



STOCK ASSESSMENT OF SUBDIVISION 3Ps COD, OCTOBER 2009

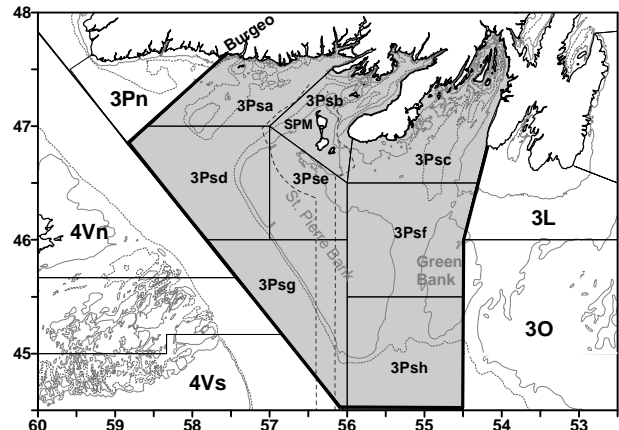
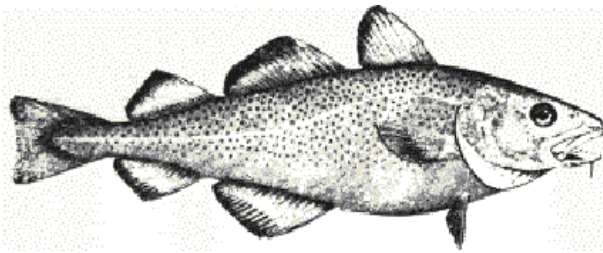


Fig. 1: 3Ps management area (shaded) unit areas (solid lines) and economic zone around the French islands of St. Pierre and Miquelon (SPM) (dashed line).

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 generally maturing at younger ages in recent years. For example, at least 30% of the females are mature by age 5 (~47 cm) in recent cohorts, compared to only about 10% at age 5 (~55 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. Beginning in 2000, the management year was changed to begin on 1 April. The TAC for each of the 2006/07 to 2008/09 management years was 13,000 t, and the TAC for the 2009/10 management year was reduced to 11,500 t. Under the terms of a 1994 Canada-France agreement, the French (St. Pierre et Miquelon) share of the TAC is 15.6%.

This stock is normally assessed on an annual basis during autumn. The 2008 assessment was postponed until spring 2009 to coincide with a Zonal assessment process during which five Atlantic cod stocks were assessed. The present assessment is a return to the typical timing of recent 3Ps cod assessments, and provides advice to Fisheries and Aquaculture Management with sufficient lead time to arrive at management decisions for the 2010/11 season. Due to the shorter than usual interval between

assessments, only a limited amount of new information was available to re-evaluate stock status. Since the February/March 2009 zonal assessment, additional commercial logbook data for the <35' fleet were received and DFO conducted a research vessel survey of Subdivision 3Ps during April 2009. The information from the sentinel survey, tagging programs and logbooks for the >35' fleet was practically unchanged from that available to the zonal assessment.

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.

Participants included DFO scientists, a scientist from IFREMER (France), fisheries managers, government officials from France and also the province of Newfoundland and Labrador, fishing industry representatives (French and Canadian) and academia.

SUMMARY

- Information available to evaluate stock status consisted of commercial landings (1959 to 25 Sept 2009) and log-book data (1997-2008) in conjunction with information from Canadian research vessel (RV) trawl surveys (1972-2009), industry trawl surveys (1997-2005, 2007), sentinel surveys (1995-2009), and telephone surveys of inshore fish harvesters from Canada and France (St. Pierre et Miquelon). Exploitation (harvest) rates were estimated from tagging experiments.
- Catch and commercial logbook data for the entire 2009/10 management year were not available to the current assessment as the 2009/10 fishery is ongoing. Tag return and sentinel survey data are also incomplete for 2009 and will be considered during the next assessment.
- The total allowable catch (TAC) for the 2009/10 management year is 11, 500 t.
- It was concluded from tagging data and ancillary information that there is a complex of stock components in 3Ps. 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.
- Exploitation rates for most inshore components in 2008 were approximately 10% which seems sustainable. The status of inshore components is uncertain, however catch rates from sentinel surveys and logbooks for vessels <35' suggest stability.
- Indices of total biomass and spawning stock biomass (SSB) from DFO RV surveys declined over 2004–08, but increased in 2009 and are near the 1998-2009 average.
- The 2006 cohort is estimated to be relatively strong, and is beginning to recruit to the fishery. Year-classes currently supporting the fishery are relatively weak in comparison to the strong 1997 and 1998 cohorts.
- Based upon the 2008/09 fishing season, the perspective of the fishing industry is that cod are abundant and there appears to be a good mixture of year-classes; fishers also see evidence of the reasonably strong 2006 year-class.

- Estimates of total mortality (ages 4-11) from a cohort model over 2004-08 were approximately 0.55 (42% mortality). This high level of mortality is a concern. Total mortality rates reflect mortality due to all causes, including fishing.
- 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.
- Estimated survey SSB from a cohort model decreased in recent years and in 2009 was above the limit reference point (LRP). However, the probability that the SSB in 2009 was below the LRP varies from 20% to 40% depending on catchability assumptions.

