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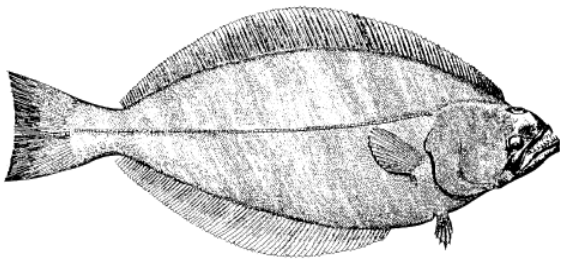
Science Advisory Report 2006/011

ASSESSMENT OF THE GREENLAND HALIBUT STOCK IN THE GULF OF ST. LAWRENCE (4RST) IN 2005



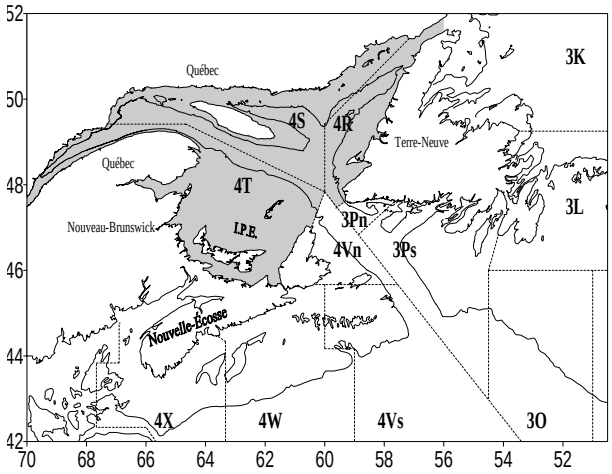


Figure 1. Map of the Gulf of St. Lawrence and adjacent areas showing NAFO 4RST divisions.

Context

Until the mid 1970s, Greenland halibut (so-called 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 was developed using gillnets and bottom trawls.

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, the Department of Fisheries and Oceans (DFO) has implemented other conservation measures that have helped reduce the number of immature fish caught. However, exploitation rates that could jeopardize the resource are unknown. Also unknown is the optimal exploitation rate which could help set precise targets.

Since 1995, due to the cod fishery moratorium, no directed fishery using mobile gear was permitted. This fishery is now dominated by boats equipped with gillnets, whose homeports are located in Quebec or on the west coast of Newfoundland. 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.

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 for the fishery, size at sexual maturity for each sex, fish condition index, catches per unit of effort (CPUEs) from traditional gillnetters using 6 in. mesh nets, and the average size of fish caught. Standardized indices of exploitable stock biomass (44 cm and above) from fishery CPUEs and surveys are used as indicators for determining the size of the exploitable stock.

SUMMARY

- Greenland Halibut landings from divisions 4RST in 2005 remained mostly the same as in 2004, reaching 3,967 tons.

- After standardizing, catch rates by traditional gillnetters using 6-inch mesh nets increased from 2001 to 2003, and then dropped by 13% in 2004 and 4% in 2005. However, the model used for standardizing the catch rates only explains 20% of the data's total variability.

- Catches were mostly made up of females in a proportion exceeding 85%. The average size of the fish caught, which had been dropping between 1997 and 2002, increased until 2004 and remained more or less the same in 2005, reaching approximately 47 cm. The number of Greenland halibut captured per ton is comparable from 2004 to 2005.

- Biomass indices obtained from data collected on board the *CCGS Alfred Needler* show an upward trend until 2005. However, there is a significant drop in catch rates (kg/tow) from 2003 to 2005 (no data for 2004). The lenght frequency shows a significant presence of the 2004 year class (17 cm).

- Biomass estimates from the July sentinel fishery survey have shown an increase since 1995.

- The size at which 50% of males reach maturity has dropped from 40 cm to 34 cm and females from 50 cm to 46 cm since 1996.

- Survey data suggests that recruitment to the fishery in 2006 should be similar to recent years.

- Considering the stability of abundance indicators, the status quo is recommended for the 2006 TAC.

