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Catch at age for SA 2 + Div 3KLMNO Greenland halibut during 2017 to 2019

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Introduction

The purpose of this report is to document the catch at age analyses for SA 2 + 3KLMNO Greenland halibut during 2017 to 2019. Estimates of number and weight at age for 2017 and 2018 were derived according to standard procedures for the stock, but commercial aging data was not available from Canada during 2019 due to the pandemic preventing completion of the otolith reading. Aging data were available from the Canadian surveys for 2019, but the survey does not sample the older ages (10+) that occur in the catch, hence it was not appropriate to use survey age length keys to age the commercial catch. Therefore, it was decided to apply the commercial age length key from 2018 to length frequency data from 2019 to derive catch at age estimates. Using an age length key from a previous year may introduce bias. To evaluate the sensitivity of model results to using the 2018 key for aging the 2019 catch an alternate key was developed which averaged data over 2015 to 2018.

Methods

Estimation of catch at age for 2+3KLMNO Greenland halibut typically requires length frequencies from observer sampling of catch at sea or by port monitoring, an age length key from commercial sampling by Canada and catch which is broken into the smallest time unit (month/quarters/annual) and by gear. Computational procedures for the Canadian catch-at-age is described by Brodie *et al*. (2011).

Samples of length and age composition of the Canadian gillnet and otter trawl catches during 2017 to 2018 were available from Canadian port sampling and at sea observers (Table 1). Length sampling of the catch by EU-Portugal (Vargas *et al*. 2017, 2018, 2019), EU-Spain (González-Costas *et al*. 2017, 2018, 2019), Russia (Pochtar 2017, 2018) and the Faroe Islands (2019) was also used in catch at age analyses, but age composition for these fleets was determined using age length keys combining data from the Canadian fishing gears. At a given age, the Spanish data have greater mean lengths than Canadian data. Until the differences can be resolved, convention has been that the length samples from all fishing are converted to catch-at-age using Canadian age length keys. In addition to these inconsistencies, the Canadian, EU and Russian age determination methods may be underestimating ages (Treble *et a*l., 2005, Dwyer *et al*., 2016).

Limited or no sampling data were available for catches taken by the Faroe Islands (Denmark, 2017-2018), Cuba, EU-Latvia, EU-Lituania, and the USA, all operating in the NAFO Regulatory Area (NRA) during 2017 to 2019. Catch-at-age was developed for these fleets under the assumption that the age-composition was similar to that of the combined Spanish, Portuguese and Russian (2017-2018) fisheries operating within the NRA. Data from Russia were unavailable in time to be included in the 2019 catch at age estimates.

Results/Discussion

Total catch numbers-at-age for 1975-2019 are given in Table 3. Modal catch during 2017-18 was at age eight which matched observations since 2014. There is little evidence of year-classes tracking through the entire catch at age time series. Catch weights at age (Table 4 , Fig. 2) are computed as weighted means of the values from national sampling using length-weight relationships derived from the Canadian RV survey in NAFO divisions 2J3K or from Portugal (Table 2). Generally, catch weights at age have been stable over time, although for older ages (10 +) there was evidence of a decade long decreasing trend prior to the mid to late 2000s followed by an increase over 2009 to 2011, and a general declining trend since then (Fig. 2).

Ages 6-8 dominate the catch throughout the entire time period and in 2019 comprised 68% of annual catch numbers. Age groups 10+ currently contribute about 15% to the total annual landed weight. To illustrate the recent age composition of the catch, annual C@A over 2017-2019 is plotted in Figure 1. Overall, the sum-of-products for 2017 and 2018 were 0.99 and 1.02 respectively. The SOP for 2019 using the 2018 key was 1.00 and using the alternate (average) key it was 1.04.

Literature cited

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Table 1. Length and age sampling available for catch at age analysis of 2+3KLMNO Greenland halibut during 2017-19.