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).

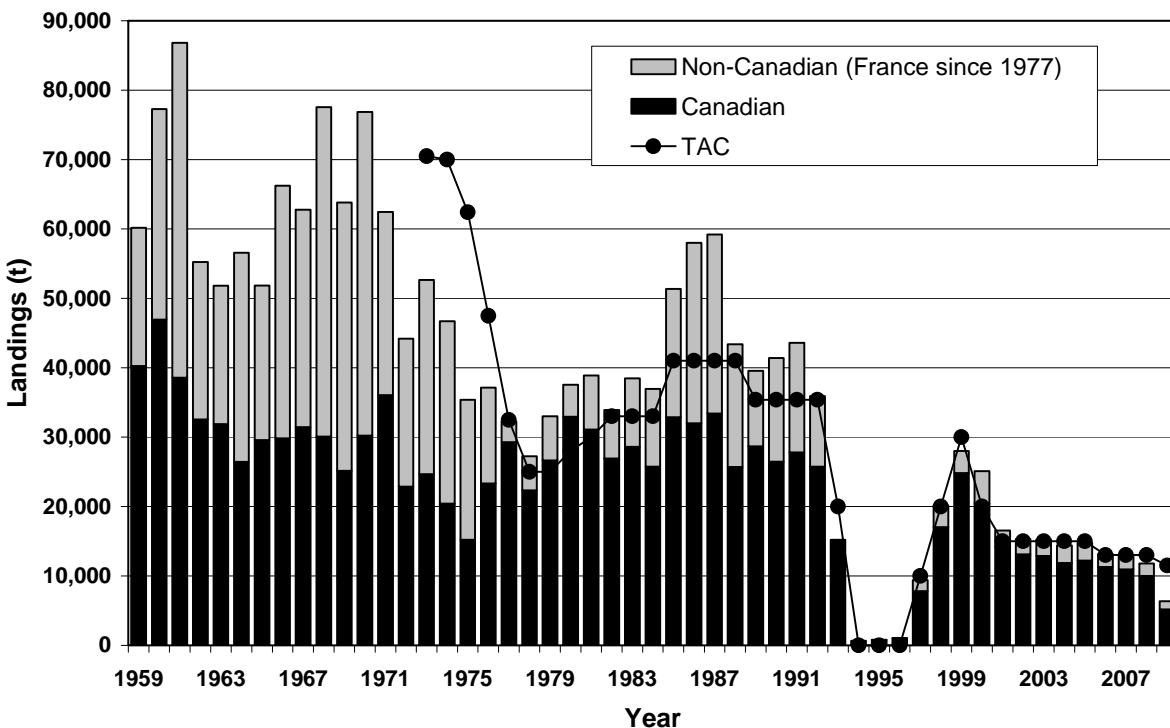


Fig. 2. Reported calendar year landings (t) of cod in 3Ps, 1959-2009 (2009/10 fishing season ongoing). Note that since 2000 TAC's are by management year (1 April-31 March).

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.

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. Subsequent TACs are shown in Table 1. The TAC for the 2009/10 management year was set at 11,500 t.

Landings

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

Management Year	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08 ¹	08-09 ¹	09-10 ^{1,2}
TAC ³	20.0	15.0	15.0	15.0	15.0	15.0	13.0	13.0	13.0	11.5
Canada	20.3	13.2	12.5	12.6	12.1	11.7	11.3	10.8 ⁴	10.6 ⁴	2.9 ⁴
France	4.7	2.3	2.3	2.4	2.4	2.2	1.9	2.0	2.0	0.2
Totals	25.0	15.5	14.8	15.0	14.5	13.9	13.2	12.8	12.6	3.1

¹ Provisional.

² Approximate landings to September 2009.

³ France (St. Pierre and Miquelon) has a 15.6% share of the TAC.

⁴ Does not include Canadian recreational fisheries.

In the 2008/09 management year, total reported landings were 12,600 t, mostly (77%) from the fixed gear sector. The total includes French landings of 1,998 t, approximately 75% of which was caught by otter trawlers. Sentinel surveys removed a total of 28 t. Estimated landings from the recreational fishery in the summer of 2008 were 101 t.

Provisional data (as of Sept 25 2009) indicate total landings during the ongoing 2009/10 management year were approximately 3,100 t, 170 t of which was landed by France. The French landings for 2009 are low due to processing sector problems. Sentinel surveys have landed 11 t to date. No estimates were available from the Canadian recreational fishery in 2009 as the season was ongoing.

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 2003-08. 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 and have a genetic component but may partly be a response to high levels of mortality. The most recent estimates of maturity indicate a decrease in the proportion of female cod maturing at younger ages. 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 the Halibut Channel. Timing of spawning is variable and extremely protracted, with spawning fish present from March until August in Placentia Bay.

During the current assessment, a review of spawning time found no indication of any shift in the timing of spawning.

