8 Icelandic saithe

8.1 Summary

- The assessment model is a separable statistical catch-at-age model implemented in AD Model Builder. Selectivity is age-specific and varies between three periods: 1980-1996, 1997-2003, and 2004 onwards.
- Icelandic saithe stock biomass declined by one third from 2004 to 2009, but appears to be increasing since then, and is now around the long-term average. The fishing mortality has fluctuated around 0.3 between 1998 and 2011, decreasing from around 0.4 in the mid 1990s. Year classes 1998-2000 and 2002 were large, but recruitment since then has been around the long-term average.
- An issue in this year's assessment involves the 2008 cohort which is estimated large by the default assessment model, and this increases the biomass estimate compared to recent years. However, the size of the 2008 cohort is very uncertain, due to mixed signals about this cohort in the commercial and survey catch-at-age data.
- The discrepancy between the default separable model and a TSA model (NWWG 2012 WD 27) is greater than in recent years, estimating the current biomass as 265 kt and 219 kt, respectively. This difference is mainly due to uncertainty about the 2008 cohort. Next year's data should decrease this uncertainty about the 2008 cohort size. If the 2008 cohort does not turn out to be large, then the current biomass estimate of 265 kt is most likely an overestimate.
- Biological reference points were estimated in a recent benchmark (ICES 2010): F_{MSY}=0.28, $B_{trigger}$=80 kt (candidate for B_{pa}), and B_{loss}=65 kt (candidate for B_{lim}).
- The estimation of the reference point F_{MSY}=0.28 (ICES 2010) was based on the selectivity pattern estimated in 2010. The currently estimated selectivity targets younger fish, and simulation analysis with this selectivity would lead to a different F_{MSY}.
- Two implementations of the MSY approach have been analyzed, called F-rule (fixed target F) and B-rule (fixed proportion of biomass). The two approaches give similar results, but the B-rule is more robust to changes in selectivity, and reduces the probability of giving advice that leads to temporary overfishing or underutilization.
- The NWWG recommends that the advice for 2013 is based on the MSY approach B-rule, corresponding to landings of 49 kt.

8.2 Stock description and management units

Description of the stock and management units is provided in the stock annex.

8.3 Fisheries-dependent data

8.3.1 Landings, advice and TAC

Landings of saithe in Icelandic waters in 2011 are estimated to have been 51,123 t (Table 8.1 and Figure 8.1). Of the landings, 40,692 were caught by trawl, 3,428 t

caught by gillnets, and 7,003 t caught by other means. The domestic as well as ICES advice for the fishing year 2011/2012 was based on F_{MSY} resulting in 45,000 t. The TAC issued was 52,000 t. The trajectory of the landings in the current fishing year and calendar year is shown in Figure 8.2.

Most of the catch is caught in bottom trawl (82% in 2007-2011), with gillnet and jiggers taking the majority of the rest. The share taken by the gillnet fleet was larger in the past, 25% in 1982-1996 compared to 9% in 1997-2011 (Figure 8.1).

8.3.2 Landings by age

Catch in numbers by age based on landings are listed in Table 8.2. Discarding is not considered to be a problem in the Icelandic saithe fisheries, for which monitoring programmes have been in place (annual reports by Palsson *et al*. 2003 and later). Comparison of sea and harbour samples indicate that discards have been small in most years since 2000. The sea samples constitute about 60-70% of the length samples used in the calculation of the catch in number. Since the amount of discard is likely to be small, not taking discards into account in the total catches and catch in numbers is not considered to have major effect on the stock dynamics estimated.

The sampling program and sampling intensity in 2011, as well as the approach used for calculating catch in numbers is the same as in preceding years. The sampling level in 2011 is indicated in the following text table:

Gear/nation	Landings (t)	No. of otolith samples	No. of otoliths read	No. of length samples	No of length measurements
Gillnets	3428	6	299	30	5239
Jiggers	3780	7	338	16	2170
Danish seine	1439	2	100	12	815
Bottom trawl	39955	76	3800	189	24798
Other gear	1784	-	-	78	522
Foreign landings	737	-	-	-	-
Total	51123	91	4537	325	33544

Gillnet catches are split according to a gear-specific age-length key, the rest of the catches are split according to a key based on all samples from commercial gear except those from gillnets. The length-weight relationship used (W = 0.02498 * L^2.75674) is applied to length distributions from both fleets.

8.3.3 Mean weight and maturity at age

Weight at age has declined rather steadily in 1980-2011, but weights of 5 to 8 year-olds has increased rapidly in recent years and are close to the long-term average (Table 8.3 and Figure 8.3). Weight at age in the landings is also used as weight at age in the stock. Weights for 2012 are estimated by applying a linear model using survey weights and the weight of a year class in the previous year as predictors (see stock annex).

A model using maturity-at-age data from the Icelandic groundfish spring survey (Table 8.4 and Figure 8.4) is used to derive smoothed trends in maturity by age and year (see stock annex).

8.3.4 Logbook data

Commercial CPUE indices are not used for tuning in this assessment. Although these indices have been explored for inclusion in the past, they were not considered for inclusion in the benchmark (ICES 2010), as the trends in CPUE are considered unreliable as an indicator of changes in abundance.

8.4 Scientific surveys

In the benchmark, spring survey data were considered superior to the autumn survey for calibrating the assessment. Saithe is among the most difficult demersal fishes to get reliable information on from bottom trawl surveys. In the spring survey, which has 500-600 stations, large proportion of the saithe is caught in relatively few hauls and there seems to be considerable inter-annual variability in the number of these hauls.

The survey biomass indices were high in the beginning of the period, low in the period 1995-2001, high in the period around 2005, declining to a low level in recent years, but the 2012 survey biomass index is relatively high (Table 8.5 and Figure 8.5).

Internal consistency in the surveys measured by the correlation of the indices for the same year class in 2 adjacent surveys is poor, with R^2 close to 0.3 for the best-defined age groups, and much lower for some other.

Young saithe tend to live very close to shore, so it is not surprising that survey indices for ages 1 and 2 are poor measures of recruitment, and the number of those saithe caught in the survey is very low.

8.5 Assessment method

In accordance with the recommendation from the benchmark (ICES 2010), a separable forward-projecting statistical catch-age model, developed in AD Model Builder, is used to fit commercial catch at age (ages 3-14, years 1980-2011) and survey catch at age (ages 1-10, years 1985-2012). Natural mortality is set at 0.2 for all age groups.

Selectivity is age-specific, and varies between three periods: 1980-1996, 1997-2003, and 2004 onwards (Figure 8.6). The selectivity pattern is constant within each period. This is the same model used in last year's assessment, when the third period was added.

The commercial catch-at-age residuals (Table 8.6 and Figure 8.7) are relatively small in recent years, owing to the model flexibility provided by the two recent selectivity periods 1997-2003 and 2004 onwards. The survey catch-at-age residuals (Table 8.7 and Figure 8.7) have year blocks with all residuals being only negative or only positive in a given year. The survey residuals are modelled as multivariate normal distribution with the correlation estimated (one coefficient).

8.6 MSY considerations, HCR and reference points

8.6.1 Background

Stochastic simulations to estimate likely advisory reference points were done during the benchmark workshop (ICES 2010). It was concluded that the simulations included enough uncertainty so that F=0.28 can be used as a fishing mortality upon which an advisory catch could be set. It was also concluded that the estimated breakpoint / Bpa of 80 kt is a candidate for Btrigger. The estimated value of Bloss of 65 kt was regarded

as a candidate for Blim. The benchmark workshop also concluded that a 20% rule based on a proportion of stock biomass (B4+) as estimated in the assessment year would achieve the same objectives as an F=0.28 applied in the advisory year. That is, in terms of high long-term yield and low probability that the stock would go below Bloss. Following the benchmark, ACOM based its TAC advice for 2011 and 2012 on the above values.

The F-based rule is the traditional/conventional method used by ICES, i.e. where the stock in numbers, catch weight at age and selection pattern are estimated in the beginning of the advisory year. Given of course assumptions of selection pattern, catch weights, and F or TAC in the advisory year.

The B-based rule as defined here is based on taking a certain proportion of a reference biomass in the assessment year. If the weight at age used to calculate the reference biomass are survey weights from the current year then no additional calculations are needed. If the weight at age in the reference biomass are catch weights (as is the case for saithe) some additional predictions of catch weights in the assessment year are required. In the case of the gadoid stocks in Icelandic waters, the convention is to predict the current year's catch weights using a linear model, with the current year's survey weights and the previous year's catch weights as predictors, in some cases with the inclusion of an additional factor. For the Icelandic cod the established HCR is based on the biomass estimates of ages 4+. Since the first age with any significant numbers in the catches of saithe are similar to that of cod, it was also chosen as the reference biomass.

The analysis done at the benchmark was repeated for the NWWG 2012 using the same framework as used in the 2010 benchmark. The reason for repeating the analysis was that the model used for the advice is a separable model, where during the benchmark the periods where constant selection pattern is assumed were only two: 1980-1996 and 1997 onwards. In 2011, the NWWG set in an additional period, hence assuming that selectivity was constant within 3 periods: 1980-1996, 1997-2003 and 2004 onward. That assessment indicated that in recent years the fleet was taking a higher portion of younger fish than in preceding years (Figure 8.8). Since the establishment of an Fmsy as an advisory reference value upon which the TAC advice is based (0.28, set in 2010) was based on a selection pattern targeting older fish, questions arose if the Fmsy value established at the benchmark were still valid given the currently estimated selection pattern. The analysis was hence repeated prior to this WG meeting using the same framework as used in the Benchmark (technical details and settings described in WD 27).

8.6.2 Results

The analysis of the estimated SSB breakpoint of 80kt from the benchmark could not be repeated. In order to check if this was due to addition of new datapoints, a retrospective analysis of the current time series back to the year 2000 was done. The estimates are relatively stable around 63-65 kt SSB and 32 million (Figure 8.9). The reason for the difference in the estimates done here and that obtained during the benchmark were not investigated in detail. In the analysis that follows the estimates of an SSBbreak of 65 kt was used in the simulations as an input value rather than being estimated in each run as done in the benchmark. This was done because in the reanalysis process it was discovered that the when the SSBbreak is estimated in each stochastic simulatio, often unrealistically low SSBbreaks were estimated (below Bloss).

Under the F-rule the MSY is obtained at around an advisory F of around 0.35 under more favourable selection pattern (sel1) but is closer to 0.30 under the less favourable selection pattern (sel2) (Figure 8.10). Under the B-rule the estimated harvest rate that results in MSY is somewhere in the range of 22-23% for both selectivity patterns explored. In both cases the recent move towards target younger fish results in some loss of yield in the long run.

Under the F-rule the advisory fishing mortality that results in 5% probability that the stock falls below Bloss is 0.33 and 0.30 for the more and less favourable selection patterns, respectively (Figure 8.11). Relative to Blim (technical basis Bloss!) and SSBbreak, the equivalent values are 0.32 and 0.28. For the B-rule the harvest rate that results in 5% probability that the stock falls below Bloss is at an advisory harvest rate of around 23% for both selection scenarios. Relative to Blim and SSBbreak, the equivalent values are 22% harvest rate. If a catch stabilizer is incorporated in the harvest control rule for saithe, equivalent to that used for cod, the resulting harvest rate in the advisory harvest rate needs to be reduced by around 2%.