		Length sampling		Age sampling	Catch with
Country	Year	Gillnet	Otter trawl		no sampling
Canada	2017	8008	7946	2087	1104 t
	2018	13,714	9388	2538	1136 t
	2019	13,467	10,823	2538	678 t
	2019 a	13,467	10,823	3055	678 t
Estonia	2017		1600		
	2018		1458		64 t 3N
	2019		1852		
	2019 a		1852		
Faroe Islands	2017				180 t 3M
	2018				211 t 3LM
	2019		1619		11 t 3M
	2019 a		1619		11 t 3M
	8.634				
France (SPM)	2017				117 t 2J
	2018				
	2019		2208		128 t 2J
	2019 a		2208		129 t 2J
EU-Portugal	2017		5101		47 t 3NO
	2018		6456		6 t 3NO
	2019		2180		6 t 3NO
	2019 a		2180		6 t 3NO
Russia	2017		16,018		3 t 3 N
	2018		21,673		19 t 3N
	2019				1555 t in 3LMN
	2019 a				
EU-Spain	2017		16,695		
	2018		13,861		3 t 3O
	2019		52,480		12 t 3O
	2019 a		52,480		12 t 3O

Table 2. Length-weight relationships used in the catch at age analysis of 2+3KLMNO Greenland halibut during 2017-2019.

Year	Source	Slope	Intercept	Fleets
2017-2019	Canadian standard	3.336	-5.695	Canada
2017	2J3K survey	3.17	-5.36603	EU-Spain, Estonia, Russia
2017	Portugal	3.177	-5.39794	Portugal
2018	2J3K survey	3.159	-5.33696	EU-Spain, Estonia, Russia
2018	Portugal	3.189	-5.39794	Portugal
2019	2J3K survey	3.073	-5.21134	EU-Spain, Faroe Islands, Estonia
2019	Portugal	3.1919	-5.4318	Portugal

Table 3. 2+3KLMNO Greenland halibut numbers at age (000s) in the commercial catch. 2019a uses average key.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14+
1975	0	0	0	0	334	2819	5750	4956	3961	1688	702	135	279	288
1976	0	0	0	0	17	610	3231	5413	3769	2205	829	260	101	53
1977	0	0	0	0	534	5012	10798	7346	2933	1013	220	130	116	84
1978	0	0	0	0	2982	8415	8970	7576	2865	1438	723	367	222	258
1979	0	0	0	0	2386	8727	12824	6136	1169	481	287	149	143	284
1980	0	0	0	0	209	2086	9150	9679	5398	3828	1013	128	53	27
1981	0	0	0	0	863	4517	9806	11451	4307	890	256	142	43	69
1982	0	0	0	0	269	2299	6319	5763	3542	1684	596	256	163	191
1983	0	0	0	0	701	3557	9800	7514	2295	692	209	76	106	175
1984	0	0	0	0	902	2324	5844	7682	4087	1259	407	143	106	183
1985	0	0	0	0	1983	5309	5913	3500	1380	512	159	99	87	86
1986	0	0	0	0	280	2240	6411	5091	1469	471	244	140	70	117
1987	0	0	0	0	137	1902	11004	8935	2835	853	384	281	225	349
1988	0	0	0	0	296	3186	8136	4380	1288	465	201	105	107	129
1989	0	0	0	0	181	1988	7480	4273	1482	767	438	267	145	71
1990	0	0	0	95	1102	6758	12632	7557	4072	2692	1204	885	434	318
1991	0	0	0	220	2862	7756	13152	10796	7145	3721	1865	1216	558	422
1992	0	0	0	1064	4180	10922	20639	12205	4332	1762	1012	738	395	335
1993	0	0	0	1010	9570	15928	17716	11918	4642	1836	1055	964	401	182
1994	0	0	0	5395	16500	15815	11142	6739	3081	1103	811	422	320	215
1995	0	0	0	323	1352	2342	3201	2130	1183	540	345	273	251	201
1996	0	0	0	190	1659	5197	6387	1914	956	504	436	233	143	89
1997	0	0	0	335	1903	4169	7544	3215	1139	606	420	246	137	89
1998	0	0	0	552	3575	5407	5787	3653	1435	541	377	161	92	51
1999	0	0	0	297	2149	5625	8611	3793	1659	623	343	306	145	151
2000	0	0	0	271	2029	12583	21175	3299	973	528	368	203	129	104
2001	0	0	0	448	2239	12163	22122	5154	1010	495	439	203	156	75
2002	0	0	37	479	1662	7239	17581	6607	1244	659	360	224	126	81
2003	0	0	203	1279	4491	10723	16764	6385	1614	516	290	144	76	85
2004	0	0	17	897	4062	8236	10542	4126	1307	529	289	184	87	75
2005	0	0	40	534	1652	5999	10313	3996	1410	444	244	114	64	46
2006	0	0	10	216	1869	6450	12144	4902	1089	372	136	47	32	40
2007	0	0	0	88	570	3732	11912	5414	1230	472	163	80	41	29
2008	0	0	0	29	448	3312	10697	5558	1453	393	115	46	26	15
2009	0	0	0	61	476	3121	8801	7276	1949	508	206	67	31	34
2010	0	0	0	146	825	5077	11202	6171	2134	520	214	64	22	21
2011	0	0	430	690	1385	4101	7257	3953	1255	455	155	66	21	18
2012	0	0	1216	706	1982	3422	7618	5529	1992	657	287	134	36	29
2013	0	0	125	460	1744	3873	3997	3255	787	240	49	16	8	17
2014	0	0	119	259	1007	3041	3583	4626	910	199	49	18	7	15
2015	0	0	59	89	429	1237	4037	5546	1571	223	58	22	9	19
2016	0	0	39	116	445	1294	2457	6072	1399	337	57	26	7	19
2017	0	0	0	2	38	442	2688	4623	2922	1234	320	65	24	28
2018	0	0	0	117	516	1582	2671	4587	2923	499	191	90	24	26
2019	0	0	0	221	752	2038	3168	4288	2605	537	248	110	28	24
2019a	0	0	16	162	981	1836	3364	4510	2334	660	222	83	28	28