Growth, calculated from length-at-age in research trawl survey samples, has varied over time. From the mid-1980s to early-2000s, length-at-age tended to increase at young ages (2-3), and varied with no consistent trend at older ages. Recent (2007-09) values of length-at-age are below the time-series average, possibly indicating a reduction in growth rates.

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, the overall condition of cod in the surveys post-1992 shows no consistent trend although the values from 2009 are below average. Examination of the data across select size ranges indicated that the condition for cod from 36 to 62 cm over 2007-09 was very low relative to previous observations.

ASSESSMENT

Resource Status

Sources of information:

Stock status was updated from the winter 2009 assessment (DFO, 2009) using data from **commercial landings** to September 2009, log-book data (1997-2008), **abundance indices** from Canadian research vessel (RV) trawl surveys (1972-2009), industry trawl surveys (1997-2005, 2007), and sentinel surveys (1995-2009). Results of telephone surveys of inshore fish harvesters from Canada and France (St. Pierre and Miquelon) and exploitation (harvest) rates estimated from tagging experiments were also available.

Research vessel surveys:

Canadian DFO RV bottom **trawl surveys** have been conducted since 1972. Surveys from 1972-1982 had 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.

Survey indices of cod in 3Ps are at times influenced by “year-effects”, an atypical survey result that can be caused by a number of factors (e.g., environmental conditions, movement, degree of aggregation, etc.) which may be unrelated to absolute stock size. 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. In the 2009 DFO RV survey the estimated abundance at ages 2-8 increased compared to these cohorts at ages 1-7 as measured in the 2008 survey. This is unusual and indicates that one (or possibly both) of the 2008 and 2009 surveys may be influenced by a year-effect.

The **biomass index** from the offshore strata is variable but declined from the mid-1980s to the early 1990s (Fig. 3). Values for most of 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 survey index shows a general declining trend from 87,000 t in 2001 to 20,525 t in 2008. The biomass index in 2009 was 56,025 t and was dominated by catches on Burgeo Bank and in the southern part of the Halibut Channel (3Psh). Survey biomass from the combined index shows similar trends to the offshore only index.

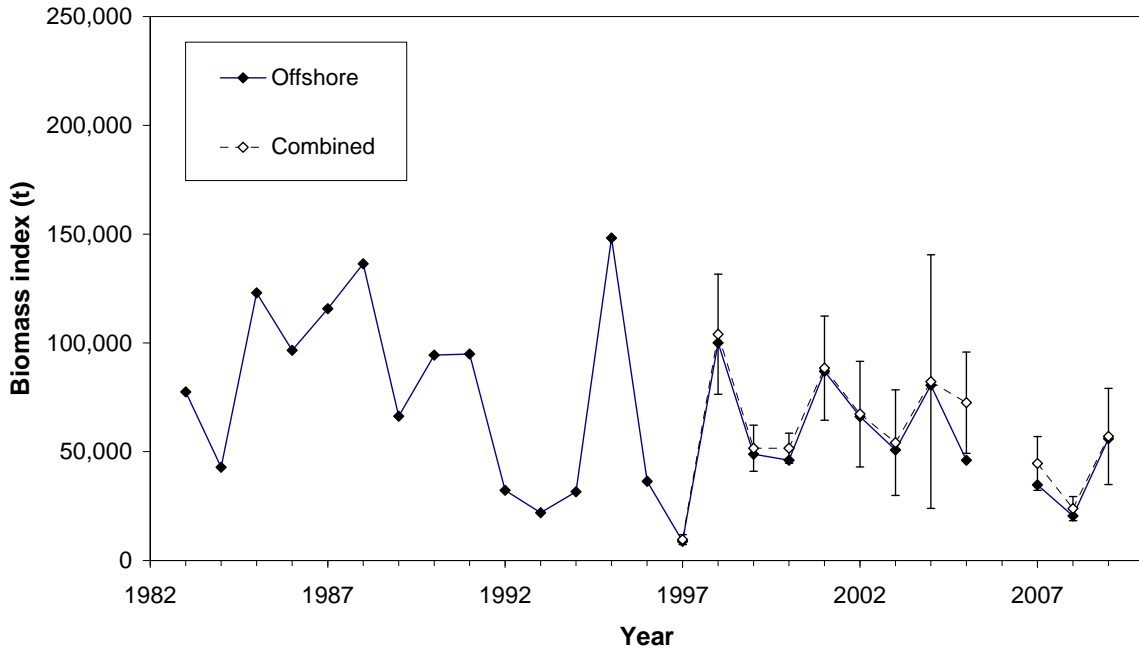


Fig. 3. Research vessel survey biomass indices (t)(error bars are 95% confidence intervals for combined survey index).

An index of **mature (adult) biomass** was computed from the offshore survey (Fig. 4) and current values are slightly below the time-series average.

