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Gulf of St. Lawrence (4RST) Greenland Halibut Stock Status in 2024

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

The status of the Greenland halibut (*Reinhardtius hippoglossoides*) stock in the Gulf of St. Lawrence (NAFO Divisions 4RST) is assessed on a two-year cycle that corresponds to the management cycle for this stock. This research document presents the data, analyses, and indicators reviewed during the peer review meeting held on February 20–21, 2025, at the Maurice Lamontagne Institute and virtually. The data used to assess stock status come from fishery statistics, commercial catch sampling, the at-sea observer program, and scientific surveys.

Preliminary landings, fishing effort, and catch per unit effort have shown declining trends for several years and reached their lowest values of their respective time series in the 2024–2025 fishing season. The average size of Greenland halibut in the commercial fishery and the proportion of individuals below the minimum regulatory size reached, respectively, the lowest and highest values observed since the mesh size change in 1996. Abundance and biomass indices from the three scientific surveys have shown a downward trajectory since the mid-2000s, and nothing in the survey size-structure in 2024 suggest that this trend might change. Current environmental conditions and climate projections indicate that the situation is likely to remain unfavorable for stock productivity.

The exploitation rate indicator was at its lowest observed levels in 2023 and 2024. The stock status index in 2024, estimated at 11,240 t, placed the stock in the lower part of the cautious zone of its Precautionary Approach framework. Based on the harvest decision rule for this stock, the 2024 stock status indicator corresponds to a maximum exploitation rate of 2.58% and a catch option of 290 t for the 2025–2026 and 2026–2027 fishing seasons.

This document also presents analyses on bycatch in the Greenland halibut and northern shrimp fisheries, the spatial and environmental distribution of Greenland halibut in summer and winter, size at maturity, the stock–recruitment relationship, diet, and unaccounted mortality in the directed gillnet fishery.

1. INTRODUCTION

1.1. BIOLOGY

Greenland halibut is a flatfish belonging to the family *Pleuronectidae* and is also known as black halibut and turbot. Its Latin name, *Reinhardtius hippoglossoides*, means that it resembles a horse's tongue (Figure 1). Like other flatfish, Greenland halibut undergoes significant physical and physiological changes over its lifetime. At hatching, its body is bilaterally symmetrical, and it swims upright like a roundfish; shortly afterward, it turns over on its side to swim. Gradually, the eye on the lower side migrates to the upper side and its skull twists. The fact that its left eye does not migrate completely gives it extensive peripheral vision. After this metamorphosis, its diamond-shaped body becomes laterally compressed and asymmetrical. The eyed (upper) side is blackish, dark brown or gray with lighter markings, while the blind side is usually pale grey. Principal distinguishing features include a straight lateral line and caudal fin, a large mouth and large, pointed teeth.

Current knowledge of the Gulf of St. Lawrence (GSL) stock indicates that spawning occurs in winter, between January and March, in the deep part of the Laurentian Channel southwest of Newfoundland (Templeman 1973, Ouellet et al. 2011, Ghinter et al. 2023). The female produces large eggs (diameter 3.4 to 4.7 mm), and the species is considered to have low fecundity (Kennedy et al. 2009, Dominguez-Petit et al. 2012). Turbot spawns only once per year, and some individuals may not reproduce every year (Kennedy et al. 2009). Histological studies have identified an unusual reproductive strategy in Greenland halibut, in which two cohorts of oocytes develop simultaneously (Kennedy et al. 2011, Rideout et al. 2012). One cohort of larger oocytes from the previous year develops for the upcoming spawning season, while a second cohort of smaller oocytes develops for the following year's spawning. This strategy allows Greenland halibut to spawn annually in principle, although each cohort requires more than one year to complete vitellogenesis.

The eggs produced by turbot are mesopelagic due to their specific density. For most of their development, they remain at depths of around 300 m and, following a significant change in their specific density, rise to shallower depths to hatch (Ouellet et al. 2011). After the yolk sac is absorbed, pelagic larvae are mostly found in the surface layer, based on sampling conducted from the surface down to 50 m, where larval development occurs. Larval development takes place in this surface layer and may last up to four months. Afterwards, the larvae settle on the bottom and eventually complete their metamorphosis.

The main nursery area for the Gulf of St. Lawrence Greenland halibut stock is located in the St. Lawrence Estuary, with a secondary nursery north of Anticosti Island (Youcef et al. 2013). One- and two-year-old individuals are relatively sedentary in these two regions and are generally found at shallower depths than adults. Juveniles grow continuously in length, and the size increase between ages 1 and 2 is influenced by temperature, dissolved oxygen levels, and fish density (Youcef et al. 2015). Turbot is considered a strong swimmer, performing significant daily vertical migrations, covering more than 100 m in 15 minutes, and spending about 25% of its time in the water column (Albert et al. 2011).

Greenland halibut exhibits sexual size dimorphism due to a slowdown in growth upon reaching sexual maturity. Males reach sexual maturity at smaller sizes (~36 cm) than females (~45 cm) and attain smaller adult sizes (Chamberland and Benoît 2024). In addition, GSL turbot reach sexual maturity at sizes significantly smaller than individuals found elsewhere in the Northwest Atlantic, except in the Laurentian Channel, where individuals show sizes at maturity similar to those observed in the GSL (Yan et al. 2023).

Greenland halibut has a circumpolar distribution, and the GSL represents the southern limit of its range. In the early 1990s, a study on parasite species composition indicated that the GSL population was isolated and distinct from the main Northwest Atlantic population (NAFO Subarea 2 and Divisions 3KL), located east and north of the Grand Banks of Newfoundland (Arthur and Albert 1993). This study concluded that the GSL Greenland halibut stock completes its life cycle within the GSL, which constitutes one of the management areas for this species (Figure 2). Two subsequent genetic studies confirmed that GSL Greenland halibut represent a unique stock genetically distinct from Atlantic Greenland halibut (Carrier et al. 2020, Ferchaud et al. 2022). However, the low differentiation factor estimated in these studies and the genetic identification of migrants suggest some gene flow between GSL individuals and those of the Atlantic population. The GSL stock also differs from the Northwest Atlantic stock by its smaller size at maturity, similar to individuals found in the Laurentian Channel outside the Gulf of St. Lawrence (NAFO 3P4V, Yan et al. 2023). This evidence suggests these individuals may be part of the GSL population, which should be confirmed or refuted by a current genetics projects for which results are expected within a year or two.

1.2. ECOSYSTEM

The deep-water layer (>150 m) of the GSL originates from the mixing of Labrador Current waters (cold, less saline, and well oxygenated) with Gulf Stream waters (warm, saline, and less oxygenated). This mixture enters through the Laurentian Channel and progresses to the heads of the Esquiman, Anticosti, and Laurentian channels. The progression of deep waters from the Cabot Strait to the head of the Laurentian Channel is estimated to take three to four years. Since the early 2010s, Gulf Stream waters have made up an increasingly large proportion of the mixture, resulting in higher temperatures and oxygen depletion of deep waters in the GSL (Galbraith et al. 2024).

Preliminary analysis of 2024 water temperature measurements shows conditions that have slightly cooled at depths of 150 m and deeper for a second consecutive year, after reaching century-record highs in 2022. Conditions, however, remain warm and well above the historical average at these depths. The temperature of the cold intermediate layer during summer in 2024 was similar to that of 2023; it ranked as the 4th warmest measured with modern instruments since 1985 (Chamberland et al. 2025). These conditions may be unfavorable for Greenland halibut, which prefers waters between -0.5 °C and 6.0 °C (Scott and Scott 1988).

A laboratory study on juvenile Greenland halibut captured in the GSL showed that mortality rate increased with temperature, rising from 4.5% at 4.0 °C to 15.2% at 7.5 °C. Relative growth was also lower in individuals maintained at 7.5 °C compared to those kept at lower temperatures (Ghinter et al. 2021). How these results relate to Greenland halibut in the wild is uncertain.

During the progression of deep waters between the Cabot Strait and the channel heads, in situ respiration and oxidation of organic matter lead to a reduction in dissolved oxygen saturation (DO). Another factor contributing to oxygen depletion is the higher proportion of Gulf Stream waters relative to Labrador Current waters (Galbraith et al. 2024). Since deep waters travel a greater distance to reach the head of the Laurentian Channel, the lowest DO levels are found in the marine estuary. In this area, DO levels decreased by 50% between 1930 and 1980 (Gilbert et al. 2005, Gilbert et al. 2007). DO levels in the marine estuary from 2022 to 2024 at 300 m reached historical minima of 12 %, compared to an average of 19.3 % for the 2002–2024 period (Blais et al. 2024).

According to research on hypoxia tolerance and the effects of low oxygen levels on the metabolic capacity of Greenland halibut, at a temperature of 5°C, juveniles have a higher critical oxygen threshold than adults (15% versus 11% saturation), indicating that they are less tolerant

of hypoxia (Dupont-Prinet et al. 2013). In this study, severe hypoxia increased the duration of digestive processes in juveniles, putting them on the edge of their metabolic capacity at levels close to those currently found in the lower St. Lawrence estuary. As noted earlier, the Estuary is the main nursery area for Greenland halibut. Consequently, any worsening of hypoxic conditions could affect the growth and distribution of Greenland halibut. Another study on juvenile fish showed that the rate of growth between ages 1 and 2 varied inversely with DO levels and decreased significantly at a saturation level of less than 25 % (Youcef et al. 2015). However, the study also observed a greater number of juveniles in the deep waters of the Estuary, which are characterized by low oxygen levels, as well as continuous growth in juveniles throughout the year. These observations suggest that the negative effects of low DO levels are likely limited or are mostly offset by other physical or biological characteristics in the lower estuary such as food abundance, or by behavioural processes such as rising in the water column to occupy more favorable conditions.

Species distribution models have been used to predict the impact of several warming and oxygen depletion scenarios in GSL deep waters on the local density of northern shrimp (*Pandalus borealis*), Atlantic cod (*Gadus morhua*), and Greenland halibut (Stortini et al. 2017). Among these three species, Greenland halibut were predicted to be the most affected by the predicted environmental changes. The model predicts a loss of about 55 % of high-density area under the combined impacts of warming and oxygen depletion in the GSL.

In the early 1990s, major groundfish stocks in the GSL ecosystem, including Atlantic cod and redfish (*Sebastes spp.*), collapsed (Senay et al. 2023, Ouellette-Plante et al. 2025). The decline of these predators may have favored an increase in the biomass of forage species, including various shrimp species. Greenland halibut biomass increased in parallel with that of northern shrimp. In recent years, a simultaneous decrease in northern shrimp and Greenland halibut biomass, along with an increase in deep-water temperature, has been observed in the GSL, while redfish biomass has increased considerably (Chamberland et al. 2025).

The arrival of three exceptionally abundant redfish cohorts (2011 to 2013) may have caused and/or intensified interspecific competition, either directly (for food resources) or indirectly (for habitat), with Greenland halibut in the GSL ecosystem. These species share common prey in their diets, including northern shrimp and pink glass shrimp (*Pasiphaea multidentata*, Ouellette-Plante et al. 2020). Redfish abundance is among the highest levels ever observed in the GSL since the start of DFO August surveys in the nGSL in 1984 (Senay et al. 2023). In 2024, the combined biomass of the two redfish species represented 81% of the biomass of all organisms captured in the survey (e.g., invertebrates, pelagic fish, demersal and benthic species), compared to an average of 15% between 1995 and 2012 (Figure 3). Although redfish are long-lived species, their biomass has been declining since 2020 in the GSL (DFO 2025). They are expected to share the GSL ecosystem with Greenland halibut for several more years.

Overall, observed ecosystem conditions indicate that the structure of the GSL ecosystem is changing. Rising temperature, declining dissolved oxygen, reduced prey availability, and high redfish abundance are all unfavorable factors for Greenland halibut.

1.3. COMMERCIAL FISHERY

1.3.1. History

Until the mid-1970s, Greenland halibut landings in the GSL came mainly from bycatch of trawlers targeting either northern shrimp or Atlantic cod (Figures 4 and 5). The gillnet fishery directed at Greenland halibut developed rapidly starting in 1977, and a first peak in landings was reached in 1979, followed by a sharp decline (Table 1, Figure 4). A second peak in

landings occurred in 1987, and was also followed by a similar decline. From 1982 to 1992, GSL Greenland halibut was managed as part of the Atlantic stock (NAFO Subarea 2 and Divisions 3KL). During this period, the total allowable catch (TAC) for NAFO Divisions 4RST ranged between 5,000 tonnes (t) and 10,500 t (Figures 4, 5, and 6).

From 1988 to 1992, no assessment of the GSL Greenland halibut stock status was conducted due to uncertainty about stock structure. During these five years, the TAC remained constant at 10,500 t, with landings ranging from 2,293 to 7,569 t.

In the early 1990s, studies on parasite species composition helped distinguish Greenland halibut populations in the Northwest Atlantic and demonstrated that the GSL population was distinct (Arthur and Albert 1993). Stock assessments for GSL Greenland halibut resumed in 1992 (Morin et al. 1992), and the TAC was set at 4,000 t. It subsequently varied between 2,000 t and 4,000 t.

Since 1993, turbot catches by mobile gear have been very low (less than 5% of total catches, Table 2) due to the closure of the turbot and cod directed mobile gear fisheries. Another factor is the mandatory use of the Nordmore grid by shrimpers since 1993, one of the main fisheries where turbot was caught as bycatch (Hurtubise et al. 1991, Fréchet et al. 2006). However, a variable quantity of small turbot that is not excluded by the grid is still discarded at sea annually by shrimpers (Chamberland and Benoît 2024). Since 1993, the only Greenland halibut landings by mobile gear have come from bycatch in other fisheries, such as directed redfish fishing and mobile sentinel surveys.

Since the closure of the turbot mobile gear fishery, only a fraction of the TAC previously allocated to them has been transferred to the fixed-gear fleet, leaving a portion of the TAC unallocated. In this document, the term “fishing allocation” refers to the sum of catches allocated to fixed-gear fleets (Tables 1 and 3, Figures 4 and 6). Fishing is currently authorized for coastal fixed-gear fleets from Quebec and the west coast of Newfoundland. The allocation of fishing quotas between these two provinces is 82% and 18%, respectively.

1.3.2. Management Measures

Several management and conservation measures regulate turbot fishing activities (Table 1). These measures include, among others, area closures, seasonal restrictions, gear specifications (e.g., mesh size and hook size), fleet quotas, and a minimum regulatory size for various groundfish species under a small fish protocol. A maximum number of gillnets is authorized, and this number has varied over time and between regions (Table 1). Since the 2015–2016 fishing season, Quebec harvesters have been allowed to use up to 120 nets, and Newfoundland harvesters 90 nets.

Monitoring measures for the commercial turbot fishery include mandatory completion of a logbook (target coverage of 100%), dockside weighing of catches (target coverage of 100%), and a requirement to take an at-sea observer on board at the request of DFO (coverage of 5 to 15% depending on fleets). In addition, the use of the Vessel Monitoring System (VMS) has been mandatory for all Quebec fleets since 2017. In Newfoundland, VMS use is not required for all fleets. License conditions for Greenland halibut gillnet fishing in Quebec have required since 2014 that the time between setting and hauling the nets must not exceed 72 hours (3 days). In Newfoundland, the Atlantic Fisheries Regulations stipulates that “No person shall leave fishing gear unattended in the water for more than 72 consecutive hours”. Inclement weather conditions or vessel breakdowns are some of the factors taken into account in allowing a soak time greater than 72 hours.

The directed turbot fishery was essentially under a competitive regime before 1999, but an Individual Transferable Quota (ITQ) system has been implemented for Quebec harvesters since then (Table 1). In 2020, most Quebec harvesters were under the ITQ regime, while all Newfoundland fishers remained under a competitive regime.

Until 1998, the management cycle for this resource was based on the calendar year, and the TAC was set for the period from January 1 to December 31 of the same year. Since 2000, the management cycle runs from May 15 of a given year to May 14 of the following year. In 1999, to bridge these two management cycles, the TAC was set for the period from January 1, 1999, to May 14, 2000.

Since 1996, Greenland halibut harvesters have been required to complete a logbook, regardless of vessel size in Quebec and for vessels over 35 feet in Newfoundland. In addition to catch weight estimates, information such as date and fishing area, gear type, effort (number of nets), gear soak time, and position are recorded for each day at sea. For their part, harvesters in the Newfoundland fleet under 35 feet must complete the science logbook. These documents are sent to the science sector for analysis. Compliance with this logbook requirement is not very high. The < 35 feet fleet accounts for less than 5% of annual landings in the directed Greenland halibut gillnet fishery.

2. COMMERCIAL FISHERY DATA

2.1. LANDINGS AND EFFORT STATISTICS

Data from logbooks are validated using purchase receipts from processing plants and dockside weighing summaries, and entered by teams responsible for collecting fishery statistics in each DFO region. These data are then made available by each region in 'ZIFF' files (Zonal Interchange File Format), which are consolidated at the Maurice Lamontagne Institute and contain information from all fleets, regardless of region. Data from the last 5 years (2020–2024) are considered preliminary in this research document.

Greenland halibut landing data prior to 1985 come from NAFO Statistical Bulletins (Bernier and Chabot 2013), while data from 1985 to 2024 were compiled from ZIFF files (Tables 1, 2, and 3; data downloaded on 2025-01-16). Data from 1985 to 1997 differ from those previously published by Bernier and Chabot (2013) and Morin and Bernier (2003). Landing values from ZIFF are slightly higher than those published by these authors. Differences between these two data sources are less than 1%, except for the years 1989, 1993, and 1997, where differences are 2%, 12%, and 7%, respectively.

Following the closure of the mobile gear fishery in 1993, landings ranged between 2,000 and 4,000 t in the 1990s, decreased to about 1,300 t in the early 2000s, and remained between 3,000 and 4,000 t until 2016. Since 2017, landings have been declining and reached the two lowest values in the series in 2023–2024 (158.8 t) and 2024–2025 (11.3 t; Figure 4).

More than 90% of landings have come from the directed gillnet fishery since 1993, the year corresponding to the closure of the mobile gear fishery and the imposition of the Nordmore grid by shrimpers (Figure 5). The only exception is the 2024–2025 management year, during which landings were extremely low and those from the gillnet fishery represented only 40% of the total landings (Table 2).

Greenland halibut fishing occurs in the three NAFO divisions of the GSL: 4R, 4S, and 4T. The annual proportion of landings from each of these divisions has varied over time. On average, the proportions of landings in 4R, 4S, and 4T were 22%, 37%, and 42%, respectively. The

proportion of landings from subdivision 4T was close to or above 50% from 2019 to 2023, but dropped to 25% in 2024 (Table 3, Figure 6).

Throughout the GSL, the directed Greenland halibut gillnet fishery takes place from April to November (Table 4). The highest proportion of landings is generally recorded in June and July, these two months accounting for nearly 60% of annual catches. The years 2023 and 2024 were atypical in terms of fishing seasonality. Most landings were spread over a longer period in 2023, whereas in 2024 they occurred earlier than average in the Western GSL and to a lesser degree Esquiman, likely due to low fishing yields (Table 4, Figure 7).

2.2. SPATIAL DISTRIBUTION OF LANDINGS AND EFFORT

Maps of the spatial distribution of fishing activities in the GSL were generated using position data (latitude and longitude) and fishing grids (10-minute by 10-minute squares) extracted from ZIFF files. For the most recent year of ZIFF data, information on fishing positions is sometimes missing, and this gap is more important for data from the Newfoundland region (harvesters fishing in Esquiman; Figure 8).

The VMS is another data source available to represent the spatial distribution of directed Greenland halibut fishing activities in the GSL. VMS use was gradually implemented in Quebec starting in 2013 and has been mandatory for all vessels since 2017. In Newfoundland, VMS use is not required for the fleet under 35 feet, the fleet of vessels over 35 feet used for coastal snow crab (*Chionoecetes opilio*) fishing, and vessels used exclusively in fixed-gear groundfish fisheries. During fishing trips, VMS positions vessels via satellite at a frequency of 30 minutes. The collected information includes the vessel number (NBPC), geographic position (latitude and longitude), date and time. There is no information indicating whether the vessel is actively fishing. To eliminate fishing activities not directed at Greenland halibut, vessel numbers (NBPC) and dates from VMS data are compared to logbook data compiled in ZIFF. VMS positions that match Greenland halibut catches recorded in logbooks within ± 1 day are retained. VMS data are then filtered based on vessel speed, estimated from the distance between two positions. Positions where the vessel is moving (speed greater than 2.5 knots) and those where the vessel is stationary either at sea or dockside (speed less than 0.5 knots) are removed from analyses. Positions where vessels are moving at speeds between 0.5 and 2.5 knots are retained. These speeds are associated with directed Greenland halibut fishing activities, as validated by harvesters. Greenland halibut fishing positions were aggregated annually into grids of one minute of longitude by one minute of latitude for mapping purposes.

Directed Greenland halibut fishing in the GSL is concentrated in three main areas: the western Gulf, North Anticosti, and Esquiman, which correspond to stock concentration zones (Figure 9). Some indicators used to assess population status are presented for the entire Gulf (4RST) as well as for each of these three areas to determine whether spatial variability may be attributed to environmental dynamics or different fishing practices among regions.

The western Gulf and Esquiman areas are visited annually, while the north Anticosti area is visited sporadically. In years when the North Anticosti area is not fished, effort shifts mainly to the western Gulf. Fishing effort maps based on logbook data (ZIFF data, Figure 10) and VMS data (Figure 11) show very consistent patterns. However, VMS data allow for more precise mapping of fishing grounds, even though most Newfoundland fleets are not required to have VMS.

2.3. CATCH PER UNIT OF EFFORT

Although the term ‘catch per unit effort’ is used in this section, it should be noted that it actually refers to ‘landings per unit effort,’ since the only available measure is the quantity weighed

dockside. Catch also includes discards at sea, which are not accounted for in the data used here.

2.3.1. Unstandardized catch per unit effort

Unstandardized catch per unit effort (CPUE, kg/net) is calculated using ZIFF data from 1999 to 2024 where the fishing gear is gillnet and the target species is Greenland halibut. Gillnets have been used for more than 90% of catches in the directed Greenland halibut fishery since 1999. Data prior to 1996 are not used due to the mesh size change from 140 to 152 mm (5.5 to 6 inches), which makes catch values difficult to compare between the two periods. Data from 1996 to 1998 are not used because they were incomplete. Catch and effort data are validated, and fishing activities with missing or aberrant values for catch or effort are excluded from subsequent analyses. Unstandardized CPUE corresponds to landings divided by fishing effort (number of gillnets hauled) in this data subset. Total (nominal) effort is then estimated by dividing total landings in the directed gillnet fishery (including those without effort data) by CPUE.

The CPUE values for the entire GSL and by fishing sectors (western Gulf, Esquiman, and North Anticosti; Figure 9) presented in Figure 12 cover the years 1999 to 2024. For the entire GSL (4RST), estimated annual fishing effort has shown a downward trend since the mid-2000s. From 2015 to 2019, estimated effort was relatively stable at about 130,000 gillnets deployed annually. This number dropped sharply from 2019 to 2024, reaching the lowest value in the series at 2,197 in 2024. Unstandardized CPUE decreased drastically in 2023 and 2024 and also reached the lowest value in the series in 2024 (Table 5, Figure 12). In the western Gulf sector, the situation is similar to that of the entire Gulf, with fishing effort and landings declining for more than 10 years.

The North Anticosti sector is frequented sporadically by Greenland halibut harvesters (Figures 10 and 11). This sector experienced a significant increase in effort and landings from 2006 to 2010, which remained high until 2013. Landings and effort declined after 2013, and this sector was not fished from 2015 to 2017. Fishing activity resumed from 2018 to 2020, but landings and effort dropped sharply, reaching near-zero values in 2024 (Figure 12). CPUE could not be calculated in 2024 due to the absence of effort data at the time of preparing this document.

In the Esquiman sector, landings dropped significantly between the peak of 2011–2012 and 2017, despite similar and sustained effort levels. Landings and fishing effort declined sharply from 2019 to 2024. CPUE showed a significant and steady decrease from 2011 to 2017. It remained stable from 2018 to 2022, reaching the lowest value in the series in 2023 (Figure 12). Effort and CPUE were not estimated for this sector in 2024 due to the very small number of observations ($n = 4$).

On average between 1999 and 2023, 70%, 23%, and 7% of fishing effort was deployed in the western Gulf, Esquiman, and North Anticosti sectors, respectively. In 2023, the proportion of fishing effort deployed in these sectors was 76%, 20%, and 3%. The distribution of effort among these sectors in 2024 was not calculated due to the very small number of observations with effort in Esquiman ($n = 4$). Total effort was nevertheless estimated at the GSL scale for this year and showed a drastic reduction from 2020 to 2024 (Figure 13).

2.3.2. Fishery Performance Index

The standardized CPUE of the commercial fishery is used as a performance index for the fishery and not as an index of the abundance of the exploitable stock.

Annual CPUE values were standardized using a multiplicative model (Gavaris 1980) to account for interannual variations in fishing seasonality, fishing location, and different soak-time (categories ranging from 24 hours to 5 days or more). General linear models between the logarithm of CPUE values (kg per gillnet) and the factors year, month, NAFO unit area, and soak-time category were fitted. The models accounted for the effects of the last three factors, making CPUE values comparable across years. Standardizations were performed separately for the entire Gulf (4RST) and for each of the three fishing sectors. Reference levels for standardized CPUE corresponded to fishing activity occurring in July with a soak time of three days in NAFO unit area 4Si for the entire Gulf and the Western Gulf indices, or 4Rb and 4Sx for Esquiman and North Anticosti indices, respectively.

Trends over time in standardized and non-standardized CPUE series are similar (Table 6, Figures 12 and 14). The trajectory of standardized CPUE is similar for the entire Gulf and the western Gulf sector. These indices showed a decline of more than 50% between 2015 and 2018 and fell below the average of their respective series in 2017. They then increased from 2018 to 2022 before dropping drastically in 2023 and 2024 to reach the lowest documented values (Figure 14). In the North Anticosti and Esquiman sectors, fishery performance indices declined by more than 75% between 2012 and 2017 and have remained below the average of their respective series since 2013. In 2023, these indices reached the lowest value of their respective series (Figure 14).

2.4. GILLNET DEPLOYMENT DEPTHS AND SOAK TIMES

The data used to calculate gillnet deployment depths and soak times are the same as those used for CPUE calculations, namely the ZIFF files that underwent the validation procedure described in 2.3.1 Unstandardized catch per unit effort. The exact depth value has been reported in the ZIFF since 2008; prior to that, a depth-class variable was reported. Deployment depths were represented using box-and-whisker plots, and soak times were expressed as proportions of fishing activities using soak times of 1, 2, 3, or ≥ 4 days.

In Greenland halibut gillnet fisheries, the mean deployment depth for the period 2010–2022 was approximately 296 m for the entire Gulf (4RST), 298 m in the western Gulf sector, 265 m in North Anticosti, and 302 m in Esquiman (Figure 15A). Differences in gear deployment depth among the western Gulf, Esquiman, and North Anticosti sectors reflect the bathymetry specific to each area.

Since the 2020–2021 fishing season, Greenland halibut fishing has been prohibited at depths shallower than 229 m (125 fathoms) in Division 4S for all fixed-gear fleets under 19.81 m from the Québec region due to high cod bycatch. This temporary management measure is evident when fishing depth data are represented by NAFO division (Figure 15B). A ban on fishing in waters shallower than 229 m has also been in place in Division 4R since 2001, and the minimal depth was increased to 256 m in 2014. Figure 15B also shows that fishing activities in Division 4T occurred at greater depths than average from 2019 to 2023.

Figure 16A shows the annual proportion of gillnet fishing activities by soak-time category: 1, 2, 3, and 4 days or more (4+). The “4+” category includes soak times of 4 to 8 days. The percentage of 4+ activities (which exceed the 3-day limit under license conditions) ranged from 13% to 32% during the 1999–2024 period, with an annual mean of 23%. The highest proportions of fishing activity exceeding 72 hours occurred in the Esquiman sector.

On average about 20% of activities in the western Gulf and North Anticosti sectors have soak times greater than 72 hours, while this percentage increased to 39% in Esquiman (Figure 16B). In some years, more than 50% of fishing activities exceeded 72-hour soak times in Esquiman (Figure 16C). Extended soak times reduce the quality of landed fish and increase unaccounted

mortality due to degraded fish lost during gillnet soaking and retrieval (see Section 4 Unaccounted mortality in the gillnet fishery).

2.5. COMMERCIAL CATCH SAMPLING

Sampling of commercial catches is carried out through two distinct programs: the DFO dockside monitoring program and the At-Sea Observer (ASO) program. DFO samplers are distributed across the territory, and their work includes collecting data on fish size and sex at landing sites, either at the dock or at processing plants. The ASO, implemented in the early 1980s, collects detailed information on fishing activities at sea, including data on the target species as well as bycatch and discards. Information gathered by these two programs (dockside and at-sea) is used annually to determine the mean size of Greenland halibut and the sex ratio in landings. Data are first extracted from these two databases and then validated. Data used in these analyses begin in 1987 for the DFO dockside sampling program and in 2000 for the ASO program. Data are discarded in cases where: fish were not sexed; the proportion of females is questionable (females, being larger, dominate in this gillnet fishery); the mean length of males exceeds that of females; or the number of measured fish is fewer than 10. Missing sample weights or weights exceeding the catch weight are corrected using a length-weight relationship derived from DFO research survey data collected in August.

The number of fish measured per sample varies greatly between data collected by DFO samplers (250 fish per sample before 2005, and 150 per trip since) and those from the ASO program (150–200 fish per sample, with several sets sampled per trip). Length frequency distributions of fish caught in the commercial fishery (catch-at-length, CAL) are estimated as follows: first, for each sex separately, a relative length frequency (fork length) per DFO sample and per observer trip (multiple sets) is calculated. Second, the mean of relative frequencies for samples within the same NAFO division, year, and quarter combination is produced. Length-frequency distributions are then weighted by annual landings in weight per NAFO division and quarter to produce an annual size structure. Mean size and female proportion in the fishery are calculated from the resulting numbers at length.

The mean length of fish caught in the commercial fishery increased from 44.0 to 47.6 cm between 1995 and 1996 following an increase in mesh size from 140 mm (5.5 in) to 152 mm (6.0 in) (Table 7, Figure 17). Experimental fishing conducted with 140 mm mesh contributed to the decrease in mean length observed in 2002 (Morin and Bernier 2003).

Annual variations in mean length of commercial catches at the Gulf scale (4RST) can be partly explained by the strength of cohorts recruited to the fishery. A strong cohort entering the fishery will reduce the mean length of fish caught. The mean length, which declined between 1997 and 2002 (from 48 to 45 cm), subsequently increased steadily to reach 49 cm in 2012, the highest value in the series (Figure 17). This increase is explained by the growth of strong 1997 and 1999 cohorts, which comprised a large portion of catches between 2003 and 2006, and by the growth of the good 2001 and 2002 cohorts, which began to be exploited around 2006 and were still present in catches in 2010 (lengths estimated at over 50 cm) (Figure 17). Mean length fluctuated between 2012 and 2016 and then followed a downward trend, reaching in 2024 the lowest value in the series (44.5 cm) since the mesh size change.

The mean length of fish caught in Division 4R was greater than that of fish caught in Divisions 4S and 4T from 2003 to 2015 (Table 7, Figure 17). From 2016 to 2019, mean lengths in catches in Division 4R were comparable to those in Division 4S. Fish caught in Division 4T were on average smaller than those from the other two divisions. This difference may be explained by the fact that the main nursery area of the stock is located in the St. Lawrence Estuary, which lies within Division 4T.

The mean length of females caught is greater than that of males, and annual fluctuations in mean size of males and females are generally in phase (Table 7, Figure 17). Mean lengths of male and female fish in the commercial fishery have shown a downward trend since 2012 and 2016, respectively.

The impact of the mesh size change in 1996 is also evident in the commercial fishery catch-at-length (CAL; Figure 18). Following this change, a gradual increase in the number of fish caught per centimeter is observed starting at approximately 40 cm, peaking around 47 cm. Since 2019, however, the CAL has extended to the left of the minimum regulatory size of 44 cm, and fish smaller than 40 cm represented a non-negligible proportion of catches. This phenomenon is even more pronounced in the CAL estimates for 2023 and 2024 and is explained by the low abundance of legal-size fish in the stock (see Section 3.6 Demographic structure).

The percentage of fish caught below the minimum regulatory size in the commercial fishery followed an upward trend from 1996 to 2002, decreased from 2003 to 2015, and has been increasing since (Figure 19). For the period 1996–2020, an average of 18% of fish caught in the Greenland halibut gillnet fishery were smaller than 44 cm, compared to 31% and 32% in 2021 and 2022, respectively, and more than 40% in 2023 and 2024 (Figures 18 and 19). The proportions of fish below the legal length of 44 cm observed in 2023 and 2024 are the highest estimated since 1996. The 44 cm size is the minimum regulatory size according to the small fish protocol.

The decline in mean length of fish in the commercial fishery has significant implications for the number of fish landed for a given landing weight. Between 2016 and 2022, annual landings in tonnes decreased by 72%, while the number of fish landed decreased by 58%. This difference is also related to low weights-at-length for commercially sized individuals since 2022 (see Section 3.9 Condition).

The higher proportion of females in catches is explained by sexual dimorphism in this species, as females reach larger mean lengths than males. The mesh size used in the fishery is intended to target sexually mature fish so they can reproduce before being caught and thus contribute to population recruitment. The proportion of females in commercial catches increased sharply following the mesh size increase in 1996, rising from 60% to 81% between the periods 1987–1995 and 1996–2024 (Table 8, Figure 20). The proportion of females in the commercial fishery has varied without a temporal trend since 1999. In 2023 and 2024, females accounted for 84% and 86% of catches, respectively.

2.6. BYCATCH IN THE DIRECTED GREENLAND HALIBUT FISHERY

Two data sources were combined to provide an overall picture of bycatch in the Greenland halibut gillnet fishery: ZIFF and the ASO program. ZIFF provides information on all reported landings. The ASO program covers a certain percentage of fishing trips and provides partial information on bycatch. The ASO data is the only source of data on catches discarded at sea, which are not recorded in ZIFF files.

Greenland halibut harvesters are required to take an observer on board upon DFO request. Detailed information on sets is recorded by observers (position, duration, catch by species or taxon, specimen lengths for certain species). ASO data used in these analyses were collected between 2000 and 2024 during directed Greenland halibut fishing in the GSL to estimate bycatch. The ASO program aims for a minimum coverage of 5% of all directed fishing trips. This percentage can reach 15% for certain fleets, such as Québec large longliners. The required coverage for Newfoundland harvesters is 10%. No observers have been deployed on vessels from Newfoundland and Labrador in the directed gillnet fishery since 2021.

The methodology for processing bycatch data from the ASO is similar to that presented in Savard et al. (2013). Since 2000, approximately 10,000 gillnet sets from over 600 fishing trips have been sampled. Scaling factors (ratio between Greenland halibut catch by all gillnetters in the ZIFF and Greenland halibut catch in observed activities) were calculated by grouping NAFO unit areas to adjust ASO database results to the entire gillnet fleet based on landings (Table 9).

Although the commercial fishery seeks to maximize the catch of the target species, incidental capture of non-target marine species is common. Bycatch in the Greenland halibut gillnet fishery was estimated for the 2000–2024 period using ASO data (with variable annual coverage; Table 9) and ZIFF. In this fishery, about 500 t of bycatch are captured annually on average (Figure 21). Nearly one-third of bycatch is landed, while the rest is discarded at sea. Bycatch represents an average of 19% of the weight of Greenland halibut landings for the 2000–2022 period (Table 10, Figure 22). However, 2023 and 2024 are exceptions, with estimated bycatch far exceeding Greenland halibut landings (ratio >350%; Figure 22). The large amount of bycatch estimated for 2023 is explained by substantial catches of Black Dogfish (*Centroscyllium fabricii*, 4 t per set) in 4 of 21 sets during a single fishing trip (Figure 23). These catches occurred at uncommon depths (380 m) and in an unusual location for Greenland halibut fishing. Higher-than-average bycatch estimates were also observed in 2023 for species such as White Hake (*Urophycis tenuis*), Spiny Dogfish (*Squalus acanthias*), and Norway King Crab (*Lithodes maja*; Table 11). Bycatch quantities estimated in 2024 are not abnormal, but the bycatch-to-Greenland halibut landing ratio is due to extremely low yields for the targeted species (Figures 12 and 14). ASO coverage appears less representative of typical fishing activities in 2023 and 2024 (Figure 24), and few trips have been observed since 2021 (Figure 25). Bycatch estimates for 2023 and 2024 are therefore more uncertain than average and are not considered representative of the Greenland halibut gillnet fishery.

The most frequent bycatch species, in order of importance, are American Plaice (*Hippoglossoides platessoides*), redfish, Thorny Skate (*Amblyraja radiata*), Snow Crab, Atlantic Halibut (*Hippoglossus hippoglossus*), Witch Flounder (*Glyptocephalus cynoglossus*), Norway King Crab, and unspecified skates (Table 11 and Figure 23). In terms of biomass, Atlantic halibut is the most significant bycatch species across the entire series, although a decline in estimates for this species was observed from 2016 to 2022. The estimate was near the average in 2023 and very low in 2024 (Figure 23). Incidental catches of redfish, which were above average from 2017 to 2020, were below average in 2021 and 2022, above average in 2023, and below average again in 2024. Discards at sea include species that harvesters may release alive, such as Black Dogfish, Lumpfish (*Cyclopterus lumpus*), Girard's hagfish (*Myxine limosa*), and Atlantic wolffish (*Anarhichas lupus*); species subject to mandatory release, such as Atlantic Halibut under 85 cm, Snow Crab, and skates; as well as species with no commercial value, such as sea stars, skate eggs, polychaetes, etc.

Bycatch estimates in the directed gillnet fishery assume that observed trips are representative of Greenland halibut fishing in the various fishing sectors. This assumption may not hold for 2023 and 2024 due to the low number of observed trips, observations in atypical sectors, and the absence of observer coverage for Newfoundland fleets since 2021.

2.7. GREENLAND HALIBUT BYCATCH IN THE SHRIMP FISHERY

Shrimpers are also required to take an ASO on board upon DFO request. The ASO aims for 5 % coverage of all shrimp fishing trips. The information collected is the same as for Greenland halibut gillnetters. The methodology for processing these data is presented in Savard et al. (2013) and Bourdages et al. (2022). Since 2000, approximately 25,000 trawl sets have been sampled by ASO. Weighting factors (Σ shrimp fleet effort / Σ observer effort) were calculated to

scale observer data results to the total fishing effort deployed by the Gulf of St. Lawrence (GSL) shrimp fleet.

Shrimp fishing is conducted using a small-mesh trawl that captures and retains several species of fish and marine invertebrates. Although large individuals can escape through the mandatory use of a separator grid installed inside the trawl (Nordmore grid), a certain amount of small specimens remains in shrimp catches. Greenland halibut bycatch in the shrimp fishery was examined using ASO data from 2000 to 2024 (Table 12). Note that no observers were deployed in the Estuary shrimp fishing area in 2021, nor in North Anticosti and Esquiman in 2024.

The spatial distribution of Greenland halibut bycatch in shrimp fishing activities with an ASO is presented for the 2000–2024 period. The mean catch (kg per tow) in 5-minute grid cells was calculated for the 2000–2024 period and annually for 2022, 2023, and 2024 (Figure 26). Greenland halibut was present on average in 91% of sampled activities.

Greenland halibut bycatch is mostly less than 3 kg per trawl tow and consists primarily of 1-year-old individuals, and to a lesser extent 2-year-olds (Figure 27). The annual mean Greenland halibut bycatch from shrimp fishing in the Estuary and GSL from 2000 to 2024 was estimated at 87.7 t (Figure 28). In 2023 and 2024, Greenland halibut bycatch in this fishery was estimated at 31.8 and 9.1 t, respectively, representing 0.9% and 0.1% of the biomass of Greenland halibut under 31 cm estimated by the DFO August survey in the northern GSL (Table 12 and Figure 29). In comparison, Greenland halibut landings in the directed gillnet fishery were 151 t and 5 t for these same years.

Greenland halibut is also caught in fisheries directed at other groundfish species, but these catches should be landed and therefore present in landing data.

3. SCIENTIFIC SURVEY DATA

3.1. DESCRIPTION OF SURVEYS

3.1.1. DFO Survey in the Northern Gulf of St. Lawrence

An ecosystem survey has been conducted annually in August in the marine Estuary and northern GSL (hereafter referred to as the nGSL survey) since 1984 to estimate groundfish abundance using a bottom trawl (Chamberland et al. 2025). This survey is carried out by DFO Québec Region and covers NAFO Divisions 4R, 4S, and part of 4T (northern GSL) (Figures 2 and 30).

The survey was conducted aboard the motor vessel (MV) *Lady Hammond* equipped with a *Western IIA* trawl with a 19 mm liner from 1984 to 1990. From 1990 to 2005, the survey was conducted aboard *CCGS Alfred Needler*, equipped with a URI 81'/114' shrimp trawl (University of Rhode Island) with a 19 mm liner. From 2004 to 2022, the survey was conducted aboard *CCGS Teleost* using a *Campelen 1800* shrimp trawl with a 12.7 mm liner. Finally, starting in 2021, the survey has been conducted aboard *CCGS John Cabot* using a slightly modified *Campelen 1800* shrimp trawl with a 12.7 mm liner. The main difference between the *Campelen 1800* trawls used on *CCGS Teleost* and *Cabot* was in the footgear (see details in Benoît et al. 2024) as well as minor modifications to the trawl itself. The footgear of the *CCGS Cabot* trawl was slightly heavier than that of the *CCGS Teleost*. Comparative fishing experiments were conducted in 1990, 2004, and 2005, as well as in 2021 and 2022 to estimate catchability differences between vessel-trawl pairs and establish conversion factors (Yin and Benoît 2022; Benoît et al. 2024). The results of these experiments were used to produce a standardized

series by adjusting catches from *MV Lady Hammond*, *CCGS Alfred Needler*, and *Teleost* into equivalent catches of the CCGS John Cabot.

The target tow duration for a standard fishing set with the *Campelen* trawl since 2004 is 15 minutes, calculated from bottom contact, determined using the *Scanmar*™ hydroacoustic system. The target towing speed is 3 knots. Fishing operations are conducted 24 hours a day.

This survey follows a stratified random sampling design where the study area consists of 56 strata, delineated based on depth, NAFO divisions, and substrate type (Figure 30).

3.1.2. DFO Survey in the Southern Gulf of St. Lawrence

Each September since 1971, bottom trawl surveys have been conducted aboard a research vessel in the southern Gulf of St. Lawrence (sGSL) (NAFO Division 4T) (Figure 30). This survey has been carried out by DFO Gulf Region since the mid-1980s. The primary objective of this survey is to obtain abundance indices for various groundfish species in this region.

This survey also follows a stratified random sampling design. Figure 30 shows the area sampled by the nGSL survey and that covered by the sGSL survey. There is an overlap of some strata covered by both surveys along the southern slope of the Laurentian Channel.

From 1971 to 1985, the sGSL survey was conducted aboard the research vessel *E.E. Prince* equipped with a *Yankee 36* trawl. The survey was then conducted aboard *Lady Hammond* from 1985–1991, *CCGS Alfred Needler* from 1992–2002 and 2004–2005, *Wilfred Templeman* (a sister ship of the *Needler*) in 2003, and *CCGS Teleost* from 2004–2022. The fishing gear used by *Hammond*, *Needler*, *Templeman*, and *Teleost* was a *Western IIA* trawl with a 19 mm codend liner. From 2021 to 2024, the survey was conducted aboard *CCGS Captain Jacques Cartier* using a slightly modified version of the Northeast Fisheries Science Center Ecosystem Survey Trawl (NEST). Comparative fishing experiments were conducted at each change of vessel and/or trawl type to produce conversion factors allowing the creation of a continuous time series starting in 1971 (Benoît and Swain 2003a; Benoît 2006; Benoît and Yin 2023). The standard tow duration was targeted at 30 minutes at a speed of 3.5 knots for surveys using the *Yankee 36* or *Western IIA* trawls, and 20 minutes at a speed of 3.0 knots for tows conducted by *CCGS Captain Jacques Cartier*. The survey operated only during daylight hours from 1971 to 1984 and on a 24-hour schedule thereafter. Greenland halibut catchability in the survey did not appear to differ between day and night, so no adjustment was made for this protocol change (Benoît and Swain 2003b; Benoît and Yin 2023).

3.1.3. Mobile-gear Survey of the Sentinel Fisheries Program in the nGSL

A mobile-gear survey from the Sentinel Fisheries Program (MSP) conducted in July since 1995 is also used to assess the status of the Greenland halibut stock in the GSL. This survey follows a sampling design and fishing protocol similar to that of the DFO nGSL scientific survey. It covers NAFO areas 3Pn, 4R, 4S, and part of 4T. However, the portion corresponding to the marine Estuary is not covered by this survey (strata 411 to 414, 851, 852, 854, and 855), where a large proportion of Greenland halibut, particularly juveniles, are found in summer. Each year, approximately 300 fishing stations are distributed among six to nine trawlers from Newfoundland and Québec that participate in the survey. All participating vessels use the same trawl, a *Star Balloon 300* mounted on *Rock Hopper* footgear. This trawl has a 145 mm mesh and a 40 mm liner in the codend. A standard tow has a target duration of 30 minutes at a speed of 2.5 knots. The 30-minute duration is calculated from the moment the winches are stopped (after gear deployment) until the winches are restarted to haul the trawl. The total Greenland halibut catch is weighed for each tow, and a sample of a maximum of 200 fish is taken to determine certain

biological characteristics, including fork length and sex. A description of the MSP survey is available on the [Saint Lawrence Observatory](#) website.

3.1.4. Winter Surveys

The spatial distribution, depth distribution, and size structure of Greenland halibut in winter surveys are presented in the context of the potential reopening of the winter redfish fishery. Such information could be useful for efforts to limit Greenland halibut bycatch in this fishery. Data from two winter surveys are presented: one conducted aboard *MV Gadus Atlantica* (1978–1994) and the other aboard *MV Mersey Venture* (2022–2024). For each survey, the spatial distribution of Greenland halibut is shown as maps of catch rates (in number and weight per standard tow). Cumulative proportions of Greenland halibut catches (by weight), redfish (*Sebastes fasciatus* and *S. mentella*), and sampled stations by depth are also presented. The normalized annual mean size structure (normalized by dividing by the mean) in winter surveys is compared to that of the summer nGSL survey.

The stratified random bottom trawl survey conducted in January from 1978 to 1994 (excluding 1982) was carried out aboard the chartered vessel *MV Gadus Atlantica* using an *Engel 145 Otter* trawl with a 160 mm codend liner (McCallum and Walsh 1997). The study area included NAFO Divisions 4RST and Subdivision 3Pn. Although the same stratification scheme used for the summer nGSL survey was applied (Figure 30; Fréchet 1986), spatial coverage varied greatly from year to year, particularly in 4S, generally due to constraints caused by the presence of sea ice. The inability to fully cover the study area has prevented estimation of a standardized abundance index (e.g., Rivest et al. 2021). Station coordinates were recorded in degrees-minutes in 1978 and in degrees-minutes-seconds from 1979 onward. The mission was discontinued in 1995 mainly because northern Gulf cod were found in Subdivision 3Ps during the survey period and biomass estimates were considered biased (Fréchet and Schwab 1995). Another reason cited was the retirement of the *MV Gadus Atlantica* (Fréchet et al. 1994).

A winter survey was conducted in 2022 (February 10–26), 2023 (January 17–February 3), and 2024 (February 8–March 8) aboard *MV Mersey Venture*, a chartered vessel of identical length and width to the *CCGS Teleost*, built in the same year and by the same shipyard (DFO 2020). The objective of this 3-year survey was to determine the recent winter geographic distribution of fish species in waters ≥ 150 m in anticipation of a possible reopening of the redfish fishery in the region. The vessel fished with a *Campelen 1800* trawl with a 12.7 mm codend liner, identical to that used for nGSL surveys aboard *CCGS Teleost*. The study area for all three years included depths of 150 m and greater in the Laurentian Channel from the western tip of Anticosti Island to the channel opening in 3Ps and 4Vn, as well as the Esquiman, Anticosti, and Hermitage channels (Figure 31). Stations were determined using an unaligned systematic sampling design, which consists of gridding the study area (in NAD83 Québec Lambert), placing a station at each grid node, and adding a random x-component per row and a random y-component per column (Ripley 1981). The number of stations in the study area was set to achieve an average distance of 11 nautical miles (nm) between stations, corresponding to approximately 1.5 hours of transit at 7.5 knots. The `spSample` function from the R `sp` library (Pebesma and Bivand 2005) was used for station selection. Station distribution targeted the central portion of the study area in 2022, the central and northwestern portions in 2023, and the entire study area in 2024, including stations in shallower waters on the eastern Anticosti Bank, the west coast of Newfoundland, and Burgeo Bank, as well as at greater depths along the continental slope (Figure 31).

In both survey series (*MV Gadus Atlantica*, 1978–1994, and *MV Mersey Venture*, 2022–2024), the highest Greenland halibut catch rates were observed in the Laurentian Channel, from southern Anticosti to Cabot Strait. Significant aggregations were generally observed in 3Pns and 4Vn when these areas were covered. Some smaller aggregations of Greenland halibut

were also observed in certain years at the head of the Esquiman Channel in both sets of winter surveys (Figures 32 and 33).

Small individuals ([0–20] and]20–30] cm) were captured in low abundances in the *Mersey Venture* winter surveys (2022–2024), and their catches were mainly distributed in the northern and western parts of the study area. Conversely, most individuals measuring 30 cm and larger were observed in the Laurentian Channel, with the highest catch rates in the Cabot Strait sector (Figure 34).

The surveys conducted aboard *MV Gadus Atlantica* and *MV Mersey Venture* sampled similar depths, although depths covered by the *Mersey Venture* were slightly greater due to its sampling design (Figure 35). In both surveys, Greenland halibut occupied deeper waters than those occupied by redfish. In winter, 69% and 76% of Greenland halibut biomass occurred at depths greater than 400 m according to the *Mersey Venture* and *Gadus Atlantica* surveys, respectively (Table 14, Figure 35), whereas 67% and 63% of redfish biomass occurred at shallower depths according to the *Gadus Atlantica* and *Mersey Venture* surveys, respectively. The apparent difference in redfish biomass distribution by depth between the *Gadus* and *Mersey Venture* series may be explained by differences in redfish species composition between the two periods or by the sectors and depths sampled. Acadian Redfish (*S. fasciatus*) generally occupies shallower depths than Atlantic Redfish (*S. mentella*) and accounted for a larger proportion of biomass in the 1980s than in recent years (Senay et al. 2023).

Annual mean size structures from winter and nGSL surveys show similar maximum sizes, even when size structures are calculated separately for Divisions 4RST (GSL) and 3Pns4Vns. In these surveys, Greenland halibut larger than 60 cm and 50 cm were virtually absent during 1984–1994 and 2022–2024, respectively (Figures 36 and 37).

These analyses highlight the importance of deep channels (400 m and deeper) as winter habitat for Greenland halibut.

3.2. SUMMER SPATIAL DISTRIBUTION

The geographic distribution of catch rates for DFO and MSP surveys in the GSL, presented in weight and numbers per tow, was compiled for four- or five-year periods. Interpolation of survey catch rates (number per standard tow) was performed on a grid in NAD83 Québec Lambert projection covering the study area using inverse distance weighting from the *gstat* library (Gräler et al. 2016) in the R software package (R Core Team 2023). The spatial distribution of Greenland halibut is expressed in numbers per tow for each size class [0–20] cm,]20–30] cm,]30–40] cm, and >40 cm in the nGSL and MSP surveys, and aggregated by size in the sGSL survey.

The distribution area of the Greenland halibut population in the GSL is well represented by the study area of the DFO nGSL survey conducted in August. At this time of year, the highest fish concentrations are observed in the St. Lawrence Estuary, in the Sept-Îles Basin, in the Laurentian Channel south of Anticosti, and at the heads of the Anticosti and Esquiman channels. Overall, an increase in the spatial distribution of high catch rates was observed from 1984–1989 to 2005–2009, followed by a decline to the most recent period (Figures 38–41). The distribution of Greenland halibut catch rates from the July MSP survey shows a similar pattern, although this survey does not cover the marine Estuary (Figures 42–45).

Greenland halibut in the [0–20] cm size class (i.e., ≤ 1 year) are most abundant in the marine Estuary and north of Anticosti (Figure 38). Studies have shown that the main nursery area for Greenland halibut in the GSL is located in the Estuary, with a secondary nursery north of Anticosti (Ouellet et al. 2011; Youcef et al. 2013).

The spatial distribution of Greenland halibut catch rates (number per tow) from the DFO sGSL survey is presented in 9- or 10-year blocks between 1971 and 2019 and for 2020–2024 (Figure 46). In the area covered by this survey during the 1970s, Greenland halibut were present only at the tip of the Gaspé Peninsula, with a few rare catches in Chaleur Bay. In the 1980s, Greenland halibut abundance increased, but its spatial distribution remained similar to that of the 1970s. Subsequently, in the 1990s and 2000s, an increase in abundance and an expansion of distribution along the southern slope of the Laurentian Channel and into the Cape Breton Basin were observed. This expansion persisted during 2010–2019, and a new concentration of Greenland halibut was observed in the Shediac Valley. For the 2020–2024 period, fewer high catch rates were observed than in the previous period, but the spatial distribution remained similar.

The historical perspective provided by the sGSL survey suggests that Greenland halibut abundance was low throughout the GSL during the 13 years (i.e., 1971–1983) preceding the summer nGSL survey.

3.3. INDICES OF SUMMER SPATIAL DISTRIBUTION

Three descriptors of spatial distribution were calculated from nGSL survey data: the design-weighted area of occupancy (DWA0), D95, and the Gini index. The design-weighted area of occupancy (DWA0) represents the surface area of the study zone where Greenland halibut is present (Smedbol et al. 2002). The minimum area containing 95% of Greenland halibut biomass (D95) is a spatial spread index that is insensitive to a simple uniform increase in mean abundance (Swain and Sinclair 1994). The Gini index quantifies the level of homogeneity in the spatial distribution of Greenland halibut. This index is calculated using the Lorenz curve (Myers and Cadigan 1995). Its values range from 0 to 1, where 0 corresponds to a perfectly homogeneous distribution and 1 to a highly concentrated distribution.

Spatial distribution indices indicate that Greenland halibut occupies more than 85,000 km² in the nGSL and that 95% of its biomass is concentrated in less than 50,000 km². Since the mid-2000s, the design-weighted area of occupancy (DWA0) has remained stable, but the area containing 95% of stock biomass (D95) has decreased. At the same time, the Gini index has increased, indicating a growing concentration of the Greenland halibut population within its distribution area (Figure 47).

