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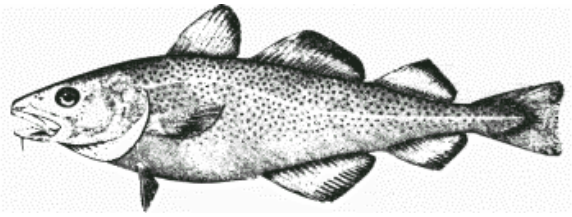
Newfoundland and Labrador Region **Stock Status Report 2004/042**



Allowable Harm Assessment for Newfoundland and Labrador Cod

Background

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) grouped all cod from northern Labrador to the southern Grand Bank within a Newfoundland and Labrador population (designated unit). This population was assessed as "endangered" and listed on Schedule 3 of the Species at Risk Act (SARA). In the event that the population is listed on Schedule 1, SARA provides that the Minister of Fisheries and Oceans may issue a permit to allow for incidental harm in the period prior to establishment of a recovery plan, provided that a number of conditions are met.

Under section 73(2), authorizations may be issued only if:

- *a) the activity is scientific research relating to the conservation of the species and conducted by qualified persons;*
- *b) the activity benefits the species or is required to enhance its chance of survival in the wild; or*
- *c) affecting the species is incidental to the carrying out of the activity.*

Section 73(3) establishes that authorizations may be issued only if the competent minister is of the opinion that:

- *a) all reasonable alternatives to the activity that would reduce the impact on the species have been considered and the best solution has been adopted;*
- *b) all feasible measures will be taken to minimize the impact of the activity on the species or its critical habitat or the residences of its individuals; and*
- *c) the activity will not jeopardize the survival or recovery of the species.*

The analysis provided herein will support the Minister of Fisheries and Oceans in determining the basis under which permits are to be issued in Atlantic Canadian waters. In the context of this status report, "harm" refers to all prohibitions as defined in SARA.

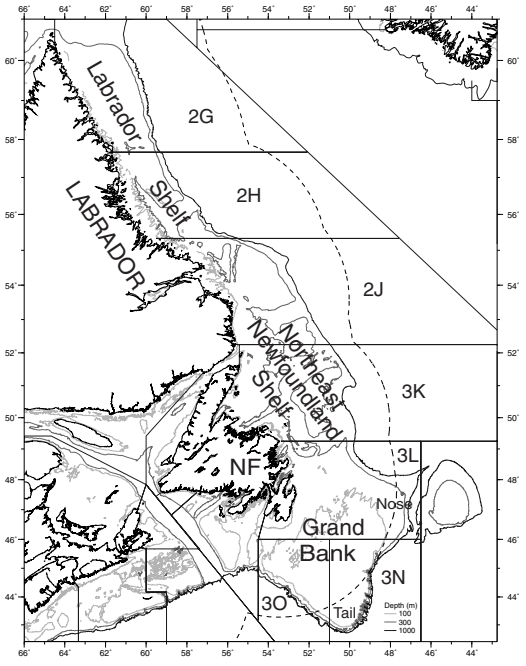


Figure 1: Location of the Newfoundland and Labrador designated unit, which extends from just north of the northern tip of Labrador to the southern end (Tail) of Grand Bank. The unit encompasses Northwest Atlantic Fisheries Organization (NAFO) Divisions 2GHJ3KLNO, and includes the 2GH, 2J+3KL and 3NO cod stocks. The dashed line indicates Canada's 200 nautical mile exclusive economic zone.

Summary

- The abundance of the 2GH cod stock is very low. There is insufficient information to know what level of human-induced mortality would jeopardize survival or recovery of the stock, but there is no evidence that current practices have caused any recent decline in the stock.

- The cod in 2J+3KL as a whole declined to a very low level by the mid-1990s. Since that time, the inshore populations have been more productive than the offshore populations. The offshore survey index no

longer reflects trends in the population as a whole.

- The autumn research vessel catches indicate that the current levels in the offshore are at about 1-2% of levels in the 1980s. In addition, recruitment is very low and there are very few fish older than age 5 and longer than 50 cm, reflecting an extraordinarily high mortality rate.

- It has been recommended that a conservation limit reference point for spawning stock biomass (B_{lim}) may be above 300,000 t. A target for recovery would exceed an accepted B_{lim}.

- It is anticipated that the offshore populations (and hence the stock as a whole) will take decades to recover, and cannot do so until recruitment increases and mortality decreases.

- By-catches and discards of cod in offshore 2J3KL have been small. There is no reason to suspect that they will increase in the next two years.

- By-catches reported for non-Canadian fisheries in the NAFO Regulatory Area on the Nose of Grand Bank in Div. 3L are small.

- Because abundance/biomass has not declined since the mid 1990s under recent levels of by-catch, continuance of current fishing practices in the offshore of 2J3KL will not jeopardize survival or recovery over the permitting period, should the population be listed on SARA Schedule 1.

- Numerous sources of information are consistent with the concept that the populations currently inshore are distinct from populations in the offshore.

