Northwest Atlantic Fisheries Organization

Serial No. N6320 NAFO SCR Doc. 14/025

SCIENTIFIC COUNCIL MEETING – JUNE 2014

Assessment of Demersal Redfish in NAFO Subarea 1

by

Rasmus Nygaard
Greenland Institute of Natural Resources
rany@natur.gl

Abstract

Two species of redfish are common in West Greenland, golden redfish (*Sebastes marinus*) and deep-sea redfish (*Sebastes mentella*). In general, Golden redfish is connected to shelf and fjord areas, whereas the stock structure of deep-sea redfish is more complicated and can be divided into demersal stocks abundant in both shelf and fjord areas and pelagic stocks offshore.

The fishery targeting demersal redfish in subarea 1 increased during the 1950 from a level of more than 10.000 tons and peaked in 1962 at more than 60.000 tons. Catches then decreased to around 3000 tons in the beginning of the 1970's but increased again to around 10.000 tons by 1975. By 1986 catches had decreased to around 5000 tons and thereafter remained below 1000 tons per year with few exceptions.

The differentiation between stocks in official statistics is however not straight forward. Even the correctness of the total landings of redfish from the area are highly uncertain, particularly in the years 1977 to 1979 (overestimated) and with the increasing shrimp fishery during the 1980's and 1990 (underestimated). However, the amount of discarded redfish in the fishery targeting shrimp has been significantly reduced since the implementation of sorting grids in the shrimp trawls. A pelagic fishery for pelagic/beaked redfish (*Sebastes mentella*) occurred for the first time off West Greenland in 1999 and was conducted close to the edge of the Greenland EEZ and far off the shelf of division 1F. The pelagic redfish in West Greenland is part of the Irminger stock complex and is assessed by ICES.

In 2013 only 170 tons of redfish were reported, of which the majority was caught inshore and landed to factories (156 tons) and a minor part was reported as by-catch in the shrimp fishery (11 tons) and offshore fishery mostly targeting Greenland halibut (3 tons).

There are three recent surveys covering the demersal redfish stocks in sub area 1. The EU-Germany survey (since 1982), the Greenland deep-water survey (since 1998) and the shallower Greenland Shrimp and Fish survey in West Greenland (SFW - since 1992). The latter has a more appropriate depth coverage and geographic coverage (0-600m, 1A,B,C,D,E,F) in regards to the redfish distribution, than both the EU-Germany survey (0-400m, 1Bs,C,D,E,F) and the Greenland deep-water survey (400-1500m, 1C,D). The surveys have revealed increasing biomasses for both golden redfish since 2004 (EU-Germany and Greenland SFW) and deep-sea redfish since 2008 (all surveys). However, the abundance of redfish in subarea 1 still is at a very low level both in the Greenland SFW survey (all sizes) and the EU-Germany (juvenile redfish). Therefore recruitment and spawning still seems to be depressed in the area and the increasing biomasses observed are likely a consequence of either increased survival of redfish and/or migration of redfish into subarea 1 from nearby areas (East Greenland). Therefore no increase in catches can be advised until significant new year-classes are observed.

Introduction

Two species of redfish are common inshore and offshore in West Greenland, golden redfish (*Sebastes marinus*) and deep-sea redfish (*Sebastes mentella*). In general Golden redfish is connected to the shelf and fjord areas on shallower water, whereas the stock structure of deep-sea redfish is more complicated and can be divided into demersal stocks, and pelagic stocks. Deep-sea redfish can in general be found in the same areas as golden redfish including shallow waters and inside the fjords, but also at greater depths offshore. Relationship to other redfish stocks off East Greenland, Irminger Sea and Iceland is unclear. Stock identities in terms of reproduction were investigated by a joint ICES/ICNAF Study Group (Anon., 1983). The concept of self-sustaining units or stocks in NAFO Subarea 1 remains unproved for both species due to a general lack of records of maturing or spawning (bearing) specimens. Therefore, the working group suggested strong relations to the two golden and deep-sea redfish stock complexes off East Greenland, Iceland and Faroes (ICES Subareas V and XIV). However, the common occurrence of golden redfish at length groups being mature in other areas were proved from historical length measurements before the 1970s. Ongoing genetic studies on the East Greenland and Iceland stocks of redfish include juvenile redfish caught in the Greenland shrimp and fish survey but results are yet unpublished.