8.6.3 Conclusions

The results show that a B-rule as a basis for advice is more robust than using an F-rule, especially given that selectivity may change in the near future. An additional analysis was performed using 4 arbitrary but wider ranges of selection pattern than the two explored in the assessment (Figure 8.12). The analysis confirmed the conclusion reached here, that an advice based on a B-rule is relatively insensitive to changes in future selection pattern but that advice based on an F-rule may under such circumstances lead to unintended consequences for the stock (Figure 8.13). Given the prevalence of the latter method within ICES, it may call for a revision of the advisory rule for stocks when selection pattern has changed since the establishment of reference points and/or HCR.

Given the above analysis the NWWG suggest that the basis of the advice for saithe should be based a B-rule rather than an F-rule. An inclusion of a buffer equivalent to that set by managers for the cod in Icelandic waters may be sensible in order to achieve more inter-annual stability in catches and reduce the influence if large year classes entering the fisheries.

In the ICES introduction to the advice, it is stated that Btrigger could be defined as the the 5th percentile of the SSB when fishing at Fmsy. When fishing at a harvest rate that results in MSY (22%), there is a 5% probability that the stock will be 65kt. This is equivalent to the currently defined Blim and SSBbreak and in the proximity to Bloss (SSB in 1996). Any value between 60-65 kt may be considered as a reasonable candidate for Btrigger in an advisory control rule. The analysis indicates that the currently defined Btrigger of 80kt is most likely an error, given the technical basis stated in the advisory sheet. It is not unlikely that this value was actually based on the old Bpa.

8.7 State of the stock

The results of the principal stock quantities (Table 8.8 and Figure 8.14) show that the reference biomass declined by one third from 2004 to 2009, but appears to be increasing since then, and is now around the long-term average. The fishing mortality has fluctuated around 0.3 between 1998 and 2011, decreasing from around 0.4 in the mid 1990s. SSB has been declining since 2006 and is at present close to the long-term average.

Year classes 1998-2000 and 2002 were large, but recruitment since then has been around the long-term average, except for the 2008 cohort which is estimated as large. The details of the fishing mortality and stock in numbers are presented in Tables 8.9 and 8.10.

8.8 Short-term forecast

The input for the short-term forecast is shown in Table 8.11. Future weights, maturity, and selectivity are assumed to be the same as in the assessment year, as described in the stock annex. Recruitment predictions are based on the segmented stock-recruitment function estimated in the assessment model.

A "TAC-constraint" of 52 kt landings is applied in the assessment year, based on best estimates of catches in 2012. This results in a fishing mortality somewhat lower than the terminal value (F_{2011}=0.26 and F_{2012}=0.24).

Results from the short-term forecast are shown in Table 8.12. They indicate that if F = 0.22 is applied in 2013, corresponding to 20% HCR (MSY approach B-rule), the landings in 2013 will be 49 kt and the SSB in 2014 will be 143 kt. If the F_{MSY}=0.28 is applied (MSY approach F-rule, see discussion in Section 8.6), the fishing mortality is considerably higher, resulting in landings of 61 kt and SSB of 134 kt.

For the calendar year 2013 the NWWG recommends that advice is based on the MSY approach B-rule, corresponding to landings of 49 kt.

8.9 Uncertainties in assessment and forecast

The assessment of Icelandic saithe is relatively uncertain due to lack of good tuning data. The internal consistency in the survey that is used for the assessment is very low. This is not surprising, considering the nature of the species that is partly pelagic, schooling, and relatively widely migrating. The retrospective pattern (Figure 8.15) reveals some of the assessment uncertainty. The benchmark evaluation of F_{MSY} and the 20% harvest control rule incorporated uncertainties about assessment estimates, among other sources of uncertainty (ICES 2010).

An issue in this year's assessment involves the 2008 cohort which is estimated large by the default assessment model, and this increases the biomass estimate compared to recent years. However, the size of the 2008 cohort is very uncertain, due to mixed signals about this cohort in the commercial and survey catch-at-age data.

The discrepancy between the default separable model and a TSA model (NWWG 2012 WD 27) is greater than in recent years, estimating the current biomass as 265 kt and 219 kt, respectively. This difference is mainly due to uncertainty about the 2008 cohort. Next year's data should decrease this uncertainty about the 2008 cohort size. If the 2008 cohort does not turn out to be large, then the current biomass estimate of 265 kt is most likely an overestimate.

8.10 Comparison with previous assessment and forecast

Compared to last year's NWWG 2011 estimates, the reference biomass B_{4+} in 2011 has increased substantially from 184 to 234 kt, SSB 2011 has increased by the same proportion from 88 to 112 kt, F_{bar} 2010 has decreased from 0.37 to 0.29, and the stock numbers at ages 3 to 5 have all increased as shown below.

	NWWG2011	NWWG2012
B_{4+}(2011)	184	234
SSB(2011)	88	112
F_{4-9}(2010)	0.37	0.29
N_3(2011)	44	61
N_4(2011)	26	34
N_5(2011)	19	23

8.11 Ecosystem considerations

Changes in the distribution of large pelagic stocks (blue whiting, Norwegian spring-spawning herring) may affect the propensity of saithe to migrate off shelf and between management units. The evidence from tagging experiments (ICES 2008) show some migrations along the Faroe-Iceland Ridge, as well as onto the East Greenland shelf. It is possible that due to migratory behavior, larger saithe become partially out of reach from the fishery. A hypothesis of a descending right limb on the selectivity curve for saithe might have some merit, increasing the saithe resilience to fishing if enough saithe 'escape' from the fishery onto the niche where the large pelagic stocks are available.

8.12 Changes in fishing technology and fishing patterns

There are indications that the fleet may be increasingly targeting younger fish in recent years.

References

Gudmundsson, G. 2012. Fish stock assessment by time series analysis. ICES NWWG-2012 WD27.

ICES 2008. Report of the North-Western Working Group (NWWG). ICES CM 2008/ACOM:03.

ICES 2010. Report of the Benchmark Workshop on Roundfish (WKROUND). ICES CM 2010/ACOM:36.

Palsson, O.K., G. Karlsson, A. Arason, G.R. Gislason, G. Johannesson, and S. Adalsteinsson. 2003. Discards in demersal Icelandic fisheries 2002. Mar. Res. Inst. Rep. 94.

Table 8.1. Saithe in division Va. Nominal catch (t) by countries, as officially reported to ICES.

	Belgium	Faroe Islands	France	Germany	Iceland	Norway	UK (E/W/NI)	UK (Scotland)	UK	Total
1980	980	4 930			52 436	1				58 347
1981	532	3 545			54 921	3				59 001
1982	201	3 582	23		65 124	1				68 931
1983	224	2 138			55 904					58 266
1984	269	2 044			60 406					62 719
1985	158	1 778			55 135	1	29			57 101
1986	218	2 291			63 867					66 376
1987	217	2 139			78 175					80 531
1988	268	2 596			74 383					77 247
1989	369	2 246			79 796					82 411
1990	190	2 905			95 032					98 127
1991	236	2 690			99 811					102 737
1992	195	1 570			77 832					79 597
1993	104	1 562			69 982					71 648
1994	30	975		1	63 333					64 339
1995		1 161		1	47 466	1				48 629
1996		803		1	39 297					40 101
1997		716			36 548					37 264
1998		997		3	30 531					31 531
1999		700		2	30 583	6	1	1		31 293
2000		228		1	32 914	1	2			33 146
2001		128		14	31 854	44	23			32 063
2002		366		6	41 687	3	7	2		42 071
2003		143		56	51 857	164			35	52 255
2004		214		157	62 614	1	105			63 091
2005		322		224	67 283	2			312	68 143
2006		415		33	75 197	2			16	75 663
2007		392			64 008	3			30	64 433
2008		196			69 992	2				70 190
2009		269			61 391	3				61 663
2010		499			53 772	1				54 272
2011		735			50 386	2				51 123

Table 8.2. Saithe in division Va. Commercial catch at age (millions).

	3	4	5	6	7	8	9	10	11	12	13	14
1980	0.275	2.540	5.214	2.596	2.169	1.341	0.387	0.262	0.155	0.112	0.064	0.033
1981	0.203	1.325	3.503	5.404	1.457	1.415	0.578	0.242	0.061	0.154	0.135	0.128
1982	0.508	1.092	2.804	4.845	4.293	1.215	0.975	0.306	0.059	0.035	0.048	0.046
1983	0.107	1.750	1.065	2.455	4.454	2.311	0.501	0.251	0.038	0.012	0.002	0.004
1984	0.053	0.657	0.800	1.825	2.184	3.610	0.844	0.376	0.291	0.135	0.185	0.226
1985	0.376	4.014	3.366	1.958	1.536	1.172	0.747	0.479	0.074	0.023	0.072	0.071
1986	3.108	1.400	4.170	2.665	1.550	1.116	0.628	1.549	0.216	0.051	0.030	0.014
1987	0.956	5.135	4.428	5.409	2.915	1.348	0.661	0.496	0.498	0.058	0.027	0.048
1988	1.318	5.067	6.619	3.678	2.859	1.775	0.845	0.226	0.270	0.107	0.024	0.001
1989	0.315	4.313	8.471	7.309	1.794	1.928	0.848	0.270	0.191	0.135	0.076	0.010
1990	0.143	1.692	5.471	10.112	6.174	1.816	1.087	0.380	0.151	0.055	0.076	0.037
1991	0.198	0.874	3.613	6.844	10.772	3.223	0.858	0.838	0.228	0.040	0.006	0.005
1992	0.242	2.928	3.844	4.355	3.884	4.046	1.290	0.350	0.196	0.056	0.054	0.015
1993	0.657	1.083	2.841	2.252	2.247	2.314	3.671	0.830	0.223	0.188	0.081	0.012
1994	0.702	2.955	1.770	2.603	1.377	1.243	1.263	2.009	0.454	0.158	0.188	0.082
1995	1.573	1.853	2.661	1.807	2.370	0.905	0.574	0.482	0.521	0.106	0.035	0.013
1996	1.102	2.608	1.868	1.649	0.835	1.233	0.385	0.267	0.210	0.232	0.141	0.074
1997	0.603	2.960	2.766	1.651	1.178	0.599	0.454	0.125	0.095	0.114	0.077	0.043
1998	0.183	1.289	1.767	1.545	1.114	0.658	0.351	0.265	0.120	0.081	0.085	0.085
1999	0.989	0.732	1.564	2.176	1.934	0.669	0.324	0.140	0.072	0.025	0.028	0.022
2000	0.850	2.383	0.896	1.511	1.612	1.806	0.335	0.173	0.057	0.033	0.017	0.007
2001	1.223	2.619	2.184	0.591	0.977	0.943	0.819	0.186	0.094	0.028	0.028	0.013
2002	1.187	4.190	3.147	2.970	0.519	0.820	0.570	0.309	0.101	0.027	0.015	0.011
2003	2.262	4.320	5.973	2.448	1.924	0.282	0.434	0.287	0.195	0.027	0.029	0.015
2004	0.952	7.841	7.195	5.363	1.563	1.057	0.211	0.224	0.157	0.074	0.039	0.011
2005	2.607	3.089	7.333	6.876	3.592	0.978	0.642	0.119	0.149	0.089	0.046	0.012
2006	1.380	10.051	2.616	5.840	4.514	1.989	0.667	0.485	0.118	0.112	0.086	0.031
2007	1.244	6.552	8.751	2.124	2.935	1.817	0.964	0.395	0.190	0.043	0.036	0.020
2008	1.432	3.602	5.874	6.706	1.155	1.894	1.248	0.803	0.262	0.176	0.087	0.044
2009	2.820	5.166	2.084	2.734	2.883	0.777	1.101	0.847	0.555	0.203	0.134	0.036
2010	2.146	6.284	3.058	0.997	1.644	1.571	0.514	0.656	0.522	0.231	0.114	0.064
2011	2.004	4.850	4.006	1.502	0.677	1.065	1.145	0.323	0.433	0.244	0.150	0.075

Table 8.3. Saithe in division Va. Mean weight at age (g) in the catches and in the spawning stock, with predictions in gray.

