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Assessment of wolffish in NAFO subarea 1

by

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Abstract

There are three species of wolffish in Greenland waters, Atlantic wolffish (*Anarhichas lupus*), spotted wolffish (*Anarhichas minor*) and Northern wolffish (*Anarhichas denticulatus*), but only the two first are of commercial interest. Although spotted and Atlantic wolffish are easily distinguishable from one another (spotted wolffish has spots, and Atlantic wolffish has stripes), the fishing industry and catch statistics rarely report by species. A historic separation of the catch statics on a species level, may prove difficult, although some observations of the species composition have been made through research work and exists in the literature. Commercial fishery targeting wolffish started in the 1928, but significant landings were not seen until after World War II. Initially, wolffish were targeted inshore for production of wolffish skin. In 1951 production of frozen filets started and reported landings increased to a level of 5000-6000 tons. With the failing cod fishery off West Greenland trawlers started targeting Atlantic wolffish on the banks off West Greenland and from 1974-1976 reported landings from trawlers were around 3000 tons per year. During the 1980's reported catches gradually decreased and landings were at a very low level during the 1990's. From 2003 landings gradually increased and stabilized at a level of around 1000 tons, mainly spotted wolffish landed from small vessels and open boats to factories in division 1A-C and remained at this level until 2014. In 2015, reported catches have decreased and the lower catch level has continued. In 2022 just 175 t were reported. It is reasonable to assume that the decrease is related to fishery targeting more profitable species, limiting catches to exploited bycatch only.
Two surveys covers the stock of wolffish in NAFO 1A. The surveys have both registered an increasing spotted wolffish biomass in the recent decade. The difference between the survey indices for Atlantic wolffish can largely be explained by differences in survey area where the increase in the Greenland SFW survey is mainly observed north of the EU-Germany survey area. In the Greenland Shrimp and fish survey, the abundance index of both species seem to increase at a steady rate.

Introduction

Three species of wolffish occur in Greenland waters, Atlantic wolffish (*Anarhichas lupus*), spotted wolffish (*Anarhichas minor*) and Northern wolffish (*Anarhichas denticulatus*). Only the first two (spotted wolffish and Atlantic wolffish) are of commercial interest, since northern wolffish is of low quality (gelatines and watery). Spotted wolffish has a larger maximum length (~140 cm) than Atlantic wolffish (~ less than 100 cm) and the individual growth rate for Atlantic wolffish is slower than for Spotted wolffish in subarea 1 (Beese and Känder 1969, Schmidt 1980). Although spotted and Atlantic wolffish are easily distinguishable from one another (spotted wolffish has spots, and Atlantic wolffish has stripes), the fishing industry and catch statistics have

rarely distinguished between the two species in landing reports or logbooks. A historic separation of the catch statics on a species level, may prove difficult, although some observations of the species composition have been made through research work. A thorough breakdown of the catches on a species level and inshore offshore areas might improve the knowledge about the distribution of the species (see also Riget F.F. 1985). Research performed by Greenland and Federal Republic of Germany (Beese and Kändler, 1969), revealed an almost complete absence of Atlantic wolffish in landings and research fishery from division 1A and 1B in 1957 and 1960, but a dominance of Atlantic wolffish in division 1C in 1976 (99% by weight, depth 70-90 meters) and 1D in 1980 (58% by weight, depth 300-500 meters) (Schmidt 1980). Therefore, the breakdown of the catches by division gives some indication of species composition as Atlantic wolffish has a more southern distribution and seems more connected to the shallow offshore banks. Spotted wolffish can be found in all divisions offshore and through survey and landing observations, still seems to be the dominant species in the fjords. However, Atlantic wolffish has shifted its distribution further north during the past decade (Nygaard and Nogueira, 2020) and can be found as far north as the Upernavik district. Atlantic wolffish has also been observed in surveys in the Disko bay (1A inshore) and Sisimiut (1B inshore).

Description of the Fisheries

From 1928, small catches of wolffish from Greenland waters were landed by British fishing vessels. However, the commercial fishery for wolffish in West Greenland started around 1938 and was originally based on the production of wolffish skins (mostly spotted wolffish) while the meat was used locally. Production of skins stopped during World War II, but resumed in 1945 and peaked in 1948 with a production of more than 100.000 wolffish skins equivalent of about 800 tons (table 1, fig 1). In 1951, a production of frozen fillets started and developed to an important production in the Maniitsoq area (div. 1C) and the fishery gradually spread to the northern inshore areas (Divisions 1A-1B). The fishery was carried out by longliners as a directed fishery targeting mainly spotted wolffish. Annual landings reached a level of more than 5000 tons by 1957 and stayed at this level of 4000 to 6000 until 1970. With the failing cod fishery off West Greenland trawlers started targeting Atlantic wolffish on the banks off West Greenland and from 1974-1976 reported landings from trawlers were around 3000 tons per year (Schmidt 1980). The highest reported catches occurred in 1977-1979, but in these years non-Greenlandic vessels were excluded from the valuable cod fishery on the banks off West Greenland and massive misreporting were documented (cod reported as American plaice, wolffish or other species). The corrected landings in these years are much lower than official landing statistics (Horsted 1980). After 1980 the cod fishery gradually decreased from West Greenland and catches of wolffish also decreased in this period. The Gradual switch from cod to shrimp fishery may however have meant that an unknown amount of wolffish could have been taken and discarded in the shrimp fishery. A study of by-catch in the shrimp fishery conducted in 1994 indicated a low by-catch of spotted wolffish in all divisions and than by-catch of Atlantic wolffish where low and mainly occurred in the southernmost divisions (Engelstoft 1996). However, survey indices of wolffish were at a low level during the 1990's. 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 been mandatory for inshore operating vessels since 2011 (G.S. 2011). After the implementation of the sorting grids, studies of by-catch in the shrimp fishery indicated very low bycatches of wolffish in the shrimp fishery when using the grid separators (Sünksen 2007). The study does not provide length distributions, but the estimated amounts were converted to total estimates of wolffish to be around 15 tons of Atlantic wolffish (~0,01%), 1,5 tons of spotted wolffish (~0,001%) and less than 0,2 tons of northern wolffish (~0,0001%) in 2007. In 2007, all survey indices of wolffish were at a higher level than during the 1990's and it seems likely that the grids separators used in the shrimp fishery offer high protection to wolfish. After the implementation of the sorting grids several species have been increasing in abundance and biomass. From 2003 catches gradually increased and stabilized at a level of around 1000 tons, mainly spotted wolffish landed from small vessels and open boats to factories in division 1A-C and remained at this level until 2014. In 2015, reported catch decreased to and has further decreased since then to just 175 t in 2022. Of these 165 were landed to

