5 Saithe in subareas 1 and 2 (Northeast Arctic)

An assessment based on the decisions of the Inter-Benchmark Protocol (IBP) on Northeast Arctic saithe from March/April 2014 (ICES CM 2014/ACOM: 53) is presented for this stock. The main decisions were to change model from XSA to the state–space assessment model SAM (Nielsen and Berg, 2014) and to leave out the CPUE time-series in its current form.

The last benchmark assessment was done at WKROUND February 2010 (ICES CM 2010/ACOM: 36).

The 2019 assessment (ICES CM 2015/ACOM: 05) showed that the SSB has been above B_{pa} since 1996, declined considerably from 2007 to 2011, then increased again and is currently (2018) estimated to be well above B_{pa}. The fishing mortality was below F_{pa} from 1997 to 2009, started to increase in 2005 and was above F_{pa} from 2010 to 2012, but is currently estimated to be below F_{pa}. The 2008, 2010, 2013 year classes are above average, while the 2007, 2009, 2011, and 2012 year classes were below average strength

ICES advised that catches in 2019 should be no more than 149 550 t, and The Norwegian Ministry of Trade, Industry and Fisheries set the final TAC at 149 550 t. ICES evaluated the management plan (harvest control rule, HCR) in 2007 and again in 2011 due to changes introduced at the 2010 benchmark and concluded that it is consistent with the precautionary approach. The HCR has not yet been evaluated for the new assessment model that the NEA saithe IBP decided to use.

More details and general information is given in (ICES CM 2010/ACOM: 36) and the Stock Annex (Quality Handbook).

5.1 The Fishery (Tables 5.1-5.2, 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 2018 landings increased to 181 282 t.

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 2018 and 2019

The advice from ICES for 2018 was as follows:

ICES advised that catches in 2018 should be no more than 172 500 t.

The advice from ICES for 2019 was as follows:

ICES advised that catches in 2018 should be no more than 149 550 t.

5.1.2 Management applicable in 2018 and 2019

Management of Saithe in subareas 1 and 2 is by TAC and technical measures. For 2018, The Norwegian Ministry of Trade, Industry and Fisheries set the TAC according to the advice from ICES, i.e. 172 500 t.

For 2019, The Norwegian Ministry of Trade, Industry and Fisheries set the TAC according to the advice from ICES, i.e. 149 550 t.

5.1.3 The fishery in 2018 and expected landings in 2019

Provisional figures show that the landings in 2018 were approximately 181 250 t, approximately 10 000 t higher than the TAC of 172 500 t.

Since the WG does not have any prognosis of total landings in 2019 available, the TAC of 149 550 t is used in the projections.

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 fitwith 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 impacts 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 impacts on model performance.

Though the echo abundance in 2019 (Staby *et al*., 2019) estimated using StoX decreased by 24% compared to 2018 (which in 2018 had decreased by 15% compared to the previous year), and was about 72% of the average for 2003–2017, the estimated biomass increased due to increased abundances of 5-, 6-, and 8-year old saithe, which were well above the average (2003–2017) for those age classes. The 4 year old saithe (2014 year class) was most abundant, followed by 5 year old fish (2013 year class), while the index for 3 year olds was well below the 2003-2017 average. The proportion of saithe in the southern part of the survey area (subareas C+D) increased from about 20% in 1997 to above 60% in 2008, decreased in later years to below 20% in 2017, and was approximately 21% in 2018.

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 in 2018 and 2018 landings data for all other countries were updated based on the official total catch (preliminary) reported to ICES or to Norwegian authorities.

Age composition data for 2018 were available for Norway and Germany. An ALK for Norwegian trawl was applied to Russian length data for subareas 2.a, and for 2.b and 1 combined. Landings from other countries were assumed to have the same age composition as the combined Norwegian trawl catches. The biological sampling of some vessel groups, periods and areas may have become critically low after the termination of the Norwegian port-sampling program in 2009. Sampling of age data from purse-seine catches had improved by 2016, but catches from some areas and particularly quarter 3 in 2017 were not sampled adequately.

Catch-at-age data were estimated by ECA for the 2019 assessment of NEA saithe. This is the third year that catch-at-age estimates from ECA are used as input in the SAM assessment. In previous years catch-at-age was estimated manually, as described in the NEA saithe stock annex.

In 2016, it was not possible due to time constraints to apply the manual method to 2017 to compare the 2016 data. A comparison of ECA and manual allocation data using 2015 catch data, showed that ECA produced somewhat lower estimates of number of younger fish, while it produced slightly higher estimates for older fish. However, a comparison of two respective SAM runs with 2016 ECA and manually allocated data showed that estimates of numbers by age for the intermediate year (2016) did not differ substantially. They also showed very similar trends in SSB and estimated fishing mortality (F_{bar}), though the SSB estimated with ECA data showed a slightly higher SSB estimate than the estimate based on manually allocated data.

5.3.2 Weight-at-age (Table 5.4)

Constant weights-at-age values are used for the period 1960–1979. 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 last year negligible differences in weight-at-age for the most important age groups in 2018 were estimated, with an increase in weight of 3 year old fish most notable.

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). Table 5.3.3 presents the maturity ogives used in the present assessment. It needs to be clarified why the above mentioned inconsistencies occurred, e.g. are spawning zones not a robust indicator for maturity.

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 does not show the trends in stock size abundance of NEA saithe in later years (Figure 5.3.2). In the most recent years there are 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, seems to track the stock changes better, both in abundance and distribution.

The trawl CPUE series does not show the trends in stock size abundance of NEA saithe in later years. In the most recent years there are 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). The acoustic survey, on the other hand, seems 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 show that the residual pattern get worse (strong year effects) when using both tuning series in SAM. It becomes obvious that SAM tries to fit something in between both contradicting data sources. Therefore, it had to be decided whether one data source is more reliable or whether both data sources should be taken into account 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 has 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:

- 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 2002–2018, 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). Therefore, no new exploratory runs were performed during the 2019 AFWG, just one SAM run with 2018 data included and model settings decided in the IBP:

- Catch data age 3–12+;
- 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 (Tables 5.8-5.11, Figures 5.4-5.7)

The state–space assessment model (SAM) was used for the final. SAM catchabilities and negative log likelihood values are given in Table 5.8. The predictive power (AIC) of the model was estimated to 1128.45, compared to 1111.73 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 fishing mortality ($F_{4–7}$) in 2017 was 0.22, which is below the value of 0.26 from last year's assessment and below the F_{pa} of 0.35, while in 2018 fishing mortality ($F_{4–7}$) was 0.23. 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 2019 assessment the SSB has in recent years been underestimated and F_{4-7} overestimated.

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 2008, 2010, and 2013 have been above the long-term 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 (1960–2018) 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 stock number-at-age in 2019 was taken from the SAM for age 4 (2015 year class) and older. The GM age 3 recruitment of 159 million was used for the 2019 and subsequent year classes. The natural mortality of 0.2 is the same as used in the assessment. For exploitation pattern the average of 2016–2018 was used for all age groups. For weight-at-age in stock and catch the average of the last three years in the SAM was used. For maturity-at-age the average of the 2005–2007 annual determinations was applied.

5.7.2 Catch options for 2020 (short-term predictions; Tables 5.13-14)

The management option table (Table 5.13) shows that the expected catch of 149 550 t in 2019 will reduce the fishing mortality compared to 2018 from 0.26 to 0.22, which well below the F_{pa} of 0.35. A catch in 2020 corresponding to the $F_{status\ quo}$ level (3-year average 2016–2018) of 0.23 will be 156 484 t, while a catch in 2020 corresponding to the evaluated and implemented HCR of 171 982 t will result in F of 0.26 (Table 5.13).

For a catch in 2019 corresponding to the TAC, i.e. 149 550 t, the SSB is expected to decrease from about 555 377 t at the beginning of 2019 to 537 009 t at the beginning of 2020. At $F_{status\ quo}$ in 2020 SSB is estimated to decrease to 497 334 t at the beginning of 2021 and for a catch corresponding to the HCR it will decrease to about 483 172 t.