	3	4	5	6	7	8	9	10	11	12	13	14
1980	1428	1983	2667	3689	5409	6321	7213	8565	9147	9617	10066	11041
1981	1585	2037	2696	3525	4541	6247	6991	8202	9537	9089	9351	10225
1982	1547	2194	3015	3183	5114	6202	7256	7922	8924	10134	9447	10535
1983	1530	2221	3171	4270	4107	5984	7565	8673	8801	9039	11138	9818
1984	1653	2432	3330	4681	5466	4973	7407	8179	8770	8831	11010	11127
1985	1609	2172	3169	3922	4697	6411	6492	8346	9401	10335	11027	10644
1986	1450	2190	2959	4402	5488	6406	7570	6487	9616	10462	11747	11902
1987	1516	1715	2670	3839	5081	6185	7330	8025	7974	9615	12246	11656
1988	1261	2017	2513	3476	4719	5932	7523	8439	8748	9559	10824	14099
1989	1403	2021	2194	3047	4505	5889	7172	8852	10170	10392	12522	11923
1990	1647	1983	2566	3021	4077	5744	7038	7564	8854	10645	11674	11431
1991	1224	1939	2432	3160	3634	4967	6629	7704	9061	9117	10922	11342
1992	1269	1909	2578	3288	4150	4865	6168	7926	8349	9029	11574	9466
1993	1381	2143	2742	3636	4398	5421	5319	7006	8070	10048	9106	11591
1994	1444	1836	2649	3512	4906	5539	6818	6374	8341	9770	10528	11257
1995	1370	1977	2769	3722	4621	5854	6416	7356	6815	8312	9119	11910
1996	1229	1755	2670	3802	4902	5681	7182	7734	9256	8322	10501	11894
1997	1325	1936	2409	3906	5032	6171	7202	7883	8856	9649	9621	10877
1998	1347	1972	2943	3419	4850	5962	6933	7781	8695	9564	10164	10379
1999	1279	2106	2752	3497	3831	5819	7072	8078	8865	10550	10823	11300
2000	1367	1929	2751	3274	4171	4447	6790	8216	9369	9817	10932	12204
2001	1280	1882	2599	3697	4420	5538	5639	7985	9059	9942	10632	10988
2002	1308	1946	2569	3266	4872	5365	6830	7067	9240	9659	10088	11632
2003	1310	1908	2545	3336	4069	5792	7156	8131	8051	10186	10948	11780
2004	1467	1847	2181	2918	4017	5135	7125	7732	8420	8927	10420	10622
2005	1287	1888	2307	2619	3516	5080	6060	8052	8292	8342	8567	10256
2006	1164	1722	2369	2808	3235	4361	6007	7166	8459	9324	9902	9636
2007	1140	1578	2122	2719	3495	4114	5402	6995	7792	9331	9970	10738
2008	1306	1805	2295	2749	3515	4530	5132	6394	7694	9170	9594	11258
2009	1412	1862	2561	3023	3676	4596	5651	6074	7356	8608	9812	10639
2010	1287	1787	2579	3469	4135	4850	5558	6289	6750	7997	9429	10481
2011	1175	1801	2526	3680	4613	5367	5685	6466	6851	7039	8268	8958
2012	1291	1629	2390	3298	4623	5680	6570	6276	6986	7881	9170	10026
2013	1291	1629	2390	3298	4623	5680	6570	6276	6986	7881	9170	10026
2014	1291	1629	2390	3298	4623	5680	6570	6276	6986	7881	9170	10026
Avg80-11	1375	1953	2634	3455	4414	5492	6635	7614	8549	9388	10374	11050

Table 8.4. Saithe in division Va. Maturity at age used for calculating the SSB.

	3	4	5	6	7	8	9	10	11	12	13	14
1980	0.000	0.087	0.211	0.425	0.670	0.849	0.941	1.000	1.000	1.000	1.000	1.000
1981	0.000	0.087	0.211	0.425	0.670	0.849	0.941	1.000	1.000	1.000	1.000	1.000
1982	0.000	0.087	0.211	0.425	0.670	0.849	0.941	1.000	1.000	1.000	1.000	1.000
1983	0.000	0.087	0.211	0.425	0.670	0.849	0.941	1.000	1.000	1.000	1.000	1.000
1984	0.000	0.087	0.211	0.425	0.670	0.849	0.941	1.000	1.000	1.000	1.000	1.000
1985	0.000	0.101	0.214	0.396	0.612	0.792	0.901	1.000	1.000	1.000	1.000	1.000
1986	0.000	0.087	0.188	0.357	0.572	0.763	0.886	1.000	1.000	1.000	1.000	1.000
1987	0.000	0.076	0.166	0.324	0.535	0.735	0.870	1.000	1.000	1.000	1.000	1.000
1988	0.000	0.068	0.149	0.297	0.505	0.710	0.855	1.000	1.000	1.000	1.000	1.000
1989	0.000	0.063	0.139	0.280	0.484	0.693	0.845	1.000	1.000	1.000	1.000	1.000
1990	0.000	0.061	0.135	0.273	0.475	0.686	0.840	1.000	1.000	1.000	1.000	1.000
1991	0.000	0.061	0.136	0.275	0.478	0.688	0.841	1.000	1.000	1.000	1.000	1.000
1992	0.000	0.064	0.142	0.284	0.489	0.697	0.847	1.000	1.000	1.000	1.000	1.000
1993	0.000	0.068	0.150	0.299	0.506	0.712	0.856	1.000	1.000	1.000	1.000	1.000
1994	0.000	0.074	0.162	0.317	0.528	0.729	0.866	1.000	1.000	1.000	1.000	1.000
1995	0.000	0.081	0.175	0.338	0.551	0.747	0.877	1.000	1.000	1.000	1.000	1.000
1996	0.000	0.089	0.190	0.361	0.577	0.766	0.888	1.000	1.000	1.000	1.000	1.000
1997	0.000	0.099	0.209	0.389	0.605	0.787	0.899	1.000	1.000	1.000	1.000	1.000
1998	0.000	0.112	0.233	0.423	0.638	0.809	0.911	1.000	1.000	1.000	1.000	1.000
1999	0.000	0.129	0.263	0.463	0.675	0.833	0.923	1.000	1.000	1.000	1.000	1.000
2000	0.000	0.150	0.299	0.507	0.712	0.856	0.935	1.000	1.000	1.000	1.000	1.000
2001	0.000	0.172	0.334	0.547	0.744	0.875	0.944	1.000	1.000	1.000	1.000	1.000
2002	0.000	0.191	0.362	0.578	0.767	0.888	0.950	1.000	1.000	1.000	1.000	1.000
2003	0.000	0.201	0.377	0.593	0.778	0.894	0.953	1.000	1.000	1.000	1.000	1.000
2004	0.000	0.197	0.372	0.588	0.774	0.892	0.952	1.000	1.000	1.000	1.000	1.000
2005	0.000	0.184	0.353	0.567	0.760	0.884	0.948	1.000	1.000	1.000	1.000	1.000
2006	0.000	0.168	0.326	0.539	0.738	0.871	0.942	1.000	1.000	1.000	1.000	1.000
2007	0.000	0.151	0.300	0.508	0.713	0.857	0.935	1.000	1.000	1.000	1.000	1.000
2008	0.000	0.139	0.279	0.483	0.692	0.844	0.929	1.000	1.000	1.000	1.000	1.000
2009	0.000	0.132	0.268	0.468	0.679	0.836	0.925	1.000	1.000	1.000	1.000	1.000
2010	0.000	0.129	0.264	0.463	0.675	0.833	0.923	1.000	1.000	1.000	1.000	1.000
2011	0.000	0.130	0.264	0.464	0.676	0.834	0.924	1.000	1.000	1.000	1.000	1.000
2012	0.000	0.132	0.268	0.468	0.679	0.836	0.925	1.000	1.000	1.000	1.000	1.000
2013	0.000	0.132	0.268	0.468	0.679	0.836	0.925	1.000	1.000	1.000	1.000	1.000
2014	0.000	0.132	0.268	0.468	0.679	0.836	0.925	1.000	1.000	1.000	1.000	1.000

