5 Saithe in Sub-areas I and II (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 2017 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 presently (2017) 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 Fpa from 2010 to 2012, but is presently estimated to be below Fpa. The 2007 year class is strong, the 2008 and 2009 year classes are below average strength, the 2010 year class is above average strength while the 2011 year class is below average.

ICES advised that catches in 2017 should be no more than 150,000 t, and The Norwegian Ministry of Trade, Industry and Fisheries set the final TAC at 150,000t. 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 5.1.1–5.1.2, Figure 5.1.1)

Currently the main fleets targeting saithe include trawl, purse seine, gillnet, hand line 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 2016 landings increased to 140,000t.

Discarding, although illegal, occurs in the saithe fishery, but is not considered a major problem in the assessment. Due to its near-shore 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 2016 and 2017

The advice from ICES for 2016 was as follows:

ICES advised that catches in 2016 should be no more than 140,000 t.

The advice from ICES for 2017was as follows:

ICES advised that catches in 2017 should be no more than 150,000 t.

5.1.2 Management applicable in 2016 and 2017

Management of Saithe in Sub-areas I and II is by TAC and technical measures. For 2016, The Norwegian Ministry of Trade, Industry and Fisheries set the TAC according to the advice from ICES, i.e. 140,000 t.

For 2017, The Norwegian Ministry of Trade, Industry and Fisheries set the TAC according to the advice from ICES, i.e. 150,000 t.

5.1.3 The fishery in 2016 and expected landings in 2017

Provisional figures show that the landings in 2016 were approximately 140,400 t, the same as the TAC of 140,000 t, which also were expected landings in the forecast last year.

Since the WG does not have any prognosis of total landings in 2017 available, the TAC of 150,000 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 (Table 5.2.1, Figure 5.2.1)

The estimation of abundance indices is as far as possible done the same way as before the combination of the saithe and coastal survey surveys in 2003 (Berg *et al.*, WD 11 2004). The echo abundance in 2016 (Mehl *et al*. 2016) increased by 14 % compared to 2015, but is still among the lowest in the time series since 1997, about 80 % of the average for 1997-2015. The indices for 3, 6, 7, 8 and 9 olds were above the 1994-2015 average, while other age groups were only 45-99 % of this average. The proportion of saithe in the southern part of the survey area (sub areas C+D) increased from about 20 % in 1997 to above 60 % in 2008, while it has decreased in later years to below 30 % in 2016 (Figure 5.2.1).

5.2.3 Recruitment indices

Owing to the near-shore 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 5.3.1)

Age composition data for 2016 were available for Norway and Germany. An ALK for Norwegian trawl and Danish seine was applied to Russian length data for Subareas IIa, and for IIb and I combined. Landings from other countries were assumed to have the same age composition as Norwegian trawl and Danish seine catches combined. 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, but had improved in 2016. The 2016 catch and sample data were uploaded to the InterCatch database.

Catch at age data was estimated by ECA for the 2017 assessment of NEA saithe. This is the first 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.

Due to time constraints, it was not possible to apply the manual method in 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 the 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 (Fbar), 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 5.3.2)

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, there were relatively small differences in weight at age for the most important age groups in 2016.

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 5.3.3)

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 5.3.4, Figures 5.3.1–5.3.2)

Until the 2005 WG, the XSA tuning was based on three data series: 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, in comparison to the trawl CPUE time series, seems to track the stock changes better, both in abundance and distribution.

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 2002-2016, age groups 3 to 7.

Figure 5.3.1 presents the tuning data by year and age for the two periods combined.

5.4 SAM runs and settings

In connection with the NEA saithe IBP a number of exploratory state–space assessment model (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 2016 AFWG, just one SAM run with 2015 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 5.5.1–5.5.5, Figures 5.5.1–5.5.4)

The state–space assessment model (SAM) was used for the final assessment with settings shown in Table 5.5.1. SAM catchabilities and negative log likelihood values are given in Table 5.5.2. The predictive power (AIC) of the model was estimated to 529.90.

Figure 5.5.1 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 5.5.2 shows plots of the tuning indices versus stock numbers from the SAM.

5.5.1 SAM F, N and SSB results (Tables 5.5.3–5.5.5, Figures 5.5.3–5.5.4)

The fishing mortality ($F_{4\text{-}7}$) in 2015 was 0.23, which is below the value of 0.31 from last year's assessment and well below the F_{pa} of 0.35. The fishing mortality ($F_{4\text{-}7}$) in 2016 was also 0.23. The fishing mortality was below F_{pa} from 1997 to 2009, but started to increase in 2005 and was above Fpa in 2010-2012.

Fishing mortality and stock size have in the last decade been considerably over- and underestimated, respectively, in the last assessment year. 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 5.5.4, and now shows signs of an opposite retrospective trend for the last years.

The SAM-estimate of the 2012-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. The 2005-year class is well above average level, the 2006-year below average strength, the 2007-year class is strong, the 2008-year class is poor, the 2009-year class a little below average strength, the 2010-year class is stronger than the 2009-year class and somewhat above average, while the 2011 year class is below average.

The total biomass (ages 3+) was above the long-term (1960-2016) average from 1996 to 2010, reached a maximum in 2005 and from that declined to below average level since 2011. The SSB was above the long-term mean from 2000 to 2009 and above B_{pa} from 1996 (Table 5.5.5). It declined from 2007 to 2011 and then increased again, and is presently (2017) estimated to be well above B_{pa} (Table 5.7.2).

5.5.2 Recruitment (Tables 5.3.1 and 5.5.6, Figure 5.1.1and 5.5.6)

Catches of age group 3 have varied considerably during the period 2004-2016 (Table 5.3.1). 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 5.1.1)

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 $\mathbf{F}_{mp}$. 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) in the beginning of the year for which the quota is set (first year of prediction), is below $\mathbf{B}_{pa}$, the procedure for establishing TAC should be based on a fishing mortality that is linearly reduced from $\mathbf{F}_{mp}$ at SSB=$\mathbf{B}_{pa}$ to 0 at SSB equal to zero. At SSB levels below $\mathbf{B}_{pa}$ 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 5.7.1)

The input data to the predictions based on results from the final model run are given in Table 5.7.1. The stock number at age in 2017 was taken from the SAM for age 4 (2013 year class) and older. The GM age 3 recruitment of 159 million was used for the 2014 and subsequent year classes. The natural mortality of 0.2 is the same as used in the assessment. For exploitation pattern the average of 2014-2016 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 2017 (short-term predictions)(Tables 5.7.2–5.7.3)

The management option table (Table 5.7.2) shows that the expected catch of 150,000 t in 2017 will increase the fishing mortality compared to 2016 from 0.23 to 0.24, which is well below the F_{pa} of 0.35. A catch in 2018 corresponding to the $F_{status\ quo}$ level (3-year average 2014-2016) of 0.24 will be 142,000 t, while a catch in 2018 corresponding to the evaluated and implemented HCR is 172,500 t, (Table 5.7.3). This catch corresponds to a fishing mortality of 0.31 in 2018.

