



Serial No. N4131

NAFO SCS Doc. 99/20

SCIENTIFIC COUNCIL MEETING – SEPTEMBER 1999

Canadian Research Report for 1998

Newfoundland Region – D. Kulka and J.M. Tillman

SUBAREAS 0 AND 1

A. Status of the Fisheries

Nominal landings from 1990 to 1998 for fish stocks are listed in Table 1. Additional information on the status of the fisheries is as follows:

a) *Shrimp* - Div. 0B

Catches for *Pandalus borealis* in 1998 were 5,204 t against a TAC that was increased, experimentally, to 5,250 t for the 1997-1999 multi-year management plan. The 1998 reported catch for *P. montagui* against the 3,800 t. TAC in the area west of 63 degrees was 2,703 t. Both standardised and unstandardized catch rates were the highest over the 1988 to 1998 period. The status of the resource remains uncertain as fluctuations in catches and catch rates are not considered to be valid indicators of overall stock conditions and may reflect oceanographic conditions - presence of ice, sudden shifts in water masses, or strong tides – that are believed by fishermen to affect shrimp distribution. The mixed fishery for *P. borealis/montagui* and the absence of a time series of research vessel trawl surveys further confound the assessment of the distribution and abundance of both species.

b) *Greenland Halibut* - 0B+1B-F

The Greenland halibut stock in Subarea 0 + 1B-F is part of the stock distributed in Subarea 2 and 3. Canadian catches for 1998 were approximately 3,300 t. Recent scientific information on this stock is limited as the last complete survey was conducted in 1986. NAFO Scientific Council and the Canadian Fisheries Resource Conservation Council (FRCC) recommended that the 1997 and 1998 TAC should not exceed 11,000 t.

SUBAREA 2

A. Status of the Fisheries

Nominal landings from 1990 to 1998 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 1998. Approximately 6,900 salmon were retained or hooked and released in the recreational fishery.

b) *Arctic charr.*

Landings of Arctic charr in northern Labrador were 37 t, similar to those of 1997, but were derived entirely from the Nain fishing region as no catch was reported for Makkovik. Catch rates increased substantially in two of three stock complexes. Catch and effort have increased at Nain during the past three years coinciding with the introduction of a community-based licensing system.

c) *Shrimp* – 2G, Hopedale and Cartwright Channels (2HJ), and Hawke Channel (2J) + 3K.

The shrimp fishery in Subarea 2 is divided into three management areas - 2G, Hopedale and Cartwright Channels (2HJ), and Hawke Channel (2J) + 3K. Catches in 2G for 1998 increased to 8,051 tons with an increase in TAC from 5,200 to 8,320 t. Fishing effort increased in 1998 with the increased TAC. Historically, the fishery has been concentrated north of 60°N in an area noted for producing high catch rates of large, high-quality shrimp. Most of the catch increase in 1998 was located south of 60°. Both standardised and unstandardized catch per unit effort (CPUE) analyses show similar catch rates in 1997 and 1998. The spawning stock remains healthy as evidenced in continued high catch rates for female shrimp.

Catches in Hopedale and Cartwright Channels (2HJ) were about 15,000 t. in both 1997 and 1998. Fishing effort approximately parallels the same trends over time as catch, except in recent years. In recent years however, effort has decreased while catches have increased. In the 1990s effort has expanded throughout the area and the timing of the fishery has shifted from a summer-fall fishery to mainly a winter-spring operation. Both standardised and unstandardized CPUE series show approximately the same trend – a decline to the mid 1980s, a substantial increase in 1986 followed by stability to the early 1990s, and an increase since that period. The resource in this area appears healthy, from fishery data, with commercial catch rates of both male and female components stable over the 1980s and increasing in recent years. Variable estimates of stock size from surveys are uncertain, however, for interpretation of trends.