factories from vessels sledges and small boats operating inshore. Only 10 t were reported by offshore operating vessels mostly targeting Greenland halibut and cod. The decreasing landings in the recent years is likely a result of fishermen targeting easier and more profitable species like cod and Greenland halibut inshore and in some cases utilizing the wolffish as bait in these fisheries.

Commercial fishery data

Data on length distribution in catches are rarely available from wolffish. Discrepancy between the species is not always done in logbooks or factory landings data and wolffish are often reported as wolffish sp. ("CAT"). Factory landing data and logbook data for both species combined was available (table 1 and fig 1). Combining logbook data from vessels operating offshore with Factory landing data from small boats and vessels operating inshore gives a distribution of the catches and bycatches from 2017-2019 (Figure 2).

Research Survey data

There are two surveys partly covering the stocks of Atlantic wolffish and spotted wolffish in subarea 1. The EU-Germany (EU-G) survey (Fock et al. 2020) and Greenland Shrimp Fish (SFW) survey in West Greenland (Nygaard and Nogueira 2023). Survey biomass and abundance indices are summarized in table 2.
The EU-G survey started in 1982 and covers the shelf at East Greenland (ICES14) continuing to the southern part of Westgreenland with (0-400m, 1C-F). The EU-G survey has had limited coverage of the Greenland West coast in recent years.
The SFW survey started in 1990 and covers the Shelf at Westgreenland from 72N to the south tip of Greenland, Cape farewell (0 to 600m, divisions 1A-F). The Gear was changed in the Greenland SFW survey from an older commercial type shrimp trawl (skjaervoy) to ad more modern and slightly larger commercial shrimptrawl with rockhopper gear (cosmos) thus braking the timeseries and starting a new index in 2005. Due to vessel decommission of the R/V Paamiut, chartered commercial vessels completed the survey in 2018 (Sjodürberg) and 2019-2020 (Helga Maria). In 2022 the new research vessel R/V Tarajoq completed the survey. All chartered vessels used the gear from the previously used research vessel (RV Pâmiut) and the Tarajoq continues the survey time series with the Cosmos trawl. Examinations of gear parameters found that the effects of these vessel changes had a minimal effect on trawl performance (Nogueira and Treble 2020 and Nogueira and Christiansen, 2023).
Both surveys are appropriate in regards to main depth distribution of Atlantic and spotted wolffish, but the Greenland Shrimp and Fish Survey, has a larger and better geographical coverage in relation to wolffish.

Results (Atlantic wolffish)

The EU-G Abundance index of Atlantic wolffish was stable from 1982 to 2005 and then gradually decreased (figure 3). The Biomass index decreased substantially from 1982 to 1984 and the decreased continued until the late 1990's

The Greenland SFW survey biomass index has slowly increased both prior to and after the gear change in 2005 and the abundance index has gradually increased throughout the time series (disregard the two extreme outlier years 2005 and 2015) (figure 3). Although the gear was changed in 2005, the two separate time series seems well connected (figure 3).

The differing trends observed in the EU-Germany survey and the Greenland shrimp and fish survey can largely be explained with the difference in survey area. The increase in the indices observed in Greenland shrimp and fish survey are mainly observed in divisions 1A-B and therefore outside the EU-Germany survey area (figure 7). Therefore, the stagnant indices observed in the EU-Germany survey are likely caused by a change in distribution further North (1AB), than during the 1990s (Nygaard and Nogueira 2023). Length distributions in the Greenland Shrimp and fish survey consist of all sizes from 5-70 cm with a mode at 10 cm and decreasing numbers with size (figure 5). The updated indices for wolffish fall within the same range and overall trend of the previous survey vessel indices for both wolffish species.

Results (Spotted wolffish)

The EU-G survey biomass indices decreased after 1982 and remained at low levels during the 1990's (figure 4). After 2003, the survey biomass index started increasing and have reached the level seen in the beginning of the time series. Abundance indices in the EU-Germany survey decreased from 1982 to 1995, but have gradually increased since then and reached a highest level observed since the beginning of the 1980s (figure 4).

The Greenland SFW survey biomass index was at low levels during 1990's but started increasing after 2002. The biomass index continued the increase after the gear change in 2005 with the highest biomass estimates observed in the most recent three years. The time series before and after the gear change seems well connected (figure 4).

The Greenland SFW survey abundance index have gradually increased both prior to and after the gearchange and the indices seems well connected (figure 4). Spotted wolffish are found in all divisions and show a continuous distribution from East to West Greenland (figure 8). Length distributions in the Greenland SFW survey consist of all sizes from 5-130 cm with a mode at 10 cm and adult individuals around 100 cm. Particularly in the most recent 5 years there seems to be good recruitment as higher than usual numbers spotted wolffish in the interval 10-14 cm are observed (figure 7).

Discussion

Since the biomass indices in the surveys have increased since 2015 it seems unlikely that the decreasing catches are caused by a decrease in the stock. The decreasing catch is likely related to very little directed fishery and the catches have been mainly been limited to by-catches in other fisheries. The increase in survey abundance and biomass indices for both species, coincide with the implementation of sorting grids in the shrimp fishery in 2002.