5.7.3 Comparison of the present and last year's assessment

The current assessment estimated the total stock in 2018 to be 27% higher and the SSB 29% higher, compared to the previous assessment. The F in 2017 is estimated to be the same as estimated in the previous assessment, and the realized F in 2018 is 32% lower compared to the predicted one based on the TAC.

	Total stock (3+) by 1 January 2018 (tonnes)	SSB by 1 January 2018 (tonnes)	$F_{4\text{-}7}$ in 2018	$F_{4\text{-}7}$ in 2017
WG 2018	714 440	383 022	0.34	0.22
WG 2019	909 053	494 841	0.23	0.22

5.8 Comments to the assessment and the forecast (Figure 5.5.4).

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 neighboring 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 somewhat more stable.

The biological sampling from the fishery may have become 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 Division 1 and age samples from purse-seine fishery south of Lofoten and in quarter two in ICES Division 1. This may affect the precision of the catch, weight and maturity-at-age data.

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.

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	Fed.Rep. Germany	Iceland	Norway	Poland	Portugal	Russia[3]	Spain	UK	Others [5]	Total all countries
1960	23	1 700		25 948		96 050					9 780	14	133 515
1961	61	3 625		19 757		77 875					4 595	18	105 951
1962	2	544		12 651		101 895			912		4 699	4	120 707
1963		1 110		8 108		135 297					4 112		148 627
1964		1 525		4 420		184 700			84		6 511	186	197 426
1965		1 618		11 387		165 531			137		6 741	181	185 600
1966		2 987	813	11 269		175 037			563		13 078	41	203 788
1967		9 472	304	11 822		150 860			441		8 379	48	181 326
1968			70	4 753		96 641					8 781		110 247
1969	20	193	6 744	4 355		115 140					13 585	23	140 060
1970	1 097		29 362	23 466		151 759			43 550		15 469		264 924
1971	215	14 536	16 840	12 204		128 499	6 017		39 397	13 097	10 361		241 272
1972	109	14 519	7 474	24 595		143 775	1 111		1 278	13 125	8 223		214 334
1973	7	11320	12 015	30 338		148 789	23		2 411	2 115	6 841		213 859
1974	46	7119	29 466	33 155		152 699	2521		28 931	7 075	3 104	5	264 121
1975	28	3156	28 517	41 260		122 598	3860	6430	13 389	11 397	2 763	55	233 453
1976	20	5609	10 266	49 056		131 675	3164	7233	9 013	21 661	4 724	65	242 486
1977	270	5658	7 164	19 985		139 705	1	783	989	1 327	6 935		182 817
1978	809	4345	6 484	19 190		121 069	35	203	381	121	2 827		155 464
1979	1117	2601	2 435	15 323		141 346			3	685	1 170		164 680
1980	532	1016		12 511		128 878			43	780	794		144 554
1981	236	218		8 431		166 139			121		395		175 540
1982	339	82		7 224		159 643			14		732		168 034
1983	539	418		4 933		149 556			206	33	1 251		156 936
1984	503	431	6	4 532		152 818			161		335		158 786
1985	490	657	11	1 873		103 899			51		202		107 183
1986	426	308		3 470		63 090			27		75		67 396
1987	712	576		4 909		85 710			426		57	1	92 391
1988	441	411		4 574		108 244			130		442		114 242

Year	Faroe Islands	France	Germany Dem.Rep	Fed.Rep. Germany	Iceland	Norway	Poland	Portugal	Russia[3]	Spain	UK	Others [5]	Total all countries
1989	388	460 [2]		606		119 625			506	506	726		122 817
1990	1207	340 [2]		1 143		92 397			52		709		95 848
1991	963	77 [2]	**Greenland**	2 003		103 283			504 [4]		492	5	107 327
1992	165	1980	734	3 451		119 763			964	6	541		127 604
1993	31	566	78	3 687	3	140 604		1	9 509	4 [2]	415	5	154 903
1994	67 [2]	557	15	1 863	4 [2]	141 589		1 [2]	1640 [2]	655 [2]	557	2	146 950
1995	172 [2]	358	53	935		165 001		5	1 148		688	18	168 378
1996	248 [2]	346	165	2 615		166 045		24	1 159	6	707	33	171 348
1997	193 [2]	560	363 [2]	2 915		136 927		12	1 774	41	799	45	143 629
1998	366	932	437 [2]	2 936		144 103		47	3 836	275	355	40	153 327
1999	181	638 [2]	655 [2]	2 473	146	141 941		17	3 929	24	339	32	150 375
2000	224 [2]	1438	651 [2]	2 573	33	125 932		46	4 452	117	454	8 [2]	135 928
2001	537	1279	701 [2]	2 690	57	124 928		75	4 951	119	514	2	135 853
2002	788	1048	1393	2 642	78	142 941		118	5 402	37	420	3	154 870
2003	2056	1022	929 [2]	2 763	80 [2]	150 400		147	3 894	18	265	18 [2]	161 592
2004	3071	255	891 [2]	2 161	319	147 975		127	9 192	87	544	14	164 636
2005	3152	447	817 [2]	2 048	395	162 338		354	8 362	25	630		178 568
2006	1795	899	786 [2]	2 779	255	195 462	89	339 [2]	9 823	21 [2]	532	42	212 822
2007	2048	966	810 [2]	3 019	219	178 644	99	412	12 168	53 [2]	558	12	199 008
2008	2314	1009	503 [2]	2 263	113	165 998	66	348	11 577	33	506	10	184 740
2009	1611 [2]	326 [2]	697	2 021	69	144 570	30	204 [2]	11 899	2 [2]	379	45 [2]	161 853
2010	1632	677 [2]	954	1 592	109 [2]	174 544	279	93	14 664	8	283	2 [2]	194 837
2011	112	367	445	1 371	65	143 314		46	10 007	2	972	15	156 716
2012	146	781	658	1 371	126	143 145		23 [2]	13 607	4	1 000	4 [2]	160 865
2013	80	1901	972	1326 [6]	290 [2]	111 962	2	17	14 796	5	433	22	131 806
2014	273	1 674	407	259	659	115 798	1	8	12 396	12	518	0	132 005
2015	576	514	393	424	249	114 830	1 154	10	13 181	34	400		131 765
2016	1 139	526	613	952	301	120 740	528	53	15 203	26	301	10	140 392
2017 [1]	638	680	407	1 148	560	126 946	504	86	14 551	88	439	23	146 070

Year	Faroe Islands	France	Germany Dem.Rep	Fed.Rep. Germany	Iceland	Norway	Poland	Portugal	Russia[3]	Spain	UK	Others [5]	Total all countries
2018	626	937	448	1642		162460	404	51	14171	60	464	17	181282

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 members

Table 5.2 Saithe in subareas 1 and 2 (Northeast Arctic). Catch 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 [2]
87	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 [3]
1995	21,8	103,5	26,9	16,1	168,4 [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
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	21,4	27,3	146,1
2018	1	36	83,4	28,8	33,2	181.3

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) 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
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

	Age groups									
Year	3	4	5	6	7	8	9	10	11	12+
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
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

	Age groups									
Year	3	4	5	6	7	8	9	10	11	12+
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

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

	Age groups									
Year	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12+**
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
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

	Age groups									
Year	3	4	5	6	7	8	9	10	11	12+
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
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

Table 5.5. 3-year running average maturity ogive 1985–2006, values for 2007–2017 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

Year	3	4	5	6	7	8	9	10	11	12+
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
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

Table 5.6 Northeast Arctic saithe. Tuning datasets applied in final SAM run

FLT13: Norway Ac Survey (Catch: Unknown) (Effort: Unknown)
1994 2001
1 1 0.75 0.85
3 7

1	87.1	108.9	41.4	8.1	0.7
1	166.1	86.5	46.5	16.5	2.4
1	122.6	207.4	31.7	15.1	4
1	38	184.8	79.8	50.6	9.6
1	96.7	202.6	69.3	84.3	6.6
1	233.8	72.9	62.2	21	19.2
1	142.5	176.3	11.6	11.5	8
1	275.9	45.9	53.8	5.6	6.1

FLT14: Norway Ac Survey (Catch: Unknown) (Effort: Unknown)
2002 2018
1 1 0.75 0.85
3 7

1	230.2	92.6	18.9	10.6	2.2
1	87.5	151.7	26.1	6.2	6.4
1	191.2	107.6	44.3	15.2	4.25
1	198.5	51.9	17.6	13.2	7.68
1	40.9	129.9	14.4	4.62	9.49
1	93.5	23.9	58.5	6.51	3.95
1	55.9	15.9	7.84	9.99	3.06
1	96.9	61.4	6.99	4.01	7.62
1	143	22.5	17.1	3.95	1.68
1	42.7	59.6	4.61	4.23	1.07
1	69	29.7	18.8	3.48	2.83
1	77.1	16.5	13.3	11.6	2.19
1	40.1	70.8	8.73	5.6	5.44
1	72.4	22.7	30.1	6.08	4.22
1	145.7	32	10.5	11.2	4.15
1	91.1	63.9	13.3	2.76	5.35
1	30.6	61.1	45.4	12.3	4.2

Table 5.7 SAM parameter settings.