INTRODUCTION

Species biology and basic 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 allowed concluding 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, so their growth rate drops earlier than that of females. This difference helps explain why females grow to be larger than males and make up the majority of commercial catches.

Since 1996, size at maturity for males and females has dropped. This change has resulted in an increase of immature fish landed and represents a source of concern for the future of the stock's reproductive potential.

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 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

Table 1. Landings (thousands of tons)

Year	77-98 avg.	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006[1]
TAC	-	4,5[2]	4,5[3]	4,53	3,53	3,53	4,53	4,53
Fixed gear	3,1	3,4	2,0	1,2	1,6	3,5	3.8	3.8
Mobile gear	1,1	0,2	0,1	0,1	0,1	0,1	0,1	0,2
Total	4,2	3,6	2,1	1,3	1,7	3,6	3,9	4,0

[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

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.

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.

There were 294 active boats in the Greenland halibut fishery in the estuary and Gulf in 2005.

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. Total catches, including mobile gear, peaked on two occasions, in 1979

and 1987, followed by severe drops. Since 1993, catches made by mobile gear have been very low (4% in 2005) because of the stopping of directed cod fishing with this type of gear, and because shrimpers are required to use Nordmore grates. Catches stabilized between 2,000 tons and 4,000 tons from 1989 to 1998.

Landings decreased by 67% between 1999 and 2001, dropping from 3,600 tons to 1,300 tons, and more than tripled between 2001 and 2004. Preliminary landings reached 3,967 tons in 2005 (Figure 2). Newfoundland fishermen exceeded their 2005 allocation by 31%. Since 1998, this is the third consecutive year that fixed gear fishermen of both provinces catch their allocation.

Between 1999 and 2001, TAC was set at 4,500 tons, and than dropped by 22%, totalling 3,500 tons in 2002 and 2003. TAC was increased to 4,500 tons in 2004 and 2005.

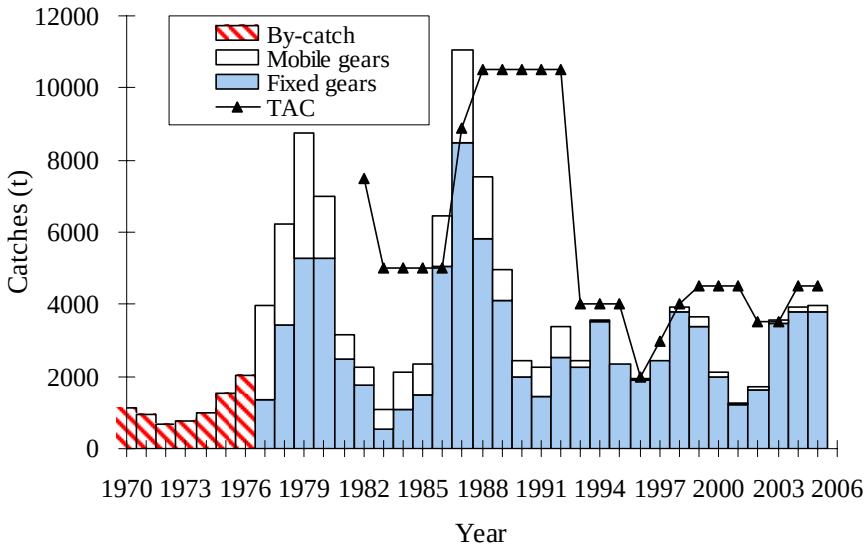


Figure 2. Annual Greenland halibut landings and total allowable catch (TAC). Data for 2005 are preliminary.

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 stock biomass, fishery success and the stock's general condition. In order to assess the significance of the changes, the value of the 2005 indicators was compared with the 1996–2000 averages.

Indicators were rated according to one of the three following categories:

Positive (+): the indicator's value differs from the average in a way that positively affects resource status;
Neutral (=): the indicator's value is similar to the average;
Negative (-): the indicator's value differs from the average in a way that adversely affects resource status.

The limits of the neutral category are delineated by the confidence intervals (95%) for the 1996–2000 average. Indicators differ from the average when their annual value is outside of the confidence interval.

