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Denmark/Greenland Research Report for 2011

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This report presents information on preliminary catch statistics from the commercial Greenland fishery in 2011. Furthermore, the report gives a brief overview over the research carried out in 2011 by the Greenland Institute of Natural Resources.

WEST GREENLAND (NAFO SUBAREA 1)

A. Status of the fisheries

Provisional statistics for the fisheries from 2008 to 2011 are presented in Table 1. Additional information on the status of the fisheries is as follows:

1. Shrimp

The shrimp stock off West Greenland is distributed in NAFO SA 1 (Div. 1A-1F), but a small part of the habitat, and of the stock, intrudes into the eastern edge of Div. 0A (east of 60°30' W). Northern shrimp is found mainly in depths between 150 and 600 m. The stock is assessed as a single population. The Greenland fishery exploits the stock in SA 1, Canada in Div. 0A.

Three fleets, one from Canada and two from Greenland (vessels above and below 75 GRT) have participated in the fishery since the late1970s. The Canadian fleet and the Greenland offshore fleet (> 75 GRT) have been restricted by areas and quotas since 1977. The fishery by the Greenland coastal fleet (< 75 GRT) was unrestricted until 1997, when quota regulation was imposed. Mesh size is at least 44 mm in Greenland, 40 mm in Canada. Sorting grids to reduce by-catch of fish are required in both of the Greenland fleets (but dispensation from this has been granted for all vessels under 75 GRT since 2001 for safety reasons) and in the Canadian fleet. Discarding of shrimps is prohibited.

The annual TAC advised for the entire stock for 2004-2007 was 130 000 tons live-caught weight, which was reduced to 110 000 tons for 2008-2010. The advised TAC for 2011 was 120 000 tons. The advised TAC for 2012 is 90 000 tons.

The TAC set by the Greenland authorities for SA 1 was 114 570 tons in 2009 and 2010 and 124 000 tons in 2011. The TAC for SA 1 for 2012 is 101 675 tons. A TAC of 18 417 tons was set by the Canadian authorities for Div. 0A east of 60°30'W for 2007-2012.

Greenland requires that logbooks should record catch live weight, but for shrimps sold to on-shore processing plants an allowance was made for crushed and broken shrimps in reckoning quota draw-downs, which were based on weight sold, not on weight caught. From 1st of January 2011 the quotas is required to be drawn down by the amount caught without allowances for shrimps landed in poor condition.

Catches peaked in 1992 at 105 000 tons, but then decreased to around 80 000 tons by 1998 owing to management measures. Since then increases in allowed takes have been accompanied by increased catches. The logbook recorded catches in 2005 and 2006, around 157 000 tons, were the highest recorded. Total catch

for 2008 was 153 900 tons, total catch for 2009 was 135 450 tons and for 2010 was 134 000 tons. Total catch for 2011 is approximately 128 000 tons.

The overall combined index of standardized catch rates (CPUE) for the 3 fleets fluctuated without trend by a factor of 2 between 1976 and 1987. It then dropped precipitously to the lowest levels in the series in 1990–91, and stayed fairly flat until 1996. Since then, the unified CPUE index increased markedly and sustainedly for 9 years, reaching a plateau in 2004–2008, to turn downward in 2009 and to decrease further in 2010. In 2011 the combined index has increased by 20 % over its 2010 value to stand at the second highest value ever.

According to logbook records, the early fishery was concentrated in NAFO Division 1B, but from the late 1980s the fishery spread southwards, - and by 1996–98 Divisions 1C–1F were producing nearly 70% of the catches. However, these southern areas have since become less important and the fishery is now again concentrated in Division 1B - more so than at any time since the late 1980s.

2. **Greenland halibut**

The total catches of Greenland halibut by Greenland vessels in NAFO Subarea 1 (excluding Div. 1A inshore) amounted in to 8 240 tons in 2011. 5 722 tons were taken off shore in Div. 1AB (north) and 2 240 tons were taken off shore in Div 1C-1F (south), mainly in Div. 1CD. The reported catches from inshore in Div. 1B-1F amounted to 253 tons. The offshore catches were exclusively taken by trawlers (Fig. 1), while the inshore catches were taken mainly by gill net.

