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Assessment of Demersal Redfish in NAFO Subarea 1

by

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Abstract

Two species of redfish are common in West Greenland, golden redfish (*Sebastes norvegicus*) 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 reduced after the implementation of sorting grids in the shrimp trawls in 2002. 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 2016 only 166 tons of redfish were reported, of which the majority was caught inshore and landed to factories (140 tons) and a minor part was reported as by-catch in the shrimp fishery and offshore fishery targeting Greenland halibut and cod (25 tons).

There are currently three recent surveys covering the demersal redfish stocks in West Greenland: The EU-Germany survey, the Greenland deep-water survey and the Greenland Shrimp and Fish survey. The latter has a more appropriate depth coverage and area (0-600m, NAFO 1A-F since 1988 and ICES XIV since 2008) in regards to the redfish distribution, than both the EU-Germany survey (0-400m, ICES XIV, NAFO 1C-F since 1982) and the Greenland deep-water survey (400-1500m, NAFO 1C-D since 1998). In West Greenland 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). Length distributions from the Greenland SFW survey reveals an almost complete lack of new incoming year classes since 2011. The increasing biomasses observed could be a consequence of either increased survival of redfish after the implementation of the sorting grids in 2002 and/or migration of redfish into subarea 1 from nearby

areas (East Greenland). Therefore, no increase in catches can be advised as long as recruitment is so low. In the nearby East Greenland shelf area, new yearclasses have likewise been missing in the most recent 4-6 years.

Biology

Two species of redfish are common inshore and offshore in West Greenland, golden redfish (*Sebastes norvegicus*) 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 be found in the same areas as golden redfish including shallow waters and inside the fjords, but is the dominating species at greater depths offshore (>400m). 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. 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).

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. However, 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, before finally retrieving the trawl. 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 2016, only 166 tons of redfish were reported from West Greenland (Table 1 and fig 1), of which the majority was caught inshore and landed to factories (140 tons) and a minor part was reported as by-catch in the shrimp fishery and offshore fishery mostly targeting Greenland halibut and cod (25 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. 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 fishery took place far of the shelf in the southern part of 1F.

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 norvegicus. 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 3). 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 daily landings of few individuals taken as bycatch, 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 ongoing surveys covering the demersal redfish stocks in subarea 1: The EU-Germany (EU-G) survey (SCR 13/015), the Greenland deep-water survey (Jørgensen, O. A. 2017) and the shallower Greenland Shrimp Fish survey in West Greenland (Nygaard R. and Jørgensen O.A. 2017). 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, ICES XIV and NAFO 1Bs-F) and the Greenland deep-water survey (400-1500m, 1C-D). The Greenland SFW survey was originally designed to survey the shrimp stock and relies on a large commercial sized and fine meshed shrimp trawl. Therefore, even small fish and juvenile fish are retained. The Gear was changed in the Greenland SFW survey in 2015. The EU-G survey does not fully cover the depth distribution of deep-sea redfish and the Greenland deep water survey is stratified at too great depth for Golden redfish. 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 SFW 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-G survey and the Greenland deep-water survey, the Greenland 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 2007 the Greenland SFW survey was enhanced to include the shelf off East Greenland (SFE, 0-600m, ices XIV).

Besides the recent surveys, a joint *Greenland-Japan* existed from 1987 to 1995 somewhat overlapping the 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 norvegicus)*

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 2015 index reached the highest level observed since 1986 (Fig 4). In 2016, the EU-G survey had few hauls and only covered the southern part of division 1E and 1F.

The biomass index for golden redfish in the Greenland SFW survey has increased substantially since 2011 (fig 4). The peaks observed in 2013 and 2016 is caused by few single hauls giving up to 80 of the year estimate (fig 5). In 2016 more than 80% of the year biomass derives from a single haul in division 1E (fig 5) consisting of large Golden redfish at lengths between 45 and 70 cm (fig 11). In the Greenland SFW survey no separation of species were made prior to 2006. The combined survey indices indicate an increasing biomass of Golden redfish in West Greenland.

