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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*). Golden redfish has a shallower depth distribution than deep-sea redfish. The deep-sea redfish stock structure is more complicated and is in ICES 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. Reported landings are also 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 off West Greenland in 1999 and was conducted close to the edge of the Greenland EEZ and far off the shelf of division 1F and ICES 14. The pelagic redfish in West Greenland is considered part of the Irminger stock complex and is assessed by ICES.

There are currently five 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 regard 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 after 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 in the recent decade (lack of 1-4 year old redfish less than 20 cm). The increasing biomasses observed could be a consequence of either increased survival of redfish after the implementation of the sorting grids in 2002 or migration of redfish into subarea 1 from nearby areas (East Greenland). However, it seems unrealistic to advise a directed fishery as long as recruitment is so limited.

Biology

Two species of redfish are common inshore and offshore in West Greenland, golden redfish (*Sebastes norvegicus*) and deep-sea redfish (*Sebastes mentella*). Golden redfish has a shallower 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, and 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, spawning individuals with live larvae are yearly observed in the inshore trawl survey in Nuuk in April. Furthermore, 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. 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 operating shrimp trawlers have 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 equivalent to about 700 tons in 2007 (Sünksen 2007).

In 2016, 291 tons of redfish were reported from West Greenland (Table 1 and Figure 1), of which 69 tonnes was caught inshore and landed to factories. A further 198 tonnes were reported as by-catch by-catch in the shrimp fishery which is a substantial increase compared to previous years. Offshore trawlers and other vessels fishery mostly targeting Greenland halibut and cod reported a 22 tons of redfish. 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 (Figure 2). Samples were quarterly aggregated and mean length was calculated. These data revealed a gradual mean 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 several ongoing and historic surveys of interest in regards to the demersal redfish stocks in subarea 1: The EU-Germany (EU-G) survey started (Werner et al. 2020), The Greenland deep-water survey is relevant for deep-sea redfish (Nogueira and Estévez-Barcia, 2023). The shallower Greenland Shrimp Fish survey in West Greenland is ongoing and started in 1990. It use a finemeshed shrimp survey an catch redfish from age 1 (Nygaard R. and Nogueira, 2023). The Shrimp and Fish survey inshore in 1D takes place in April provides information on the fjord areas and occasionally find spawning females.

The Greenland SFW survey has a more appropriate depth coverage and geographic coverage (0-600m, 1A-F) in regard 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 2005 from an older type bobbin based shrimp trawl (skjarevoy) to a slightly larger shrimp trawl wi. 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). For the inshore areas the gillnet survey in the Disko bay (since 2001) and the Uummannaq fjord (since 2015) in Division 1A and a Trawl survey in the Godthåbs fjord and Ameralik fjord in Division 1D inshore (since 2015), provides information on species composition in the inshore areas.

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.

Results

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. Increasing biomass indices of golden redfish (>17cm) was observed after 2004 and peaking in the 2015 with the index reached the highest level observed since 1986 (Figure 4). Since the EU-Germany survey in West Greenland is an extension of the East Greenland survey targeting cod the survey has experienced varying survey coverage in West Greenland since 2016.

Redfish were not always separated on a species level in Greenland shrimp and fish survey prior to 2006. In this survey, golden redfish biomass was stable from 2006-2010 but increased gradually until 2016. The 2017 and 2018 biomass indices were however close to the 2006-2011 level. The increasing biomass observed from 2011-2016 occurred division 1E and 1F and was often caused by one or 2 hauls containing larger individuals contributing more than half the total West Greenland biomass. In 2016, a single haul in division 1E consisted of large golden redfish between 45-70 cm and provided 80% of the total biomass estimate. In 2019, the biomass index reached the second highest value observed since 2006, but this was attributed to two hauls, one in division 1C (60%) and one in division 1B (12%). the rest of the biomass being distributed from 1A including the Disko Bay to 1F in South Greenland (figure 8a). Intermediate sized golden redfish are rare in West Greenland. Overall, the biomass indices of deep-sea redfish in surveys seems to be slowly decreasing in the recent decade.

The gillnet surveys in Division 1A inshore supported that the redfish in this area were almost exclusively Golden redfish. This was not the case in Division 1D inshore. Distribution since 2010 is shown in figure 8a.