The fishery in Hawke Channel (southern Div. 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 from 1989 to 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 those three years. Based upon analyses of commercial fishery and research vessel data, the 1997, 1998 and the 1999 assessments concluded that the resource was healthy and exploitation low. The TAC for 1998 was raised to 46,200 t. and was taken primarily by inshore vessels. Fall multispecies research vessel surveys in 1995-1998 showed that shrimp were widely distributed and abundant throughout the area. Abundance was dominated by the 1993 and 1994 year-classes. The data suggest that the 1995 and the 1996 year-classes are weaker than either the 1994 or 1993. Catch rates in the 1998 fishery were among the highest observed and despite the increased catch, exploitation remained low.

d) *Cod* – 2GH, 2J3KL.

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

The northern cod moratorium has been in effect since July 1992 for cod from Div. 2J3KL. Reported catches come from by-catch and sentinel surveys in 1998. There is evidence of removals in excess of legal fisheries and the sentinel surveys, but the magnitude of these reductions cannot be estimated. A TAC of 9,000 t was set for 1999.

e) *American Plaice* – 2+3K

There was no directed fishery on this stock in 1998. Analyses of data from annual fall multispecies research vessel trawl surveys indicate that recruitment, abundance, and total and spawning biomass are 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 1998 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* – 2J

Catches increased by 29% to 4,081 t in 1998 from 3,166 t in 1997. Fishery performance is monitored in the three management areas through analyses of commercial logbook data, observer program data, and dockside monitoring. CPUE from logbook data increased by 22% in 1998.

B. Special Research Studies

1. Environmental Studies

a) *Hydrographic studies*

Field surveys and field sheet production were conducted for inshore areas of southern Labrador (2J) by the Canadian Hydrographic Service at Makkovik, Black Tickle, Windy Tickle, and Postville. Quality control baseline data was collected in the Voisey's Bay area (Div. 2H) in support of the nickel mine/mill development. New charts, chart inserts, or chart patches were produced for Punchbowl, St. Lewis Inlet, Sango Bay, and Williams Harbour.

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. Juvenile and adult cod densities and distributions and acoustic properties mixed cod, arctic cod, capelin, and shrimp were studied in Div. 2J.

b) *Arctic charr.*

Samples were obtained for food and feeding and age, sex, and length distributions from commercial landings from 10 northern Labrador fishing areas. Analyses of sampling data demonstrated a decline in mean weight of charr, particularly for the Nain and Voisey stock units. Both areas, however, had increased mean weights during 1998. Recent analyses have also identified a possible environmental component contributing to some of the variation in stock characteristics.

SUBAREA 3

A. Status of Fisheries

Nominal landings from 1990 to 1998 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 11,600 t in 1997 before declining sharply to only 800 t in 1998. Increases in catches in 1996, 1997 and 1998 were associated with improvement in the oceanographic regime and increase in squid abundance at the northern extreme of their range.

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 1998. The 1998 recreational harvest, including both retained and hooked-and-released, was approximately 39,500 fish in insular Newfoundland. Returns to many rivers in Newfoundland improved over low returns recorded in 1997.

c) *Shrimp* – 3M.

The international fishery in Div. 3M, which began in 1993, continued in 1998. Canadian vessels caught 469 t in 1998 compared to 3724 t in 1993. By-catch of groundfish has been quantified for this fishery. Primarily consisting of redfish, the levels of groundfish by-catch have declined to low levels in 1998.

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.

In Eastern 3L only 32 t (round) were taken in 1998 from a TAC of 1,000 t. Overall mean catch rates and meat counts were low and the area is now considered marginal for the fleet.

Catches in the LCC box were 784 t (round) from a TAC of 900 t in 1998. Catch rates have declined 20% since aggregations were first exploited. Continuous exploratory movements of the fishing fleet to maintain or improve catch rates likely obscure real changes in CPUE. Individual meat-weight frequencies from 1998 show a significant shift to smaller sizes suggesting that the fleet moves around to fish new aggregations with high catch rates.

