



STOCK ASSESSMENT ON SUBDIVISION 3Ps COD

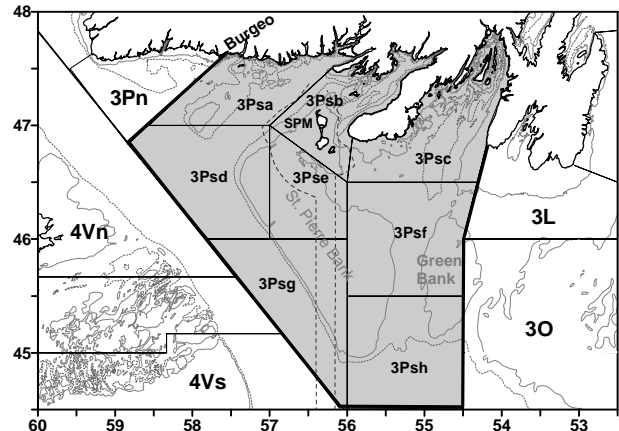
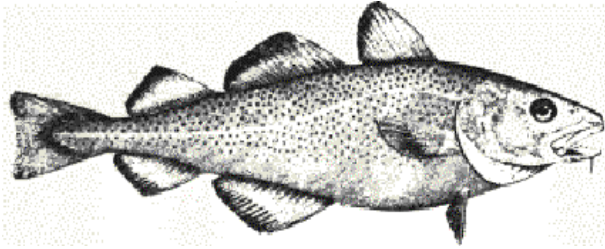


Fig. 1: 3Ps management area (shaded), unit areas (solid lines) and economic zone around the French islands of St. Pierre and Miquelon (SPM)(dashed line).

Context

In the Northwest Atlantic, cod are distributed from Greenland to Cape Hatteras and are managed as 12 stocks. The 3Ps stock off southern Newfoundland extends from Cape St. Mary's to just west of Burgeo Bank, and over St. Pierre Bank and most of Green Bank.

The distribution of 3Ps cod does not conform well to management boundaries and the stock is considered a complex mixture of sub-components. These may include fish that move seasonally between adjacent areas as well as fish that migrate seasonally between inshore and offshore. The extent to which the different components contribute to the fisheries is not fully understood.

Cod from this stock generally grow faster than those from areas further northward. At least 40% of the females are mature by age 5 (~53 cm) in recent cohorts, compared to age 6 (~58 cm) among cohorts present in the 1970s-early 1980s.

Catches from this stock have supported an inshore fixed gear fishery for centuries and are of vital importance to the area. Fish are caught offshore by mobile and fixed gear and inshore by fixed gear. Spanish and other non-Canadian fleets heavily exploited the stock in the 1960s and early 1970s. French catches increased in the offshore throughout the 1980s. A moratorium on fishing initiated in August 1993 ended in 1997 with a quota set at 10,000 t. The TAC was increased to 20,000 t for 1998 and to 30,000 t for 1999. Beginning in 2000, the management year was changed to begin on 1 April. An interim quota of 6000 t was set for Jan.-Mar. 2000. The TAC for 1 April 2000 to 31 March 2001 was set at 20,000 t, but this was reduced to 15,000 t for the next five management years to 31 March 2006.

SUMMARY

- Stock status was evaluated from commercial landings (1977 until 31 March 2005) and log-book data (1997-2004) in conjunction with abundance indices from Canadian (1972-2005) research vessel trawl surveys, industry trawl surveys (1997-2004), and sentinel surveys (1995-2004). Exploitation rates were estimated from sequential population analyses (SPA) and tagging experiments.
- Two strong year classes (1997-1998) are well represented in the 2004 catch. However, these are followed by weaker recruitment (1999-2002 year classes), and current catch levels are unlikely to be sustainable in the long-term unless recruitment improves.
- Cod in 3Ps are maturing at younger ages than in the past, but the spawner biomass still includes many older spawners that are thought to be more effective at producing eggs. Nonetheless, the stock has produced mostly weak year classes in the last 15 years. The reasons for the lower reproductive success of the 3Ps cod stock are not known.
- Bottom trawl surveys conducted since the last assessment have shown unexpectedly low abundance of the 1997 and 1998 cohorts.
- The new estimates of population size for 2002-2004 are substantially lower than those reported in the last assessment. Moreover, the current assessment showed a decrease in spawner biomass between 2003 and 2004 which was not evident in the 2004 assessment.
- In the current assessment, spawner biomass estimates from two sequential population analysis formulations decreased 10% and 12% from 1 January 2004 to 1 January 2005. Estimates of total abundance and biomass also decreased. Although the estimates were different between formulations, the declining trends were similar.
- There are no explicit management objectives for this stock. Consequently, only catch options considered to be informative for fisheries management were evaluated in the current assessment. The TAC in the past five management years ending 31 March 2006 was 15 Kt. The catch options considered in this report were 5, 7.5, 10, 12.5, and 15 Kt.
- Both SPA formulations used to illustrate stock trends indicated that spawner biomass will decline in the next management year (2006/07) for all catch options from 7.5 to 15.0 Kt. However, the estimated spawning biomass at 1 April 2007 will be greater than the recommended biological limit reference point (B_{rec}).
- At fixed annual catch options ranging from 7.5 to 15.0 Kt for the 2006/07 and 2007/08 management years, both SPA formulations indicated that spawner biomass will decline further by 1 April 2008. At a catch option of 5.0 Kt both of these SPA formulations indicated an increase in spawner biomass by 1 April 2008. Projection results for total abundance and biomass were similar.

DESCRIPTION OF THE ISSUE

There is a request for a detailed analysis of the size and productivity of the 3Ps cod stock, incorporating information that has become available in the past 12 months.

History of the fishery

The stock was heavily exploited in the 1960s and early 1970s by non-Canadian fleets, mainly from Spain, with catches peaking at 84,000 t in 1961 (Fig. 2).

After the extension of jurisdiction in 1977, catches averaged around 30,000 t until the mid-1980s when fishing effort by France increased and total landings reached about 59,000 t in 1987. Catches then declined gradually to 36,000 t in 1992.

A moratorium was imposed in August 1993 after only 15,000 t had been landed. Although offshore landings fluctuated, the inshore fixed gear fishery reported landings around 20,000 t each year up until the moratorium (Fig. 2).

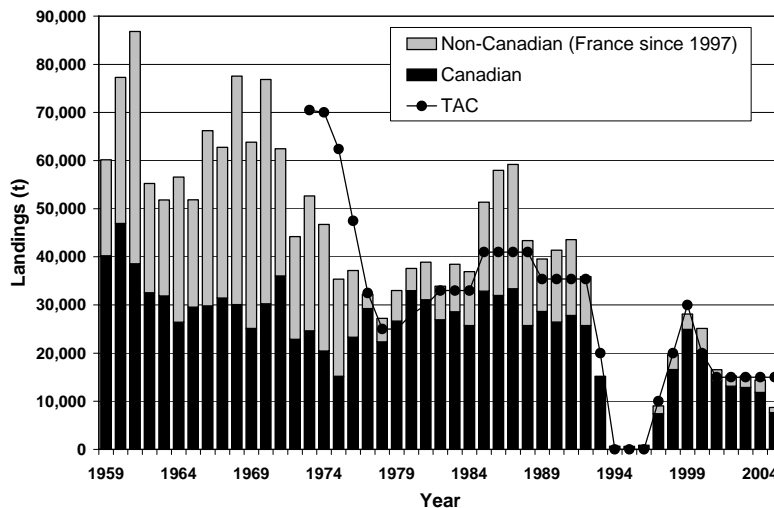


Fig. 2. Reported calendar year landings (t) by country. Note that TAC's are by management year (1 April-31 March) since 2000.

