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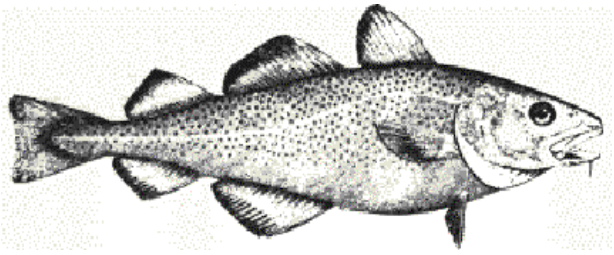
Newfoundland and Labrador Region
Canadian Science Advisory Secretariat
Science Advisory Report 2009/008

STOCK ASSESSMENT OF SUBDIVISION 3Ps COD



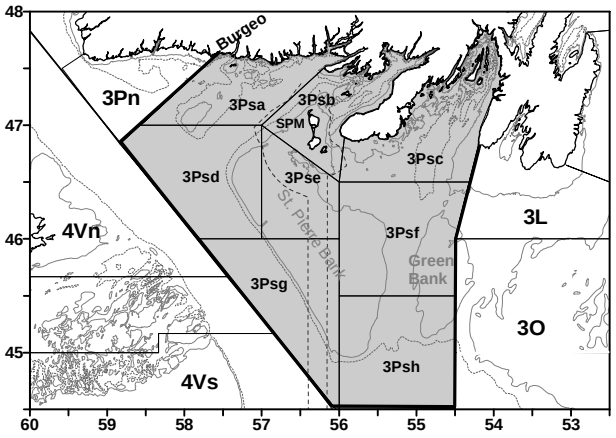


Fig. 1: 3Ps management area (shaded) unit areas (solid lines) and economic zone around the French islands of St. Pierre and Miquelon (SPM) (dashed line).

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 30% of the females are mature by age 5 (~48 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, 2007/08, and 2008/09 management years have been 13,000 t. Since 1994, France (St.Pierre et Miquelon) receives 15.6% of the total TAC. This stock is normally assessed on an annual basis.

The present assessment is the result of a request for science advice from the Fisheries and Aquaculture Management (FAM) Branch (NL Region). The main objectives were to evaluate the status of the stock and to provide scientific advice concerning conservation outcomes related to various fishery management options.

The current evaluation of the stock was conducted through a zonal assessment process where the status of 5 cod stocks in Atlantic Canada (2J3KL, 3Ps, 3Pn 4RS, 4TVn and 4X/5Y cod) was assessed. The meeting was held February 24 to March 6 2009 in St. John's (NL). Participants included DFO Scientists, fisheries managers, officials of provincial governments, fishing industry members, external experts and academia.

SUMMARY

- Information available to evaluate stock status consisted of commercial landings (1959 to 31 Dec 2008) and log-book data (1997-2008) in conjunction with information from Canadian research vessel (RV) trawl surveys (1972-2008), industry trawl surveys (1997-2005, 2007), and Sentinel surveys (1995-2008). Exploitation (harvest) rates were estimated from tagging experiments.
- Commercial catches by Canada and France combined for the ongoing 2008/09 management year totaled 9,300 t (to 31 Dec 2008), including 25 t from Sentinel surveys. Estimated landings from the recreational fishery in the summer of 2008 were 101 t. The total allowable catch (TAC) for 2008/09 is 13, 000 t.
- Commercial catches by Canada and France combined for the 2007/08 management year totaled 12,875 t, including 28 t from Sentinel surveys. In addition, two independent estimates of landings from the recreational fishery (summer 2007) ranged from 62 t to 217 t. The TAC for 2007/08 was 13, 000 t.
- The assessment concluded from tagging data and ancillary information that the complex of stock components exploited by fisheries in 3Ps does not comprise a single stock for which population biomass and abundance can be estimated from existing information. Therefore the impacts of fishing at specific TAC levels on all stock components could not be quantified.
- However, the DFO RV survey covers most of the stock, and survey trends broadly reflect stock trends.
- Indices from fixed-gear Sentinel surveys conducted shoreward of the DFO RV and industry trawl surveys have been stable in recent years.
- Inshore fish harvesters (<65' vessel sector) feel that the stability in their catch rates indicates there has been good recruitment and an overall stability in stock status.
- Exploitation rates for most inshore components in 2008 were approximately 10% which seems sustainable.
- The status of inshore components is uncertain, but indicators from the inshore are stable.
- Exploitation rates for offshore cod tagged in the Halibut Channel are not high but have increased in 2005-07.
- Total biomass from DFO RV surveys indicates a decline since 2004. The 2008 biomass estimate is less than 50% of the average for 1997-2008. The survey spawning stock biomass (SSB) is in decline and is near the lowest levels observed.
- Annual total mortality rates (age 5 -11) inferred from the DFO RV survey increased from an average of 23% in 1997-2004 to an average of 55% in 2005-07. This high value is a concern. Although the trend in natural mortality is unknown, fishing mortality has increased.
- Biological indicators of stock health, including growth rates and body condition, do not show any recent trend, but are lower compared to values in the 1980s

when the stock was considered more productive and supported fisheries in excess of 30,000 t.

