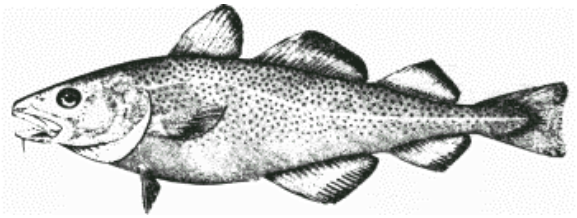
Fisheries and Oceans / Pêches et Océans
Newfoundland Region

DFO Science
Stock Status Report A2-01 (1999)



Northern (2J3KL) Cod

Background

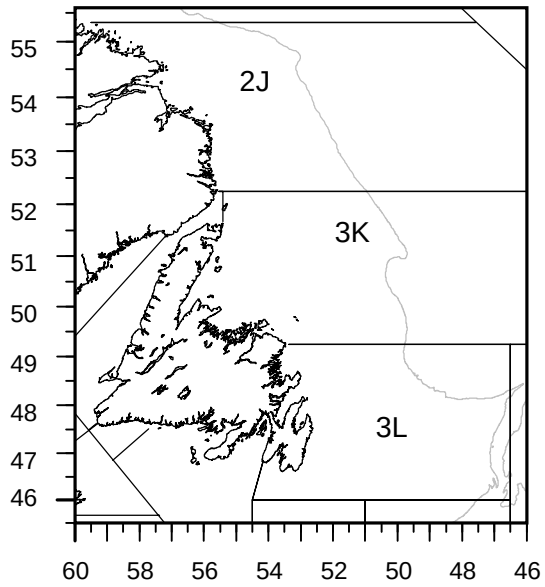
Cod has traditionally been called the "Newfoundland currency," and played a significant role in the settlement of the island. The northern (NAFO divisions 2J3KL) cod stock has been and remains potentially one of the largest in the world.

The stock covers about 117,000 square miles. Historically many cod migrated from overwintering areas offshore to feeding areas inshore. From the 1960s to the early 1990s the fishery was prosecuted with large otter trawlers offshore, mainly in the winter and spring, and a large fleet of smaller vessels that deployed traps, gillnets and hook and line inshore from late spring to autumn. Some fish overwintered inshore in the past. It appears that a substantial portion of the fish currently in the stock area remain inshore throughout the year.

Cod from this stock grow more slowly than in warmer areas. An age 5 cod would be about 50 cm.(about 20 inches) long. Throughout the area female cod have a variable age at maturity, presently about age 5.

Cod in divisions 2J3KL feed on a wide variety of food items but as adults take mainly capelin.

This stock has supported a commercial fishery since the 16th century. For the century prior to 1960 the catches were mainly between 200,000 metric tons and 300,000 metric tons. With high catches in the late 1960s, mainly by foreign fleets, the stock declined until the mid 1970s. After the extension of jurisdiction in 1977, the stock increased until the mid 1980s but has since declined to a very low level. A moratorium on commercial fishing was declared in July, 1992.



The Fishery

Catches by non-Canadian fleets increased rapidly in the 1960s, with the total catch peaking at 800,000 metric tons in 1968. Catches both offshore and inshore declined during the 1970s. The stock declined to a low biomass by 1977.

Landings (thousand metric tons)

Year	62-76 Avg.	77-91 Avg.	1994[1]	1995[1]	1996[1]	1997[1]	1998[1]
TAC	N/A	N/A	0	0	0	0	0
Can. Fixed	88	90	1	+	2	1	5[2]
Can. Mobile	9	84	0	0	+	+	+
Others	405	38	+	0	0	0	0
Totals	502	212	1	+	2	1	5[2]

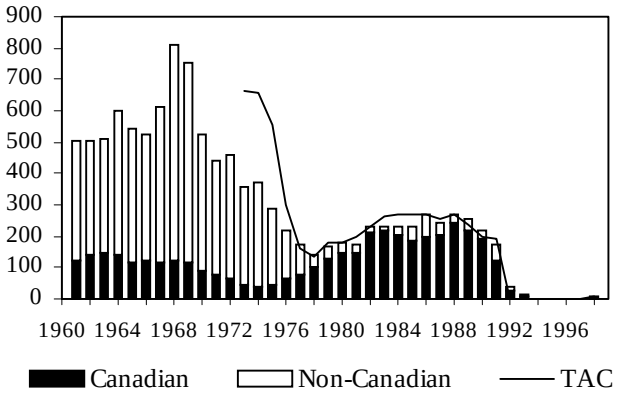
[1] Provisional

[2] Catch from bycatch, a food fishery and sentinel and index surveys.