Fishing effort in 3LN was concentrated south of 46°N. Approximately 42 t (round) of the 1500t allocation was taken in 1998. Annual catch rate here has declined 12% from the level recorded in 1995 and the total number of days expended and removals in this area by the commercial fleet have declined in each of the last three years. Only 24 days were expended here with the nominal catch estimated at only 91 t.

In 3Nf, catches declined significantly from 3,483 t in 1996 to 228 t in 1997 and only 170 t in 1998 from an allocation of 400 t. Overall reduction in CPUE was 40 % from that in 1996. Total number of days fished in 1998 declined to only 61 days from 833 days in 1996. Meat weights are among the lowest anywhere in the four "boxes" and may have contributed to the reduced effort.

Exploratory fishing outside of the TAC areas occurred from the Virgin Rocks, along the eastern edge of Grand Bank between the LCC and Kettle Canyon, and from nearshore aggregations off the Avalon Peninsula of Newfoundland. Approximately 208 t (round) were caught within these areas in 1998.

The Iceland scallop fishery on St. Pierre Bank commenced in 1989 and is now separately managed as two zones: (a) the transboundary 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. There was no directed effort for Iceland scallops in the transboundary area even if a TAC (630t) had been proposed. Much of these aggregations have been severely impacted by a starfish epidemic and catches have declined dramatically since peaking at nearly 6,000 t in 1992. Residual biomass in 1998 here is estimated at only one-tenth of the level in 1992. Meanwhile, in excess of 50 vessels actively prosecuted the species in the Canadian portion of 3Ps. Total combined catch from Canadian waters in 1998 was 2763t (round). Nearshore aggregations in Subdiv.3Ps were

heavily exploited in 1998 contributing to over 45% of the nominal catch from the area. Currently, there are three aggregations or boxes for which catch limits are imposed annually.

e) *Capelin* - Subarea 2 + Div. 3KL

Inshore capelin catches in Subarea 2 + Div. 3KL are usually 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 was not included in the 1996, 1997, and 1998 management plans. Catches increased from 12,800 t in 1997 to 30,690 t in 1998. Resource status is determined by a mathematical model that incorporated twelve partially overlapping series of indicators – an aerial survey index, purse seine and trap catch rates, fall multispecies research vessel survey by-catch, Russian 2J3K fall commercial catch rate index, egg deposition index, four larval 0-group indices, and an age 1 index. The model provides estimates of relative year-class strength. In 1999 the spawning biomass is expected to consist of two relatively strong year-classes, 1995 and 1996. No biomass estimate was available in 1998. The aerial survey index for 1998 was lower than 1997 and below the 1990-98 average. The egg deposition in 1998 was the highest in the series that started in 1990. 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* – 3K, 3LNO, and 3Ps.

Resource status in Div. 3KL was determined from inshore trap/trawl surveys, fall multispecies research vessel trawl surveys, and commercial fishery logbook and observer data. Catches in 3K increased in 1998 to 16,814 t from 14,830 t in 1997. Commercial catch rates (CPUE) in 1998 increased by 14% from the 1997 level.

Catches in 3LNO increased to 24,028 t in 1998 from 22,185 t in the previous year. CPUE increased by 9% in 1998.

Catches in 3Ps increased in 1998 to 6,615 t from 4,753 t in 1997. CPUE remained comparable to that of the previous year.

g) *Cod* – 2J3KL, 3NO, and 3Ps.

