landings compared to previous years.

2. Gulf Redfish (4RST):

The total allowable catch was 55.6 tonnes. Provisional statistics for 1986 indicate a 19% increase in catch from 1985 to 33,107 t, a catch similar to the 1984 catch. This fishery is conducted primarily by Canadian tonnage class 4 and 5 bottom trawlers. In recent years, the fishery has been primarily conducted in the second half of the year. In 1986, the highest catches were taken in July, August and October. A nonequilibrium general production model indicates a 2/3 f_{mey} yield of 56,000t.

3. Southern Gulf American Plaice (4T):

The total allowable catch for the 4T American plaice fishery has been 10,000t since 1977. Annual landings have been near or below this level; the 1986 nominal catch was 7,000t. Historically, the fishery was primarily a by-catch fishery of the southern Gulf of St. Lawrence cod fishery. However, the percent of catch from the directed plaice fishery has increased from 21% in 1980 to 55% in 1986. In 1986, the plaice fishery remained open throughout the season for all gear types.

The nominal catch during 1986 was lower than the previous two years and the average catch since 1972. Landings varied seasonally, with highest landings in June and September. Danish seines, otter trawlers (stern) and otter trawlers (side) accounted for 48%, 27% and 10% of the landings, respectively, while the remaining 15% of the landings came from longliners, gillnetters, shrimp trawlers and hand lines.

4. Southern Gulf White Hake (4T):

The total allowable catch for 1986 was 12,000 tonnes. This is a seasonal, localized fishery carried out mainly by inshore vessels of under 25 GRT. Gillnetters and small draggers account for the majority of the catch.

Nominal catches from this small vessel, inshore, mainly summer and early fall fishery, have ranged from a high of 14,039 t in 1981 to a low in 1974 of 3,616 t. In 1982, a precautionary TAC was set at 12,000 t. The 1986 nominal catch was 4,601 t, this was a drop of 1,200 t (22%) from 1985, continuing the decline since 1981. Gillnets landed 37% of the total 1986 catch, about the same as in 1985. Landings from trawlers were down to less than half their 1985 levels, while those from longliners were up to 27% of the total.

For the first time, an analytical assessment was conducted in 1986. The long-term yield at Fo.1 appears to be in the range of 6,000 tonnes to 8,000 tonnes.

The SPA indicates that the stock is extremely dependent on recruitment, which has been variable. This, coupled with the preliminary nature of the first SPA, precludes the use of forward projection techniques on this stock.

5. Southern Gulf Herring (4T):

The total allowable catch was 43,375 t in 1986, partitioned as follows:
-- 7,200 t for the spring gillnet fishery;
-- 27,500 t for the fall gillnet fishery;
-- 8,675 t for the purse seine fishery.

Final landings for 1986 are not yet available. Total landings were 59,031 tonnes, which were 36% greater than the TAC. The spring gillnet fishery was managed by seasonal quotas, i.e, 4,000 t of herring could be caught between January 1 and May 21; 2,200 t of herring could be caught between May 22 and May 31; and 1,000 t of herring could be caught between June 1 and June 30. The fall fishery was managed by a global quota and weekly closures, in order to ensure an equitable distribution of catch.

The following general points can be made with reference to the 1986 nominal catches: (1) The largest monthly catch was taken in September 1986 -- 50% of the annual catch was taken in this month; in 1985, it was also 50%. (2) 70% of the catch was taken in the fall gillnet fishery which had its largest catch since 1971, and probably the largest in history. (3) The fall 1986 purse seine catch was the largest since 1980. (4) About 5% of the 4T catch was landed in Quebec.

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

The total allowable catch for 1986 was 575 tonnes. This TAC is set by ICCAT, and is part of an overall Western Atlantic quota of 2,660 tonnes. The reported nominal landing for Canada was 439 fish (160 tonnes). The traditional fishery by Canadian rod and reel and tended line landed 94% of the fish, while on experimental offshore longline fishery, the Japanese landed 345 fish. The Canadian rod and reel and tended line catch rate series are used for calibrating the older fish, 16+ years, in the stock assessment.

7. Atlantic Salmon:

In all areas, returns of 1SW and MSW salmon were above average in 1986. One-sea-winter and MSW salmon returns to counting facilities exceeded 1985 values, and all, except Millbank, Miramichi River, and Western Arm Brook, were above 1974-85 means. One-sea-winter returns to Western Arm Brook, Newfoundland, may have been influenced by lower than average water levels, as in 1985.