3.4. SUMMER ENVIRONMENTAL DISTRIBUTION

The cumulative proportion of catches (by weight) in the nGSL survey (1984–2024) was compiled as a function of depth and temperature, taking into account the stratified random sampling design (Perry and Smith 1994). This relationship was graphically represented along with the cumulative proportion of sampled stations. Annual cumulative proportions of catches by depth, temperature, and dissolved oxygen (DO) saturation were also calculated by size class ([0–20] cm, [20–30] cm, [30–40] cm, and >40 cm) and by fishing sector. Box-and-whisker plots were used to represent the 5th, 25th, 50th, 75th, and 95th percentiles of annual cumulative catch distributions.

In the nGSL survey conducted in August, Greenland halibut is found mainly in channels at depths ranging from 200 to 400 m, with more than 80% of its cumulative biomass between 227 and 379 m, at bottom temperatures ranging from 4.6 to 6.3 °C (Table 13, Figure 48).

The annual distribution of Greenland halibut biomass by size class ([0–20] cm, [20–30] cm, [30–40] cm, and >40 cm) as a function of depth, bottom temperature, and DO saturation level is shown in Figure 49. Biomass distribution by size class as a function of depth is generally similar

from year to year and shows no temporal trend. On average, fish in the [0–20] cm class occur at shallower depths (270 m) than larger fish (301 m; Figure 49).

The situation differs for biomass distribution as a function of water temperature and DO saturation (Figure 49BC). From 2010 to 2023, all Greenland halibut size classes occurred in progressively warmer waters, increasing from 5.1 to 6.6 °C (Figures 49 and 50). Habitat warming may have stabilized in 2024. The greatest increase in median temperature occupied by Greenland halibut was observed in the Esquiman sector, rising from 5.0 to 7.1 °C between 2010 and 2023 (Figure 50). DO concentration occupied by Greenland halibut of all size classes decreased from 2016 to 2022 and was more variable or increasing in 2023 and 2024. The most significant DO decline occurred in the western Gulf sector, dropping from 28.1% to 17.2% between 2015 and 2023, then rising to 19.9% in 2024 (Figure 50). Cumulative distributions by depth, temperature, and oxygen are more uncertain in 2023 because the Estuary was not covered by the nGSL survey.

When analyses are limited to the marine Estuary, the median water temperature where Greenland halibut biomass was found increased from 4.9 to 6.4 °C from 2010 to 2022 and appears to have stabilized in 2024, while DO levels decreased from 19.2% to 15.1% from 2010 to 2022 and also appear to have stabilized in 2024 (Figure 51). This means that in 2024, 50% of Greenland halibut biomass in the Estuary was exposed to oxygen concentrations $\leq 15.1\%$ during summer. The addition of strata in 2008 does not change this picture since very little biomass occurs in these coastal zones, but it confirms that depth use has not changed in response to environmental changes.

Thus, the habitat used by all Greenland halibut size classes has warmed and become oxygen-depleted over the past decade and appears to have stabilized at high temperature and low DO values in 2024. Depth distribution has not changed in response to these environmental shifts.

3.5. ABUNDANCE INDICES

Abundance and biomass indices for the sGSL, nGSL, and MSP surveys were calculated using the standard estimator for stratified random sampling (Cochran 1977). Values in numbers or weight for years-strata where a minimum of two tows could not be completed were imputed using a multiplicative model (Gavaris 1980). The value predicted by the model is calculated from data for the current year and the three previous years (Chamberland et al. 2025). For years when comparative fishing experiments were conducted (1990, 2004–2005, 2021–2022), catches (in number and weight) from comparative tows were averaged to avoid underestimating variance (tows within comparative fishing set pairs are not independent). Thus, indicators presented for a given series are representative of a standardized total area, corresponding to the sum of the strata areas sampled: sGSL survey (73,180 km²), nGSL survey (116,115 km², excluding strata 851, 852, 854, and 855 added in 2008), and MSP survey (111,855 km²).

Indices in numbers and weight aggregated by length class ([0–20] cm, [20–30] cm, [30–40] cm, and >40 cm) and annual length frequencies in the three surveys were obtained by estimating number and weight per size class and per tow, then applying the standard estimator as described above. Abundance indices (mean number per tow) and biomass indices (mean weight per tow) are presented for the sGSL, nGSL, and MSP surveys (Figure 52).

The sGSL survey covers a longer time period (1971–2024) than the nGSL (1984–2024) and MSP (1995–2024) surveys but only a limited portion of the overall distribution area of Greenland halibut in the GSL (Figures 38–41 and 46). The historical perspective of this survey indicates that Greenland halibut abundance and biomass were low from 1971 to 1997 in the sGSL region sampled (Figure 52). In 1998, the abundance index increased sharply from 2.6 to 13.0 fish per

tow, while biomass increased more gradually. Abundance and biomass showed annual fluctuations from 1998 to 2010, while remaining at high levels for this survey. The trend in abundance and biomass indices was generally downward from 2011 to 2024, except in 2020 when an increase was observed, likely due to recruitment of small individuals from the 2018 cohort. Abundance and biomass indices were at low levels and below average in 2023 and 2024 (Figure 52).

Of the two surveys conducted in the northern GSL, the DFO nGSL survey covers a larger portion of Greenland halibut habitat (Figures 38–45). The area sampled by the MSP survey and where Greenland halibut occur is included within that of the DFO survey but does not cover the marine Estuary. Abundance and biomass indices from these two surveys showed similar trends from 1995 to 2008, with a significant increase until 2004 followed by stability until 2008 (Figure 52). Subsequently, while the abundance index from the DFO nGSL survey remained relatively stable, the biomass index from the nGSL survey and both abundance and biomass indices from the MSP survey showed a continuous downward trend until 2018 or 2019. Indices from the nGSL and MSP surveys then increased slightly from 2019 to 2021, reaching near-average levels before declining again. In 2024, abundance and biomass indices per tow from the nGSL and MSP surveys were below their respective averages, at among the lowest values observed.

Abundance indices from the nGSL survey for size classes [0–20] cm (1-year-old individuals) and [20–30] cm (2-year-old individuals) show substantial interannual variability. A strong relationship is also observed between indices for the [0–20] cm size class and the [20–30] cm class in the following year (Figure 53). Abundance of fish in the [30–40] cm and >40 cm size classes shows a general downward trend since the early 2000s. Abundances for these size classes were below average in 2024 (Figure 53).

Abundance indices derived from MSP survey data indicated that, except for fish in the [0–20] cm class, all other size classes were below their respective series averages in 2024 (Figure 53).

Normalized biomass indices (divided by the mean) for fish >40 cm from DFO research surveys in the sGSL and nGSL and from the MSP survey showed similar trends for the common period 1995–2024 (Figure 54). A significant increase occurred in the early 2000s, followed by stabilization at peak biomass levels for this stock. Subsequently, a downward trend developed, with declines of 99%, 84%, and 88% between 2008 and 2024 for the sGSL, nGSL, and MSP surveys, respectively. The sGSL survey indicates that during the 13 years preceding the nGSL survey (1971–1983), Greenland halibut biomass >40 cm was low in this ecosystem.

3.6. DEMOGRAPHIC STRUCTURE

Length-frequency distributions are presented in two ways. The first representation consists of a matrix plot where cell color varies according to the mean number of individuals caught per standard trawl tow per one-centimeter increment (or 2 cm increment in the nGSL survey in 1985–1987). A second figure illustrates the distributions for the last two years of the series (2023 and 2024) as well as the average distribution for a reference period (1984–2024 for the nGSL survey and 1995–2024 for the MSP survey).

Annual length-frequency distributions of Greenland halibut observed during the nGSL, sGSL, and MSP surveys are shown in Figures 55 and 56. The general pattern provided by these three surveys is similar, but differences in trawl selectivity and sampled areas result in smaller Greenland halibut being better represented in the nGSL survey, while larger individuals make up a greater proportion of catches in the sGSL and MSP surveys. Average catch rates are also much higher in the nGSL survey than in the MSP survey. The nGSL survey uses a smaller

mesh size, allowing more efficient sampling of small 1-year-old individuals (mode ~16–18 cm). In addition, this survey covers the marine Estuary, which is the main nursery area for the stock—a zone not covered by the other two surveys.

Figure 56 puts the size structure in 2023 and 2024 into perspective relative to the historical average. The highest abundances are observed for sizes 16–20 cm, but remain below the historical average. Abundances of 2-year-old fish (mode ~27 cm) and fish aged 3 years and older (>30 cm) are also below average. A marked decline in the abundance of individuals >30 cm is observed between 2023 and 2024.

Representing size structure by sex facilitates cohort tracking over time because male and female growth differs in Greenland halibut (Bowering 1983; Figure 57). The maximum length observed annually for females is about 60 cm, while for males it is 50 cm or less (Figure 57) which contrasts sharply with populations in NAFO areas 2 and Divisions 3KLMNO, where asymptotic sizes were 109 cm and 90 cm, respectively (Dwyer et al. 2016). A trend toward decreasing maximum length over time is also noted.

Recruitment strength is estimated by the annual abundance of fish measuring ≥ 12 cm and ≤ 21 cm caught during DFO nGSL and sGSL surveys. This length range represents 1-year-old Greenland halibut. Exceptionally, the abundance of the 2014 cohort was estimated using fish of lengths ≥ 12 cm and ≤ 18 cm to minimize the contribution of fish from the 2013 cohort which exhibited lower-than-expected growth between age 1 and 2 (Figure 55). A recruitment index is not calculated for the MSP survey for the reasons mentioned above.

Recruitment has varied greatly from year to year, and since the late 1990s, an alternation of strong and weak cohorts has been observed (Figure 58). Annual recruitment indices estimated from DFO nGSL and sGSL surveys are well correlated (Figure 58B). Analyses have shown that Greenland halibut in the GSL exhibited density-dependent expansion of its distribution area into the northern portion of the sGSL when abundance increased, and contraction when abundance decreased (Yin and Benoit 2022). This phenomenon is also observed at the recruitment level (Figures 38 and 58B, inset). Information from the sGSL survey indicates that, within its survey area, there was no strong recruitment from 1971 to 1996. Both surveys identify the 1997, 1999, 2001, 2004, 2007, and 2010 cohorts as being of high abundance. The 2018 cohort is the most recent strong cohort in both surveys, while recruitment has been weak and below average over the past five years.

The arrival of two very strong cohorts in the history of this stock—the 1997 cohort (modal size ~16 cm at age 1 in 1998) and the 1999 cohort (modal size ~16 cm at age 1 in 2000)—was observed in all three surveys. Fish from these cohorts drove the significant increase in stock abundance during the 2000s, and the arrival of strong cohorts in 2001, 2002, 2004, and 2007 supported substantial fishing in subsequent years. A high abundance of individuals >40 cm was noted from 2003 to 2008. Their abundance declined from 2009 to 2013 and has been scarce since 2015 (Figure 55).

Based on typical growth observed in the GSL, Greenland halibut generally recruit to the fishery at age 6 for females and age 7 for males. The abundant 2010 cohort showed a mode at 16 cm in 2011, then 27 cm in 2012, 35 cm in 2013, and between 40 and 44 cm in 2014. Growth rates for individuals in this cohort appear to have been faster than those of the 1997 and 1999 cohorts. The 2010 cohort may have begun recruiting to the fishery in 2014, which could explain the decline in Greenland halibut sizes in the commercial fishery (Figure 17) and the increase in commercial fishery performance indices (Figures 12 and 14).

Growth of fish from the abundant 2012, 2013, and 2014 cohorts appears to have been slower than that observed in previous cohorts. These cohorts likely contributed to the increase in

numbers and biomass of individuals >40 cm in 2021 (Figures 53 and 55). The abundance of the 2018 cohort at ages 1 and 2 was among the highest in the series, and its growth rate appeared typical for this stock until 2020, when the cohort started to disappear, suggesting a high mortality rates (Figures 55 and 57). Another notable pattern in these figures is the sudden disappearance of fish > 50 cm between 2022 and 2023, which implies high mortality on older fish.

3.7. SIZE AT SEXUAL MATURITY

Information has been collected annually since 1995 during the DFO nGSL survey to determine the size at sexual maturity of Greenland halibut. Sexual maturity stage was determined by visual inspection of gonads based on morphological criteria for up to 100 fish per tow. The macroscopic maturity stage identification chart by Morin et al. (1998) was used from 1995 to 2022, and starting in 2023, a chart based on that of ICES (2017) was employed. The latter was developed in parallel with a histological study. Also beginning in 2023, maturity stage and sex identification during the nGSL survey was performed only for individuals ≥ 22 cm due to the high proportion of fish of undetermined sex and maturity at smaller lengths (Figure 59). Finally, starting in 2024, maturity stage identification was stratified by length and sex (1/cm/sex/station for individuals ≥ 22 cm).

The length at which 50% of fish are mature (L_{50}) was determined for males and females separately using two statistical methods. First, a generalized linear model (GLM) with a Bernoulli distribution and a logit link function was fitted for each year and sex, as in the previous stock assessment (Chamberland and Benoît 2024), but with weighted observations (see below). In such a model, L_{50} corresponds to the absolute value of the ratio of the intercept to the slope. The maturity curve obtained from this model for females in 2023, and to a lesser extent for males in 2023, differed markedly from other years, likely due to lower sampling of immature individuals (note that the Estuary was not sampled in 2023; Figures 60 and 61). To mitigate this issue, a generalized linear mixed model (GLMM) of the following form was fitted by sex for all years:

$$\text{logit}(\pi_i) = \alpha + \beta \times l_i + \gamma_t + \delta_t \times l_i$$

where π_i and l_i are, respectively, the expected probability of being mature and the length (cm) observed for individual i , α and β are the global intercept and slope, γ_t is a random intercept by year (index t) following a multivariate normal (MVN) distribution with a mean of zero and an first order autoregressive (AR(1)) covariance matrix with correlation ϕ_T and stationary variance σ_T^2 . Similarly, δ_t is a random slope by year following an MVN distribution with a mean of zero and an AR(1) covariance matrix with correlation ϕ_Y and stationary variance σ_Y^2 . Note that the T and Y subscripts indicate parameters for the year effect and do not refer to a specific year. Even if the response variable is binary (immature = 0, mature = 1), the expected value and variance follow a binomial distribution because observations are weighted (see next paragraph). When implementing the model, length is normalized by subtracting the mean length, which reduces correlation between slopes and intercepts and eliminates the need to model correlation between γ_t and δ_t (Cadigan et al. 2014).

A weighting scheme was applied to the negative log-likelihood used for fitting the models (GLM and GLMM) to account for the survey sampling design (stratum area), Greenland halibut abundance per trawl tow, size class (1 cm), sex, and number of mature individuals (Morgan and Hoenig 1997). Annual weighting factors were normalized to sum to 1, then multiplied by the number of annual maturity observations to ensure proportional weighting to the available information, similar to Equation 10 in Beaudry-Sylvestre et al. (2025).

The GLMM was fitted to female and male Greenland halibut data separately. The RTMB v.1.6 library (Kristensen 2023) was used to compute the marginal negative log-likelihood for the model, and model parameters were estimated using the 'nlminb' function in R. L_{50} values were calculated within the RTMB function, and associated confidence intervals were obtained using the delta method.

The first method (one GLM per year and sex) produced maturity curves nearly identical to those obtained with the mixed model. The latter therefore did not mitigate the issue of missing immature individuals in 2023, likely due to the abundance of observations even for that year (Figure 62). The aberrant maturity ogive for females in 2023 cannot have been caused by the change in maturity chart that same year, since under the previous chart, functionally immature individuals (fish with a first cohort of eggs that would mature the following winter, about 1.5 years later) were classified as mature (Table 16). The new maturity chart based on histological work (ICES 2017) provides criteria that distinguish these two stages and should therefore have shifted the maturity ogive toward slightly larger lengths. Likewise, the aberrant ogive for females in 2023 was probably not caused by the absence of data for individuals <22 cm, as adding these individuals under the assumption of a balanced sex ratio and 100% immaturity had virtually no effect on the maturity ogives for 2023 and 2024 (Figure 63). The mixed model calibrated without 2023 data was therefore used to estimate maturity ogives and L_{50} across the entire 1995–2024 time series for both females and males. Models fit for females and males are shown in Figure 64.

L_{50} decreased markedly between 1997 and 2001 for males and between 1998 and 2004 for females. It remained relatively stable at average levels for both sexes from 2004 to 2014. Subsequently, L_{50} declined to reach the lowest values in the series in 2019 for males and in 2019–2021 for females. L_{50} for males then showed an upward trend until 2022. L_{50} for females, on the other hand, increased sharply in 2022 before returning to average levels. Confidence intervals for L_{50} in 2023 for both sexes are wide because data from adjacent years were used for estimation. L_{50} for males and females returned to values among the lowest in their respective series in 2024 (Figure 65).

The rapid decreases in L_{50} in 2019 and 2024 may be linked to the arrival of the 2013 and 2017–2018 cohorts into the mature population, as female L_{50} (37 cm) and male L_{50} (29 cm) fell within the size ranges possible for these cohorts in 2019 and 2024 (Figure 57). These decreases in L_{50} may also be partly explained by density-dependent phenomena, as the 2013 cohort was preceded and followed by abundant cohorts and shared resources with the large redfish cohorts (Gauthier et al. 2021). A decrease in L_{50} could also reflect individual responses to environmental changes, but this hypothesis was not tested here.

Data collected since 1995 indicate a trend toward earlier sexual maturation in Greenland halibut in the GSL. This could have significant implications for population productivity, as earlier maturation generally leads to earlier growth slowdown, thereby limiting the maximum size these fish can reach and reducing egg production by females (Roff 1984; Bowering 1980).

3.8. STOCK-RECRUITMENT RELATIONSHIP

The relationship between spawning stock biomass and recruitment (hereafter referred to as the stock–recruitment relationship) was examined to better understand population demographics and productivity. Data from the nGSL survey were used to calculate spawning stock biomass (biomass of mature females) and recruitment (see section 3.6 Demographic structure).

Annual biomass of mature females was estimated by first calculating the weight of mature females (w) per tow according to the following equation:

$$w = \sum_{i=1}^{120} b_i f_{iys} m_{iy}$$

where b_i is the biomass of Greenland halibut per 1 cm length class i for the tow of interest (not indexed in the equation), f_{iys} is the mean proportion of females at length i for year y and stratum s (sex ratio at length), and m_{iy} is the annual mean proportion of mature females at length obtained from the mixed model (excluding 2023 maturity data; maturity-at-length for 2023 was therefore imputed). Proportions of females and female maturity at length could not be calculated at the tow level due to the non-negligible number of fish with undetermined sex and/or maturity stage within certain tows. Female proportions were estimated by year and stratum rather than annually because the spatial distribution of sex ratio showed some structure (Figure 66). Mean female proportions at length from 1986 to 1989 were used to impute values for 1984 and 1985 due to missing data for these two years (Figure 67). Similarly, mean maturity-at-length values from 1995 to 1998 were used to impute values for 1984 to 1994 due to missing data (Figure 68). The standard stratified mean estimator was then applied to w values to obtain annual biomass of mature females (see Section 3.5 Abundance Indices).

Four stock–recruitment models were fitted to mature female biomass and recruitment indices from 1984 to 2023, namely the density-independent $E[R|S] = aS$, Beverton-Holt (1957) $E[R|S] = \frac{aS}{1+bS}$ and Ricker (1954) $E[R|S] = aSe^{-a\frac{S}{R_{pe}}}$ models. In these models, a , b and R_p are estimated parameters. A null model including an intercept only was also fitted for comparison with the previous models to validate whether a stock–recruitment relationship existed. All models were fitted with a multiplicative error term by applying the natural logarithm to both sides of the equations. The `nls` function from the `stats` library in R (R Core Team 2023) was used to fit the models. Models were compared using Akaike Information Criterion corrected for small samples (AICc). Residuals (on the natural log scale) were plotted against years, and residual autocorrelation was examined.

The relationship between spawning stock biomass and recruitment was characterized by low recruitment in the late 1980s and early 1990s, when the stock was at its lowest levels, and by recruitment that tended to increase proportionally with spawning stock biomass (Figure 69). Variability also tended to increase with mature female biomass, which justifies the choice of a multiplicative error term.

Residuals plotted against year showed a dome-shaped pattern, with a negative trend from 1984 to 1989, a positive one from 1990 to 2010, and negative trend from 2011 to 2023. Positive and negative residuals were present in the last decade, although some negative values were observed from 2019 to 2023. The confidence interval of the cubic smoothing function encompassed zero for most years (Figure 70). Significant autocorrelation in residuals at a one-year lag was also detected (Figure 71), but this does not pose a problem in a context where no inference is made from the stock–recruitment relationship. Since Greenland halibut habitat in the nGSL has been warming since 2010 (Figure 50), the absence of a strong pattern in residuals over this period suggests that the stock–recruitment relationship is not currently influenced by environmental changes.

Fits of the density-independent, Beverton-Holt, and Ricker models were similar, as evidenced by small AICc differences among these models (Table 15). However, the null and density-independent models were less supported by the data than the Beverton-Holt and Ricker models, which supports the existence of a density-dependent relationship between spawning biomass and recruitment. Mature female biomass in the last two years (2022 and 2023) was close to the series average and produced low or moderate recruitment, as expected under the two best-supported models (Figure 69).

Regardless of model choice, the presence of a stock–recruitment relationship means that conserving a substantial spawning biomass will tend to produce higher recruitment and thus maintain the stock at elevated levels.

3.9. CONDITION

Fulton's condition index ($K = \text{weight (g)} / \text{length}^3 \text{ (cm)}$), calculated from DFO nGSL survey data (1987–2024), is used as an indicator of Greenland halibut health status in August. The index is calculated from total fish weight, which was deemed adequate for calculating the condition index, as the index is computed for the same time period each year in August, outside the spawning season.

An analysis of covariance (ANCOVA) was used to compare condition indices among years. ANCOVA accounts for and removes the linear effect of fish length on the condition index and evaluates the effect of year. Annual condition index estimates were calculated by size interval: 10–20 cm, 20–30 cm, 30–40 cm, and >40 cm, with observations weighted according to the method described in section 3.7 Size at sexual maturity, but aggregating sexes. The model predicts a condition index for each year at median lengths for each interval: 15, 25, 35, and 45 cm. The two largest size categories approximately correspond to mature individuals since 2019 (Figure 61). Annual predictions are compared among themselves. Abnormally high K values were obtained for several lengths in 1987, 1988, and 1989; therefore, indices are presented starting in 1990.

In 2022, condition indices estimated for all Greenland halibut size classes dropped sharply and were well below average. Condition for individuals of 35 and 45 cm remained at historically low levels in 2023 and 2024, while condition for individuals of 15 and 25 cm returned to average levels (Figure 72). Poor condition in individuals >35 cm may be attributed to low abundance or biomass of the three main prey species for Greenland halibut during these years: capelin (*Mallotus villosus*), Northern Shrimp, and Pink Glass Shrimp (see section 3.10 Description of diet, Figure A1 à Figure A3). Stomach fullness indices, which reflect feeding intensity, were calculated from stomachs collected during the nGSL survey. These showed the three lowest fullness values in the series from 2022 to 2024 (Figure 73). The sharp decline in condition indices in 2022 cannot be explained solely by low stomach content weights, as the average weight of non-empty stomach contents represented 1.45% of total fish weight, and 90% of non-empty stomachs represented less than 3.6% of total weight (Figure 74).

Although condition indices examined here are based on total weight rather than somatic weight, the recent decline in condition among individuals ≥ 35 cm does not appear to be caused by low filling indices alone. The combination of low filling indices and low prey availability instead suggests a decrease in feeding intensity and energy accumulation. Low condition indices have been associated with reduced growth and increased mortality in Greenland halibut maintained in laboratory conditions (Ghinter et al. 2021).

3.10. DESCRIPTION OF DIET

Stomachs from several fish species have been collected and analyzed since the early 1990s during the nGSL survey in order to document trophic relationships and thus better understand the functioning of the GSL ecosystem. This section presents Greenland Halibut stomach content data by year and size class, as well as a comparison with the diet of redfish.

3.10.1. Methodology

The stomachs collected during the nGSL survey were thawed just before laboratory analysis. Each taxon d found in a given stomach j was then weighed and identified to the most precise

possible taxonomic level. The mass of the taxon from a given stomach (M_{dj}) was then entered into the database field corresponding to the digestion stage of the taxon. A non-digested taxon was recorded as stage 1, a partially digested taxon still identifiable to species as stage 2, and everything else as stage 3. For this study, data from all digestion stages were used. However, taxa corresponding to parasites or debris (e.g., rock, sand, liquid, mucus) were removed. The same applies to everted stomachs or those that could not be matched to a fish length value.

Five indicators from the method presented in Bernier and Chabot (2013) and Ouellette-Plante et al. (2020) were used to classify the importance of different taxa in the Greenland Halibut diet. These measures are:

- Percentage of empty stomachs (PES)
- Mass contribution (MC)
- Fullness index (FI) or total fullness index (TFI)
- Contribution to the fullness index (CFI)
- Frequency of occurrence (FO)

For a sample e of N stomachs that includes N_e empty stomachs, the percentage of empty stomachs (PES) is calculated as follows:

$$PES_e = \frac{N_{ev}}{N_e} \times 100 \quad (1)$$

For a taxon d with mass M_{dj} found in stomach j from a sample of N_e stomachs, the sum of the masses M_{dj} in this sample corresponds to M_d and contributes to MC_d % of the total stomach content, M_{tot} , found in these N stomachs. D corresponds to the number of different taxa present in sample e .

$$M_d = \sum_{j=1}^{N_e} M_{dj} \quad (2)$$

$$M_{tot} = \sum_{d=1}^D M_d \quad (3)$$

$$MC_d = \frac{M_d}{M_{tot}} \times 100 \quad (4)$$

As highlighted in Bernier and Chabot (2013), using MC_d alone has certain disadvantages:

1. For a sample of N_e stomachs, the sum of MC_d for the D prey items found equals 100%. This implies an interdependence between the MC_d values of different taxa, where a high value for a given taxon d may reflect a decrease in the abundance of alternative taxa rather than an actual increase in the abundance of taxon d in the predator's diet.
2. Taxa found in small stomachs may be disadvantaged compared to those in large stomachs, which, proportionally to the predator's capacity, could be heavier and therefore represent a higher proportion of M_{tot} .
3. MC_d does not account for empty stomachs.

To address these disadvantages, the fullness index FI_{dj} was calculated based on the mass M_{dj} of the taxon, the length of the fish associated with stomach j (L_j , in mm), the allometric exponent b , and a constant (10^7). The value of the allometric exponent b used is 3.24 and corresponds to the slope of the linear relationship $\log(\text{mass}) \sim \log(\text{length})$ expressed as $\text{mass} = aL^b$, where length is in centimeters and mass in grams for the fish whose stomach contents were analyzed. For a given taxon d in a sample, the contribution to the fullness index FI_d of this taxon corresponds to CFI_d . For a given sample (a stomach content) e , the total fullness index (TFI) is the sum of FI_d from the different taxa present in sample e .

$$FI_{dj} = M_{dj} \times L^{-b} \times 10^7 \quad (5)$$

$$FI_d = \frac{\sum_{j=1}^{N_e} FI_{dj}}{N_e} \quad (6)$$

$$TFI = \sum_{d=1}^D FI_d \quad (7)$$

$$CFI_d = \frac{FI_d}{TFI} \times 100 \quad (8)$$

For a given sample of size N_e where N_{ed} stomachs contain taxon d , the frequency of occurrence (FO_d) of this taxon is calculated as follows:

$$FO_d = \frac{N_{ed}}{N_e} \times 100 \quad (9)$$

The detailed diet analysis was completed using different groupings:

- Periods: 2004–2009, 2015–2019, and 2020–2024. It should be noted that no Greenland Halibut stomachs were sampled during the nGSL surveys from 2010 to 2014.
- Length classes: <20, [20–30[, [30–40], and >40 cm.

For each observed taxon, the values of FO , MC , and CFI were calculated. These same values were also calculated for the following major prey groups: *Fish*, *Shrimps*, *Zooplankton* (calanoid copepods, euphausiids, gammarids, hyperiids, and mysids), *Other invertebrates* (invertebrates not included in shrimps or zooplankton), and *Unidentified prey*. For clarity in the tables, FI values are not provided for each taxon. However, this value can be obtained for a given taxon and period/length class/region by multiplying the corresponding CFI and TFI values.

Since several dozen taxa were found in Greenland Halibut stomach contents, 14 taxonomic groupings were created to simplify the graphical analysis of its diet. These groupings were chosen based on FI value and prey type.

Finally, the diets of Greenland Halibut and redfish were compared graphically for the years 2015 to 2024. The same taxonomic groupings and length classes used for Greenland Halibut were applied to redfish.

3.10.2. Temporal Variations in Diet

The diet is described based on the analysis of 10,979 Greenland Halibut stomachs: 5,456 stomachs for the 2004–2009 period, 2,650 stomachs for 2015–2019, and 2,873 stomachs

for 2020–2024 (Table A1, Figure 75). The number of stomachs collected annually ranged from 359 to 1,041. The fish sampled for this study are well distributed across all considered length classes (Table A2) and throughout the study area (Figure 76). The *TFI* of Greenland Halibut under 20 cm decreased in 2022 and 2023 (Figures 73 and 77). Total stomach fullness was also very low over the last three years (2022–2024) for Greenland halibut ≥ 30 cm.

For all periods considered, regardless of size classes, taxa from the *Fish* group were the main prey of Greenland Halibut (Tables A3 and A4). Twenty-nine different fish taxa have been identified since 2004, with an average *FO* of nearly 20% and an average *CFI* of 56%. Apart from capelin, Atlantic Soft Pout (*Melanostigma atlanticum*), Fourbeard Rockling (*Enchelyopus cimbrius*), sand lances (*Ammodytes sp.*), and redfish, no other fish taxon identifiable at least to genus was observed in $>1\%$ of stomachs during 2004–2024. Capelin is the most important prey in Greenland Halibut diet based on the percentage of *TFI* for all studied periods (Table A3 and Figure 77) and mean capelin *FI* decreased between 2020 and 2024 (Figure 78). During 2004–2009, redfish were not an important prey in Greenland Halibut diet, with *FO* $<1\%$ (Table A3). In 2015–2019, redfish *FO* increased to 4.8%, then dropped back to $<1\%$ in recent years (2020–2024).

Since 2004, fifteen taxa from the *Shrimp* group have been reported in Greenland Halibut stomachs (Table A3). Four taxa identifiable at least to genus were observed during each studied period: Pink Glass Shrimp, Northern Shrimp, Aesop Shrimp (*Pandalus montagui*), and the genus *Pandalus sp.* For all periods considered, Northern Shrimp is the most important shrimp taxon in Greenland Halibut diet. Its contribution to *TFI* has decreased, with *FO* dropping from 5.3% to 5%, then 2.2% for the periods 2004–2009, 2015–2019, and 2020–2024, respectively. Overall, shrimp occurrence in Greenland Halibut stomach contents has declined when comparing 2004–2009 to 2015–2019 and 2020–2024, dropping from *FO* of 17.8% to about 7.3%. In terms of mass contribution, a decrease of more than half was observed between 2004–2009 (31.1%) and 2020–2024 (14.4%) for this group (Table A3).

Thirty-four taxa from the *Zooplankton* group have been identified, and this prey group has a frequency of occurrence of more than 10% in Greenland halibut stomachs analyzed since 2004 (Table A3). Hyperiid of the genus *Themisto* and euphausiids, mainly northern krill (*Meganyctiphanes norvegica*), are the most important zooplankton taxa in Greenland Halibut diet (Table A3 and Figure 77).

The *Other Invertebrates* group, composed of twenty-three taxa that are neither shrimps nor zooplankton, shows a significant decrease in Greenland Halibut diet during 2015–2019 (Table A3). This decrease could be attributable to improved taxonomic identification expertise during these years, as the decline is mainly due to the taxon *Crustacea*, a generic group used when the examiner cannot identify the specimen to genus or species.

3.10.3. Size-Related Variations in Diet

The sample sizes are substantial for each length class considered ($>1,000$; Table A2). The *PES* is highest for the [20–30[cm and [30–40[cm size classes, with 58.3% and 58.4%, respectively. Greenland Halibut under 20 cm have the lowest *PES* (36.7 %). This size group also feeds the most: its *TFI* (0.32) is double the average fullness index (0.16; Tables A1 and A2, Figure 73).

The diet of Greenland Halibut under 20 cm consists mainly of fish and invertebrates (Table A4, Figures 79 and 80), while larger Greenland Halibut feed primarily on fish. For fish <20 cm, the proportion of stomach content represented by zooplankton is slightly lower than that from fish (32.4% versus 42.7% of *TFI*; Table A4). Capelin, sand lances, euphausiids, and hyperiids (*Themisto sp.*) are the most important prey groups at this size (Table A4, Figure 79).

The diet of Greenland Halibut in the 20–30 cm size class consists of larger prey than that of Greenland Halibut under 20 cm. The importance of zooplankton decreases in this size class, and there is an increased intake of fish and shrimp based on *TFI* (Table A4, Figure 79). Capelin is the most important prey at this size and is also the only fish species contributing at least 10% of *TFI* across all length classes considered in the study (Table A4). For the *Shrimp* group, Northern shrimp and Pink Glass Shrimp are the two most important taxa in the diet of Greenland Halibut in the 20–30 cm size class (Table A4). The occurrence and contribution of Northern Shrimp to Greenland Halibut diet increase with predator size (Table A4).

The diet of Greenland Halibut 30–40 cm in length relies even more on shrimp (30.6% of *TFI*), mainly Northern Shrimp (Table A4). The *Fish* group contributes 57.6% of *TFI* for this size class (Figure 79).

The diet of Greenland Halibut over 40 cm is focused on fish (67.7% of *TFI*; Table A4 and Figure 79). Capelin remains one of the main prey for this size class, but redfish contribute the most to the diet (Table A4). The importance of redfish in Greenland Halibut diet increases with predator size, rising from <1% of *TFI* for the [0–20] cm size class to 14.75% for fish over 40 cm. Similar conclusions can be drawn when looking at *MC* (Figure 81).

3.10.4. Comparison of Greenland Halibut and Redfish Diets

In total, 5,523 Greenland Halibut stomachs and 7,422 redfish stomachs, collected between 2015 and 2024 for both species, were retained for a diet comparison (Table A5 and Figure 82). Few redfish stomachs from specimens over 40 cm were available. Compared to Greenland Halibut, redfish maintained a significant proportion of invertebrates in their diet throughout their development (Figure 82).

Greenland Halibut consumed a greater variety of fish taxa (29) than redfish (19) (Table A5). Capelin was much more important in the diet of Greenland Halibut (27.3% of *TFI*) than in that of redfish (3.4% of *TFI*) for all periods included in the comparison. For redfish, the importance of the “Other Fish” taxonomic grouping increased with specimen length, whereas for Greenland Halibut, the contribution of this grouping was high for individuals under 20 cm. Its importance then decreased to a minimum for individuals between 30 and 40 cm, before increasing again for those over 40 cm. The high contribution of *Other Fish* to the diet of small Greenland Halibut reflected the important contribution of sand lances in their diet in 2019. Redfish as prey contributed similar *CFI* values between Greenland Halibut and redfish. As for the *Digested Fish* grouping, which combines taxa used to describe fish too digested for identification, it was more important in the diet of Greenland Halibut than in that of redfish (Figure 83).

Among shrimps, Pink Glass Shrimp was much more important in the diet of redfish than in that of Greenland Halibut. Its presence in the diet increased with redfish size. Northern Shrimp, as well as the *Other Shrimps*, contributed similarly to the diet of both predators across size ranges (Figure 83). Within the *Other Shrimps* group, only *Pandalus sp.*, Aesop Shrimp, and digested shrimp were observed in the stomach contents of both predators.

For all size classes considered, hyperiids contributed more to the diet of redfish than to that of Greenland Halibut. The same trend is observed for euphausiids, except for the <20 cm size class, where Greenland Halibut and redfish used this group of prey items similarly in their respective diets (Figure 83). The prey group *Other Zooplankton* combined 36 taxa in redfish under 20 cm, compared to only 11 in Greenland Halibut. For this size class, 28 taxa were found exclusively in redfish stomach contents.

In conclusion, the analysis of Greenland Halibut diet in August reveals a diversity of consumed prey, with a predominance of fish, particularly capelin. Temporal and size-related variations

were observed, with a notable decrease in shrimp consumption and an increase in fish consumption as predator size increased. The comparison with redfish diet shows important differences, with Greenland Halibut consuming a greater variety of fish taxa and redfish relying more heavily on invertebrates. Nevertheless, it is clear that Greenland Halibut and redfish are generalist predators, and their respective diets share many common taxa.

4. UNACCOUNTED MORTALITY IN THE GILLNET FISHERY

The Greenland Halibut directed fishery employs extended gillnet immersion times, which have long been suspected of generating unaccounted fishing losses resulting from fish decomposition and drop out of the gear (DFO 2009a). Median soak times since 2000 have typically been approximately 72 hours (Chamberland and Benoît 2024; Benoît et al. 2025). Recently, a project undertaken in collaboration with l'Association des pêcheurs propriétaire des la Gaspésie (ACPG) and funded by DFO Fisheries-Science Collaborative Fund estimated the amounts of Greenland Halibut lost to decomposition and dropout. The study was based on a simple theoretical process model from which two independent modeling approaches were defined to estimate unaccounted mortalities in this fishery. The first approach was based on the analysis of commercial fishery landing and effort data presented at the previous assessment for this stock (Chamberland and Benoît 2024), while the second was based on field experiments and data collected by ASO. The main metric estimated in the modelling was the removals/landings ratio, which expresses the total amount of Greenland Halibut killed by fishing (dropped-out, discarded or landed) as a function of the landed amount.

The two approaches produced similar results, estimating that after 24 hours of soaking, the removals/landings ratio had a value of about three, while after 72 hours that value was about five (Figure 84). Integrating over the soak times employed in the fishery each year since 2000, the average removals/landings ratio varied between 4.7 to 5.4, depending on the approach (Figure 85). Put another way, there has been about four times as much Greenland Halibut lost to dropout and discarding of degraded catch, compared to landings. This result is consistent with the high mortality levels suggested by the stock assessment.

Based on the results of the study there are a few options to mitigate catch losses, while maintaining yields produced by longer soak duration. Shortening gillnet soak times would be a highly effective strategy to reduce catch losses due to fish degradation and drop-outs. Standardized catch rate data from 2000–2024 show that 6-hour soak times can yield landable catches comparable to longer durations but with significantly less waste (Chamberland and Benoît 2024; Benoît et al. 2025). Although results may vary by conditions, experimentation with shorter soak durations could optimize both yield and fish quality, especially when nets are re-deployed multiple times per day. Furthermore, using baited nets could improve initial fishing power, as demonstrated off Baffin Island (Bayes and Grant 2020). Additionally, selecting fishing sites with fewer scavengers such as amphipods and hagfish could further reduce losses. Selection of these sites could be informed by harvesters' local knowledge and/or survey data.

5. EXPLOITATION RATE AND PRECAUTIONARY APPROACH

5.1. RELATIVE EXPLOITATION RATES

Relative annual exploitation rates are presented for the entire GSL (4RST) and by fishing sector. The nGSL survey strata selected to determine biomass by fishing sector are shown in Figure 86. As with the Precautionary Approach indicators, Greenland Halibut biomass over 40 cm is expressed in *NGCC Teleost* equivalents, and the conversion factors between *NGCC Needler* and *NGCC Teleost* used are those from Bourdages et al. (2007). Relative exploitation

rates are calculated by dividing biomass estimates by landed quantities. They therefore do not account for unreported fishing mortality.

The relative exploitation rate for the entire GSL (4RST) increased and then dropped sharply in the late 1990s. This indicator then gradually increased until 2009, before fluctuating around the maximum reference exploitation rate (6.51%) during the 2010–2019 period. From 2020 to 2024, the relative exploitation rate decreased sharply in response to reduced landings, reaching a value of 0.06% in 2024 (Table 18, Figure 87).

The exploitation rate indicator for the Western Gulf sector varied similarly to that for the entire GSL, as most of the fishing and stock biomass were located in this sector. For the North Anticosti sector, the exploitation rate varied greatly from year to year, peaking in 2001, 2009, and 2020; note that this sector is occasionally abandoned by harvesters. Following the peak in 2020, the exploitation rate dropped sharply, reaching values close to zero in 2023 and 2024. In the Esquiman sector, biomass of fish >40 cm estimated by the nGSL survey has shown a strong downward trend since 2011. The exploitation rate peaked in 2020 in response to one of the lowest biomass estimates in this sector from the nGSL survey combined with non-negligible landings. Biomass estimates for this sector from 2021 to 2024 were also very low, but since landings also decreased significantly, exploitation rates followed the same trend.

5.2. PRECAUTIONARY APPROACH

The Precautionary Approach (PA) applied to fisheries management aims to avoid serious harm to fish stocks or their ecosystems and consists of exercising caution when conclusive scientific evidence is lacking, and not using the absence of relevant scientific data as a reason to delay or avoid taking measures (DFO 2009b). This approach is widely recognized nationally and internationally as an essential element of sustainable fisheries management.

A first PA was completed for the Greenland Halibut stock in the GSL in 2022 (DFO 2022). It is based on reference points and an empirical harvest decision rule. The indicator selected for monitoring stock status is the biomass of fish >40 cm estimated from the nGSL survey. This survey covers almost the entire distribution area of the stock, and this indicator represents a relative approximation of spawning stock biomass, since the catchability of Greenland Halibut in this survey is unknown (DFO 2018). The stock status indicator is expressed in *NGCC Teleost* equivalents, and the conversion factors between *NGCC Needler* and *NGCC Teleost* used are those from Bourdages et al. (2007).

The Limit Reference Point (LRP) was defined as the geometric mean of the indicator during the 1990–1994 period, which corresponds to the time when the population was at its lowest level and from which stock recovery was observed in the survey series. This LRP is estimated at 10,000 t (Figure 88A). The Upper Stock Reference point (USR) is based on the average productivity period of 1996–2002 and the high productivity period of 2004–2012. According to this proposal, an approximation of the biomass at maximum sustainable yield (Bmsy) represented the average biomass of these two periods, *i.e.*, 47,170 t, and the USR corresponded to 80% of this Bmsy, or 37,740 t (Figure 88A). The Bmsy is considered the Target Reference Point (TRP) in this PA. This choice of USR was made to account, to some extent, for ecosystem changes in the GSL as well as the decline in stock productivity (DFO 2022).

The Harvest Control Rule (HCR) was developed in accordance with PA principles using the stock biomass indicator and reference exploitation rates. It is a “status-based” HCR, where expected exploitation rates are a function of stock status (Kronlund et al. 2014). The maximum reference exploitation rate, *i.e.*, the maximum exploitation rate targeted when the stock status indicator is above the TRP, was defined as the average of the mean exploitation rates for the

periods 1996–2002 (excluding 1998) and 2004–2012, which were used to define the TRP and USR, and corresponds to 6.51%.

According to the selected HCR, the exploitation rate for any stock status $\geq$ TRP is set at 6.51%, while the exploitation rate at the midpoint of the cautious zone, which corresponds to the average of the LRP and USR, was set at 5.31%, the mean exploitation rate for a growth period from 2002 to 2006 (DFO 2022). The exploitation rates at the TRP and midpoint of the cautious zone are then converted into removals, and a straight line is drawn to connect these values to the LRP. The removals on this line are then converted into exploitation rates. This results in a curvilinear decrease in exploitation rates within the cautious zone as the stock status indicator approaches the LRP (Figure 88B). The exploitation rate corresponding to the LRP is 1.94%. The HCR does not project removals beyond a biomass of 76,805 t (5,000 t / 6.51%) since the stock has never sustained annual landings of more than 5,000 t in the past (Gauthier et al. 2021).

The stock status indicator decreased by more than 65% between 2008 and 2017, moving from the healthy zone to the cautious zone. The indicator was stable at the midpoint of the cautious zone from 2017 to 2020, increased to values near the USR in 2021 and 2022, and then declined to reach one of the lowest values (11,240 t) in the time series starting in 1990, just above the LRP (Figure 88A).

The probabilities that the stock was in the critical zone and the cautious zone in 2024 were estimated using parametric confidence intervals of the biomass estimate. Specifically, the integral of a Gaussian density function with the mean and standard deviation estimated in 2024 was calculated for these zones. This is a heuristic, very simplistic approach, since a frequentist confidence interval does not contain the true value with a probability of 95%. Rather, such an interval would contain the true value 95% of the time if 100 estimates were available in 2024 (Sokal and Rohlf 1995). Thus, in 2024, the frequentist probabilities that the stock was in the critical and cautious zones were 29% and 71%, respectively.

Based on the HCR agreed upon in the PA, the stock status indicator corresponds to a maximum exploitation rate of 2.58% and a harvest option not exceeding 290 t for the 2025–2026 and 2026–2027 fishing seasons in the GSL (Figure 88B).

According to the PA for this stock (DFO 2022), the TAC decision will apply for two years. In the interim year, an update of the stock status indicator will be produced. If this indicator varies by more than 30% or if the stock status changes according to the PA, the projected harvest option under the HCR will be recalculated.

6. CONCLUSION

Greenland Halibut landings, fishing effort, and catch per unit effort in the commercial fishery reached the lowest values ever observed in 2023 and 2024. The last two strong cohorts (2017 and 2018) appear to have followed typical growth patterns, but their abundance declined sharply in 2023. In 2024, abundance across all size classes was low, reflecting the decline of these strong cohorts and the absence of strong recruitment since 2020. Biomass of fish over 40 cm has shown a downward trend since the mid-2000s, and no indication in the 2024 size structure suggests that this trend could change in the near future.

The Greenland Halibut stock status indicator in 2024, estimated at 11,240 t, is above the LRP with a moderately high probability, placing the stock at the lower end of the PA cautious zone. The relative exploitation rate in 2024 is near zero and represents the lowest value in the series starting in 1996. The downward trend in stock status could continue in the short term given the absence of strong recruitment since 2020. According to the HCR for this stock, the 2024 stock

status indicator corresponds to a maximum exploitation rate of 2.58% and a harvest option of 290 t for the 2025–2026 and 2027–2028 fishing seasons in the GSL.

The outlook for the Greenland Halibut stock in the GSL are concerning given unfavorable ecosystem changes for this species, declining abundance and biomass indices, lack of strong recruitment since 2020, and poor condition indices for mature individuals since 2022.

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9. TABLES

Table 1. History of the main management measures put in place for the directed Greenland halibut fishery. F-ALL: fixed gear fishing allocation; Comp: Competitive Regime; ITQ: Individual Transferable Quota; Bo : Boat.

Management year	TAC (t)	F-ALL	Landing (t)	Fishing Regime	Mesh size (inch)	Number of net	Minimum size ⁴ (cm)
1980	-	-	7,006	<i>Freeze on the issuance of groundfish licenses</i>			
1981	-	-	3,176	-	-	-	-
1982	7,500	-	2,269	<i>Establishment of a management plan</i>			
1983	5,000	-	1,105	-	-	-	-
1984	5,000	-	2,126	-	-	-	-
1985	5,000	-	2,369	-	-	-	-
1986	5,000	-	6,595	-	-	-	-
1987	8,900	-	11,080	<i>Problem of high bycatch by mobile gear > 65 feet</i>			
1988	10,500	-	7,569	-	-	-	-
1989	10,500	-	5,136	-	-	-	-
1990	10,500	-	2,445	-	-	-	-
1991	10,500	-	2,293	-	-	-	-
1992	10,500	-	3,419	Comp.	5.5	>120	-
1993	4,000	-	2,602	Comp.	5.5	>120	-
	<i>Recognition than GSL Greenland halibut is distinct from the Atlantic one. Stop of mobile gear directed fishery. Mandatory use of the Nordmore grid for shrimpers since winter 1993 to reduce bycatch, including Greenland halibut > 30cm.</i>						
1994	4,000	-	3,620	Comp.	5.5	120 (Bo < 45 ft.) 160 (Bo > 45 ft.)	-
1995	4,000 (-900 ¹)	-	2,426	Comp.	70% 5.5 30% 5.7	120	-
1996	2,000	-	1,962	Comp.	30% 5.7 70% 6.0	80 = QC 120 = NL	42
1997	3,000	-	2,633	Comp.	6.0	80 = QC 120 = NL	44
1998	4,000	-	3,945	Comp.	6.0	80 = QC 120 = NL	44
1999-2000	4,500	-	3,674	QC = ITQ + Comp. NL = Comp.	6.0	80 = QC 120 = NL	44
2000-2001	4,500	-	2,078	Idem	6.0	80/100 = QC ³ 120 = NL	44
2001-2002 ⁹	4,500	-	1,288	Idem	6.0	120	44
2002-2003	3,500	-	1,752	Idem	QC ² = 5.5 et 6.0 NL : 6.0	120	44
2003-2004	3,500	2,917	3,573	Idem	QC ² = 5.5 et 6.0 NL : 6.0	120	44
2004-2005	4,500	3,751	3,952	Idem	6.0	120	44
2005-2006	4,500	3,751	4,048	Idem	6.0	120	44
2006-2007	4,500	3,751	3,868	Idem	6.0	120	44
2007-2008	4,500	3,751	3,921	Idem	6.0	120	44

Management year	TAC (t)	F-ALL	Landing (t)	Fishing Regime	Mesh size (inch)	Number of net	Minimum size ⁴ (cm)
2008-2009	4,500	3,751	3,770	ITQ + Comp. = QC Comp. = NL	6.0	120	44
2009-2010	4,500	3,751	4,268	Idem	6.0	120	44
2010-2011 ⁵	4,500	3,751	3,972	Idem	6.0	120	44
2011-2012	4,500	3,751	3,872	Idem	6.0	QC = 120 NL = 90	44
2012-2013	4,500	3,751	3,481	Idem	6.0	QC = 120 NL = Option A- 80 and 3 fishing days, or Option B- 35 and 5 fishing days	44
2013-2014 ⁶	4,500	3,751	2,774	Idem	6.0	QC = 120 NL = Option A- 80 and 3 fishing days, or Option B- 35 and 5 fishing days	44
2014-2015 ¹⁰	4,500	3,751	3,179	Idem	6.0	QC = 120 NL = 80	44
2015-2016	4,500	3,751	3,410	Idem	6.0	QC = 120 NL = 90	44
2016-2017	4,500	3,751	3,300	Idem	6.0	Idem	44
2017-2018 ⁷	4,500	3,751	1,765	Idem	6.0	Idem	44
2018-2019	3,375	2,813	1,604	Idem	6.0	Idem	44
2019-2020	3,375	2,813	1,896	Idem	6.0	Idem	44
2020-2021 ¹¹	2,250	1,875	1,330	Idem	6.0	Idem	44
2021-2022	2,025	1,688	1,195	Idem	6.0	Idem	44
2022-2023	2,400	2,000	930	Idem	6.0	Idem	44
2023-2024 ¹²	2 400	1 524	158	Idem	6,0	Idem	44
2024-2025 ¹³	2 000	1 524	11	Idem	6,0	Idem	44

¹ TAC reduction to protect juvenile fish.

² QC experimental fishery (4T4 et 4T3a): fishery with 5,5 inches mesh size gillnet allowed to catch 30% du IQ of traditional fishers. The other fishers used 6 inches.

³ The maximum number of nets was increased from 80 to 100 from July 17, 2000 to May 14, 2001 for QC fishers.

⁴ Minimum regulatory size according to the small fish protocol.

⁵ Establishment of quota reconciliation.

⁶ Mandatory use of Vessel Monitoring System (VMS) for some QC fleet.

⁷ Mandatory use of VMS for all QC fleet.

⁹ Ban on fishing in depth less than 125 fathoms in Division 4R from 2001 to 2013 for all fleets.

¹⁰ Ban on fishing in depth less than 140 fathoms in Division 4R since 2014 for NFL fleets. For the Quebec Region, the maximum 72-hour time between launching and hauling of the nets is added to the licence conditions starting in May 2014

¹¹ Ban on fishing in depth less than 125 fathoms in Division 4S, measure implemented in 2020.

¹² Closure of 4Tp from June 20, 2023 due to high proportions of turbot below the legal regulatory size.

Table 2. Landings (t) of Greenland halibut by fishing gear and management year. Data source 1977-1983: Morin and Bernier 2003 ; 1984-2024 ZIFF as of 2025-01-15.

Management year	Gillnet	Longline	Bottom trawl	Seine	Shrimp trawl	Other	Total
1977	1329	3	1626	0	993	10	3961
1978	3450	0	1577	0	1210	10	6247
1979	3373	1901	2888	0	609	20	8791
1980	5239	39	1042	0	686	0	7006
1981	2464	7	409	0	286	10	3176
1982	1771	3	165	0	330	0	2269
1983	469	94	231	0	311	0	1105
1984	1026	36	582	0	457	25	2126
1985	1451	61	97	1	650	108	2369
1986	4941	122	231	1	1300	0	6595
1987	8350	147	1199	4	1376	4	11080
1988	5793	52	694	19	1010	1	7569
1989	4193	22	404	0	517	0	5136
1990	1937	39	178	0	290	0	2445
1991	1372	74	141	4	700	2	2293
1992	2401	112	156	16	733	0	3419
1993	2479	68	70	28	128	12	2785
1994	3438	87	33	11	10	74	3654
1995	2330	17	10	14	1	54	2426
1996	1811	34	93	23	1	0	1962
1997	2456	57	89	30	1	0	2633
1998	3758	35	117	28	1	2	3941
1999-2000	3381	28	187	71	2	1	3670
2000-2001	1876	78	99	26	1	0	2079
2001-2002	1166	66	40	24	2	0	1299
2002-2003	1568	87	54	34	1	10	1754
2003-2004	3413	49	66	43	2	0	3573
2004-2005	3796	48	40	61	1	0	3947
2005-2006	3837	39	49	122	0	0	4048
2006-2007	3722	47	48	49	2	0	3868
2007-2008	3743	47	15	111	2	4	3921
2008-2009	3627	47	28	55	1	12	3769
2009-2010	4159	28	52	14	1	15	4268
2010-2011	3904	20	18	11	1	18	3972
2011-2012	3791	20	27	16	1	18	3872
2012-2013	3417	15	19	16	1	13	3481
2013-2014	2722	5	11	14	1	21	2774
2014-2015	3139	6	3	10	1	20	3179
2015-2016	3363	5	7	15	1	19	3410
2016-2017	3277	3	8	11	1	11	3311
2017-2018	1744	7	1	12	1	8	1773
2018-2019	1576	6	3	12	1	12	1610
2019-2020	1874	7	2	7	1	9	1899
2020-2021	1437	9	0	3	1	4	1454
2021-2022	1187	7	1	2	2	5	1203
2022-2023	988	6	0	1	1	1	997
2023-2024	151	5	1	0	1	0	158
2024-2025	5	3	3	0	0	0	11

Table 3. Landings (t) by NAFO Divisions and Total Allowable Catch (TAC) of Greenland halibut by management year. Data source 1977-1983: Morin and Bernier 2003; 1984-2024 ZIFF as of 2025-01-15. N.d.: not determined, F-ALL: fixed gear fishing allocation.