The 2005 indicator's value is also compared with 2004 and 2003 value for the DFO research survey because of the absence of this survey in 2004 (Table 2). The two annual values (2003 or 2004 and 2005) are similar when the difference is less than 10%.

Table 2. Indicators used to assess stock trends.

Indicators	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2003→ 2005	2004→ 2005
Stock Biomass													
Alfred Needler (DFO)	−	=	=	=	=	+	+	=	+	na	+	↓	na
Sentinel July	−	=	−	=	+	=	=	=	+	+	+		↑
Juveniles (<30 cm)													
Alfred Needler (DFO)	−	−	=	=	=	+	=	=	+	na	=	↓	na
Sentinel July	−	−	=	=	+	+	=	=	=	=	=		↑
Prerecruits (40-43 cm)													
Alfred Needler (DFO)	=	=	=	−	+	+	+	+	+	na	+	↓	na
Sentinel July	−	−	=	=	+	=	=	+	+	+	+		↑
44 cm and more													
Alfred Needler (DFO)	=	+	+	−	=	=	=	−	+	na	+	↓	na
Sentinel July	−	=	=	+	=	=	=	=	+	+	+		↑
Stock condition													
Distribution index	+	−	=	=	+	=	−	−	=	na	na		na
Condition index	=	=	=	+	=	−	=	=	=	=	=		±
Growth index	=	=	=	=	=	−	−	−	=	na	na		na
Male maturity		+	=	=	=	−	−	−	−	−	−		±
Female maturity		=	=	+	=	−	−	−	−	−	−		±
Fishery													
Difference between fixed gear allocation and landings	+	+	+	+	=	−	−	−	+	+	+		±
CPUE		=	=	=	=	−	−	−	=	=	=		±
Mean size	−	=	+	=	−	−	−	−	−	−	−		±

± no or little change (0 à 5 %) ; ↑ ↓ change of 5 % à 10 %; ↑↑ ↓↓ change of 10 % or more; **na** indicator not available

Surveys

A research survey is conducted annually in the Estuary and Gulf of St. Lawrence in August on board a Department's vessel, the C.C.G.S. Alfred Needler, equipped with a shrimp trawl. According to a stratified random sampling plan, this survey was conducted from 1990 to 2003 and again in 2005.

The cod sentinel fishery survey, conducted 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 an average of 15% of the Greenland halibut biomass is located and where a large concentration of 1 year-olds can be found.

Indices for minimum trawlable biomass, juvenile fish abundance (fish under 30 cm and 1 to 2-years old), pre-recruit (40-43 cm) abundance, and the abundance of fish above the minimum legal size (over 44 cm) are calculated for these two surveys (DFO and sentinel).