The inshore fishery in Div. 1A was concentrated in three areas in Disko Bay (8 005 tons) Uummannaq (6 397 tons) and Upernavik (6 471 tons). The fishery is conducted by long lines and gill nets.

Commercial fisheries data. CPUE data, based on logbooks reported to the Greenland authorities, were available from four Greenland trawlers. The CPUE for all vessels combined increased in Div. 1AB from 0.82 ton/hr in 2009 to 0.93 ton/hr in 2010 and further to 1.29 ton/hr in 2011which is the largest level in the time series apart from small trial fisheries in 2000 and 2001.

In Div. 1CD the CPUE for three Greenland vessels fishing there has been fluctuating between 0.55 ton/hr and 0.87 ton/hr since 2000. The CPUE has been rather stable sinsc 2005. In 2011 the CPUE was 0.87 ton/hr compared to 0.79 ton/hr in 2010

Length frequency samples were available from Greenland trawlers fishing in Div. 1A

3. **Cod**

Cod in Greenland derives from three stock components, labeled by their spawning areas: I) an offshore Greenland spawning stock, II) inshore West Greenland fiords spawning populations, and III) Icelandic spawned cod that drift to Greenland with the Irminger current. Previously the stocks have been assessed together as it was difficult to sample and assess stock status of the various stock components separately. From this year the inshore component (West Greenland, NAFO Area 1) is assessed separate from the offshore components (offshore West and East Greenland, NAFO area 1 and ICES Subdivision XIVB). The stocks are assessed by ICES see the North-western Working Group (NWWG) report, April 2012 and ACFM report 2012.

In 2011 a management plan was agreed for the offshore cod stocks. The overall objective is to "rebuild the spawning stock in both West and East Greenland" and that "stable recruitment is used as an indicator of the spawning population stable condition". The overall strategy to fulfill the objective was that ICES advice must be followed.

There are no explicit management objectives for the inshore cod in Greenland.

The cod fishery in Greenland consists of two components, an offshore fishery and an inshore fishery. The offshore fishery completely collapsed in 1993. From 1994 to 2001 no directed offshore cod fishery has taken place. In the 2000s catches have gradually increased with maximum catches in 2008. Between 2008-2010 offshore areal closures were implemented in order to protect the spawning stock in offshore areas. The management plan for the offshore fisheries states that ICES advice must be followed and the advice for 2011 was

that no directed fisheries should take place. However an experimental fishery was allowed in order to collect information on the distribution and composition of the cod stock. The TAC for the experimental fishery was set at 5,000 tons. Total offshore catches in 2011 amounted to 5,100 tons.

The Greenland inshore commercial cod fishery in West Greenland started in the 1920s. The fishery gradually developed culminating with catch levels above 30,000 tons annually in the 1960s. Catches then fluctuated between 5,000 and 35,000 tons in the 70s and 80s. The stock size then declined and the catches went below 500 tons in the 1990's. In the 2000s catches have gradually increased with maximum catches in 2007 and 2008 of 13.000 tons. The inshore fisheries did not require a license until 2009 and has historically not been constrained by catch ceilings (for 2009 a TAC of 10,000 tons was introduced). In 2011 a TAC of 11,500 tons was allotted to the inshore fisheries. In 2011 the catches from the coastal fleet amounted to 11,000, which is 19% above last years catch. The coastal fleet catches peaks during summer where the dominant pound net fishery takes place.

The offshore Greenland spawning component has not been fished during the last 15 years. Surveys and exploratory fishery now suggest dense concentrations of large spawning cod in East Greenland north of 63°N. The area is limited in distribution compared to the spawning grounds observed historically. Recruitments in the offshore area have improved since the end of the 1990s although it is still low compared to the recruitments before the stock was depleted.

Inshore spawning occurs in many fiords and recruitment has increased in recent years in the areas surveyed. Recruitment is now well above the lows observed in the late 1990's.