- These inshore populations were subjected to a directed fishery in 1998-2002. Abundance/biomass indices and abundance/biomass estimated from a sequential population analysis (SPA) declined up to 2002. The population has started to increase again more recently with improved recruitment.

- The historic magnitude of the inshore populations is not known. There is opportunity for some population growth, at least a return to the peak seen in the late 1990s. Opportunity for growth is greatest in 3K, where decline was most notable during the period of the recent inshore fishery.

- The inshore populations continue to be subject to incidental catch in fisheries directed at other species, most notably those deploying bottom gillnets for winter (blackback) flounder and lumpfish, but cod may be taken in almost any gear, including capelin traps, herring gillnets and even lobster pots (traps).

- It is concluded that current fishing practices in the inshore of 2J3KL will not jeopardize survival or recovery over the permitting period, should the population be listed on SARA Schedule 1.

- Based on the most recent (2003) assessment of cod in 3NO, the estimate of population abundance is considered to be at its historic low and declining.

- A spawner biomass limit reference point (B_{lim}) of 60,000 t has been proposed for 3NO cod by the Scientific Council of NAFO. The most recent assessment estimated that SSB in 2003 (at 4,500 t) is well below this.

- Based on the current status of the stock in 3NO there is very little scope for human induced mortality without jeopardizing recovery of the stock.

- Continuation of the Canadian fishing practices of recent years during the permitting period would not jeopardize survival or recovery of the stock in 3NO. The addition of non-Canadian activity

would, however, result in a further overall decline and could jeopardize recovery.

Issue

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2003) defined the Newfoundland and Labrador population (designated unit) of Atlantic cod as those cod from just north of the northern tip of Labrador to the southern tip of Grand Bank (Figure 1). This area encompasses Northwest Atlantic Fisheries Organization (NAFO) Divisions 2GHJ3KLNO. In its assessment summary, COSEWIC designated this population as endangered based on the following. “Cod in the inshore and offshore waters (of this area), having declined 97% since the early 1970s and more than 99% since the early 1960s, are now at historically low levels. There has been virtually no recovery of either the abundance or age structure of cod in offshore waters since the moratoria imposed in 1992 and 1993. Threats to persistence include fishing (now halted), predation by fish and seals, and natural and fishing-induced changes to the ecosystem.”

The COSEWIC assessment summarized evidence for a decline in populations in the inshore of eastern Newfoundland (COSEWIC 2003, p. 29), but did not take the magnitude of these populations into account when considering trends in either the 2J+3KL stock alone or the Newfoundland and Labrador designated unit as a whole.

In respect to SARA Sect. 73, a scientific evaluation was carried out to identify potential sources of harm and to determine a level of incidental harm, if any, that would not jeopardize survival or recovery of cod in the Newfoundland and Labrador designated unit.

Assessment of Issue

Description of the Species

The Atlantic cod inhabits sub-Arctic to temperate waters on both sides of the North Atlantic Ocean. In Canadian waters, it is found from Baffin Island to Georges Bank.

It is generally considered a demersal species, but it can spend considerable periods off bottom. It spawns in the water column and has pelagic eggs and larvae. Juveniles have a pelagic phase before settling to the bottom.

Distribution changes with age. Young/small cod tend to occur in shallow waters along the coasts of Labrador and eastern Newfoundland and on the plateau of Grand Bank. Older cod tend to undertake seasonal migrations. Historically, most of the cod off Labrador and eastern Newfoundland migrated between overwintering areas near the edge of the continental shelf and feeding areas on the shelf. Many migrated to shallow inshore waters where they supported the traditional fixed-gear fishery for centuries. Cod on Grand Bank overwintered on the slopes of the bank and moved onto the bank during summer.

The Newfoundland and Labrador population is characterized by clines in many biological characteristics. Growth rate and theoretical maximum length are lowest off Labrador and highest on the southwestern Grand Bank. Age and length at maturation are also lowest off Labrador and highest on the southwestern Grand Bank. Cod in the north spawn earlier than those in the south.

The cod in this area have long been divided for purposes of fisheries management into three stocks: 2GH, 2J+3KL and 3NO. The present assessment will consider each of the stocks separately because most scientific information on population dynamics has been aggregated at the stock level, the vital rates of the fish vary geographically, the dynamics of the stocks have differed over time, and the human and non-human factors currently affecting recovery differ geographically.

In addition, since the mid-1990s there has been a dichotomy within the 2J+3KL stock between the offshore, where cod have been small and at very low density, and the inshore, where cod have included larger sizes and have been found in relatively high

densities in some times and places. For the period from the mid-1990s to the present, the cod in the offshore of 2J+3KL will be discussed separately from those in the inshore.

History of the fishery

Cod has supported fisheries on the plateau of Grand Bank and in coastal waters of eastern Newfoundland and Labrador for centuries. The fisheries expanded to deeper waters in the 1950s and 1960s with the introduction of stern trawlers to the offshore and longliners to deep waters nearshore.