The fishery reopened in May 1997 with a TAC of 10,000 t. This was subsequently increased to 20,000 t for 1998 and to 30,000 t for 1999. In 2000 the management year was changed to begin on 1 April. An interim quota of 6000 t was set for the first three months of 2000. For 1 April 2000 to 31 March 2001 the TAC was set at 20,000 t, and for the next five management years ending 31 March 2006 the TAC was set at 15,000 t.

Landings (000s t)

Year ¹	97	98	99	00 ² (J-M)	00-01	01-02 ³	02-03 ³	03-04 ³	04-05 ³	05-06 ³
TAC	10.0	20.0	30.0	6.0 ²	20.0	15.0	15.0	15.0	15.0	15.0
Can.	7.4	16.6	20.4	3.5	20.3	13.2	12.5	12.6	12.1	7.6 ⁵
French	1.6	3.1	3.2	4.7 ⁴	4.7	2.3	2.3	2.4	2.4	1.0 ⁵
Totals	9	19.7	23.6	8.2	25.0	15.5	14.8	15.0	14.5	8.6 ⁵

¹ During the moratorium (1994-1996) catches were limited to by-catch and sentinel fishery and were <1000 t and are not shown.

² During 2000 the management year was changed to begin on 1 April (rather than 1 January) and an interim TAC of 6000 t was allocated for the first three months (Jan.-Mar.) of 2000.

³ Provisional.

⁴ France (St. Pierre and Miquelon) is allocated 15.6% of the TAC but carried forward a portion the 1999 allocation to the first three months (Jan-Mar) of 2000.

⁵ Approximate landings to 20 September 2005.

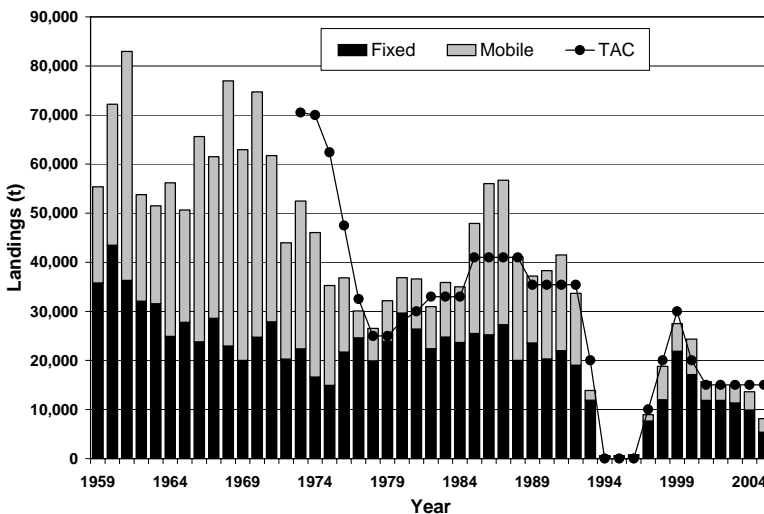


Fig. 3. Reported annual calendar year landings (t) by gear sector. Note that TAC's are by management year (1 April-31 March) since 2000.

In 2004/05, total reported landings were 14,500 t, mostly (74.4%) from the fixed gear sector. The total includes a recreational fishery catch of 174 t, and a French catch of 2202 t, approximately 1737 t of which was caught by otter trawlers and the remainder (465 t) by fixed gear, particularly gillnets.

During 2004, cod landings comprised a range of ages (mostly 5-8 year olds). The 1997 and 1998 year classes combined accounted for >60% of the total catch numbers in the 2004 fishery. These year classes were strongly represented in catches of all gear types.

The catch in the first three months of 2005 was taken mostly by offshore mobile gear and was dominated by 7 and 8 yr old, i.e. the 1997 and 1998 year classes which become 1 yr older on 1 January and were also prevalent in the catch in 2004.

Species Biology

Stock structure and migration patterns of 3Ps cod are complex and poorly understood. Migration of offshore components of the stock to inshore areas during spring and summer, as well as the existence of inshore components that remain outside the research vessel trawl survey areas throughout the year, complicate the assessment of stock status.

Tagging studies initiated in spring 1997 in Placentia Bay were expanded in subsequent years (1998-2004) to include inner and outer Fortune Bay and two offshore areas (Burgeo/Hermitage Channel and Halibut Channel). In these eight years over 65,400 fish were tagged and 12,600 reported as recaptured. Cod tagged inshore were mostly recaptured inshore, even 5-6 years after release. Some cod tagged offshore were recaptured in the inshore fixed gear fishery on the south coast during the summer and fall. Tagging indicated some **movement** of cod between 3Ps and neighbouring stock areas (3Pn4RS, 3KL, and 3NO). No tagging was conducted in the inshore of 3Ps during 2004.

Maturation in female cod sampled during research trawl surveys was estimated by cohort for the current assessment. The proportion of female cod maturing at younger ages has increased over the last two decades (Fig. 4).

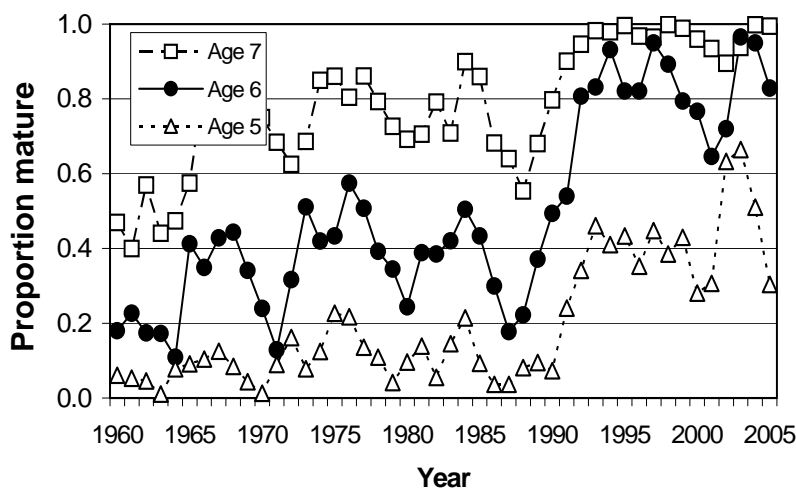


Fig. 4. Estimated proportion mature at ages 5-7 (females).

For example, the proportion of 5 year old females that are mature is now higher than in the past and has increased from about 10-20% in the 1970s and early 1980s to 40% in the mid-1990s. The proportion increased further to over 60% in 2002-2003 but has subsequently declined. The reasons for the change toward earlier age at maturity are not fully understood. Changing age at maturity has a considerable influence in the calculation of spawner biomass (see Fig. 15),

particularly since 2001. Males generally mature about one year younger than females but show a similar trend over time.

Spawning is spatially widespread in 3Ps, occurring close to shore as well as on Burgeo Bank, St. Pierre Bank, and in Halibut Channel. Timing of spawning is variable and extremely protracted, with spawning fish present from March until August in Placentia Bay. The proportions of fish at various stages of maturation during the 2004 spring research vessel survey were similar to those observed in recent years.

