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Biomass and Abundance of Demersal Fish Stocks in the Nuuk fjord.

by

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Abstract

In 2015, the Greenland Institute of Natural Resources initiated a trawl survey in the inshore area of NAFO subarea 1D. The fjords surround the capitol of Greenland, Nuuk and supports several fisheries including Cod and Greenland halibut. The survey is performed with the 458 GT and 32m long research vessels RV Sanna, equipped with a 1440 mesh bacalao trawl. The survey is based on a depth stratification of the fjords using fixed stations where bottom conditions allows bottom trawling. This paper includes biomass and abundance estimates for the Nuuk fjord and Ameralik for Greenland halibut, shrimp, cod, deep-sea redfish and Golden redfish.

Introduction

The survey area

The survey initially covered 3 fjord areas in NAFO division 1D located in West Greenland (Fig. 1). The Nuuk fjord is the larger of the fjords. It is connected to the Davis trait through a narrow channel in the western part and bottom temperatures are influenced by influx of warmer water from the Davis strait/irminger current. The fjord branches towards the East in several channels that meet again in the eastern part of the fjord. An icefjord is located in the North-eastern branch of the system with 3 smaller iceberg producing glaciers. Glacier activity and tidal currents allows exchange of water masses with the Davis strait and the fjord is known to be highly productive, with both a spring and autumn bloom supplemented with secondary blooms driven by glacier activity (ref).

The Ameralik fjord is a long narrow and fjord branching in two shallow areas in the eastern part. Ameralik is about 7 times smaller than the Nuuk fjord. It is connected to the Davis strait through a shallow archipelago in the western part. The western opening limits the exchange of water masses with the Davis strait, and the bottom waters are very stationary with a constant summer and winter temperature of about -0.3 degrees C. Large amounts of highly silty glacier water flows into the fjord in the eastern part partly limiting primary production.

The Qarajat fjord is a more open coastal zone or archipelago surrounded basin south of the other larger fjords. The area was only surveyed in the first years, as bottom conditions and kelp debris makes bottom trawling difficult in the area. However, the few stations in the area revealed higher numbers of juvenile one and two-year-old Greenland halibut in the area. The stations were however omitted from the survey indices.

Materials and Methods

Survey design, stratification and area coverage

The survey area is divided into primary and secondary strata. The survey primary stratum correspond to the fjords. The primary stratum is further subdivided into secondary (depth) strata at 0–200 m, 200-400 m, 400-600 m and deeper than 600 m (Table 1).

Survey period and daily sampling period

The trawl survey has in some years been conducted in the spring (years) and in the autumn (years), in an attempt to find a suitable period to survey cod along with the other species.

Trawling is carried out in the daytime. It takes about 5 days to complete the survey in a year.

Tow duration and speed

In all years towing time has been 30 min. Towing speed is about 2-2.5 knots throughout the years.

Survey vessel, gear and trawl

The survey is performed with the 458 GT and 32m long and 10 m wide research vessel *RV Sanna* owned by the GINR. Since *RV Sanna* was built in 2012, the vessels has gone through several equipment updates. In 2015, no trawl sensors were installed on the vessel and tow start was estimated from vessel movement and skippers experience. In 2017, Sanna was equipped with marport trawlsensors and a Seabat T50 sidescan zonar from Teledyne. The trawl is a 1440 mesh bacalao trawl supplied by Vónin. The bacalao trawl is a fish trawl with an overhanging headrope, but modified with a finer meshed codend and bell for scientific purposes to also select shrimp and juvenile fish.

Swept area calculation

Nominal swept area for each tow was calculated as the straight-line distance between its GPS start and end positions multiplied by the wingspread. The distance between the trawl doors is recorded 3 or 5 times during each tow; provided it was recorded at least 3 times, wingspread for a tow was calculated from the mean door spread and the geometry of the trawl. For the years without trawl censors a modelled door spread was calculated based on depth and door spread in the 2017-2019 trawl survey. The length of the bacalao 1440 mesh trawl is estimated to 32m and the length of the bridles, chains and front wings 41,7m. (see appendix I)

Biomass estimation

The catch in each haul is divided by the estimated swept area calculated from wingspread and track length to estimate a biomass density. Unweighted mean stratum densities were multiplied by the stratum area (table 1) to calculate stratum biomass, and a corresponding error variance for the stratum biomass estimate was also calculated for strata with two or more accepted hauls. For strata with only one accepted haul, an average error of variance for all strata was assigned. If a strata has no stations in a given year, the neighbouring strata with stations in that year is geographically enhanced to include the un-surveyed strata. This way the total area surveyed is kept constant across years.

Results

The number of valid hauls by year and strata are listed in table 2 and by depth strata in table 3. Although the survey is based on fixed stations, stations have been moved due to bottom conditions on some occasions or to avoid conflicts with commercial fishery. Only hauls in the Nuuk fjord and Ameralik were used in the biomass and abundance calculations and in the length frequencies. The Qarajat stations were only completed in the initial years, and therefore not used in the indices. For illustrative purposes, the biomass and abundance densities from Qarajat were included on the maps. Bottom temperatures in Amaralik is about 2 to 3 degrees C° colder than in both The Nuuk fjord and in the Qarajat area (Table 4).

Greenland halibut (*Reinhardtius hippoglossoides*).

Greenland halibut in the Nuuk fjord are believed to be dependent on recruitment from the offshore spawning stocks in either the Davis strait or East Greenland. During the 1960's to the mid 1980's the fjord supported average landings of Greenland halibut of about 500 MT/year. The fishery peaked in 1984 at more than 2100 MT, but thereafter decreased to less than 100 MT in 1989 and remained at a low level for two decades. From 2009 the fishery gradually increased and 2013 and onwards the average landings have been around 1100 MT/ year.