Table 8.5. Saithe in division Va. Survey catch at age.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1985	0.05	0.61	0.58	2.99	5.11	1.74	1.06	0.50	1.37	0.16	0.08	0.08	0.07	0.07
1986	0.02	2.33	2.40	2.06	2.09	1.42	0.62	0.28	0.19	0.32	0.09	0.07	0.03	0.00
1987	0.10	0.39	11.52	12.93	6.42	3.95	3.07	0.79	0.36	0.26	0.33	0.05	0.01	0.03
1988	0.69	0.31	0.49	2.72	2.81	1.71	0.95	0.40	0.07	0.08	0.10	0.05	0.01	0.00
1989	0.20	1.43	3.96	5.05	6.57	2.49	1.77	0.91	0.40	0.00	0.02	0.00	0.03	0.00
1990	0.01	0.35	1.69	4.86	6.37	12.33	3.30	1.21	0.64	0.12	0.06	0.02	0.01	0.03
1991	0.01	0.22	1.40	1.72	2.22	1.13	2.50	0.30	0.02	0.03	0.00	0.01	0.00	0.01
1992	0.01	0.15	0.91	5.73	5.52	2.79	2.68	1.91	0.28	0.06	0.06	0.02	0.00	0.00
1993	0.00	1.27	11.04	2.00	6.80	2.41	2.25	1.02	4.02	0.64	0.05	0.00	0.02	0.00
1994	0.04	0.82	0.73	1.89	1.74	1.95	0.53	0.84	1.00	3.62	0.41	0.18	0.00	0.04
1995	0.06	0.48	1.98	1.12	0.51	0.28	0.34	0.10	0.15	0.15	0.33	0.02	0.00	0.00
1996	0.03	0.13	0.51	3.76	1.12	0.99	0.58	1.00	0.05	0.09	0.10	0.25	0.03	0.00
1997	0.16	0.32	0.90	4.72	3.95	0.94	0.40	0.16	0.10	0.05	0.02	0.02	0.02	0.00
1998	0.01	0.11	1.64	2.33	2.53	1.23	0.71	0.31	0.08	0.07	0.04	0.03	0.05	0.03
1999	0.57	0.75	3.71	0.93	1.25	1.64	0.57	0.17	0.02	0.02	0.02	0.00	0.00	0.02
2000	0.00	0.38	2.02	2.54	0.61	0.84	0.53	0.47	0.07	0.03	0.01	0.00	0.01	0.01
2001	0.00	0.89	1.90	2.64	1.60	0.20	0.23	0.40	0.13	0.07	0.04	0.01	0.00	0.00
2002	0.02	1.05	2.23	2.97	3.08	2.15	0.42	0.49	0.32	0.22	0.02	0.03	0.00	0.00
2003	0.01	0.05	9.62	5.06	2.94	1.34	0.77	0.21	0.05	0.10	0.02	0.03	0.00	0.00
2004	0.01	0.91	1.38	9.39	6.04	4.35	1.48	0.81	0.17	0.16	0.12	0.06	0.02	0.00
2005	0.00	0.26	4.32	2.39	7.42	4.66	2.31	0.86	0.44	0.12	0.05	0.08	0.03	0.00
2006	0.01	0.00	2.18	6.69	1.98	8.91	3.52	1.21	0.29	0.25	0.03	0.04	0.04	0.00
2007	0.00	0.06	0.31	1.73	3.22	0.81	1.62	0.70	0.29	0.16	0.11	0.08	0.02	0.00
2008	0.01	0.08	2.25	1.79	2.85	4.01	0.61	0.78	0.34	0.15	0.09	0.13	0.04	0.02
2009	0.01	0.21	2.43	1.80	0.68	0.91	0.84	0.12	0.26	0.15	0.03	0.04	0.00	0.02
2010	0.00	0.07	1.23	4.99	2.49	0.63	0.60	0.48	0.07	0.13	0.07	0.07	0.07	0.02
2011	0.00	0.15	3.83	4.20	3.06	1.15	0.41	0.39	0.44	0.17	0.10	0.09	0.06	0.05
2012	0.02	0.02	1.75	12.04	6.86	2.75	0.62	0.17	0.38	0.50	0.13	0.12	0.06	0.08

Table 8.6. Saithe in division Va. Commercial catch-at-age log residuals from the fitted model.

	3	4	5	6	7	8	9	10	11	12	13	14
1980	-0.41	-0.31	0.13	0.08	-0.04	0.11	-0.02	0.12	-0.16	-0.22	-0.36	-0.02
1981	-0.27	-0.13	-0.29	0.19	-0.08	0.03	0.06	0.15	-0.45	0.49	0.62	0.98
1982	0.44	-0.13	0.07	-0.19	0.12	-0.01	0.19	-0.19	-0.63	-0.60	-0.28	-0.05
1983	-1.30	0.49	-0.35	0.06	0.24	0.11	-0.01	-0.42	-1.27	-1.46	-2.71	-2.01
1984	-2.21	-0.85	-0.67	0.12	0.25	0.41	-0.24	0.22	0.50	0.53	1.81	2.56
1985	-0.15	0.65	0.30	0.04	0.14	-0.10	-0.61	-0.39	-0.74	-1.61	0.34	1.29
1986	1.19	-0.38	0.13	-0.17	-0.04	0.05	-0.21	0.48	-0.57	-0.73	-0.96	-0.92
1987	-0.52	0.08	0.16	0.12	0.05	0.04	0.03	-0.09	-0.05	-1.53	-1.00	-0.13
1988	0.48	-0.17	0.03	0.02	-0.07	0.10	0.42	-0.35	0.25	-0.89	-1.71	-3.60
1989	-0.44	0.32	0.00	0.12	-0.30	0.02	0.14	-0.09	0.37	0.19	-0.59	-1.95
1990	-0.93	-0.29	0.04	0.00	0.18	0.03	0.06	-0.20	0.04	-0.41	0.08	-0.85
1991	-1.03	-0.58	0.03	0.18	0.02	-0.04	0.00	0.38	0.11	-0.72	-2.05	-2.07
1992	-0.11	0.30	0.55	0.22	0.03	-0.43	-0.13	-0.21	-0.15	-0.62	0.25	-0.46
1993	0.51	-0.08	-0.18	-0.07	-0.11	-0.04	0.21	0.02	0.17	0.39	0.33	-0.67
1994	0.57	0.51	-0.06	-0.36	-0.23	-0.24	0.11	0.21	0.27	0.41	0.98	0.93
1995	0.83	0.15	0.05	-0.01	0.02	-0.04	-0.11	-0.10	-0.13	-0.45	-0.36	-0.96
1996	0.76	0.09	-0.06	-0.27	-0.18	0.10	0.14	0.01	0.21	-0.08	0.70	1.25
1997	0.13	0.17	-0.16	0.04	-0.01	0.15	-0.05	-0.20	-0.15	0.20	-0.58	0.12
1998	-0.19	-0.04	-0.25	-0.40	0.10	0.00	0.44	0.36	0.65	0.60	0.82	0.44
1999	0.20	0.01	0.00	0.04	0.00	-0.10	-0.18	0.18	-0.34	-0.30	0.15	0.08
2000	-0.03	-0.11	0.05	0.04	-0.08	0.25	-0.25	-0.14	-0.11	-0.50	-0.07	-0.61
2001	-0.05	0.12	-0.14	-0.07	-0.01	-0.09	0.21	0.03	0.06	0.01	0.17	0.50
2002	-0.32	-0.04	0.09	0.19	-0.09	0.06	-0.14	-0.18	-0.05	-0.64	-0.07	-0.22
2003	0.21	-0.14	0.22	-0.01	-0.01	-0.32	0.02	-0.10	0.02	-0.69	0.11	0.61
2004	-0.04	-0.21	0.00	0.13	-0.11	0.09	0.33	0.27	0.02	-0.21	0.42	-0.11
2005	-0.17	-0.14	-0.11	0.20	0.13	-0.16	-0.04	0.05	0.18	-0.03	-0.16	-0.24
2006	-0.29	-0.07	-0.10	-0.05	0.22	0.00	-0.13	0.01	0.41	0.47	0.51	0.02
2007	0.44	0.15	0.13	0.12	-0.15	-0.08	-0.17	-0.18	-0.41	0.12	0.06	-0.22
2008	-0.03	0.18	0.18	0.09	-0.11	-0.19	-0.10	-0.07	-0.27	0.03	1.35	0.79
2009	0.22	0.16	0.01	-0.12	-0.13	0.14	-0.14	0.03	0.12	0.25	0.54	1.24
2010	0.12	-0.02	0.05	-0.23	0.03	-0.05	0.35	-0.11	0.13	0.03	0.47	0.59
2011	-0.18	-0.13	-0.10	-0.21	0.00	0.23	0.21	0.39	0.00	0.10	0.34	0.78

Table 8.7. Saithe in division Va. Survey catch-at-age log residuals from the fitted model.

	2	3	4	5	6	7	8	9	10
1985	-0.44	-1.33	-0.36	0.48	0.16	0.28	-0.16	0.68	-0.83
1986	0.58	-0.54	-0.57	-0.67	-0.43	-0.32	-0.41	-0.59	-0.31
1987	-0.60	0.71	0.64	0.64	0.37	0.93	0.62	0.43	0.24
1988	-0.38	-1.85	-1.23	-0.80	-0.25	-0.42	-0.35	-1.13	-0.48
1989	1.58	0.69	-0.02	-0.28	-0.51	0.39	0.27	0.28	-4.84
1990	-0.18	0.27	0.40	0.29	0.77	0.38	0.73	0.53	-0.38
1991	0.05	-0.26	-0.20	-0.30	-1.00	-0.56	-1.24	-2.64	-1.89
1992	-0.62	0.00	0.65	1.05	0.38	0.53	-0.03	-0.60	-0.95
1993	1.63	2.20	0.29	0.91	0.68	0.84	0.36	1.42	0.85
1994	0.67	-0.40	-0.05	0.26	0.15	-0.13	0.70	1.10	1.99
1995	0.28	0.08	-0.46	-1.24	-1.06	-0.85	-0.89	-0.20	-0.05
1996	-0.60	-1.13	0.23	-0.34	-0.08	0.41	1.12	-0.76	0.02
1997	0.96	-0.14	0.61	0.38	-0.06	-0.30	-0.05	-0.42	-0.11
1998	-1.34	1.13	0.33	0.10	-0.35	0.25	0.18	-0.08	-0.14
1999	0.54	0.69	0.08	-0.20	0.07	-0.57	-0.50	-1.92	-0.87
2000	-0.68	0.06	-0.17	-0.24	-0.18	-0.50	-0.07	-0.76	-0.95
2001	0.01	-0.54	-0.16	-0.53	-0.94	-0.91	-0.08	-0.73	-0.17
2002	0.04	-0.54	-0.58	0.09	0.16	0.33	0.50	0.27	0.33
2003	-1.91	0.78	-0.20	-0.50	-0.34	-0.32	0.31	-1.17	-0.32
2004	-0.08	-0.08	0.29	0.08	0.30	0.29	0.38	0.66	0.52
2005	-0.74	0.01	0.02	0.24	0.28	0.23	0.36	0.21	0.72
2006	-5.53	-0.08	0.01	0.03	0.91	0.59	0.22	-0.25	0.09
2007	-1.86	-1.25	-0.75	-0.51	-0.36	-0.19	-0.37	-0.71	-0.39
2008	-2.07	0.28	0.06	-0.04	0.21	-0.04	-0.27	-0.60	-0.92
2009	-1.07	-0.13	-0.37	-0.66	-0.65	-0.71	-0.97	-0.84	-0.93
2010	-2.50	-0.77	0.14	0.17	-0.23	-0.45	-0.61	-1.01	-1.06
2011	-0.86	0.01	0.01	-0.16	-0.13	-0.09	-0.26	-0.24	0.29
2012	-3.00	0.13	0.70	0.66	0.18	-0.21	-0.38	0.14	0.28

Table 8.8. Saithe in division Va. Main population estimates from the fitted model.