Demersal deep-sea redfish (*Sebastes mentella*)

The biomass indices in the EU-G survey have fluctuated at a low level throughout the time series (fig 6). The fluctuating trend is likely caused by poor survey overlap with the depth distribution of adult deep-sea redfish. The joint Greenland-Japan deep-sea (1CD) survey biomass index decreased from 1987 to 1995 when the survey ended (fig 6). The Greenland deep-sea survey (1CD) indices were at a low level from 1997 to 2007, but the biomass index have increased since then and remained at a higher level.

In the Greenland SFW survey, no separation of redfish species was made prior to 2006. The biomass index for deep-sea redfish in the SFW survey has steadily increased since 2008 and the 2016 indices are the highest observed (fig 6). Length frequencies by division in the 2016 survey revealed large redfish in the area at lengths between 25 and 40 cm (fig 11). The combined impression of these surveys is a steadily increasing biomass of deep-sea redfish.

Recruitment redfish (*S. norvegicus and S. mentella combined*)

The EU-Germany survey regularly found juvenile redfish from 1984 to 2000. After 2000 the abundance of juvenile redfish decreased to a low level and have remained low since then (fig 8). The Greenland SFW survey initially had high levels of juvenile redfish in the survey. Therefore the total abundance for both species combined and all sizes can be regarded a recruitment index in the initial period. From 1992 to 1999 high numbers of redfish recruits were observed yearly but the index gradually decreased. After 1999 the abundance index gradually decreased and has remained low since then (fig 8). Since 2011, virtually no new incoming year classes have been observed in West Greenland (fig 9 and 10). In the East Greenland area, which could potentially supply west Greenland with recruits as known for other stocks (Cod, Haddock), new year classes of redfish has not been observed in the recent 4-6 years (fig 9 and 10).

Assessment results

Recruitment

Recruitment has been at a low level in the area since 2000 and since 2011 virtually now new incoming year classes have been observed in either the Greenland SFW survey or the EU-Germany survey in West Greenland. In East Greenland, recruitment has also been at a very low level in the recent 4 to 6 years.

Golden redfish

The EU-Germany and Greenland SFW survey 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. The 1982 indices must have been obtained from a stock that was already in a decreasing trend, since the size reduction in the landings occurred already during the 1970's. Virtually no new incoming year classes have been observed since 2011 in West Greenland and in the nearby East Greenland waters in the recent 4-6 years. The increasing biomasses observed is likely a consequence of either increased survival of redfish and/or migration of redfish into subarea 1 from nearby areas (East Greenland). No directed fishery can be advised as long as no new large year-classes are observed.

Demersal deep-sea redfish

The surveys have revealed increasing biomasses of deep-sea redfish since 2008. Recruitment has been at a very low level in the area for almost 2 decades. Virtually no new incoming year classes have been observed since 2011 in West Greenland and in the nearby East Greenland waters in the recent 4-6 years. The increasing biomasses observed is likely a consequence of either increased survival of redfish and/or migration of redfish into subarea 1 from nearby areas (East Greenland). No directed fishery can be advised as long as no new large year-classes are observed.

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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
2014	35	6	36	52	5	36	0	0	170	
2015								0	270	
2016	35	2	33	68	8	20	0	0	166	