For a catch in 2017 corresponding to the TAC, i.e. 150,000 t, the SSB is expected to decrease from about 465,000 t at the beginning of 2017 to 454,000 t at the beginning of 2018. At $F_{status\ quo}$ in 2018 SSB is estimated to decrease to 459,000 t at the beginning of 2018 and for a catch corresponding to the HCR it will decrease to about 425,000 t. Table 5.7.3 presents detailed output for fishing according to the HCR in 2017.

5.7.3 Comparison of the present and last year's assessment

The current assessment estimated the total stock in 2016 to be 25 % higher and the SSB 20 % higher, compared to the previous assessment. The F in 2015 is estimated to be 17 % lower than in the previous assessment and the realized F in 2016 is 22 % lower compared to the predicted one based on the TAC.

	Total stock (3+) by 1 January 2016 (tonnes)	SSB by 1 January 2016 (tonnes)	F4-7 in 2016	F4-7 in 2015
WG 2016	640003	391404	0,28	0,27
WG 2017	802912	469301	0,23	0,23

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 high 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 (Table 0.5). In 2015 this was in particular the case for samples from trawl in quarter two and three in ICES division I and age samples from purse seine fishery south of Lofoten and in quarter two in ICES division I. In 2016 the biological sampling of the purse seine and bottom trawl fishery was sufficient in areas with high catches. None the less,

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 5.1.1 Saithe in Sub-areas I and OO (Northeast and Arctic)

Table 5.1.1 Saithe in Sub-areas I and II (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	11 320	12 015	30 338		148 789	23		2 411	2 115	6 841		213 859
1974	46	7 119	29 466	33 155		152 699	2 521		28 931	7 075	3 104	5	264 121
1975	28	3 156	28 517	41 260		122 598	3 860	6 430	13 389	11 397	2 763	55	233 453
1976	20	5 609	10 266	49 056		131 675	3 164	7 233	9 013	21 661	4 724	65	242 486
1977	270	5 658	7 164	19 985		139 705	1	783	989	1 327	6 935		182 817
1978	809	4 345	6 484	19 190		121 069	35	203	381	121	2 827		155 464
1979	1 117	2 601	2 435	15 323		141 346			3	685	1 170		164 680
1980	532	1 016		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
1989	388	460 [2]		606		119 625			506	506	726		122 817
1990	1 207	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	1 980	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 [2]	154 903
1994	67 [2]	557	15	1 863	4 [2]	141 589		1 [2]	1 640 [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]	1 438	651 [2]	2 573	33	125 932		46	4 452	117	454	8 [2]	135 928
2001	537	1 279	701 [2]	2 690	57	124 928		75	4 951	119	514	2	135 853
2002	788	1 048	1 393	2 642	78	142 941		118	5 402	37	420	3	154 870
2003	2 056	1 022	929 [2]	2 763	80 [2]	150 400		147	3 894	18	265	18 [2]	161 592
2004	3 071	255	891 [2]	2 161	319	147 975		127	9 192	87	544	14	164 636
2005	3 152	447	817 [2]	2 048	395	162 338		354	8 362	25	630		178 568
2006	1 795	899	786 [2]	2 779	255	195 462	89	339 [2]	9 823	21 [2]	532	42	212 822
2007	2 048	966	810 [2]	3 019	219	178 644	99	412	12 168	53 [2]	558	12	199 008
2008	2 314	1 009	503 [2]	2 263	113	165 998	66	348	11 577	33	506	10	184 740
2009	1 611 [2]	326 2	697	2 021	69	144 570	30	204 [2]	11 899	2 [2]	379	45 [2]	161 853
2010	1 632	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	1 901	972	1 326 [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]	1 139	526	613	952	301	120 740	528	53	15 203	26	301	10	140 392

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 5.1.2 Saithe in Sub areas I and II (Northeast Arctic)

Year	Purse Seine	Trawl	Gill Net	Others	Total	
1977	75,2	69,5	19,3	12,7	176,7	2
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	14,8	175,5	
1982	76,4	59,4	16,7	15,5	168	
1983	54,1	68,2	19,6	15	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
1987	34,9	27,7	19	10,8	92,4	
1988	43,5	45,4	15,3	10	114,2	
1989	49,5	45	16,9	11,4	122,8	
1990	24,6	44	19,3	7,9	95,8	
1991	38,9	40,1	18,9	9,4	107,3	
1992	27,1	67	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	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	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	
2008	39,4	91,2	37	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	
2015	30,4	55,4	23,5	22,5	131,8	
2016 [1]	28,9	64,1	21,4	26,9	141,3	

Table 5.3.1 Catch numbers at age North-East 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
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

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

Table 5.3.3. 3-year running average maturity ogive 1985-2006, values for 2007-2015 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
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

Table 5.3.4 Northeast Arctic saithe. Tuning data sets applied in final SAM run

```
North-East Arctic saithe (Sub-areas I and II)
102
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     4.0
   1    38.0   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    21.0    19.2
   1   142.5   176.3    11.6    11.5     8.0
   1   275.9    45.9    53.8     5.6     6.1
FLT14: Norway Ac Survey (Catch: Unknown) (Effort: Unknown)
2002 2016
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   212.4   118.7    49.1    19.2     4.7
   1   228.1    67.2    20.3    16.5     7.7
   1    42.6   142.9    19.4     4.6     8.5
   1   111.0    27.1    61.1     7.9     5.8
   1    97.2    29.2    13.8    11.9     4.0
   1   139.8    80.2     7.7     5.2     6.8
   1   185.7    31.0    22.0     4.0     1.9
   1    46.9    77.7     5.2     5.7     1.0
   1    99.7    35.3    23.4     3.8     3.1
   1   113.4    19.8    10.9    11.1     2.8
   1    40.1    87.8    14.9     8.7     8.6
   1    72.3    29.0    34.2     7.5     5.8
   1   135.3    42.7    15.4    16.1     7.5
```

Table 5.5.1 SAM parameter settings

Model used: State-space assessment model SAM (https://www.stockassessment.org).
Software used: AD Model Builder (ADMB) and R.
Visible stock on (https://www.stockassessment.org) “saithe_afwg2016”.
Model Options agreed upon at IBP saithe winter 2014.

```
# Min Age (should not be modified unless data is modified accordingly)
3
# Max Age (should not be modified unless data is modified accordingly)
12
# Max Age considered a plus group (0=No, 1=Yes)
1
# The following matrix describes the coupling
# of fishing mortality STATES
# Rows represent fleets.
# Columns represent ages. Flat F from age group 8
1	2	3	4	5	6	6	6	6	6
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
# Use correlated random walks for the fishing mortalities
# ( 0 = independent, 1 = symmetrical correlation estimated, 2=AR(1)-correlation estimated)
2
# Coupling of catchability PARAMETERS
0	0	0	0	0	0	0	0	0	0
1	2	3	4	4	0	0	0	0	0
5	6	7	8	8	0	0	0	0	0
# Coupling of power law model EXPONENTS (if used)
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
# Coupling of fishing mortality RW VARIANCES
1	1	1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
# Coupling of log N RW VARIANCES
1	2	2	2	2	2	2	2	2	2
# Coupling of OBSERVATION VARIANCES
1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	0	0	0	0	0
3	3	3	3	3	0	0	0	0	0
# Stock recruitment model code (0=RW, 1=Ricker, 2=BH, ... more in time)
2
# Years in which catch data are to be scaled by an estimated parameter
0
# First the number of years
# Then the actual years
# Then the model config lines years cols ages
# Define Fbar range
4	7
```

Table 5.5.2 SAM catchabilities, negative log likelihood values and number of parameters

Table 5.5.2. SAM catchabilities, negative log likelihood values and number of parameters.