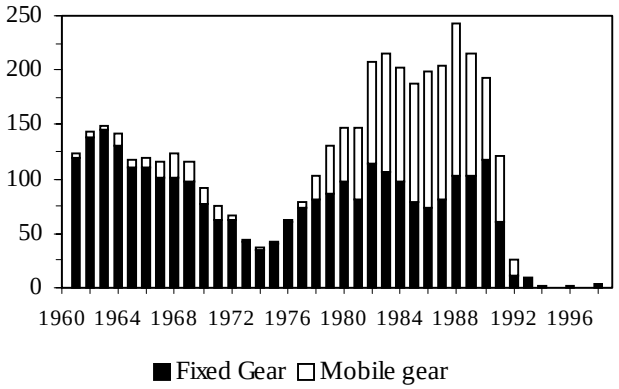
[+] Catch less than 500 metric t

Canada

Reported catch ('000 t)



Reported Canadian catch ('000 t)



Following extension of jurisdiction the stock began to recover as a consequence of smaller catches, entry of the strong 1973-1975 yearclasses, and an increase in individual growth rate. However, recovery of the spawner biomass stopped after about 1982 as a result of higher fishing mortality, entry of the weak 1976-1977 yearclasses and a decline in individual growth rate. The 1978-1982 yearclasses were moderate to strong but experienced slow growth rates. Catches during the mid- to late 1980s were relatively stable but fishing mortality was higher than thought and the stock declined through the latter half of the 1980s. The 1986-1987 yearclasses appeared strong at an early age, but in concert with older yearclasses appeared to decline very rapidly in the early 1990s. Fishing mortality was very high during this period but reported landings including documented discards are insufficient to account for the decline observed in the research vessel indices. A moratorium on directed commercial fishing was imposed in July 1992.

Reported catches in 1993-1998 came from bycatch, food fisheries (1994, 1996, 1998) and sentinel surveys (1995-1998). The reported catch of about 4500 t in 1998 came mainly (68%) from a new inshore index fishery. There is evidence of removals in excess of sentinel surveys and legal fisheries, but the magnitude of these removals cannot be estimated.

Resource Status

Stock status at the end of 1998 was updated from 1997 based on an additional year of data from commercial bycatch, the research bottom trawl surveys, prerecruit surveys, acoustic surveys in specific areas, sentinel surveys and a brief food fishery. A new source of information was the index fishery conducted in the inshore and the offshore. Also new were descriptions of cod distribution and migrations based on returns from recent tagging studies, and estimates of population size in the inshore based on those returns. Estimates of the consumption of cod by seals were revised and updated.

Stock Structure

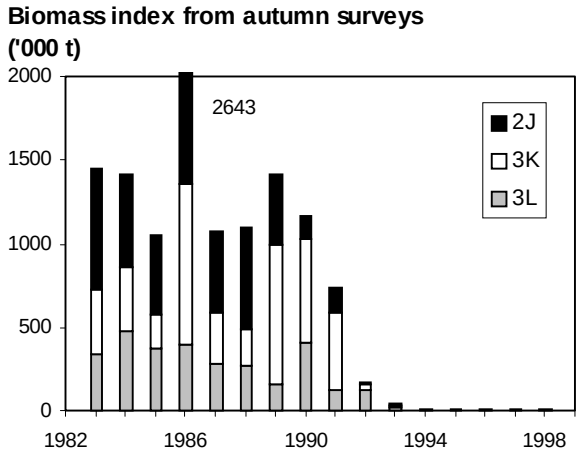
Since the mid-1990s a dichotomy has arisen between continued low cod density in the offshore and indications of higher fish densities in the inshore from White Bay in central Division 3K southward to the boundary with Subdivision 3Ps. A review of historical data indicates there have always been some cod that have overwintered