Management	NAFO Division				Total	TAC	F-ALL
year	4R	4S	4T	n. d.			
1970	381	496	255	-	1132		
1971	300	450	204	-	954		
1972	199	379	105	-	683		
1973	216	431	116	-	763		
1974	167	752	92	-	1011		
1975	195	1102	247	-	1544		
1976	517	1367	135	-	2019		
1977	1108	2298	555	-	3961		
1978	1344	3549	1354	-	6247		
1979	2920	1889	3982	-	8791		
1980	1631	2063	3312	-	7006		
1981	533	803	1840	-	3176		
1982	158	548	1563	-	2269	7 500	
1983	205	444	456	-	1105	5 000	
1984	200	571	1355	-	2126	5 000	
1985	213	863	1292	-	2368	5 000	
1986	148	2161	4286	-	6595	5 000	
1987	229	4395	6456	-	11080	8 900	
1988	366	2366	4838	-	7570	10 500	
1989	389	1872	2875	-	5136	10 500	
1990	304	828	1313	-	2445	10 500	
1991	627	877	789	-	2293	10 500	
1992	751	856	1811	-	3418	10 500	
1993	502	725	1558	-	2785	4 000	
1994	507	800	2347	-	3654	4 000	
1995	320	425	1681	-	2426	4 000	
1996	359	532	1071	-	1962	2 000	
1997	549	439	1645	-	2633	3 000	
1998	686	879	2376	-	3941	4 000	
1999-2000	553	837	2280	-	3670	4 500	
2000-2001	513	483	1083	-	2079	4 500	
2001-2002	409	232	657	-	1298	4 500	
2002-2003	567	298	888	2	1755	3 500	
2003-2004	1062	807	1704	-	3573	3 500	2 917
2004-2005	1029	1097	1820	-	3946	4 500	3 751
2005-2006	1192	1201	1656	-	4049	4 500	3 751
2006-2007	1032	1696	1140	-	3868	4 500	3 751
2007-2008	944	2107	866	4	3921	4 500	3 751
2008-2009	739	1746	1272	12	3769	4 500	3 751
2009-2010	1320	1890	1044	15	4269	4 500	3 751
2010-2011	1193	1920	841	18	3972	4 500	3 751
2011-2012	1636	1822	397	18	3873	4 500	3 751
2012-2013	1457	1334	676	13	3480	4 500	3 751
2013-2014	793	1387	573	21	2774	4 500	3 751
2014-2015	488	1396	1275	20	3179	4 500	3 751
2015-2016	477	1726	1187	19	3409	4 500	3 751
2016-2017	519	1453	1328	11	3311	4 500	3 751
2017-2018	210	823	732	8	1773	4 500	3 751
2018-2019	550	574	475	10	1609	3 375	2 813
2019-2020	537	460	893	9	1899	3 375	2 813
2020-2021	310	428	711	4	1453	2 250	1 875
2021-2022	130	543	526	4	1203	2 025	1 688
2022-2023	125	164	707	1	997	2 400	2 000
2023-2024	34	27	97	-	158	2 400	1 524
2024-2025	5	4	3	-	12	2 000	1 524

Table 4. Monthly gillnet catch (t) for the entire Gulf (4RST), by sector and calendar year. Data source: ZIFF as of 2025-01-15.

4RST

Year	J	F	M	A	M	J	J	A	S	O	N	D
1985	0	0	0	30	221	249	188	323	252	178	8	0
1986	-	-	-	149	766	770	792	612	1193	641	18	0
1987	-	-	-	487	1088	1484	1879	2343	1034	33	1	0
1988	-	-	5	307	668	1064	1588	1105	707	340	9	0
1989	-	-	4	183	809	1127	1079	603	247	106	34	1
1990	-	-	2	69	413	456	392	270	163	148	21	2
1991	-	-	-	47	190	382	285	233	167	61	8	0
1992	-	-	-	98	417	595	609	377	229	72	5	-
1993	-	-	-	37	194	540	610	575	318	145	61	-
1994	-	-	-	42	550	766	853	826	401	-	-	-
1995	-	-	-	-	665	826	794	46	-	-	1	-
1996	-	-	-	-	117	995	588	89	11	10	-	-
1997	-	-	-	-	822	1374	252	2	3	3	-	-
1998	-	-	-	-	25	272	2320	464	594	81	2	-
1999	-	-	-	-	10	1219	828	566	448	155	25	1
2000	-	-	-	33	249	452	664	441	114	15	5	-
2001	-	-	-	8	41	186	587	267	58	25	14	-
2002	-	-	-	7	22	254	501	420	155	69	21	-
2003	-	-	1	43	369	1030	1245	521	193	54	5	-
2004	-	-	-	57	694	1150	966	648	210	45	0	-
2005	-	-	-	43	743	1514	757	534	199	80	1	-
2006	-	-	-	43	396	1387	863	645	207	31	1	-
2007	-	-	-	118	726	1538	697	545	95	43	0	-
2008	-	-	-	87	615	1208	893	480	184	49	2	-
2009	-	-	-	130	661	2032	934	317	145	25	-	-
2010	-	-	-	131	561	2066	671	392	111	38	0	-
2011	-	-	-	55	618	1589	970	269	109	40	0	-
2012	-	-	-	95	719	1165	955	376	179	15	0	-
2013	-	-	-	71	319	595	767	386	185	147	4	-
2014	-	-	-	109	799	1080	637	521	247	60	-	-
2015	-	-	-	23	726	1238	769	386	211	72	-	-
2016	-	-	-	45	436	1274	782	430	207	69	40	3
2017	-	-	-	35	280	559	399	282	110	44	10	-
2018	-	-	-	56	85	293	502	377	138	84	38	-
2019	-	-	-	48	120	432	549	434	182	82	0	-
2020	-	-	-	71	157	370	400	183	142	126	1	-
2021	-	-	-	48	244	376	261	137	84	51	-	-
2022	-	-	-	42	146	244	272	174	116	41	0	-
2023	-	-	-	22	67	22	12	48	32	3	-	-
2024	-	-	-	1	2	1	2	0	1	0	-	-

Western Gulf

Year	J	F	M	A	M	J	J	A	S	O	N	D
1999	-	-	-	-	2	1045	671	378	316	116	24	1
2000	-	-	-	32	236	294	377	307	98	11	5	-
2001	-	-	-	8	41	119	382	148	22	5	0	-
2002	-	-	-	2	13	53	181	341	140	46	18	-
2003	-	-	-	43	359	542	608	362	193	54	5	-
2004	-	-	-	57	256	603	708	648	209	44	0	-
2005	-	-	-	43	307	652	752	530	197	80	1	-

Year	J	F	M	A	M	J	J	A	S	O	N	D
2006	-	-	-	40	61	570	721	598	203	31	1	-
2007	-	-	-	118	632	573	586	493	94	42	-	-
2008	-	-	-	87	562	537	618	374	164	26	2	-
2009	-	-	-	130	601	578	500	308	141	24	-	-
2010	-	-	-	131	435	697	357	253	48	5	-	-
2011	-	-	-	55	433	306	230	138	87	40	-	-
2012	-	-	-	79	435	329	269	96	40	14	-	-
2013	-	-	-	61	260	191	263	203	112	54	-	-
2014	-	-	-	107	794	654	522	478	239	58	-	-
2015	-	-	-	23	726	1018	633	311	169	57	-	-
2016	-	-	-	45	432	1063	651	341	162	29	-	-
2017	-	-	-	35	280	486	372	239	71	16	1	-
2018	-	-	-	56	85	76	179	219	112	63	19	-
2019	-	-	-	48	118	160	367	287	142	58	0	-
2020	-	-	-	69	153	181	258	84	81	80	-	-
2021	-	-	-	48	238	287	180	97	65	50	-	-
2022	-	-	-	42	146	203	203	131	97	41	0	-
2023	-	-	-	22	66	19	4	31	24	2	-	-
2024	-	-	-	1	2	-	1	0	1	-	-	-

North Anticosti

Year	J	F	M	A	M	J	J	A	S	O	N	D
1999	-	-	-	-	7	172	148	148	78	28	1	-
2000	-	-	-	-	11	156	244	106	15	4	0	-
2001	-	-	-	-	-	65	183	89	28	19	14	-
2002	-	-	-	-	8	201	311	9	7	23	4	-
2003	-	-	1	-	7	483	590	146	-	-	-	-
2004	-	-	-	-	437	536	253	0	1	1	-	-
2005	-	-	-	-	429	861	3	2	1	1	-	-
2006	-	-	-	-	331	703	48	1	0	0	0	-
2007	-	-	-	-	86	966	37	0	1	1	0	-
2008	-	-	-	-	52	645	227	15	18	23	-	-
2009	-	-	-	-	57	1338	30	3	4	1	-	-
2010	-	-	-	-	125	1123	100	6	3	2	0	-
2011	-	-	-	-	164	1096	572	43	3	-	0	-
2012	-	-	-	16	271	728	449	188	88	1	0	-
2013	-	-	-	10	36	369	262	63	55	93	4	-
2014	-	-	-	-	4	380	78	22	9	2	-	-
2015	-	-	-	-	-	220	136	75	42	15	-	-
2016	-	-	-	-	3	208	131	86	45	40	40	3
2017	-	-	-	-	-	68	26	43	36	28	9	-
2018	-	-	-	-	-	183	215	102	11	21	19	-
2019	-	-	-	-	-	262	136	98	18	23	-	-
2020	-	-	-	-	4	166	78	53	7	2	-	-
2021	-	-	-	-	-	51	39	25	14	1	-	-
2022	-	-	-	-	-	18	46	43	19	-	-	-
2023	-	-	-	-	-	2	8	14	8	2	-	-
2024	-	-	-	-	-	1	0	-	-	0	-	-

Esquiman

Year	J	F	M	A	M	J	J	A	S	O	N	D
1999	-	-	-	-	7	172	148	148	78	28	1	-
2000	-	-	-	-	11	156	244	106	15	4	0	-

Year	J	F	M	A	M	J	J	A	S	O	N	D
2001	-	-	-	-	-	65	183	89	28	19	14	-
2002	-	-	-	-	8	201	311	9	7	23	4	-
2003	-	-	1	-	7	483	590	146	-	-	-	-
2004	-	-	-	-	437	536	253	0	1	1	-	-
2005	-	-	-	-	429	861	3	2	1	1	-	-
2006	-	-	-	-	331	703	48	1	0	0	0	-
2007	-	-	-	-	86	966	37	0	1	1	0	-
2008	-	-	-	-	52	645	227	15	18	23	-	-
2009	-	-	-	-	57	1338	30	3	4	1	-	-
2010	-	-	-	-	125	1123	100	6	3	2	0	-
2011	-	-	-	-	164	1096	572	43	3	-	0	-
2012	-	-	-	16	271	728	449	188	88	1	0	-
2013	-	-	-	10	36	369	262	63	55	93	4	-
2014	-	-	-	-	4	380	78	22	9	2	-	-
2015	-	-	-	-	-	220	136	75	42	15	-	-
2016	-	-	-	-	3	208	131	86	45	40	40	3
2017	-	-	-	-	-	68	26	43	36	28	9	-
2018	-	-	-	-	-	183	215	102	11	21	19	-
2019	-	-	-	-	-	262	136	98	18	23	-	-
2020	-	-	-	-	4	166	78	53	7	2	-	-
2021	-	-	-	-	-	51	39	25	14	1	-	-
2022	-	-	-	-	-	18	46	43	19	-	-	-
2023	-	-	-	-	-	2	8	14	8	2	-	-
2024	-	-	-	-	-	1	0	-	-	0	-	-

Table 5. Number of observations (N obs), catch (t), effort (number of gillnets), catch per unit effort (CPUE, kg/net) and its standard error (SE), percentage (%) of landings corresponding to observations, landings (t) and nominal effort for gillnets by fishing sector and calendar year. Data source: ZIFF as of 2025-01-15.

4RST

Year	N obs	Catch	Effort	CPUE	SE	%	Tot. lan. (t)	Tot. effort
1999	1332	1196	83095	14.4	0.3	37	3251	225802
2000	1204	919	87532	10.5	0.2	47	1974	187837
2001	574	469	41311	11.4	0.3	40	1186	104585
2002	834	774	47699	16.2	0.4	53	1450	89324
2003	1356	1967	80788	24.4	0.5	57	3462	142232
2004	2703	3172	161259	19.7	0.3	84	3770	191747
2005	2775	3250	174420	18.6	0.3	84	3871	207643
2006	2291	2986	148991	20.0	0.3	84	3573	178219
2007	1898	3199	121159	26.4	0.4	85	3762	142540
2008	1986	3091	131091	23.6	0.3	88	3518	149137
2009	2027	3481	130865	26.6	0.4	82	4244	159592
2010	2002	3552	143085	24.8	0.4	90	3970	159872
2011	1851	3222	132475	24.3	0.5	88	3650	150028
2012	1777	3001	121075	24.8	0.5	86	3504	141443
2013	2192	2235	159792	14.0	0.2	90	2474	176957
2014	2002	3141	148411	21.2	0.3	91	3454	163268
2015	1759	3130	118439	26.4	0.4	91	3425	129583
2016	1814	2980	121245	24.6	0.4	91	3286	133677
2017	1513	1564	111986	14.0	0.2	91	1720	123197
2018	1571	1455	112977	12.9	0.2	93	1573	122137
2019	1785	1697	122302	13.9	0.2	92	1847	133082
2020	1389	1355	94608	14.3	0.3	93	1450	101293
2021	929	1104	68538	16.1	0.3	92	1202	74579
2022	782	935	53515	17.5	0.4	90	1036	59264
2023	275	168	20079	8.4	0.4	82	205	24517
2024	35	5	1674	3.0	0.2	76	7	2197

Western Gulf

Year	N obs	Catch	Effort	CPUE	SE	%	Tot. lan. (t)	Tot. effort
1999	835	728	42795	17.0	0.4	29	2552	150158
2000	807	532	52694	10.1	0.2	39	1361	134767
2001	360	218	22757	9.6	0.3	30	727	76110
2002	613	358	29015	12.3	0.3	45	793	64193
2003	986	1010	50762	19.9	0.4	47	2167	108931
2004	2386	2277	136695	16.7	0.2	90	2526	151547
2005	2532	2451	155761	15.7	0.2	96	2562	162760
2006	1912	2100	118994	17.7	0.3	94	2225	126053
2007	1516	2371	92910	25.5	0.4	93	2538	99475
2008	1547	2240	98796	22.7	0.3	95	2371	104546
2009	1546	2047	99791	20.5	0.3	90	2282	111250
2010	1349	1836	94447	19.4	0.3	95	1927	99105
2011	1097	1265	79591	15.9	0.3	98	1290	81133
2012	954	1145	67249	17.0	0.4	91	1262	74144
2013	1208	1090	95171	11.5	0.2	95	1144	99865
2014	1484	2679	117635	22.8	0.3	94	2851	125144
2015	1282	2790	92716	30.1	0.4	95	2937	97596
2016	1255	2560	86004	29.8	0.4	94	2723	91494
2017	1240	1408	92332	15.3	0.2	94	1500	98330
2018	967	777	69288	11.2	0.2	96	809	72175

Year	N obs	Catch	Effort	CPUE	SE	%	Tot. lan. (t)	Tot. effort
2019	1108	1118	79063	14.1	0.3	95	1181	83488
2020	918	871	66647	13.1	0.3	96	907	69352
2021	712	895	53254	16.8	0.4	93	965	57386
2022	640	808	44457	18.2	0.4	94	863	47446
2023	223	149	16987	8.8	0.4	90	167	18980
2024	29	4	1380	3.0	0.2	89	5	1547

North Anticosti

Year	N obs	Catch	Effort	CPUE	SE	%	Tot. lan. (t)	Tot. effort
1999	136	103	8778	11.7	0.6	92	113	9593
2000	73	72	4863	14.8	0.9	98	74	4978
2001	39	29	2051	14.1	1.2	64	45	3185
2002	31	70	2168	32.2	3.8	78	90	2787
2003	33	66	2329	28.2	2.6	97	67	2394
2004	7	13	532	-	-	95	13	562
2005	3	6	150	-	-	89	6	169
2006	111	243	9702	25.0	1.1	94	259	10365
2007	65	129	5506	23.4	1.5	97	133	5676
2008	89	162	5968	27.2	1.9	100	162	5968
2009	172	499	15748	31.7	1.1	95	527	16629
2010	299	667	25831	25.8	1.0	99	672	26013
2011	279	458	22764	20.1	0.8	96	475	23614
2012	201	442	16002	27.6	1.1	89	499	18061
2013	359	424	31367	13.5	0.4	97	436	32237
2014	113	104	8921	11.7	0.7	98	106	9066
2015	-	-	-	-	-	-	0	-
2016	8	5	357	-	-	89	5	403
2017	7	5	541	-	-	95	5	569
2018	184	209	15921	13.2	0.6	100	210	15969
2019	143	126	10127	12.5	0.6	99	128	10271
2020	135	220	10475	21.0	1.1	95	232	11038
2021	79	99	5897	16.8	1.1	99	100	5963
2022	39	45	3173	14.2	1.2	96	47	3295
2023	9	4	855	-	-	98	4	870
2024	-	-	-	-	-	-	1	-

Esquiman

Year	N obs	Catch	Effort	CPUE	SE	%	Tot. lan. (t)	Tot. effort
1999	360	363	31442	11.6	0.4	62	583	50469
2000	322	314	29815	10.5	0.4	59	537	50879
2001	160	213	15626	13.6	0.7	54	397	29208
2002	190	346	16516	21.0	0.6	62	562	26855
2003	337	892	27697	32.2	1.0	73	1226	38098
2004	309	880	23952	36.8	1.4	72	1229	33406
2005	236	789	18270	43.2	1.5	61	1297	30000
2006	268	643	20295	31.7	1.2	59	1083	34167
2007	317	699	22743	30.7	1.2	64	1091	35536
2008	349	688	26293	26.2	0.7	70	980	37454
2009	309	935	15326	61.0	1.7	65	1435	23506
2010	347	1037	22167	46.8	1.4	76	1360	29052
2011	473	1497	29957	50.0	1.3	80	1879	37587
2012	620	1413	37740	37.4	1.0	81	1741	46535
2013	622	720	32984	21.8	0.5	81	893	40872
2014	403	355	21685	16.4	0.6	72	495	30202

Year	N obs	Catch	Effort	CPUE	SE	%	Tot. lan. (t)	Tot. effort
2015	477	341	25723	13.2	0.4	70	488	36852
2016	550	414	34817	11.9	0.3	74	557	46797
2017	266	151	19113	7.9	0.3	72	211	26657
2018	420	469	27768	16.9	0.5	85	552	32668
2019	534	452	33112	13.7	0.3	84	537	39325
2020	334	262	17396	15.1	0.6	85	310	20587
2021	134	107	9145	11.7	0.5	82	129	11098
2022	101	81	5818	13.9	0.8	65	125	9020
2023	42	14	2132	6.6	0.4	42	34	5076
2024	4	1	240	-	-	82	1	292

Table 6. Standardized annual catch per unit effort (CPUE) and its standard error (SE) for the gillnet fishery for the whole Gulf (4RST) and by fishing sector. Data source: ZIFF as of 2025-01-15.

Year	4RST		Western Gulf		North Anticosti		Esquiman	
	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE
1999	20.20	0.45	26.47	0.66	15.17	0.87	11.36	0.38
2000	13.48	0.30	13.86	0.34	19.75	1.37	11.17	0.38
2001	13.47	0.41	12.52	0.43	17.90	1.66	13.13	0.61
2002	18.99	0.50	16.47	0.46	36.42	3.60	21.96	0.92
2003	31.46	0.66	29.83	0.68	33.08	3.03	32.52	1.04
2004	25.47	0.44	23.78	0.41	17.90	3.51	33.83	1.20
2005	23.58	0.40	21.49	0.36	115.57	34.68	44.33	1.86
2006	25.39	0.44	23.10	0.40	46.05	2.59	33.00	1.31
2007	34.43	0.64	33.91	0.64	44.60	3.10	31.19	1.12
2008	32.65	0.60	32.88	0.62	41.82	2.58	27.01	0.90
2009	35.39	0.65	29.14	0.56	56.31	2.56	68.02	2.48
2010	32.51	0.61	27.49	0.55	41.73	1.67	53.75	1.89
2011	28.83	0.55	20.12	0.43	33.69	1.38	66.43	2.01
2012	31.85	0.62	23.14	0.53	43.50	1.89	48.51	1.37
2013	18.31	0.33	15.28	0.32	21.04	0.75	23.57	0.62
2014	28.94	0.53	34.18	0.66	17.15	0.94	16.03	0.51
2015	34.32	0.65	46.52	0.94	-	-	13.64	0.39
2016	30.77	0.59	44.04	0.90	13.16	2.48	11.36	0.33
2017	18.73	0.37	21.64	0.44	9.91	1.95	7.69	0.30
2018	16.58	0.33	15.03	0.34	18.75	0.84	17.28	0.51
2019	18.05	0.35	18.83	0.40	16.37	0.82	14.87	0.41
2020	18.60	0.39	18.56	0.44	23.75	1.25	14.76	0.49
2021	20.37	0.49	22.12	0.56	22.84	1.40	11.40	0.56
2022	23.42	0.62	24.87	0.67	19.83	1.69	14.45	0.83
2023	11.18	0.47	11.83	0.51	9.78	1.70	7.13	0.61
2024	4.85	0.56	4.81	0.55	-	-	-	-

Table 7. Average length (cm) of fish caught in the commercial gillnet fishery by sex (Male, Female and Total) and NAFO Division.

Year	4RST			4R			4S			4T		
	M	F	T	M	F	T	M	F	T	M	F	T
1987	42.2	44.5	43.5	43.0	45.3	44.2	43.0	45.3	44.2	41.5	44.1	43.1
1988	42.5	45.1	44.0	43.3	45.5	44.6	43.2	45.6	44.6	42.2	44.8	43.7
1989	44.0	47.8	46.4	43.2	46.4	44.5	43.3	46.1	44.7	45.9	48.8	48.2
1990	44.6	48.5	46.2	44.9	49.7	46.9	44.5	48.9	46.3	44.6	47.9	46.0
1991	43.9	47.0	45.3	43.5	45.8	44.5	43.5	45.8	44.4	45.2	48.9	47.4
1992	43.4	44.8	44.3	48.2	49.2	48.7	41.2	44.3	43.1	42.2	44.2	43.5
1993	42.3	44.0	43.4	46.1	48.0	47.0	42.4	44.6	43.9	41.0	43.1	42.4
1994	39.2	42.9	42.0	36.6	38.0	37.6	40.8	44.0	43.4	40.0	43.8	43.0
1995	41.8	44.9	44.0	41.9	43.1	42.6	42.1	44.8	43.9	41.7	45.2	44.3
1996	45.1	48.2	47.6	45.0	47.6	46.6	45.6	48.5	48.0	44.7	48.3	47.9
1997	44.5	48.9	48.1	44.5	48.4	47.5	44.7	48.7	47.8	44.5	49.1	48.4
1998	44.5	49.0	47.3	44.4	49.2	47.9	44.6	48.3	46.7	44.5	49.1	47.4
1999	44.7	47.4	46.8	43.7	46.1	45.5	44.6	48.0	47.4	44.9	47.6	46.9
2000	43.7	47.1	46.4	43.0	46.4	45.7	44.3	48.3	47.3	43.7	47.1	46.4
2001	43.6	46.9	46.2	44.6	46.4	46.0	43.5	49.2	48.5	42.8	46.4	45.6
2002	42.6	45.2	44.8	43.2	46.0	45.6	41.5	47.2	46.4	42.5	44.2	43.9
2003	43.9	46.1	45.7	46.4	48.0	47.5	41.3	46.1	45.5	41.2	45.4	44.9
2004	42.6	46.6	46.1	45.4	48.4	47.9	41.9	46.5	45.9	41.2	45.8	45.3
2005	43.6	46.7	46.1	46.0	48.1	47.5	42.7	47.2	46.5	40.8	45.7	45.1
2006	44.3	47.5	46.9	45.9	48.9	48.1	44.0	47.7	47.2	42.6	45.9	45.4
2007	43.6	47.8	47.0	45.9	50.0	48.6	42.0	47.7	46.6	43.1	46.8	46.4
2008	44.1	47.4	46.8	45.9	48.9	48.0	44.0	47.5	46.8	42.4	46.8	46.1
2009	44.4	47.7	47.2	46.8	49.7	49.0	43.0	47.4	46.8	42.9	46.5	46.0
2010	45.6	48.8	48.2	47.1	50.0	49.2	45.0	48.9	48.1	43.0	47.5	46.9
2011	46.3	49.1	48.4	47.4	50.8	49.6	45.1	48.5	47.9	44.3	46.8	46.3
2012	46.6	49.6	48.8	47.9	51.7	50.3	45.8	49.4	48.7	42.7	47.3	46.7
2013	45.6	48.4	47.8	47.4	50.3	49.4	44.4	48.0	47.4	44.4	47.0	46.5
2014	44.4	47.3	46.7	46.2	48.6	47.9	43.8	47.1	46.4	44.4	47.2	46.7
2015	45.1	48.8	48.3	47.1	50.6	50.1	45.1	48.9	48.3	43.9	48.2	47.8
2016	45.0	49.6	48.7	45.1	49.8	48.9	45.5	50.2	49.0	44.2	49.0	48.3
2017	44.1	48.4	47.4	43.8	47.0	46.2	44.4	48.7	47.7	43.7	48.4	47.6
2018	44.4	48.4	47.8	44.9	48.3	47.5	43.9	48.6	48.1	43.6	48.4	47.9
2019	41.2	46.0	45.3	42.6	46.2	45.3	42.7	47.2	46.8	39.1	45.3	44.5
2020	41.2	46.0	45.6	42.5	47.6	47.2	43.1	47.5	47.1	40.1	44.9	44.4
2021	41.8	46.3	45.3	44.0	47.8	47.0	43.5	47.3	46.7	40.9	44.9	43.6
2022	41.1	45.7	45.1	43.6	47.0	46.1	43.4	47.4	47.0	39.7	45.2	44.6
2023	40.1	45.4	44.5	43.9	46.3	45.9	41.6	47.2	46.7	39.2	44.9	43.9
2024	40.6	45.1	44.5	44.1	47.8	47.7	40.6	44.9	43.9	39.5	43.3	42.8

Table 8. Estimated number (thousand) of males (M) and females (F) Greenland halibut landed and proportion (Prop) of females in the gillnet fishery by NAFO Division.

Year	4RST			4R			4S			4T		
	F	M	Prop.	F	M	Prop.	F	M	Prop.	F	M	Prop.
1987	8130	6252	0.57	141	144	0.49	2718	2777	0.49	5270	3331	0.61
1988	5475	4024	0.58	259	181	0.59	1682	1151	0.59	3534	2692	0.57
1989	3318	1993	0.62	195	277	0.41	1104	1144	0.49	2019	572	0.78
1990	1065	1550	0.41	123	183	0.40	347	527	0.40	595	840	0.41
1991	1224	1405	0.47	324	446	0.42	443	639	0.41	457	321	0.59
1992	2719	1632	0.62	328	396	0.45	715	456	0.61	1675	780	0.68
1993	2368	1307	0.64	253	259	0.49	628	308	0.67	1487	740	0.67
1994	4222	1275	0.77	727	367	0.66	878	223	0.80	2617	684	0.79
1995	2156	848	0.72	246	189	0.57	360	175	0.67	1549	484	0.76
1996	1532	350	0.81	223	149	0.60	413	87	0.83	896	115	0.89
1997	1951	439	0.82	402	117	0.77	313	95	0.77	1236	227	0.84
1998	2381	1375	0.63	448	180	0.71	495	378	0.57	1439	817	0.64
1999	2813	878	0.76	493	144	0.77	651	160	0.80	1669	574	0.74
2000	1865	505	0.79	473	120	0.80	385	117	0.77	1007	267	0.79
2001	1127	300	0.79	351	110	0.76	188	30	0.86	588	160	0.79
2002	1661	301	0.85	549	95	0.85	269	39	0.87	843	167	0.83
2003	3287	692	0.83	698	347	0.67	790	120	0.87	1799	224	0.89
2004	3695	559	0.87	831	165	0.83	1028	166	0.86	1836	229	0.89
2005	3570	799	0.82	810	366	0.69	1054	194	0.84	1706	239	0.88
2006	3122	681	0.82	723	253	0.74	1412	238	0.86	987	190	0.84
2007	3236	779	0.81	590	285	0.67	1743	379	0.82	903	114	0.89
2008	3069	740	0.81	509	203	0.72	1413	351	0.80	1147	187	0.86
2009	3657	756	0.83	919	283	0.76	1700	304	0.85	1038	170	0.86
2010	3029	756	0.80	767	296	0.72	1492	351	0.81	771	109	0.88
2011	2585	845	0.75	920	490	0.65	1355	289	0.82	309	66	0.82
2012	2456	786	0.76	759	443	0.63	1039	252	0.80	659	91	0.88
2013	1893	533	0.78	494	212	0.70	974	220	0.82	425	102	0.81
2014	2770	766	0.78	330	121	0.73	1344	371	0.78	1096	274	0.80
2015	2785	431	0.87	333	55	0.86	1394	276	0.83	1058	100	0.91
2016	2407	588	0.80	369	88	0.81	977	322	0.75	1061	177	0.86
2017	1364	382	0.78	172	59	0.74	620	191	0.76	573	132	0.81
2018	1285	238	0.84	421	125	0.77	471	60	0.89	394	54	0.88
2019	1816	328	0.85	479	152	0.76	450	47	0.91	887	130	0.87
2020	1487	137	0.92	288	20	0.93	371	36	0.91	828	81	0.91
2021	1045	328	0.76	104	26	0.80	499	89	0.85	441	213	0.67
2022	1105	150	0.88	105	37	0.74	162	18	0.90	838	96	0.90
2023	228	44	0.84	34	6	0.84	28	3	0.91	166	35	0.83
2024	15	3	0.86	5	0	0.95	5	1	0.76	6	1	0.88

Table 9. Percentage of Greenland halibut catches covered by at-sea observers in the directed Greenland halibut gillnet fishery by combinations of year NAFO unit areas.

Sector	Western Gulf				North Anticosti	Esquiman
	4Tp 4Tq	4Sz	4Si 4Ss 4Sy	4Tk 4Tn 4To	4Ss 4Sv 4Sx 4Sy	4R 4Rb 4Rc 4Sv
2000	18	9	3	11		3
2001	14	4	1	6	2	1
2002	17	5	3	15		2
2003	9	14	10	5		3
2004	3	7	5	5		0
2005	3	6	4	4		3
2006	5	5	3	4	5	4
2007	6	3	5	7		3
2008	5	1	5	7	25	6
2009	3	7	5	4	3	1
2010	4	4	6	5	5	5
2011	2	4	3	6	6	6
2012	3	4	4	7	14	11
2013	6	5	7	5	11	3
2014	6	13	8	6	14	0
2015	5	12	10	4		0
2016	6	8	9	4		1
2017	5	9	7	5		2
2018	7	9	4	6	11	4
2019	3	4	2	5	8	2
2020	2	7	1	4	8	1
2021	5	2	4	3		
2022	3			1	4	
2023	5	6	6	2	13	0
2024	80		34	1		

Table 10. Estimation of bycatch (t) and the ratio (%) of bycatch to total catch of Greenland halibut catch per year and per fishing sector for all species combined in the directed gillnet fishery.

Sector	Bycatch (t)				Ratio (%)			
	West Gulf	North Anticosti	Esquiman	4RST	West. Gulf	North Anticosti	Esquiman	4RST
2000	210	0	71	282	37.2		13.1	25.4
2001	175	19	37	231	63.6	44.2	8.7	31.0
2002	143	0	18	161	29.8		3.1	15.1
2003	312	0	65	377	14.5		5.2	11.1
2004	493	0	107	600	18.9		8.4	15.5
2005	425	0	20	444	15.4		1.5	11.0
2006	317	29	67	414	13.7	11.1	6.2	11.3
2007	310	0	191	501	11.7		17.4	13.4
2008	252	62	322	637	10.2	37.7	29.2	17.0
2009	280	46	21	346	11.5	8.6	1.5	7.9
2010	275	113	84	472	13.6	16.7	6.2	11.7
2011	247	86	74	408	17.6	17.9	3.7	10.5
2012	234	101	274	609	17.3	19.4	15.0	16.5
2013	329	155	231	716	25.6	32.4	25.4	26.7
2014	325	23	550	897	10.8	21.0	111.1	24.8
2015	239	0	103	343	7.5		20.9	9.3
2016	258	0	242	500	8.5		30.8	13.1
2017	605	0	234	839	35.3		85.8	42.2
2018	349	73	104	526	38.4	32.5	16.6	29.9
2019	388	63	41	492	29.4	43.9	7.0	23.9
2020	347	37	152	536	35.6	15.4	30.4	31.3
2021	193	0	0	193	19.3			19.3
2022	136	14	0	150	16.6	28.2		17.2
2023	1191	3	445	1639	610.5	60.5	1218.3	694.4
2024	20	0	0	20	387.4			387.4
Mean								
2000-2024	322	33	138	493	60.0	27.8	75.7	60.7

Table 11. Average occurrence (%) and bycatch (kg) of other species in the directed gillnet Greenland halibut fishery for the period 2000 to 2022 and for the years 2023 and 2024.

Taxon	Occurrence (%)			catch (kg)		
	2000-2022	2023	2024	2000-2022	2023	2024
Greenland halibut	99.7	98.9	100.0	2806602	235995	5055
American plaice	79.1	85.6	87.0	47213	60187	746
Redfishes	62.4	82.2	39.1	27611	38163	91
Thorny skate	53.1	38.9	26.1	59599	36085	329
Snow crab	52.4	20.0	73.9	57858	3198	1517
Atlantic halibut	47.4	37.8	17.4	96079	105489	386
Witch flounder	45.3	58.9	82.6	10961	33095	437
Norway king crab	44.1	25.6	17.4	21120	76222	2285
Skates	40.3	66.7	60.9	41483	35150	741
Anthozoan	27.3	32.2	30.4	6223	2974	25
White hake	26.1	60.0	69.6	9987	159311	131
Monkfish	21.6	50.0	21.7	7625	34904	21
Atlantic cod	17.6	3.3	4.3	15761	7324	114
Smooth skate	13.8	20.0	13.0	7592	12922	68
Black dogfish	13.4	56.7	69.6	24404	996988	10699
Scyphozoans	10.1	8.9	17.4	1419	391	22
Sea stars	9.8	6.7	0.0	1141	152	0
Sea pen	8.7	30.0	8.7	719	1266	4
Atlantic hagfish	8.1	7.8	8.7	702	1025	6
Silver hake	5.2	33.3	30.4	648	4476	127
Spiny dogfish	4.9	5.6	4.3	4080	11285	2
Skate eggs	4.2	13.3	0.0	274	372	0
Sea star	2.9	4.4	4.3	320	206	9
Sponges	2.4	1.1	0.0	149	62	0
Wrymouth	1.9	0.0	0.0	483	0	0
Sculpins	1.7	0.0	0.0	357	0	0
Whelks	1.6	0.0	0.0	128	0	0
Winter flounder	1.6	0.0	0.0	541	0	0
Atlantic herring	1.5	0.0	0.0	589	0	0
American lobster	1.3	8.9	4.3	155	1563	3
Longfin hake	1.2	0.0	0.0	537	0	0
Brittle stars	1.1	0.0	0.0	74	0	0
Sea raven	0.9	0.0	0.0	169	0	0
Righteye flounders	0.8	0.0	0.0	484	0	0
Grenadiers	0.8	1.1	0.0	142	21	0
Crabs	0.7	0.0	0.0	152	0	0
Northern shrimp	0.6	0.0	0.0	373	0	0
Sharks	0.6	0.0	0.0	7101	0	0
Toad crabs	0.5	0.0	0.0	87	0	0
Lumpfish	0.5	0.0	0.0	47	0	0
Eelpouts	0.5	0.0	0.0	76	0	0
Yellowtail flounder	0.4	0.0	0.0	156	0	0
Sea peach	0.3	0.0	0.0	60	0	0
Marlin-spike	0.3	1.1	0.0	29	745	0
Pollock	0.3	1.1	0.0	90	2236	0
Finfishes (ns)	0.3	0.0	0.0	263	0	0
Haddock	0.3	1.1	0.0	68	8199	0
Atlantic mackerel	0.3	0.0	0.0	34	0	0
Squids	0.3	0.0	0.0	18	0	0
Waved whelk eggs	0.3	0.0	0.0	8	0	0
Sea urchins	0.2	0.0	0.0	12	0	0

Taxon	Occurrence (%)			catch (kg)		
	2000-2022	2023	2024	2000-2022	2023	2024
Sea cucumbers	0.2	0.0	0.0	23	0	0
Comb jellies	0.2	0.0	0.0	8	0	0
Mud star	0.2	0.0	0.0	16	0	0
Atlantic wolffish	0.2	0.0	0.0	107	0	0
Porbeagle	0.2	0.0	0.0	1840	0	0
Eels	0.2	0.0	0.0	48	0	0
Spotted wolffish	0.2	0.0	0.0	54	0	0
Sea spiders	0.2	0.0	0.0	16	0	0
Harbour porpoise	0.2	0.0	0.0	799	0	0
Gannet	0.1	0.0	0.0	107	0	0
Purple sunstar	0.1	0.0	0.0	45	0	0
Greenland cod	0.1	0.0	0.0	29	0	0
Blue mussel	0.1	0.0	0.0	5	0	0
Basket stars	0.1	1.1	4.3	13	62	1819
American shad	0.1	0.0	0.0	2	0	0
Common sunstar	0.1	0.0	0.0	7	0	0
Arctic cod	0.1	0.0	0.0	18	0	0
Shads	0.1	0.0	0.0	16	0	0
Blue shark	0.1	0.0	0.0	666	0	0
Decapods	0.1	0.0	0.0	7	0	0
Alewife	0.1	0.0	0.0	9	0	0
North atlantic octopus	0.1	0.0	0.0	6	0	0
Sea potato	0.1	0.0	0.0	14	0	0
Capelin	0.0	0.0	0.0	4	0	0
Incirrata octopuses	0.0	0.0	0.0	3	0	0
Harp seal	0.0	0.0	0.0	262	0	0
Polychaetes	0.0	0.0	0.0	3	0	0
Fourbeard rockling	0.0	0.0	0.0	3	0	0
Basking shark	0.0	0.0	0.0	1346	0	0
Greenland shark	0.0	0.0	0.0	987	0	0
Dogfishes	0.0	0.0	0.0	11	0	0
Molluscs	0.0	0.0	0.0	2	0	0
Gull, larus sp.	0.0	0.0	0.0	2	0	0
Seals	0.0	0.0	0.0	231	0	0
Barnacles	0.0	0.0	0.0	2	0	0
Striped bass	0.0	0.0	0.0	25	0	0
Northern pipefish	0.0	0.0	0.0	11	0	0
Atlantic argentine	0.0	2.2	0.0	2	1491	0
Blood star	0.0	0.0	0.0	1	0	0
Dolphin	0.0	0.0	0.0	70	0	0
Fulmar, northern (noddy)	0.0	0.0	0.0	1	0	0
Blue whiting	0.0	0.0	0.0	2	0	0
Shrimp	0.0	0.0	0.0	2	0	0
Gull, herring	0.0	0.0	0.0	0	0	0
Kittiwake, black-legged	0.0	0.0	0.0	1	0	0
Alcids	0.0	0.0	0.0	12	0	0
Atlantic salmon	0.0	0.0	0.0	1	0	0
Blueback herring	0.0	0.0	0.0	1	0	0
Atlantic sturgeon	0.0	0.0	0.0	21	0	0
Longfin snailfish	0.0	0.0	0.0	1	0	0
Crustaceans	0.0	0.0	0.0	1	0	0
Isopods	0.0	0.0	0.0	0	0	0
Balanidae	0.0	0.0	0.0	1	0	0
Northern wolffish	0.0	0.0	0.0	7	0	0

Taxon	Occurrence (%)			catch (kg)		
	2000-2022	2023	2024	2000-2022	2023	2024
Atl. white sided dolphin	0.0	0.0	0.0	52	0	0
Windowpane	0.0	0.0	0.0	1	0	0
Whales	0.0	0.0	0.0	58	0	0
Northern moonsnail	0.0	0.0	0.0	0	0	0
Mussels	0.0	0.0	0.0	1	0	0
Stimpson's surf clam	0.0	0.0	0.0	0	0	0
Heart urchin	0.0	0.0	0.0	1	0	0
Pandalids	0.0	0.0	0.0	0	0	0
Hermit crabs	0.0	0.0	0.0	1	0	0

Table 12. Estimated Greenland halibut bycatch in number and weight by shrimpers in the GSL, abundance and biomass of Greenland halibut less than 31 cm estimated in the DFO nGSL survey and ratio (%) of bycatch to survey estimate.

Year	Number (x1000)		Weight (t)		Ratio (%)	
	Bycatch	Survey	Bycatch	Survey	N	Weight
2000	2 281	422 178	123	42 439	0.54	0.29
2001	831	267 550	87	31 954	0.31	0.27
2002	1 577	203 433	104	19 048	0.78	0.55
2003	1 098	457 485	92	55 439	0.24	0.17
2004	642	152 257	62	21 968	0.42	0.28
2005	1 241	211 082	66	13 699	0.59	0.48
2006	1 135	271 862	83	35 617	0.42	0.23
2007	1 275	210 047	83	19 559	0.61	0.42
2008	2 130	270 492	122	25 755	0.79	0.47
2009	834	187 253	66	20 672	0.45	0.32
2010	841	163 592	72	20 005	0.51	0.36
2011	2 323	300 873	84	20 365	0.77	0.41
2012	508	266 470	51	34 176	0.19	0.15
2013	2 735	199 356	95	12 317	1.37	0.77
2014	3 812	415 041	117	28 787	0.92	0.41
2015	2 577	461 880	132	39 432	0.56	0.34
2016	2 400	237 130	133	30 755	1.01	0.43
2017	1 403	160 799	109	22 335	0.87	0.49
2018	2 148	197 051	76	13 750	1.09	0.55
2019	6 735	287 458	212	17 980	2.34	1.18
2020 ¹	1 328	274 432	78	34 210	0.48	0.23
2021	2 581	79 277	53	12 493	3.26	0.42
2022	749	48 227	53	5 707	1.55	0.93
2023	675	45 893	32	3 533	1.47	0.9
2024 ²	237	92 355	9	7 684	0.26	0.12

¹ No data for the Estuary sector

² No data for the North Anticosti and Esquiman sectors

Table 13. Cumulative distribution of Greenland halibut catches (percentile) from the nGSL survey by depth and temperature.

Percentile	Depth (m)	Temperature (°C)
5	202	4.1
10	227	4.6
25	261	5.1
50	305	5.4
75	339	5.7
90	379	6.3
95	408	6.5

Table 14. Cumulative proportion of catches (by weight) of Greenland Halibut (GH) and redfish by depth in DFO nGSL Winter Surveys. p: percentile

Vessel	Year	Species	p5	p25	p50	p75	p95
Gadus Atlantica	1978 - 1994	GH	271	407	449	494	519
Gadus Atlantica	1978 - 1994	Redfish	209	290	349	430	473
Mersey Venture	2022-2024	GH	277	385	452	490	516
Mersey Venture	2022-2024	Redfish	228	250	357	427	494

Table 15. Comparison of the 4 fitted stock-recruitment models.

Model	Degrees of freedom	AICc	ΔAICc
Intercept	2	134.6	4.1
Density independant	2	134.5	4.0
Beverton-Holt	3	131.8	1.6
Ricker	3	130.2	0.0

Table 16. Comparison of the macroscopic identification criteria for maturity stages of females (F) used during the nGSL survey.

Sex	Maturity	Maturity stages 1995 - 2022	Maturity stages 2023 – 2024 (Adapted from ICES 2017)
F	Immature	500 – Juvenile and immature Ovary small, pinkish, with thin walls; Eggs not visible to the naked eye.	1 – Immature Small ovaries, eggs not visual to naked eye.
F	Immature		2 – Inactive maturing The ovary walls are thin, transparent, as well as the margin of the gonad. Appearance of the first blood vessels. The ovary is filled with eggs visible to the naked eye, but all are less than 1 mm in diameter (granular matrix). This stage corresponds to females who have a first cohort of developing oocytes. No spawning will take place in the winter since the development of oocytes takes 2 years.
F	Mature	600 – Maturing Eggs visible with the naked eye, and opaque. Ovary walls thin.	3 – Mature Egg diameter of 1-2 mm, eggs still opaque (not hydrated). Matrix between the eggs is well present and visible.
F	Mature		4 – Mature late Egg diameter of 2-4 mm, eggs are getting translucent but still having a colour. Almost no visible matrix between the eggs, but the eggs are not free. The ovary is intact when removed (the eggs do not come out freely from the ovary).
F	Mature	550 – Spawning Clear eggs (partial or total bulk of eggs) and visible to the naked eye.	5 – Spawning Transparent and large eggs (> 4 mm). Eggs come out freely and in quantity when pressure is applied to the abdomen or when the ovary is removed.
F	Mature	560 – Spent Reddish or purple ovaries, with thick walls; Old eggs (opaque or clear) can be observed; New eggs not visible to the naked eye.	6 – Spent Flaccid and bloody ovary of red-purple color. The ovary membrane and the margin of the gonad are thick. Blood vessels are clearly visible. Residual transparent eggs can be observed. Some time after spawning, eggs of < 1 mm can be seen with the naked eye.
F	Mature		8 – Spent recovering Thick, non-transparent ovary walls. The ovary regains a healthy appearance, firm texture, and pink color. Blood vessels are absorbed. Granular structure (precursor of eggs) or presence of small eggs less than 1 mm. This stage resembles stage 2 but has already spawned. If difficult to distinguish between 8 and 2, use 8. If the eggs are > 1 mm, put stage 3. If the transparency of the gonad is difficult to determine, put the knife under the gonad and assess if you can see the knife. Removing the gonads from their cavity also allows a good assessment of their firmness (firm = 8, collapses or flattens = 6).
F	-	620 - Uncertain	0 – Uncertain

Table 17. Comparison of the macroscopic identification criteria for maturity stages of males (M) used during the nGSL survey.

Sex	Maturity	Maturity stages 1995 - 2022	Maturity stages 2023 – 2024
M	Immat.	100 – Juvenile and immature Small, firm and pinkish testis.	1 - Immature Gonads are small, pinkish, and firm. Often they have not yet taken their triangular shape and/or are very small and look more like two filaments.
M	Mat.	200 – Maturing Whitish and more distended testis. The milk can be firm or small amount of milk may be forced out by pressure. This stage means that the fish will spawn during the present year.	3 - Maturation Gonad is fleshier, whitish or pinkish (a thickness is clearly appearing (3D)). The milt is usually still solid, but can be liquid when cut and pressure is applied. This stage means that the fish will spawn sooner or later in the winter.
M	Mat.	150 – Spawning Spawning occurring. Whitish, well developed testis, with anterior edge looks like a sharp knife; testis can be half empty. Vas deferens wide with milk that goes out freely.	5 – Spawning (winter) Spawning in progress. Testes are very developed, with a 'sharp' anterior border and can be half empty. Testes are whitish. Presence of milt in the vas deferens, which flows freely when pressure is applied to the abdomen.
M	Mat.	160 – Spent Testis flabby with thick walls. Testis color: reddish. Vas deferens with or without milk.	6 - Spent Testes are sagging and have thick walls. Testicles are reddish - bloody. Presence or absence of milt in the vas deferens.
M	Mat.		8 – Resting/recovering Gonad is small but in good condition and fleshy.
M	-	220 - Uncertain	0 - Uncertain
F/M	-		9 – Not observed

Table 18. Annual landing and biomass of Greenland halibut > 40 cm (in Teleost equivalent) and relative exploitation rate for the Gulf (4RST), by fishing sector.

4RST

Year	Landing (t)	Biomass (t)	Exploitation rate (%)
1996	1811	34994	5.18
1997	2456	34239	7.17
1998	3758	23462	16.02
1999	3251	33852	9.60
2000	1974	33869	5.83
2001	1186	28804	4.12
2002	1450	30522	4.75
2003	3462	87143	3.97
2004	3770	65736	5.73
2005	3871	71870	5.39
2006	3573	76437	4.67
2007	3762	74926	5.02
2008	3518	68668	5.12
2009	4244	46960	9.04
2010	3970	58836	6.75
2011	3650	55939	6.53
2012	3504	56109	6.24
2013	2474	39192	6.31
2014	3454	66308	5.21
2015	3425	54935	6.23
2016	3286	45559	7.21
2017	1720	25445	6.76
2018	1573	27509	5.72
2019	1847	22143	8.34
2020	1450	24515	5.92
2021	1202	35859	3.35
2022	1036	33363	3.10
2023	205	18131	1.13
2024	7	11240	0.06

Western Gulf

Year	Landing (t)	Biomass (t)	Exploitation rate (%)
1996	1488	20160	7.38
1997	1905	19045	10.00
1998	2893	12633	22.90
1999	2552	16580	15.39
2000	1361	17688	7.69
2001	727	12557	5.79
2002	793	15413	5.14
2003	2167	42812	5.06
2004	2526	32653	7.73
2005	2562	35675	7.18
2006	2225	38083	5.84
2007	2538	35467	7.16
2008	2371	38900	6.10
2009	2282	21797	10.47
2010	1927	27098	7.11
2011	1290	22343	5.77
2012	1262	29881	4.22

Year	Landing (t)	Biomass (t)	Exploitation rate (%)
2013	1144	17996	6.36
2014	2851	44320	6.43
2015	2937	39011	7.53
2016	2723	29081	9.36
2017	1500	14460	10.37
2018	809	15885	5.09
2019	1181	14114	8.37
2020	907	15910	5.70
2021	965	25150	3.84
2022	863	22853	3.77
2023	167	10854	1.54
2024	5	8409	0.05

North Anticosti

Year	Landing (t)	Biomass (t)	Exploitation rate (%)
1997	2	3 073	0,07
1998	52	1 482	3,48
1999	113	3 031	3,71
2000	74	2 941	2,51
2001	45	619	7,26
2002	90	4 186	2,14
2003	67	3 359	2,01
2004	13	3 329	0,40
2005	6	6 636	0,09
2006	259	9 553	2,71
2007	133	7 188	1,85
2008	162	4 658	3,48
2009	527	5 203	10,13
2010	672	10 650	6,31
2011	475	7 765	6,12
2012	499	7 155	6,97
2013	436	7 117	6,12
2014	106	4 427	2,39
2015	0	3 982	0,00
2016	5	2 721	0,20
2017	5	3 744	0,13
2018	210	3 673	5,71
2019	128	1 607	7,98
2020	232	2 391	9,70
2021	100	2 494	4,03
2022	47	3 432	1,37
2023	4	1574	0.28
2024	1	918	0.09

Esquiman

Year	Landing (t)	Biomass (t)	Exploitation rate (%)
1996	1996	1996	1996
1997	1997	1997	1997
1998	1998	1998	1998
1999	1999	1999	1999
2000	2000	2000	2000
2001	2001	2001	2001
2002	2002	2002	2002
2003	2003	2003	2003

Year	Landing (t)	Biomass (t)	Exploitation rate (%)
2004	2004	2004	2004
2005	2005	2005	2005
2006	2006	2006	2006
2007	2007	2007	2007
2008	2008	2008	2008
2009	2009	2009	2009
2010	2010	2010	2010
2011	2011	2011	2011
2012	2012	2012	2012
2013	2013	2013	2013
2014	2014	2014	2014
2015	2015	2015	2015
2016	2016	2016	2016
2017	2017	2017	2017
2018	2018	2018	2018
2019	2019	2019	2019
2020	2020	2020	2020
2021	2021	2021	2021
2022	2022	2022	2022
2023	2023	2023	2023
2024	2024	2024	2024

10. FIGURES

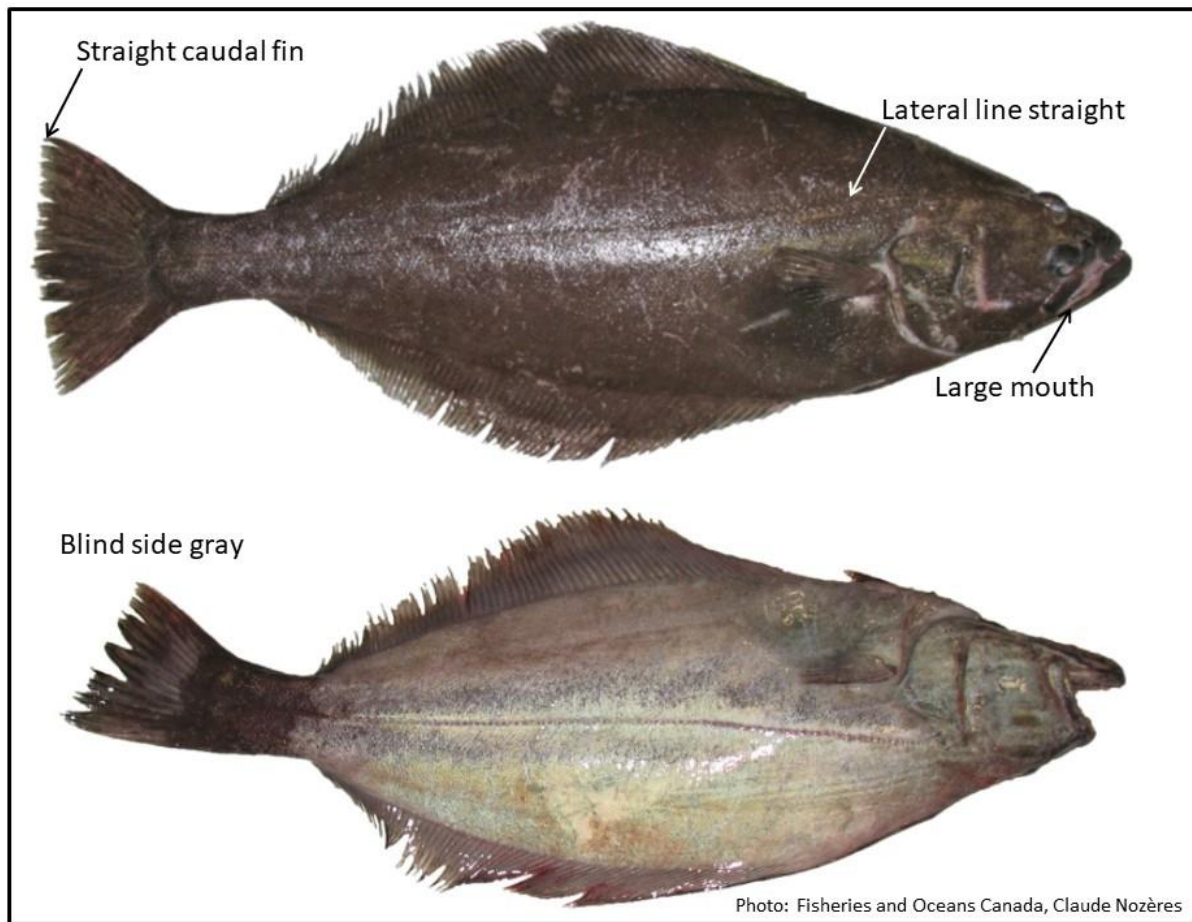


Figure 1. Greenland halibut morphology.