Description of the Fisheries

The fishery targeting redfish in subarea 1 increased during the 1950 from a level of more than 10.000 tons and peaked in 1962 at more than 60.000 tons. Catches then decreased to around 3000 tons in the beginning of the 1970's but increased again to around 10.000 tons by 1975. By 1986 catches had decreased to around 5000 tons and since then has been below 1000 tons per year with few exceptions. In general there is high uncertainty about the total landings of redfish in subarea 1. In the 1977, non-Greenland vessels were excluded access to the valuable cod fishery in subarea 1, which led to massive miss-reporting, where catches of cod were reported as other species such as American plaice, redfish, wolffish, finfish not specified and in these years total catches of redfish are overestimated (Horsted S.A. 1980). With the decreasing cod stock and the increasing shrimp fishery during the 1980's and 1990, significant amounts of redfish may have been taken and discarded in the trawl fishery targeting shrimp. At least in the early part of the shrimp fishery some trawlers would to stop hauling close to the surface and leave the trawl hanging vertically in water so that the floating redfish would surface and be sorted from the shrimp catch. After a while the redfish free shrimp trawl could then be retrieved. It seems unlikely that this practice would have been reported, since the redfish catch never reached the deck and the by-catch of redfish in the early part of the shrimp fishery may have been significantly underestimated. Riget et al, 1988, estimated a by-catch of redfish in 1988 to be 111 million and 15.584 tons out of a total shrimp catch of 49.089 tons. And based on the by-catch pr. kg shrimp from the Greenland shrimp and fish survey (SFW) and the total shrimp catch, Engelstoft J.J. (1996) estimated the total by-catch of redfish in the 1994 shrimp fishery to 4234 tons and 180 million individuals. A higher mean length of the redfish stock in the 1988 study accounted for the weight difference between the two studies (Engelstoft J.J. 1996). To minimize by-catch in the shrimp fishery, offshore shrimp trawlers has been equipped with grid separators since 2002 (G.H. 2001) and the grid separators have also been mandatory for inshore operating vessels since 2011(G.S. 2011). The implementation of sorting grids in the shrimp fishery has led to a high protection of redfish larger than 14 cm and in 2007 the by-catch of redfish in the shrimp fishery was estimated to 0.5% of the shrimp catch (Sünksen 2007) which is equivalent to about 700 tons in 2007.

In 2013 only 170 tons of redfish were reported from West Greenland, of which the majority was caught inshore and landed to factories (156 tons) and a minor part was reported as by-catch in the shrimp fishery (11 tons) and offshore fishery mostly targeting Greenland halibut (3 tons). From surveys it is known that the inshore landings of redfish are a mixture of golden redfish and deep-sea redfish, but the separation of landings is difficult, since redfish are landed to factories without head. The distribution of catch by division (table 1) indicates that only a fraction of the catches of redfish were taken as a by-catch in the inshore fishery targeting Greenland halibut, which is concentrated in division 1A inshore. Thus, the redfish catches inshore is a mixture of direct small boat fishery and by-catches in other fisheries targeting Greenland halibut and cod.

A pelagic fishery for pelagic redfish/beaked redfish (*Sebastes mentella*) occurred for the first time off West Greenland in 1999 and was conducted close to the edge of the Greenland EEZ and far off the shelf of division 1F. The differentiation between stocks in official statistics is however not straight forward. The pelagic redfish in West Greenland is believed to be part of the Irminger stock complexes and is assessed by ICES.

The differentiation between stocks in official statistics is not straight forward, and the two redfish species, golden redfish are combined in the catch statistics (table 1). The Greenland authority operates the quota uptake by categorising the catches in three types of redfish. 1) Fish caught by bottom trawl and longlines on the bottom are called Sebastes marinus. 2) Fish caught pelagic are called Sebastes mentella and 3) fish caught as by-catch in the shrimp fishery are named Sebastes sp.

Commercial fishery data

Information on historical length composition was derived from sampling of EU-German commercial catches of golden redfish during 1962-90 covering fresh fish landings as well as catches taken by freezer trawlers (Fig 2). Samples were quarterly aggregated and mean length was calculated. These data revealed significant size reductions from 45 to 35 cm, with the most significant reductions occurring during the 70s. Since the landings currently are at a very low level it is difficult to obtain data from the fishery. There are no data available to estimate the size composition of historical catches of deep-sea redfish.

Survey data

There are three recent surveys surveys covering the demersal redfish stocks in subarea 1. The EU-Germany survey (Fock H. and Stransky C. 2013), the Greenland deep-water survey (Jørgensen, O. A. 2014) and the shallower Greenland Shrimp Fish survey in West Greenland (Nygaard R. and Jørgensen O.A. 2014). The latter has a more appropriate depth coverage and geographic coverage (0-600m, 1A-F) in regards to redfish distribution, than both the EU-Germany survey (0-400m, 1Bs-F) and the Greenland deep-water survey (400-1500m, 1C-D). However, the EU Germany survey has the longest time series (1982 to present), and spans the last part of the decreasing redfish catches that took place in the same divisions, although likely at greater depths. The Greenland Shrimp and Fish survey in West Greenland has the second longest time series but started after the directed redfish fishery in West Greenland had ended. However, unlike the EU-Germany survey and the Greenland deep-water survey, the Greenland Shrimp and Fish survey (SFW) include divisions where the highest abundances of juvenile redfish are normally found (division 1A-B). In the Greenland deep-water survey deep-sea redfish are mainly caught in division 1C at depths less than 800 m with the highest abundance found at 400-600m. In 2013 only Div. 1D was covered which makes comparison with previous years difficult (Jørgensen O.A. 2014).