Table 4. 2+3KLMNO Greenland halibut weights at age (kg) in the commercial catch.

CW	1	2	3	4	5	6	7	8	9	10	11	12	13	14+
1975	0	0	0.126	0.244	0.61	0.76	0.955	1.19	1.58	2.21	2.7	3.37	3.88	5.76
1976	0	0	0.126	0.244	0.61	0.76	0.955	1.19	1.58	2.21	2.7	3.37	3.88	5.14
1977	0	0	0.126	0.244	0.61	0.76	0.955	1.19	1.58	2.21	2.7	3.37	3.88	5.99
1978	0	0	0.126	0.244	0.61	0.76	0.955	1.19	1.58	2.21	2.7	3.37	3.88	5.89
1979	0	0	0.126	0.244	0.61	0.76	0.955	1.19	1.58	2.21	2.7	3.37	3.88	6.08
1980	0	0	0.126	0.244	0.51	0.66	0.869	1.05	1.15	1.26	1.57	2.71	3.12	5.05
1981	0	0	0.126	0.244	0.39	0.6	0.789	0.985	1.24	1.7	2.46	3.51	4.79	7.43
1982	0	0	0.126	0.244	0.53	0.68	0.891	1.13	1.4	1.79	2.38	3.47	4.51	7.36
1983	0	0	0.126	0.244	0.41	0.63	0.861	1.18	1.65	2.23	3.01	3.96	5.06	7.06
1984	0	0	0.126	0.244	0.38	0.58	0.826	1.1	1.46	1.94	2.63	3.49	4.49	7.02
1985	0	0	0.126	0.244	0.57	0.75	0.941	1.24	1.69	2.24	2.95	3.71	4.85	7.01
1986	0	0	0.126	0.244	0.35	0.58	0.811	1.1	1.58	2.12	2.89	3.89	4.95	7.35
1987	0	0	0.126	0.244	0.36	0.59	0.836	1.16	1.59	2.13	2.82	3.6	4.63	6.45
1988	0	0	0.126	0.244	0.36	0.57	0.805	1.163	1.661	2.216	3.01	3.925	5.09	7.16
1989	0	0	0.126	0.244	0.4	0.56	0.767	1.082	1.657	2.237	3	3.862	4.92	6.37
1990	0	0	0.09	0.181	0.34	0.55	0.766	1.119	1.608	2.173	2.85	3.731	4.69	6.39
1991	0	0	0.126	0.244	0.38	0.59	0.831	1.228	1.811	2.461	3.31	4.142	5.33	7.08
1992	0	0	0.175	0.289	0.43	0.58	0.793	1.234	1.816	2.462	3.12	3.972	5.1	6.65
1993	0	0	0.134	0.232	0.37	0.55	0.809	1.207	1.728	2.309	3	3.965	4.82	6.49
1994	0	0	0.08	0.196	0.33	0.51	0.788	1.179	1.701	2.268	2.99	3.766	4.88	6.35
1995	0	0	0.08	0.288	0.36	0.53	0.808	1.202	1.759	2.446	3.12	3.813	4.89	6.79
1996	0	0	0.161	0.242	0.36	0.54	0.832	1.272	1.801	2.478	3.15	3.856	4.95	6.31
