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Section contents

5 Saithe in subareas 1 and 2 (Northeast Arctic)

Pollachius virens – pok.27.1-2

5.1 The fishery (Table 5.1 and Table 5.2, Figure 5.1)

Currently, the main fleets targeting saithe include trawl, purse-seine, gillnet, handline, and Danish seine. Landings of saithe were highest in 1970–1976 with an average of 239 000 t and a maximum of 265 000 t in 1970. This period was followed by a sharp decline to a level of about 160 000 t in the years 1978–1984, while in 1985 to 1991 the landings ranged from 67 000-123 000 t. After 1991 landings increased, ranging between 136 000 t (in 2000) and 212 000 t (in 2006), followed by a decline to 132 000 t in 2015. In 2019 landings were 163 180 t and 169 405 t in 2020.

Discarding, although illegal, occurs in the saithe fishery, but is not considered a major problem in the assessment. Due to its nearshore distribution saithe is virtually inaccessible for commercial gears during the first couple of years of life and there are no reports indicating overall high discard rates in the Norwegian fisheries. There are reported incidents of slipping in the purse-seine fishery, mainly related to minimum landing size. Observations from non-Norwegian commercial trawlers indicate that discarding may occur when vessels targeting other species catch saithe, for which they may not have a quota or have filled it. However, there are no quantitative estimates of the level of discarding available.

5.1.1 ICES advice applicable to 2020 and 2021

The advice from ICES for 2020 was as follows:

ICES advised that catches in 2020 should be no more than 171 982 t.

The advice from ICES for 2021 was as follows:

ICES advised that catches in 2021 should be no more than 197 779 t.

5.1.2 Management applicable in 2020 and 2021

Management of Saithe in subareas 1 and 2 is by TAC and technical measures. For 2020, The Norwegian Ministry of Trade, Industry and Fisheries set the TAC according to the advice from ICES, i.e. 171 982 t.

For 2021, The Norwegian Ministry of Trade, Industry and Fisheries set the TAC according to the advice from ICES, i.e. 197 779 t.

5.1.3 The fishery in 2020 and expected landings in 2021

Provisional figures show that the landings in 2020 were approximately 169 892 t, approximately 2 090 t lower than the TAC of 171 982t.

Since the WG does not have any prognosis of total landings in 2021 available, the TAC of 197 779 t is used in the projections. Here it should be mentioned that the Norwegian quota for 2021 was adjusted, based on quota flexibility, down from 182 404 t to 172 438 t, which means that the total quota of 197 779 t may not be caught in 2021.

5.2 Commercial catch-effort data and research vessel surveys

5.2.1 Catch-per-unit-effort

The NEA saithe IBP (ICES CM 2014/ACOM: 53) recommended leaving out the cpue time-series in the model tuning (see section 5.3.5). A detailed description of the Norwegian trawl cpue and its previous use is given in the stock annex.

5.2.2 Survey results (Figure 5.2-5.3)

An *ad hoc* subgroup of the AFWG was held to review proposed changes to several survey series using the new "StoX" survey computation methodology on 16 and 17 April 2017 at the JRC, Italy. The survey series reviewed included the coastal survey for saithe for the period 2003 to 2017. StoX is a new program developed at IMR Norway, to produce a more robust, transparent, and automated method of computing survey series. The method is currently used in ICES assessments (for example for NSS herring). For the saithe survey series, a WD was presented to the group (Mehl *et al*., 2018a), examining the differences between the previous survey series and those resulting from StoX in survey indices by age, as well as mean weight and mean length. During the meeting consistency plots were produced for each survey and showed to have a better fit with the StoX series compared to the old series. The meeting concluded that the new StoX survey series should be used to replace the previous survey series in AFWG stock assessment, but that once the assessment model is run the residuals and fits to the data should be examined to check for unexpected detrimental affects on model performance. The resulting SAM model fits using the old and the StoX survey series (using data for both survey series up to 2016, but excluding the 2003 StoX estimate, as this was considered abnormally high) were practically the same, without any detrimental affects on model performance.

The echo abundance observed in 2020 (Staby *et al*., 2021) increased by < 1% compared to 2019 and was about 92.5% of the average for 2003–2019. The abundance estimated using StoX increased by 1% compared to 2019. This slight increase is the result of higher estimates of 4-, 5-, and 7-year old saithe (2016, 2015 and 2013 year classes respectively), which were 80%, 19% and 84% higher than in 2019, while estimates for 3-, 6-, 8- and 9-year old saithe were below 2019 estimates. The proportion of saithe in the southern part of the survey area (south of the Lofoten islands between 62^0-67^0N) increased from about 20% in 1997 to above 60% in 2008, decreased in later years and was similar to 2019 at 21% in 2020.

5.2.3 Recruitment indices

Owing to the nearshore distribution of juvenile saithe, obtaining early estimates of recruitment for ages 0–2 has not been possible so far. The survey recruitment indices are strongly dependent on the extent to which 2–4 year old saithe have migrated from the coastal areas and become available to the acoustic saithe survey on the banks, and this varies between years. Also, observations from an observer programme, established in 2000 to start a 0-group index series (Borge and Mehl, WD 21 2002) did not seem to reflect the dynamics in year-class strength very well. (Mehl, WD 6 2007; Mehl, WD 7 to WKROUND 2010). The programme was consequently terminated in 2010.

5.3 Data used in the assessment

5.3.1 Catch numbers-at-age (Table 5.3)

Total Norwegian landings by gear and landings data for all other countries from 2020 were updated based on the official total catch (preliminary) reported to ICES or to Norwegian authorities.

Age composition data for 2020 were available for Norwegian and German landings. An age–length key estimated for Norwegian trawl catches for area 1 and 2.b combined, and 2.a was applied to Russian length data from those subareas respectively. The age length key was based on 500 iterations done in ECA. Landings from other countries were assumed to have the same age composition as the combined Norwegian trawl catches. The biological sampling of all gear groups, areas, and quarters was sufficient to produce a reliable catch-at-age matrix for 2020. As in previous years age data from the Danish seine and bottom-trawl fishery were combined to increase the number of samples by area and quarter, thereby improving the estimate of catch-at-age numbers.

Catch-at-age estimates (numbers and mean weight and length-at-age) were produced with StoX-Reca for the 2020 assessment[1]. Comparative runs with ECA showed that estimates for 2020 and previous years were very similar. This is the first year that catch-at-age estimates are produced with StoX-Reca for input in the SAM assessment. In previous years catch-at-age was estimated manually, and until 2020 with ECA.

5.3.2 Weight-at-age (Table 5.4)

Constant weights-at-age values for age groups 3–11 are used for the period 1960–1979, whereas estimated values for the 12+ group vary during this period. For subsequent years, annual estimates of weight-at-age in the catches are used. Weight-at-age in the stock is assumed to be the same as weight-at-age in the catch. Compared to 2019, estimated weight-at-age for age groups 3–12+ differed only slightly in 2020, with the most notable difference the estimated weight for age group 12+, which showed a visible increase in mean weight.

5.3.3 Natural mortality

A fixed natural mortality of 0.2 for all age groups was used both in the assessment and the forecast.

5.3.4 Maturity-at-age (Table 5.5)

A 3-year running average is used for the period from 1985 and onwards (2-year average for the first and last year). Inconsistencies between proportion mature fish and trends in SSB and recruitment since 2008 resulted in the NEA saithe IBP to recommend the use of a constant maturity ogive for the years from 2007 and onwards based on the average 2005–2007 (ICES CM 2014/ACOM: 53). Analysis are currently being done to investigate which method, i.e. macroscopic determination, otolith spawning rings or histological analysis, is the most reliable to determine the maturity stage.

