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CANADIAN RESEARCH REPORT, 1976

Section I. Subareas 1, 2 and 3

by

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Government agencies involved: Department of Environment: Fisheries and Marine Service; Department of Energy, Mines and Resources: Atlantic Geosciences Centre. Harp and hood seals are dealt with in Section III.

Subarea 1

A. STATUS OF THE FISHERIES

There was no Canadian commercial fishery in this subarea.

B. SPECIAL RESEARCH STUDIES

2. Biological Studies

a) Atlantic salmon. During August 1976, a total of 369 Atlantic salmon were caught at West Greenland by the Danish research vessel ADOLF JENSEN. These were sampled for length, weight, sex, scales, blood and gonads. A comparison of results from the discriminant function analysis of scale characteristics and blood serum transferrin patterns indicated that the estimated North American proportions at Greenland were 41% and 35% from scale and blood analyses respectively. These results yield estimates which differ in the same direction and degree of magnitude as those from the previous two years.

Subarea 2

A. STATUS OF THE FISHERIES

1. Cod

The landings from the Labrador coastal fishery were about 3900 tons, 28% above the 1975 level and 114% above the 1974 level. There were 1476 tons recorded from the offshore fishery.

2. Other groundfish

Landings of 2450 tons of redfish, 38 tons of American plaice, 12 tons of witch, 327 tons of Greenland halibut and 78 tons of other groundfish species were recorded from the offshore fishery. This total (2905 tons) is considerably above the total of 63 tons of these species recorded in 1975 and reflects the expansion of the Canadian offshore fleet into the northern areas.

3. Capelin

Landings remained at low levels (< 10 tons).

4. Mackere1

Landings remained at the 1975 level (15 tons).

5. Herring

Landings decreased from 738 tons in 1975 to 315 tons in 1976.

6. Atlantic salmon

The coastal fishery by set gillnets along the shore yielded a catch of 656 tons in 1976, an increase from 1975 (600 tons).

7. Arctic char

The commercial fishery by set gillnets along the shore yielded a catch of 159 tons, an increase from 1975 (85 tons).

8. Squid

Nil landings as in previous year.

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

a) Hydrography. Surface temperatures over the Labrador Shelf early in August were similar to those of 1975 and the 1951-71 average. The volume of cold water less than 0°C was greater especially in the area covering the shoreward stations seaward to the top of Hamilton Inlet Bank where the cold Arctic water extended from the upper layers to bottom.

Temperatures at intermediate depths were slightly lower than average, well below average at lower and bottom layers and except for the abnormally cold year 1972, were generally lower than any of the earlier observations.

In the deeper slope water, temperatures were below average and lower than any previously encountered including the unusual cold year of 1972, which suggests that the Irminger component of the West Greenland Current was apparently weak, or the inflow of usually warmer Irminger water contained relatively cold temperatures at that time of the year.

2. Biological Studies

a) Cod. Monitoring of the coastal fishery was continued in 1976. Catches by trap and gillnet were small. In the trap catches the length frequencies indicated the presence of a year-class with a mode of 37 cm, probably the 1972 year-class.

Samples were also taken from the Canadian commercial offshore fishery.

From research catches taken by lined otter trawl in Division 2J in November-December, the length frequency showed a pronounced peak at 37-40 cm, indicating the presence of the 1972 year-class.

b) Redfish. General production models previously used to estimate MSY for redfish in Subarea 2 and Division 3K indicated the stock to be in a depressed state. The TAC for 1977 was set at the 1974 to 1976 level of 30,000 tons to take advantage of improved recruitment entering the fishery.

c) Flatfish. All of the flatfish stocks in Subarea 2 overlap with Subarea 3 and hence assessment results are dealt with under the latter Subarea.

During 1976 a research cruise in collaboration with the Federal Republic of Germany and two commercial trawler cruises collected considerable amounts of data that are being used to improve the various parameters necessary for stock assessment as well as contribute to an understanding of the total biology of the various flatfish species.

d) Capelin. An acoustic survey of Hamilton Bank in November was unsuccessful because of bad weather.

e) Atlantic salmon. A program of commercial sampling was continued to provide quantitative descriptions on seasonal sizes and age patterns of salmon taken by commercial fisheries in the northern Labrador area.

f) Arctic char. A portable counting fence was installed to monitor the upstream migration of Arctic char in the Fraser River, northwest of Nain, Labrador, in July of 1975. Various aspects of the timing, duration, size and sex composition of the run have been studied. The river is being monitored to provide an account of the effects of the commercial fishing activities on the Fraser River char stock.