Index	Fleet number	Age	Catchability	Low	High
1	2	3	0.87832	0.59886	1.28819
2	2	4	1.18336	0.80802	1.73304
3	2	5	0.61235	0.41774	0.89764
4	2	6	0.37665	0.27987	0.50689
5	2	7	0.37665	0.27987	0.50689
6	3	3	0.78998	0.63008	0.99046
7	3	4	0.59927	0.47798	0.75133
8	3	5	0.31085	0.24723	0.39084
9	3	6	0.20100	0.16432	0.24587
10	3	7	0.20100	0.16432	0.24587

Model	Negative log likelihood	Number of parameters
Base	515.74	17
Current	529.80	17

Table 5.5.3 Estimated fishing mortalities

Table 5.5.3. Estimated fishing mortalities.

Year\Age	3	4	5	6	7	8+
1960	0.236	0.284	0.320	0.277	0.221	0.163
1961	0.222	0.259	0.273	0.226	0.174	0.127
1962	0.222	0.261	0.268	0.225	0.177	0.133
1963	0.225	0.273	0.281	0.238	0.194	0.154
1964	0.238	0.298	0.318	0.277	0.241	0.208
1965	0.235	0.292	0.325	0.288	0.253	0.230
1966	0.260	0.319	0.342	0.288	0.244	0.224
1967	0.260	0.309	0.317	0.263	0.224	0.216
1968	0.221	0.240	0.229	0.184	0.153	0.147
1969	0.230	0.240	0.221	0.174	0.143	0.131
1970	0.328	0.361	0.340	0.283	0.250	0.239
1971	0.359	0.384	0.356	0.294	0.269	0.258
1972	0.380	0.391	0.350	0.283	0.259	0.244
1973	0.419	0.428	0.386	0.317	0.299	0.284
1974	0.541	0.561	0.513	0.429	0.416	0.394
1975	0.596	0.621	0.568	0.478	0.487	0.476
1976	0.649	0.682	0.611	0.498	0.495	0.469
1977	0.574	0.613	0.540	0.430	0.416	0.377
1978	0.572	0.650	0.595	0.487	0.474	0.429
1979	0.552	0.675	0.635	0.527	0.506	0.450
1980	0.494	0.637	0.619	0.519	0.481	0.420
1981	0.459	0.631	0.622	0.522	0.461	0.391
1982	0.423	0.622	0.623	0.527	0.451	0.374
1983	0.403	0.629	0.653	0.594	0.532	0.451
1984	0.444	0.712	0.728	0.719	0.680	0.588
1985	0.354	0.593	0.614	0.650	0.681	0.590
1986	0.247	0.457	0.504	0.577	0.653	0.594
1987	0.230	0.463	0.540	0.671	0.812	0.751
1988	0.218	0.460	0.541	0.661	0.768	0.655
1989	0.202	0.422	0.469	0.522	0.531	0.399
1990	0.222	0.475	0.521	0.590	0.599	0.450
1991	0.192	0.427	0.480	0.554	0.570	0.431
1992	0.173	0.430	0.542	0.690	0.753	0.601
1993	0.131	0.355	0.476	0.622	0.680	0.541
1994	0.101	0.297	0.420	0.569	0.630	0.504
1995	0.082	0.248	0.337	0.438	0.473	0.373
1996	0.073	0.225	0.313	0.420	0.487	0.416
1997	0.053	0.163	0.226	0.297	0.339	0.292
1998	0.047	0.154	0.221	0.298	0.348	0.323
1999	0.046	0.159	0.230	0.300	0.340	0.323
2000	0.040	0.142	0.207	0.270	0.299	0.293
2001	0.031	0.119	0.181	0.241	0.269	0.275
2002	0.028	0.113	0.173	0.235	0.267	0.294
2003	0.026	0.107	0.162	0.221	0.267	0.328
2004	0.024	0.097	0.149	0.208	0.264	0.352
2005	0.033	0.127	0.180	0.240	0.292	0.383
2006	0.040	0.153	0.210	0.281	0.345	0.461
2007	0.046	0.165	0.219	0.288	0.348	0.464
2008	0.068	0.232	0.281	0.348	0.409	0.533
2009	0.080	0.265	0.311	0.364	0.416	0.533
2010	0.099	0.317	0.359	0.394	0.427	0.519
2011	0.100	0.305	0.353	0.391	0.428	0.503
2012	0.104	0.293	0.331	0.356	0.386	0.446
2013	0.088	0.239	0.268	0.282	0.306	0.353
2014	0.079	0.211	0.235	0.242	0.267	0.316
2015	0.078	0.208	0.228	0.226	0.245	0.289
2016	0.075	0.206	0.228	0.226	0.250	0.305

Table 5.5.4 Estimated stock numbers

Table 5.5.4. Estimated stock numbers.