Moratoria on directed cod fisheries remained in place in 1998 for Div. 2J3KL (since July 1992) and Div. 3NO (beginning in 1995). Resource status was determined from data from commercial by-catch, spring research vessel bottom trawl surveys, fall multispecies research vessel bottom trawl surveys, inshore sentinel surveys, new offshore sentinel surveys, inshore acoustic surveys in specific bays, pre-recruit surveys, and a new and intensive fall acoustic survey of the inshore from White Bay to St. Mary's Bay (3KL). Additional data on the consumption of cod by harp seals up to 1995 were also analysed but require further analysis to reconcile consumption estimates with estimates of population numbers. Biomass remains at less than 10% of the long-term average with no significant indications of recruitment and is coupled with increased natural mortality. Age at maturity has declined since 1991 and while weight at age has increased in recent years, it is still low compared with peak values in the 1970's.

Biomass estimates for 3NO cod from Canadian spring stratified-random surveys in Div. 3LNO and 3NO in the fall were conducted in 1998 and were tabled at the June 1999 meeting of the NAFO Scientific Council.

In May 1997, the Div. 3Ps commercial fishery was re-opened with a TAC of 10,000 t. Catches from the sentinel survey, a recreational fishery, by-catch, and Canadian and French commercial fisheries were about 9,045 t. Stock status was estimated from commercial landings in conjunction with abundance and biomass indices from Canadian (1978-1997) and French (1980-1991) research vessel trawl surveys. Other information for 1997 included an industry trawl survey on St. Pierre Bank, sentinel surveys (1995-1997), acoustic surveys in Placentia Bay and Fortune Bay, tagging experiments in Placentia Bay, and a new logbook for vessels less than 35 ft. to provide detailed information on catch and effort for the inshore fixed gear fishery. A reliable interpretation of stock status

was impeded by severe problems of stock structure, seasonal migrations, variability in trawl survey estimates, and poor quality historical data on catch and effort. The 1989 and 1990 year-classes have contributed to the growth of the spawning stock although recent recruitment has been poor. The Fisheries Resource Conservation Council has recommended an increase in the TAC for 1998 to 20,000 t consistent with the DFO Science Stock Status Report.

h) *Yellowtail flounder* – 3LNO

There was no directed fishery on this stock between 1994 and 1997 but 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. Review of stock status at the June 1997 Scientific Council meeting indicated that stock size has increased since 1994 but remains at a lower level than in the 1980s. In addition to the annual spring stratified-random groundfish survey in 3LNO and the fall multispecies bottom trawl survey, a joint DFO-Industry survey was conducted in 1998. The objective of this Fisheries Products International-DFO survey is to develop a commercial-type index of abundance and determine distribution of yellowtail flounder within a zone traditionally fished by commercial fleets.

i) *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 October 1998.

Unit 2 landings in 1998 totalled approximately 10,500 t from a TAC of 10,600 t. Catches have declined steadily from 27,000 t in 1993 matching reductions in TACs. Stock status was determined from annual stratified random research vessel surveys and sampling of the commercial fishery. Commercial sampling suggested that the majority of the catch was comprised of fish between 28 cm to 33 cm, the bulk of which represents the early 1980's year-class. The 1988-year-class was also present in catches since 1994. Survey results indicated a bimodal length distribution consisting of the 1988 and 1994 year-classes. The former 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 then declined in 1997 to approximately 2,300 t. the 1998 catch increased to 8,800 t. Resource status has been determined from a standardised catch rate index from commercial fishery data and spring and fall stratified random surveys in 3O. The spring survey index increased steadily from 1992 through 1996 but declined sharply in 1997 and was similar in 1998. The fall survey index increased gradually from 1991 through 1993 but declined slightly in 1994 before increasing significantly in 1995. The index declined sharply in 1996 but the extent of the decline is unknown because four important strata were not sampled. The surveys catch fish in the 10 cm to 25 cm range whereas the commercial catch is mostly comprised of fish greater than 25 cm. Recent declines in the survey estimates may not be related to fishing and it is difficult to interpret these events in relation to stock status as a whole. There is also some concern that there has been little sign in the recent surveys of size groups smaller than 17 cm. In all surveys, the biomass indices in strata outside 200 miles were low compared to those inside.

