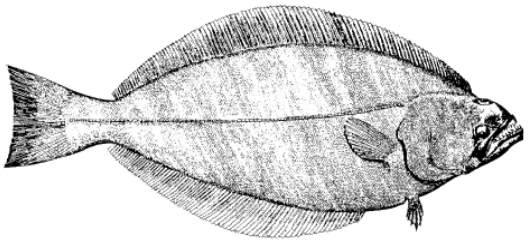
ASSESSMENT OF THE GREENLAND HALIBUT STOCK IN THE GULF OF ST. LAWRENCE (4RST) IN 2009



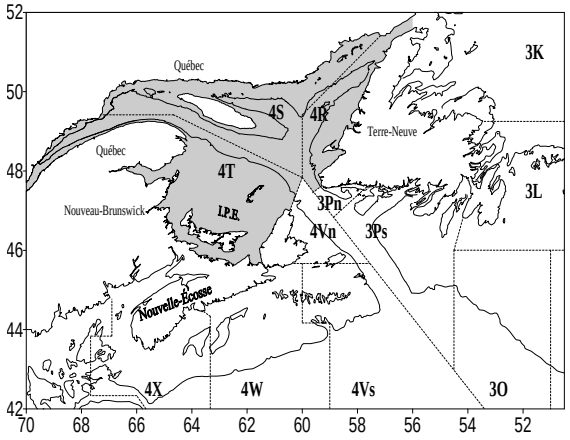


Figure 1. Map of the Gulf of St. Lawrence and neighbouring areas showing NAFO divisions 4RST.

Context

Until the mid 1970s, Greenland halibut (also called black turbot, or more commonly turbot) from the Gulf of St. Lawrence (4RST) were not subjected to any directed fishery. At the end of the 1970s, a Greenland halibut fishery developed using gillnets and bottom trawls.

The Atlantic cod mobile gear fishery has been closed since 1993 and, subsequently, any mobile gear directed fishery for Greenland halibut has been prohibited. This fishery is now dominated by boats equipped with gillnets, whose homeports are located in Quebec or on the west coast of Newfoundland.

Since 1982, the Greenland halibut fishery has been managed by controlling total allowable catches (TAC). This TAC management helps limit exploitation in order to protect the population's reproductive potential. Over the years, Fisheries and Oceans Canada (DFO) has implemented other conservation measures that have helped reduce the number of immature fish caught. However, minimum biomass or maximum exploitation rates that could jeopardize the resource are unknown. Also unknown is the optimal exploitation rate which could help set precise targets.

The main information used to evaluate this resource is biomass indices from DFO research surveys and sentinel fishery surveys conducted each year in July, evolution and strength of cohorts that will be recruited to the fishery, size at sexual maturity for each sex and the fish condition index. Catches per unit of effort (CPUEs) from traditional gillnetters using 6 in. mesh nets, the mean size of fish caught as well as standardized indices of exploitable stock biomass (44 cm and above) from fishery CPUEs and surveys are also used as indicators of stock status and fishery success.

Greenland halibut population assessment is done annually in order to highlight changes in the status of the resource that would justify adjustments to the conservation measures and management plan.

SUMMARY

- Preliminary Greenland halibut landings as of December 2009 increased compared with 2008 and totalled 4,002 t.

- Catch rates of traditional gillnetters using 6 in. mesh nets have remained stable and high over the last three years. In 2009, they increased in Esquiman and north of Anticosti and decreased in the western Gulf.

- The proportion of females in catches was 85% in 2009 and has remained more or less the same since 2000. The mean size of fish increased by 0.9 cm to 48.2 cm between 2008 and 2009, and the proportion of individuals smaller than the legal size of 44 cm decreased from 19% in 2008 to 12% in 2009.

- The size at which 50% of fish are mature has remained rather low since 2001. At the minimum legal size of 44 cm, 57% of females and 3% of males are immature.

- The biomass index (kg/tow) from the DFO survey and from the sentinel fishery dropped in 2009 and is below the average from the last ten years (1999-2008). The trend from both surveys is similar for each region. The 2009 index is comparable to 2008 north of Anticosti and in Esquiman and dropped sharply in the western Gulf.

- The 2003 and 2004 year-classes will significantly contribute to the fishery in 2010, but their abundance has largely decreased between 2008 and 2009 on both surveys. The 2005 year-class that should begin to contribute to the 2010 fishery is below the average from the last ten years (1999-2008) and below the long term average (1990-2008).

- A drop in the exploitable biomass in 2010 is expected based on the scientific survey indices.

- However, there is still some uncertainty as to the causes for the decrease in abundance as observed on these two scientific surveys in 2009.

- As it is preferable that the exploitation rate not increase, it would be necessary to reduce the catch level.

INTRODUCTION

Species Biology and Background Information

The Greenland halibut population of the Gulf of St. Lawrence is considered to be a stock isolated from the main Northwest Atlantic population found east and north of Newfoundland's Grand Bank. Parasite studies conducted in the early 1990s showed that the Gulf population was distinct, which led to the conclusion that Greenland halibut complete their entire life cycle within the Gulf.