The abundance index for Greenland halibut was higher in the initial year 2015, than estimated in 2017 and 2019 (table 5, figure 2, figure 11). The length frequencies indicate higher numbers of Greenland halibut in the commercial size range 40+ cm in 2015 than in the preceding years (figure 7). The biomass index was highest in 2015, with an estimated 3015 MT in the fjord (Table 6). The 2017 biomass index was only 1263 t but has gradually increased since and the 2019 biomass index was almost as high as in 2015. However, the length distribution indicates higher numbers of Greenland halibut in the pre-fishery size of 30-40 cm, indicating good recruitment in the preceding years (figure 6).

Shrimp (*Pandalus borealis*)

The shrimp biomass index has varied between 1500 and 2500 Mt from 2015-2019 without a clear trend (table 7 and figure 3). The maps of biomass densities show that shrimp are distributed over several locations but mainly in the deeper parts of the fjord.

Cod (*Gadus morhua*)

Since the fishery for cod in the fjord are several times greater than the survey index, any conclusion based on cod indices are tentative. Instead juvenile cod are surveyed with gillnets along the beaches and with a pelagic survey and acoustics also from RV Sanna. Cod are known to migrate to shallow water during the summer and to swim pelagic in the area year around and are therefore not easy to survey with bottom trawl in the area. Cod abundance and biomass indices are given in table and figure 7.In all years, cod were

in the south eastern part of the Nuuk fjord (towards the Kapisillit settlement) and in the north eastern branch of Ameralik mainly from 200-400 m (figure 10).

Deep-sea redfish (*Sebastes mentella*)

Both the abundance index (table 10) and the biomass index (table 11) of deep-sea redfish fluctuates without a clear trend from 2015 to 2019. Like Cod, redfish swim pelagic and some caution should be given when interpreting the results. Length frequencies show that only deep-sea redfish in the size range from 25 to 44 cm are present in the fjord, but no juveniles are observed. This is in agreement with similar surveys from both East Greenland (ices NWWG, anon) and West Greenland indicating poor redfish recruitment at least since 2010 (Nygaard and Nogueira 2020).

Golden Redfish (*S. Norvegicus*)

Very few golden redfish were found in the survey and the abundance (table 12) and biomass (table 13) indices are low in all years (figure 6). Previously it was thought that most of the redfish in the fjord were golden redfish but in both 2018 and 2019, less than 10% of the redfish biomass in the fjord was estimated to be golden redfish. Only large golden redfish were caught in the survey in a similar size range as observed in the nearby offshore area (see SCR 20/0xx).

Discussion

Catchability is set at 1 for all species. However, since swept area is calculated for the trawl only, excluding doors and bridles, catchability may be higher than 1 for some species and below 1 for other species, implying that both biomass and abundance should be regarded as index values only, not absolute values.

Redfish in the fjords have mainly been believed to be Golden redfish. However the survey indicates an overweight of deep-sea redfish in the fjord about one order of magnitude greater than golden redfish in all years.

References

Anon., 2016. Report of the North-Western Working Group (NWWG). *ICES CM 2016.*

Burmeister, A. and Rigét F. The West Greenland trawl for Pandalus borealis, 2018, with reference to earlier results. NAFO Scientific Research Documeent 18/055.

Cochran, W. G. 1977: Sampling Techniques, Third edtion, Wiley & Sons.

Table 1. The survey area (km2) in the Greenland Shrimp and Fish Survey.

Stratum1	Stratum2	Area in Km2
GHF – Nuuk fjord	0001-0200	765,597
GHF – Nuuk fjord	0201-0400	537,756
GHF – Nuuk fjord	0401-0600	710,101
GHF – Nuuk fjord	0601-0700	90,223
Sum		2103,667
AME – Ameralik	0001-0200	179,453
AME – Ameralik	0201-0400	131,021
AME – Ameralik	0401-0600	68,808
AME – Ameralik	0601-0700	43,030
Sum		422,312
Total area		2525,989

Table 2. Numbers of valid hauls in the Nuuk fjord and Ameralik excluding Qarajat.

Year	Ameralik	Nuuk fjord	Total
2015	5	16	21
2016			0
2017	5	14	19
2018	5	16	21
2019	5	16	21

Table 3. Numbers of valid hauls in the Nuuk fjord, Ameralik and Qarajat by depth strata.

	Ameralik			Nuuk fjord				Qarajat	
Year	0-200	200-400	600+	0-200	200-400	400-600	600+	0-200	200-400
2015	1	2	2	2	6	3	5		4
2016									
2017	1	3	1	1	4	4	5		2
2018	1	3	1	1	6	4	5		1
2019	1	3	1	1	6	4	5		

Note: Ameralik 400-600 strata included in Ameralik 600+

Table 4. Mean bottom temperature in degrees C.

Year	Ameralik	Nuuk fjord	Qarajat
2015	-0,17	1,23	2,26
2016			
2017	-0,32	1,37	3,00
2018	-0,01	1,69	3,10
2019			

Table 5. Greenland halibut *Reinhardtius hippoglossoides* Abundance (Mio.)

Year	Ameralik	Nuuk fjord	Total	CV
2015	0.33	4.85	5.18	36
2016				
2017	0.4	2.37	2.76	37
2018	0.61	2.58	3.19	20
2019	0.5	4.97	5.47	18

Table 6. Greenland halibut *Reinhardtius hippoglossoides* biomass (MT)

Year	Ameralik	Nuuk fjord	Total	CV
2015	307	2709	3015	44
2016				
2017	282	981	1263	23
2018	351	1204	1556	18
2019	253	2187	2441	12

Table 7. Shrimp *Pandalus borealis* biomass (MT)

Year	Ameralik	Nuuk fjord	Total	CV
2015	152	1910	2061	24
2016				
2017	203	1360	1564	33
2018	294	1715	2009	37
2019	142	2279	2421	56

Table 8. Cod *Gadus morhua* abundance (Mio.)