Deep-sea redfish (*Sebastes mentella*)

The biomass indices in the EU-Germany survey have fluctuated at a low level throughout the time series (Figure 5). The fluctuating trend is likely caused by poor survey overlap with the depth distribution of adult deep-sea redfish. **The Greenland-Japan survey** biomass index gradually decreased from 1987 to 1995 when the survey ended (Figure 5). **The Greenland deep-sea survey** (1CD) indices were at a low level from 1997 to 2007, but the biomass index has been at a higher level since 2008 (Figure 5). T**he Greenland shrimp and fish survey** biomass index for deep-sea redfish steadily increased after 2006 and the 2016 indices were among the highest observed (Figure 5). However, the high 2016 biomass index was caused by a single haul in division 1D of large redfish between 25 and 40 cm. In 2017, there were no such large hauls in the survey but the indices remain in an increasing trend. About 80-95% of the redfish biomass in the trawl survey in Division 1D inshore since 2015 has been deep-sea redfish. Overall, the biomass indices of deep-sea redfish in surveys seems to be slowly decreasing in the recent decade. Deep-sea redfish is mainly distributed on the slope of the shelf (figure 8b) and occasionally inside the fjords, perhaps as isolated meta stocks.

Redfish recruitment (*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 has decreased to a low level and remained low until 2016 (Figure 6). **The Greenland shrimp and fish survey** initially had high levels of juvenile redfish in the survey particularly in the important nursery grounds in Division 1B (Figure 6). The total abundance of both species combined can be regarded as a recruitment index, since the Greenland Shrimp and Fish survey normally catches high numbers of small redfish in the fine meshed shrimp trawl used for the survey. From 1992 to 1999, high numbers of redfish recruits were observed annually, but the index gradually decreased and remained low until 2004. After the gear change in 2005, the abundance index gradually decreased until 2019 (Figure 6). In 2020 and 2022 the abundance index has increased to a level not observed since the mid 1990's. The recruits are found allover the shelf of both East and West Greenland (Figure 8c and 8d). The increased by-catch reported by shrimp

trawlers in spite of the sorting grids furthermore supports the observation of unusually good recruitment. The length frequencies in 2022 reveal 3 new year classes (age 1-3) (figure 8). The Shrimp and Fish survey in East Greenland took place in the autumn in 2022 and furthermore found substantial numbers of redfish at 2-3 cm, which can be attributed to the 2022 year class or age 0 recruits (not shown). These observations implies an unusually good recruitment from the 2019-2022 YC. Length distributions reveal that the increase in survey biomass observed in 2016 is primarily large mature redfish and not recruits Figure 8.

Assessment

Golden redfish

The EU-Germany and Greenland Shrimp and fish survey have revealed a slightly increasing biomass of golden redfish from 2005 to 2015.

Updated indices in the Greenland shrimp and fish survey (until 2019) and the EU-Germany survey (until 2016) has indicated that the biomass remains near the 2015 level. Overall it seems likely that an immigration event occurred about a decade ago and the stock is currently based on old individuals with a lag of new commercial size YC. It can therefore be assumed that the biomass is still far below the 1980s level. Furthermore, the size of the commercial catches provided by Germany from the historic fishery in 1960-1975 indicate that a significant proportion of the historic stock was Golden redfish. The EU-Germany survey and the Greenland Shrimp and Fish survey indicates poor recruitment during the two decades prior to 2020. The new good recruitment in 2020-2021 will have to be assigned to a species level before it is known whether or not they are golden redfish. Since annual growth is about 4 cm/year it will take several years to reach commercial interesting sizes.

Deep-sea redfish

The Greenland-Japan survey indicate that the biomass decreased from 1987 to 1995. The Greenland deep survey and the Greenland Shrimp and fish survey both indicated that the biomass remained low until 2007. Both the Greenland deep-sea survey and the Greenland shrimp and fish survey agree that the biomass of deep-sea redfish increased from 2008 to 2013/2017, but the biomass indices have slowly decreased since then. Both the EU-Germany survey and the Greenland Shrimp and Fish survey indicate poor recruitment during the past two decades prior to 2020. In the Greenland shrimp and fish survey, virtually no new incoming year classes have been observed during the decade before 2020 (lack of 1-4 year old fish less than 20 cm since 2013-2020) in West Greenland and East Greenland.

Overall it seems likely that an immigration event occurred about a decade ago and the stock is currently based on old individuals with a lag of new commercial size YC. The good recruitment in 2020-2021 will have to be assigned to a species level before it is known whether or not they are deep-sea redfish. Since annual growth is about 4 cm/year it will take several years to reach commercial interesting sizes. To continue the good recruitment and rebuilding of the stock it is not advisable to initiate a fishery at this moment.