The gearchange in the Greenland Shrimp and fish survey from 2004 to 2005 and the update of the survey indices using chartered vessels in 2018 and 2019, does not seem to have impacted the survey indices. The indices indicate that the calibration between the old skjervoy gear and the new Cosmos gear in the Greenland SFW survey should be close to 1:1.

In the EU-Germany survey the % of Atlantic wolffish survey biomass to spotted wolffish biomass has gradually decreased from around 60% to about 10%. A similar trend is observed in the Greenland SFW survey. (figure 5). The slower somatic growth rate of Atlantic halibut and could explain the slower increase in the biomass index for Atlantic wolffish, compared to spotted wolffish. A shift in the distribution of the stocks can also explain the initial differences between the EU-G and the Greenland SFW survey.

Assessment

Atlantic wolffish

The stock of Atlantic wolffish was assessed in 2020, with the advice that there should be no directed fishery targeting Atlantic wolffish in Subarea 1, since the biomass indices of the EU-Germany survey remain below the initial values. Although the EU-G survey has had poor coverage in West Greenland since 2016, the EU-G and the Greenland SFW survey were around the same level in the overlapping period. Therefore, it can be assumed that the biomass remains below the level of the 1980's. The survey biomass and abundance indices continue to increase in the Greenland SFW survey. Survey length frequencies indicates that the stock is mainly younger individuals. The higher survey abundance indices observed in the Greenland SFW survey in the recent 6 to 8 years, indicate better recruitment than during the preceding decade.

Spotted wolffish.

Although the catches have been below the TAC since 2015, there is no indications that the decreasing catches are related to a decrease in the stock since the biomass indices in the Greenland SFW survey continue to increase. The decrease in the catches is likely related to more valuable species being targeted.
Although the EU-G survey has had poor coverage in West Greenland since 2016, the most recent updated biomass indices (2013,2014,2015 and 2020) were close to the indices observed in the beginning of the 1980's. The survey biomass and abundance indices in the Greenland SFW survey continue to increase. The increasing abundance indices in the Greenland SFW survey and the higher numbers of smaller individuals, indicate better recruitment than during the preceding decade. The length frequencies further reveal substantial numbers of Spotted wolffish close to L_{max} indicating high survival of the cohords. The fishery induced mortality is likely low with the previous level of catches.

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Table 1. Catches of wolffish, Atlantic wolffish and spotted wolffish combined in Subarea 1 by NAFO division. (NK indicates subarea 1 – Not Known).

YEAR	1A	1B	1C	1D	1E	1F	NK	Total	NOTE
1945							60	60	1
1946	32,5	16	0,5	1	0	0	0	50	1
1947	375	90	0	0	15	20	0	500	1
1948	576	120	16	8	24	64	155	955	1
1949	632	94	16	0	16	23	324	1104	1
1950	621	73	7	15	15	15	12	742	1
1951	434	149	0	12	6	19	266	886	1
1952	53	380	327	0	0	0	628	1388	1
1953	0	126	1974	0	0	0	634	2734	1
1954	24	0	2410	0	0	0	370	2804	1
1955	35	141	3274	70	0	0	519	4039	1
1956	315	385	2800	35	0	0	1191	4691	1
1957	585	540	3330	45	0	0	1102	5602	1
1958	640	880	2480	0	0	0	879	4879	1
1959	372	806	1922	0	0	0	808	3908	1
1960	304	1164	1528	575	364	468	0	4403	2
1961	382	887	1794	1152	667	678	63	5623	3
1962	254	862	1576	820	850	581	0	4941	3
1963	525	842	1930	1191	907	718	5	6158	4
1964	474	838	1133	870	807	731	25	4878	5
1965	519	1152	2079	968	416	645	0	5779	5
1966	298	1001	1540	955	672	919	6	5391	5
1967	460	1243	1312	1119	483	506	10	5133	5
1968	594	1405	1635	365	176	384	120	4679	5
1969	644	1050	1409	248	92	110	219	3772	6
1970	658	979	765	174	354	173	214	3317	7
1971	525	842	737	181	58	167	522	3032	8
1972	508	894	744	684	346	100	871	4147	8
1973	764	1001	1095	1100	684	235	22	4901	8
1974	516	1203	1424	2156	848	147	0	6290	8
1975	509	1370	1664	2055	545	235	0	6378	8
1976	432	783	1966	1725	855	344	0	6105	8
1977	445	618	1060	416	422	133	(1000)	4110	9
1978	460	753	746	130	72	7	(800)	2970	9
1979	357	515	692	90	43	34	(1400)	3529	10
1980	620	1423	1898	861	275	335	0	5412	11
1981	400	839	1394	308	207	278	291	3717	11
1982	262	636	1539	898	331	263	0	3929	11
1983	145	692	719	475	679	559	0	3269	11
1984	50	231	880	228	268	173	60	1890	11
1985	39	238	933	162	206	226	0	1804	11
1986	80	249	678	204	251	205	30	1697	11
1987	0	0	0	0	17	12	1438	1467	11
1988	68	134	628	261	214	573	111	1989	11
1989	90	91	180	117	309	222	74	1083	11
1990	65	86	116	97	57	182	152	755	11

Table 1 continued. Catches of wolffish, Atlantic wolffish and spotted wolffish combined in Subarea 1 by NAFO division (NK indicates subarea 1 - Not Known).