inshore, and there has always been spawning inshore. An examination of age compositions reveals that the cod inshore in 1995-1998 are of younger yearclasses than those that disappeared from the offshore in the early 1990s, indicating that the cod now inshore are not predominantly fish that formerly migrated between offshore and inshore and have remained inshore. The results of **genetic** and **tagging** studies in the 1990s provide evidence that the cod currently inshore tend to stay inshore and are genetically distinct from some but not all of the cod components in the offshore. Tagging studies also indicate that cod north of a line down the axis of Trinity Bay tend to remain north of that line. A portion of the cod caught south of that line are from pre-spawning and spawning aggregations tagged in Subdivision 3Ps in the spring, both within Placentia Bay and near the outer edge of the shelf, particularly in the vicinity of Halibut Channel.

Because of the dissimilarity between the offshore and the inshore, information from the two areas will be presented separately where available. It is emphasized, however, that it is not clear that inshore (coastal, bay) components are any more distinct from offshore components than the various offshore components are distinct from one another. Many studies, including tagging, meristics and genetics, have shown that fish sampled from different regions of the offshore in winter/spring appear distinct, with the degree of distinction increasing with distance. Even though samples of cod from different parts of the stock area can be shown to be distinct with respect to various features, the cod move over considerable distances on a seasonal basis. Different groups of cod occupy the same area at different times and often at the same time. Attempting to keep track of the removals from a specific component would appear to be impossible.

Surveys and index fisheries

The abundance index from the **autumn research bottom-trawl survey** in the offshore of divisions 2J3KL declined from 1995 to 1997 and increased a little in 1998. Very few fish older than age 5 were caught. The biomass index from this survey increased a little from 1995 to 1997 as a consequence of individual growth and remained unchanged in 1998. The biomass index in 1997 and 1998 was 1.4% of the average in the period 1983-1988 (excluding 1986).



The **spring research bottom-trawl survey** in the offshore of Division 3L continued to show low abundance and biomass indices in 1998. The average biomass index for 1996-1998 was 0.7% of the average in the period 1985-1988.

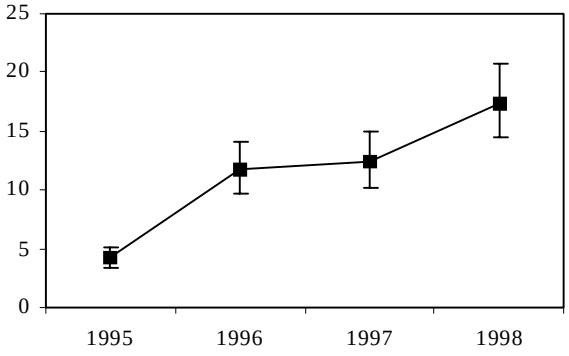
An **offshore index fishery** was conducted by one trawler in Division 3L in November 1998. No cod concentrations were located and catch rates were extremely low.

Offshore acoustic studies were conducted in Hawke Channel in Division 2J in June

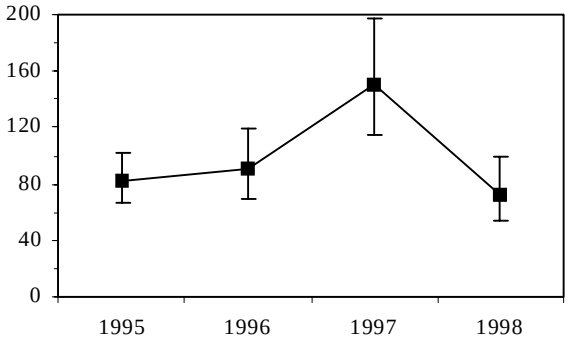
1994-1996 and 1998. There was no evidence of an increase in the number of fish in the study area over the five years of study.

The **sentinel surveys** in divisions 2J3KL, initiated in 1995 to provide catch rates of cod in inshore waters, have been conducted primarily with gillnets and linetrawls but also with handlines and cod traps. Catch rates have been low from White Bay north including southern Labrador since the start of the surveys. Catch rates from White Bay south are described by participants as being good and to have increased since initiation of the surveys. Seasonality was apparent for some sites. An analysis of standardized catch rates in divisions 3K and 3L combined revealed that gillnet catch rates increased from 1995 to 1996, remained steady in 1997, and increased in 1998, whereas linetrawl catch rates showed relatively little change from 1995 to 1996, increased in 1997 and declined again in 1998 to approximately the level seen in 1995.