Model used: State-space assessment model SAM (https://www.stockassessment.org).

Software used: Template Model Builder (TMB) and R.

Visible stock on (https://www.stockassessment.org) "afwg_saithe_ 2019_001".

Model Options agreed upon at IBP saithe winter 2014.

```
$minAge
# The minimium age class in the assessment
 3
$maxAge
# The maximum age class in the assessment
 12
```

```
$maxAgePlusGroup
# Is last age group considered a plus group (1 yes, or 0 no).
1
$keyLogFsta
# Coupling of the fishing mortality states (nomally only first row is used).
  0  1  2  3  4  5  5  5  5  5
 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
$corFlag
# Correlation of fishing mortality across ages (0 independent, 1 compound symmetry, or 2 AR(1)
 2
$keyLogFpar
# Coupling of the survey catchability parameters (nomally first row is not used, as that is covered by fishing mortality).
 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
  0  1  2  3  3 -1 -1 -1 -1 -1
  4  5  6  7  7 -1 -1 -1 -1 -1
$keyQpow
# Density dependent catchability power parameters (if any).
 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
$keyVarF
# Coupling of process variance parameters for log(F)-process (nomally only first row is used)
  0  0  0  0  0  0  0  0  0  0
 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1
$keyVarLogN
# Coupling of process variance parameters for log(N)-process
 0 1 1 1 1 1 1 1 1 1

$keyVarObs
# Coupling of the variance parameters for the observations.
  0  0  0  0  0  0  0  0  0  0
  1  1  1  1  1 -1 -1 -1 -1 -1
  2  2  2  2  2 -1 -1 -1 -1 -1
```

Table 5.7 SAM parameter settings continued

$obsCorStruct
Covariance structure for each fleet ("ID" independent, "AR" AR(1), or "US" for unstructured). | Possible values are: "ID" "AR" "US"
 "ID" "ID" "ID"
$keyCorObs
Coupling of correlation parameters can only be specified if the AR(1) structure is chosen above.
NA's indicate where correlation parameters can be specified (-1 where they cannot).
#3-4 4-5 5-6 6-7 7-8 8-9 9-10 10-11 11-12
 NA NA NA NA NA NA NA NA NA
 NA NA NA NA -1 -1 -1 -1 -1
 NA NA NA NA -1 -1 -1 -1 -1
$stockRecruitmentModelCode
Stock recruitment code (0 for plain random walk, 1 for Ricker, and 2 for Beverton–Holt).
 2
$noScaledYears
Number of years where catch scaling is applied.
 0
$keyScaledYears
A vector of the years where catch scaling is applied.
 $keyParScaledYA
A matrix specifying the couplings of scale parameters (nrow = no scaled years, ncols = no ages).
$fbarRange
lowest and higest age included in Fbar
 4 7
$keyBiomassTreat
To be defined only if a biomass survey is used (0 SSB index, 1 catch index, and 2 FSB index).
 -1 -1 -1
$obsLikelihoodFlag
Option for observational likelihood | Possible values are: "LN" "ALN"
 "LN" "LN" "LN"
$fixVarToWeight
If weight attribute is supplied for observations this option sets the treatment (0 relative weight, 1 fix variance to weight).
 0

Table 5.8. SAM catchabilities, negative log likelihood values, and number of parameters.

Index	Fleet number	Age	Catchability	Low	High
1	2	3	0.864	0.588	1.269
2	2	4	1.164	0.794	1.706
3	2	5	0.604	0.412	0.886
4	2	6	0.373	0.278	0.502
5	2	7	0.373	0.278	0.502
6	3	3	0.638	0.517	0.788
7	3	4	0.489	0.396	0.604
8	3	5	0.269	0.217	0.333
9	3	6	0.177	0.147	0.214
10	3	7	0.177	0.147	0.214

Model fitting.

Model	log(L)	#par	AIC
Current	-547.23	17	1128.45
base	-547.23	17	1128.45

Table 5.9 Estimated fishing mortalities.

Year Age	3	4	5	6	7	8	9	10	11	12
1960	0.237	0.285	0.321	0.277	0.221	0.163	0.163	0.163	0.163	0.163
1961	0.223	0.260	0.273	0.226	0.174	0.127	0.127	0.127	0.127	0.127
1962	0.223	0.262	0.268	0.226	0.177	0.133	0.133	0.133	0.133	0.133
1963	0.225	0.273	0.282	0.239	0.194	0.154	0.154	0.154	0.154	0.154
1964	0.239	0.299	0.319	0.277	0.241	0.208	0.208	0.208	0.208	0.208
1965	0.235	0.292	0.326	0.288	0.254	0.231	0.231	0.231	0.231	0.231
1966	0.261	0.320	0.343	0.289	0.245	0.224	0.224	0.224	0.224	0.224
1967	0.261	0.309	0.318	0.264	0.225	0.217	0.217	0.217	0.217	0.217
1968	0.221	0.241	0.229	0.185	0.153	0.147	0.147	0.147	0.147	0.147
1969	0.230	0.240	0.221	0.175	0.143	0.132	0.132	0.132	0.132	0.132
1970	0.328	0.361	0.340	0.283	0.250	0.240	0.240	0.240	0.240	0.240

Year Age	3	4	5	6	7	8	9	10	11	12
1971	0.359	0.384	0.356	0.295	0.269	0.259	0.259	0.259	0.259	0.259
1972	0.380	0.390	0.350	0.283	0.259	0.245	0.245	0.245	0.245	0.245
1973	0.419	0.428	0.386	0.317	0.299	0.284	0.284	0.284	0.284	0.284
1974	0.542	0.561	0.513	0.429	0.416	0.395	0.395	0.395	0.395	0.395
1975	0.596	0.621	0.568	0.479	0.488	0.477	0.477	0.477	0.477	0.477
1976	0.649	0.683	0.611	0.499	0.496	0.470	0.470	0.470	0.470	0.470
1977	0.575	0.615	0.540	0.431	0.417	0.377	0.377	0.377	0.377	0.377
1978	0.574	0.653	0.596	0.488	0.475	0.430	0.430	0.430	0.430	0.430
1979	0.554	0.678	0.638	0.529	0.508	0.451	0.451	0.451	0.451	0.451
1980	0.494	0.638	0.619	0.519	0.481	0.420	0.420	0.420	0.420	0.420
1981	0.458	0.630	0.621	0.521	0.460	0.391	0.391	0.391	0.391	0.391
1982	0.422	0.622	0.622	0.527	0.450	0.374	0.374	0.374	0.374	0.374
1983	0.403	0.630	0.655	0.596	0.533	0.452	0.452	0.452	0.452	0.452
1984	0.444	0.716	0.733	0.725	0.685	0.591	0.591	0.591	0.591	0.591
1985	0.352	0.592	0.614	0.652	0.683	0.590	0.590	0.590	0.590	0.590
1986	0.243	0.451	0.499	0.574	0.650	0.591	0.591	0.591	0.591	0.591
1987	0.226	0.457	0.533	0.666	0.806	0.747	0.747	0.747	0.747	0.747
1988	0.215	0.457	0.538	0.660	0.766	0.652	0.652	0.652	0.652	0.652
1989	0.201	0.422	0.470	0.525	0.533	0.399	0.399	0.399	0.399	0.399
1990	0.223	0.478	0.525	0.595	0.602	0.451	0.451	0.451	0.451	0.451
1991	0.191	0.428	0.481	0.556	0.571	0.430	0.430	0.430	0.430	0.430
1992	0.172	0.430	0.543	0.692	0.754	0.601	0.601	0.601	0.601	0.601
1993	0.130	0.354	0.476	0.622	0.680	0.540	0.540	0.540	0.540	0.540
1994	0.100	0.296	0.418	0.567	0.627	0.503	0.503	0.503	0.503	0.503
1995	0.081	0.246	0.336	0.436	0.470	0.372	0.372	0.372	0.372	0.372
1996	0.072	0.224	0.312	0.419	0.485	0.415	0.415	0.415	0.415	0.415
1997	0.052	0.162	0.225	0.296	0.338	0.292	0.292	0.292	0.292	0.292
1998	0.046	0.153	0.220	0.296	0.346	0.322	0.322	0.322	0.322	0.322
1999	0.045	0.156	0.227	0.297	0.338	0.322	0.322	0.322	0.322	0.322

