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Atlantic salmon at West Greenland

Summary of the advice for 2018–2020

ICES advises that, in line with the management objectives agreed by NASCO and consistent with the MSY approach, there are no mixed-stock fishery options at West Greenland for the fishing years 2018 to 2020.

Management advice for West Greenland is based on non-maturing 1SW salmon from North America and Southern NEAC. In the absence of any fishing in the period 2018 to 2020, there is less than 75% probability that the numbers of 2SW salmon returns will be above the management objectives simultaneously for the six regions of North America and for the MSW stock of Southern NEAC.

The Framework of Indicators (FWI) was updated in support of the multi-year catch advice and the potential approval of multi-year regulatory measures. The FWI can be applied at the beginning of 2019, with the returns or return rate data for 2018, to evaluate the appropriateness of the advice for 2019, and again at the beginning of 2020, with the returns or return rate data for 2019, to evaluate the appropriateness of the advice for 2020.

NASCO 4.1 Describe the key events of the 2017 fishery, including details of catch, gear, effort, composition and origin of the catch, rates of exploitation, and location of the catch as in-river, estuarine, and coastal

Fishing for salmon at Greenland is currently allowed using hook, fixed gillnets, and driftnets along the entire coast of Greenland (Figure 1). The commercial fishery for export closed in 1998; however, the fishery for internal use continues. Since 2002, licensed fishers have only been allowed to sell salmon to hotels, institutions, and local markets. People fishing for private consumption only are not required to have a licence, but they are prohibited from selling salmon. Since 2012, the Government of Greenland has unilaterally set the quota for the fishery, since the quota could not be agreed to by all parties of the West Greenland Commission of NASCO (Table 2). From 2012 to 2015, licensed fishers were also permitted to sell to factories, although the export ban persisted. Specific factory quotas were set at 35 tonnes (t) for 2012 and 2013, and 30 t in 2014. In 2015, the Government of Greenland set a quota for all components of the fishery (private, commercial, and factory landings) at 45 t but stated that any overharvest in a particular year would result in an equal reduction in the quota the following year. As a result of an overharvest in 2015, the 2016 quota was set by Greenland at 32 t. The quota for 2017 remained at 45 t. Factory landings were not permitted in 2016 and 2017. In 2017, the fishing season opened on 15 August and the closing date of the salmon season was extended by one day, to 10:00 pm 1 November, due to bad weather.

Catches of Atlantic salmon at West Greenland (Figure 2 and Table 2) increased through the 1960s, reaching a peak reported harvest of approximately 2700 t in 1971 and then decreased until the closure of the commercial fishery for export in 1998. However, the fishery for internal use has been increasing in recent years.

A total salmon catch of 28 t was reported for the 2017 fishery, similar to that for 2016 (Table 1). In total, 89% of the commercial landings in 2017 were from licensed fishers (24.9 t). For private landings, 24% (3.1 t) were from unlicensed fishers and 76% (9.7 t) from licensed fishers. Although not permitted to sell catch, 0.2% (32 kg, approximately ten fish) of the commercial landings were reported by unlicensed fishers. The 2017 commercial landings increased over the 2016 value whereas the private landings in 2017 decreased from the 2016 value (Tables 1 and 4).

Landings were reported across all NAFO divisions and a harvest of 0.3 t was reported from ICES Division 14 (East Greenland; Table 3).

Table 1 Reported 2016 and 2017 catches by fisheries. A value of 0.0 indicates a catch less than 0.05 t.

Licence type	Fishery Type	Reported 2017 catch (t)	Reported 2016 catch (t)
Licensed	Commercial	15.3	8.6
	Private	9.7	10.8
Unlicensed	Commercial	0.0	0.1
	Private	3.1	7.6
All	Commercial	15.3	8.7
	Private	12.8	18.4
All	Total	28.0	27.1

There is currently no quantitative approach for estimating the unreported catch for the private fishery, but the 2017 value is likely to have been at the same level as in recent years (10 t), as reported by the Greenlandic authorities. The 10 t estimate was historically meant to account for private non-licensed fishers in smaller communities fishing for personal consumption – not to represent underreporting by commercial fishers.

The variations in the numbers of people reporting catches, variation in reported landings in each of the NAFO divisions, and documentation of underreporting of landings suggest that there are inconsistencies in the reported catch data in both the commercial and private fisheries. A phone survey to gain further information on catch and effort was conducted after the fishing season from 2014 to 2016. Unreported catches of 12.2 t (2014), 5 t (2015), and 4.2 t (2016) were identified from these surveys (referred to as adjusted landings (survey) for assessment). With just nine fishers taking part, the phone survey conducted in 2017 was not considered adequate to adjust the reported landings.

An adjustment for some unreported catch, primarily for commercial landings, has been done since 2002 by comparing the weight of salmon observed by the sampling teams and the corresponding community-specific reported landings for the entire fishing season (commercial and private landings combined; referred to as adjusted landings (sampling) for assessment). However, sampling only occurs during a portion of the fishing season, and therefore these adjustments are considered to be minimum adjustments for unreported catch (Table 5).

The international sampling programme continued in 2017 (Figures 1 and 3). A summary of the biological characteristics of the 2017 catch is presented in Table 6. The 2017 total number of fish harvested (8300) was similar to the 2016 estimate (8400) and only 2.5% of the maximum fish harvest (1982: 336 000) (Figure 4). In 2017, 74.4% of the salmon sampled were determined to be of North American origin and 25.6% of European origin (Figure 3), approximately 6100 (20.9 t) North American and 2200 (7.2 t) Fish of European origin were harvested in 2017. The North American origin of salmon harvested at West Greenland has been further refined to 12 regional groups of North America using genetic microsatellite analyses (Figure 5) (Bradbury *et al.*, 2016). Contributions from 2015 to 2017 samples were dominated by three regional groups: Labrador, Gulf of St Lawrence, and Gaspe Peninsula (Table 7).

Table 2 Nominal catches of salmon at West Greenland since 1960 (tonnes, round fresh weight) by participating nations. For Greenlandic vessels specifically, all catches up to 1968 were taken with set gillnets only and catches after 1968 were taken with set gillnets and driftnets. All non-Greenlandic vessel catches from 1969–1975 were taken with driftnets. The quota figures applied to Greenlandic vessels only and parenthetical entries identify when quotas did not apply to all sectors of the fishery.

Year	Norway	Faroes	Sweden	Denmark	Greenland	Total	Quota	Comments
1960	-	-	-	-	60	60		
1961	-	-	-	-	127	127		
1962	-	-	-	-	244	244		
1963	-	-	-	-	466	466		
1964	-	-	-	-	1539	1539		
1965	-	36	-	-	825	858		Norwegian harvest figures not available, but known to be less than Faroese catch
1966	32	87	-	-	1251	1370		
1967	78	155	-	85	1283	1601		
1968	138	134	4	272	579	1127		
1969	250	215	30	355	1360	2210		
1970	270	259	8	358	1244	2139		Greenlandic total includes 7 t caught by longlines in the Labrador Sea
1971	340	255	-	645	1449	2689	-	
1972	158	144	-	401	1410	2113	1100	
1973	200	171	-	385	1585	2341	1100	
1974	140	110	-	505	1162	1917	1191	
1975	217	260	-	382	1171	2030	1191	
1976	-	-	-	-	1175	1175	1191	
1977	-	-	-	-	1420	1420	1191	
1978	-	-	-	-	984	984	1191	
1979	-	-	-	-	1395	1395	1191	
1980	-	-	-	-	1194	1194	1191	
1981	-	-	-	-	1264	1264	1265	Quota set to a specific opening date for the fishery
1982	-	-	-	-	1077	1077	1253	Quota set to a specific opening date for the fishery
1983	-	-	-	-	310	310	1191	
1984	-	-	-	-	297	297	870	
1985	-	-	-	-	864	864	852	
1986	-	-	-	-	960	960	909	
1987	-	-	-	-	966	966	935	
1988	-	-	-	-	893	893	840	Quota for 1988–1990 was 2520 t with an opening date of August 1. Annual catches were not to exceed an annual average (840 t) by more than 10%. Quota adjusted to 900 t in 1989 and 924 t in 1990 for later opening dates.
1989	-	-	-	-	337	337	900	
1990	-	-	-	-	274	274	924	
1991	-	-	-	-	472	472	840	
1992	-	-	-	-	237	237	258	Quota set by Greenlandic authorities
1993	-	-	-	-			89	The fishery was suspended. NASCO adopted a new quota allocation model.
1994	-	-	-	-			137	The fishery was suspended and the quotas were bought out.
1995	-	-	-	-	83	83	77	Quota advised by NASCO
1996	-	-	-	-	92	92	174	Quota set by Greenlandic authorities
1997	-	-	-	-	58	58	57	Private (non-commercial) catches to be reported after 1997
1998	-	-	-	-	11	11	20	Fishery restricted to catches used for internal consumption in Greenland
1999	-	-	-	-	19	19	20	

