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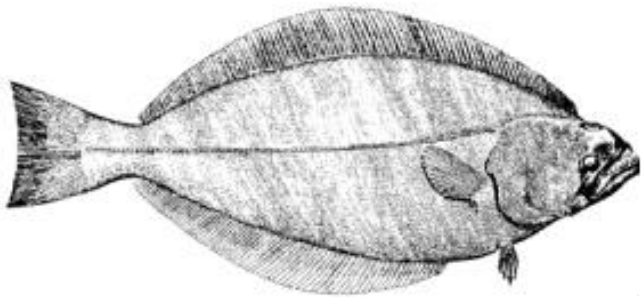
Canadian Science Advisory Secretariat
Quebec Region **Science Advisory Report 2017/049**

ASSESSMENT OF GREENLAND HALIBUT IN THE GULF OF ST. LAWRENCE (4RST) IN 2016



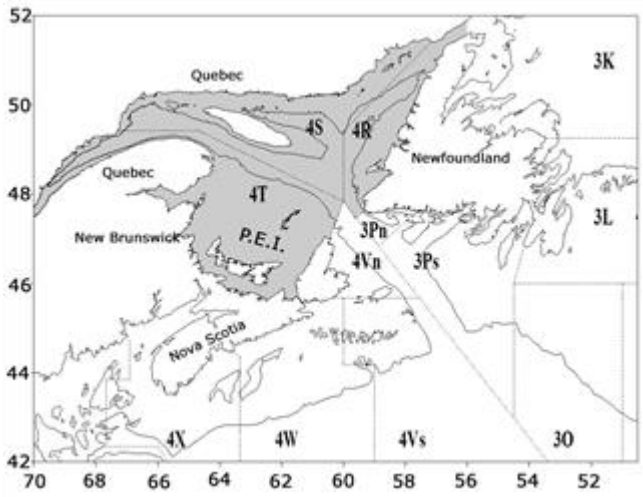


Figure 1. Greenland Halibut management area in the Gulf of St. Lawrence (shaded area) and neighbouring regions.

Context

Until the mid-1970s, Greenland Halibut (commonly called black halibut or 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. Following the closure of the Atlantic cod mobile gear in 1993, any mobile gear directed fishery for Greenland Halibut has been prohibited. This fishery is currently carried out by boats equipped with gillnets, whose home ports are mainly located in Quebec or on the west coast of Newfoundland.

The fishery is subject to several management measures including catch control by a total allowable catch (TAC) to limit the exploitation of the stock and a minimum size of 44 cm which aims to protect the reproductive potential of the population.

Resource assessment is conducted every two years to highlight changes in the status of the resource justify adjustments to the conservation approach and management plan. The main indicators used for the assessment are taken from fishery statistical data, sampling of commercial catches and research surveys. A science peer review meeting was conducted February 22, 2017 in Mont-Joli, Qc. Participants at the science review were from DFO Science, DFO Fisheries Management, fishing industry, provincial governments, Academia and Aboriginal organisations. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

SUMMARY

- Greenland Halibut landings reached 3,228 t (preliminary as of December 31) in 2016-2017 out of an allocation of 3,751 t. The fishing season will run until May 14, 2017.
- For the past 3 years, more than 83% of catches have been from the western Gulf. Landings are lower in Esquiman and negligible in northern Anticosti.
- Catch per unit effort (CPUE) from fishing is very high in the western Gulf, whereas it is lower in northern Anticosti and in Esquiman.
- In the gillnet directed fishery, bycatch estimated by at-sea observers represents on average 15% of the weight of the Greenland Halibut catch. Approximately one-third of these by-catches are landed.
- Size at sexual maturity decreased over the past two years to the lowest observed since 1990, 33 cm for males and 41 cm for females.
- Biomass indices from DFO research survey for fish over 40 cm decreased slightly in 2016 while the estimate for fish of 30 to 40 cm, pre-recruits to the fishery, has slightly increased. In both cases, the indices are comparable to the average of those series.
- The cohorts of 2012, 2013 and 2014 are very strong and will start recruiting to the fishery in 2018 while the 2015 cohort is very low. The growth of the 2013 and 2014 cohorts is slower than normal which could delay their recruitment to the fishery.
- Estimation the total biomass of Greenland Halibut by a preliminary population dynamics model (SCALE) shows a slight increase since 2013 and was at the highest value since 1990. The arrival of the cohorts 2012 and 2013 contributed to this increase.
- Deep water temperature increased in the Gulf of St. Lawrence and particularly in northern Anticosti and in Esquiman. For the last 4 or 5 years, fish were found on average at temperatures over 6°C, which is more than 1°C above the average between 1990 and 2015.
- Locally, in northern Anticosti and Esquiman, there is a decrease in catches, CPUE and biomass as well as an increase in bottom temperature, the situation is to be considered.
- The exploitable biomass of Greenland Halibut stock in 4RST has been high and stable since 2008. The landings of the past 10 years have helped to maintain a stable exploitation rate. The SCALE model projection indicates that exploitation biomass will remain stable, with an annual landing of 3,750 t for the next two seasons.

INTRODUCTION

Species Biology

In the early 1990s, parasite studies demonstrated that Greenland Halibut population of the Gulf of St. Lawrence (GSL) is a stock isolated from the main population of the northwestern Atlantic found east and west of the Grand Banks of Newfoundland. These studies concluded that GSL Greenland Halibut complete their life cycle within the Gulf.

Spawning takes place in winter, mainly between January and March. Males reach sexual maturity at a smaller size than females, at about 36 cm for males compared to 46 cm for females. This difference helps explain why females grow to be larger than males and make up the majority of commercial catches.

The diet of the Greenland Halibut varies depending on its size. Turbot under 40 cm have a diet that consists mainly of shrimps, capelin, small demersal fishes and macrozooplankton. Larger turbot eat mainly shrimps, herring, small demersal fishes, redfish and capelin. The turbot's main predators are Harp, Grey and Hooded seals and Atlantic Halibut.

The DFO research survey data indicate that Greenland Halibut occupy more than 85,000 km^2 in the northern Gulf of St. Lawrence (nGSL) and 95% of its biomass is concentrated over less than 50,000 km^2. It is mainly found in the channels of the GSL at depths ranging between 200 and 400 m (Figure 2) with more than 80% of the cumulative biomass of Greenland Halibut found between 230 and 365 m in areas with bottom temperature ranging from 4.4 and 5.7°C (Figure 3). This is the population living in the warmest waters of the Atlantic. Greenland Halibut is generally associated to the channels where sediments are fine and consolidated. Juveniles are predominant in the Estuary and north of Anticosti.