Besides the recent surveys, a joint *Greenland-Japan* existed from 1987 to 1995 including the same areas and depths as the present Greenland deep-water survey. The surveys were however conducted with different vessels and gears and the results are not directly comparable. Results from division 1C and 1D indicated a decreasing biomass of deep-sea redfish from 1987 to 1995.

Assessment

Due to a lack of adequate commercial data no analytical assessment could be formulated. The assessment was based on survey indices.

Golden redfish *(Sebastes marinus)*

The indices of the EU-Germany survey (Division 1Bs-F) decreased in the 1980s and were at a very low level in the 1990s. However, the survey has revealed increasing biomass indices of Golden redfish (>17cm) since 2004 and the 2013 indices are the highest observed since 1986 (Fig 3). The biomass of golden redfish in the EU-Germany survey is however still far below the 1982 indices, which were obtained from a stock that had already gone through substantial reductions in mean length in the landings. The biomass index for golden redfish in the Greenland shrimp fish survey increased in 2011 and 2012, but decreased slightly in 2013. For this survey no separation of species were made prior to 2006. However, since redfish are highly aggregating, some caution should be given when interpreting single year estimates that may be affected with some stochastic variation. The general impression is a slowly but steadily increasing biomass of Golden redfish.

Demersal deep-sea redfish (*Sebastes mentella*)

The indices of the EU-Germany survey have fluctuated at a low level throughout the time series, but with very low values after 2007 (fig 4). The fluctuating trend is likely caused by poor survey overlap with the depth distribution of adult deep-sea redfish. Still, a slight increase was observed in this survey in 2012 and the 2013 indices are among the highest observed for this survey.

The joint Greenland-Japan deep-sea (1CD) survey biomass index decreased from 1987 to 1995 (Fig 4).
The Greenland deep-sea survey (1CD) indices were at a low level from 1997 to 2007, but the indices have steadily increased since then and the 2013 estimate is the highest on record even though less than half the normal hauls were conducted. Deep-sea redfish were only caught in 5 out of 27 valid hauls and the biomass estimate was driven by 2 large hauls. The length distribution in this survey ranged from 21 to 45 cm with modes at 28 and 41 cm.
In the Greenland Shrimp and Fish survey, no separation of redfish species was made prior to 2006. During the years, annual growth increments of 4 cm were indicated by repeatedly pronounced peaks in length compositions at 7-8 cm and 12 cm probably corresponding to age 1 and 2 (Nederaas, 1990). The resent survey estimates have revealed only small modes at 7-8 cm and 10-14 cm. indicating recruitment at a low level. The biomass index for deep-sea redfish in this survey has steadily increased since 2008 and the 2013 indices are the highest observed since 2006 (fig 4). Length frequencies by division in the 2013 survey revealed modes at 8 cm (1B), 17 cm (1A-B) 28 cm (1C) and 32 cm (1E). The combined impression of these surveys is a steadily increasing biomass of deep-sea redfish.

Juvenile redfish (*S. marinus and S. mentella combined*)

Abundance index of juvenile redfish (both species combined) in the EU-Germany survey has been at a very low level since 2001 (Fig 5). Abundance indices of both redfish species combined in the Greenland Shrimp and Fish survey (Division 1A-F) decreased during the 1990's and has remained at a low level since then. In 2012 the combined redfish abundance from the Greenland Shrimp and Fish survey was the lowest on record and the 2013 total abundance is the second lowest observed since 1992 (fig 5). Therefore, recruitment of juvenile redfish still seems to be highly depressed in the area.

Estimation of SSB and recruitment

The golden redfish spawning stock biomass was estimated assuming knife edge maturity at 35 cm for golden redfish and 30 for deep-sea redfish, as observed in East Greenland applied to the length disaggregated abundance indices derived from the EU-German survey. Recruitment was estimated as the abundance of length groups 17-20 cm, taken as proxies for golden redfish recruitment at age 5.

For Golden redfish, the estimated SSB has increased since 2006 and the estimated recruitment at age 5 has increased since 2007 compared to the low levels seen since the 1990's (Fig. 6). A stock recruitment plot can be estimated by combining the recruitment at age 5 with the estimated SSB 5 years earlier. Thus the most recent year is 2008, which is estimated as the 2013 abundance of 17-20 cm golden redfish plotted against the 2008 biomass of individuals > 35 cm (fig 7). The plot indicates higher recruitment since 2002 at low SSB levels. Such a pattern could be caused by higher spawning success in recent years, migration from nearby stocks into subarea 1 or low survival of recruits in the beginning of the 1980's combined with increased survival of recruits since 2002.

For deep-sea redfish, the estimated SSB was high in 2006 and 2013 the estimated recruitment at age 5 has been at a low level since 2004 compared to the 1990's (Fig. 8). The stock recruitment plot for deep-sea redfish (2013 abundance of 17-20 cm golden redfish plotted against the 2008 SSB) reveals unusually poor relationship between SSB and recruitment for deep-sea redfish with years of high recruitment at low SSB and years of low recruitment at high SSB (fig 9). A simple explanation for this pattern could be a poor overlap between the survey and the SSB for deep-sea redfish.