Standardized gillnet catch rate from sentinel surveys in 3KL (number of fish per net)



Standardized linetrawl catch rate from sentinel surveys in 3KL (number of fish per 1000 hooks)



An **inshore index fishery** was conducted to provide information to supplement sentinel surveys. Almost 3000 enterprises using <65 foot vessels fished individual quotas of 2700 lb. (round weight) during September 24 – October 16, 1998. Fish harvesters in sentinel survey communities reported that north of White Bay many harvesters did not fish or attained very poor catch rates. Catch rates from the Baie Verte Peninsula to St. Mary's Bay were reported to have been good to excellent in all but a few communities. Catch and effort data are available from science logbooks that were a requirement of licence. Catch rates were highest in eastern Notre Dame Bay, in a continuous band from northern Bonavista Bay to western Trinity Bay, and in St. Mary's Bay.

Inshore acoustic studies have been conducted in Smith Sound in western Trinity Bay at various times since spring 1995. Why cod aggregate in this Sound and how frequently they move in and out is not known. A simple but incomplete description is that fish overwinter and perhaps spawn in the Sound in winter/spring, move into shallow water and along the coast from late spring to early autumn, and return to the Sound in late autumn. The quantity of cod detected in the Sound at any specific time will depend on where the cod are in their annual cycle. Studies in June 1998 and January 1999 gave biomass estimates of 14-15 thousand t. The size and age compositions differed considerably between the two surveys, indicating that the total cod population in Trinity Bay may be greater than 15 thousand t. Previous biomass estimates for Smith Sound have been as low

as 150 t in April 1996 but others were higher (13 thousand t in May 1995 and 21 thousand t in April 1997).

Pelagic juvenile fish surveys, designed to provide an index of the abundance of 0-group cod prior to settling, were conducted in offshore and inshore waters of 2J3KL in August-September 1994-1998. The abundance index for all of 2J3KL in 1998 was lower than in 1994-1995 but higher than in 1996-1997. In 1998 there were very few cod found offshore in 2J3K, but good catches occurred in the bays of 3K. Most of the fish caught offshore came from southern 3L. The catches in this area were contiguous with larger catches immediately to the south in divisions 3NO. It is thought that cod in the large catches in southern 3L may have come from spawning in 3NO.

A broadscale **beach seine survey** of demersal 0-group and 1-group cod had been conducted in divisions 3KL in 1992-1997. Results of surveys on a much smaller scale in Newman Sound in southwestern Bonavista Bay in 1995-1996 and 1998 were consistent with the broadscale survey. A combination of the two series indicated that the 1997 and 1998 yearclasses are stronger than the 1995 and 1996 yearclasses. The pelagic surveys and the demersal surveys are consistent in indicating that the 1996 yearclass is weak and there is improvement in 1997 and 1998.

Stock biology

The **distribution** of cod differs from the historical norm. There are few cod in the offshore. From catches during the autumn bottom-trawl survey the cod appear to be broadly distributed, with most of the larger/older cod on the plateau of Grand Bank in Division 3L. Acoustic studies in Hawke Channel (Division 2J) in winter and spring reveal small cod at low densities. Cod in the inshore appear to be in low abundance north of White Bay but to be broadly distributed from late spring to late autumn at traditional fishing depths (less than about 50-60 m) from White Bay south to St. Mary's Bay. The seasonal movements of these fish are not well understood. A simple but incomplete description, based largely on observations of the cod in Smith Sound, Trinity Bay, is that they overwinter in deep inshore waters, often within fjords, and move into shallower water and along the coast in spring, returning to the overwintering areas by late autumn. Tagging studies demonstrate that these fish move into adjacent bays, often moving northward. For example, the Smith Sound fish appear to migrate along the north shore of Trinity Bay, with some moving into Bonavista Bay and even into Notre Dame Bay. There is no evidence of movement to the offshore, but there has been no offshore fishery that might recover tags. Additional aggregations exist in other Sounds in Trinity Bay, in Bonavista Bay and in Notre Dame Bay, but the number and size of such aggregations are not known. There is no evidence of such aggregations south of Trinity Bay or north of White Bay, with the exception of the small population in semi-enclosed Gilberts Bay in southern Labrador.