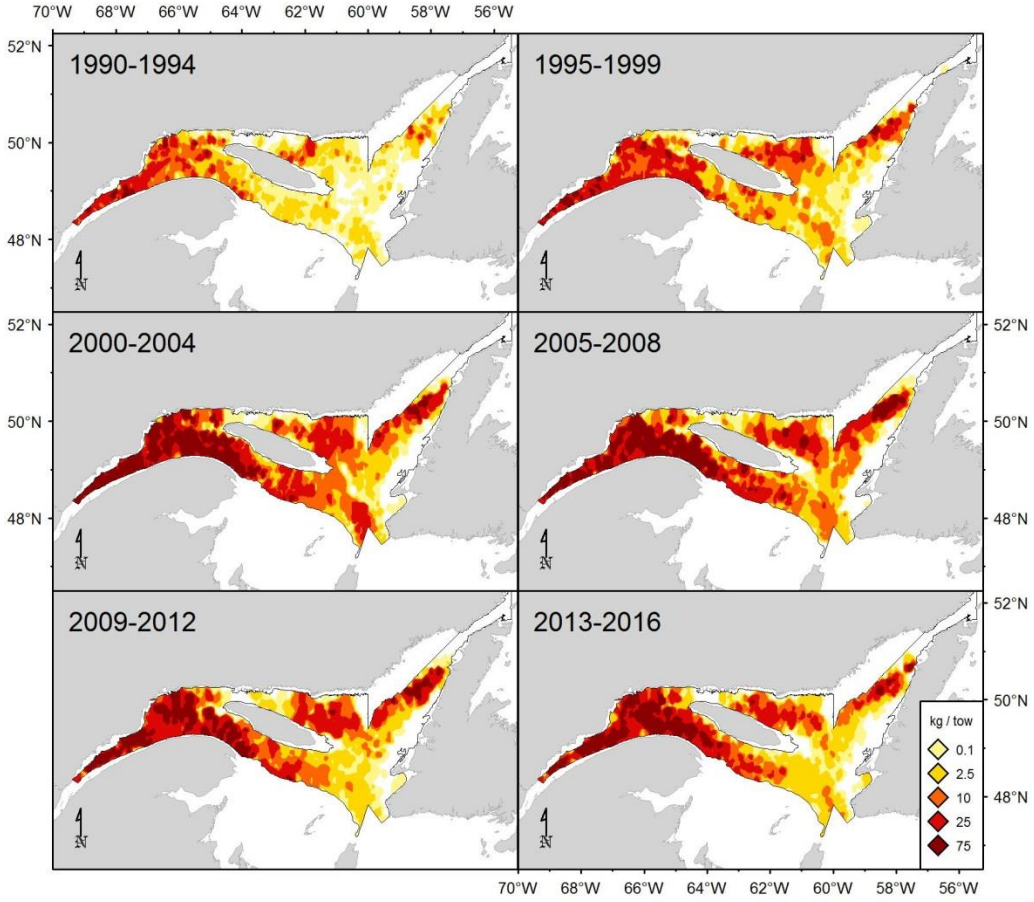


Figure 2. Greenland Halibut catch rates (kg/15 minutes tow) distribution during the nGSL DFO survey.

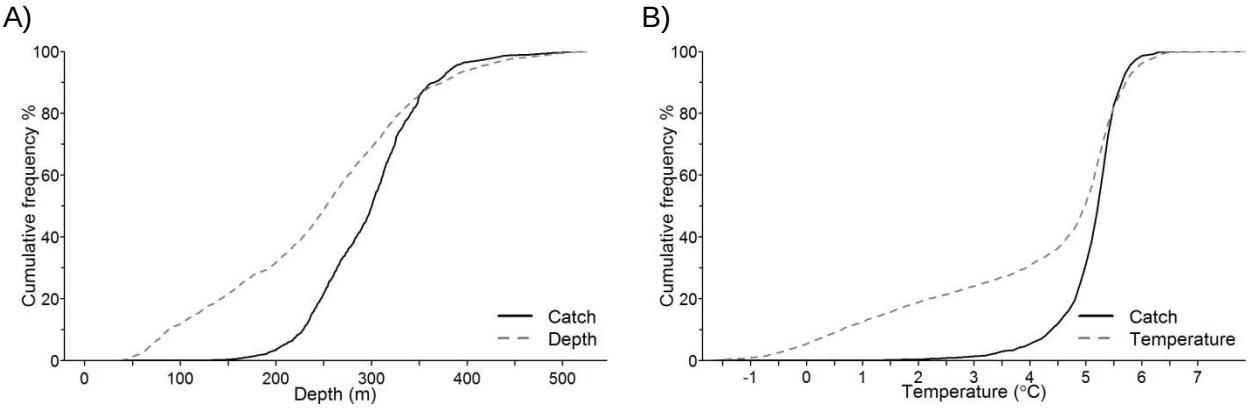


Figure 3. Cumulative frequency of catches (in weight) and of the number of tows sampled based on depth (A) and temperature (B) in the nGSL DFO survey from 1990 to 2016.

Description of the Fishery

In 2016, the number of active licences was about 89 from Quebec and 60 from Newfoundland. The fishery management measures include the imposition of a minimum mesh size of 152 mm (6.0 inches) and a minimum size of 44 cm for turbot as part of a small fish tolerance protocol in commercial catches.Fishermen must also keep a logbook, have their catches weighted by a dockside monitoring program and agree to have an observer on board at the DFO's request (5% coverage). Use of a vessel monitoring system (VMS) has been mandatory since 2013 on all vessels except for those of the less than 35 foot vessel sector in Newfoundland. The fishery opens on May 15 and closes on May 14 of the following year. The fishery has been managed by TAC since 1982. Some fishermen have individual quotas while others are under competitive regime.

Until the mid-1970s, Greenland Halibut landings in 4RST consisted mainly of by-catches from other fisheries (Figure 4). Subsequently, a directed gillnet fishery developed and landings fluctuated substantially, exceeding 8,000 t in 1979 and 1987. These peaks were both followed by sharp drops. Catches remained between 2,000 t and 4,000 t from 1989 to 1998. Landings decreased between 1999 and 2001, dropping from 3,600 tons to less than 1,300 tons. Landings increased to 3,900 tons between 2001 and 2004 and have been relatively stable since. TAC was set at 4,500 tons since 2004 and the allocation for the fixed gear directed fishery for Greenland Halibut was set at 3,751 t. Since 2012, the allocation of the directed fishery has not been reached, landings have averaged 3,200 t.

In 2015, landings for NAFO Divisions 4RST amounted to 3,373 t for fixed gear and 23 t for mobile gear (fishery not targeting Greenland Halibut), for a total of 3,396 t (Table 1). In 2016, preliminary landings by December 31 were 3,214 t for fixed gear and 14 t for mobile gear, for a total of 3,228 t.

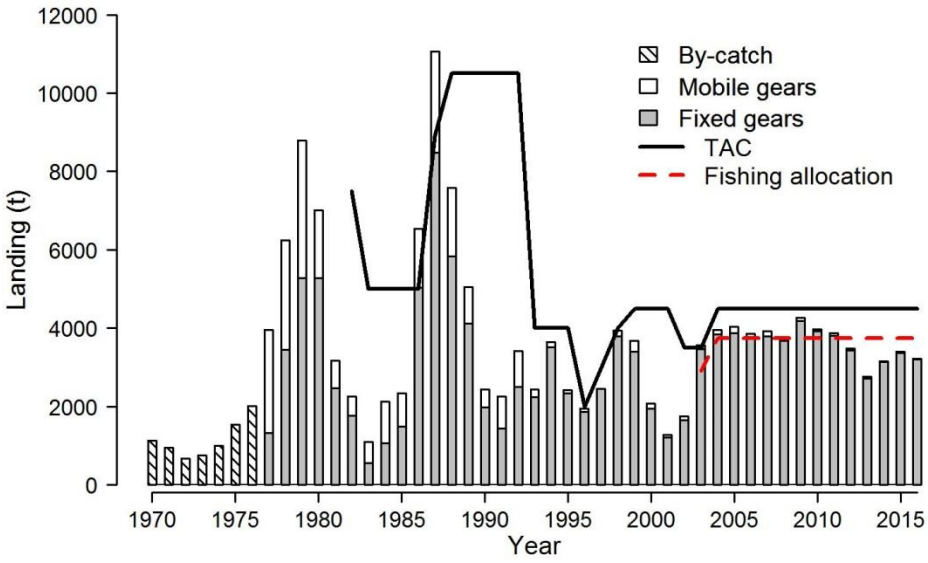


Figure 4. Greenland Halibut landings and total allowable catch (TAC) since 1970. Data for 2016 are preliminary. The 3,751 t fishing allocation to fixed gear is also highlighted.

Table 1. Annual landings (tons) per fishing season and annual average per 10-year period.

	Gears			
Period	Fixed	Mobile	Total	TAC
1980-1989	3612	1215	4827	7175
1990-1999	2558	309	2868	5700
2000-2010	3144	108	3252	4300
2010-2011	3924	47	3972	4500
2011-2012	3811	61	3872	4500
2012-2013	3432	49	3481	4500
2013-2014	2727	47	2774	4500
2014-2015	3145	14	3159	4500
2015-2016	3373	23	3396	4500
2016-2017[1]	3214	14	3228	4500

[1] *Preliminary data by December 31 2016.*

RESOURCE ASSESSMENT

The assessment of the Greenland Halibut stock (4RST) is mostly based on analysis of commercial fishery data and from research surveys. The fishery data come from three different sources of information; purchase slip, fisherman's daily logbook and samples of commercial catches. Two research surveys with trawl were conducted annually in the nGSL. The first one in July with the Sentinel program and the second in August with a DFO vessel. During sampling of commercial and survey catches, the fish are sexed. In addition, data on weight, sexual maturity of males and females and the condition of the fish are collected during the DFO survey.