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

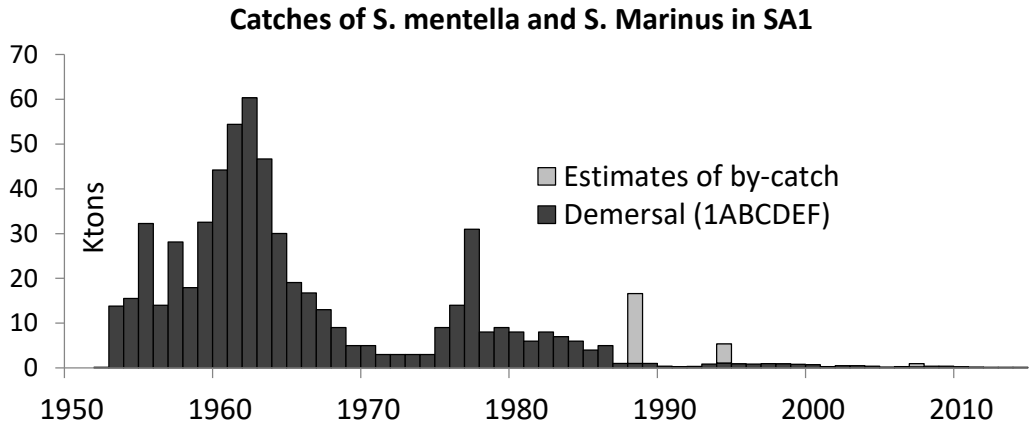

Fig. 1. Catches of demersal golden redfish and deep-sea redfish combined in NAFO Subarea 1 (West Greenland).

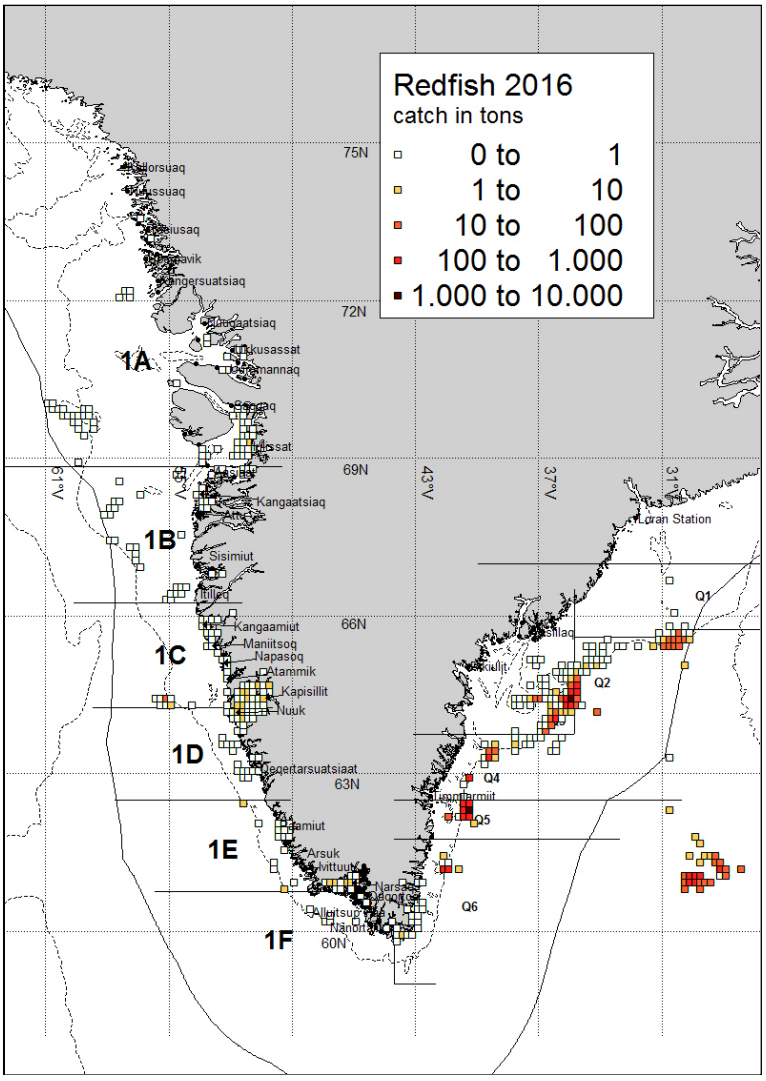

Fig. 2. Map of factory landings and logbook reported catches and by-catches of redfish (Golden, deep-sea and beeked combined) by statistical square in 2016.