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

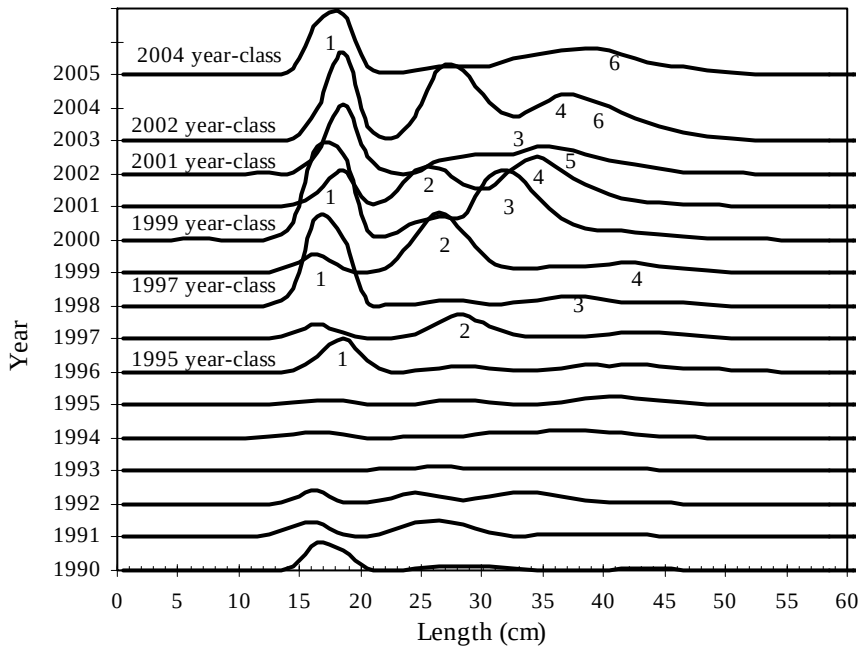
Commercial fishery

Commercial fishery statistics and logbooks from traditional gillnetters (6-inch mesh) from Québec and Newfoundland have been used to estimate catches per unit of effort (CPUEs) since 1996. The catch rate indicator was determined by standardizing (according to sector, soak time and month) the catch rates. The two other fishery success indicators are the difference between the fixed gear allocation and the landings associated to this fleet, and the estimate of the average size of fish caught with gillnets from commercial fishery samples.

Resource status in 2005

In the early 1990s, most abundance indicators were negative. Total biomass and the abundance of fish available for the fishery (44+ cm) were the lowest of the 1990-2005 series (Figures 4 and 7). Greenland halibut stock distribution was limited to the Estuary and the head of the Gulf channels. Recruitment of average abundance year classes (1989, 1990 1991 and 1995) then led to a productivity increase, and biomass and productivity indicators have been rather positive since 1999 (Table 2). However, fishery indicators and those describing stock condition have been mostly negative since 2000. Over most recent years, an alternation between productions of juveniles of high (1997, 1999, 2001 and 2004) and average or low abundance (1996, 1998, 2000 and 2003) has been observed (Figure 3). Biomass indices show an upward trend which can be explained by the arrival of strong year classes from 1997 and 1999. Correspondingly to the increase of biomass, an expansion of the distribution range was observed south of Anticosti, along the Laurentian Channel and in the Anticosti Channel during good recruitment years.

A)



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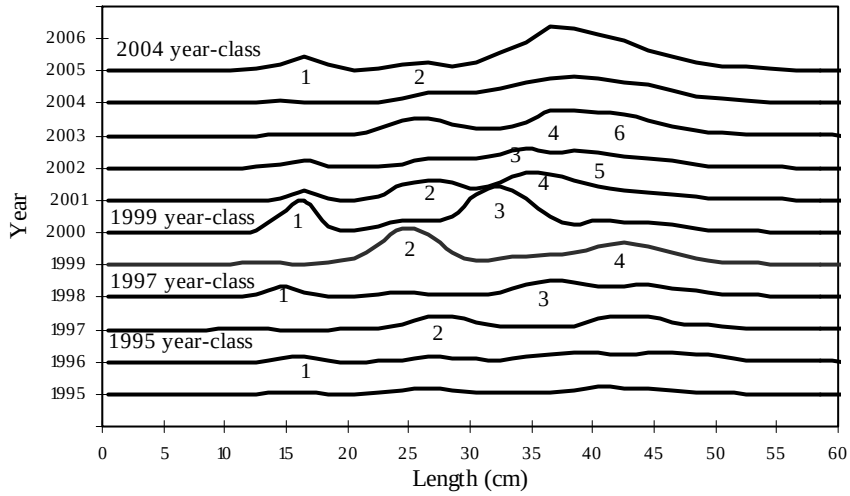

Figure 3. Size structure of Greenland halibut caught during DFO research surveys (A) (1990-2005) and (B) July sentinel survey (1995-2005). The largest year-classes (1995, 1997, 1999, 2001, 2002 et 2004) are shown, as is the age of the fish each year.