Biological Data

Males and females Greenland Halibut size at 50% maturity has dropped between 1996 and 2001 and has remained relatively stable until 2014, then declined again to reach the lowest value of the series in 2016 (Figure 5A). The size dropped from 40 cm to 33 cm for males and from 50 cm to 41 cm for females over the past 20 years. The size at maturity for males is considerably lower than the minimum size of 44 cm established for the small fish protocol. Moreover, the proportion of mature individuals at length indicates that at 44 cm, 71% of females and 95% of males are mature. Because the 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. The proportion of females in the catch was 84% in 2015-2016.

The average size of turbot caught in the commercial fishery increased from 2002 to 2012, from 45 cm to 49 cm (Figure 5B). It remained high for females in 2015 and 2016 while it declined for males. The average size of turbot caught in 2016 was 45 cm and 50 cm for males and females respectively. These annual variations in commercial average sizes can be explained in part by a shift in fishing effort, such as the recent increase in fishing effort in the western Gulf and the strength of recruiting cohorts to fishing; a large cohort entering the fishery could decrease the average size of the fish caught.

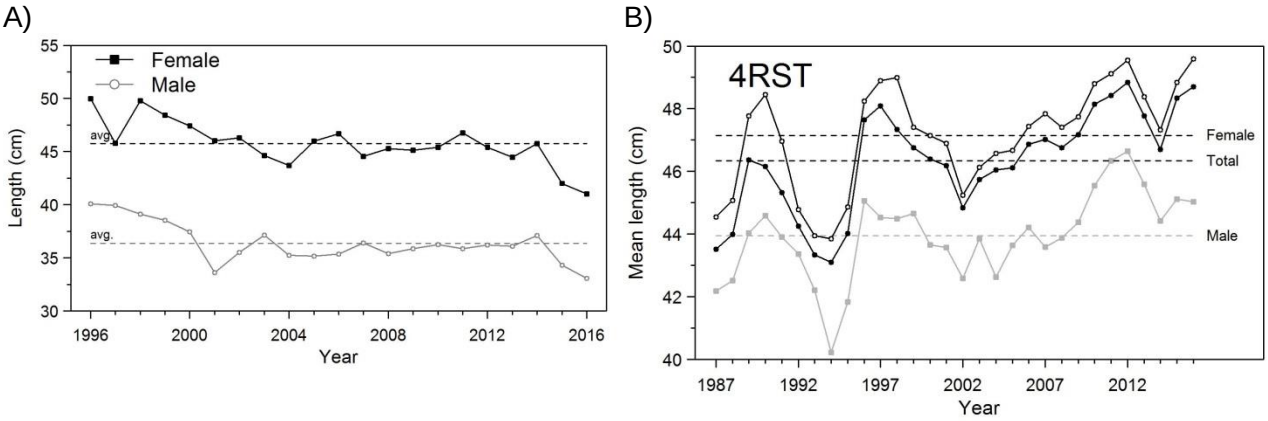


Figure 5. Size at 50% maturity for fish caught in the DFO research survey (A) and mean length of fish caught in the commercial gillnet fishery (B). The horizontal lines indicate the mean of the series.

Commercial Fishery Performance

In 4RST area, fishing effort has been decreasing since 2014 while landings remain constant (Figure 6). Since 2014, there has been a shift in fishing effort from northern Anticosti and Esquiman to the western Gulf, with over 83% of the catch now coming from the western Gulf. The fishing effort was almost zero in 2015 and 2016 in northern Anticosti. In Esquiman, there has been a decrease in landings of about 70% over the past five years while effort has decreased by only 23%. Conversely, in the western Gulf, landings increased by 149% in 2014 and remained high for comparable fishing effort.

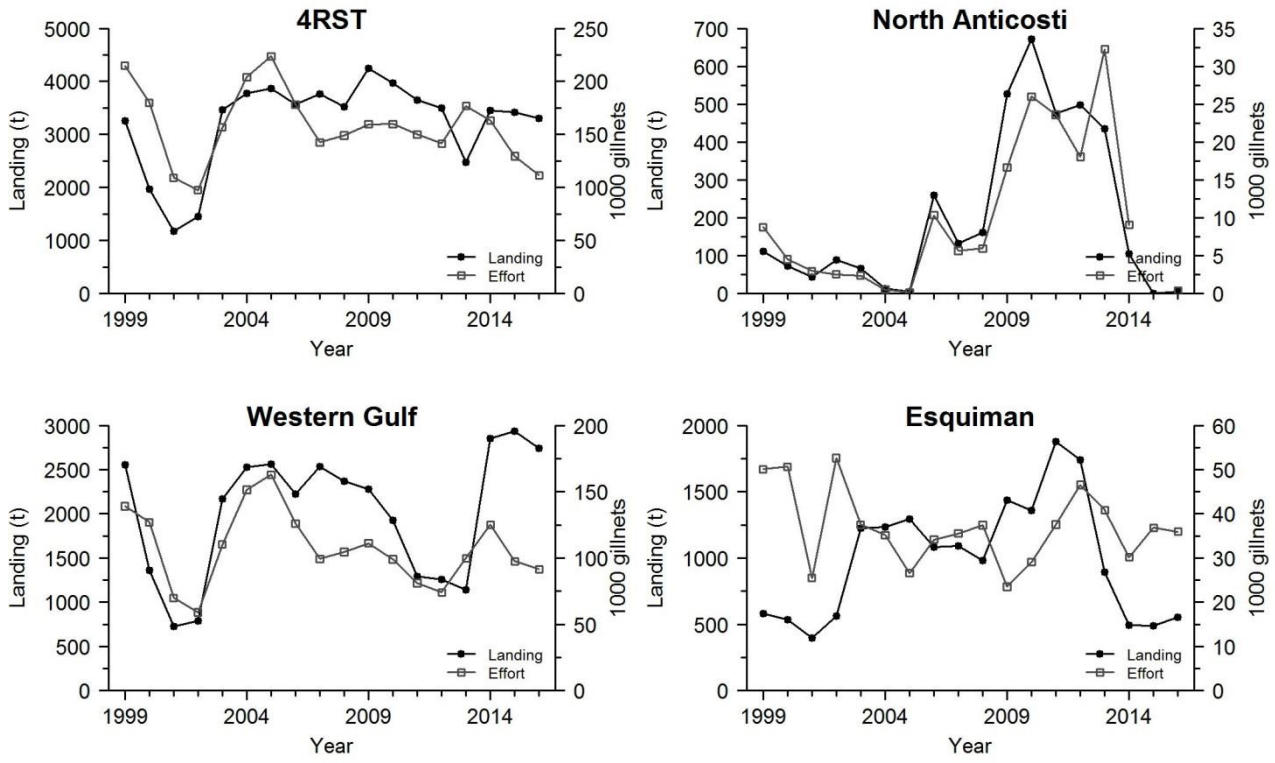


Figure 6. Landing and fishing effort for the Gulf (4RST) and per fishing sectors.

In 2013, the fishing effort was spread over a larger area (Figure 7). An expansion of fishing effort was observed eastward in the Laurentian Channel, south and north of Anticosti Island, and southwest of Esquiman. The spatial distribution of fishing effort changed in 2014, while the fishing effort was concentrated on a smaller area north of Anticosti and Esquiman. The increase in effort in the western Gulf was mainly observed along the Gaspé Peninsula and in the Estuary. In 2015 and 2016, there was very little or no fishing effort north of Anticosti, the fishing effort was mainly deployed in the western Gulf.

The commercial catch rate is used as an index of fishery performance and not as an index of abundance of exploitable stock. This index is standardized to account for changes based on NAFO subarea, soak time and seasonal pattern. The average catch per unit effort (CPUE) in the Gulf has been increasing since 2013 (Figure 8). This increase is only observed in the western Gulf where CPUEs are very high, while in northern Anticosti and Esquiman CPUEs are decreasing and have been very low for three or four years.