- Recent year-classes supporting the fishery are relatively weak in comparison to the strong 1997 and 1998 cohorts. Although preliminary indications are that the 2006 cohort is strong, this cohort will not recruit to the fishery until 2011.
- The 1997 and 1998 cohorts have now largely passed through the fishery. The 2006 year-class appears strong, and fisheries in 2009 and 2010 should be managed in ways to protect this year-class from premature capture until it has reached a size where it fully contributes to the mature population.
- Offshore harvesters (>65' vessels) see evidence that the relative abundance of the older fish in the offshore component is less than in recent years, and also see evidence of the reasonably strong 2006 year-class. Catch rates in the offshore fishery remain high in traditional areas, but a reduction in the 2009 catch is warranted to risk manage the SSB decline until the 2006 year- class recruits to the fishery.
- The basis for a limit reference point for this stock is $B_{Recovery}$, defined as the lowest observed SSB from which there has been a sustained recovery. The 1994 value of SSB has been identified as the limit reference level for this stock.
- Survey SSB has been decreasing in recent years and in 2008 was just above the limit reference point. If management is to be consistent with the Precautionary Approach, catches should be reduced compared to recent levels, and greater priority should be given to increasing SSB.
- If the management goal is to stop the current decline in offshore biomass then a reduction in TAC to 10,000 t is considered the minimum necessary, notwithstanding the uncertainties about survivorship and absolute size of biomass. If the management objective is to ensure growth in offshore biomass, then a greater reduction is considered necessary.
- The fishery should be managed such that catches are not concentrated in ways that result in high exploitation rates on any stock components.

INTRODUCTION

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).

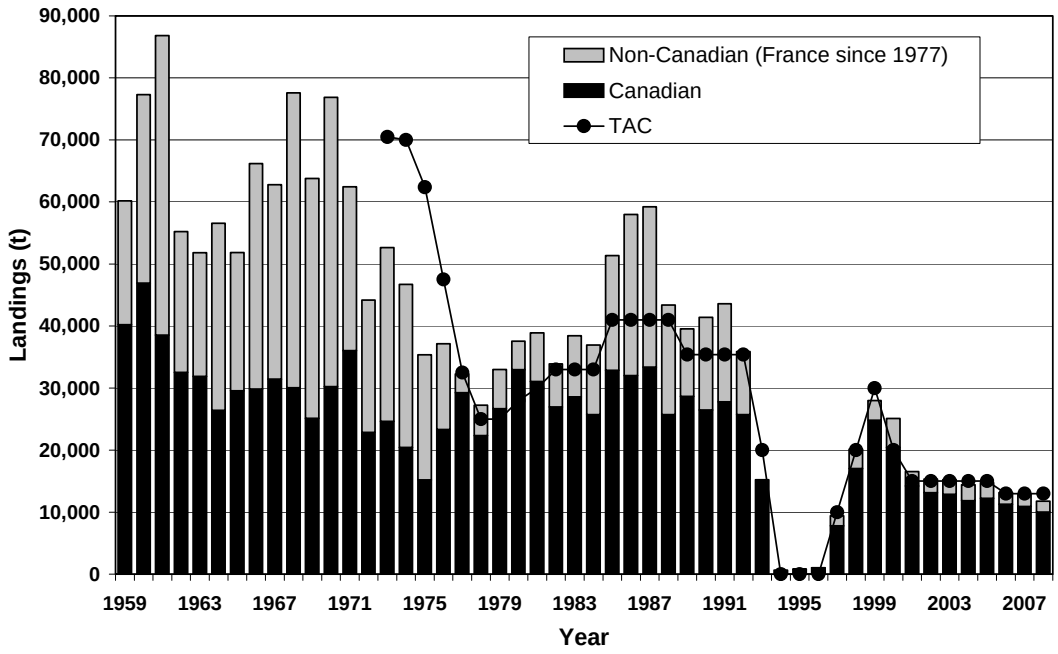


Fig. 2. Reported calendar year landings (t) of cod in 3Ps, 1959-2008. Note that TAC's are by management year (1 April-31 March) since 2000.

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 6,000 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 2006/07, 2007/08 and 2008/09 management years.

Landings

Table 1: Landings by management year in NAFO Subdivision 3Ps (nearest thousand metric tons).

Management Year	97	98	99	00 (J-M)	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08[1,4]	08-09[1,4]
TAC	10.0	20.0	30.0	6.0	20.0	15.0	15.0	15.0	15.0	15.0	13.0	13.0	13.0
Canada	7.4	16.6	20.4	3.5	20.3	13.2	12.5	12.6	12.1	11.7	11.3	10.8	8.4
France	1.6	3.1	3.2	4.7[2]	4.7	2.3	2.3	2.4	2.4	2.2	1.9	2.0	1.0
Totals	9.0	19.7	23.6	8.2	25.0	15.5	14.8	15.0	14.5	13.9	13.2	12.8	9.4[3]

[1] Provisional.

[2] 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.

[3] Approximate landings to December 2008.

[4] Does not include Canadian recreational fisheries.

In 2007/08, total reported landings were 12,875 t, mostly (77%) from the fixed gear sector (Fig. 3). The total includes French landings of 2,045 t, approximately 1,525 t of which was caught by otter trawlers and the remainder (520 t) by fixed gear, particularly gillnets. Sentinel surveys removed a total of 28 t. In addition, two independent estimates of landings from the recreational fishery (summer 2007) were 62 t and 217 t.