	B4+	SSB	Landings	Landings/B4+	F4-9	N3	Cohort
1980	312	122	58	19%	0.29	28	32
1981	305	130	59	19%	0.26	20	42
1982	294	149	69	23%	0.30	22	35
1983	270	147	58	22%	0.24	32	67
1984	287	149	63	22%	0.23	42	92
1985	299	142	57	19%	0.25	35	50
1986	318	138	65	20%	0.28	67	32
1987	335	127	81	24%	0.35	92	21
1988	416	123	77	19%	0.32	50	30
1989	398	126	82	21%	0.31	32	15
1990	378	134	98	26%	0.35	21	20
1991	336	144	102	30%	0.37	30	18
1992	288	138	80	28%	0.37	15	30
1993	231	115	72	31%	0.40	20	26
1994	187	96	64	34%	0.45	18	17
1995	153	71	49	32%	0.46	30	9
1996	149	62	40	27%	0.41	26	30
1997	156	61	37	24%	0.37	17	31
1998	153	66	32	21%	0.30	9	53
1999	131	69	31	24%	0.31	30	62
2000	142	72	33	23%	0.33	31	71
2001	161	80	32	20%	0.28	53	24
2002	216	100	42	19%	0.30	62	70
2003	274	126	52	19%	0.30	71	38
2004	315	147	65	21%	0.27	24	18
2005	279	153	69	25%	0.29	70	28
2006	301	156	76	25%	0.32	38	45
2007	267	146	64	24%	0.30	18	43
2008	234	138	70	30%	0.35	28	61
2009	211	124	61	29%	0.33	45	25
2010	219	114	54	25%	0.29	43	
2011	234	112	51	22%	0.26	61	
2012	265	121				25	
Average	258	118	61	24%	0.32	36	36

Table 8.9. Saithe in division Va. Stock in numbers from the fitted model.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1980	32.2	24.6	28.2	46.8	30.9	10.3	8.1	3.7	1.3	0.7	0.7	0.5	0.3	0.1
1981	48.1	26.4	20.2	22.7	35.2	21.2	6.3	4.6	2.0	0.7	0.4	0.4	0.3	0.2
1982	62.3	39.4	21.6	16.3	17.2	24.6	13.3	3.7	2.6	1.1	0.4	0.2	0.2	0.2
1983	52.9	51.0	32.2	17.4	12.2	11.8	14.9	7.5	1.9	1.4	0.6	0.2	0.1	0.1
1984	99.5	43.3	41.8	26.0	13.3	8.6	7.5	9.0	4.3	1.1	0.8	0.4	0.1	0.1
1985	137.2	81.4	35.4	33.8	19.9	9.4	5.6	4.6	5.2	2.5	0.7	0.5	0.2	0.1
1986	75.1	112.3	66.7	28.6	25.8	14.1	6.0	3.4	2.6	3.0	1.4	0.4	0.3	0.1
1987	47.7	61.5	92.0	53.7	21.6	17.8	8.7	3.5	1.8	1.5	1.6	0.8	0.2	0.2
1988	31.1	39.1	50.4	73.8	39.7	14.3	10.2	4.6	1.7	0.9	0.7	0.9	0.4	0.1
1989	44.1	25.4	32.0	40.5	55.1	26.8	8.5	5.6	2.3	0.9	0.5	0.4	0.5	0.2
1990	22.1	36.1	20.8	25.7	30.3	37.5	16.1	4.8	2.9	1.2	0.5	0.3	0.2	0.3
1991	29.5	18.1	29.5	16.7	19.1	20.1	31.4	8.6	2.3	1.5	0.6	0.2	0.1	0.1
1992	26.3	24.2	14.8	23.7	12.3	12.4	11.3	16.2	4.0	1.1	0.7	0.3	0.1	0.1
1993	44.4	21.5	19.8	11.9	17.4	8.1	7.1	5.9	7.7	2.0	0.5	0.4	0.2	0.1
1994	38.1	36.3	17.6	15.9	8.7	11.2	4.4	3.5	2.7	3.6	0.9	0.3	0.2	0.1
1995	25.0	31.2	29.7	14.1	11.4	5.4	5.8	2.1	1.5	1.2	1.5	0.4	0.1	0.1
1996	12.8	20.5	25.5	23.7	10.1	7.1	2.8	2.7	0.9	0.6	0.5	0.7	0.2	0.1
1997	44.8	10.5	16.8	20.4	17.3	6.5	3.8	1.4	1.2	0.4	0.3	0.2	0.4	0.1
1998	46.0	36.7	8.6	13.3	14.5	11.2	3.9	2.1	0.7	0.6	0.2	0.1	0.1	0.2
1999	79.2	37.7	30.0	6.8	9.6	9.8	7.1	2.3	1.1	0.3	0.3	0.1	0.1	0.1
2000	92.5	64.9	30.8	23.9	5.0	6.5	6.2	4.1	1.2	0.6	0.2	0.2	0.1	0.0
2001	106.2	75.7	53.1	24.5	17.1	3.3	4.0	3.5	2.1	0.6	0.3	0.1	0.1	0.0
2002	36.4	86.9	62.0	42.3	17.9	11.8	2.1	2.4	1.9	1.1	0.3	0.2	0.0	0.0
2003	103.7	29.8	71.2	49.3	30.7	12.1	7.4	1.2	1.3	1.0	0.6	0.2	0.1	0.0
2004	57.4	84.9	24.4	56.6	35.9	20.8	7.7	4.3	0.7	0.7	0.5	0.3	0.1	0.0
2005	26.4	47.0	69.5	19.1	37.7	22.9	12.8	4.7	2.7	0.4	0.4	0.3	0.2	0.0
2006	41.3	21.6	38.5	54.1	12.4	23.4	13.7	7.7	2.8	1.6	0.2	0.2	0.1	0.1
2007	67.5	33.8	17.7	29.8	34.6	7.6	13.7	8.0	4.5	1.6	0.9	0.1	0.1	0.1
2008	64.5	55.3	27.7	13.7	19.3	21.4	4.5	8.1	4.8	2.6	0.9	0.5	0.1	0.1
2009	91.6	52.8	45.2	21.4	8.6	11.4	12.0	2.5	4.6	2.7	1.4	0.4	0.2	0.0
2010	37.4	75.0	43.2	35.0	13.5	5.2	6.6	6.9	1.5	2.6	1.4	0.7	0.2	0.1
2011	44.5	30.6	61.4	33.7	22.9	8.5	3.1	3.9	4.2	0.9	1.5	0.8	0.4	0.1
2012	48.5	36.4	25.1	48.1	22.6	14.8	5.3	1.9	2.5	2.6	0.5	0.8	0.4	0.2

Table 8.10. Saithe in division Va. Fishing mortality from the fitted model.

	3	4	5	6	7	8	9	10	11	12	13	14
1980	0.02	0.09	0.18	0.30	0.36	0.44	0.41	0.44	0.36	0.36	0.36	0.36
1981	0.02	0.08	0.16	0.26	0.32	0.39	0.36	0.39	0.32	0.32	0.32	0.32
1982	0.02	0.09	0.18	0.30	0.37	0.45	0.42	0.45	0.37	0.37	0.37	0.37
1983	0.01	0.07	0.15	0.24	0.30	0.36	0.34	0.36	0.30	0.30	0.30	0.30
1984	0.01	0.07	0.14	0.23	0.29	0.34	0.32	0.34	0.28	0.28	0.28	0.28
1985	0.01	0.07	0.15	0.25	0.30	0.37	0.34	0.37	0.30	0.30	0.30	0.30
1986	0.02	0.08	0.17	0.28	0.35	0.42	0.39	0.42	0.34	0.34	0.34	0.34
1987	0.02	0.10	0.21	0.35	0.43	0.52	0.49	0.52	0.43	0.43	0.43	0.43
1988	0.02	0.09	0.20	0.32	0.40	0.48	0.45	0.48	0.39	0.39	0.39	0.39
1989	0.02	0.09	0.19	0.31	0.38	0.46	0.42	0.46	0.37	0.37	0.37	0.37
1990	0.02	0.10	0.21	0.35	0.43	0.52	0.48	0.52	0.43	0.43	0.43	0.43
1991	0.02	0.11	0.23	0.38	0.46	0.56	0.52	0.56	0.46	0.46	0.46	0.46
1992	0.02	0.11	0.22	0.37	0.45	0.55	0.51	0.55	0.45	0.45	0.45	0.45
1993	0.02	0.12	0.24	0.40	0.49	0.59	0.55	0.59	0.49	0.49	0.49	0.49
1994	0.03	0.13	0.27	0.45	0.56	0.67	0.63	0.67	0.55	0.55	0.55	0.55
1995	0.03	0.13	0.28	0.46	0.57	0.69	0.64	0.69	0.56	0.56	0.56	0.56
1996	0.02	0.12	0.25	0.41	0.50	0.60	0.56	0.60	0.49	0.49	0.49	0.49
1997	0.04	0.15	0.23	0.31	0.42	0.52	0.57	0.54	0.55	0.55	0.55	0.55
1998	0.03	0.12	0.19	0.26	0.34	0.43	0.46	0.44	0.45	0.45	0.45	0.45
1999	0.03	0.12	0.20	0.27	0.35	0.45	0.48	0.46	0.47	0.47	0.47	0.47
2000	0.03	0.13	0.21	0.28	0.37	0.47	0.51	0.49	0.50	0.50	0.50	0.50
2001	0.03	0.11	0.18	0.24	0.32	0.40	0.43	0.41	0.42	0.42	0.42	0.42
2002	0.03	0.12	0.19	0.26	0.35	0.44	0.47	0.45	0.46	0.46	0.46	0.46
2003	0.03	0.12	0.19	0.26	0.34	0.43	0.46	0.44	0.45	0.45	0.45	0.45
2004	0.05	0.21	0.25	0.29	0.29	0.28	0.29	0.34	0.40	0.40	0.40	0.40
2005	0.05	0.23	0.27	0.31	0.32	0.31	0.32	0.37	0.44	0.44	0.44	0.44
2006	0.06	0.25	0.30	0.34	0.34	0.34	0.35	0.40	0.48	0.48	0.48	0.48
2007	0.05	0.23	0.28	0.32	0.32	0.32	0.33	0.38	0.45	0.45	0.45	0.45
2008	0.06	0.27	0.33	0.38	0.38	0.37	0.38	0.44	0.53	0.53	0.53	0.53
2009	0.06	0.26	0.31	0.35	0.35	0.35	0.36	0.42	0.49	0.49	0.49	0.49
2010	0.05	0.23	0.27	0.31	0.31	0.31	0.32	0.37	0.43	0.43	0.43	0.43
2011	0.04	0.20	0.24	0.27	0.28	0.27	0.28	0.32	0.38	0.38	0.38	0.38
2012	0.04	0.19	0.23	0.26	0.26	0.25	0.26	0.31	0.36	0.36	0.36	0.36

Table 8.11. Saithe in division Va. Input values for the short-term projections. Same weights are used for catch weights and stock weights.

