



## STOCK ASSESSMENT OF SUBDIVISION 3Ps COD

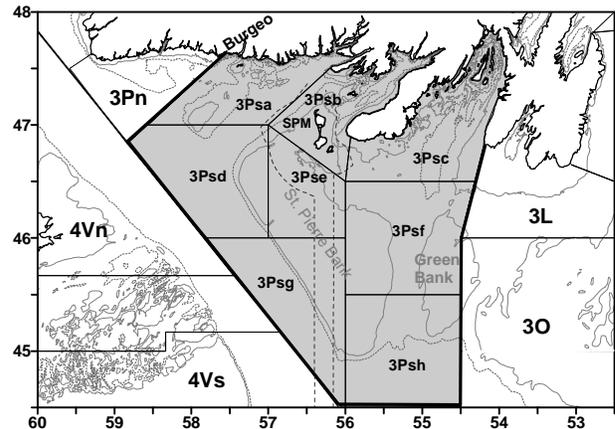
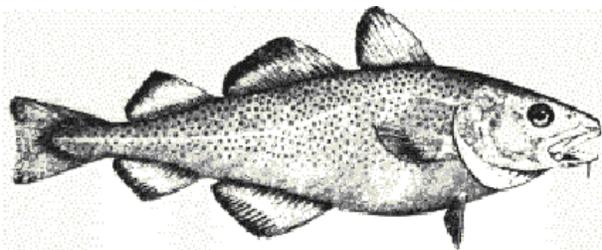


Fig. 1: 3Ps management area (shaded) unit areas (solid lines) and economic zone around the French islands of St. Pierre and Miquelon (SPM) (dashed line).

### 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 (Fig. 1).*

*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. Female cod from this stock are maturing at younger ages in recent years. For example, at least 40% of the females are mature by age 5 (~53 cm) in recent cohorts, compared to only about 10% at age 5 (~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 only. 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 January-March 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. The TAC for the 2006/07 and 2007/08 management years was reduced to 13,000 t. This stock is normally assessed on an annual basis.*

## SUMMARY

- Information available to evaluate stock status consisted of commercial landings (1977 to 31 March 2007) and log-book data (1997-2006) in conjunction with abundance indices from Canadian research vessel (RV) trawl surveys (1972-2007), industry trawl surveys (1997-2005), and sentinel surveys (1995-2006). Exploitation (harvest) rates were estimated from tagging experiments.
- The assessment did not produce estimates of total absolute biomass and abundance and therefore the impacts of fishing at specific TAC levels could not be quantified.
- The risk that fishing could do serious harm to the stock could not be evaluated in the absence of an assessment of stock size and productivity. The Precautionary Approach would imply erring on the side of caution.
- DFO Research Vessel (RV) biomass and abundance indices have been revised to include data from inshore strata that have been surveyed since 1997. These indices have been variable in the recent time period with no clear trend.
- Mortality (age 5 -11) inferred from the DFO RV survey indices varied without trend with an average of 30% annually indicating that fishing mortality does not appear to be excessive.
- The two fixed gear indices from fishing conducted shoreward of the DFO RV survey have been stable in recent years.
- Exploitation rates based on tagging of cod in Placentia Bay shoreward of the DFO RV survey are higher than exploitation rates among cod in the DFO RV survey area.
- Two strong year-classes (1997-1998) are well represented in the surveys and catch. However, these are followed by weaker year-classes (2000-2004), and at current catch levels it is anticipated that fishing mortality will increase over the next few years.
- Fish harvesters are of the opinion that the fish stock is healthy and recruitment is good.

## INTRODUCTION

### Description of the Request for Advice

Advice was requested by Fisheries Management on the stock status of 3Ps cod. Specifically:

- Assess the current status of the stock as a whole. In particular, assess current spawning biomass, total (age 3+) biomass, exploitation rate, natural mortality and biological characteristics (including age composition, size at age, age at maturity, and distribution). Describe these variables in relation to historic observations.
- Further to the previous assessment, analyze and assess the implications of the year classes subsequent to the relatively strong year classes of 1997 & 1998 as it relates to the level of recruitment. To the extent possible with available information, provide information

on the strengths (or relative strengths) of year-classes expected to enter the exploitable populations in the next 1-3 years.

- Consistent with the precautionary approach, consider the risk that fishing could do serious harm to the stock, including but not limited to assessing the implications of fishing at the following catch options: zero, 11,000 t, 13,000 t, and 15,000 t.
- In the event that an analytical model is not available to underpin the advice, the prospects for changes in stock biomass over a range of catch options should be considered, based on analysis of recent trends in abundance indicators in relation to recent removals (tempered by productivity factors noted above).
- Highlight major sources of uncertainty in the assessment, and where appropriate, consider alternative analytical formulations of the assessment.
- Report on results of tagging and the distribution of this stock in other areas (eg.3L/3Pn).