[1] https://github.com/StoXProject/RstoxFDA/

5.3.5 Tuning data (Table 5.6)

Until the 2005 WG, the XSA tuning was based on three dataseries: cpue from Norwegian purse-seine and Norwegian trawl and indices from a Norwegian acoustic survey. The 2005 WG found rather large and variable log q residuals and large S.E. log q for the purse-seine fleet, as well as strong year effects, and in the combined tuning the fleet got low scaled weights. The WG decided not to include the purse-seine tuning fleet in the analysis. This was confirmed by new analyses at the 2010 benchmark assessment (ICES CM 2010/ACOM:36). The trawl cpue series on the other hand did not show the trends in stock size abundance of NEA saithe in later years. In the more recent years there were signs of changes in fishing strategy, with fewer and shorter fishing periods and a smaller proportion of directed saithe fishery (Mehl and Fotland, WD 20 2013).

Analyses of the two remaining tuning series done at the 2010 benchmark assessment indicated that there had been a shift in catchability around year 2002. The survey was redesigned in 2003, and the fishery to a larger degree targeted older ages. Permanent breaks were made in both tuning series in 2002. The acoustic survey, compared with the trawl cpue time-series, seemed to track the stock changes better, both in abundance and distribution.

The sensitivity runs presented to the IBP (Fotland WD 30 2014 IBP NEA saithe) clearly showed that the residual pattern got worse (strong year effects) when using both tuning series in SAM. It became obvious that SAM tries to fit something in between both contradicting data sources. Therefore, it had to be decided whether one data source was more reliable or whether both data sources should be considered leading to a fit in between both extremes. Given that cpue series should not be used when larger changes in fishing patterns occur (selectivity, spatial distribution of the fleet, change between targeted and bycatch fishery) it was recommended to leave out the cpue time-series in its current form for now (ICES CM 2014/ACOM: 53). Another reason was that the proportion of catches covered by the index had decreased steadily between 2002 and 2011, further questioning the representativeness of the cpue index. However, it may be worth trying alternative cpue indices (e.g. one index for the targeted fishery only and one index for the fishery with saithe bycatches) until the next benchmark.
The following two tuning fleets are thus used in the present assessment (by the time this report was written the new ICES name for this survey was not available)

- NOcoast-Aco-4Q: Indices from the Norwegian acoustic survey 1994–2001, age groups 3 to 7.
- NOcoast-Aco-4Q: Indices from the Norwegian acoustic survey 2002–2020, age groups 3 to 7.

5.4 SAM runs and settings (Table 5.7)

In connection with the NEA saithe IBP a number of exploratory SAM runs were performed. Model settings and results are presented in working documents included in the IBP report (ICES CM 2014/ACOM: 53).

SAM model settings and configuration in 2021 were the same as in previous simulations.

- Tuning data: Acoustic survey series (age 3–7) only, time-series split (1994–2001 and 2002–present);
- Maturity data: Ogives for the years 2007 and later based on the average of the 2005–2007 data;
- Flat exploitation pattern for age groups 8+;
- Correlated Fs between age groups and time;
- Beverton–Holt stock–recruitment relationship used to estimate recent recruitment.

5.5 Final assessment run (Table 5.8 to Table 5.11, Figure 5.4 to Figure 5.7)

The state–space assessment model (SAM) was used for the final run. SAM catchabilities and negative log likelihood values are given in Table 5.8. The predictive power (AIC) of the model was estimated to 1154. 81, compared to 1128.45 for the 2018 run.

Figure 5.4 presents normalized residuals for the total catches and the two parts of the acoustic tuning series. There are both year- and age effects and the second part of the series seems to perform better than the first part. Figure 5.5 shows plots of the stock numbers from the SAM vs. tuning indices, a circle indicates last year's result.

5.5.1 SAM F, N, and SSB results (Tables 5.9-5.11, Figures 5.6-5.7)

The estimated fishing mortality ($F_{4–7}$) in 2019 was 0.225 (AFWG 2020), which is similar to 0.226 from this year's assessment and below the F_{pa} of 0.35. The fishing mortality ($F_{4–7}$) in 2020 was estimated at 0.219. From 1997 to 2009 fishing mortality was below F_{pa}, but started to increase in 2005 and was above F_{pa} in 2010–2012.

Fishing mortality and stock size have in the last decade generally been considerably over- and underestimated respectively. Due to the changes made to the assessment following the benchmark assessment workshop in 2010 (ICES CM 2010/ACOM: 36) and later the NEA saithe IBP in 2014 (ICES CM 2014/ACOM: 53), the retrospective patterns have improved considerably, as is illustrated in Figure 5.7. Based on the 2020 assessment the SSB has in recent years been slightly overestimated and F_{4-7} underestimated.

The SAM-estimate of the 2014 year class was considered to be reliable enough to be used in the projections. In previous assessments the value of the 3-year olds in the last data year has been set to the long-term geometrical mean, and the value of the year class at age 4 were obtained by applying Pope's approximation. Since 2007 the 2007, 2010, 2013, and 2016 have been above the longterm geometric mean, while in the other years, year-class strength has been considered average or below.

The total biomass (ages 3+) was above the long-term (1960–2019) average from 1996 to 2010, reached a maximum in 2005, declined below the average level between 2011 and 2015, and has been above the long-term average since 2016. The SSB was above the long-term mean from 2000 to 2009, decreased below the average between 2010 to 2013, and has been above since 2014. SSB has been above B_{pa} (220 000 t) since 1996 (Figure 5.1).

5.5.2 Recruitment (Table 5.10, Figure 5.1)

Catches of age group 3 have varied considerably during the period 2004–2017 (Table 5.10). Until the 2005 WG, RCT3-runs were conducted to estimate the corresponding year classes, with 2 and 3 year olds from the acoustic survey as input together with XSA numbers. However, it was stated several times in the ACOM Technical Minutes that it would be more transparent to use the long-term geometric mean (GM) recruitment. GM values were therefore used in the 2005–2014 since the issue was not discussed at the IBP when SAM was adopted as assessment model. During the 2015 AFWG assessment, analyses were performed to investigate if the last year recruitment value from SAM could be used instead of the long-term GM (for method description refer to Stock Annex). Results from this analysis showed that the retrospective runs of SAM gave better estimates of recruitment than the geometric mean and consequently estimates of the recruiting year class (3 year olds in the last data year) from the SAM were accepted for the last year.

5.6 Reference points (Figure 5.1)

In 2010 the age span was expanded from 11+ to 15+ and important XSA parameter settings were changed (ICES CM 2010/ACOM: 36). LIM reference points were re-estimated at the 2010 WG according to the methodology outlined in ICES CM 2003/ACFM: 15, while the PA reference point estimation was based on the old procedure (ICES CM 1998/ACFM: 10). The results were not very much different from the previous analyses performed in 2005 (ICES CM 2005/ACFM: 20), and it was decided not to change the existing LIM and PA reference points. The shift from XSA to SAM resulted in only minor changes in estimated fishing mortality, spawning-stock-biomass and recruitment and no new reference points were estimated.