Year	Norway	Faroes	Sweden	Denmark	Greenland	Total	Quota	Comments
2000	-	-	-	-	21	21	20	
2001	-	-	-	-	43	43	114	Final quota calculated according to the *ad hoc* manage-ment system
2002	-	-	-	-	9	9	55	Quota bought out, quota represented the maximum allowable catch (no factory landing allowed), and higher catch figures based on sampling programme information are used for the assessments.
2003	-	-	-	-	9	9		Quota set to nil (no factory landing allowed), fishery restricted to catches used for internal consumption in Greenland, and higher catch figures based on sampling programme information are used for the assessments.
2004	-	-	-	-	15	15		Same as previous year
2005	-	-	-	-	15	15		Same as previous year
2006	-	-	-	-	22	22		Quota set to nil (no factory landing allowed) and fishery restricted to catches used for internal consumption in Greenland.
2007	-	-	-	-	25	25		Quota set to nil (no factory landing allowed), fishery restricted to catches used for internal consumption in Greenland, and higher catch figures based on sampling programme information are used for the assessments.
2008	-	-	-	-	26	26		Same as previous year
2009	-	-	-	-	26	26		Same as previous year
2010	-	-	-	-	40	40		No factory landing allowed and fishery restricted to catches used for internal consumption in Greenland
2011	-	-	-	-	28	28		Same as previous
2012	-	-	-	-	33	33	(35)	Unilateral decision made by Greenland to allow factory landing with a 35 t quota for factory landings only, fish-ery restricted to catches used for internal consumption in Greenland, and higher catch figures based on sampling programme information are used for the assessments
2013	-	-	-	-	47	47	(35)	same as previous year
2014	-	-	-	-	58	58	(30)	Unilateral decision made by Greenland to allow factory landing with a 30 t quota for factory landings only, fish-ery restricted to catches used for internal consumption in Greenland, and higher catch figures based on sampling programme information and phone surveys are used for the assessments.
2015	-	-	-	-	57	57	45	Unilateral decision made by Greenland to set a 45 t quota for all sectors of the fishery, fishery restricted to catches used for internal consumption in Greenland, and higher catch figures based on sampling programme information and phone surveys are used for the assess-ments.
2016	-	-	-	-	27	27	32	Unilateral decision made by Greenland to reduce the previously set 45 t quota for all sectors of the fishery to 32 t based on overage of 2015 fishery, fishery restricted to catches used for internal consumption in Greenland, and higher catch figures based on sampling programme information and phone surveys are used for the assess-ments.
2017	-	-	-	-	28	28	45	Unilateral decision made by Greenland to set a 45 t quota for all sectors of the fishery, fishery restricted to catches used for internal consumption in Greenland, and higher catch figures based on sampling programme information are used for the assessments,

Table 3 Annual distribution of nominal catches (t) at Greenland by NAFO division when known. NAFO divisions are shown in Figure 2. Since 2005, gutted weights have been reported and converted to total weight by a factor of 1.11.

Year	1A	1B	1C	1D	1E	1F	Unknown	West Greenland	East Greenland	Total
1960							60	60		60
1961							127	127		127
1962							244	244		244
1963	1	172	180	68	45			466		466
1964	21	326	564	182	339	107		1 539		1 539
1965	19	234	274	86	202	10	36	861		861
1966	17	223	321	207	353	130	87	1 338		1 338
1967	2	205	382	228	336	125	236	1 514		1 514
1968	1	90	241	125	70	34	272	833		833
1969	41	396	245	234	370		867	2 153		2 153
1970	58	239	122	123	496	207	862	2 107		2 107
1971	144	355	724	302	410	159	560	2 654		2 654
1972	117	136	190	374	385	118	703	2 023		2 023
1973	220	271	262	440	619	329	200	2 341		2 341
1974	44	175	272	298	395	88	645	1 917		1 917
1975	147	468	212	224	352	185	442	2 030		2 030
1976	166	302	262	225	182	38		1 175		1 175
1977	201	393	336	207	237	46	-	1 420	6	1 426
1978	81	349	245	186	113	10	-	984	8	992
1979	120	343	524	213	164	31	-	1 395	+	1 395
1980	52	275	404	231	158	74	-	1 194	+	1 194
1981	105	403	348	203	153	32	20	1 264	+	1 264
1982	111	330	239	136	167	76	18	1 077	+	1 077
1983	14	77	93	41	55	30	-	310	+	310
1984	33	116	64	4	43	32	5	297	+	297
1985	85	124	198	207	147	103	-	864	7	871
1986	46	73	128	203	233	277	-	960	19	979
1987	48	114	229	205	261	109	-	966	+	966
1988	24	100	213	191	198	167	-	893	4	897
1989	9	28	81	73	75	71	-	337	-	337
1990	4	20	132	54	16	48	-	274	-	274
1991	12	36	120	38	108	158	-	472	4	476
1992	-	4	23	5	75	130	-	237	5	242
1993 [1]	-	-	-	-	-	-	-	-	-	-
1994 [1]	-	-	-	-	-	-	-	-	-	-
1995	+	10	28	17	22	5	-	83	2	85
1996	+	+	50	8	23	10	-	92	+	92
1997	1	5	15	4	16	17	-	58	1	59
1998	1	2	2	4	1	2	-	11	-	11
1999	+	2	3	9	2	2	-	19	+	19
2000	+	+	1	7	+	13	-	21	-	21
2001	+	1	4	5	3	28	-	43	-	43
2002	+	+	2	4	1	2	-	9	-	9
2003	1	+	2	1	1	5	-	9	-	9
2004	3	1	4	2	3	2	-	15	-	15
2005	1	3	2	1	3	5	-	15	-	15
2006	6	2	3	4	2	4	-	22	-	22
2007	2	5	6	4	5	2	-	25	-	25
2008	4.9	2.2	10.0	1.6	2.5	5.0	0	26.2	0	26.2
2009	0.2	6.2	7.1	3.0	4.3	4.8	0	25.6	0.8	26.3
2010	17.3	4.6	2.4	2.7	6.8	4.3	0	38.1	1.7	39.6

Year	1A	1B	1C	1D	1E	1F	Unknown	West Greenland	East Green-land	Total
2011	1.8	3.7	5.3	8.0	4.0	4.6	0	27.4	0.1	27.5
2012	5.4	0.8	15.0	4.6	4.0	3.0	0	32.6	0.5	33.1
2013	3.1	2.4	17.9	13.4	6.4	3.8	0	47.0	0.0	47.0
2014	3.6	2.8	13.8	19.1	15.0	3.4	0	57.8	0.1	57.9
2015	0.8	8.8	10.0	18.0	4.2	14.1	0	55.9	1.0	56.8
2016	0.8	1.2	7.3	4.6	4.5	7.3	0	25.7	1.5	27.1
2017	1.1	1.7	9.3	6.9	3.2	5.6	0	27.8	0.3	28.0

[1] The fishery was suspended.
+ Small catches < 5 t.
- No catch.