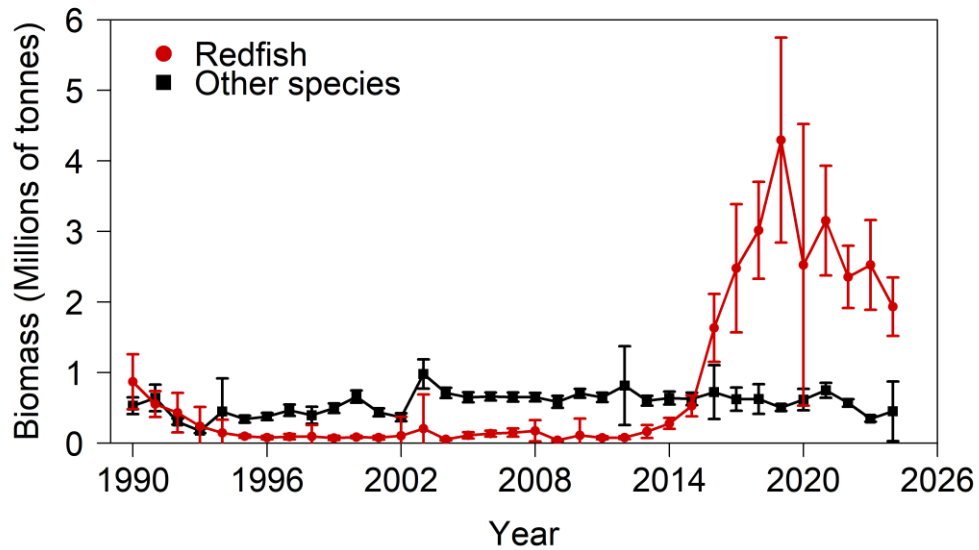


Figure 3. Biomass indices (million tonnes) estimated for the two redfish species combined and for all other species caught during the DFO survey in the nGSL. Error bars indicate 95% confidence intervals.

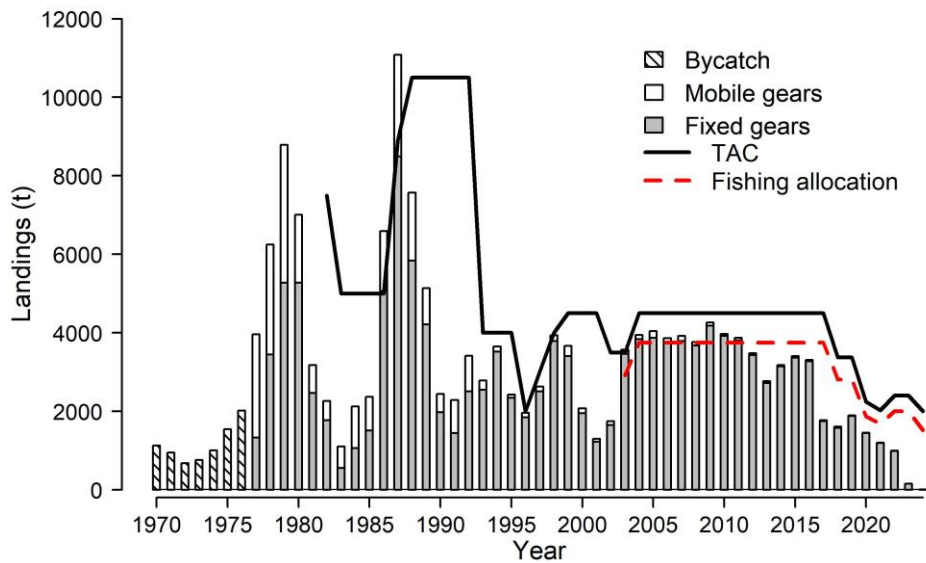


Figure 4. Greenland halibut landings (t) for fixed and mobile gears by management year. TAC: total allowable catch. Fishing allocation: catch allocated to fixed gear fleets.

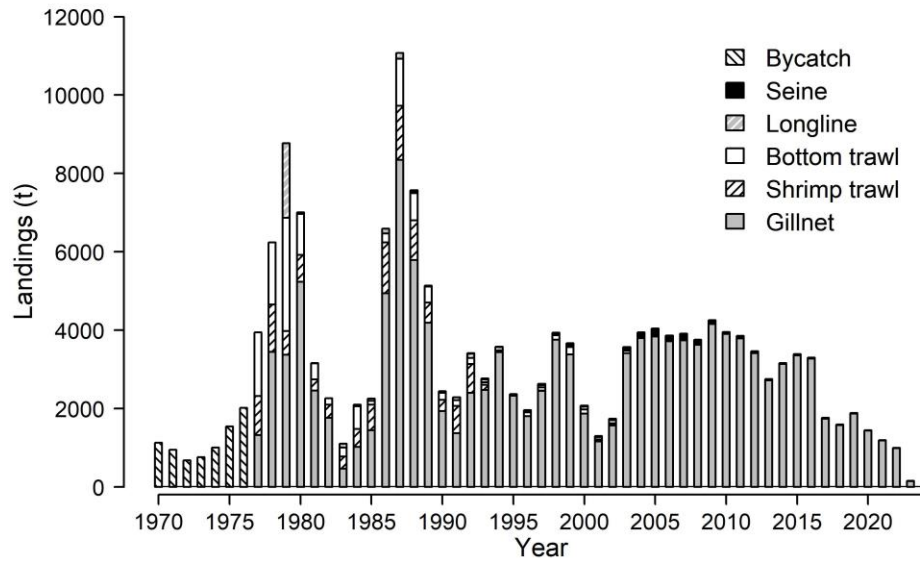


Figure 5. Greenland halibut landings (t) as bycatch, and by gear as a function of management year.

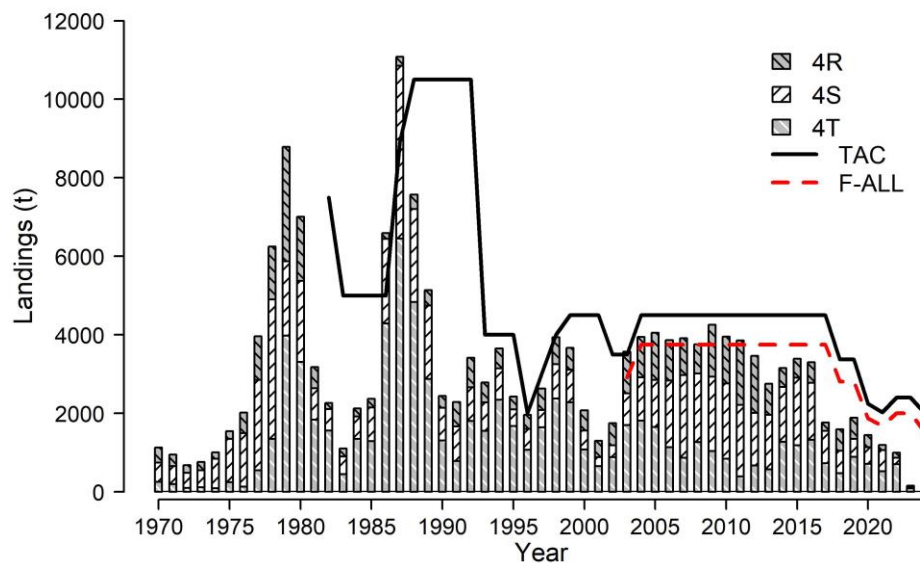


Figure 6. Greenland halibut landings (t) by NAFO Divisions and management year. Total Allowable Catch (TAC) and Fishery Allocation (F-ALL, catch allocated to fixed gear fleets) are indicated.

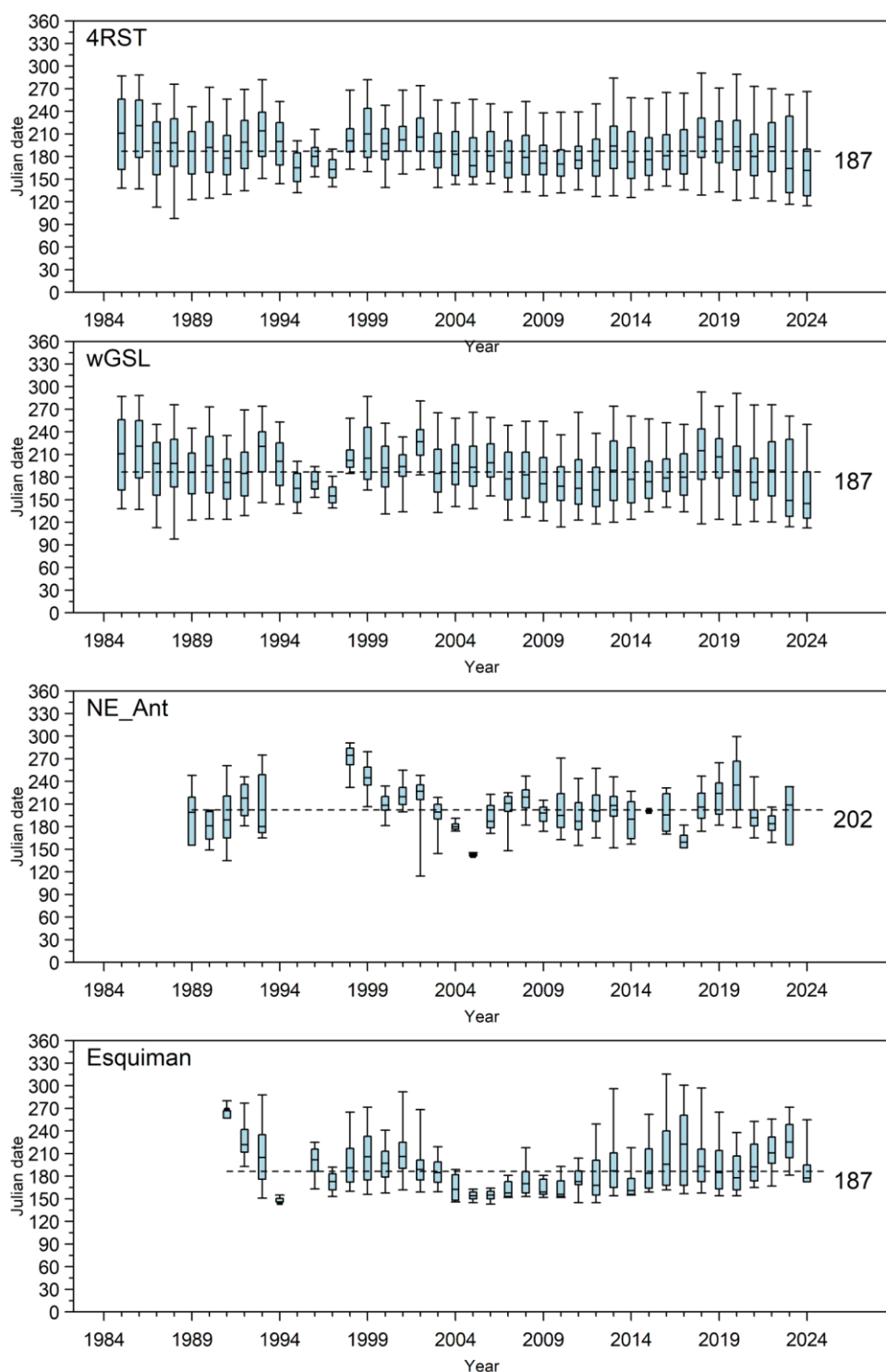


Figure 7. Annual distribution of Greenland halibut landings as a function of Julian day for the GSL (4RST) and by fishing sector. Box and whiskers plot: the line inside the box represents the median (50% of landings). the box extends from percentiles 25 to 75 and the whiskers extend from percentiles 5 to 95. The horizontal dotted line on each graph shows the average of the series. The day 135 corresponds to May 15, which is the start date of the management year.

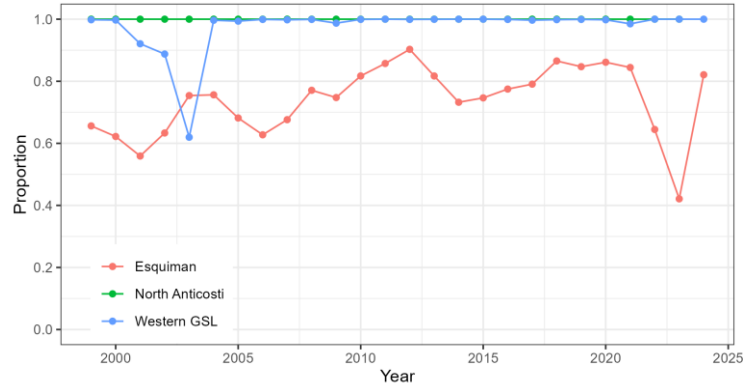


Figure 8. Proportion of landings for which the geographical position of catch is known in the ZIFF by year and fishing sector (Figure 9).

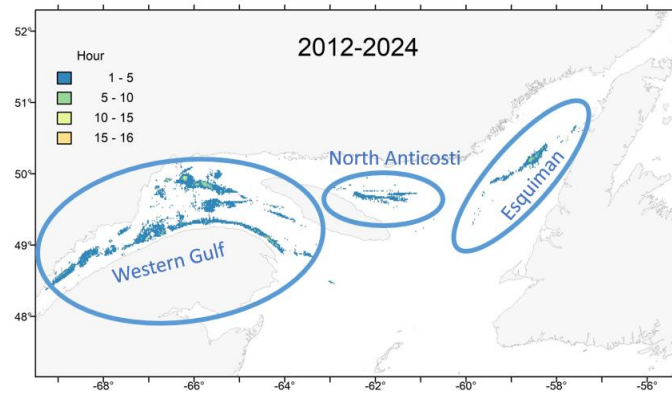


Figure 9. Mean fishing effort estimated with SSN data for the period 2012-2024, in number of hours per 1-minute square. The concentrations of fishing effort allow for the definition of three sectors: the western Gulf, North Anticosti, and Esquiman.

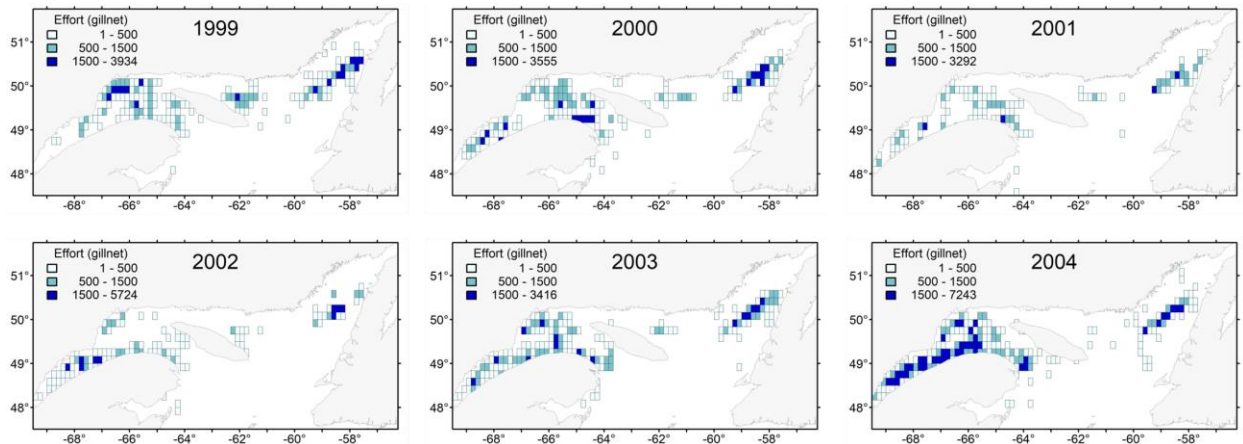


Figure 10. Annual fishing effort (number of gillnets) per statistical square, from 1999 to 2024. The percentage of landings for which the geographical position is known varies by year and sector (Figure 8).

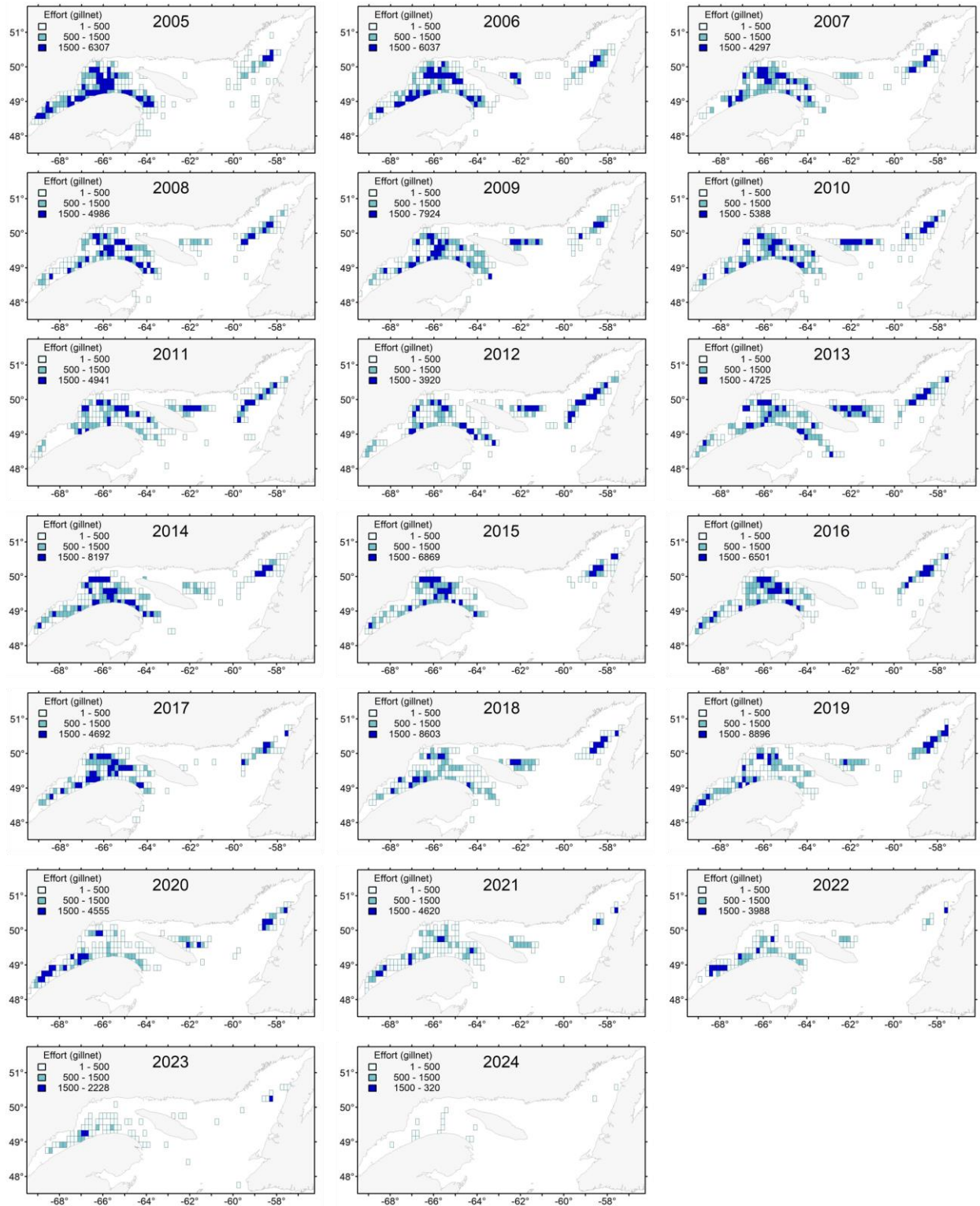


Figure 10. (continued)

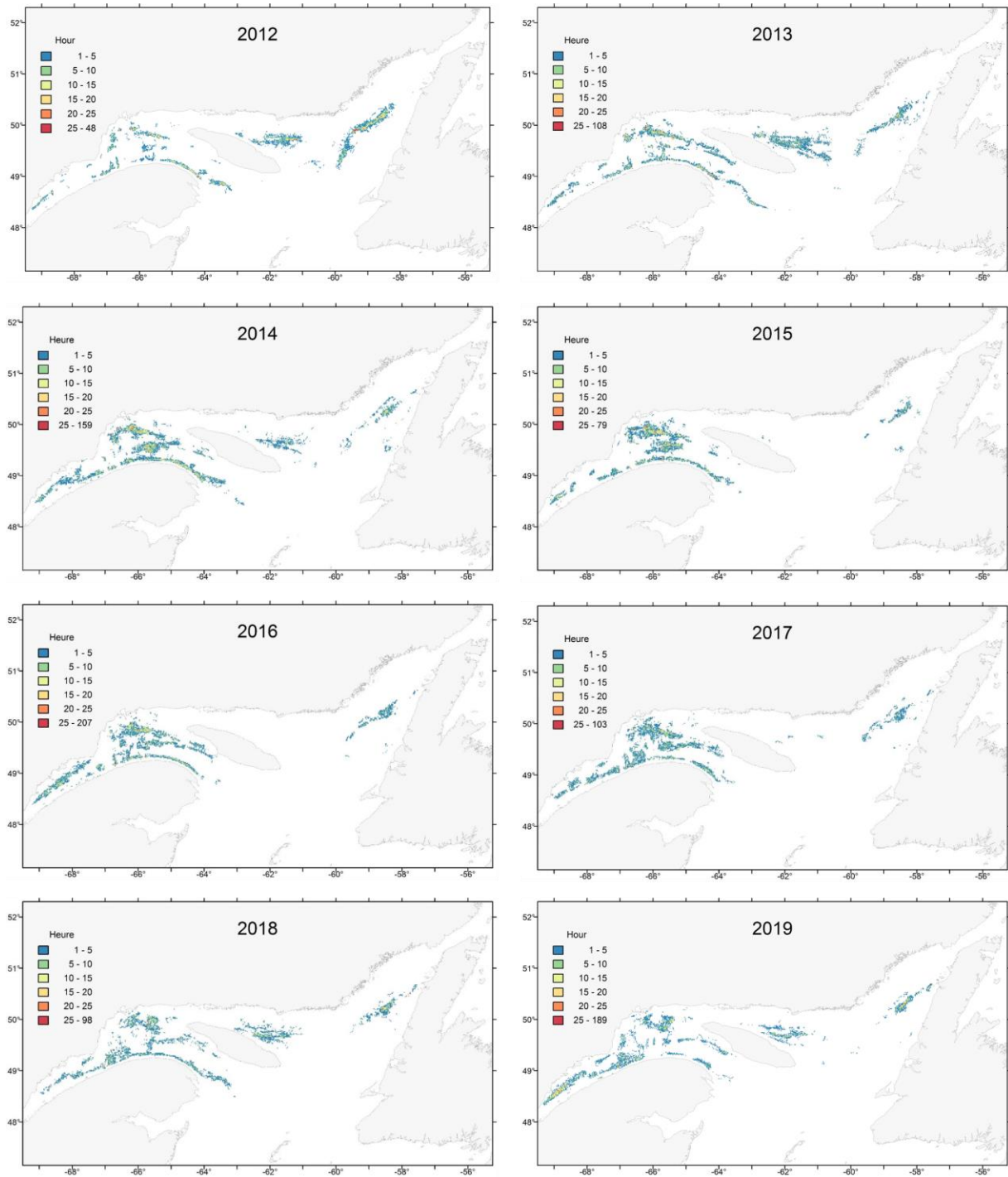


Figure 11. Distribution of directed fishing effort for Greenland halibut in the Gulf of St. Lawrence from 2013 to 2022 according to Vessel Monitoring System (VMS) data, with the effort expressed as the number of hours per 1 minute square. Since 2017, data has been available for nearly 100% of the activities of the Quebec fleets. The proportion is less than 50% for the Newfoundland and Labrador fleets that fish in easter GSL.

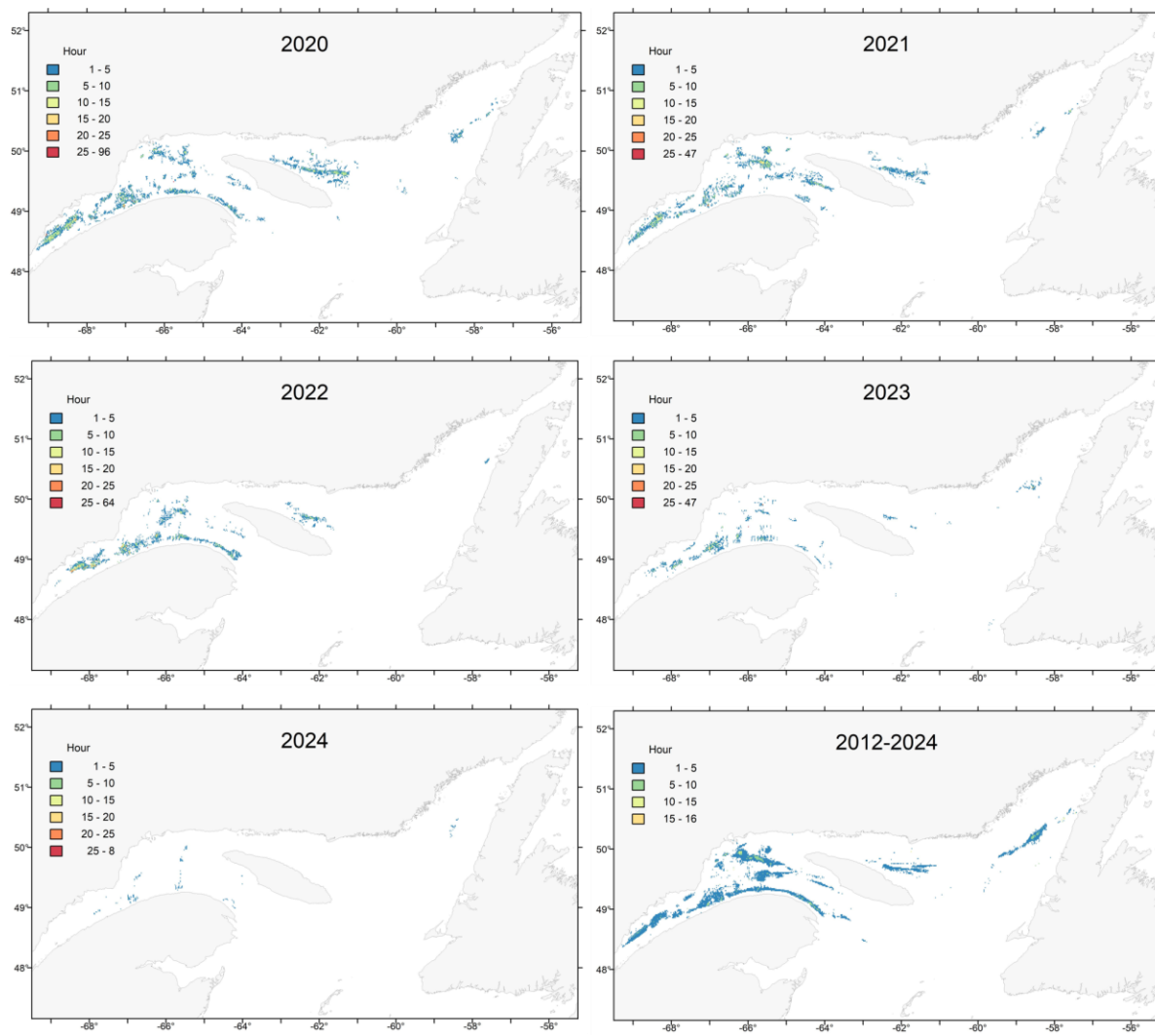


Figure 11. (Continued).

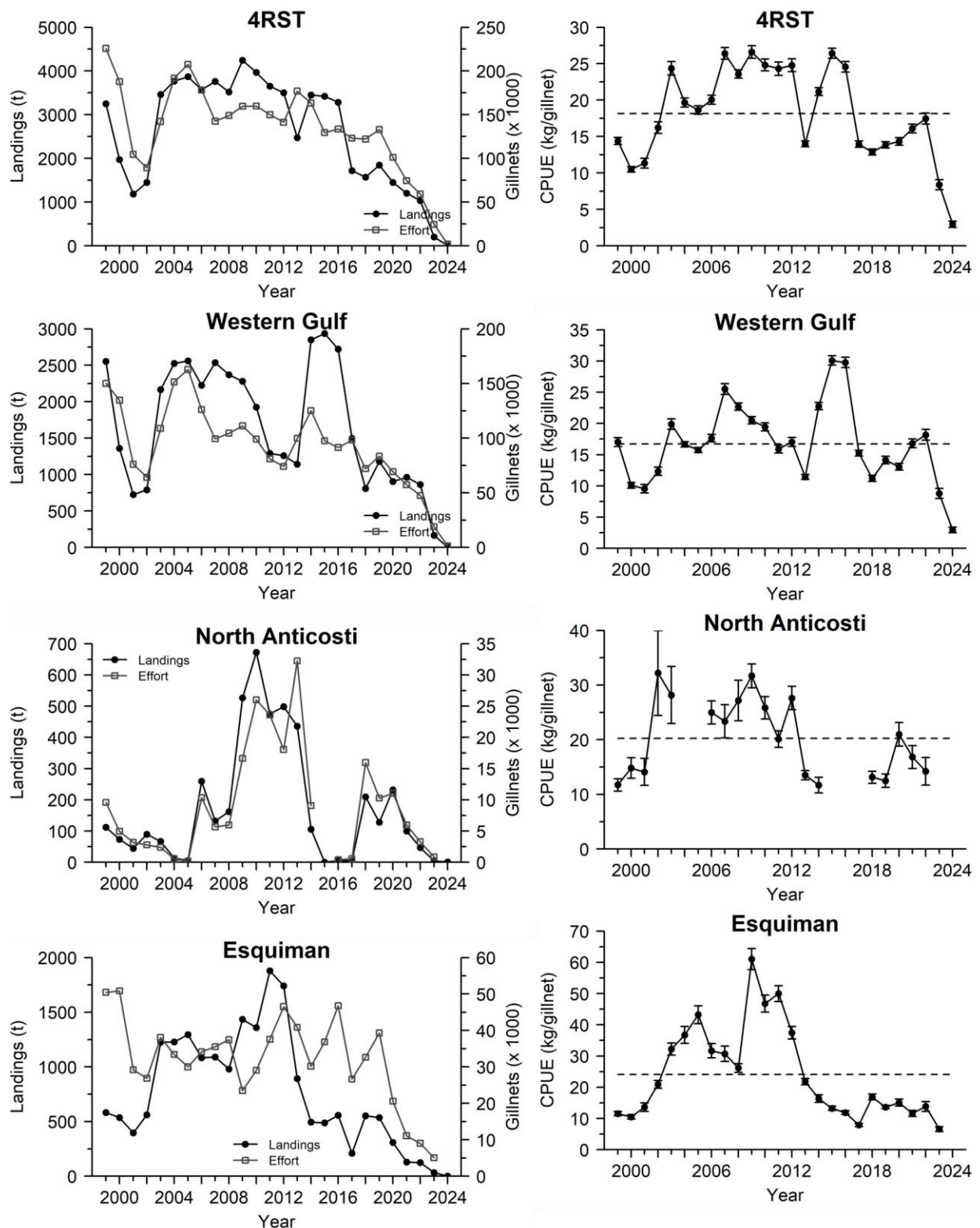


Figure 12. Landing, nominal effort and unstandardized catch per unit effort (CPUE) $\pm$ 95% confidence interval, by calendar year and fishing sector. Effort was not estimated in Esquiman in 2024 because only 4 observations were available.



Figure 13. Fishing effort and proportion deployed by fishing sector in the gillnet fishery targeting Greenland halibut from 1999 to 2024.

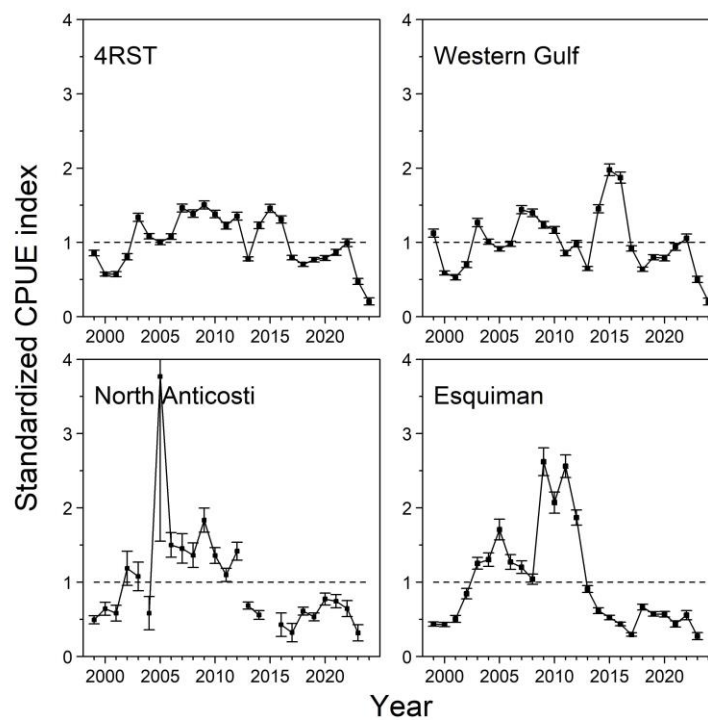
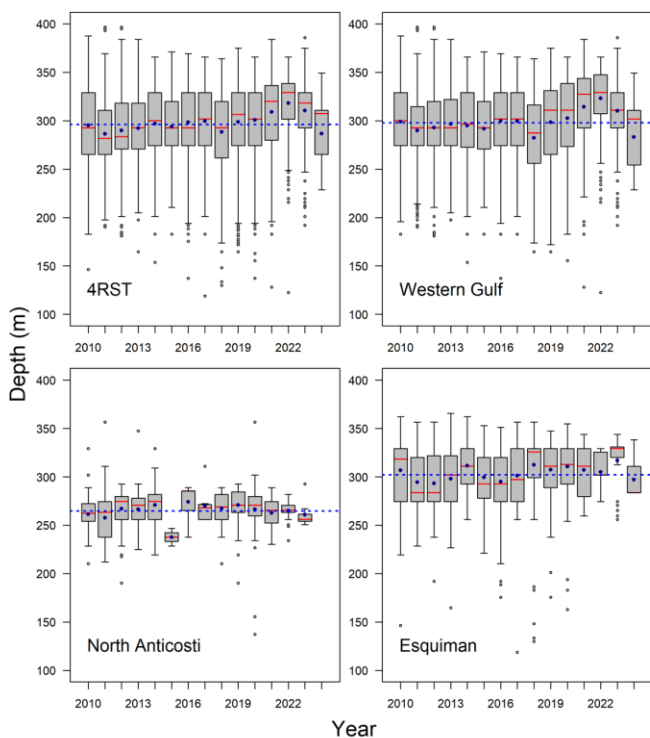


Figure 14. Annual fishing performance index (standardized CPUE) $\pm$ 95% confidence interval for the Gulf as a whole (4RST) and by fishing sector.

A)



B)

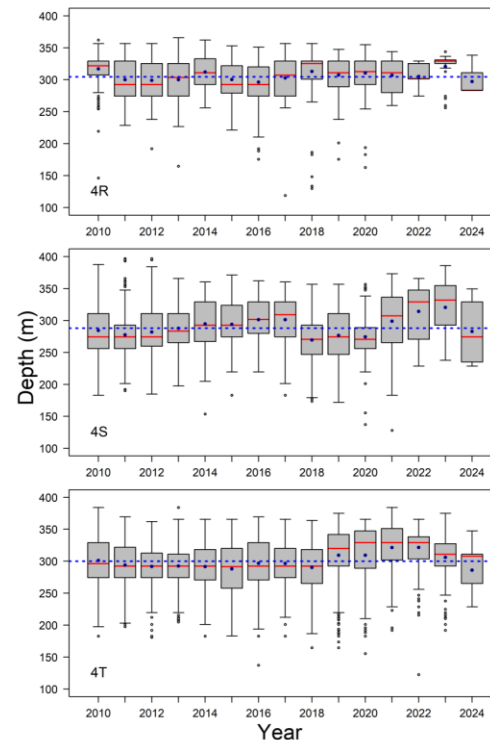


Figure 15. Annual deployment depth of directed Greenland halibut gillnet fishery in A) the Gulf (4RST) and by fishing sector B) by NAFO Division. Box and whiskers plot; box extends from percentile 25 to 75, line in the box represents the median, the filled circle represents the mean, whiskers extend from percentile 5 to 95 and open circles represent extreme values. Horizontal lines are average of each series.



Figure 16. A) Annual proportion (%) of fishing activities by soak time categories (1 to 4 days and over) in the gillnet directed commercial Greenland halibut fishery from 1999 to 2024. The horizontal line represents the average (22%) for immersion of 4 days and over. B) Average proportion of fishing activities exceeding by soak time category and fishing sector for 1999-2024. C) Annual proportion of fishing activities employing soak times of 4 days and over by year and sector (horizontal lines are sector specific means).

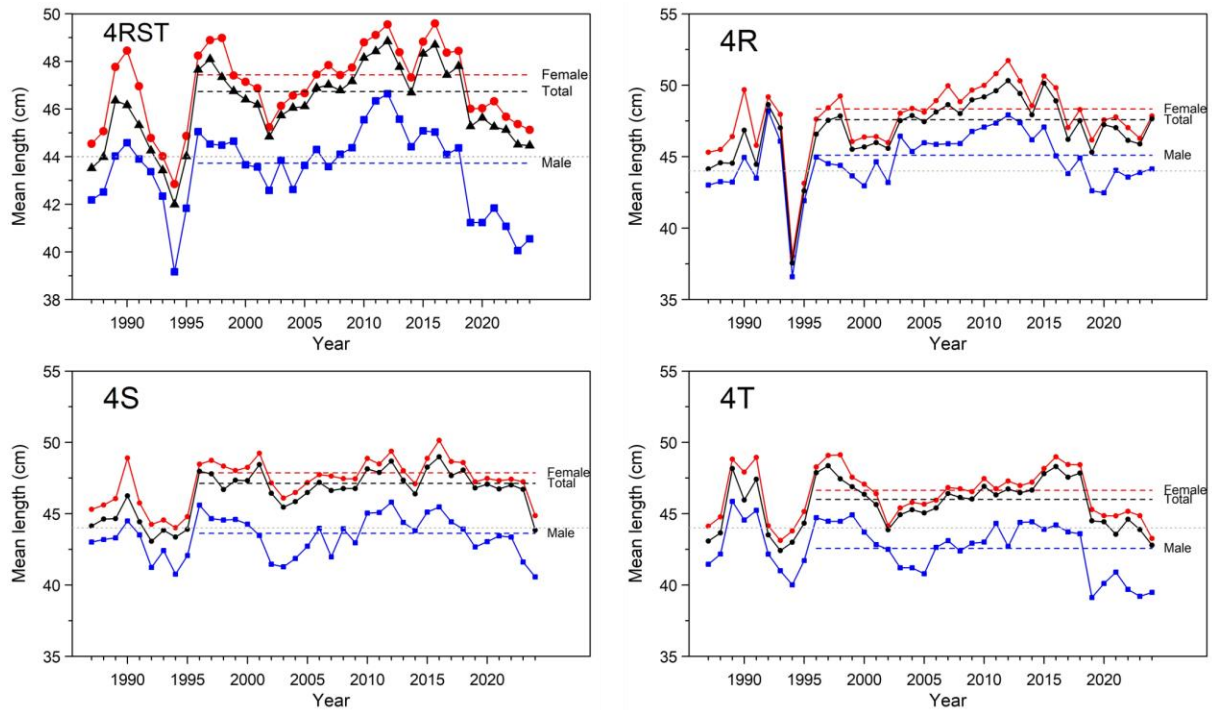


Figure 17. Average annual mean length of Greenland halibut caught in the commercial gillnet fishery by sex and NAFO Division from 1987 to 2024. The dotted lines represent the average for each series since the change in mesh size in 1996.

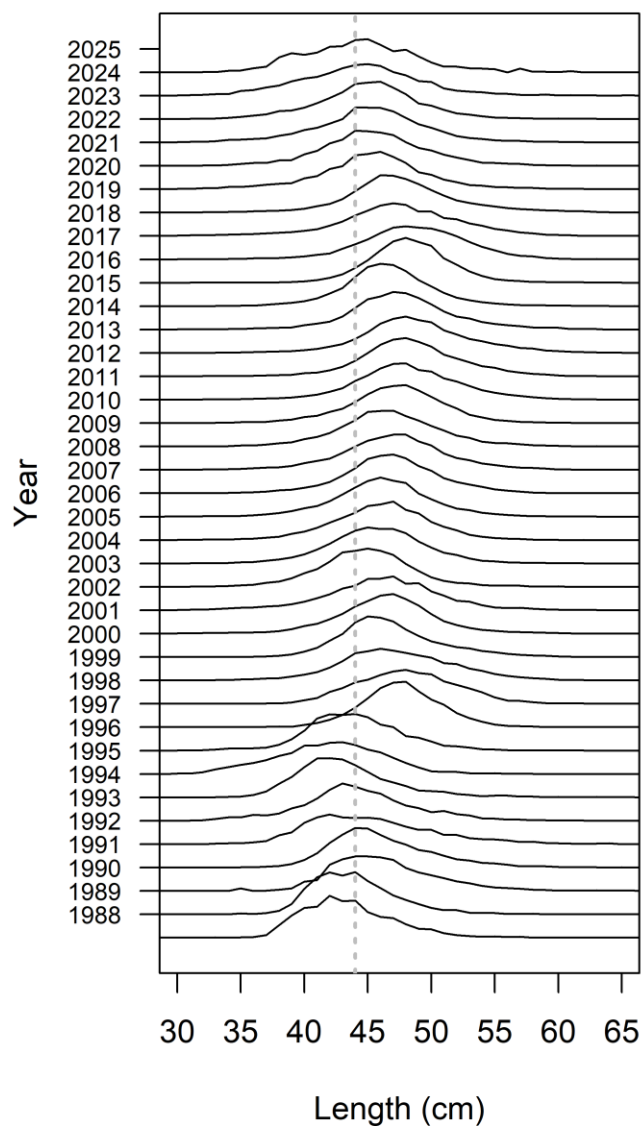


Figure 18. Catch-at-length of Greenland halibuts caught in the commercial fishery from 1987 to 2024 expressed in annual proportions per cm. In 1996, the mesh size of the gillnets was increased from 127 to 152 mm. The vertical line cuts the graph at 44 cm, which is the minimum regulatory size according to the small fish protocol since 1997.

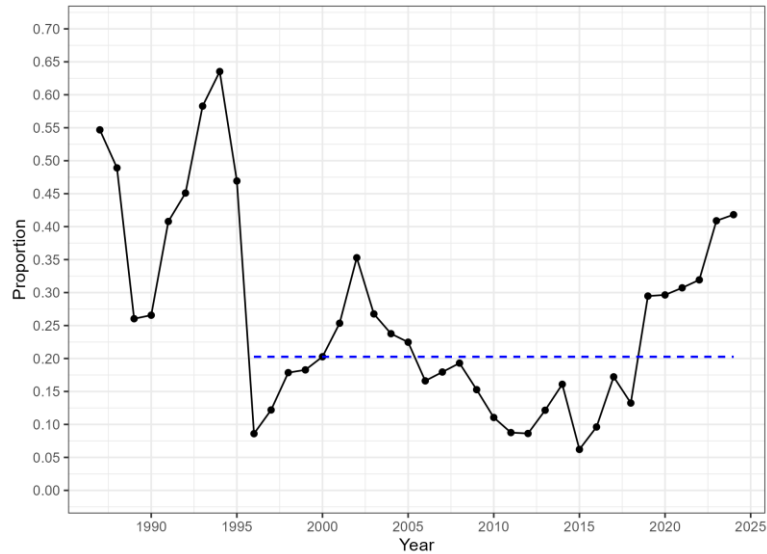


Figure 19. Annual proportion of Greenland halibut less than the minimum regulatory size of 44 cm in the commercial catch established in 1997. The dotted line represents the average 1996-2024, i.e. after the change in gillnet mesh size.

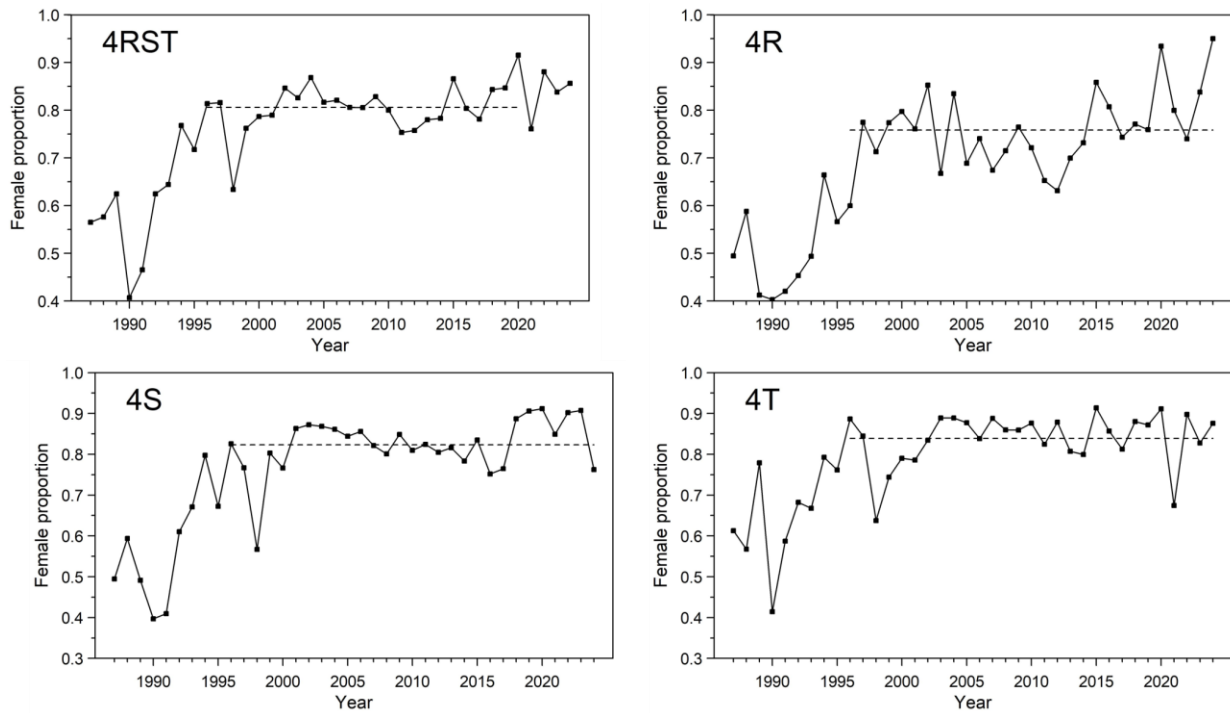


Figure 20. Proportion of females in gillnet catches by NAFO Division. The dotted line represents the average starting in 1996, the year of the change in mesh size from 127 to 152 mm.

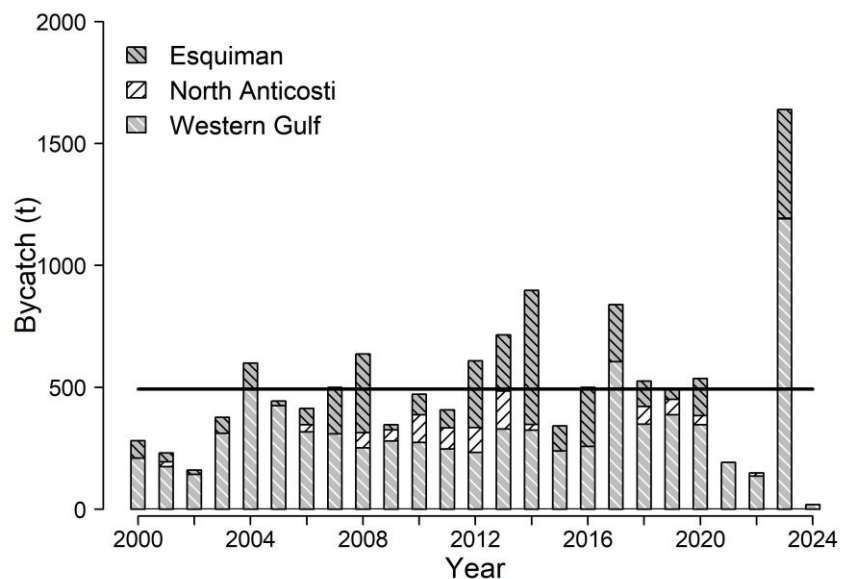


Figure 21. Total bycatch (t) of all species in the directed Greenland halibut gillnet fishery by year and fishing area estimated with data from the at-sea observer program. Solid line indicates the average for the years 2000-2024. No observers were deployed since 2021 on vessels from the province of Newfoundland and Labrador in the gillnet fishery targeting Greenland halibut.

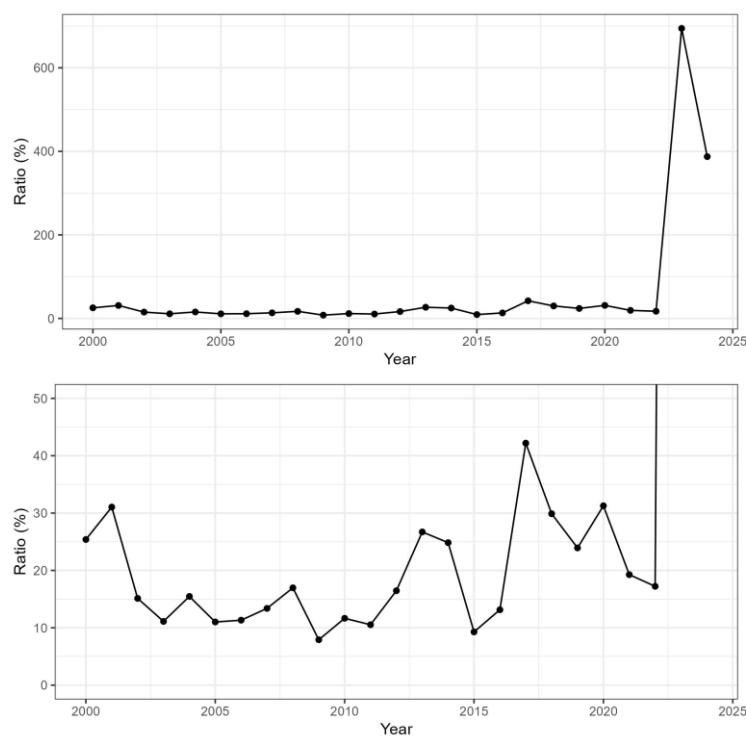


Figure 22. Ratio (%) of bycatch for all species combined to total Greenland halibut landings. Solid line indicates the average for the years 2000-2024. The bottom panel allows for the visualization of the interannual variation of the ratio excluding outlier values. No observers were deployed since 2021 on vessels from the province of Newfoundland and Labrador in the gillnet fishery targeting Greenland halibut.

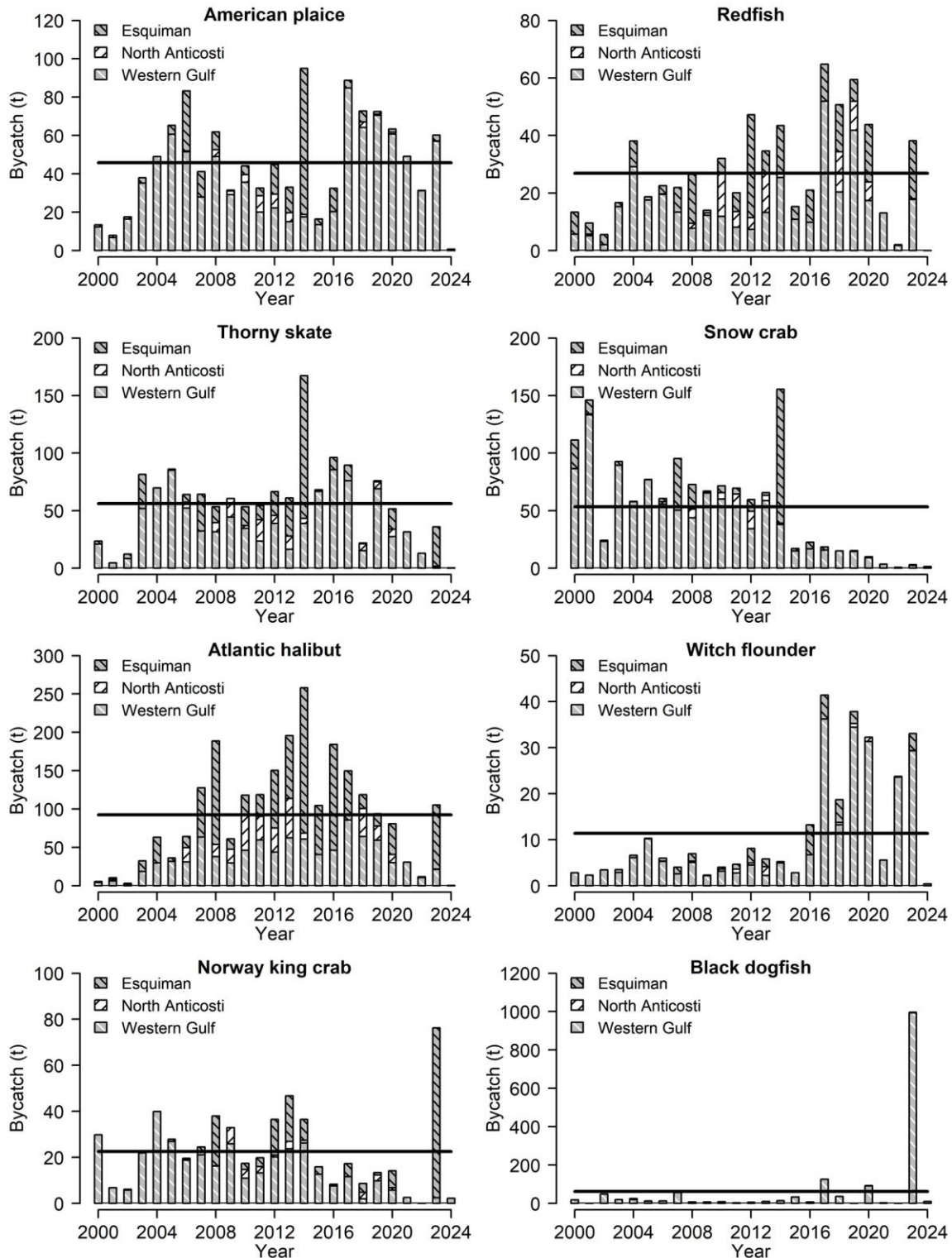


Figure 23. Annual bycatch in the directed Greenland halibut gillnet fishery, estimated for six species per fishing sector based on data from the at-sea observer program. The solid line indicates the average for the years 2000-2024. No observers were deployed since 2021 on vessels from the province of Newfoundland and Labrador in the gillnet fishery targeting Greenland halibut.