2GH stock: On the northern and central Labrador Shelf, landings of 60,000 – 90,000 t per year were reported in the period 1965-1969, but landings declined to less than 5,000 t in most years during the 1970s and early 1980s, to fewer than 1,000 t during the latter half of the 1980s, and to zero in 1991. The fishery stopped due to a low abundance of fish.

2J+3KL stock: In the area from southern Labrador to the northern Grand Bank, annual landings escalated from 360,000 t in 1959 to 810,000 t in 1968, and then plummeted to 140,000 t in 1978. Landings increased again to more than 200,000 t during the 1980s but declined rapidly in the late 1980s and early 1990s in advance of a moratorium on directed fishing in July 1992. The moratorium has remained in effect in the offshore, but a small directed fishery was permitted in the inshore during 1998-2002. This inshore area was closed to directed commercial and recreational fishing in April 2003 and has remained closed.

3NO stock: On the southern Grand Bank, annual landings peaked at 227,000 t in 1967 and then declined steadily to 15,000 t in 1978. Catches then increased during the 1980s, reaching a peak of 51,000 t in 1986, but declined again to 11,000 t in 1993. Most of the catch was taken by non-Canadian fleets from the 1950s to the late 1970s, but the proportion of the catch taken by Canada increased subsequent to the establishment of the 200 nautical mile exclusive economic zone in 1977. A moratorium on directed fishing was declared by NAFO in February 1994, and has been in effect to the present. By-catch has increased each year since the imposition of the moratorium, reaching almost 5,000 t in 2003. This is approximately the same quantity of catch taken by the directed fisheries during the two years prior to the moratorium.

Species Status

Recent Trajectory and Current Status

2GH stock: Cod abundance in this area is at an extremely low level (Smedbol et al. 2002). However, recent population trajectory and current status are uncertain, because research vessel surveys in the area have been sporadic and have not covered the depth zones in which most of the cod would be expected to occur.

2J+3KL stock as a whole: Assessments up to 1993 were based on sequential population analysis (SPA) of the stock as a whole. The use of SPAs was suspended when it became clear that there was a severe lack of fit between model output and the index from the DFO research vessel surveys. Several whole-stock SPA models have been attempted in more recent years to explore stock dynamics, but these models have not been accepted as representative of recent stock dynamics.

Total (3+) biomass collapsed from almost 3,000,000 t in 1962 to about 500,000 t in 1976, and then increased to just over 1,000,000 t in the mid-1980s (Figure 2). There then followed a steady decline toward a crash in the early 1990s.

The spawner stock biomass (SSB) collapsed from about 1,500,000 t in 1962 to about 125,000 t in 1977, and then increased to 400-500,000 t through most of the 1980s (Figure 2). SSB declined rapidly after 1988, with perception of the time course varying among models.

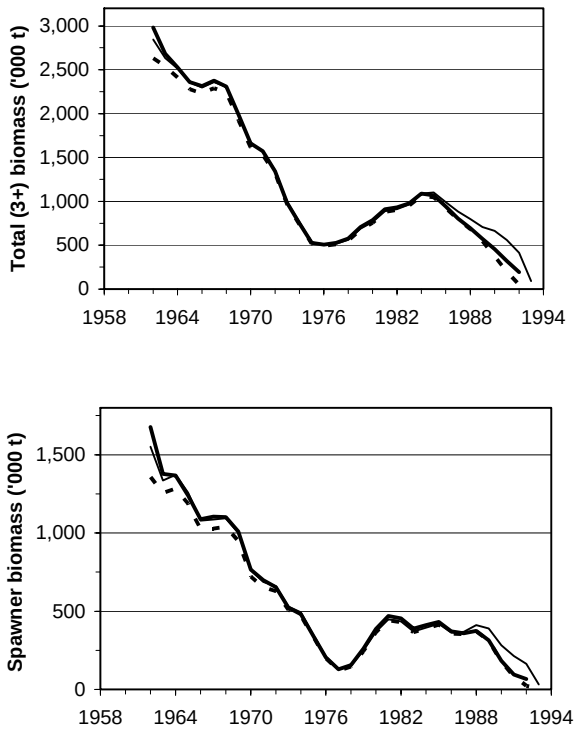


Figure 2: Trends in the biomass of the 2J+3KL cod stock as a whole. The upper panel illustrates population biomass (ages 3 and older) and the lower panel illustrates spawner stock biomass (SSB). The heavy line depicts the model results from the 1993 assessment (Bishop et al. 1993), and the other two lines depict the results from more recent illustrative models (dashed line - Lilly et al. 1998; light line - Smedbol et al. 2002).

2J+3KL cod – offshore populations: Trends in abundance/biomass in the offshore of 2J+3KL are deduced from indices derived from the DFO autumn bottom-trawl surveys.

The indices were variable during the period 1983-1990, with one very strong positive outlier in 1986. The indices declined rapidly during the early 1990s to reach a low in 1994. The average index of abundance of cod in the past 3 years has been 3.6% of the average in the 1980s, and the corresponding index of biomass (Figure 3) has been 1.8%. The values in 2003 were 2.7% and 1.0% respectively.