Sport catches of 1SW and MSW salmon on the Restigouche (Statistical Fisheries Area 15), Miramichi (SFA 16) and Margaree rivers, and all other rivers in SFA 18, were above 1985 figures and 1974-85 means. One-sea-winter and MSW salmon sport catches in west Newfoundland, exceeded 1985 values, but were equivalent to 1974-85 means. Commercial catches in west Newfoundland also exceeded 1985 values with those of 1SW fish being above, and those of MSW salmon being equivalent to 1974-85 means.

In 1986, actual 1SW returns to the Miramichi and Restigouche rivers exceeded predictions, while MSW returns to these rivers and those in west Newfoundland were close to forecasts. Forecasts of MSW salmon returns for the Restigouche and Miramichi rivers, in 1987, suggest that 1974-85 means will again be exceeded. Forecasts for SFA 13 (S.W. Newfoundland) indicate slightly above average returns in 1987.

8. Gaspereau (4T):

Advice on the status of two gaspereau stocks in the Gulf Region were presented. The data indicated that for the Miramichi River fishery, 36 nets, which were fished seven days a week, caught 1,154 t, and for the Margaree River fishery, the catch was 545 t. The 1986 catch was, like that of 1985, almost (99.8%) exclusively of alewives of which 55% were of the 1983 year-class, and 26% were of the 1981 year-class. The latter year-class dominated the 1985 fishery, and also made a strong contribution to the 1984 harvest, exemplifying the importance of the strength of a single year class to the success of the current fishery.

9. Gulf Lobster (4RT):

The 1985 and 1986 landings of 17,721 t and 15,449 t respectively, compared with 1984 landings of 14,085 t. Catches have been increasing or remaining stable in most areas since 1975, present landings reflecting a stable fishery. The previously depressed central Northumberland Strait area has experienced a high level of landing increases since 1982. This area now leads lobster District #8 in landings.

10. Southern Gulf Snow Crab (4T):

The overall total allowable catch for this fishery was set at 26,000 t in 1984, increased to 28,000 t for 1985, and was replaced by a season (April 12 to July 1) for 1986. The preliminary figure for landings in 1986 is 24,267 t. The catch rate for New Brunswick vessels fell in both years, while that for Quebec vessels increased to levels reported previously for New Brunswick vessels. The average catch rates for the two fleets combined showed a slight drop between 1985 and 1986 -- 57.3 kg/trap haul to 55.7 kg/trap haul.

The TAC, for the Gulf Coast of Cape Breton (Areas 19 & 18 -- snow crab fishery), was 1,338 t and 627 t, while the preliminary nominal catch was 1,420 t and 627 t respectively. The 1986 fishery for the Gulf Coast of Cape Breton produced the highest catches in recent years despite the lowest average catch per trap hauled. This was achieved as a result of more effort, and it generated an increase in the exploitation rate to 55%.

In Prince Edward Island (Areas 25 and 26 - snow crab fishery), an experimental fishery was initiated in 1985, when 16 permits were issued, and expanded in 1986, when an additional 14 permits were issued.

11. Southern Gulf Scallop (4T):

The total landings for 1986 are not available at this time. Compared to 1985 data, the 1986 relative recruitment potential (% of prerecruits) increased between 2.7% to 24.9%. In 1987, the recruitment rate to the fishery is expected to continue to increase or to stabilize, unless a natural disaster occurs, i.e., mass mortality.

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

Temperature profiles were collected at 80 stations in the southern Gulf Divisions 4T area; and 175 stations in the northern Gulf Divisions 4RST during 1986.