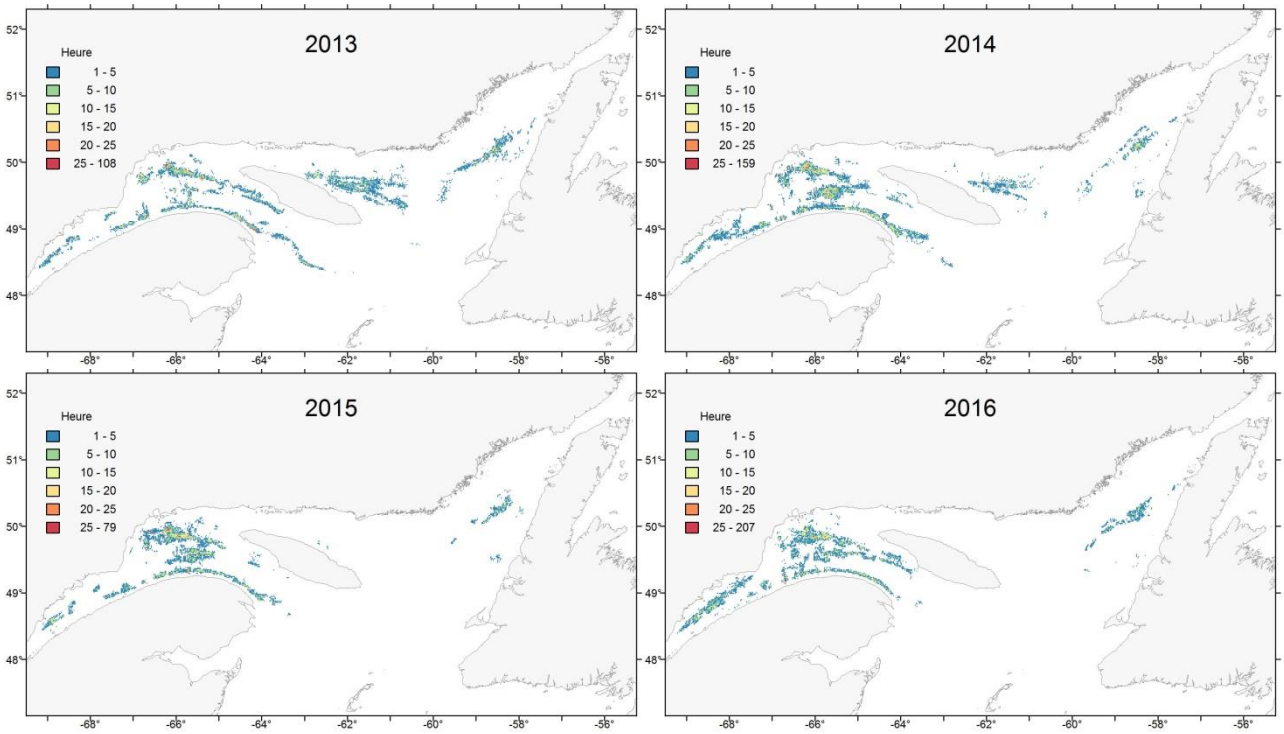


Figure 7. Distribution of directed fishing effort on Greenland Halibut, total number hours of fishing vessel positioning according to the vessel monitoring system (VMS) data for the years 2013 to 2016.

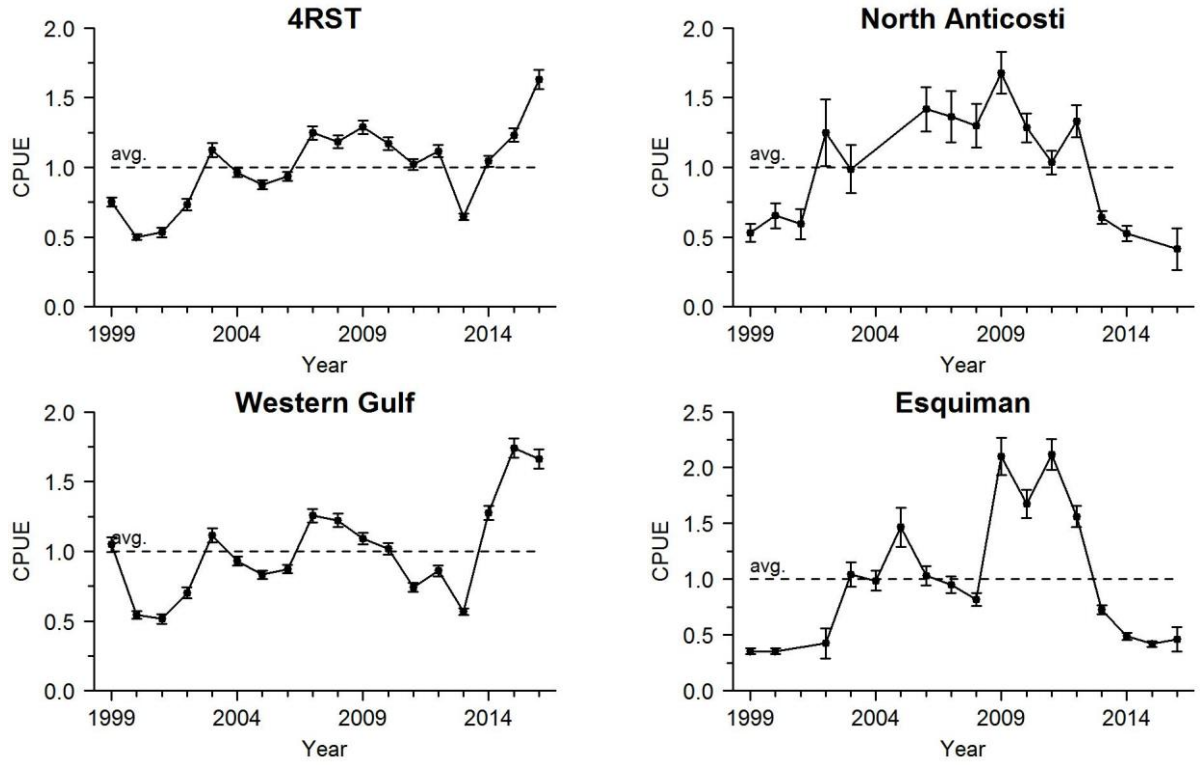


Figure 8. Standardized indices of fishing performance for the Gulf (4RST) and per fishing regions.

Stock status indices

The turbot biomass index derived from the DFO survey has been stable and slightly above average since 2009, while that from the sentinel survey is below average in 2015 and 2016 (Figure 9). These two indices show different trends, namely stability for the DFO survey and a downward trend for the sentinel survey. This difference can be explained by the fact that the sentinel survey does not cover the estuary and the selectivity of the trawls used is low for small fish. A significant proportion of the total biomass is therefore not sampled by this survey.

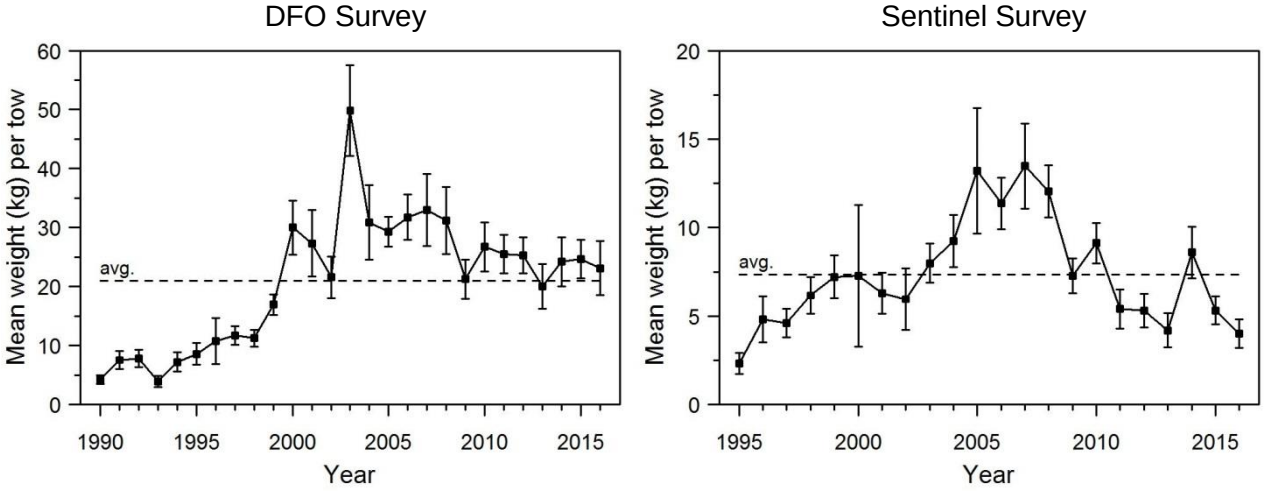


Figure 9. Indices of mean weights per tow estimated from the DFO research survey and the July Sentinel mobile survey.

