Northwest Atlantic Fisheries Organization

Serial No. N6804 **NAFO SCR Doc. 18/020REV2**

SCIENTIFIC COUNCIL MEETING – JUNE 2018

Greenland shark (*Somniosus microcephalus*) catches in fisheries conducted in the Northwest Atlantic Fisheries Organization Regulatory Area

by
Lisa C. Hendrickson[1], Jana Aker[2], Sebastian Glindtvad[2] and Tom Blasdale[2]

[1]U. S. National Marine Fisheries Service, Northeast Fisheries Science Center,
166 Water St., Woods Hole, MA 02543
[2]Northwest Atlantic Fisheries Organization,
Morris Drive, Suite 100, Dartmouth, Nova Scotia, Canada B3B 1K8

Abstract

The Greenland shark (*Somniosus microcephalus*), a large, benthopelagic shark, has been listed as "Near Threatened" on the International Union for the Conservation of Nature and Natural Resources (IUCN) Red List since 2006. The IUCN-recommended conservation actions include documentation of catches in North Atlantic and Arctic fisheries and determination of fisheries-related population declines. This report is a response, in part, to a request from the Fisheries Commission of the Northwest Atlantic Fisheries Organization (NAFO) to the Scientific Council for documentation of Greenland shark catches in NAFO fisheries and summarization of existing data useful for assessing the status of the population inhabiting NAFO waters. We found that nominal catches of Greenland shark have been reported to NAFO since 2002, but reporting was inconsistent. Catches ranged from 1 t in 2002 and 2004 to 71 t in 2017; 69% of the catches during 2002-2017 were from Subarea 1. NAFO Observer Program data indicated that bycatch of Greenland shark in the NAFO Regulatory Area increased rapidly between 2014 and 2017, from 34 t to 281 t and from at least 75 to 180 individuals, respectively. Most of the bycatch during 2014-2017, 89% of the weight and 67% of the numbers, occurred in bottom trawls and the remainder occurred on longlines. Total bycatch numbers (representing minimums) were highest (43%) in the Greenland halibut bottom trawl fishery, mainly in Division 3L, followed by the Atlantic halibut longline fishery (26%), mainly in Division 3N, and the redfish bottom trawl fishery (19%), mainly in Divisions 3M and 3N. Bycatch weight was also highest in the Greenland halibut bottom trawl fishery (52%), followed by the redfish bottom trawl fishery (27%), and the Atlantic halibut longline fishery (8%). The inconsistent reporting of nominal catches of Greenland sharks should be remedied and we also suggest improvements to the collection of Greenland shark bycatch data by NAFO observers. These recommendations will improve our knowledge about the Greenland shark population inhabiting the Northwest Atlantic Ocean and many of the recommendations can be implemented now.

Introduction

The Greenland shark (*Somniosus microcephalus*) is a large, benthopelagic shark that inhabits the Arctic and North Atlantic Oceans at depths of 0-2,200 m (MacNeil et al. 2012). The species' geographic range (Figure 1) has been documented primarily from fishery catches and the southernmost limit in the Northwest Atlantic Ocean remains unknown.

S. microcephalus has been listed as "Near Threatened" on the International Union for the Conservation of Nature and Natural Resources (IUCN) Red List since 2006 (Kyne et al. 2006). The IUCN-recommended conservation actions for the species are the documentation of catches in North Atlantic and Arctic fisheries and determination of any fisheries-related population declines.

This report was prepared (in part) in response to a request, by the Fisheries Commission of the Northwest Atlantic Fisheries Organization (NAFO), for the Scientific Council to document Greenland shark bycatch in NAFO fisheries. In addition, the request included a summarization of existing data about the species in order to assess the current fishing mortality rate and determine the status of the population inhabiting waters under NAFO jurisdiction. The purpose of the request was noted as development of management advice, in line with the NAFO Precautionary Approach, for consideration of the Fisheries Commission.

The objectives of this report are to quantify Greenland shark bycatch in fisheries that operated in the NAFO Regulatory Area (NRA, Figure 2), using haul-based data from the NAFO Observer Program, and to quantify nominal catches of Greenland sharks in the NRA that were reported to the NAFO Secretariat by the Flag States.

Material and Methods

We evaluated the bycatch of Greenland shark in NAFO fisheries that operated in the NRA using recent haul-based data contained in the NAFO Observer Program Database. The fishery observers who collected these data are trained scientists who are required by the NAFO Conservation and Enforcement Measures (CEM) to be retained by the Flag States of each Contracting Party that fishes in the NRA. The first year that a species code was available for recording Greenland shark catches by fishery observers was 2000 (Jana Aker, pers. comm., May 30, 2018). However, we analyzed NAFO observer data for 2014-2017 because 2014 was the first year that a standardized haul-by-haul reporting template was required for data reporting (as outlined in Annex II.M of the NAFO CEM). The standard template for observer reports is available at https://www.nafo.int/Fisheries/MCS/ObserverScheme. Therefore, NAFO observer data from 2014 onward were used to quantify Greenland shark bycatch in NAFO fisheries.

We also summarized the annual nominal catches of Greenland shark in the NRA, reported to the NAFO Secretariat by Flag State, for all years contained in the STATLANT 21A Database. We used the 21A data instead of 21B data (i.e., the final catch dataset) because the U.S. has not reported 21B catch data to the Secretariat since 1994 and we wanted to include the U.S. catch data in the analysis. The resolution of the 21A data is one ton.

Data for hauls with catches of Greenland shark during 2014-2017 were extracted from the NAFO Observer Database. The target species for each haul was identified as the species that comprised the highest percentage, by weight, of the retained catch (excluding Greenland shark except when Greenland shark was the only catch for a haul). Data were not available to scale-up the observer-recorded catches of Greenland shark to the total catch of Greenland shark for all trips that occurred

in the NRA. As a result, our summaries of Greenland shark catch data pertain to the subset of trips sampled by NAFO fishery observers. However, NAFO observer trip coverage was fairly high and increased over time, with sampling of 60%, 72%, 83% and 88% of the total numbers of trips that occurred in the NRA during 2014-2017, respectively (Table 1). Days fished data obtained from the VMS database should also be analyzed in the future to determine observer coverage rates, but these data were not available for the entire time series at the time that this report was prepared. Numbers of Greenland shark caught in NRA fisheries represent minimum numbers because NAFO observers did not always record bycatch numbers.

The 2014-2017 NAFO Observer Program data were subsetted by gear type into longline hauls and bottom trawl hauls, using R software (version 3.5.0), and the R packages ggplot2 (https://CRAN.R-project.org/package=ggplot2) and gridExtra (https://CRAN.R-project.org/package=gridExtra) were used to produce graphs of bycatch weight (kg) by Division, gear type and target species. The same dataset was used to map Greenland shark bycatch weight, in kg per haul, by quarter and gear type. The maps were created using QGIS (version 3.0.3). The area fished per haul was roughly estimated as a straight line between the start and end coordinates of each haul. Data from the mapped dataset was also tabulated for ease of assessing the temporal and spatial characteristics of Greenland shark bycatch during 2014-2017.

The 2016-2017 NAFO Observer Program data were used to map the distribution of all hauls sampled by NAFO Observers in relation to hauls with Greenland shark bycatch (presence/absence) for trips conducted in the NRA. These were the only years for which presence/absence data could be easily extracted.

Results

For unknown reasons, a query of the STALANT 21A database indicated that Flag States did not report nominal catches of Greenland shark to the Secretariat until 2002. Annual catch reporting was also inconsistent. For example, no catches were reported during 2011-2014. Greenland shark catches totaled 134 t during 2002-2017 and were low and variable (ranging from 1-10 t) during 2002-2005, but then increased from 2 t in 2007 to 71 t in 2017 (Figure 3). Nominal catches totaled 90 t during 2015-2017 and most (69%) of the catches during 2002-2017 occurred in Subarea 1. During 2017, 92% of the Greenland shark catches were taken by Denmark/Greenland in Subarea 1, primarily (58%) in Division 1A.

A map of the distribution of all hauls sampled by NAFO Observers during 2016-2017 (i.e., with and without Greenland shark bycatch) indicated that most of the hauls with Greenland shark bycatch occurred at depths of 400-600 m in Division 3N (Figure 4). The next highest number of positive hauls occurred at depths near 400 m and 800-1,400 m along the west and north sides, respectively, of the Flemish Pass in Division 3L. Low numbers of positive hauls also occurred at depths of 700-900 m on the Flemish Cap in Division 3M.

During 2014-2017, maps of the spatial distribution of hauls with Greenland shark catches, by gear type, indicated that longline catches were most prevalent in Division 3N, while bottom trawl catches were most prevalent in Divisions 3L and 3M (Figure 5). Most of the longline catches in Division 3N occurred at depths of 200-1,200 m (mainly 400-800 m), with only a few longline catches on the Flemish Cap at depths of 800-1,200 m. Bottom trawl catches were more widespread and occurred in Divisions 3LMNO, but were mainly concentrated in 3L and 3M at depths of 400-1,400 m and 300-1,000 m, respectively. Interestingly, there were catches of this deepwater species in shallow areas of the Flemish Cap at depths of 200 m and shallower (Figure 5).

NAFO observer data indicated that most of the Greenland shark catches were discarded (catches were only retained on three hauls). Bycatch numbers of Greenland shark caught in the NRA during 2014-2017 totaled 486 and were highest in Division 3N (199 individuals totaling 41%) followed by Division 3L (173 individuals totaling 36%, Table 2). Bycatch numbers were highest (43%) in the Greenland halibut bottom trawl fishery, mainly in Division 3L, followed by the Atlantic halibut longline fishery (26%), mainly in Division 3N, and then the redfish bottom trawl fishery (19%), mainly in Divisions 3N and 3M (Tables 2-4).