Conclusion

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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	33	25	28	68	2	35	2	0	260	
2016	35	2	33	68	8	20	0	0	166	
2017	47	5	48	72	3	47	0	0	222	
2018	17	3	19	91	6	58	0	0	194	
2019	22	6	38	45	4	27	0	0	142	
2020	21	52	47	48	4	23	0	0	194	
2021	40	91	19	61	18	26	0	0	256	
2022	59	127	36	38	5	26	0	0	291	

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- Redfish bycatch in shrimp trawl fishery estimated to 15.584 tons (Riget et al. 1988).
9- Statlant 21.
10- Redfish bycatch in shrimp trawl fishery 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- Redfish bycatch bycatch in shrimp fishery 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

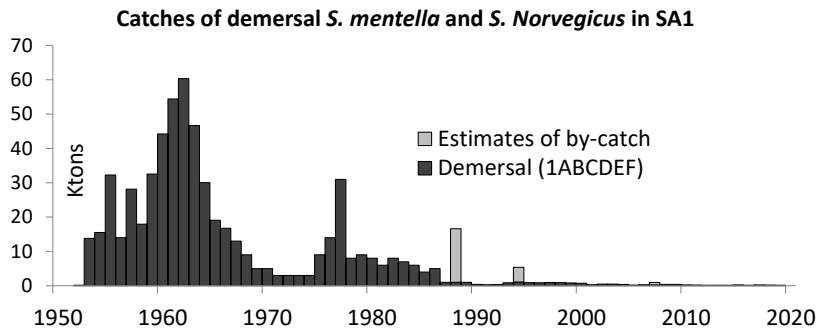

Figure 1. Catches of demersal golden redfish and deep-sea redfish combined in NAFO Subarea 1 (West Greenland).

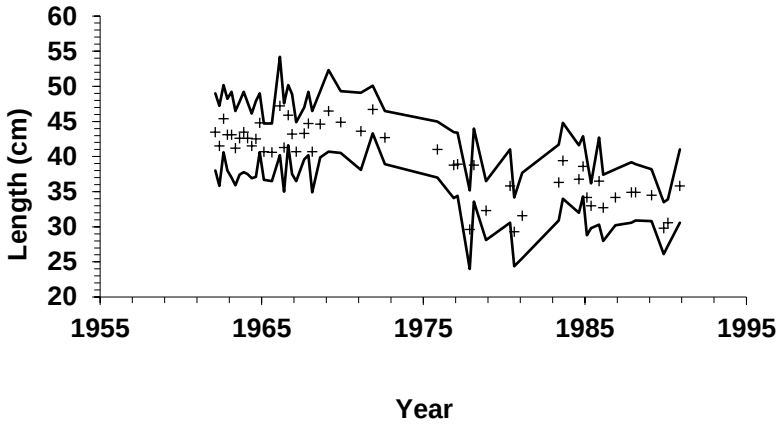

Figure 2. Mean length ± standard deviation derived from German catches of golden redfish in NAFO Subarea 1, 1962-90.