Table 4 Reported landings (t) by landing category, the number of fishers reporting, and the total number of landing reports received for licensed and unlicensed fishers in 2014–2017. Empty cells identify categories with no reported landings and 0.0 entries represents reported values of < 0.1.

NAFO/ICES	Licensed	No. of Fishers	No. of Reports	Comm.	Private	Factory	Total		Licensed	No. of Fishers	No. of Reports	Comm.	Private	Factory	Total
	2017								2016						
1A	No	2	12	0.0	0.0		0.0		No						0.0
1A	Yes	15	66	0.3	0.8		1.1		Yes	9	19		0.7		0.7
1A	Total	17	78	0.3	0.9		1.1		Total	9	19	0.0	0.7		0.7
1B	No						0.0		No	4	9		0.2		0.2
1B	Yes	9	40	1.4	0.2		1.7		Yes	7	22	0.1	1.0		1.0
1B	Total	9	40	1.4	0.2		1.7		Total	11	31	0.1	1.1		1.2
1C	No	7	23	0.0	0.4		0.4		No	8	30		1.0		1.0
1C	Yes	33	135	5.9	3.0		8.9		Yes	23	113	4.1	2.1		6.2
1C	Total	40	158	5.9	3.4		9.3		Total	31	143	4.1	3.1		7.3
1D	No	17	44	0.0	0.9		0.9		No	8	13		0.9		0.9
1D	Yes	7	23	5.1	0.9		5.9		Yes	8	42	1.2	2.5		3.8
1D	Total	24	67	5.1	1.8		6.9		Total	16	55	1.2	3.4		4.6
1E	No	8	24	0.0	0.6		0.6		No	13	22		1.4		1.4
1E	Yes	15	114	0.7	1.9		2.6		Yes	10	74	0.6	2.5		3.1
1E	Total	23	138	0.7	2.5		3.2		Total	23	96	0.6	3.9		4.5
1F	No	16	51	0.0	1.2		1.2		No	27	66	0.1	2.9		3.0
1F	Yes	12	78	1.8	2.6		4.4		Yes	13	46	2.6	1.7		4.3
1F	Total	28	129	1.8	3.8		5.6		Total	40	112	2.7	4.6		7.3
XIV	No						0.0		No	9	46		1.3		1.3
XIV	Yes	2	21	0.1	0.2		0.3		Yes	1	1		0.2		0.2
XIV	Total	2	21	0.1	0.2		0.3		Total	10	47	0.0	1.5		1.5
ALL	No	50	154	0.0	3.1		3.1		No	69	186	0.1	7.6		7.7
ALL	Yes	93	477	15.3	9.7		24.9		Yes	71	317	8.6	10.8		19.4
ALL	Total	143	631	15.3	12.8		28.0		Total	140	503	8.7	18.4		27.1

NAFO/ICES	Licensed	No. of Fishers	No. of Reports	Comm.	Private	Factory	Total		Licensed	No. of Fishers	No. of Reports	Comm.	Private	Factory	Total
	2015								2014						
1A	No	5	6		0.1		0.1		No	1	1		0.1		0.1
1A	Yes	13	29	0.1	0.6		0.7		Yes	20	87	3.0	0.5		3.5
1B	Total	18	35	0.1	0.7		0.8		Total	21	88	3.0	0.6		3.6
1B	No	3	5		0.1		0.1		No						
1B	Yes	15	96	7.3	1.5		8.7		Yes	8	28	2.1	0.7		2.8
1C	Total	18	101	7.3	1.5		8.8		Total	8	28	2.1	0.7		2.8
1C	No	16	58	0.1	1.7		1.8		No	5	18	0.6			0.6
1C	Yes	42	181	2.9	3.9	1.5	8.2		Yes	35	212	1.5	2.1	9.7	13.2
1D	Total	58	239	3.0	5.6	1.5	10.1		Total	40	230	2.1	2.1	9.7	13.8
1D	No	20	35		0.8		0.8		No	6	10	0.2	0.3		0.5
1D	Yes	11	161	14.3	0.5	2.4	17.1		Yes	14	115	0.4	5.5	12.8	18.6
1E	Total	31	196	14.3	1.3	2.4	18.0		Total	20	135	0.6	5.7	12.8	19.1
1E	No	3	5	0.1	0.2		0.2		No	1	1	0.2			0.2
1E	Yes	11	71	2.0	1.9		3.9		Yes	9	102	1.4	0.8	12.6	14.8
1F	Total	14	76	2.1	2.1		4.2		Total	10	103	1.6	0.8	12.6	15.0
1F	No	20	69		2.4		2.4		No	3	3	0.1	0.1		0.2
1F	Yes	21	173	7.1	4.6		11.7		Yes	11	80	2.0	1.2		3.2
XIV	Total	41	242	7.1	7.0		14.1		Total	14	83	2.1	1.3		3.4
XIV	No	8	32		0.6		0.6		No						0.0
XIV	Yes	1	17	0.0	0.4		0.4		Yes	1	12	0.1	0.0		0.1
ALL	Total	9	49	0.0	0.9		1.0		Total	1	12	0.1	0.0		0.1
ALL	No	75	210	0.1	5.9		6.0		No	16	33	1.2	0.4		1.6
ALL	Yes	114	728	33.7	13.3	3.8	50.8		Yes	98	636	10.5	10.7	35.0	56.2
	Total	189	938	33.8	19.2	3.8	56.8		Total	114	669	11.6	11.2	35.0	57.8

Table 5 Reported landings and adjusted landings for assessment of Atlantic salmon at West Greenland 2002–2017. The total adjusted landings number does not include the unreported catch (10 t per year since 2000).

Year	Reported landings (West Greenland)	Adjusted landings (Sampling)	Adjusted landings (Survey)	Total adjusted landings
2002	9.0	0.7	-	9.8
2003	8.7	3.6	-	12.3
2004	14.7	2.5	-	17.2
2005	15.3	2.0	-	17.3
2006	23.0	0.0	-	23.0
2007	24.6	0.2	-	24.8
2008	26.1	2.5	-	28.6
2009	25.5	2.5	-	28.0
2010	37.9	5.1	-	43.1
2011	27.4	0.0	-	27.4
2012	32.6	2.0	-	34.6
2013	46.9	0.7	-	47.7
2014	57.7	0.6	12.2	70.5
2015	55.9	0.0	5.0	60.9
2016	25.7	0.3	4.2	30.2
2017	27.8	0.3	-	28.0

Table 6 Summary of biological characteristics of catches of Atlantic salmon at West Greenland in 2017 (NA – North America, E – Europe).

River-age distribution (%) by origin								
	1	2	3	4	5	6	7	8
NA	0.3	31.0	41.6	19.6	7.2	0.3	0	0
E	10.0	73.0	15.4	1.7	0	0	0	0

Length and weight by origin and sea age								
	1 SW		2 SW		Previous spawners		All sea ages	
	Fork length	Whole	Fork length	Whole	Fork length (cm)	Whole	Fork length	Whole
NA	66.6	3.42	85.1	6.50	76.7	4.94	67.4	3.50
E	64.8	3.31	72.4	3.69	81.9	8.00	65.4	3.36

Continent of origin (%)	
North America	Europe
74.4	25.6

Sea-age composition (%) by continent of origin			
	1SW	2SW	Previous spawners
NA	92.5	1.5	6.0
E	93.1	5.7	1.2

Table 7 Genetic mixture analyses (proportion of samples) of Atlantic salmon harvested at West Greenland from 2015–2017. Three regional groups (GUL, GAS, and LAB) account for > 70% of the harvest on average. Mean (proportion) estimates provided with 95% credible interval in parentheses. Credible intervals with a lower bound of zero indicate little support for mean assignment value. Regional group acronyms were identified in Figure 5.