Size and age compositions differ considerably between the offshore and the inshore. Although there are differences in selectivities between the Campelen bottom-trawl used in the offshore and the various fixed gears (mainly gillnet and linetrawl) deployed inshore, it is clear that the offshore has very few fish larger than about 50 cm whereas the inshore has high proportions of larger fish. Age compositions from sentinel surveys in 1995-1998 reveal that the 1990 yearclass was relatively strong in Divisions 3K and 3L and that the 1989 yearclass was stronger in Division 3L than in Division 3K.

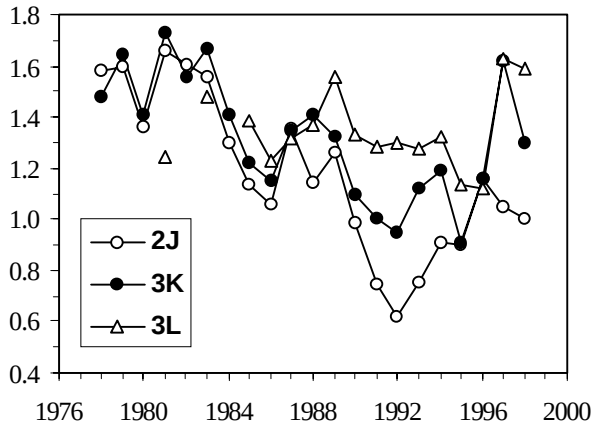
Neither of these yearclasses was prominent in the offshore.

Over the period 1994-1998, **recruitment in the offshore**, as measured at the pelagic 0-group stage, was greatest in 1994. Catches during the autumn bottom-trawl survey have shown that this yearclass was weak relative to many yearclasses born in the 1980s and appears to be suffering high mortality. It is expected to contribute very little to offshore spawner biomass. The 1998 yearclass was third strongest at the pelagic 0-group stage, but most of the fish were caught in southern 3L. It is not clear whether these fish were spawned in 3L and will contribute to the 2J3KL stock. The bottom-trawl survey did catch some of this yearclass in 3L in the autumn. **Recruitment in the inshore** may be better than in the offshore. The pelagic 0-group survey has consistently experienced higher catch rates in the bays than offshore. The beach seine surveys have experienced good catches for the 1997 and 1998 yearclasses. Fish harvesters in many sentinel survey communities, especially from the Baie Verte Peninsula south, reported that small cod were abundant in 1998.

Trends in size, maturity and condition are presented from sampling during the autumn bottom-trawl surveys. The time series from sentinel surveys is now four years long and will be presented during the next assessment.

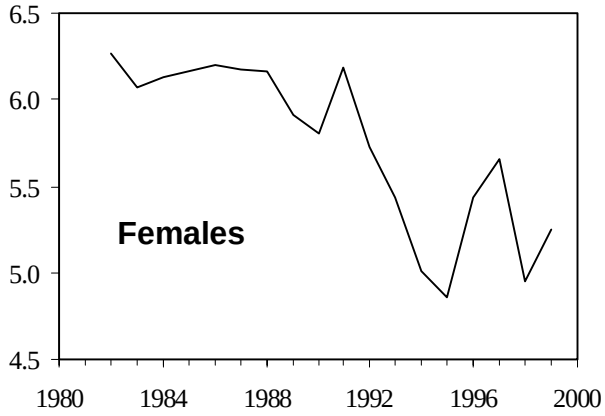
Size-at-age declined during 1983-1985 and again in the early 1990s, especially in Division 2J. Size-at-age has increased in recent years but is still low compared with peak values in the late 1970s. Much of the variability in growth is related to variability in water temperature.

Mean weight at age 5 (kg)



Age at 50% **maturity** declined in the early 1990s and has fluctuated considerably in recent years. In recent years female cod mature approximately one year earlier than they did in the 1980s.