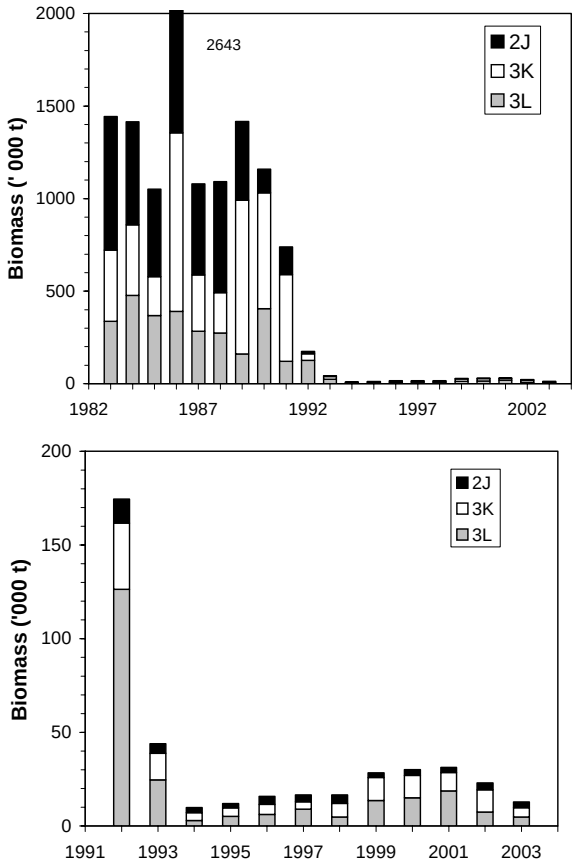


Figure 3: Biomass index from autumn bottom-trawl surveys in 2J+3KL in 1983-2003. The upper panel shows the full series. The lower panel expands the lower 10% of the upper panel for the period 1992-2003 (updated from Lilly et al. 2003). Note that the ability of the trawl to catch cod in its path is not known, so the estimate of biomass computed from the trawl survey is an index. The actual biomass could be higher or lower.

Cod in the offshore have experienced very low recruitment and very high mortality since at least the mid-1990s. Few fish survive beyond age 5 and 50 cm, especially in Div. 2J and 3K.

2J+3KL cod - inshore populations: Information on the size of inshore populations started to accumulate only after the offshore populations declined to an extremely low level in the mid-1990s. Tagging studies have shown that the inshore of 3KL is currently inhabited by at least two groups of cod: a northern resident coastal group that inhabits the area from western Trinity Bay northward to western Notre Dame Bay, and a migrant

group that overwinters in 3Ps and moves into 3KL during late spring and summer and returns to 3Ps during autumn.

Hydroacoustic studies that have been conducted since the mid-1990s in Smith Sound (western Trinity Bay) have monitored the overwintering status of the largest of the resident populations. Biomass estimates increased from the mid-1990s to a peak of 26,000 t in 2001, and subsequently declined to 18,000 t in 2004 (Rose 2003; DFO 2004).

Other studies have been conducted during summer and/or early autumn, and have provided information on the combined abundance and/or biomass of the 3KL inshore residents and the migrants from 3Ps.

Sentinel surveys, which were designed to provide catch rate information from traditional fixed gears fished by commercial fish harvesters, provided indices that increased from 1995 to 1997 (linetrawl) or 1998 (gillnet) and then declined to lows in the early 2000s. There was some increase in 2003 (DFO 2004). In addition, small mesh gillnets deployed at many sentinel sites yielded high catch rates of small fish in 2003.

Mark-recapture studies produced an estimate of 24,000 t for the biomass of cod available to the fisheries in 2002. Estimates for the previous three years were considerably larger, but none exceeded 60,000 t (DFO 2003).

The trend in inshore abundance/biomass is available from a sequential population analysis (SPA) based on inshore catches and indices for the period 1995-2002. This analysis was conducted during the 2003 stock assessment (DFO 2003), and was not available for the COSEWIC status update. The model indicated that stock biomass (ages 3 and older) decreased from about 60,000 t in 1996-1997 to less than 40,000 t in 2002, and then increased a little by the beginning of 2003 (Figure 4). Spawner stock biomass (SSB) increased from 26,000 t in 1995 to 41,000 t in 1998, but subsequently declined to less than 15,000 t at the beginning of 2003.

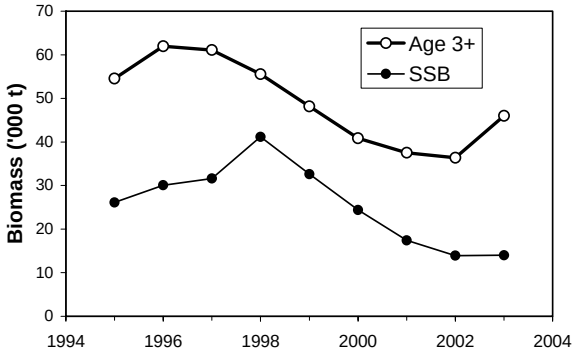


Figure 4: Trends in population biomass (ages 3 and older) and spawner stock biomass (SSB) of cod in the inshore of 2J+3KL, based on a sequential population analysis (SPA) in 2003 (DFO 2003; Lilly et al. 2003).