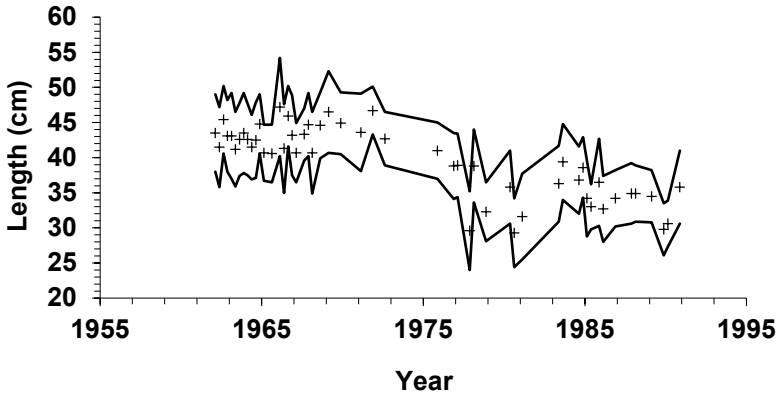

Fig. 3. Mean length ± standard deviation derived from German catches of golden redfish in NAFO Subarea 1, 1962-90.

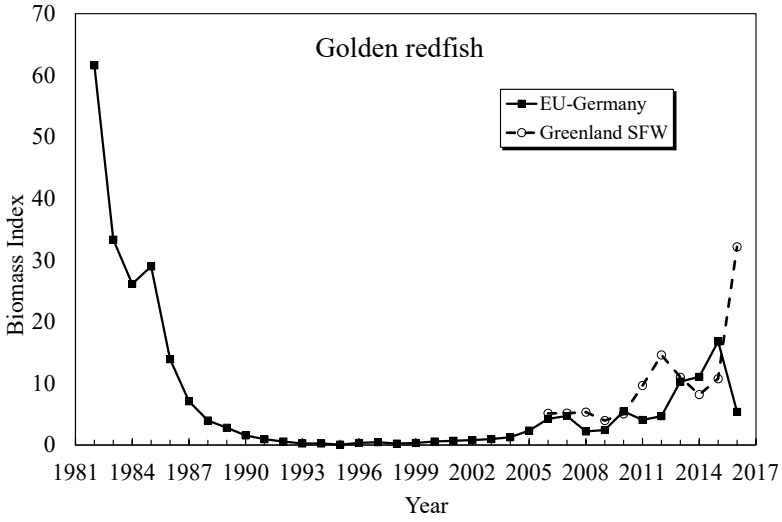

Fig. 4. Golden redfish (≥17 cm) survey biomass indices derived from the EU-G survey and the Greenland SFW survey.

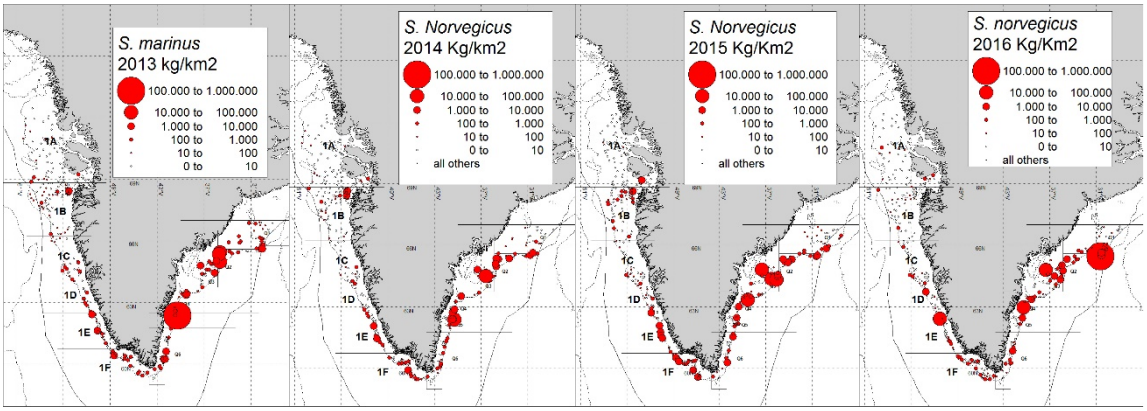

Fig. 5. Golden redfish survey biomass in kg/km² and abundance in numbers/km² from the Greenland SFW survey in West Greenland and the SFE survey in East Greenland.