Year	Ameralik	Nuuk fjord	Total	CV
2015	0,24	1,45	1,69	85
2016				
2017	0,21	1,53	1,74	75
2018	0,28	0,30	0,59	81
2019	0,04	0,36	0,40	66

Table 9. Cod *Gadus morhua* biomass (MT)

Year	Ameralik	Nuuk fjord	Total	CV
2015	550	3081	3632	89
2016				
2017	195	1082	1277	88
2018	362	416	779	83
2019	32	237	269	62

Table 10. Deep-sea redfish *Sebastes mentella* abundance (Mio.)

Year	Ameralik	Nuuk fjord	Total	CV
2015	0.05	0.32	0.37	30
0	0.00	0.00	0.00	0
2017	0.01	0.26	0.26	49
2018	0.08	0.86	0.94	56
2019	0.18	0.27	0.44	40

Table 11. Deep-sea redfish *Sebastes mentella* biomass (MT)

Year	Ameralik	Nuuk fjord	Total	CV
2015	29	192	221	30
2016				
2017	3	151	154	45
2018	58	608	666	59
2019	127	164	291	44

Tabele 12. Golden redfish *Sebastes norvegicus* abundance (Mio.)

Year	Ameralik	Nuuk fjord	Total	CV
2015	0.04	0.00	0.05	170
2016	.	.	.	
2017	0.00	0.02	0.02	187
2018	0.00	0.03	0.03	70
2019	0.01	0.00	0.02	120

Table 13. Golden redfish *Sebastes norvegicus* biomass (MT)

Year	Ameralik	Nuuk fjord	Total	CV
2015	61	11	72	159
0	0	0	0	0
2017	0	43	43	195
2018	2	59	61	79
2019	11	9	20	88

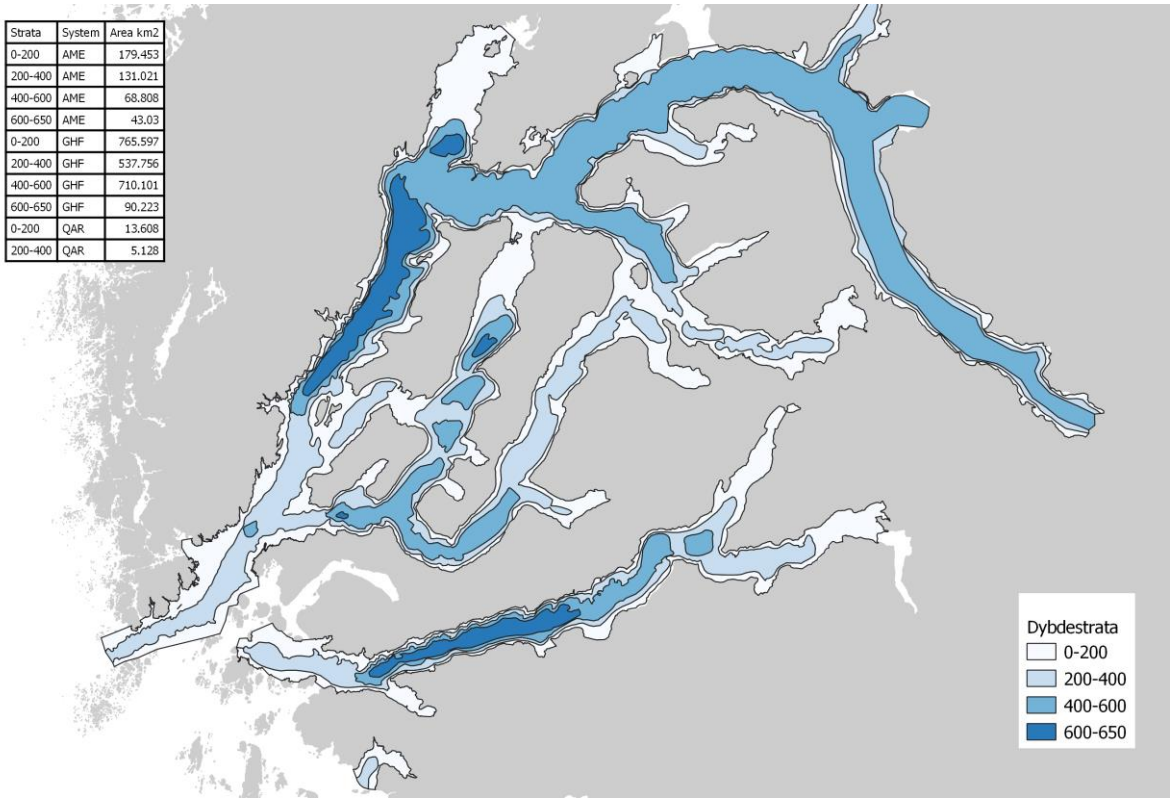


Figure 1. The Stratification areas used in the Shrimp and Fish inshore trawl survey in the Nuuk Fjord and the Ameralik fjord in West Greenland. Each Strata is divided in depth strata of 0-200m, 200-400m, 400-600m and deeper than 600m. The Nuuk fjord (GHF) is the larger fjord in the northern part of the area only open to the west through a narrow chanel. The ameralik fjord is a long narrow fjord branching to the east and only open the west through shallow chanels. Qarajat is the small coastal area south of Ameralik.