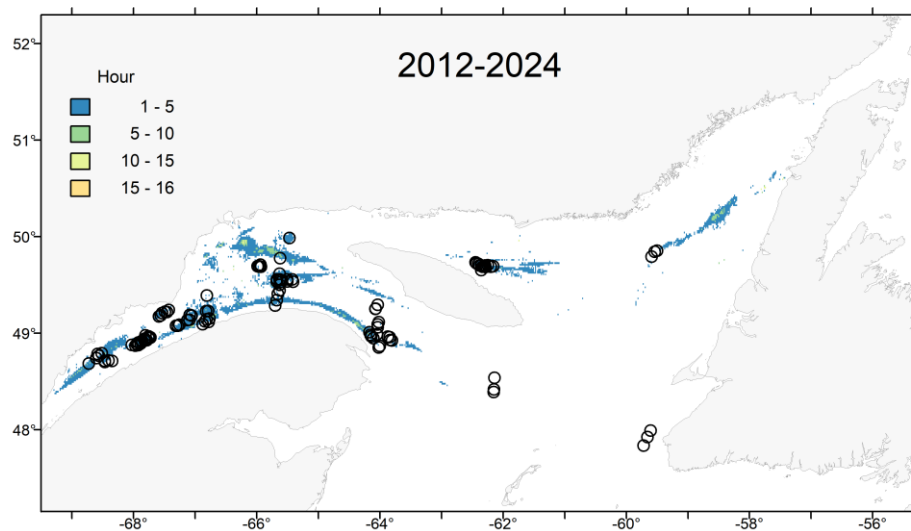


Figure 24. Comparison of the spatial distribution of the average annual fishing effort according to SSN data (colored pixels) and observations from at-sea observers for the years 2023 and 2024 (black circles).

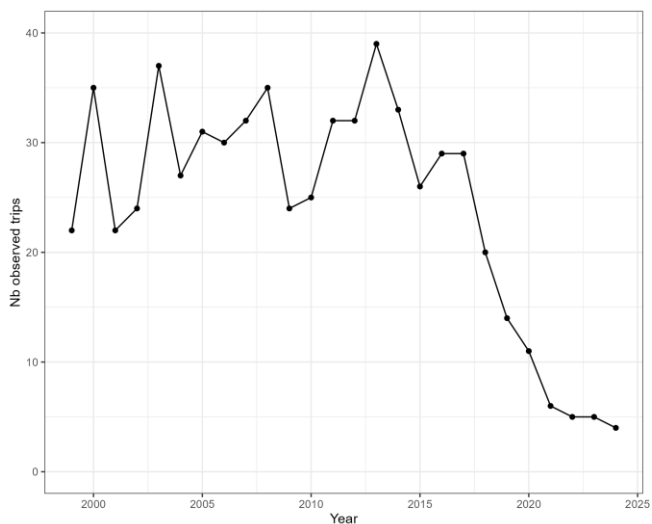


Figure 25. Annual number of observed trip by the at-sea observer program in the gillnet fishery targeting 4RST Greenland halibut.

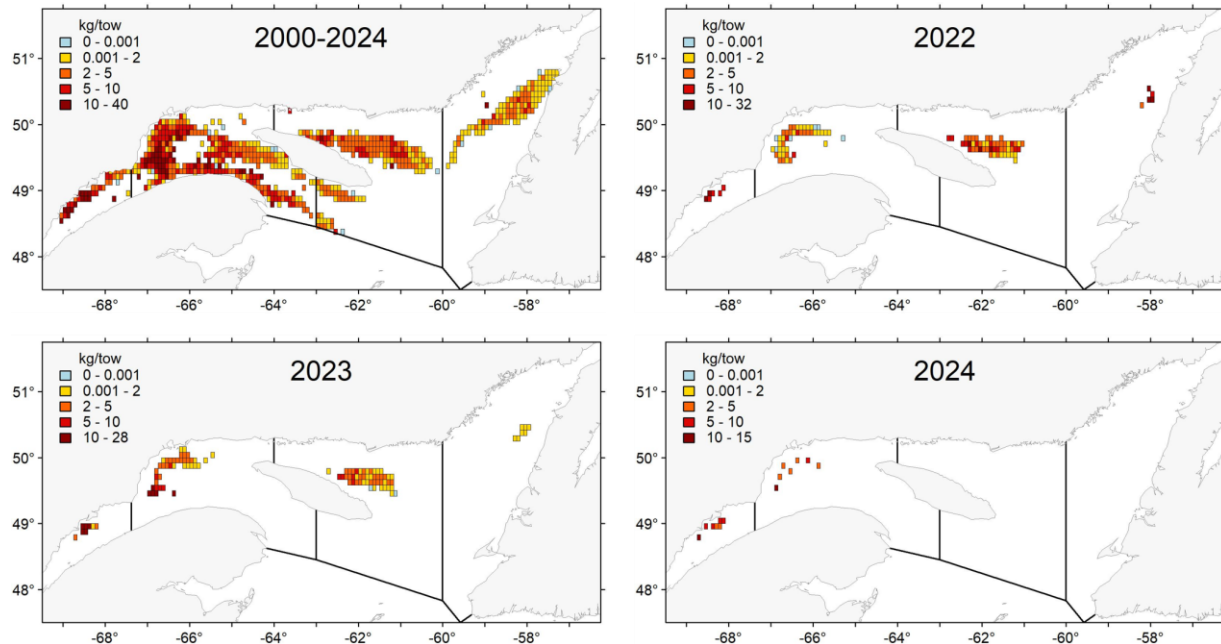


Figure 26. Spatial distribution of Greenland halibut bycatch averaged per 5-minute square in directed shrimp fisheries in the presence of an at-sea observer. Average for 2000-2024 and data for 2022, 2023 and 2024.

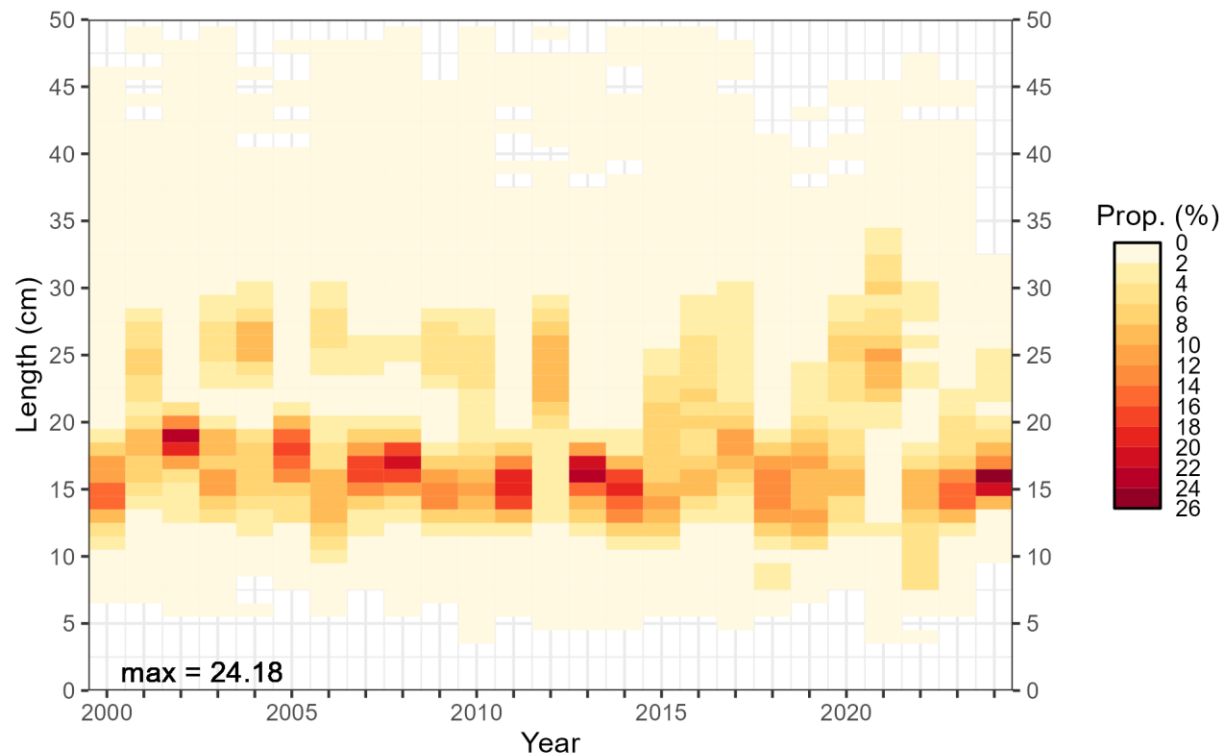


Figure 27. Annual relative length frequency distribution of Greenland halibut sampled by the sea observer program from 2000 to 2024 during shrimp-directed fishing activities. Colors represent annual proportions (prop) at length.

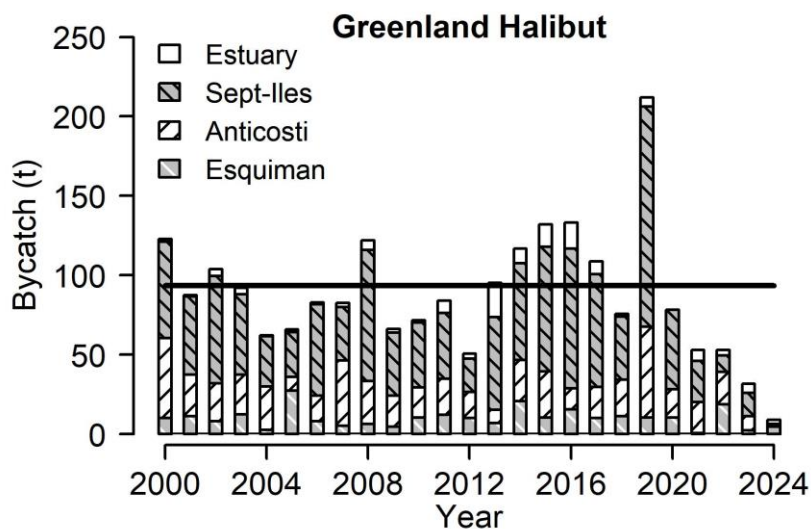


Figure 28. Bycatch of Greenland halibut in the directed shrimp fishery, estimated annually by at-sea observers according to shrimp fishing areas. The solid line indicates the average for the years 2000-2024. No data were available for the Estuary in 2021 as well as North Anticosti and Esquiman in 2024.

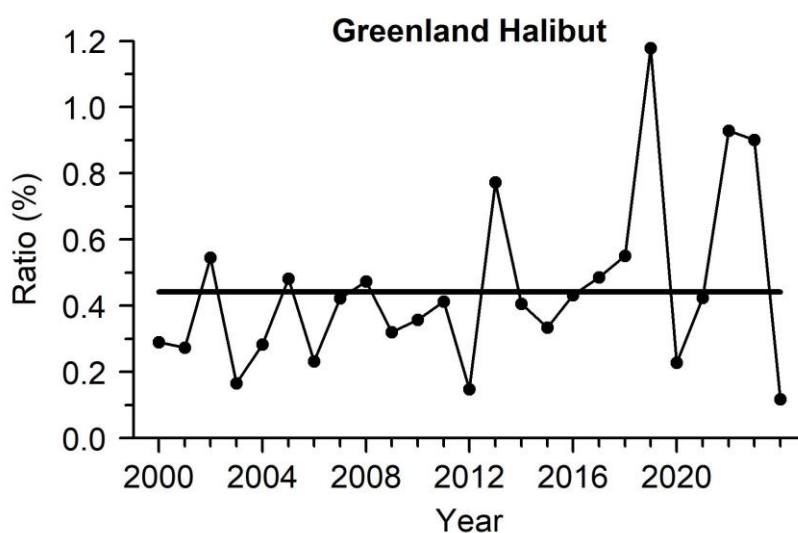


Figure 29. Ratio (%) of Greenland halibut bycatch in the shrimp fishery to estimated <31 cm Greenland halibut biomass in the Northern Gulf of St. Lawrence survey data. Solid line indicates the average for the years 2000-2024.

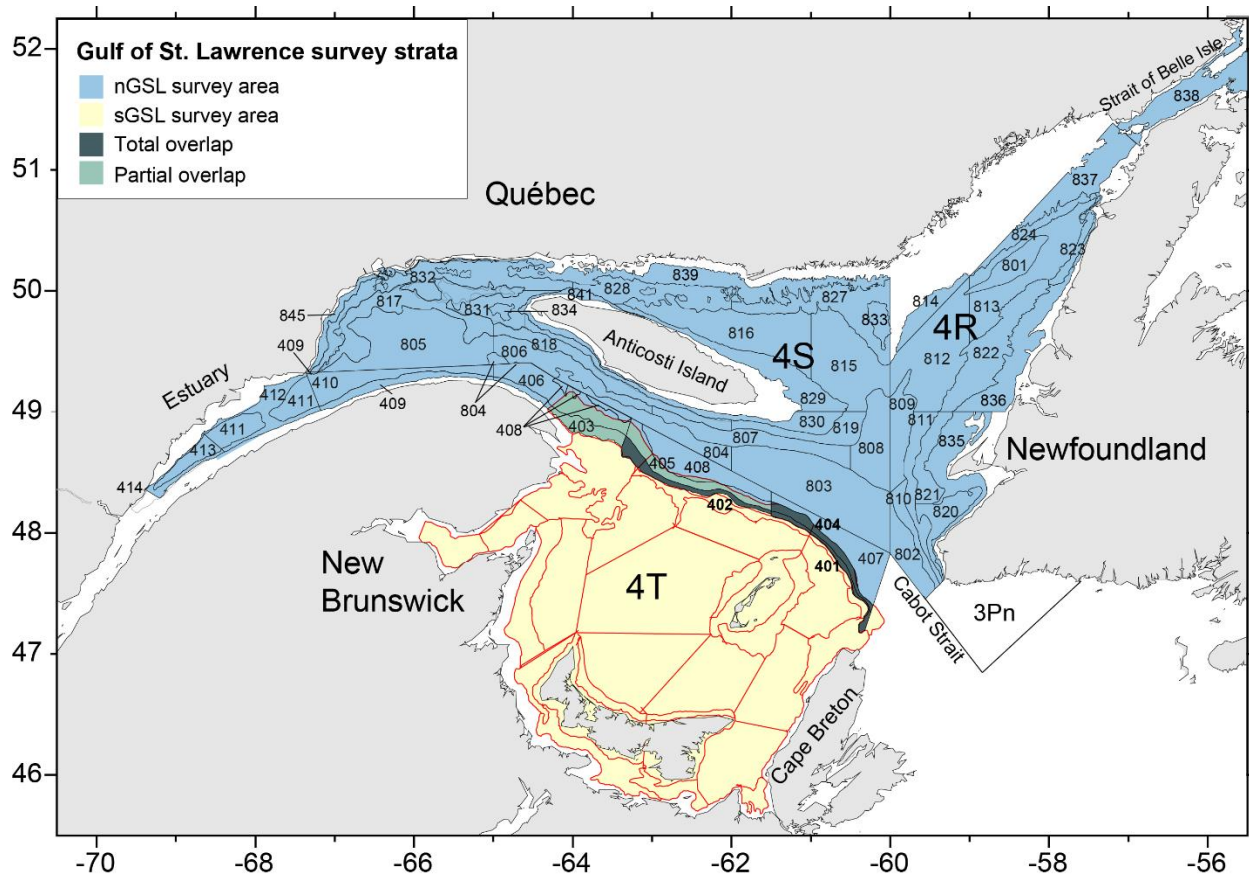


Figure 30. Map illustrating the stratification scheme of the multi-species research surveys in the Lower Estuary and northern Gulf of St. Lawrence (nGSL) (blue) and the southern Gulf of St. Lawrence (sGSL) (yellow, 4T). Survey strata in which there is partial (light green) or total (dark green) overlap of the surveys at their respective boundaries are also identified.

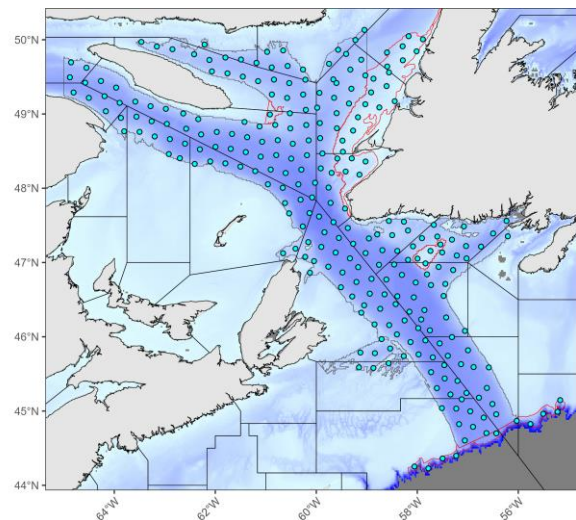


Figure 31. Sampling plan for the winter survey on the Mersey Venture. Dots represent the sampling stations. Gray polygon: 150 m isobath (study area), red polygons: additional areas added for the 2024 survey, black polygons: NAFO unit areas.

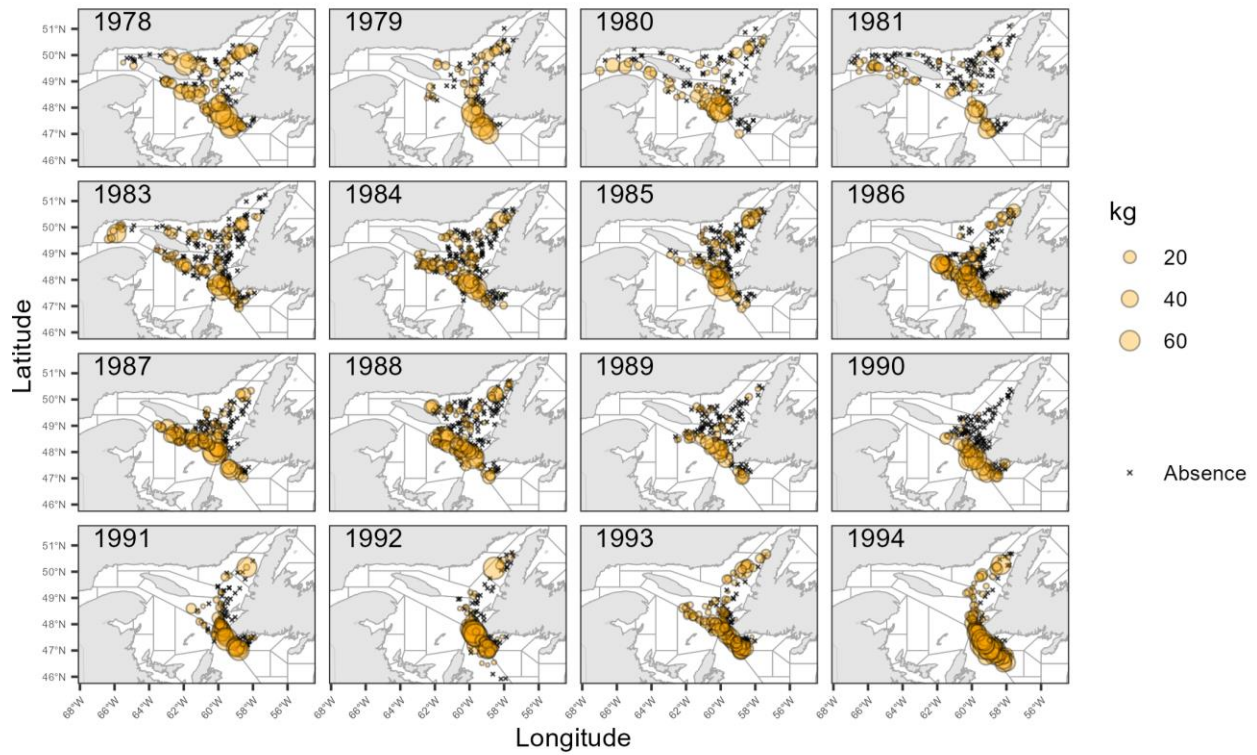


Figure 32. Annual Greenland halibut catch rates (number / 1.75 nm standard tow) in the 1978 – 1994 MV *Gadus Atlantica* winter survey.

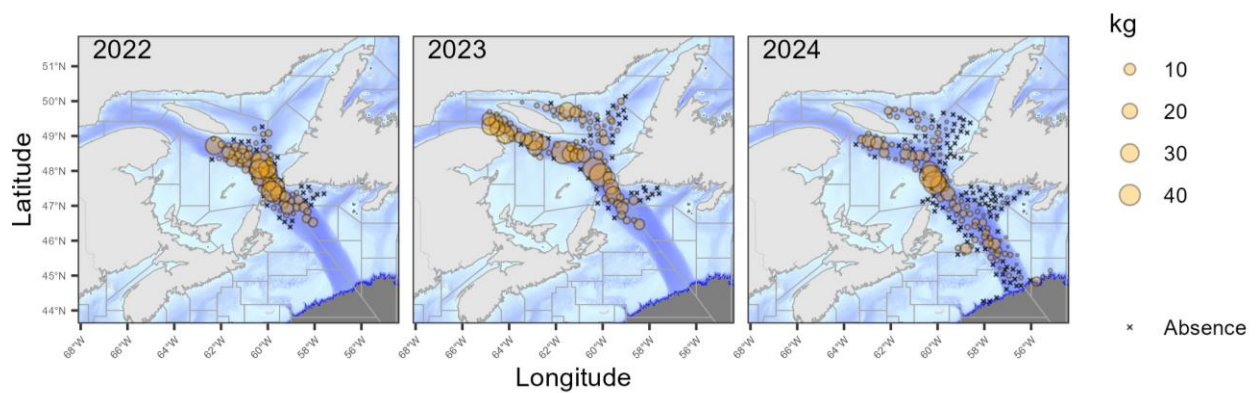


Figure 33. Annual spatial distribution of Greenland halibut catch rates (kg / 0.75 nm standard tow) in the 2022-2024 MV Mersey Venture winter survey.

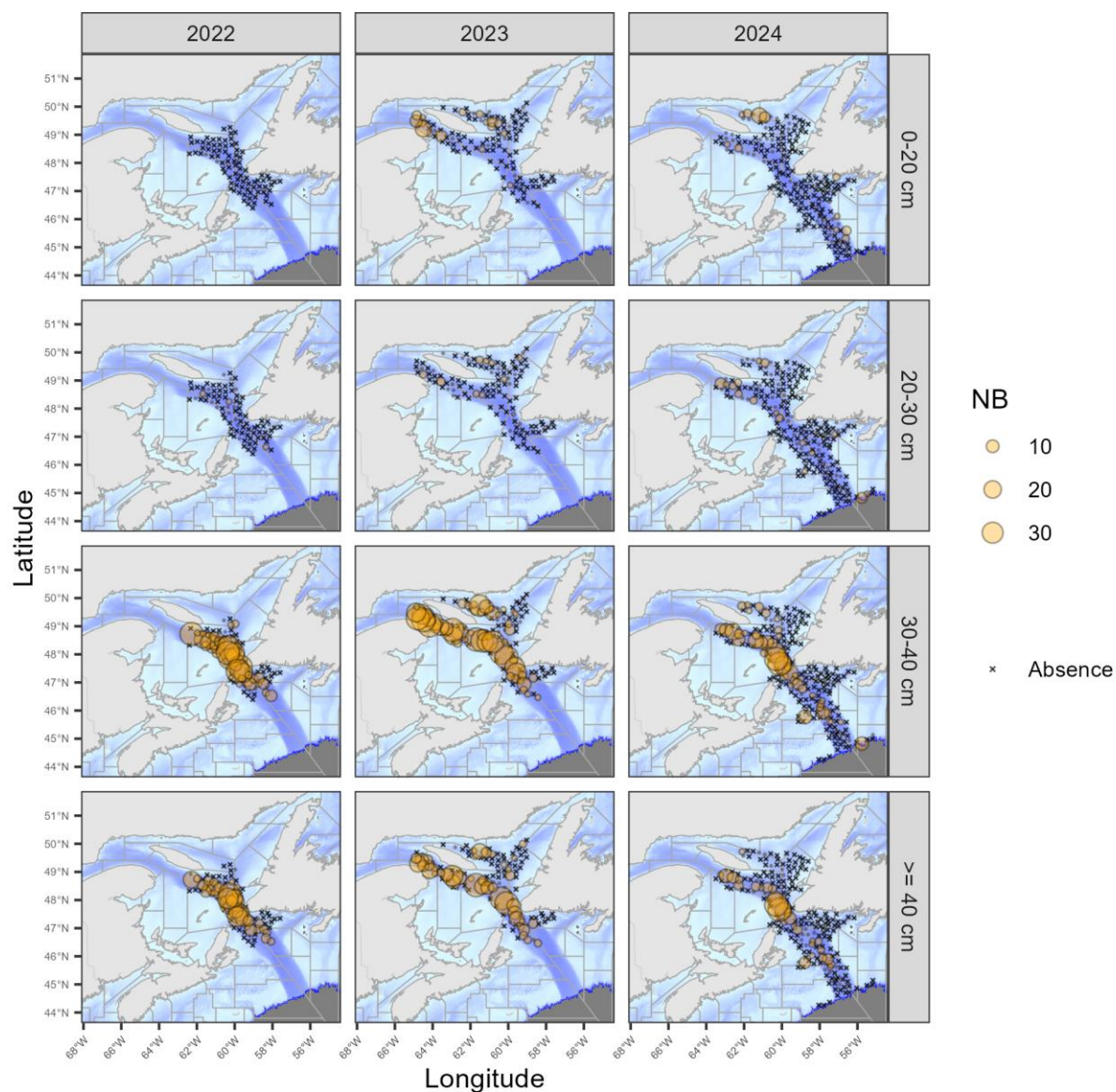


Figure 34. Annual spatial distribution of Greenland halibut catch rates (number (NB) per standard 0.75 mn tow) in the 2022 - 2024 winter survey aboard the MV Mersey Venture for different size classes.

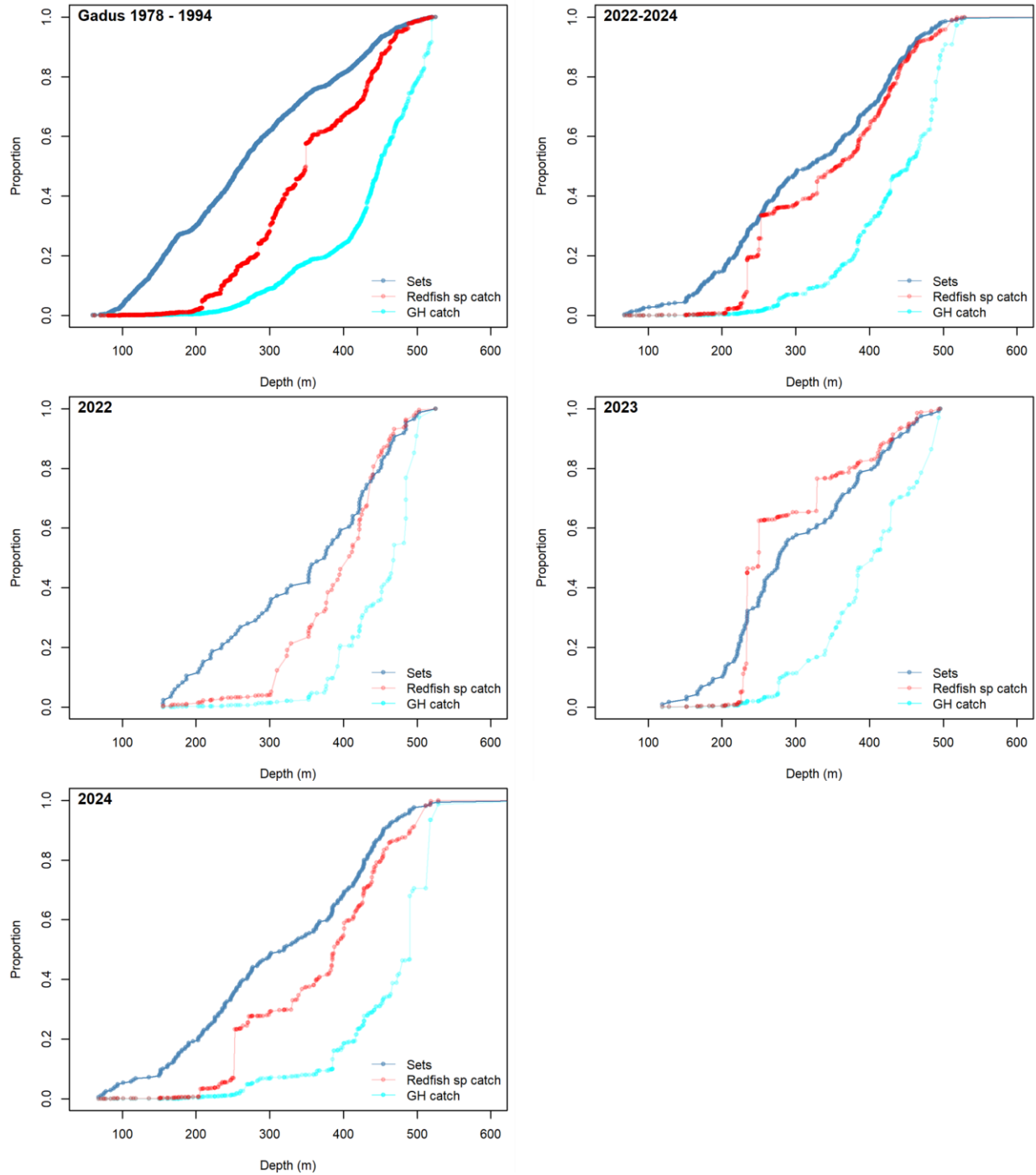


Figure 35. Cumulative proportion of the catch (by weight) of Greenland halibut (GH, light blue) and redfish (*S. mentella* and *fasciatus*) in winter surveys carried out with the MV *Gadus Atlantica* and the MV *Mersey Venture* and cumulative proportion of sampled stations (dark blue) according to depth.

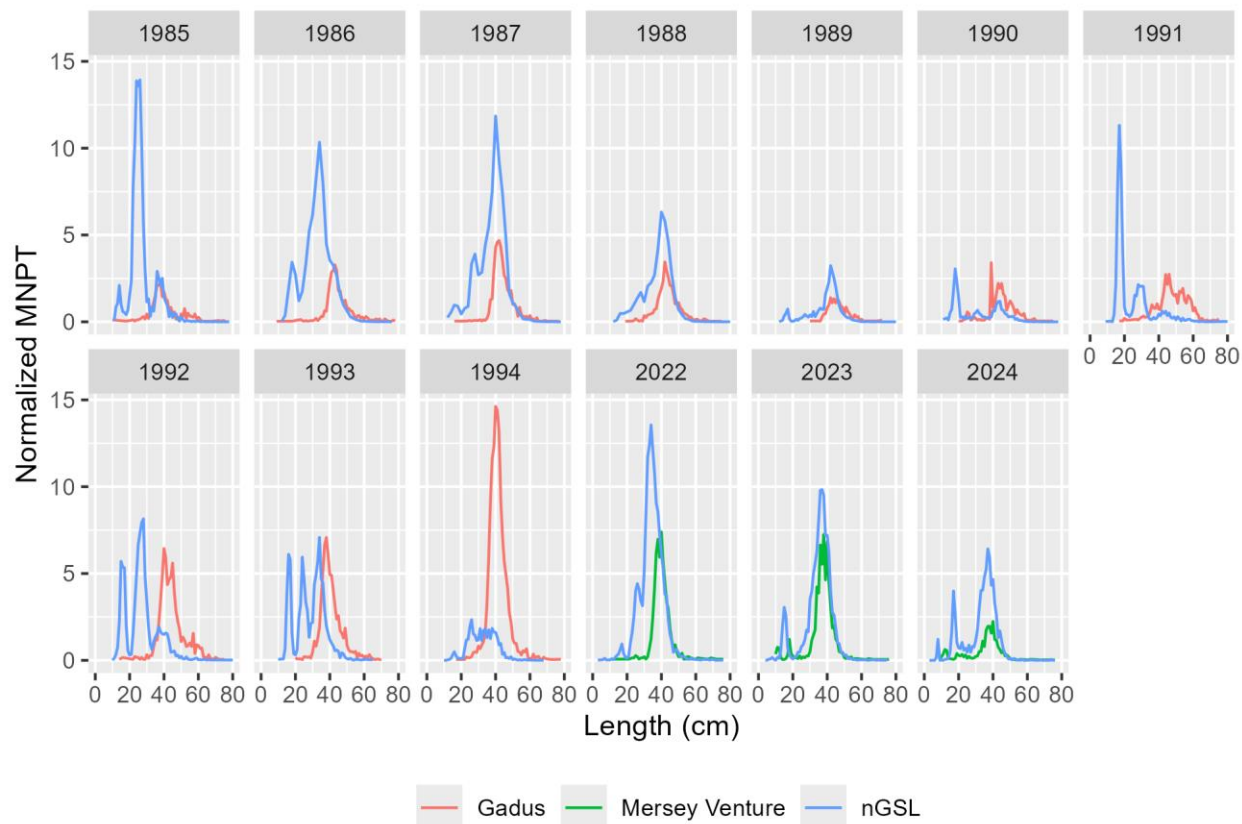


Figure 36. Annual mean size frequencies in the Gadus, Mersey Venture, and nGSL surveys in normalized mean number per tow (MNPT). The nGSL survey curves (in August) have been shifted by one year in order to be compared to the nearest winter survey (January-February).

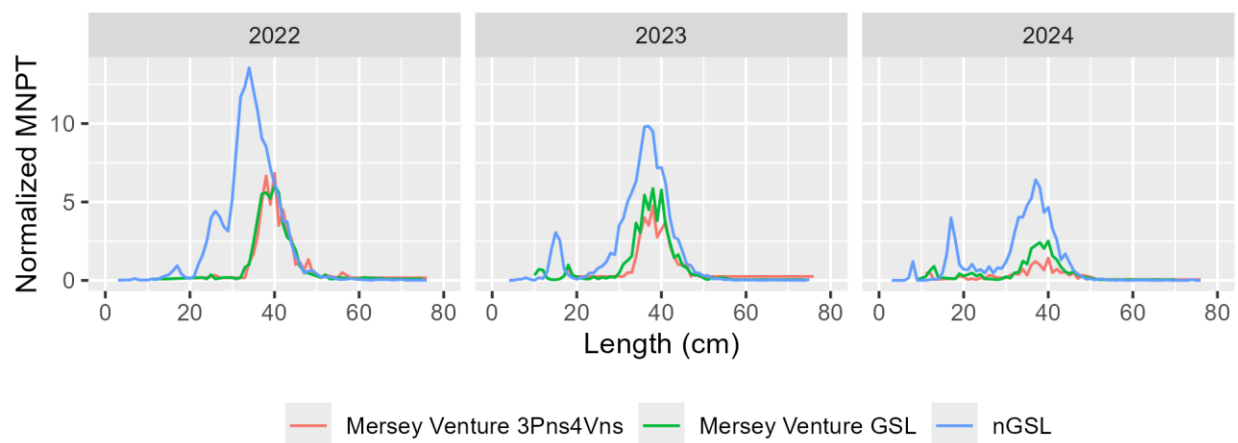


Figure 37. Annual mean size frequencies in the Mersey Venture survey inside (4RST) and outside (3Pns4Vns) of the GSL compared to the nGSL survey mean size frequencies, in normalized mean number per tow (MNPT). The nGSL survey curves (in August) have been shifted by one year in order to be compared to the nearest winter survey (January-February).

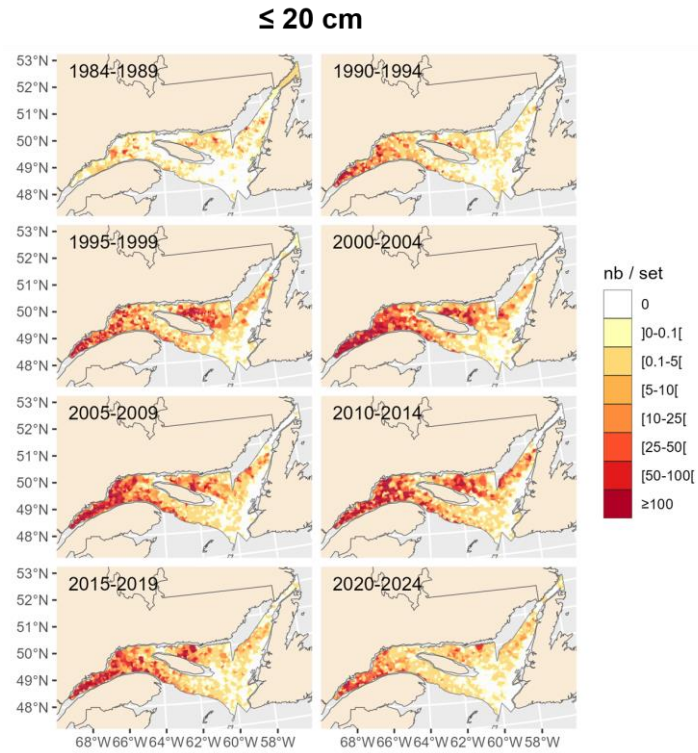


Figure 38. Spatial distribution of catch rates (number / 15 minute tow) of Greenland halibut ≤20 cm in the DFO nGSL survey over five or six year periods.

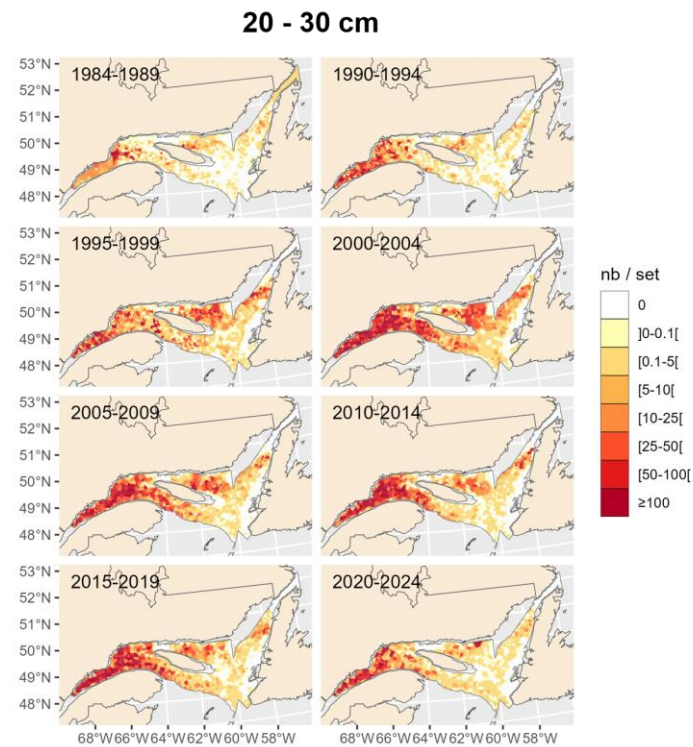


Figure 39. Spatial distribution of catch rates (number / 15 minute tow) of 20 to 30 cm Greenland halibut in the DFO nGSL survey five or six year periods.

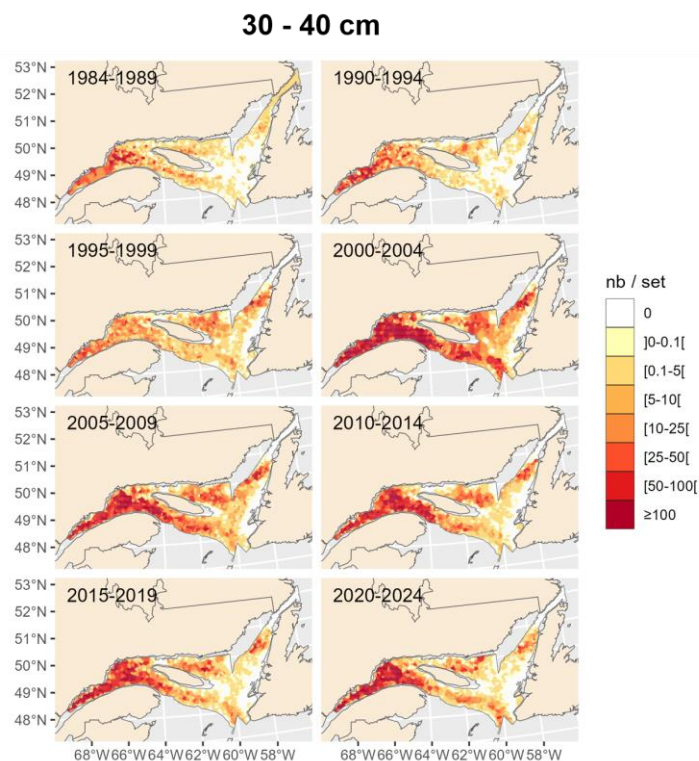


Figure 40. Spatial distribution of catch rates (number / 15 minute tow) of 30 to 40 cm Greenland halibut in the DFO nGSL survey over five or six year periods.

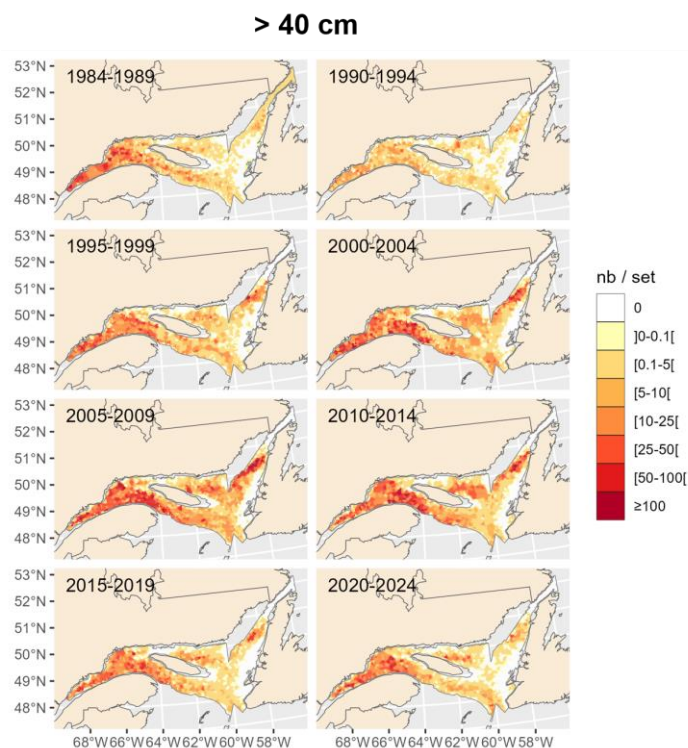


Figure 41. Spatial distribution of catch rates (number / 15 minute tow) of Greenland halibut greater than 40 cm the DFO nGSL survey over five or six year periods.

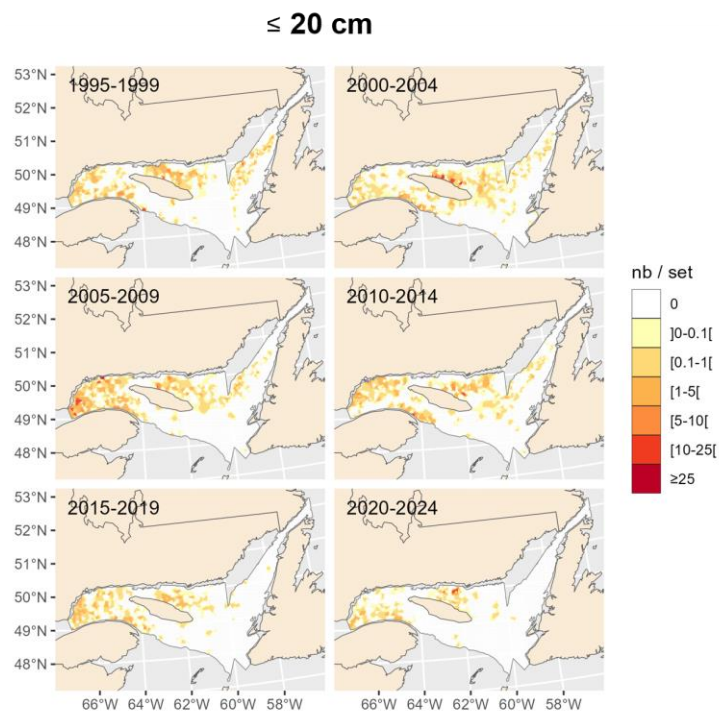


Figure 42. Spatial distribution of catch rates (number / 30-minute tow) of Greenland halibut less than 20 cm in July mobile sentinel survey over five year periods.

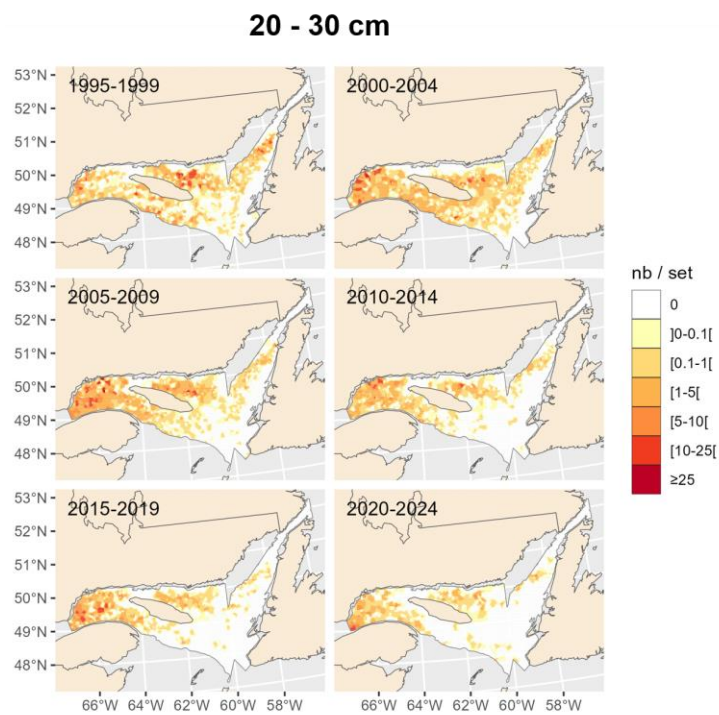


Figure 43. Spatial distribution of catch rates (number / 30 minute tow) of Greenland halibut 20 to 30 cm in July mobile sentinel survey over five year periods.

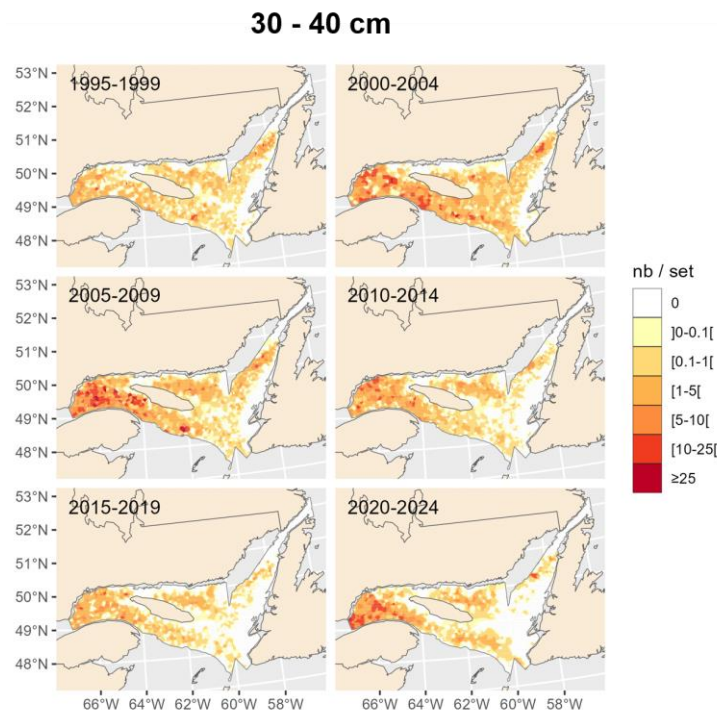


Figure 44. Spatial distribution of catch rates (number / 30 minute tow) of Greenland halibut 30 to 40 cm in July mobile sentinel survey over five year periods.

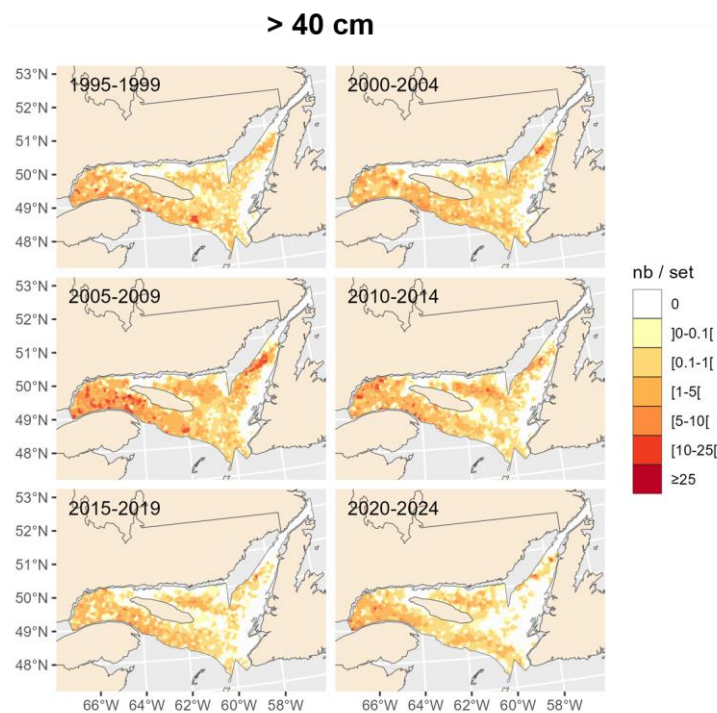


Figure 45. Spatial distribution of catch rates (number / 30-minute tow) of Greenland halibut greater than 40 cm in July mobile sentinel survey over five year periods.

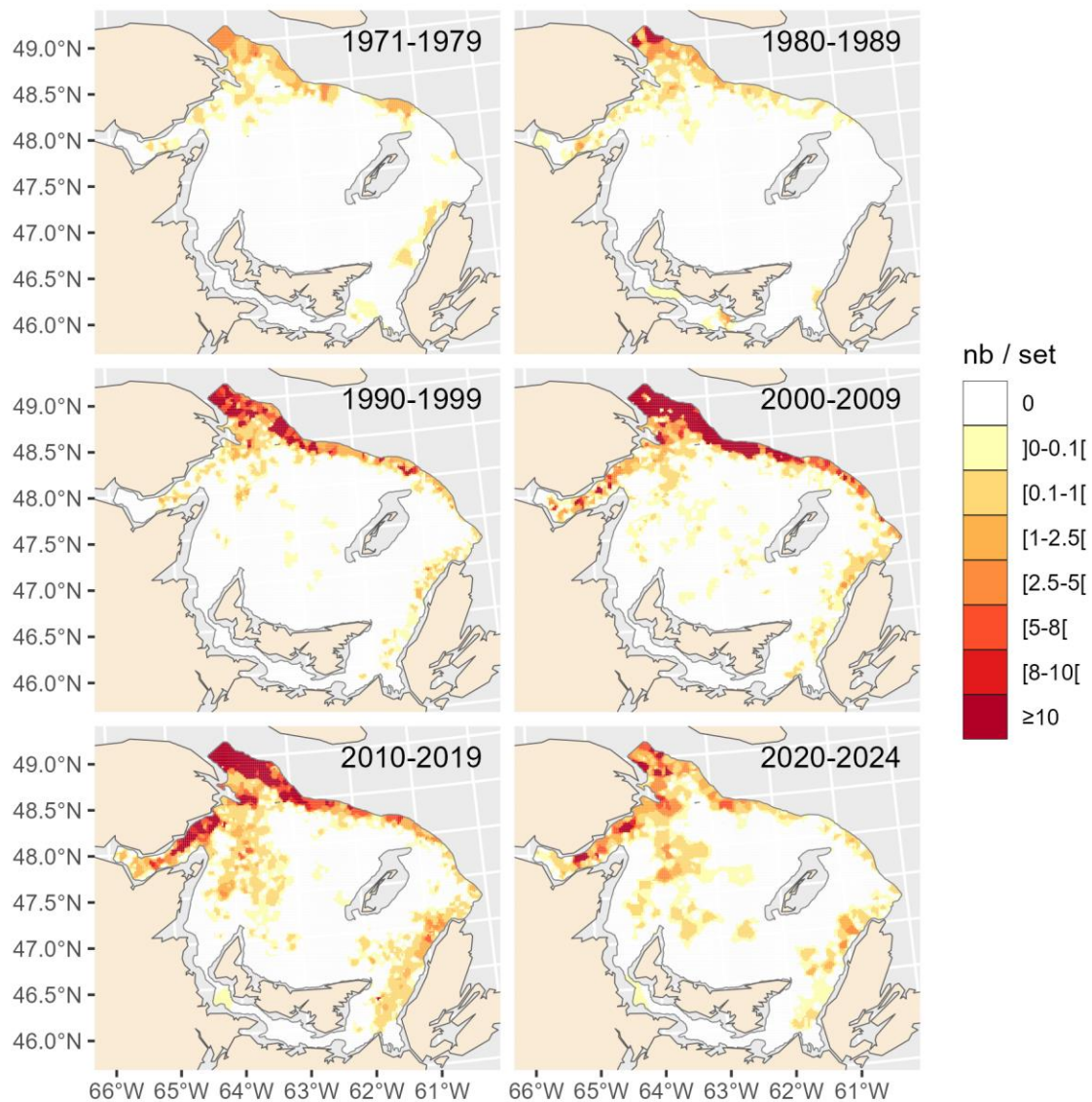


Figure 46. Spatial distribution of Greenland halibut catches (all sizes) in number per tow by period in DFO's sGSL survey.