2. Biological Studies

a) Cod

Commerical fishery data (catch and weight at age, catch per unit of effort, discard rates) and research survey data were used for the assessment of the 4TVn cod stock. During the year, the technique of sectioning otoliths was evaluated, and it was decided that this technique would be used in the future for the preparation of 4T otoliths.

b) Redfish

The input data for the assessment of the redfish in the areas 4RST came from commercial fishery data and research surveys. The nonequilibrium version of the Schaefer model was used for the general production model. During the year, the distribution of redfish biomass was reexamined using new data on sea temperature. The Shipboard Data System (SDS) for electronic data acquisition on research vessel surveys was refined to improve the collection of biological data at sea.

c) American plaice

The input data for the assessment of the American plaice in area 4T came from commercial fisheries data and research vessels. Commercial catch rates for Maritimes - Quebec and Newfoundland, using otter trawlers (stern), otter trawlers (side), Danish seines, Scottish seines and longlines were standardized over 1977 to 1986 for the directed fishery using a multiplicative model. There has been a decreasing trend in catch rate since 1979 with a slight increase in 1985 and levelling off in 1986.

d) White Hake

The input data for the assessment of the white hake in area 4T came from age composition of the catch, commercial catch rate and research surveys. During the 1986 assessment, the historic catch at age was adjusted to remove the plus group. Inshore cruises were completed throughout the summer and fall, in order to collect data for the analytical assessment.

e) Herring

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. In the fall of 1986, an independent abundance index was initiated within 15 index fishermen.

A study on herring stock identification using meristics and morphometrics was conducted. An acoustic survey was conducted, along with a workshop on stock assessment for representatives from the herring industry. Spawning bed surveys of Atlantic herring, in the southern Gulf of St. Lawrence (NAFO Division 4T), were continued in the fall of 1986. An underwater video camera was used to assist the scuba divers in locating and delineating the spawning bed. A spawning bed of an area 1.1 km² on Fisherman's Bank over a depth of 15m was found. Scuba divers collected samples of eggs, in order to estimate egg density and spawning biomass. Egg density was estimated at 3,800,000 eggs/m². The number of spawners was estimated at 58,200,000, comprising a spawning biomass of approximately 17,000 mt.

A number of samples of fish predators were also collected for the first time. We recorded mackerel (Scomber scombrus) feeding heavily on herring eggs. Winter flounder (Pseudopleuronectes Americanus) was another major predator. Estimated egg mortality, due to predation, was crudely estimated to be 30% of initial spawn.

f) Atlantic Bluefin Tuna

A stock update 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 Canadian waters. However, in 1986, the limited catch precluded such data collection. Fishermen's logs were coded and analysed for a commercial catch rate series.

g) Atlantic Salmon

In addition to providing input to the status of Atlantic Salmon stocks in Atlantic Canada, and advice for their management in 1987, research was conducted in the following topics - selection at sea of 1SW salmon; oocyte development research; dynamics of river age; morphometric and meristic studies; field studies of drifting prey and selective feeding of salmon fry; studies of the effect of discharge on angling catches; and the effect of density on mortality of parr.

h) Gaspereau

Assessments of the 1986 fisheries for the Margaree and Miramichi rivers were completed using samples from commercial traps, weighed by daily catches estimated from logbook, to generate a catch-at-age matrix. A mark-recapture experiment was completed. In addition, research was conducted on the following topics: stock-recruitment relationship for gaspereau in South River; and a study on gaspereau fecundity.

i) Lobster

Lobsters (Homarus Americanus). Extensive tagging of lobsters was conducted in Cape Breton, Nova Scotia; Baie des Chaleurs, New Brunswick; and St. John's Bay, Newfoundland. These series of tagging are part of a general survey of short and long-term patterns in movements of lobsters in the Gulf of St. Lawrence. The information on recaptures is also used for growth and mortality studies.

At sea, sampling of commercial lobster, catch is conducted from the Baie des Chaleurs to the Labrador coast. The information is used for providing management advice for local adjustments in fishery regulations.

Detailed surveys on relative performance of several mechanisms designed for allowing the escape of lobsters, smaller than the minimum legal size, were conducted in New Brunswick and Prince Edward Island. A computer model was designed for forecasting the performance (retention of lobsters of commercial size versus escape of lobsters smaller than the minimum legal size) of escape mechanisms of any gap width and, therefore, the best option for a gap width as a function of minimum legal size.

Underwater television and diving observations on behaviour of lobsters entering traps provided complementary information on daily rythms in foraging activity of lobsters and competitors and on the efficiency of gear.

j) Snow Crab

Snow Crab (Chionoecetes opilio). 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 and port sampling programs were supplemented by trawl and camera surveys to estimate distributions and other biological parameters of the Gulf's snow crab populations. An aerial survey of fishing effort was performed for the northern Prince Edward Island inshore fishery. All of the Gulf fisheries appear to have reached or exceeded their maximum sustainable levels of fishing effort. Effort may need to be decreased in some areas to maintain the long-term viability of the stocks. The opportunity of modifying management policies, as a function of recent advances in the knowledge of the maturation and reproductive processes of snow crabs (terminal molt at maturity), are being considered.