Year\Age	3	4	5	6	7	8	9	10	11	12+
1970	222126	167209	58747	54666	22629	29792	9153	14026	5149	7233
1971	230268	143918	87116	35703	32860	14444	17732	6482	9242	7964
1972	154199	138413	85819	46583	23063	19683	9639	10467	4253	10181
1973	201793	80660	79221	52156	27889	15458	12740	6778	6435	8960
1974	101417	111302	42024	45936	32663	16848	10262	8260	4261	9100
1975	168215	44623	53104	20056	23766	17819	9332	6013	4773	7204
1976	217510	75207	19452	25771	10564	11417	8696	4718	3067	5810
1977	199586	89769	31008	8464	13312	5482	5718	4292	2327	4257
1978	134323	89411	38638	15028	4607	7298	3209	3110	2412	3977
1979	193300	59695	38793	17266	7691	2367	4019	1761	1562	3441
1980	117712	94183	23624	16967	8598	3672	1143	2071	964	2694
1981	224583	56727	43217	10051	8308	4422	1854	689	1074	1850
1982	128412	120813	24270	19374	4726	4380	2262	1042	397	1649
1983	101722	68734	52208	9918	9283	2580	2502	1255	607	1288
1984	93901	58571	31008	20135	4341	4533	1302	1335	712	1056
1985	102232	42319	23506	13094	6973	1938	2092	561	612	831
1986	173685	48972	17749	11102	6067	2414	950	957	270	637
1987	138690	127516	22471	8297	5459	2793	854	478	426	463
1988	78984	97929	72548	10907	3401	2020	1313	235	200	299
1989	77343	54231	54014	37086	4787	1184	820	611	56	285
1990	87116	47667	29584	26108	18385	2409	598	462	366	214
1991	224583	48630	22226	15176	11190	8435	1233	300	264	322
1992	280127	142629	22743	10958	7792	4996	4669	646	169	368
1993	207524	211716	76191	10213	4286	3109	1968	2302	281	237
1994	149194	160653	131400	37459	4364	1727	1486	771	1231	267
1995	277618	130483	110636	74682	15656	1853	804	775	313	815
1996	161943	243775	87553	67846	39815	7962	1036	485	446	698
1997	163898	122272	177549	57584	39616	21197	4158	509	260	626
1998	103777	134457	84881	126880	32794	23885	12723	2548	332	620
1999	236807	78198	94656	54068	73424	18361	14855	7572	1474	573
2000	154045	188528	50615	55548	31508	40579	11264	9462	4333	1132
2001	204638	103881	135537	34718	32958	19101	24077	7162	5960	3175
2002	319017	168552	75584	89859	23179	20382	12577	14879	4429	5804
2003	138413	286072	120090	50212	54776	16627	12554	8487	9041	6364
2004	151903	115266	199187	86422	34996	35419	10624	7315	5360	8991
2005	401515	121905	78276	123007	56050	23459	21653	6665	3787	7502
2006	71970	322223	84711	48923	71111	34579	14529	12253	3786	6029
2007	114806	55548	207731	55770	31445	39027	19504	8080	6134	4381
2008	215346	80822	42108	113550	32273	17202	19628	10602	4106	5063
2009	149941	163898	47335	27474	61023	16574	8074	9150	5203	4212
2010	269952	101620	97538	28311	15119	32565	7961	3793	4084	4298
2011	107152	203822	52365	50362	15221	8476	15626	3938	1833	3868
2012	159692	88787	129056	32403	25822	8885	4455	7539	1900	2796
2013	220136	99409	62755	81879	19827	13677	4892	2441	3813	2448
2014	103156	182225	70615	46677	52839	12193	7681	3048	1439	3588
2015	146972	81797	135944	50665	32696	32370	7290	4369	1897	3121
2016	171442	110304	59219	92226	36316	20773	19561	4458	2732	3433
pred		130215	73512	38592	60215	23161	12540	11808	2691	3722

Table 5.5.5. Estimated recruitment, total stock biomass (TBS), spawning stock biomass (SSB), and average fishing mortality for ages 4 to 7 (F47)

Year	Recruits	Low	High	TSB	Low	High	SSB	Low	High	F47	Low	High
1970	222126	147491	334529	972864	816474	1159211	567502	457074	704610	0.308	0.236	0.403
1971	230268	153587	345235	955510	806959	1131406	555709	452616	682283	0.326	0.251	0.423
1972	154199	102942	230979	880284	746425	1038149	537670	441517	654763	0.321	0.249	0.414
1973	201793	134753	302187	847461	723036	993298	537132	446150	646669	0.358	0.279	0.458
1974	101417	67392	152622	736011	630934	858588	492870	411403	590469	0.479	0.378	0.607
1975	168215	112241	252105	614768	526869	717331	399113	334258	476552	0.539	0.427	0.679
1976	217510	144758	326825	543074	459631	641664	282377	234955	339372	0.572	0.454	0.719
1977	199586	133223	299006	477347	400958	568290	210239	174316	253565	0.500	0.396	0.631
1978	134323	89581	201410	417066	352579	493348	189662	158327	227200	0.551	0.439	0.693
1979	193300	128955	289752	408808	341414	489505	170928	142665	204790	0.586	0.467	0.734
1980	117712	78581	176331	391210	326850	468244	151146	126124	181131	0.564	0.449	0.707
1981	224583	148833	338886	441971	363247	537757	154817	128499	186526	0.559	0.445	0.701
1982	128412	85455	192964	398316	328760	482588	135537	112493	163302	0.556	0.442	0.699
1983	101722	67481	153338	407583	339478	489351	161781	133140	196583	0.602	0.481	0.753
1984	93901	62047	142110	322546	270793	384189	145947	120508	176757	0.710	0.570	0.883
1985	102232	67570	154675	270763	225882	324561	111525	92491	134474	0.635	0.507	0.795
1986	173685	114275	263983	263814	214426	324578	84036	69605	101459	0.548	0.436	0.688
1987	138690	91963	209161	277063	225132	340973	71826	59544	86641	0.621	0.500	0.772
1988	78984	51820	120386	292728	239802	357335	86163	70893	104723	0.607	0.487	0.757
1989	77343	50910	117498	278173	228888	338071	100007	77462	129115	0.486	0.385	0.614
1990	87116	57040	133053	270493	225631	324274	118066	94050	148215	0.546	0.434	0.688
1991	224583	148467	339721	354690	287817	437101	114577	93731	140059	0.508	0.402	0.641
1992	280127	185146	423835	463703	372503	577232	95130	79750	113477	0.604	0.482	0.757
1993	207524	138054	311951	529665	428198	655177	97343	80844	117210	0.533	0.425	0.669
1994	149194	101367	219586	482627	399283	583368	148153	120136	182704	0.479	0.378	0.606
1995	277618	187982	409995	585370	486349	704552	196222	157286	244796	0.374	0.293	0.478
1996	161943	110512	237309	680103	568533	813569	244019	198519	299947	0.361	0.282	0.463
1997	163898	111687	240516	722881	602795	866891	243531	198817	298302	0.256	0.198	0.332
1998	103777	70888	151925	799706	666891	958973	292436	239005	357811	0.255	0.196	0.332
1999	236807	161720	346757	799706	672792	950561	308045	248694	381559	0.257	0.197	0.336
2000	154045	105217	225533	815862	689994	964690	367692	297313	454730	0.230	0.176	0.300
2001	204638	140975	297051	864581	735124	1016836	371759	304713	453556	0.202	0.155	0.264
2002	319017	224848	452625	974812	835300	1137626	439327	365682	527804	0.197	0.152	0.256
2003	138413	97267	196965	949794	812125	1110799	425917	357526	507391	0.189	0.146	0.245
2004	151903	105120	219507	987567	840431	1160463	508897	430706	601282	0.180	0.138	0.235
2005	401515	281216	573275	1066614	910395	1249640	591845	498464	702720	0.210	0.161	0.273
2006	71970	50585	102394	918962	785561	1075016	527551	447465	621969	0.247	0.191	0.320
2007	114806	80909	162905	875894	745266	1029418	544705	462584	641405	0.255	0.197	0.330
2008	215346	152763	303568	752382	644969	877684	473071	396743	564083	0.317	0.247	0.408
2009	149941	106300	211500	695231	595993	810994	365492	306210	436251	0.339	0.264	0.434
2010	269952	192275	379011	710696	605355	834368	331705	277795	396075	0.374	0.292	0.480
2011	107152	75284	152509	591845	501862	697962	297747	247537	358142	0.369	0.286	0.476
2012	159692	113360	224960	606828	511504	719916	307737	254136	372642	0.342	0.264	0.442
2013	220136	155453	311732	632225	527534	757692	333367	268225	414331	0.274	0.209	0.359
2014	103156	71903	147993	694537	573317	841386	383080	302422	485250	0.239	0.180	0.317
2015	146972	100216	215544	679424	548740	841230	407583	314217	528691	0.227	0.167	0.308
2016	171442	106799	275213	802912	630091	1023133	469301	348488	631997	0.228	0.159	0.325