The bycatch weight of Greenland shark during 2014-2017 totaled 512.7 t (Table 5) and was highest in Division 3L (Figure 6). Bycatch weight was much higher in bottom trawls (Table 6) than on longlines (Table 7) in all Divisions (i.e., Divisions 3LMNO). Twice as many Greenland sharks were caught in bottom trawls (N=328, Table 3), which comprised 67% of the total bycatch numbers (Tables 2-4), than on longlines (N=158, Table 4). Bycatch weight in bottom trawls (456.1 t, Table 6), which comprised 89% of the total bycatch weight (Tables 5-7), was eight times the bycatch weight of longlines (56.6 t, Table 7). Most (52%) of the total bycatch weight occurred in the Greenland halibut bottom trawl fishery, mainly in Division 3L (Table 5). Spatial distributions of Greenland shark bycatch weight (kg per haul) during 2014-2017 are shown for bottom trawls during quarters 1 and 2 (Figures 7) and quarters 3 and 4 (Figure 8) and for longline hauls during quarters 1-4 in Figures 9-12, respectively.

Monthly trends in Greenland shark bycatch were similar between weights and numbers for both bottom trawls (Figure 13) and longlines (Figure 14). For bottom trawls, most of the bycatch weight occurred during quarters 1 and 3 (36% and 33%, respectively) and most of the bycatch numbers occurred during quarters 1 (49%) and 4 (25%). For longlines, most of the Greenland shark bycatch weight occurred during quarters 4 (40%) and 3 (37%) and most of the bycatch numbers occurred during quarters 3 (46%) and 4 (30%). The average weight of individuals during 2014-2017 was much higher for bottom trawl catches (1.4 t) than for longline catches (0.4 t).

Directed fisheries for Greenland halibut, Atlantic halibut and redfish comprised 52%, 27% and 8%, respectively, of the total Greenland shark bycatch weight during 2014-2017 (Table 8) and the same fisheries comprised 43%, 26% and 19% of the bycatch numbers (Table 8). The Greenland halibut bottom trawl fishery was responsible for the highest Greenland shark bycatch weight during all four quarters, followed by the redfish bottom trawl fishery then the Atlantic halibut fishery (Figure 15). The numbers and weight of Greenland shark bycatch in the Greenland halibut bottom trawl fishery has nearly doubled every year since 2014 (Table 9). Although the number and weight of Greenland sharks caught in the Atlantic halibut longline fishery increased between 2014 and 2016, bycatch decreased in 2017 (Table 10).

Discussion

The global catch of Greenland shark reported to FAO during 1950-2015 was 3,289 t and when unreported bycatch and landings were added to this catch total (www.seaaroundus.org), Victorero et al. (2018) estimated a global catch of 13,513 t during 1950-2015. In comparison, the estimated bycatch weight of Greenland shark in NAFO-regulated fisheries during 2014-2017 totaled 512.7 t (representing a minimum number of 486 individuals) based on NAFO Observer data.

Nominal catches of Greenland shark have been reported to NAFO since 2002, but reporting was inconsistent. In recent years, catches increased from 1 t in 2002 and 2004 to 71 t in 2017; 69% of the catches during 2002-2017 were from Subarea 1. Nominal catches increased in recent years,

from 2 t in 200 to 71 t in 2017. During 2017, 92% of the Greenland shark catches were taken by Denmark/Greenland in Subarea 1, primarily (58%) in Division 1A.

The bycatch weight of Greenland shark in the NRA during 2014-2017 was more than eight times higher in bottom trawl fisheries than longline fisheries, totaling 89% of the total bycatch weight. Twice as many Greenland sharks were caught in bottom trawls as well, totaling 67% of the total bycatch numbers. Most individuals caught in bottom trawls occurred during quarters 1 and 4 whereas longline-caught individuals were most prevalent during quarters 3 and 4. The average weight of individuals caught during 2014-2017 was also much higher for bottom trawl catches (1.4 t) than for longline catches (0.4 t). Most of the Greenland shark bycatch weight in bottom trawls occurred during quarters 1 and 3 and the bycatch weight for longlines was most prevalent during quarters 4 and 3.

Bycatch weight of Greenland shark was highest in Division 3L and bycatch numbers were highest in Division 3N. The numbers caught in the NRA were highest (43%) in the Greenland halibut bottom trawl fishery, mainly in Division 3L, followed by the Atlantic halibut longline fishery (26%), mainly in Division 3N, then the redfish bottom trawl fishery (19%), mainly in Divisions 3N and 3M. The same three directed fisheries (in the same order) comprised 52%, 27% and 8%, respectively, of the total Greenland shark bycatch weight.

Greenland shark bycatch in the Greenland halibut bottom trawl fishery increased during 2014-2017 in terms of both numbers (from a minimum of 75 to 180 individuals) and weight (from 35.0 to 281.4 t). Therefore, the potential impacts of increased effort in the Greenland halibut fishery on the Greenland shark population inhabiting the NAFO Regulatory Area should be considered in the future. Although discard mortality for bottom trawls in unknown, it is high for individuals caught on longlines (MacNeil et al. 2012).

MacNeil et al. (2012) also noted that this long-lived species probably exhibits slow growth, late maturation and low fecundity, making it especially vulnerable to exploitation. In addition to fishing mortality impacts on the population, ongoing climate-related impacts on Greenland shark habitat are an important concern. Walter et al. (2107) noted that the species' Arctic Ocean habitat is undergoing major climate-related changes (Wassmann et al. 2011) and recommended that the impacts of these changes be considered when assessing the status of the population. In addition, Walter et al. (2017) found a lack of geographic structuring across the geographic range of Greenland shark and also that hybridization with Pacific sleeper sharks occurs near the edge of it's the range of Greenland shark. As a result, Walter et al. (2017) suggested that continued Arctic warming may contribute to a reduction in the genetic integrity of both species. This warming may also cause distribution changes for the Greenland shark population.

A quantitative assessment of the status of the Greenland shark population in NAFO-regulated waters would require much more knowledge about the species' life history and population dynamics than currently exists. For example, total fishery removals are unknown. Nominal catches of Greenland sharks have not been consistently reported to the Secretariat by Flag States based on data from the STALANT 21A Database and bycatch numbers and more biological data could be collected by NAFO fishery observers. In order to improve the quality and quantity of the bycatch data, all Greenland shark catches would need to be brought onboard the vessel for proper species identification and would allow the collection of biological data unless observers use photographs and an alternative method to measure shark length while a hooked or entangled individual is hauled in alongside the vessel. A Greenland shark identification sheet (e.g., FAO Species Identification Sheet) and photos, if provided to all fishery observers, would be helpful for accurate

species identification. In addition, observer instructions regarding collection of the following data would be useful for stock status assessment purposes: number and estimated weight of each shark caught per haul or set, catch disposition, measured total length and fork length. Currently, the number of sharks caught per haul or set is infrequently recorded in the "comments" section of the haul catch log. Catch weight per haul or set is generally estimated by the captain but the number of individuals caught is needed to determine the numbers of fishery removals. The collection of measured rather than estimated total length data are also needed and the collection of fork length data would allow for the calculation of length conversion factors. Sex should be recorded when possible and calcification of male claspers is useful for determining sexual maturity. Photo verification would be helpful in this regard. In order to improve the collection of biological data, individual animal haul logs would be necessary to record such data. Tagging of bottom trawl and longline catches of Greenland sharks by fishery observers would also be useful for determining discard survival rates and migration patterns.

Limited data make the assessment of Greenland shark stock status challenging, but as we have suggested here, this situation can be improved through the collection of fishery-dependent data such as catch and biological data as well as data relating to discard mortality and migration patterns. These recommendations will improve our knowledge about the Greenland shark population in the Northwest Atlantic and many of them can be implemented now.

Acknowledgements

We thank all of the hard-working fishery observers who have collected the data analyzed in this report.

References

Campana S. E., A. T. Fisk and A. P. Klimley. 2015. Movements of Arctic and northwest Atlantic Greenland shark (Somniosus microcephalus) monitored with archival satellite pop-up tags suggest long-range migrations. Deep Sea Research Part II. doi:10.1016/j.dsr2.2013.11.001

Jana Aker, NAFO staff, personal communication on May 30, 2018.

Kyne, P.M., Sherrill-Mix, S.A. & Burgess, G.H. 2006. *Somniosus microcephalus*. The IUCN Red List of Threatened Species 2006: e.T60213A12321694. http://dx.doi.org/10.2305/IUCN.UK.2006.RLTS.T60213A12321694.en. Downloaded on 24 May 2018.

MacNeil M.A., B.C. McMeans, N.E. Hussey, P. Vecsei, J. Svavarsson, K.M. Kovacs, C. Lydersen, M.A. Treble, G.B. Skomal, M. Ramsey, and A.T. Fisk. 2012. Biology of the Greenland shark *Somniosus microcephalus*. J Fish Biol 80: 991–1018.

Victorero, L., L. Watling, M.L. Deng Palomares and C. Nouvian. 2018. Out of Sight, But Within Reach: A Global History of Bottom-Trawled Deep-Sea Fisheries From >400m Depth. Front. Mar. Sci. 5:98. doi: 10.3389/fmars.2018.00098

Walter, Ryan P., Denis Roy, Nigel E. Hussey, Björn Stelbrink, Kit M. Kovacs, Christian Lydersen, Bailey C. McMeans, Jörundur Svavarsson, Steven T. Kessel, Sebastián Biton Porsmoguer, Sharon

Wildes, Cindy A. Tribuzio, Steven E. Campana, Stephen D. Petersen, R. Dean Grubbs, Daniel D. Heath, Kevin J. Hedges, and Aaron T. Fisk. 2017. Ecol Evol. 7(19): 8113–8125.

Wassmann, P., Duarte, C. M., Agusti, S., & Sejr, M. (2011). Footprints of climate change in the Arctic marine ecosystem. Global Change Biology, 17: 1235–1249.