YEAR	1A	1B	1C	1D	1E	1F	NK	Total	NOTE
1991	98	33	84	16	30	79	14	354	11
1992	62	62	44	5	5	12	0	190	11
1993	41	67	33	3	2	11	0	157	11
1994	26	31	36	0	0	4	0	97	11
1995	19	7	22	0	0	1	0	49	11
1996	29	0	15	0	0	1	0	45	11
1997	30	2	30	0	0	0	0	62	11
1998	0	0	28	0	0	0	0	28	11
1999	1	1	17	87	0	6	0	112	11
2000	0	1	22	5	0	3	21	52	11
2001	1	1	29	4	1	3	26	65	11
2002	14	0	28	8	27	10	0	87	11
2003	142	1	90	2	25	46	0	306	11
2004	205	18	0	35	2	51	0	311	11
2005	161	28	162	47	35	91	0	524	11
2006	267	94	236	26	42	99	0	764	11
2007	425	211	133	32	20	59	0	880	11
2008	600	217	276	37	5	66	0	1201	11
2009							1175	1175	12
2010							1315	1315	12
2011	365	158	196	13	4	3	42	779	13
2012	344	335	292	17	7	15	0	1010	14
2013	441	175	203	11	7	15	0	855	14
2014	342	119	388	12	9	34	0	908	
2015	64	30	141	13	72	10	0	331	
2016	40	27	80	7	19	10	0	183	
2017	18	21	81	51	26	41	0	238	
2018	17	18	114	47	44	20	0	260	
2019	27	32	81	17	6	23	0	186	
2020	43	71	88	25	2	23	0	251	
2021	53	66	98	11	6	9	0	243	
2022	29	54	65	11	2	14	1	175	

NOTES

1. After E. Schmidt 1980. Total landings are given by E.Schmidt. Division landings are estimated from division percentage from the Greenlandic fleet only given by E. S. (1946-1959). Landing division by other nations are listed as NK (not known).
2. 116 Tons landed by Icelandic vessels in 1960 (Statlant) does not figure in the statistics by E.S. Division landings are estimated from division percentage (all nations) given by E. Schmidt 1980 and corresponds well with Statlant 21 statistics (years 1960-1976).
3. After E. Schmidt 1980.
4. After E. Schmidt 1980. Estimate of Greenland catch in 1963 is 40 tons higher than Statlant 21 statistics.
5. After E. Schmidt 1980.
6. After E. Schmidt 1980. 13 Tons landed by DDR vessels in 1969 does not figure in the statistics by E.S.
7. After E. Schmidt 1980. 324 Tons landed by DDR vessels in 1970 does not figure in the statistics by E.S.
8. After E. Schmidt 1980.
9. After E. Schmidt 1980. Unreliable statlant 21 catches. See S.A. Horsted 1980, for discussion.
10. After E. Schmidt 1980. Unreliable statlant 21 catches. See S.A. Horsted 1980, for discussion. Estimate of Greenland catch is 398 tons higher in the statistics by E.S. than in Statlant 21 statistics.
11. Based on IGNAF/Statlant 21 data (1980-2008).
12. STACFIS estimate.
13. 42 tons from unknown division by factory vessel receiving catches from small boats.
14. Division recalculated by author.

Table 2. Biomass and Abundance indices from the EU-Germany and the Greenland Shrimp and Fish surveys.

	Atlantic wolffish				Spotted wolffish				Note
	Abundance	Biomass	Abundance	Biomass	Abundance	Biomass	Abundance	Biomass	
Unit	Mio	.000 t	Mio	.000 t	Mio	.000 t	Mio	.000 t	
YEAR	EU-G	EU-G	G-SFW	G-SFW	EU-G	EU-G	G-SFW	G-SFW	
1982	12.61	13.96			0.87	5.14			
1983	8.12	7.87			0.95	6.44			
1984	6.04	3.89			0.47	2.41			
1985	6.56	3.34			0.32	0.98			
1986	5.81	3.45			0.48	1.75			
1987	5.13	2.95			0.47	2.31			
1988	5.62	2.55			0.52	2.55			
1989	5.6	2.44			0.5	1.44			
1990	6.07	1.87			0.37	1.39			
1991	5.46	1.25			0.4	0.64			
1992	7.59	1.78	0.8	0.16	0.18	0.06	0.27	0.35	
1993	5.14	0.87	1.23	0.29	0.29	0.23	0.37	0.57	
1994	5.98	1.12	4.89	0.64	0.18	0.16	1.11	0.68	
1995	2.24	0.41	1.3	0.22	0.1	0.23	0.4	0.38	
1996	4.14	0.81	2.04	0.32	0.11	0.14	0.5	0.55	
1997	7.72	1.18	1.67	0.23	0.21	0.14	0.81	0.53	
1998	5.51	0.89	2.98	0.36	0.17	0.31	0.59	0.47	
1999	9.23	1.44	1.97	0.33	0.19	0.35	1.75	0.35	
2000	6.11	1.1	3.97	0.63	0.36	0.77	1.6	1	
2001	5.24	1.33	1.53	0.12	0.12	0.54	1.08	0.98	
2002	6.56	1.45	4.11	0.58	0.13	0.56	3.13	1.1	
2003	7.11	2.4	8.78	1.15	0.09	0.33	4.33	3.99	
2004	11.11	2.76	4.36	0.62	0.36	1.44	2.08	4.16	
2005	8.02	2.94	20.43	4.13	0.3	1.65	5.09	7.28	1
2006	6.26	2.5	9.98	2.29	0.58	2.15	3.88	7.93	
2007	5.2	1.96	4.64	1.55	0.4	3	3.95	5.44	
2008	2.3	0.77	4.72	1.09	0.3	1.65	2.09	6.57	
2009	2.74	0.7	5.63	1.61	0.16	0.8	3.08	3.66	
2010	4.13	1.38	11.6	2.36	0.23	1.61	4.49	8.69	
2011	2.43	0.84	5.13	1.11	0.13	0.99	4.44	12.96	
2012	2.59	1.16	7.27	1.73	0.31	1.96	3.22	8.38	
2013	2.41	1.32	8.15	2.11	0.56	4.42	6.88	18.91	
2014	1.72	0.81	5.46	1.12	0.69	6.08	4.7	11.54	
2015	1.69	0.83	21.48	5.07	0.45	3.54	7.41	22.26	
2016			7.73	2.43			4.94	12.44	
2017			16.71	3.58			7.45	19.96	
2018			17.22	3.16			7.45	15.81	
2019			13.45	3.43			6.48	22.25	
2020	0.74	0.32	13.85	3.22	0.37	3.56	6.69	27.61	
2021									
2022			17.02	4.91			5.8	23.45	

Notes 1. Gearchange in the Greenland shrimp and fish survey after 2005.