3. Salmon

Atlantic salmon migrates to Greenland from most salmon producing countries around the North Atlantic and in Greenland only one spawning population Atlantic salmon is known. The modern fishery for Atlantic salmon fishery in Greenland waters started around 1960 and peaked in the early seventies at a catch level of more than 2000 tons a year. The fishery was quota regulated from 1972, but due to declining stocks NASCO in June 1998, agreed that no commercial fishery for salmon should be allowed, but that the catch at West Greenland should be restricted to *'that amount used for internal consumption in Greenland, which in the past has been estimated at 20 tonnes'*. Since then export of salmon from Greenland has been banned. The salmon caught along the shores of West Greenland are mostly (>90%) non-maturing 1SW salmon, most of which are destined to return to home waters in Europe or North America as MSW fish if they survive. In 2011 total nominal catches amounted to 28 tons including 1 tons from East Greenland.

5. Capelin

The capelin fishery in West Greenland is carried out inshore and in the spawning season only (May-July). Catches are low and have been for the last decade with highest catches being 267 tons in 2004 and in 2011 catches were 124 tons. The main part of the catches is produced as whole frozen fish for bait and local consumption, while a smaller part is dried and stored as food for sledge dogs in the winter season. The majority of the catches were taken are taken in the northern part of West Greenland (NAFO 1A and 1B).

6. Redfish

Two species of redfish of commercial interest occur off West Greenland inshore and offshore, golden redfish (*Sebastes marinus* L.) and deep-sea redfish (*Sebastes mentella* Travin). Relationships to other North Atlantic redfish stocks are unclear. Redfish catches in West Greenland are reported as redfish (unspecified, mainly by-catch), golden redfish and beaked redfish (pelagic redfish). In 2011 logbook reported by-catch by Greenlandic shrimp vessels of un-specified redfish amounted to 46 t. Catches of golden redfish amounted to 136 t of which 133 t taken mostly inshore in fjords were sold to factories on land and only 3 tons of golden redfish were reported in logbooks. There is no forecast for golden and deep-sea redfish stocks in West Greenland and the advice from NAFO is "no direct fishery".

Pelagic redfish

The aggregations of pelagic redfish *S. mentella* found in the NAFO Convention Area belong to the same stock of pelagic redfish from the Irminger Sea. The stock is assessed by ICES (NWWG report 2012) and the assessment covers the pelagic redfish in ICES Divisions Va, Vb, and XIV and in the NAFO Div. 1F, 2H and 2J. ACFM has advised for 2012 that catches of deep pelagic *S. mentella* are set at 20 000 t as a starting point for the

adaptive part of the management plan.

The pelagic fishery on *S. mentella* in NAFO Div. 1F started in 1999 and from 2000 - 2009, significant catches with up to 20% of total catches as in 2003 were taken in NAFO Divisions 1F and 2J. In 2010, however, only 1074 t was taken in the NAFO area 1F and in 2011 zero catches was reported for 1F. The Greenland fleet has reported a total catch of deep pelagic *S. mentella* of 1 932 tons (caught only in ICES Divisions).in 2010 and zero catch in 2011.

7. Grenadiers

There are two species of grenadiers of commercial interest in Greenland: roundnose grenadier and roughead grenadier. All catches are, however, reported as roundnose grenadier. The catch reported is taken as by-catch in the Greenland halibut fishery. No forecast – the biological advice is "no direct fishery".

8. **Snow Crab**

The snow crab stock for the fisheries is distributed in the Div. 0A along the west coast of Greenland. The fishery is conducted mainly by Greenland vessels. Since 2004, the crab resource has been managed in 6 areas (from North to South: Upernavik, Uummannaq-Disko Bay, Sisimiut, Maniitsoq-Kangaamiut, Nuuk-Paamiut and Narsaq-Qaqortoq). The fishing fleet is dominated by small vessels (less than 75 GRT), which have exclusive rights for fishing inshore within the basis-line as well as offshore. Large vessels (greater than 75 GRT) may only fish in all offshore areas (outside the basis-line). Total allowable catch (TAC) restrictions have been imposed since 1995, but have only limited the catch in some areas since 2004.