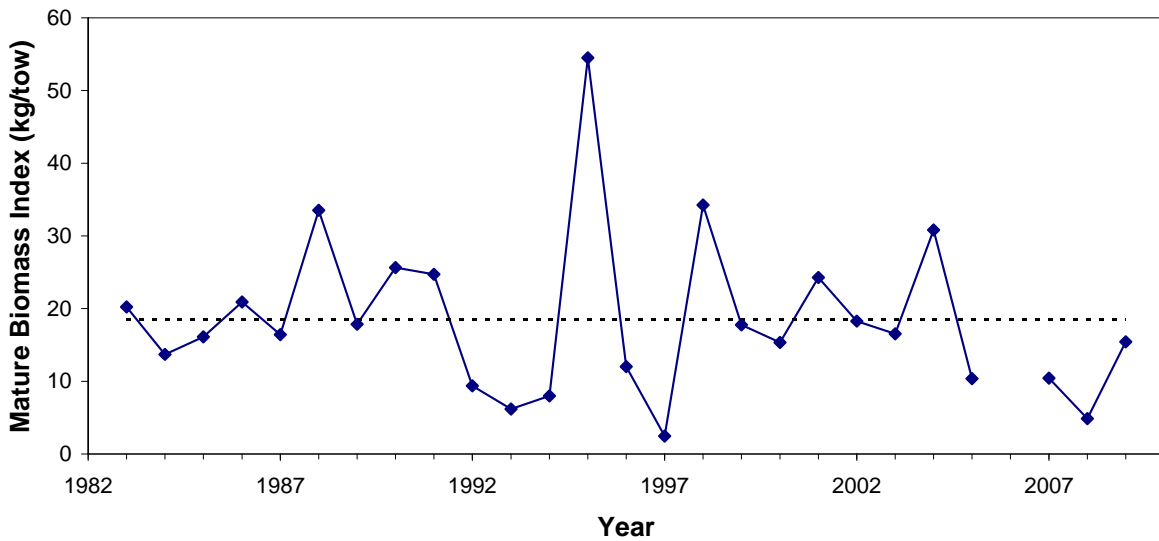


Fig. 4. Mature biomass index from DFO RV offshore survey. Dashed line is the time-series average.

The offshore DFO RV abundance index is variable, but values during the 1990s were generally lower than those from the 1980s (Fig. 5). The index generally declined from 88.25 million fish in 2001 to 38.65 million in 2008. The 2009 index increased to 69.46 million fish. The combined DFO RV abundance index shows similar trends to the offshore index.

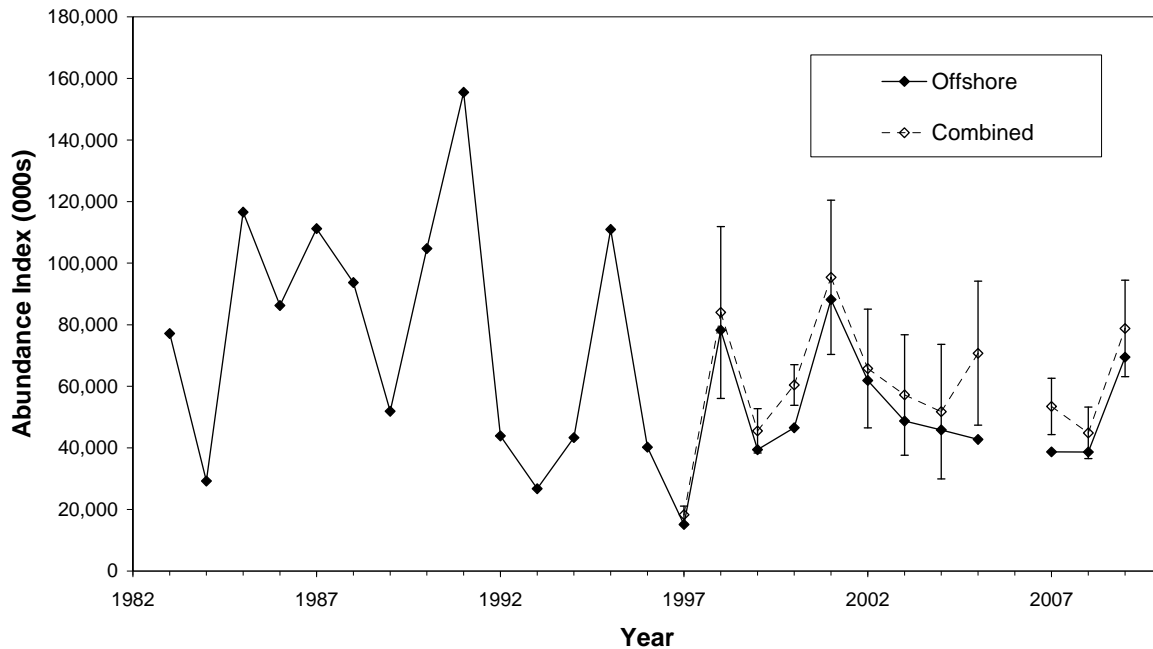


Fig. 5. Research vessel survey abundance indices (error bars are 95% confidence intervals for combined survey).

Age composition:

Catches during the 2009 RV survey consisted mainly of cod aged 3-5. The 2006 year-class (age 3 in 2009) has now been detected as above average at each of ages 1-3 in the last three surveys. A relatively large number of age 1 fish were captured in the 2009 survey; however, the majority of these from a single tow in Fortune Bay. The 1997 and 1998 year-classes were strongly represented in the survey index for several years, but have not been strongly represented in most recent surveys.