3NO cod: The most recent assessment of 3NO cod was conducted by NAFO in 2003 based on a sequential population analysis (SPA). A complete description of the data sources and model formulation are presented in Healey et al. (2003).

The SPA results indicate the 3NO population biomass of cod 3 years and older (3+) was near 200,000 t during the late 1950s, increased quickly to a peak of almost 400,000 t in 1967, and then declined rapidly to a low of 46,000 t in 1976 (Figure 5). There was then a steady rise to a peak of 175,000 t in 1985, followed by a steady decline to 14,000 t in 1993. The biomass reached an all-time low of about 6,000 t in 1995, started to increase a little toward the end of the decade, but has since declined once again. A preliminary analysis suggests that the 5,000 t catch for 2003 has reduced the population to the lowest observed level.

The estimates of spawning stock biomass (SSB) follow a trend similar to that of the 3+ biomass, except that the peaks in 3+ biomass in the mid-1960s and mid-1980s were not followed by peaks in SSB. The increase in 3+ biomass in the mid-1960s was a consequence of good recruitment in the early 1960s (notably the 1962-1964 year-classes). The estimate of SSB at Jan 1, 2003 was 4,500 t.

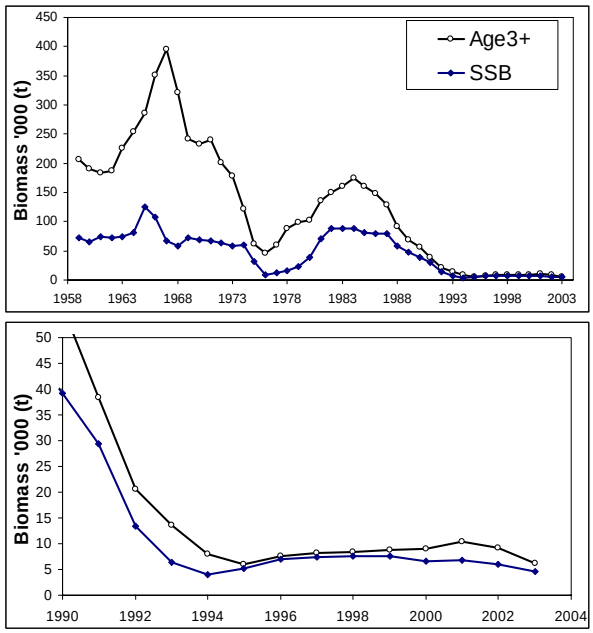


Figure 5: Trends in population biomass (ages 3 and older) and spawner stock biomass (SSB) of cod in 3NO based on an assessment in 2003. Lower panel focuses on estimates since 1990.

The rapid decline in the stock from its peak in 1967 was primarily caused by intensive fishing. Fishing mortality was reduced considerably during the late 1970s and early 1980s and 3+ biomass increased, even though recruitment was not particularly strong. Although the stock remains closed to directed fishing, fishing mortality is currently estimated to be at or above levels of the mid-1980s, during which time a sizable fishery existed (Figure 6).

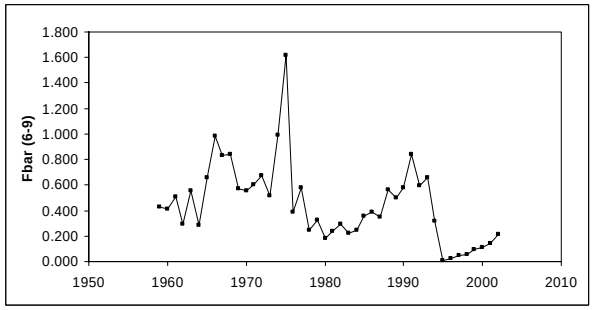


Figure 6: Trends in fishing mortality (averaged over ages 6 to 9) of cod in 3NO, based on an assessment in 2003 (Healey et al. 2003).

Recruitment declined to low levels in the 1970s and 1980s and to very low levels in the 1990s (Figure 7).

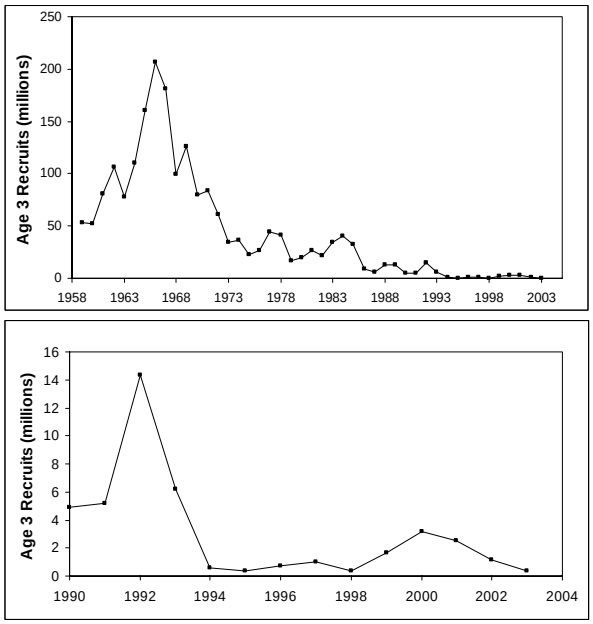


Figure 7: Trends in age 3 recruitment (Healey et al. 2003). Lower panel focuses on estimates since 1990.