Analysis of the growth data indicates that for the majority of the char, age at first seaward migration is five years. Similarly at age five, greater than 60% of the fish examined were mature. Through marking and tagging experiments, information regarding the growth, distribution, distance travelled and homing tendencies of the char will be clarified.

In addition, a total of 329 Arctic char were collected from selected areas and discrete stocks. These were analyzed in detail to determine if there are morphometric or meristic differences in stocks from northern Labrador. This, in conjunction with tagging, will help in identifying stocks which are intermingled and form a basis for managing the char stocks on an individual stock basis.

Subarea 3

A. STATUS OF THE FISHERIES

1. Cod

Total Canadian landings were 90,800 tons, 56% above the 1975 landings. Almost all of this increased catch was from the inshore fishery, the offshore catch comprising only about 10% of the total.

The increased catch in the inshore fishery was probably a result of both increased effective effort, since ice conditions were less severe allowing fishing operations to commence earlier in the season than in 1975, and increased availability of cod to inshore gears.

2. Redfish

The Canadian redfish catch was 36,800 tons, an increase of 69% above the 1975 catch and almost 270% above the 1974 catch. This increase reflected an increase in effort as a result of diversion from the Gulf of St. Lawrence redfish fishery. The increase occurred in all ICNAF Divisions except 3Ps and 3Pn where quota restrictions resulted in a catch slightly less than in 1975.

3. Flatfish

These were the principal species taken by the Canadian trawler fishery in Subarea 3 and also formed an important part of the coastal boat fishery. Canadian landings of American plaice totalled 56,400 tons, 45% above the 1975 landings because of diversion of effort from the Gulf of St. Lawrence redfish and Grand Bank yellowtail fisheries. Canadian yellowtail landings were 10,100 tons, 46% below the 1975 landings because of quota restriction on 3LNO yellowtail. Witch landings were about 7100 tons, 80% above the 1975 landings because of diversion of effort from the Gulf of St. Lawrence redfish and Grand Bank yellowtail fisheries. Greenland halibut landings were about 9100 tons, 14% higher than in 1975. The total flatfish landings of 82,700 tons were about 19% above the 1975 landings because the decrease in yellowtail and Greenland halibut landings was more than offset by the increased plaice and witch landings.

4. Other groundfish

Landings of other groundfish totalled 4000 tons, compared to 2400 tons in 1975.

5. Capelin

Landings increased from 4600 tons in 1975 to 9500 tons in 1976, mainly due to increased effort in offshore areas.

6. Mackerel

Landings increased from 4000 tons in 1975 to 5200 tons in 1976, due mainly to an increase in effort.

7. Herring

Landings increased from 32,200 tons in 1975 to 38,000 tons in 1976, mainly due to increased effort on underexploited stocks along eastern Newfoundland.

8. Atlantic salmon

The coastal fishery by set gillnets and salmon traps along the shore yielded a catch of 1189 tons in 1976, a decrease from 1975 (1285 tons).

9. Squid

Landings increased from 3200 tons to 9805 tons taken in the inshore fishery.

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

a) Hydrography. In the northern Grand Bank to the Flemish Cap area, surface temperatures were above those of 1975 but similar to the 1951-71 average.

The volume of cold Labrador Current water which usually forms an unbroken core from the Avalon Channel to the eastern Grand Bank was divided into an inshore and an offshore stream with bottom and lower layer temperatures on the western slope and top of the Grand Bank well above the 1951-71 average and as high as any previously observed during the period.

In the deep water adjacent to the seaward slope of the Flemish Cap, temperatures were slightly below average but very similar to the lowest of the 1951-71 period.

Unfortunately we cannot report on conditions over the central and southern Grand Bank as the hydrographic stations in the area were not occupied during 1975.

2. Biological Studies

a) Cod. Monitoring of the coastal and offshore fisheries was continued in 1976. In the trap fishery, all areas showed a strong peak at 37-40 cm, indicating the presence of the 1972 year-class at 4 years of age. Gillnet catches were composed of larger and older cod. In Division 3K, while the average length in July was about 65 cm and catches included a great range of sizes, the presence of the year-class at lengths 34-40 cm was evident. Catches by the offshore fleet were generally composed of cod of ages 4-8 years.