Growth, calculated from length-at-age in research trawl survey samples, has varied over time. A peak occurred in the mid-1970s for young ages (3-4) and progressively later to 1980 for older ages. From the mid-1980s to the present, length-at-age tended to increase at young ages (2-3) and to vary with no clear trend at older ages. Year-to-year variability at older ages has been considerable (as much as 20 cm at age 10) during the past decade or so. In general, current values of length at age are not unusual in comparison to past values.

The **condition** of cod is typically expressed as W/L^3 , where W is the gutted weight or liver weight, and L is the length. Comparison of post-1992 condition with that observed during 1985-1992 is difficult because survey timing has changed. Condition varies seasonally and tends to decline during winter and early spring. In general, condition of cod in the 1993-2004 surveys shows no clear trend and does not appear to be unusual.

ASSESSMENT

Resource Status

Sources of information: Stock status at the end of March 2005 was updated using age-disaggregated data from **commercial landings** to the end of the 2004/05 fishery, and **abundance indices** from Canadian (1972-2005) research vessel trawl surveys, industry trawl surveys (Groundfish Enterprise Allocation Council (GEAC), 1997-2004), and sentinel surveys (1995-2004). Age-aggregated catch rate data from logbooks for the < 35 ft sector (1997-2004) and > 35 ft sector (1998-2004) were also examined. Annual exploitation rates were estimated from tagging experiments conducted in different regions of 3Ps during 1997-2004.

Research vessel surveys: Canadian research vessel bottom **trawl surveys** were conducted from 1972-1982 by the research vessel A. T. Cameron using a Yankee 41.5 otter trawl. Surveys from 1983 to 1995 were conducted by the Wilfred Templeman, or the sister vessel the Alfred Needler, using the Engel 145 Hi-Lift otter trawl. Since 1996, the surveys have been conducted by the Wilfred Templeman and the Teleost using the Campelen 1800 shrimp trawl. Data collected with the gear used between 1983 and 1995 were converted to Campelen-equivalent units based on comparative fishing experiments.

The survey **biomass index** is variable but declined from the mid-1980s to the lowest values observed during the early 1990s. Values for the post-moratorium period have been higher than those of the early 1990s, but not as high as those of the 1980s (Fig. 5). The biomass index in 2005 was 46,000 t, substantially less than the 2004 survey estimate (80,500 t).

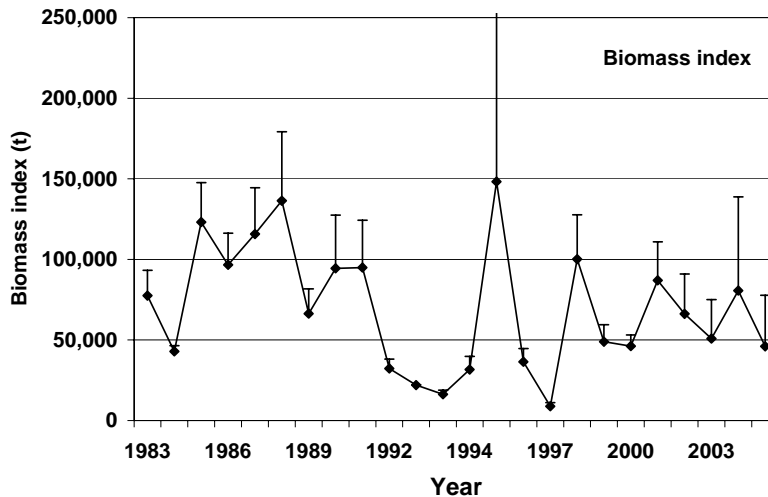


Fig. 5. Research vessel survey biomass index (t) (+1 SD). There were two surveys in 1993 (February and April).

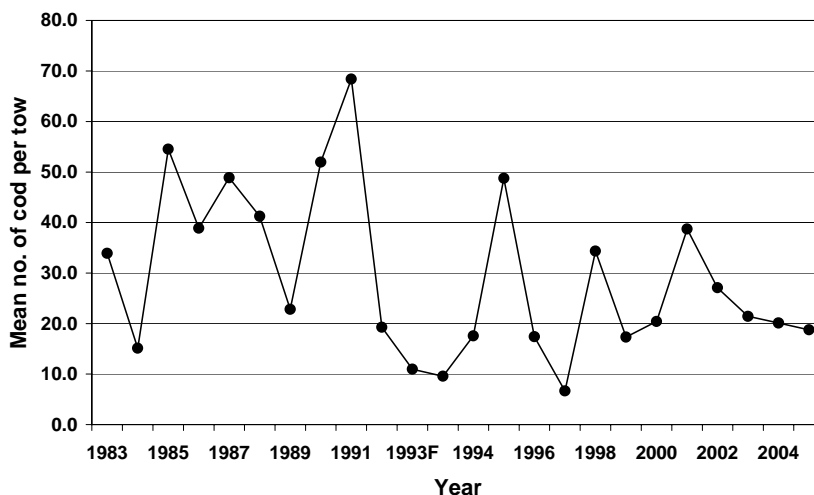


Fig. 6. Research vessel survey abundance index (mean numbers per tow) for 3Ps. There were two surveys in 1993 (February and April).

The survey abundance index is variable, but shows a declining trend from the mid-1980s to the early 1990s. There was a slight upward trend since the early 1990s, but this has reversed in the past four years. The high 1995 estimate was strongly influenced by a single large catch. The 1997 survey was low and did not encounter aggregations of fish that were observed in surveys and commercial catches in subsequent years.

Spatial distribution: During the April 2005 survey, the distribution of cod (Fig. 7) was more widespread than during the 2004 survey. Cod in recent surveys remain less widely distributed across the top of St. Pierre Bank than in 1999 and 2000. The largest catches in 2005 were localized in the southern Halibut Channel, Fortune Bay, and in the Burgeo Bank-Hermitage Channel area.

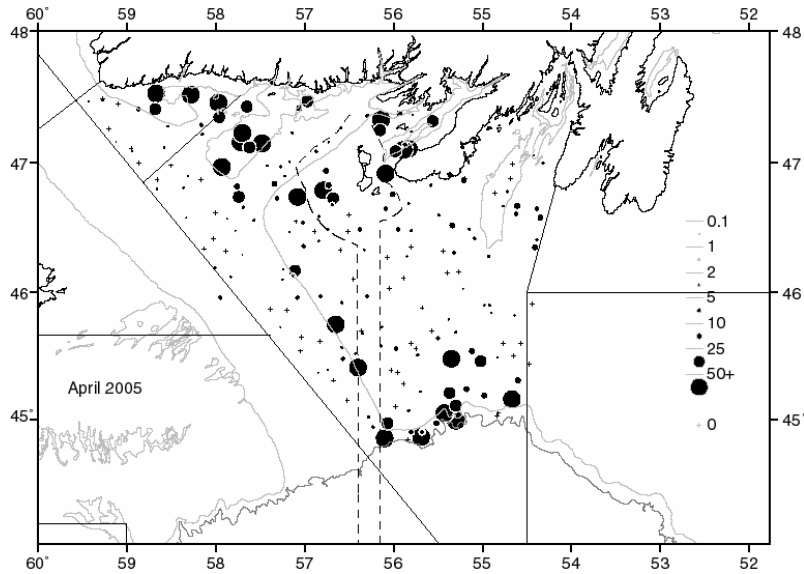


Fig. 7. Spatial distribution of 2005 research vessel trawl survey catches. The scale is numbers of cod per tow.