Year Age	3	4	5	6	7	8	9	10	11	12
2000	0.039	0.138	0.202	0.265	0.295	0.291	0.291	0.291	0.291	0.291
2001	0.030	0.114	0.174	0.234	0.262	0.272	0.272	0.272	0.272	0.272
2002	0.027	0.107	0.164	0.224	0.258	0.288	0.288	0.288	0.288	0.288
2003	0.025	0.102	0.155	0.212	0.259	0.322	0.322	0.322	0.322	0.322
2004	0.023	0.095	0.146	0.204	0.259	0.347	0.347	0.347	0.347	0.347
2005	0.032	0.126	0.178	0.237	0.287	0.377	0.377	0.377	0.377	0.377
2006	0.040	0.154	0.211	0.281	0.341	0.453	0.453	0.453	0.453	0.453
2007	0.047	0.172	0.227	0.294	0.352	0.462	0.462	0.462	0.462	0.462
2008	0.071	0.247	0.295	0.359	0.415	0.529	0.529	0.529	0.529	0.529
2009	0.081	0.274	0.317	0.366	0.411	0.516	0.516	0.516	0.516	0.516
2010	0.098	0.326	0.366	0.396	0.422	0.499	0.499	0.499	0.499	0.499
2011	0.097	0.311	0.361	0.396	0.424	0.479	0.479	0.479	0.479	0.479
2012	0.101	0.301	0.344	0.369	0.389	0.424	0.424	0.424	0.424	0.424
2013	0.085	0.249	0.286	0.303	0.319	0.337	0.337	0.337	0.337	0.337
2014	0.074	0.220	0.259	0.273	0.291	0.308	0.308	0.308	0.308	0.308
2015	0.069	0.209	0.249	0.257	0.272	0.285	0.285	0.285	0.285	0.285
2016	0.060	0.192	0.239	0.254	0.278	0.303	0.303	0.303	0.303	0.303
2017	0.054	0.172	0.215	0.233	0.258	0.285	0.285	0.285	0.285	0.285
2018	0.057	0.182	0.229	0.244	0.271	0.301	0.301	0.301	0.301	0.301

Table 5.10 Estimated stock numbers.

Year Age	3	4	5	6	7	8	9	10	11	12
1960	84953	103904	53236	28382	25891	14185	10448	7310	3636	12144
1961	113991	57040	68506	29916	17462	15984	8965	7019	5131	11311
1962	204021	67565	36783	44139	18586	12666	11383	6223	5183	12481
1963	272404	131433	38770	25370	28421	11911	9816	8233	4504	13308
1964	81247	190059	77135	22676	17496	18776	8048	7407	6112	13620
1965	254964	50569	111626	44903	14509	11523	12223	5047	5124	13712
1966	133647	180099	34520	62977	26265	9306	7491	7294	3201	12474

Year Age	3	4	5	6	7	8	9	10	11	12
1967	175109	83126	109699	20308	36792	16017	6271	5176	4570	10014
1968	143445	116785	47572	63747	13139	23976	10074	4086	3333	8339
1969	263307	88992	80107	31887	42237	10727	17842	7014	2683	6987
1970	222544	167148	58646	54433	22553	29671	9099	13972	5137	7225
1971	230101	143955	87218	35633	32767	14407	17683	6437	9200	7946
1972	152826	138329	85802	46674	23034	19654	9613	10453	4223	10163
1973	201514	80296	79128	52164	27951	15438	12729	6750	6432	8942
1974	99937	111129	41931	45832	32604	16864	10235	8242	4242	9093
1975	167491	44241	53047	20033	23716	17771	9325	5987	4754	7186
1976	218085	74991	19349	25717	10549	11398	8677	4711	3053	5795
1977	201382	89952	30941	8438	13285	5472	5706	4284	2325	4250
1978	135201	89894	38650	14992	4595	7285	3202	3105	2408	3964
1979	196410	59793	38777	17236	7663	2361	4007	1756	1560	3429
1980	118184	95062	23552	16879	8549	3656	1142	2063	959	2679
1981	228873	56954	43392	10036	8279	4402	1851	687	1072	1845
1982	128955	122451	24390	19481	4730	4374	2260	1041	396	1649
1983	101770	69009	52742	9989	9344	2582	2503	1256	607	1286
1984	92939	58374	31018	20223	4362	4549	1304	1334	711	1053
1985	102179	42054	23298	12987	6931	1935	2090	561	610	826
1986	181485	49360	17680	11001	6017	2399	948	956	270	635
1987	144147	132627	22860	8336	5449	2790	854	478	427	463
1988	81210	100494	75832	11190	3437	2032	1317	237	200	302
1989	77229	55200	54872	38727	4882	1196	827	613	58	285
1990	85530	47645	29824	26222	18793	2434	603	464	366	214
1991	224375	48153	22181	15160	11132	8507	1240	302	264	321
1992	284775	142387	22612	10936	7768	4972	4698	649	170	367
1993	214176	213634	75813	10177	4277	3100	1964	2310	283	237
1994	152907	164086	131822	37195	4354	1726	1484	773	1232	268
1995	279958	132487	112233	74894	15642	1855	806	775	316	815

Year Age	3	4	5	6	7	8	9	10	11	12
1996	159923	245472	88521	68711	40088	7977	1038	485	446	699
1997	163808	121588	178450	57936	40057	21346	4172	511	261	627
1998	104103	134629	84741	127215	33048	24098	12802	2556	333	620
1999	241993	79020	94981	54183	73867	18535	14982	7619	1480	574
2000	158151	193548	51618	55945	31677	40831	11359	9527	4366	1139
2001	215548	108271	140484	35692	33322	19275	24261	7227	6008	3208
2002	352556	180435	79997	94702	24173	20679	12720	15047	4487	5875
2003	148627	311662	127203	53078	57822	17188	12745	8594	9172	6465
2004	152693	121343	210503	88709	36362	36899	10916	7440	5439	9144
2005	421639	119362	80483	127711	58194	24177	22344	6823	3869	7650
2006	72565	338396	81185	49712	75583	35640	14884	12586	3879	6163
2007	109959	54438	217166	53402	30453	40781	20006	8258	6302	4501
2008	193144	75595	38677	117533	30774	16862	20293	10824	4189	5194
2009	141340	151572	46633	25587	64227	16064	8015	9425	5314	4318
2010	264731	97189	91272	29030	14589	33984	7925	3842	4260	4456
2011	112113	198663	51136	47722	15981	8347	16392	4005	1892	4073
2012	148149	92242	125070	31626	25474	9277	4512	8009	1976	2973
2013	206890	91996	64882	79060	18872	13852	5184	2526	4116	2624
2014	105605	171403	61425	43997	47400	11482	8080	3265	1510	3923
2015	161651	80013	123650	43117	29994	28380	6820	4766	2058	3457
2016	247419	120379	55033	77373	28965	19171	16748	4065	3123	4006
2017	164535	214344	84656	35149	46157	18031	11775	9535	2341	5056
2018	90346	134793	171393	63525	25309	28233	11257	7417	5654	4856
pred		69862	92020	111650	40735	15800	17116	6824	4496	6371

Table 5.11. Estimated recruitment, total-stock-biomass (TBS), spawning-stock-biomass (SSB), and average fishing mortality for ages 4 to 7 (F47).