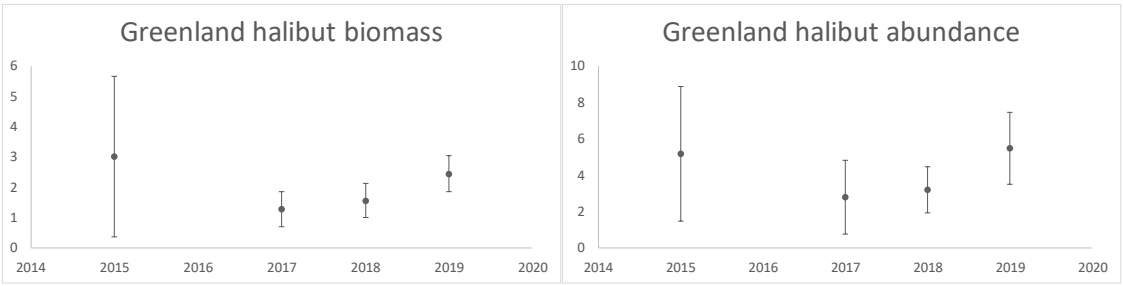


Figure 2. Greenland halibut biomass and abundance indices for the Nuuk fjord and Ameralik combined.

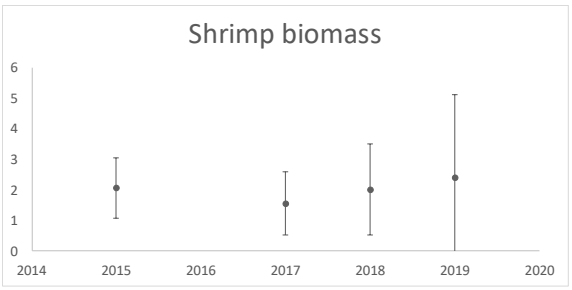


Figure 3. Shrimp biomass indices for the Nuuk fjord and Ameralik combined.

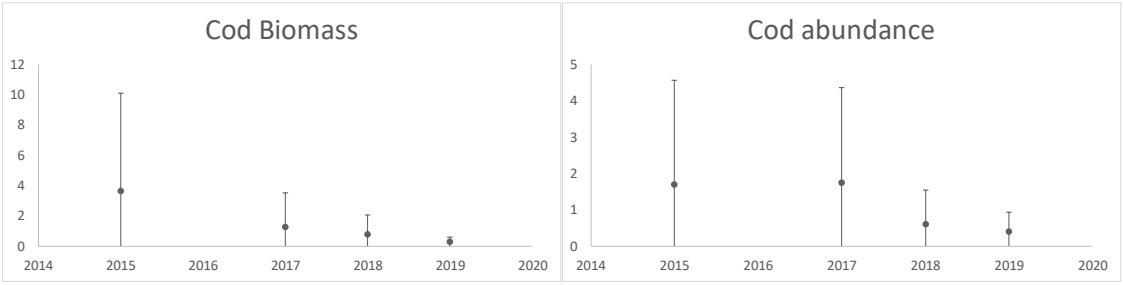


Figure 4. Cod biomass and abundance indices for the Nuuk fjord and Ameralik combined.

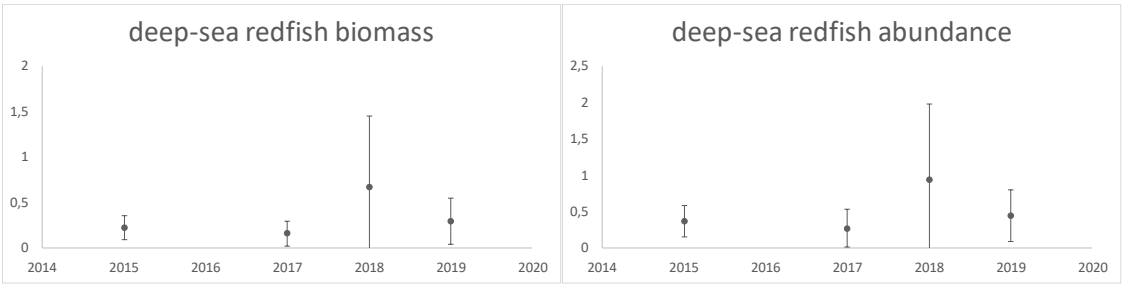


Figure 5. Deep-sea redfish biomass and abundance indices for the Nuuk fjord and Ameralik combined.

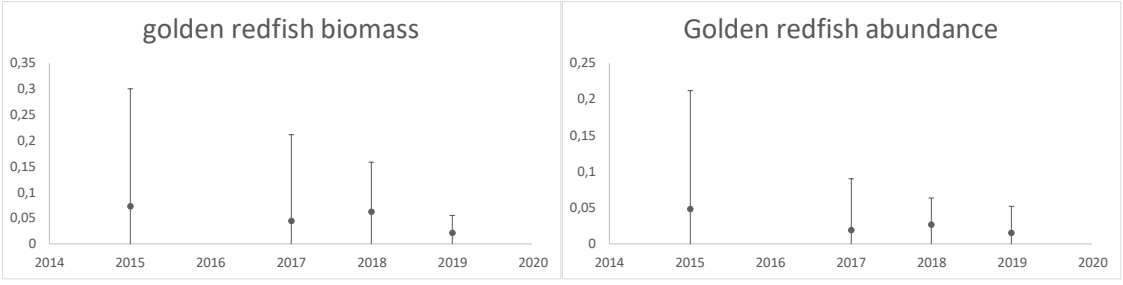


Figure 6. Golden redfish biomass and abundance indices for the Nuuk fjord and Ameralik combined.