## 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).

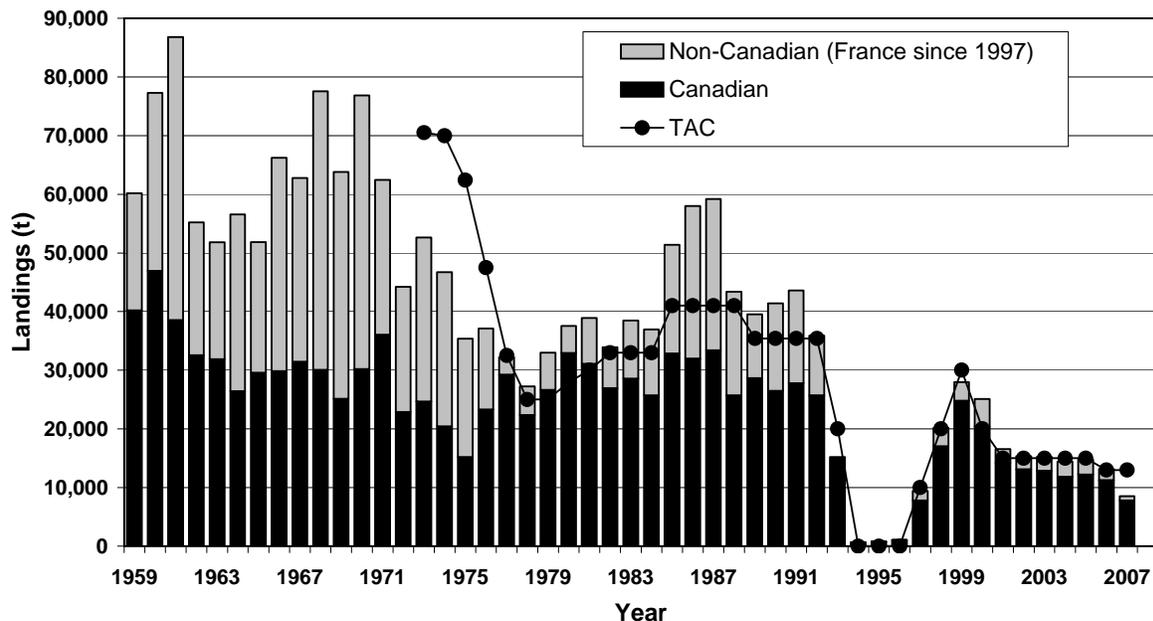


Fig. 2. Reported calendar year landings (t) by country. Note that TAC's are by management year (1 April-31 March) since 2000.

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. 3).

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. For the next five management years ending 31 March 2006 the TAC was set at 15,000 t, but this was reduced to 13,000 t for the 2006/7 and 2007/08 management years.

### **Landings (000s t)**

Year <sup>1</sup>	97	98	99	00 <sup>2</sup> (J-M)	00- 01	01- 02	02- 03	03- 04	04- 05 <sup>3</sup>	05- 06 <sup>3</sup>	06- 07 <sup>3</sup>	07- 08 <sup>3</sup>
<b>TAC</b>	10.0	20.0	30.0	6.0 <sup>2</sup>	20.0	15.0	15.0	15.0	15.0	15.0	13.0	13.0
<b>Can.</b>	7.4	16.6	20.4	3.5	20.3	13.2	12.5	12.6	12.1	11.7	11.3	7.8 <sup>5</sup>
<b>French</b>	1.6	3.1	3.2	4.7 <sup>4</sup>	4.7	2.3	2.3	2.4	2.4	2.2	1.9	0.8 <sup>5</sup>
<b>Totals</b>	9	19.7	23.6	8.2	25.0	15.5	14.8	15.0	14.5	13.9	13.2	8.6 <sup>5</sup>

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

<sup>2</sup> 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.

<sup>3</sup> Provisional.

<sup>4</sup> 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.

<sup>5</sup> Approximate landings to 1 October 2007.

In 2006/07, total reported landings were 13,169 t, mostly (78.4%) from the fixed gear sector (Fig. 3). The total includes a recreational fishery catch of 42 t, and a French catch of 1916 t, approximately 1361 t of which was caught by otter trawlers and the remainder (555 t) by fixed gear, particularly gillnets.