Studies were conducted on molt stage determination based on setal morphogenesis and also on integumental development. Studies on functional and morphometric maturity using a bivariate discriminant technique were completed. Tagging surveys using T-bar tags were continued in the Prince Edward Island fishery to determine movement of crabs in this area. Monitoring of short-term movements of crabs were continued in Bonne Bay by using biotelemetry. A geostatistical technique for biomass analyses was developed.

k) Scallop

Icelandic Scallop (Chlamys islandica). The Icelandic scallop stock, in the Strait of Belle Isle, was surveyed through logbooks and landing statistics analysis, and by experimental fishing. The fishing grounds and the fishing effort were mapped. Historical records show that the fishery expanded in the area until 1985, it is now believed that all productive grounds are being harvested. A levelling or slight decrease in CPUE's is forecasted for 1987. A management plan for maintaining a sustainable yield is suggested.

Giant scallop (Placopecten magellanicus). A new voluntary logbook system was designed for monitoring the catch of giant scallop. Observers were embarked aboard fishing vessels for collecting detailed biological information on the catch. Experimental surveys were performed from chartered vessels in the Northumberland Strait. It was shown that the relative abundance of prerecruits (scallops $\leq$ 70 mm) had increased in 1986. These new classes may ensure the renewal of the fishable stock which had been mostly limited to 1978 and 1979 year-classes over the last four to five years.

Research on geographic variability of selectivity, maturity and growth was pursued and results presented.

l) Bar Clam

Bar Clam (Spisula solidissima). Biological studies on bar clams were completed at sites on the Northumberland Strait and Gulf of St. Lawrence coasts of Prince Edward Island. The results of two consecutive years study of the reproductive cycle showed that gonads developed quickly to the ripe stage by June and July, as water temperature warmed, followed by a prolonged spawning period from late July to October, and spawning ceased, as water temperature decreased in October. The sex ratio was 1:1 and no hermaphrodites were found. A study to determine age and growth rates (from chondrophore sections) of clams from different areas of P.E.I., and a mark-recapture field experiment will be completed in 1987.

A voluntary logbook program was initiated during the 1986 fishing season, and the catch and effort data were analysed to provide a first estimate of catch per unit of effort for the P.E.I. fishery.

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 - Artic Biological Station, Ste Anne de Bellevue (A certain amount of research is carried on outside the NAFO convention area but is still presented here in order to describe research activities). DFO

MLI - Maurice Lamontagne Institute, Mont-Joli (Formerly identified as QUE and CREP) DFO

MLI-MAPAQ - Joint projects for MLI and MAPAQ

MAPAQ - Direction de la Recherche scientifique et technique, Quebec Provincial Government.

1- Research report 1986

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) 1983	1984	1985[1]	1986[2]
Cod	4RS,3Pn	106 (100)	93 (100)	87 (100)	N.A. (92.1)
Greenland Halibut	4RST	1.1 (5)	1.8 (5)	2.4 (5)	N.A. (5)
Redfish	4RST	25 (33)	36 (50.6)	28 (50.6)	N.A. (55.6)
Herring	4R	8.7 (10)	8.1 (10)	9.1 (10)	N.A. (17)
	4S	1.1 (1)	1.0 (1)	0.5 (1)	N.A. (1)
Mackerel	3-6	32.5	29.5	68.3	N.A.
Capelin	4R	0.9 (20)	1.9 (20)	2.2 (20)	3.3 (20)
	4T	0.1 (5)	0.2 (5)	0.5 (5)	0.7 (5)
Snow crab	4S,4Tpq	3.8	5.1	5.8	5.6
Shrimp	4RST	9.0 (15.3)	7.5 (16.3)	8.8 (14.5)	9.5 (12.1)
Lobster	4S,4T[3]	2.1	1.9	2.1	2.3
Scallop[4]	4S,4T[3]	0.8	1.1	1.3	1.0

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

MAPAQ The statistical data collection system implemented in 1985 was extended in 1986 and now covers more than 260 fresh and salt water commercial fishermen. The fixed gears fishing activities in the St. Lawrence estuary are related to species such as American eel, Atlantic sturgeon, American shad, capelin and rainbow smelt. Halibut, Atlantic cod and plaice are also recorded in the fixed gears of those fishermen. Data on effort, catches and discards are quite detailed and allow good estimation of the C.P.U.E. The 1986 catches of American eel and Atlantic sturgeon are respectively 499 and 75 tons while discards are 0.7% and 8.8%.