Catches of cod by the A. T. CAMERON on the Grand Bank and St. Pierre Bank were small.

b) Haddock. Research vessel cruises indicated no improvement in the very low level of this population.

c) Redfish. Catch per hour from Division 3P levelled off at 0.5 tons in 1975. Despite impending recruitment, the TAC remained at 18,000 tons for 1977 for two main reasons: first, present recruitment is anticipated to be lower than that experienced in the 1960's and second, the MSY from the general production model is 18,000 tons.

The transition to a midwater trawl fishery in Divisions 3LN left some doubt as to actual impact of the fishery upon this stock. There is a possibility of 2 species of redfish in this area but this is unresolved at present. Since comparable data did not exist from previous years to evaluate the midwater trawl fishery, an updating of the assessment using catch and effort data from the traditional bottom trawl fishery indicated that the fishery was beyond F_{msy} in 1971-73 and the TAC was reduced from 20,000 tons in 1976 to 16,000 tons in 1977 to reduce effort below F_{msy} . Using limited data to update the assessment of the remaining redfish stocks in Subarea 3 (Divisions 3M and 3O) TAC's were recommended

to remain at the same level as in 1976, 16,000 tons for both.

d) Flatfish - general. As in the previous year, the main emphasis has been on the improvement of the data base and various parameters used in updating stock assessments. However, work on other aspects of the life history of flatfish is continuing.

e) American plaice. An updating of assessment for the stock in Divisions 3LN0 pointed to a relatively stable condition and the recommended TAC remained at 47,000 tons. The TAC in Subdivision 3Ps was reduced to 6000 tons from 7000 tons since the average catch 1974-75 of 5500 tons generated a fishing mortality at the $F_{0.1}$ level. TAC's in Divisions 2 + 3K and in Division 3M remained at the 1976 level at 8000 and 2000 tons respectively.

f) Greenland halibut. Studies on growth rates in Subareas 2 and 3 indicated that the largest and oldest fish were caught in the most northerly localities (Subarea 2) studied; however, there was indication of an increase in rate of growth from north to south. The TAC remained at the 1976 level of 30,000 tons. Studies on other phases of the life history of this species are continuing.

g) Witch. A new analytical assessment for witch in Subdivision 3Ps was prepared and indicated that 3000 tons could be removed in 1977 fishing at the $F_{0.1}$ level. The TAC for witch in Divisions 2 + 3K and Divisions 3N0 remained at the 1976 levels at 17,000 and 10,000 tons respectively.

Information on the fecundity of this species is being analyzed and prepared for publication.

h) Yellowtail. Catches from this stock increased from very low levels prior to 1965 to 39,000 tons in 1972 and declined to about 23,000 tons in 1975. TAC's in 1973-75 were set at 50,000, 40,000 and 30,000 tons respectively. In 1975 an assessment indicated a drastic reduction in stock abundance and the TAC was reduced to 10,000 tons. An updating of the assessment using 1975 data suggested a TAC for 1977 should range between 10,300 and 15,400 tons, depending on the level of recruitment at age 5. Thus, if the level of recruitment were 60 million fish and fishing at $F_{0.1}$, 12,000 tons could be removed in 1977 and this was the TAC agreed to for 1977.

i) Capelin. The echo integration system was tested during a June-July trip of the A. T. CAMERON to the Southeast Shoal. The stock discrimination study based on meristic and morphometric characters continued during 1976. Studies of capelin fecundity, age at maturity and growth were continued.

j) Herring. An assessment of biomass levels and potential yields of herring populations along eastern Newfoundland indicates a substantial increase in abundance from 70,000 tons in 1965 to 180,000 tons in 1972, mainly due to a very strong 1968 year-class. Optimum sustainable yield, assuming historical recruitment levels are in the order of 20,000 tons but catches will fluctuate greatly due to sporadic occurrences of strong year-classes. Due to the underexploited nature of these populations, the 1976 TAC was set at 27,000 tons.