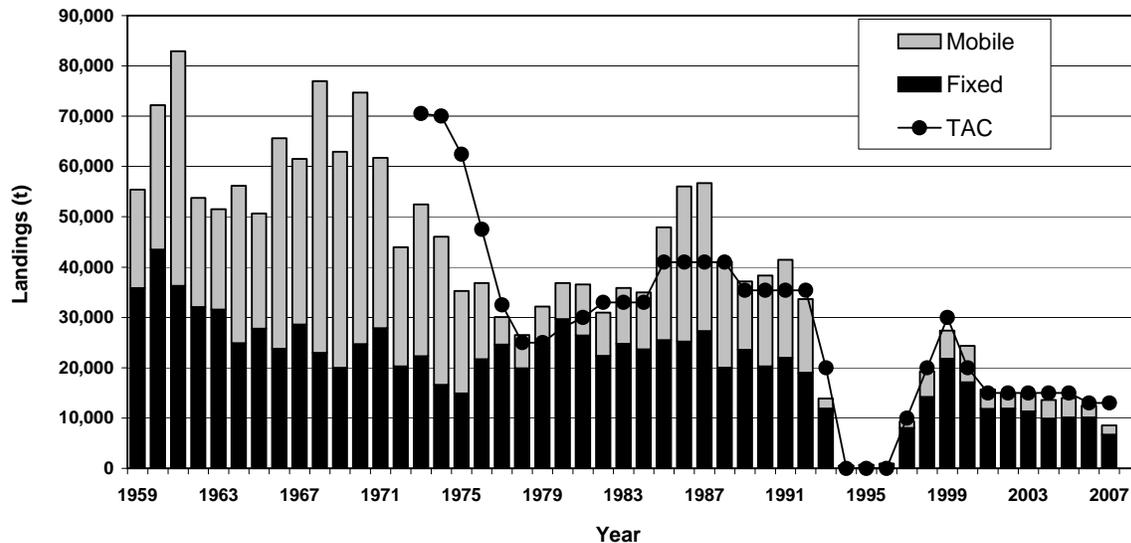


Fig. 3. Reported annual calendar year landings (t) by gear sector. Note that TAC's are by management year (1 April-31 March) since 2000.

During 2006, most of the catch was taken by gillnets and landings comprised a range of ages (mostly 5-9 year olds). The 1997 and 1998 year-classes were well represented in the catch during 2003-2006. Cod ages 8 and 9 were strongly represented in otter trawl catches during 2006, whereas ages 5-8 were well represented in line trawl catches.

## 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 DFO RV 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 (1998-2003) to include inner and outer Fortune Bay and two offshore areas (Burgeo/Hermitage Channel and Halibut Channel). 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). A telemetry study conducted from May 2004 to September 2005 to examine mixing of northern Gulf cod (3Pn4RS) into 3Ps showed that 61% of cod implanted with transmitters in the northern Gulf (3Pn4RS) crossed into 3Ps during winter. The peak of movement into 3Ps was in December and the peak of return into 3Pn was in the first two weeks of April.

**Maturation** in female cod was estimated by cohort. The proportion of female cod maturing at younger ages has increased over the last two decades. The reasons for the change toward earlier age at maturity are not fully understood but may partly be a response to high levels of mortality and have a genetic component. 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 2007 DFO RV 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 during the past decade or so. In general, recent 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 recent surveys shows no clear trend and does not appear to be unusual.

## ASSESSMENT

### Resource Status

Sources of information: Stock status was updated using data from **commercial landings** to the end of the 2006/07 fishery, and **abundance indices** from Canadian research vessel (RV) trawl surveys (1972-2007), industry trawl surveys (Groundfish Enterprise Allocation Council, GEAC), (1997-2005), and sentinel surveys (1995-2006). Catch rate data from logbooks for the < 35 ft sector (1997-2006) and of larger vessels (>35' sector, 1998-2006) were also examined. Annual exploitation rates were estimated from tagging experiments conducted in different regions of 3Ps during 1997-2005.

Research vessel surveys: Canadian RV bottom **trawl surveys** were conducted from 1972-1982 by 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 and the area covered was increased by 12% when new inshore strata were added during 1997. The Canadian DFO RV survey was not completed in 2006 due to unforeseen operational difficulties with the vessels.

Previous assessments reported RV indices from the offshore strata only. The **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. 4). The biomass index in 2007 was 35,000 t, substantially less than the 2005 survey estimate (46,000 t).

The RV survey was augmented by inshore strata that have now been fished for ten years and for the first time indices from this augmented survey are presented. The biomass index from the augmented survey shows similar values to the old index and is variable with no clear trend.