Table 5.7.1 Northeast arctic saithe. Prediction input data

MFDP version 1a
Run: a26
Time and date: 10:24 26.04.2017
Fbar age range: 4-7

2017

Age	N	M	Mat	PF	PM	SWt	Sel
3	158831	0,2	0	0	0	0,703	0,077
4	130215	0,2	0,05	0	0	0,938	0,208
5	73512	0,2	0,42	0	0	1,428	0,230
6	38592	0,2	0,87	0	0	2,015	0,231
7	60215	0,2	0,97	0	0	2,451	0,254
8	23161	0,2	0,98	0	0	3,210	0,303
9	12540	0,2	0,98	0	0	3,837	0,303
10	11808	0,2	0,97	0	0	4,366	0,303
11	2691	0,2	0,97	0	0	4,619	0,303
12	3722	0,2	0,994	0	0	5,959	0,303

2018

Age	N	M	Mat	PF	PM	SWt	Sel
3	158831	0,2	0	0	0	0,703	0,077
4	.	0,2	0,05	0	0	0,938	0,208
5	.	0,2	0,42	0	0	1,428	0,230
6	.	0,2	0,87	0	0	2,015	0,231
7	.	0,2	0,97	0	0	2,451	0,254
8	.	0,2	0,98	0	0	3,210	0,303
9	.	0,2	0,98	0	0	3,837	0,303
10	.	0,2	0,97	0	0	4,366	0,303
11	.	0,2	0,97	0	0	4,619	0,303
12	.	0,2	0,994	0	0	5,959	0,303

2019

Age	N	M	Mat	PF	PM	SWt	Sel
3	158831	0,2	0	0	0	0,703	0,077
4	.	0,2	0,05	0	0	0,938	0,208
5	.	0,2	0,42	0	0	1,428	0,230
6	.	0,2	0,87	0	0	2,015	0,231
7	.	0,2	0,97	0	0	2,451	0,254
8	.	0,2	0,98	0	0	3,210	0,303
9	.	0,2	0,98	0	0	3,837	0,303
10	.	0,2	0,97	0	0	4,366	0,303
11	.	0,2	0,97	0	0	4,619	0,303
12	.	0,2	0,994	0	0	5,959	0,303

Input units are thousands and kg - output in tonnes

Table 5.7.2 Northeast Arctic saithe. Short term prediction

MFDP version 1a
Run:
a26
North-East Arctic saithe
Time and date: 10:24 26.04.2017
Fbar age range:
4-7

2017				
Biomass	SSB	FMult	FBar	Landings
772766	465149	1,0595	0,2447	150000

2018					2019	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
763000	454042	0	0	0	922802	586549
.	454042	0,1	0,0231	15827	904547	571525
.	454042	0,2	0,0462	31269	886744	556896
.	454042	0,3	0,0693	46337	869381	542651
.	454042	0,4	0,0924	61040	852447	528779
.	454042	0,5	0,1155	75387	835931	515270
.	454042	0,6	0,1386	89388	819822	502116
.	454042	0,7	0,1617	103051	804109	489305
.	454042	0,8	0,1848	116386	788782	476830
.	454042	0,9	0,2079	129401	773832	464681
.	454042	1	0,231	142103	759248	452850
.	454042	1,1	0,2541	154501	745021	441328
.	454042	1,2	0,2772	166604	731142	430106
.	454042	1,3	0,3003	178417	717602	419177
.	454042	1,4	0,3234	189949	704392	408533
.	454042	1,5	0,3465	201207	691504	398167
.	454042	1,6	0,3696	212198	678929	388070
.	454042	1,7	0,3927	222929	666659	378237
.	454042	1,8	0,4158	233406	654687	368659
.	454042	1,9	0,4389	243636	643005	359330
.	454042	2	0,462	253625	631606	350244

Input units are thousands and kg - output in tonnes

Table 5.7.3. Northeast arctic saithe. Short term projection output HCR landings

MFDP version 1a
Run: a28
a27MFDP Index file
26.04.2017
Time and date: 10:38 26.04.2017
Fbar age range: 4-7

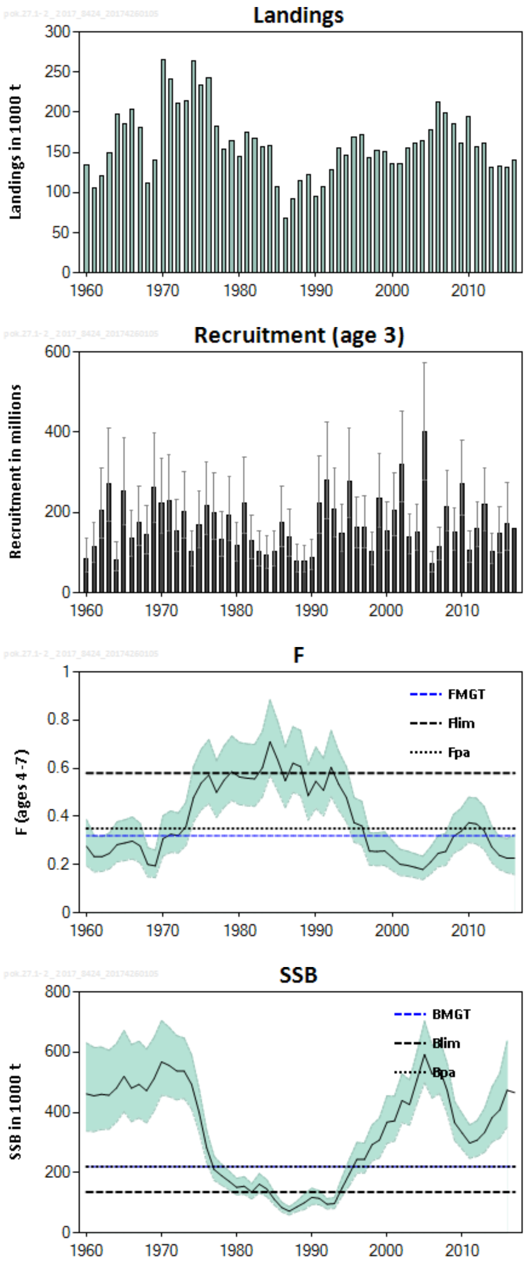
2017							
Biomass	SSB	FMult	FBar	Landings			Fmp (0.32) landings
772766	465149	1,0595	0,2447	150000			
							188269
2018							171037
Biomass	SSB	FMult	FBar	Landings			158774
763000	454042	1,2496	0,2887	172500		average	172693