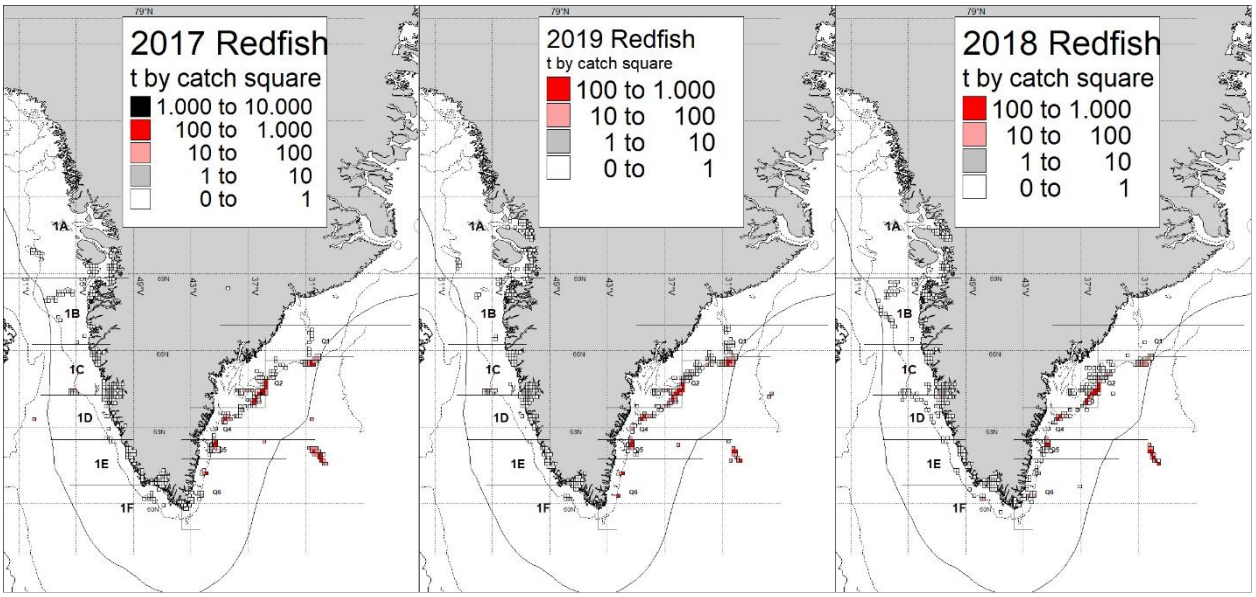

Figure 3. Map of factory landings (inshore) and logbook reported catches and by-catches (offshore) of redfish (Golden, deep-sea and beeked combined) by statistical square 2017-2019.

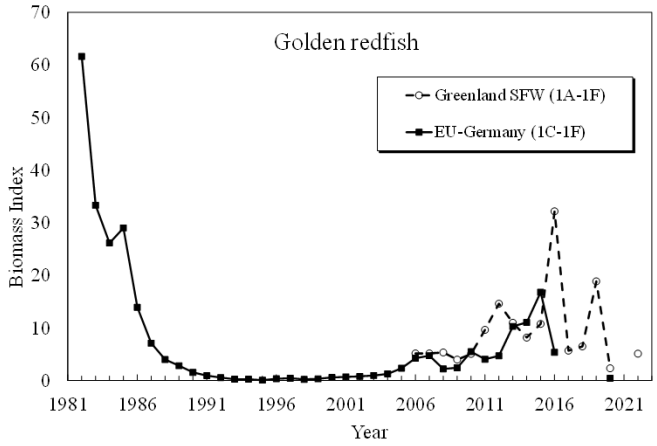

Figure 4. Golden redfish (≥17 cm) survey biomass indices derived from the EU-G survey and the Greenland SFW survey.

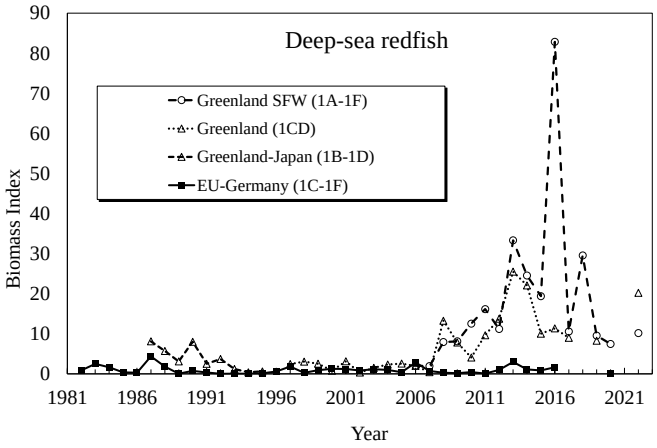

Figure 5. Deep-sea (adult ≥17 cm) survey biomass indices derived from the EU/Germany survey, the Greenland-Japan deep-sea survey, the Greenland deep sea survey and the Greenland SFW survey.

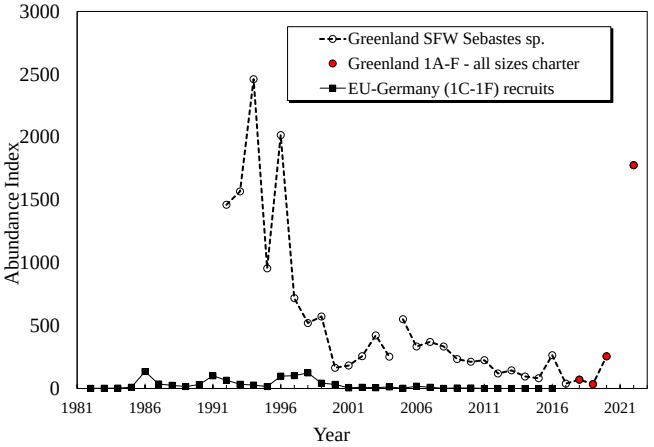

Figure 6. Survey abundance indices derived from the EU-German groundfish survey (recruits <17 cm) and from the Greenland shrimp and fish survey (all sizes).