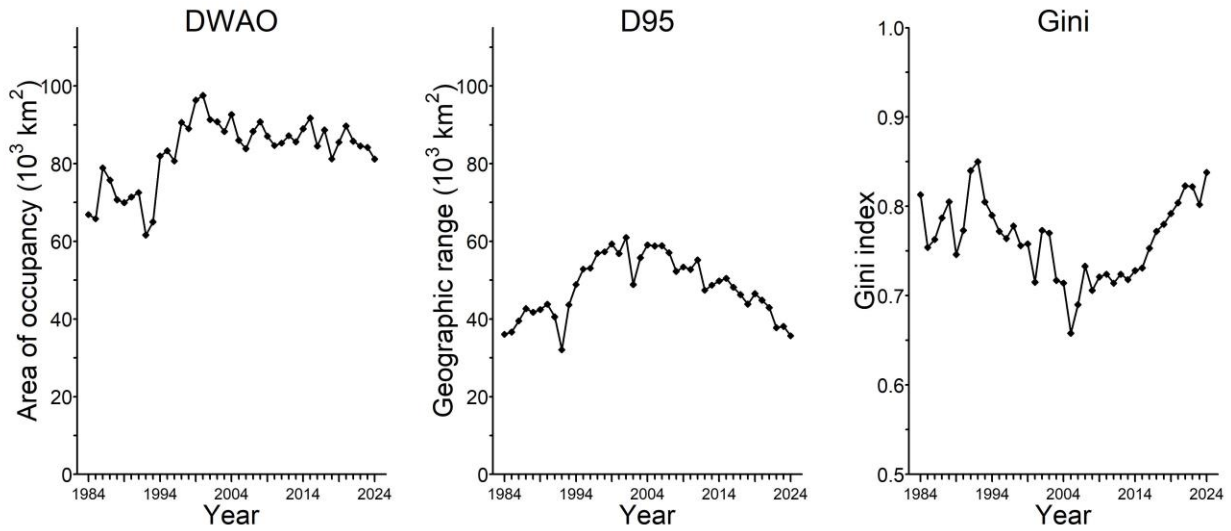


Figure 47. Annual spatial distribution indices: DWAO, weighted area of occupancy. D95, minimum area where 95% of the biomass is concentrated, and Gini index. The total DFO nGSL surveyed area is 116,115 km².

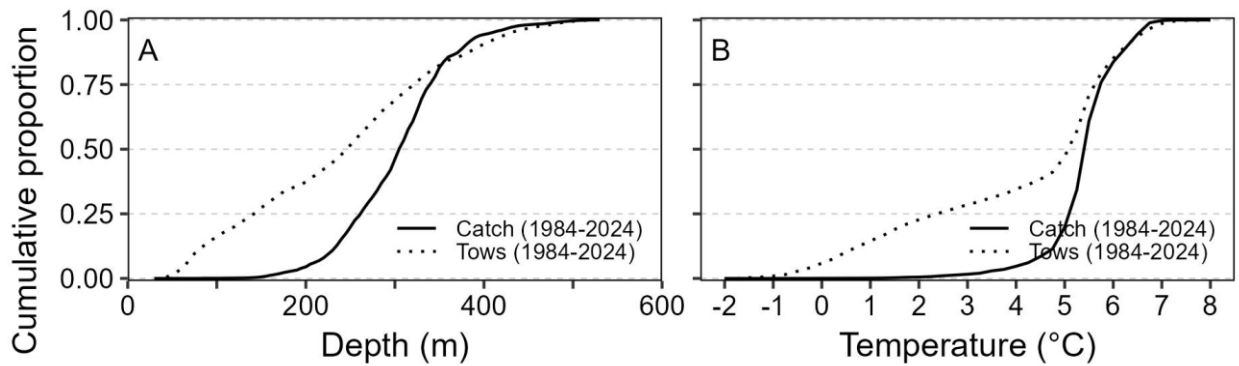
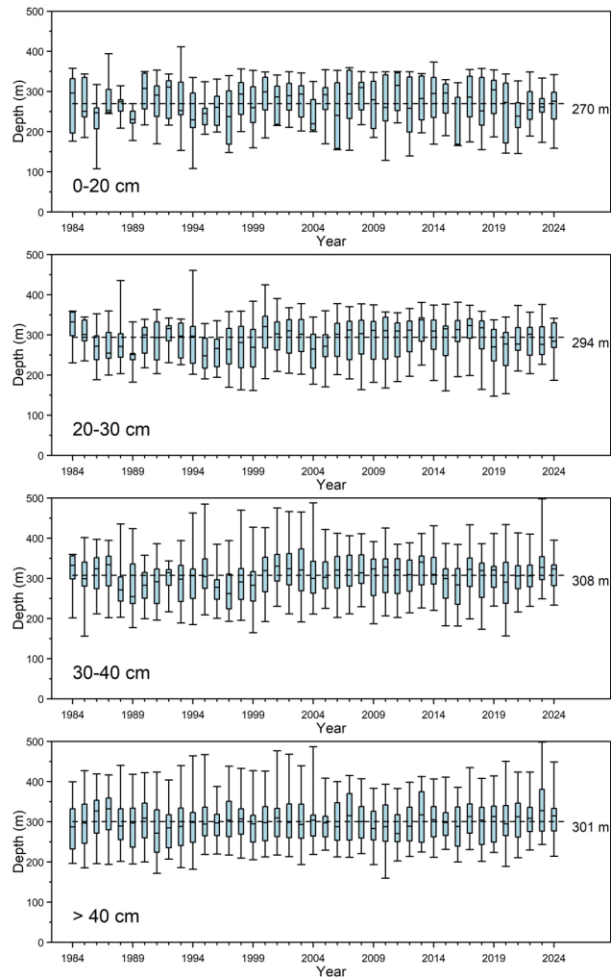


Figure 48. Cumulative proportion of Greenland halibut catches (weight per tow) and number of stations sampled as a function of depth (left graph) and bottom temperature (right graph) in the DFO nGSL survey from 1984 to 2024.

A)



B)

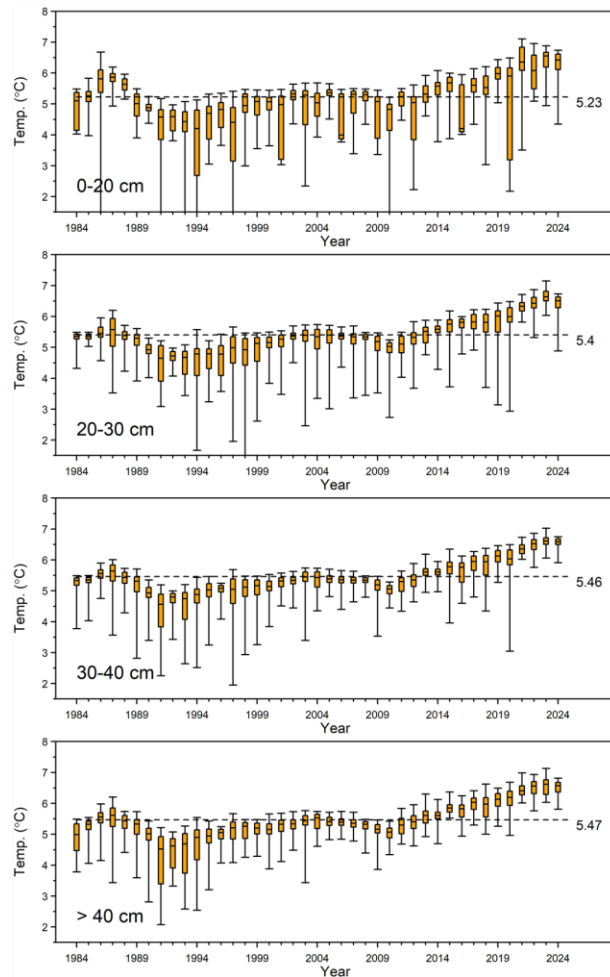


Figure 49. Distribution of Greenland halibut biomass as a function of A) depth B) temperature and C) dissolved oxygen saturation level for different size categories observed in the DFO nGSL survey. Box and whiskers plot: the line inside the box represents the median. the box extends from percentiles 25 to 75 and the whiskers (vertical lines on either side of the box) extend from percentiles 5 to 95. The horizontal dotted line on each graph shows the average of the series.

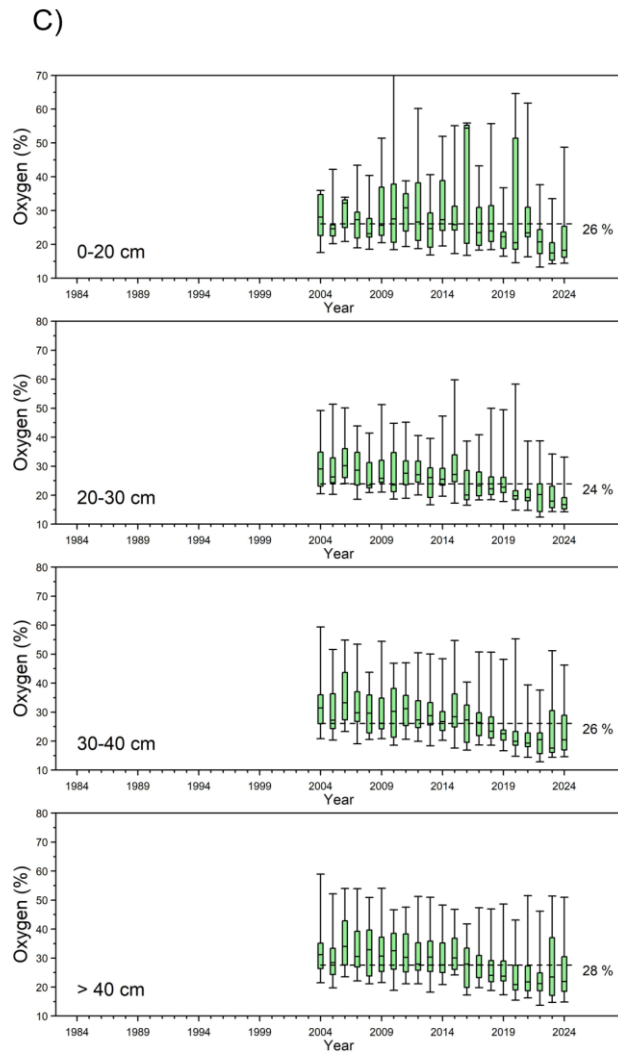


Figure 49. (cont.)

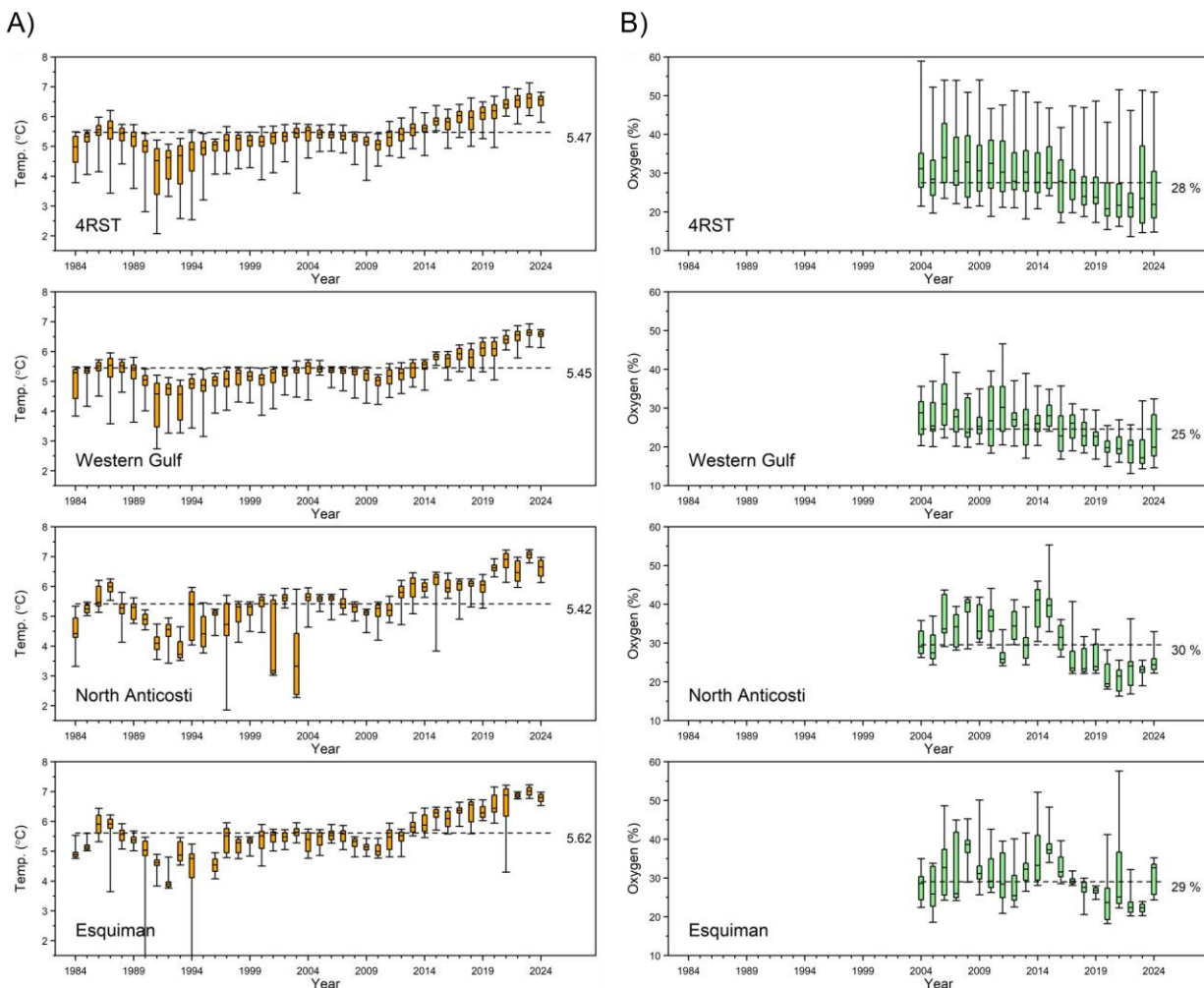


Figure 50. Distribution of Greenland halibut biomass as a function of A) bottom temperature, B) dissolved oxygen saturation level by fishing sector for fish larger than 40 cm observed in the DFO nGSL survey. Box and whiskers plot: the line inside the box represents the median, the box extends from percentiles 25 to 75 and the whiskers (vertical lines on either side of the box) extend from percentiles 5 to 95. The horizontal dotted line on each graph shows the average of the series.

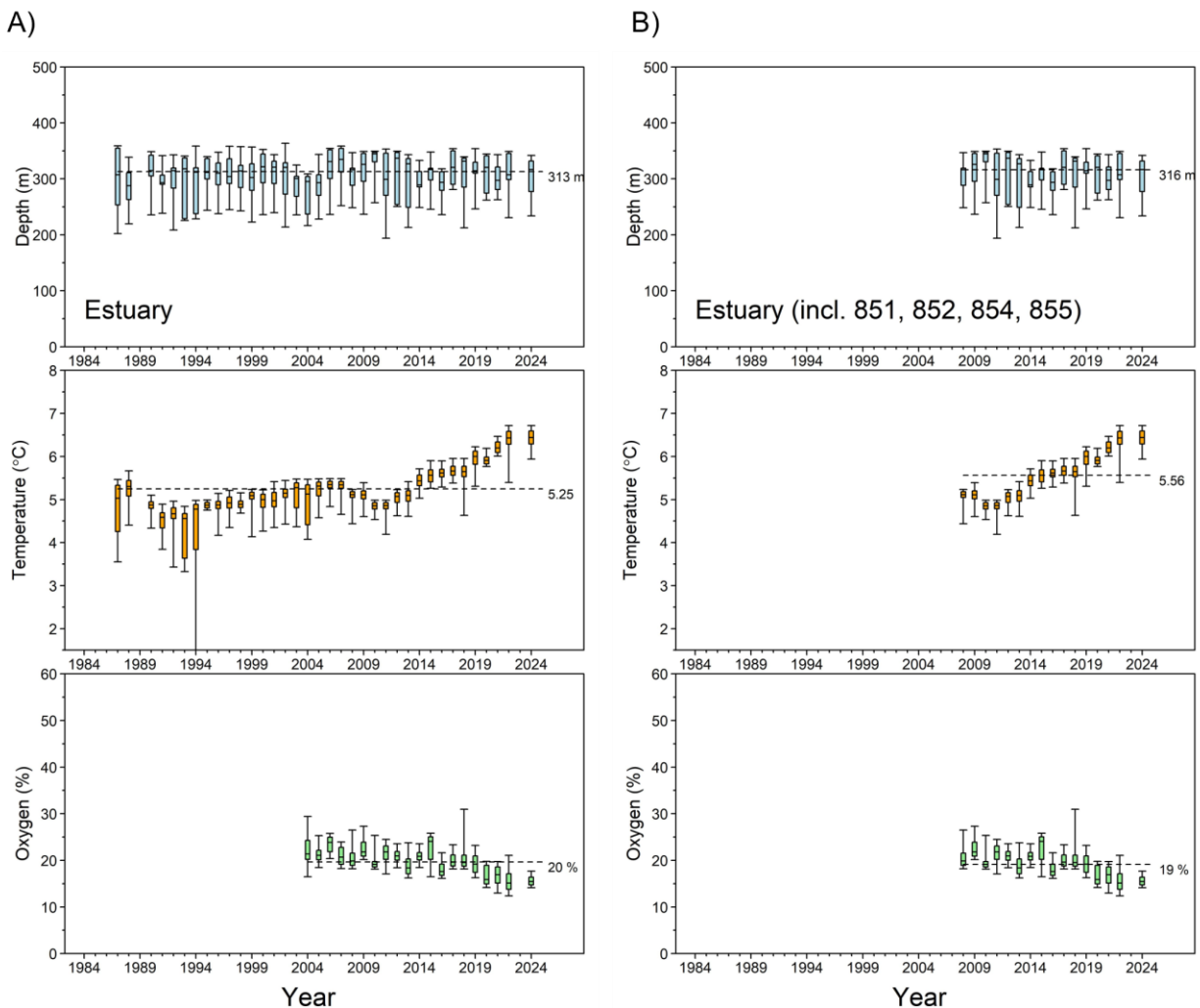


Figure 51. Greenland halibut biomass distributions in the Lower Estuary as a function of depth, bottom temperature and dissolved oxygen saturation level based on DFO nGSL survey data in A) the estuary (strata 411 to 414) and B) the estuary including the strata added in 2008 (851, 852, 854, 855). Boxplot graphical representation: the line inside the box represents the median, the box extends from the 25th to 75th percentiles, and the whiskers (vertical lines on either side of the box) extend from the percentiles 5 to 95. The dashed horizontal line on each of the graphs represents the series mean.

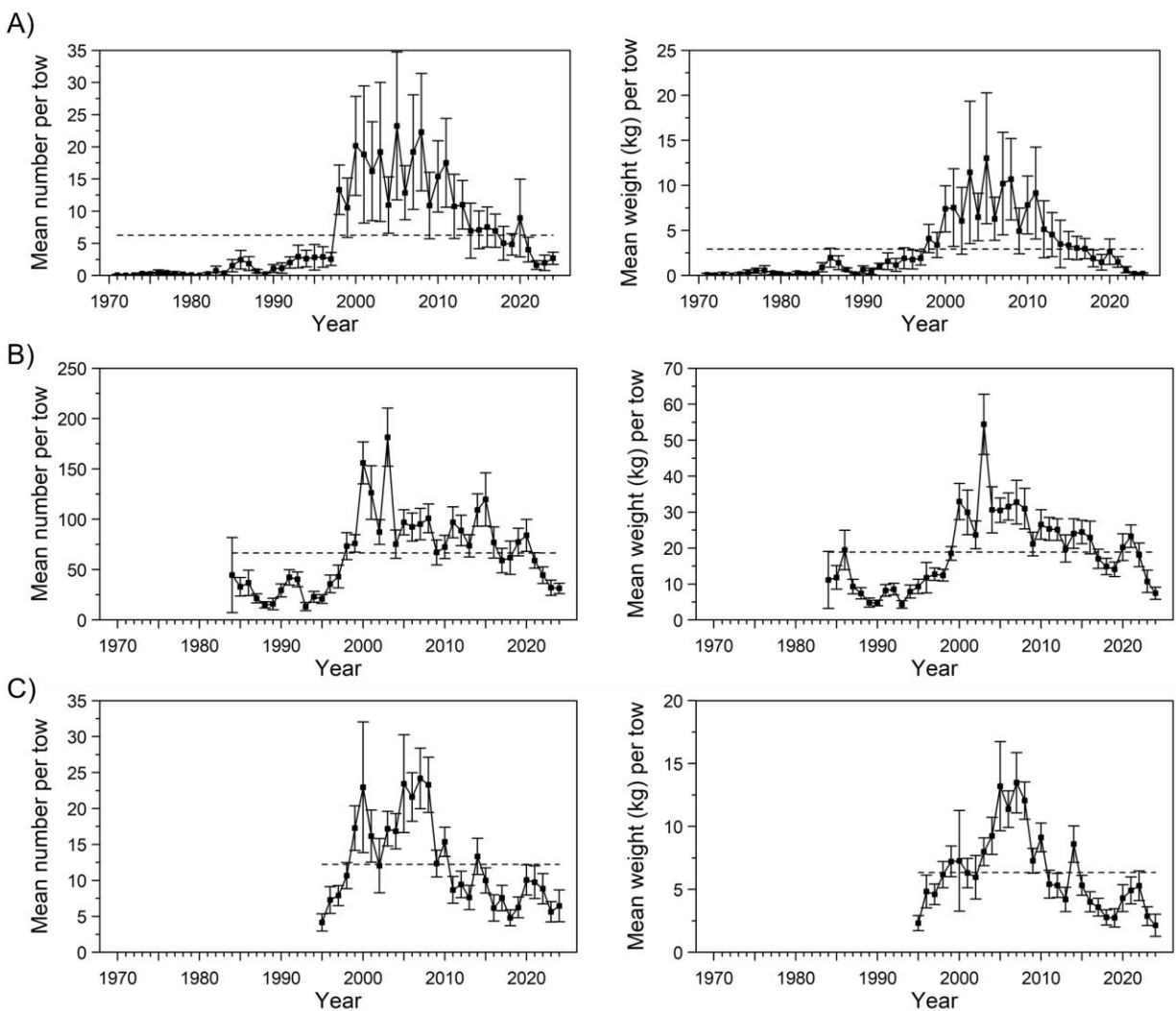


Figure 52. Mean number and weight per tow for Greenland halibut observed in A) the sGSL (1971-2024), B) the nGSL (1984-2024) and, C) the mobile sentinel (1995-2024) surveys. Error bars indicate the 95% confidence interval. Horizontal lines indicate average for each series.

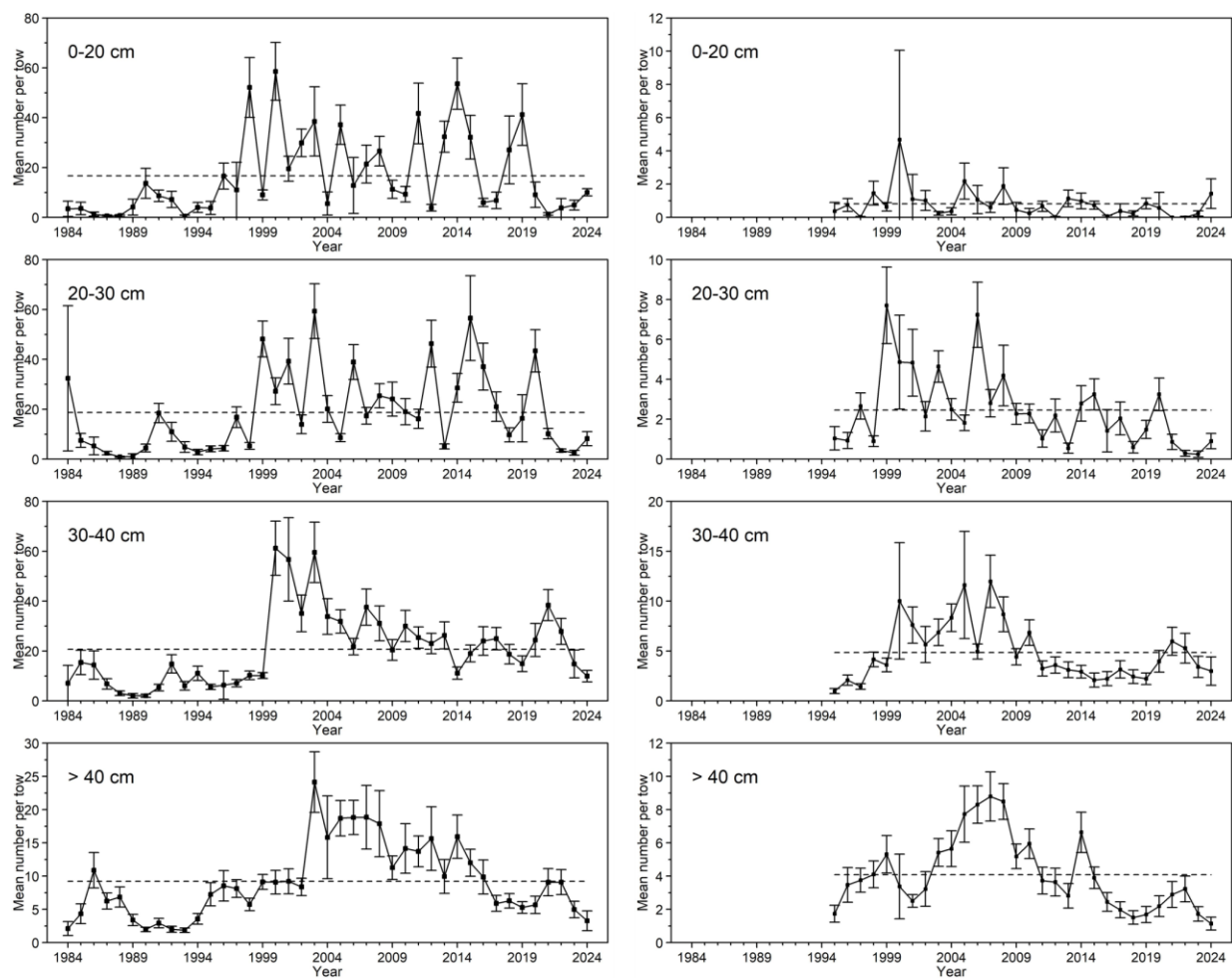


Figure 53. Greenland halibut abundance indices (mean number per tow) for different size categories observed in the nGSL (left) and mobile sentinel (right) surveys.

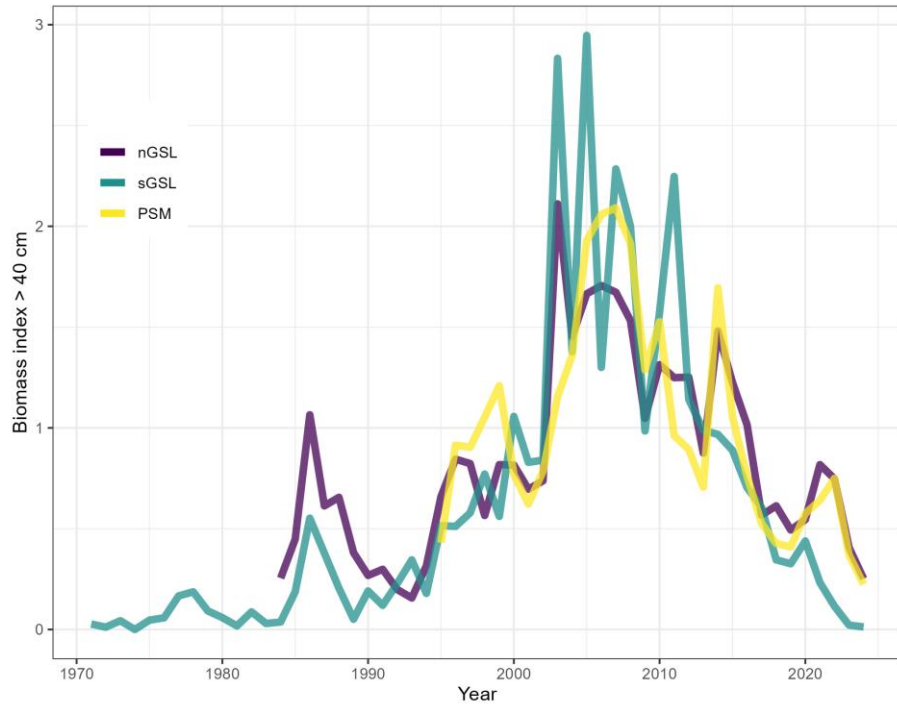


Figure 54. Normalized biomass (divided by the mean) indices for Greenland halibut >40 cm calculated from DFO nGSL, sGSL surveys and MSP surveys.

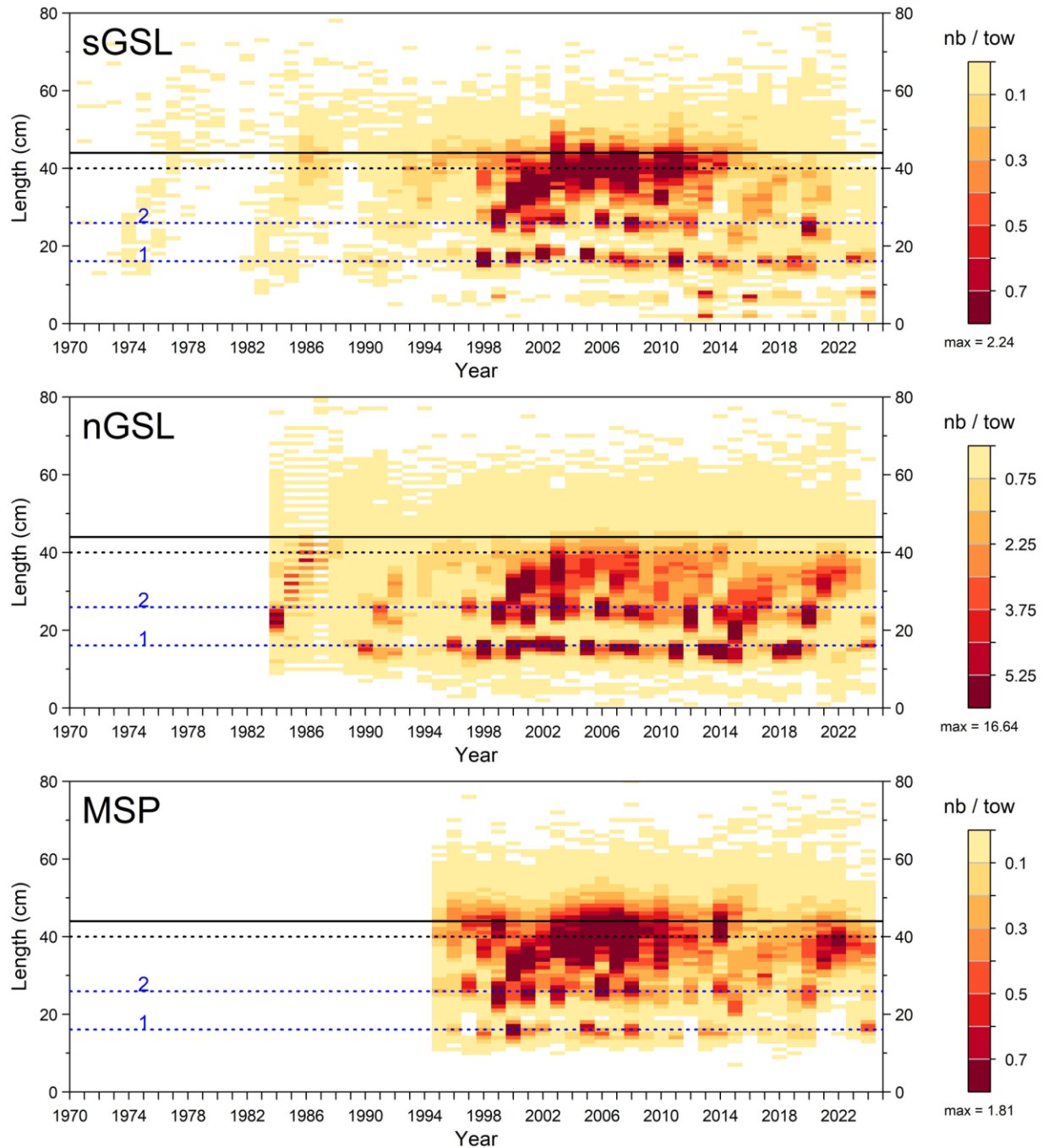


Figure 55. Length frequency distributions estimated with the DFO sGSL (1971-2024), and nGSL (1984-2024) surveys and MSP (1995-2024) survey. The blue dotted lines indicate the average lengths expected for 1- and 2-year-old fish. Black dotted lines at 40 cm indicate the limit for biomass indices for fish over 40 cm. Black solid lines at 44 cm indicate the minimum regulatory size according to the small fish protocol.

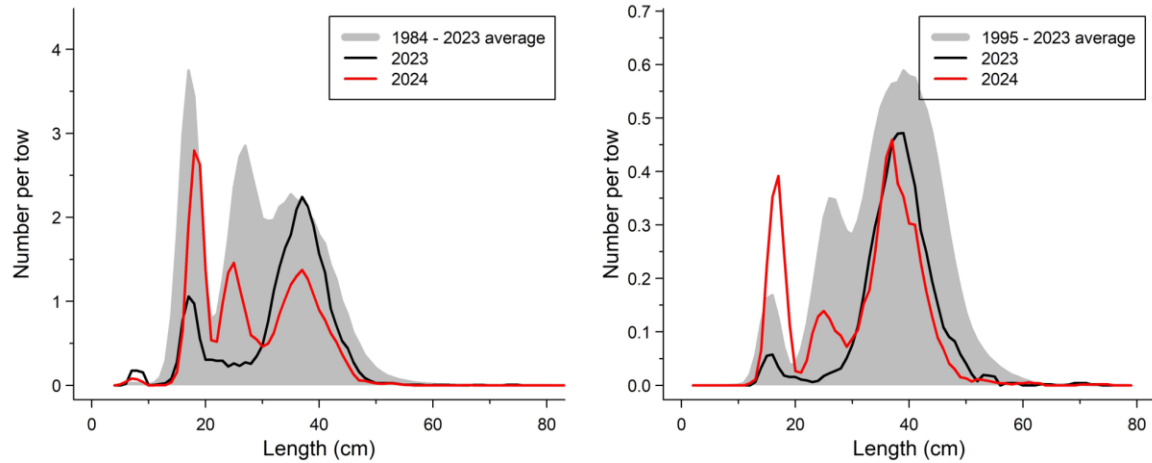


Figure 56. Length frequency distributions (mean number per tow) estimated with the DFO nGSL (left) and mobile sentinel (right) surveys for Greenland halibut.

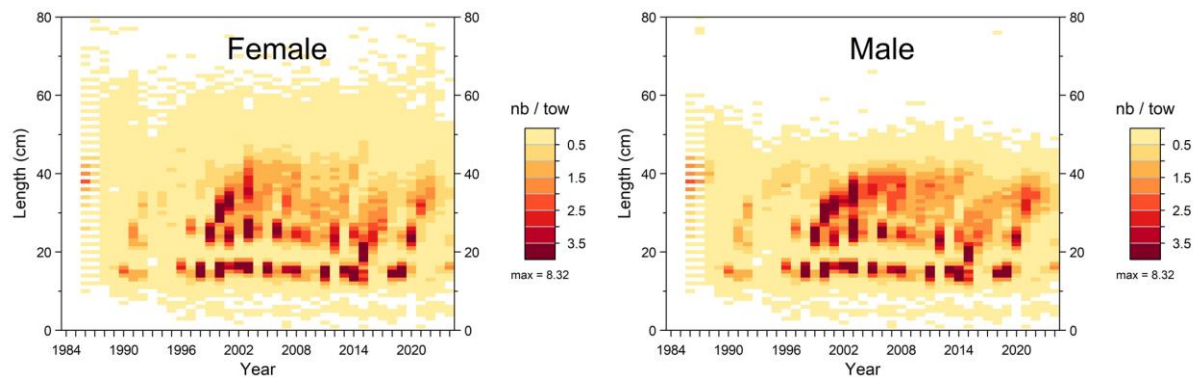


Figure 57. Length frequency distribution by sex and year estimated with the nGSL survey (1986-2024).

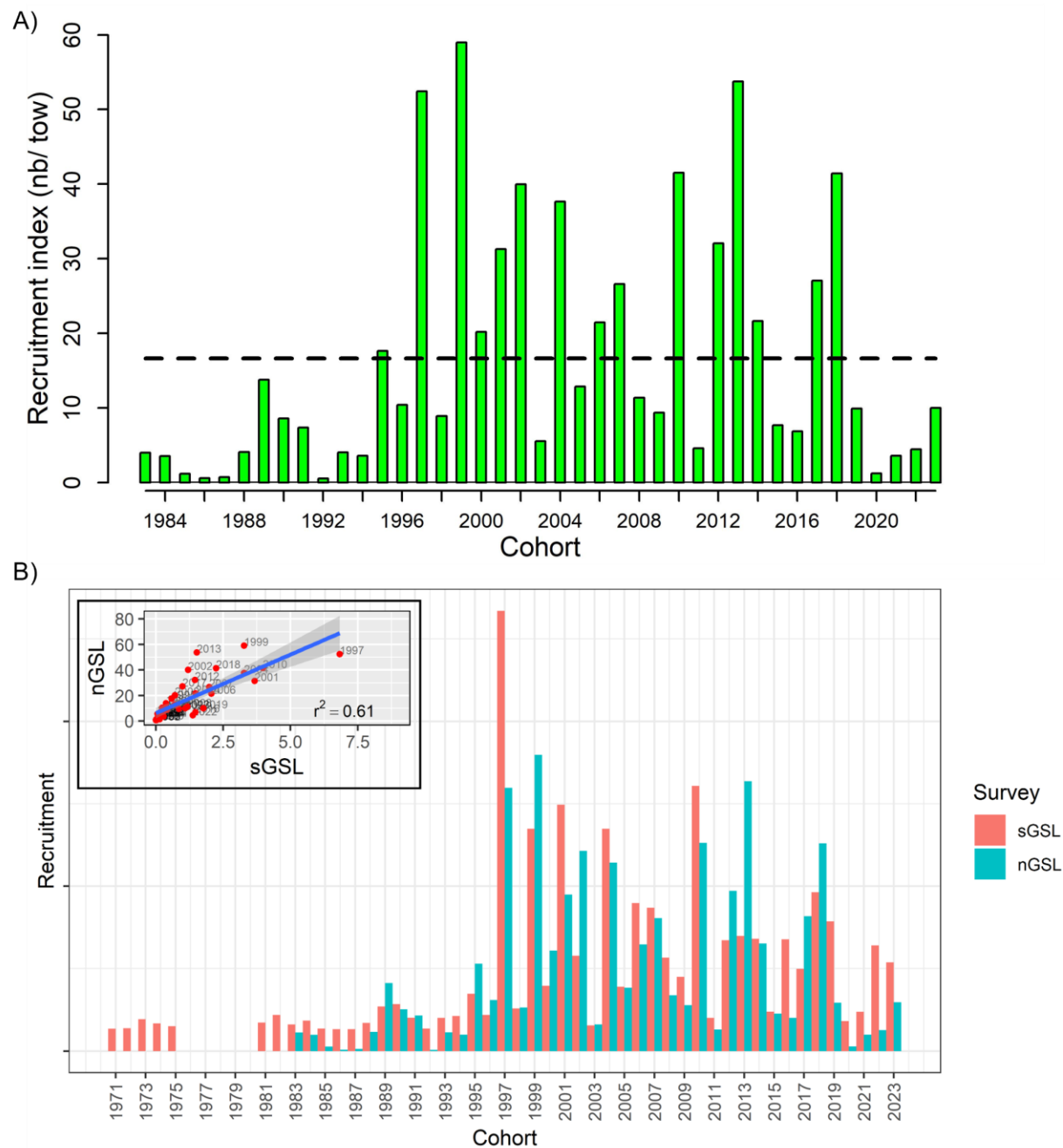


Figure 58. Recruitment indices for Greenland halibut estimated by the annual abundance of 12-21 cm (age 1) fish in the A) DFO nGSL survey. B) Comparison of recruitment indices for Greenland halibut from the DFO nGSL and sGSL surveys. The box shows the relationship between the annual cohort abundance estimated by each survey.

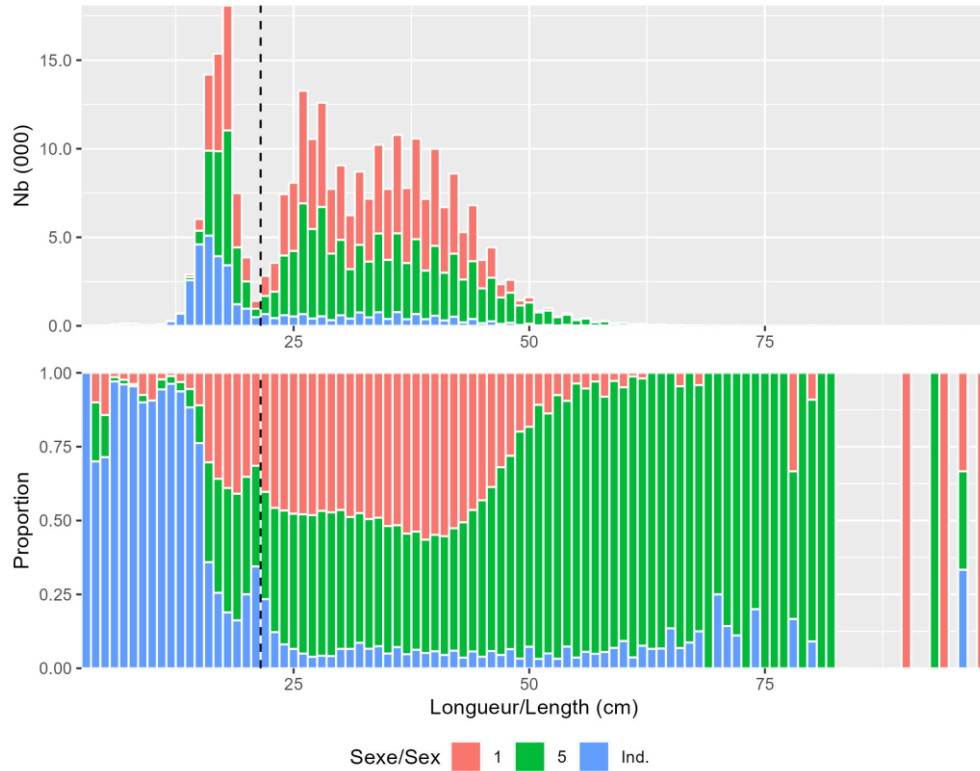


Figure 59. Number and proportion by sex and 1 cm length class in the nGSL survey 1995 – 2022. The vertical dotted line separates individuals of more or less 22 cm.

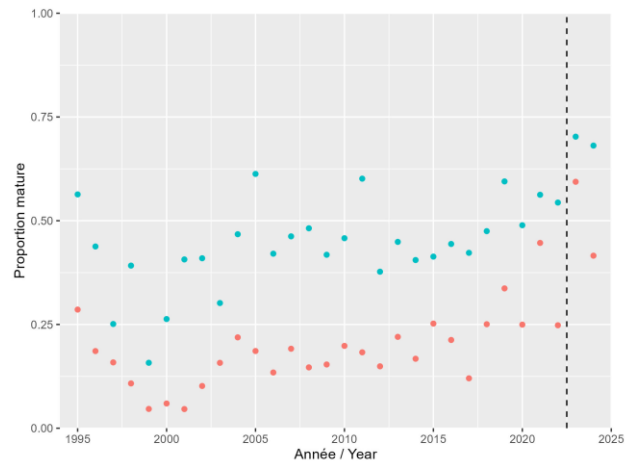


Figure 60. Annual proportion mature by sex in the nGSL data used to calculate maturity ogives (excluding individuals of undetermined sex).

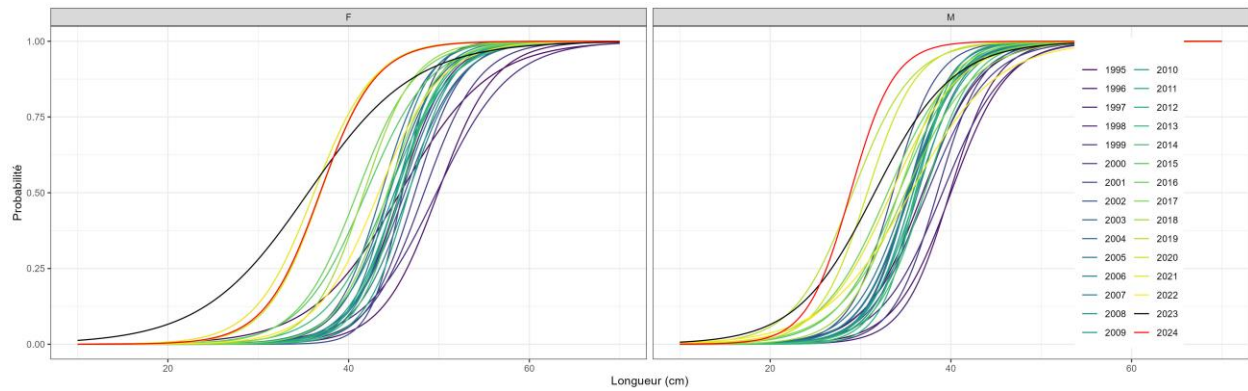


Figure 61. Maturity ogives based on visual determination of the gonad state for male and female Greenland halibut in the nGSL survey, estimated using 1 glm per year and sex.

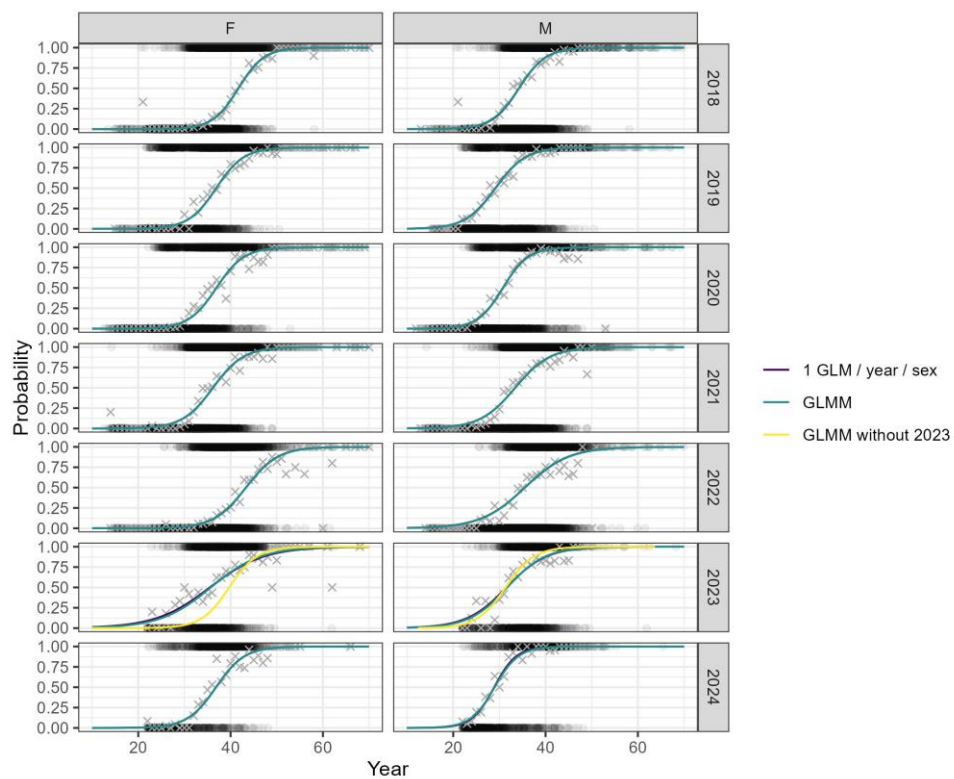


Figure 62. Comparison of predicted probabilities of being mature from the GLMs (1 per year and sex) and the mixed effect models (GLMM) including or not the data from 2023 with the observed values (transparent black points) and the average observed proportions (gray x) for 2018 to 2024.

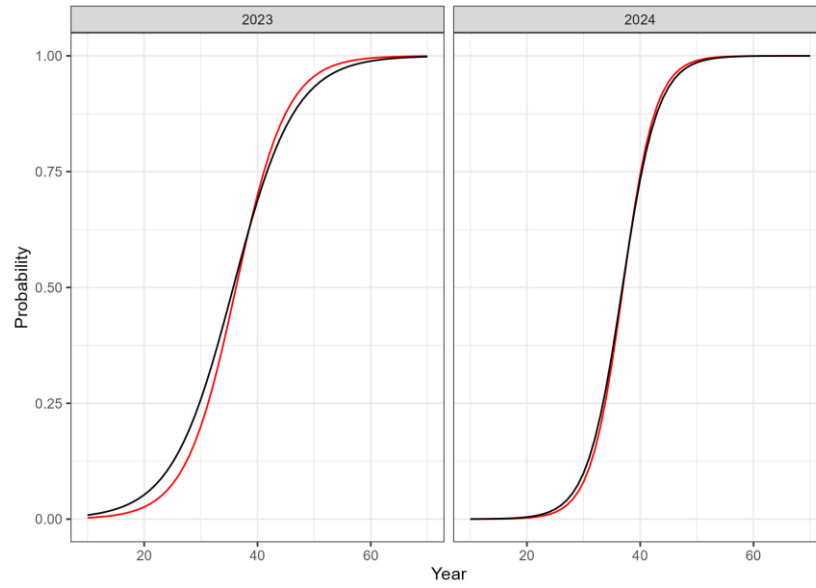


Figure 63. Comparison of the maturity ogives in 2023 and 2024 estimated for females with the mixed effect model (black) and with the same model but adding individuals of less than 22 cm in the nGSL survey assuming a balanced sex ratio and that they are 100% immature (red).

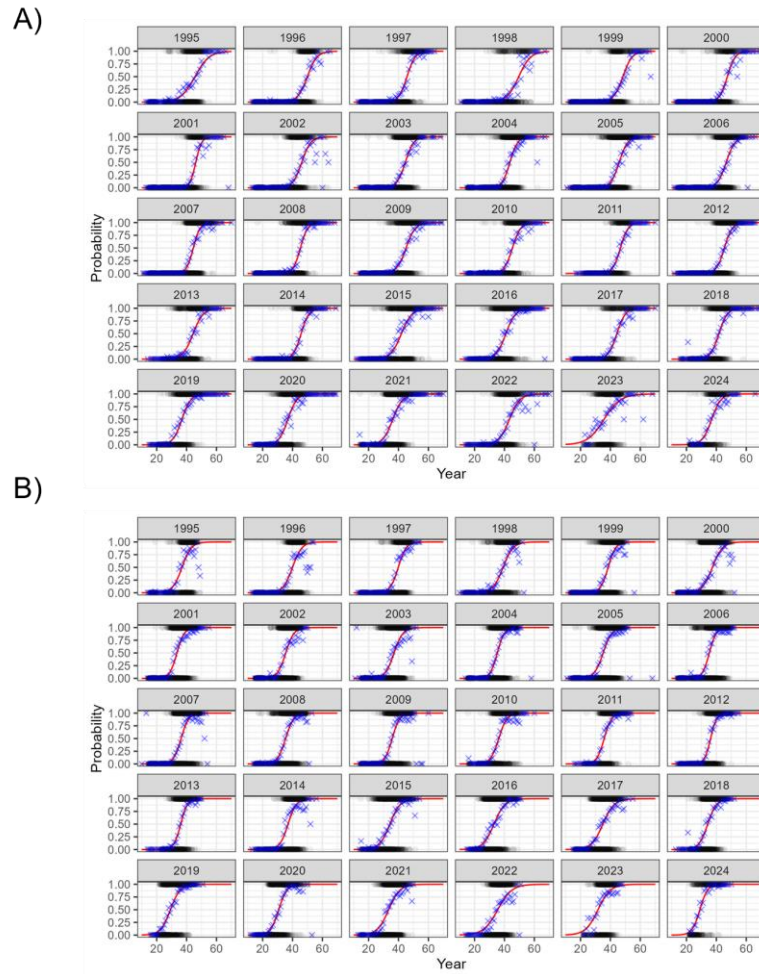


Figure 64. Mixed effect model predicted values (red lines), average proportion mature at length (blue crosses) and observations (gray points) for females (A) and males (B).

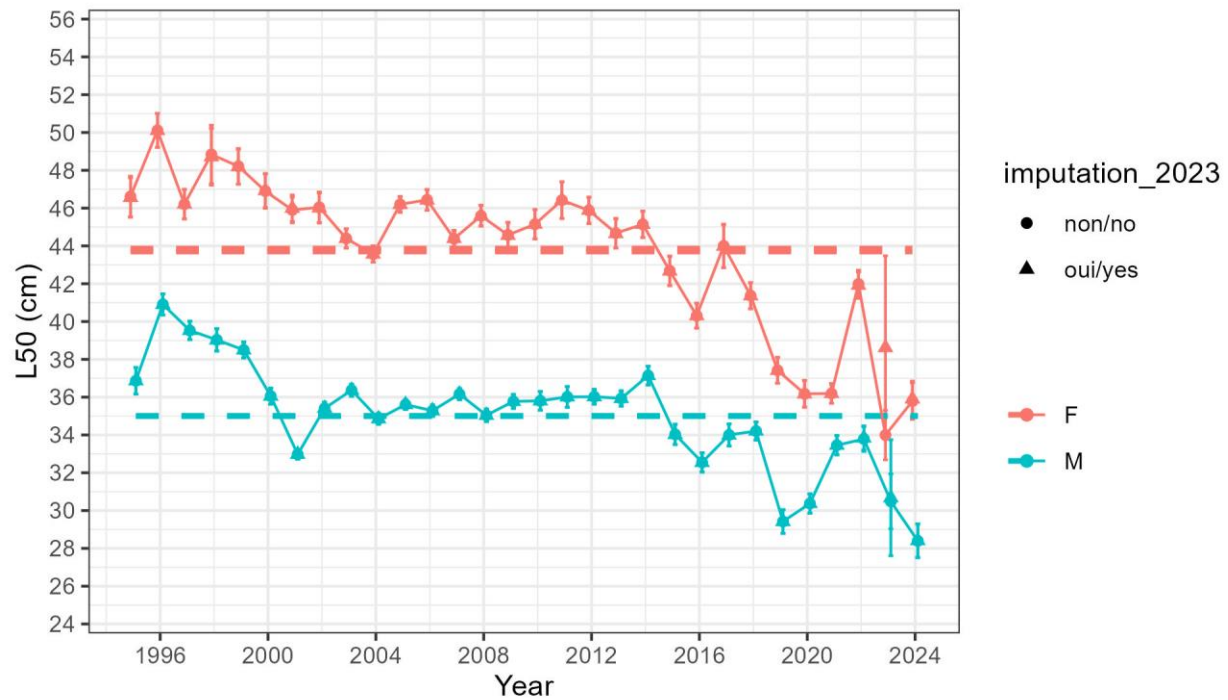


Figure 65. Length at which 50% of female and male fish are sexually mature (L_{50}), calculated using the mixed model including (circles) or excluding (triangles) the 2023 data.