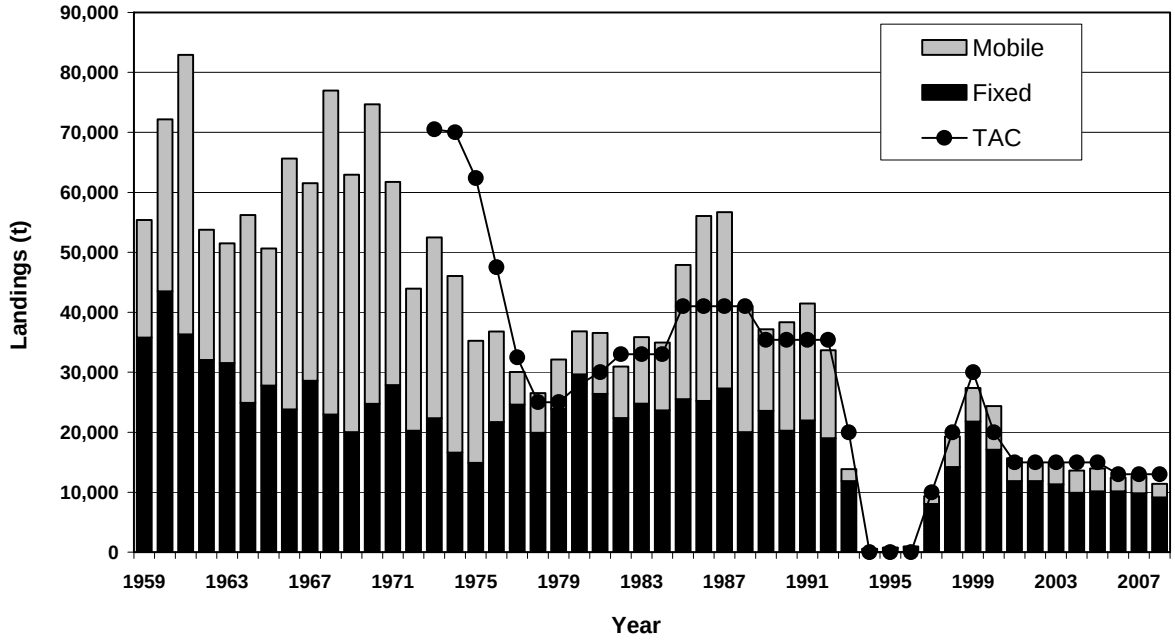


Fig. 3. Reported annual calendar year landings (t) by gear sector. Note that TAC's are by management year (1 April-31 March) since 2000.

Provisional data (as of Dec 31 2008) indicate total landings during the ongoing 2008/09 management year were approximately 9,400 t, 1,000 t of which was landed by France. The Sentinel surveys landed 25 t. In addition, estimated landings from the recreational fishery (summer 2008) were 101 t.

During the calendar year 2008, 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 2003-2008. Cod ages 4-7 were strongly represented in line trawl catches during 2008, whereas the proportion of older fish (ages 7+) was unusually low in otter trawl catches.

Species Biology

Stock structure and **migration patterns** of 3Ps cod are complex. 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.

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. Current values of length-at-age (from 2007 and 2008 surveys) are unusually low compared to previous observations.

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 although the values from 2008 are relatively low.

ASSESSMENT

Resource Status

Sources of information:

Stock status was updated using data from **commercial landings** to the end of 2008, and **abundance indices** from Canadian research vessel (RV) trawl surveys (1972-2008), industry trawl surveys (Groundfish Enterprise Allocation Council, GEAC), (1997-2005; 2007), and Sentinel surveys (1995-2008). Catch rate data from logbooks for the < 35 ft sector (1997-2008) and of larger vessels (>35' sector, 1998-2008) were also examined. Annual exploitation rates were estimated from tagging experiments conducted in different regions of 3Ps during 1997-2008.

Research vessel surveys:

Canadian DFO RV bottom **trawl surveys** have been conducted since 1972. Surveys from 1972-1982 have poor coverage. The surveyed area was increased by 12% during 1997 when inshore strata were added. The DFO RV survey was not completed in 2006 due to unforeseen operational difficulties with the vessels. Survey indices are presented for the expanded DFO survey area (inshore and offshore; denoted "Combined" in figures) as well as for the offshore strata ("Offshore" in figures). The DFO RV survey covers most of the stock, and survey trends broadly reflect stock trends.

The **biomass index** from the offshore strata is variable but declined from the mid-1980s to the lowest values observed during the early 1990s (Fig. 4). Values for the post-moratorium period up to 2004 were higher than those of the early 1990s, but not as high as those of the 1980s. The biomass index in 2008 was 21,750 t and has generally been declining from the level measured in 2001 (87,000 t). The biomass index from the combined index shows similar trends to the offshore only index.

Survey results for cod in 3Ps are at times subject to large inter-annual variations. For example, the high 1995 estimate was strongly influenced by a single large catch. Also, the 1997 survey was low and did not encounter aggregations of fish that were observed in surveys and commercial catches in subsequent years.