Target and time-frame for recovery

2GH cod: There has been no documented discussion of a target for recovery of cod in 2GH. The abundance/biomass of cod in the area has been low since at least the mid-1980s and extremely low since the early 1990s, so recovery to even the levels of the early 1980s is expected to take a long time.

2J+3KL cod – whole stock and offshore populations: A target for recovery of the stock as a whole has not been documented, but it has been determined that a conservation limit reference point for spawning stock biomass (B_{lim}) may be above 300,000 t. A target for recovery would exceed an accepted B_{lim}.

Because the offshore populations of the 2J+3KL stock historically represented the bulk of the stock, a very high proportion of the target biomass would have to appear in the offshore. The target might also include a much broader range of ages and sizes, and a distribution expanded such that most of the open coast and headlands from southern

Labrador to the southern Avalon Peninsula would receive migrants from the offshore in most summers. It is anticipated that the offshore populations (and hence the stock as a whole) will take decades to recover, and cannot do so until such time as recruitment increases and mortality decreases.

2J+3KL cod – inshore populations: There has been no formal discussion of a target, or even a conservation limit reference point, for inshore populations. The historic magnitude of these populations is not known. There is opportunity for population growth, at least a return to the level seen in the late 1990s. There is also some opportunity for expansion of the age/size structure, although there is currently good representation of fish up to age 14 and 100 cm. Opportunity for growth is greatest in Div. 3K, where decline was most notable during the period of the recent inshore fishery (1998-2002).

3NO cod: In April 2003 the NAFO Scientific Council re-iterated that 60,000 t is the current best estimate of the conservation biomass reference point B_{lim} (Anon 2004). In the recent period of low productivity (since 1982), there is an indication of even further reduction in recruitment at about half the B_{lim} level. Under assumptions of zero fishing mortality beginning in 2004, the SSB is estimated to increase to only 6,000 t by Jan 1, 2008. Assuming the stock continues at the current low productivity, it will likely be decades before the B_{lim} reference point is approached.

Scope for Human-induced Harm (or Mortality)

2GH stock: There is insufficient information to know what level of human-induced mortality would jeopardize recovery of the cod in 2GH. Nevertheless, the stock is clearly at an extremely low level, and the scope for human-induced mortality must be low.

2J+3KL stock – whole stock and offshore populations: There is very little scope for human-induced mortality in the offshore without jeopardizing recovery of the offshore populations and hence the stock as a whole.

2J+3KL stock – inshore populations: There is some scope for human-induced mortality in the inshore, but the quantity of fish that might be removed without jeopardizing recovery was not determined.

Projections conducted during the 2003 stock assessment meeting indicated that, if exploitation rates remained at a level equal to the average from the 2000-2002 fishing seasons, then the spawner biomass would grow slightly in the short term as a consequence of the incoming recruits, but would then decline (DFO 2003; Shelton et al. 2003). Projections also indicated that the population would grow in the absence of fishing, but that growth in the next decade would be insufficient for the population to reach the level attained in 1998.

Any consideration of landings from inshore populations must take into account risk from two additional concerns. First, it is possible that cod from the inshore could spread into the offshore and thereby assist recovery in the offshore. The likelihood of this happening may increase as the inshore populations grow, and hence an inshore fishery might reduce the likelihood of offshore recovery. However, there is no evidence that cod from inshore populations have moved offshore during the decade since the collapse. A second consideration is that rejuvenating offshore populations might migrate to the inshore to feed, and some portion of them might then be caught in any inshore fishery. Hence, an inshore fishery might mitigate against recovery of offshore populations and the stock as a whole even if inshore populations are distinct from offshore populations.

3NO stock: Deterministic projections were carried out using three year averages of recruits-per-spawner, partial recruitment at age, stock weights-at-age and the January 1 2003 survivors from the most recent NAFO assessment. The estimated 2003 total catch of 4,870 t was used for the first year of the projection and the Canadian catch averaged

between 2002 and 2003 (about 600 t) was input for the catches for 2004-2006 to determine the impact on recovery. The results (Figure 8) indicate that recent Canadian fishing practices would not result in a decline in the stock over the period to 2007. However, inclusion of non-Canadian activity, which is believed to have returned to a by-catch fishery of about 650 t, would result in a further overall decline in the stock (not illustrated).