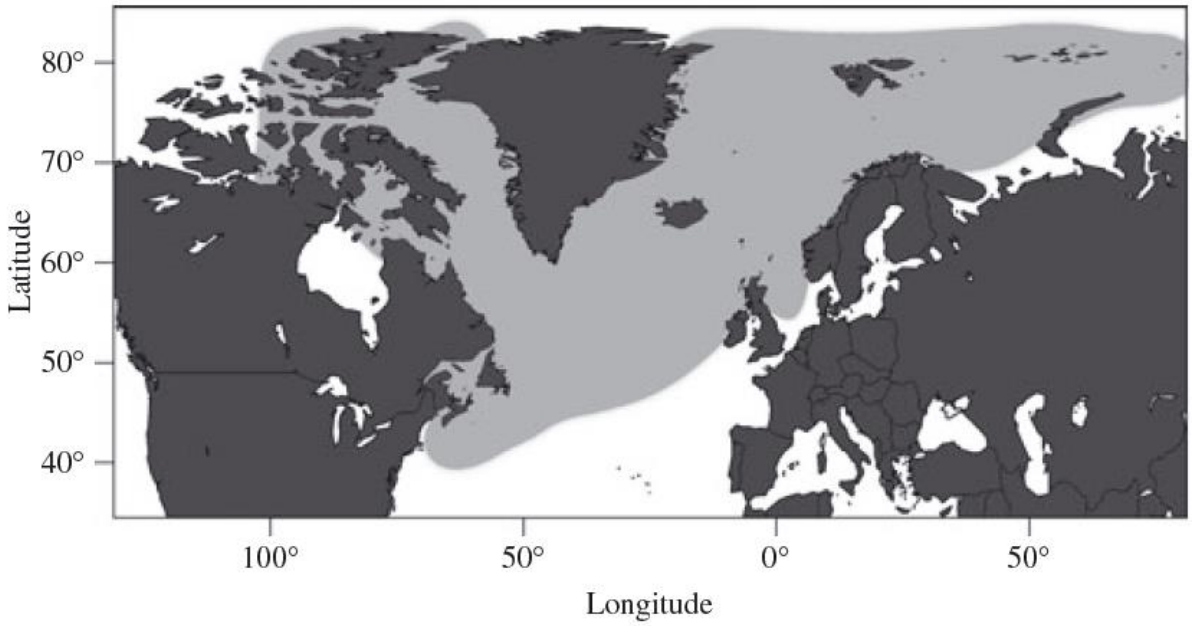

Fig. 1. The geographic range of Greenland shark, *Somniosus microcephalus* (from MacNeil et al. 2012).

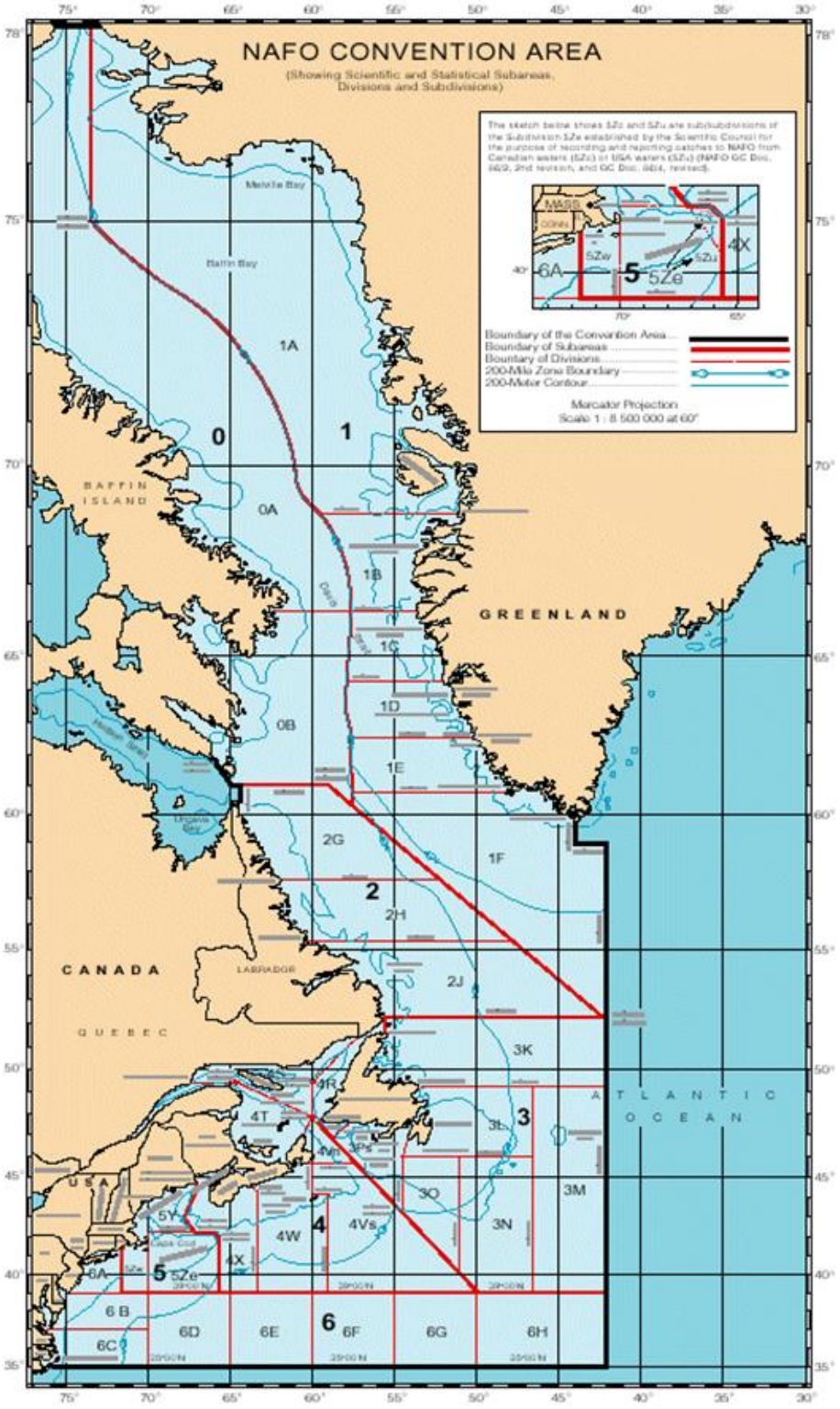

Fig. 2. Northwest Atlantic Fisheries Organization (NAFO) nominal catch reporting areas, Subareas 0-6 and associated Divisions, for fisheries conducted in the Northwest Atlantic Ocean.

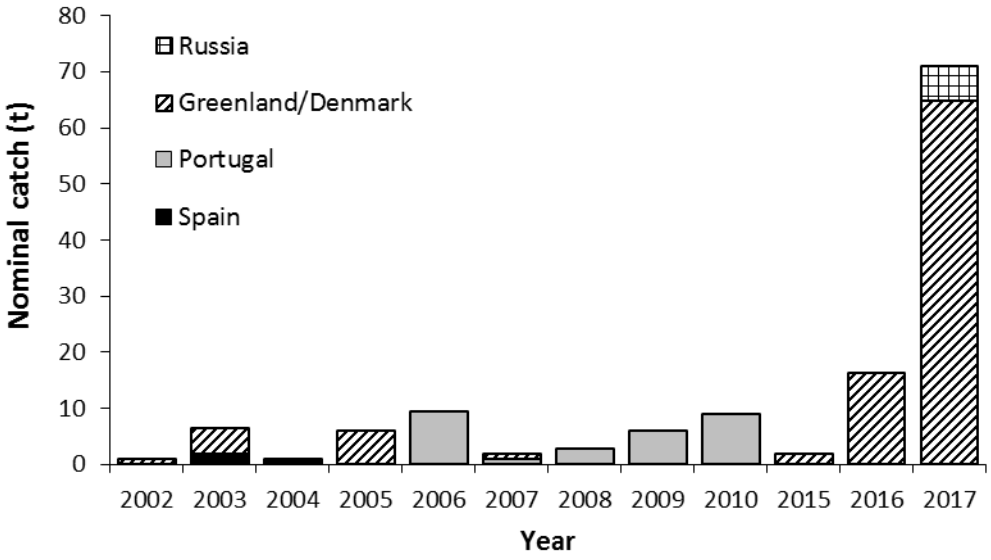

Fig. 3. Nominal catches (t) of Greenland shark reported by Flag States to the NAFO Secretariat during 1960-2017 (Source: STATLANT 21A Database). Greenland shark catch data have only been reported since 2002.