Stock discrimination studies, based mainly on external taggings, continued in 1975. Tag recovery indicated that considerable straying of herring may occur but the general pattern is a northward feeding migration in summer followed by a southward migration to overwintering areas in the fall.

k) Mackerel. Sampling from the Newfoundland commercial fishery shows > 60% of the population was composed of age groups 3, 4 and 5. There was no evidence of a strong year-class being recruited to the fishery and 2-year-old fish represented < 1% of the catch. The 1967 year-class is still dominant in the older age groups (7+) but continues to decline in abundance.

A winter kill of mackerel in Notre Dame Bay (3K) resulted in a mortality of the order of 10,000 tons.

l) Atlantic salmon. During May-June, 214 Atlantic salmon were tagged and released in the Port aux Basques area of southwestern Newfoundland. Of the 29 recaptures, 2 were from the Newfoundland commercial fishery, 3 from Newfoundland rivers, 4 from New Brunswick, 5 from Nova Scotia and 15 from Quebec.

During June-July, 39 Atlantic salmon, mainly grilse, were tagged and released in Fortune Bay in southern Newfoundland. Of 3 recaptures, 2 were taken in the Newfoundland commercial fishery and 1 from

New Brunswick. During both tagging experiments, blood samples were obtained from the tagged salmon to determine the levels of gonadotropin in the blood plasma and to provide a reference sample for fish which are destined to spawn in the year of tagging on the basis of recaptures in fresh water.

Scales of adult Atlantic salmon were collected from 18 river systems from Labrador to Maine (55°N - 44°N). Analyses were conducted on 4 scale characters: (1) circuli in first river year; (2) circuli in second river year; (3) river age; (4) circuli in first sea year.

Multivariate analysis of variance indicated that the means for areas were not equal. A clinal discriminant function was then constructed using latitude as a "dummy" variable. This function explained 73% of the total variation. Four main groups of fish were readily identifiable by the discriminant function analysis: (1) Labrador; (2) Newfoundland (NE and NW coasts); (3) South Newfoundland-Miramichi-Cape Breton; (4) Southern Nova Scotia-Maine.

A sampling program for the commercial fishery is continuing to provide quantitative descriptions on seasonal size, age and sex ratios of salmon in various areas of the fishery. The biological data are used to monitor the fishery from year to year and provide estimates of 1- and 2-sea-year fish in the stocks. In addition, landing reports combined with effort data are derived from fish plant sales and are summarized in a yearly series. One project is to update this and capture data on catch effort from earlier years. A simple model for the 1975 fishery was constructed from data on landings and effort. The predicative capabilities of this type of model could prove useful if expanded to include environmental parameters.

- m) Squid. Standard biological sampling of the commercial catch from July to November was continued.

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SECTION II. SUBAREAS 4 and 5

by

J. S. Scott

Information reported here was supplied by the Department of Fisheries and Environment, Biological Stations, St. Andrews, New Brunswick and St. John's, Newfoundland; the Arctic Station, Ste Anne de Bellevue, Quebec; the Marine Ecology Laboratory and Atlantic Oceanographic Laboratory, Bedford Institute, Dartmouth, Nova Scotia; and by the Quebec Ministry of Industry and Commerce and Quebec Salmon Council, P. Q. Data on landings was supplied by the Department of Fisheries and Environment, Fisheries Information Branch, Maritimes Region.

Subarea 4

A. STATUS OF THE FISHERIES

1. Groundfish general

The decrease in total nominal annual catches (Maritimes and Quebec) continued in 1976, showing a fall of about 8% from the 1975 figure to about 187,400 metric tons. The major contributor to the decrease was a fall of about 37% in redfish catches, mainly from the Gulf of St. Lawrence. Quotas on all major stocks limited the effort in some areas.

2. Cod

Landings from Maritimes and Quebec increased by almost 8% from the 1975 level to about 70,700 metric tons, approximately the same level as in 1974. They made the highest individual contribution (37%) to the total groundfish catch. Scotian Shelf (Divs. 4W-X, Subdiv. 4V_S) decreased from the 1975 level but this was more than compensated for by a 21% increase from the Gulf of St. Lawrence and north-east Cape Breton (Divs. 4-R-S-T-V_N).

Newfoundland landings totalled 26,000 metric tons, an increase of 58% above the 1975 catch and 11% above the 1974 catch. Since the decrease in the 1975 catch was caused primarily by suspension of trawler operations in January-March, the 1976 level represents the normal level of catch in recent years.