Stock status indicators from surveys:

Biomass indices obtained from the DFO survey and the July sentinel fishery survey show an upward trend between 1995 and 2005 (Figure 4). However, results from the 2005 DFO survey indicate that the minimum trawlable biomass decreased in 2005 compared to 2003. The 2005 drop is mostly due to a reduction of nearly 50% of the biomass in the western Gulf, while there were no noticeable changes in the east. The most significant biomass proportion of Greenland halibut in the Gulf of St. Lawrence is located in the west and has represented on average 77%

of the total biomass since 1995. This proportion is 72% in 2005. The biomass proportion in the Estuary compared with total biomass reached the lowest value in the series. A study on summer dispersal (August) of individuals from the CCGS Alfred Needler research surveys from 1993 to 2003 show that the distribution range of larger fish extends eastward, along the Laurentian Channel, south of Anticosti, while this is not the case for juveniles. However, the abundance of larger size fish is still higher west of 63° W. A large concentration of juvenile fish (< 32 cm) was observed in the Estuary and considerably drops east of 65° W, except for the northern part of Anticosti.

The sentinel fishery survey index reached a maximum value for this series in 2005 (Figure 4). The 2005 value is due in large part to a catch made along the Laurentian Channel, south of Anticosti, which had an unusually high value for this survey. This catch also significantly impacted the scope of the 2005 estimate confidence interval. Overall, good concentrations were observed in all areas. A marked increase in biomass (over 300%) was noticed north of Anticosti between 2004 and 2005.

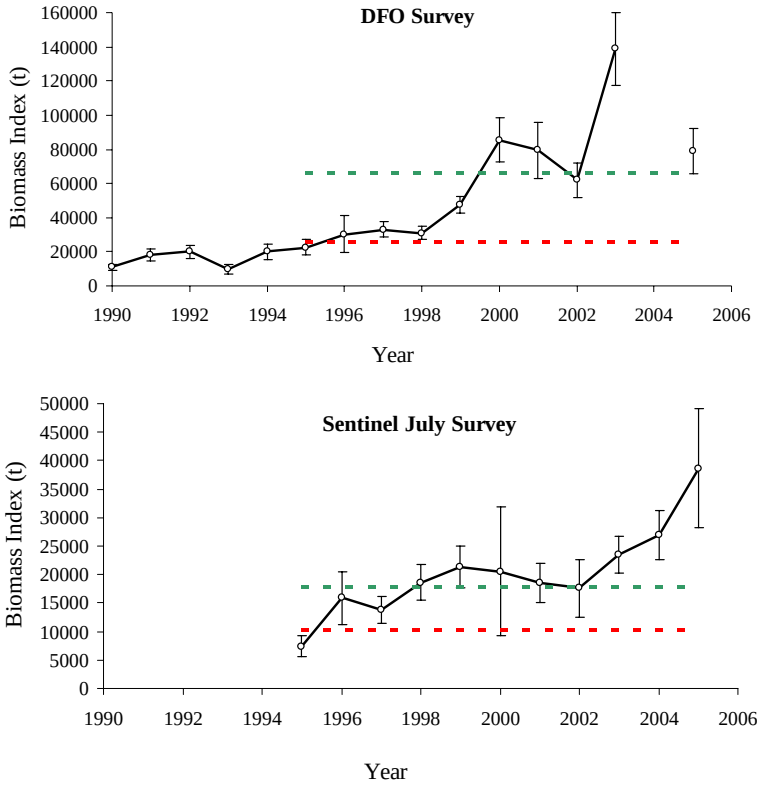

Figure 4. Minimum trawlable biomass indices for Greenland halibut in DivisioSn 4RST estimated from DFO and July sentinel survey data. The dotted lines represent the upper and lower limits for confidence intervals for the 1996-2000 mean.

For the two surveys, abundance indices expressed in numbers of pre-recruits (40-43 cm) and recruits to the fishery (over 44 cm) have values that are higher in 2005 than the 1996-2000 series average.

The Fulton condition index, which is used as a fish health status indicator, began decreasing in 1999, and then improved from 2001 to 2003, and dropped again in 2004 and 2005. Information regarding sexual maturity shows a downward trend since 1996. The size at which 50% of males

are mature dropped from 40 cm to 34 cm and from 50 to 46 cm for females (figure 5). 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.