Assessment results

Golden redfish

The EU-Germany and Greenland Shrimp Fish survey (SFW) have revealed increasing biomass of golden redfish since 2004. The biomass of golden redfish in the EU-Germany survey is however still far below the 1982 indices. Also the 1982 indices must have been obtained from a stock below historic levels, since the size reduction in the landings occurred already during the 1970's. The abundance of redfish in subarea 1 still is at a very low level both in the Greenland SFW survey (all sizes) and the EU-Germany survey (redfish < 17cm). Therefore recruitment and spawning still seems to be depressed in the area and the increasing biomasses observed are likely a consequence of either increased survival of redfish and/or migration of redfish into subarea 1 from nearby areas. Therefore no increase in catches can be advised until significant new year-classes are observed.

Demersal deep-sea redfish

The surveys have revealed increasing biomasses for deep-sea redfish since 2008. However, the abundance of redfish in subarea 1 still is at a very low level both in the Greenland SFW survey (all sizes) and the EU-Germany (juvenile redfish). Therefore recruitment and spawning still seems to be depressed in the area and the increasing biomasses observed are likely a consequence of either increased survival of redfish and/or migration of redfish into subarea 1 from nearby areas (East Greenland). Therefore no increase in catches can be advised until significant new year-classes are observed.

References

Engelstoft J.J. 1996. By-Catches in the Shrimp Fishery at West Greenland. NAFO SCR Doc. 96/36. Serial No. N2711

Engelstoft, J. J, Isaksen, B., Larsen, R. B., Rosing, M. and K. Zachariassen, 2001. Studies of technical methods for secure shrimp fishery in the Redfish Box, East Greenland. Project Report for the Nordic Strategy for the Environment and Fisheries. *Tema Nord* (technical report at Greenland Institute of Natural Resources).

Fock H. and Stransky C. 2013. Stock Abundance Indices and Length Compositions of Demersal Redfish and Other Finfish in NAFO Sub-area 1 and near bottom water temperature derived from the German bottom trawl survey 1982-2012. NAFO SCR Doc. 13/015, Ser. No. N6166.

G.H. 2001. Hjemmestyrets bekendtgørelse nr. 39 af 6. december 2001 om regulering af fiskeri ved tekniske bevaringsforanstaltninger. (available online on)

G.S. 2011. Selvstyrets bekendtgørelse nr. 12 af 17. november 2011 om tekniske bevaringsforanstaltninger i fiskeriet http://lovgivning.gl/lov?rid={0F40DF8E-7625-4C33-90EA-8A62F02061AB}

Horsted S. A. 1980. Data for 1979 and earl 1980, and Estimates of Stock and Yield for 1980-82. NAFO SCR Doc. 80/VI/72 Serial No. N124 (Revised)

Jørgensen, O. A. 2014. Survey for Greenland Halibut in NAFO Divisions 1C-1D, 2013. NAFO SCR Doc. 13/002, Ser. No. N6292:1-37.

Nygaard R. and Jørgensen O.A. 2014. Biomass and Abundance of Demersal Fish Stocks off West and East Greenland estimated from the Greenland Institute of Natural resources Shrimp Fish Survey, 1988-2013. NAFO SCR Doc. 14/003, Ser. No. N6293.

Nygaard R. 2014. Denmark/Greenland Research Report for 2013. NAFO SCS Doc. 14/12, Ser. No. N6307.

Riget, F., J. Boje and K. Lehman 1988. By-catches of Greenland Halibut and Redfish in the Shrimp Fishery at West Greenland. NAFO SCR Doc. 88/12.

Sünksen, K. 2007: Discarded by-catch in shrimp fisheries in Greenlandic offshore waters 2006-2007. NAFO SCR Doc. 07/88

Table 1. Annual reported catches of redfish in NAFO Subarea 1: Golden and deep-sea redfish combined. Figures include reported discard by shrimp vessels.