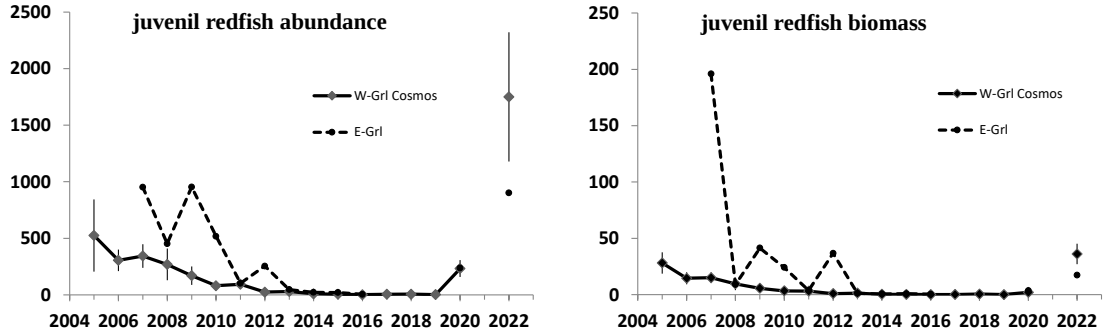

Figure 7. Juvenil redfish >20 cm (*S. mentella* and *S. norvegicus* combined) abundance (million) and biomass ('000 t) in the Greenland SFW survey in West and the identical survey in East Greenland (2007-2016).

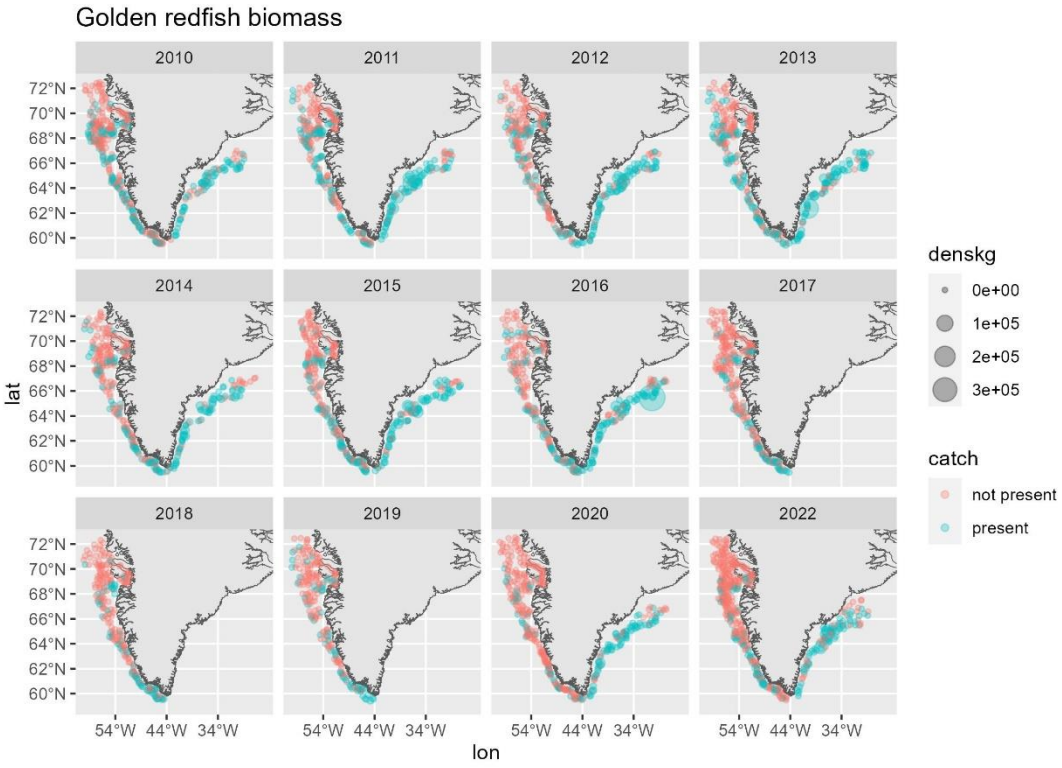

Figure 8a. Golden redfish survey biomass in kg/km ^{2} in the Greenland Shrimp and fish survey in West and the identical survey in East Greenland.