The abundance of one-year-old fish (0-20 cm) is very low in 2016 in the DFO survey, whereas it was high between 2013 and 2015 (Figure 10). Abundance of two-year-old fish (20-30 cm) is higher than average while for fish of 30-40 cm and those over 40 cm their abundance is comparable to average. Abundance indices in the sentinel survey show that they are below average for all four length categories.

Size frequency distributions in 2015 and 2016 indicate that one-year (15-20 cm) and two-year (20-30 cm) fish are smaller than average for the same age (Figure 11) . The lower growth of cohorts in 2013 and 2014 may delay their recruitment to the fishery.

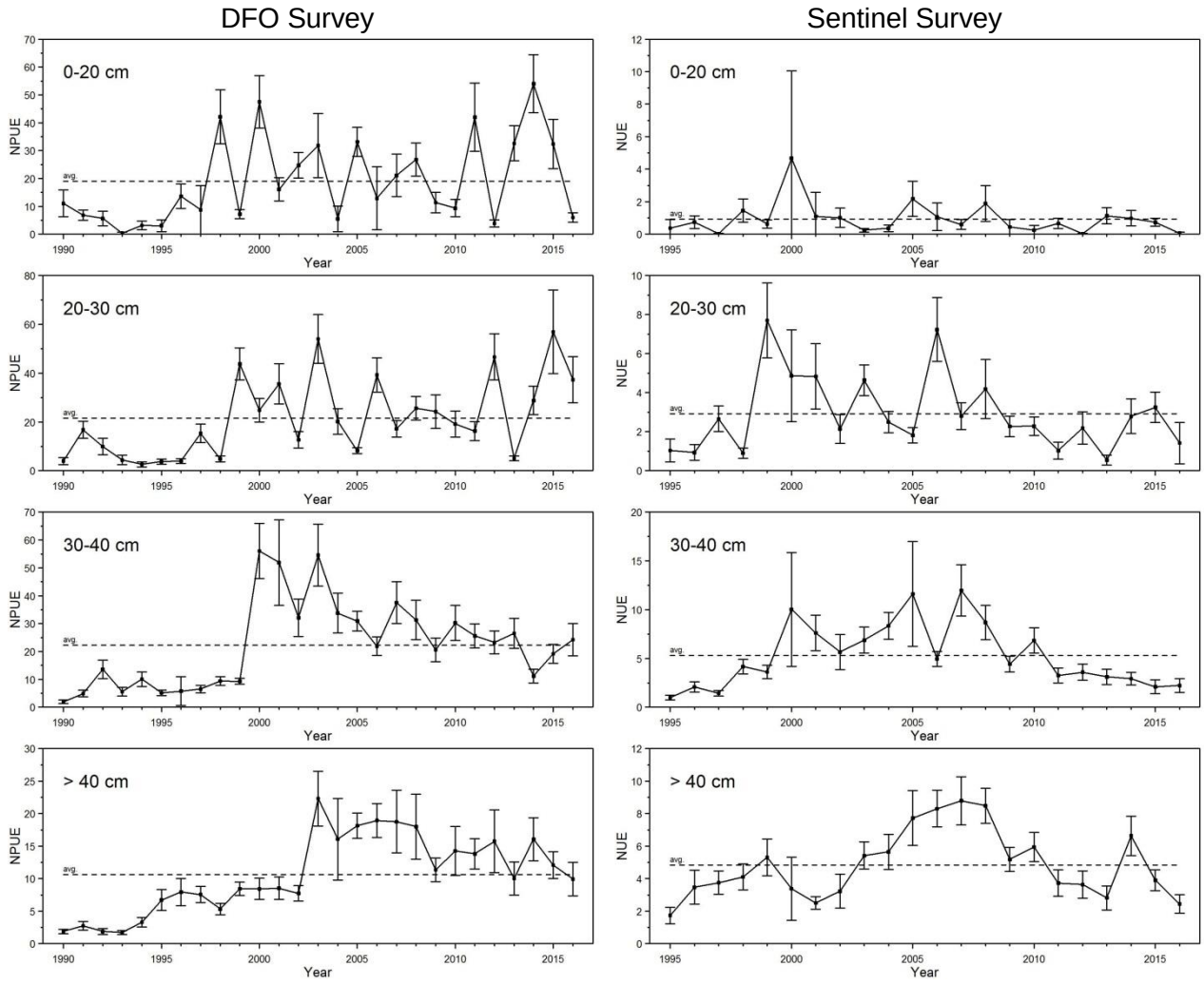


Figure 10. Indices of number per tow of Greenland Halibut for the different size categories observed in the DFO survey and in the July Sentinel mobile survey.

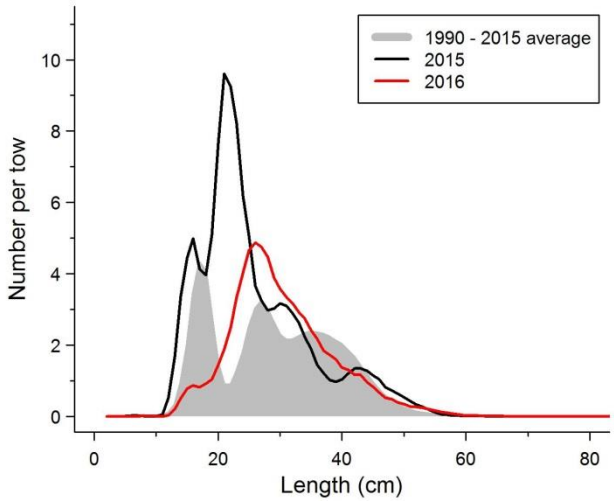


Figure 11. Length frequency distributions (mean number per 15 minutes tow) observed for Greenland Halibut during the DFO survey.

The condition index for Greenland Halibut has declined in recent years (Figure 12). Fish less than 40 cm have condition index lower than their respective series average while Greenland Halibut over 40 cm have condition index comparable to the average (1990-2015).

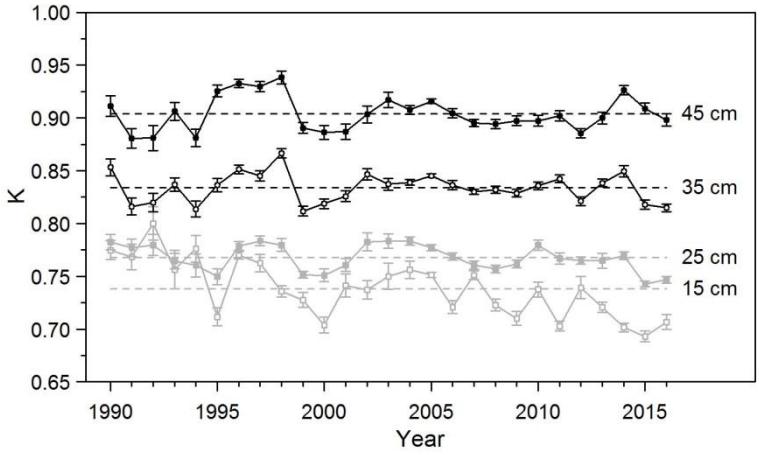


Figure 12. Fulton condition index by year for Greenland Halibut of 15, 25, 35 and 45 cm measured during the DFO survey. The dotted lines represent the chronological series average.

Catches of Greenland Halibut during the DFO survey show that it is distributed in the estuary and area west of Anticosti Island and at the head of the Esquiman, Laurentien and Anticosti channels, at depths greater than 200 m (Figure 2). In 2016, Greenland Halibut was mainly concentrated west and southwest of Anticosti Island and in the Estuary while catch rates in northern Anticosti and Esquiman declined in recent years (Figure 13).