3. Haddock

Landings were at about the same level as in 1975 at 17,500 metric tons, reflecting the quota control of the various stocks. The major part of the catch (16,156 metric tons) was taken in Div. 4X where there was a slight increase over the 1975 landings, compensating for a slight decrease in landings from the remainder of the Scotian Shelf. The southwestern Nova Scotia (Div. 4X) haddock stock continues to show signs of recovery.

4. Flatfish

Total nominal landings (Maritimes & Quebec) of combined flatfish species increased by 5% over 1975 landings to more than 28,000 metric tons. There was a decrease in total landings in each of the Divisions of the Scotian Shelf (Divs. 4V-W-X) but this was more than compensated for by an increase in landings from the Gulf of St. Lawrence and northwest Cape Breton areas (4R-S-T-V_N).

American plaice constituted 51% of the landings and there was a further increase in Greenland halibut landings to 3,800 metric tons, three times the 1975 figure, mostly from the northern Gulf of St. Lawrence (Div. 4S).

Newfoundland landings were 9,800 tons, 115% higher than in 1975, probably because of diversion of effort from redfish fishing in the Gulf of St. Lawrence and yellowtail fishing on the Grand Bank.

Atlantic halibut landings increased by about 5% from 1975 to 950 metric tons, about 11% below the 1974 level.

5. Redfish

The trend of decreasing redfish landings (Maritimes & Quebec) since 1973 continued in 1976 with a fall to about 34,000 metric tons, 30% of the 1975 level. There were decreased landings from all areas including a 39% fall from the 1975 level in the Gulf of St. Lawrence (Divs. 4R-S-T). Gulf landings constituted 84% of the redfish landings in Subarea 4. Newfoundland landings totalled 14,900 tons, 42% below the 1975 catch and 12% below the 1974 catch.

The decrease in redfish landings was mainly a result of quota restrictions and declining catch rates in recent years in the Gulf of St. Lawrence causing diversion to other areas and species.

6. Pollock

Total landings of pollock fell by about 3% from the 1975 level to about 21,000 metric tons. The bulk of the landings (89%) were from the southwest part of the Scotian Shelf (Div. 4X) where there was a 5% increase over the 1975 level bringing the landings from this area back to about the 1974 level. Landings from the central part of the Shelf (Div. 4W) decreased by about 42%.

7. Other groundfish

Landings by Maritimes & Quebec were down 14% from the 1975 level at about 14,500 metric tons and those from Newfoundland were about the same at 470 metric tons. White hake again was the most important species, constituting 49% of the landings but showing a decrease of 16% from the 1975 level thus continuing the decreasing trend since 1973. Cusk was next most important, making up 20% of the landings, but reaching only 58% (about 3,000 tons) of the 1975 landings.

8. Scallops

Sea scallop (*Placopecten magellanicus*) landings (Maritimes & Quebec) from the Scotian Shelf (Divs. 4V-W-X) totalled 12,727 metric tons whole weight, an increase of 175% over 1975 landings. Much of the increase is due to increased effort on Browns Bank (Div. 4X).

9. Herring

Total nominal landings of herring from Subarea 4 were 175,618 metric tons, a decrease of 7% from the 1975 level. Landings from southwest Nova Scotia (Div. 4X) were about 104,000 metric tons, a decrease of 8% from the 1975 landings, while those from Div. 4W increased by 18% to about 30,500 metric tons. The southern Gulf of St. Lawrence fishery landed over 31,000 metric tons, an increase of 14% from 1975. Landings from the northeast Scotian Shelf (Div. 4V_n) fell slightly to about 8,500 metric tons.

10. Mackerel

Mackerel landings in Subarea 4 (including Div. 4R) showed a slight increase of 8% from the 1975 level to 10,400 metric tons. Landings from the southern Gulf of St. Lawrence remained well below the 1974 level, increasing by about 38% over the 1975 level to about 2,950 metric tons. Newfoundland landings from the northern Gulf of St. Lawrence (Div. 4R) amounted to 100 metric tons.

11. Tuna

Total landings of all tunas in 1976 were approximately 10,000 metric tons, live weight. The commercial (trap) catch of bluefin in St. Margaret's Bay area (Div. 4X) yielded 168 metric tons, an increase of 19% over the 1975 catch, with an average weight of 369.2 kg compared with 319 kg in 1975. Catches in the sport fishery were 76% higher than in 1975, at 340 metric tons, most (257 metric tons) from the Gulf of St. Lawrence.