2012	3	4	5	6	7	8	9	10	11	12	13	14
N	25.1	48.1	22.6	14.8	5.3	1.9	2.5	2.6	0.5	0.8	0.4	0.2
M	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Mat	0.000	0.132	0.268	0.468	0.679	0.836	0.925	1.000	1.000	1.000	1.000	1.000
W	1.291	1.629	2.390	3.298	4.623	5.680	6.570	6.276	6.986	7.881	9.170	10.026
Sel	0.114	0.521	0.623	0.717	0.717	0.704	0.731	0.845	1.000	1.000	1.000	1.000
pF	0	0	0	0	0	0	0	0	0	0	0	0
pM	0	0	0	0	0	0	0	0	0	0	0	0

2013	3	4	5	6	7	8	9	10	11	12	13	14
N	29.8											
M	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Mat	0.000	0.132	0.268	0.468	0.679	0.836	0.925	1.000	1.000	1.000	1.000	1.000
W	1.291	1.629	2.390	3.298	4.623	5.680	6.570	6.276	6.986	7.881	9.170	10.026
Sel	0.114	0.521	0.623	0.717	0.717	0.704	0.731	0.845	1.000	1.000	1.000	1.000
pF	0	0	0	0	0	0	0	0	0	0	0	0
pM	0	0	0	0	0	0	0	0	0	0	0	0

2014	3	4	5	6	7	8	9	10	11	12	13	14
N												
M	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Mat	0.000	0.132	0.268	0.468	0.679	0.836	0.925	1.000	1.000	1.000	1.000	1.000
W	1.291	1.629	2.390	3.298	4.623	5.680	6.570	6.276	6.986	7.881	9.170	10.026
Sel	0.114	0.521	0.623	0.717	0.717	0.704	0.731	0.845	1.000	1.000	1.000	1.000
pF	0	0	0	0	0	0	0	0	0	0	0	0
pM	0	0	0	0	0	0	0	0	0	0	0	0

Table 8.12. Saithe in division Va. Output from the short-term projections.

F2011=0.256

2012									
B4	SSB	Fmult	Fbar	Landings					
265	121	0.933	0.239	52					
2013					**2014**				
B4+	SSB	Fmult	Fbar	Landings	B4+	SSB	SSBchange	TACchange	Rationale
260	131	0.000	0.00	0	316	180	37	-100	Zero catch
		0.039	0.01	2	313	178	36	-96	
		0.078	0.02	5	310	176	34	-90	
		0.117	0.03	7	308	174	33	-87	
		0.156	0.04	10	305	172	31	-81	
		0.195	0.05	12	302	171	31	-77	
		0.235	0.06	14	299	169	29	-73	
		0.274	0.07	17	297	167	27	-67	
		0.313	0.08	19	294	165	26	-63	
		0.352	0.09	21	291	164	25	-60	
		0.391	0.10	24	289	162	24	-54	
		0.430	0.11	26	286	160	22	-50	
		0.469	0.12	28	284	159	21	-46	
		0.508	0.13	30	281	157	20	-42	
		0.547	0.14	33	279	155	18	-37	
		0.586	0.15	35	276	154	18	-33	
		0.625	0.16	37	274	152	16	-29	
		0.665	0.17	39	271	151	15	-25	
		0.704	0.18	41	269	149	14	-21	
		0.743	0.19	43	266	147	12	-17	
		0.782	0.20	45	264	146	11	-13	
		0.821	0.21	47	262	144	10	-10	
		0.860	0.22	49	259	143	9	-6	20% HCR
		0.899	0.23	51	257	142	8	-2	
		0.938	0.24	53	255	140	7	2	$F=F_{2012}$
		0.977	0.25	55	253	139	6	6	
		1.016	0.26	57	250	137	5	10	$F=F_{2011}$
		1.055	0.27	59	248	136	4	13	
		1.094	0.28	61	246	134	2	17	$F=F_{MSY}$
		1.134	0.29	63	244	133	2	21	
		1.173	0.30	65	242	132	1	25	
		1.212	0.31	66	240	130	-1	27	
		1.251	0.32	68	238	129	-2	31	
		1.290	0.33	70	236	128	-2	35	
		1.329	0.34	72	233	126	-4	38	
		1.368	0.35	74	231	125	-5	42	
		1.407	0.36	75	229	124	-5	44	
		1.446	0.37	77	227	123	-6	48	
		1.485	0.38	79	225	121	-8	52	
		1.524	0.39	80	224	120	-8	54	
		1.564	0.40	82	222	119	-9	58	
		1.603	0.41	84	220	118	-10	62	
		1.642	0.42	85	218	116	-11	63	
		1.681	0.43	87	216	115	-12	67	
		1.720	0.44	89	214	114	-13	71	
		1.759	0.45	90	212	113	-14	73	
		1.798	0.46	92	210	112	-15	77	
		1.837	0.47	93	209	111	-15	79	
		1.876	0.48	95	207	110	-16	83	
		1.915	0.49	97	205	108	-18	87	
		1.954	0.50	98	203	107	-18	88	

20% HCR = average between 0.2 B4+ (current year) and last year's advice

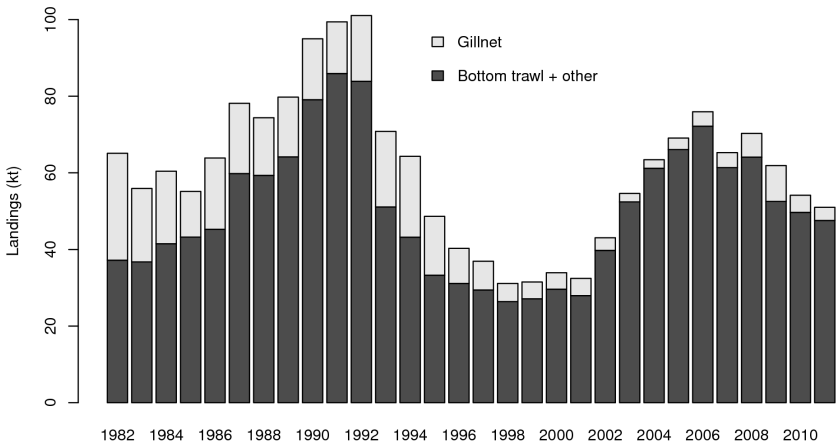

Figure 8.1 Saithe in Division Va. Landings by gear.

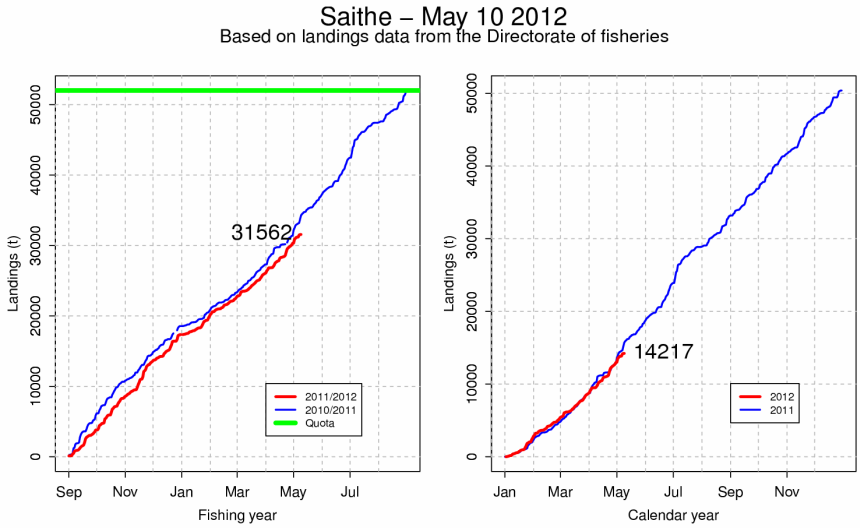

Figure 8.2 Saithe in division Va. Cumulative landings in the current fishing year (left) and calendar year (right). The vertical (green line) in the left figure shows the quota for the current fishing year.

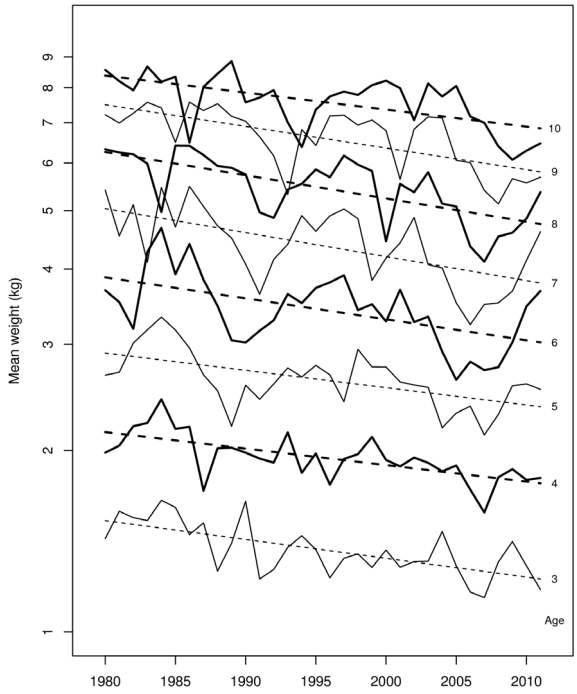

Figure 8.3 Saithe in division Va. Weight at age in the catches. The dotted lines show a linear regression trend on a log-scale.

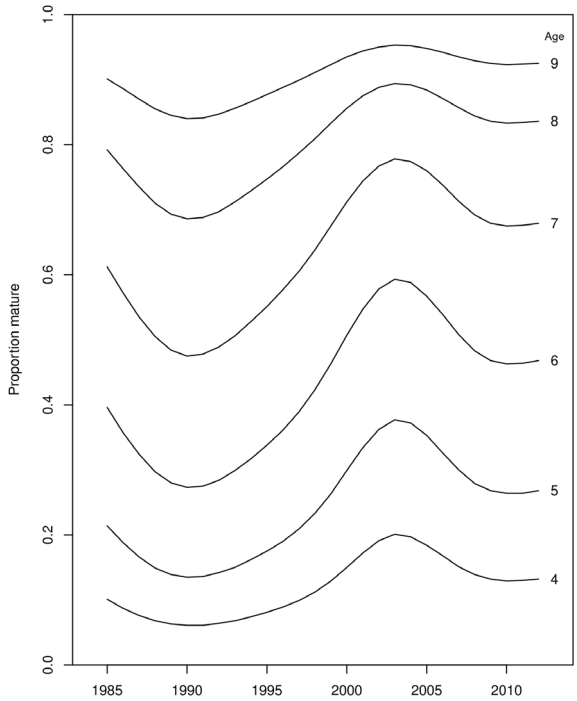

Figure 8.4 Saithe in division Va. Maturity at age used for calculating the SSB.

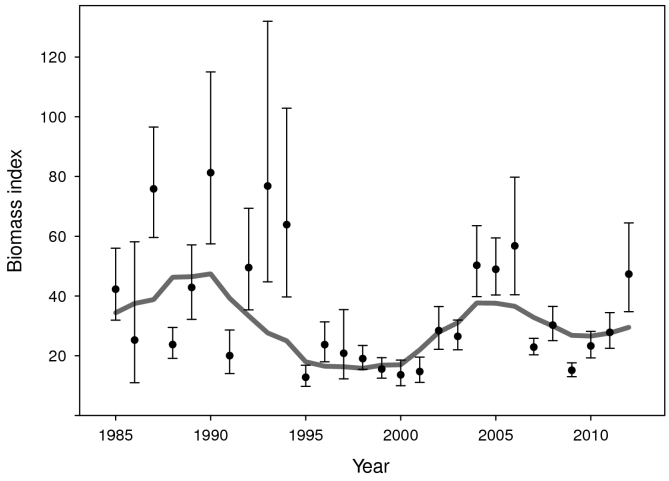

Figure 8.5 Saithe in division Va. Spring survey biomass index and model fit. The vertical lines indicate +/- 1 standard error.