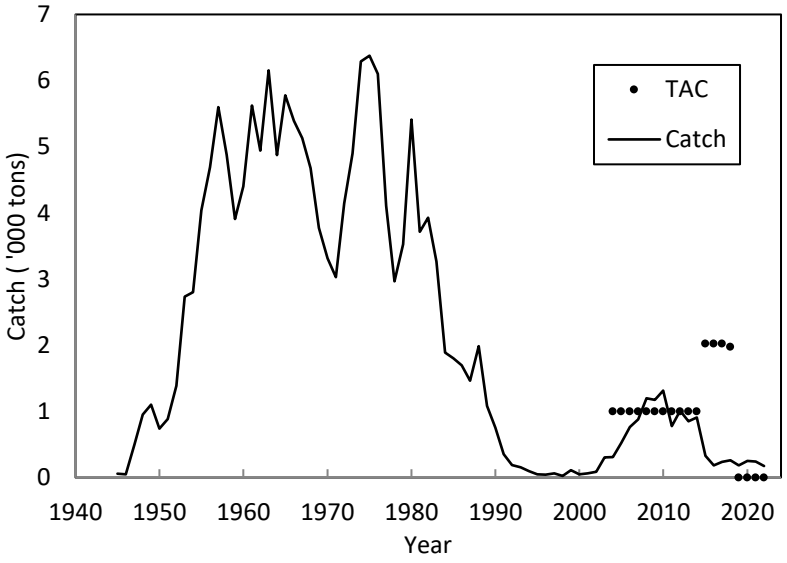

Figure 1. Annual landings of spotted and Atlantic wolffish combined in West Greenland (Subarea 1) since 1945.

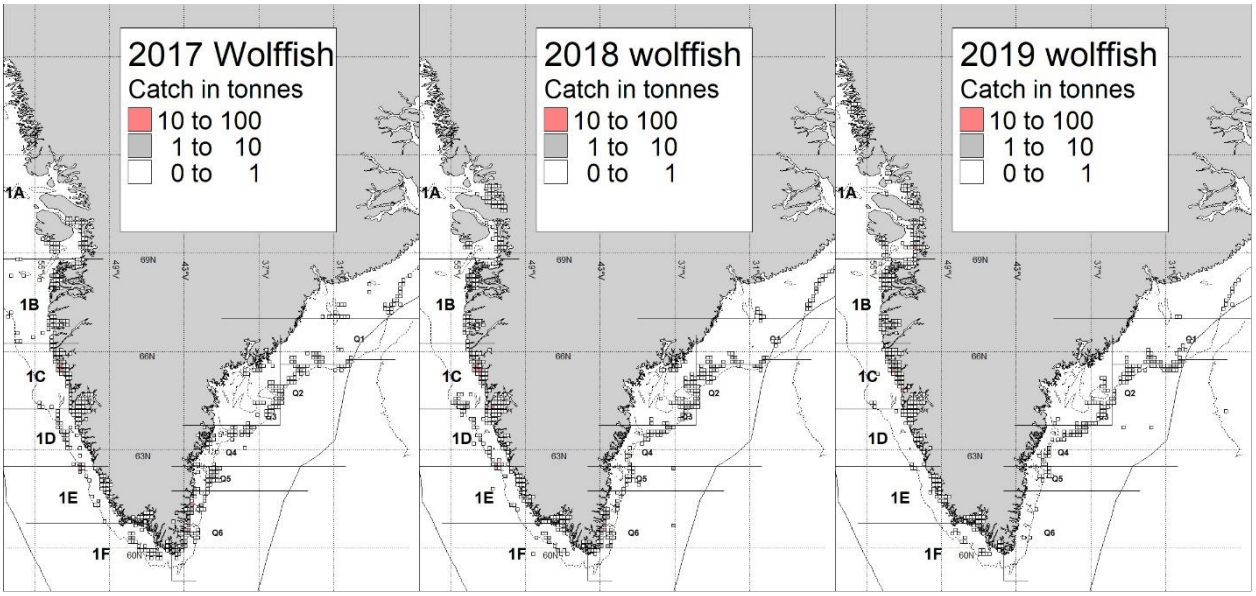

Figure 2. Landings and reported offshore catch of wolffish by statistical square from 2017-2019.

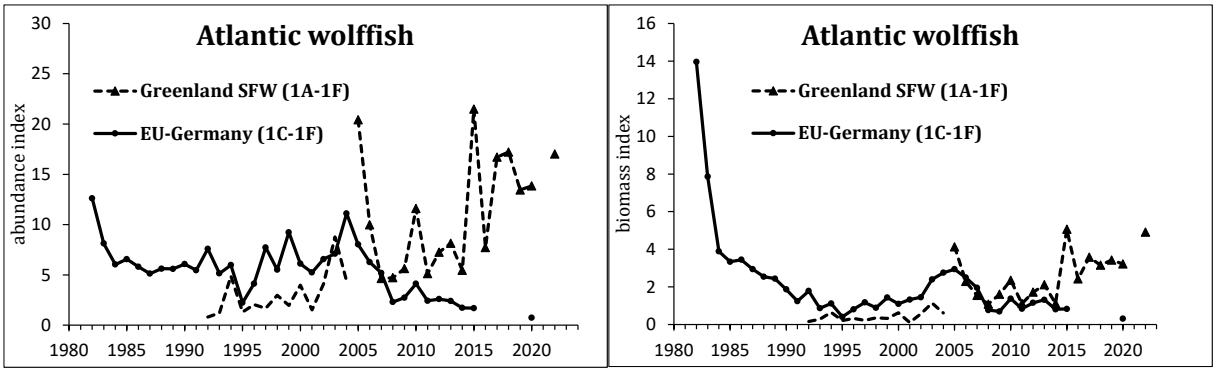

Figure. 3. Atlantic wolffish survey indices of biomass (left) and abundance (right) indices from the EU-Germany survey and the Greenland shrimp and fish survey in West Greenland.