5.6.1 Harvest control rule

In 2007 ICES evaluated the harvest control rule for setting the annual fishing quota (TAC) for Northeast Arctic saithe. ICES concluded that the HCR was consistent with the precautionary approach for all simulated data and settings, including a rebuilding situation under the condition that the assessment uncertainty and error are not greater than those calculated from historic data. This also held true when an implementation error (difference between TAC and catch) equal to the historic level was included. The HCR was implemented the same year. It contains the following elements:

- Estimate the average TAC level for the coming 3 years based on F_{mp}. TAC for the next year will be set to this level as a starting value for the 3-year period.
- The year after, the TAC calculation for the next 3 years is repeated based on the updated information about the stock development. However, the TAC should not be changed by more than 15% compared with the previous year's TAC.
- If the spawning-stock-biomass (SSB) at the beginning of the year for which the quota is set (first year of prediction), is below B_{pa}, the procedure for establishing TAC should be based on a fishing mortality that is linearly reduced from F_{mp} at SSB = B_{pa} to 0 at SSB equal to zero. At SSB levels below B_{pa} in any of the operational years (current year and 3 years of prediction) there should be no limitations on the year-to-year variations in TAC.

In 2011 the evaluation was repeated taking into account the changes made to the assessment after the 2010 benchmark assessment (ICES CM 2010/ACOM: 36). The analyses indicate that the HCR still is in agreement with the precautionary approach (Mehl and Fotland, WD 11 2011).

The fishing mortality used in the harvest control rule (F_{mp}) was in 2007 set to F_{pa} = 0.35. In June 2013, after the ICES advice for 2014 for this stock had been given, F_{mp} was reduced to 0.32.

5.7 Predictions

5.7.1 Input data (Table 5.12)

The input data to the predictions based on results from the final model run are given in Table 5.12. The estimates for stock number-at-age in 2021 were taken from the final SAM run for ages 4+. The geometric mean (GM) for recruitment (age 3) of 160 million was used in 2021 and subsequent year classes. The natural mortality of 0.2 is the same as used in the assessment. For exploitation pattern the average of the 2018–2020 fishing mortalities for ages 3 to 12 was used, with mortalities for 8+ being constant. For weight-at-age in stock and catch the average of the last three years (2018–2020) from the final SAM run was used. For maturity-at-age the average of the 2005–2007 annual ogives was applied.

5.7.2 Catch options for 2021 (short-term predictions; Tables 5.13-14)

The management option table (Table 5.13) shows that the expected landings of 197 779 t in 2021 will result in a fishing mortality F_{bar} of 0.23 (which adjusted with the F_{Mult} will be 0.265), slightly higher compared to 2020 of 0.26, but well below the F_{pa} of 0.35. A catch in 2022 corresponding to the $F_{status\ quo}$ level (3-year average 2018–2020) of 0.23 will be 169 313 t, while a catch in 2022 corresponding to the evaluated and implemented HCR of 197 212 t will result in F of 0.28 (Table 5.13).

For a catch in 2021 corresponding to the TAC of 197 779 t, the SSB is expected to decrease from about 568 972 t at the beginning of 2021 to 541 708 t at the beginning of 2022. At $F_{status\ quo}$ in 2022 SSB is estimated to decrease to 531 508t at the beginning of 2023 and for a catch corresponding to the HCR it will decrease to about 482 900 in 2023 t.

5.7.3 Comparison of the present and last year's assessment

The current assessment estimated the total stock in 2021 to be 1% higher and the SSB at the same level, compared to the previous assessment. The F in 2019 from the current assessment is virtually the same as from the previous assessment, and the realized F in 2020 is lower compared to the predicted one in 2020 based on the TAC.

	Total stock (3+) by 1 January 2020 (tonnes)	SSB by 1 January 2020 (tonnes)	F_{4-7} in 2020	F_{4-7} in 2019
WG 2020	944 239	552 168	0.236	0.225
WG 2021	949 910	557 582	0.219	0.226

5.8 Comments to the assessment and the forecast (Fig 5.7)

A statistical model is less sensitive to +group setting than XSA. In addition, the results from XSA were more dependent on the input data (use or no use of cpue, split of the tuning survey time-series), the shrinkage parameter and whether the number of iterations is capped or not. XSA only converged at a large number of iterations. In contrast, results from SAM are much more robust and depend to a lesser degree on subjective choice of model settings (such as shrinkage). In addition, SAM as a stochastic model is not treating catches as known without error. The fishing mortality rates could be considered correlated in time, and to reflect that neighbouring age groups have more similar fishing mortalities.

The retrospective pattern has been a major concern in the assessment, but due to the changes done at the benchmark assessment in 2010 (ICES CM 2010/ACOM: 36) and later at the NEA saithe IBP in 2014 (ICES CM 2014/ACOM: 53), the assessment has become stable (Figure 5.7)

The biological sampling from the fishery got critically low after the termination of the original Norwegian port-sampling program in 2009. In 2015 this was in particular the case for samples from trawl in quarter two and three in ICES area 1 and age samples from purse-seine fishery south of Lofoten (ICES area 2.a). In 2020 biological sampling from the saithe purse-seine fishery catches in Norwegian waters was adequate.

Lack of reliable recruitment estimates is a major problem. Prediction of catches will still, to a large extent, be dependent on assumptions of average recruitment in the intermediate year and the forecast period, since fish from age four to seven constitute major parts of the catches. Since the saithe HCR is a three-year-rule, the estimation of average F_{mp} catch in the HCR will affect stock numbers up to age five, and thereby affect the total prognosis of the fishable stock and the quotas derived from it. The recruitment-at-age 3 estimated by the SAM has on average been at about the long-term geometric mean level since 2005.

5.9 Tables and figures

Table 5.1. Saithe in subareas 1 and 2 (Northeast Arctic). Nominal catch (t) by countries as officially reported to ICES.

Year	Faroe Islands	France	Germany (Dem Rep)	Germany (Fed Rep)	Iceland	Norway	Poland	Portugal	Russia[3]	Spain	UK	Others[5]	Total all countries
1960	23	1700		25 948		96 050					9780	14	**133 515**
1961	61	3625		19 757		77 875					4615	18	**105 951**
1962	2	544		12 651		101 895			912		4699	4	**120 707**
1963		1110		8108		135 297					4112		**148 627**
1964		1525		4420		184 700			84		6511	186	**197 426**
1965		1618		11 387		165 531			137		6746	181	**185 600**
1966		2987	813	11 269		175 037			563		13 078	41	**203 788**
1967		9472	304	11 822		150 860			441		8379	48	**181 326**
1968			1248	4753		96 641					8782		**111 424**
1969	20	193	6744	4355		115 140					13 585	23	**140 060**
1970	1097		29 200	23 466		151 759			43 550		15 690		**264 924**
1971	215	14 536	16 840	12 204		128 499	6017		39 397	13 097	10 467		**241 272**
1972	109	14 519	7474	24 595		143 775	1111		1278	9247	8348		**210 456**
1973	7	11320	12 015	30 338		148 789	23		2411	2115	6841		**213 859**
1974	46	7119	29 466	33 155		152 699	2521		28 931	7075	3104	5	**264 121**