Cohort Analysis:

Spawning Biomass:

Cohort analyses (Cook, 1997) of the DFO RV data indicated that spawning stock biomass (SSB) declined by 13% per year over 2004-09 (Fig. 6). In one of these formulations (Model 1), older ages were assumed to be fully selected by the survey; in the other (Model 2) it was assumed that older ages were not fully selected by the survey. 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).

Estimated survey SSB from a cohort model decreased in recent years and in 2009 was above the limit reference point (LRP). However, the probability that the SSB in 2009 was below the LRP varied from 20% to 40% depending upon the assumptions regarding the catchability of different age fish by the survey.

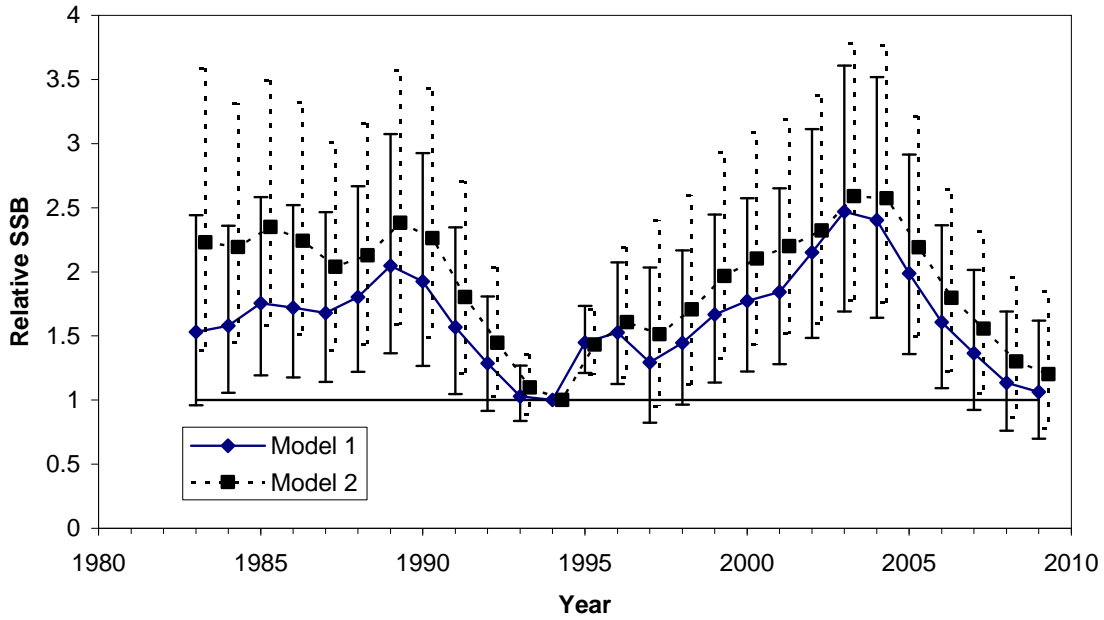


Fig. 6. Cohort analysis estimates of Survey Spawning Stock Biomass (SSB), relative to the 1994 value (with 95% confidence intervals). Model 1 and Model 2 illustrate results for two model assumptions regarding survey catchability. A horizontal dashed line at one (reference level) represents the SSB Limit Reference Point.

Mortality rates:

Estimates of total mortality from the cohort model (Fig. 7) over 2004-2008 (ages 4-11) were approximately 0.55 (42% mortality). This value represents the average of the mortality across the two model results evaluated. This high level of mortality is a concern. Total mortality rates reflect mortality due to all causes, including fishing.