1997	0	0	0.12	0.206	0.34	0.49	0.771	1.159	1.727	2.355	3.05	3.953	5.11	6.32
1998	0	0	0.119	0.228	0.37	0.54	0.81	1.203	1.754	2.351	3.1	4.01	5.13	6.12
1999	0	0	0.176	0.253	0.36	0.53	0.825	1.253	1.675	2.287	2.89	3.509	4.46	5.79
2000	0	0	0	0.254	0.35	0.52	0.787	1.192	1.774	2.279	2.9	3.645	4.49	5.53
2001	0	0	0	0.249	0.38	0.57	0.83	1.168	1.794	2.367	2.95	3.715	4.59	5.46
2002	0	0	0.217	0.251	0.37	0.56	0.841	1.193	1.76	2.277	2.9	3.579	4.41	5.48
2003	0	0	0.188	0.247	0.39	0.56	0.822	1.199	1.651	2.166	2.7	3.404	4.38	5.41
2004	0	0	0.18	0.249	0.38	0.54	0.808	1.196	1.629	2.146	2.73	3.538	4.38	5.7
2005	0	0	0.252	0.301	0.4	0.56	0.849	1.247	1.691	2.177	2.71	3.464	4.26	5.22
2006	0	0	0.129	0.267	0.41	0.61	0.815	1.092	1.495	1.874	2.4	3.139	3.75	4.7
2007	0	0	0	0.276	0.39	0.58	0.833	1.137	1.5	1.948	2.61	3.057	3.87	4.95
2008	0	0	0	0.278	0.4	0.62	0.891	1.195	1.605	2.038	2.8	3.247	4.23	4.72
2009	0	0	0	0.279	0.39	0.6	0.862	1.158	1.611	2.099	2.55	3.118	3.43	4.43
2010	0	0	0	0.25	0.35	0.57	0.84	1.21	1.65	2.1	2.61	3.31	4.18	5.22
2011	0	0	0.13	0.21	0.31	0.53	0.85	1.25	1.75	2.23	2.78	3.56	4.41	5.84
2012	0	0	0.17	0.24	0.3	0.57	0.89	1.28	1.75	2.29	2.81	3.62	4.4	5.73
2013	0	0	0.14	0.27	0.42	0.63	0.87	1.25	1.83	2.47	3.26	3.84	4.36	5.79
2014	0	0	0.15	0.24	0.4	0.62	0.89	1.31	1.92	2.53	3.32	3.89	4.55	5.54
2015	0	0	0.16	0.24	0.41	0.63	0.89	1.22	1.76	2.49	3.27	3.81	4.36	5.39
2016	0	0	0.219	0.313	0.47	0.67	0.903	1.277	1.821	2.415	3.13	3.553	4.13	5.19
2017	0	0	0	0.255	0.31	0.52	0.715	1.085	1.366	1.791	2.38	3.084	3.82	4.81
2018	0	0	0	0.301	0.42	0.62	0.876	1.254	1.788	2.358	2.88	3.519	4.14	5.45
2019	0	0	0.191	0.279	0.41	0.6	0.847	1.191	1.733	2.27	2.76	3.311	3.9	5.42
2019a	0	0	0.156	0.275	0.423	0.611	0.859	1.238	1.808	2.39	2.967	3.462	3.974	5.328