12. Atlantic salmon

Total landings, including those from commercial and sports fishery, but excluding those from the Newfoundland fishery in the eastern Gulf of St. Lawrence (Div. 4R), were 394.7 metric tons, an increase of 33% over the 1975 total. The commercial catch, 196 metric tons, was almost the same as for 1975 (199 metric tons) but the angling catch at 199 metric tons was more than twice that of 1975 (96 metric tons).

The Newfoundland coastal set net fishery yielded a catch of 164 tons in 1976, about the same as that for 1975 (161 metric tons).

The ban on commercial fishing in New Brunswick and the Gaspé Peninsula (Divs. 4X-T) continued.

13. Squid

Landings increased from nil to 64 tons taken in the inshore fishery.

B. SPECIAL RESEARCH STUDIES

1. Environmental Studies

a) Hydrography. Seasonal physical oceanographic surveys, including T-S and current measurements, were carried out in the Gulf of St. Lawrence (Divs. 4R-S-T) and T-S measurements made along the Halifax section (Div. 4X).

The outflow from the Gulf of St. Lawrence was shown to influence sea temperatures on the north American coast as far south as Boston. In the Gulf of Maine (Div. 4X, 5Z-Y), 50% of variation of fish catch can be assigned to environmental influences.

b) Plankton studies. Studies of pelagic fish eggs and larvae in Georges Bay (Div. 4T) show that average size of the eggs, and of the food of the larvae decrease as the season advances from spring to summer. Plankton samples are being analysed for organochlorines, wet-weight and dry-weight.

Zooplankton distributions in the St. Lawrence estuary and on the Scotian Shelf were studied, using an instrumented net and acoustics system.

Quantitative analysis of zooplankton samples from survey cruises was continued to investigate persistence, distribution and movement of selected local stocks of plankton in the Bay of Fundy.

A long-term program was initiated to investigate distribution and recruitment of fish eggs and larvae in relation to environment on the Scotian Shelf (Divs. 4V-W-X). Results of a preliminary cruise showed new and different species associations from those of the Gulf of St. Lawrence and a number of new records of larval species from the area.

c) Other environmental studies. Field studies of levels, behaviour and dynamics of heavy metals in the Saguenay Fjord (Div. 4S) and in the sediments of the St. Lawrence estuary and Gulf of St. Lawrence (Divs. 4R-S-T) have been completed.

Studies were continued into the impact of Arrow Bunker C oil residues on the biota of Chedabucto Bay (Div. 4T) including field sampling and measurements of chlorophyll and redox potentials in oiled sediments.

Measurements were made of sedimentation, bottom sediment organic content and plant-pigment concentrations along transects normal to shore in the southern Gulf of St. Lawrence (Div. 4T).

2. Biological Studies

a) General. Annual groundfish research survey cruises were completed on the Scotian Shelf (Divs. 4V-W-X) in July-August, and in southern Gulf of St. Lawrence (4T) in September. A survey of the haddock stocks in the southwest part of the Scotian Shelf (Divs. 4W-X) was carried out in February. Annual larval herring surveys were completed in the Bay of Fundy and off southwest Nova Scotia (Div. 4X) in April and November.

Monitoring and biological sampling of commercial landings continued.

b) Cod. Stocks on the Scotian Shelf were assessed to provide advice on their management in 1977. The Div. 4V_SW complex is suffering a severe reduction in recruitment levels which do not appear to be related to the size of the adult stock. Silver hake predation, and bycatches of juvenile cod in small mesh gears such as are used in the silver hake fishery have been hypothesized as possible causes of the decline.

In the eastern Gulf of St. Lawrence (Divs. 3P_D-4R-S), the cod stock was reduced in abundance below that necessary to maintain catches at the MSY level.

Examination of historical files on cod catches in the southern Gulf of St. Lawrence (Div. 4T) enabled a relationship for density-dependent growth rate to be determined for all weights from 1950 to 1976. Examination of maturity data from 1959 to present indicated that mean length at maturity had declined by as much as 13 cm. Length at first maturity had declined since 1959 and is correlated with growth in the first year of life.