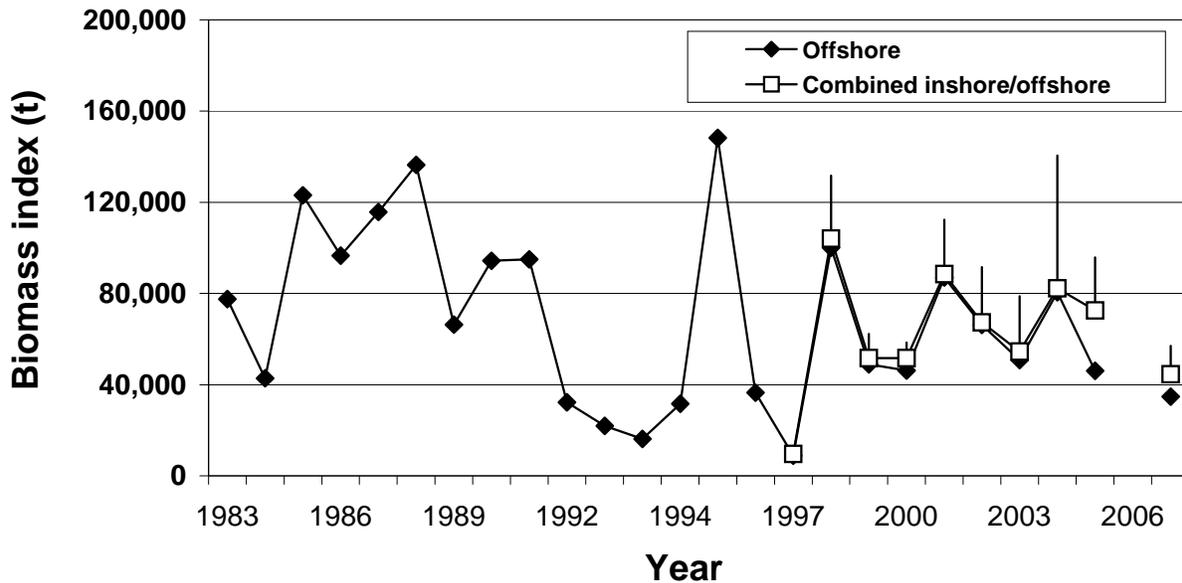


Fig. 4. Research vessel survey biomass indices (t)(+1 SD). There were two surveys in 1993 (February and April).

The offshore DFO RV abundance index is variable, but shows a declining trend from the mid-1980s to the early 1990s (Fig. 5). 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. The combined DFO RV abundance index shows similar values to the offshore index and is variable with no clear trend.

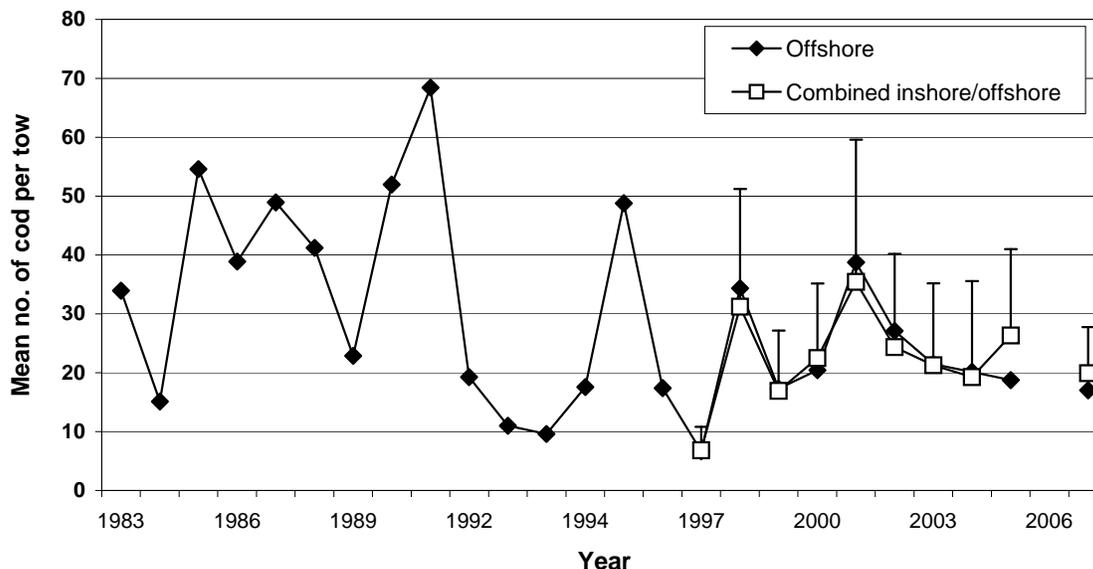


Fig. 5. Research vessel survey abundance indices (+ 1 SD) (mean numbers per tow) for 3Ps. There were two surveys in 1993 (February and April).

**Age composition:** The age range of combined DFO RV survey catches over the post-moratorium period has expanded. The 1997 and 1998 year-classes have been strongly represented in the survey index for several years, but are not strongly represented in the 2005 and 2007 surveys. The 2000-2004 year-classes also appear weaker than the 1997 and 1998 year classes in the most recent (2007) survey. The combined RV survey caught relatively large numbers of 1 yr olds in 2007 and these were widely distributed across the surveyed area.

**Mortality rates:** The annual **mortality rate** for cod aged 5-11 from the combined DFO RV survey has varied without trend with an average of 30% annually, using data from 1997-2007. This suggests that fishing mortality does not appear to be excessive.