YEAR	1A	1B	1C	1D	1E	1F	NK	Pelagic (1F)	TOTAL	Note
1952							159		159	1
1953							13800		13800	1
1954							15520		15520	1
1955							32249		32249	1
1956							14008		14008	1
1957							28137		28137	1
1958							17945		17945	1
1959							32540		32540	1
1960		224	8275	16960	8810	9836	25		44130	2
1961	59	1404	11808	17129	9808	13685	525		54418	2
1962	82	2259	12248	15850	20490	9219	204		60352	2
1963		2770	8323	12561	15389	7403	5559		52005	3
1964	10	3370	5466	7083	6657	4500	2925		30011	4
1965		1364	3702	4065	4605	5216	100		19052	4
1966		281	3158	3819	3137	6316	47		16758	4
1967		346	1588	5384	2699	2923	270		13210	5
1968		3	1665	2240	2014	3712	65		9699	5
1969	5	2	724	1295	1056	1553	190		4825	5
1970			363	832	1826	2298	197		5516	5
1971			141	223	317	1687	388		2756	5
1972			99	223	1610	848	208		2988	5
1973		15	315	611	1385	977	16		3319	5
1974		78	511	790	1286	661			3326	5
1975		3609	639	787	1613	1981			8629	5
1976		2873	443	1706	3488	5188			13698	5
1977	3	1	1839	10925	4082	14061			30911	6
1978		5	417	1143	3313	3175			8053	6
1979		2	1357	3231	2172	2115			8877	6
1980	2	12	1895	776	1617	3205			7507	7
1981	9	12	462	205	1672	3401			5761	7
1982	1	24	734	2236	2708	2325			8028	7
1983	1	14	56	292	3812	2535	7		6717	7
1984			1	416	2303	2116	915		5751	7
1985	2	54	37	667	1524	1756			4040	7
1986	6	7		110	1595	952	2674		5344	7
1987		3		2	315	663	159		1142	7
1988	3	4	1	41	548	650	154		1401	8
1989		8		77	350	338	67		840	9
1990	15	25		84	163	67	60		414	9
1991	42	23		137	67	19	15		303	9
1992	6	44	4	163	104	122	2		445	9
1993	42	261	113	288	116	32			852	9
1994	18	373	224	284	123	87			1109	10
1995	8	262	256	259	104	1371	7		2267	11
1996	19	147	279	289	106	19			859	11
1997	13	191	216	421	114	127	1		1083	11
1998		187	256	319	126	39			927	11
1999	8	195	192	263	67	215	1	0	941	11

YEAR	1A	1B	1C	1D	1E	1F	NK	Pelagic (1F)	TOTAL	Note
2000	6	106	173	217	57	141		11034	700	12
2001	7	87	78	103	21	4		5272	300	12
2002	4	151	171	113	31	30		15579	500	12
2003	9	136	102	113	48	92		24702	500	12
2004	112	21	0	26	11	230		24220	400	12
2005	88	55	0	50	17	(0)		22345	200	12
2006	45	63	162	93	16	(0)		19432	300	12
2007	59	29	58	75	19	(0)		2762	235	13
2008	60	3	30	54	10	232		1895	389	14
2009	0	1	6	6	3	358		0	374	14
2010							251	0	251	15
2011	40	4	35	32	4	1	64	0	180	15
2012	32	14	68	32	5	10	0	0	161	15
2013	43	9	44	56	4	14	0	0	170	15

NOTES

1- W.G.Mattox.
2- Statlant 21. Identical to W.G. Mattox. (years)
3- Statlant 21 (5 Kt more in statlant than in W.G. Mattox).
4- Statlant 21. Identical to W.G. Mattox.
5- Statlant 21.
6- Unreliable Catch data for 1977-1979 (Horsted S. A. 1980).
7- Statlant 21.
8- Shrimp bycatch estimated to 15.584 tons (Riget et al. 1988).
9- Statlant 21.
10- Shrimp bycatch estimated to 4234 tons (Engelstoft J.J. 1996).
11- Statlant 21.
12- Pelagic estimated as Statlant 1F redfish minus demersal redfish from previous assessments (STACFIS). (0) indicates minor negative result.
13- Shrimp bycatch estimated to 0.5% of the shrimp catch ~700 tons (SCR 07/88). Pelagic estimated as Statlant 1F redfish minus Demersal redfish from previous assessments (STACFIS). (0) indicates minor negative result.
14- Pelagic estimated as Statlant 1F redfish minus Demersal redfish from previous assessments (STACFIS). (0) indicates minor negative result.
15- STACFIS