B. Special Research Studies

1. Environmental Studies

a) *Hydrographic Studies*

Field surveys using 100% multibeam bottom coverage were conducted for St. John's harbour and approaches, Come-by-Chance/Whiffen Head, and Marystown harbour. Paper and electronic charts were produced. New charts were published for Twillingate (3K) and new sailing direction diagrams (SDD) were produced for Musgrave Harbour, Summerford, Lumsden, and St. John's.

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*

Oceanographic observations from Hamilton Bank on the Southern Labrador Shelf to the Southern Grand Bank (NAFO Div. 2J3KLNMO) during 1998 were presented referenced to their long-term (1961-1990) means. Temperatures off St. John's at Station 27 ranged from 0.3 to 0.5 °C above normal during winter and spring over most of the water column and into early summer near the surface. By mid-summer, however, a negative temperature anomaly developed in the upper water column with temperatures reaching 1 to 2°C below normal by late summer. These colder than normal temperatures propagated deeper into the water column reaching below 100 m depth by November. Bottom temperatures throughout the year at Station 27 were slightly above normal and upper layer salinities were below normal during the first half of the year, particularly during the summer months. The 1998 summer CIL area off Bonavista and Hamilton Bank increased over 1997 values but was still below normal, continuing a trend established in 1995. Along the Flemish Cap transect across the Grand Bank the CIL area was normal during 1998, a decrease from 1997 and identical to the 1996 value. The total volume of sub-zero °C water on the Newfoundland Shelf during both summer and fall is below normal continuing the trend established in 1995. Bottom temperatures on the Grand Bank during the spring were up to 1°C above the long-term average. During the fall of 1998 bottom temperatures were still above normal over many areas, particularly on the offshore portion of the Northeast Newfoundland. An analysis of the areal extent of bottom water in different temperature bins revealed a significant decrease in the areal extent of sub-zero °C water and a corresponding increase of about 70% in the extent of water above 1°C during the spring of 1998 compared to 1997. In general, the below normal oceanographic trends in temperature and salinity, established in the late 1980s reached a peak in 1991, started to moderate during 1994 and were above normal by 1996. During 1997 and 1998 temperatures continued above normal over many areas, particularly on the Grand Bank during spring and over the deeper portions of the Northeast Newfoundland Shelf. The main exception being the near shore coastal regions in the upper to mid water column where temperatures were colder than normal during summer and early fall.

Oceanographic data from NAFO subdivisions 3Pn and 3Ps during 1997 and 1998 were examined and compared to the long-term (1961-1990) average. The data were presented in several ways, as vertical transects across the major banks and channels, horizontal bottom temperature maps, time series of areal extent of bottom water in selected temperature ranges and as time-series of temperature anomalies at standard depths. Time series of 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- to late-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. 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 1996 and 1998, while in 1997 it represented approximately 60% of the total area. The areal extent of bottom water with temperatures above 1°C was about 50% of the total area of the banks in the 3Ps region during 1998 the first significant amount since 1984.

Oceanographic data from the summer of 1998 on the Flemish Cap (NAFO Div. 3M) were examined and compared to the long-term (1961-1990) average and to conditions during the summer of 1997. The cold near-surface temperatures (0.5 to 2.0 °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. Bottom

temperatures over the Cap were slightly below normal during 1997 and up to 0.5 °C above normal during 1998. Upper layer (top 100-m) salinities were above the long-term mean (by 0.2-0.5 PSU) during both 1997 and 1998, 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 1998. 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) *Cod.*

A multispecies survey of pelagic juvenile fish (0-group cod and 0- and 1-group capelin) was again conducted in 1998 to measure pre-recruit abundance. Acoustic measurements of the distribution and abundance of fish in the top 100m of the water column at each fishing station, incorporated for the first time in 1997 was incorporated again in 1998. The abundance of pelagic 0-group cod was found to be relatively low although cod were sampled throughout the 2J3KLNO survey area.