Age composition: The age range of survey catches over the post-moratorium period has expanded, with the 1989 year class relatively well represented in the most recent survey at age 16. The 1997 and 1998 year classes have been strongly represented in the survey index for several years, but are poorly represented in the 2005 survey. The 1999 and 2000 year classes appear weak, whereas the 2001 and 2002 year classes appear stronger in the most recent survey.

Industry (GEAC) trawl survey: During fall 2004, an eighth consecutive industry survey was conducted with a standardized un-lined commercial trawl. Survey coverage has varied slightly and results for 1997 were from a smaller surveyed area. In all years this survey has shown aggregations of cod in the southern Halibut Channel and on or adjacent to St. Pierre Bank.

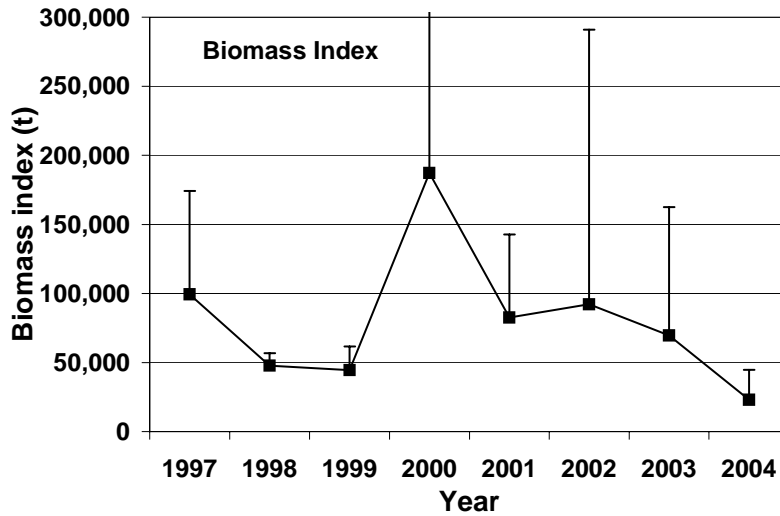


Fig. 8. Biomass index (t) (+1 SD) from the industry (GEAC) trawl surveys.

The biomass index from the GEAC surveys is variable, but shows a declining trend over the past 4 yrs. The estimate for 2004 (23.1 Kt) was the lowest in the time series (Fig. 8).

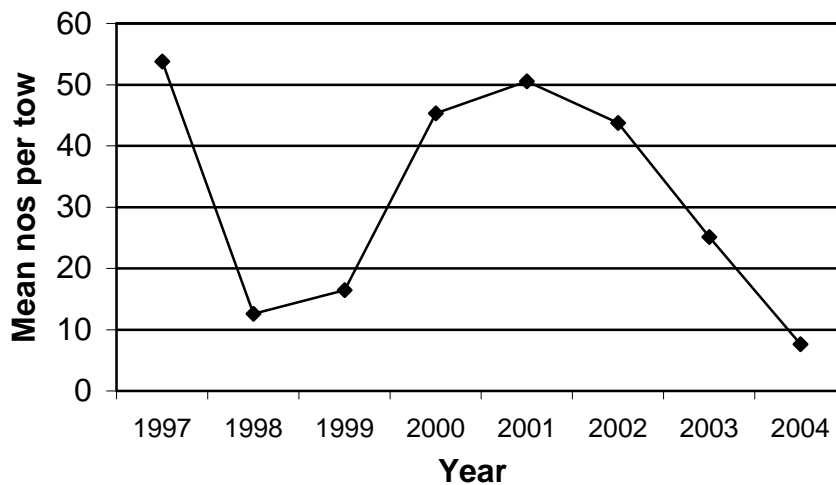


Fig. 9. Abundance index (mean numbers per tow) from the industry (GEAC) trawl surveys.

The abundance index (numbers per tow) from the GEAC surveys has also shown a declining trend in recent years. The estimate for 2004 (6.6) is the lowest in the time-series (Fig. 9).

The 1997 and 1998 year classes have been strongly represented in the GEAC survey index for several years. However, in the 2004 survey catches of all ages, including the 1997 and 1998 year classes, were substantially less than in recent years.

Sentinel survey: Fixed gear **sentinel surveys** have been conducted at several sites along the south coast of Newfoundland from St. Brides to Burgeo from late February of 1995 and are continuing in 2005. However, the 2005 survey is not yet complete and the analysis could not be extended to include the current year.

Gillnet catch rates come mostly from sites in Placentia Bay whereas line-trawl catch rates come mostly from sites west of the Burin Peninsula.

The sentinel survey data were standardized to remove site and seasonal effects to produce annual indices of the total and age-specific catch rates.

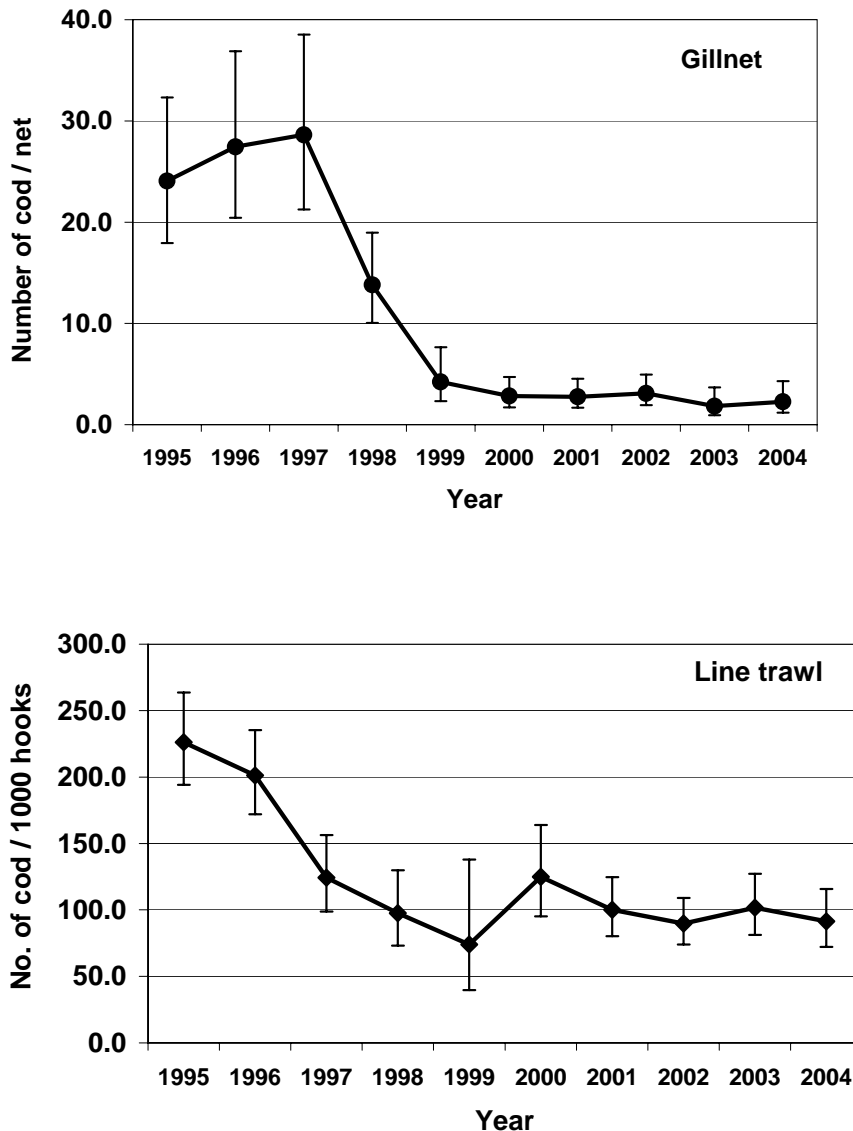


Fig. 10. Standardized sentinel catch rate indices for gillnets (upper panel) and line-trawls (lower panel). Error bars are 95% confidence intervals for the estimates.