B) Special Research Studies

1- Environmental Studies

a) Hydrographic studies

b) Plankton studies (including eggs and larvae)

MLI A study of seasonal evolution of the ichtyoplanktonic and zooplanktonic communities was undertaken in the southwest part of the Gulf (Div. 4T). These surveys relate to the spatial distribution and abundance of mackerel, cod, herring, capelin and shrimp larvae.

c) Benthic studies

d) Observations on ice conditions in Subareas 0 to 4

e) Other environmental studies

2- Biological studies by species

2.1 Demersal fish

2.1.1 Cod

MLI The tagging program initiated in 1984 continued in 1986 along the west coast of Newfoundland. Sampling of the landings from the commercial fishery (Divs. 4RS,3Pn) and results from the winter groundfish survey were used to produce a stock assessment.

MAPAQ Migratory studies on the cod (Gadus morhua) populations of the lower North Shore of the Gulf of St. Lawrence (NAFO subdivisions 4Sv and 4Sw) have been conducted since 1983. The research was initiated to better understand the migratory patterns and to estimate the proportion of cod present belonging to the 4RS-3Pn stock and from 2J and 3K. From historical tagging-recapture date, it is hypothesized that a part of 2J and 3K cod stocks move into the Gulf of St. Lawrence. The studies were done using tagging-recapture method as well as analysis of a blood parasite (Trypanosama murmanensis) which appears to be specific to certain stocks. Twelve thousand cod have been tagged at different localities on the lower North Shore from 1983 to 1985 in the months of June and July, also numerous blood samples were taken to evaluate trypamosome infections. Thus far, approximately 1,800 (15%) have been recaptured. Preliminary results from recaptures show that the majority of the cod tagged in winter in the Cabot Strait area (NAFO division 4R and 3Pn) subsequently move northwards and inshore along the lower North Shore of the Gulf of St. Lawrence near the tagging sites in June. There seems to be some migration through the strait of Belle-Isle, however at this stage this migration seems to be minimal. Results of trypanosome infections have not yet been analyzed in detail. The tagging results and the prevelance of trypanosomes for the different areas are presently being analysed.

2.1.2 Greenland Halibut

MLI An analytical assessment was performed on this stock (Divs. 4RST) for the first time and results indicated a possible emigration of this stock from the Gulf of St. Lawrence.

2.2 Pelagic fish

2.2.1 Herring

MLI Stock assessments are performed on herring in Divisions 4R and 4S. This involves analysis of samples from the commercial fishery and analysis of log books of the gill net fishery. An analysis of macroscopic and microscopic maturity stage determination of herring was accomplished. Two tagging programs were initiated in order to determine the degree of intermingling of these two stocks.

2.2.2 Mackerel

MLI The stock (NAFO Areas 2-6) status is revised on an annual basis and is based on results of a survey aimed at estimating egg and larvae production around spawning areas in the southern part of the Gulf of St. Lawrence (Division 4T-4Vn) as well as results of the sampling of landings from the commercial fishery. A stock discrimination study was undertaken. A model bases on Gulf currents and mackerel landings was developed.

2.2.3 Capelin

MLI Stock assessment of the Gulf stock (Divs. 4RST) is undertaken annually.

2.2.4 Salmon

MLI A study on survival of post-smolts has been completed.

2.2.5 Eel

MLI Studies on this species were concentrated on glass eels, these involved work on the behavior and endocrinology of migrating fish, microstructure of otoliths and on mortality of adults as well.

2.3 Invertebrates

2.3.1 Snow Crab

MLI Stocks assessments of the snow crab of the St. Lawrence estuary and the north shore are performed on an annual basis.

MLI-MAPAQ In 1986, a cooperative project, dealing with a new sampling gear for juvenile snow crabs, was done on the middle North Shore (NAFO subdivision 4Sy) and in the Bay of Chaleurs area (NAFO subdivision 4Tn).