Year	Faroe Islands	France	Germany (Dem Rep)	Germany (Fed Rep)	Iceland	Norway	Poland	Portugal	Russia[3]	Spain	UK	Others[5]	Total all countries
1975	28	3156	28 517	41 260		122 598	3860	6430	13 389	11 397	2763	55	**233 453**
1976	20	5609	10 266	49 056		131 675	3164	7233	9013	21 661	4724	65	**242 486**
1977	270	5658	7164	19 985		139 705	1	783	989	1327	6935		**182 817**
1978	809	4345	6484	19 190		121 069	35	203	381	121	2827		**155 464**
1979	1117	2601	2435	15 323		141 346			3	685	1170		**164 680**
1980	532	1016		12 511		128 878			43	780	794		**144 554**
1981	236	218		8431		166 139			121		395		**175 540**
1982	339	82		7224		159 643			14		732		**168 034**
1983	539	418		4933		149 556			206	33	1251		**156 936**
1984	503	431	6	4532		152 818			161		335		**158 786**
1985	490	657	11	1873		103 899			51		202		**107 183**
1986	426	308		3470		63 090			27		75		**67 396**
1987	712	576		4909		85 710			426		57	1	**92 391**
1988	441	411		4574		108 244			130		442		**114 242**
1989	388	460[2]		606		119 625			506	506	726		**122 817**
1990	1207	340[2]		1143		92 397			52		709		**95 848**
1991	963	77[2]	Greenland	2003		103 283			504 [4]		492	5	**107 327**
1992	165	1980	734	3451		119 763			964	6	541		**127 604**

Year	Faroe Islands	France	Germany (Dem Rep)	Germany (Fed Rep)	Iceland	Norway	Poland	Portugal	Russia[3]	Spain	UK	Others[5]	Total all countries
1993	31	566	78	3687	3	140 604		1	9509	4 [2]	415	5	**154 903**
1994	67 [2]	557	15	1863	4 [2]	141 589		1 [2]	1640 [2]	655 [2]	557	2	**146 950**
1995	172 [2]	358	53	935		165 001		5	1148		688	18	**168 378**
1996	248 [2]	346	165	2615		166 045		24	1159	6	707	33	**171 348**
1997	193[2]	560	363[2]	2915		136 927		12	1774	41	799	45	**143 629**
1998	366	932	437[2]	2936		144 103		47	3836	275	355	40	**153 327**
1999	181	638 [2]	655[2]	2473	146	141 941		17	3929	24	339	32	**150 375**
2000	224[2]	1438	651[2]	2573	33	125 932		46	4452	117	454	8 [2]	**135 928**
2001	537	1279	701[2]	2690	57	124 928		75	4951	119	514	2	**135 853**
2002	788	1048	1393	2642	78	142 941		118	5402	37	420	3	**154 870**
2003	2056	1022	929[2]	2763	80 [2]	150 400		147	3894	18	265	18 [2]	**161 592**
2004	3071	255	891[2]	2161	319	147 975		127	9192	87	544	14	**164 636**
2005	3152	447	817[2]	2048	395	162 338		354	8362	25	630		**178 568**
2006	1795	899.7	779[2]	2780	255	195 462	88.9	101	9823	0	532	42	**212 557**
2007	2048	965.6	801[2]	3019	219	178 644	99.3	412	12 168	22	557	11.8	**198 967**
2008	2405	1008.6	513[2]	2264	113	165 998	65.8	348	11 577	33	506	9.7	**184 840**
2009	1611	378.6	697	2021	69	144 570	30.6	184.01	11 899	2	379	24	**161 865**
2010	1632	677.2	954	1592	124	175 246	278.9	93	14 664	8	283	2.5	**195 554**

Year	Faroe Islands	France	Germany (Dem Rep)	Germany (Fed Rep)	Iceland	Norway	Poland	Portugal	Russia[3]	Spain	UK	Others[5]	Total all countries
2011	306	504.2	445	1371	66	143 314	0	45.34	10 007	2	972	15.14	**157 048**
2012	146	780.55	658	1371	126	143 174	0	7.65	13 607	4	1087	0	**160 960**
2013	80	1900.92	972	1212	245	111 961	2.21	17.24	14 796	5	415	21.93	**131 629**
2014	273	1674	407	259	659	115 864	0.86	8.25	12 396	12	518	0	**132 070**
2015	766	515	393	424	248	115 157	1143	10.42	13 181	34	403	0	**132 275**
2016	1148	526	613	952	702	121 705	530	52	15 203	26	301	10	**141 768**
2017 [1]	639	680	407	865	589	126 947	504	86	14 551	88	439	24	**145 819**
2018	626	937	448	1642		162 460	404	51	14 171	60	464	17	**181 280**
2019	618	1472	424	1371		144 076	46	131	13 990	199	419	434	**163 180**
2020		530	410	1544		151697	1.2	132	14082	0	517	118	**169 405**

[1] **Provisional figures.**

[2] **As reported to Norwegian authorities.**

[3] **USSR prior to 1991.**

[4] **Includes Estonia.**

[5] **Includes Denmark. Netherlands. Ireland. and Sweden.**

[6] **As reported by Working Group member**

Table 5.2 Saithe in subareas 1 and 2 (Northeast Arctic). Catch (´000) by fishing gear.

Year	Purse-seine	Trawl	Gillnet	Others	Total
1977	75.2	69.5	19.3	12.7	176.7
1978	62.9	57.6	21.1	13.9	155.5
1979	74.7	52.5	21.6	15.9	164.7
1980	61.3	46.8	21.1	15.4	144.6
1981	64.3	72.4	24.0	14.8	175.5
1982	76.4	59.4	16.7	15.5	168.0
1983	54.1	68.2	19.6	15.0	156.9
1984	36.4	85.6	23.7	13.1	158.8
1985	31.1	49.9	14.6	11.6	107.2
1986	7.9	36.2	12.3	8.2	64.6
1987	34.9	27.7	19.0	10.8	92.4
1988	43.5	45.4	15.3	10.0	114.2
1989	49.5	45.0	16.9	11.4	122.8
1990	24.6	44.0	19.3	7.9	95.8
1991	38.9	40.1	18.9	9.4	107.3
1992	27.1	67.0	22.3	11.2	127.6
1993	33.1	84.9	21.2	15.7	154.9
1994	30.2	82.2	21.1	13.5	147.0
1995	21.8	103.5	26.9	16.1	168.4
1996	46.9	72.5	31.6	20.3	171.3
1997	44.4	55.9	24.4	19.0	143.6
1998	44.4	57.7	27.6	23.6	153.3
1999	39.2	57.9	29.7	23.6	150.4
2000	28.3	54.5	29.6	23.5	135.9
2001	28.1	58.1	28.2	21.5	135.9
2002	27.4	75.5	30.4	21.5	154.8
2003	43.3	73.8	25.2	19.3	161.6
2004	41.8	74.6	26.9	21.3	164.6

Year	Purse-seine	Trawl	Gillnet	Others	Total
2005	42.1	91.8	25.6	19.1	178.6
2006	73.5	87.1	29.7	22.5	212.8
2007	41.8	100.7	33.3	23.2	199.0
2008	39.4	91.2	37.0	17.1	184.7
2009	35.5	81.1	33.2	12.1	161.9
2010	54.9	89.8	36.9	13.2	194.8
2011	45.3	67.1	32.1	12.2	156.7
2012	44.2	73.9	28.3	14.5	160.9
2013	34.7	65.2	19.2	12.7	131.8
2014	29.3	54.8	26.7	21.2	132.0
2015	30.4	55.4	23.5	22.5	131.8
2016	28.9	64.1	21.4	26.9	141.3
2017[1]	32.4	65.0	21.4	27.3	146.1
2018	36.0	83.6	28.8	33.2	181.5
2019	28.7	68.6	29.4	36.6	163.1
2020	26.8	74	30.3	38.3	169.4

[1] **Provisional figures.**

[2] **Unresolved discrepancies between Norwegian catch by gear figures and the total reported to ICES for these years.**

[3] **Includes 4300 tonnes not categorized by gear. proportionally adjusted.**

[4] **Reduced by 1200 tonnes not categorized by gear. proportionally adjusted.**

Table 5.3 Catch numbers-at-age ('000) of northeast Arctic saithe.

