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Canadian Research Report for 1999

Newfoundland Region

by

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SUBAREAS 0 AND 1

A. Status of the Fisheries

Nominal landings from 1990 to 1999 for fish stocks are listed in Table 1. Additional information on the status of the fisheries is as follows:

a) *Shrimp* - Div. 0AB

Between 1991 and 1997, the *Pandalus borealis* quota in Div. 0A was set at 8,500 t. Since that time, the quota has been reduced to 7,650 t. Annual catches of 4,800 – 7,500 t were made between 1991 and 1994, but have since fluctuated between 500 and 2,600 t.

The *P. borealis* quota in Div. 0B was increased from 5,250 t in 1998 to 8,750 t during 1999. The increase was due to the inclusion of a 3,500 t exploratory quota for areas north of 63°N. In the traditional fishing area south of 63°N, 5,100 t were caught whereas only 100 t were taken in the northern areas. The unstandardized and standardized catch per unit effort indices increased between 1993 and 1998 then decreased in 1999 to the 1997 level. Fluctuations in catches and catch rates are not considered to be valid indicators of overall stock conditions and may reflect oceanographic conditions.

In 1999, about 3,700 t of *Pandalus montagui* were caught from a 3,800 t quota. This quota was taken west of 63° N and includes a part of Div. 2G.

The mixed fishery for *P. borealis/montagui* and the absence of a time series of research vessel trawl surveys further confounds the assessment of the distribution and abundance of both stocks.

b) *Greenland Halibut* – 0B+1B-F

The Greenland halibut stock in Subarea 0 + 1B-F (offshore) is considered to be part of the same stock distributed in Subarea 2 and 3. Canadian catches for 1999 were approximately 4,300 t. The stock is managed jointly by Canada and Denmark (Greenland), with the TAC being split equally. Recent scientific information on this stock is limited, although a new survey was completed in Div. 0A in 1999. NAFO Scientific Council and the Canadian Fisheries Resource Conservation Council (FRCC) recommended that the TAC in 2000 should not exceed 11,000 t, as in recent years.

SUBAREA 2

A. Status of the Fisheries

Nominal landings from 1990 to 1999 for fish stocks are listed in Table 1. Additional information on the status of the fisheries is as follows:

a) *Atlantic Salmon*

The commercial fishery remained closed for 1999. Approximately 5,900 salmon were retained or hooked and released in the recreational fishery.

b) *Arctic charr*

Commercial landings of Arctic charr in northern Labrador were 41 t, about 8% higher than landings in 1998, and the highest catch recorded since 1992. Catch rates increased in each of the three primary stock complex areas. Increased landings are partly related to the introduction of a community-based licensing system. Over the past 26 years (1974 – 1999), more than 2600 tonnes of charr have been harvested from a limited stretch of the north Labrador coast, and attests to the capacity of this area to produce fish. No data are available on the amount of charr harvested for subsistence (food) purposes.

c) *Shrimp*

The shrimp fishery in Subarea 2 and the northern portion of Subarea 3 is divided into three management areas – 2G, Hopedale and Cartwright Channels (2HJ), and Hawke Channel (2J) + 3K. During both 1998 and 1999, 8,000 t were caught in 2G from 8,320 t TACs. The standardized and unstandardized fishing effort and catch per unit effort indices have fluctuated without trend since 1991, reflecting stability in the resource. Historically, the fishery has been concentrated north of 60°N in an area noted for producing high catch rates of large, high-quality shrimp. During 1998, a separate quota was created for the area south of 60°N to reflect the existence of high concentrations of shrimp along the shelf slope. The new quota resulted in a southward shift in fishing effort. Overall, the stock remains healthy as evidenced in continued high catch rates for female shrimp and expansion of the resource.

Catches in Hopedale and Cartwright Channels (2HJ) have increased from 7,500 t during 1994-1996 to 15,000 t during 1997 – 1999 due to TAC increases. The 1998 and 1999 standardized effort and catch per unit effort indices remained at 1997 levels. The resource appears healthy, from fishery data, with commercial rates of both male and female components stable throughout the 1980s and increasing during recent years. However, research survey stock size estimates are highly variable making it difficult to interpret trends.