Greenland halibut are generally found in the channels of the Gulf of St. Lawrence at depths ranging between 130 and 500 m (70-280 fathoms). Juveniles dominate the estuary and north of Anticosti. Spawning takes place primarily in winter, from January to March. Males reach sexual maturity at a smaller size than females. This difference helps explain why females grow to be larger than males and make up the majority of commercial catches.

Size at maturity for male Greenland halibut in the Gulf of St. Lawrence decreased considerably between 1996 and 2001 and has since generally remained below the series average (1996-2008).

Juvenile abundance varies a lot from one year to the next, and they are recruited to the fishery around the age of 5. The strength of these annual year-classes, their growth, as well as environmental conditions influence stock abundance fluctuations and have an impact on the fishery's success.

Description of the Fishery and Conservation Measures

All the fishermen's boats' homeports are located in Quebec and on the west coast of Newfoundland. Prior to 1999, the Greenland halibut fishery was essentially competitive based. An individual quota pilot project was introduced in 1999 for traditional fishermen in Quebec in order to extend their fishing season. This pilot project became permanent in 2002. Beginning in 1999, the fishing season was modified in order to correspond with the year of the management plan, i.e. from the current year until May 14 of the following year (Table 1).

The number of active boats in the Greenland halibut fishery in the Estuary and Gulf was around 205 in 2009.

Table 1. Landings (thousands of tons)

Year	77-98 avg.	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010[1]
TAC	-	4.5[2]	4.5[3]	4.5[3]	3.5[3]	3.5[3]	4.5[3]	4.5[3]	4.5[3]	4.5[3]	4.5[3]	4.5[3]
Fixed gear	3.1	3.4	2.0	1.2	1.6	3.5	3.8	3.8	3.8	3.6	3.7	3.9
Mobile gear	1.1	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1
Total	4.2	3.6	2.1	1.3	1.7	3.6	3.9	4.0	3.9	3.7	3.8	4.0[1]

[1] *Preliminary data*
[2] *TAC from January 1, 1999 to May 14, 2000*
[3] *TAC from May 15 of the current year to May 14 of the following year*

In addition to managing the fishery by total allowable catches (TAC), other conservation measures have been implemented since 1995 following recommendations from the Fisheries Resource Conservation Council (FRCC), which are aimed at reducing the fishing effort and the number of immature fish caught:

- increase in mesh size from 140 mm (5.5 inches) to 152 mm (6 inches);
- adoption of a more selective fishing net configuration;
- implementation of a small-fish tolerance protocol for commercial catches with a minimum legal size increasing from 42 cm in 1996 to 44 cm since 1997;
- establishment of a dockside monitoring program for commercial catches;
- voluntary reduction in the number of nets used by Quebec fishermen (from 120 to 80 nets) between 1996 and 2000.

Fishermen are also required to have an observer on board according to DFO requirements (5% coverage). Since 1993, because the Atlantic cod mobile gear fishery has been closed in the northern Gulf and because of the mandatory use of the Nordmore grate by shrimpers, recorded catches from mobile gear are limited to accidental catches and special projects (varying between 1% and 7% of the total catches).

Until the mid-1970s, Greenland halibut landings in 4RST consisted mainly of by-catches from other fisheries (Figure 2). Subsequently, a directed gillnet fishery developed and landings fluctuated substantially, exceeding 8,000 t in 1979 and 1987. These peaks were both followed by severe drops. Catches remained between 2,000 t and 4,000 t from 1989 to 1998. Landings decreased by 67% between 1999 and 2001, dropping from 3,600 t to less than 1,300 t. This significant drop was indicative of the poor fishery results of 2000 and 2001, particularly for Quebec fishermen. Landings increased to 3,900 t between 2001 and 2004 and have been relatively stable since. Between 1999 and 2001, TAC was set at 4,500 t, and then dropped to 3,500 t in 2002 and 2003. TAC has been increased to 4,500 t since 2004 and the allocation for the fixed gear directed fishery for Greenland halibut was set at 3,751 t. In 2009, preliminary landings of the current year for NAFO Divisions 4RST totalled 4,002 t.