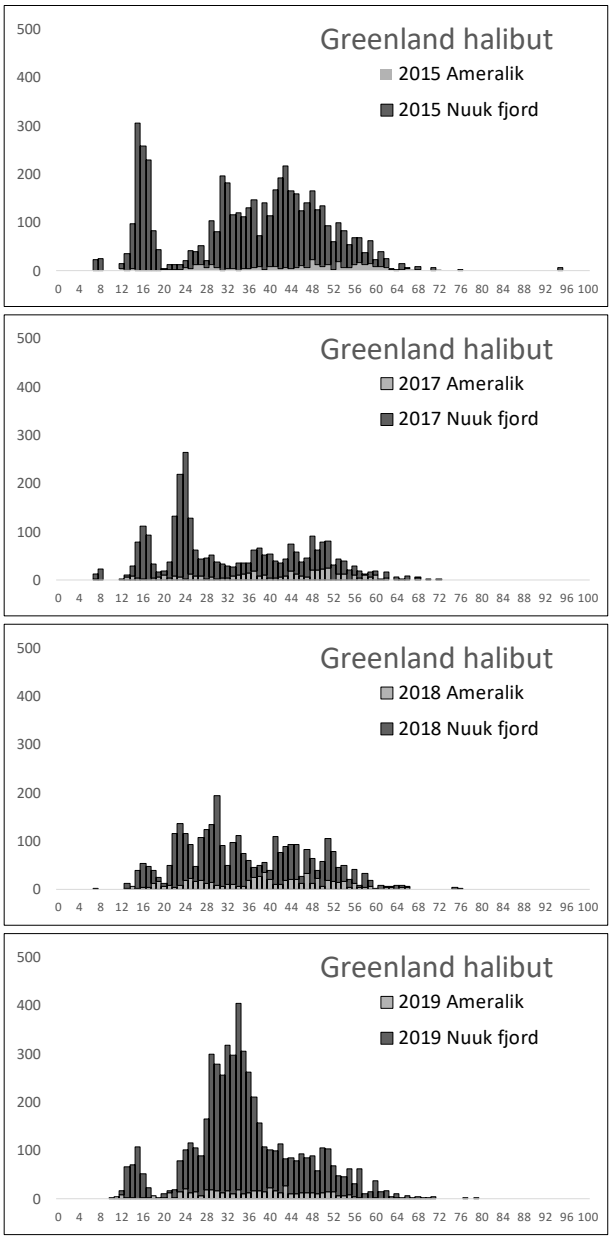


Figure 7. Stacked length frequencies for Greenland halibut in the Nuuk fjord and Ameralik.

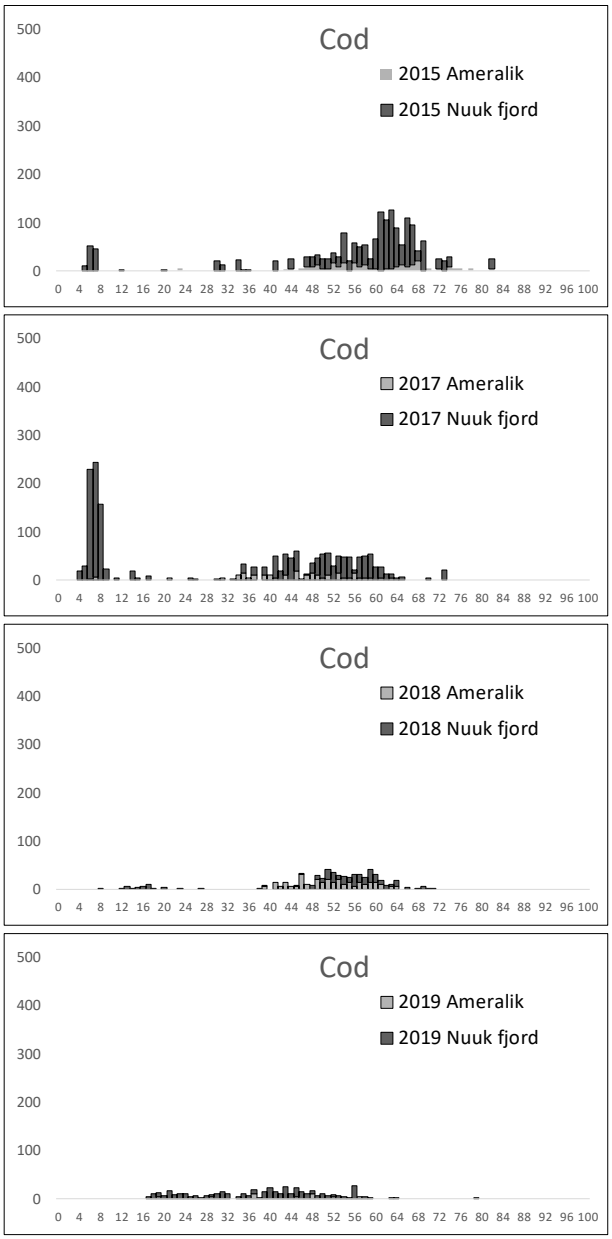


Figure 8. Stacked length frequencies for Cod in the Nuuk fjord and Ameralik.