	Age groups									
Year	3	4	5	6	7	8	9	10	11	12+
1960	13517	16828	17422	6514	6281	3088	1691	956	481	1481
1961	25237	12929	17707	5379	1886	1371	736	573	538	1202
1962	45932	13720	5449	10218	2991	1262	1156	556	611	1518
1963	51171	35199	7165	5659	4699	1337	1308	848	550	1612
1964	10925	72344	15966	3299	4214	3223	1518	1482	1282	3038
1965	42578	5737	30171	11635	3282	2421	3135	802	1136	2986
1966	25127	61199	14727	14475	5220	1542	1047	1083	530	2724

	Age groups									
Year	3	4	5	6	7	8	9	10	11	12+
1967	28457	23826	34493	3957	5388	2797	1356	1340	814	2536
1968	29955	21856	6065	9846	936	2274	1070	686	465	922
1969	76011	11745	16650	4666	4716	1107	1682	663	199	303
1970	43834	63270	14081	16298	5157	8004	2521	3722	1103	1714
1971	61743	47522	21614	7661	7690	2326	3489	1760	2514	1888
1972	55351	44490	24752	8650	4769	3012	1584	1817	1044	1631
1973	62938	20793	22199	13224	5868	3246	2368	2153	1291	1947
1974	36884	44149	15714	20476	12182	4815	3267	2512	1440	2392
1975	70255	13502	18901	5123	9018	7841	3365	2714	2237	2544
1976	135592	33159	8618	9448	3725	3483	2905	1870	1183	1940
1977	105935	36703	10845	2205	4633	1557	1718	1030	495	718
1978	56505	31946	14396	5232	1694	2132	1082	1126	756	1726
1979	75819	28545	17280	5384	3550	1178	1659	536	373	1086
1980	40303	36202	9100	6302	3161	1322	145	721	406	1204
1981	85966	22345	22044	3706	2611	2056	378	286	258	385
1982	35853	67150	13481	8477	1088	1291	476	271	124	338
1983	18216	25108	34543	3408	3178	1243	803	261	215	587
1984	43579	34927	12679	11775	1193	1862	589	585	407	537
1985	48989	11992	7200	5287	3746	776	879	134	274	427
1986	21322	12433	5845	4363	2704	1349	338	438	123	152
1987	18555	51742	4506	3238	3624	784	644	267	263	565
1988	8144	35928	32901	4570	2333	1222	968	321	73	30
1989	12607	19400	33343	18578	1762	352	177	189	1	205
1990	23792	16930	9054	10238	7341	1076	160	112	150	118
1991	68682	13630	5752	4883	3877	2381	383	61	90	89
1992	44627	33294	5987	5412	4751	3176	1462	286	93	350
1993	22812	61931	31102	3747	1759	1378	1027	797	76	71
1994	7063	32671	49410	19058	2058	724	421	278	528	129

	Age groups									
Year	3	4	5	6	7	8	9	10	11	12+
1995	17178	52109	40145	30451	4177	483	125	259	31	263
1996	10510	54886	18499	18357	17834	2849	485	214	148	325
1997	11789	11698	35011	13567	13452	7058	812	55	48	98
1998	3091	16215	11946	31818	8376	5539	2873	727	111	282
1999	9655	12236	22872	10347	18930	3374	3343	2290	419	170
2000	9175	22768	7747	10676	6123	8303	2530	2652	1022	197
2001	3816	7946	26960	8769	7120	3146	4687	1935	1406	528
2002	6582	17492	11573	25671	5312	4276	2382	3431	965	1420
2003	2345	50653	13600	7123	9594	5494	3545	2519	2327	1813
2004	1002	6129	33840	10613	7494	8307	2792	3088	2377	3072
2005	26093	12543	9841	23141	10799	5659	7852	2674	713	1588
2006	1590	68137	12328	10098	16757	8080	5671	5127	1815	2529
2007	3144	4115	39889	15301	7963	11302	7749	4138	2157	849
2008	25259	18953	5969	24363	9712	5624	7697	4705	1606	1572
2009	9050	34311	9954	6628	15930	4766	3021	4224	2471	1426
2010	26382	43436	28514	7988	3129	12444	2749	1314	1212	1431
2011	6239	45213	13307	15157	6622	2901	5934	1730	647	1115
2012	30742	17841	33911	10496	7058	3522	1570	2586	557	890
2013	17151	15491	15946	21980	5512	3298	1149	729	885	653
2014	7650	24769	13822	9343	12331	3284	2130	904	378	763
2015	13185	15459	30159	9271	7324	7133	1697	723	433	620
2016	8278	20955	13044	15532	6621	4774	4363	1053	718	1382
2017	5421	34736	12901	7324	9032	3885	2562	1924	376	1999
2018	5260	19260	41425	12618	5903	5667	2843	1956	1112	1567
2019	12421	15078	15388	25177	8327	3243	2848	1357	619	1171
2020	6216	27602	13466	14054	17767	5031	2034	1469	564	1236

Table 5.4 Catch weight-at-age (kg) northeast Arctic saithe.

	Age groups									
Year	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12+**
1960	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	8.55
1961	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	8.75
1962	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	8.52
1963	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	8.33
1964	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	8.35
1965	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	8.54
1966	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	8.43
1967	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	8.49
1968	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	8.36
1969	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	8.16
1970	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	8.03
1971	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	7.87
1972	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	8.14
1973	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	8.01
1974	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	7.69
1975	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	7.73
1976	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	7.86
1977	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	8.05
1978	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	8.00
1979	0.71	1.11	1.63	2.33	3.16	4.03	4.87	5.63	6.44	8.28
1980	0.79	1.27	2.03	2.55	3.29	4.34	5.15	5.75	6.11	7.22
1981	0.73	1.40	2.05	2.76	3.30	4.38	5.95	6.39	6.61	7.00
1982	0.77	1.12	2.02	2.61	3.27	3.91	4.69	5.63	7.18	7.69
1983	1.05	1.33	1.86	2.80	4.00	4.18	5.33	5.68	7.31	9.16
1984	0.71	1.26	2.02	2.70	3.88	4.47	5.36	6.06	6.28	7.88
1985	0.75	1.33	2.07	2.63	3.28	3.96	4.54	5.55	6.88	8.74
1986	0.59	1.22	1.97	2.30	2.87	3.72	4.30	4.69	5.84	7.21
1987	0.53	0.84	1.66	2.32	2.97	4.00	4.72	5.44	5.79	7.42