Results of egg and larval surveys in the southern Gulf of St. Lawrence (Div. 4T) indicate that the average catch per unit of eggs per individual mature fish was a power function (1.222) of the weighted average growth rate of the mature stock. The number of larvae was predictable from the initial number of eggs but the death rates of eggs and larvae were not found to be linear or quadratic functions of initial numbers.

c) Haddock. The southwest Nova Scotia stock (Div. 4X) continues to show signs of recovery. Good correlations between research vessel estimates and cohort analysis estimates of year class size have been obtained but discard problems bias the results of analyses.

The Sable Island (Div. 4V-W) stock remains at a low level of abundance but research vessel monitoring indicates that the 1974 year class may be considerably stronger than those entering the fishery for a number of years.

Research cruise results indicate that day trawl catches of haddock were greater than night catches with greater movement of juveniles than of adults off the bottom at night. This may also be correlated with the effect of gas bladder disease on the buoyancy of commercially-sized fish.

d) Redfish. Cohort analysis of the Gulf of St. Lawrence (Divs. 4R-S-T) redfish stock in early 1976 suggested an adult biomass of approximately 100,000 tons, which may be less than 25% of the present at the beginning of 1972. Monitoring of recruitment prospects in 1976 confirmed a very low stock abundance for next four or five years.

Monitoring of research vessel catch size compositions and catch rates for Scotian Shelf (Divs. 4V-W-X) redfish indicate that the stock abundance continues to decline and indications of improved recruitment observed in 1974 surveys was not confirmed by those of 1975.

A survey was initiated to assess the effect of the bycatch in the shrimp fishery upon the biomass of juvenile redfish in the Gulf of St. Lawrence. Preliminary evaluation of the data indicates the shrimp fishery may have a serious effect upon the survival of young redfish.

e) Pollock. Derivation of growth and mortality rates for pollock from the Scotian Shelf-Gulf of Maine-Georges Bank area allowed derivation of $F_{\max} = 0.4$ and $F_{0.1} = 0.24$ for the present mean selection age

estimated to be 3.5 years. Fishing mortality has been above these levels since 1973 and population abundance has been declining. Earlier estimates of average long-term potential yield were over-optimistic.

f) Herring. A midwater trawl survey for juvenile herring was carried out in the Gaspé-St. Lawrence River estuary area (Divs. 4S-T) in August-September and in October-November, but few herring were captured. During the year, 10,000 herring were tagged at Magdalen Islands (Div. 4T) and 28,000 in the Gaspé-Chaleur Bay area (Div. 4T), but only local recoveries were made to the end of 1976.

Tag recoveries from 1974 tagging in the Bay of Fundy and southwest Nova Scotia (Div. 4X) are still being received from Divs. 4Wa and 4X-Wb and continue to indicate substantial movement between the two areas. Yield per recruit calculations for the 4X-VWb stock indicate $F_{\max} = 0.7$ and $F_{0.1} = 0.3$. Revisions of the sizes of

the 1972 and 1973 year classes indicated that the state of the stock was better than previously assumed.

g) Mackerel. Continuing decline in the abundance of the Subarea 3-6 mackerel stock has resulted in the fishery becoming increasingly dependent on 1, 2 and 3 year-old fish. An extremely clear density-dependent relationship was found between year class size and the size of 0-group mackerel in the Div. 4X fishery. Examination of mean length at age 1 by back calculation from otoliths indicated significant variation between year classes, suggesting a density-dependent growth mechanism.

In a midwater trawl survey on the Scotian Shelf in November-December to estimate abundance of overwintering mackerel, small numbers of mackerel were caught in the region of the continental slope in Div. 4X and the western portion of Div. 4W.

h) Tuna. An experimental bluefin otolith sampling program for age determination was continued with approximately 500 fish sampled from Subarea 4.

Twenty-eight (28) bluefin were tagged and released. Two bluefin were recaptured in the Gulf of St. Lawrence (Div. 4RST) from fish tagged in St. Margaret's Bay (Div. 4X) in 1971 and 1976. One released in St. Margaret's Bay in 1975 was recaptured in the same general area and one tagged in Chaleur Bay (Div. 4T) was recaptured off Prince Edward Island (Div. 4T).

i) Swordfish. One swordfish tagged in 1970 was recaptured in 1976 approximately 200 miles from the tagging site.