Region	Overall	2015	2016	2017
GUL	0.263 (0.161, 0.361)	0.225 (0.152, 0.296)	0.243 (0.165, 0.322)	0.306 (0.165, 0.439)
FUN	0.001 (0, 0.019)	0.002 (0, 0.013)	0 (0, 0.012)	0 (0, 0.028)
QUE	0.083 (0.036, 0.155)	0.119 (0.062, 0.181)	0.076 (0.026, 0.136)	0.06 (0.024, 0.149)
GAS	0.275 (0.166, 0.367)	0.29 (0.2, 0.356)	0.218 (0.138, 0.295)	0.305 (0.16, 0.429)
ANT	0.016 (0.003, 0.042)	0.028 (0.006, 0.054)	0.016 (0.003, 0.037)	0.007 (0.001, 0.037)
QLS	0.041 (0.008, 0.102)	0.022 (0.003, 0.061)	0.05 (0.014, 0.099)	0.05 (0.008, 0.135)
AVA	0 (0, 0.013)	0 (0, 0.007)	0 (0, 0.007)	0 (0, 0.023)
NFL	0.042 (0.018, 0.126)	0.064 (0.031, 0.149)	0.049 (0.024, 0.124)	0.019 (0.004, 0.111)
LAB	0.189 (0.132, 0.285)	0.212 (0.154, 0.29)	0.229 (0.165, 0.315)	0.141 (0.091, 0.259)
UNG	0.068 (0.023, 0.123)	0.032 (0.009, 0.061)	0.075 (0.034, 0.114)	0.09 (0.026, 0.175)
NOS	0.006 (0, 0.035)	0 (0, 0.008)	0.01 (0.001, 0.04)	0.007 (0, 0.052)
USA	0.018 (0.005, 0.045)	0.007 (0.003, 0.018)	0.034 (0.011, 0.066)	0.014 (0.002, 0.051)
Samples	1806	749	508	549

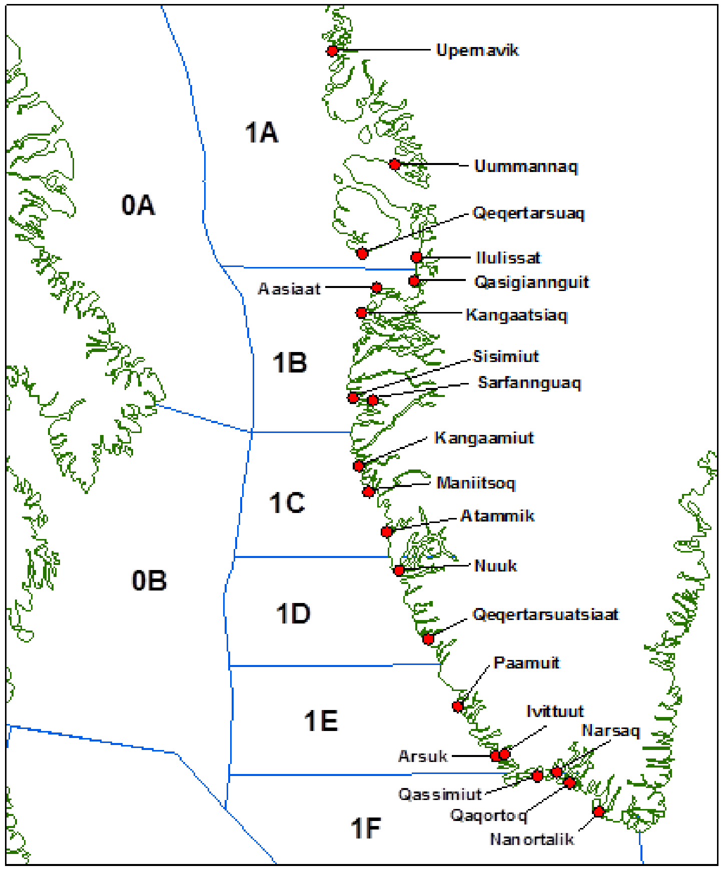


Figure 1 Map of communities in West Greenland where Atlantic salmon have historically been landed and corresponding NAFO divisions (1A–1F). In 2017, samples were obtained from Sisimiut (1B), Maniitsoq (1C), Paamuit (1E), and Qaqortoq (1F).

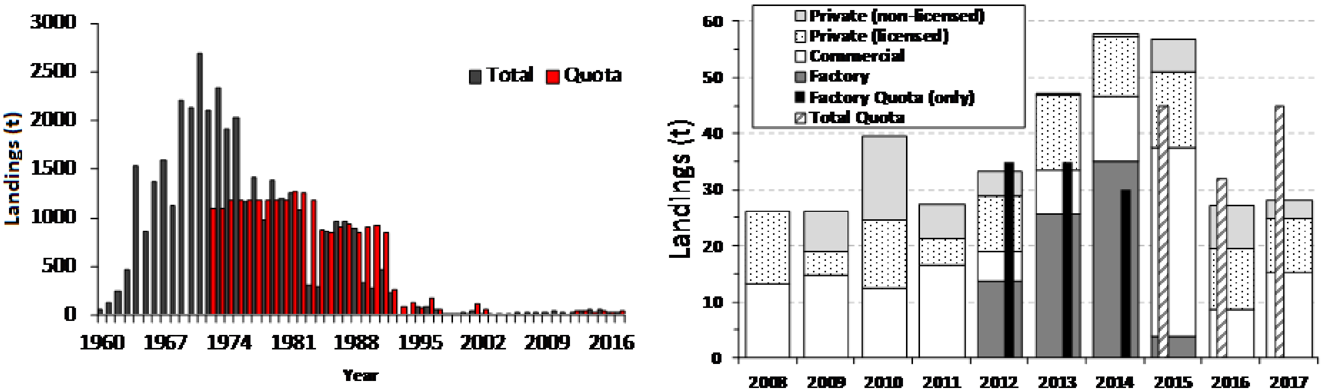


Figure 2 Nominal landings and commercial quotas (t, round fresh weight) of salmon at West Greenland from 1960–2017 (left panel). Landings from 2008–2017 are also displayed by landing type (right panel). No quotas were set from 2002–2011.

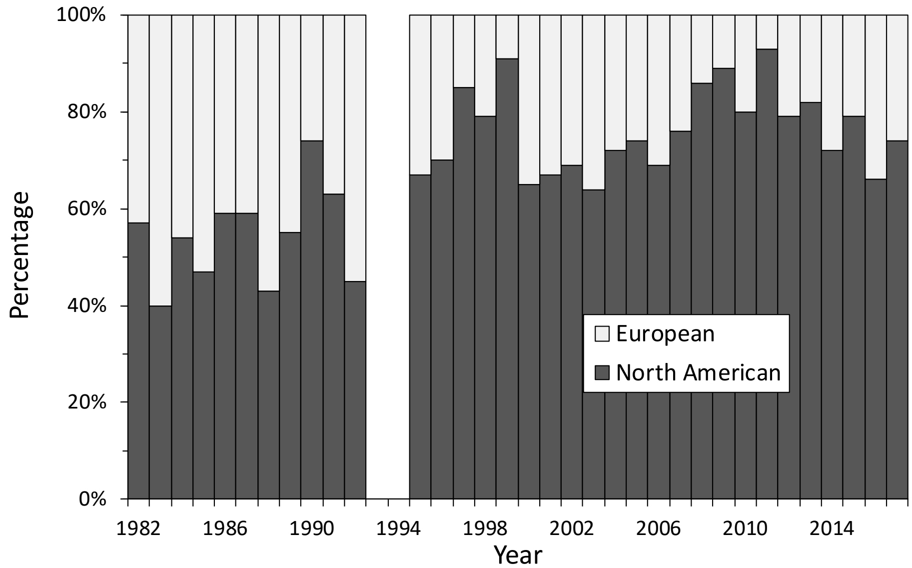


Figure 3 Estimated percent continent of origin of Atlantic salmon harvested at West Greenland from 1982 to 2017.