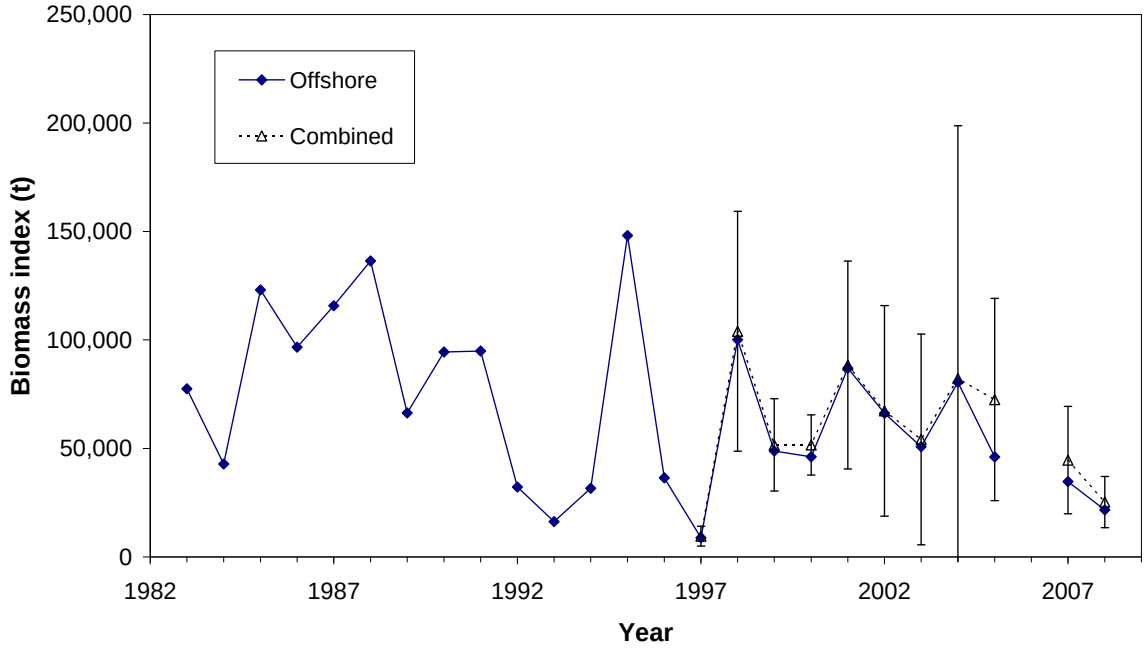


Fig. 4. Research vessel survey biomass indices (t)(error bars are 95% confidence intervals for combined survey index).

An index of **mature biomass** computed from the offshore survey (Fig. 5) indicates that current values are amongst the lowest in the time-series.

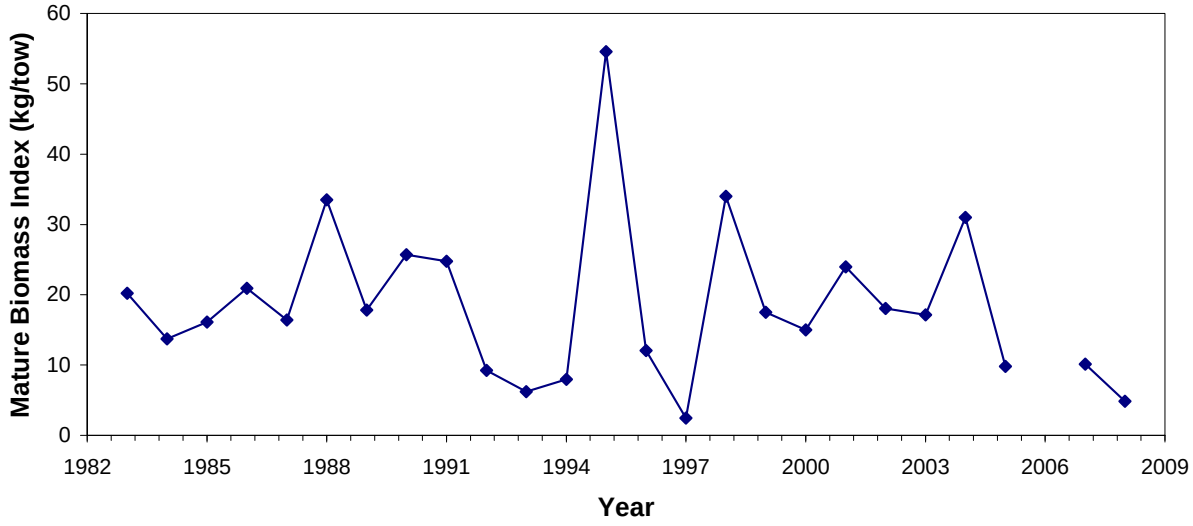


Fig. 5. Mature biomass index from DFO RV offshore survey.

The offshore DFO RV abundance index is variable, but shows a declining trend from the mid-1980s to the early 1990s (Fig. 6). There was a slight upward trend since the early 1990s, but has generally been declining since 2001. The combined DFO RV abundance index shows similar trends to the offshore index.

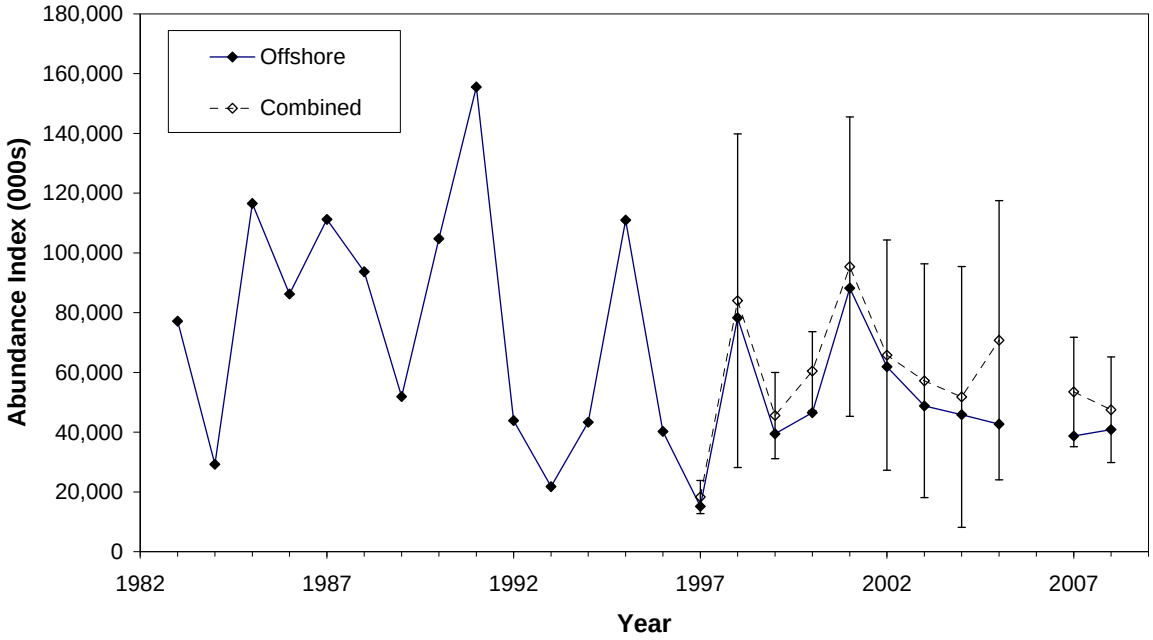


Fig. 6. Research vessel survey abundance indices (error bars are 95% confidence intervals for combined survey).