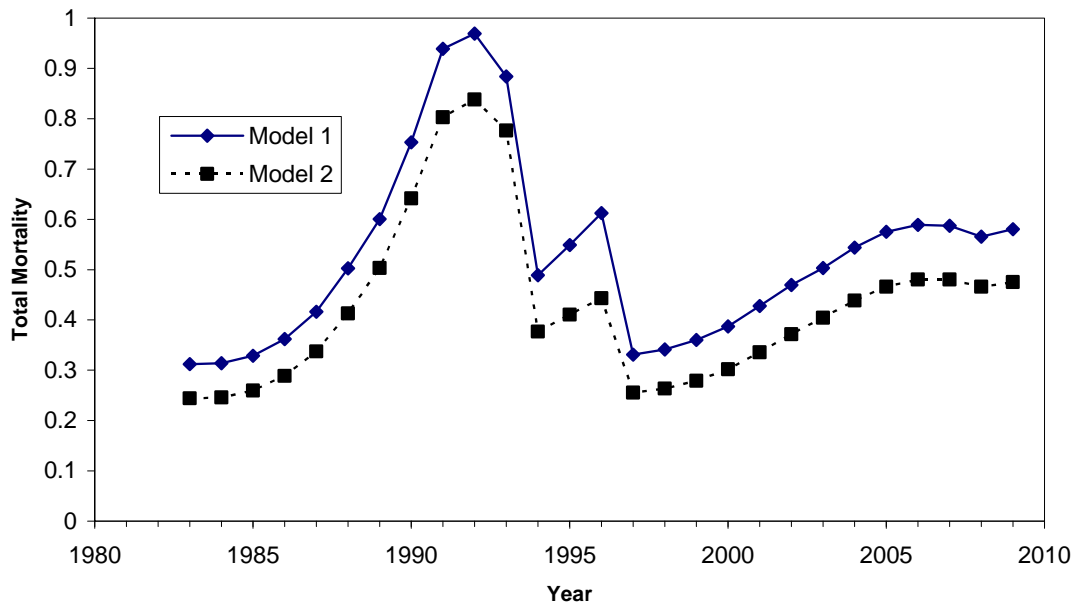


Fig. 7. Cohort analysis estimates of total mortality. Model 1 and Model 2 illustrate results for two model assumptions regarding survey catchability.

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 2009. 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 for 2009 is still ongoing; hence, the data for 2009 were not included in the modeling reported below.

The sentinel survey data were standardized during the previous assessment 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.

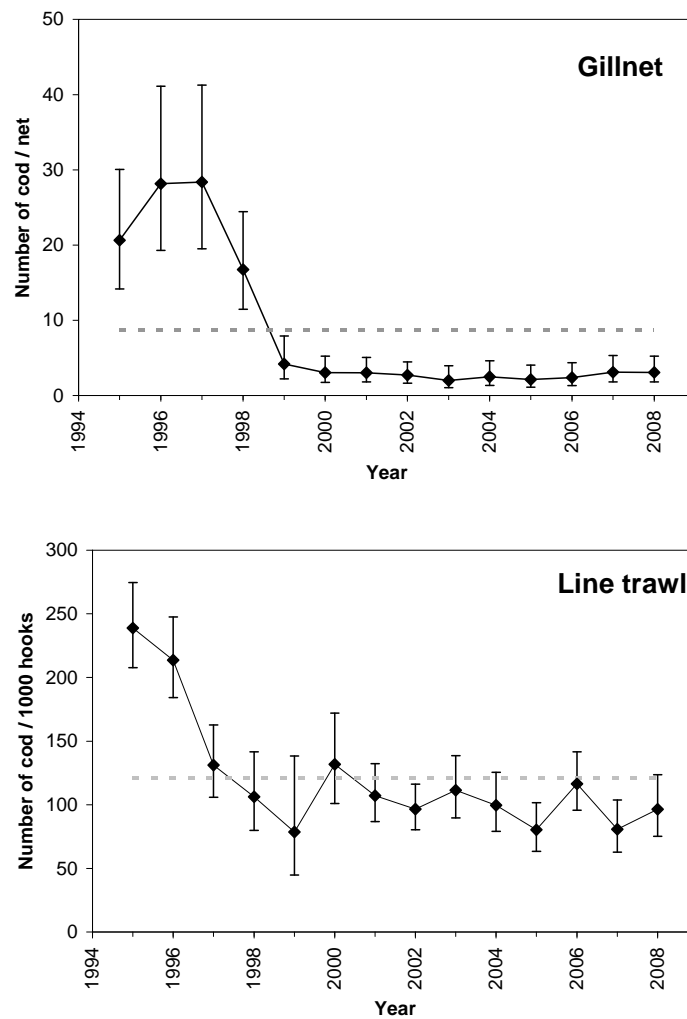


Fig. 8. Standardized sentinel catch rate indices for gillnets (upper panel) and line-trawls (lower panel). Error bars are 95% confidence intervals; dashed lines represent the time-series average.

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 2008 catch rate is similar to the 2007 level and 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 approximately 70% at the start of the time series in 1997. This likely affects the quality, and comparability, of this index over time.