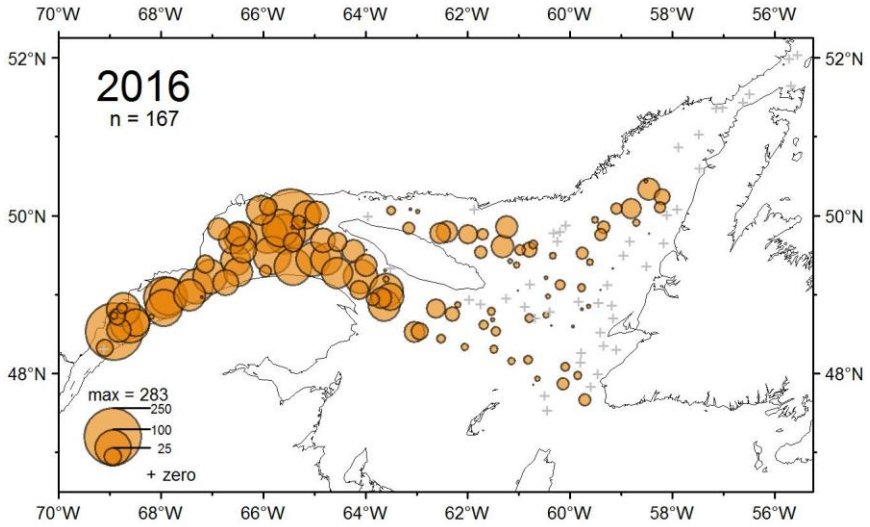


Figure 13. Greenland Halibut catch rates (kg/15 minutes tow) distribution in 2016 during the DFO survey.

An exploitation rate index is obtained by dividing the commercial catches in weight by the biomass of fish over 40 cm estimated using the DFO research survey data. This method cannot be used to estimate the absolute exploitation rate or to relate it to target exploitation rates. However, the method makes it possible to track relative changes over time. For the whole Gulf, the exploitation rate increased slightly in 2016 (Figure 14). In the northern Anticosti sector, the exploitation rate was practically nil in 2015 and 2016 since fishing effort was very low. In

contrast, in the western Gulf and Esquiman sectors, there has been an increase in the exploitation rate in recent years and it is now above average.

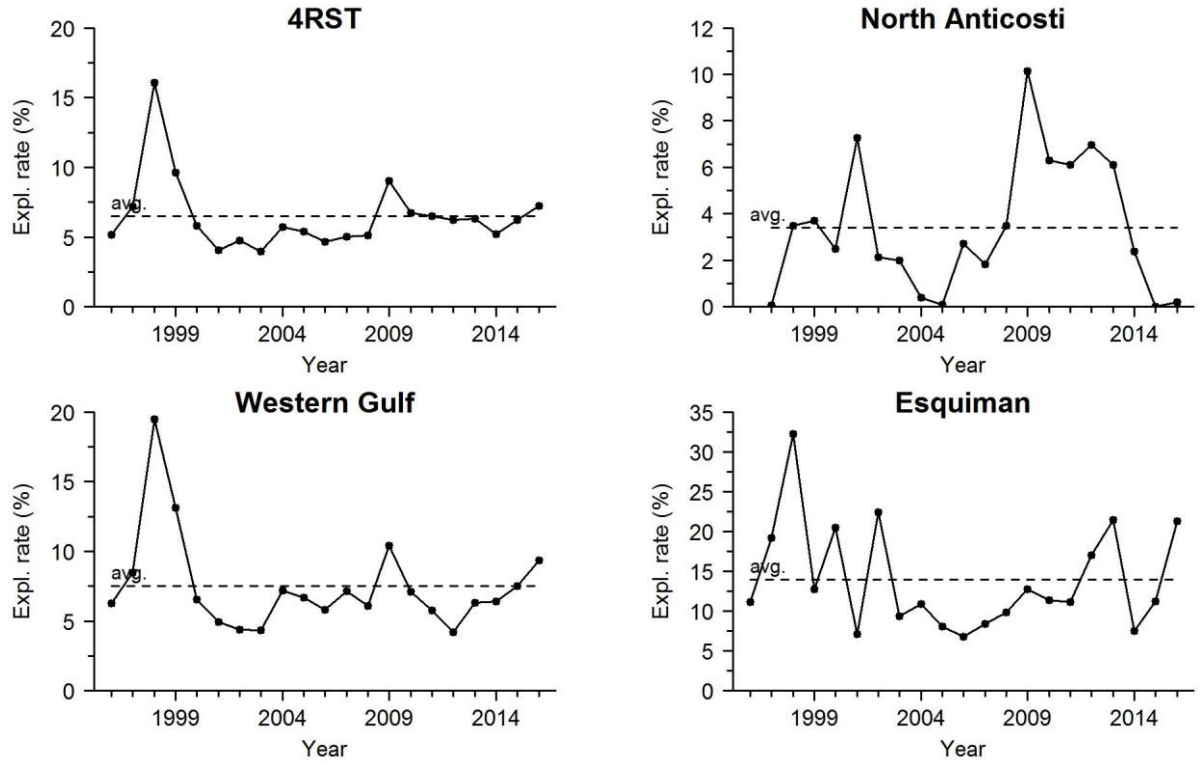


Figure 14. Indices of the relative exploitation rate for the Gulf (4RST) and per fishing sectors.

Precautionary approach

As part of the development of a precautionary approach, reference points for the Greenland Halibut stock were examined. The biomass of fish larger than 40 cm estimated during the DFO summer survey, from 1990 to 2016, was chosen as the indicator to set reference points. This indicator corresponds to the longest time series available and represents a proxy for mature stock biomass. During this period, the stock experienced significant variations in productivity and biomass, these variations are taken into account in the establishment of reference points.

By definition, the limit reference point (LRP) is the level of a stock below which productivity is sufficiently weakened to cause severe damage and yet is above the level where extinction becomes a concern. This limit reference point for 4RST Greenland Halibut has been estimated at 10,056 t (Figure 15). It corresponds to the geometric mean of the estimated mature biomass for the period 1990 to 1994, which is the lowest level of population where a recovery of the stock was observed.

The Upper Reference Point (URP) was discussed, but will be determined by fisheries managers based on consultations with the fishing community, other interested groups and advice provided by the Science Sector. From these reference points, decision rules for catch adjustment will need to be developed in collaboration with industry and fisheries managers.

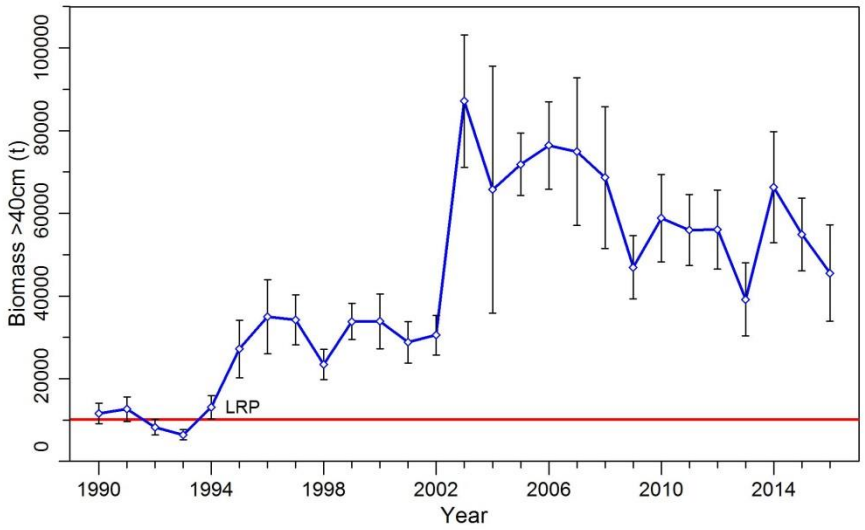


Figure 15. Indicator of biomass of Greenland Halibut greater than 40 cm from the DFO survey. The horizontal line shows the limit reference point (LRP) in the context of a precautionary approach.

Juvenile abundance varies greatly from one year to the next. The strength of these annual year-classes, their growth, as well as environmental conditions influence stock abundance. These fluctuations of stock abundance have an impact on the fishery's success. According to growth estimates, females and males reach a size of 44 cm at age six and seven, respectively.

The 2012, 2013 and 2014 cohorts of are very strong and will start recruiting to the fishery in 2018. The 2015 cohort is very weak (Figure 16). However, growth of the 2013 and 2014 cohorts is slower than normal, which could delay their recruitment to the fishery.