Age composition:
The 1997 and 1998 year-classes were strongly represented in the survey index for several years, but have not been strongly represented since the 2004 survey. The 1999-2005 year-classes (ages 3-9) also appear weaker in the most recent (2008) survey than the 1997 and 1998 year-classes did at these ages. The combined DFO RV survey caught relatively large numbers of 2 yr olds in 2008 and these were widely distributed across the surveyed area. However, the abundance of cod ages 5 and older in the 2008 survey is the third lowest in the time-series.

Mortality rates:
The annual **total mortality rates** (age 5 -11) inferred from the DFO RV combined survey increased from an average of 23% in 1997-2004 to an average of 55% in 2005-07. Total mortality rates reflect mortality due to all causes, including fishing.

Cohort Analysis:
A cohort analysis (Cook, 1997) of the DFO RV data indicated that spawning stock biomass (SSB) declined by more than 20% per year over 2004-08 (Fig. 7). The basis for a limit reference point (LRP) for this stock is $B_{Recovery}$, defined as the lowest observed SSB from which there has been a sustained recovery. The 1994 value of SSB has been identified as the LRP for this stock (DFO, 2004). The 2008 estimate of SSB was near the LRP, and there is a high probability (about 50%) that SSB in 2008 was less than the LRP.

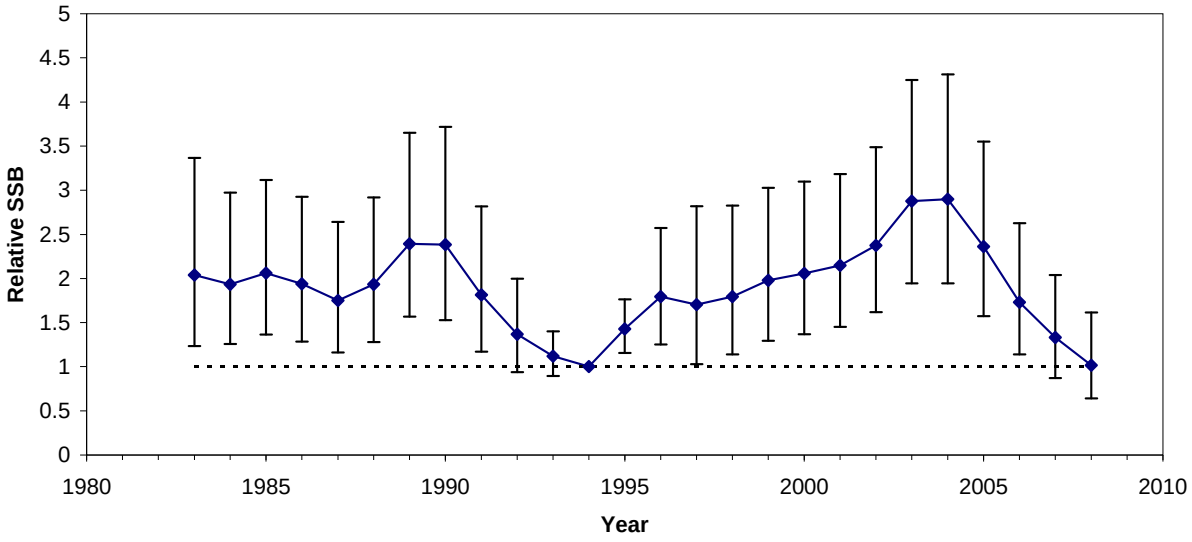


Fig. 7. Cohort analysis estimates of Survey Spawning Stock Biomass (SSB), scaled to the 1994 value (with 95% confidence intervals). A horizontal dashed line at one (reference level) is shown.

Industry (GEAC) trawl survey**:**

During fall 1997-2005, an industry trawl survey was conducted with an un-lined commercial trawl. In each of these years this survey showed 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 decline over 2001-05. 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. During the fall of 2007, a new survey was conducted using a lined shrimp trawl and altered tow protocol from previous surveys and hence results are not comparable with previous estimates. In the 2007 survey, the 2006 year-class (age 1) was detected across most of the surveyed area, consistent with the DFO RV survey.

Sentinel survey**:**

Fixed gear **Sentinel surveys** have been conducted at sites along the south coast of Newfoundland from St. Bride's to Burgeo from 1995 through 2008. 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 1995-97, but progressively lower in 1998 and 1999, and remained quite low from 2000 to 2008 (Fig. 8, upper panel). The index for line-trawls was high in 1995 with a steady decline to 1999, but has subsequently been fairly constant (Fig. 8, lower panel). Considerable declines have been measured by both gear types. Current gillnet estimates are about 12% of the 1995-97 average, whereas current line-trawl values are about 43% of the first two estimates.