The fishery in Hawke Channel (southern Division 2J) + 3K began in 1987 with landings of approximately 1,800 t. Catches increased to more than 7,800 t in 1988 and ranged between 5,500 and 8,000 t between 1989 and 1993. The first multi-year management plan for 1994–1996 set the annual TAC at 11,050 t for the Hawke Channel, St. Anthony Basin, east St. Anthony, Funk Island Deep, and three exploratory areas on the seaward slope of the shelf. Catches increased to 11,000 t in each of these years. The TAC has since increased to 23,100, 46,200 and finally 58,632 respectively over the years 1997–1999. The inshore shrimp fishing fleet (<65') has been exploiting this resource since 1997 and took approximately 66% of the 1999 catch. Fall multi-species research vessel surveys throughout 1995–1999 indicate that the shrimp are widely distributed and abundant throughout the area. Survey data indicate that biomass of males could decline in 2000/ 2001 due to the weak 1996 year class. However, the impact of the 1996 year class should be buffered by the residual female stock from the 1993 and 1994 year classes as well as the relatively strong 1997 and 1998 year classes. Based upon analyses of the offshore component (>65') of the commercial fishery and research survey data, the 1997–1999 assessments concluded that the resource was healthy and exploitation has remained low.

The mandatory use of sorting grates, low groundfish abundance and avoidance of problem locations have minimized bycatch within subarea 2. A recent study estimated that fewer than 2% per age group of Greenland halibut were being caught by the offshore shrimp fishing fleet.

d) *Cod* – 2GH, 2J+3KL.

The catch from Div. 2GH has been negligible since 1990. The 1996 DFO Stock Status Report indicates the abundance of this stock to be low. The next regional review of stock status is proposed for 2000.

The northern (2J+3KL) cod was under moratorium from July 1992 to the end of 1998. The small catches reported for 1993-1997 came from bycatch, sentinel surveys and, in some years, recreational fisheries. Catches increased to nearly 5,000 t in 1998 under an index fishery. A commercial fishery reopened in 1999 with a TAC of 9,000 t for the inshore only. A catch of approximately 8,500 t was reported.

e) *American Plaice* – 2+3K

There was no directed fishery on this stock in 1999. Analysis of data from annual fall multispecies research vessel trawl surveys indicate that recruitment, abundance, and total and spawning biomass remain low. Low exploitation rate on this stock suggests that fishing mortality cannot be responsible for the observed decline in this species.

f) *Redfish* – 2+3K

There was no directed fishery in 1999 for the Subarea 2 +3K stock. Results from fall multispecies research vessel surveys suggested that population biomass indices in both areas are at extremely low levels.

g) *Snow crab* – 2J3KLNO

Catches increased by 33% to 59,600 t in 1999 from 44,400 t in 1998, while fishing effort (number of trap hauls) increased by 35%. Fishery performance is monitored in through analyses of commercial logbook data, observer program data, and dockside monitoring. CPUE from logbook data decreased slightly in 2J3K, increased slightly in 3LNO, but overall remained at a high level in 1999. Resource status was determined from fall multispecies bottom trawl surveys and inshore trap/trawl surveys. The residual biomass index of crabs 95 mm and larger, based on fall multispecies bottom trawl surveys, which was stable during 1996-1998, decreased from 85,000 t in 1998 to 47,000 t in 1999. The fall survey biomass index of 76-94 mm small-clawed males (immediate prerecruits) decreased by 54% from 1998 to 1999. A decrease in the exploitable biomass is projected for 2000 due to the 45% decrease in residual biomass in 1999 and the projected decrease in recruitment for 2000. The fall biomass index of males smaller than 40 mm has declined since 1996. This may indicate a series of weak year classes that is expected to provide poor recruitment in the longer term.

h) *Iceland scallop* - 2HJ

Inshore aggregations here were again fished with nominal catches estimated at 644 t, round. The fishery is prosecuted by inshore vessels, typically under 45 ft (14m), L.O.A. There have been no directed research missions into scallop aggregations along the Labrador coast.

i) *Greenland Halibut* – SA 2 + Div. 3KLMNO

Improved recruitment has led to an increase in this stock, although it remains below historical levels. Fisheries Commission set a TAC of 33,000 tons for this stock in 1999.

B. Special Research Studies**1. Environmental Studies**a) *Hydrographic studies*

Hydrographic multi-beam and single beam acoustic surveys were conducted to develop a two (2) mile wide navigation corridor from Turnavik Islands near Makkovik to Cape Harrigan. A similar corridor was also surveyed to provide a safe passage eastward to deeper water, from shallow coastal waters, through the area known as the

Farmyards. Hydrographic surveys were also conducted to provide modern hydrographic data to replace outdated and suspect hydrographic data in Shoal Tickle and to fill an uncharted gap in an existing route through Windy Tickle. Numerous client reported dangerous to navigation were investigated and resolved, and all navigational aids in the area were also positioned and described.

2. **Biological Studies**

a) *Groundfish and Shellfish*

Biological and oceanographic data from fall multi-species research vessel surveys were collected from Div. 2GHJ to conduct distribution and abundance studies and detailed biological sampling. Stomach analysis is conducted from specimens of Greenland halibut caught during the fall surveys.

b) *Arctic charr*

Samples were obtained for food and feeding, age, sex, and length distributions from commercial landings from 11 north Labrador subareas. Following a long term decline in mean weight of charr harvested in north Labrador, analyses of recent data show that mean weight has increased in each of the three primary stock complex areas during the past two years (1998 - 1999). Besides the long term effects of fishing on stock characteristics, recent analyses have identified a possible environmental component contributing to some of the variation in stock characteristics. Information on ocean migrations of Arctic charr have been updated from analyses of over 3400 tag recaptures through 1999 in the context of consistency with past data used to designate individual stock complexes.