	Age groups									
Year	3	4	5	6	7	8	9	10	11	12+
1988	0.62	0.87	1.31	2.43	3.87	5.38	5.83	5.36	6.92	8.82
1989	0.74	0.95	1.40	1.78	2.96	3.73	4.62	4.66	8.34	7.69
1990	0.71	1.00	1.45	2.09	2.49	3.75	3.90	6.74	4.94	7.34
1991	0.68	1.05	1.85	2.39	3.08	3.35	4.48	4.66	5.62	7.31
1992	0.67	1.01	1.92	2.28	2.77	3.20	3.73	6.35	6.90	7.83
1993	0.61	0.99	1.65	2.46	2.85	3.03	3.71	4.49	5.56	7.13
1994	0.52	0.76	1.24	2.12	3.22	3.83	4.69	5.31	5.66	7.29
1995	0.56	0.79	1.19	1.71	2.87	3.78	4.06	5.30	6.86	7.65
1996	0.59	0.82	1.33	1.84	2.48	3.73	4.32	5.34	5.98	7.58
1997	0.62	0.95	1.24	1.72	2.35	3.10	4.19	5.79	6.77	7.75
1998	0.68	1.00	1.48	1.87	2.58	3.07	4.13	5.44	6.70	8.59
1999	0.67	1.05	1.45	1.93	2.27	2.97	3.61	4.10	4.93	6.97
2000	0.60	1.03	1.63	2.10	2.67	3.14	3.81	4.41	5.76	8.07
2001	0.75	1.12	1.54	2.04	2.60	3.14	3.63	4.54	5.05	6.17
2002	0.69	1.01	1.50	1.97	2.54	3.25	3.77	4.31	4.91	6.11
2003	0.66	0.91	1.42	1.89	2.54	2.58	3.49	3.75	4.12	5.90
2004	0.70	1.03	1.37	1.90	2.41	2.98	3.44	3.73	4.14	5.47
2005	0.59	0.89	1.49	2.09	2.16	2.99	3.24	3.82	3.92	6.19
2006	0.63	0.83	1.43	1.78	2.27	2.73	3.02	3.90	4.06	5.82
2007	0.73	1.08	1.41	1.86	2.43	2.94	3.35	3.66	4.17	5.54
2008	0.63	0.98	1.38	1.92	2.31	2.83	3.16	3.43	3.82	4.75
2009	0.73	1.03	1.65	2.00	2.37	2.69	3.23	3.38	3.46	4.67
2010	0.70	0.99	1.45	2.14	2.50	3.13	3.34	3.81	3.99	5.17
2011	0.70	0.82	1.42	2.07	2.68	3.25	3.62	3.97	4.52	5.84
2012	0.59	1.07	1.35	2.15	2.82	3.20	3.67	4.16	4.60	5.70
2013	0.57	1.01	1.50	1.83	2.74	3.33	3.91	4.61	4.50	6.13
2014	0.66	0.92	1.58	2.12	2.54	3.49	4.01	4.22	4.71	5.80
2015	0.61	0.85	1.24	1.91	2.45	3.02	3.97	4.74	4.51	6.05

	Age groups									
Year	3	4	5	6	7	8	9	10	11	12+
2016	0.84	1.04	1.46	2.02	2.36	3.12	3.53	4.14	4.65	6.03
2017	0.89	1.12	1.68	2.18	2.63	3.13	3.63	4.16	4.5	5.9
2018	0.91	1.21	1.56	2.02	2.51	3.04	3.44	3.89	4.50	5.60
2019	0.83	1.17	1.64	2.06	2.62	3.18	3.71	4.13	4.88	6.14
2020	0.74	1.06	1.57	2.01	2.53	3.13	3.75	4.36	5.05	6.80

Table 5.5. 3-year running average maturity ogive 1985–2006. Values for 2007–2020 average of 2005–2007.

Year	3	4	5	6	7	8	9	10	11	12+
1985	0	0.02	0.5	0.92	0.99	1	1	1	1	1
1986	0	0.02	0.51	0.94	0.99	1	1	1	1	1
1987	0	0	0.35	0.98	1	1	1	1	1	1
1988	0	0	0.25	0.96	1	1	1	1	1	1
1989	0	0	0.15	0.92	1	1	1	1	1	1
1990	0	0	0.2	0.85	0.99	1	1	1	1	1
1991	0	0.02	0.25	0.84	0.98	1	1	1	1	1
1992	0	0.02	0.3	0.83	0.93	0.92	0.9	0.95	1	1
1993	0	0.02	0.26	0.88	0.92	0.89	0.87	0.89	1	0.99
1994	0	0.02	0.26	0.84	0.9	0.82	0.87	0.89	1	0.99
1995	0	0.02	0.22	0.8	0.92	0.9	0.97	0.94	1	0.99
1996	0	0.03	0.21	0.65	0.91	0.93	1	1	1	1.00
1997	0	0.03	0.14	0.45	0.83	0.94	0.93	0.97	1	1.00
1998	0	0.04	0.07	0.33	0.74	0.93	0.92	0.96	1	1.00
1999	0	0	0.08	0.32	0.74	0.92	0.92	0.96	0.99	0.98
2000	0	0	0.08	0.46	0.82	0.96	0.98	0.99	0.97	0.95
2001	0	0	0.11	0.64	0.93	0.97	0.98	0.99	0.97	0.94
2002	0	0	0.13	0.78	0.95	0.98	0.98	0.99	0.98	0.97
2003	0	0	0.14	0.82	0.96	0.98	0.98	0.99	1	0.99
2004	0	0	0.21	0.8	0.97	0.99	0.99	1	1	0.98
2005	0	0.03	0.3	0.82	0.97	0.99	0.99	1	1	1.00

Year	3	4	5	6	7	8	9	10	11	12+
2006	0	0.04	0.4	0.86	0.98	0.99	1	1	1	1.00
2007	0	0.05	0.42	0.87	0.97	0.98	0.98	0.97	0.97	0.99
2008	0	0.05	0.42	0.87	0.97	0.98	0.98	0.97	0.97	0.99
2009	0	0.05	0.42	0.87	0.97	0.98	0.98	0.97	0.97	0.99
2010	0	0.05	0.42	0.87	0.97	0.98	0.98	0.97	0.97	0.99
2011	0	0.05	0.42	0.87	0.97	0.98	0.98	0.97	0.97	1.00
2012	0	0.05	0.42	0.87	0.97	0.98	0.98	0.97	0.97	1.00
2013	0	0.05	0.42	0.87	0.97	0.98	0.98	0.97	0.97	1.00
2014	0	0.05	0.42	0.87	0.97	0.98	0.98	0.97	0.97	1.00
2015	0	0.05	0.42	0.87	0.97	0.98	0.98	0.97	0.97	1.00
2016	0	0.05	0.42	0.87	0.97	0.98	0.98	0.97	0.97	1.00
2017	0	0.05	0.42	0.87	0.97	0.98	0.98	0.97	0.97	1.00
2018	0	0.05	0.42	0.87	0.97	0.98	0.98	0.97	0.97	1.00
2019	0	0.05	0.42	0.87	0.97	0.98	0.98	0.97	0.97	1.00
2020	0	0.05	0.42	0.87	0.97	0.98	0.98	0.97	0.97	1.00