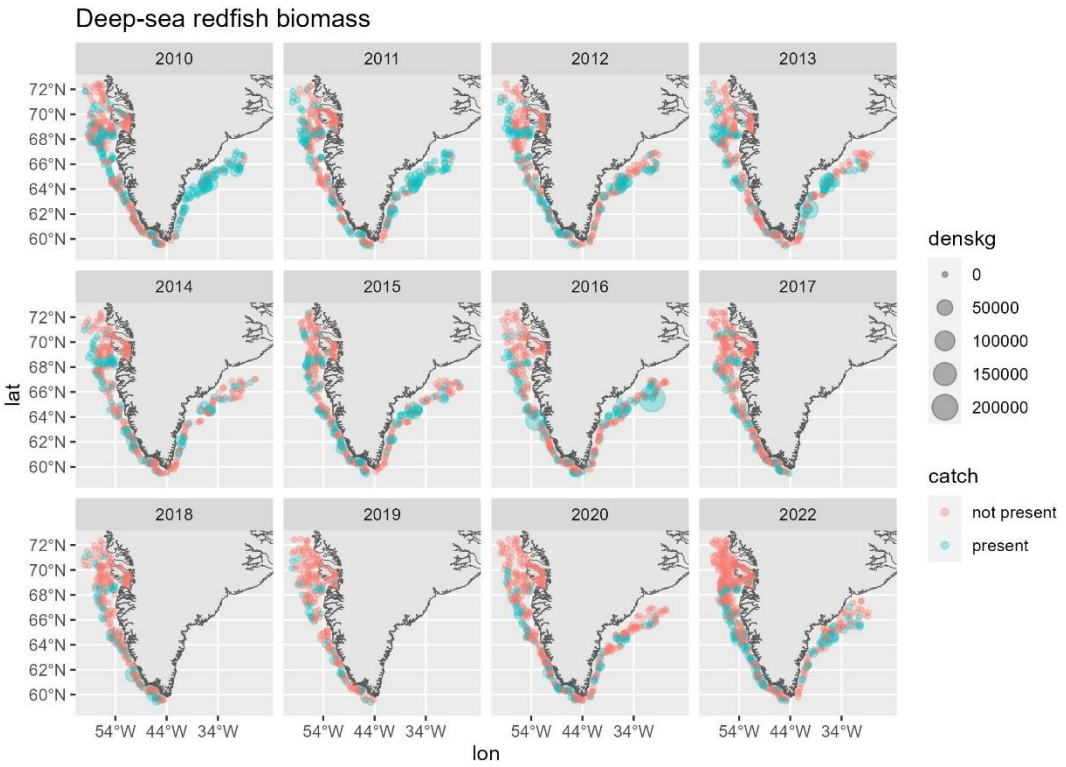

Figure 8b. Deep-sea redfish survey biomass in kg/km^2 in the Greenland Shrimp and fish survey in West and the identical survey in East Greenland.