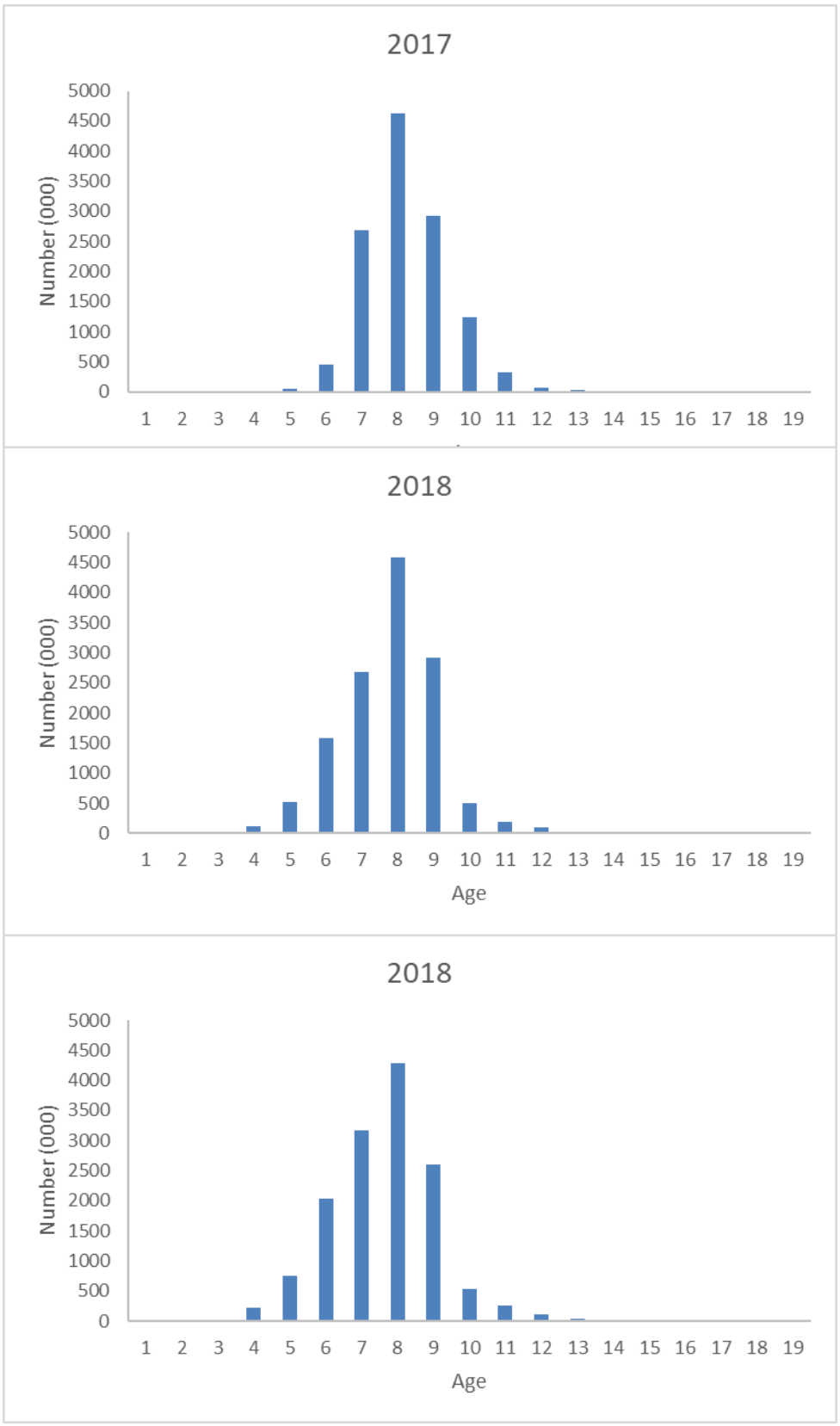

Figure 1. Greenland halibut numbers at age in the commercial catch during 2017 to 2019.