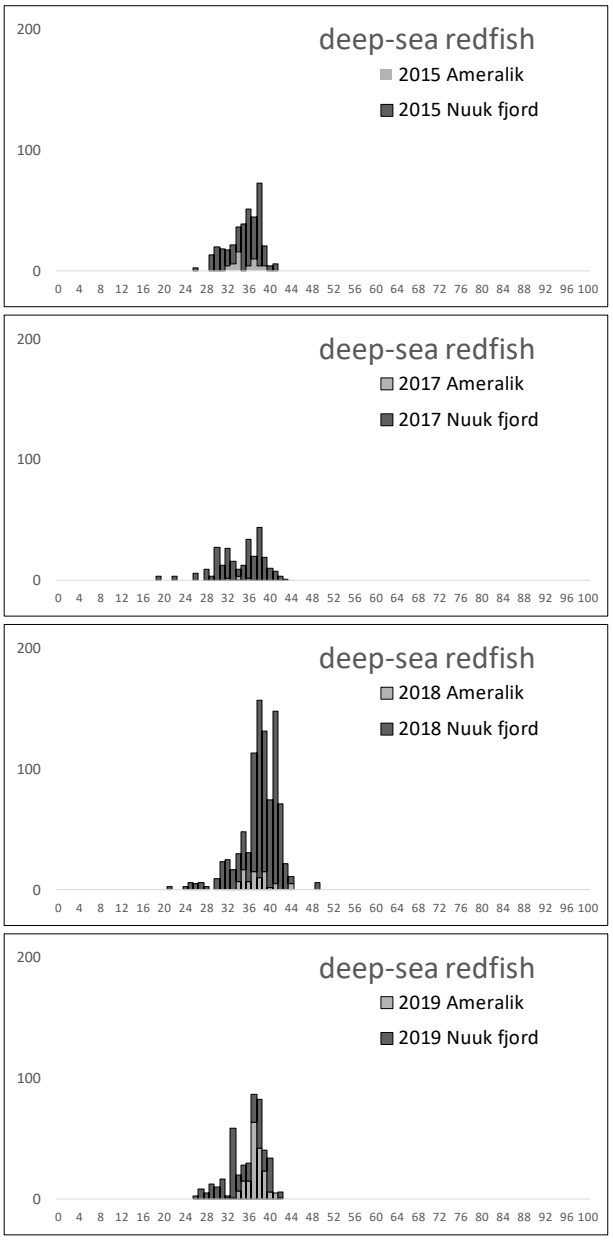


Figure 9. Stacked length frequencies for deep-sea redfish in the Nuuk fjord and Ameralik.

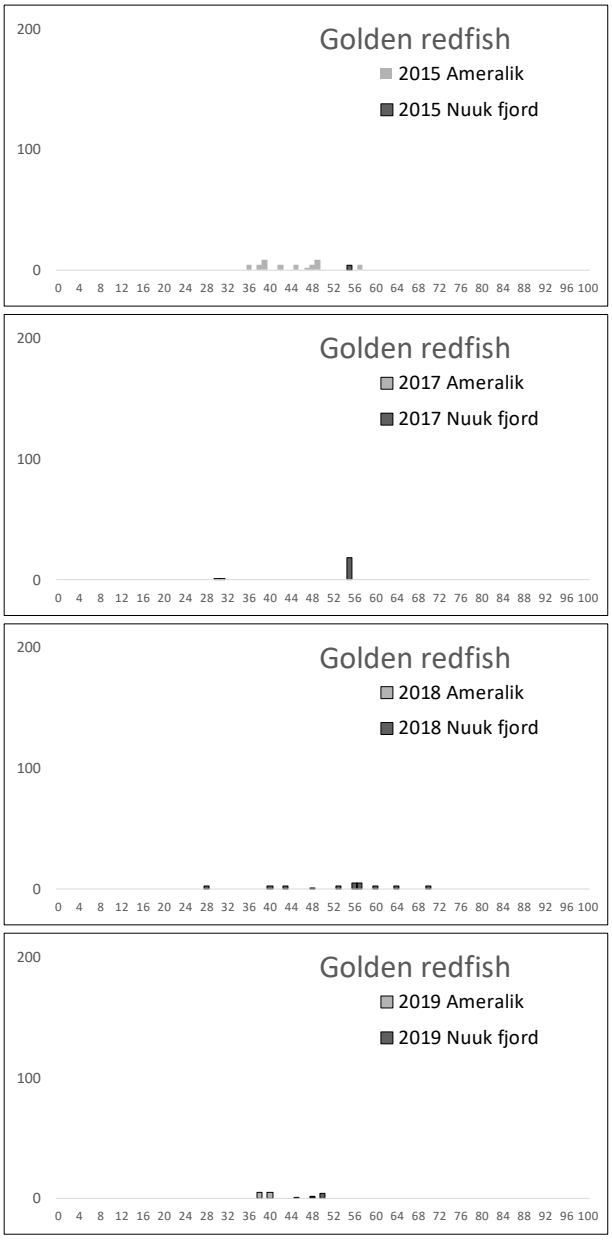


Figure 10. Stacked length frequencies for golden redfish in the Nuuk fjord and Ameralik.

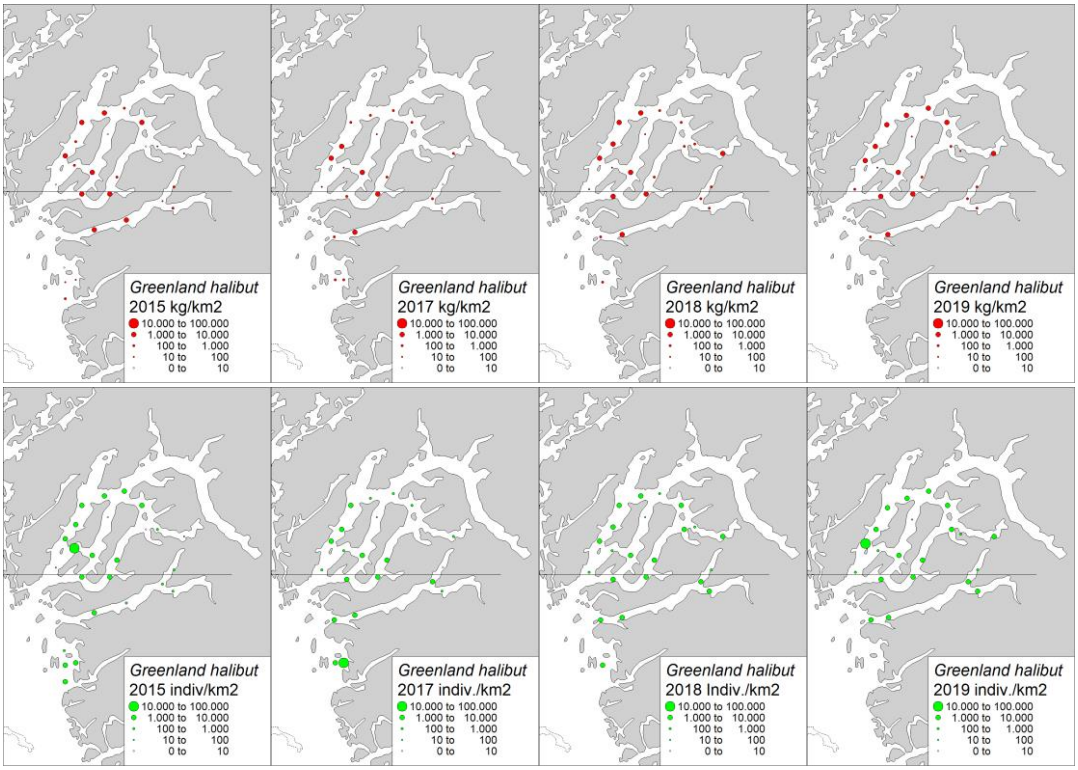


Figure 11. Survey biomass (top) and abundance (bottom) densities of Greenland halibut.