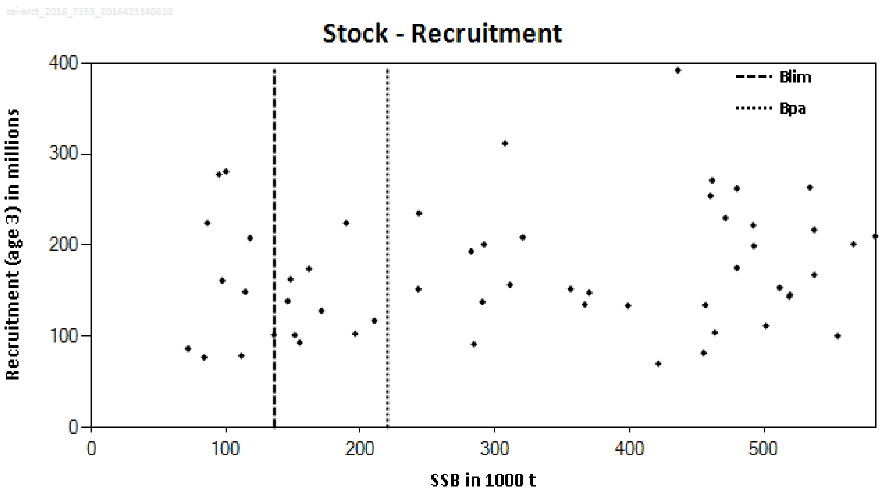
The TAC should not be changed by more than 15% compared with the previous year'

172500

2019					2020	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
724383	424648	0	0	0	878576	545726
.	424648	0,1	0,0231	14772	861635	531938
.	424648	0,2	0,0462	29191	845107	518506
.	424648	0,3	0,0693	43265	828981	505423
.	424648	0,4	0,0924	57002	813247	492677
.	424648	0,5	0,1155	70413	797895	480261
.	424648	0,6	0,1386	83504	782915	468166
.	424648	0,7	0,1617	96285	768298	456383
.	424648	0,8	0,1848	108762	754034	444904
.	424648	0,9	0,2079	120944	740115	433721
.	424648	1	0,231	132838	726532	422827
.	424648	1,1	0,2541	144452	713275	412213
.	424648	1,2	0,2772	155792	700338	401872
.	424648	1,3	0,3003	166865	687711	391797
.	424648	1,4	0,3234	177679	675387	381982
.	424648	1,5	0,3465	188239	663359	372418
.	424648	1,6	0,3696	198553	651618	363101
.	424648	1,7	0,3927	208626	640158	354023
.	424648	1,8	0,4158	218464	628971	345177
.	424648	1,9	0,4389	228073	618051	336559
.	424648	2	0,462	237460	607390	328161

Input units are thousands and kg - output in tonnes


Landings
Landings in 1000 t
Recruitment (age 3)
Recruitment in millions
F
F (ages 4-7)
FMGT
Flim
Fpa
SSB
SSB in 1000 t
BMGT
Blim
Bpa


Stock - Recruitment
Recruitment (age 3) in millions
SSB in 1000 t
Blim
Bpa

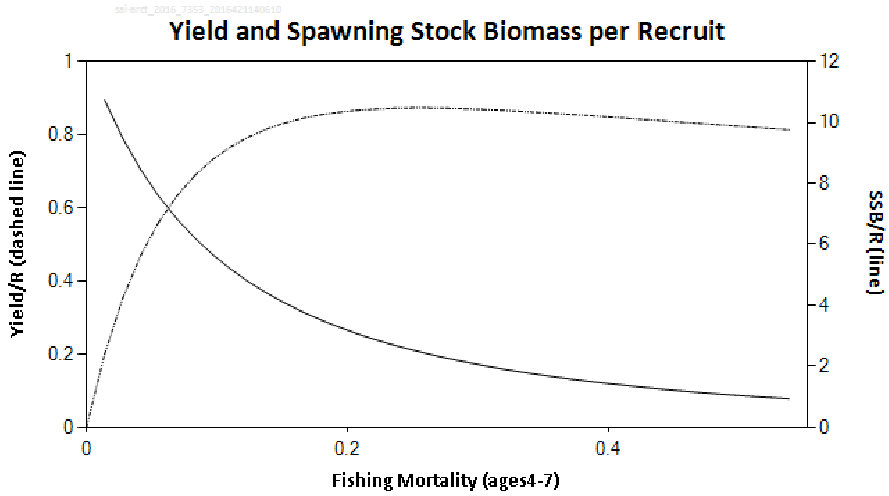


Figure 5.1.1 Northeast Arctic saithe (Subareas I and II)

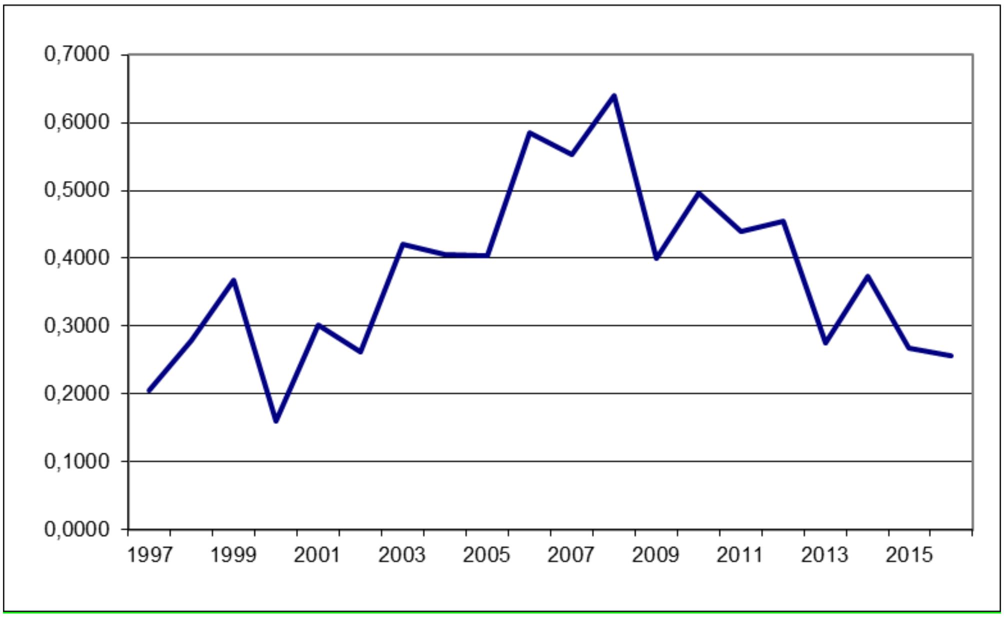


Figure 5.2.1. Northeast Arctic saithe. Proportion of saithe in the southern half of the survey area (sub area C+D).