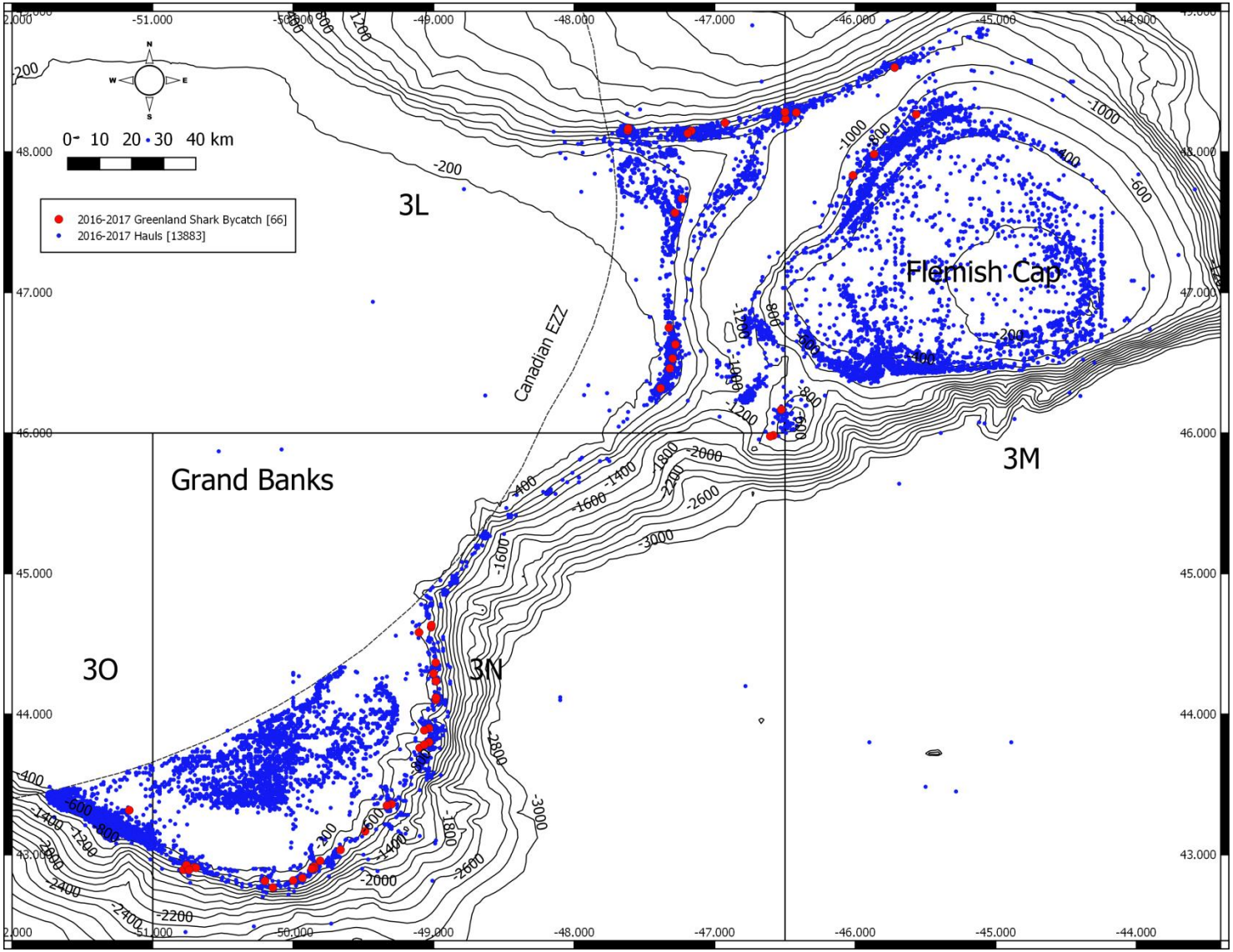

Fig. 4. Distribution of hauls (N=13,949) sampled by NAFO observers during 2016-2017 in the Regulatory Area. Red dots and blue dots indicate hauls with and without, respectively, of Greenland shark bycatch. The isobaths shown extend from 200 m to 3,000 m.

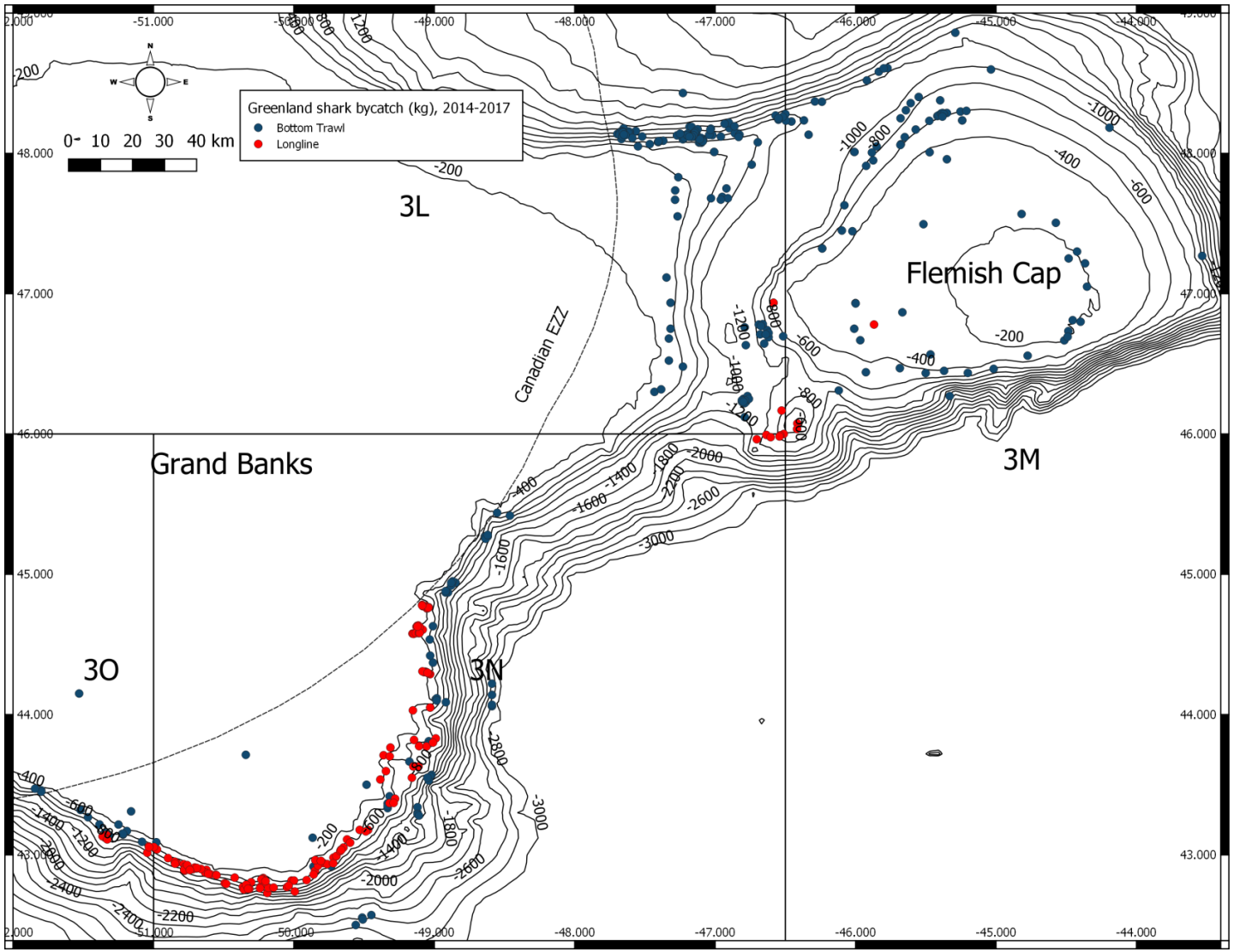

Fig. 5. Distribution of hauls with Greenland shark bycatch on longlines (red dots) and in bottom trawls (blue dots) during trips that occurred in the NAFO Regulatory Area, during 2014-2017, based on data from the NAFO Observer Program. The isobaths shown extend from 200 m to 3,000 m.

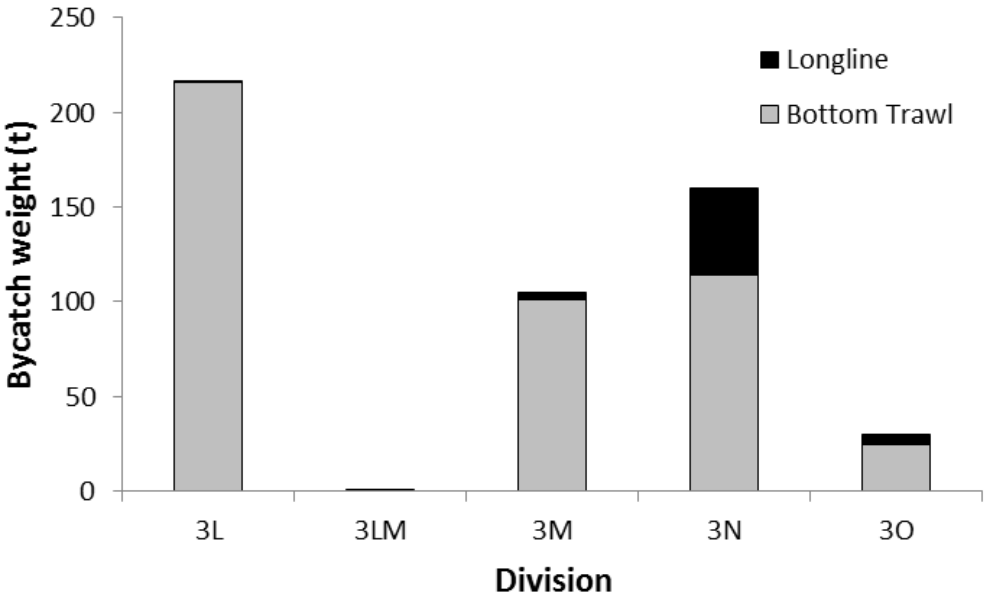

Fig.6. Bycatch weight (t) of Greenland shark, by gear type and Division, based on data from the NAFO Observer Program during 2014-2017.