Year	R(age 3)	Low	High	SSB	Low	High	Fbar(4-7)	Low	High	TSB	Low	High
1960	84953	53213	135625	461689	339573	627718	0.276	0.197	0.386	686789	536357	879413
1961	113991	74988	173281	455025	337687	613137	0.233	0.171	0.319	660449	518551	841176
1962	204021	134901	308555	459946	344568	613958	0.233	0.172	0.315	722629	576484	905823
1963	272404	180374	411390	456518	345564	603096	0.247	0.184	0.331	833457	674314	1030159
1964	81247	53331	123774	479946	368704	624751	0.284	0.214	0.378	812097	655854	1005561
1965	254964	168970	384722	518913	402944	668257	0.290	0.218	0.385	853996	694371	1050316
1966	133647	88803	201136	479829	370205	621914	0.299	0.225	0.397	821621	668022	1010536
1967	175109	116074	264169	492147	382841	632661	0.279	0.209	0.372	797709	650261	978590
1968	143445	95235	216059	470746	365312	606608	0.202	0.151	0.270	758931	619329	930000
1969	263307	174102	398218	510616	404502	644568	0.195	0.146	0.259	867929	718894	1047862
1970	222544	147873	334922	565689	457145	700004	0.309	0.237	0.402	970841	816929	1153751
1971	230101	153659	344569	554013	452646	678081	0.326	0.252	0.422	954076	807610	1127106
1972	152826	102171	228594	537029	442242	652133	0.321	0.249	0.413	878250	746367	1033436
1973	201514	134688	301495	536980	447205	644777	0.358	0.280	0.457	846330	723541	989957
1974	99937	66532	150114	491972	411626	588002	0.480	0.380	0.606	733882	630319	854462
1975	167491	111838	250838	398071	334125	474256	0.539	0.428	0.678	613017	526276	714055

Year	R(age 3)	Low	High	SSB	Low	High	Fbar(4-7)	Low	High	TSB	Low	High
1976	218085	145204	327547	281688	234905	337787	0.572	0.456	0.718	542783	459946	640538
1977	201382	134484	301557	209744	174292	252408	0.501	0.397	0.631	478057	401975	568541
1978	135201	90182	202694	189232	158315	226188	0.553	0.441	0.693	417890	353732	493684
1979	196410	131211	294009	170643	142701	204056	0.588	0.470	0.736	410752	343305	491450
1980	118184	78976	176858	150451	125725	180039	0.564	0.451	0.707	391872	327740	468552
1981	228873	151892	344868	154708	128584	186140	0.558	0.446	0.699	445454	366436	541512
1982	128955	85880	193635	135940	113036	163486	0.555	0.442	0.698	401117	331603	485202
1983	101770	67590	153232	162762	134204	197398	0.604	0.483	0.754	409572	341772	490824
1984	92939	61440	140588	146367	121055	176972	0.715	0.575	0.888	321894	270606	382901
1985	102179	67571	154512	110846	91985	133576	0.635	0.509	0.794	269367	224837	322715
1986	181485	119911	274676	83484	69196	100721	0.544	0.433	0.682	268332	218247	329911
1987	144147	96109	216195	72113	59887	86835	0.615	0.496	0.764	284971	232456	349350
1988	81210	53571	123108	88171	72705	106928	0.605	0.486	0.754	301544	248007	366637
1989	77229	50831	117336	103206	79899	133312	0.487	0.386	0.615	283608	234165	343491
1990	85530	55836	131015	119544	95302	149954	0.550	0.437	0.692	271200	226913	324130
1991	224375	147958	340259	114596	93844	139936	0.509	0.404	0.641	353979	287222	436252
1992	284775	188451	430334	94977	79749	113113	0.605	0.484	0.756	466078	374271	580405

Year	R(age 3)	Low	High	SSB	Low	High	Fbar(4-7)	Low	High	TSB	Low	High
1993	214176	143148	320446	97175	80832	116824	0.533	0.425	0.668	534776	432767	660829
1994	152907	104146	224499	147869	120016	182186	0.477	0.377	0.603	487145	403474	588168
1995	279958	189137	414389	196889	158045	245281	0.372	0.292	0.474	590750	491160	710532
1996	159923	108730	235220	246126	200675	301873	0.360	0.281	0.461	684019	572213	817671
1997	163808	111598	240444	245371	200710	299969	0.255	0.197	0.330	725368	605273	869292
1998	104103	71194	152225	294112	240778	359259	0.254	0.196	0.329	802304	669727	961126
1999	241993	165404	354045	310104	250776	383467	0.254	0.195	0.332	806750	679444	957908
2000	158151	108128	231316	370374	299911	457391	0.225	0.172	0.294	828281	701242	978334
2001	215548	148663	312527	376555	309143	458667	0.196	0.150	0.255	890268	757854	1045818
2002	352556	248584	500016	452970	377812	543079	0.188	0.145	0.244	1031417	883813	1203671
2003	148627	104512	211364	442949	372768	526343	0.182	0.140	0.236	1006522	860468	1177367
2004	152693	106208	219522	525691	446290	619219	0.176	0.135	0.229	1024250	874615	1199487
2005	421639	296491	599610	611511	516830	723537	0.207	0.160	0.269	1100766	943264	1284568
2006	72565	51298	102647	543695	462224	639526	0.247	0.191	0.319	945673	811022	1102681
2007	109959	78021	154973	552527	471214	647870	0.261	0.203	0.337	886965	757850	1038076
2008	193144	137329	271643	477066	400833	567796	0.329	0.257	0.421	735530	632395	855485
2009	141340	100766	198250	368792	309450	439514	0.342	0.269	0.435	679141	585406	787884

Year	R(age 3)	Low	High	SSB	Low	High	Fbar(4-7)	Low	High	TSB	Low	High
2010	264731	189270	370278	333601	280568	396658	0.377	0.297	0.480	699993	599725	817025
2011	112113	79199	158706	298212	249961	355777	0.373	0.292	0.477	590297	504186	691115
2012	148149	105266	208500	307997	258049	367614	0.351	0.274	0.449	600392	511828	704280
2013	206890	147166	290853	331872	273460	402762	0.289	0.224	0.373	617206	523281	727991
2014	105605	74941	148817	360463	294502	441199	0.261	0.201	0.339	654209	551999	775344
2015	161651	114736	227750	372942	300919	462203	0.247	0.189	0.323	641337	535873	767557
2016	247419	173046	353756	413202	326495	522936	0.241	0.181	0.320	812806	673015	981632
2017	164535	112238	241200	431671	334567	556957	0.220	0.161	0.298	905925	740380	1108484
2018	90346	55636	146710	494841	375262	652524	0.231	0.164	0.327	909053	717470	1151795

Table 5.12 Northeast Arctic saithe. Prediction input data

MFDP version 1a
Run: fsh
Time and date: 10:15 29.04.2019
F_{bar} age range: 4-7

2019

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	159107	0.2	0	0	0	0.880	0.0570	0.880
4	69862	0.2	0.05	0	0	1.123	0.1820	1.123
5	92020	0.2	0.42	0	0	1.566	0.2277	1.566
6	111650	0.2	0.87	0	0	2.071	0.2437	2.071
7	40735	0.2	0.97	0	0	2.500	0.2690	2.500
8	15800	0.2	0.98	0	0	3.096	0.2963	3.096
9	17116	0.2	0.98	0	0	3.536	0.2963	3.536
10	6824	0.2	0.97	0	0	4.062	0.2963	4.062
11	4496	0.2	0.97	0	0	4.550	0.2963	4.550
12	6371	0.2	0.994	0	0	5.844	0.2963	5.844

2020

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	159107	0.2	0	0	0	0.880	0.0570	0.880
4	.	0.2	0.05	0	0	1.123	0.1820	1.123
5	.	0.2	0.42	0	0	1.566	0.2277	1.566
6	.	0.2	0.87	0	0	2.071	0.2437	2.071
7	.	0.2	0.97	0	0	2.500	0.2690	2.500
8	.	0.2	0.98	0	0	3.096	0.2963	3.096
9	.	0.2	0.98	0	0	3.536	0.2963	3.536
10	.	0.2	0.97	0	0	4.062	0.2963	4.062
11	.	0.2	0.97	0	0	4.550	0.2963	4.550
12	.	0.2	0.994	0	0	5.844	0.2963	5.844