The standardized total annual **catch rate index** for gillnets was high from 1995-1997, but progressively lower in 1998 and 1999, and remained low from 2000 to 2004 (Fig. 10, upper panel). The index for line-trawls was high in 1995 with a steady decline to 1999, but has subsequently been fairly constant (Fig. 10, lower panel).

The standardized age-specific indices for gillnets and line-trawls show similar trends with the relatively strong 1989 and 1990 year-classes being replaced by subsequent weaker year-classes resulting in an overall decline in catch rates. The 1997 and 1998 year-classes appear to be slightly stronger in the line-trawl index in 2001-2004, but are poorly represented in the gillnet index in those years.

Log books: Standardized annual catch rates from science log books (<35' sector) for vessels fishing gillnets show a declining trend during 1998-2000, but have subsequently been fairly constant. A declining trend during 1997-1999 was observed for line-trawls, followed by stable catch rates to 2002 and an increase in 2003-2004. The commercial index is based on weight of fish caught whereas the sentinel index is based on numbers.

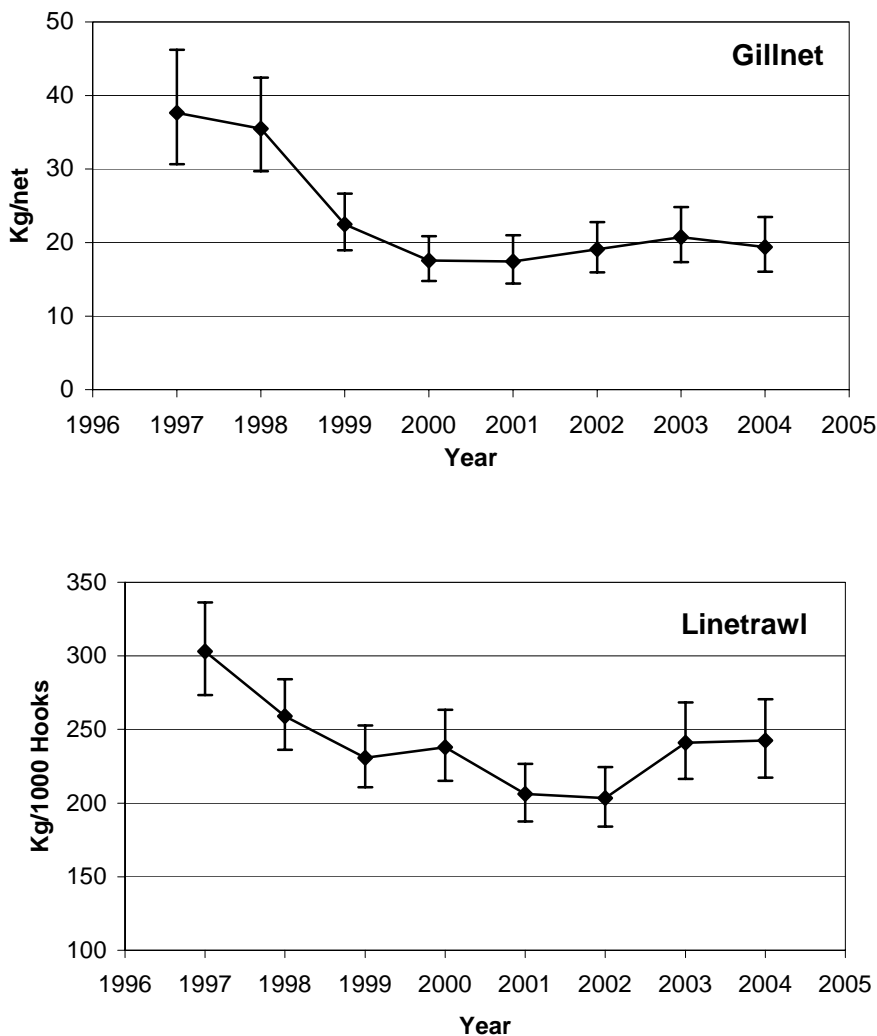


Fig. 11. Standardized catch rates for gillnets and line-trawls from science log books for vessels <35'. Error bars are 95% confidence intervals of the means.

Median annual catch rates by gear sector and unit area from log books of larger vessels (>35' sector) were also examined. The catch rate trends for these vessels fishing inshore areas (3Psa,b,c) generally agreed with those from the under 35' sector, but those for offshore areas (3Pse/f/g/h) showed mostly showed variable catch rates or declining trends.

Tagging: Information from recaptures of cod tagged in various regions of 3Ps since 1997 was used to estimate average **annual exploitation (harvest) rates** for cod tagged in specific unit areas. During 2001-2003, the mean exploitation rate was relatively high for cod tagged in Placentia Bay (3Psc, 21-27%) compared to those tagged in Fortune Bay (3Psb, 10-13%), Burgeo Bank/Hermitage Channel (3Psd, 2-8%) or Halibut Channel (3Psg/h, 1-3%), respectively.

During 2004, mean annual exploitation estimates remained high for cod tagged in Placentia Bay (20%), but remained low (2-10%) for cod tagged elsewhere in 3Ps.

As in the previous assessment, mean exploitation was much lower among cod tagged offshore (3Psh) in spite of substantial offshore landings. These low offshore exploitation rates are consistent with a large offshore biomass in relation to the magnitude of recent offshore catches. However, the offshore estimates of exploitation are considered uncertain because of localized offshore tagging coverage and localized distribution of fishing activity in the offshore. There is also greater uncertainty in the reporting rates of tags from the offshore, and in the survival of fish caught for tagging offshore in deep (>200 m) water.

Tagging coverage of the offshore was expanded in 2003 and again in 2004 to address some of these concerns and to investigate whether winter catches in the offshore portion of 3Ps includes northern Gulf cod. A total of 3800 cod were tagged and released in 3Psg/h during the December 2003 and 2004 GEAC surveys. Results to date are preliminary, but both the numbers of tagged cod returned and distribution of recaptures (all within 3Ps) are similar to those of cod tagged in the offshore of 3Ps during April.

ADDITIONAL STAKEHOLDER PERSPECTIVES

In the offshore fishery, catch rates in 2004/05 remained consistent with previous years. The catch consisted predominantly of fish greater than 60 cm. The proportion of fish >90 cm in the catch was highest in January and February. Offshore captains reported that cod were found in depths of ≥ 600 m in January and February, much deeper than in previous years.