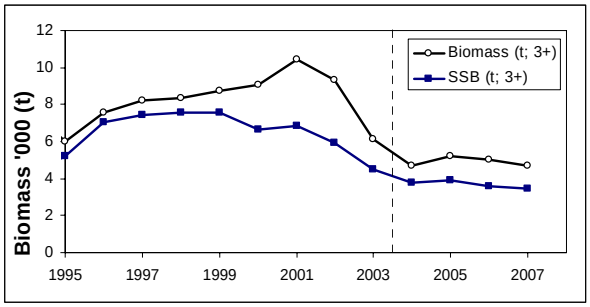


Figure 8. Deterministic projection for the 3NO cod stock through the allowable harm permitting period based on recent Canadian catch levels for 2004-2006 (see text).

Potential Sources of Mortality and Aggregate Harm

Mortality and harm can be caused by both human and non-human factors. This document focuses on human-induced harm, with the emphasis on fishery removals. However, the mortality imposed by environmental factors, both biotic and abiotic, may be sufficient to prevent recovery, at least in some geographic areas. In addition, such mortality is often difficult to measure, making it difficult to quantify the impact of human-induced mortality.

Sources of natural mortality include predation and starvation. It is thought that seals may be important contributors to the high mortality being sustained by cod in the offshore of 2J3KL, and to the high natural mortality sustained by adult cod in the inshore of 3KL (especially 3K). Predation by seals has not been suggested as an important source of mortality in 3NO. Poor body condition resulting from inadequate availability of prey, especially capelin, has been cited as a contributor to the high mortality of cod in offshore 2J3KL, but there is evidence to the contrary. Starvation has not been suggested as an important source of mortality in the inshore of 3KL or in 3NO.

Fishery removals: The area from southern Labrador to the southern Grand Bank (2J3KLNO) is currently closed to directed fishing, both commercial and recreational. However, cod are caught incidentally in Canadian and non-Canadian fisheries directed at other species.

2GH: By-catch landings of cod have not been reported from Div. 2GH. Estimates of discards from the large vessel shrimp fleet have been very small (less than 1 t annually in 2002-2003)

2J+3KL offshore: Reported by-catch landings of cod have been small in the Greenland halibut fisheries in 3KL (about 3 t annually in 2002-2003) and the yellowtail flounder fishery in 3L (about 4 t annually in 2002-2003). There are currently no estimates of discards from these fisheries. However, there are estimates of discards from both the large vessel and small vessel shrimp fisheries. These estimates are small: less than 1 t annually from the large vessel fleet in 2002-2003 and about 3 t annually from the small vessel fleet.

By-catches by non-Canadian fleets, which occur only in the NAFO Regulatory Area on the Nose of Grand Bank, are understood to be larger than the by-catches of Canadian offshore fleets, but are still relatively small (50-80 t annually in 2000-2002).

2J+3KL inshore: Incidental catches of cod are taken in a variety of fisheries directed at other species, most notably those deploying bottom-set gillnets for blackback (winter) flounder and lumpfish, but cod may be taken in almost any gear, including capelin traps, herring gillnets and lobster pots (traps). Reported by-catch from lumpfish and blackback fisheries was about 100 t in 2003. By-catch of cod increased to about 500 t in 2004 as a consequence of a change in

regulations regarding the blackback fishery.

There are no estimates of the quantities of cod landed or discarded from other inshore fisheries. There is also no estimate of the quantity of fish landed illegally.

3NO stock: A by-catch of cod is taken in Canadian fisheries for yellowtail flounder, redfish, skate, white hake, monkfish, Atlantic halibut and Greenland halibut. Documented landings were about 420 t in 2002 and about 730 t in 2003.

By-catches of cod are also taken by non-Canadian fleets in the NAFO Regulatory Area. By-catch averaged about 650 t during 1999-2001 but then increased sharply to 1750 t in 2002 and 4052 t in 2003. The increases in these last 2 years are believed to have resulted from illegal directed fishing.

Other human-induced harm: Other potential sources of harm (habitat alteration, oil exploration and production, pollution, shipping, cables and lines, military activities, ecotourism, scientific research) are considered to have negligible impacts on the ability of Newfoundland and Labrador cod to recover.

Feasible Mitigation Measures

Although cod are at low density in the offshore of Newfoundland and Labrador, they remain broadly distributed over the shelf and upper continental slope. Area closures to reduce the impact of fisheries on cod have been proposed within divisions 2J3KL, but the efficacy of such closures has not been evaluated.

Sorting grates are in use in the Canadian shrimp fisheries in 2GHJ3KL and in the yellowtail flounder fishery on Grand Bank (3LNO). These grates reduce the amount of cod removed as by-catch. The harm that may be caused to any cod that come into contact with the grates has not been assessed for these specific fisheries.

The use of live release, a key measure for minimizing wolffish mortality, is likely to be much less effective with cod. Cod have gas bladders which often inflate when the fish are brought to the surface.

Rationale for Permitting

2GH: There is no evidence that current fishing practices have caused any recent decline in the 2GH stock. It is therefore concluded that continuance of current fishing practices will not jeopardize survival or recovery of the stock over the permitting period, should the stock be listed on SARA Schedule 1.