Food and feeding studies continued in 1998 with investigations on kinds, quantities, and sizes of prey consumed by cod to determine the importance of various prey to migration, growth, and reproduction of the 2J3KL and 3Ps cod stocks.

Inshore-nearshore cod stock structure research continued in 1998. Tagging, acoustics, genetic, and morphometric data was collected to delineate the relationship between inshore and offshore stock components of 2J3KL and 3Ps cod stocks, the relationship and movements between the 3Ps and 3Pn4RS cod stocks, and identification of mixed stocks – 3Pn4RS, 3Ps, 4T, 4Vs - in the Gulf of St. Lawrence. Tagging studies in 3Ps and 3L were implemented using Brownie models to enable estimation of exploitation rate at the end of year one, survival rate, fishing mortality, and natural mortality. New methods were incorporated to estimate tag shedding rates and short-term tagging mortality. Blood and tissue samples were collected for genetic analyses with initial results suggesting genetic differentiation between Flemish Cap (3M) and offshore 3K cod and some differentiation between inshore and offshore cod aggregations.

A multi-year, multidisciplinary study on partitioning the total mortality of Atlantic cod stocks concluded in 1997-98. The project had five components to ascertain the degree of variability in the total mortality of cod that can be attributed to environmental and ecosystem factors and its relationship to fishing activity. The research components are: understanding changes in physiological condition of cod; evaluation of fishing effort, discarding, and reporting; evaluation of the impact of harp seals and minke whales; distribution and dynamics of pre-recruit cod; and comparative ecosystem dynamics studies to delineate the association between community structures and physical conditions in the North Atlantic.

b) *Seals*

A multi-disciplinary study on harp hooded, and grey seal population dynamics and seal -fish interactions continued in 1998. The objectives of the programs 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 model seal predation.

c) *Capelin.*

Studies to determine factors governing capelin survival during egg development and larval emergence from beach sediments continued at one beach site in 1998. 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 (3LNO) was

conducted to provide pre-recruit indices for ages 0, 1, and 2 year old capelin. An acoustic survey in the spring of 1999 is designed to examine capelin distribution and behaviour in Div. 3KL.

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.

SUBAREA 4

A. Status of the Fisheries

Nominal landings from 1990 to 1998 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 totalled 1063 t in 1998 up from 969 t in 1997. Evaluation of fishery performance was conducted through analysis of dockside monitoring, commercial logbook, and observer data. Catch rates increased but remain low compared to the snow crab fishery in Divisions 2J, 3K, 3LNO, and 3Ps.

b) *Iceland scallops – 4R*

The nominal catch from the Strait of Belle Isle (4R) in 1998 is estimated at 1307 t (round) against a TAC of 930 t.

The overrun was in part caused by a temporary adjustment to the conversion factor (9.2) used to estimate round weight from landed meats. Total effort and CPUEs appear to have stabilized although fishing effort has been drifting southwards into aggregations first targeted for in the 1970's and long left idle. 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 1998 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 which continued in 1998. The program examines the biology and fisheries of redfish to develop a better understanding of these species and to ensure sustainability of the fishery. The program concentrates on species identification and stock structure; improved stock assessment and management approaches; distribution in relation to environmental conditions; and recruitment studies.

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 multi-year project on the impact of mobile fishing gear on benthic habitat and communities continued in 1998. Spatial and temporal mapping of benthos on the Grand Bank (3L), Western Bank (4W), and Banquereau Bank (4V) through grab sampling of macrofauna, meiofauna, organic carbon, and sediment for grain size analyses during spring groundfish surveys have been conducted. Experimental otter trawling was carried out in an area of the Grand Bank and on Western Bank. A hydraulic clam dredging experiment on Banquereau Bank, designed in 1997 was implemented in 1998.

Table 1. Summary of preliminary catches for stocks within the DFO, Newfoundland Region, 1990-1998.