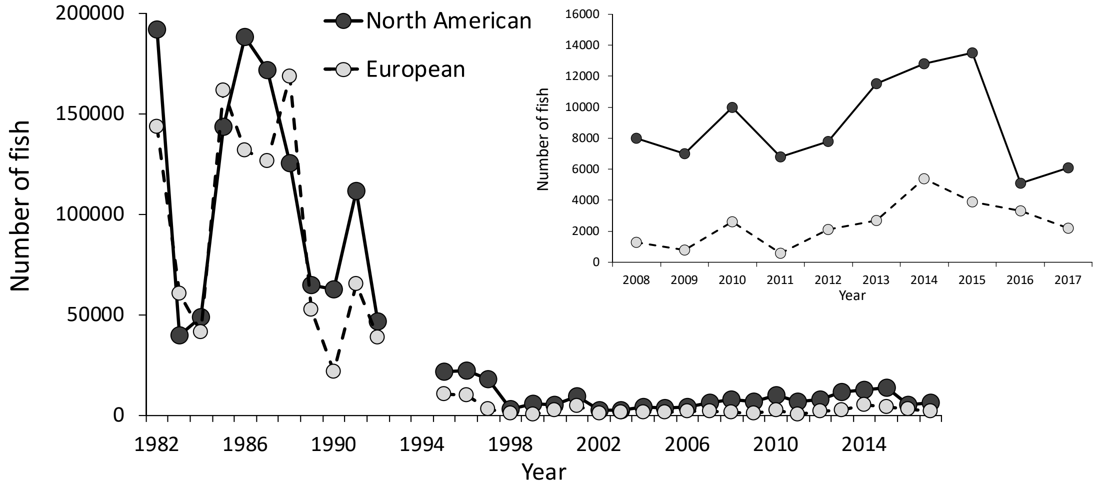
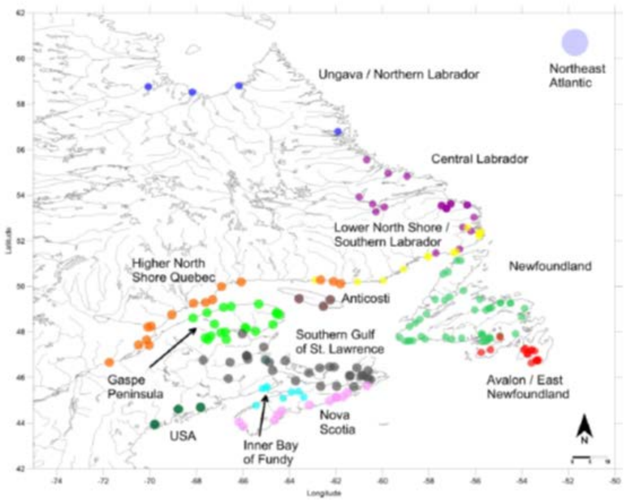


Figure 4 Number of North American (red bars) and European (blue bars) Atlantic salmon caught at West Greenland from 1982–2017 and 2008–2017 (inset). Estimates are based on continent of origin by NAFO division, weighted by catch (weight) in each division. Numbers are rounded to the nearest hundred fish. Unreported catch not included.



ICES region	Regional group	Group acronym
Quebec	Ungava / Northern Labrador	UNG
Labrador	Labrador Central	LAB
	Quebec / Labrador South	QLS
Quebec	Quebec	QUE
	Anticosti	ANT
	Gaspe	GAS
Gulf	Gulf of St. Lawrence	GUL
Scotia-Fundy	Nova Scotia	NOS
	Inner Bay of Fundy	FUN
USA	USA	US
Newfoundland	Newfoundland	NFL
	Avalon	AVA

Figure 5 Map of sample locations used in the microsatellite baseline for Atlantic salmon which provided twelve defined regional groups for eastern North America (labelled and identified by colour) and correspondence between regional groups and ICES assessment regions for eastern North America.

NASCO 4.2 Describe the status of the stocks

Recruitment (pre-fishery abundance) estimates of non-maturing 1SW salmon suggest continued low abundance of North American (Figure 6) and Southern NEAC (Figure 7) salmon at Greenland. In 2017, the median estimates of returns to rivers and spawners were below the CLs for 2SW salmon for all regions of NAC except Labrador, and are therefore suffering reduced reproductive capacity (Figure 8). The median estimates of the 2SW returns and spawners for Labrador exceeded the CL, but the fifth percentiles were below the CL and for this region the stock is at risk of suffering reduced reproductive capacity (Figure 8). Particularly large deficits relative to CLs and rebuilding management objectives are noted in the Scotia–Fundy and USA regions. In 2017, the median estimates of spawners for the southern NEAC MSW stock complex was above the CL, but the fifth percentiles were below the CL and, as such, considered at risk of suffering reduced reproductive capacity (Figure 8). For individual countries within the Southern NEAC MSW stock complex, estimated spawners for three countries were considered at full reproductive capacity, whereas spawners for three countries were suffering reduced reproductive capacity.

The exploitation rate (catch in Greenland/PFA) on NAC fish in 2016 was 5.4%, and among the lowest in the time-series (Figure 9). The 2016 southern NEAC exploitation rate was 0.8% and among the lowest in the time-series (Figure 9).

The abundance of salmon within the West Greenland area is considered to be low compared to historical levels (Figures 6 and 7). This is broadly consistent with the general pattern of decline in marine survival in most monitored stocks. Despite major changes in fisheries management in the past few decades and increasingly more restrictive fisheries measures, returns in many of these regions have remained near historical lows. The continued low abundance of salmon stocks across North America and in the Northeast Atlantic, despite significant fishery reductions, further strengthens the conclusions that factors other than fisheries are constraining production.

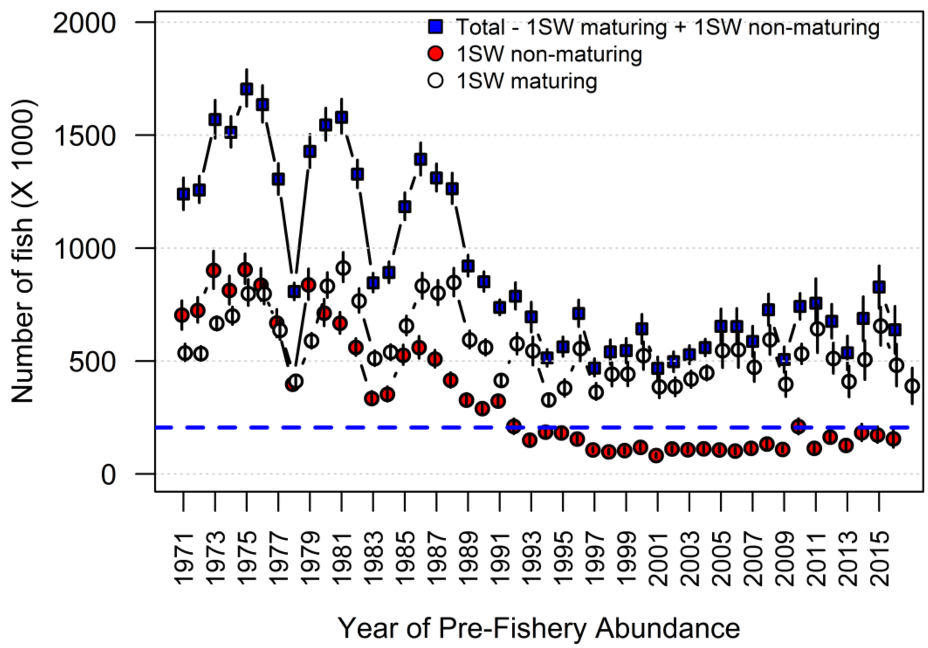


Figure 6 Estimated (median, fifth to 95th percentile range) pre-fishery abundance (PFA) for 1SW maturing, 1SW non-maturing, and total cohort of 1SW salmon for NAC, PFA years 1971 to 2016. The dashed blue horizontal line is the corresponding sum of the 2SW conservation limits for NAC (152 548), corrected for 11 months of natural mortality (205 918) against which 1SW non-maturing are assessed.