**Industry (GEAC) trawl survey:** During fall 1997-2005, an industry trawl survey was conducted with a standardized un-lined commercial trawl. Survey coverage 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. Abundance and biomass indices from this survey were variable, but show a declining trend in last 4-5 yrs. The 1997 and 1998 year classes were strongly represented in the GEAC survey index during 2001 to 2003. However, in both the 2004 and 2005 surveys, catches of several older ages, including the 1997 and 1998 year-classes, were substantially lower. Year-classes produced during 1999-2002 appear weak.

**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 2007. However, the 2007 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.

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 2006 (Fig. 6, upper panel). The index for line-trawls was high in 1995 with a steady decline to 1999, but has subsequently been fairly constant (Fig. 6, lower panel).

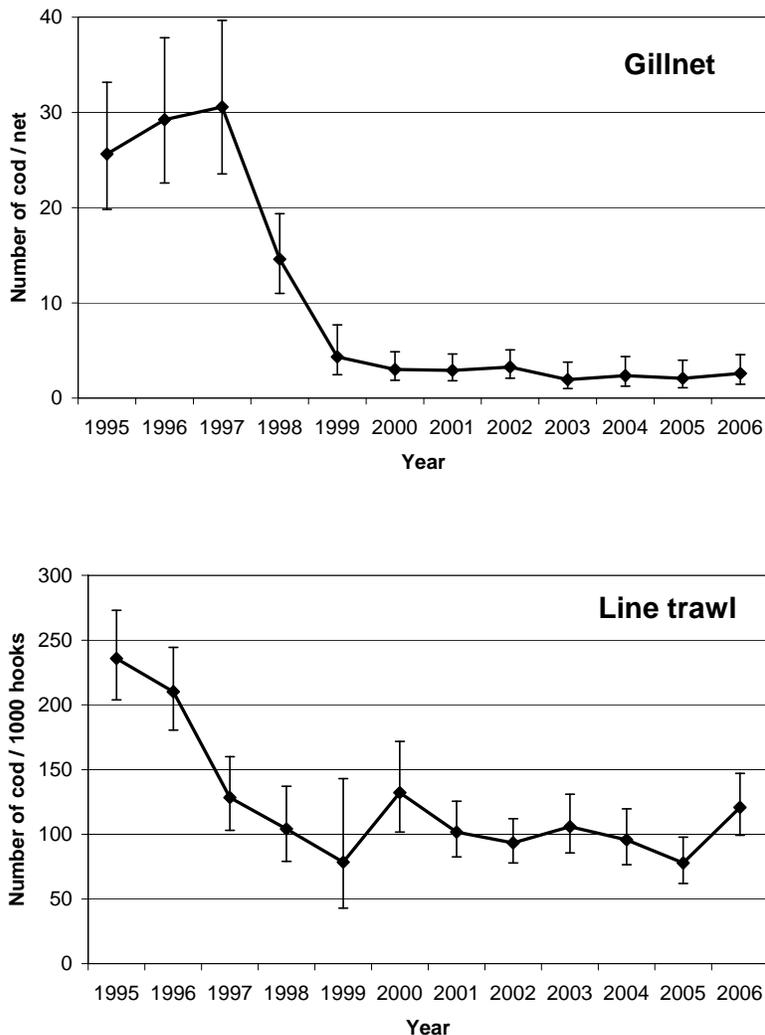


Fig. 6. Standardized sentinel catch rate indices for gillnets (upper panel) and line-trawls (lower panel). Error bars are 95% confidence intervals for the estimates.

The standardized 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 and gillnet indices in 2001-2006. Year-classes produced during 2000-2002 appear weaker.

**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 (Fig. 7, upper panel). A declining trend during 1997-1999 was observed for line-trawls,

followed by stable catch rates to 2002 and an increase in 2004-2006 (Fig. 7, lower panel). The commercial index is based on weight of fish caught whereas the sentinel index is based on numbers. The percentage of the catch from the <35' sector that is accounted for in the standardized logbook indices has declined over time and now represents only about 25% of the catch as compared to 70% at the start of the time series in 1997.