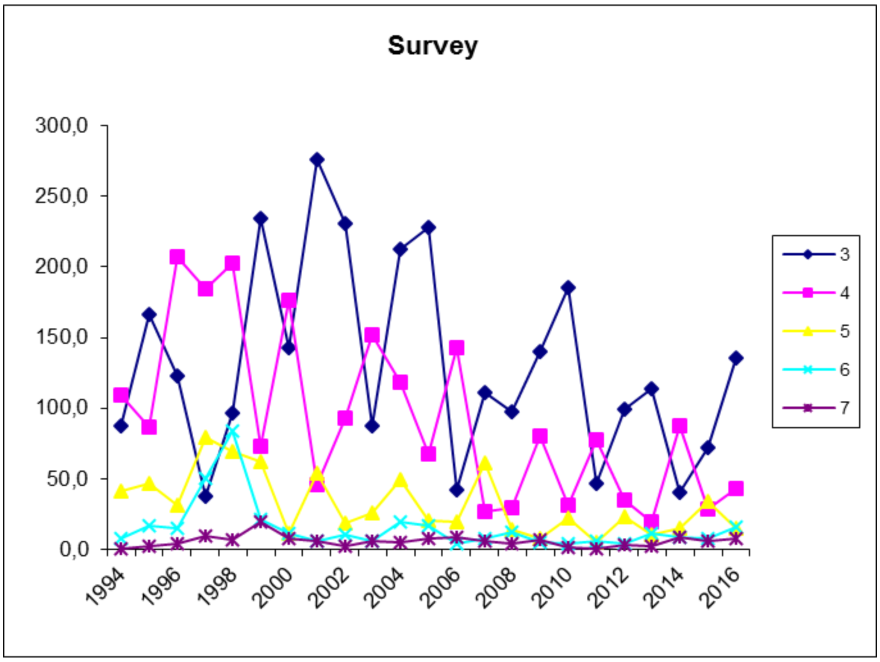


Figure 5.3.1 Northeast Arctic saithe, acoustic survey tuning indices, break in 2002 black line

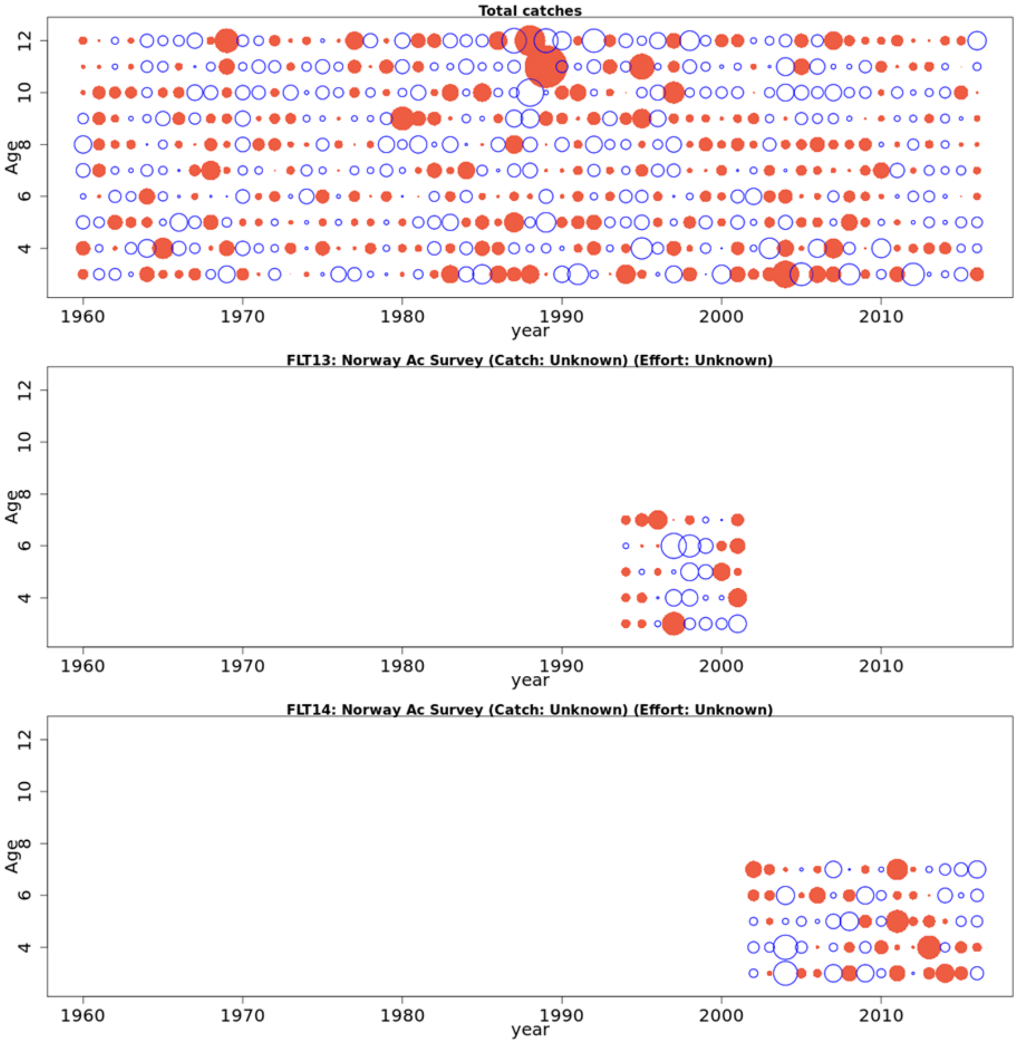


Figure 5.5.1. Northeast Arctic saithe. Final run normalized residuals. Blue circles indicate positive residuals (obs larger than predicted) and filled red circles indicate negative residuals.

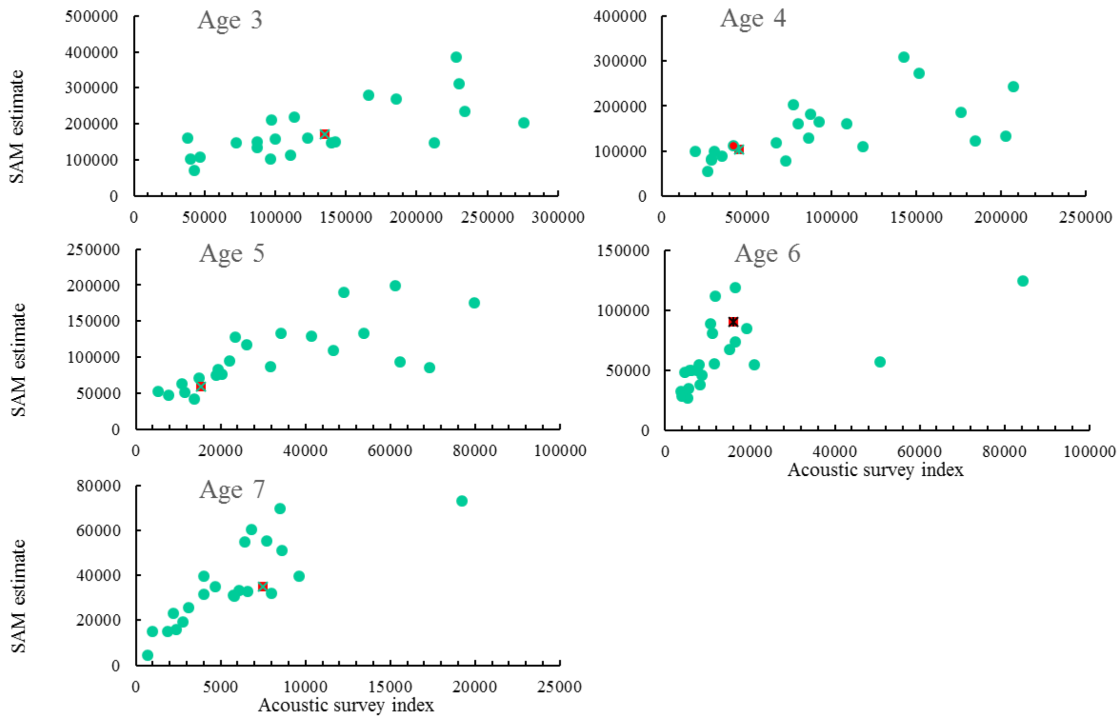


Figure 5.5.2. NEA Saithe - Acoustic survey vs. SAM, red circle shows last data year

.