A telephone questionnaire of fish harvesters was conducted by the Fish, Food and Allied Workers (FFAW) Union to provide an industry perspective on the 2004/05 fishery and ongoing 2005/06 fishery. A total of 143 (14%) license holders participated in the survey. Most participants in the survey reported that cod abundance in area 11 (Fortune Bay [3Psb] to Burgeo [3Psa]) and St. Pierre Bank is higher than it was prior to the moratorium in 1993. The collective response for those fishing area 10 (Placentia Bay, 3Psc) was inconsistent, with approximately equal numbers of respondents reporting higher, lower, or similar abundance compared to the pre-moratorium period. Most participants fishing inshore (areas 10 and 11) felt that abundance was about the same in 2005 compared to 2004, whereas those fishing St. Pierre Bank felt abundance was the same or higher in 2005. Size range and condition of cod in 2005 was about the same as was observed in 2004 and the timing of migration of cod was the same as it had been traditionally.

Inshore fish harvesters are concerned about the effects of seismic surveys on cod. Seismic testing did not conclude in the 3Ps area until mid-November 2004 and if cod left the area it may have affected the GEAC survey which took place shortly after the seismic operation concluded. Fish harvesters also feel that not enough is known about the short and longer term effects of seismic surveys on all marine species.

OTHER CONSIDERATIONS

Temperature

Oceanographic information collected during spring indicated that temperature during both 2004 and 2005 increased considerably over 2003 values to 1°C above normal in some areas. The areal extent of <0°C bottom waters increased during 2003 to the highest in about 13 years, but decreased during 2004 and 2005 to <10%, the lowest since 1988.

Cold water in the late 1980s and early 1990s was associated with a disappearance of cod from the shallow strata on top of St. Pierre Bank and a shift to deeper water at the time of year when the research trawl survey was conducted. Survey results from 1998-2000, when waters were warmer, indicate some reappearance of cod in these shallow strata; however, in 2001-2003 the numbers of cod in these shallow strata and regions to the east were lower and this pattern persisted into 2004 in spite of the warmer temperatures. During the spring of 2005 there was an increase in the number of non-zero catches on St. Pierre Bank and an apparent increase in the size of the catches in deeper waters with temperatures >2°C.

Sequential Population Analyses

Several **sequential population analysis** (SPA) model formulations were applied in the current assessment. These included the same formulations used in the 2004 assessment, updated with one more year of data. In addition to the total reported commercial catch (from 1977 onwards), results from DFO research vessel surveys, GEAC surveys and sentinel line-trawl surveys were used in the analysis.

Trends in population size, spawner biomass, recruitment, and exploitation were similar among different model formulations. Results from two of the SPA formulations are given to show these trends and to illustrate uncertainty related to different fishery selectivity patterns, although many other sources of uncertainty remain to be explored. In one of these formulations (Run 1), older ages were assumed to be not fully selected by the fishery; in the other (Run 2) it was assumed that older ages were fully selected by the fishery.

SPA results from successive recent assessments show a tendency to reduce estimates of recent population size. The current assessment also indicates a decrease in spawner biomass between 2003 and 2004 which was not evident in the 2004 assessment.

Results from the two SPA formulations indicate that there is considerable uncertainty about the absolute size of the cod population. The spawner stock biomass estimates for 1 January 2004 from these two SPA formulations ranged from 50,000 to 82,000 t.

Population numbers increased from the late 1970s to a peak in 1985 (Fig. 12). Numbers declined from the mid-1980s to the early 1990s, and remained low during the moratorium. Population numbers increased during the late 1990s (1998-2000), but have subsequently declined.

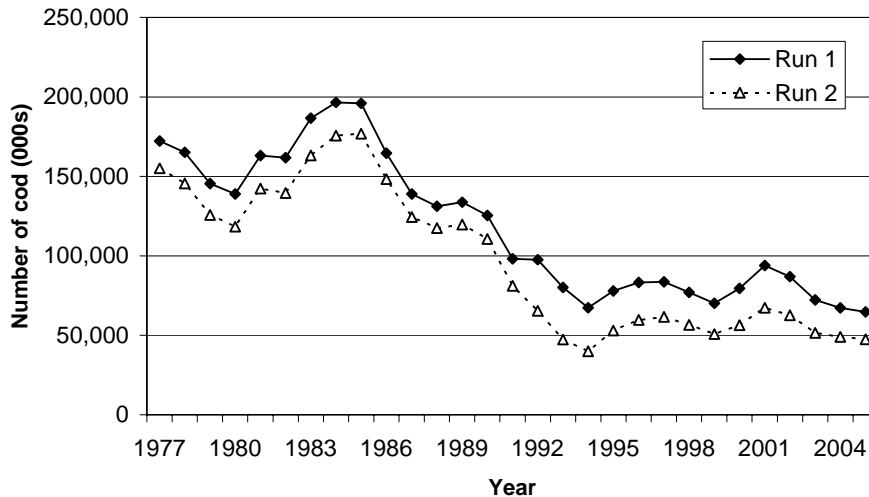


Fig. 12. Trends in 3+ cod population numbers.

Population biomass increased during the late 1970s to a peak in 1985 then declined steadily through the late 1980s and early 1990s (Fig. 13). Population biomass increased during the moratorium, but leveled off or declined slightly during 1998-2000. Estimates of population biomass show a decline in recent years.

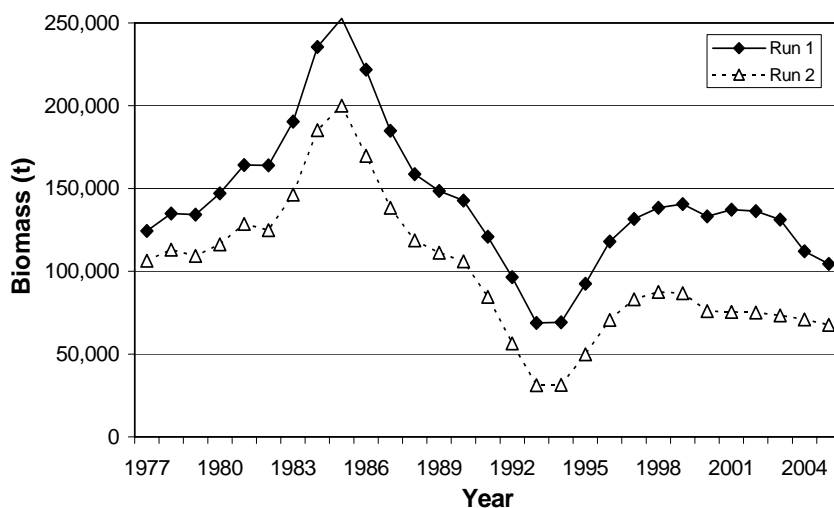


Fig. 13. Trends in 3+ cod population biomass.

Spawner biomass showed a similar trend to that of population biomass from 1977 to 1999; Spawner biomass increased during the moratorium, but leveled off or declined slightly during

1998-2000 (Fig. 14). Estimates of spawner biomass have been variable but show a decline in recent years.