Subarea	Species	Division	Catch (t)									
			1998	1997	1996	1995	1994	1993	1992	1991	1990	
0+1	Greenland halibut Shrimp	0B+1B-F	3,300	1,700	1,453	5,852	3,723	2,561	8,200	5,945	6,194	
		0A	933	517	2,623	2,361	4,727	5,501	7,493	6,788	6,177	
		0B	5,204	5,670	3,220	3,564	476	106	1,291	1,107	1,609	
2	Cod Shrimp	2GH	0	0	0	0	0	3	0	0	400	
		2G (SFA 4)	8,051	5,217	5,160	5,104	3,982	2,723	2,706	2,561	2,945	
	2HJ (SFA 5)	15,170	15,103	7,383	7,616	7,499	5,719	6,315	6,118	5,360		
	2HJ3K (SFA 6)	46,337	21,246	10,923	10,914	10,978	8,035	6,609	5,500	5,599		
	Crab	2J	4,081	3,166	3,090	3,178	2,978	2,275	1,529	989	645	
2+3	Redfish	2+3K	3	4	2	1		2	9	161	1,806	
	Greenland halibut	2+3KLMNO	4,081	5,877	5,891	3,229	2,928	4,899	6,933	6,664	9,129	
	American plaice	2+3K	6	2	16	28	16	77	103	494	1,770	
	Witch	2J+3KL	1	6	4	10	11	343	1,632	2,430	2,825	
	Cod	2J3KL			350	330	1,309	3,938	24,356	120,135	204,900	
	Grenadier	2+3	209	98	225	125	130	614	992	365	152	
	Capelin	2J3KL (offshore)	0	0	0	0	0	0	0	450	57,170	
	Squid	2+3	800	11,652	8,285	48	1,954	276	924	1,719	4,440	
	3	Redfish	3LN	7	19				46	657	362	958
			3M								1	
3O			6,121	1,895	128	24	1,192	677	845	173	5,131	
Yellowtail		3LNO	3,536	1				6,265	6,369	6,257	4,754	
American plaice		3LNO										
		3Ps										
Witch flounder		3NO	4	18			437	3,971	4,093	2,457	2,499	
		3Ps										
Atlantic halibut		3	165	152	101	107	36	138	114	231	165	
Cod		3NO	306	289	54	31	3	3,719	5,232	5,456	7,222	
		3Pn	559	1,993	70	32	158	2,412	843	1,063	1,216	
		3Ps	15,664	7,518	520	337	574	13,519	21,845	24,693	23,048	
Haddock		3LNO	14	190	28	9	0	675	598	708	1,423	
		3Ps	191	69	118	48	20	86	251	263	232	
Pollock		3Ps	428	592	435	248	59	113	437	1,188	1,060	
Capelin		3L	20,300	3,560	16,840	100	890	23,480	3,160	22,310	48,000	
		3K	10,420	9,230	8,920	30	70	13,525	19,350	20,000	35,140	
Shrimp		3M	469	785	906	970	1,041	3,724				
Sea scallop		3Ps	257	9	8	564	1,299	1,438	676	1,279	1,559	
Iceland scallop	3LNO	1,310	3,986	9,454	6,501	3,941	817	22	-	-		
Crab	3K	16,814	14,830	14,190	12,245	11,039	9,760	7,295	7,675	4,253		
	3LNO	24,028	22,185	16,656	13,790	12,237	8,979	6,652	6,394	5,211		
	3Ps	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		
Arctic Charr	2J3KLPS+4R	38	38	16	30	31	38	74	70	100		
3+4	Redfish	3P+4V	4,101	3,825	4,566	3,978	7,594	9,350	4,635	6,628	6,227	
4	Iceland scallop	4R	1,307	1,205	1,204	1,497	2,294	1,914	1,169	412	79	
	Crab	4R	1,063	969	833	920	655	-	-	-	-	

Note: Newfoundland landings only