3. Gear and Selectivity Studies

Measurements of target strengths of fish in various aspects in an acoustic beam were made to determine relationship between target strength, fish length and fish aspect for cod. More than two (2) million echoes from live cod at aspects ranging from 45° head up to 45° head down on pitch and 90° in roll were measured.

Work has been completed on effects of trawl noise on cod. The fish is physiologically capable of detecting the approach of trawlers from several kilometres away. This, in conjunction with results of previous experiments which indicate that cod change their swimming activity in presence of trawling noise, points to potential bias of density estimates based on trawl catches.

Development work continued on the bottom-referencing underwater towed instrument vehicle (BRUTIV).

Subarea 5

A. STATUS OF THE FISHERIES

1. Groundfish general

Total nominal landings, from Divs. 5Y-Z, were 7,650 metric tons, a decrease of 16% from the 1975 landings to about the level of the 1973 total.

2. Cod

Landings of cod increased by 20% over the 1975 landings to 2,315 metric tons, almost all from Div. 5Z.

3. Haddock

Landings were approximately at the same level as in 1975 at 1,408 metric tons.

4. Pollock

There was a reversal of the trend of recent years in pollock catches, with a decrease to 2,068 metric tons, 44% of the 1975 level. The Georges Bank area yield 98% of the catch.

5. Sea scallop (*Placopecten magellanicus*)

Landings totalled 76,546 metric tons whole weight, an increase of 23% over 1975. The offshore fleet expended 90% of its effort on Georges Bank (Div. 5Z).

In June, 1976, the final step was taken to meet the ICNAF regulations prohibiting landing of scallop meats averaging more than 40 meats/lb by boats over 65 ft in length.

6. Herring

Landings of herring, from Div. 5Y, decreased to only 18% of the 1975 level, at 921 metric tons.

7. Tuna

The purse-seine fishery off the mid-Atlantic coast yielded 332 metric tons, an increase of 12% over the 1975 landings. The length range of the fish was lower than in 1975, ranging from 51-113 cm.

HARP AND HOODED SEALS

Subareas 2, 3 and 4

A. STATUS OF THE FISHERIES

Catches by large vessels of both harp and hooded seals were restricted by quotas, which were 97,000 for harp seals, divided between Canada with 53,000 and Norway with 44,000, and 15,000 for hooded seals, divided 6,000 to Canada and 9,000 to Norway. Catches by Canadian small vessels and landsmen, which were not controlled by quota, reached 67,000 harp seals. The total catch of young harp seals for the second year reached about 140,000.

B. SPECIAL RESEARCH STUDIES

Harp Seals

Age samples totalling 1,600 animals were analysed from five shore fisheries and two vessels' catches, in order to study age-class strengths in relation to levels of catch of young seals.

The sealing vessel Carino was chartered from April 10-19 and 350 moulting harp seals sampled in Subarea 3K. Foods eaten included a large percentage of shrimp *Pandalus borealis* taken over depths exceeding 200 m. Studies were made of the selectivity of shooting by comparing the distribution of pelt types in seals initially observed with that of seals shot, and converting to age from the shot sample. The results allow correction for selectivity in past samples. Correction for this factor alone, however, does not adequately explain apparently high juvenile mortality rates. Correction is also now possible from knowledge (from tag returns) of the degree of crossover of juveniles aged 1-4 years from Subarea 4 to Subareas 2 and 3; the rise in the percentage of juveniles from this source in Subareas 2 and 3 also inflates apparent mortality rates.

Studies of age specific reproductive frequency from 1976 samples show a continuing trend towards a younger median age at first reproduction, but it is supposed that the lag in the process is of the same order as the period from birth to maturity (4-5 years), so that it measures the results of population changes 4-5 years earlier.

Tag and brand recoveries continue to show crossover of juvenile seals from Subarea 4 to Subarea 3, and one example of the reverse movement, but to date, adults from Subarea 4 were found to return there. Tagging continued in 1976 in both subareas, with 351 harp seal pups and 106 adults tagged in the Gulf of St. Lawrence and 100 pups and 5 adults at the "Front" ice, all with yellow Dalton "rototags".

Hooded Seals

A sample of 500 adult hooded seals was collected at the "Front" icefields and aged, for a study of survival rates in relation to catch.

Eighty hooded seal pups were tagged, 77 in the Gulf of St. Lawrence and 3 at the "Front" icefields, using Dalton "rototags".