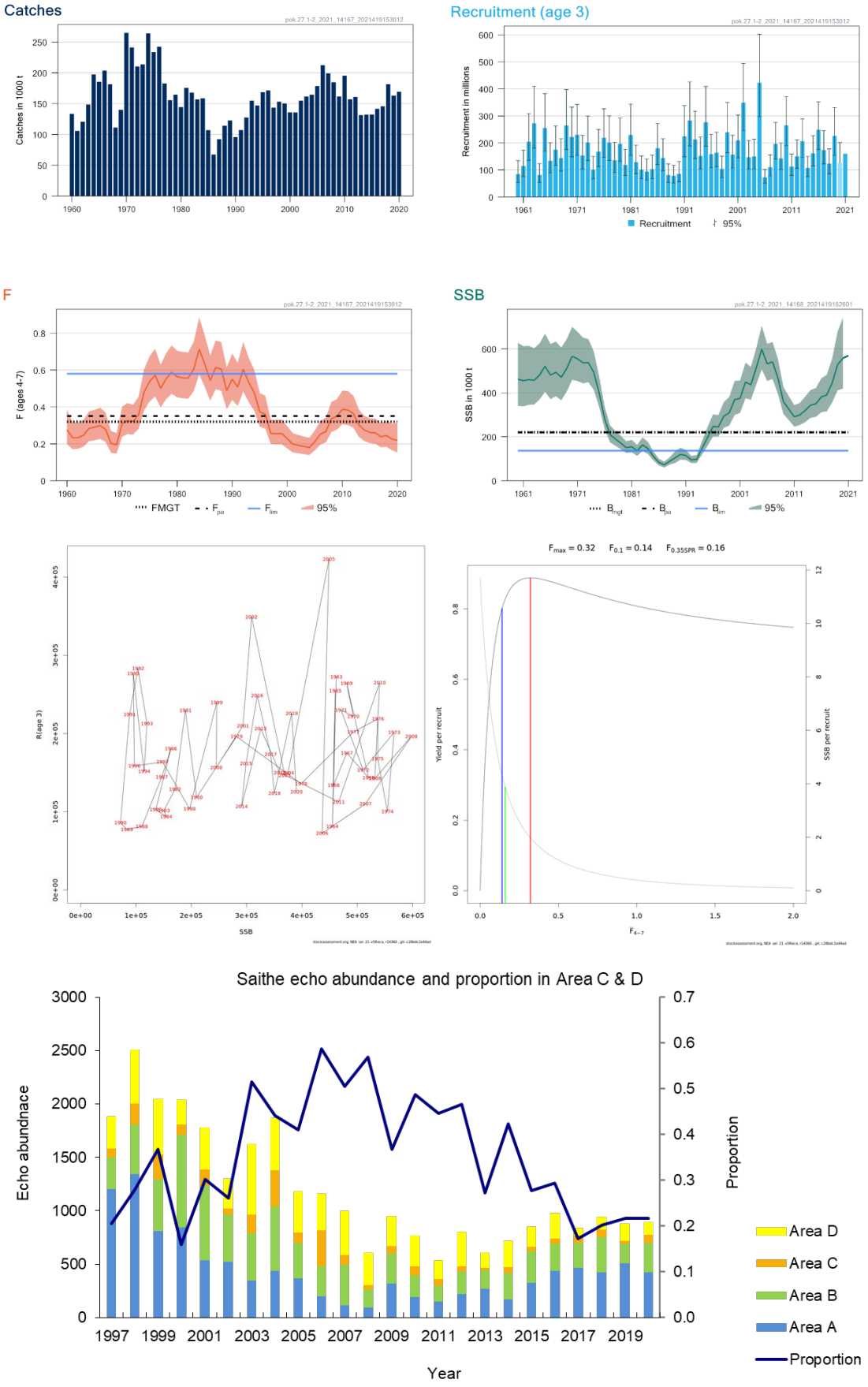

Figure 5.1. Northeast Arctic saithe. Echo abundance and proportion of saithe in the southern half of the survey area (subarea C+D).

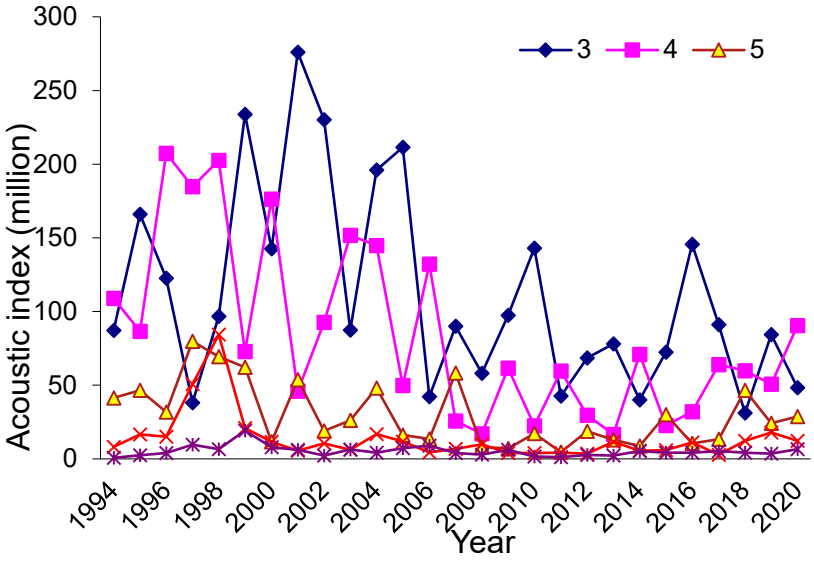

Figure 5.3. Northeast Arctic saithe. acoustic survey tuning indices by age class (3–7). break in 2002 black line.

Figure 5.4. Northeast Arctic saithe. Final run normalized residuals. Blue circles indicate positive residuals (larger than predicted) and filled red circles indicate negative residuals. The top figure shows residuals for the total catch series. the figure in the middle the residuals for the first survey series and the bottom figure the residuals for the survey series from 2002.