SUBAREA 3

A. Status of Fisheries

Nominal landings from 1990 to 1999 for fish stocks are listed in Table 1. Additional information on the status of the fisheries is as follows:

a) *Squid* – Subarea 2+3.

Following a peak catch in 1979 of 88,800 t, Subarea 3 catch declined regularly to 5 t in 1983. Catches remained lower than 5,000t during the thirteen-year period 1983 to 1995. Catches increased since 1995 to 12,700 t in 1997 before declining sharply to 800 t in 1998 and only 19 t in 1999. Increases in catches in 1996 and 1997 were associated with environmental warming and increase in squid abundance at the northern extreme of their range. The subsequent decline in catches during 1998 and 1999 reflects low squid abundance in Canadian waters, despite persistence of a warm oceanographic regime.

b) *Atlantic Salmon* - Subarea 3+4

A moratorium on the Canadian commercial fishery has been in place since 1992. Landings at St. Pierre (Div. 3PS) totalled 2.3 t in 1999. The 1999 recreational harvest, including both retained and hooked-and-released, was approximately 26,900 fish in insular Newfoundland.

c) *Shrimp* – 3LMNO.

Subarea 3 has been divided into two shrimp management areas - 3L and 3M. The fall survey data indicate that the biomass of 3LNO *P. borealis* increased from 6,000 to 62,000 t between 1995 and 1999. At least 72% of the biomass was within Canada's 200 Nmi limit, and at least 86% of the total biomass was found within NAFO Division 3L. Divisions 3N and 3O accounted for less than 14% and 1% of the biomass respectively. This is a new fishery with 2000 and 2001 TACs set at 6,000 t and fishing restricted to areas within 3L that have depths greater than 200m. The areal and depth restrictions are to reduce bycatch of economically important groundfish presently under moratoria.

An international shrimp fishery has been conducted in 3M since 1993. The number of Canadian vessels fishing for shrimp in this area has declined steadily from 13 during 1993 to 3 during 1999. Similarly, the catches have decreased from 3,724 t in 1993 to 490 t in 1999. Bycatch of groundfish has been quantified, and consists primarily of redfish and Greenland halibut.

d) *Iceland scallop.*

In the Newfoundland area, Iceland scallops are fished in Div. 3LN and Div. 3Ps. and to a lesser extent along inshore waters off Labrador.

The 3LN scallop fishery commenced in 1993. Aggregations over the eastern Grand Bank (3L) were first commercialized. In 1994 the fishery expanded into the Carson and Lilly canyons (LCC) and subsequently (1995) into the northeast of LCC between 45°30' N and 46°30' N. In 1996 a new aggregation was located and rapidly fished down. While some exploratory fishing occurs outside of these "boxed" areas, each with a catch limit, the areas around the LCC continue to attract the most effort. Nominal landings declined throughout, primarily because of effort diversion into shrimp and crab.

In Eastern 3L only 4 t (round) were taken in 1999 from a TAC of 1,000 t. Overall catch rates and meat counts (no. of meats per unit weight) are low and the area is generally considered marginal for the fleet.

Catches from the LCC box were 134 t (round) from a TAC of 900 t in 1999. Catch rate (74kg/tow) has leveled off, but is down 25% from 1995, when deposits here were first commercialized. Individual meat-weight frequency distributions show a bias toward slighter larger meats compared to 1998. Meat counts have decreased correspondingly.

Elsewhere, over the Grand Banks (Div. 3LN) little commercial activity was recorded in 1999.

The Iceland scallop fishery on St. Pierre Bank commenced in 1989 and is now separately managed as two zones: (a) the trans-boundary stock, along the northern edge co-managed by France (70% of TAC) and Canada (30% of TAC) and (b) the large area to the south that remains entirely under Canadian jurisdiction. Total removals in 1999 dropped by almost 60% compared with the previous year (1,188 t vs. 2,763 t). Near-shore aggregations accounted for 40% (478 t) of the combined removals from this area. However, catch rates in 1999 dropped by 30% from the previous year. There was no directed effort for Iceland scallops in the trans-boundary area.

e) *Capelin* – Subarea 2 + Div. 3KL

Inshore capelin catches in Subarea 2 + Div. 3KL are taken during the inshore spawning migration. Female capelin is preferred to satisfy the Japanese roe market. Inshore catches in 1994 and 1995 were less than 1000 t because female capelin were too small to meet the size criterion established in the capelin management plan. A size criterion has not been included in subsequent management plans. Catches decreased from 30,000 t in 1998 to about 19,000 t in 1999. Resource status is determined by a mathematical model that incorporated 13 partially overlapping series of indicators.