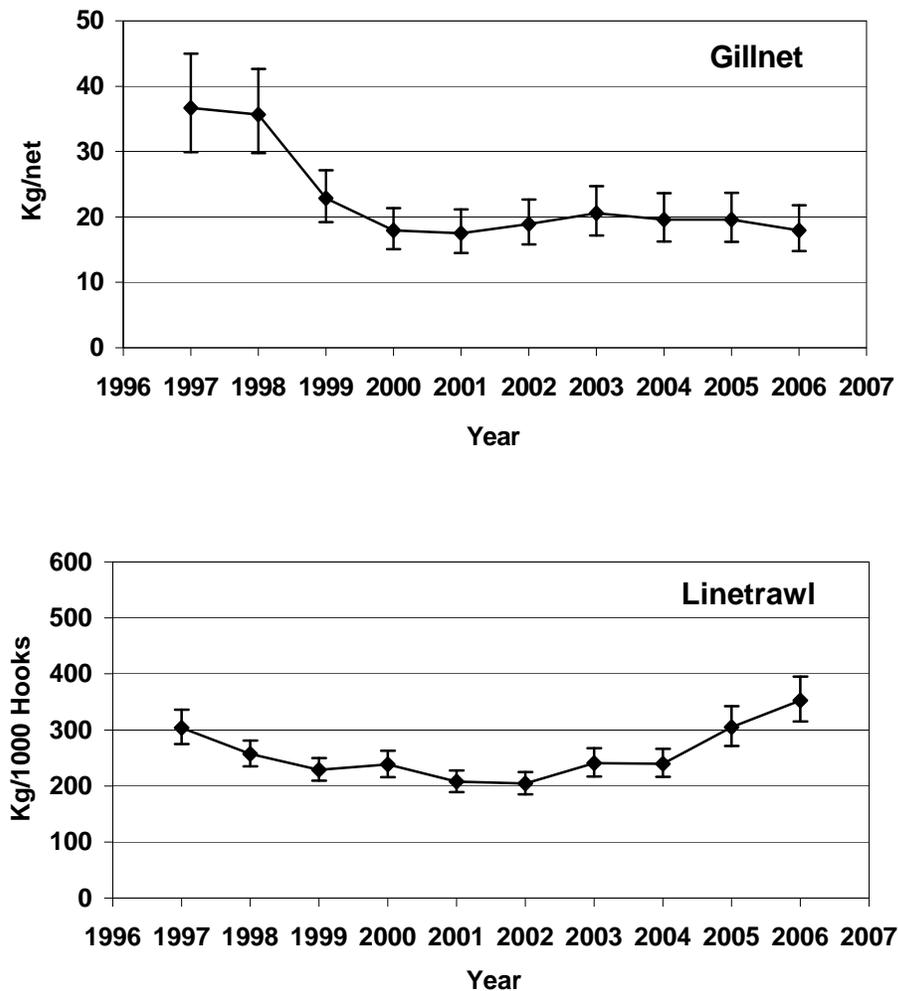


Fig. 7. Standardized catch rates for gillnets and line-trawls from science log books for vessels <35'. Error bars are 95% confidence intervals of the means.

Median annual catch rates by gear sector and unit area from log books of larger vessels (>35' sector) were also examined. The data for offshore line-trawl were too sparse for firm conclusions to be drawn. The otter trawl catch rates showed a declining trend from 1999-2004, but the 2005 and 2006 values were higher than 2004. Gill net catch rates were variable. There is considerable uncertainty in the interpretation of fishery catch rate data. These data may be more reflective of changes in the nature of the fishery than changes in population size.

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 2001-2005, the mean exploitation rate was relatively high for cod tagged in Placentia Bay (3Psc, 22-31%) compared to those tagged in Fortune Bay (3Psb, 10-12%), Burgeo Bank/Hermitage Channel (3Psd, 1-8%) or offshore in Halibut Channel (3Psg/h, 2-6%), respectively.

During 2006, mean annual exploitation estimates remained high for cod tagged in Placentia Bay (25%), and showed no major changes for cod tagged in Fortune Bay (13%), Burgeo Bank/Hermitage Channel (2%), or Halibut Channel (5.2%). The 2006 estimates for inshore tagging are for cod aged 7+. Cod are normally at least 4 years old when tagged and no inshore tagging was conducted during 2004-2006. Offshore tagging (Halibut Channel area) was conducted in 2004 and 2005 and inshore tagging resumed in 2007.

As in the previous assessment, mean exploitation was low among cod tagged offshore (3Psg/h) 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 the limited timing and localization of offshore tagging coverage and restricted 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 and released after tagging offshore in deep (>200 m) water.

The timing of offshore tagging coverage was switched from April to December in 2003-2005 to address some of these concerns and to investigate whether winter catches in the offshore portion of 3Ps includes northern Gulf cod. Both the percentage 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.

Recruitment: A recruitment index was derived from catch rates of juvenile cod during the industry (GEAC) trawl survey and the DFO RV survey (Fig. 8). The standardized index indicated that most recent year-classes (2000-2004) as well as those produced in the mid-1990's are weaker than year-classes produced during 1997 and 1998.