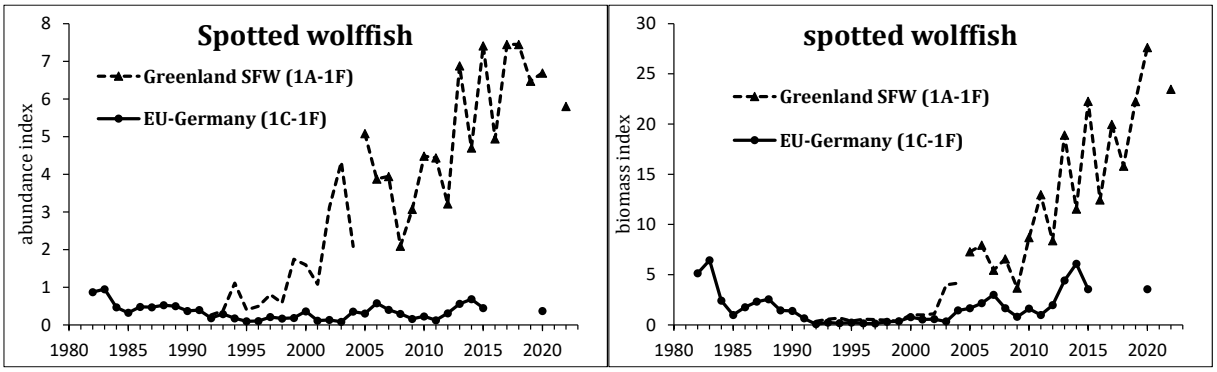

Figure. 4. Spotted wolffish survey indices of biomass (left) and abundance (right) indices from The EU-Germany survey and the Greenland shrimp and fish survey in West Greenland.

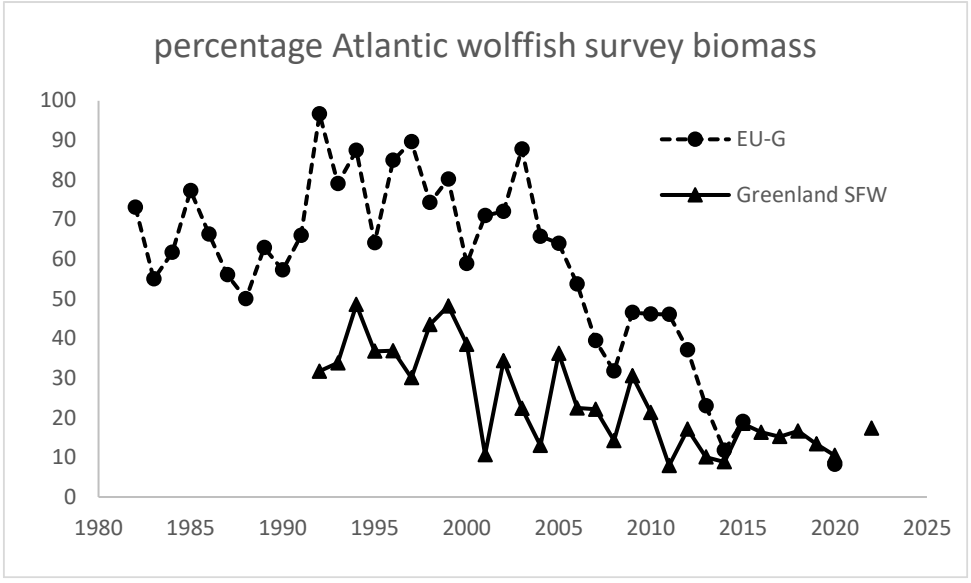

Figure 5. Percentage Atlantic wolffish in the biomass indices in the EU-G survey and the Greenland SFW survey.