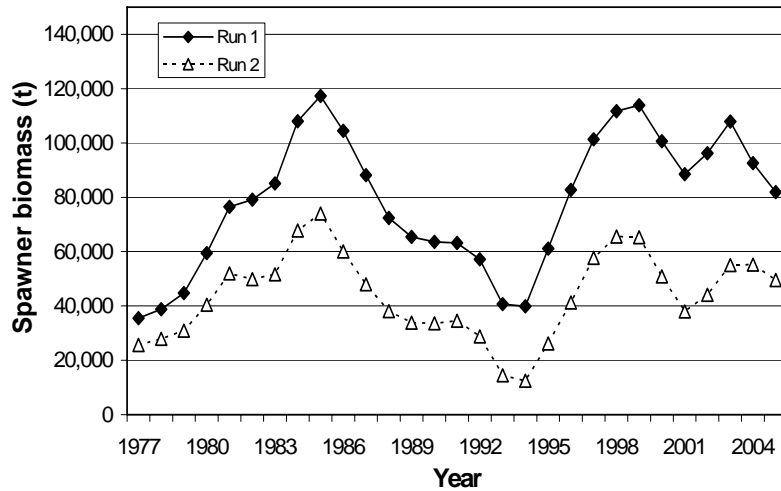
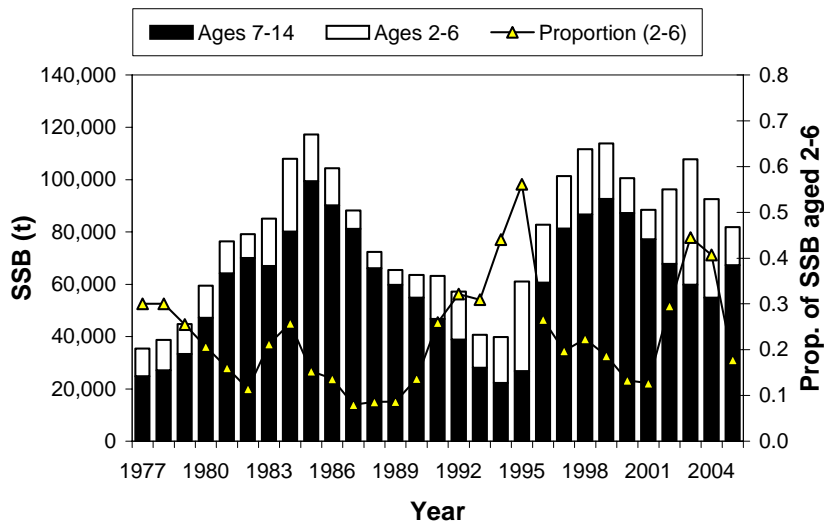


Fig. 14. Trends in cod spawner biomass.

The age composition of the spawner biomass has changed considerably in the recent period (Fig. 15). Spawner biomass increased during 2001-2003 and comprised an unusually high proportion of young (≤ 6 yr old) females. During 2003-2005, both spawner biomass and the proportion of young females declined.



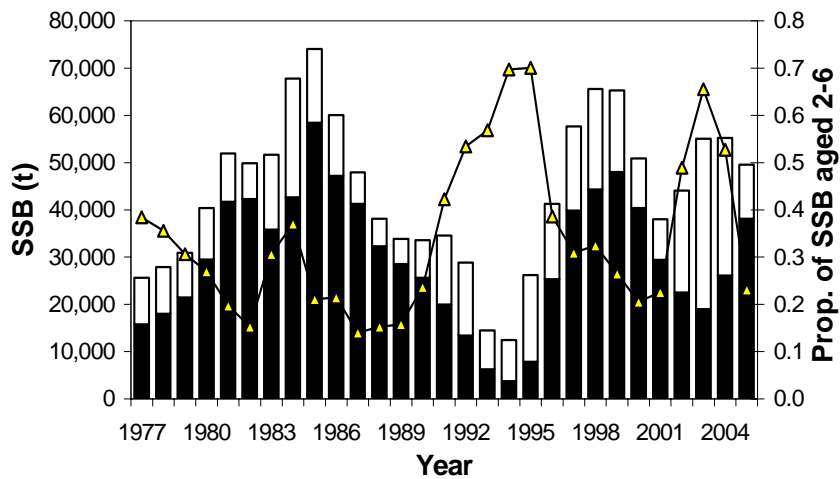


Fig. 15. Trends in the age composition of the spawner biomass. Triangles show the proportion of the spawner biomass aged ≤ 6 yr old. Upper panel - Run 1, lower panel - Run 2.

Estimates from the two SPAs show that recruitment has been variable in 3Ps, with a long-term decline between year classes in the mid-1970s and the mid-1990s (Fig. 16). The stock has produced mostly weak year classes in the last 15 years, although the 1997 and 1998 year classes are relatively strong.

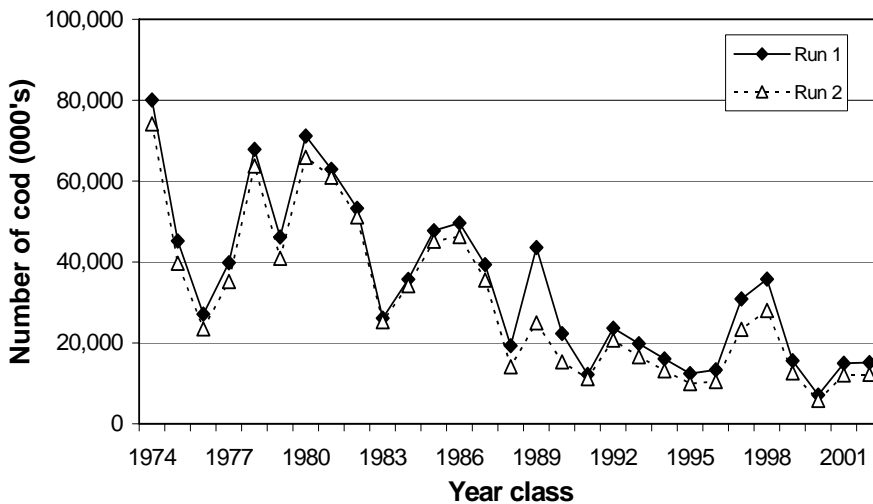


Fig. 16. Trends in recruitment (numbers at age 3).

Estimates from the two SPA formulations also show that the annual **exploitation rate**, expressed as percentage of 3+ numbers removed by the fishery, varied over time (Fig. 17). Exploitation during the late 1970s to 1985 was typically between 10 and 17%, but increased to between 20 and 38% just prior to the moratorium in 1993. With the reopening of the fishery in 1997, exploitation rates were low relative to the pre-moratorium period and increased to a peak in 1999, but declined to about 6-8% in 2001. Subsequently, exploitation rates have increased marginally to about 8-11%.

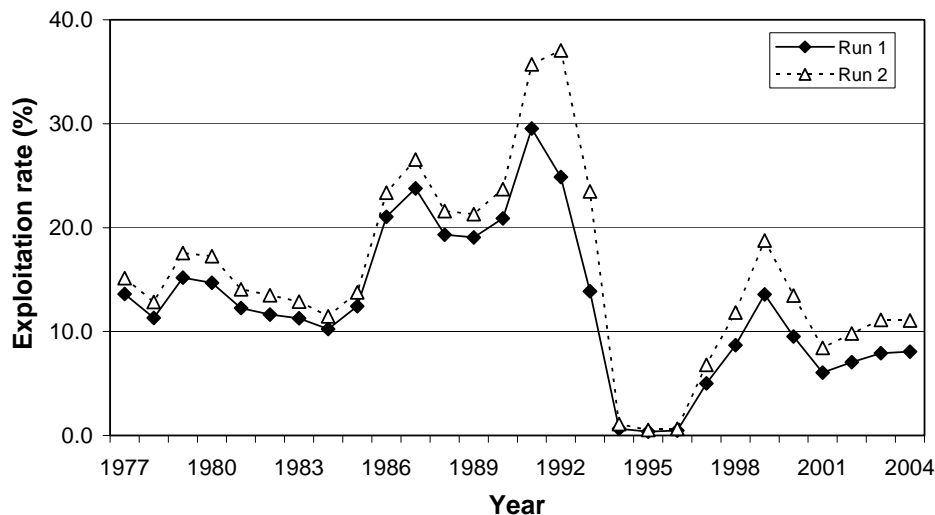


Fig. 17. Exploitation rate (percent 3+ numbers removed by the fishery).