The model provides estimates of relative yearclass strength. In 2000 the spawning biomass is expected to be about average. Commercial catch rate data have not been considered indicative of stock status in recent years because the inshore fishery was contracted both spatially and temporally. Numerous sources of uncertainty exist and there is concern about whether the individual indices are now providing reliable indications of stock status. Consequently there is uncertainty regarding the status of this resource.

f) *Snow crab* – 3Ps.

Catches in 3Ps increased by 20% in 1999 to 7,900 t from 6,600 t in 1998, while fishing effort increased by only 6%. CPUE increased steadily through the 1990's to a high in 1999. Bottom trawl surveys are unreliable for indicating resource status because they are carried out in spring when mating and molting occur and the population is incompletely available to the survey trawl. Therefore, resource status and future prospects are uncertain.

g) *Cod* – 2J3KL, 3NO, and 3Ps.

In Divisions 2J3KL in 1999, there was a quota of 9000 t in the inshore portion of the area. The amount allocated for the commercial fishery was 8,600 t after allowances of 300 t for the sentinel survey and 100 t for bycatch. Reported catches were about 8,050 t from the commercial fishery and 200 t from the sentinel survey. An additional 220 t were estimated to have been taken by the food/recreational fishery.

Resource status of Cod in Divisions 2J+3KL was determined using data from the inshore commercial fishery, commercial bycatch, spring multispecies research vessel bottom trawl surveys in Division 3L, fall multispecies research vessel bottom trawl surveys in Divisions 2J+3KL, inshore sentinel surveys, inshore acoustic surveys in specific bays, pre-recruit surveys, and an intensive mark recapture program.

The 9,000 t TAC led to exploitation rates well above a 20% reference level in 3K in 1999. The Fisheries Resource Conservation Council has recommended a decrease in the TAC for 2000 to 7,000 t to be fished under an index fishery in which the first priority is to generate information of use to Science in assessing the status of the stock.

Moratoria (beginning in 1995) on directed cod fisheries remained in place in 1999 for Div. 3NO. Preliminary catch statistics show bycatch by Canadian vessels of 585 t in 1999. Stock status will be updated in June 2001.

In sub-Division 3Ps the cod quota for 1999 was set at 30,000 t. The Stock status was estimated in autumn 1999 from commercial landings in conjunction with abundance indices from Canadian (1983-1999) and French (1980-1991) research vessel trawl surveys and sentinel surveys (1995-present). Information from tag returns in 1999 could not be used to determine resource status because the fishery was still in progress. As in 1997 and 1998, a science logbook for vessels <35 ft. was used in 1999 to provide detailed information on catch and effort for the inshore fixed gear fishery.

The research vessel estimate of trawlable biomass index in 1999 was 48,857 t, i.e. approximately half the 1998-survey estimate. The age composition of the survey catch in 1999 comprised a range of ages from 1 to 13 with ages 2-6 predominating, but with no particularly strong year classes present. Survey catches over the past three years have consistently shown few survivors from year classes prior to 1989.

The sentinel survey began in late February of 1995 and continued in 1999 but there was insufficient sentinel activity in the first half of 1999 to extend the analyses to include the current year. Gillnet catch rates, mostly from sites in Placentia Bay, were low in 1998 relative to previous years but show no clear trend during 1995-1997; they also show strong seasonality and are consistently highest during fall in the eastern side of Placentia Bay. Line-trawl catch rates, mostly from sites west of the Burin Peninsula, have declined since 1995 and exhibit strong seasonality within each year.

Inshore catch rate data from science log-books for vessels <35 ft for the period 1997 to mid-1999 suggest a seasonal cycle in gillnet catch rates within each year. There is an overall declining trend between years in 3Psa and 3Psb, but no trend in 3Psc. Line-trawl catch rates also show some seasonality, with a declining trend between years in 3Psa and 3Psc and no trend in 3Psb.

h) *Yellowtail flounder* – 3LNO

There was no directed fishery on this stock between 1994 and 1997 and the fishery was re-opened in 1998 with a TAC of 4,000 t for 1998 as recommended by Scientific Council and the FRCC to permit a limited directed fishery in 3NO. In 1999, because of good results from annual surveys with respect to increases in biomass and recruitment, a TAC of 6,000 tons was advised. Stock size has continued to increase and the TAC recommended for 2000 was 10,000 tons. In addition to the annual spring stratified-random survey in 3LNO and the fall multispecies bottom trawl survey, joint DFO-Industry surveys have been conducted since July of 1996. Three such surveys were conducted in 1999. The objective of these Fisheries Products International-DFO surveys is to develop a commercial-type index of abundance and determine distribution of yellowtail flounder within a zone traditionally fished by commercial fleets.

i) *American plaice* – 3LNO.