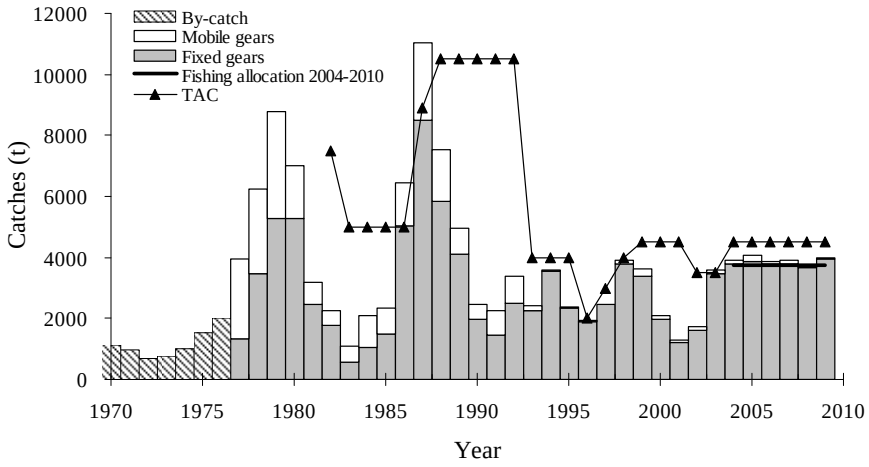


Figure 2. Annual Greenland halibut landings and total allowable catch (TAC) since 1970. Data for 2009 are preliminary.

RESOURCE ASSESSMENT

The status of the resource is determined by examining indicators from the DFO's research survey, the July sentinel survey, and from the commercial fishery. These indicators concern the stock's abundance and general condition as well as the fishery success. In order to assess the significance of the changes, the value of the 2009 indicators was compared with the average from the last ten years (1999–2008). The average related to the complete series (1990-2008) is also presented for the DFO research survey indicators.

The significance of recruitment to the population (one-year-old fish) is characterized based on their abundance index value (in millions of fish) recorded from the research survey. These values, which are arranged in ascending order, were divided into four large categories based on their relative level between 1990 and 2009. They were represented as follows (Figure 3): Low: 0-50; Moderately low: 50-100; Moderately high: 100-150; High: above 150. Furthermore, the 1992, 1993 and 1994 year-classes represent the lowest abundance level (less than 20) and the 1997 and 1999 year-classes represent the highest level of the series (more than 200).

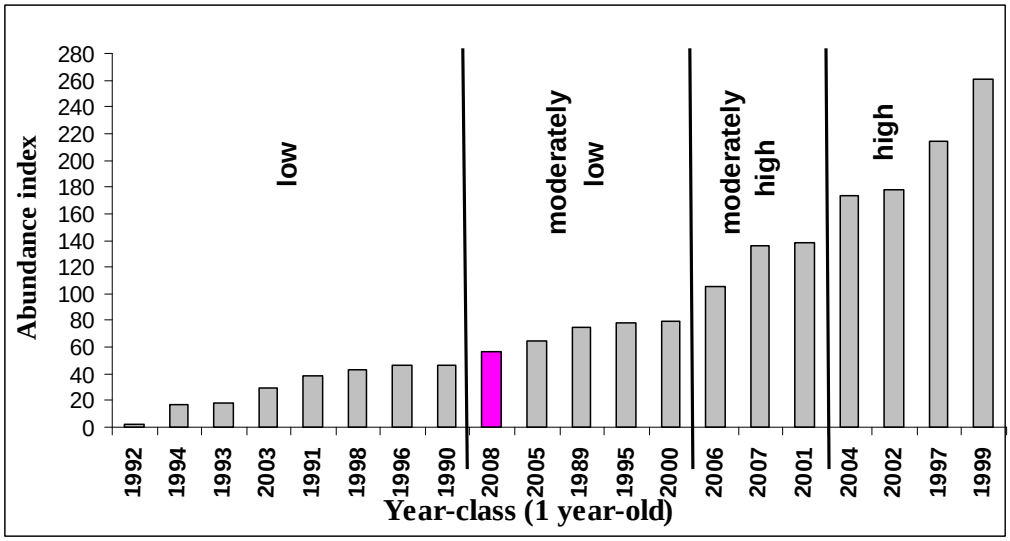


Figure 3. Recruitment to the population abundance index (year-class - 1 year-old) of Greenland halibut calculated from the research survey from 1990 to 2009. The significance of recruitment is presented in four categories (low, moderately low, moderately high and high). The dotted line represents the series average (1990-2009).

Surveys

A research survey is conducted annually in the Estuary and Gulf of St. Lawrence in August on board a DFO vessel. Between 1990 and 2003, the survey was conducted on board the CCGS *Alfred Needler*. It was then replaced by the CCGS *Teleost*. Following some comparative fishing experiments between the two vessels, catches by the CCGS *Alfred Needler* between 1990 and 2003 were corrected to match the catches made by the CCGS *Teleost.*

The cod sentinel fishery survey, conducted in July in the northern Gulf since 1995, is also used for determining the status of the resource. This survey is conducted by nine otter trawlers according to a stratified sampling plan. It does not cover the St. Lawrence Estuary, where 16% (13% over the last ten years and 18% for the series) of the Greenland halibut biomass was located in 2009, including a large concentration of 1 and 2 years-olds.