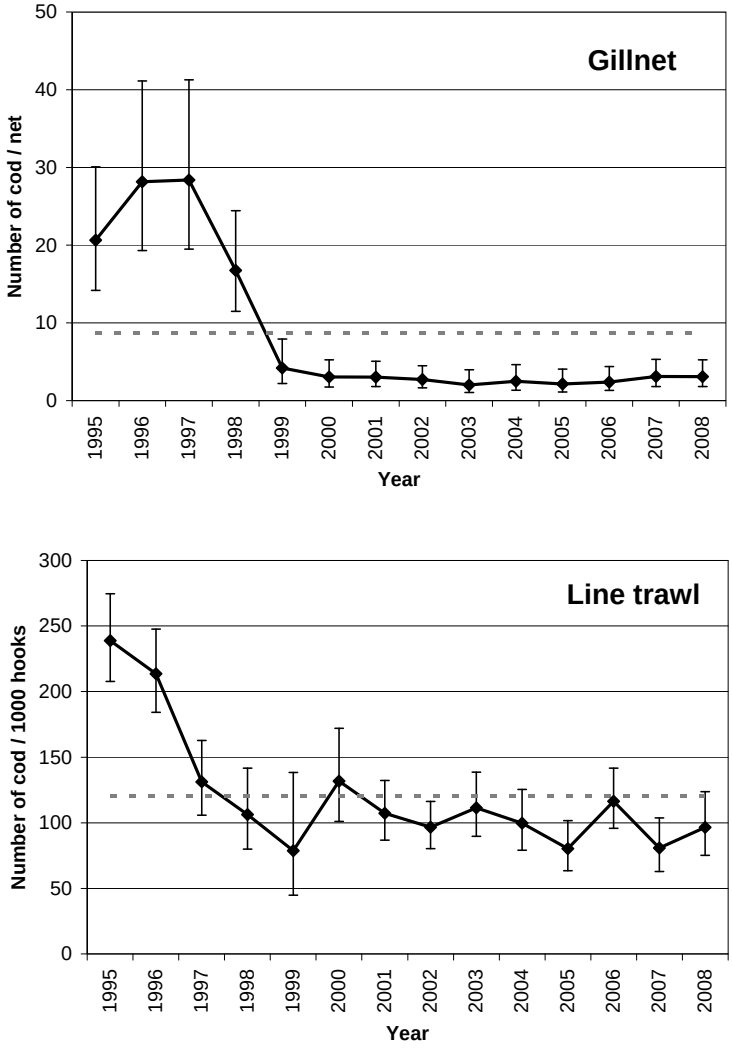


Fig. 8. Standardized sentinel catch rate indices for gillnets (upper panel) and line-trawls (lower panel). Error bars are 95% confidence intervals; dashed lines represent the time-series average.

Age composition:

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.

Log books:

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.

<35' Vessels:

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. 9, upper panel). A declining trend during 1997-99 was observed for line-trawls, followed by stable catch rates to 2002 and an increase in 2004-06 (Fig. 9, lower panel). The 2007 catch rate has declined from the 2006 level but remains relatively high. 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. This likely affects the quality, and comparability, of this index over time.

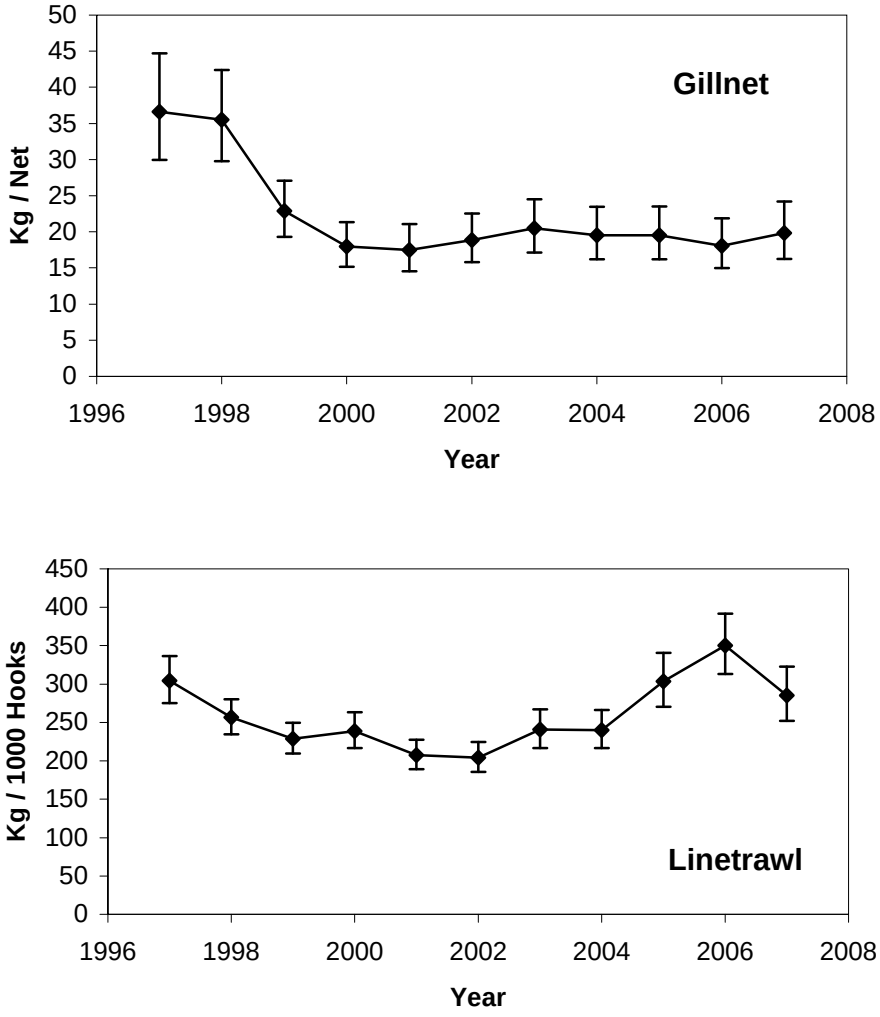


Fig. 9. Standardized catch rates for gillnets and line-trawls from science log books for vessels <35'. Error bars are 95% confidence intervals.

>35' Vessels:

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. Otter trawl catch rates have declined considerably over 2006-08. Gillnet catch rates were variable over the stock area, and in the recent period have been stable in Placentia Bay but generally decreased in the offshore.