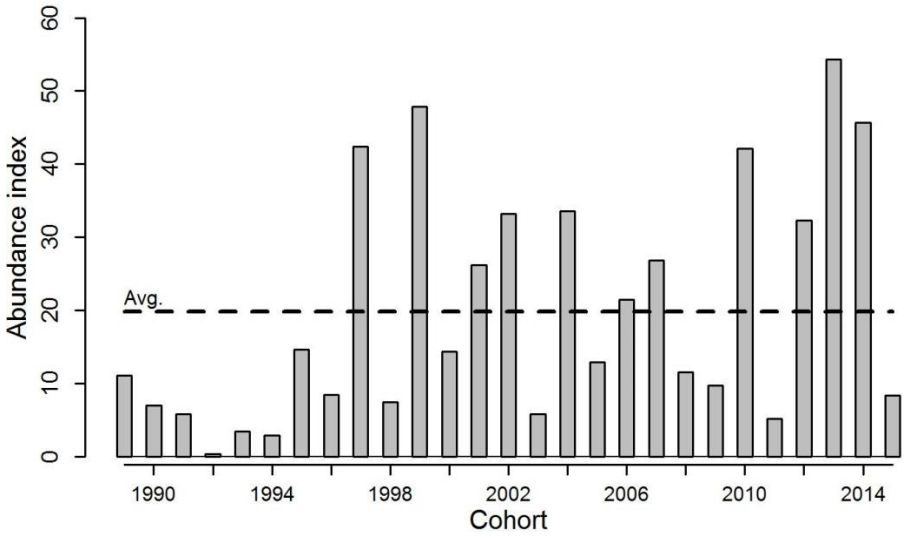


Figure 16. Annual recruitment index per cohort. Abundance of Greenland Halibut determined for each cohort at age 1 during the DFO survey.

A new model of population dynamics (SCALE) based on length data was used to provide an overview of the state of the population. Total stock biomass has been increasing since 2013 and would be at its highest level since 1990 (Figure 17). The arrival of the 2012 and 2013 cohorts would have contributed to this increase while the exploitable biomass remained stable for the same period. Projections indicate that abundance and exploitable biomass for the period 2017 to 2020 would increase with annual catches of 3,750 t. This increase would be due to the recruitment to the fishery of the 2012 to 2014 cohorts in the coming years.

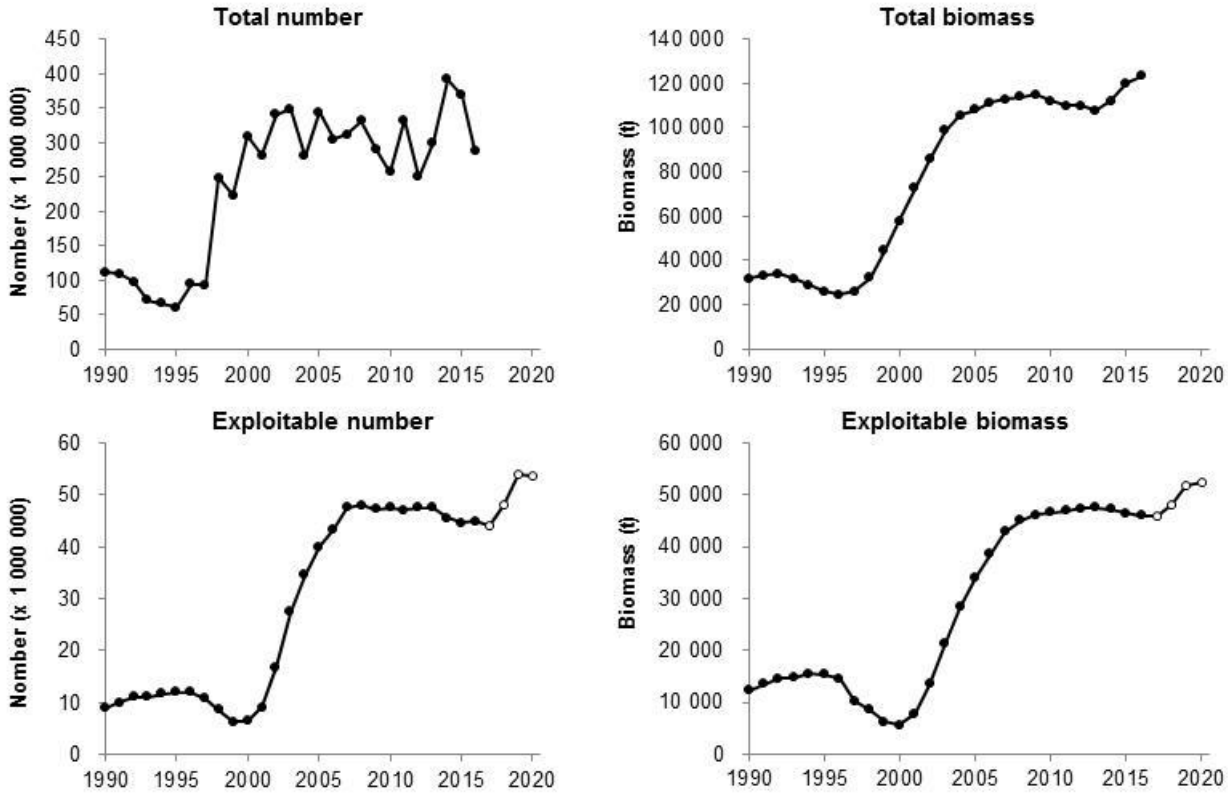


Figure 17. Total and exploitable number and biomass estimated by population dynamic model SCALE for the period 1990 to 2016 (solid circle) and projections for 2017 to 2020 (open circle).

Sources of Uncertainty

The growth rate of Greenland Halibut appears to have decreased in recent years. Slower growth is observed in the 2013 and 2014 cohorts. In addition, there is a decrease in size at 50% maturity and in the condition of the fish. These decreases in growth and condition could delay the recruitment of fish to the fishery.

Locally, in northern Anticosti and Esquiman, there is a decrease in catches, CPUE and biomass. A combination of factors could explain these decreases, for example the increase in the exploitation rate in previous years and the increase in the bottom temperature. These changes in the environment are to be considered because they could have impacts on the evolution and the level of future biomass of the population.

CONCLUSIONS AND ADVICE

The exploitable biomass of Greenland Halibut stock in 4RST has been high and stable since 2008. Landings over the last 10 years have helped maintain a stable exploitation rate. The SCALE model projection indicates that exploitable biomass will remain stable, with an annual landing of 3,750 t for the next two seasons.

Changes in the environmental and ecosystem conditions observed in the Gulf of St. Lawrence could have an impact on the population dynamics of Greenland Halibut, such as effects on spatial distribution, growth, reproduction and trophic relationships.

OTHER CONSIDERATIONS

Bycatch in the directed Greenland Halibut fishery with gillnets was estimated for the period 2000 to 2016 using data from the at-sea observer program. Bycatch in this fishery averages slightly over 400 t (Figure 18) which represent 15% of Greenland Halibut landed weight. The most common species are, in order of importance, American Plaice, Snow Crab, Redfish, Spiny Crab, Thorny Skate, Atlantic Halibut, Skates and Witch Flounder (Table 2). Approximately one third of the bycatch is landed, the rest being discarded at sea.

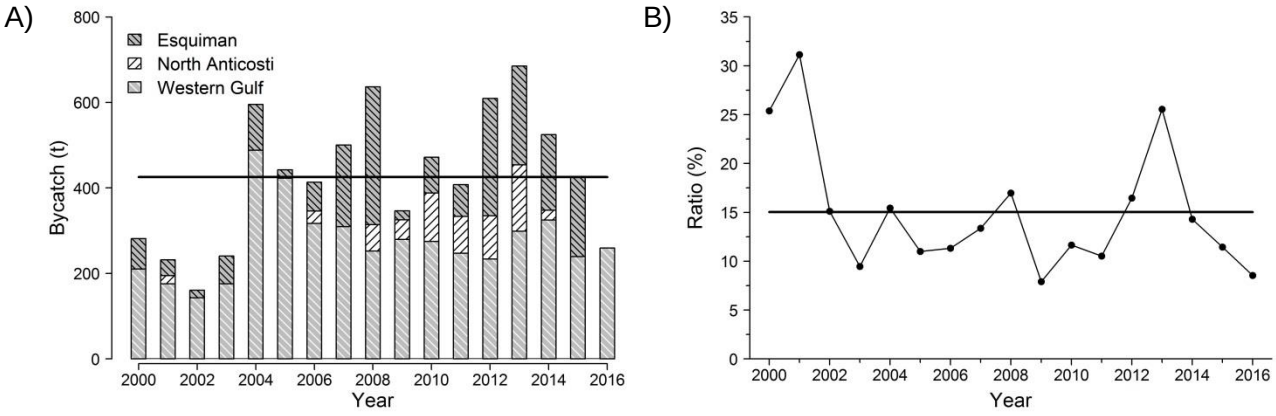


Figure 18. A) Bycatch for all species combined by year and fishing sector during the Greenland Halibut directed gillnet fishery in the presence of an at-sea observer. B) Ratio (%) of bycatch weight over the weight of total catch of Greenland Halibut. The solid lines indicate the average for the period 2000 to 2014. Data for 2016 are preliminary; no information was received from the Newfoundland region as of December 31, 2016.