For these two surveys (DFO and sentinel), indices for overall biomass and exploitable stock biomass (44+ cm) were calculated. Abundance indices per size class such as recruitment to the population (fish of less than 30 cm and 1-2 years-old), pre-recruits (fish of 40-43 cm entering the fishery the following year), and fish above the minimum legal size (44+ cm) also serve as stock status indicators. Furthermore, abundance indices per region are also calculated; the western Gulf (including the Estuary and southern Anticosti), northern Anticosti and Esquiman Channel (Figure 4).

Data on the sexual maturity of males and females have been gathered since 1996 during DFO August missions, i.e. several months before spawning. Sexual maturity is assessed according to morphological criteria for all fish measured during these missions. A maturity ogive is then calculated for estimating the length at which 50% of fish are mature (L50) for both males and females. The Fulton condition index (fish weight / cubed length) was calculated for fish of 40+ cm. This index provides information on the physical condition of the fish.

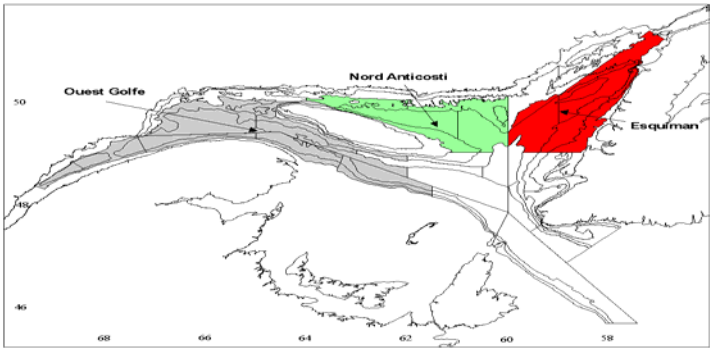


Figure 4. Reference areas for calculating biomass per region.

Commercial Fishery

Commercial fishery statistics and logbooks from traditional gillnetters (6-inch mesh) from Quebec and Newfoundland have been used to estimate catches per unit of effort (CPUEs) since 1996. The CPUE is defined as the average weight in kg of Greenland halibut caught in a net per trip. The gross values are standardized to account for changes based on NAFO subarea 4Si, duration of immersion (three days) and seasonal pattern (July).

The mean size of fish caught in gillnets from commercial samples is also calculated.

Resource Status in 2009

Since 2006, commercial fishing sites have expanded in the south-west and north of Anticosti. In 2009, the fishing effort increased north of Anticosti. The surveys indicate no significant difference in the distribution pattern of the stock in 2009. Between 2007 and 2009, the biomass index fell by 37% and 46% and the abundance index of fish available to the fishery (44+ cm) by 40% and 41% for the research survey and sentinel fisheries, respectively (Figure 5). A substantial decrease was also observed between 2008 and 2009 in the abundance of pre-recruits to the fishery (40-43 cm) in both surveys. In recent years, biomass has decreased by half in the Esquiman channel and north of Anticosti and there was an upward trend in the western Gulf. However, in 2009, the indices showed a significant decrease in biomass in the western Gulf and no significant difference in Esquiman and north of Anticosti compared to 2008. The proportion of biomass recorded in the western Gulf accounts for 70% of the total biomass in 2009, with 16% in the Estuary. The 1990-2008 series average was 74% and 18% in the Estuary.

The abundance of recruitment to the population (one year-olds) produced between 2006 and 2009 was at a *moderately low* to *moderately high* level. The last four years represent the longest period since the late 1990s where there was no production of *strong* recruitment. Fish condition and size at first maturity showed a deterioration beginning in 1999 and has remained at lower level than before this period.

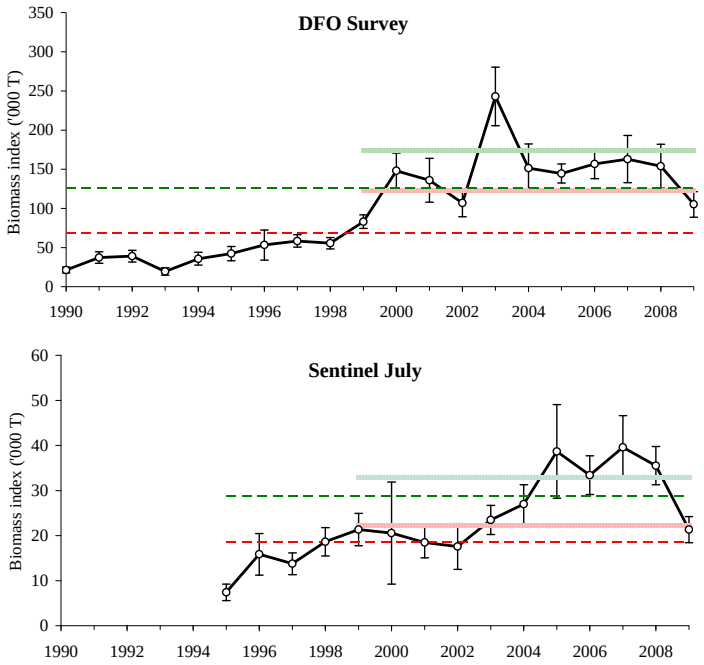


Figure 5. Minimum trawlable biomass indices for Greenland halibut in Divisions 4RST estimated from the DFO and the July sentinel survey data. The lines represent the confidence intervals (95%) for the 1999-2008 average (solid lines) and for the entire series (dotted lines).