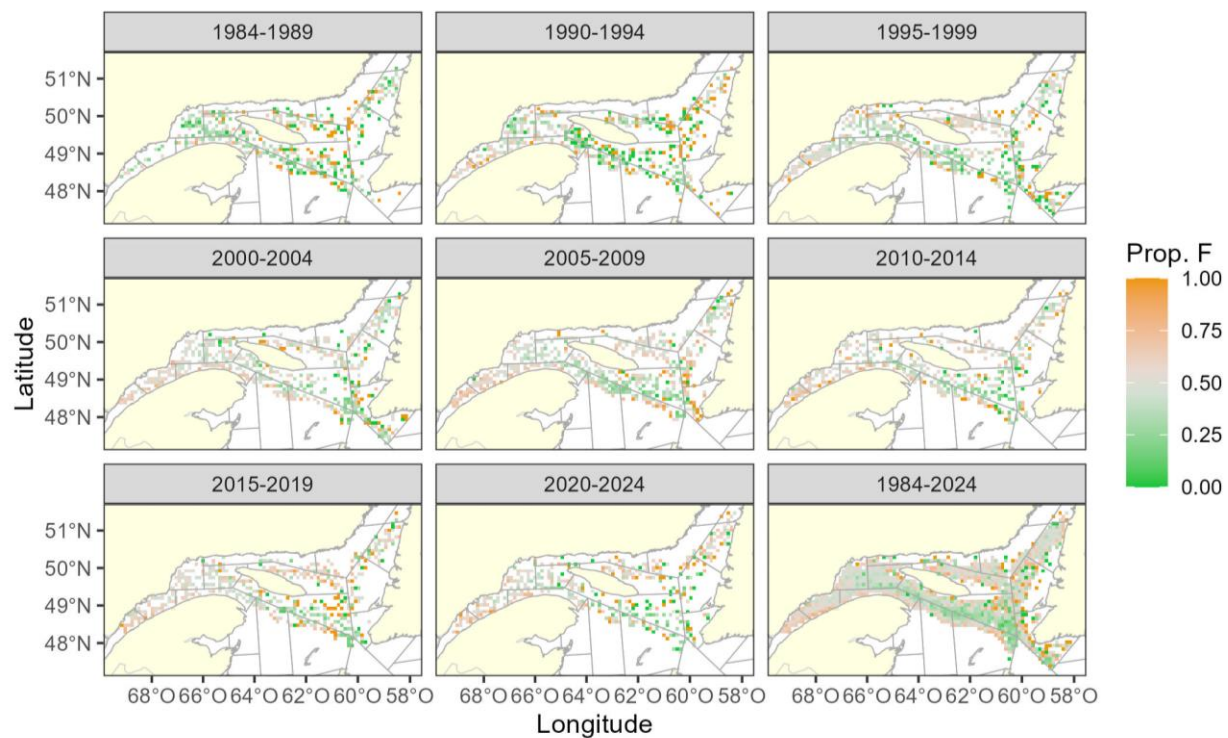


Figure 66. Spatial distribution of the sex ratio in the nGSL survey by period and for the entire series (1984-2024). The proportion of females (Prop. F) was calculated excluding individuals of undetermined sex.

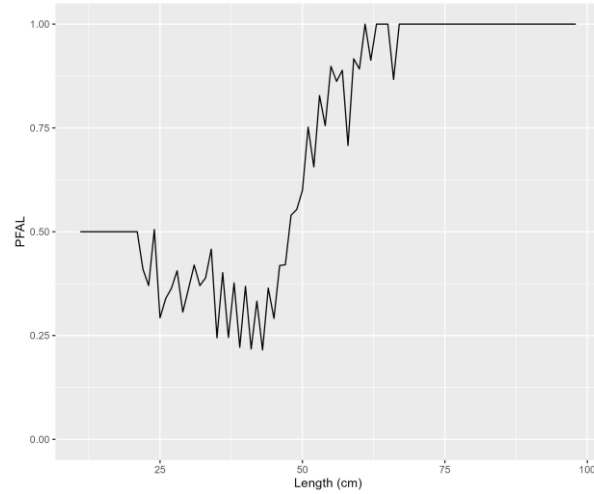


Figure 67. Average female proportion at length (PFAL) for the 1986-1989 period used to impute values in 1984 and 1985 in the calculation of mature female biomass.

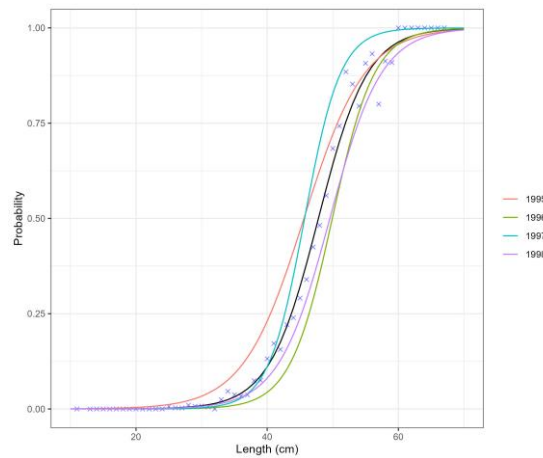


Figure 68. Mean maturity ogives for females from 1995 to 1998 (black line), annual ogives 1995-1998 and mean proportions mature observed for these same years (blue x) in the nGSL survey. The mean ogive 1995-1998 was used to impute maturities at length for the years 1984-1994 in the calculation of mature female biomass.

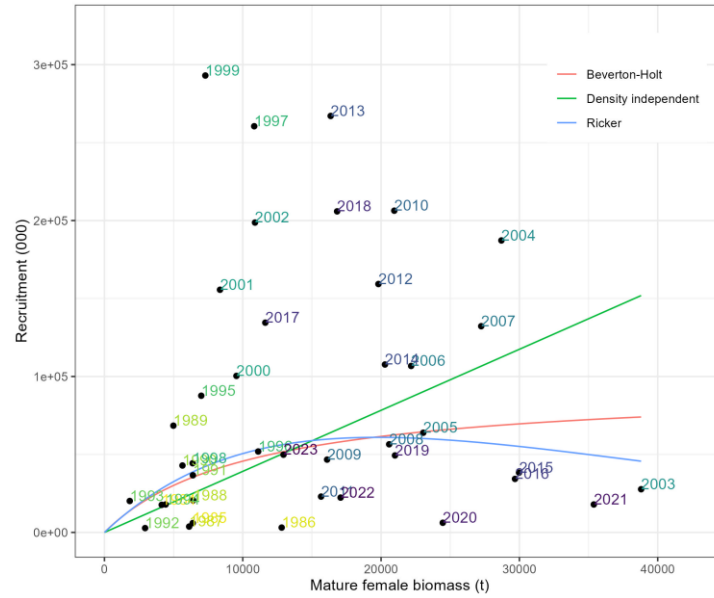


Figure 69. Relationship between mature female biomass and recruitment (thousand of 1 year old individuals) estimated in the nGSL survey. The predictions of the density independent, Beverton-Holt and Ricker models are presented as lines. Years represent cohort years.

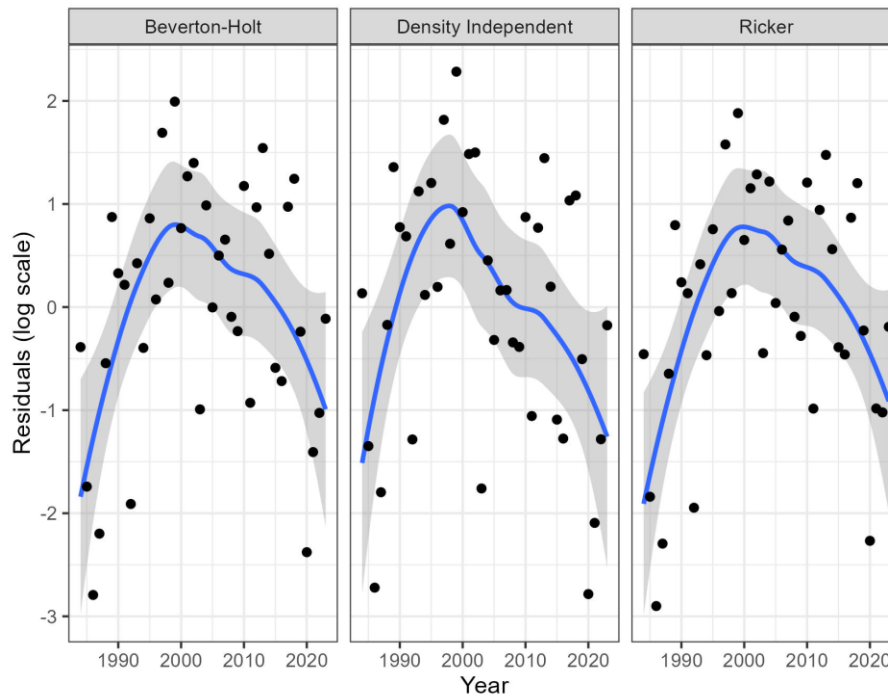


Figure 70. Residuals of the stock-recruitment relationships (log scale) as a function of year. The blue lines represent a cubic smoothing function of year and associated 95% confidence interval.

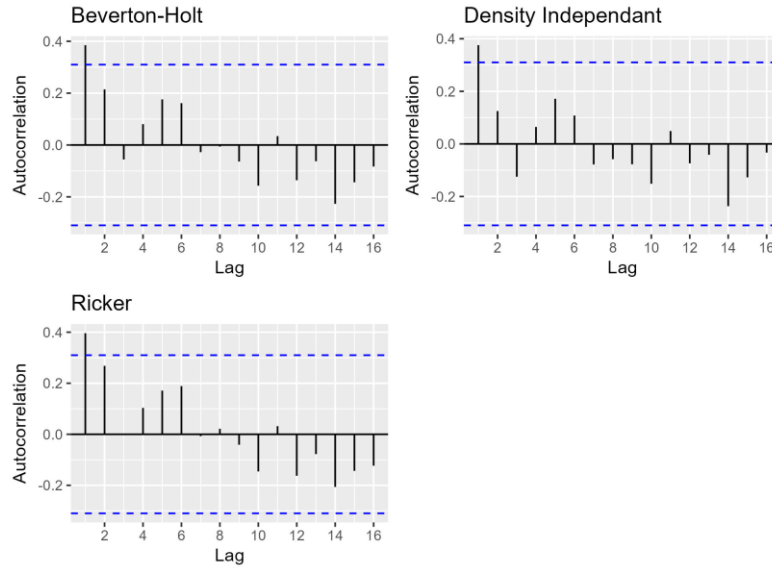


Figure 71. Temporal autocorrelation in the residuals of stock–recruitment relationships for different time lags (in years).

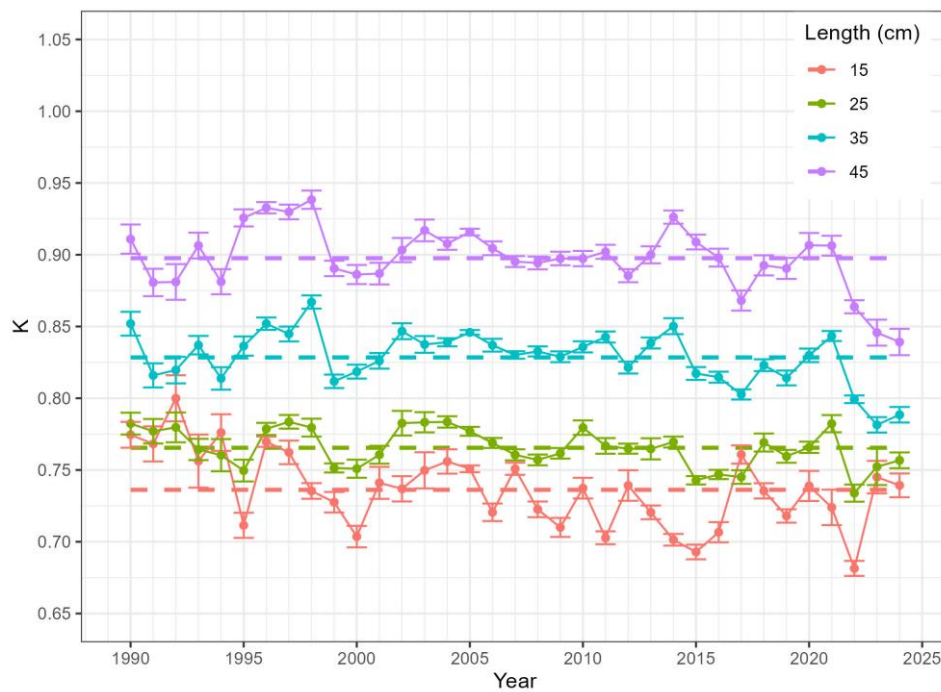


Figure 72. Annual Fulton condition index for 15, 25, 35 and, 45 cm Greenland halibut based on the DFO nGSL survey data. Dotted lines represent time series averages.

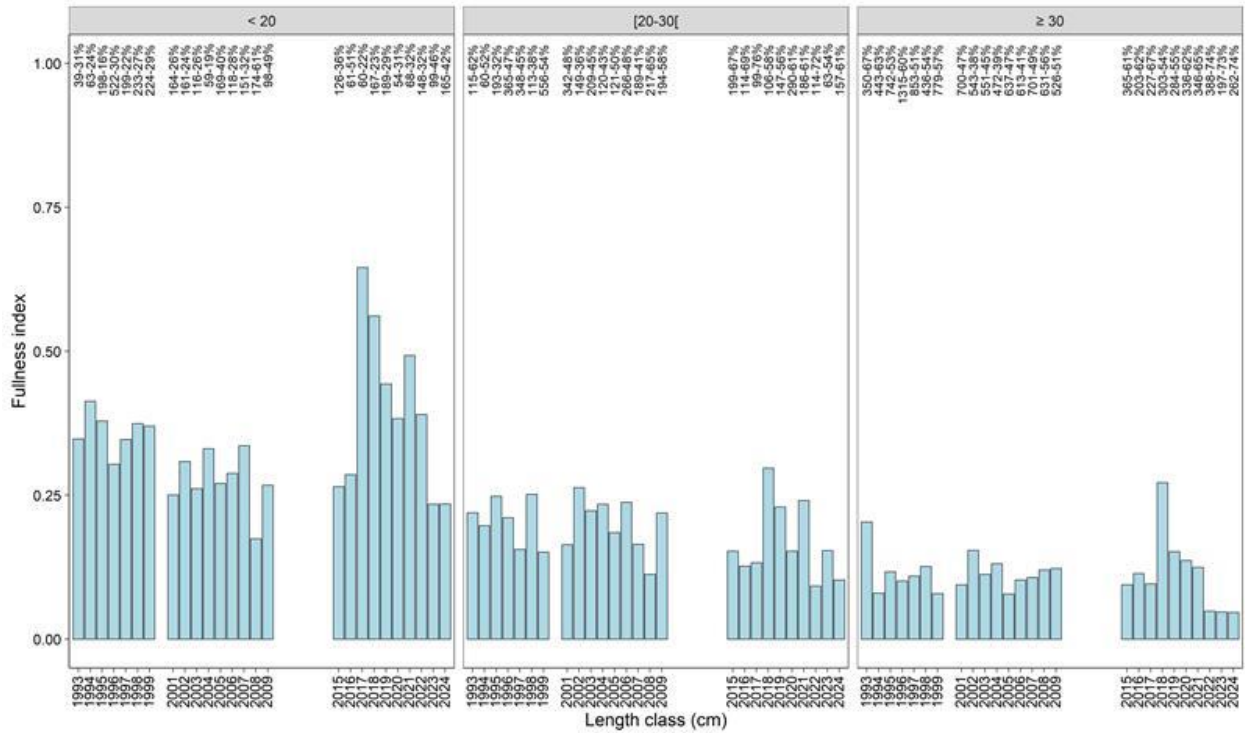


Figure 73. Greenland halibut total stomach fullness indices by year and size classes. Values above the bars represent the number of stomachs and the percentage of empty stomachs.

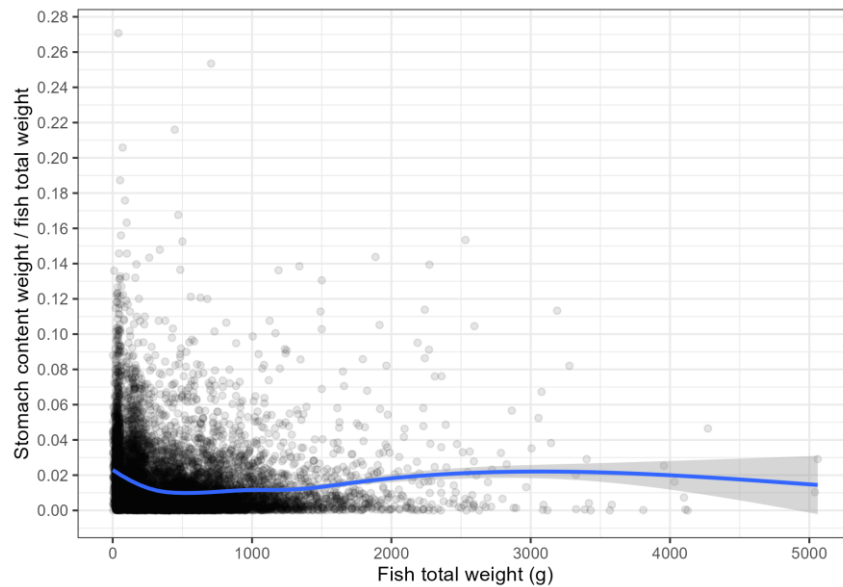


Figure 74. Proportion Greenland halibut total weight represented by the stomach content in relation with individual total weight. Individuals whose stomach contained no prey were not considered. The blue line represents a cubic smoothing function.

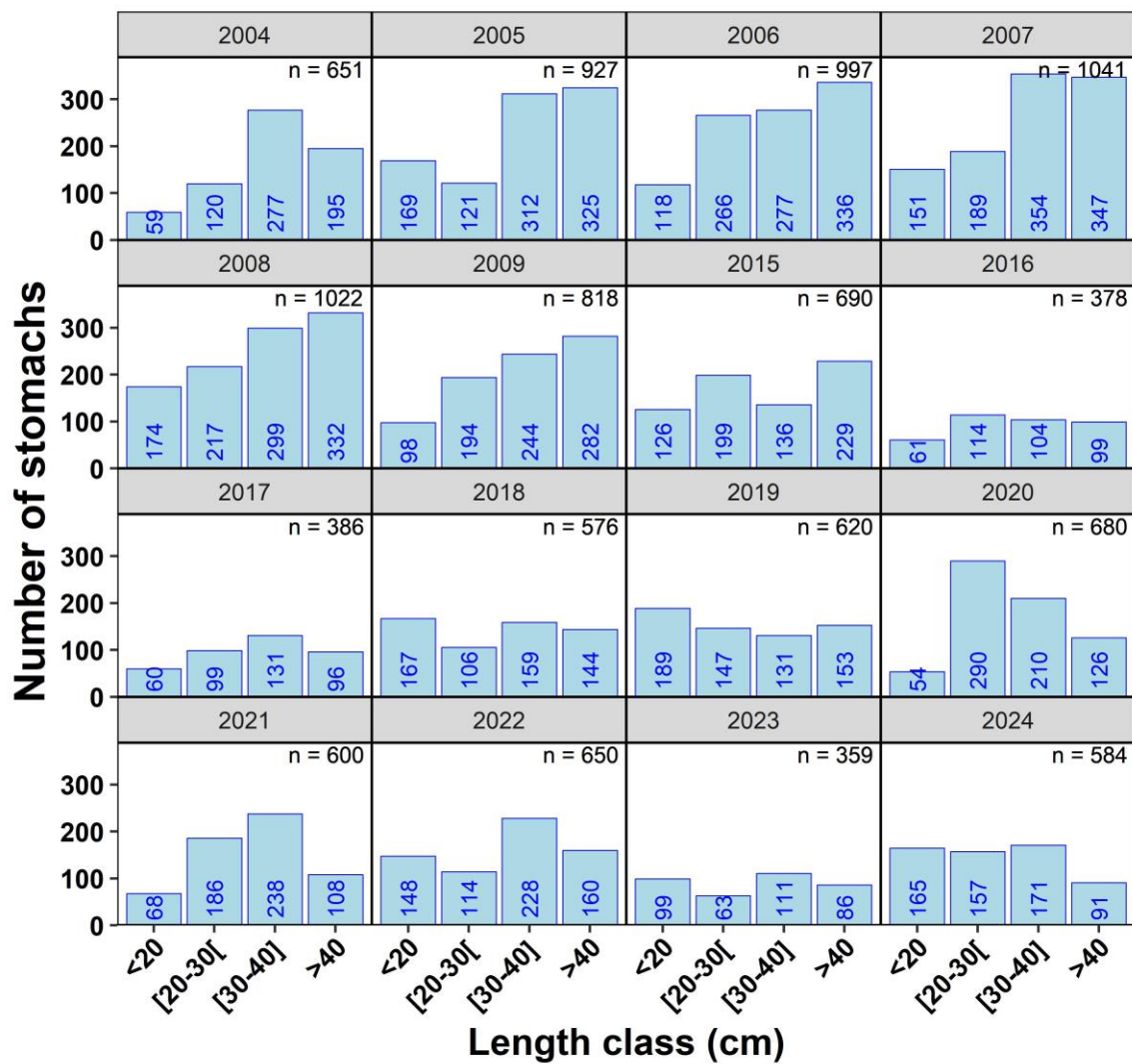


Figure 75. Number of Greenland halibut stomachs sampled by length class and year. The 'n' in the upper right corner of each panel indicates the total number for that year.

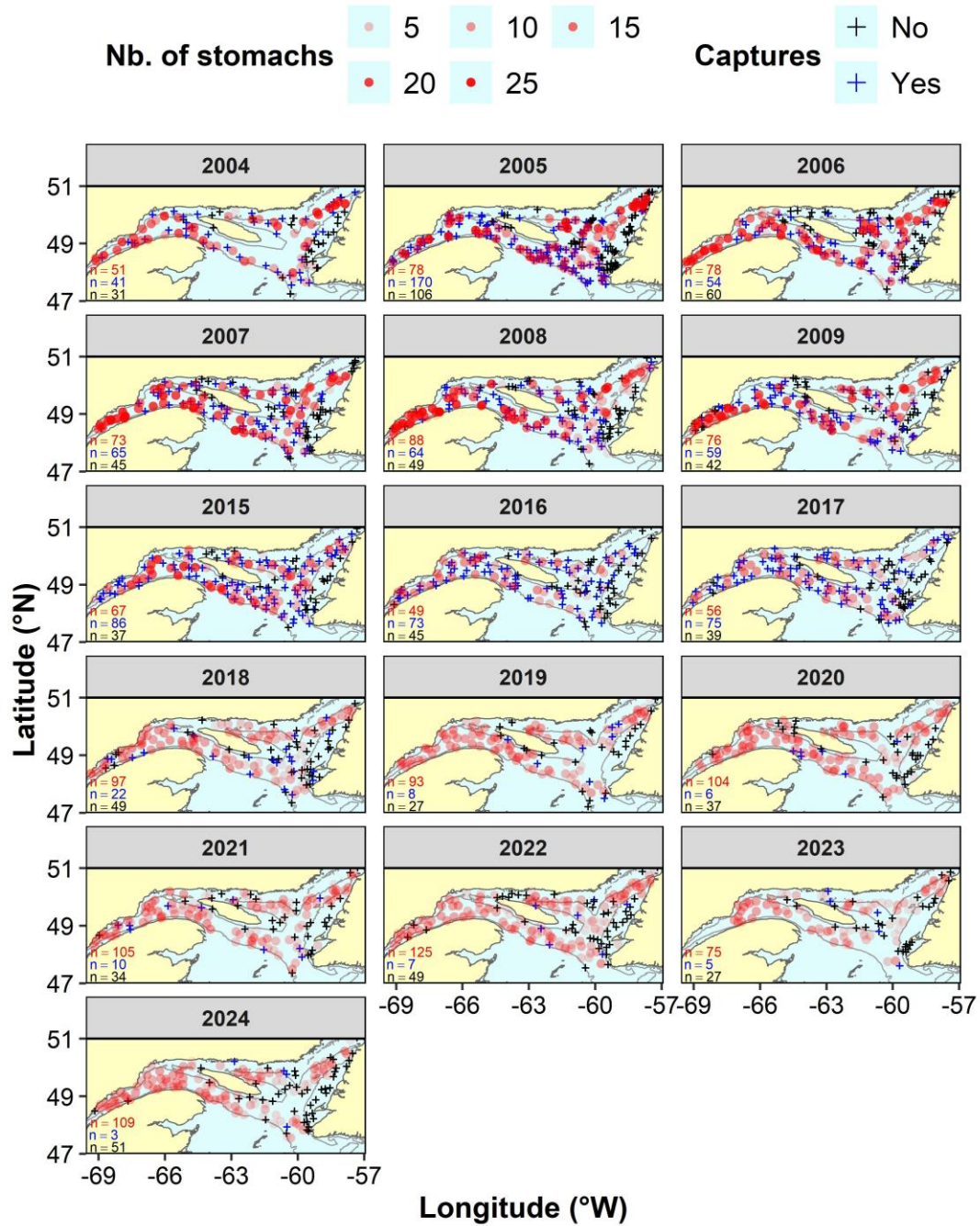


Figure 76. Location of Greenland halibut stomachs retained for analysis by year of capture. The dots on the map reflect the number of stomachs available for analysis. The black and blue crosses are respectively the tows where no Greenland halibut were caught and where no stomachs were harvested despite catches. The numbers for each type of tow are provided in the lower left corners of each year.

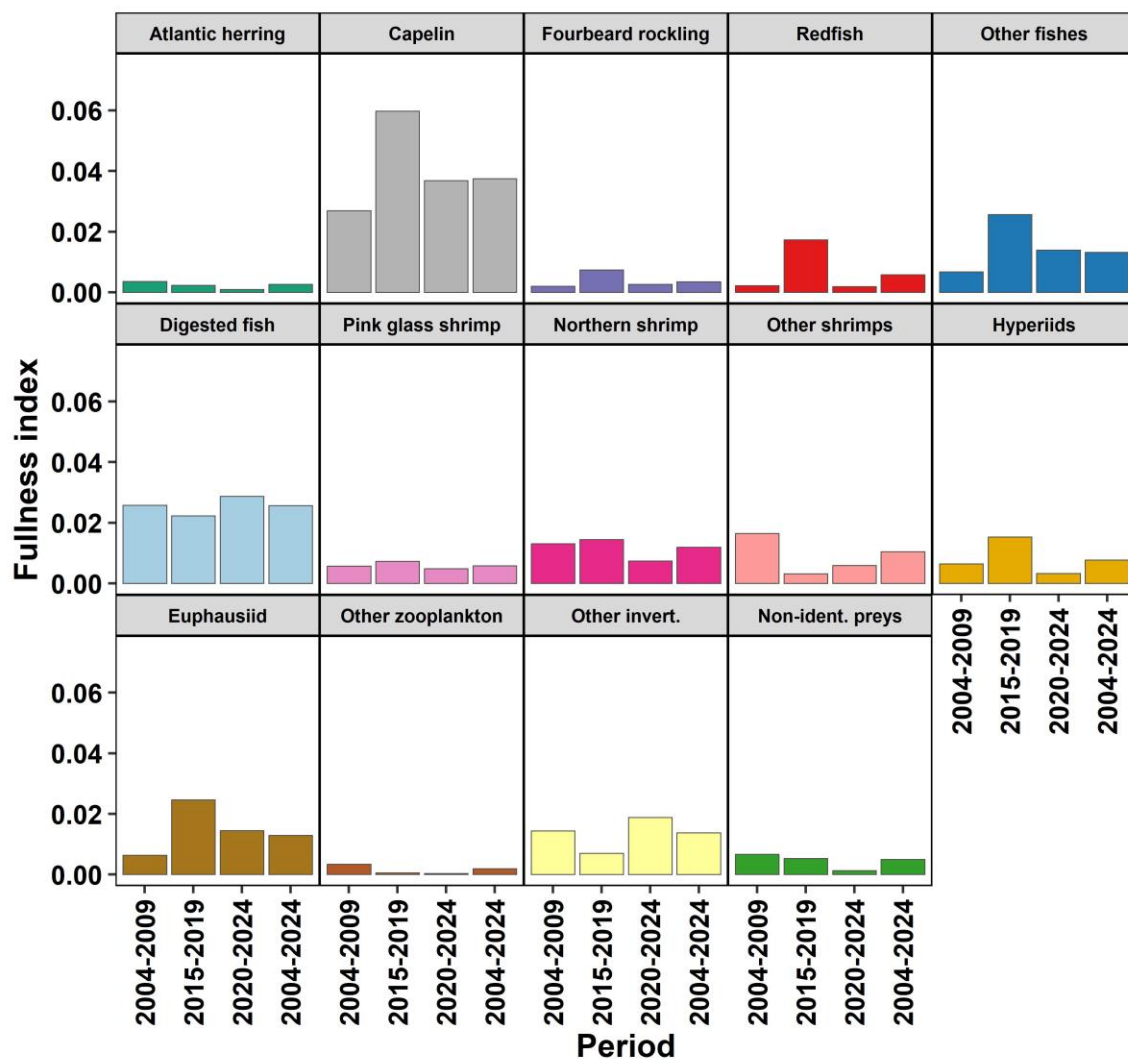


Figure 77. Fullness index of Greenland halibut stomachs by period considered, broken down by prey group. No stomachs are available for the period 2010-2014. The values above the bars are the sample size and percentage of empty stomachs.

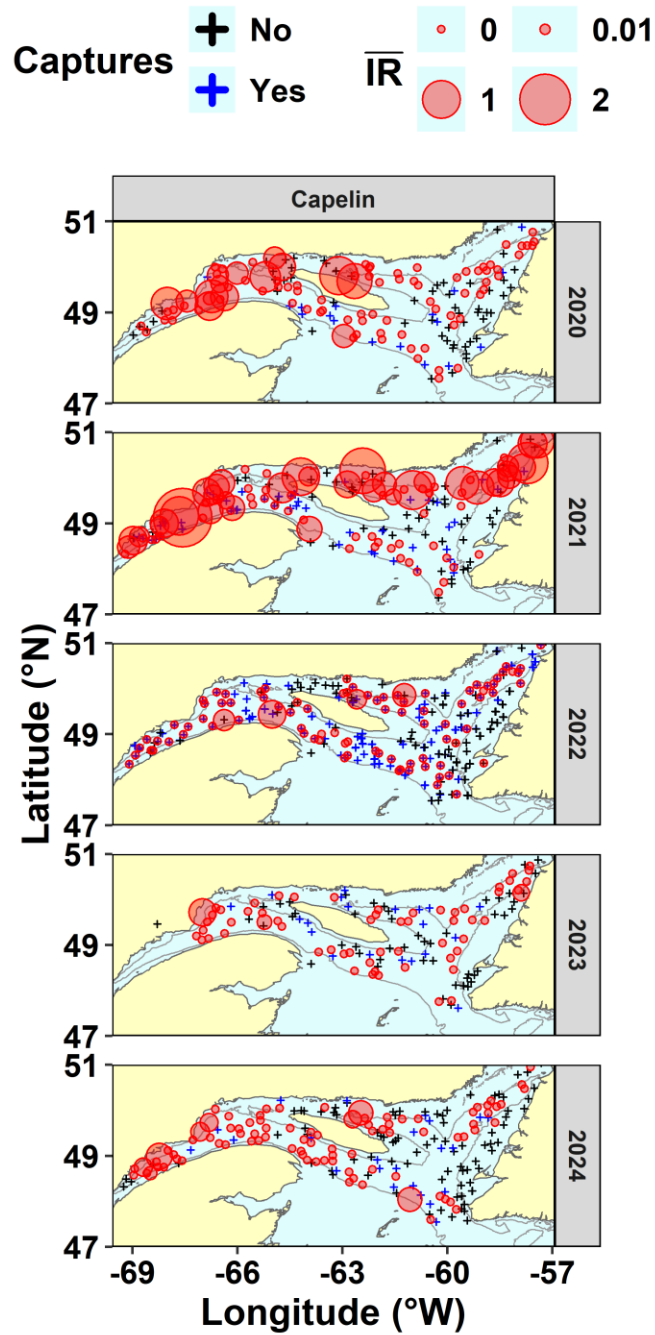


Figure 78. Average fullness index per tow in capelin for the years 2020-2024. Stomachs from Greenland halibut of all sizes were selected. Black and blue crosses are respectively the tows where no Greenland halibut were caught and where no stomachs were harvested although captures have been made.

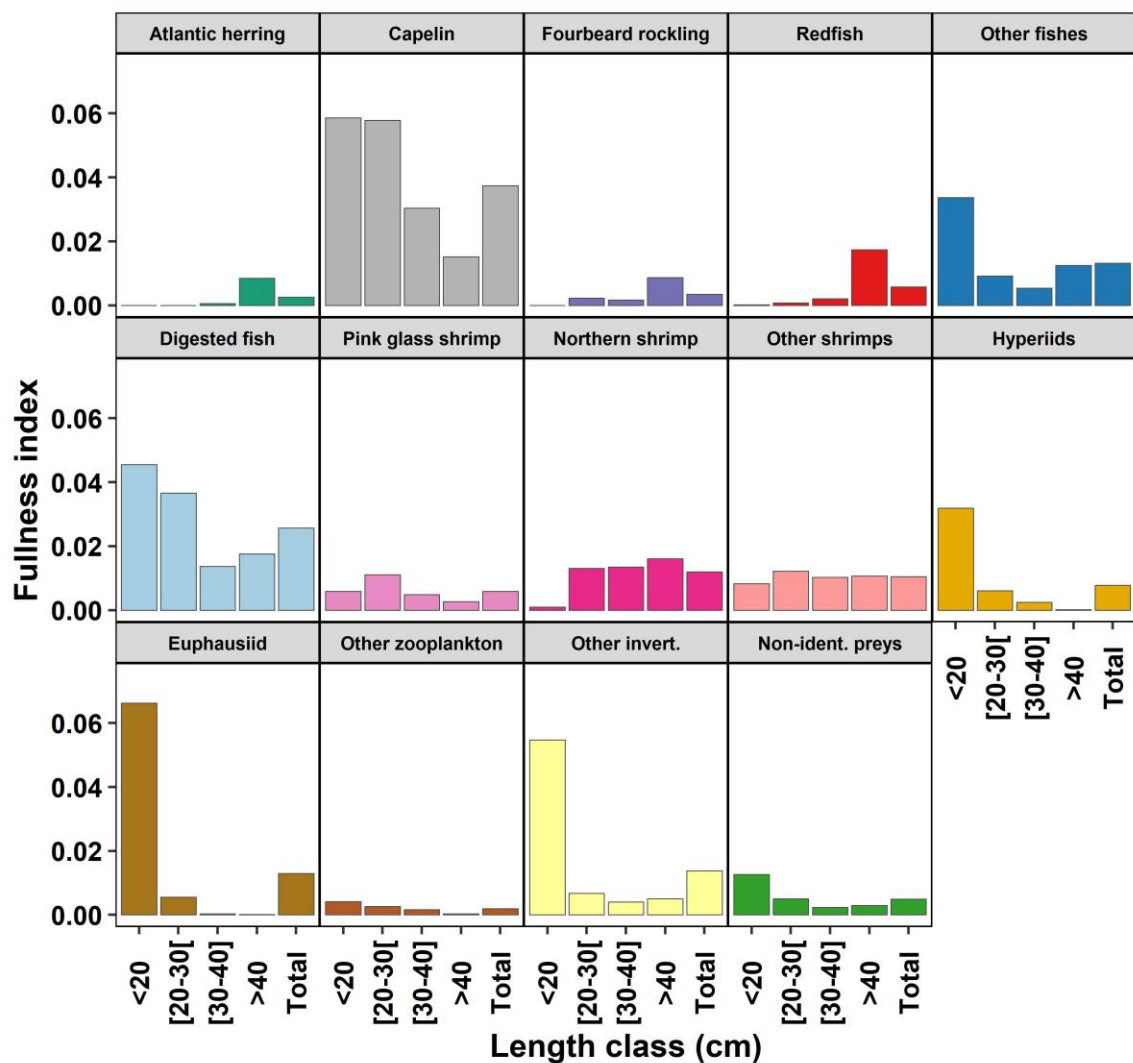


Figure 79. Fullness index of Greenland halibut stomach by length class, broken down by prey group and for all selected years (2004-2024). No stomachs are available for the period 2010-2014.

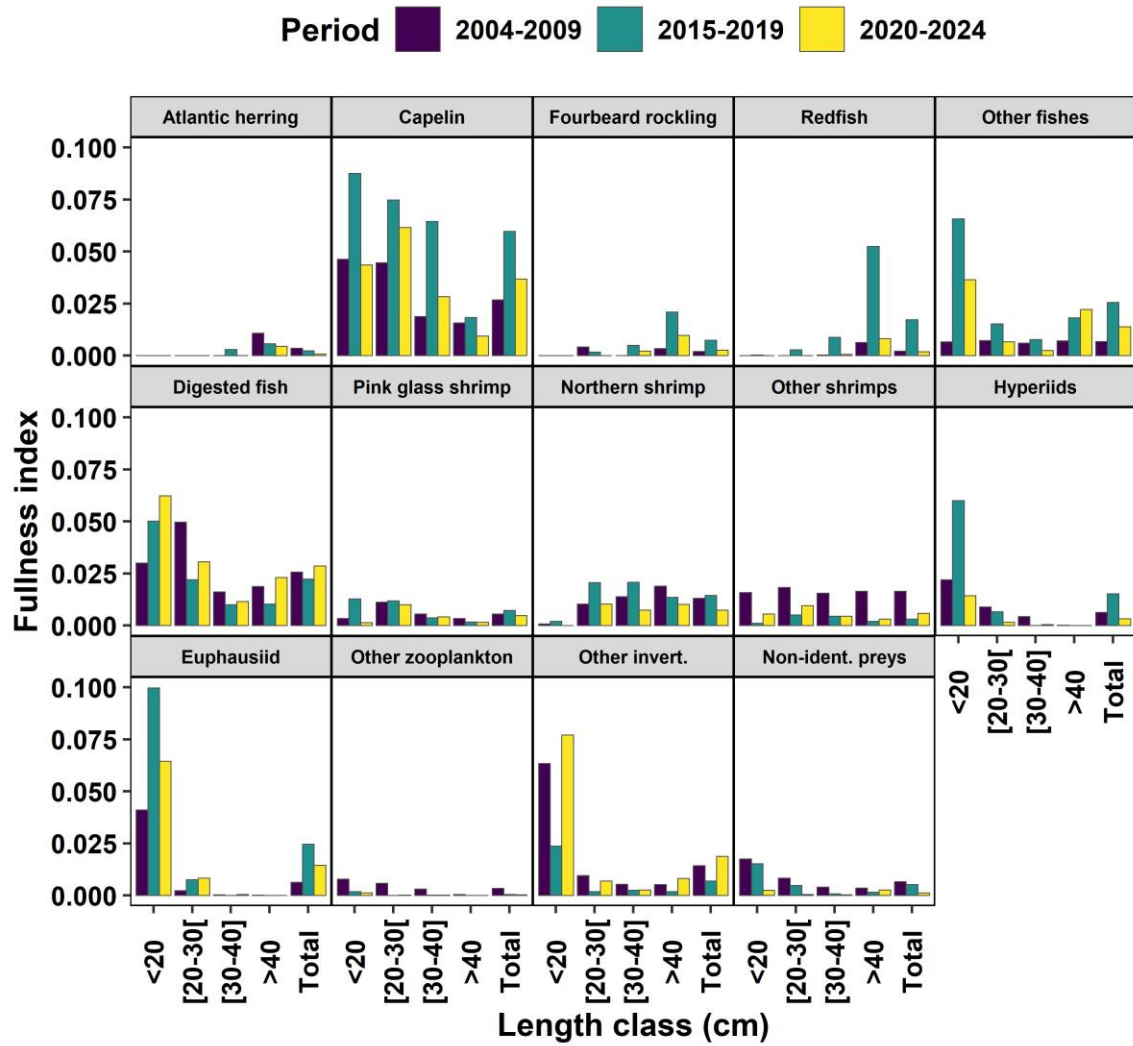


Figure 80. Fullness index of Greenland halibut stomach by length class or for all lengths (Total), broken down by prey group and time period.

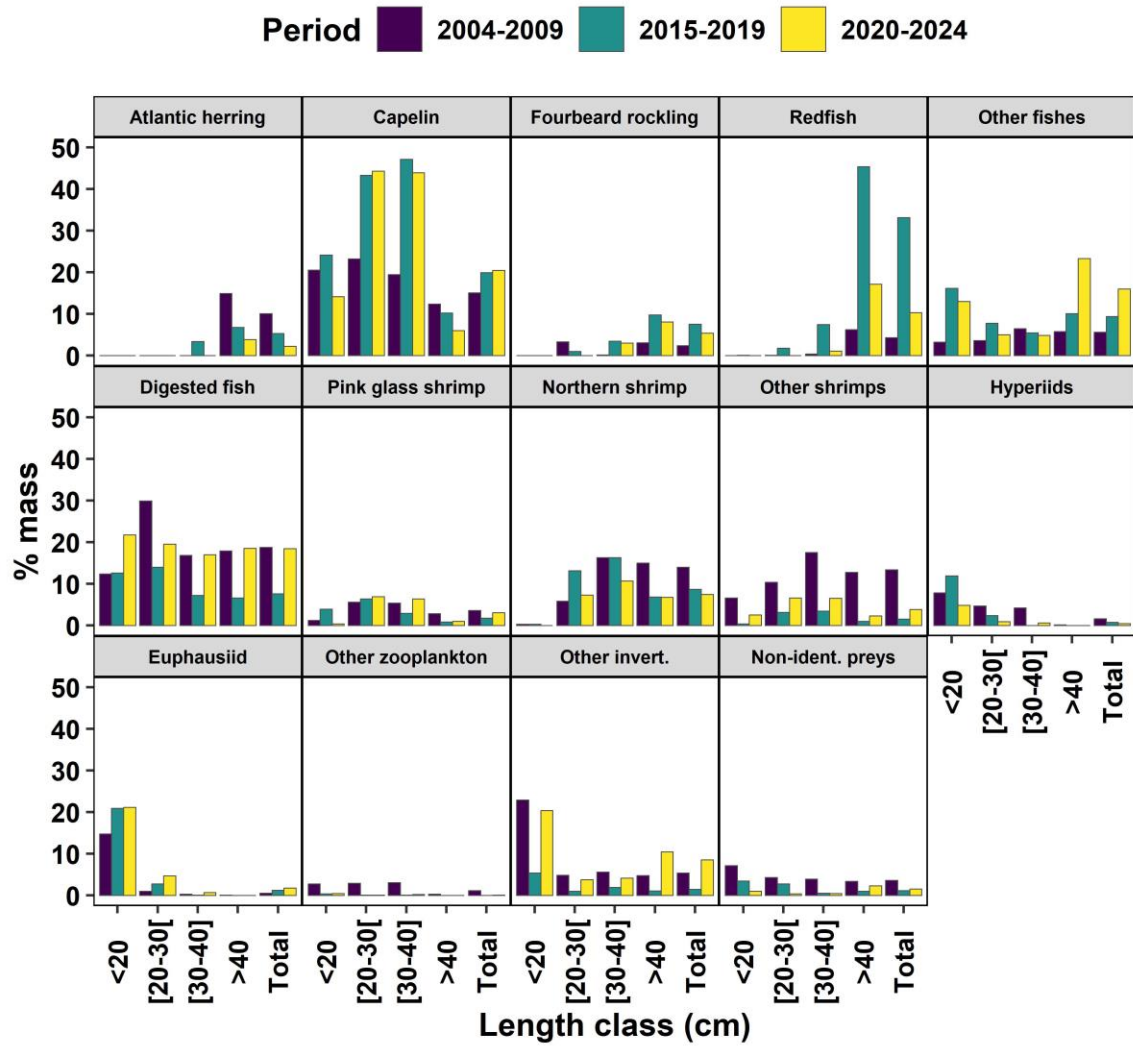


Figure 81. Percentage of mass of stomach contents of Greenland halibut by length class or for all lengths (Total), broken down by prey group and time period.

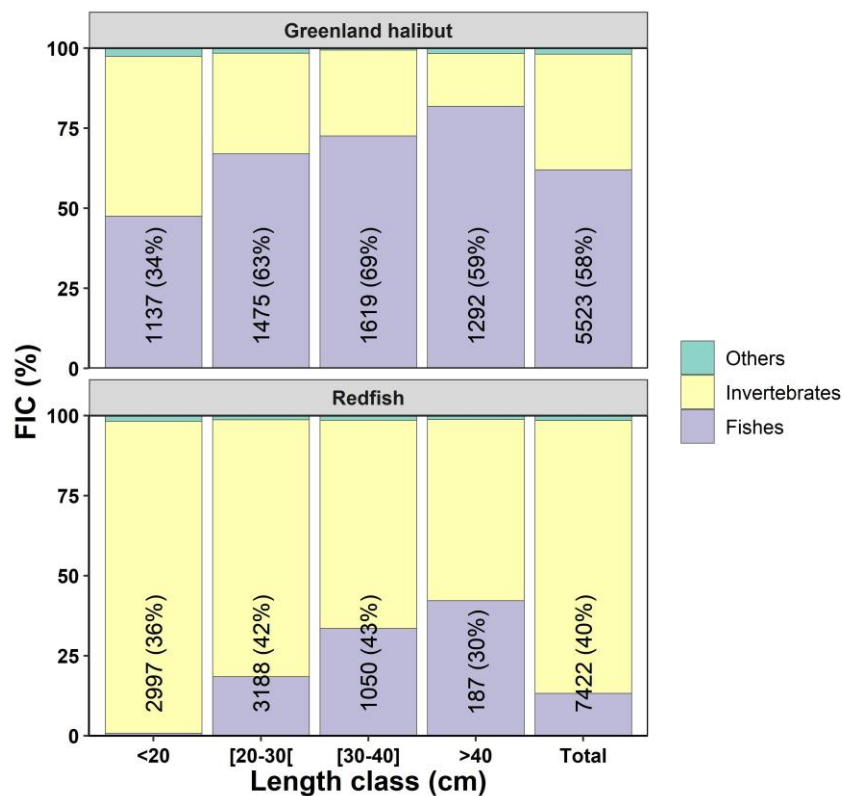


Figure 82. Contribution to the fullness index of major prey classes for the period 2015-2024, by predator, Greenland halibut and redfish, and length class or for all lengths (Total). The values in the bars are the number of stomach and percentage of empty stomachs.

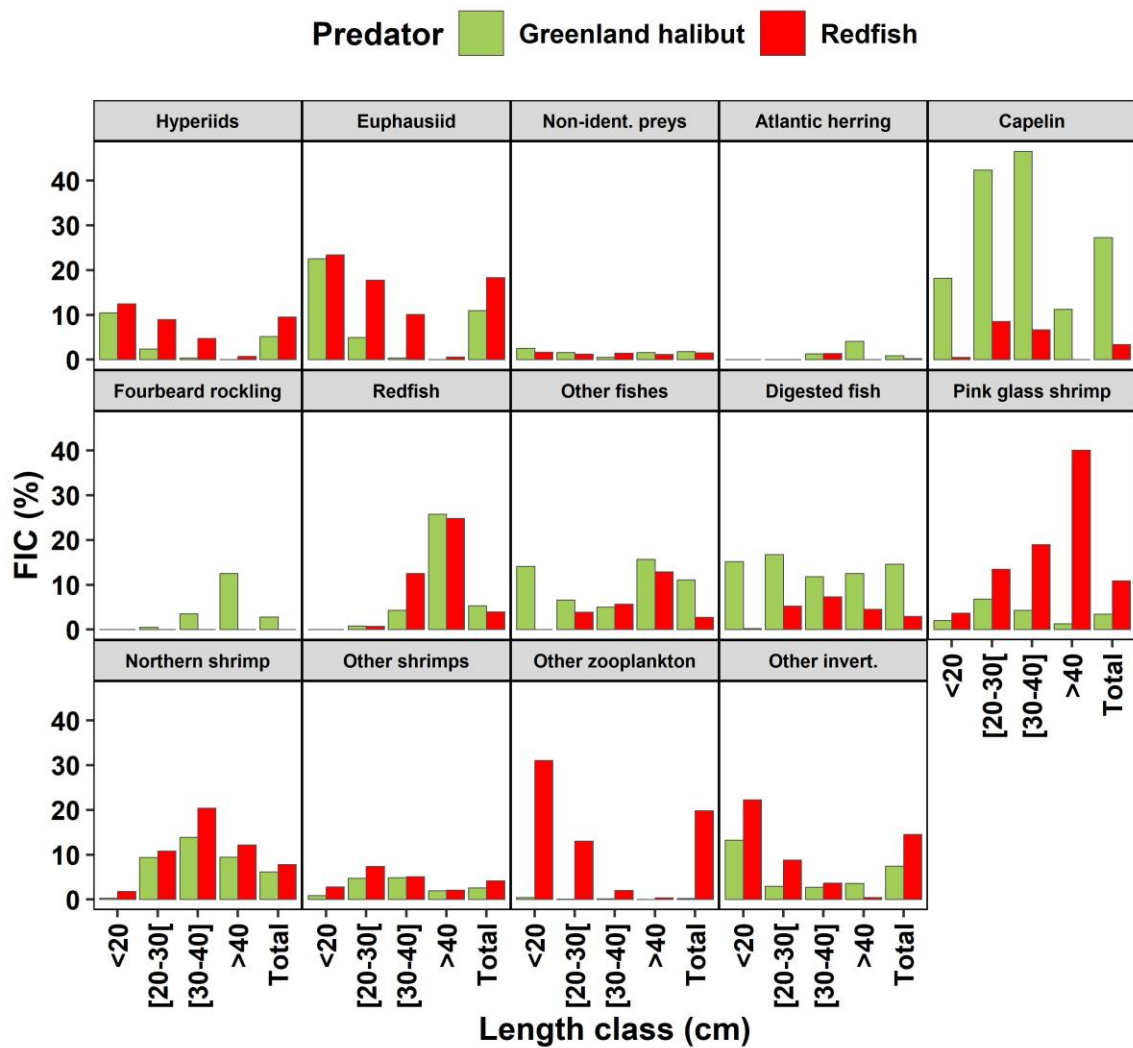


Figure 83. Contribution to the fullness index (CFI) of different taxonomic groupings for Greenland halibut and redfish during the 2015–2024 period, broken down by length class.

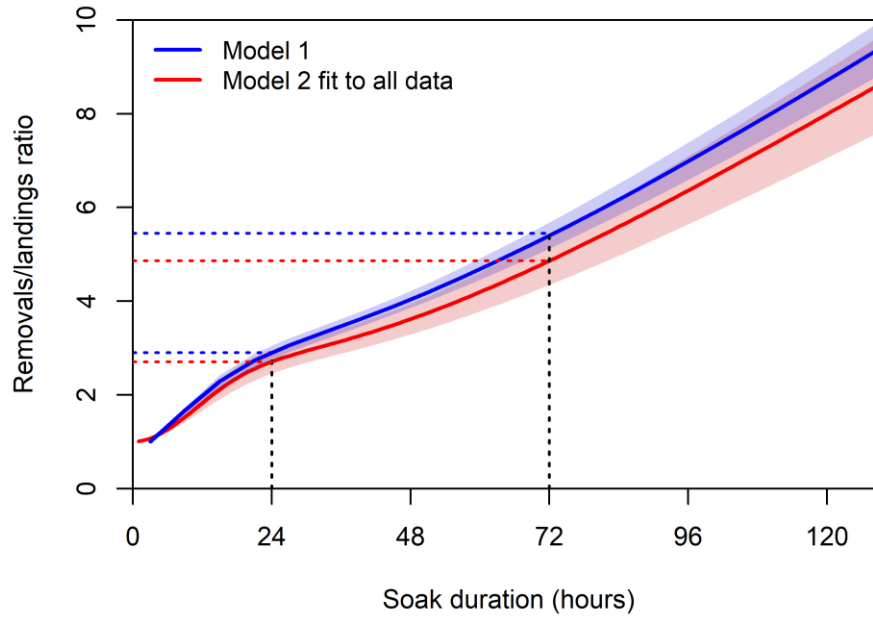


Figure 84. Estimated removals/landings ratio with associated standard error (lines and shaded areas), as a function of soak duration for Model 1 and Model 2 fit to all data. The removals/landings ratio expresses the total removals, drop-out losses and landings, as a function of landings.

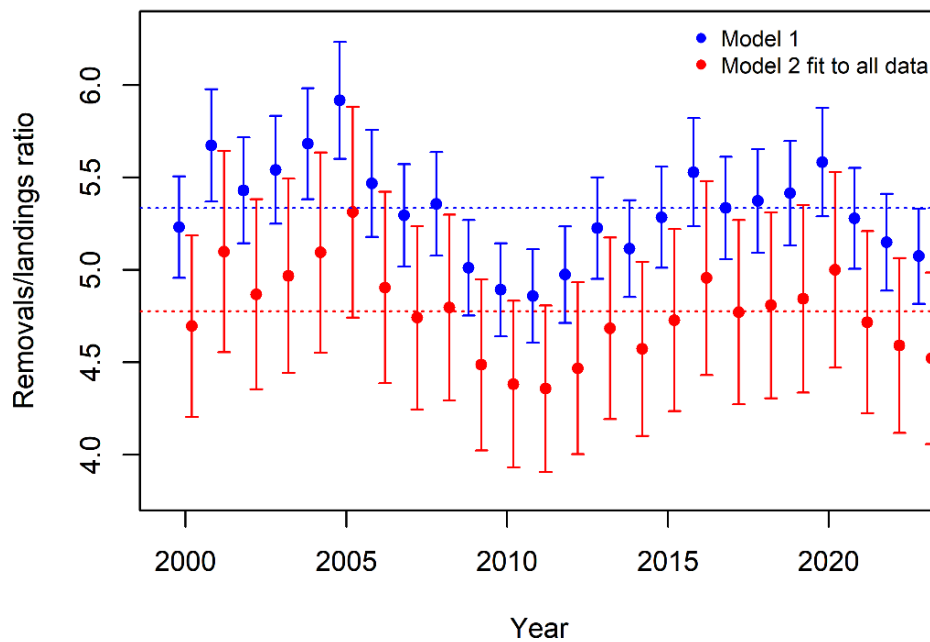


Figure 85. Mean annual removals/landings ratio (with S.E.), estimated from two independent modelling approaches. Model 1 was fitted only to catch and effort data, while Model 2 was fitted primarily to catch status data from experiments and at-sea observers. The removals/landings ratio expresses the total removals, drop-out losses and landings, as a function of landings. The dashed horizontal lines indicate the mean for 2000-2024.