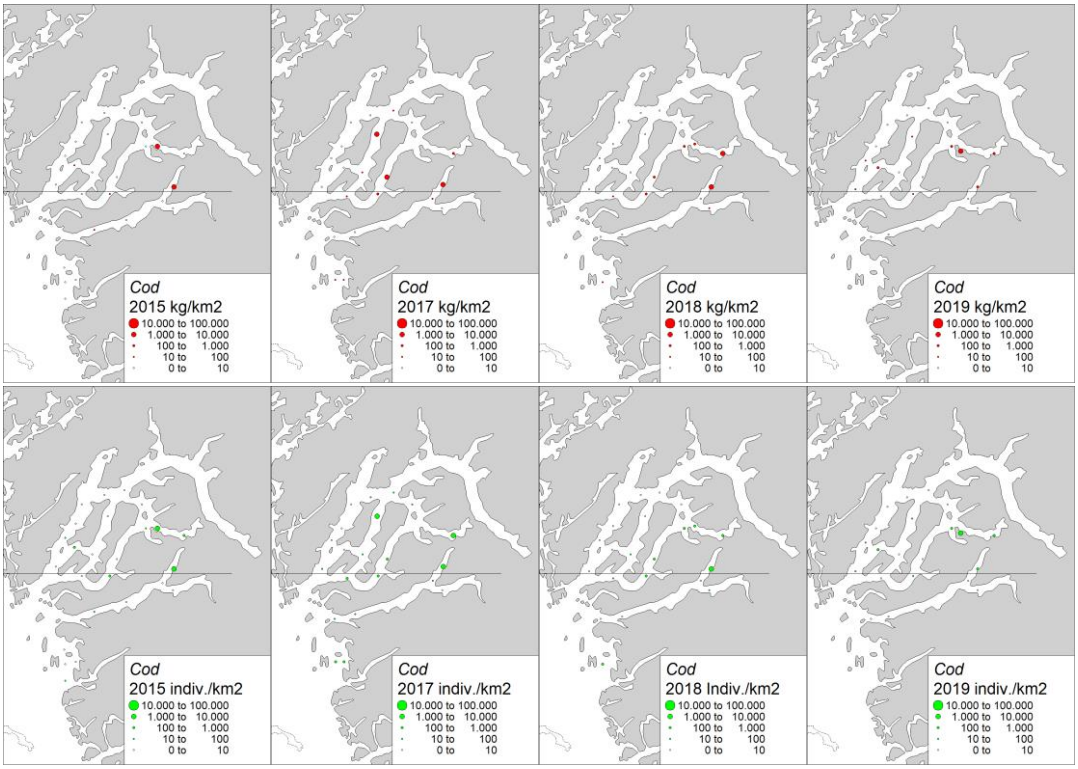


Figure 12. Survey biomass (top) and abundance (bottom) densities of Cod.

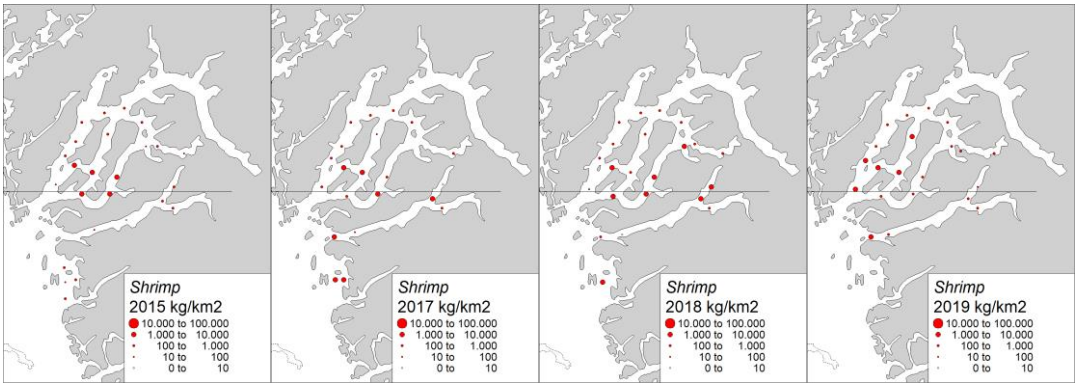


Figure 13. Survey biomass densities of Shrimp.