Table 2. Occurrence and bycatch of the most common species (occurrence > 10%) in the Greenland Halibut directed gillnet fishery in 2015 and 2016 and average values for the period 2000 to 2014.

	Occurrence (%)			Bycatches (kg)		
Taxon	2000-2014	2015	2016	2000-2014	2015	2016
*Greenland Halibut	99.7	100.0	100.0	3122037	3707544	3038494
*American Plaice	77.8	64.1	76.3	38305	19750	20488
Snow Crab	62.7	54.7	59.4	71848	23079	16890
*Redfishes	54.8	60.6	66.4	23280	19593	9950
Spiny Crab	48.6	61.0	43.0	26323	21245	7626
Thorny Skate	47.3	56.6	84.9	53695	77148	86076
*Atlantic Halibut	45.2	49.7	49.2	86338	93856	46573
Skates	41.4	32.0	15.6	44131	23586	14467
*Witch Flounder	31.4	31.3	71.6	5012	8098	6771
Anthozoan	19.2	38.8	62.8	5685	6421	8913
*Monkfish	18.9	7.5	17.4	6771	2001	4107
*Atlantic Cod	18.7	30.7	18.0	14407	9717	4714
Smooth Skate	14.9	13.3	13.3	8591	26583	3021
*White Hake	14.7	10.7	24.0	5086	1780	6166
Black Dogfish	12.2	3.6	21.1	16753	34353	6673

* Species landed in commercial fisheries.

The shrimp fishery is carried out using small-meshed trawls that catch and retain several fish and marine invertebrate species. Although large fish are released from trawls due to the mandatory use of a separator grate, catches still contain a certain number of small specimens. Greenland Halibut bycatch from the shrimp fishery from 2000 to 2015 were examined using the observers at sea database. Greenland Halibut were present on average in 89% of the activities observed. Greenland Halibut bycatch are mostly of the order of 3 kg or less per tow and are mostly made up of 1 year-old individuals, and in a lesser extent 2 year-old individuals. The average annual Greenland Halibut bycatch from the shrimp fishery in the Estuary and Gulf from 2000 to 2013 are around 85 tons. In 2015, they were estimated at 135 t of Greenland Halibut, representing approximately 0.34% of the biomass of small turbot estimated from the DFO survey.

In recent years, the temperature of deep waters has increased throughout the Gulf. The warming of the waters at 300 m depth, observed in the last 3 to 4 years in the north-west and the center of the Gulf, should continue for 1 to 2 years. In the Estuary, the colder temperature of recent years at the same depth has now become normal and is expected to increase over the next 3 to 4 years. Waters flowing in through the Cabot Strait continue to be warm. Thus, future temperatures at 200 m and 300 m in the Gulf will continue to be warm over the next few years. North of Anticosti and Esquiman, turbots are found on average at temperatures of more than 6^{o}C, which is more than 1^{o}C above the 1990-2014 average. Greenland Halibut is a cold-water species, if warming of bottom water continues, its range of distribution in the Gulf of St. Lawrence could decrease.

The nGSL ecosystem, dominated by groundfish in the early 1990s, has migrated to an ecosystem dominated by forage species. The abundance of Greenland Halibut and Northern Shrimp increased as the abundance of large groundfish species declined. In recent years, there has been an increase in the abundance of Redfish and Cod in the northern Gulf (Figure 19). Trophic changes could be observed in the next few years since Redfish are a competitor of Greenland Halibut, both species having several common preys in their diet including Northern Shrimp.

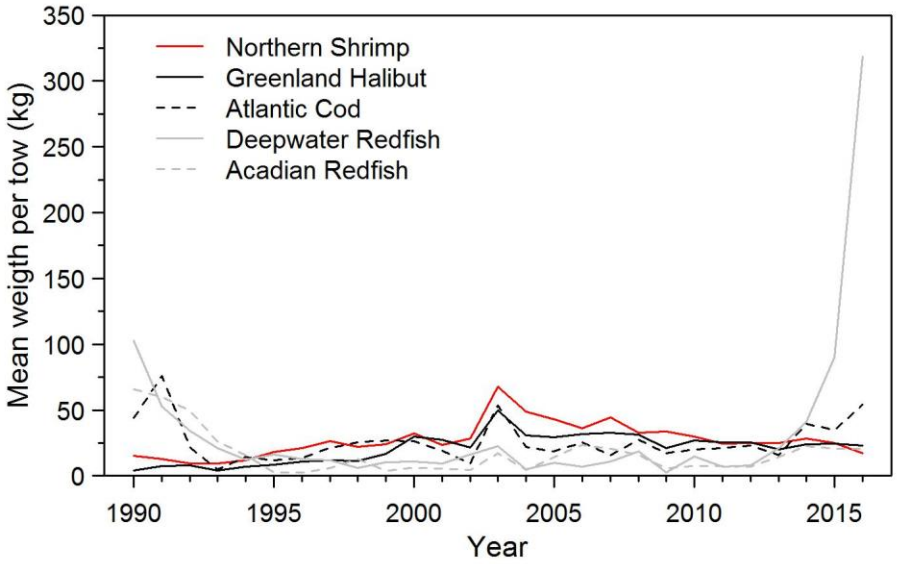


Figure 19. Biomass indices (kg per tow) estimated during the DFO survey in the nGSL for the main groundfish species and Northern Shrimp

Assessment calendar

The 4RST Greenland Halibut stock is currently assessed and managed on a two-year cycle. In the interim years, an update of key resource indicators is prepared to provide fisheries management with an overview of the most recent stock status. The indicators used to monitor the status of the stock are landings and abundance indices from the DFO survey. The next update is scheduled for December 2017, to allow sufficient time to prepare a full assessment and to plan for peer review if the indicators signalled that a full assessment is required prior to the one scheduled for winter 2019. The element that could trigger a re-assessment is a decrease of more than 30% in the biomass index of fish greater than 40 cm in the DFO survey when this biomass is in the caution or critical zone defined according to the precautionary approach.

SOURCES OF INFORMATION

This Science Advisory Report is from the meeting of February 22, 2017 on the Assessment of Greenland Halibut in the Gulf of St. Lawrence (4RST). Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

Bernier, B. and Chabot, D. 2012. Évaluation de l'état du stock de flétan du Groenland (*Reinhardtius hippoglossoides*) du golfe du Saint-Laurent (4RST) en 2010 et description de son régime alimentaire. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/140, 93 p.

Bourdages, H., Brassard, C., Desgagnés, M., Galbraith, P., Gauthier, J., Légaré, B., Nozères, C. and Parent, E. 2017. Preliminary results from the groundfish and shrimp multidisciplinary survey in August 2016 in the Estuary and northern Gulf of St. Lawrence. DFO Can. Sci. Advis. Sec. Res. Doc. 2017/002. v + 87 p.

Bourdages, H., and Marquis, M.C. 2014. Évaluation des stocks de crevette nordique de l'estuaire et du golfe du Saint-Laurent en 2013 : données de la pêche commerciale. DFO Can. Sci. Advis. Sec. Res. Doc. 2014/051. v + 90 p.

DFO. 2016. Guidelines for providing interim-year updates and science advice for multi-year assessments. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2016/020.

Galbraith, P.S., Chassé, J., Caverhill, C., Nicot, P., Gilbert, D., Pettigrew, B., Lefaivre, D., Brickman, D., Devine, L., and Lafleur, C. 2017. Physical Oceanographic Conditions in the Gulf of St. Lawrence in 2016. DFO Can. Sci. Advis. Sec. Res. Doc. 2017/044. v + 91 p.

Stortini, C.H., Chabot, D. and Shackell, N.L. 2016. Marine species in ambient low-oxygen regions subject to double jeopardy impacts of climate change. Global Change Biology (2016), doi: 10.1111/gcb.13534.

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