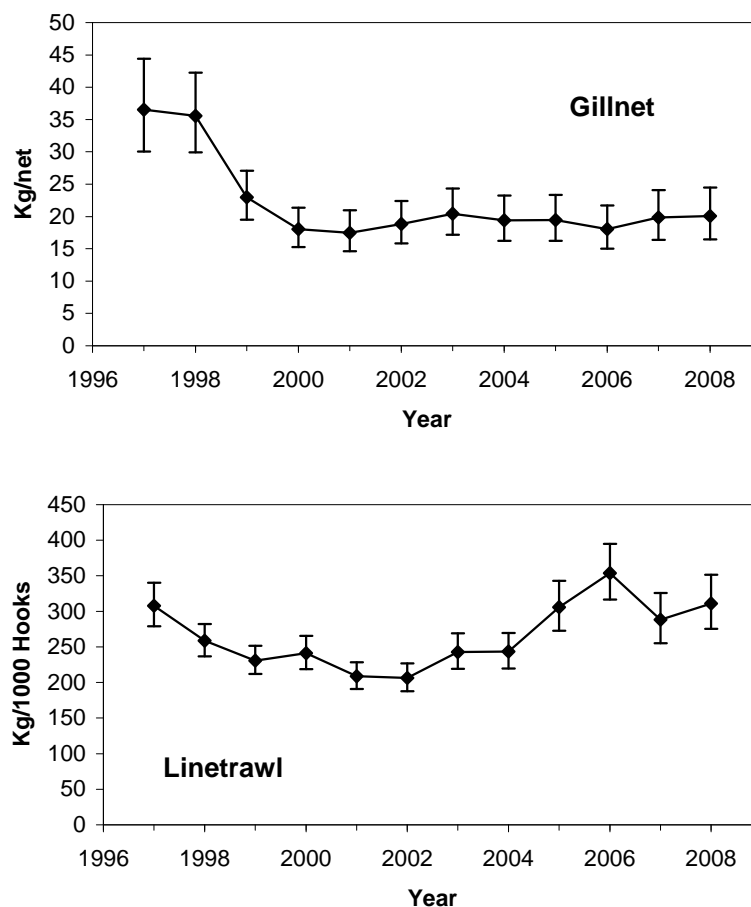


Fig. 9. Standardized catch rates for gillnets and line-trawls from science log books for vessels <35'. Error bars are 95% confidence intervals.

>35' Vessels:

Median annual catch rates by gear sector and unit area from log books of larger vessels (>35' sector) were not examined in the current assessment as no new data are yet available. The log books for the >35' fleet will be re-examined in future assessments as new data becomes available.

Median annual catch rates by gear sector and unit area from log books of larger vessels (>35' sector) were examined during the previous assessment. 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:

Few cod tags have been returned since the previous assessment as the fishing season is continuing. The most recent analysis of the tagging data is provided below.

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 DFO RV survey and the industry (GEAC) trawl survey (Fig. 10). The standardized index indicated that most recent year-classes (2000-05, 2007) 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, comparable to the 1997 and 1998 year-classes. Harvesters indicated that these fish are likely being captured at age 3 in the current fishery.

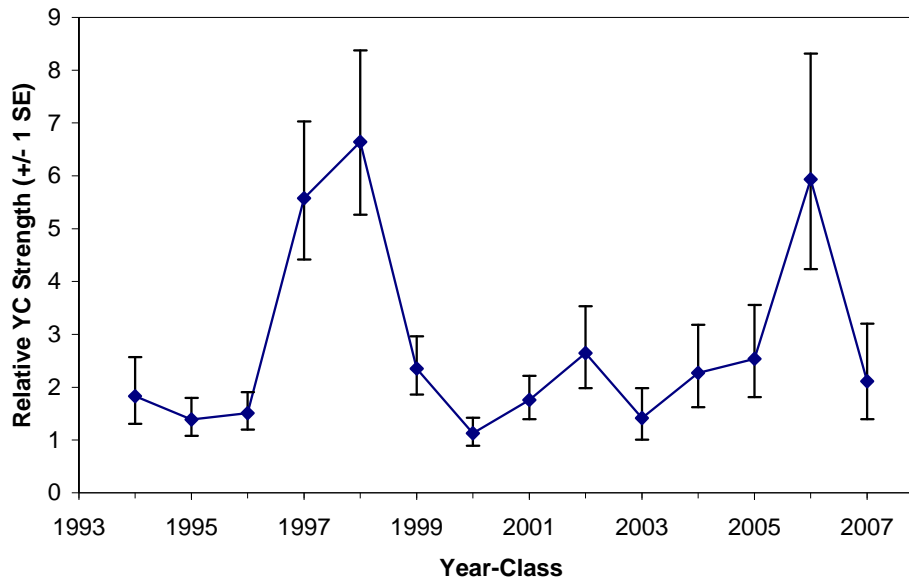


Fig. 10. Standardized year-class strength.

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 over time. This may contribute to unusual year-to-year variability in survey indices.

Comparison of sentinel catch rates and the DFO RV index show inconsistent trends during the recent period. This may be indicative of differences between stock 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 numbers available to be recaptured diminish. Further, the tagged fish begin to grow beyond the main selection range of various commercial gears.

Tagging was conducted only in the western part of Placentia Bay in 2007, and exploitation rates from these experiments 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.

Survey indices of cod in 3Ps are at times influenced by “year-effects”, an atypical survey result that can be caused by a number of factors (e.g., environmental conditions, movement, degree of aggregation, etc.) which may be unrelated to absolute stock size. In the 2009 DFO RV survey the estimated abundance at ages 2-8 *increased* compared to these cohorts at ages 1-7 as measured in the 2008 survey. This is unusual and indicates that one (or possibly both) of the 2008 and 2009 surveys may be influenced by a year-effect. Year-effects are also evident in the 1995 and 1997 survey results.

ADDITIONAL STAKEHOLDER PERSPECTIVES

Due to poor market conditions at the time of this assessment, fishing effort has been low, and as a result only 32% of the quota has been taken. Fish harvesters feel that the entire quota may still be taken before the end of the fishing season, but if this is not it will be entirely due to the lack of effort to date and not a lack of cod.