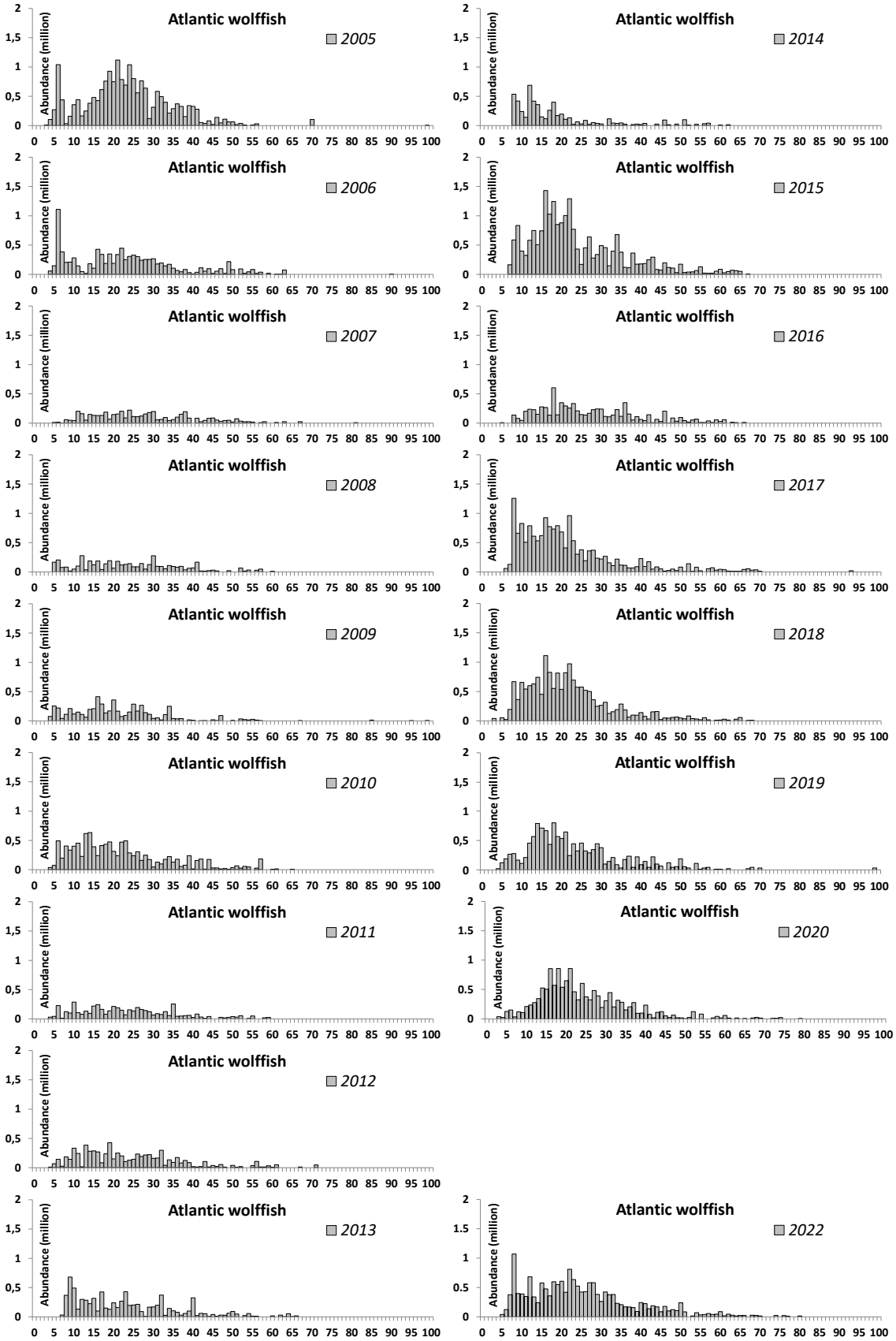

Figure. 6. Atlantic wolfish (Anarhichas lupus) length frequencies for West Greenland.

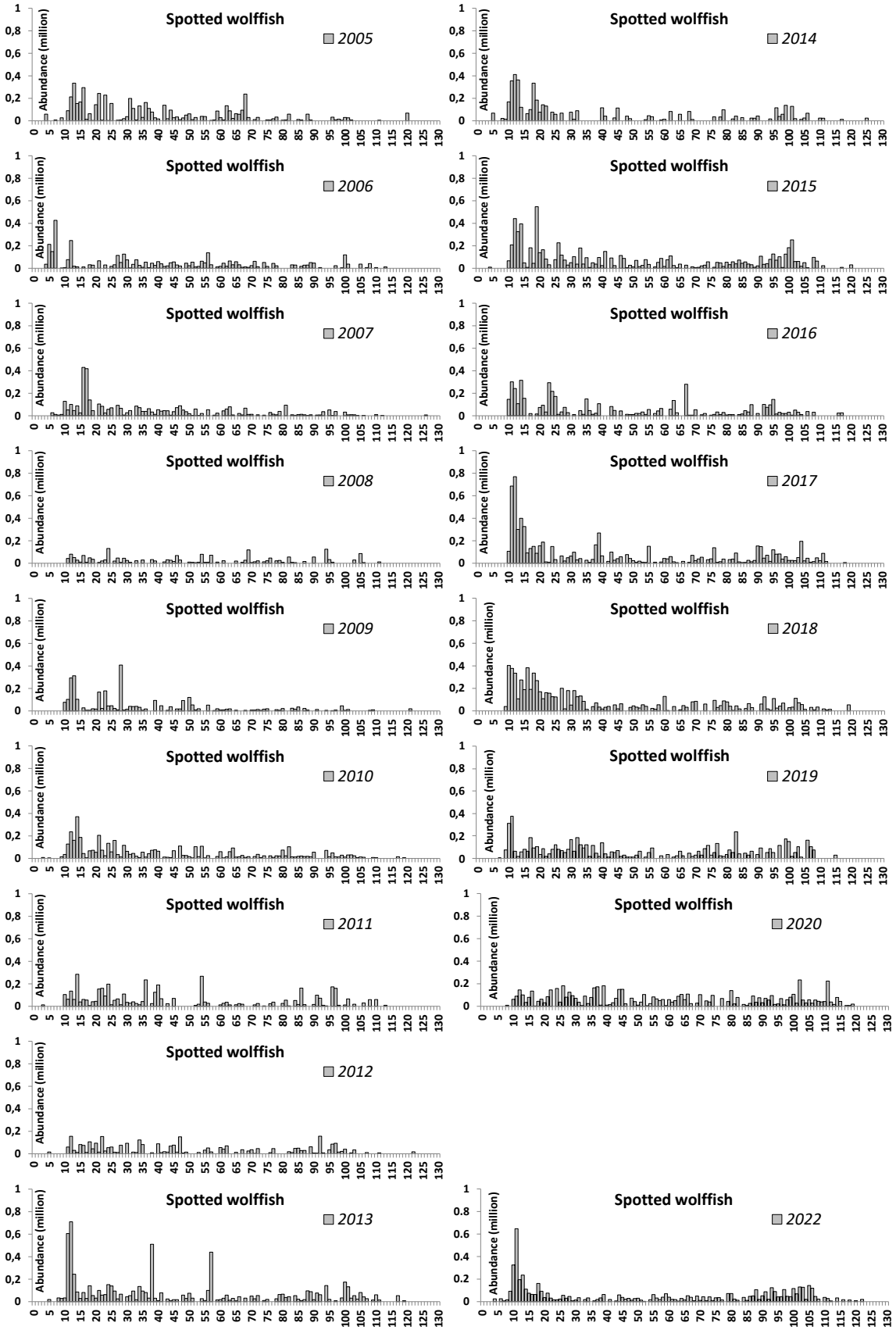

Figure. 7. Spotted wolfish (Anarhichas minor) length frequencies for West Greenland.