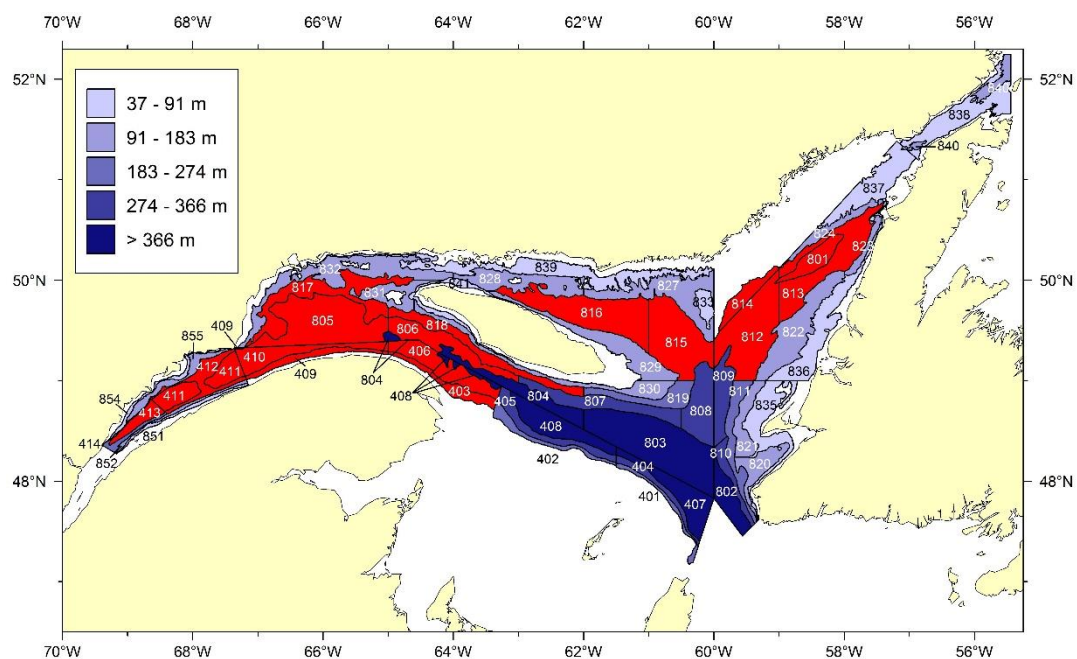


Figure 86. Identification of nGSL DFO survey strata corresponding to the commercial fishing sectors (Western Gulf (403, 406, 409, 410, 411, 412, 413, 805, 806, 817, 818), North Anticosti (815, 816) and, Esquiman (801, 812, 813, 814)).

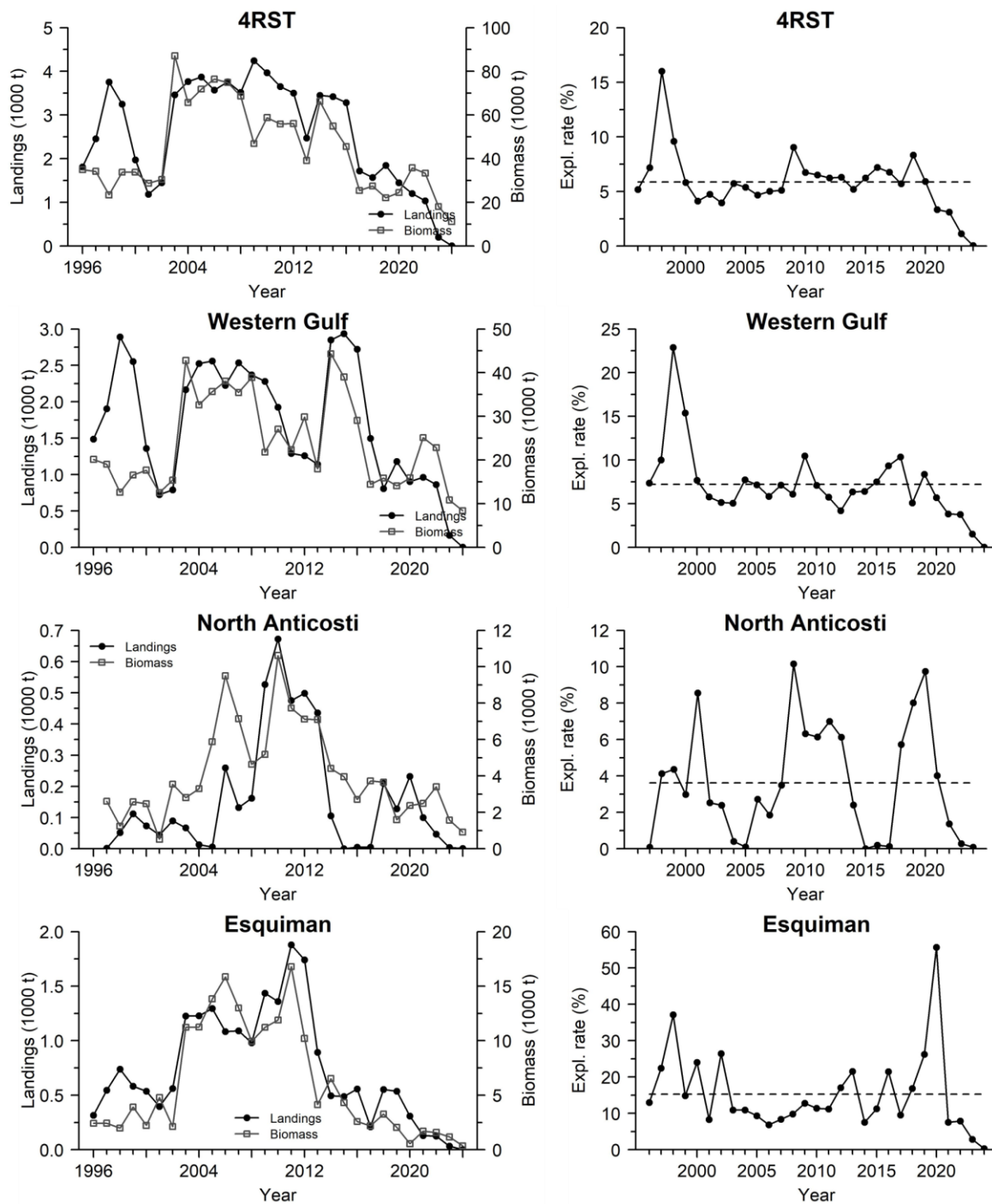


Figure 87. Annual landings and biomass of Greenland halibut >40 cm (Teleost equivalent) and relative exploitation rate (Expl. Rate (%)) for the entire Gulf (4RST) and by fishing sector.

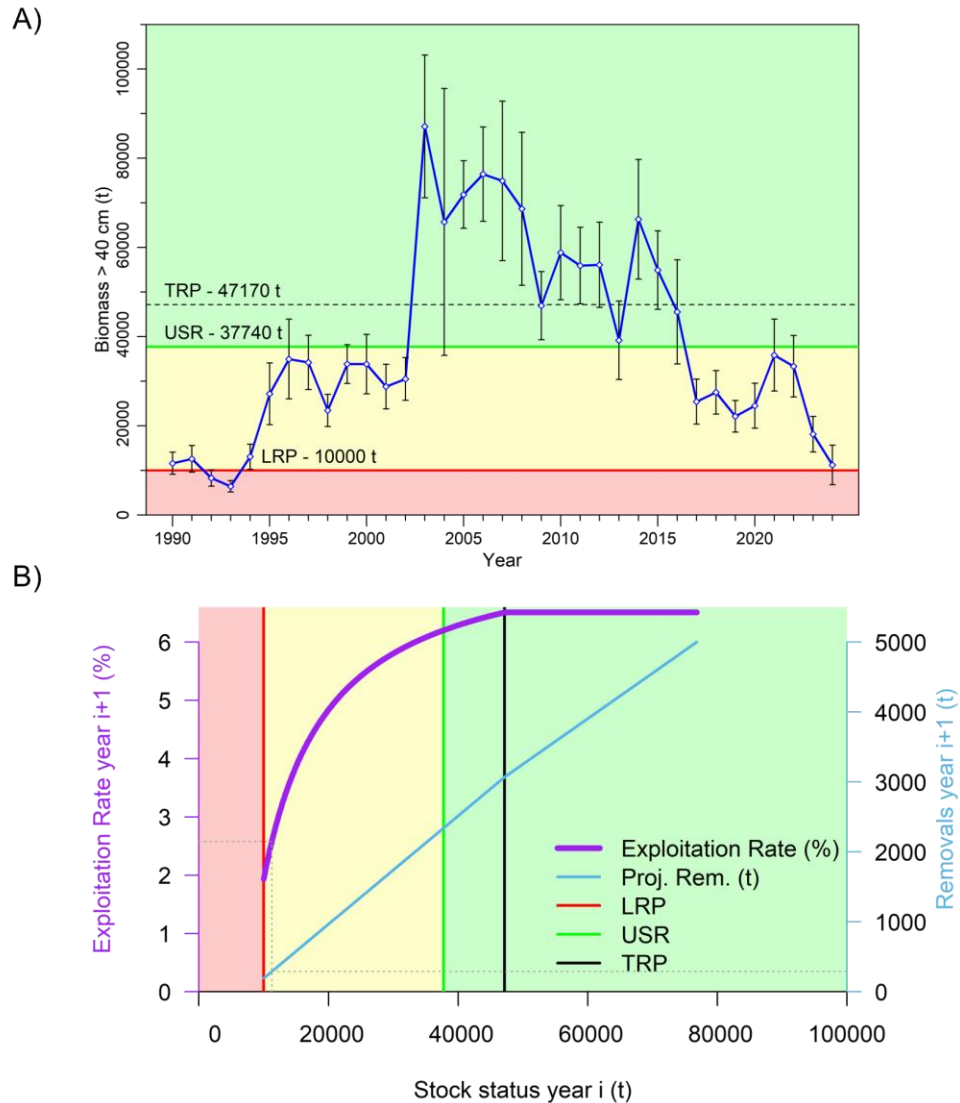


Figure 88. A) Greenland halibut biomass index >40 cm estimated from nGSL survey. The red horizontal line identifies the limit reference point (LRP) that delineates the critical (red) and cautious (yellow) zones. The horizontal green line is the upper stock reference point (USR) that delineates the cautious and healthy (green) zones. The black line indicates the target reference point (TRP). Error bars indicate the 95% confidence interval. B) Harvest control rule in terms of projected exploitation rate (purple) and removals (blue). The grey dotted lines indicate the projected removal and exploitation rates for the next seasons.

11. APPENDICES

11.1. ABUNDANCE AND BIOMASS INDICES OF THE MAIN PREY OF GREENLAND HALIBUT

This section presents the capelin abundance index and the Northern Shrimp and Pink Glass Shrimp biomass indices calculated from the data of the nGSL survey (Figure A1 to Figure A3). The capelin index was estimated using a negative binomial first order autoregressive model described in Chamberland et al. (2022) and the Pink Glass Shrimp and Northern Shrimp biomass indices using the standard estimator of the stratified mean.

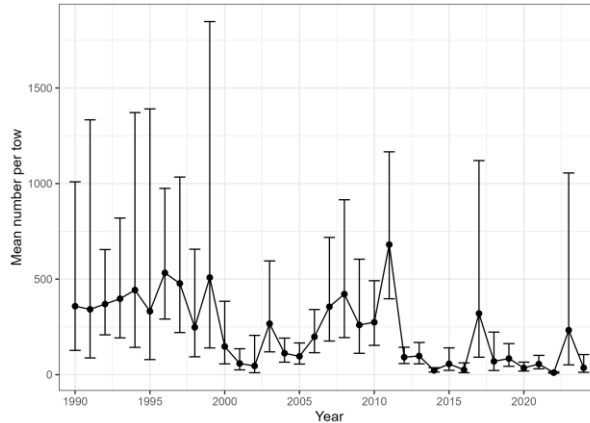


Figure A1: Capelin abundance index for the northern Gulf of St. Lawrence survey estimated using the negative binomial AR(1) model (Chamberland et al. 2022) on all strata that have been part of the sampling plan since 1990.

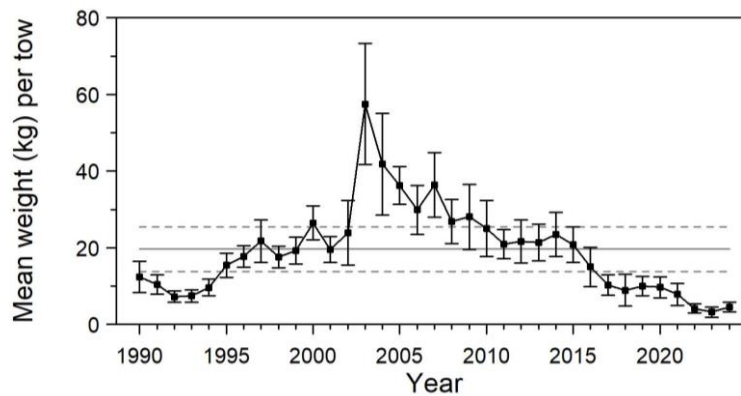


Figure A2. Northern Shrimp mean weight per 15 minute tow in the nGSL survey. The error bars indicate the 95% confidence interval of the standard estimator of the stratified mean and the horizontal lines indicate the average for the period 1990-2023 (solid line). Figure taken from Chamberland et al. (2025).

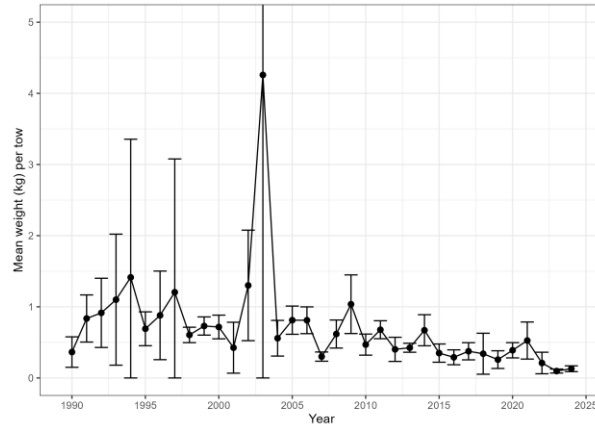


Figure A3. Pink Glass Shrimp mean weight per 15 minute tow in the nGSL survey. The error bars indicate the 95% confidence interval of the standard estimator of the stratified mean. Data presented in Chamberland et al. (2025).

11.2. GREENLAND HALIBUT DIET

Table A19. Number of Greenland halibut stomachs according to the different period investigated. Information on the size of the fish from which the stomachs were obtained as well as information on the total stomach contents after removal of waste, parasites, and empty stomachs are provided.

Parameter		2004-2009	2015-2019	2020-2024	Total
	Nb. of stomachs	5456	2650	2873	10979
	Nb. of empty stomachs	2589	1434	1763	5786
	% d'estomacs vides	47.5	54.1	61.4	52.7
	TFI*	0.14	0.21	0.14	0.16
Length (mm)	Min	56	63	45	45
	Median	354	309	315	336
	Mean	344.6	319	314.4	330.5
	Max	700	767	752	767
Total stomach content (g)	Min	0.002	0.001	0.002	0.001
	Median	1.47	1.49	1.09	1.38
	Mean	5.1	7.12	4.84	5.52
	Max	363.23	316.92	192.31	363.23

*TFI = Total fullness index

Table A20. Summary of the sampling effort for Greenland halibut stomachs according to the different length classes considered in the study. A description of the length of the fish from which the stomachs were obtained is provided as well as the weight of the total stomach contents after removal of waste, parasites, and empty stomachs.

Parameter		<20	[20-30[	[30-40]	>40	Total
	Nb. of stomachs	1906	2582	3382	3109	10979
	Nb. of empty stomachs	700	1506	1974	1606	5786
	% of empty stomachs	36.7	58.3	58.4	51.7	52.7
	TFI*	0.32	0.17	0.09	0.12	0.16
Length (mm)	Min	45	200	300	401	45
	Median	170	262	357	449	336
	Mean	166.6	259.3	354	464.7	330.5
	Max	199	299	400	767	767
Total stomach content (g)	Min	0.001	0.002	0.001	0.002	0.001
	Median	0.52	1.23	1.69	5.07	1.38
	Mean	0.82	2.69	4.05	12.68	5.52
	Max	9.203	185.282	61.805	363.23	363.23

*TFI = Total fullness index

Table A21. Diet of Greenland halibut in the Estuary and nGSL for the periods 2004-09, 2015-19, 2020-24 and, 2004-24. For each taxon found in the stomach contents, the frequency of occurrence (Focc), the contributions in mass (MC, as % of the mass of all taxa), and in fullness index (CTFI, as % of the TFI of all taxa) were calculated.

Prey	F _{occ}				MC				CTFI			
	2004-2009	2015-2019	2020-2024	2004-2024	2004-2009	2015-2019	2020-2024	2004-2024	2004-2009	2015-2019	2020-2024	2004-2024
Winter skate (<i>Leucoraja ocellata</i>)	<1	-	-	<1	0.05	-	-	0.02	0.11	-	-	0.05
Mud hagfish (<i>Myxine limosa</i>)	-	<1	<1	<1	-	1.1	4.33	1.14	-	0.26	0.99	0.32
Bony fish (Actinopterygii)	<1	-	-	<1	0.07	-	-	0.03	0.06	-	-	0.03
Herring (Clupeidae)	-	-	<1	<1	-	-	0.53	0.1	-	-	0.17	0.04
Atlantic herring (<i>Clupea harengus</i>)	<1	<1	<1	<1	10.09	5.33	2.28	7.19	2.58	1.09	0.64	1.64
Capelin (<i>Mallotus villosus</i>)	2.8	4.9	4	3.6	15.11	19.99	20.47	17.59	19.21	28.11	26.05	23.71
White barracudina (<i>Arctozenus risso</i>)	<1	<1	<1	<1	0.35	2.2	1.85	1.19	0.16	0.89	0.85	0.56
Threespine stickleback (<i>Gasterosteus aculeatus</i>)	-	<1	-	<1	-	0.01	-	<0.01	-	0.04	-	0.01
Codfish (Gadidae)	<1	<1	-	<1	0.1	<0.01	-	0.05	0.04	<0.01	-	0.02
Atlantic cod (<i>Gadus morhua</i>)	<1	<1	<1	<1	0.22	0.22	1.8	0.52	0.1	0.11	0.45	0.18
Silver rockling (<i>Gaidropsarus argentatus</i>)	<1	-	-	<1	0.03	-	-	0.02	0.02	-	-	0.01
Fourbeard rockling (<i>Enchelyopus cimbrius</i>)	<1	1.4	<1	<1	2.43	7.54	5.41	4.53	1.45	3.47	1.89	2.21
Marlin-spike (<i>Nezumia bairdii</i>)	<1	<1	<1	<1	2.1	1.75	1.08	1.8	1.06	0.71	0.41	0.79
Atlantic mackerel (<i>Scomber scombrus</i>)	-	<1	-	<1	-	<0.01	-	<0.01	-	<0.01	-	<0.01
Sand lance (Ammodytidae)	<1	-	<1	<1	0.02	-	0.69	0.14	0.26	-	3.52	0.94
Sand lance (<i>Ammodytes</i> sp.)	-	2.2	<1	<1	-	1.25	0.55	0.48	-	7.84	2.52	3.14
Shannies (<i>Lumpenus</i> sp.)	-	-	<1	<1	-	-	0.03	<0.01	-	-	0.04	0.01
Snakeblenny (<i>Lumpenus lampraeformis</i>)	<1	-	-	<1	0.08	-	-	0.04	0.05	-	-	0.02
Daubed shanny (<i>Leptoclinus maculatus</i>)	-	<1	<1	<1	-	0.02	0.04	0.01	-	0.04	0.05	0.02

Prey	F _{occ}				MC				CTFI			
	2004-2009	2015-2019	2020-2024	2004-2024	2004-2009	2015-2019	2020-2024	2004-2024	2004-2009	2015-2019	2020-2024	2004-2024
Eelpout (Zoarcidae (Zoarcidae))	<1	-	-	<1	0.14	-	-	0.07	0.11	-	-	0.05
Eelpout (<i>Lycodes</i> sp.)	<1	-	-	<1	0.04	-	-	0.02	0.04	-	-	0.02
Checker eelpout (<i>Lycodes vahlii</i>)	-	-	<1	<1	-	-	0.05	<0.01	-	-	0.02	<0.01
Atlantic soft pout (<i>Melanostigma atlanticum</i>)	3.9	1.5	<1	2.3	1.74	0.63	0.1	1.1	2.55	0.67	0.07	1.36
Redfish (<i>Sebastes</i> spp.)	<1	4.8	<1	1.7	4.33	33.21	10.31	14.17	1.6	8.12	1.31	3.65
Sculpin (Cottidae)	-	<1	-	<1	-	0.16	-	0.05	-	0.04	-	0.01
Atlantic hookear sculpin (<i>Artediellus atlanticus</i>)	<1	-	-	<1	0.03	-	-	0.02	<0.01	-	-	<0.01
Sea tadpole (<i>Careproctus reinhardtii</i>)	<1	-	-	<1	<0.01	-	-	<0.01	<0.01	-	-	<0.01
Skate (Rajidae)	-	<1	-	<1	-	0.07	-	0.02	-	0.04	-	0.01
Flatfish (Pleuronectiformes)	<1	<1	<1	<1	0.62	0.05	0.08	0.35	0.22	0.02	0.05	0.11
Righteye flounder (Pleuronectidae)	<1	-	-	<1	<0.01	-	-	<0.01	<0.01	-	-	<0.01
American plaice (<i>Hippoglossoides platessoides</i>)	-	<1	<1	<1	-	0.26	0.57	0.19	-	0.09	0.21	0.08
Witch flounder (<i>Glyptocephalus cynoglossus</i>)	-	<1	<1	<1	-	0.43	1.14	0.34	-	0.15	0.18	0.09
Greenland halibut (<i>Reinhardtius hippoglossoides</i>)	-	<1	<1	<1	-	0.8	3.2	0.84	-	0.43	0.33	0.22
Thorny skate (<i>Amblyraja radiata</i>)	-	<1	-	<1	-	0.15	-	0.04	-	0.04	-	0.01
Digested roundfish	2.6	4.4	<1	2.6	8.24	5.89	3.58	6.66	8.25	7.62	3.48	6.93
Fish (spawn) egg (Pisces)	<1	<1	-	<1	0.05	0.32	-	0.12	0.04	0.7	-	0.25
Digested fish	9	3.8	9.7	7.9	10.55	1.75	14.91	8.71	10.18	2.86	16.85	9.36
Fishes, total	18.2	23.3	17.8	19.3	56.4	83.13	73	67.59	48.09	63.35	60.07	55.86
Digested shrimp	10.4	1.6	1.7	6	12.08	0.77	2.11	6.8	10.52	0.68	1.33	5.17
Scarlet sergestid (<i>Sergia robusta</i>)	-	<1	-	<1	-	0.04	-	0.01	-	0.04	-	0.01

Prey	F _{occ}				MC				CTFI			
	2004-2009	2015-2019	2020-2024	2004-2024	2004-2009	2015-2019	2020-2024	2004-2024	2004-2009	2015-2019	2020-2024	2004-2024
Glass shrimp (Pasiphaeidae)	<1	-	-	<1	0.42	-	-	0.21	0.4	-	-	0.18
Pink glass shrimp (<i>Pasiphaea multidentata</i>)	3	2.6	2.5	2.8	3.65	1.8	3.07	2.98	4.05	3.46	3.42	3.71
Eualid (<i>Eualus</i> sp.)	<1	-	-	<1	<0.01	-	-	<0.01	0.02	-	-	<0.01
Circumpolar eualid (<i>Eualus gaimardii</i>)	<1	-	<1	<1	<0.01	-	0.02	<0.01	0.03	-	0.21	0.06
Friendly blade shrimp (<i>Spirontocaris liljeborgii</i>)	-	<1	-	<1	-	<0.01	-	<0.01	-	<0.01	-	<0.01
Lebbeids (<i>Lebbeus</i> sp.)	<1	-	-	<1	<0.01	-	-	<0.01	0.01	-	-	<0.01
Polar lebbeid (<i>Lebbeus polaris</i>)	<1	-	-	<1	0.02	-	-	<0.01	<0.01	-	-	<0.01
Boreal red shrimps (<i>Pandalus</i> sp.)	<1	1	<1	<1	0.43	0.6	1.29	0.64	0.41	0.66	1.6	0.77
Northern shrimp (<i>Pandalus borealis</i>)	5.3	5	2.2	4.4	14.03	8.74	7.46	11.2	9.33	6.82	5.26	7.56
Striped pink shrimp (<i>Pandalus montagui</i>)	<1	<1	<1	<1	0.41	0.09	0.44	0.32	0.36	0.08	0.97	0.41
Crangon shrimp (Crangonidae)	<1	-	-	<1	0.02	-	-	<0.01	<0.01	-	-	<0.01
Sars shrimp (<i>Sabinea sarsii</i>)	<1	-	<1	<1	<0.01	-	0.02	<0.01	<0.01	-	0.03	<0.01
Norwegian shrimp (<i>Pontophilus norvegicus</i>)	-	<1	<1	<1	-	0.06	0.03	0.02	-	0.03	0.04	0.02
Shrimps, total	17.8	10	7.3	13.2	31.07	12.11	14.44	22.23	25.16	11.78	12.86	17.93
Copepod (Copepoda)	-	<1	-	<1	-	<0.01	-	<0.01	-	0.01	-	<0.01
Calanoid copepod (Calanoida)	-	<1	<1	<1	-	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01
Calanoid copepod (<i>Calanus</i> sp.)	-	-	<1	<1	-	-	<0.01	<0.01	-	-	<0.01	<0.01
Calanoid copepod (<i>Temora longicornis</i>)	-	<1	-	<1	-	<0.01	-	<0.01	-	<0.01	-	<0.01
Calanoid copepod (<i>Paraeuchaeta norvegica</i>)	-	<1	<1	<1	-	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01
Calanoid copepod (<i>Metridia lucens</i>)	-	<1	-	<1	-	<0.01	-	<0.01	-	<0.01	-	<0.01
Amphipod (Amphipoda)	<1	-	<1	<1	0.08	-	<0.01	0.04	0.63	-	0.08	0.3
Hyperiid (Hyperidea)	-	-	<1	<1	-	-	0.01	<0.01	-	-	0.07	0.02

Prey	F _{occ}				MC				CTFI			
	2004-2009	2015-2019	2020-2024	2004-2024	2004-2009	2015-2019	2020-2024	2004-2024	2004-2009	2015-2019	2020-2024	2004-2024
Hyperiid (Hyperidae)	1.6	<1	<1	<1	0.77	<0.01	0.01	0.39	1.49	0.02	0.08	0.68
Hyperiids (<i>Themisto</i> sp.)	1.2	4.9	1.6	2.2	0.47	0.43	0.24	0.41	1.25	4.02	1.11	2.12
Hyperiid (<i>Themisto abyssorum</i>)	<1	<1	<1	<1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
Hyperiid (<i>Themisto compressa</i>)	<1	<1	<1	<1	<0.01	0.05	0.04	0.02	<0.01	0.75	0.2	0.29
Hyperiid (<i>Themisto libellula</i>)	1.9	2.2	<1	1.6	1.2	0.29	0.22	0.74	3.34	2.44	1.02	2.5
Hyperiid (<i>Scina borealis</i>)	-	<1	-	<1	-	<0.01	-	<0.01	-	<0.01	-	<0.01
Gammarid (Gammaridea)	<1	<1	-	<1	<0.01	<0.01	-	<0.01	0.01	0.09	-	0.04
Gammarid (<i>Byblis gaimardi</i>)	-	<1	-	<1	-	<0.01	-	<0.01	-	0.06	-	0.02
Gammarid (<i>Maera loveni</i>)	-	<1	-	<1	-	<0.01	-	<0.01	-	<0.01	-	<0.01
Gammarid (<i>Tmetonyx cicada</i>)	-	<1	-	<1	-	<0.01	-	<0.01	-	<0.01	-	<0.01
Gammarid (Oedicerotidae)	-	<1	-	<1	-	<0.01	-	<0.01	-	<0.01	-	<0.01
Gammarid (<i>Wimvadocus torelli</i>)	-	<1	<1	<1	-	<0.01	0.02	<0.01	-	<0.01	0.02	<0.01
Gammarid (<i>Stegocephalus inflatus</i>)	-	<1	-	<1	-	<0.01	-	<0.01	-	<0.01	-	<0.01
Mysid (Mysidae)	2	<1	<1	1	0.15	<0.01	<0.01	0.08	0.37	<0.01	<0.01	0.16
Mysid (<i>Boreomysis</i> sp.)	<1	<1	<1	<1	0.05	0.03	0.01	0.04	0.11	0.05	0.02	0.07
Mysid (<i>Boreomysis tridens</i>)	<1	-	<1	<1	0.04	-	0.01	0.02	0.04	-	<0.01	0.02
Mysid (<i>Boreomysis arctica</i>)	2.5	<1	<1	1.3	0.19	<0.01	0.02	0.1	0.41	<0.01	0.02	0.19
Mysid (<i>Boreomysis nobilis</i>)	<1	-	-	<1	<0.01	-	-	<0.01	<0.01	-	-	<0.01
Mysid (<i>Mysis</i> sp.)	-	-	<1	<1	-	-	<0.01	<0.01	-	-	0.04	<0.01
Mysid (<i>Mysis mixta</i>)	<1	-	-	<1	<0.01	-	-	<0.01	0.04	-	-	0.02
Euphausiid (Euphausiacea)	<1	-	-	<1	<0.01	-	-	<0.01	0.1	-	-	0.04
Euphausiid (Euphausiidae)	1.5	3.5	<1	1.7	0.38	0.51	0.23	0.39	3.34	5.76	1.67	3.74

Prey	F _{occ}				MC				CTFI			
	2004-2009	2015-2019	2020-2024	2004-2024	2004-2009	2015-2019	2020-2024	2004-2024	2004-2009	2015-2019	2020-2024	2004-2024
Northern krill (<i>Meganyctiphanes norvegica</i>)	<1	2.6	3.8	2.1	0.15	0.31	1.46	0.44	0.79	2.64	8.13	3.11
Euphausiid (<i>Thysanoessa</i> sp.)	<1	1.2	<1	<1	0.02	0.43	0.02	0.14	0.15	2.99	0.15	1.07
Euphausiid (<i>Thysanoessa inermis</i>)	<1	<1	<1	<1	0.02	<0.01	0.1	0.03	0.17	0.02	0.28	0.15
Arctic krill (<i>Thysanoessa raschii</i>)	<1	<1	<1	<1	<0.01	0.02	0.02	0.01	0.05	0.18	0.04	0.09
Zooplankton, total	10.6	13.6	8	10.7	3.54	2.11	2.44	2.9	12.29	19.07	12.95	14.65
Zoanthid (<i>Epizoanthus erdmanni</i>)	-	-	<1	<1	-	-	<0.01	<0.01	-	-	<0.01	<0.01
Flatworm (Platyhelminthes)	<1	-	-	<1	<0.01	-	-	<0.01	<0.01	-	-	<0.01
Mollusc (Mollusca)	-	<1	<1	<1	-	0.02	0.05	0.02	-	0.2	0.17	0.1
Gastropod (Gastropoda)	<1	-	-	<1	0.06	-	-	0.03	0.01	-	-	<0.01
Giant canoe bubble (<i>Scaphander punctostriatus</i>)	-	-	<1	<1	-	-	0.07	0.01	-	-	0.02	<0.01
Bivalve (Bivalvia)	<1	<1	<1	<1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cephalopod (Cephalopoda)	<1	-	-	<1	0.16	-	-	0.08	0.06	-	-	0.03
Bobtail (<i>Rossia</i> sp.)	-	<1	<1	<1	-	0.22	<0.01	0.07	-	0.17	<0.01	0.06
Lesser bobtail squid (<i>Semirossia tenera</i>)	<1	-	-	<1	0.17	-	-	0.09	0.08	-	-	0.03
Squid (Teuthida)	<1	-	-	<1	0.27	-	-	0.14	0.08	-	-	0.04
Northern shortfin squid (<i>Illex illecebrosus</i>)	<1	<1	<1	<1	1.18	0.54	5.85	1.86	0.42	0.17	1.06	0.49
Polychaete (Polychaeta)	<1	<1	<1	<1	0.04	<0.01	<0.01	0.02	<0.01	0.02	0.01	0.01
Crustacean (Crustacea)	13.7	3.7	9.5	10.2	3.37	0.45	1.74	2.18	8.96	2.34	11.4	7.38
Water flea (Cladocera)	-	<1	-	<1	-	<0.01	-	<0.01	-	<0.01	-	<0.01
Cumacean (Cumacea)	-	<1	<1	<1	-	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01
Isopod (Isopoda)	<1	-	-	<1	0.02	-	-	<0.01	<0.01	-	-	<0.01
Isopod (<i>Syscenus infelix</i>)	<1	-	<1	<1	0.04	-	0.01	0.02	0.03	-	<0.01	0.01

Prey	F _{occ}				MC				CTFI			
	2004-2009	2015-2019	2020-2024	2004-2024	2004-2009	2015-2019	2020-2024	2004-2024	2004-2009	2015-2019	2020-2024	2004-2024
Crustacean decapod (Decapoda)	-	<1	<1	<1	-	<0.01	0.65	0.12	-	<0.01	0.39	0.09
Echinoderm (Echinodermata)	<1	-	-	<1	<0.01	-	-	<0.01	<0.01	-	-	<0.01
Sea urchin (Echinoidea)	<1	-	-	<1	<0.01	-	-	<0.01	<0.01	-	-	<0.01
Mud heart urchin (<i>Brisaster fragilis</i>)	-	<1	<1	<1	-	0.14	0.05	0.05	-	0.03	0.02	0.01
Brittle star (Ophiuroidea)	<1	<1	<1	<1	0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
Digested invertebrates	-	-	<1	<1	-	-	<0.01	<0.01	-	-	0.01	<0.01
Other invertebrates, total	14.2	4.1	10.1	10.7	5.32	1.38	8.45	4.71	9.68	2.93	13.09	8.28
Invertebrates, total	36.5	26.1	22.8	30.4	39.93	15.69	25.42	29.88	47.13	34.13	39.03	41.01
Unidentified digested material	11.4	4	1.9	7.1	3.66	1.18	1.58	2.52	4.77	2.52	0.9	3.13
Unidentified egg	<1	<1	<1	<1	0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
Unidentified preys, total	11.5	4.1	1.9	7.2	3.67	1.18	1.59	2.53	4.78	2.52	0.91	3.14
Total	-	-	-	-	100	100	100	100	100	100	100	100

Table A22. Diet of Greenland halibut from the Estuary and nGSL according to the different length classes considered in the study and for the entire period investigated (2004-2024). For each taxon found in the stomach contents, the frequency of occurrence (F_{occ}), the contributions in mass (MC, as % of the mass of all taxa) and in fullness index (CTFI, as % of the TFI of all taxa) were calculated.

Prey	F _{occ}				MC				CTFI			
	<20	[20-30[	[30-40]	>40	<20	[20-30[	[30-40]	>40	<20	[20-30[	[30-40]	>40
Winter skate (<i>Leucoraja ocellata</i>)	-	<1	-	-	-	0.23	-	-	-	0.19	-	-
Mud hagfish (<i>Myxine limosa</i>)	-	-	-	<1	-	-	-	1.72	-	-	-	1.49
Bony fish (Actinopterygii)	-	<1	<1	<1	-	<0.01	0.12	0.02	-	<0.01	0.12	0.02
Herring (Clupeidae)	-	-	-	<1	-	-	-	0.15	-	-	-	0.19
Atlantic herring (<i>Clupea harengus</i>)	-	-	<1	<1	-	-	0.91	10.54	-	-	0.63	7.22
Capelin (<i>Mallotus villosus</i>)	3.4	4.9	3.6	2.7	20.5	33.61	32.06	10.67	18.16	34.24	32.6	12.85
White barracudina (<i>Arctozenus risso</i>)	-	-	<1	<1	-	-	1.24	1.42	-	-	1.2	1.6
Threespine stickleback (<i>Gasterosteus aculeatus</i>)	-	<1	-	-	-	0.04	-	-	-	0.06	-	-
Codfish (Gadidae)	-	-	<1	<1	-	-	<0.01	0.07	-	-	<0.01	0.08
Atlantic cod (<i>Gadus morhua</i>)	-	-	<1	<1	-	-	0.1	0.75	-	-	0.09	0.79
Silver rockling (<i>Gaidropsarus argentatus</i>)	-	<1	-	<1	-	0.02	-	0.02	-	0.02	-	0.03
Fourbeard rockling (<i>Enchelyopus cimbrius</i>)	-	<1	<1	1.9	-	1.9	1.66	6.03	-	1.32	1.75	7.37
Marlin-spike (<i>Nezumia bairdii</i>)	-	-	<1	<1	-	-	1.11	2.38	-	-	0.88	2.99
Atlantic mackerel (<i>Scomber scombrus</i>)	-	-	<1	-	-	-	<0.01	-	-	-	<0.01	-
Sand lance (Ammodytidae)	<1	<1	-	-	1.84	0.76	-	-	2.17	0.66	-	-
Sand lance (<i>Ammodytes</i> sp.)	2.8	<1	<1	<1	7.67	1.81	0.15	<0.01	7.15	2.27	0.15	<0.01
Shannies (<i>Lumpenus</i> sp.)	-	<1	-	-	-	0.06	-	-	-	0.04	-	-
Snakeblenny (<i>Lumpenus lampretaeformis</i>)	-	-	-	<1	-	-	-	0.06	-	-	-	0.1
Daubed shanny (<i>Leptoclinus maculatus</i>)	-	<1	<1	-	-	0.09	0.02	-	-	0.08	0.02	-
Eelpout (Zoarcidae)	-	-	<1	<1	-	-	0.29	0.02	-	-	0.24	0.03
Eelpout (<i>Lycodes</i> sp.)	-	-	<1	-	-	-	0.1	-	-	-	0.1	-

Prey	F _{occ}				MC				CTFI			
	<20	[20-30[	[30-40]	>40	<20	[20-30[	[30-40]	>40	<20	[20-30[	[30-40]	>40
Checker eelpout (<i>Lycodes vahlii</i>)	-	-	-	<1	-	-	-	0.01	-	-	-	0.02
Atlantic soft pout (<i>Melanostigma atlanticum</i>)	<1	2.1	3.1	2.9	0.86	1.94	2.22	0.64	0.56	2.08	2.41	0.92
Redfish (<i>Sebastes</i> spp.)	<1	<1	<1	5	0.04	0.46	2.44	20.51	0.04	0.45	2.23	14.75
Sculpin (Cottidae)	-	-	<1	<1	-	-	<0.01	0.07	-	-	<0.01	0.05
Atlantic hookear sculpin (<i>Artediellus atlanticus</i>)	-	-	-	<1	-	-	-	0.03	-	-	-	0.02
Sea tadpole (<i>Careproctus reinhardtii</i>)	-	-	-	<1	-	-	-	<0.01	-	-	-	<0.01
Skate (Rajidae)	-	-	-	<1	-	-	-	0.03	-	-	-	0.06
Flatfish (Pleuronectiformes)	-	-	<1	<1	-	-	0.14	0.48	-	-	0.14	0.42
Righteye flounder (Pleuronectidae)	-	-	<1	-	-	-	<0.01	-	-	-	<0.01	-
American plaice (<i>Hippoglossoides platessoides</i>)	-	-	-	<1	-	-	-	0.28	-	-	-	0.37
Witch flounder (<i>Glyptocephalus cynoglossus</i>)	-	-	-	<1	-	-	-	0.52	-	-	-	0.42
Greenland halibut (<i>Reinhardtius hippoglossoides</i>)	<1	-	-	<1	0.09	-	-	1.26	0.09	-	-	0.86
Thorny skate (<i>Amblyraja radiata</i>)	-	-	-	<1	-	-	-	0.07	-	-	-	0.06
Digested roundfish	2.5	2.4	2.3	3.2	6.02	12.02	5.46	6.23	5.43	10.7	5.87	5.87
Fish (spawn) egg (Pisces)	<1	<1	<1	<1	0.5	0.02	0.41	0.03	0.46	0.03	0.38	0.04
Digested fish	6.6	8.4	7.8	8.5	8.78	11.41	8.91	8.24	8.67	10.99	8.81	9.06
Fishes, total	16.3	18	17.4	24.3	46.31	64.37	57.33	72.26	42.73	63.13	57.62	67.71
Digested shrimp	2.2	4.1	6.5	9.5	2.34	4.95	9.77	6.42	2.01	4.51	9.09	7.88
Scarlet sergestid (<i>Sergia robusta</i>)	-	-	<1	-	-	-	0.06	-	-	-	0.07	-
Glass shrimp (Pasiphaeidae)	-	<1	<1	<1	-	0.34	0.32	0.17	-	0.26	0.36	0.21
Pink glass shrimp (<i>Pasiphaea multidentata</i>)	<1	3.1	3.2	3.1	2.15	6.17	4.99	1.94	1.82	6.54	5.16	2.27
Eualid (<i>Eualus</i> sp.)	<1	-	-	-	0.04	-	-	-	0.03	-	-	-
Circumpolar eualid (<i>Eualus gaimardii</i>)	<1	-	-	-	0.13	-	-	-	0.17	-	-	-
Friendly blade shrimp (<i>Spirontocaris liljeborgii</i>)	-	<1	-	-	-	0.01	-	-	-	0.01	-	-

Prey	F _{occ}				MC				CTFI			
	<20	[20-30[	[30-40]	>40	<20	[20-30[	[30-40]	>40	<20	[20-30[	[30-40]	>40
Lebbeids (<i>Lebbeus</i> sp.)	<1	-	-	-	0.02	-	-	-	0.02	-	-	-
Polar lebbeid (<i>Lebbeus polaris</i>)	-	-	-	<1	-	-	-	0.01	-	-	-	0.02
Boreal red shrimps (<i>Pandalus</i> sp.)	<1	1.1	<1	<1	<0.01	1.67	1.03	0.41	<0.01	1.79	1.21	0.46
Northern shrimp (<i>Pandalus borealis</i>)	<1	2.1	4.4	8.9	0.25	8.02	15.14	11.08	0.31	7.72	14.42	13.64
Striped pink shrimp (<i>Pandalus montagui</i>)	<1	<1	<1	<1	0.53	0.62	0.25	0.28	0.35	0.56	0.3	0.44
Crangon shrimp (Crangonidae)	-	-	-	<1	-	-	-	0.01	-	-	-	0.01
Sars shrimp (<i>Sabinea sarsii</i>)	-	<1	-	<1	-	0.05	-	<0.01	-	0.03	-	<0.01
Norwegian shrimp (<i>Pontophilus norvegicus</i>)	-	<1	<1	<1	-	0.05	0.04	0.02	-	0.04	0.03	0.02
Shrimps, total	3.5	10.4	14.3	20.3	5.46	21.88	31.61	20.34	4.7	21.48	30.65	24.97
Copepod (Copepoda)	<1	<1	-	-	0.01	<0.01	-	-	0.01	<0.01	-	-
Calanoid copepod (Calanoida)	<1	<1	-	-	<0.01	<0.01	-	-	<0.01	<0.01	-	-
Calanoid copepod (<i>Calanus</i> sp.)	-	<1	-	-	-	<0.01	-	-	-	<0.01	-	-
Calanoid copepod (<i>Temora longicornis</i>)	<1	-	-	-	<0.01	-	-	-	<0.01	-	-	-
Calanoid copepod (<i>Paraeuchaeta norvegica</i>)	<1	<1	-	-	<0.01	<0.01	-	-	<0.01	<0.01	-	-
Calanoid copepod (<i>Metridia lucens</i>)	<1	-	-	-	<0.01	-	-	-	<0.01	-	-	-
Amphipod (Amphipoda)	1	<1	<1	<1	0.7	0.15	0.03	<0.01	0.73	0.11	0.04	<0.01
Hyperiid (Hyperiidea)	<1	-	-	-	0.06	-	-	-	0.05	-	-	-
Hyperiid (Hyperiidae)	1.2	1.2	1	<1	0.47	1.11	1.06	0.08	0.46	1.12	1.19	0.1
Hyperiids (<i>Themisto</i> sp.)	8.6	1.9	<1	<1	4.34	0.89	0.63	0.07	4.74	1.14	0.71	0.08
Hyperiid (<i>Themisto abyssorum</i>)	<1	-	-	-	0.02	-	-	-	0.02	-	-	-
Hyperiid (<i>Themisto compressa</i>)	1.5	<1	<1	-	0.58	<0.01	0.01	-	0.81	<0.01	0.01	-
Hyperiid (<i>Themisto libellula</i>)	4	2.1	1.2	<1	3.88	2.29	1.73	0.04	4.33	2.42	1.91	0.06
Hyperiid (<i>Scina borealis</i>)	-	<1	-	-	-	<0.01	-	-	-	<0.01	-	-
Gammarid (Gammaridea)	<1	<1	-	<1	0.05	0.02	-	<0.01	0.09	0.02	-	<0.01

Prey	F _{occ}				MC				CTFI			
	<20	[20-30[	[30-40]	>40	<20	[20-30[	[30-40]	>40	<20	[20-30[	[30-40]	>40
Gammarid (<i>Byblis gaimardi</i>)	<1	-	-	-	0.07	-	-	-	0.06	-	-	-
Gammarid (<i>Maera loveni</i>)	<1	-	-	-	<0.01	-	-	-	<0.01	-	-	-
Gammarid (<i>Tmetonyx cicada</i>)	-	-	-	<1	-	-	-	<0.01	-	-	-	<0.01
Gammarid (Oedicerotidae)	<1	-	-	-	<0.01	-	-	-	<0.01	-	-	-
Gammarid (<i>Wimvadocus torelli</i>)	-	-	<1	-	-	-	0.03	-	-	-	0.03	-
Gammarid (<i>Stegocephalus inflatus</i>)	-	<1	-	-	-	<0.01	-	-	-	<0.01	-	-
Mysid (Mysidae)	<1	1.1	1.5	<1	0.2	0.16	0.18	0.02	0.22	0.17	0.17	0.04
Mysid (<i>Boreomysis</i> sp.)	<1	<1	<1	<1	0.11	0.08	0.09	0.02	0.08	0.08	0.09	0.03
Mysid (<i>Boreomysis tridens</i>)	-	<1	<1	<1	-	0.01	0.06	0.01	-	0.01	0.06	0.02
Mysid (<i>Boreomysis arctica</i>)	<1	<1	2.1	1.2	0.25	0.14	0.27	0.04	0.26	0.14	0.26	0.06
Mysid (<i>Boreomysis nobilis</i>)	-	-	<1	<1	-	-	<0.01	<0.01	-	-	<0.01	<0.01
Mysid (<i>Mysis</i> sp.)	<1	-	-	-	0.02	-	-	-	0.02	-	-	-
Mysid (<i>Mysis mixta</i>)	<1	<1	-	-	0.02	<0.01	-	-	0.05	<0.01	-	-
Euphausiid (Euphausiacea)	<1	-	-	-	0.09	-	-	-	0.12	-	-	-
Euphausiid (Euphausiidae)	7.6	<1	<1	<1	8.56	0.61	0.09	0.02	9.92	0.76	0.09	0.03
Northern krill (<i>Meganyctiphanes norvegica</i>)	7.1	2	<1	<1	6.79	1.19	0.25	0.06	7.51	1.52	0.28	0.07
Euphausiid (<i>Thysanoessa</i> sp.)	1.5	<1	-	-	2.84	0.43	-	-	2.42	0.85	-	-
Euphausiid (<i>Thysanoessa inermis</i>)	<1	<1	<1	-	0.36	0.16	<0.01	-	0.31	0.14	<0.01	-
Arctic krill (<i>Thysanoessa raschii</i>)	<1	<1	<1	<1	0.27	0.02	<0.01	<0.01	0.24	0.02	<0.01	<0.01
Zooplankton, total	29.5	9	7.5	3.9	29.69	7.29	4.45	0.38	32.44	8.52	4.86	0.5
Zoanthid (<i>Epizoanthus erdmanni</i>)	-	-	-	<1	-	-	-	<0.01	-	-	-	<0.01
Flatworm (Platyhelminthes)	-	<1	-	-	-	<0.01	-	-	-	<0.01	-	-
Mollusc (Mollusca)	<1	<1	-	-	0.18	0.09	-	-	0.18	0.16	-	-
Gastropod (Gastropoda)	-	-	-	<1	-	-	-	0.05	-	-	-	0.02

Prey	F _{occ}				MC				CTFI			
	<20	[20-30[	[30-40]	>40	<20	[20-30[	[30-40]	>40	<20	[20-30[	[30-40]	>40
Giant canoe bubble (<i>Scaphander punctostriatus</i>)	-	-	-	<1	-	-	-	0.02	-	-	-	0.02
Bivalve (Bivalvia)	-	-	<1	<1	-	-	<0.01	<0.01	-	-	<0.01	<0.01
Cephalopod (Cephalopoda)	-	-	-	<1	-	-	-	0.13	-	-	-	0.13
Bobtail (<i>Rossia</i> sp.)	-	-	<1	<1	-	-	0.33	<0.01	-	-	0.31	<0.01
Lesser bobtail squid (<i>Semirossia tenera</i>)	-	-	-	<1	-	-	-	0.13	-	-	-	0.16
Squid (Teuthida)	-	-	-	<1	-	-	-	0.21	-	-	-	0.17
Northern shortfin squid (<i>Illex illecebrosus</i>)	-	-	-	<1	-	-	-	2.8	-	-	-	2.31
Polychaete (Polychaeta)	<1	<1	<1	<1	0.02	0.01	<0.01	0.03	0.02	<0.01	<0.01	0.02
Crustacean (Crustacea)	21.4	8.5	8.5	6.7	13.84	3.28	3.22	1.09	15.68	3.61	3.42	1.32
Water flea (Cladocera)	<1	-	-	-	<0.01	-	-	-	<0.01	-	-	-
Cumacean (Cumacea)	<1	<1	-	-	<0.01	<0.01	-	-	<0.01	<0.01	-	-
Isopod (Isopoda)	-	-	<1	<1	-	-	<0.01	0.01	-	-	<0.01	0.02
Isopod (<i>Syscenus infelix</i>)	-	-	<1	<1	-	-	0.07	0.01	-	-	0.06	0.02
Crustacean decapod (Decapoda)	<1	<1	<1	<1	<0.01	<0.01	0.61	<0.01	<0.01	<0.01	0.48	<0.01
Echinoderm (Echinodermata)	-	-	<1	<1	-	-	<0.01	<0.01	-	-	<0.01	<0.01
Sea urchin (Echinoidea)	-	<1	<1	-	-	<0.01	<0.01	-	-	<0.01	<0.01	-
Mud heart urchin (<i>Brisaster fragilis</i>)	-	<1	-	<1	-	<0.01	-	0.08	-	<0.01	-	0.06
Brittle star (Ophiuroidea)	<1	<1	<1	<1	<0.01	0.02	0.02	<0.01	<0.01	0.02	0.02	<0.01
Digested invertebrates	<1	-	-	-	0.01	-	-	-	<0.01	-	-	-
Other invertebrates, total	21.5	8.8	8.8	7.6	14.06	3.41	4.26	4.56	15.89	3.81	4.3	4.26
Invertebrates, total	48.7	24.8	26.5	28	49.54	32.7	40.38	25.29	53.34	33.9	39.85	29.75
Unidentified digested material	7.5	6.9	6.9	7.4	4.15	2.92	2.27	2.45	3.93	2.95	2.51	2.54
Unidentified egg	<1	<1	<1	<1	<0.01	0.01	0.02	<0.01	<0.01	0.01	0.02	<0.01
Unidentified preys, total	7.5	7	7	7.5	4.15	2.93	2.29	2.45	3.93	2.97	2.53	2.54

Prey	F _{occ}				MC				CTFI			
	<20	[20-30[	[30-40]	>40	<20	[20-30[	[30-40]	>40	<20	[20-30[	[30-40]	>40
Total	-	-	-	-	100	100	100	100	100	100	100	100

Table A23. Summary of Greenland halibut and redfish stomach sampling effort for the period 2015-2024 by length class. Statistics on length, total stomach contents (after waste/parasite/empty stomachs are removed) and taxonomic diversity are provided.

Parameter		Redfish					Greenland Halibut				
		<20	[20-30[	[30-40]	>40	Total	<20	[20-30[	[30-40]	>40	Total
	Nb. of stomachs	2997	3188	1050	187	7422	1137	1475	1619	1292	5523
	Nb. of empty stomachs	1087	1339	453	56	2935	385	933	1115	764	3197
	% of empty stomachs	36.3	42	43.1	29.9	39.5	33.9	63.3	68.9	59.1	57.9
	TFI	0.15	0.06	0.14	0.27	0.11	0.39	0.17	0.1	0.14	0.19
Length (mm)	Min	35	200	300	401	35	45	200	300	401	45
	Median	147	240	340	416	225	168	257	358	451	312
	Mean	144.5	242	343.2	421.4	221.5	164.9	256.4	354.8	471.1	316.6
	Max	199	299	400	501	501	199	299	400	767	767
Total stomach content (g)	Min	0.001	0.001	0.001	0.013	0.001	0.001	0.003	0.001	0.002	0.001
	Median	0.06	0.09	1.34	3.84	0.1	0.54	1.34	2.44	7.44	1.28
	Mean	0.19	0.55	4.14	11.7	1.2	0.87	2.68	5.42	17.41	6.03
	Max	6.46	19.77	74.67	88.33	88.33	9.20	23.74	61.81	316.92	316.92
Nb. of taxa	Fish	4	10	16	8	19	9	12	17	23	29
	Shrimp	10	7	8	5	13	6	8	7	6	10
	Zooplankton	50	39	31	12	56	24	17	12	8	31
	Other invertebrates	12	3	7	2	15	8	7	4	10	15
	Non-identifiable prey	2	2	1	1	2	1	1	2	2	2