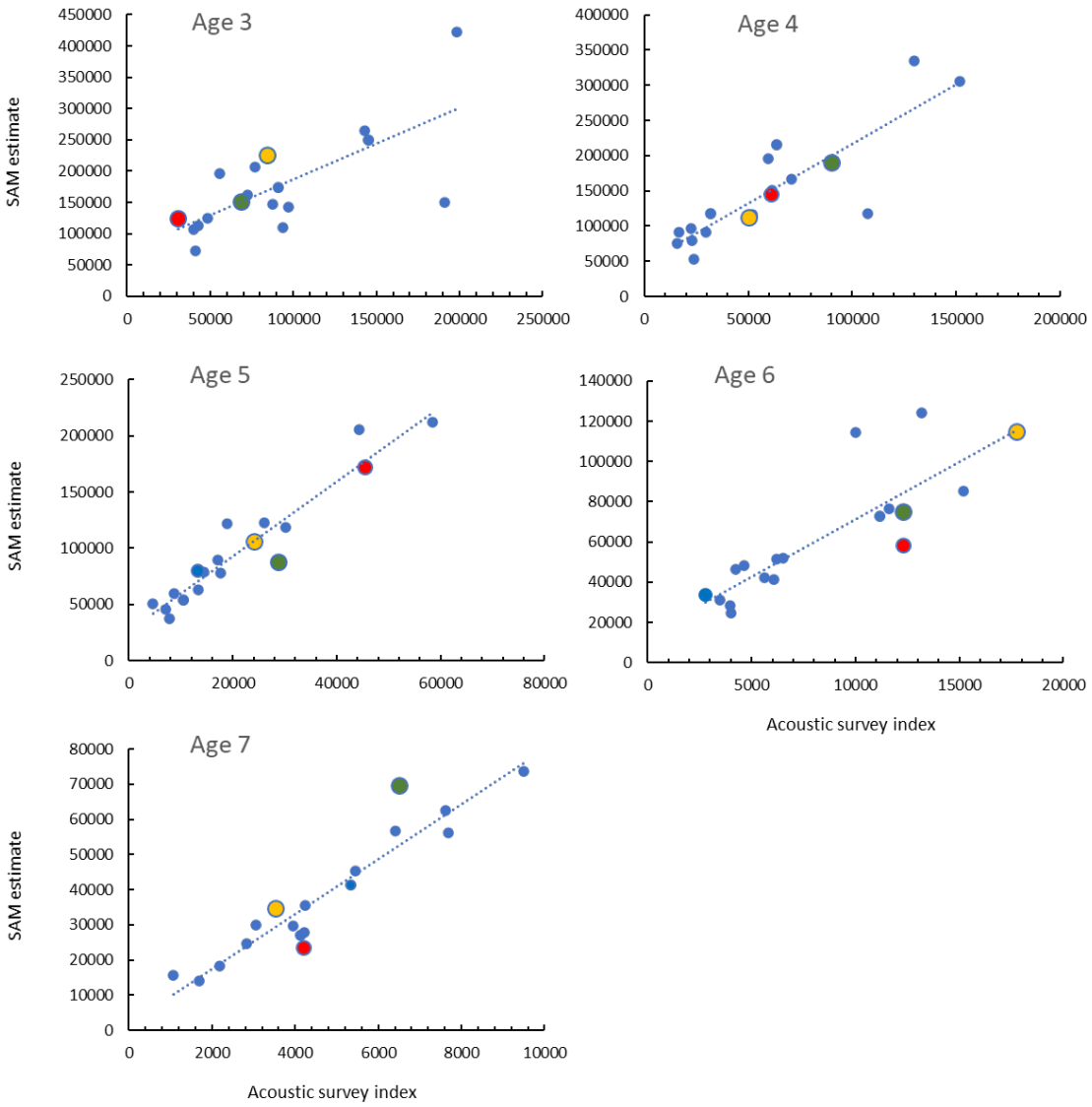

Figure 5.5. NEA saithe - Acoustic survey vs. SAM. red circles show 2018 data. orange circles 2019 data. and green circles 2020 data

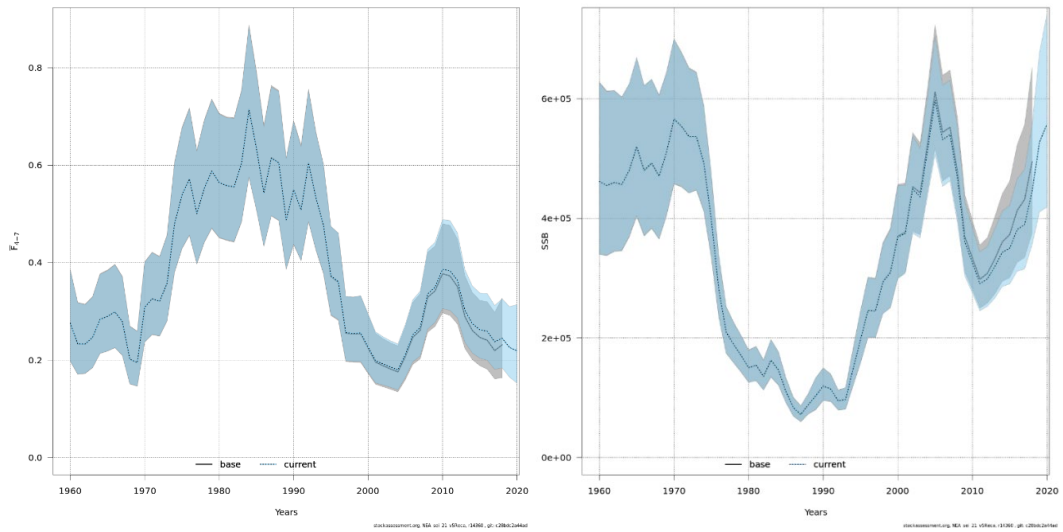

Figure 5.6. F_{4-7} and SSB. Estimates from the current run and point wise 95% confidence intervals are shown by black line and shaded area.

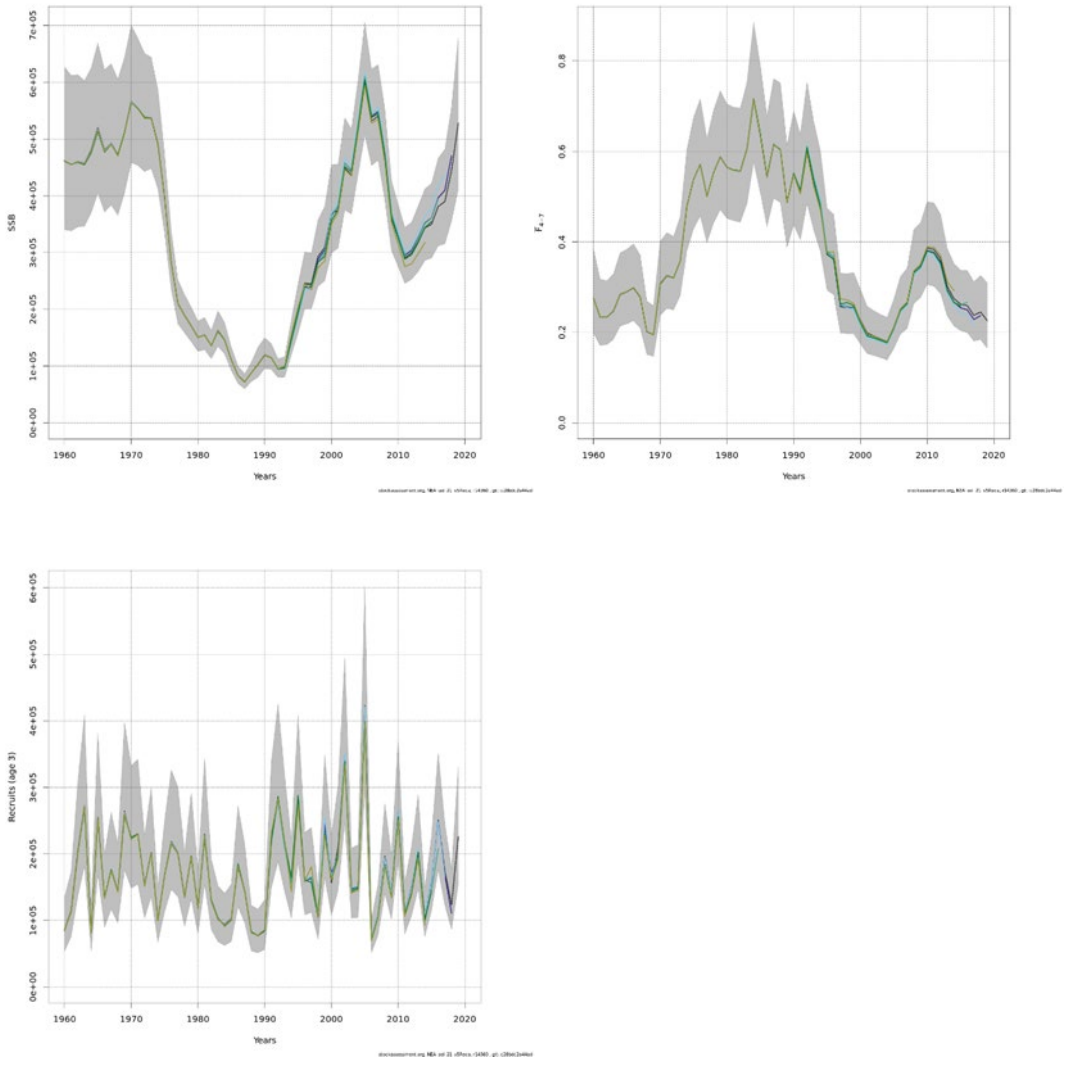

Figure 5.7. Saithe in subareas 1 and 2 (Northeast Arctic) RETROSPECTIVE SAM SSB. F4-7. and recruits.