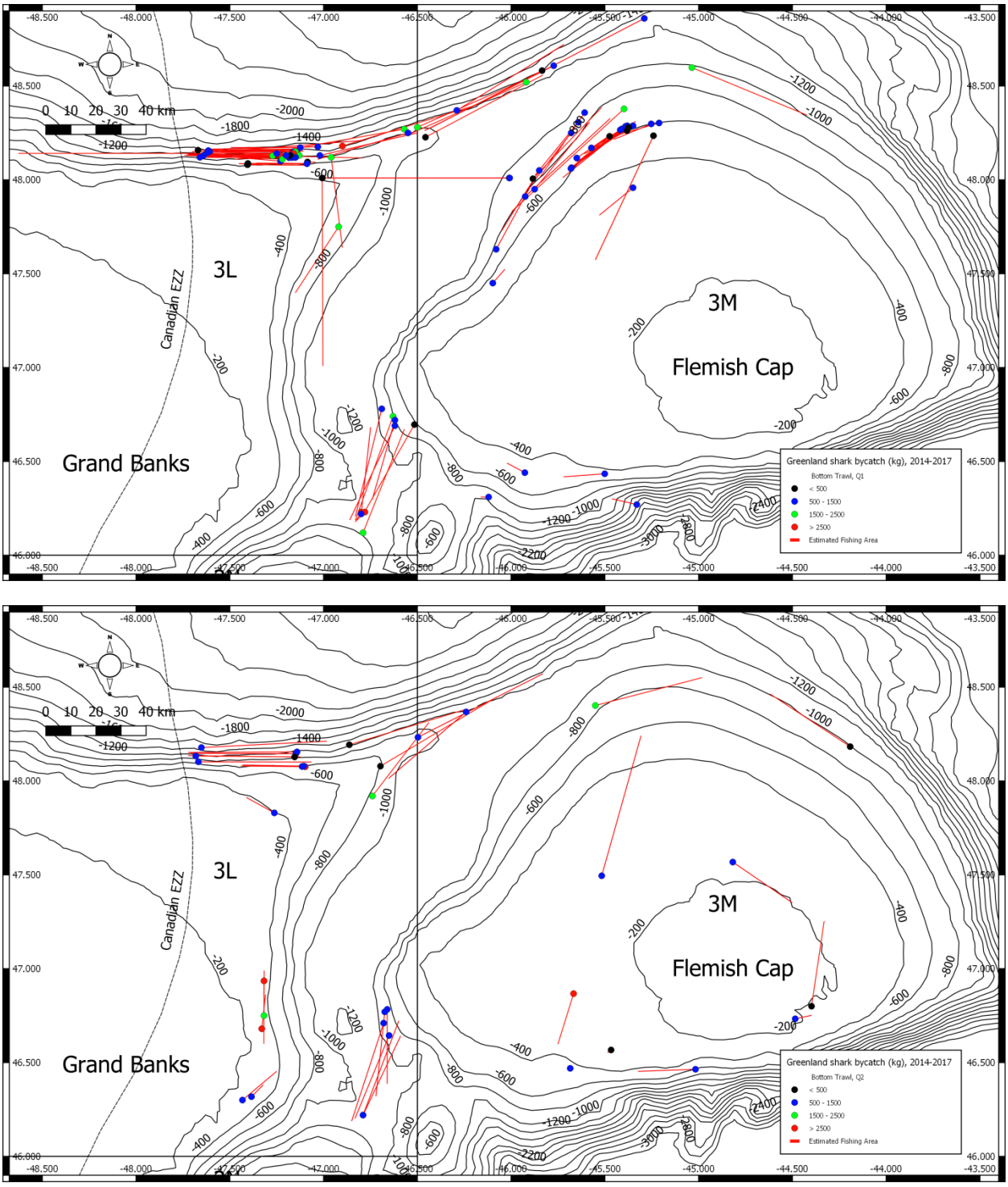

Fig. 7. Hauls with Greenland shark bycatch (kg) in bottom trawl fisheries conducted in Divisions 3LM of the NAFO Regulatory Area, during quarters 1 (top) and 2 (bottom) of 2014-2017, based on data from the NAFO Observer Program. The red lines represent straight-line estimates of the areas fished during each haul.

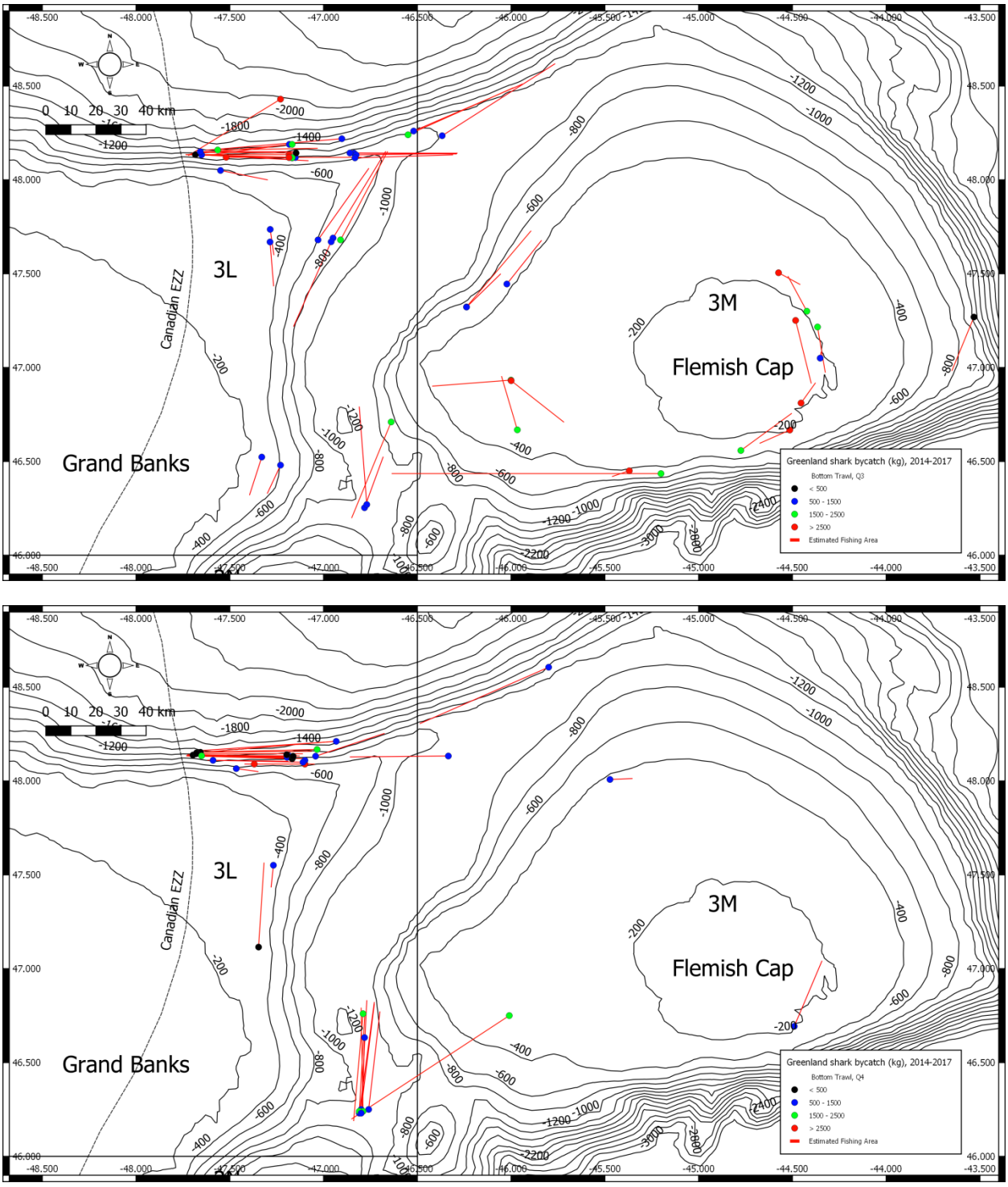

Fig. 8. Hauls with Greenland shark bycatch (kg) in bottom trawl fisheries conducted in Divisions 3LM of the NAFO Regulatory Area, during quarters 3 (top) and 4 (bottom) of 2014-2017, based on data from the NAFO Observer Program. The red lines represent straight-line estimates of the areas fished during each haul.