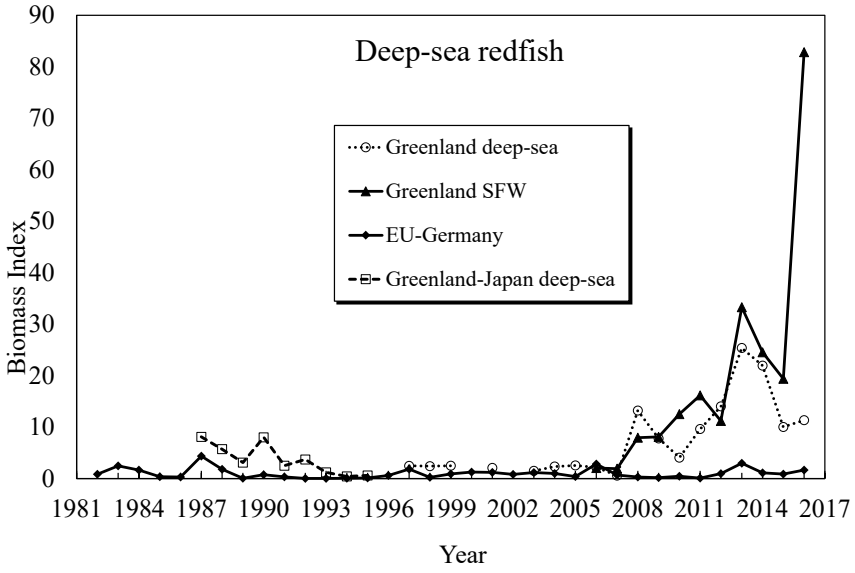

Fig. 6. Deep-sea (≥17 cm) survey biomass indices derived from the EU/Germany survey, the Greenland-Japan deep-sea survey, the Greenland deep sea survey and the Greenland SFW survey.

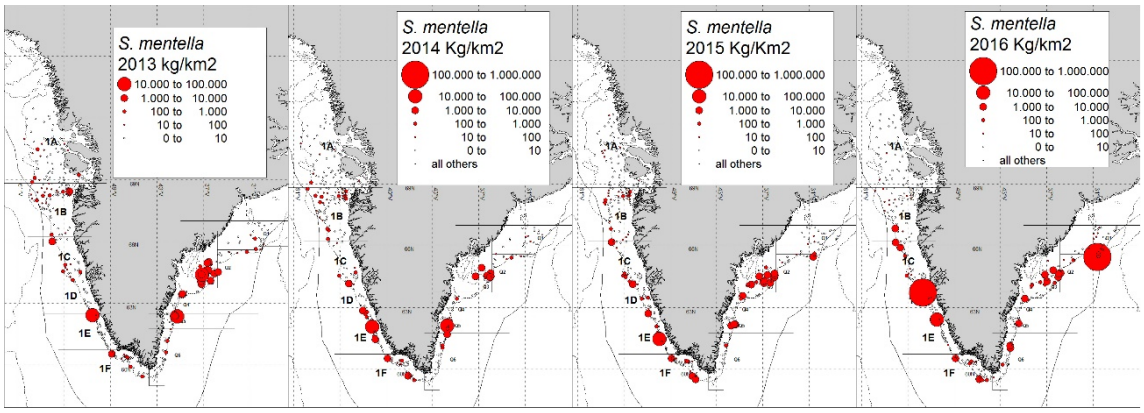

Fig. 7. Deep-sea redfish survey biomass in kg/km² and abundance in numbers/km² in the Greenland SFW survey in West Greenland and the identical Greenland SFE survey in East Greenland.

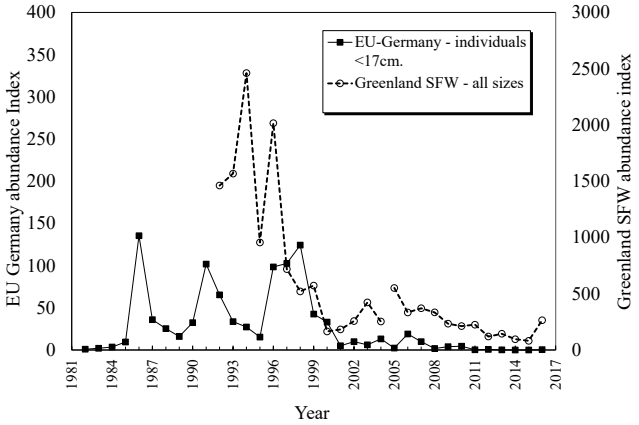

Fig. 8. Abundance indices for unspecified (recruits) redfish in Subarea 1. Survey abundance indices derived from the EU-German groundfish survey (individuals <17 cm) and from the Greenland shrimp and fish survey (SFW) all sizes. Notice the different scales.