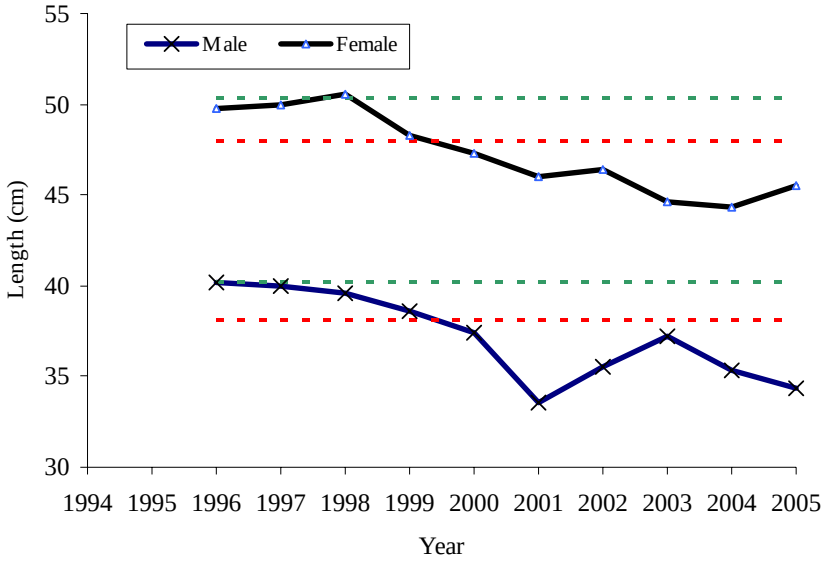

Figure 5. Length at 50% maturity for fish caught in DFO research surveys between 1996 and 2005. The dotted lines represent the upper and lower limits for confidence intervals for the 1996-2000 mean.

Stock status indicators from the fishery:

The three fishery indicators show some stability from 2004 to 2005. Two of the three fishery indicators (i.e. the difference between allocation and landings and the CPUEs) have shown the same trend since the late 1990s. The have shown an improved situation since 2003, yet they were negative between 2000 and 2002 (Table 2). Thus, the difference between the allocation of fixed-gear fishermen and landings was positive and stable in 2004 and 2005, indicating that these fishermen reached their allocation. CPUEs decreased by 13% in 2004 and by 5% in 2005, but remain at the 1996-2000 series' average. It should be noted that CPUEs began to increase in the Esquiman Channel in 2001 and 2002 and have remained higher than in other areas of the Gulf since 2003.

The average size of the fish caught by commercial fishery, which was roughly 43 cm in 1995, shifted to 48 cm in 1996, after an increase in mesh size from 140 mm (5.5 inches) to 152 mm (6 inches) (Figure 6). The average size of fish caught, which had been generally decreasing between 1998 and 2002 (from 48 cm to 45 cm), increased in 2004, reaching 47 cm, and remained more or less the same in 2005. However, it still remains below the series' average. Even though there is an increase trend in the average size in commercial catches over the last years, 24% of the fish landed are less than 44 cm in length, which represents a significant proportion of individuals having not reached sexual maturity. This percentage differs according to the division. It is around 8% in 4R, 19% in 4S, and 37% in 4T.