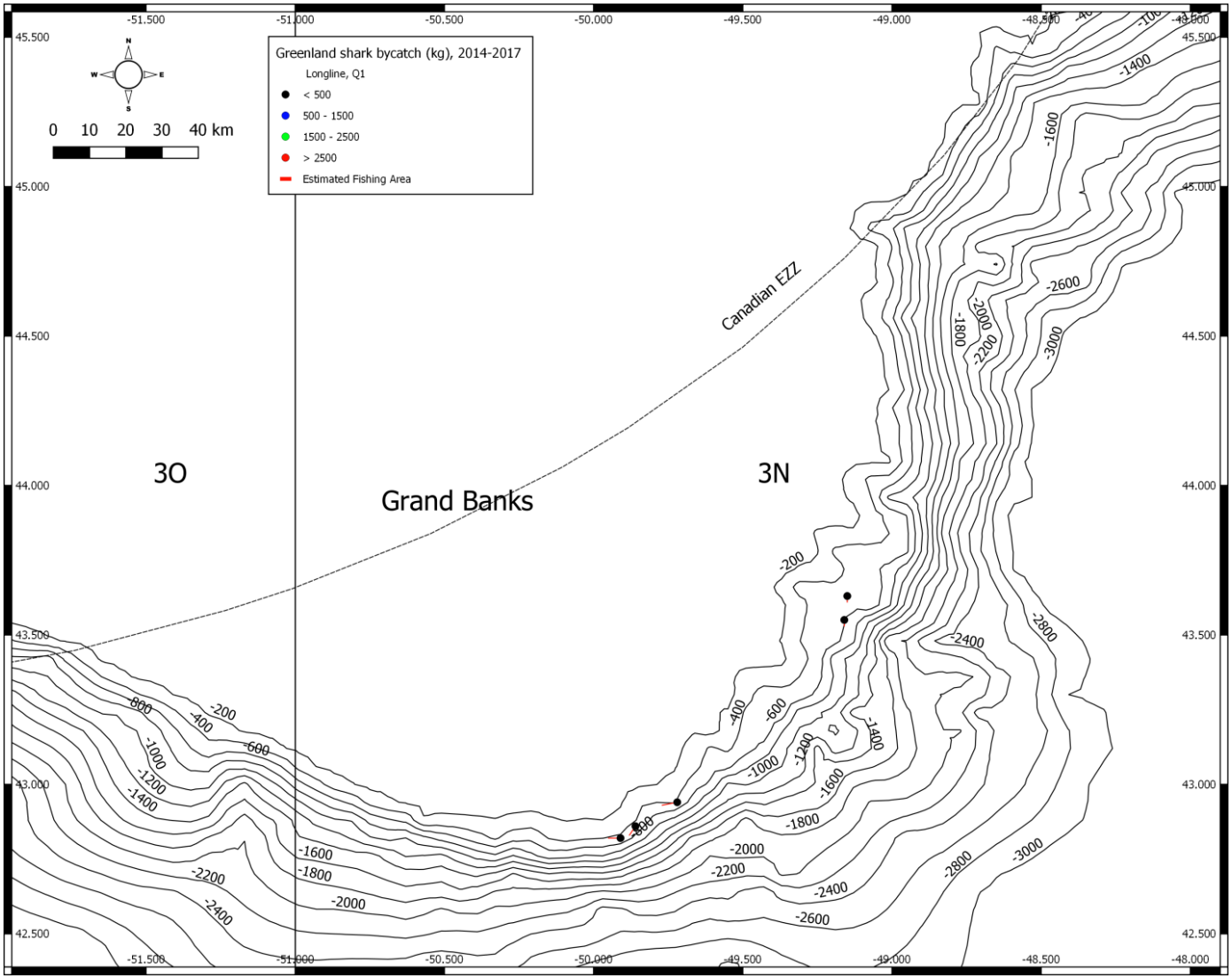

Fig. 9. Hauls with Greenland shark bycatch (kg) in longline fisheries conducted in Divisions 3NO of the NAFO Regulatory Area, during quarter 1 of 2014-2017, based on data from the NAFO Observer Program. The red lines represent straight-line estimates of the areas fished.

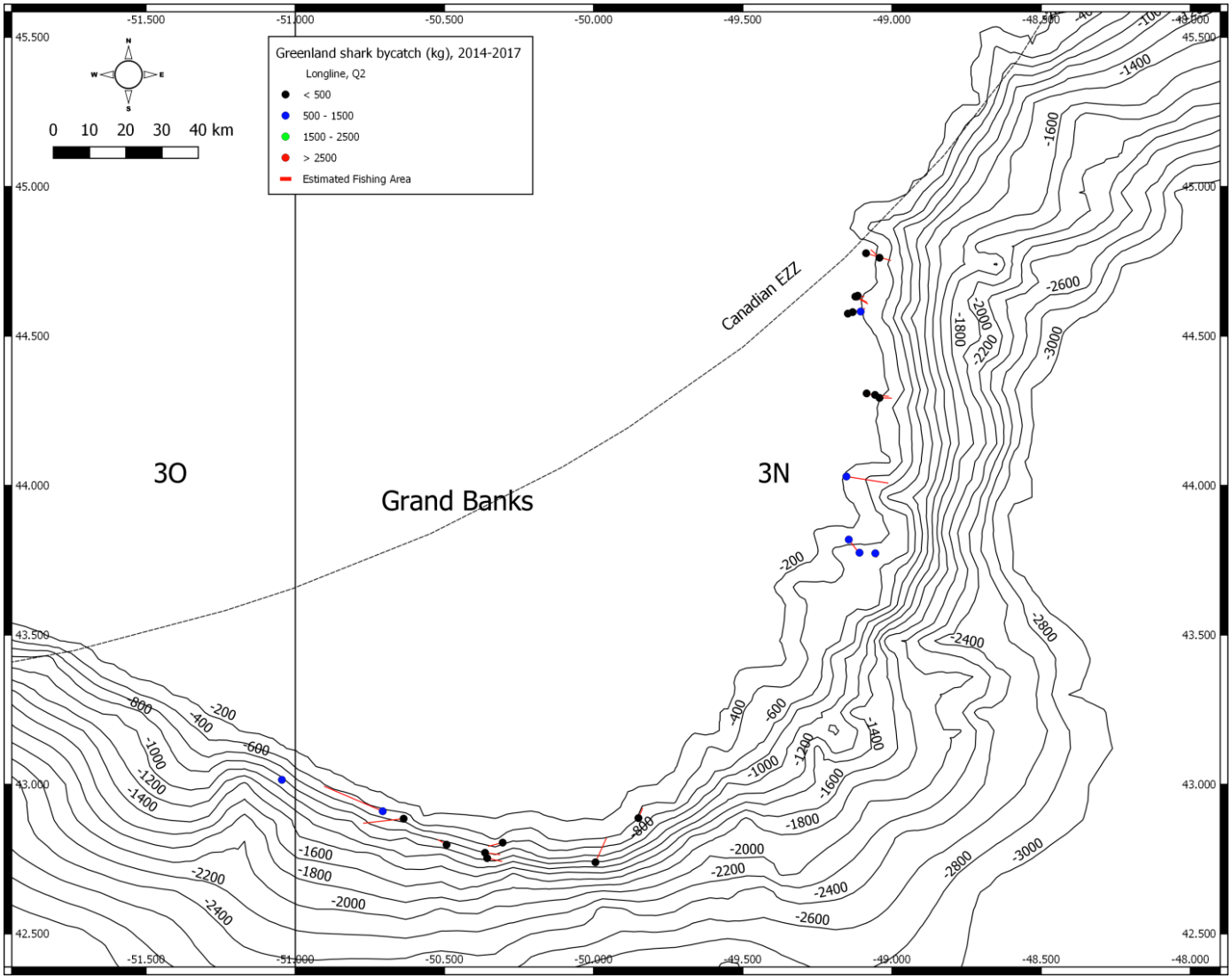

Fig. 10. Hauls with Greenland shark bycatch (kg) in longline fisheries conducted in Divisions 3NO of the NAFO Regulatory Area, during quarter 2 of 2014-2017, based on data from the NAFO Observer Program. The red lines represent straight-line estimates of the areas fished.

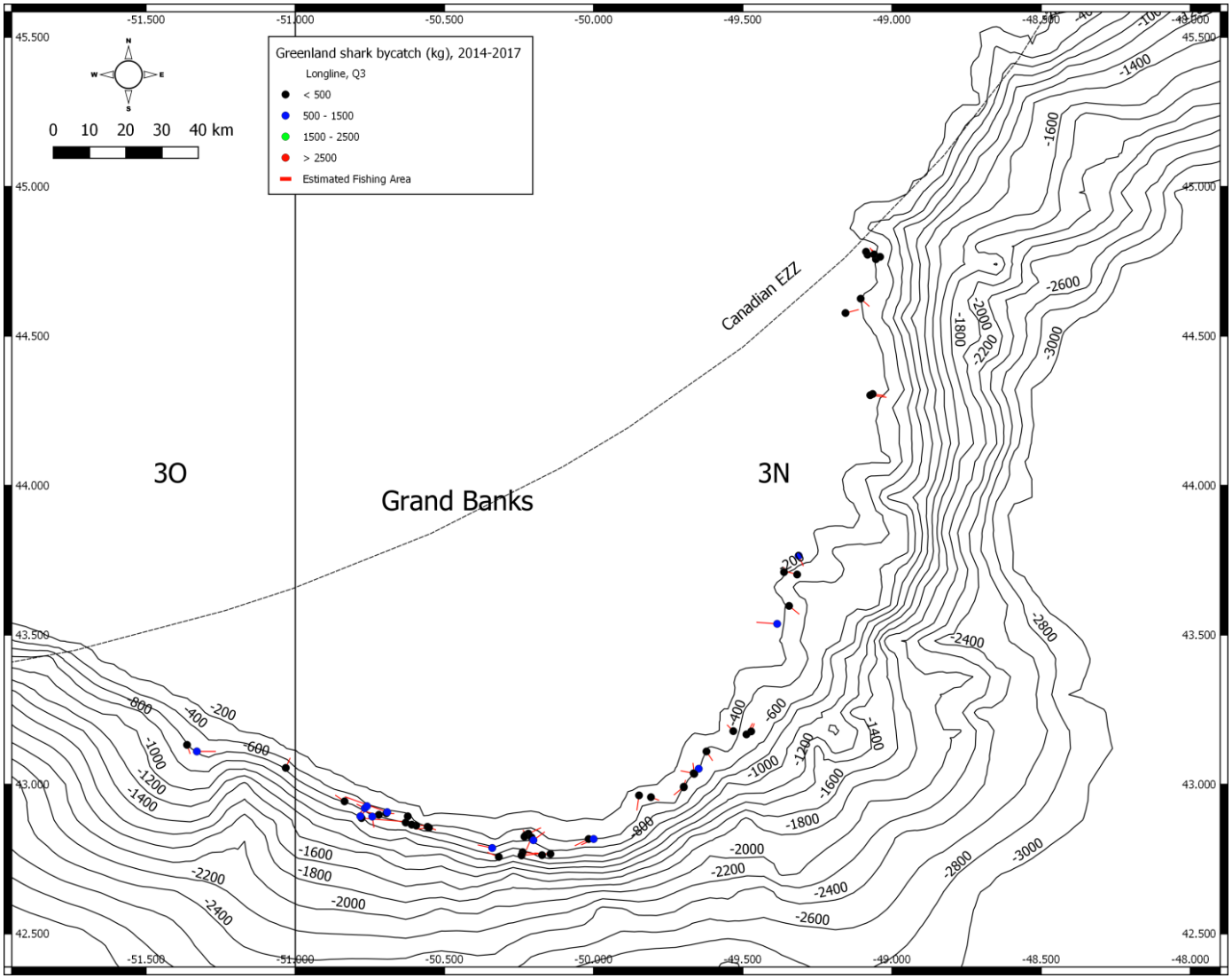

Fig. 11. Hauls with Greenland shark bycatch (kg) in longline fisheries conducted in Divisions 3NO of the NAFO Regulatory Area, during quarter 3 of 2014-2017, based on data from the NAFO Observer Program. The red lines represent straight-line estimates of the areas fished.