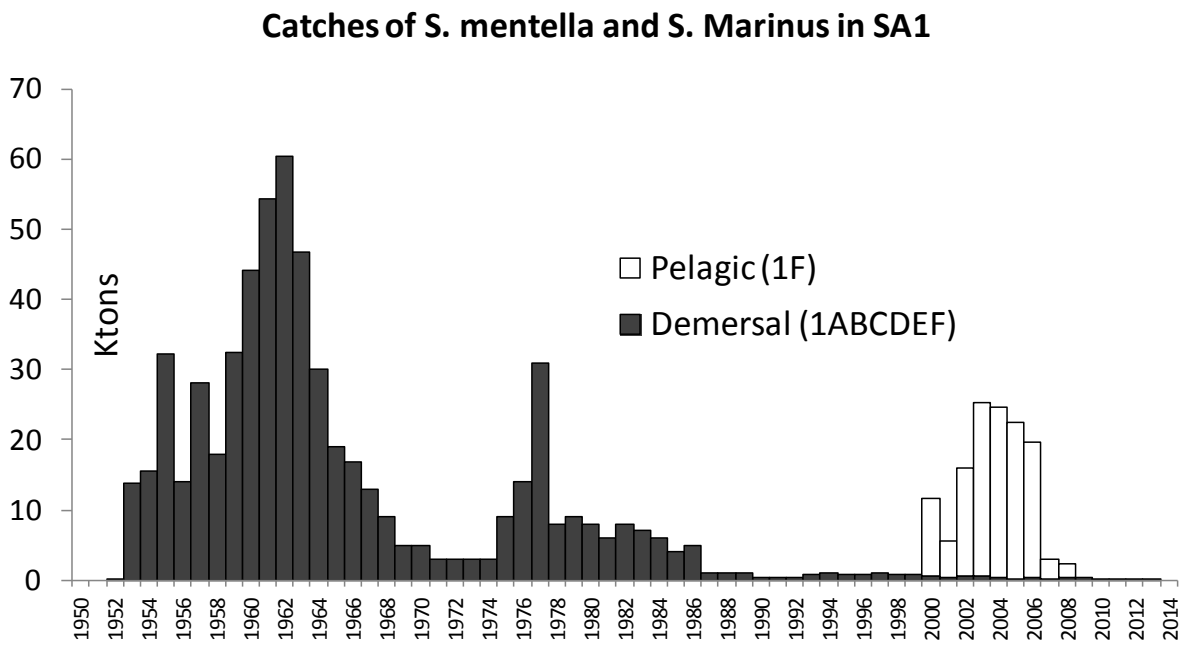

Fig. 1. Official catches of demersal golden redfish and deep-sea redfish combined in NAFO Subarea 1 (West Greenland).

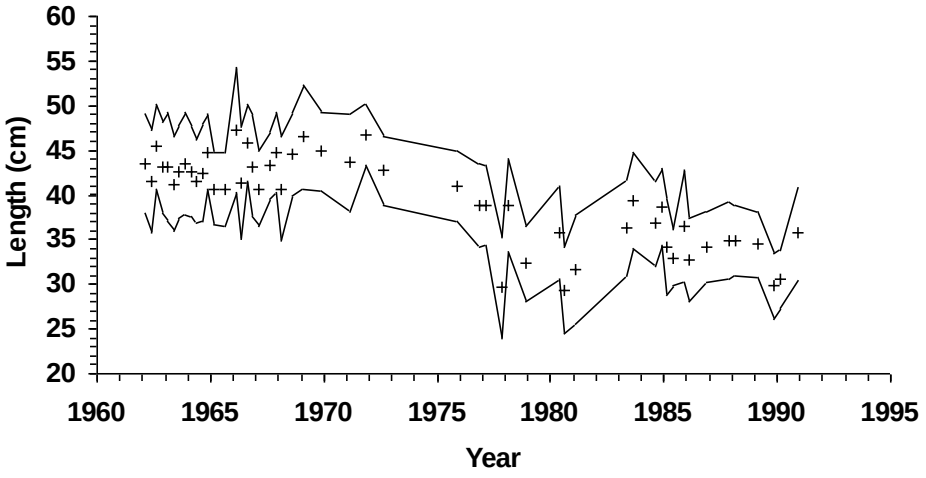

Fig. 2. Mean length ± standard deviation derived from German catches of golden redfish in NAFO Subarea 1, 1962-90.

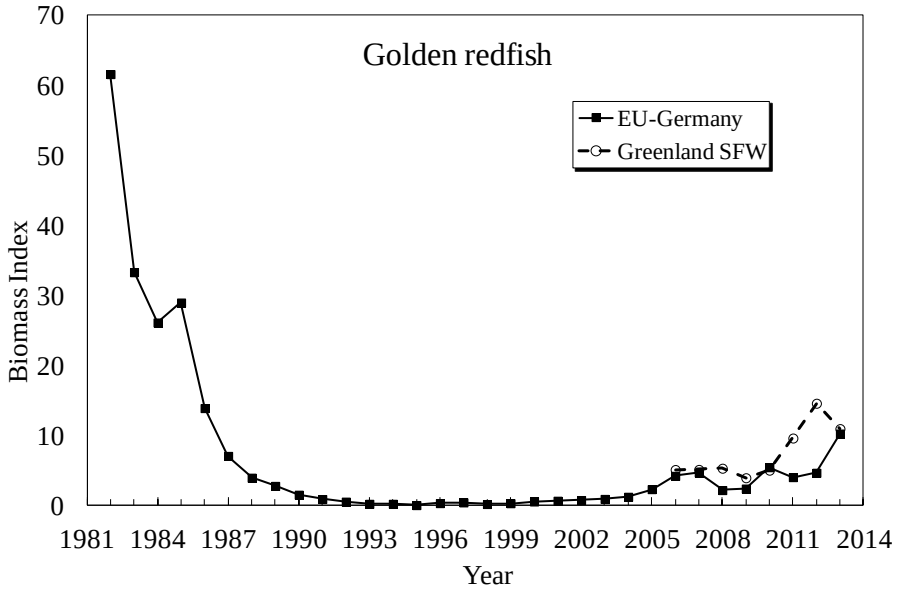

Fig. 3. Golden redfish (≥17 cm) survey biomass indices derived from the EU/Germany survey.