2021

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	159107	0.2	0	0	0	0.880	0.0570	0.880
4	.	0.2	0.05	0	0	1.123	0.1820	1.123
5	.	0.2	0.42	0	0	1.566	0.2277	1.566
6	.	0.2	0.87	0	0	2.071	0.2437	2.071
7	.	0.2	0.97	0	0	2.500	0.2690	2.500
8	.	0.2	0.98	0	0	3.096	0.2963	3.096
9	.	0.2	0.98	0	0	3.536	0.2963	3.536
10	.	0.2	0.97	0	0	4.062	0.2963	4.062
11	.	0.2	0.97	0	0	4.550	0.2963	4.550
12	.	0.2	0.994	0	0	5.844	0.2963	5.844

Input units are thousands and kg - output in tonnes

Table 5.13 Northeast Arctic saithe. Short-term prediction

MFDP version 1a
Run: fsh
North-East Arctic saithe
Time and date: 10:15 29.04.2019
F_{bar} age range: 4-7

2019

Biomass	SSB	F_{Mult}	F_{Bar}	Landings
890462	555377	0.9368	0.216	149550

2020–2021

2020					2021	
Biomass	SSB	F_{Mult}	F_{Bar}	Landings	Biomass	SSB
878824	537009	0	0	0	1035106	642238
.	537009	0.1	0.0231	17396	1015853	625976
.	537009	0.2	0.0461	34377	997071	610136
.	537009	0.3	0.0692	50953	978747	594707
.	537009	0.4	0.0922	67135	960868	579677

2020					2021	
Biomass	SSB	F_{Mult}	F_{Bar}	Landings	Biomass	SSB
.	537009	0.5	0.1153	82932	943425	565038
.	537009	0.6	0.1384	98355	926405	550778
.	537009	0.7	0.1614	113412	909798	536887
.	537009	0.8	0.1845	128114	893594	523355
.	537009	0.9	0.2075	142468	877782	510174
.	537009	1	0.2306	156484	862351	497334
.	537009	1.1	0.2536	170171	847293	484825
.	537009	1.2	0.2767	183536	832598	472640
.	537009	1.3	0.2998	196588	818256	460769
.	537009	1.4	0.3228	209335	804259	449205
.	537009	1.5	0.3459	221784	790598	437939
.	537009	1.6	0.3689	233943	777264	426964
.	537009	1.7	0.392	245819	764249	416272
.	537009	1.8	0.4151	257419	751545	405855
.	537009	1.9	0.4381	268751	739144	395706
.	537009	2	0.4612	279820	727038	385818

Input units are thousands and kg - output in tonnes

Table 5.14 Northeast arctic saithe. Short-term projection output HCR landings

MFDP version 1a
Run: fmp
tst1MFDP Index file 29.04.2019
Time and date: 10:30 29.04.2019
F_{bar} age range: 4-7

2019							
Biomass	SSB	FMult	FBar	Landings		Fmp (0.32)	
890462	555377	0.9368	0.216	149550		landings	SSB
						207794	537009
2020						188110	450602
Biomass	SSB	FMult	FBar	Landings		172354	399973
878824	537009	1.1134	0.2567	171982	average	189419	

The TAC should not be changed by more than 15% compared with the previous year's TAC.

171982

2021-2022

2021					2022	
Biomass	**SSB**	**F_{Mult}**	**F_{Bar}**	**Landings**	**Biomass**	**SSB**
845301	483172	0	0	0	1002927	605922
.	483172	0.1	0.0231	16697	984434	590514
.	483172	0.2	0.0461	32993	966395	575510
.	483172	0.3	0.0692	48899	948797	560898
.	483172	0.4	0.0922	64424	931630	546667
.	483172	0.5	0.1153	79578	914881	532809
.	483172	0.6	0.1384	94371	898541	519313
.	483172	0.7	0.1614	108812	882598	506168
.	483172	0.8	0.1845	122909	867043	493367
.	483172	0.9	0.2075	136673	851866	480899
.	483172	1	0.2306	150110	837056	468756
.	483172	1.1	0.2536	163231	822604	456929
.	483172	1.2	0.2767	176041	808502	445410
.	483172	1.3	0.2998	188551	794739	434190
.	483172	1.4	0.3228	200766	781309	423263
.	483172	1.5	0.3459	212695	768201	412619
.	483172	1.6	0.3689	224345	755408	402251

2021					2022	
Biomass	SSB	F_{Mult}	F_{Bar}	Landings	Biomass	SSB
.	483172	1.7	0.392	235723	742921	392153
.	483172	1.8	0.4151	246836	730734	382316
.	483172	1.9	0.4381	257690	718837	372734
.	483172	2	0.4612	268293	707225	363401

Input units are thousands and kg - output in tonnes

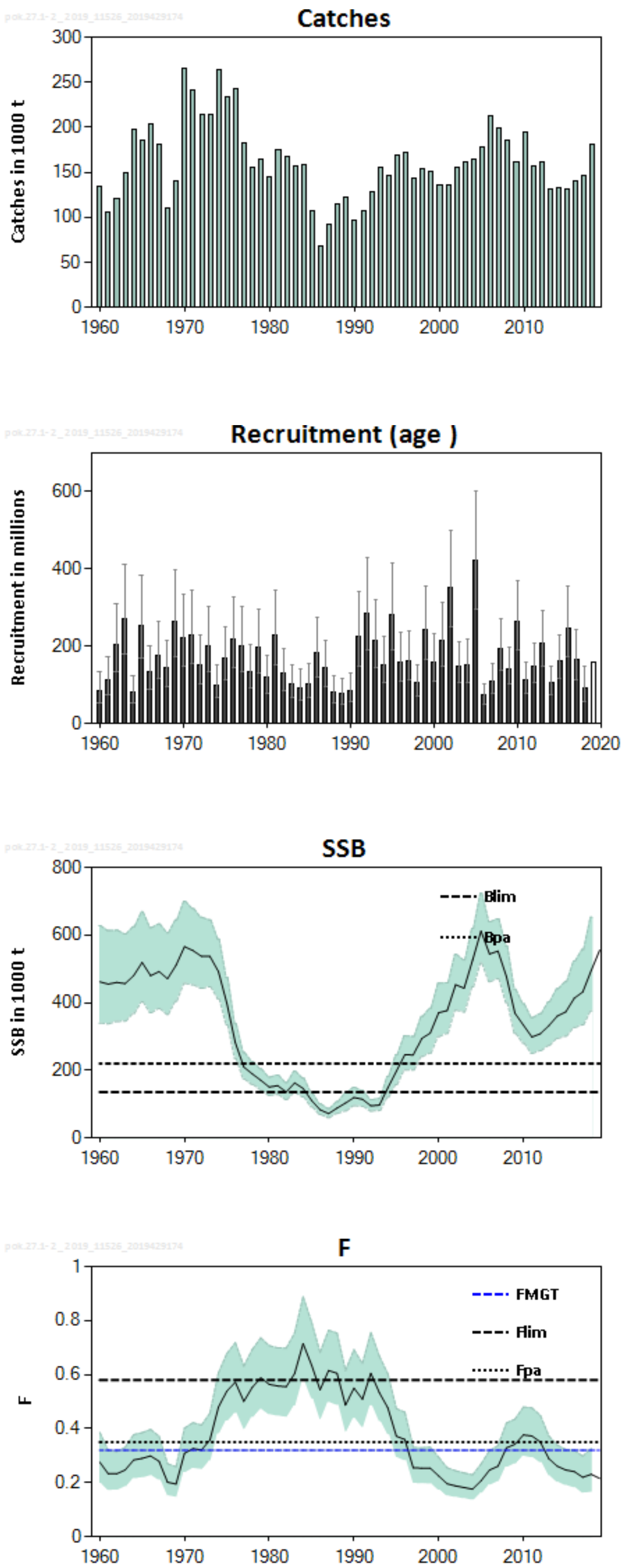
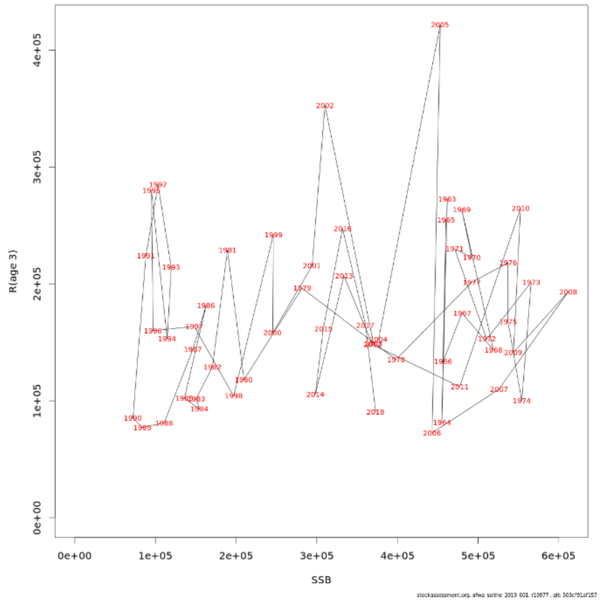


Figure 5.1. Northeast Arctic saithe (subareas 1 and 2).