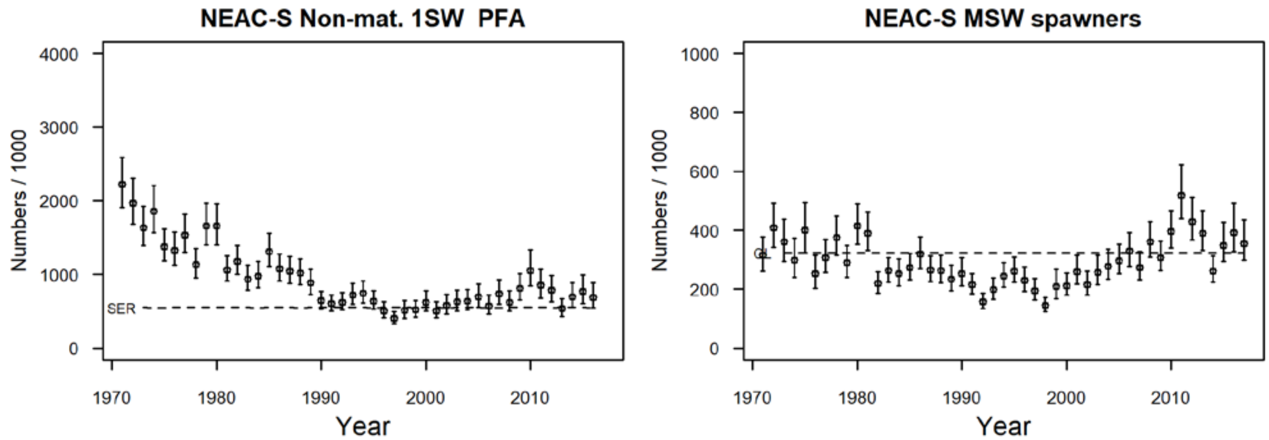


Figure 7 Estimated PFA (left panel) and spawning escapement (right panel) with 90% confidence limits, for non-maturing 1SW (MSW spawners) salmon in southern NEAC (NEAC – S) stock complex.

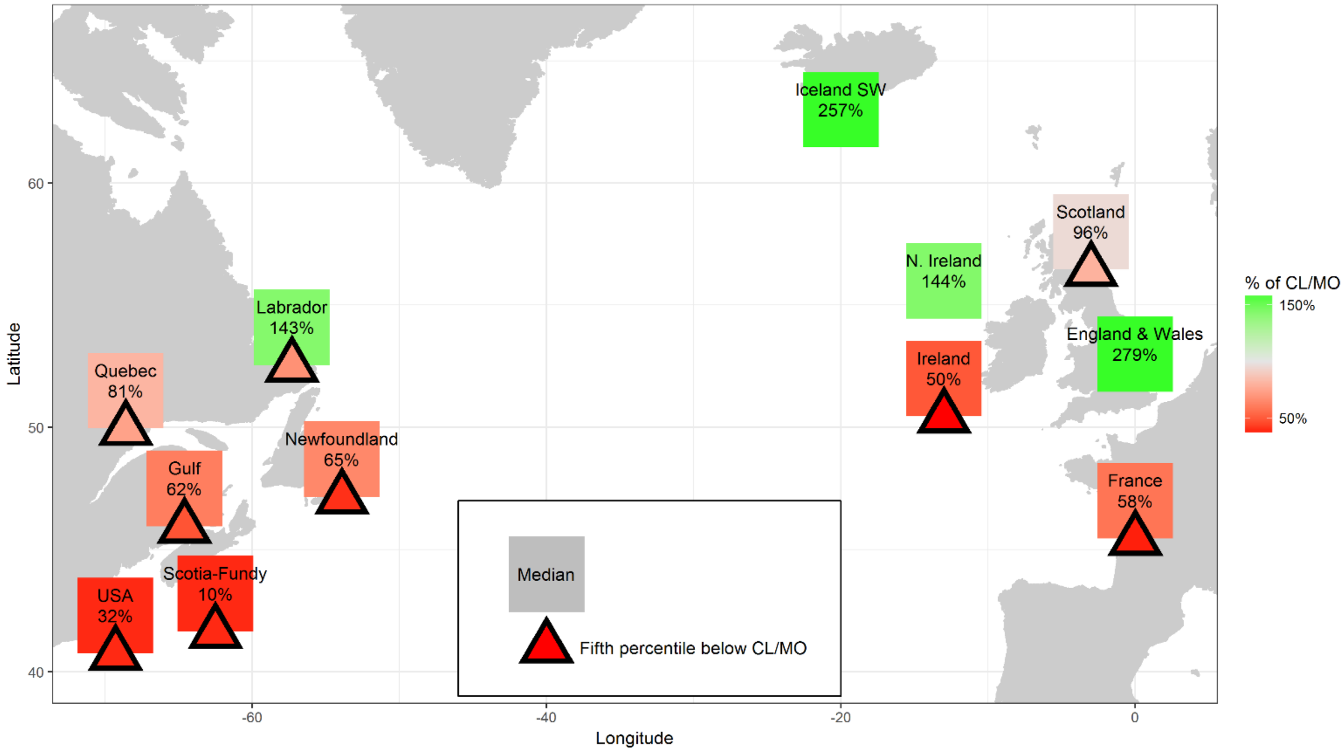


Figure 8 Summary of 2SW (NAC regions) and MSW (Southern NEAC regions) spawner estimates in 2017 in relation to CLs or management objectives (for USA and Scotia-Fundy). Median and fifth percentiles refer to the Monte Carlo posterior distributions of each estimate. The colour shading of the symbols represents the percentage of the CL or rebuilding objective attained, with red < 100% and green > 100%. The triangular symbols accompanying the respective spawners symbols indicate when the fifth percentiles of the estimates are below the CLs or management objective, i.e., the stocks are at risk of or suffering reduced reproductive capacity. The intensity of the red colour shading is inversely associated with the percentage of the objective attained.

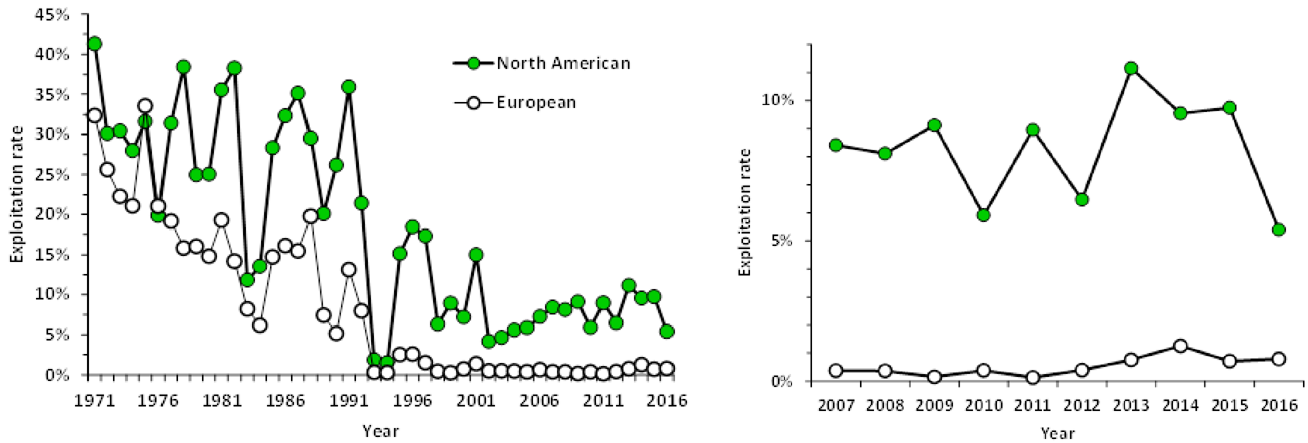


Figure 9 Exploitation rate (%) for NAC 1SW non-maturing and southern NEAC non-maturing Atlantic salmon at West Greenland, 1971–2016 (left panel) and 2007–2016 (right panel). Exploitation rate estimates are only available to 2016, as 2017 exploitation rates are dependent on 2018 returns.