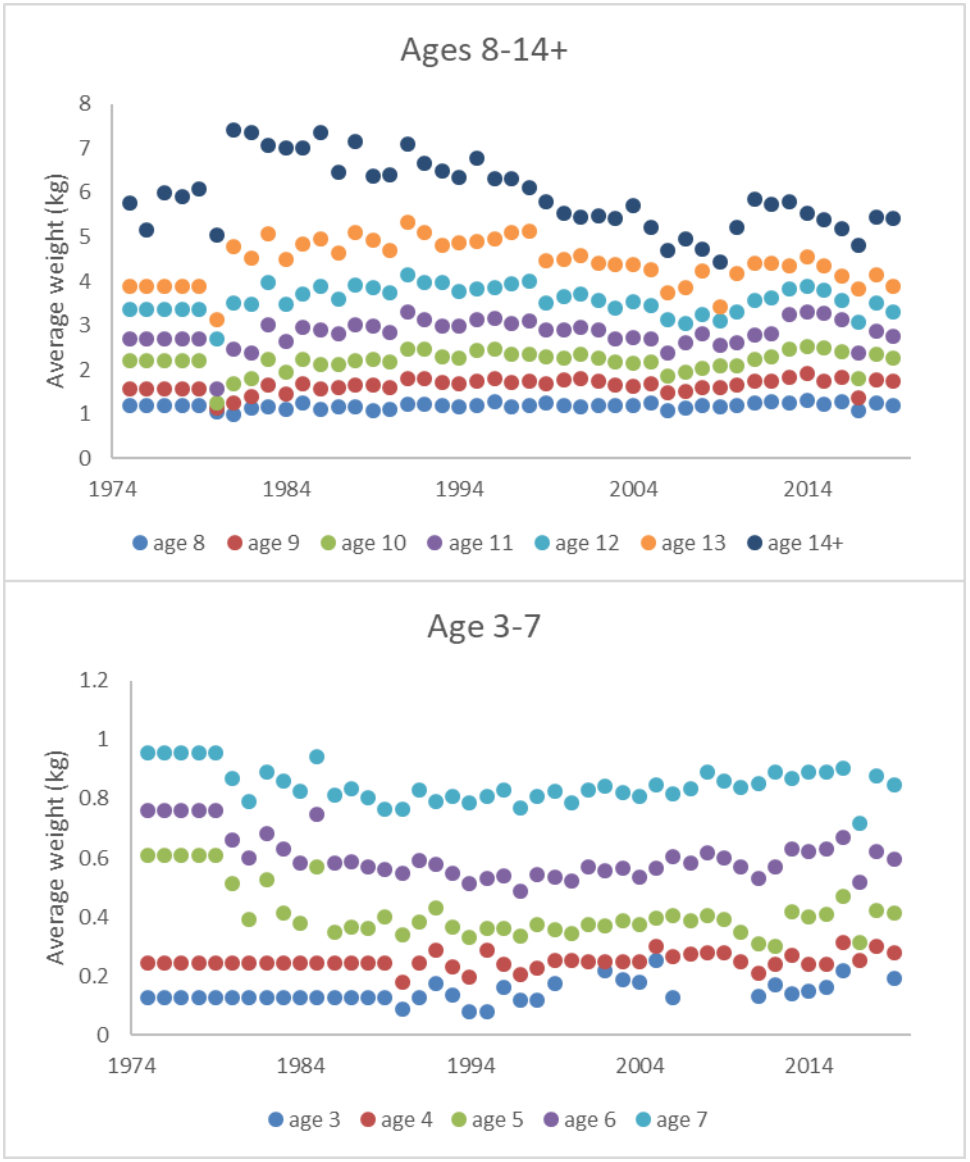

Figure 2. Average weight at age (kg) for 2+3KLMNO Greenland halibut during 1975 to 2019.