Tagging:

Information from recaptures of cod tagged in 3Ps since 1997 was used to estimate average **annual exploitation (harvest) rates** in specific unit areas. During 1999-2005, the mean exploitation rate was relatively high for cod tagged in Placentia Bay (3Psc, 23-35%) compared to those tagged in Fortune Bay (3Psb, 9-17%), and Burgeo Bank/Hermitage Channel (3Psd, 1-9%).

There was insufficient information to estimate inshore exploitation rates in 2006 and 2007. During 2008, estimates of mean exploitation rate for cod tagged in Fortune Bay and Placentia Bay were approximately 10%. Tagging was conducted only in the western part of Placentia Bay in 2007, and exploitation rates for Placentia Bay may not be comparable to those from previous years when tagging was more widespread.

Exploitation rates for offshore cod tagged in the Halibut Channel are not high (2-9%) but have increased in 2005-07. There is uncertainty in the survival of fish caught and released after tagging offshore in deep (>200 m) water.

Recruitment:

A recruitment index was derived from catch rates of juvenile cod during the industry (GEAC) trawl survey and the DFO RV survey (Fig. 10). The standardized index indicated that most recent year-classes (2000-05) as well as those produced in the mid-1990's are weaker than year-classes produced during 1997 and 1998. The 2006 year-class was estimated to be one of the strongest over this time period; however, the 2006 estimate is based on only two observations (DFO RV catch at age 1 in 2007 and age 2 in 2008) and is considered preliminary. These fish will not recruit to the fishery until 2011.

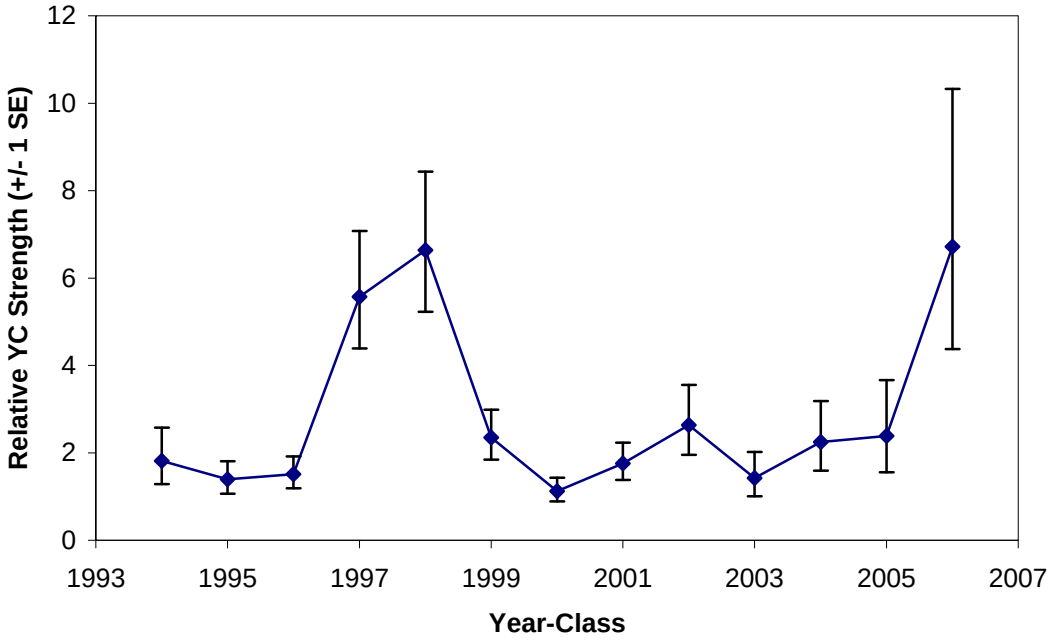


Fig. 10. Standardized year-class strength.

In the sentinel line-trawl data at ages 3 and 4, the 2004 year-class appears to be slightly better than recent year-classes and is about average. In the gillnet index, the 2002 year-class (at ages 3-5) is stronger than all other recent cohorts, but is of below average strength. All other year-classes produced during 2000-05 appear weaker. Note that the 2006 year-class is not yet within the selection range of these gears.

Sources of Uncertainty

There is 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 incursions of non-3Ps fish into the stock area at the time of the survey and the fishery.

Sentinel catch rates have remained stable at relatively low levels during the recent period while the DFO RV index has been declining. This may be indicative of differing trends within stock components.

Exploitation rates estimated from tagging in Halibut Channel have increased over 2005-07 while those in the inshore are variable. Thus it is uncertain if fishing mortality has increased on inshore components.

There is uncertainty in the survival of fish caught and released after tagging offshore in deep (>200 m) water. Lack of tagging in the inshore during 2004-06 makes estimation of exploitation rates in 2005-07 more uncertain as the catchability and numbers available to be recaptured diminish.

Tagging was conducted only in the western part of Placentia Bay in 2007, and exploitation rates for Placentia Bay may not be comparable to those from previous years when tagging was more widespread.

Trends in the level of natural mortality are difficult to measure and are uncertain.

ADDITIONAL STAKEHOLDER PERSPECTIVES

From an historical perspective, inshore harvesters attending the assessment meeting (<65' vessel sector) felt that current catch rates are average to high. Since 2000, catch rates for both gear types (longlines and gillnets) have been stable. The stability in catch rates indicates there has been good recruitment and an overall stability in stock status.

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 205 (22% of the 917 licence holders) participated in the survey. Harvesters said that catch rates and abundance were the same or better than in 2007. Harvesters said cod were about the same size as the previous year, were distributed throughout the area and were in good condition. When asked about baitfish species, harvesters said capelin and squid abundance was at a low level and decreasing, while herring abundance was good and increasing. There was no clear consensus on mackerel abundance.