Spawner biomass limit reference points: As in the previous assessment, current spawning stock biomass (Jan. 1) was compared in relative terms with a biological limit reference point, i.e. B_{rec} , defined as the lowest spawning stock biomass from which the stock has recovered. For 3Ps cod this is the spawning stock biomass at the beginning of 1994 (i.e. 40,000 t and 12,000 t for the two respective SPA formulations). The current biomass estimate is 2.1 times larger and 4.0 times larger than the B_{rec} estimate for the two SPA formulations (see Fig. 14).

Projections: In the current assessment, 3-year deterministic projections to 1 April 2008 were computed for the two SPA formulations. In the first year the catch was assumed to be 15,000 t which is the TAC for the 1 April 2005 – 31 March 2006 management year. At this catch level, the spawner biomass is estimated to decrease by approximately 6000 t (6%) and 5000 t (13%) for the two SPA formulations (Table 1).

The projections for the management years 2006/07 and 2007/08 were for fixed annual catch options in 2.5 Kt increments ranging from 5.0 to 15.0 Kt. At catch options ranging from 7.5 to 15.0 Kt both formulations indicated that spawner biomass will decline by 1 April 2008 (Table 1). At a catch option of 5.0 Kt both formulations indicated a small increase (5-8%) in spawner biomass by 1 April 2008. Projection results for total abundance and biomass were similar.

Under all catch options considered for the two SPA formulations, the projected spawner biomass on 1 April 2008 was greater than B_{rec} .

	Management Year	% change in SSB from 74,900 t (Apr. 1 / 2005)				
		5,000 t	7,500 t	10,000 t	12,500 t	15,000 t
Run 1	2005/06					-6
	2006/07	1	-2	-5	-8	-11
	2007/08	5	-1	-7	-13	-20

	Management Year	% change in SSB from 44,400 t (Apr. 1 / 2005)				
		5,000 t	7,500 t	10,000 t	12,500 t	15,000 t
Run 2	2005/06					-13
	2006/07	-1	-6	-12	-17	-22
	2007/08	8	-3	-13	-24	-34

Table 1. Projected changes in spawner biomass (SSB) at various fixed catch options from 1 April 2006 to 1 April 2008. Note that 1 April 2006 values are for the end of the current management year and assume that the 15,000 TAC will be caught.

In the 2004 assessment SSB was projected to decrease during 2004/05 by 6% for both runs. In this assessment the declines over the last year were estimated to have been 12% and 10%. These declines differ from the 2004 assessment because SPA results from successive recent assessments show a tendency to reduce estimates of recent population size.

Sources of uncertainty

Information on fish older than age 14 is not included in the analytical assessment of this stock, because the available data are not considered reliable. Nevertheless, the proportion of the population greater than age 14 is likely to have been small since the moratorium.

There is considerable uncertainty regarding the origins of fish found in 3Ps at various times of year. Tagging experiments suggest that the amount of mixing with adjacent stocks can vary from year to year. The assessment is sensitive to mortality on 3Ps cod occurring when fish are outside 3Ps and to the incursions of non-3Ps fish into the stock area at the time of the survey and the fishery.

As described in previous assessments, there is considerable uncertainty regarding the appropriate SPA formulation for this stock. For example, to estimate population numbers using SPA, some assumptions are usually made about how commercial fishery selectivity changes with cod size and hence age. Different assumptions can produce estimates that differ substantially, although overall trends are similar for this stock.

The 3-year deterministic projections do not take any uncertainties into account. The trends in the projections depend heavily on the accuracy of estimates of recent year classes, and their subsequent survival and recruitment to the fishery in 2006-2008. These projections are also sensitive to recent and substantial changes in estimates of the proportion of females that mature at young ages and become part of the spawning population.

The estimates of exploitation for fish tagged offshore are considered more uncertain because of localized offshore tagging coverage and localized distribution of fishing activity in the offshore. There is also greater uncertainty in the reporting rates of tags from the offshore and possibly in the survival of fish caught for tagging offshore in deep water.

There is considerable uncertainty about the current productivity of this stock. The spawner biomass is currently producing far fewer recruits than it did at the start of this period (i.e. 1977). The ability of the stock to rebuild from B_{rec} may be lower than in the past, should it be reduced to that level.

CONCLUSIONS AND ADVICE

Two strong year classes (1997-1998) are well represented in the 2004 catch. However, these are followed by weaker recruitment (1999-2002 year classes), and current catch levels are unlikely to be sustainable in the long-term unless recruitment improves.

Both SPA formulations used to illustrate stock trends indicated that spawner biomass will decline in the next management year (2006/07) for all catch options from 7500 to 15,000 t. However, the estimated spawning biomass at 1 April 2007 will be greater than the recommended biological limit reference point (B_{rec}).

Cod in 3Ps are maturing at younger ages than in the past, but the spawner biomass still includes many older spawners that are thought to be more effective at producing eggs. Nonetheless, the stock has produced mostly weak year classes in the last 15 years. The reasons for the lower reproductive success of the 3Ps cod stock are not known.

MANAGEMENT CONSIDERATIONS

There are no explicit management objectives for this stock. Consequently, only catch options considered to be informative for fisheries management were evaluated in the current assessment. The TAC in the five management years ending 31 March 2006 was 15 Kt and the catch options considered were 5, 7.5, 10, 12.5, and 15 Kt .

At fixed annual catch options ranging from 7.5 to 15.0 Kt for the 2006/07 and 2007/08 management years, both SPA formulations indicated that spawner biomass will decline further by 1 April 2007 (see Table 1). At a catch option of 5.0 Kt both SPA formulations indicated a small increase in spawner biomass by 1 April 2008.

The incentive for under-reporting of catches remains with the implementation of trip limits, and individual quotas (IQ's). There are also concerns about discarding of small fish in the hook and line fishery. Increased monitoring of catches and landings would result in better estimates of deaths caused by fishing.

Because of uncertainties in stock structure, excessive exploitation on sub-components of the stock should be avoided. Measures should be implemented to further reduce the relatively high exploitation rate in Placentia Bay (3Psc) that is evident from analyses of the tagging data, sentinel catch rate indices, and commercial catch rate indices for vessels <35'.

Recent management measures (seasonal closures and switch to individual quotas, rather than a competitive fishery in western 3Ps) have reduced the reported winter catches from the mixing area (3Psa/d combined). Catches from this area in winter should continue to be minimized to reduce the potential impact on the 3Pn4RS cod stock.

A complex series of area/time closures on directed cod fishing in 3Ps has been introduced to address concerns about stock mixing and disruption of spawning activity. The consequences of area/time closures should be carefully considered as these may result in higher exploitation rates on the components of the stock that remain open to fishing.

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