The number of vessels with licenses to participate in the snow crab fishery increased from 1999 to 2002 from approximately 120 vessels to 392 vessels. Since then the number of both large and small vessels have decreased substantially as the abundance of the resource has also declined. In 2011 number of permits were 52, where by 34 were active in the snow crab fishery.

The total catch in NAFO Subarea 1 peaked in 2001 with approximately 15.000 tons. From 2001 to 2011 total catch decreased approximately 87% to 2.015 tons (table 1). Most of the landings are based on fishery in the management areas Disko Bay-Uummannaq, Sisimiut and Nuuk-Paamiut. The total fishing effort (trap hauls) has declined by 89% since 2001 (from 3,416 to 384 thousand trap hauls during 2001-2010). The decline has been mostly due to a declining number of participants in the fishery.

9. **Scallops**

Total catches of scallops in NAFO Subarea 1 amounted to 412 tons in 2011. A total quota for scallops in 2011 was set at 1.920 tons. All catches are taken in inshore areas in Div. 1A, 1B, 1C and 1D. New fishing grounds near Sisimiut (1B) was found in 2003 and quotas for two new areas was introduced in 2004.

10. Lumpfish

Total catches of lumpfish in NAFO Subarea 1 increased from 1.200 tons in 2000 to almost 9.000 tons in 2003. Catches have remained at this level until 2011 where catches increase to 11.443 tons. Catches are taken in inshore areas in Div. 1A, 1B, 1C, 1D, 1E and 1F with the majority being caught in 1D. The fishery is conducted over a short time period of one to two months and over a vast coastline from 59° N to 72° N.

B. **Special Research Studies**

1. **Environmental Studies**

a. **Hydrography Studies**

A survey of oceanographic stations along the West Greenland standard sections was carried out in summer 2011. Results are presented in NAFO scr.doc. In winter 2010/11, the North Atlantic Oscillation (NAO) index was negative describing weakening westerlies over the North Atlantic Ocean. Often this results in warmer conditions over the West Greenland region which was also the case for this winter. The air temperature was higher than normal during winter – especially over the Davis Strait.

The general settings in the region have traditionally been presented with offset in the hydrography observed over the Fylla Bank. Here, time series of mid-June temperatures on top of Fylla Bank show temperatures 0.4°C above average conditions in 2011 and the salinity was 0.2 above average. The presence of Irminger Water in the West Greenland waters was high in 2011. Pure Irminger Water (waters of Atlantic origin) could be traced north to the Maniitsoq section and modified Irminger Water further north to the Sisimiut section. The mean (400–600m) temperature and salinity was high over the Southwest Greenland Shelf Break. After one single year of decrease (Ribergaard, 2011) the bottom temperature and salinity off Ilulissat (st.3) in the Disko Bay has increased again to high values above values before mid-1990.

2. **Biological Studies**

a) **Shrimp**

The series of annual stratified trawl surveys, initiated in 1988 and converted to a semi-systematic design in 1999, was continued in 2011. In June-July-August 2011 research trawl hauls were made throughout the distribution area of the West Greenland shrimp stock, including areas in Subarea 0 and the inshore areas in Disko Bay and Vaigat.

The survey index of total biomass remained fairly stable from 1988 to 1997 (c.v. 18%, downward trend 4%/yr). It then increased by, on average, 19%/yr until 2003, when it reached 316% of the 1997 value. Subsequent values were consecutively lower, by 2008–2009 less than half the 2003 maximum (Fig. 3.4) and 9% below the series mean. In 2010 the survey biomass index increased by nearly 24%, but in 2011 it returned to below the 2009 level (SCR Doc. 11/55).

The decline in total biomass observed since 2003 occurred predominantly in the southern part of the west Greenland shrimp grounds; indices of the location and distribution of the survey biomass show that the distribution has contracted since 2001–3 and moved northward since 1999. Since 2009 fishing effort in the southernmost part of the West Greenland grounds has been low.