Stock size remains at a low level and a moratorium on fishing remained in place during 1999. By catches in other fisheries have increased in recent years.

j) *Redfish* – Unit 2 (3Ps4Vs, 3Pn4Vn-June to December, 4Wfgi) and 3O.

Redfish in the Canadian Atlantic have been reviewed on a zonal basis following redefinition of redfish management units in 1993 given substantial linkages between the various management units. Redfish were reviewed at a zonal meeting in November 1999.

Unit 2 Canadian landings in 1999 totalled approximately 11,412 t from a TAC of 12,000 t. Total Canadian catches have declined steadily from 27,000 t in 1993 matching reductions in TACs. The current stock status was determined from annual stratified random industry surveys and sampling of the commercial fishery. Commercial sampling suggested that the majority of the catch was comprised of fish between 30 cm to 35 cm, the bulk of which represents the early 1980's year class. The 1988-year class was also present in catches since 1994. Industry survey results indicated a bimodal length distribution consisting of the 1980 and 1988 year classes. The latter is now fully recruited to the fishery but its contribution will not likely be as great as that of the early 1980s year class.

Canadian catches of 30 redfish have increased dramatically from less than 200 t annually from 1983-91 to 7,000 t in 1996, declined in 1997 to approximately 2,600 t., increased in 1998 to 8,900 t. and declined in 1999 to 2,300 t. The fluctuation in catches since 1996 is related to market demands for generally smaller sized redfish (22-30 cm.) as compared with Unit 2. Resource status has been determined from spring and fall stratified random surveys in 3O. The spring index suggests that the stock may have increased since the early 1990s, but has stabilized at around 100,000 t since 1994. The fall survey generally supports this pattern. The additional 1999 survey information for both spring and autumn did not alter this perception. Historically, the surveys catch fish in the 10 cm to 25 cm range. Prior to 1998, the surveys were considered to have sampled different size groups than the commercial fishery because the commercial catch was generally comprised of fish greater than 25 cm. Beginning in 1998, there has been greater overlap in the size distributions of the surveys and commercial fishery because the fishery has been targeting size groups that have recently surpassed the small fish protocol (22 cm). There is concern that there has been little sign in the recent surveys of size groups smaller than 17 cm. despite using a shrimp trawl which is very effective at catching small fish.

B. Special Research Studies

1. Environmental Studies

a) *Hydrographic Studies*

At St. John's Harbour, a recently dredged area in the harbour entrance (The Narrows) was surveyed using multi-beam technology. As well, a reported grounding was investigated and new data provided to delineate new sewer lines constructed and extending into the harbour on the seafloor.

Multi-beam acoustic surveys were also conducted at Little Bay Arm and Tilt Cove in Notre Dame Bay, Newfoundland, as part of joint study with Natural Resources Canada (NRC), Canada Centre for Mineral and Energy Technology (CANMET). The purpose of this study was to investigate two abandoned, marine mine tailings, disposal sites to access the long-term environmental and ecotoxicological consequences of sub-marine tailings disposal.

b) *Plankton studies*

A study of the influence of small scale turbulence on the feeding of larval fish and the partitioning of the contribution of biological and physical processes to the rate of loss of ichthyoplankton were conducted in Bonavista, Trinity, and Conception bays. Data on ichthyoplankton composition, development, and mortality; current measurements of plankton drift and dispersion; and data on estimates of prey selection and ingestion rates of ichthyoplankton were collected.

c) *Oceanographic studies Sub-Areas 2 and 3*

Zonal Monitoring Program in the Newfoundland Region.

Physical oceanographic observations are routinely collected during fish assessment and research surveys in the Newfoundland Region. In 1998 an enhanced zonal monitoring program was established to include biological and

chemical oceanographic monitoring at a fixed coastal station at biweekly intervals and on offshore transects at seasonal time scales. The region now conducts three annual physical/biological oceanographic survey along several cross-shelf NAFO transects from the Southeast Grand Bank, Flemish Cap, Funk Island, White Bay and the Seal Island transect across Hamilton Bank on the southern Labrador Shelf. These surveys are conducted during mid-spring, summer and during the fall. The main objectives are to establish the mid-summer temporal and spatial distribution and abundance of plant pigments, nutrients, microzooplankton and mesozooplankton in relation to the physical environment. Physical, biological and chemical variables being monitored include temperature, salinity, dissolved oxygen, ocean currents as well as measures of primary and secondary production and biomass, species composition of phytoplankton and zooplankton and nutrients. This monitoring program will allow an understanding of changes in ecosystem productivity and changes in ecosystem structure over time.