Age When 50% Are Mature



Condition, as measured by both gutted body weight and liver weight relative to fish length, declined in Division 2J in the early 1990s. Gutted condition has since returned to approximately normal whereas the liver index has improved but not fully recovered. In Division 3K gutted condition declined and has since improved whereas liver index has changed little. In Division 3L gutted

condition has remained relatively unchanged over time whereas liver index increased considerably in the early 1990s and has since returned closer to normal. The historic trends in condition indices are complex and poorly understood. Condition in 1998 was near normal. Fish harvesters in sentinel survey communities reported that condition of cod caught during the inshore index fishery was good to excellent.

Population Analysis

An **analytical assessment** was not attempted. The inability to reconcile reported catches with the research vessel index in the late 1980s and early 1990s has not been resolved. In addition, the low abundance and high mortality of cod sampled by the research vessel catches is not reflective of the quantity, larger sizes and older ages of cod found in the inshore.

It was decided that an analytical assessment of the inshore alone was not possible because inshore catches prior to the moratorium could not be apportioned into those coming from inshore components and those coming from components that migrated into the inshore from the offshore. It is thought that most of the historic inshore catch came from the latter.

Information from recaptures of cod tagged in divisions 3KL during 1997 and 1998 were used to estimate **exploitation rates and stock size** for the 1998 index fishery. This essentially involved examining the fraction of tagged cod returned by the fishery, with adjustments made for tag loss, reporting rates and migration rates. Estimates were made for two areas; (1) 3K and northern 3L, including Bonavista and Trinity bays and (2) southern 3L from Conception Bay to St. Mary's Bay. The exploitation estimate for 3K and northern 3L was 6.2%. The estimate for southern 3L was quite variable, but a reasonable lower bound on exploitation in this region was 5%. Using the reported commercial landings in 1998 for these regions, the exploitation rate estimates suggest that 52,000 t of cod were available to the index fishery in 3K and northern 3L, with a 95% confidence interval of 36,000 – 135,000 t. The analysis suggests that no more than 15,000 t of cod were available to the index fishery in southern 3L. Some of these had migrated into southern 3L from Placentia Bay in Subdivision 3Ps. An analysis of distance moved by tagged cod showed that they were well dispersed from the tagging site and that the degree of dispersal did not increase between 1997 and 1998. Consequently, it was concluded that the tagged cod were well mixed within the population and that the estimate of biomass was not likely to be biased due to incomplete mixing. A second estimate of inshore biomass during 1996 and 1997 based on tag returns was also presented. This analysis suggested a much higher inshore biomass. However, it was demonstrated that this estimate did not account for migration of cod between bays and was therefore biased upward.

Mortality rates estimated from the research vessel surveys remain well above 0.2. Extremely few fish older than age 5 have been caught in recent years, especially in divisions 2J and 3K.

In 1998 the biomass of cod in the inshore of divisions 3KL was estimated by (i) calculating the ratio between sentinel gillnet catch rates in Placentia Bay (Subdivision 3Ps) and a mark-recapture estimate of biomass in that bay and then (ii) applying that ratio to sentinel gillnet catch rates in 3KL. The estimate is subject to many uncertainties, the most important of which

are the relationship between catch rate and fish abundance and whether the relationship derived for one area can be extrapolated to others. High catch rates can be maintained over a wide range of fish densities; ideally multiple measures of catch rate over a wide range of densities for different areas are required. It was found that the method was sensitive to the quantity of cod estimated to be in Placentia Bay, the time of the year during which the catch rates in Placentia Bay were calculated and year-to-year variation in the catch rates. The situation could arise, for example, where the catch rates within 3KL were constant from one year to another and yet the biomass estimated in one year could differ from the other because of changes in sentinel survey catch rates in Placentia Bay or the biomass estimate in Placentia Bay. It was decided that the method was unreliable.

Ecological Factors

Annual changes in **water temperatures** are hypothesized to have been associated with variability in several aspects of the biology of 2J3KL cod, including distribution, timing of migration, recruitment, mortality and individual growth rate. Water temperatures declined in the late 1980s to very low levels by 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 Grand Bank during spring and over deep portions of the Northeast Newfoundland Shelf. The main exception to the above generalization occurred in the upper to middle ranges of the water column in coastal regions where temperatures were lower than normal during summer and early autumn. The warmer water temperatures in recent years may explain some of the improvement in cod size-at-age. However, recruitment of cod in the offshore and survival of the few cod that are there have not improved during this period of warmer water temperature.