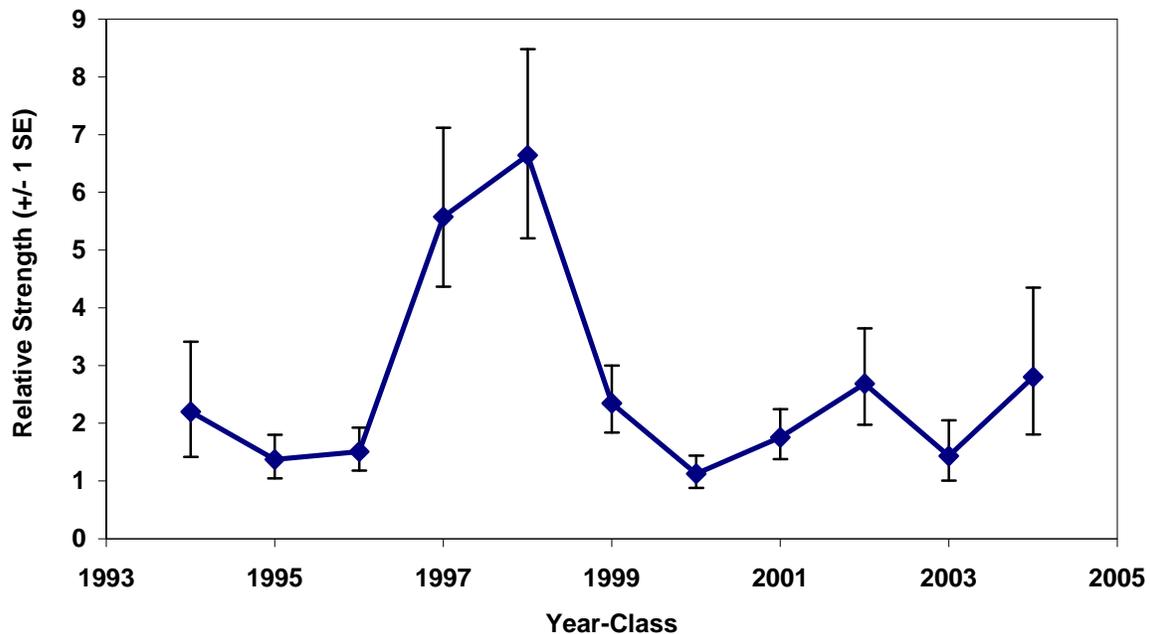


Fig. 8. Standardized year-class strength.

Some information on the relative strength of recent year-classes is also available from the sentinel line-trawl index. This index covers an inshore portion of the stock area. The sentinel line trawl index also shows that year-classes produced during 2000-2002 are weak.

## **Sources of Uncertainty**

There is considerable uncertainty regarding the origins of fish found in 3Ps at various times of the year. Tagging and telemetry experiments show that there is mixing with adjacent stocks (southern 3L and 3Pn4RS) and this may 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.

In the area covered by DFO RV survey and the GEAC survey, the distribution of cod can be highly clustered leading to large year to year variability in catch rates that are not thought to reflect annual changes in stock status.

There is considerable uncertainty regarding how the selectivity of commercial fishery and survey gear changes with size and age. This makes inferences from tagging studies, and trends in summary indices such as survey abundance, difficult to interpret.

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. Lack of tagging in the inshore during 2004-2006 makes estimation of exploitation rates in 2004-2006 more uncertain as the catchability and numbers available to be recaptured diminish.

In the absence of an appropriate analytical model that can incorporate available data and provide an absolute estimate of stock size, the impacts of fishing at specific TAC levels could not be quantified.

## **ADDITIONAL STAKEHOLDER PERSPECTIVES**

From an historical perspective, inshore harvesters (<65ft vessel sector) feel that current catch rates are average to high. Since 2000, gill net catch rates have been stable and long line catch rates have increased. In recent years the length range of cod caught in commercial gear has widened and as older cod have moved out of the selectivity range of commercial gears they have been replaced by younger cod. Harvesters feel that the combination of all these factors suggest there has been good recruitment and together they indicate stability in stock status.

Harvesters are concerned about the potential impacts of ongoing seismic surveys. They feel that not enough is known about the short and longer-term effects of seismic surveys on all marine species.

The Fish Food and Allied Workers Union provided an industry perspective on the fishery by conducting a telephone questionnaire of fish harvesters. A total of 169 (17%) license holders participated in the survey. Harvesters said that catch rates during 2007 were about the same as or better than 2006. Harvesters said that during 2007, cod were distributed throughout the area and condition was good. Harvesters feel that capelin and squid abundance are at low levels and are continuing to decline. Mackerel abundance is good and increasing and there was no clear consensus on herring abundance.

In the offshore fishery catch rates in the fall of 2006 and winter of 2007 were similar to previous years. The number of offshore trawlers fishing during the season declined because of operational issues ashore. A significant portion of the offshore quota was harvested by smaller vessels; some less than 100' including both otter trawlers and fixed gear vessels. Some of these vessels did not fish in the deeper water of the Channel but on the Bank. This could influence the size of fish caught with smaller fish being more predominant on the Bank than in the deeper water. Offshore captains reported that in the 2006/2007 season, cod were found in the 200 to 300 fathoms of water mostly in 3Psh. The proportion of large cod in the catch (greater than 10 lbs) increased over the previous year during January and February 2007. There is a perception among captains that ocean temperatures were cooler in the winter 2007 than in 2006. There were reports of small cod (6") and crab in the stomachs of larger fish.