Physical oceanographic studies were conducted on Hamilton Bank on the Southern Labrador Shelf to the Southern Grand Bank on the Newfoundland Shelf during 1999. Temperatures at Station 27 ranged from 0.25° to 1°C above normal during the winter months over most of the water column. The spring warming of the water column in the inshore Newfoundland Region began about 2 weeks earlier than normal and maximum summer surface temperatures reached a near record high of 15°C. As a result temperatures were over 2°C above normal at the surface during June and July. Bottom temperatures throughout the year ranged from 0.25° to 0.5 °C above normal. Salinities at Station 27 were above normal during the winter months and below normal during the rest of the year. During the summer and fall of 1999 the cross-sectional area of sub-zero °C (CIL) water off Bonavista, Hamilton Bank and on the Grand Bank decreased over 1998 values continuing the below normal trend established in 1995. Bottom temperatures on the Northern Grand Bank during the spring of 1999 were up to 1°C above average and over the central and Southern Grand Bank they were up to 1-3°C above the long-term average. During the fall bottom temperatures from Hamilton Bank to the southern Grand Bank were significantly above normal. The area of sub-zero °C water covering the bottom on all major banks in the Newfoundland Region during the fall, and on the Grand Banks during spring, had decreased to near 0%. In general, during 1999 ocean temperatures were above normal over most areas continuing the trend established in 1996. The main exception during 1999 was the colder-than-normal temperature anomaly associated with the Labrador Current which was evident in the standard transect data off eastern Newfoundland during the summer months and at Station 27 by early fall.

Oceanographic studies were conducted in NAFO subdivisions 3Pn and 3Ps during 1999. The temperature and salinity data were presented in several ways, as vertical transects across the major banks and channels, horizontal bottom maps, time series of areal extent of bottom water in selected temperature and salinity ranges and as time-series of temperature anomalies at standard depths. Temperature anomalies in the 3Ps St. Pierre Bank area show anomalous cold periods in the mid-1970s and since the mid-1980s, similar to conditions on the continental shelf along the East Coast of Newfoundland. The most recent cold period, which started around 1984, continued to the early 1990s with temperatures up to 1°C below average over all depths and up to 2°C below the warmer temperatures of the late 1970s and early 1980s in the surface layers. Temperatures in deeper water off the banks show no significant trends. Since 1991, temperatures have moderated in some areas from the lows experienced from the mid-1980s and early 1990s but negative temperature anomalies continued over large areas of the banks into the spring of 1995. During 1996 temperatures started to moderate, decreased again during the spring of 1997 and returned to more normal values during 1998. Temperatures during 1999 continued to warm and were above normal over most of the water column and near bottom. An analysis of the areal extent of subzero °C bottom water covering the banks shows a dramatic increase since the mid-1980s, very low values in 1998 and a complete disappearance in 1999. The areal extent of bottom water with temperatures above 1°C on the banks was about 50% of the total area during 1998 the first significant amount since 1984 and it increased further to about 70% during 1999. The salinity data clearly shows a change in water mass characteristics during the last 2 years, compared to conditions that prevailed during the first half of the 1990s. The areal extent of the relatively saltier water (>32.5) on the banks increased by approximately 40% during this time, indicative of a shift from the cold-fresh conditions of the late 1980s and first half of the 1990s on the Newfoundland Continental Shelf to warmer-saltier conditions.

An oceanographic study was conducted during the summer of 1999 on the Flemish Cap in NAFO Division 3M. The cold near-surface temperatures (0.5 to 2°C below normal) experienced over the Cap during 1993, 1995 and 1996 had warmed to 0.5 to 1.5°C above normal in July of 1997 and increased to 2°C above normal by the summer of 1998 and 1999. Bottom temperatures over the Cap were slightly below normal during 1997, up to 0.5°C above normal during 1998 and up to 1°C above normal during 1999. Upper layer (top 100-m) salinities were slightly above the long-term mean (by 0.2-0.4 PSU) during both 1998 and 1999, otherwise about normal. In general the colder than normal

temperatures experienced over the continental shelf and on the Flemish Cap from the late 1980s up to 1995 moderated by the summer of 1996 and continued above normal up to July of 1999. As in previous years, summer chlorophyll levels in the upper 100-m of the water column over the Cap were higher compared to the adjacent Grand Bank and dissolved oxygen levels were about normal for the region. Both the measured currents and the geostrophic estimates, while showing considerable differences and variability between years, indicate a general anticyclonic circulation around the Flemish Cap.

2. Biological Studies

a) *Groundfish*

Food and feeding study – Greenland halibut
 Analysis of sexual maturity data – A.plaice, yellowtail, G.halibut.
 Analysis of yellowtail age and growth.

b) *Seals*

Multi-disciplinary studies on harp hooded, and grey seal population dynamics and seal -fish interactions continued in 1999. The objectives of these studies were to develop a better understanding of seasonal distributions of seals, determine current population size of harp and grey seals, examine interannual changes in growth and reproductive status, and to estimate consumption of prey species by seals.