Performance by the local commercial fishermen for the entire Gulf did not show any significant changes in 2009. However, catch rates by region showed a significant increase between 2008 and 2009 in Esquiman and north of Anticosti and a decrease in the western Gulf (Figure 6), where over 70% of catches were made. In the early 2000s, low yields, a decrease in mean size, and an increase in the difference between the fixed gear allocations and landings reflected the fishing difficulties in the Gulf during this period. Since 2003, yields have improved significantly.

Stock Status Indicators

In the early 1990s, most abundance indicators were below the 1990-2008 average. The total biomass values at this period were the lowest in the 1990-2008 series. The distribution of the Greenland halibut stock was limited to the Estuary and at the head of the Gulf channels. It seems that the recruitment of year-classes of higher abundance (1989 and 1995) resulted in an increase in productivity to the point that biomass and abundance indicators improved in the late 1990s and early 2000s. Subsequently, between 1998 and 2005, an alternation occurred between the production of juveniles of *high* (1997, 1999, 2002 and 2004) and *moderately* to *low* abundance (1998, 2000, 2003 and 2005). The 1997 and 1999 year-classes were the strongest cohorts observed so far. The general improvement of recruitment led to a substantial increase in biomass indices followed by a fairly stable period. Therefore, between 2000 and 2007, just before the recent decline between 2008 and 2009, the values of the biomass index from the research survey were around the 1999-2008 average.

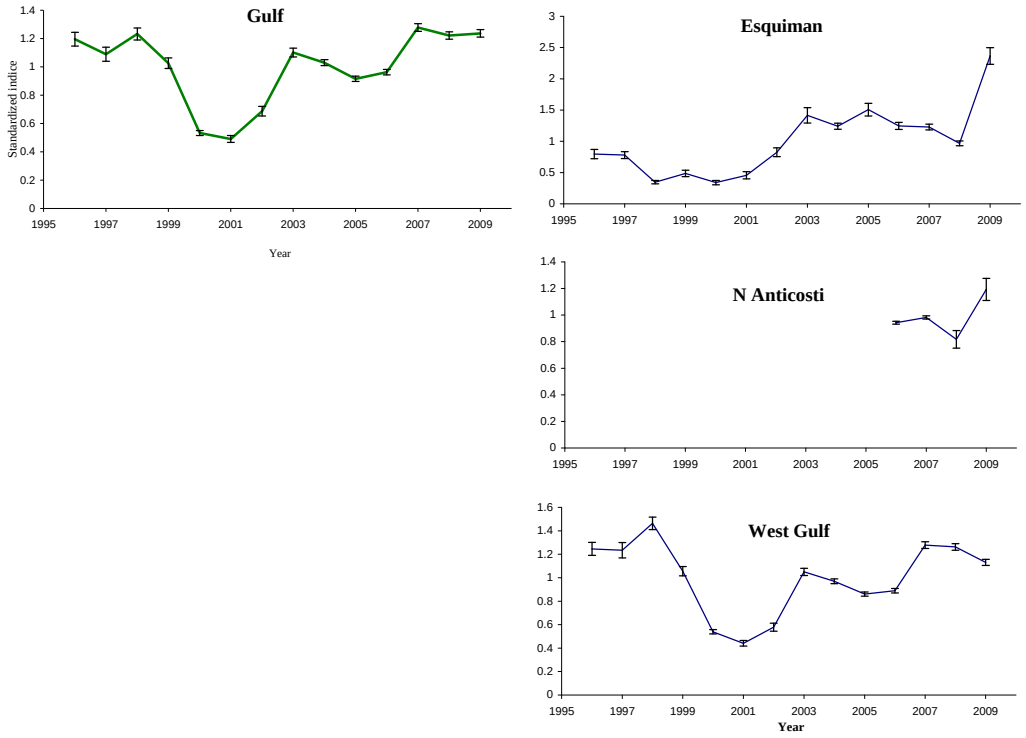


Figure 6. Standardized fishery indices for the Gulf and per region. The 95% confidence intervals are shown.

A study of the summer distribution (August) of individuals in the research surveys for the 1993-2003 period revealed that the distribution range of larger size fish extends eastwards, along the Laurentian Channel, south of Anticosti, whereas it is usually different for juveniles. Surveys over the last ten years show a high concentration of juvenile fish (< 32 cm, 1 and 2 year-olds) mostly in the Estuary (particularly at the head of the Estuary) and drops considerably in the east, except for the northern part of Anticosti. In high recruitment years, juvenile distribution seems to extend towards the Laurentian Channel and their concentration generally increases in the Sept-Iles basin and north of Anticosti.