The quantity of cod consumed by **harp seals** during the period 1972-1998 was calculated using estimates of the harp seal population numbers, energy requirements of individual seals, the average duration of occurrence within 2J3KL, the relative distribution inshore and offshore, and diets of seals sampled in the inshore and offshore in winter and summer. Several aspects of the calculations were modified based on new information or different assumptions. These changes resulted in a reduction by nearly 50% in the 1998 estimate of 108,000 t of cod consumed by seals. The magnitude of this change illustrates the uncertainty involved in these calculations. The major reason for the lower estimate of consumption is a revision in the weights of individual cod consumed by the seals as calculated from the sizes of cod otoliths found in seal stomachs. The second most important factor in the decline is a change in the proportion of the seal energy requirement estimated to be coming from the inshore. The previous estimate of 45% in both summer and winter was revised to 14% in winter and 11% in summer. This is a consequence of defining a more narrow inshore zone (the zone in which inshore stomach samples were collected) and revising the estimate of the proportion of the seal population occurring within the inshore zone. The previous estimate assumed random distribution, whereas the new estimate came from monitoring of seal movements using satellite telemetry tags. The reduction in the proportion of energy coming from the inshore caused a decline in the estimate of cod consumed because the proportion of cod in the harp seal diet is higher in the inshore than in the offshore.

The number of cod at various ages consumed by harp seals during the period

1986-1995 was calculated using the estimated quantity of cod consumed, the length frequencies of cod consumed by the seals as determined from the sizes of cod otoliths found in seal stomachs, and ages at length determined from sampling during the spring bottom-trawl survey in Division 3L and the autumn survey in divisions 2J3KL. From 1986 to 1991 most of the predation was on cod ages 0-2, with the bulk occuring on age 1. In 1992, 1993 and especially 1995 there was a greater proportion of older cod (ages 3-5) in the diet.

For many years there have been reports of seals preying on cod by taking bites from their bellies, thereby consuming the liver and most of the gut but leaving the rest of the body. Diets used in the present calculations are reconstructions of the prey composition based on hard parts found in the seal stomachs with some adjustment for predation on soft bodied animals. Belly-feeding is not included in these reconstructions. This implies that the quantity of cod consumed by harp seals may be biased, but the direction of the bias has not yet been determined. In addition, previous calculations of the size and age compositions of the cod consumed by seals have been biased toward smaller and younger cod, because cod killed by belly-feeding tend to be larger than those represented by the otoliths found in seal stomachs. The weight of cod killed by belly-feeding is much higher than the weight consumed.

Sources of Uncertainty

Reasons for the dichotomy between a low abundance of fish in the offshore and the presence of aggregations encompassing many large fish in the inshore are not well understood.

Catch rates in the sentinel surveys are considered by participants to be high relative to catch rates during commercial fisheries prior to the moratorium. As noted by participants in the sentinel surveys, this may be due in part to lack of competition for sites and fish. The sentinel survey covers only the traditional inshore fishing grounds (less than 50-60 m), and thus provides information on local fish density. The degree to which the survey reflects overall stock abundance is not yet clear. Interpretation of the catch rates is complicated by seasonal patterns at each site, the along-shore movements of fish and the migration of fish into southern Division 3L from Subdivision 3Ps.

Some of the concerns with interpretation of sentinel survey catch rates were addressed with the index fishery. Because the fishery was conducted over just 3 weeks, it demonstrated that good catch rates could be attained at about the same time over most of the area from White Bay to St. Mary's Bay. However, it also demonstrated that fish density, as reflected in catch rates, was highest in the relatively small area from northern Bonavista Bay to western Trinity Bay on the east coast and in St. Mary's Bay on the south coast. Many of the fish in the latter area were likely migrating back into 3Ps.

Exploitation rates from tagging can be overestimated if aggregations of untagged cod are exploited less than aggregations of tagged cod. It was felt that this was unlikely in the index fishery because the fishery occurred throughout the inshore and tagging included areas where cod were abundant.