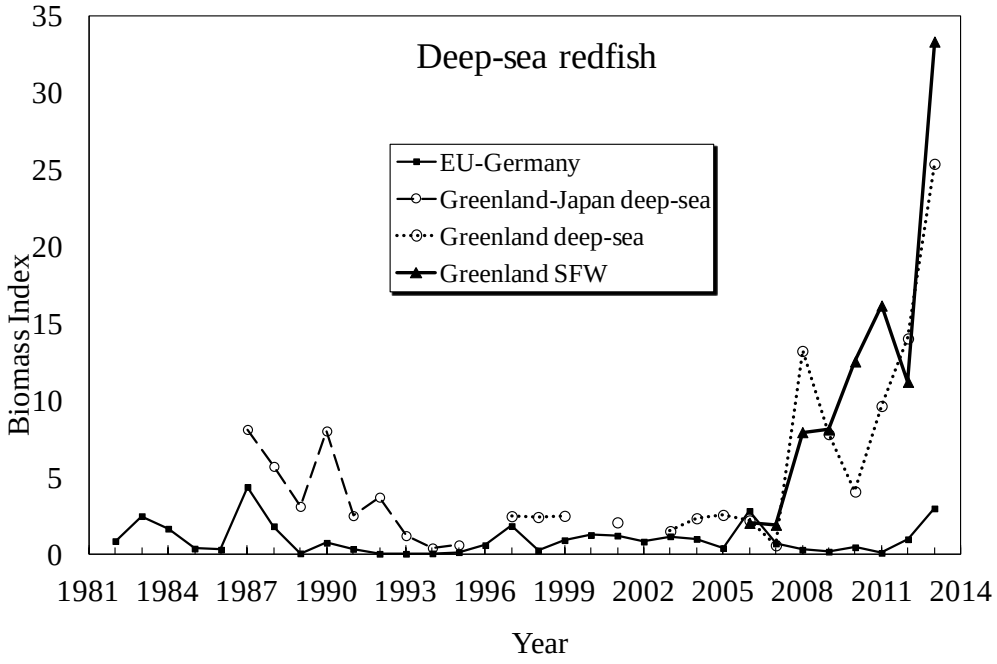

Fig. 4. Deep-sea (≥17 cm) survey biomass indices derived from the EU/Germany survey, the Greenland-Japan deep-sea survey, the Greenland deep survey and the Greenland shrimp and Fish survey.

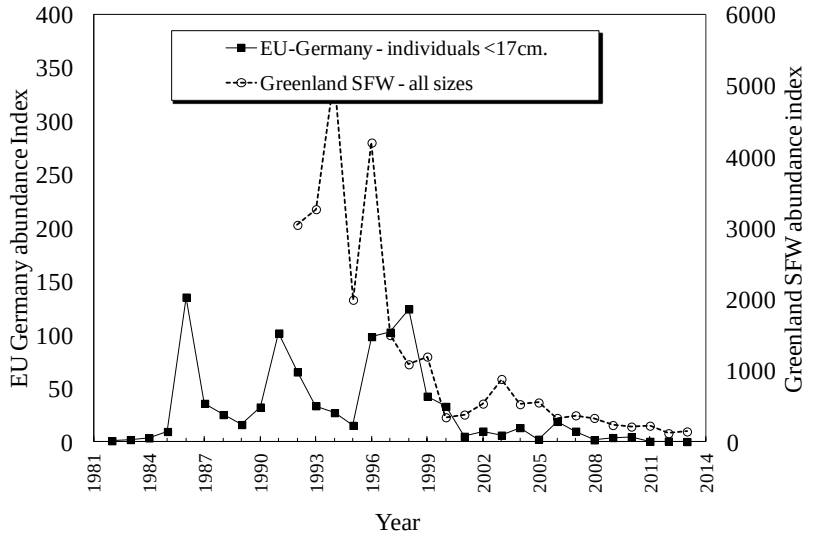

Fig. 5. Abundance indices for unspecified redfish (<17 cm) in Subarea 1: survey abundance indices derived from the EU-German groundfish survey and from the Greenland shrimp and fish survey (SFW) all sizes. Notice the different scales.

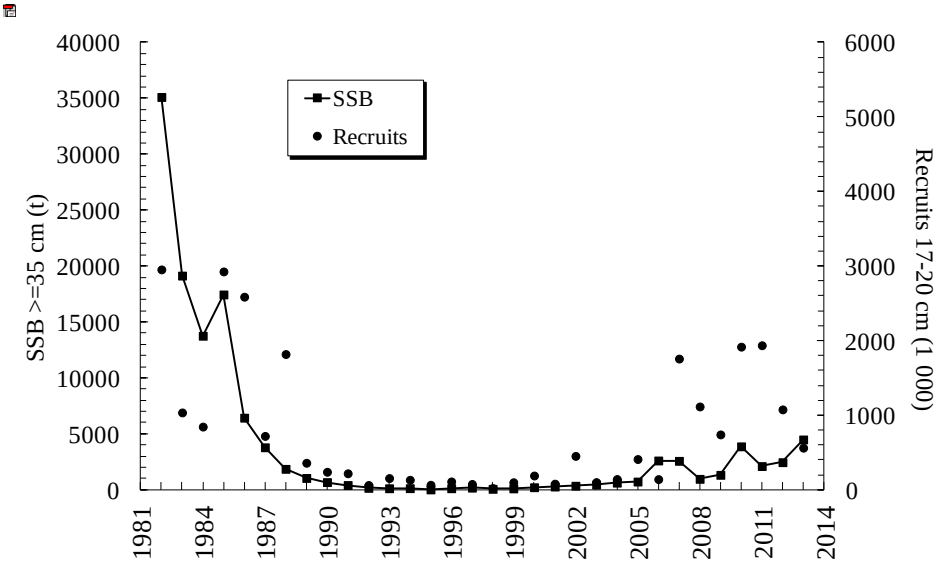

Fig. 6. Golden redfish Subarea 1. SSB and recruitment indices derived from the EU-German groundfish survey.