Biomass indices from the 2009 surveys showed a decrease compared with 2008 and were at a lower value than the confidence interval from the 1999-2008 average. This change was caused in part by the higher than expected decrease of individuals of 37-47 cm corresponding to the 2003, 2004 and 2005 year-classes.

Therefore, the abundance indices (in numbers) of fish that will be recruited to the fishery (44+ cm) presented a decrease between 2007 and 2009 (Figure 7). They were within and near the lower limit of the confidence interval of the 1999-2008 average. In addition to the unexpected decline in the 2004 year-class found in part in fish of 44+ cm, it is likely that the decrease of this size class in 2009 was also caused by the presence of the weak 2003 year-class. The abundance indices of pre-recruits (40-43 cm) dropped sharply in both surveys in 2009 to values lower than the 1999-2008 average (Figure 7). This decline is also explained in part by the sharp decrease of the 2004 and 2005 year-classes, especially that they already represented *moderately low* year-classes.

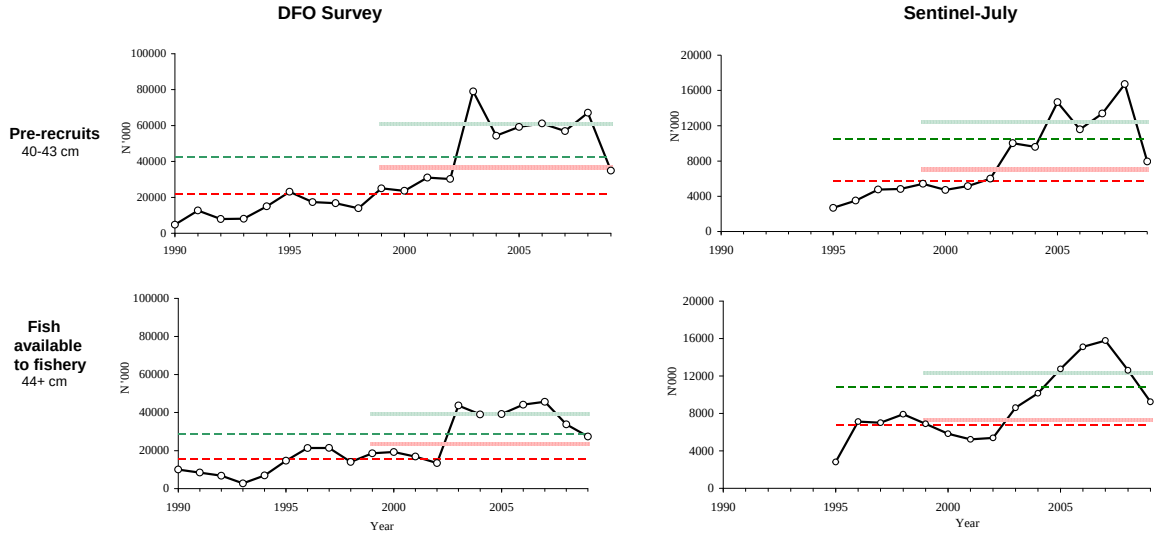


Figure 7. Abundance indices for pre-recruits and fish available to the Greenland halibut fishery in Divisions 4RST estimated for the research survey and the July sentinel fishery survey. The lines represent the confidence intervals (95%) for the 1999-2008 averages (solid lines) and for the entire series (dotted lines).

The Fulton condition index declined steadily between 2004 and 2008, reaching a value below the confidence interval of the 1999-2008 average and below the 1990-2008 series average. There does not appear to have been any change in the growth rate between 2004-2008 which could explain this drop. It improved in 2009 to average values.

Information regarding sexual maturity shows that the size at which 50% of fish are mature (L50) has dropped since 1996, from 40 cm to 36 cm for males and from 50 to 45 cm for females (Figure 8). The 2009 value has remained low for males and females and was below the series average.

The size at maturity for males is considerably lower than the minimum size of 44 cm established for the small fish protocol. Because growth rate drops after reaching sexual maturity, there exists a size dimorphism between males and females that increases the proportion of females in commercial catches. Maturity ogives that estimate the proportion of mature individuals at length indicate that at 44 cm, 57% of females and 3% of males are immature. This proportion dropped from 63% to 57% for females between 2008 and 2009. This decrease is a result of a size difference at maturity. The average number of immature individuals at 44 cm over the last three years is 59% for females and 4% for males.