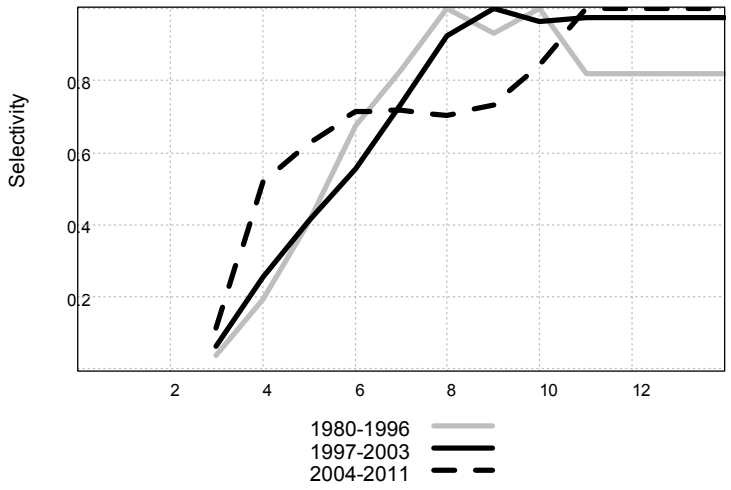

Figure 8.6. Estimated selectivity patterns for the 3 periods.

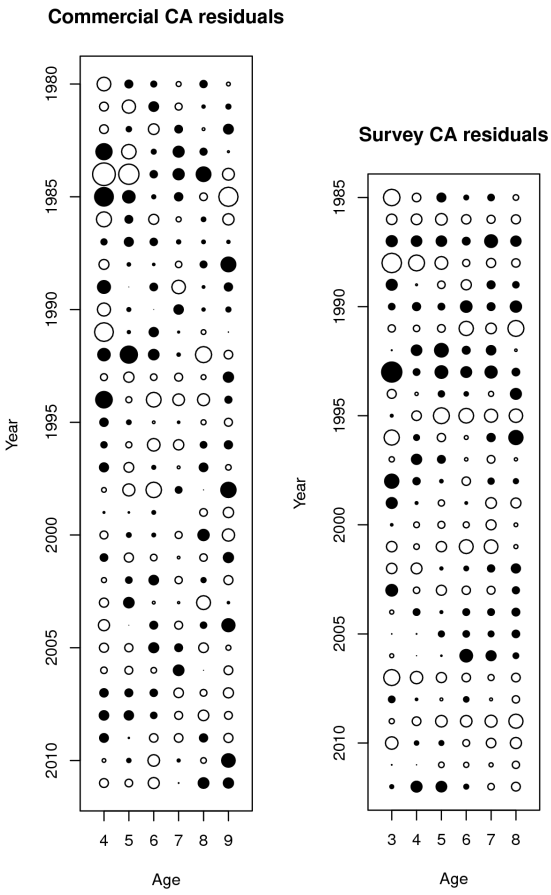

Figure 8.7. Saithe in division Va. Commercial and survey catch-at-age residuals from the fitted model. Filled circles are positive log residuals and hollow circles are negative log residuals.

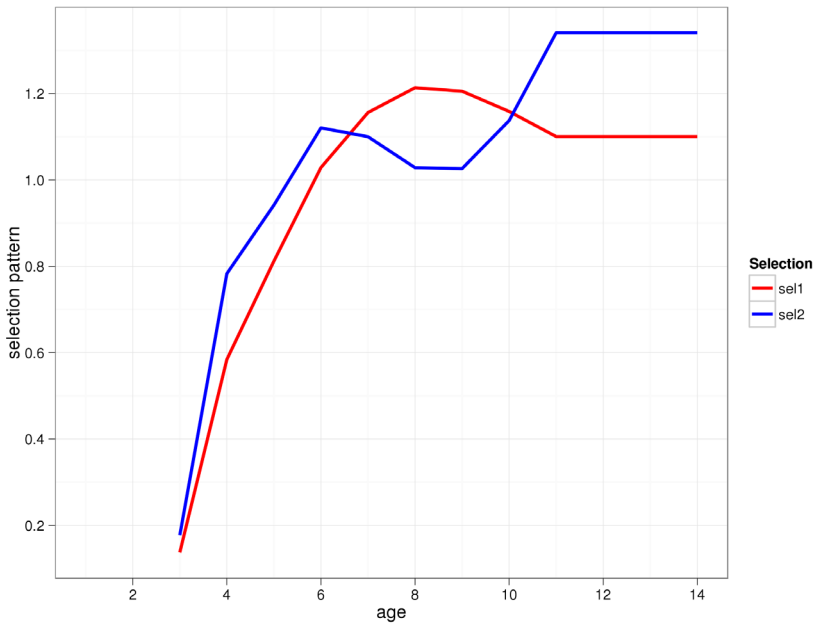

Figure 8.8. Terminal-year selection pattern scaled to mean of age 4 to 9. Sel1: selection pattern based on 2 separable periods (Benchmark 2010). Sel2: selection pattern based on 3 separable periods (NWWG 2011).

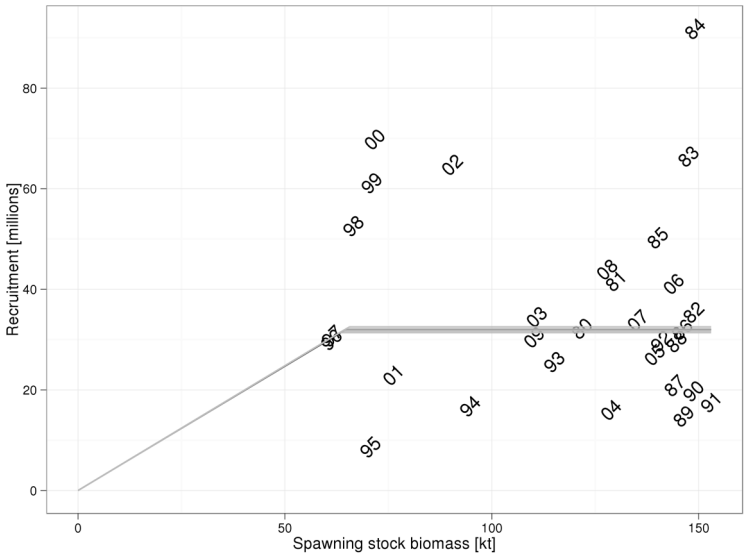

Figure 8.9. Analysis of a hockeystick recruitment function, showing the fit for the retrospective time series back to 2000.

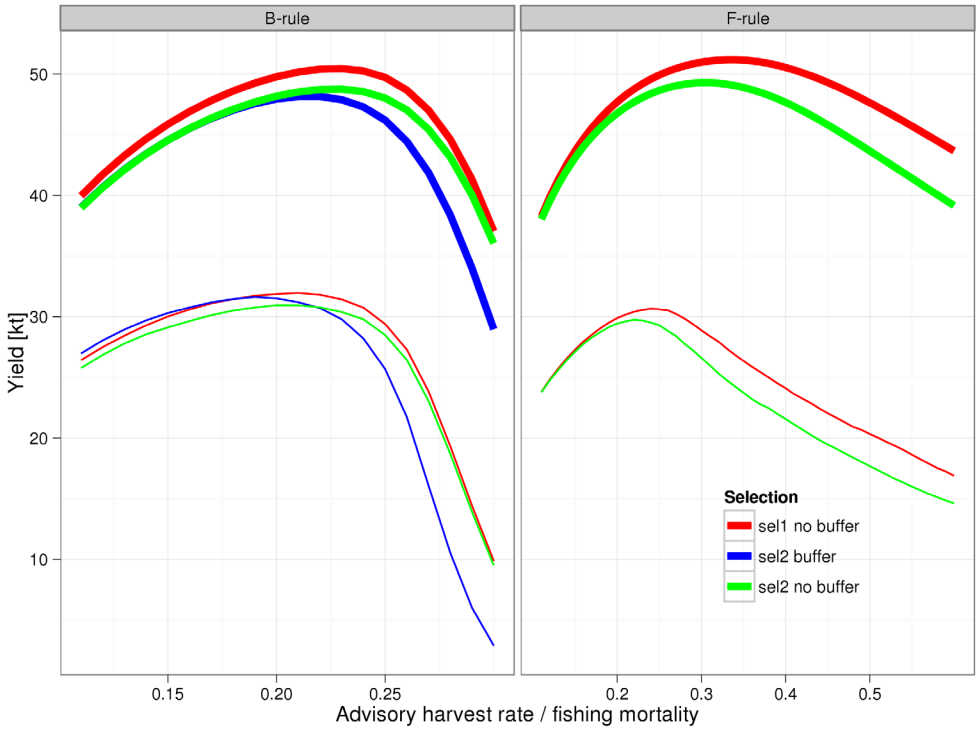

Figure 8.10. Maximum sustainable yield based on 2 selection patterns and 3 decision rules (see text for further explanation). The thick line represents the mean yield and the thin line the lower 10th percentile.

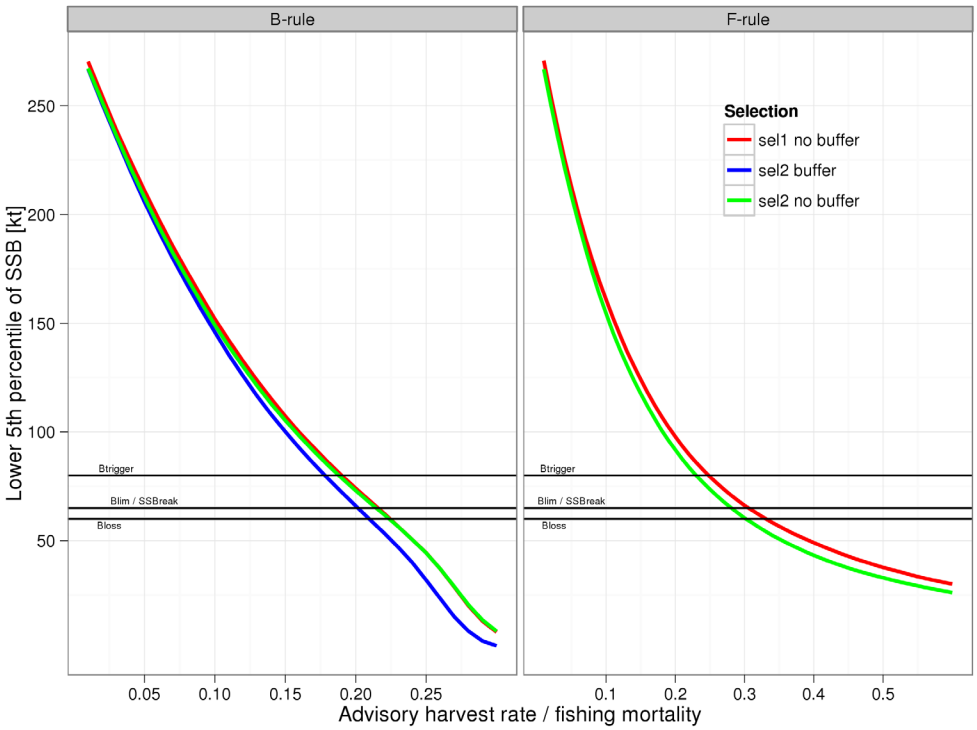

Figure 8.11. The lower 5th percentile of the spawning stock biomass based on 3 selection patterns and 2 decision rules (see text for further explanation).