The status of Northwest Atlantic harp seals was reviewed in February 1999. Population size and replacement yields were estimated based on new data and information on catches in Greenland and Canada, recent reproductive rates and various assumptions about the proportion of animals struck and lost. Estimates of struck and lost in the Canadian seal hunt were also presented. The meeting concluded that abundance of seals remained high at around 5 million animals and had been stable or declining slightly in the past several years. Replacement yield was estimated at around 400 thousand animals.

Aerial surveys were carried out in March 1999 to determine Northwest Atlantic harp seal pup production. Analysis of the data collected is underway and results will be available by the spring of 2000. The estimate will form the basis of an updated assessment for this stock.

c) *Capelin*

Studies to determine factors governing capelin survival during egg development and larval emergence from beach sediments continued at one beach site in 1999. A multi-disciplinary pelagic juvenile fish survey on the Southern Labrador Shelf (Div. 2J + 3K), the Northeast Newfoundland Shelf (Div. 3K), and the Grand Bank (Div. 3LNO) was conducted to provide pre-recruit indices for ages 0, 1, and 2 year old capelin. An acoustic survey in the spring of 2000 is designed to examine capelin distribution and behaviour in Div. 3KL.

SUBAREA 4

A. Status of the Fisheries

Nominal landings from 1990 to 1999 for fish stocks are listed in Table 1. Additional information on the status of the fisheries is as follows:

a) *Snow Crab* – 4R

Catches in 4R increased by 52% to 1,612 t in 1999 from 1,064 t in 1998. Evaluation of fishery performance was conducted through analysis of dockside monitoring, commercial logbook, and observer data. Catch rates decreased slightly in 1999 and remain low compared to the snow crab fishery in Divisions 2J3KLNO, and 3Ps.

b) *Iceland scallops* – 4R

The nominal catch from the Strait of Belle Isle (4R) in 1999 is estimated at 1,046 t (round) against a TAC of 930 t. CPUE in 1999 declined 11% from the previous year. The fishery here continues to be driven by the exploitation of an accumulated biomass consisting largely of cohorts of old, possibly well separated year classes with little potential for further growth. No significant larval settlement or recruitment has been detected in recent years. Removals from high density scallop aggregations and high incidental mortality result in rapid declines in scallop abundance. It also causes high collateral mortality to scallop spat and appears to have had a significant effect on recruitment dynamics in the area.

SUBAREAS 2 + 3 + 4

A. Status of the Fisheries

Nominal landings from 1990 to 1999 for fish stocks are listed in Table 1. Additional information on the status of the fisheries is as follows:

a) *Lobster*.

Landings have declined to 2,364 t in 1998 from long-term high of 3,207 t in 1992. This decline is part of a widespread pattern in Atlantic Canada. The fishery is monitored through a voluntary research logbook program and dockside sampling of commercial catches. Average seasonal catch rates vary considerably from year to year and are usually highest early in the season and decline rapidly as the season progresses. The fishery is characterised by high exploitation rates and size limits that are small in relation to growth rate and size at maturity. Yield per recruit and egg per recruit analyses demonstrates growth overfishing with potential substantial increases in yield through reduction in exploitation rates or an increase in size limits. Given high exploitation rates and variable recruitment, landings are expected to decline and become less stable than under a more moderate level of exploitation.

B. Special Research Studies

1. Biological Studies

a) *Redfish*.

A redfish fishery closure in Management Unit 1 (4RST and 3Pn4Vn [June to December]) for 1995 prompted the establishment of a multi-disciplinary research program on redfish that concluded in 1999. The program examined the biology and fisheries of redfish to develop a better understanding of these species and to ensure sustainability of the fishery. A workshop on the results of the program was conducted in November 1999 and a technical report is being compiled for publication in 2000.

2. Sentinel Surveys

The Sentinel Surveys, initiated in October, 1994, were continued in 1998 and data collected tabled at zonal stock assessments in the spring of 1999. Sites in 2J3K3L, 3Ps and 3Pn4Rs were sampled by inshore fish harvesters using traditional fishing gears based on historic fishing patterns. The objectives of the program are: to develop a reliable inshore catch rate, length frequencies, sex, maturity, and otolith series for use in resource assessment; to incorporate the knowledge of inshore fish harvesters in the process of resource assessment, to describe temporal and spatial inshore distributions; to establish a long-term physical oceanographic and environmental monitoring program of the inshore area; and to provide a source of biological material for other researchers for genetic, physiological, food and feeding, and toxicological analyses.