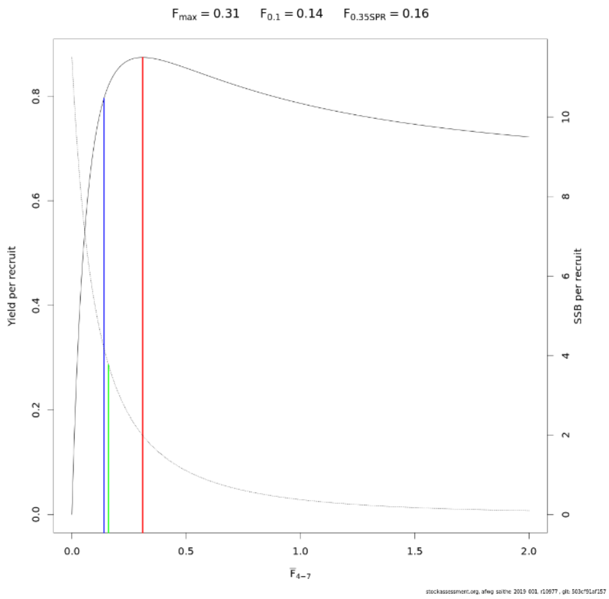


Figure 5.1. continued.

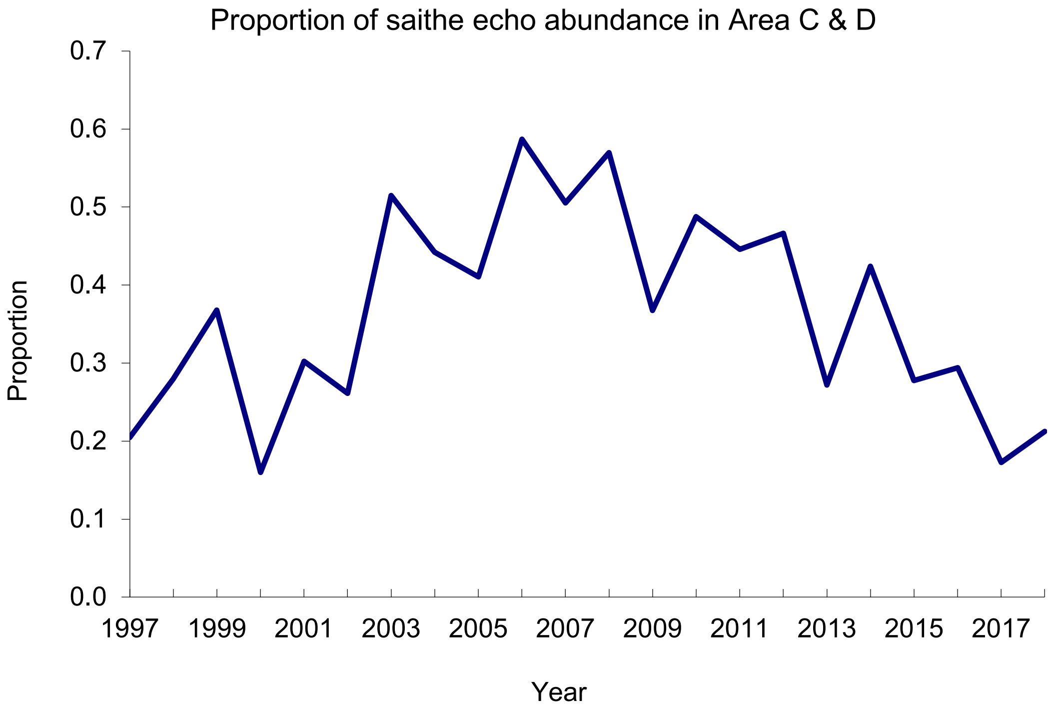


Figure 5.2. Northeast Arctic saithe. Proportion of saithe in the southern half of the survey area (subarea C+D).

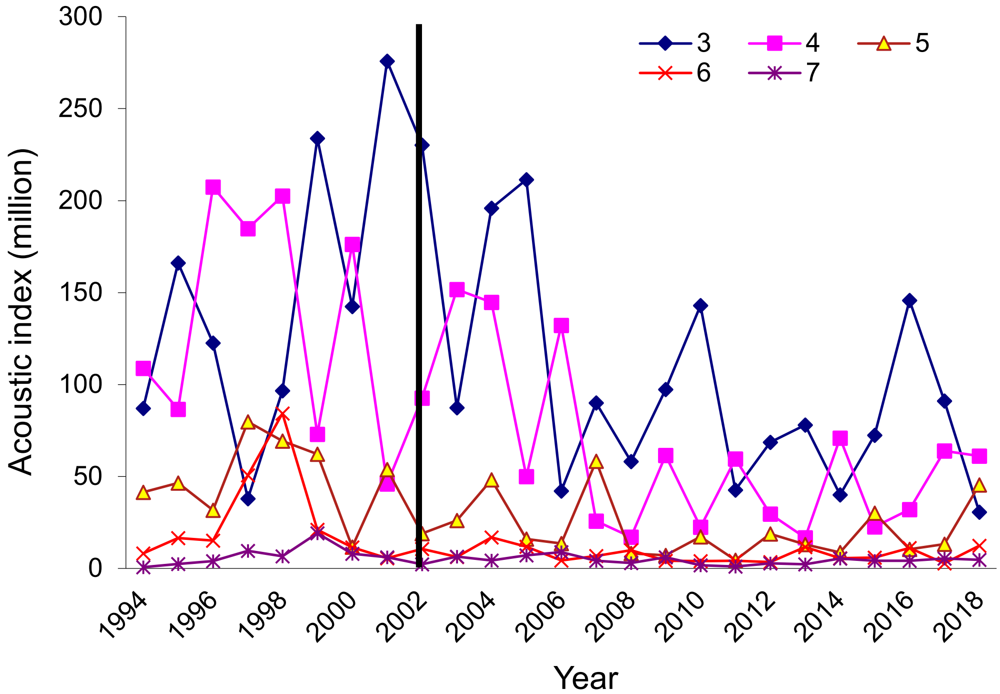


Figure 5.3. Northeast Arctic saithe, acoustic survey tuning indices, break in 2002 black line.

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.