The impact of seals on the 2J+3KL cod stock remains unclear. The estimate of the quantity of cod consumed, based on the reconstructed diets, has declined

considerably from the previous estimate, but is still high. There are numerous uncertainties in the calculation of the quantity of cod consumed. The diet data are sparse, especially in the offshore, and the proportion of cod in the inshore samples might be too high if a disproportionate number of the seal stomach samples have been obtained near the cod overwintering areas. In addition, there is uncertainty about the number of cod consumed by belly-feeding. Reports of this mode of predation have increased over the past two winters. Most reports have come from two relatively small areas. There is little information on what proportion of the seal herd is engaging in this manner of feeding, for how long it goes on, and how many cod a seal kills each day. There is a concern that perhaps the proportion of the seal herd occupying the inshore, as estimated from the satellite telemetry, has been underestimated if a high proportion of the seals inshore are young animals and the tags had been applied only to older animals. However, the tags had been applied to younger and older seals in the same proportions as the occurrence of these two groups in the population.

The consumption of cod by hooded seals needs to be calculated.

Outlook

The risk of fishing the 2J+3KL cod stock at various catch levels cannot be quantified because the current stock size is poorly measured. It is clear however that the size of the stock as a whole remains low relative to levels in the 1980s, and the level during the peak of partial recovery in the mid-1980s was itself characterized by low abundance, truncated age distribution and poor inshore catches compared with levels prior to the huge removals offshore in the 1960s and 1970s.

The prospects for recovery of cod in the offshore based on regeneration by those cod currently there appears to be dismal in both the short and medium term. The spawning biomass continued to decline after imposition of the moratorium and has for several years been extremely small, especially north of Division 3L. All yearclasses born in the 1990s have been small and have experienced high mortality.

The status of cod in the inshore remains uncertain. It is important to recognize that the inshore fishery historically was highly dependent on fish arriving from the offshore and will not return to its former prominence until such time as a substantial biomass of cod builds up in the offshore and resumes its summer feeding migration to the inshore. The risk associated with fishing those aggregations of cod in the inshore from White Bay in the north to St. Mary's Bay in the south cannot be quantified because the biomass currently inshore remains uncertain. Acoustic estimates for Smith Sound in Trinity Bay in 1995-1999 at times when cod aggregations were present have ranged from 13,000 to 20,000 t. Additional aggregations exist in Bonavista and Notre Dame bays, but the number and size of these aggregations are not known. The exploitation rates calculated from tag return data indicate a population in Division 3K and northern 3L in autumn 1998 of 36,000 – 135,000 t. An additional biomass of no more than 15,000 t of cod was available to the index fishery in southern 3L. Some of these fish had overwintered in Placentia Bay (Subdivision 3Ps) and had migrated into Division 3L during the spring-autumn period. Catch rates during the sentinel survey and the index fishery were good, but the biomass to be inferred from these catch rates is not clear.

Any consideration of exploitation of cod in the inshore of 2J3KL needs to take into account a number of additional issues. Any fishery in southern 3L will impact resident 3L fish and those components of the 3Ps stock that currently migrate into southern 3L to extents dependent on both the magnitude of the harvest and the migration rate of 3Ps fish. The migration rate cannot be predicted in advance, but if it were lower than assumed when the catch limit for 3L was set, then the fishery might cause high mortality on resident 3L fish.

Fishing those cod currently in the inshore might also create risk for recovery of cod in the offshore. This is because it will reduce the possibility that the cod currently inshore might move to the offshore as their abundance increases and thereby repopulate the offshore environment. In addition, an inshore fishery from late spring to autumn would capture some portion of any cod from the offshore that might resume the historic summer feeding migration to the inshore. Many of the fish historically caught in the inshore were immature, so the inshore fishery would capture some offshore fish before they had a chance to spawn.

It remains difficult to estimate the impact of harp seals on cod. However, the estimates of removals based on reconstructed diets are high and do not incorporate the mortality caused by seals feeding on cod bellies alone. It appears that predation by seals has been an important source of mortality of cod since the start of the moratorium. There is also the possibility that predation by seals is retarding the recovery of the cod stock, not simply because considerable numbers of cod are being consumed but also because some of those cod have already recruited to the spawning population.

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