Fishing by larger vessels (>65' vessel sector) occurs over a four month period from January to closing February 28 and from November to December. Catch rates during the later period were similar to previous years but lower during the winter months. Difficult weather conditions may have been a contributing factor as well as more fixed gear in the area competing with mobile gear for limited fishing grounds. There were fewer mobile gear vessels fishing during fall 2007 and winter 2008 because of operational issues ashore. Quota normally caught by these vessels was transferred to vessels less than 65 ft and to larger fixed gear vessels. Captains reported seeing herring sized cod escaping the cod ends during December 2008. The fishery tends to concentrate on the Bank during the fall months and in deeper water during the winter as the Bank cools off. The size and mix of fish changed dramatically as the fish moved into deeper water with large fish greater than 90 cm dominating the catch. Captains reported seeing very old fish in the catch many with bite marks and missing fins.

Offshore harvesters (>65' vessels) see evidence that the relative abundance of the older fish in the offshore component of the stock is less than in recent years, but there is also evidence of the reasonably strong 2006 year-class that is expected to recruit to the fishery beginning in 2011. Catch rates in the offshore fishery remain high in traditional areas of the fishery. A reduction in the 2009 catch is warranted as a bridging strategy to risk manage the SSB decline until the 2006 year class recruits to the fishery. The level of this reduction should be based on an objective of halting or curtailing the SSB decline during the 2009-11 period rather than being linked to achieving a rebuilding trajectory that is not likely to be achievable until 2011, regardless of the TAC level.

CONCLUSIONS AND ADVICE

The assessment concluded from tagging data and ancillary information that the complex of stock components exploited by fisheries in 3Ps does not comprise a single stock for which population biomass and abundance can be estimated from existing information. Therefore the impacts of fishing at specific TAC levels on all stock components could not be quantified. However, the DFO RV survey covers most of the stock, and survey trends broadly reflect stock trends. Any aggregations in April within the near-shore would not be measured by the DFO RV survey. The majority of the area shore-ward of the DFO RV survey lies within inner and western Placentia Bay. There is no evidence that a large fraction of the stock is shore-ward of the DFO RV survey in April.

A limit reference point (LRP, $B_{Recovery}$) was identified for this stock during the 2004 assessment (DFO, 2004). It is defined as the lowest observed spawning stock biomass (SSB) from which there has been a sustained recovery; the 1994 value of SSB has been identified as the LRP.

Survey SSB has been decreasing in recent years and in 2008 was just above the LRP. If management is to be consistent with the Precautionary Approach, catches should be reduced compared to recent levels, and greater priority should be given to increasing SSB.

Cohort analysis of the DFO RV survey data indicated that SSB declined by more than 20% per year over 2004-08. Recruitment will remain low in 2009-10 so this decline will likely continue through to 2010 with status quo landings. This also suggests that a TAC reduction of at least 20% is necessary to halt this decline. Hence, if the management goal is to stop the current decline in offshore biomass then a reduction in TAC to 10,000 t is considered the minimum necessary, notwithstanding the uncertainties about survivorship and absolute size of biomass. If the management objective is to ensure growth in offshore biomass, then a greater reduction is considered necessary.

Recent year-classes supporting the fishery are relatively weak in comparison to the strong 1997 and 1998 cohorts. Although preliminary indications are that the 2006 cohort is strong, this cohort will not recruit to the fishery until 2011. Furthermore, these fish will also begin maturing at about this time. If this year-class is as strong as presently indicated, and if total mortality is relatively low, it would be possible to quickly increase the spawning biomass. It would be prudent to consider management measures which would protect this year-class from all sources of fishing mortality (e.g. discarding, high-grading and landings) until it matures, thereby increasing the chance of the stock increasing well above the limit reference point.

Annual total mortality rates (age 5 -11) inferred from the DFO RV survey increased from an average of 23% in 1997-2004 to an average of 55% in 2005-07. This high value is a concern.

Although the trend in natural mortality is unknown, fishing mortality has increased as inferred by the reduction of stock size during a period of constant landings.

The status of inshore components is uncertain. However, both sentinel linetrawl and sentinel gillnet indices are stable.

Overall, the findings of the current assessment are consistent with those of previous assessments. Several consecutive year-classes (1999-2005) have been relatively weak and are now (during 2007 and 2008) supporting the majority of total landings. This has lead to increased exploitation rates in the offshore, and contributed to an overall reduction in stock size.

Management Considerations

The implementation of trip limits, price differentials based on size, and individual quotas (IQ's), are all potential incentives for discarding and high-grading of catches. Recent investigations into this problem have identified that high-grading is occurring, but the quantity has not been determined. Quantifying discards could improve the understanding of stock productivity. This is an unaccounted source of fishing mortality.

If the 2006 year-class recruits strongly to the fishery, it would be prudent to consider management measures which would protect this year-class from all sources of fishing mortality (e.g. discarding, high-grading and landings) until it matures, thereby increasing the chance of the stock increasing well above the limit reference point.

Management should recognize that cod which overwinter in 3Ps are also exploited in adjacent stock areas (Division 3L and Subdivision 3Pn). Hence management actions in these stock areas should consider potential impacts on 3Ps cod.

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.

The fishery should be managed such that catches are not concentrated in ways that result in high exploitation rates on any stock components.

OTHER CONSIDERATIONS

Temperature

Oceanographic information collected during the spring 2008 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 $<0^{o}$C water increased to near 30%. The areal extent of bottom water with temperatures $>3^{o}$C has remained relatively constant at about 50% of the total 3P area, although actual temperature measurements show considerable inter-annual variability.

Spring bottom temperatures were below normal in 2008. Also, the area of bottom habitat covered by <0^{o}C water was above normal in 2007 and 2008. These conditions are less favourable than those of the late 1970's and early 1980's when the stock was more productive.

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