The number at age 2 is a predictor of fishable biomass 2–4 years later (SCR Doc. 03/76). This recruitment index was high in 2001, but decreased continually to 2007. From 2008 to 2010 estimated numbers at age 2 were higher than in 2007 and about stable near 78% of the series mean, but in 2011 decreased to 55% of the mean. A relative lack of shrimps at 15–22 mm CPL in 2011 presages poor immediate recruitment to both the fishable and the spawning stocks.

b) **Greenland halibut**

A Greenland offshore trawl survey for Greenland halibut was initiated in 1997. The survey is a continuing of the joint Japanese/Greenland survey carried out in the period 1987-95. In 1997-2011 the survey covered NAFO Div. 1C and 1D between the 3 nm line and the 200 nm line or the midline against Canada at depths between 400 and 1500 m. In 2011 there were made 67 successful hauls in Div. in Div. 1CD.

In 2001 the survey area was expanded to include NAFO Div. 1B-1A (to 74°N) and in 2004 a survey was conducted in the northern part of the Baffin Bay (73°N-77°N) (Div. 1A) at depths down to 1500 m. In 2010 was conducted a survey in Div. 1A to 75°30’ where 93 successful hauls were made. There was no deep sea survey in Div. 1AB in 2011.

A longline survey for Greenland halibut in the inshore areas of Disko Bay, Uummannaq, and Upernavik was initiated in 1993. Since 2001 a gillnet survey was initiated in the Disko Bay area. The survey normally covers 4 transects and each gillnet setting is compiled of 4 different nets with differing mesh size (46, 55, 60 and 70 mm halfmesh). The distribution pattern showed a markedly higher density of Greenland halibut in the mouth of the ice fjords. In 2011 a gillnet survey was conducted in Disko Bay, the a longline survey was conducted in the Uummannaq and Upernavik areas.

c) **Cod survey**

A survey using gangs of gill nets with different mesh-sizes has been developed and used since 1985 with the objective of assessing the abundance of age 2 and age 3 cod in the inshore areas. The indices in all areas (NAFO 1B, 1D and 1F) are generally above the levels observed during the 1990’s. The West Greenland

inshore gillnet survey was in 2011 conducted in the areas NAFO 1B and NAFO 1D. Catch rates for age 2 cod (2009 YC) was the highest recorded in the time series in NAFO 1B. In NAFO 1D catch rates of age 2 cod was on average with the catch rates of age 2 cod in 2010 and 2011. Catch rates of age 3 cod (2008 YC) was higher in NAFO 1B compared to NAFO 1D where this year-class is almost absent in the survey indicating that this year-class originates from a local inshore population in NAFO 1B.

An annual stratified random trawl survey has been conducted since 1988 in West Greenland between 59º15'N and 72º30'N and the inshore area of Disko Bay from the 3 mile limit down to the 600 m. The main purpose of the survey is to evaluate the biomass and abundance of the Northern shrimp (*Pandalus borealis*), but since 1992 data on fish species have been included. Since 2008 the survey also covers the East Greenland area to Dohrn Bank at 67^{o}N.

Until 2001 the survey biomass indices of cod was below 1,000 tons but increased to about 2,300 tons in 2004 and continued to increase thereafter with highest biomass indices in 2007 and 2008 with estimated biomass and abundance indices at 28,481 tons and 53.4 mill individuals. The stock in West Greenland then declined in 2009 compared to 2008 with 85% in biomass and 70% in abundance. This was mainly caused by a decrease in the abundance of the 2003 and 2005 YC in West Greenland, which were the dominating YC in previous years. Since 2008 biomass and abundance has increased, and the 2011 survey showed that the offshore cod stock in West Greenland increased with 130% in biomass (18,730 tons) and 246% in abundance (80.8 mill individuals) compared to 2010. The abundance indice is the highest estimated in the timeseries. The main cause for the increase in biomass and especially abundance was the appearance of a 2009 YC in the survey. This 2009 YC was mainly distributed in the northern part of the survey area with 58% of the total abundance of age 2 being concentrated in NAFO area 1B (Store Hellefisk Bank). Cod older than 5 years are almost absent in West Greenland.