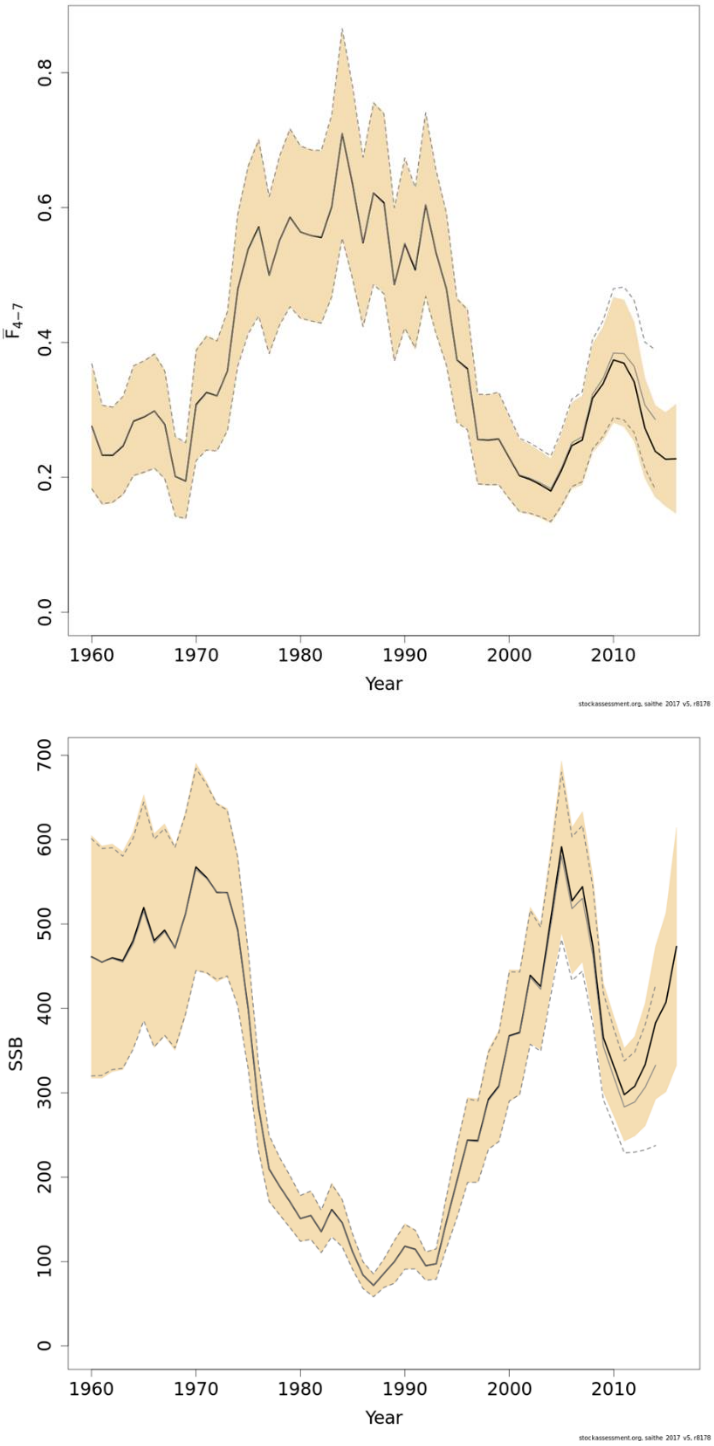


Figure 5.5.3 F_{4-7} and SSB. Estimates from the current run and point wise 95% confidence intervals are shown by black line and shaded area.

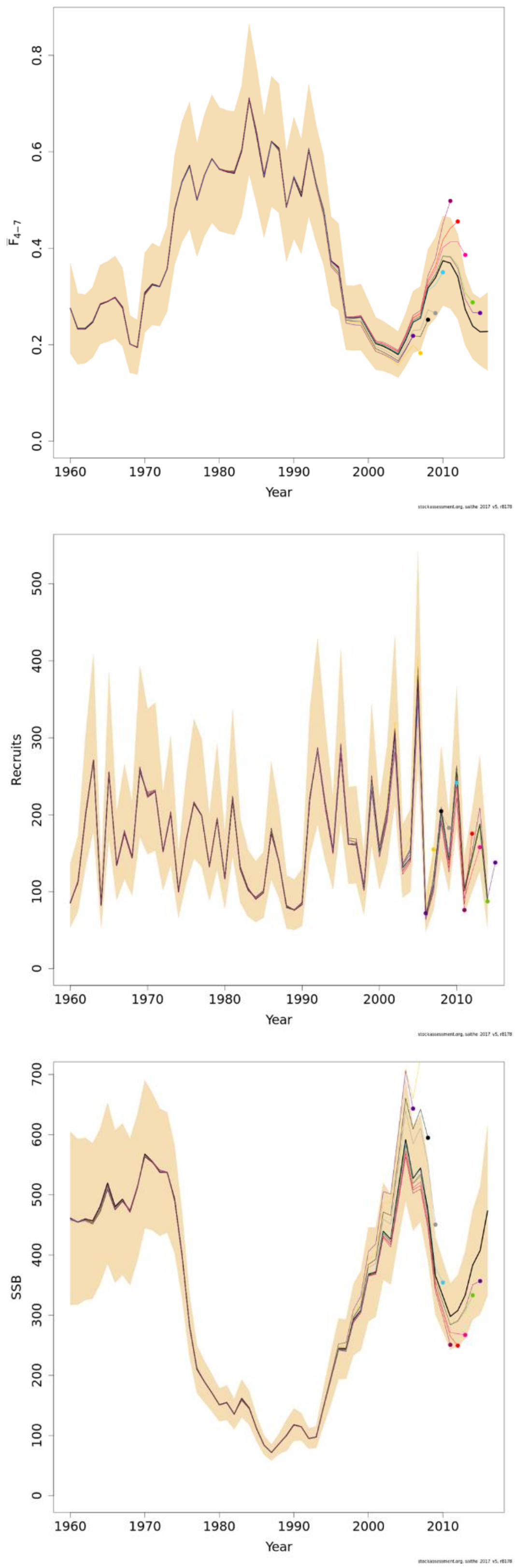


Figure 5.5.4 Saithe in Sub-areas I and II (Northeast Arctic) RETROSPECTIVE SAM F_{4-7}, recruits and SSB.