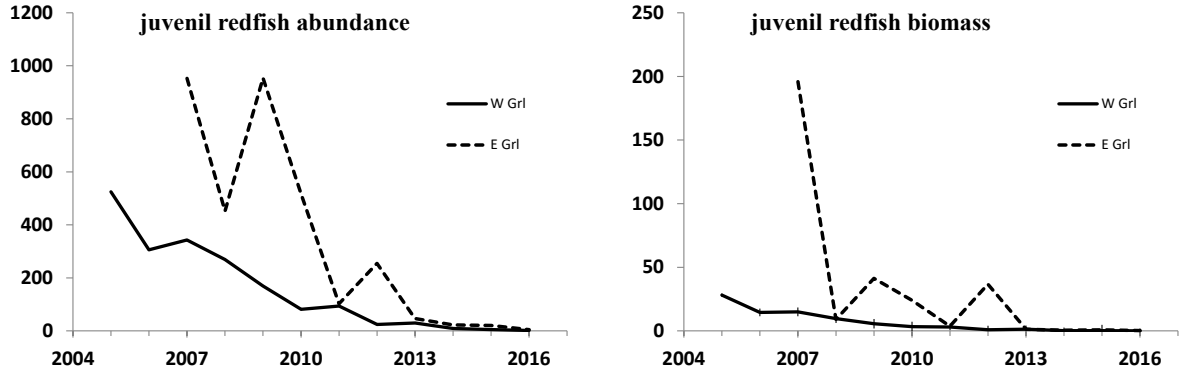

Fig 9. Juvenil redfish >20 cm (*S. mentella* and *S. norvegicus* combined) abundance (million) and biomass (Kt) in the Greenland SFW survey in West and the identical SFE survey in East Greenland.

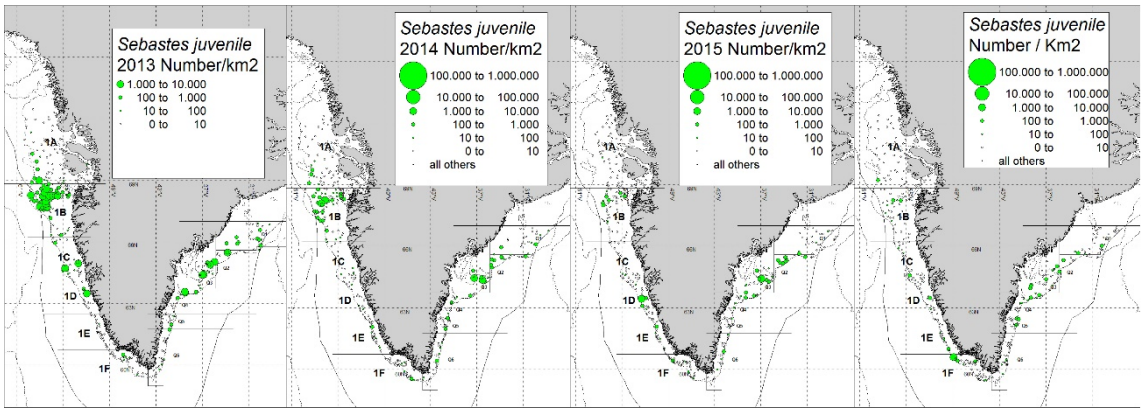

Fig. 10. Juvenile redfish < 20 cm survey biomass in kg/km^2 and abundance in numbers/km^2 in the Greenland SFW survey in West and the identical SFE survey in East Greenland.