NASCO 4.3 Provide catch options or alternative management advice for 2018-2020 with an assessment of risk relative to the objective of exceeding stock conservation limits, or pre-defined NASCO Management Objectives, and advise on the implications of these options for stock rebuilding

None of the management objectives agreed by NASCO would allow a mixed-stock fishery at West Greenland to take place in 2018, 2019, or 2020 (Table 8).

- In the absence of any fishing in the years 2018 to 2020, there is less than 75% probability that the numbers of 2SW salmon returns will be above the management objectives simultaneously for the six regions of North America and for Southern NEAC.
- In the absence of any fishing, there is a low probability (from 0.000 to 0.003) that the returns in the southern region of Scotia-Fundy will be sufficient to meet the stock rebuilding objective during the period 2018 to 2020. The probability of meeting or exceeding the stock rebuilding objective of the USA region is estimated at 0.001 to 0.006 over the three years.
- In the absence of any fishing, the probabilities of meeting or exceeding the CLs for the southern NEAC MSW complex is 0.369, 0.417, and 0.548 in 2018 to 2020, respectively.

Table 8 Catch options tables for the mixed-stock fishery at West Greenland for the fishing years 2018 to 2020. '0.000' refers to attainment of less than three out of 5000 draws.

2018 Catch option	Probability of meeting or exceeding region-specific management objectives							
	Labrador	Newfoundland	Québec	Gulf	Scotia-Fundy	US	Southern NEAC	Simultaneous
0	0.871	0.308	0.387	0.087	0.001	0.001	0.369	0.000
10	0.857	0.295	0.363	0.084	0.001	0.001	0.365	0.000
20	0.842	0.283	0.340	0.080	0.001	0.001	0.360	0.000
30	0.825	0.271	0.316	0.074	0.001	0.001	0.355	0.000
40	0.813	0.254	0.293	0.068	0.001	0.001	0.351	0.000
50	0.797	0.240	0.273	0.064	0.001	0.001	0.348	0.000
60	0.780	0.228	0.259	0.061	0.001	0.001	0.344	0.000
70	0.762	0.216	0.241	0.057	0.001	0.001	0.341	0.000
80	0.742	0.204	0.224	0.053	0.001	0.001	0.337	0.000
90	0.725	0.191	0.205	0.048	0.001	0.001	0.333	0.000
100	0.705	0.178	0.193	0.045	0.000	0.001	0.330	0.000
2019 Catch option	Probability of meeting or exceeding region-specific management objectives							
	Labrador	Newfoundland	Québec	Gulf	Scotia-Fundy	US	Southern NEAC	Simultaneous
0	0.888	0.289	0.271	0.102	0.000	0.002	0.417	0.000
10	0.875	0.278	0.258	0.098	0.000	0.001	0.412	0.000
20	0.863	0.266	0.243	0.094	0.000	0.001	0.408	0.000
30	0.851	0.253	0.230	0.088	0.000	0.001	0.405	0.000
40	0.838	0.244	0.216	0.083	0.000	0.001	0.400	0.000
50	0.823	0.235	0.205	0.080	0.000	0.001	0.397	0.000
60	0.810	0.224	0.193	0.076	0.000	0.001	0.394	0.000
70	0.795	0.215	0.182	0.071	0.000	0.001	0.389	0.000
80	0.782	0.205	0.173	0.066	0.000	0.001	0.384	0.000
90	0.765	0.196	0.163	0.063	0.000	0.001	0.379	0.000
100	0.749	0.187	0.155	0.059	0.000	0.001	0.376	0.000
2020 Catch option	Probability of meeting or exceeding region-specific management objectives							
	Labrador	Newfoundland	Québec	Gulf	Scotia-Fundy	US	Southern NEAC	Simultaneous
0	0.898	0.392	0.316	0.194	0.003	0.006	0.548	0.000
10	0.889	0.379	0.305	0.186	0.003	0.006	0.544	0.000
20	0.881	0.368	0.290	0.181	0.003	0.006	0.540	0.000
30	0.872	0.357	0.281	0.176	0.003	0.006	0.536	0.000
40	0.861	0.348	0.270	0.171	0.003	0.006	0.532	0.000
50	0.849	0.339	0.260	0.165	0.003	0.006	0.527	0.000
60	0.838	0.329	0.250	0.159	0.002	0.005	0.523	0.000
70	0.827	0.319	0.240	0.155	0.002	0.005	0.520	0.000
80	0.813	0.311	0.229	0.150	0.002	0.005	0.514	0.000
90	0.802	0.302	0.220	0.142	0.002	0.005	0.512	0.000
100	0.788	0.295	0.211	0.137	0.002	0.005	0.510	0.000

NASCO 4.4 Update the Framework of Indicators used to identify any significant change in the previously provided multi-annual management advice.

An updated Framework of Indicators (FWI) that can be used to identify any significant change in the previously provided multi-annual management advice has been provided (Figure 9). The update consisted of:

- Adding the values of the indicator variables for the most recent years;
- Running the objective function spreadsheet for each indicator variable and the variable of interest relative to the management objectives;
- Quantifying the threshold value for the indicator variables and the probabilities of a true high state and a true low state for those indicator variables retained for the framework;
- Revising/adding the indicator variables and the functions for evaluating the indicator score to the framework spreadsheet; and
- Providing the spreadsheet for doing the framework of indicators assessment.

The updated FWI contains 22 indicator variables, represented by 14 different rivers. Of these, two were survival rate indicators of hatchery fish, two were survival rate indicators of wild fish, while the remainder were of wild 2SW, MSW, and large salmon (n=16) or wild 1SW or small salmon (n=4) returns to rivers. No indicator variables were retained for the Labrador or Newfoundland areas and 15 indicator variables were explored for southern NEAC and only one met the qualifying criteria.