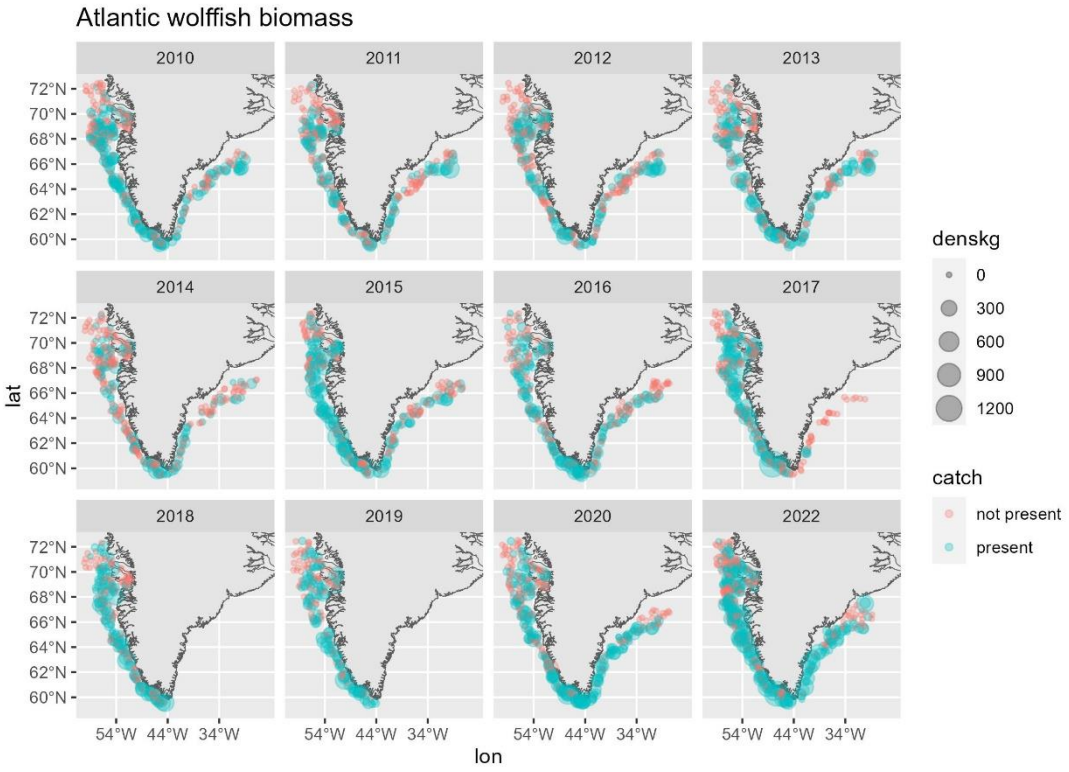

Figure. 8. Atlantic wolffish survey biomass in kg/km^2.

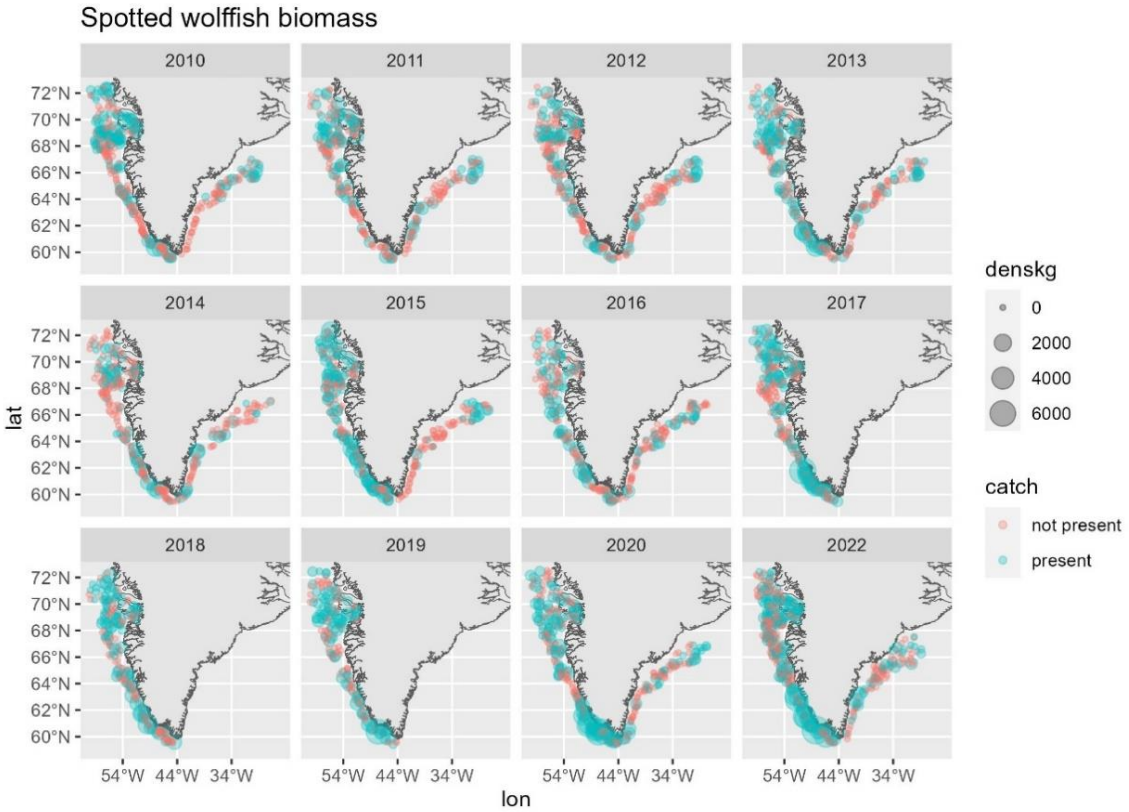

Figure. 9. Spotted wolffish survey biomass in kg/km^2.