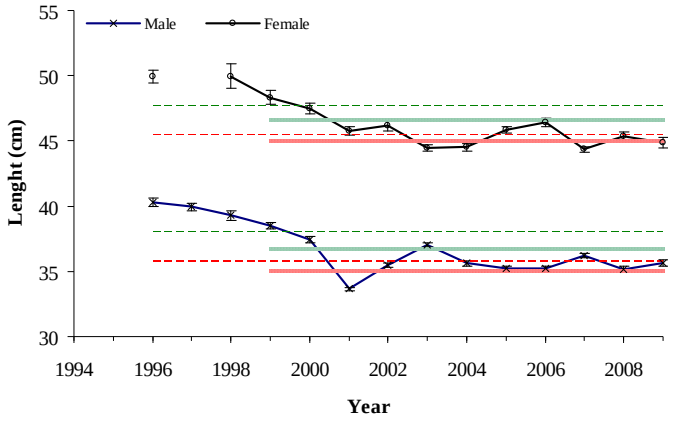


Figure 8. Length at 50% maturity for fish caught in the DFO research survey between 1996 and 2009. The sold lines represent the confidence intervals (95%) for the 1999-2008 average and the dotted lines represent the entire series.

The commercial fishery catch rate is used as an indicator of fishing success and not as an abundance index of exploitable stock. The standardized values show a drastic increase in catch rates in Esquiman and north of Anticosti and a decrease in the western Gulf between 2008 and 2009. The fishing area north of Anticosti expanded in 2009. According to Industry, the sharing of this fishing area with shrimpers was better in 2009. It seems that the increase in yields in 2009 in Esquiman and north of Anticosti could be due in part to a high abundance of capelin in these areas. In fact, capelin by-catches by shrimpers have more than tripled in 2009, mainly in this sector.

The standardized commercial catch rate for the entire Gulf did not reveal any changes.

The second fishery indicator, which was the mean size of fish caught in gillnets, increased from 47.3 to 48.2 cm between 2008 and 2009, and remained higher than the series average. A 1 cm increase was recorded in 4R and 4S and is explained by the decrease of individuals of < 44 cm as well as the increase of individuals of > 44 cm in the catches between 2008 and 2009. There has been no change in the mean size in Division 4T since 2007.

The mean size of fish was around 43 cm in 1995, and rose to 48 cm in 1996 following the mesh size increase from 140 mm (5.5 in.) to 152 mm (6.0 in). The mean size increase can be seen in the number of Greenland halibut per ton that dropped by 6% in the 2009 catches.

Overall, the percentage of fish landed that were smaller than the legal size of 44 cm decreased from 19% in 2008 to 12% in 2009 in 4RST. This proportion decreased even further in 4R (12% to 4%) and in 4S (20% to 12%), compared to 4T (23% to 22%). There have been more small fish caught in the west of the Estuary (4Tq and 4Tp), and represent a significant proportion of individuals that have not reached sexual maturity.

The proportion of females in commercial catches has been higher on average since the mesh size increase was introduced in 1996 (mesh size increased from 5.5 in. to 6.0 in.). In 2009, it was 85%. This percentage appears to be rather stable since 2000.

Outlook

Recruitment of the two very abundant year-classes of 1997 and 1999 resulted in the abundance index increases observed in the early 2000s. Prior to the arrival of these year-classes, indices were at a low level. In recent years, the fishery has targeted new and less abundant year-classes (2001 and 2002) than the 1997 and 1999 year-classes but that represent nonetheless two considerably abundant year-classes (Figure 3). Based on the research surveys, the portion of biomass available to the fishery decreased between 2008 and 2009 compared to the five previous years, which was the result of the arrival of the weak 2003 year-class combined with the successive exploitation of the same cohorts (2001 and 2002). In addition, the 2004 cohort, which was supposed to begin contributing to the fishery in 2009, was less abundant than expected.

In 2010, the fishery will target the 2003, 2004 and 2005 year-classes, that, according to the two surveys, decreased sharply between 2008 and 2009.

The catch increase in 2009, combined with a decreased in numbers, suggests that there has been an increase in the exploitation rate. The exploitation rate will likely increase in 2010 if the catch level remains the same.

As mentioned in last year's assessment, larger size individuals were expected to be less abundant in 2009, but that the biomass available to the fishery in 2010 was expected to remain at a similar level as in recent years because of the abundance of pre-recruits (40-43 cm) which indicated above average values. However, analyses conducted in 2009 showed a higher decrease than expected in terms of biomass available to the fishery and pre-recruits (40-43 cm). In light of the analyses, it appears likely that this downward trend will continue in 2010.

The precautionary approach for Greenland halibut is being developed. A peer review was conducted in January 2009 to assess the methods for establishing reference levels (LRP: limit reference point and USR: upper stock reference). The method used is based on the temporal series of biomass indices from the surveys. The decision rules will then have to be developed in collaboration with Industry and fisheries management. These preliminary reference points indicated that the stock was still in the healthy zone in 2009, but the downward trend observed urges caution.

Sources of Uncertainty

The difference between the exploitable stock size indicators and fishing success observed in 2008 continues in 2009: the biomass of fish of 44+ cm from the scientific and sentinel fisheries surveys has decreased while the CPUEs of the commercial fishery have remained stable (Figure 9). Note that the fishing success index is not used as a stock abundance index.