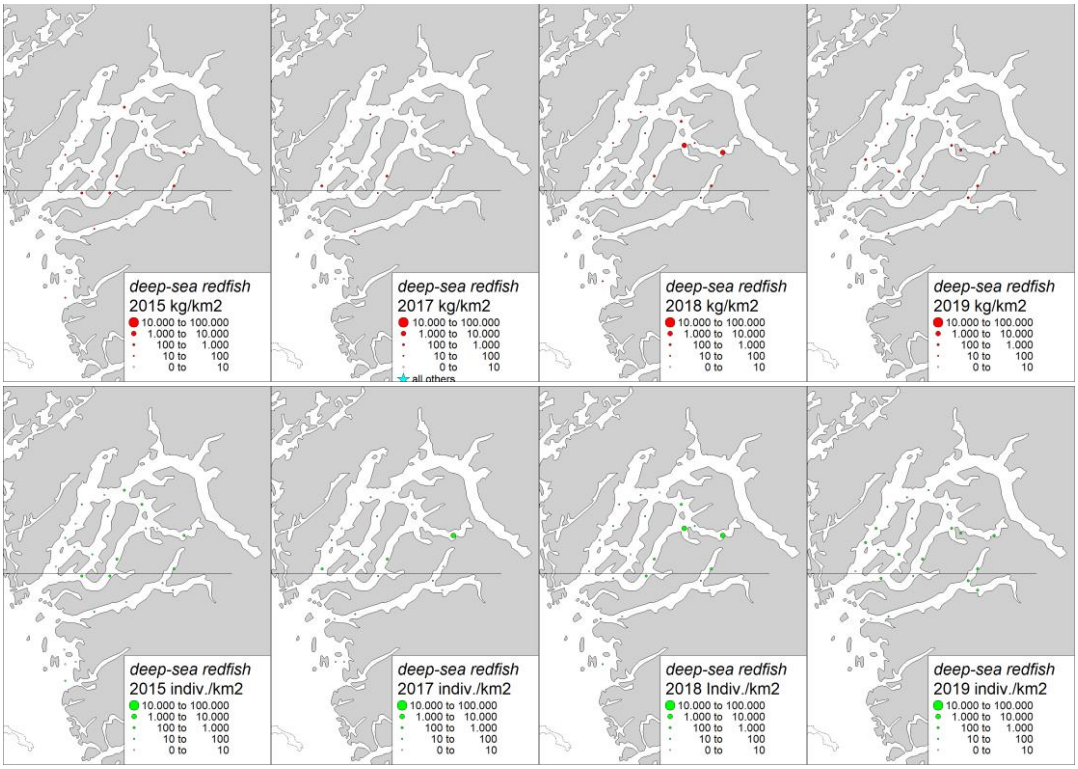
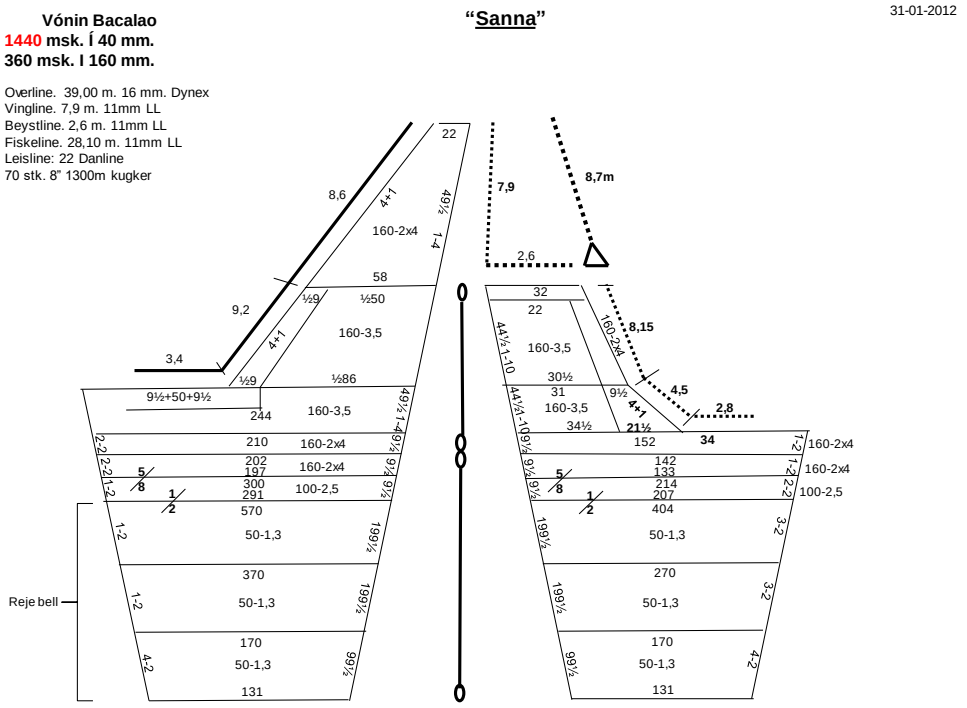


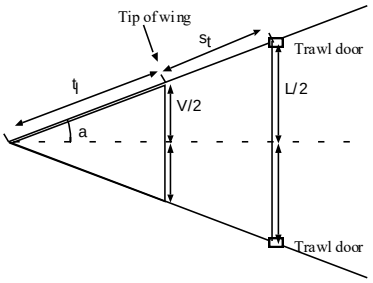
Figure 14. Survey biomass (top) and abundance (bottom) densities of deep-sea redfish.

Appendix I.



Drawings of the 1440 mesh Bacalau trawl. The trawl is a fish-trawl combined with a fine meshed shrimp codend. Notice the overhanging headline and front wings.

The wingspread (i.e. the width of the swept area) V has been calculated by assuming that the trawl and the trawl plus bridles form two similar triangles making a straight line.



Headrope	39 m
Ground gear + chain	28.1m + 8.7m
Bridles+ chain	30m+4m
Front wing	7.9m
codend	8 m
Wing tip to codend	48 m
t_l (Trawl length)	48m-7.9m-8m=32
s_t (dorchain	34m+8.7m=42,7m

The wingspread V is then calculated as: $V = (t_l * L) / (t_l + s_t)$

where L is the distance between the doors (doorspread). In most cases the distance between the doors varies from 40-50 m giving a typical estimated wingspread of (32m*45m/(74.7m)=19m. This is in the range also reported for other studies 0.4, 0.5 or up to 0.66 multiplied with the length of the headrope. The length of the gear is 28.1 m+8.7 m meters of chain in both sides and the length of the headrope is 39m.