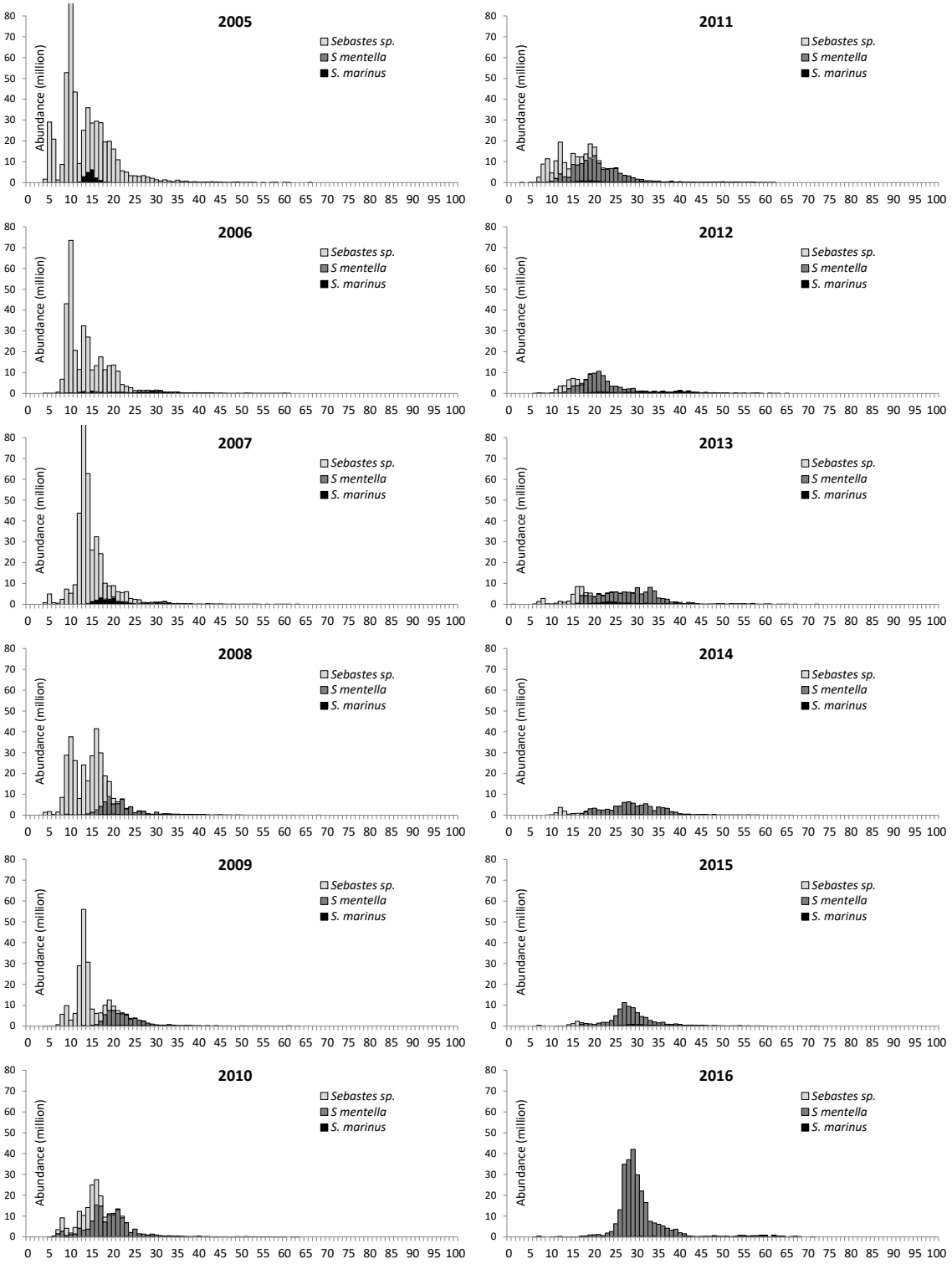

Fig. 11. Stacked Length frequencies for golden redfish (*Sebastes Norvegicus*), deep-sea redfish (Sebastes mentella) and juvenile redfish (Sebastes sp.) from the Greenland SFW survey in West Greenland.