The survey started in East Greenland in 2008 and biomass and abundance has gradually increased. In 2001 however the offshore cod stock has decreased with 4% in abundance and 25% in biomass compared to 2010. Biomass increased in the northern and southern area of the survey area, and decreased in the mid area of the survey area (Kleine Bank) in East Greenland.

Overall the two surveys covering East and West Greenland show that older cod belonging to the 2003 YC are predominantly found in the northern areas off East Greenland (Dohrn Bank) being scarcer off Cape farewell and absent from West Greenland. Younger cod (2005-2007 YC) are predominantly found in South East Greenland, and the 2009 YC is predominantly found in NAFO area 1B in West Greenland.

d) **Snow crab**

Annual monitoring program (trap survey) was initiated in 1997 in Disko Bay (Div. 1A) and Sisimiut (Div. 1B). Since 2001 annual offshore trap survey has been conducted in more southern areas in West Greenland (Div. 1C and 1D). Large and small meshed conical traps are used. All snow crab were enumerated by sex, carapace width and carapace condition. The chelae height was measured in males and the abdomen width in females, respectively for maturity determination. Ovary contents, clutch weight, sperm load and egg development stage in females was also determined and females were sampled in relation fecundity studies.

The objective of both monitoring programs is to assess the abundance of snow crab in inshore and offshore waters of Greenland. Results from this survey are presented in the Technical Report Series of the Greenland Institute of Natural Research. In general the stock and recruitment prospects are at a low level in all areas.

e) **Marine mammals**

Studies of white whale and narwhal continued in 2011 and details are being reported to JCCM and NAMMCO. In 2011 also studies of minke whale, fin whale and humpback whale continued. Monitoring study on large cetaceans is being reported to IWC. Studies of harp and hooded seals are being reported to the Joint ICES/NAFO Working Group on Harp and Hooded Seals.

f) **Special studies**

A Ph.D. project, initiated in 2004, is studying the reproductive potential of snow crab in the coastal waters of West Greenland. The present study will use existing data and data collected in fieldwork surveys in Div. 1A, 1B and 1D. Exploited and non-exploited stocks will be examined as well as temperature effects. Life history traits will be related to aspects of snow crab reproductive potential at three study sites: Disko Bay (north), Sisimiut (middle) and Nuuk (south). The study will contribute to a better understanding of the reproductive potential in the snow crab fisheries resource, and provide essential base line information for adaptive management and conservation strategies.

GREENLAND FISHERY IN OTHER NAFO SUBAREAS

A. **Status of the fisheries**

In 2011 one Greenland vessels was engaged in shrimp fishery at Grand Bank (NAFO Div. 3L) and reported catch from 3L amounted to 106 tons. 0 tons was reported from Flemish Cap (NAFO Div. 3M).

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Table 1. Estimated catches (tons) by Greenland vessels at West Greenland (NAFO Subarea 1) in 2007-2011.

	NAFO SA					
	Div. 1A, B, C, D, E, F				Div 3M	Div 3L
Species	Estimated catch 2008*	Estimated catch 2009*	Estimated catch 2010*	Estimated catch 2011*	Catch 2011	Catch 2011
American Plaice	nd	nd	0	0		
Arctic char	nd	19	nd	62		
Atlantic halibut	8	5	6	5		
Atlantic salmon	26	26	38	28		
Atlantic cod	21,921	10,958	12,000	16,100		
Capelin	138	184	90	124		
Crabs	2,354	3,191	2,363	2,015		
Greenland cod	405	161	nd	155		
Greenland halibut	31,680	24,603	29,222	29,088		
Grenadiers	0	nd	nd	8		
Roundnose Grenadier	0	nd	nd	8		
Haddoc	nd	nd	nd	0		
Lumpfish	6,436	6,557	8,482	11,443		
Polar cod	6	nd	nd	172		
Redfish (unspecified - bycatch mainly)	265	124	75	46		
Pelagic redfish	0	0	0	0		
Redfish golden	107	226	166	136		
Saithe	1	nd	nd	0		
Scallops	756	511	398	412		
Shark	nd	nd	nd	0		
Shrimp (P.boreallis)	153,889	135,458	133,986	128,000	0	106
Shrimp (P.montagui)	53	88	2,594	nd		
Skate	0	nd	0	1		
Wolffishes	1,152	1,130	1,315	779		
Fish not specified	nd	nd	nd	678		
Sum total	219,197	183,241	190,735	190,181		106

* Catch figures from recent years are provisional.