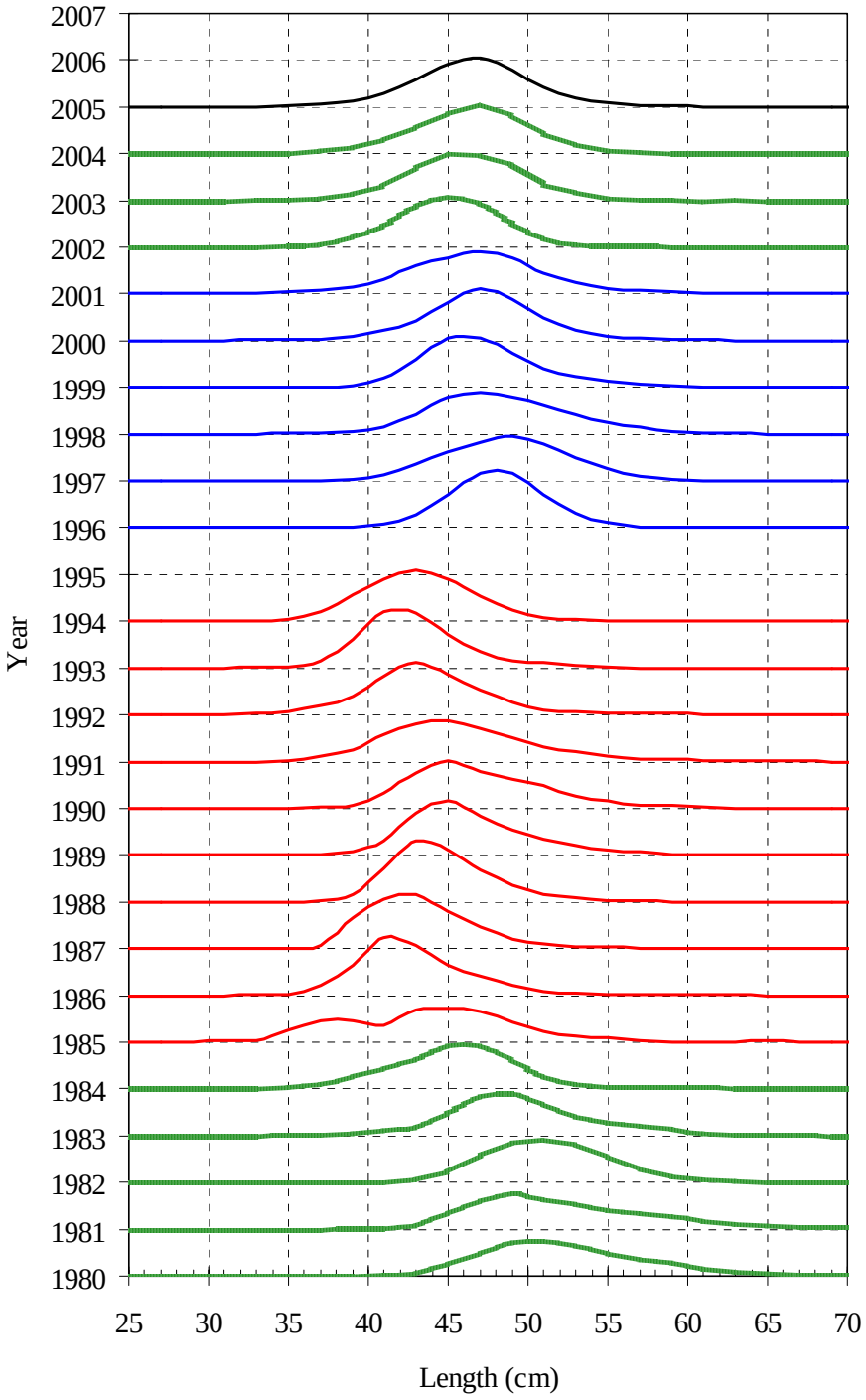

Figure 6. Size structure of Greenland halibut caught with gillnets, 1980-2005.

Along with average size stability, the number of Greenland halibut harvested per ton landed hasn't changed in 2005.

The proportion of females caught in gillnets has significantly increased since 1996 due to the increase of mesh size. Since 1998, there has been an increase in the percentage of females caught, but this percentage appears to have remained relatively stable since 2002. In 2005, 86% of commercial catches were females.

Outlook

The recruitment of the two very abundant year-classes of 1997 and 1999 is the reason for the increases of abundance indices recorded in recent years. The fishery in 2006 will be mostly supported by 2000 and 2001 year-classes, which do not appear to be as strong as the 1997 and 1999 year-classes. For this reason, the biomass available to the fishery is expected to drop in 2006, but will remain at a similar level as in recent years due to the abundance of pre-recruits, which is still higher than the 1990-1999 average. It is likely that the next year-classes, with lower abundance than 1997 and 1999, will have a downward impact on the success of the fishery in upcoming years.