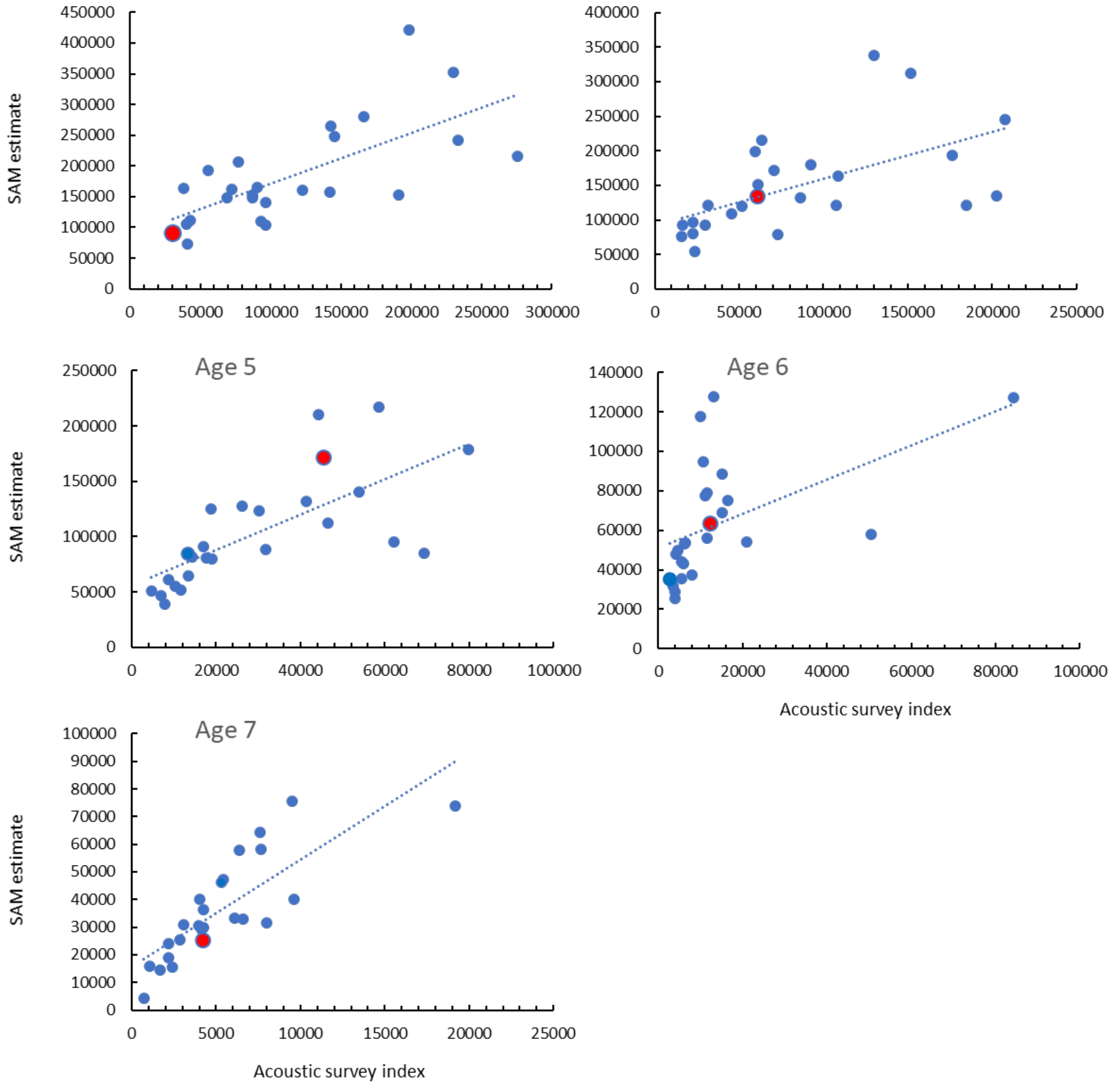


Figure 5.5. NEA saithe - Acoustic survey vs. SAM, red circles show last data year.

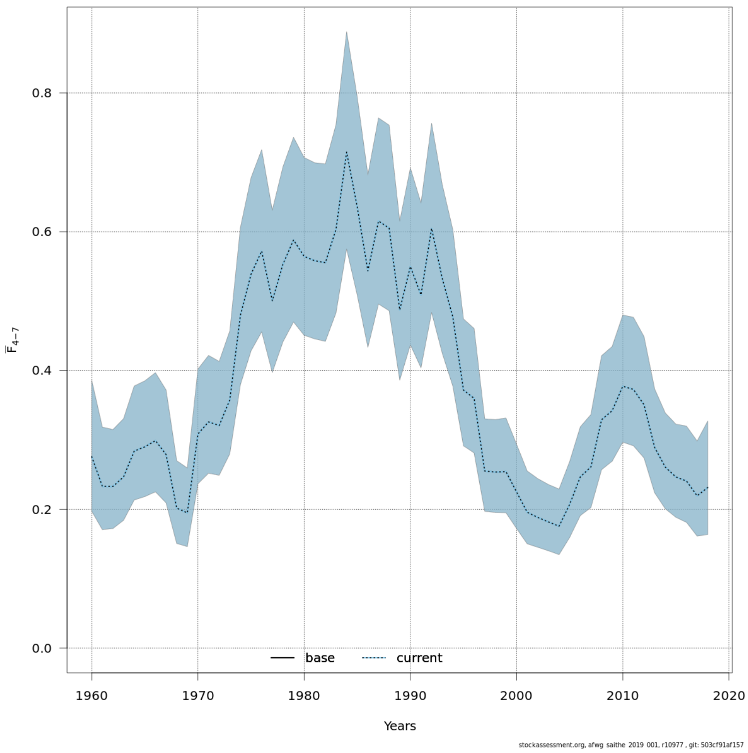


Figure 5.6. $F_{4\text{-}7}$ and SSB. Estimates from the current run and point wise 95% confidence intervals are shown by black line and shaded area.

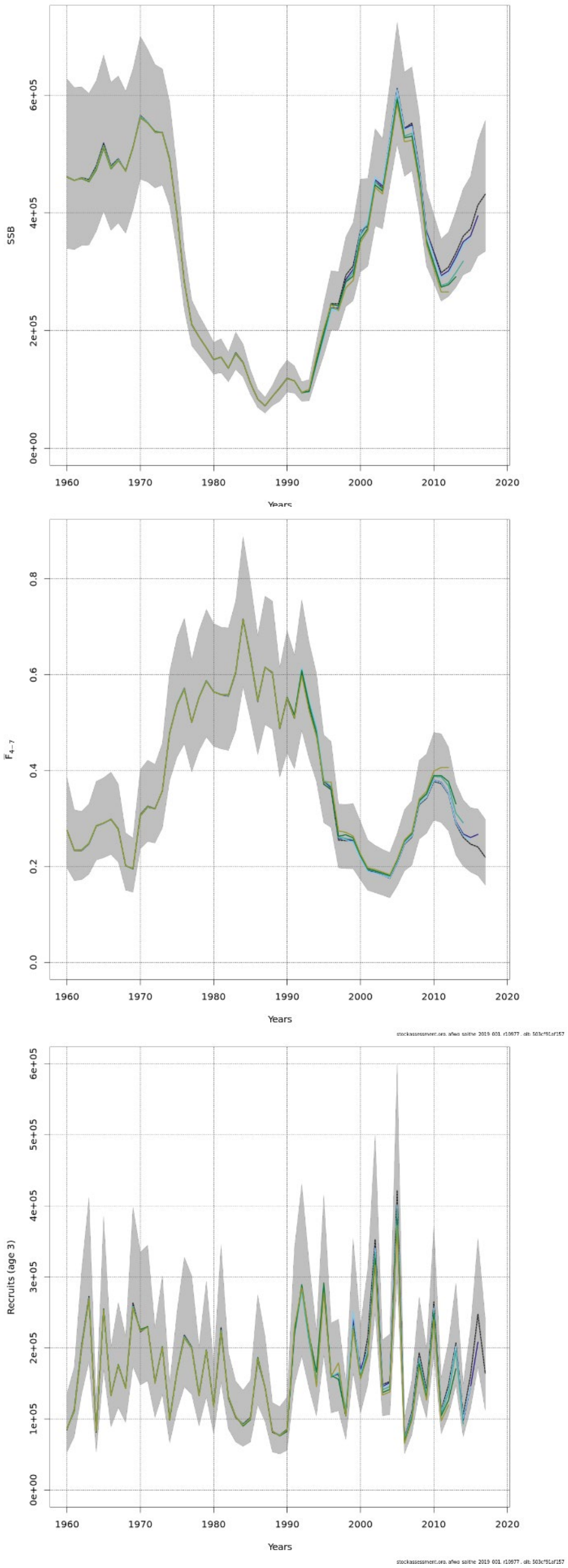


Figure 5.7. Saithe in subareas 1 and 2 (Northeast Arctic) RETROSPECTIVE SAM SSB, $F_{4\text{-}7}$, and recruits.