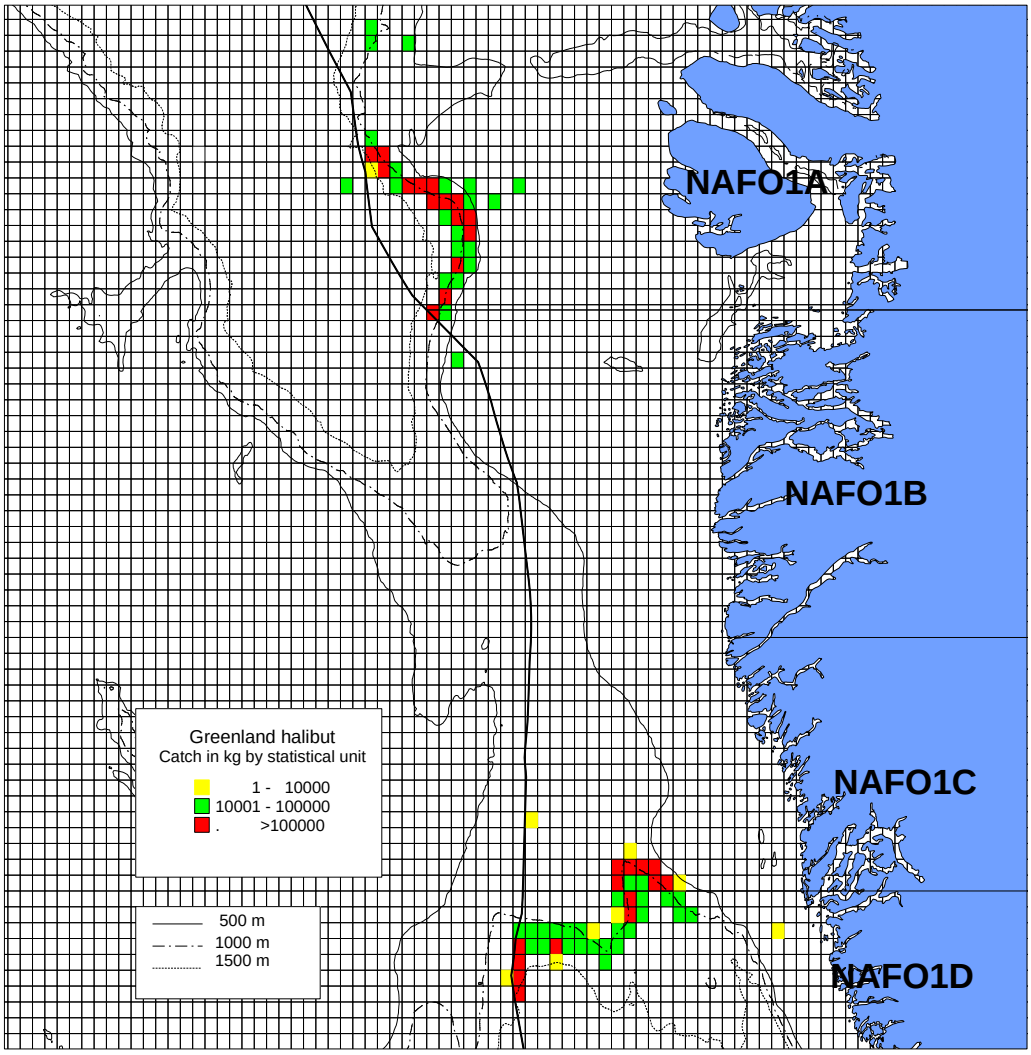

Fig. 1. Distribution of the offshore catches of Greenland halibut in SA 1 in 2011 by statistical square. All nations.