Catch Advice	Catch option > 0 (Yes = 1, No = 0)	0

Overall Recommendation

No Significant Change Identified by Indicators

Geographic Area	River/ Indicator	2017 Value	Ratio Value to Threshold	Threshold	True Low	True High	Indicator State	Probability of Correct Assignment	Indicator Score	Management Objective Met?
USA	Penobscot 2SW Returns	530	22%	2 368	100%	100%	-1	1	-1	
	possible range				*-1,00*	*1,00*				
	Average		22%						**-1,00**	**No**
Scotia-Fundy	Saint John Return Large	83	2%	3 329	97%	100%	-1	0,97	-0,97	
	Lahave Return Large	51	18%	285	81%	85%	-1	0,81	-0,81	
	North Return Large	192	31%	626	96%	74%	-1	0,96	-0,96	
	Saint John Survival 2SW (%)	0,04	18%	0,222	96%	81%	-1	0,96	-0,96	
	Saint John Survival 1SW (%)	0,1	13%	0,763	89%	73%	-1	0,89	-0,89	
	Saint John Return 1SW	195	9%	2 276	89%	80%	-1	0,89	-0,89	
	LaHave Return 1SW	45	3%	1 679	96%	67%	-1	0,96	-0,96	
	possible range				*-0,92*	*0,80*				
	Average		13%						**-0,92**	**No**
Gulf	Miramichi Return 2SW	10149	69%	14 669	100%	82%	-1	1,00	-1,00	
	Miramichi Return 1SW	1330	3%	41 588	92%	68%	-1	0,92	-0,92	
	Margaree Return Large	1550	49%	3 149	88%	56%	-1	0,88	-0,88	
	possible range				*-0,93*	*0,69*				
	Average		41%						**-0,93**	**No**
Quebec	Bonaventure Return Large	1067	72%	1 479	82%	76%	-1	0,82	-0,82	
	Grande Rivière Return Large	467	106%	442	100%	89%	1	0,89	0,89	
	Saint-Jean Return Large	554	73%	758	88%	78%	-1	0,88	-0,88	
	Dartmouth Return Large	927	123%	756	84%	87%	1	0,87	0,87	
	Madeleine Return Large	672	100%	672	88%	79%	1	0,79	0,79	
	York Return Large	1267	90%	1405	73%	83%	-1	0,73	-0,73	
	De la Trinité Return Large	264	69%	385	82%	100%	-1	0,82	-0,82	
	De la Trinité Return Small	212	37%	578	83%	85%	-1	0,83	-0,83	
	Saint-Jean 2SW Survival	1,18	164%	0,72	100%	50%	1	0,5	0,5	
	De la Trinité 2SW Survival	0,40	82%	0,49	92%	68%	-1	0,92	-0,92	
	possible range				*-0,87*	*0,80*				
	Average		91%						**-0,20**	**No**
Newfoundland										
	possible range									
	Average								**NA**	**Unknown**
Labrador										
	possible range									
	Average								**NA**	**Unknown**
Scotland	North Esk HW Return MSW	6196	74%	8369	72%	100%	-1	0,72	-0,72	
	possible range				*-0,72*	*1,00*				
	Average		74%						**-0,72**	**No**

Figure 9 Framework of indicators spreadsheet for the West Greenland fishery. For illustrative purposes, the 2017 value of returns or survival rates for the 22 retained indicators is entered in the cells corresponding to the annual indicator variable values.

Relevant data deficiencies, monitoring needs and research requirements

The following relevant data deficiencies, monitoring needs, and research requirements of relevance to the West Greenland Commission were identified:

1) Efforts to improve the reporting system of catch in the Greenland fishery should continue and that detailed statistics related to spatially and temporally explicit catch and effort data for both licensed and unlicensed fishers should be made available for analysis.

2) Continuation of the phone survey programme according to a standardized and consistent annual approach with consideration given to surveying a larger proportion of licensed fishers and the inclusion of the non-licensed fishers. Information gained on the level of total catch for this fishery will provide for a more accurate assessment of the status of stocks and assessment of risk with varying levels of harvest.

3) Continuation of the broad geographic sampling programme including in Nuuk (multiple NAFO divisions including factory landings when permitted) and consideration should be given to expanding the programme across the fishing season to more accurately estimate continent and region of origin and biological characteristics of the mixed-stock fishery.

4) In preparation for the next update to the FWI, a full suite of all potential input datasets across all regions and stock complexes be evaluated against country-specific management objectives for Southern NEAC.

The full list of data deficiencies, monitoring needs and research requirements for North Atlantic salmon is presented in Section 1.5 of the sal.oth.nasco advice (ICES, 2018a).

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Annex 1 Glossary of acronyms and abbreviations

1SW *(one-sea-winter).* Maiden adult salmon that has spent one winter at sea.
2SW *(two-sea-winter).* Maiden adult salmon that has spent two winters at sea.
CL, i.e. S_{lim} *(conservation limit).* Demarcation of undesirable stock levels or levels of fishing activity; the ultimate objective when managing stocks and regulating fisheries will be to ensure that there is a high probability that undesirable levels are avoided.
CPUE *(catch per unit of effort).* A derived quantity obtained from the independent values of catch and effort.
ICES (*International Council for the Exploration of the Sea*).
NAC (*North American Commission*). A commission under NASCO.
NAFO (*Northwest Atlantic Fisheries Organization*). NAFO is an intergovernmental fisheries science and management organization that ensures the long-term conservation and sustainable use of the fishery resources in the Northwest Atlantic.
NASCO (*North Atlantic Salmon Conservation Organization*).
NEAC (*North East Atlantic Commission*). A commission under NASCO.
PFA *(pre-fishery abundance).* The numbers of salmon estimated to be alive in the ocean from a particular stock at a specified time.
TAC *(total allowable catch).* TAC is the quantity of fish that can be taken from each stock each year.

Annex 2 General considerations

Management plans

The North Atlantic Salmon Conservation Organization (NASCO) has adopted an Action Plan for Application of the Precautionary Approach which stipulates that management measures should be aimed at maintaining all stocks above their CLs by the use of management targets. NASCO has adopted the region-specific CLs as limit reference points (S_{lim}); having populations fall below these limits should be avoided with high probability. Within the agreed management plan, a simultaneous risk level (probability) of 75% has been agreed for the provision of catch advice on the stock complexes exploited at West Greenland (non-maturing 1SW fish from North America and Southern NEAC). The management objectives are to meet the Southern NEAC MSW CL, the 2SW CLs for the four northern areas of NAC (Labrador, Newfoundland, Québec, and Gulf), to achieve a 25% increase in returns of 2SW salmon from the average returns in the period 1992–1996 for the Scotia-Fundy region of NAC, and to achieve 2SW adult returns of 4549 fish or greater for the USA region of NAC. A framework of indicators has been developed in support of the multi-annual catch options.

Biology

Atlantic salmon (*Salmo salar*) is an anadromous species found in rivers of countries bordering the North Atlantic. In the Northeast Atlantic area their current distribution extends from northern Portugal to the Pechora River in northwestern Russia and Iceland. In the Northwest Atlantic distribution ranges from the Connecticut River in USA (41.6°N) to the Leaf River in Ungava Bay (Quebec, Canada; 58.8°N). Juveniles migrate to the ocean at ages one to eight years (dependent on latitude) and generally return after one or two years at sea. Long-distance migrations to ocean feeding grounds are known to take place, with adult salmon from both the North American and Northeast Atlantic stocks migrating to West Greenland to feed during their second summer and autumn at sea.

Environmental influence on the stock

Environmental conditions in both freshwater and marine environments have a marked effect on the status of salmon stocks. Across the North Atlantic, a range of problems in the freshwater environment play a significant role in explaining the poor status of stocks. In many cases river damming and habitat deterioration have had a devastating effect on freshwater environmental conditions. In the marine environment, return rates of adult salmon have declined through the 1980s and are now at the lowest levels in the time-series for some stocks, even after closure of marine fisheries. Climatic factors modifying ecosystem conditions and the impact of predators of salmon at sea are considered to be the main factors contributing to lower productivity, which is expressed almost entirely in terms of lower marine survival.

Effects of the fisheries on the ecosystem

The current salmon fishery uses nearshore surface gillnets. There is no information on bycatch of other species with this gear. The fisheries probably have no influence, or only a minor influence, on the marine ecosystem.

Quality considerations

Uncertainties in input variables to the stock status and stock forecast models are incorporated in the assessment. Catch reporting at Greenland is considered to be incomplete.

Scientific basis

ICES stock data category	1 (ICES, 2016).
Assessment type	Run–reconstruction models and Bayesian forecasts, taking into account uncertainties in the data.
Input data	Nominal catches (by sea-age class and continent of origin) for internal use fisheries. Estimates of unreported/illegal catches. Estimates of exploitation rates. Natural mortalities (from earlier assessments).
Discards and bycatch	No salmon discards in the directed salmon fishery.
Indicators	A framework of indicators (FWI) is used to indicate whether a significant change has occurred in the status of stocks in intermediate years where multi-annual management advice applies.
Other information	Advice subject to annual review. Stock annex completed in 2014 and updated in 2017.
Working group	Working Group on North Atlantic Salmon (WGNAS) (ICES, 2018b).