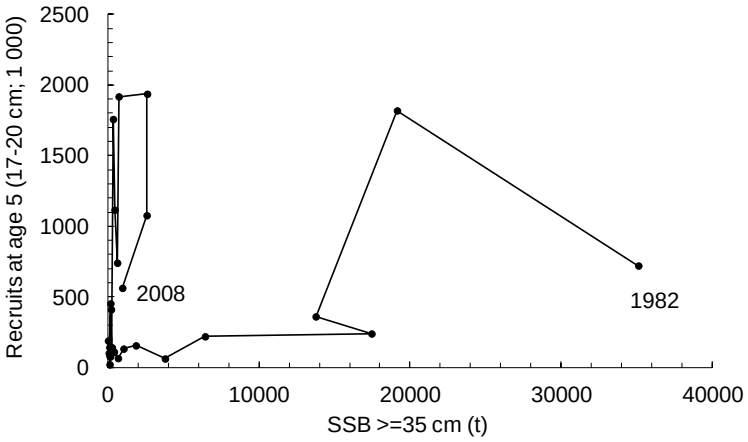

Fig. 7. Golden redfish Subarea 1. Recruitment at age 5 plotted against SSB 5 years before derived from the German groundfish survey. 2008 is the 2013 abundance of 17-20 cm plotted against the 2008 biomass of individuals > 35 cm.

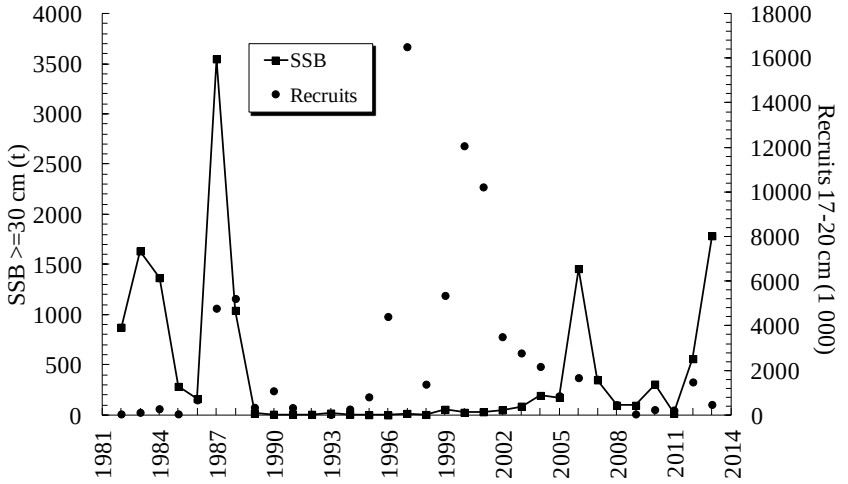

Fig. 8. Deep-sea redfish Sub-area 1. SSB and recruitment indices derived from the German groundfish survey.

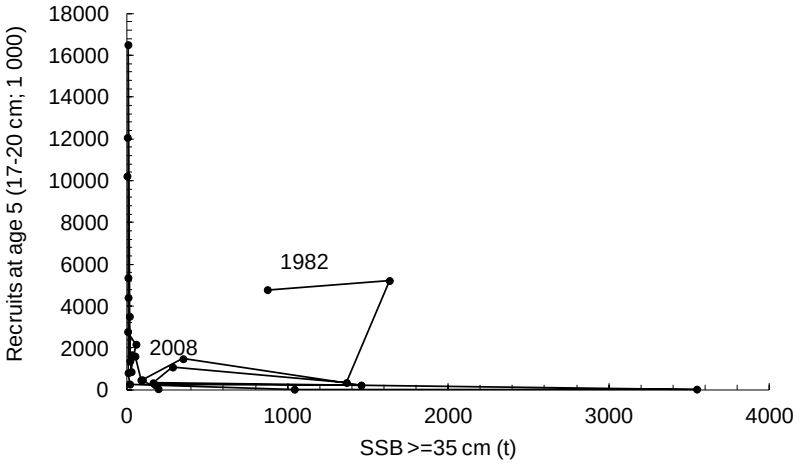

Fig. 9. Deep-sea redfish Sub-area 1. Recruitment at age 5 plotted against SSB 5 years before derived from the German groundfish survey. 2008 is the 2013 abundance of 17-20 cm plotted against the 2008 biomass of individuals > 35 cm.