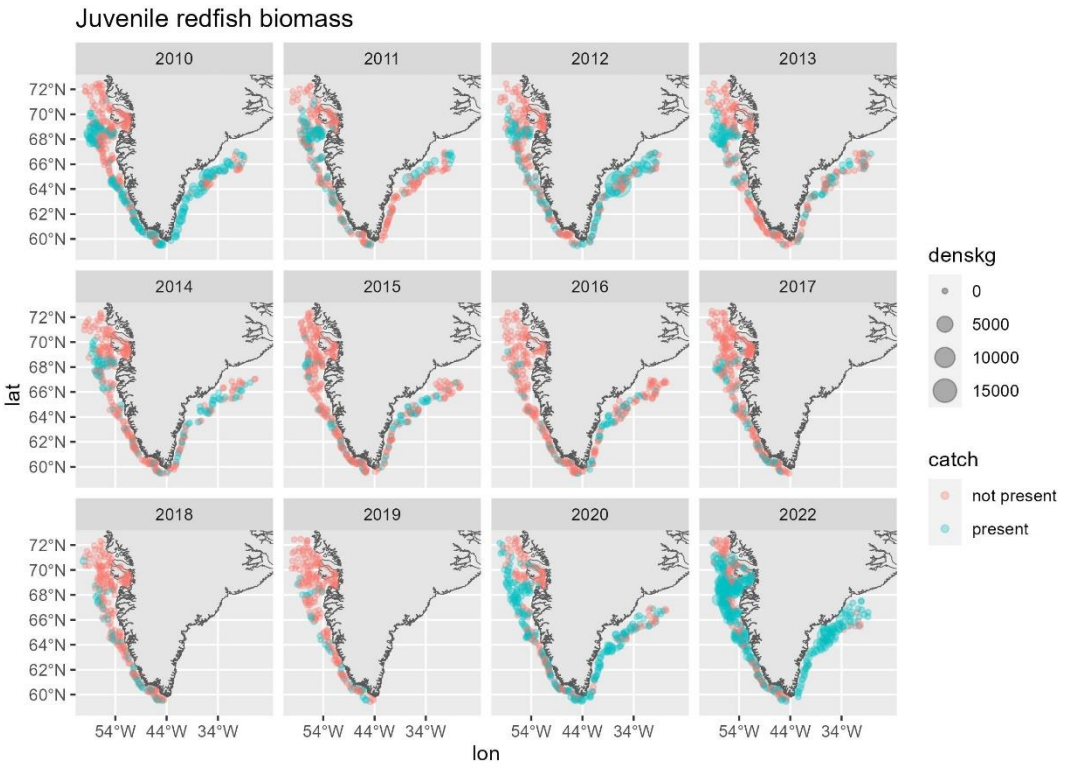

Figure 8c. Juvenile redfish < 20 cm survey biomass in kg/km^2 in the Greenland Shrimp and fish survey in West and the identical survey in East Greenland.

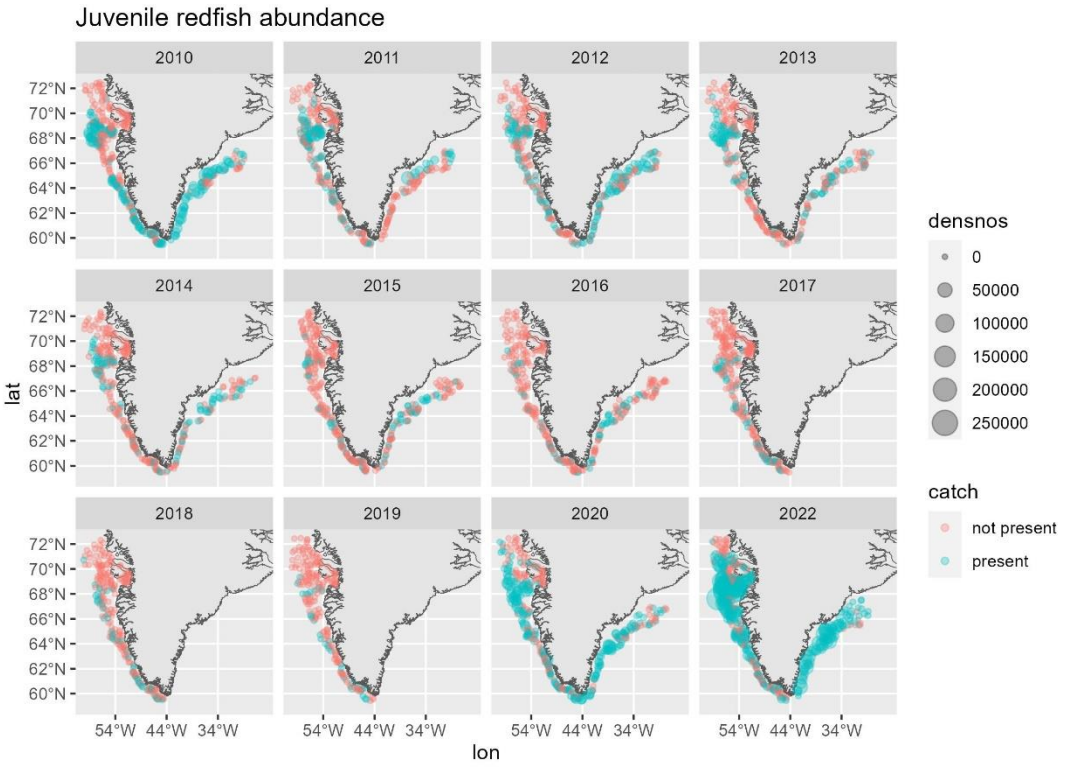

Figure 8d. Juvenile redfish < 20 cm survey abundance in numbers/km^2 in the Greenland Shrimp and fish survey in West and the identical survey in East Greenland.