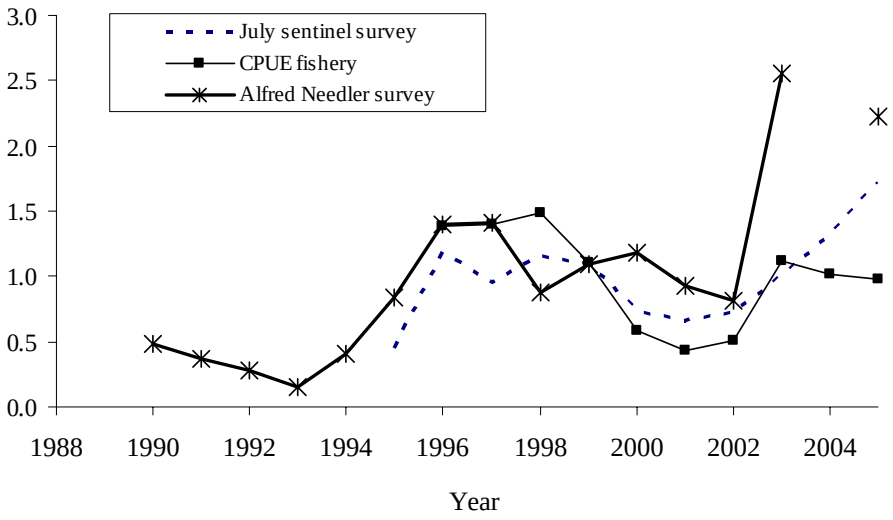

Figure 7. Standardized indices for fishable stock biomass (44 cm and over) for Greenland halibut and CPUE values for the fisher.

Sources of uncertainty

Indicators of the exploitable stock size differed in 2004 and 2005, even though they had been increasing since 2001 (Figure 7). The biomass of 44+ cm fish is still increasing according to the sentinel survey, while the commercial fishery standardized CPUEs are stable and the biomass of 44+ cm fish is decreasing in 2005 according to the DFO survey.

The increase of 208% of exploitable biomass from the 2003 research survey along with the simultaneous increase of abundance indices of each size class (juveniles, pre-recruits, 44+ cm) suggest that external factors have affected catchability upwards. Furthermore, the variation associated with the 2003 biomass estimates is higher than with other years. It is possible that environmental factors may have had an impact on trawl availability of Greenland halibut of all sizes so much so that catchability would have increased in 2003.

The abundance index from the 2005 sentinel fishery survey had the most significant value since 1995. This large increase as well as the high variability observed in 2005 would have been cut by half had it not been for the unusual presence of a large number of Greenland halibut in a localized tow south of Anticosti. This large catch makes interpreting this indicator hazardous in 2005.

CONCLUSIONS AND ADVICE

Fishery results were generally good in 2005, and forecasts indicate that they will remain at a good level for 2006, but probabilities are high that fishery success will drop over the next few years. The TAC was increased in 2004 to take advantage of the 1997 and 1999 year classes. In 2006, catches equal to the 2005 TAC should create an increase in fishing pressure because the Greenland halibut biomass available to the fishery should decrease. However, because the biomass should remain at an above average level, it does not appear necessary to lower the TACs. Consequently, the status quo is recommended for the 2006 TAC.

OTHER CONSIDERATIONS

Sexual maturity is reached at increasingly smaller sizes for Greenland halibut males and females. Based on recent studies on cod, it is believed that this drop is caused by heavy fishing pressure, although the exact causes are unknown. This reduction raises concerns in terms of conservation of the spawning stock.

The high percentage of immature individuals in commercial catches, obviously different between divisions, represents a source of concern.

Greenland halibut by-catches from the shrimp fishery from 1999 to 2005 were examined using the observers at sea database. At least one Greenland halibut was present in 89% of the activities observed. Fish by-catches are mostly of the order of 1 kg per tow observed. 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. Generally, catches (in numbers and in weight) are variable according to areas and years and appear to be largely influenced by the strength of recruitment and fishing effort by shrimpers. The annual average of Greenland halibut by-catches (in weight) from the shrimp fishery in the Estuary and Gulf from 1999 to 2005 is in the order of 100 tons and are mostly comprised of 1 and 2 year-old Greenland halibut.

SOURCES OF INFORMATION

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