3. Gear and Selectivity Studies

a) *Effect of environmental variability on catchability*

The selectivity of the survey trawl used in the co-operative DFO/industry seasonal surveys for yellowtail flounder in NAFO Div. 3LNO was estimated by comparing catches and size composition of fishing sets. For this work, the net was rigged with a tickler chain ahead of the foot gear. The platform employed was the Fishery Products International vessel Atlantic Lindsey, during March of 1999.

Table 1. Summary of preliminary catches for stocks within the DFO, Newfoundland Region, 1990-1999

Subarea	Species	Division	Catch (t)										
			1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	
0+1	Greenland halibut	0B+1B-F	3,556	3,300	1,700	1,453	5,852	3,723	2,561	8,200	5,945	6,194	
	Shrimp	0A	2,046	933	517	2,623	2,361	4,727	5,501	7,493	6,788	6,177	
		0B	5,132	5,204	5,670	3,220	3,564	476	106	1,291	1,107	1,609	
2	Cod	2GH	0	0	0	0	0	0	3	0	0	400	
		2G (SFA 4)	7,961	8,051	5,217	5,160	5,104	3,982	2,723	2,706	2,561	2,945	
		2HJ (SFA 5)	15,028	15,170	15,103	7,383	7,616	7,499	5,719	6,315	6,118	5,360	
		2HJ3K (SFA 6)	51,028	46,337	21,246	10,923	10,914	10,978	8,035	6,609	5,500	5,598	
	Crab	2J	5,448	4,061	3,166	3,090	3,178	2,978	2,275	1,529	989	645	
2+3	Redfish	2+3K	2	3	4	2	1		2	9	161	1,806	
	Greenland halibut	2+3KLMNO	4,124	4,081	5,877	5,891	3,229	2,928	4,899	6,933	6,664	9,129	
	American plaice	2+3K	6	6	2	16	28	16	77	103	494	1,770	
	Witch	2J+3KL	2	1	6	4	10	11	343	1,632	2,430	2,825	
	Cod	2J3KL	8,472	4,501	505	350	330	1,309	3,938	24,356	120,135	204,900	
	Grenadier	2+3	145	209	98	225	125	130	614	992	365	152	
	Capelin	2J3KL (offshore)	0	0	0	0	0	0	0	0	450	57,170	
	Squid	2+3	19	815	12,748	8,285	48	1,954	276	924	1,719	4,440	
	3	Redfish	3LN	5	7	19				46	657	362	958
			3M									1	
3O			1,990	6,121	1,895	128	24	1,192	677	845	173	5,131	
Yellowtail		3LNO	5,540	3,536	1				6,265	6,369	6,257	4,754	
American plaice		3LNO	269										
		3Ps	542										
Witch flounder		3NO	24	4	18				437	3,971	4,093	2,457	2,499
		3Ps	461										
Atlantic halibut		3	124	165	152	101	107	36	138	114	231	165	
Cod		3NO	525	306	289	54	31	3	3,719	5,232	5,456	7,222	
		3Pn	1,120	559	1,993	70	32	158	2,412	843	1,063	1,216	
		3Ps	23,918	15,664	7,518	520	337	574	13,519	21,845	24,693	23,048	
Haddock		3LNO	65	14	190	28	9	0	675	598	708	1,423	
		3Ps	89	191	69	118	48	20	86	251	263	232	
Pollock		3Ps	726	428	592	435	248	59	113	437	1,188	1,060	
		Capelin	3L	11,121	20,300	3,560	16,840	100	890	23,480	3,160	22,310	48,000
			3K	7,407	10,420	9,230	8,920	30	70	13,525	19,350	20,000	35,140
	Shrimp	3M	490	469	785	906	970	1,041	3,724				
	Sea scallop	3Ps	79	257	9	8	564	1,299	1,438	676	1,279	1,559	
	Iceland scallop	3LNO	138	1,310	3,986	9,454	6,501	3,941	817	22	-	-	
Crab	3K	21,470	16,788	14,830	14,190	12,245	11,039	9,760	7,295	7,675	4,253		
	3LNO	32,725	23,533	22,185	16,656	13,790	12,237	8,979	6,652	6,394	5,211		
	3Ps	7,909	6,615	4,753	3,047	1,853	1,590	704	121	176	596		
Atlantic salmon	2J3KLPs+4R		45	82	114	95	133	126	213	353	498		
	2J3KLPs+4R	41	38	38	16	30	31	38	74	70	100		
3+4	Redfish	3P+4V	5,335	4,101	3,825	4,566	3,978	7,594	9,350	4,635	6,628	6,227	
4	Iceland scallop	4R	1,046	1,307	1,205	1,204	1,497	2,294	1,914	1,169	412	79	
	Crab	4R	1,612	1,064	969	833	920	655	-	-	-	-	

Note: Newfoundland landings only