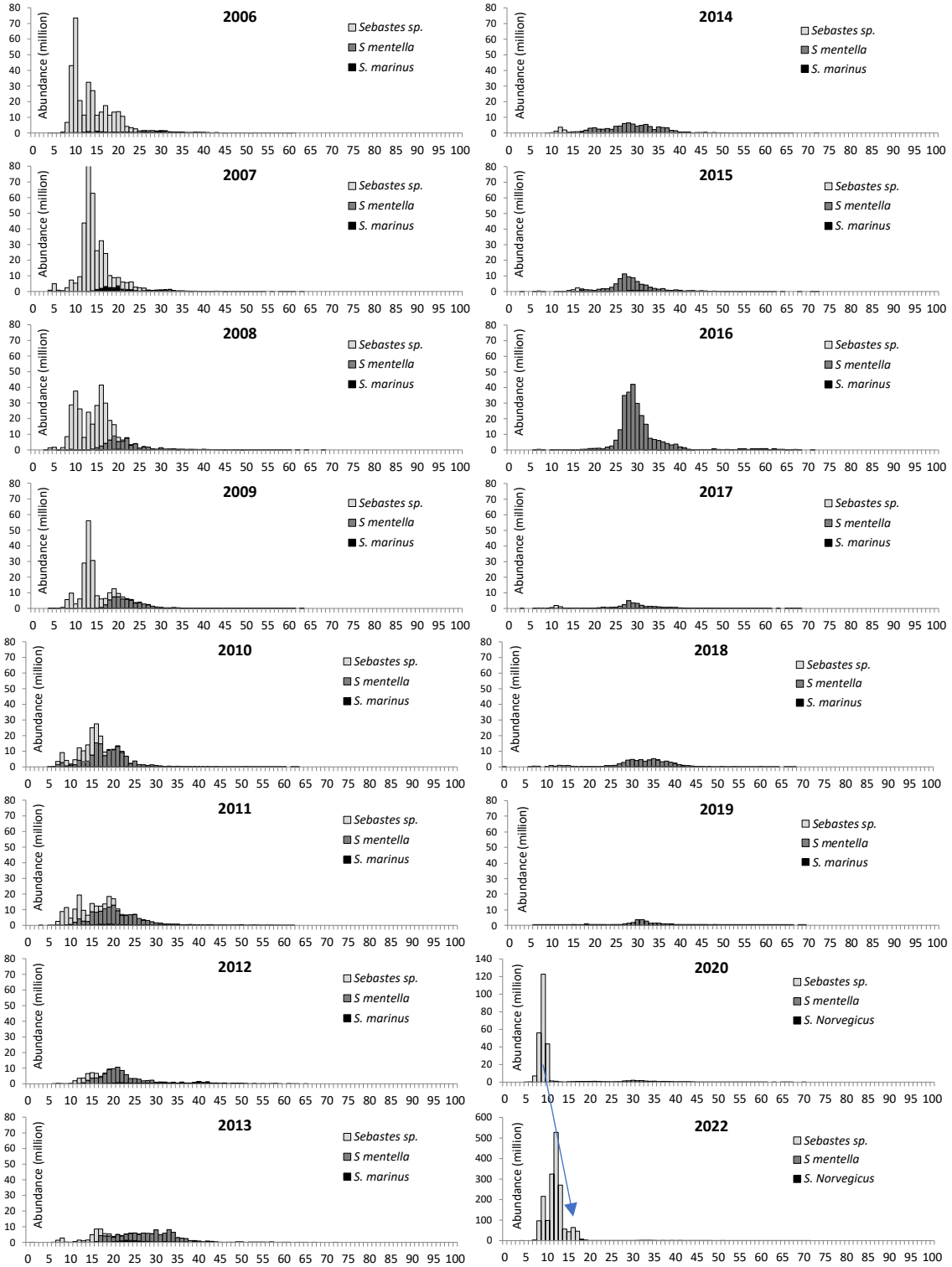

Figure 8e. Stacked Length frequencies for golden redfish (*Sebastes Norvegicus*), deep-sea redfish (Sebastes mentella) and juvenile redfish (Sebastes sp.) from the Greenland SFW survey in West Greenland. Notice X axis scale change in 2020 and again in 2022.