2J+3KL offshore: Because abundance and biomass has not declined since the mid-1990s under the recent low levels of by-catch, continuance of current fishing practices in the offshore of 2J3KL will not jeopardize survival or recovery of offshore populations over the permitting period, should the population be listed on SARA Schedule 1.

2J+3KL inshore: Sentinel survey indices indicated a small increase in cod densities in the inshore of 2J3KL in 2003. There were also good catch rates for small fish, providing evidence of improved recruitment. Projections in 2003, based on the inshore SPA, indicated that the inshore populations would increase in the absence of fishing, and would increase a little even if fishing mortality were maintained at the average of levels in 2000-2002. In fact, the fishery was closed in 2003 and 2004, and reported landings from by-catches were considerably smaller than the landings in 2000-2002. It is therefore thought that the inshore populations will have increased since early 2003. It is concluded that current fishing practices in the inshore of 2J3KL will not jeopardize survival or recovery over the permitting period, should the cod populations in that area be listed on SARA Schedule 1.

3NO: The results of projections based on the 2003 SPA indicate that recent Canadian fishing practices will not result in a decline in the 3NO stock and hence will not jeopardize survival or recovery over the permitting

period, should the stock be listed on SARA Schedule 1. However, inclusion of non-Canadian activity would result in a further overall decline in the stock and could jeopardize recovery.

Sources of Uncertainty

Assessment of the level of mortality imposed on cod populations by incidental catches (landings and discards) in fisheries directed at other species is confounded by uncertainty in the estimation of both the size of the cod populations and the magnitude of the removals.

For 2GH and the offshore of 2J3KL, information on population size is available only as an index, so mortality can be computed only in a relative sense. This can be useful for monitoring changes in fishing-induced mortality over time, but does not provide an estimate of the actual rate of mortality. There is also uncertainty associated with the level of discards in shrimp and other fisheries, and with the level of landings and discards by non-Canadian fleets.

For the inshore of 2J3KL, there are several sources of information on population size. Each has a number of uncertainties, but it may be noted that trends and population estimates are similar among sources, increasing confidence in the overall pattern. The sequential population model (SPA), which was the basis of projections, has the uncertainties usually associated with such models. Of particular concern are the uncertainties regarding the level of natural mortality (assumed to be 0.5 per year), the level of removals, and the fact that the time series of catch and population indices from which the model was constructed are short.

For 3NO, there is concern regarding the extent to which a fundamental assumption of the SPA, that catch-at-age is measured without error, may be violated. Estimates of catch for 3NO cod have for many years been derived by the NAFO Scientific Council from various sources in addition to official landings reported to NAFO. These sources include Canadian Surveillance data and data from the NAFO Observer Program. There have also been sampling deficiencies for some years, particularly for non-Canadian fleets. Taken together, these are major sources of uncertainly for reliable estimation of population size.

There is uncertainty regarding the major cause of the exceedingly high mortality experienced by cod in the offshore of 2J3KL. Discarding by the shrimp fishery appears to be small, and landings from other fisheries also appear to be small. These observations have tended to shift attention to the impact of biological factors, particularly predation by seals, but the available data are inadequate for computation of the consumption of cod by seals in the offshore.

There is uncertainty regarding why populations in the inshore of 2J3KL, particularly the population that overwinters in Smith Sound, have been more successful since the mid-1990s than populations in the offshore. There is also uncertainty regarding the extent to which the inshore populations are distinct from those in the offshore, and whether they might expand their distribution into the offshore and thereby promote recovery in the offshore.

Conclusion

Mortality due to fishery removals is considered the major source of human-induced mortality of Newfoundland and Labrador cod.

On the northern and central portions of the Labrador Shelf (2GH), the abundance of cod is exceedingly low. There is no evidence that current fishing practices have caused any recent decline in abundance, so it is concluded that a continuance of those practices will not jeopardize survival or recovery over the permitting period, should cod in the area be listed on SARA Schedule 1.

In the offshore portions of the southern

Labrador Shelf, Northeast Newfoundland Shelf and northern Grand Bank (2J+3KL), the bottom-trawl indices of abundance and biomass have not declined below levels of the mid-1990s. It is concluded that a continuance of current fishing practices will not jeopardize survival or recovery over the permitting period, should cod in the area be listed on SARA Schedule 1.

In the inshore portions of southern Labrador and eastern Newfoundland (2J+3KL), the abundance of cod appears to be increasing. It is concluded that a continuance of current (2003-2004) fishing practices will not jeopardize survival or recovery over the permitting period, should cod in the area be listed on SARA Schedule 1.

On the southern Grand Bank (3NO), projections indicate that recent Canadian fishing practices will not result in a decline in the 3NO stock and hence will not jeopardize survival or recovery over the permitting period, should the stock be listed on SARA Schedule 1. However, inclusion of non-Canadian activity would result in a further overall decline in the stock and could jeopardize recovery.

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