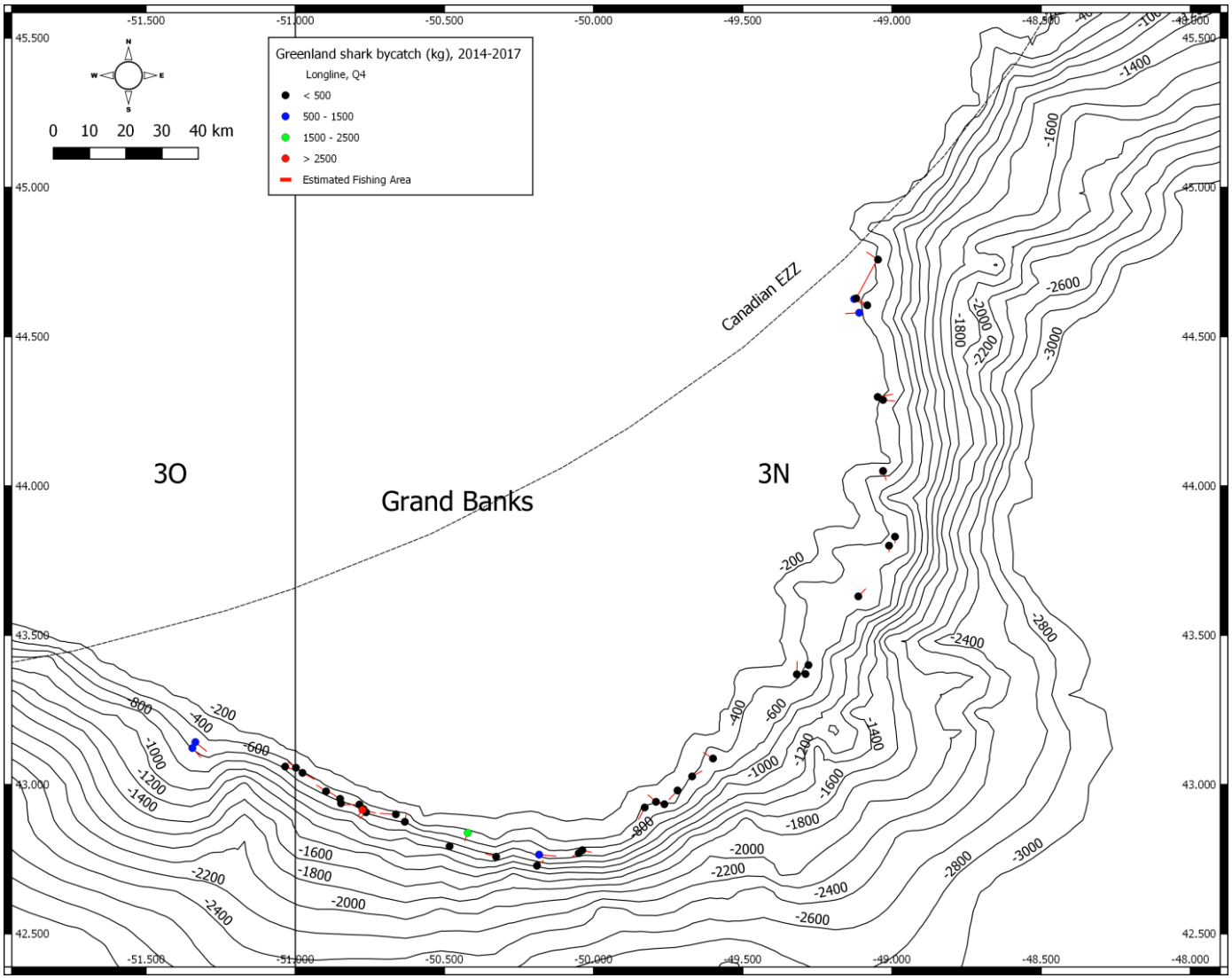

Fig. 12. Hauls with Greenland shark bycatch (kg) in longline fisheries conducted in Divisions 3NO of the NAFO Regulatory Area, during quarter 4 of 2014-2017, based on data from the NAFO Observer Program. The red lines represent straight-line estimates of the areas fished.

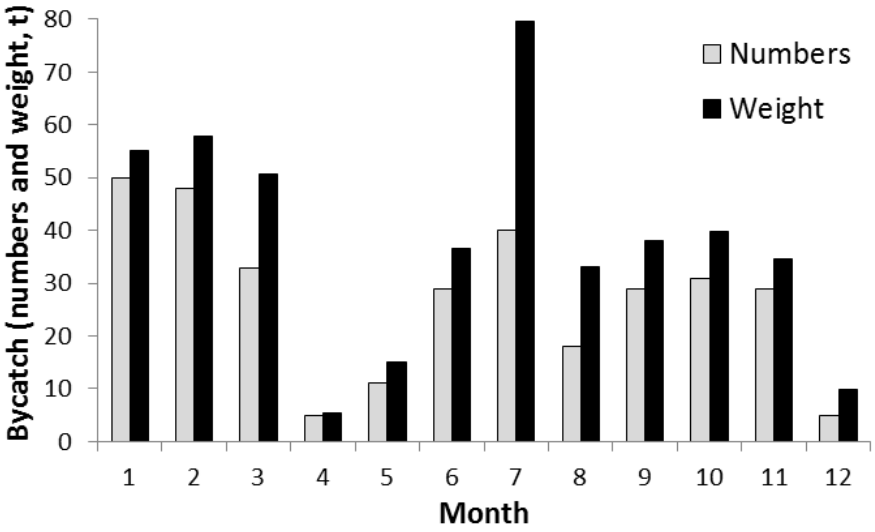

Fig. 13. Minimum numbers and weights (t) of Greenland shark bycatch in bottom trawls in the NAFO Regulatory Area, by month, based on data from the NAFO Observer Program during 2014-2017.

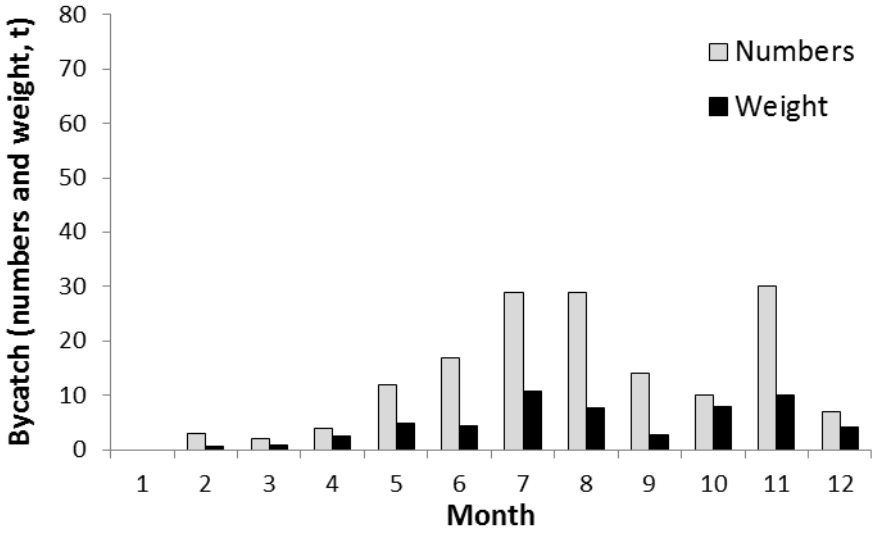

Fig. 14. Minimum numbers and weights (t) of Greenland shark bycatch on longlines in the NAFO Regulatory Area, by month, based on data from the NAFO Observer Program during 2014-2017.