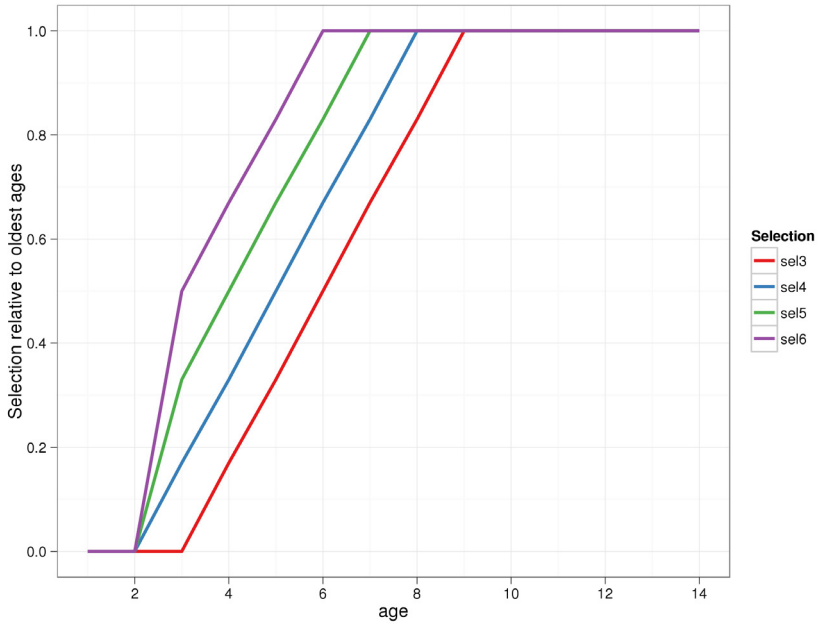

Figure 8.12. Arbritrary selection pattern (scaled here to age 9) used to test robustness of F-rule vs. B-rule.

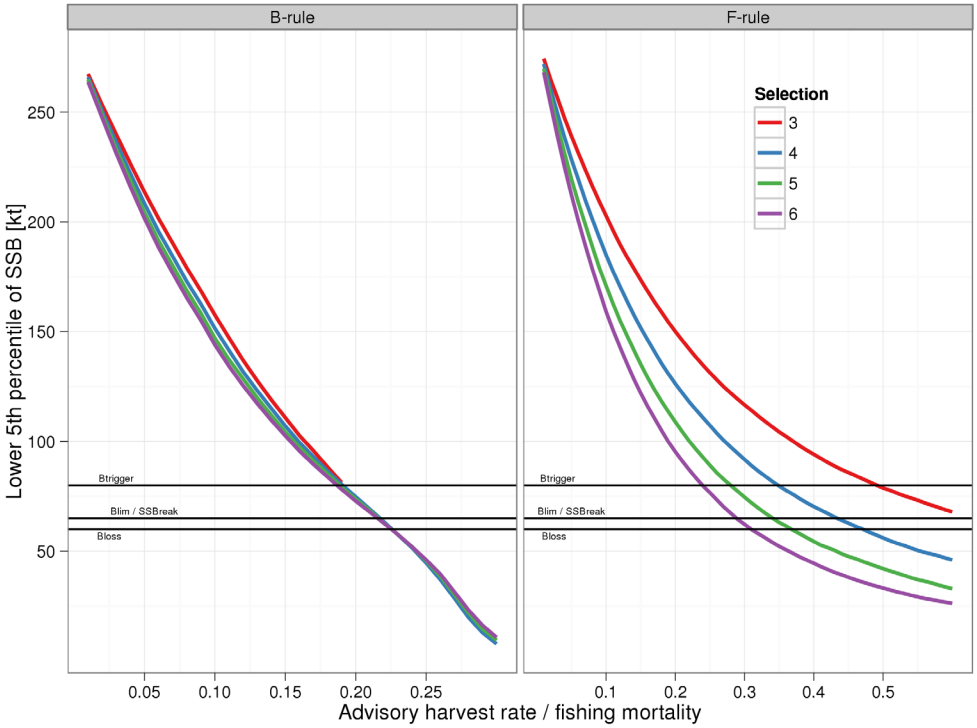

Figure 8.13. The lower 5th percentile of the spawning stock biomass based on 4 arbitrary selection patterns.

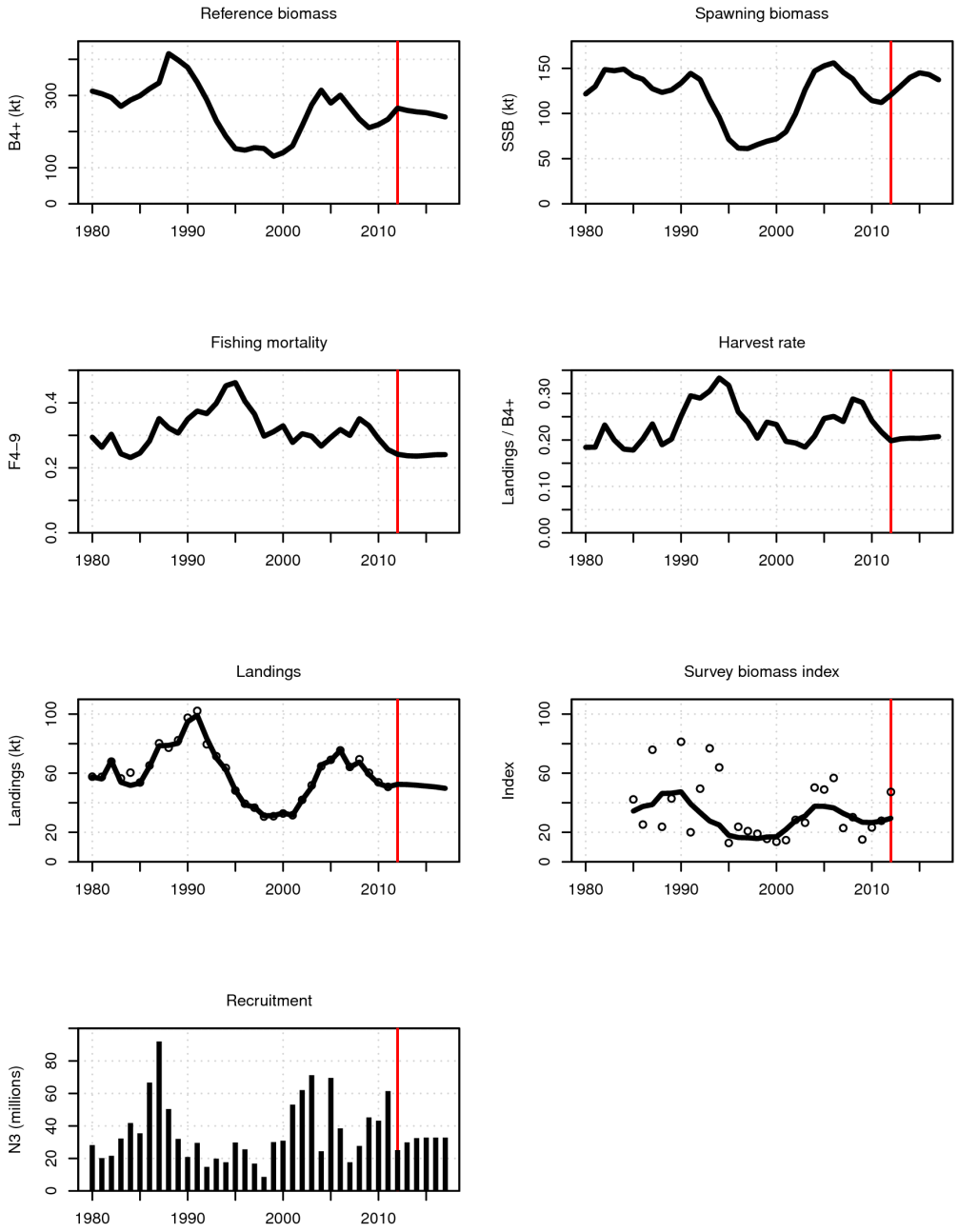

Figure 8.14. Saithe in division Va. Results from the fitted model and short-term forecast. The red line indicates the time of the current assessment.

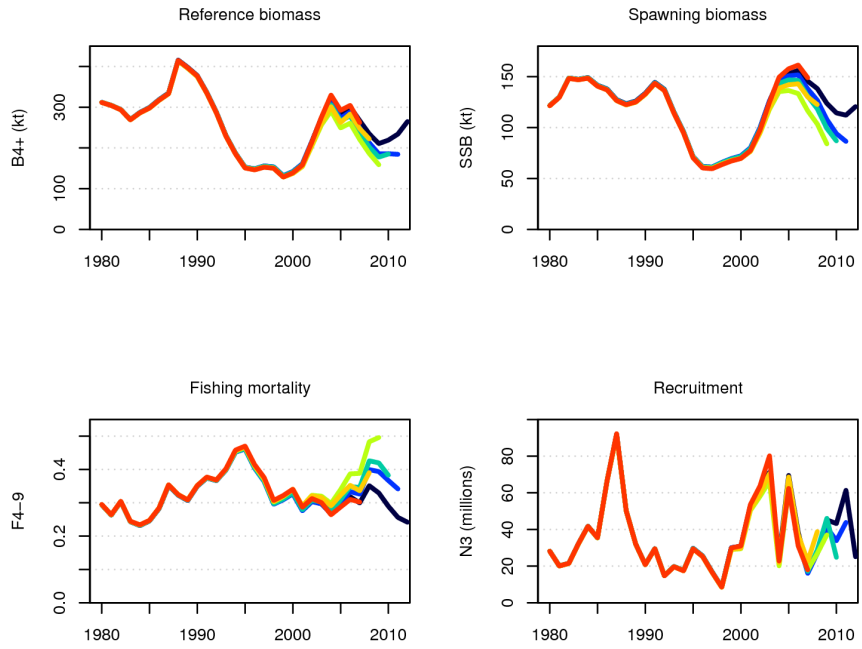

Figure 8.15. Saithe in division Va. Retrospective pattern for the assessment model.