2.3.2 Shrimp

MLI The five shrimp stocks present in the Gulf of St. Lawrence are assessed on an annual basis, these include analysis of commercial and research vessel survey results. A stock discrimination study was initiated and results are to be analyzed in 1987.

2.3.3 Lobster

MLI Research activities involved juvenile lobster ecology, including energy investment in egg production, larval distribution, egg developement and reproductive potential of female lobsters in Magdalen Islands. A tagging program was initiated using micro-tags for lobster in the Magdalen Islands.

2.3.4 Scallop

MLI Data from commercial catches and results of dredge experiments were analyzed in order to assess stock size. Also spat was collected and analysed.

2.3.5 Mussels

MLI Specific studies on the feeding of planktonic concentrations and the analysis of the fine structure of growth rings were undertaken in order to improve mariculture methods used at the Magdalen Islands.

2.4 Marine mammals

2.4.1 Arctic seals and small whales

SAB A monograph entitled "The ringed seal of the western arctic" has been submitted to the Can. J. Aquat. Sci. for publication as a bulletin. It is based on 15+ years of data from the western arctic. The first year of the evaluation of the errors involved in ground and aerial surveys was conducted at Cunningham Inlet. Bad weather and aircraft unavailability necessitated second a field season. A third and final year of study of ringed seal breeding habitat in Barrow Strait was completed and a Ph. D. thesis (M.O. Hammill) is in preparation (NOGAP support). A continuing collection (annual) of ringed seals in the Amundsen Gulf was taken to evaluate (monitor) annual changes in body condition. An economic study of the role of subsistance hunting at Holman, NWT was completed. The first year of a three year study of the ecology and energetics of ringed seals in Svalbard, Norway was conducted in collaboration with the Norsk Polarinstitutt. Three ringed seals were captured and transported to Oslo. A telemetry station was established at Ny Alesund, Spitsbergen.

2.4.2 Northern Quebec marine mammals

SAB Collection of Inuit killed belugas at the Nastopoka River and Hudson Strait was continued. The completes the collection for a skin study (Ph. D. D. St. Aubin, Univ. of Guelph) and the 3rd year of a Ph. D. project (D.W. Doidge) on population dynamics. Collection of walrus specimens from Inuit hunt was continued. A report on Lacs des Loups Marins harbour seals was completed. A report on aerial surveys of Hudson Bay was submitted. And a M. Sc. thesis on Nastapoka estuary herd of belugas was completed.

2.4.3 Whales

MLI The beaching of marine mammals in the meridional Quebec was monitored and out of 35 individuals reported, 11 were belugas. Other species involved dolphins and seals. Fundamental research on social behaviour and communication among belugas was conducted.

SAB A small sample of adult male narwhals from the hunt at Pond Inlet N.W.T. was sampled for correlation of growth layer groups in erupted tusks and the periostreum of the dentary. Progress was made on a series of papers deriving from 1984 NOGAP historical studies and bowhead feeding studies. Work continued on population distribution, stock identity, and morphology papers relating to North Atlantic fin, sei, sperm, minke, humpback and other whales. Blue whale data were summarized, all available right whale data were added to the three right whale papers then in press, and a sperm whale paper was published. Limited progress was made on the inventory, curation and study (with specialist collaborators) of biological specimens remaining from wide ranging field studies carried out from 1966 to date. A review was completed on the current status of the Bering sea bowhead. Three papers on white whale population resulting directly or indirectly from NOGAP support in 1984 were submitted to press.

2.5 Marine plants

2.5.1 Laminaria

MLI-MAPAQ An analysis of available data of the production of laminaria was undertaken in order to produce an index of commercial exploitation capacity.

2.5.2 Ascophyllum

MAPAQ Various harvesting regimes are being conducted on the intertidal brown algae Ascophyllum nodosum (L.) in order to determine management regulations permitting optimum yield for this resource. The effects of harvesting frequency (from 1 to 5 year) and degree of cutting (manual harvest method) on instantaneous and long-term biomass recovery are investigated. The work in 1986 dealt with the rates of regrowth and potential long-term production of Ascophyllum according to harvesting strategies, as well as its suitability for commercial exploitation in the St. Lawrence Estuary (NAFO subdivision 4Tp).

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

4- Miscellaneous studies.