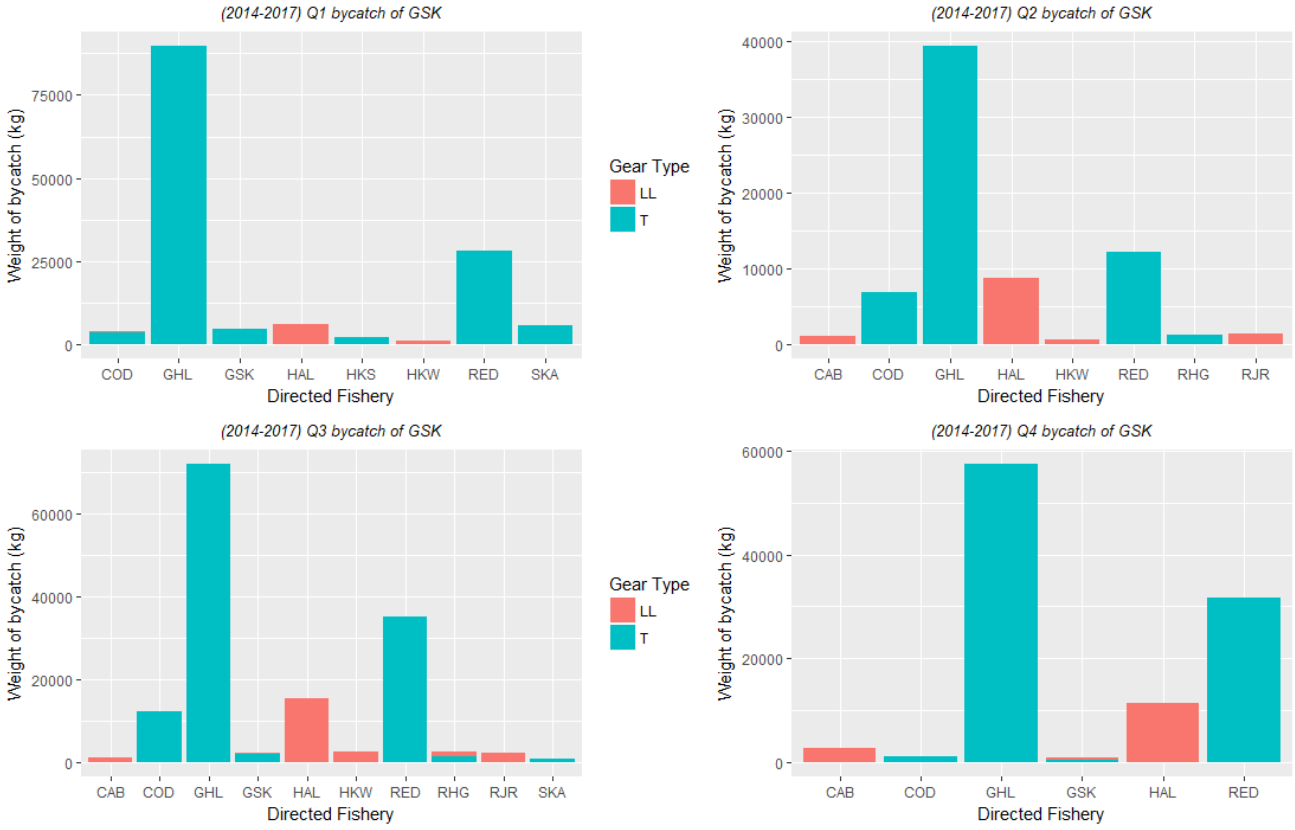

Fig. 15. Bycatch weight (kg) of Greenland shark caught in the NAFO Regulatory Area, by directed fishery, gear type (LL is longline and T is bottom trawl) and quarter, during 2014-2017 based on NAFO Observer data. Abbreviations for the directed fisheries are: CAB (Northern wolfish), COD (cod), GHL (Greenland halibut), GSK (Greenland shark), HAL (Atlantic halibut), HKS (silver hake), HKW (white hake), RED (redfishes), RHG (roughhead grenadier), RJR (thorny skate) and SKA (skates).

Table 1. NAFO observer coverage, by year, based on the percentage of sampled trips conducted in the NAFO Regulatory Area during 2014-2017.

Year	Total Number of Trips	Number of Trips With Observer Reports	% Coverage
2014	140	84	60
2015	138	99	72
2016	119	99	83
2017	112	99	88

Table 2. Minimum numbers of Greenland shark caught in the NAFO Regulatory Area, by target species and Division, based on NAFO observer data during 2014-2017.

	Division						
Target species	**3L**	**3LM**	**3M**	**3N**	**3O**	**Total**	**%**
Greenland halibut	152	1	26	30		209	43.0
Atlantic halibut	3		2	115	5	125	25.7
Atlantic redfishes	15		28	34	15	92	18.9
Cod			20			20	4.1
White hake				5	5	10	2.1
Thorny skate				8	1	9	1.9
Greenland shark	1		1		2	4	0.8
Northern wolffish	1		5			6	1.2
Roughhead grenadier	1			5		6	1.2
Skates				2	2	4	0.8
Silver hake					1	1	0.2
Total	**173**	**1**	**82**	**199**	**31**	**486**	

Table 3. Minimum numbers of Greenland sharks caught in the NAFO Regulatory Area in bottom trawls, by target species and Division, based on NAFO observer data during 2014-2017.

	Division						
Target Species	**3L**	**3LM**	**3M**	**3N**	**3O**	**Total**	**%**
Greenland halibut	151	1	26	28		206	62.8
Redfishes	14		28	34	15	91	27.7
Cod			19			19	5.8
Greenland shark	3		1		2	6	1.8
Skates				2	2	4	1.2
Silver hake					1	1	0.3
Roughhead grenadier	1					1	0.3
Total	**169**	**1**	**74**	**64**	**20**	**328**	

Table 4. Minimum numbers of Greenland sharks caught in the NAFO Regulatory Area on longlines, by target species and Division, based on NAFO observer data during 2014-2017.

	Division					
Target Species	**3L**	**3M**	**3N**	**3O**	**Total**	**%**
Atlantic halibut	3	2	115	5	125	38.1
White hake			5	5	10	3.0
Thorny skate			8	1	9	2.7
Northern wolffish	1	5			6	1.8
Roughhead grenadier			5		5	1.5
Greenland shark			2		2	0.6
Cod		1			1	0.3
Total	**4**	**8**	**135**	**11**	**158**	

Table 5. Bycatch weight (t) of Greenland sharks caught in the NAFO Regulatory Area, by target species and Division, based on NAFO observer data during 2014-2017.

	Division						
Target Species	**3L**	**3LM**	**3M**	**3N**	**3O**	**Total**	**%**
Greenland halibut	194.6	0.2	28.0	46.3		269.0	52.5
Redfishes	19.6		39.8	65.1	15.3	139.7	27.3
Atlantic halibut	0.6		0.4	39.4	2.6	43.1	8.4
Cod			32.7			32.7	6.4
Skates				2.7	5.5	8.2	1.6
White hake				3.5	1.4	4.9	0.9
Northern wolffish	0.5		3.2			3.7	0.7
Thorny skate				2.3	1.4	3.6	0.7
Greenland shark	0.5		1.0		2.0	3.5	0.7
Roughhead grenadier	1.2			1.1		2.3	0.5
Silver hake					2.0	2.0	0.4
Total	**216.9**	**0.2**	**105.1**	**160.3**	**30.2**	**512.7**	

Table 6. Bycatch weight (t) of Greenland sharks caught in the NAFO Regulatory Area in bottom trawls, by target species and Division, based on NAFO observer data during 2014-2017.

	Division						
Target Species	**3L**	**3LM**	**3M**	**3N**	**3O**	**Total**	**%**
Greenland halibut	194.6	0.2	28.0	46.3		269.0	59.0
Redfishes	19.6		39.8	65.1	15.3	139.7	30.6
Cod			32.5			32.5	7.1
Skates				2.7	5.5	8.2	1.8
Greenland shark	0.5		1.0		2.0	3.5	0.8
Silver Hake					2.0	2.0	0.4
Roughhead grenadier	1.2					1.2	0.3
Total	**215.8**	**0.2**	**101.3**	**114.0**	**24.8**	**456.1**	

Table 7. Bycatch weight (t) of Greenland sharks caught in the NAFO Regulatory Area on longlines, by target species, based on NAFO observer data during 2014-2017.

	Division					
Target Species	**3L**	**3M**	**3N**	**3O**	**Total**	**%**
Atlantic halibut	0.6	0.4	39.4	2.6	43.1	76.1
White hake			3.5	1.4	4.9	8.6
Northern wolfish	0.5	3.2			3.7	6.5
Thorny skate			2.3	1.4	3.7	6.4
Roughhead grenadier			1.1		1.1	2.0
Cod		0.2			0.2	0.4
Total	**1.1**	**3.8**	**46.3**	**5.4**	**56.6**	

Table 8. Minimum numbers and bycatch weight (t) of Greenland sharks caught in the NAFO Regulatory Area, by year and target species, based on NAFO observer data from 2014-2017.

	Minimum Number					Bycatch Weight (t)				
Target Species	**2014**	**2015**	**2016**	**2017**	**Total**	**2014**	**2015**	**2016**	**2017**	**Total**
Greenland halibut	20	42	49	96	207	11.2	29.8	65.5	162.6	269.0
Redfishes	10	5	38	39	92	7.1	4.2	43.8	84.7	139.7
Atlantic Halibut	23	42	38	24	127	6.9	11.8	9.6	14.8	43.1
Cod	3	2	11	4	20	3.8	1.1	23.3	4.5	32.7
White Hake	5			5	10	1.4			3.5	4.9
Thorny Skate	8	1			9	2.3	1.4			3.7
Roughhead grenadier	6				6	2.3				2.3
Northern Wolffish				6	6				3.7	3.7
Greenland shark		1		3	4		0.5		3.0	3.5
Skates			2	2	4			5.5	2.7	8.2
Silver hake				1	1				2.0	2.0
Total	**75**	**93**	**138**	**180**	**486**	**35.0**	**48.7**	**147.6**	**281.4**	**512.7**

Table 9. Minimum numbers and bycatch weight (t) of Greenland sharks caught in the NAFO Regulatory Area in bottom trawls, by year and target species, based on NAFO observer data during 2014-2017.

	Minimum Number					Bycatch weight (t)				
Target Species	**2014**	**2015**	**2016**	**2017**	**Total**	**2014**	**2015**	**2016**	**2017**	**Total**
Greenland halibut	20	42	49	96	207	11.2	29.8	65.5	162.6	269.0
Redfishes	10	5	38	39	92	7.1	4.2	43.8	84.7	139.7
Cod	3	2	10	4	19	3.8	1.1	23.1	4.5	32.5
Greenland shark		1		3	4		0.5		3.0	3.5
Skates			2	2	4			5.5	2.7	8.2
Silver hake				1	1				2.0	2.0
Roughhead grenadier	1				1	1.2				1.2
Total	**34**	**50**	**99**	**145**	**328**	**23.4**	**35.5**	**137.8**	**259.4**	**456.1**

Table 10. Minimum numbers and bycatch weight (t) of Greenland sharks caught in the NAFO Regulatory Area on longlines, by year and target species, based on NAFO observer data during 2014-2017.

	Minimum Number					Bycatch weight (t)				
Target Species	**2014**	**2015**	**2016**	**2017**	**Total**	**2014**	**2015**	**2016**	**2017**	**Total**
Atlantic halibut	23	42	38	24	127	6.9	11.8	9.6	14.8	43.1
White hake	5			5	10	1.4			3.5	4.9
Thorny skate	8	1			9	2.3	1.4			3.7
Northern wolfish				6	6				3.7	3.7
Roughhead grenadier	5				5	1.1				1.1
Cod			1		1			0.2		0.2
Total	**41**	**43**	**39**	**35**	**158**	**11.7**	**13.2**	**9.8**	**21.9**	**56.6**