Fish harvesters in the <65 foot vessel sector noted that early in the 2009 fishing season, the abundance of sand lance was very high and herring were fairly abundant in some areas. At that time cod were abundant and there appeared to be a very good mixture of year classes of cod (from very small to very large). They also noted that there has been a noticeable increase in the number of (approximately) 14 to 15 inch cod being caught on hooks (likely the 2006 year class). Fish harvesters are concerned about the scarcity of prey, especially capelin and the negative impact that can have on cod migration to inshore areas.

For the first time, this year, the Fishing Resource Committee from Saint Pierre and Miquelon provided a perspective on the 2008 French inshore fishery by conducting a questionnaire of fish harvesters. A total of 9 harvesters (from a total of 13 license holders) participated on this survey. On average, harvesters said that catch-rates and abundance were the same as in 2007. Harvesters said cod were smaller, showed an average distribution and were in good condition. The results of this survey are similar to the results of a telephone survey conducted by the FFAW on the 2008 commercial fishery and presented during the spring 2009 assessment.

Fish harvesters in the >65 foot vessel sector, during the 2008-09 fishing season saw an increase in the abundance of older (larger) fish in the offshore catch, up from the previous winter season. They also saw evidence of the reasonably strong 2006 year-class. Catch rates in the offshore fishery remain high in traditional areas of the fishery. Fixed-gear harvesters in this sector noted fish were healthy looking and were feeding on small redfish, sandlance and capelin. Also, larger fish were found at depths of <220 fathoms, and greater amounts of smaller fish were found in deeper water. Harvesters in this sector feel that the current TAC is a bridging strategy to risk-manage the SSB until the 2006 year class recruits to the fishery. The current TAC is considered appropriate based on the objective of curtailing further decline in the SSB during the 2009-11 period.

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.

Estimated survey SSB from a cohort model decreased in recent years and in 2009 was above the limit reference point (LRP). However, the probability that the SSB in 2009 was below the LRP varied from 20% to 40% depending on assumptions regarding the catchability of different age fish by the survey.

Cohort analysis of the DFO RV survey data indicated that SSB has declined by 13% per year over 2004-09. It is too early to assess the effect on SSB of the recent reduction in TAC to 11 500 t for the 2009/10 management year. However if the management goal is to ensure growth in SSB, then a further reduction in TAC would increase the probability of growth.

Recent year-classes supporting the fishery are relatively weak in comparison to the strong 1997 and 1998 cohorts. The 2006 cohort is relatively strong, and harvesters indicate this cohort is beginning to recruit to the fishery. These fish could contribute significantly to the SSB by 2011. 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 well above the LRP. It would be prudent to consider management measures which would protect this year-class until it matures and reproduces.

Estimates of total mortality (ages 4-11) over 2004-08 were approximately 0.55 (40-45% mortality). This high level of mortality is a concern. Total mortality rates reflect mortality due to all causes, including fishing.

Exploitation rates for offshore cod tagged in the Halibut Channel are not high (2-9%) but have increased in 2005-07. Exploitation rates for most inshore components in 2008 were approximately 10% which seems sustainable.

The status of inshore components is uncertain. However, the commercial gillnet catch rates for the <35' fleet, as well as both sentinel (gillnet and linetrawl) indices are stable. The linetrawl catch rates for the <35' fleet have increased in recent years, and remain relatively high.

Overall, the findings of the current assessment are consistent with those of previous assessments. However, the current status and recent trends in the stock are somewhat more uncertain due to the nature of the change in the survey index between 2008 and 2009. Several consecutive year-classes (1999-2005) have been relatively weak and are supporting the majority of total landings. This has led to increased exploitation rates in the offshore, and contributed to an overall reduction in stock size. The 2006 year-class is again estimated to be strong. The probability that the SSB in 2009 is below the LRP varies from 20% to 40% depending on assumptions regarding the catchability of different age fish by the survey.

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 has occurred, 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 until it matures and reproduces. Harvesters noted that this year-class is likely beginning to be captured in fisheries.

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.

Various 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 have been implemented over time to address concerns about stock mixing and disruption of spawning activity. During the current assessment, a review of spawning time found no indication of any shift in the timing of spawning. 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.

Management should be aware of within-year variations in the individual weight of cod. Greatest yield can be gained when fish are in peak condition, typically in late fall/early winter, while minimizing the number of individuals removed from the stock.

OTHER CONSIDERATIONS

Temperature

Bottom temperatures throughout subdivision 3Ps during the spring 2009 survey were warmer than those during spring 2008.

A detailed evaluation of temperatures during the 2009 spring survey was not available at the time of the current assessment and the following text is from the previous assessment.

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 $<0^{\circ}\text{C}$ water increased to near 30%. The areal extent of bottom water with temperatures $>3^{\circ}\text{C}$ 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 $<0^{\circ}\text{C}$ 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.

Ecosystem

A synthesis of research vessel survey trends in indices of abundance and biomass measured across multiple functional groups of fish indicated that overall fish productivity decreased during the 1983-1995 period. Comparisons of results from 1983-1995 and 1996-2008 are complicated by a change in the survey gear used in each period, which was not accounted for in the analysis. Over 1996-2008, no clear trends in productivity are apparent.

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