## **CONCLUSIONS AND ADVICE**

- The assessment did not produce estimates of total absolute biomass and abundance and therefore the impacts of fishing at specific TAC levels could not be quantified.
- DFO Research Vessel (RV) biomass and abundance indices have been variable in recent years with no clear trend. The two fixed gear indices from fishing conducted shoreward of the DFO RV survey have been stable in recent years.

- Mortality (age 5 -11) inferred from the DFO RV survey indices varied without trend with an average of 30% annually indicating that fishing mortality does not appear to be excessive.
- Two strong year-classes (1997-1998) are well represented in the surveys and catch. However, these are followed by weaker year-classes (2000-2004), and at current catch levels it is anticipated that fishing mortality will increase over the next few years.
- The risk that fishing could do serious harm to the stock could not be evaluated in the absence of an assessment of stock size and productivity. The Precautionary Approach would imply erring on the side of caution.

## **Management Considerations**

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 due to price differentials based on size. Quantifying discards could improve the understanding of the productivity of the stock. This is an unaccounted source of fishing mortality.

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). Results from a telemetry study confirm that the timing of these closures is appropriate and that 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.

## **OTHER CONSIDERATIONS**

### **Temperature**

Oceanographic information collected during the spring 2007 DFO RV survey indicated that near-bottom temperatures decreased to below normal values in many areas particularly on St. Pierre Bank, where the area of <0°C water increased to near 30%. The areal extent of bottom water with temperatures >3°C has remained relatively constant at about 50% of the total 3P area, although actual temperature measurements show considerable inter-annual variability.

During the multi-species surveys there were high number of zero catches in the <0°C water on St. Pierre Bank and regions to the east of the Bank, mainly from 1985 to 1998 and from 2001 to 2003. During 1999 and 2000 larger catches became more wide spread over St. Pierre Bank as cold (<0°C) water disappeared from the area. In general, cod tend to prefer the warmer (2°C-

6°C) portion of the available habitat with a slightly warmer preference based on weight than on total numbers. Variations in the estimated abundance and biomass of cod from the RV surveys in strata with water depths <92 m are significantly correlated with bottom temperatures for that depth range, indicating a potential climate effect on cod distribution in this area.

## SOURCES OF INFORMATION

Bratley, J., N. G. Cadigan, B. P. Healey, E. F. Murphy, and J.-C. Mahé. 2006. An assessment of the cod (*Gadus morhua*) stock in NAFO Subdivision 3Ps in October 2006. DFO Can. Sci. Advis. Sec. Res. Doc. 2007/053.

Bratley, J., N. G. Cadigan, B. P. Healey, G. R. Lilly, E. F. Murphy, P. A. Shelton, and J.-C. Mahé. 2005. Assessment of the cod (*Gadus morhua*) stock in NAFO Subdiv. 3Ps in October 2005. DFO Can. Sci. Advis. Sec. Res. Doc. 2005/070.

Bratley, J. and B. P. Healey. 2006. Exploitation of Atlantic cod (*Gadus morhua*) in NAFO Subdivision 3Ps: estimates from mark-recapture experiments for the October 2006 assessment. DFO Can. Sci. Advis. Sec. Res. Doc. 2006/082.

Colbourne, E.B., E.F. Murphy. 2005. Physical oceanographic conditions in NAFO Division 3P during 2005 - possible influences on the distribution and abundance of Atlantic cod (*Gadus morhua*). DFO Can. Sci. Advis. Sec. Res. Doc. 2005/065.

Maddock Parsons, D., and R. Stead. 2006. Sentinel surveys 1995-2006: Catch per unit effort in NAFO Subdivision 3Ps. DFO Can. Sci. Advis. Sec. Res. Doc. 2006/094.

## FOR MORE INFORMATION

Contact: John Bratley  
Fisheries and Oceans Canada  
PO Box 5667  
St. John's, NL  
A1C 5X1  
Tel: (709) 772-2001  
Fax: (709) 772-4501  
E-Mail: [bratleyj@dfo-mpo.gc.ca](mailto:bratleyj@dfo-mpo.gc.ca)

This report is available from the:

Centre for Science Advice  
Newfoundland and Labrador Region  
Fisheries and Oceans Canada  
PO Box 5667  
St. John's, NL  
A1C 5X1

Telephone: (709) 772-2302/8892

Fax: (709) 772-6100

E-Mail: [richardsed@dfo-mpo.gc.ca](mailto:richardsed@dfo-mpo.gc.ca)

Internet address: [www.dfo-mpo.gc.ca/csas](http://www.dfo-mpo.gc.ca/csas)

ISSN 1480-4913 (Printed)

© Her Majesty the Queen in Right of Canada, 2008

*La version française est disponible à l'adresse ci-dessus.*



## **CORRECT CITATION FOR THIS PUBLICATION**

DFO, 2008. Stock Assessment of Subdivision 3Ps cod. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2007/041.