Although the two scientific surveys show a significant decrease in abundance for all size classes (especially for pre-recruits and legal size fish), some uncertainty remains about the extent and causes of this change.

According to Industry representatives, one of the theories that could explain the significant increase in CPUE observed in 2009 north of Anticosti is that there was less interference by shrimpers with turbot fishermen. Moreover, according to preliminary by-catch data from shrimpers, the abundance of capelin has more than tripled in 2009, mainly in Esquiman (85% of catches). It is possible that this abundance of food could have affected the behaviour of turbot and had an effect on the availability of fish in gillnets, thus affecting catchability during this period.

CPUEs declined in the western Gulf and Industry representatives indicated that a shift in effort was necessary in this area in 2009 to achieve acceptable yields.

The size at sexual maturity value in 2009 remained low and was below the 1999-2008 average for males and females. This indicator remains a concern for the preservation of the spawning stock.

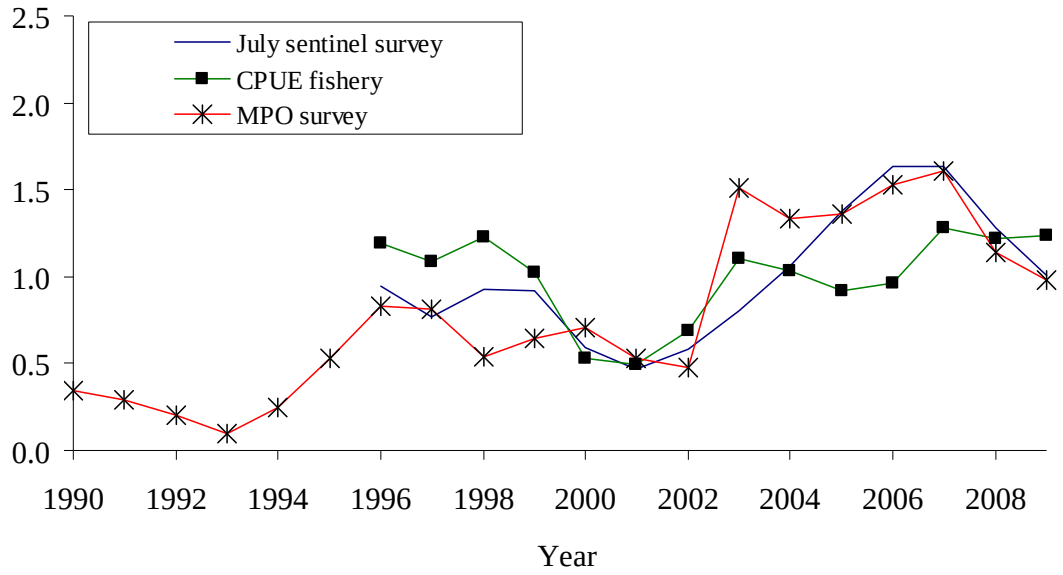


Figure 9. Standardized indices for exploitable stock biomass (44+ cm) for Greenland halibut and fishery CPUEs.

CONCLUSIONS AND ADVICE

Fishery results were generally good in 2009. Commercial catch rates in Esquiman and north of Anticosti showed an increase whereas those from the western Gulf decreased. The survey biomass indices did not show any significant increase in Esquiman and north of Anticosti and showed a decrease in the western Gulf. The biomass index for 2009 was the lowest over the last ten years and it appears that the decrease in recruitment to the fishery observed in 2009 will continue in 2010.

These conditions are of some concern and suggest not increasing the exploitation rate in 2010. To achieve this goal, it would be necessary to reduce the catch level.

OTHER CONSIDERATIONS

Greenland halibut by-catches from the shrimp fishery from 1999 to 2009 were examined using the observers at sea database. Greenland halibut was present on average in 89% of the activities observed. Fish by-catches are mostly of the order of 1 kg or less per tow observed and 3 kg or less for turbot when observers are present. The presence of an observer does not appear to disrupt the general fishing pattern, as the catch rates with or without an observer do not vary.

Greenland halibut catches are mostly made up of 1 year-old individuals, and in a lesser extent 2 year-old individuals. They vary according to areas and years and appear to be largely influenced by fishing effort by shrimpers and fishing location. Consequently, the areas of Sept-Iles and Anticosti have the highest by-catch rates of Greenland halibut, and concentrations of juveniles (1 and 2 year-olds) were higher in these areas compared to Esquiman. In 2009, they decreased by 50%. The average annual Greenland halibut by-catches from the shrimp fishery in the Estuary and Gulf from 1999 to 2009 are in the order of 100 t. In 2009, shrimp fishery by-catches of Greenland halibut in the Estuary and Gulf totalled around 66 t, which represents a 50% decrease from 2008. Considering that the effort by shrimpers has increased in areas with juvenile concentrations between 2008 and 2009, this decline could be explained by the low abundance of the year-class of one year-olds in 2009 compared to what was observed in 2008.

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