8 Icelandic saithe

8.1 Summary

- The 2014 reference biomass (B_{4+}) is estimated as 296 kt, above the average in the assessment period (1980 to the present). The spawning biomass is estimated as 150 kt, around the highest level in the assessment period and well above $B_{trigger}$ = 65 kt and B_{lim} = 61 kt.
- According to the assessment model, the reference biomass increased by almost a third between 2009 and 2014, while harvest rate decreased from 27% to 19% (fishing mortality 0.30 to 0.23). Year classes 1999-2000 and 2002 were large, but recruitment since then has been around average.
- Weights of ages 6-9 have increased in recent years towards the average, but other ages are below average weight. Maturity at ages 4-9 has decreased in recent years and is currently around average.
- 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.
- here is some discrepancy between the default separable model and alternative assessment models (ADAPT, TSA, SAM), but the difference is smaller than in recent assessments.
- In spring 2013, the Icelandic government adopted a harvest control rule for managing the Icelandic saithe fishery, evaluated by ICES (Hjorleifsson and Bjornsson 2013). It is similar to the 20% rule used for the Icelandic cod fishery. When the population is above $B_{trigger}$, the TAC set in year t equals the average of 0.2 B_{4+} in year t and last year's TAC.
- According to the adopted harvest control rule, the TAC will be 58 kt in the next fishing year.

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 2013 are estimated to have been 58 002 t (Table 8.1 and Figure 8.1). Of the landings, 48 490 t were caught by trawl, 3 103 t by gillnets, and 6 409 t caught by other fishing gear. The domestic as well as ICES advice for the fishing year 2013/2014 was based on the 20% harvest control rule and was 57 kt. The TAC issued was also 57 kt. 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 (79% in 2009-2013), 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 1997-2013 (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 discards 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 assessment.

The sampling program and sampling intensity in 2013, as well as the approach used for calculating catch in numbers, is similar to preceding years. The exception is that factory trawlers are no longer sampled, which reduces the overall the sampling intensity for bottom trawl. This reduction of bottom trawl sampling was the result of analysis of Thordarson (2012). The age and length sampling in 2013 is indicated in the following table:

Gear/nation	Landings (t)	No. of otolith samples	No. of otoliths read	No. of length samples	No. of length measurements
Gillnets	3103	9	449	9	1332
Jiggers	2946	8	400	10	1237
Danish seine	1325	2	100	5	234
Bottom trawl	47565	71	3178	221	33095
Other gear	2138	1	50	139	1662
Foreign landings	925	-	-	-	-
Total	58002	91	4177	384	37560

wo age-length keys are used to calculate catch at age, one key for the gillnet catch and another key for other gears combined. The same length-weight relationship (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 1980-2013, but weights of 6 to 9 year-olds have 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 the current calendar year are predicted by applying a linear model using survey weights and the weight of a year class in the previous year as predictors (Magnusson 2012).

A model using maturity at age 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, a 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 fluctuated greatly in 1985-1995, but were consistently low in 1995-2001, high in the period around 2005, declining to a relatively low level in 2007-2011. The 2012 and 2013 survey biomass indices were 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 young 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 from 1980 onwards) and survey catch at age (ages 3-10 from 1985 onwards). (Figure 8.6). The selectivity pattern is constant within each period (Figure 8.6). Natural mortality is set at 0.2 for all ages.

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 Reference points and HCR

In April 2013, the Icelandic government adopted a management plan for managing the Icelandic saithe fishery (Ministry of Industries and Innovation 2013). ICES evaluated this management plan and concluded that it was in accordance with the precautionary approach and the ICES MSY framework. In the harvest control rule (HCR) evaluation (Hjorleifsson and Bjornsson 2013) B_{lim} was defined as 61 kt, based on B_{loss} as estimated in 2010, and $B_{trigger}$ was defined as 65 kt, based on an estimated hockey-stick recruitment function.

The TAC set in year t is for the upcoming fishing year, from 1 September in year t, to 31 August in year t+1. The 20% HCR consists of two equations, as follows.

When $SSB \geq B_{trigger}$, the TAC set in year t equals the average of 0.20 times the current biomass and last year's TAC:

$$TAC_t = 0.5 \times 0.20\, B_{t,4+} + 0.5\, TAC_{t-1} \quad \text{(Eq. 1)}$$

When SSB is below $B_{trigger}$, the harvest rate is reduced below 0.20:

$$TAC_t = SSB_t/B_{trigger} \left[(1 - 0.5\, SSB_t/B_{trigger})\, 0.20\, B_{t,4+}) + 0.5\, TAC_{t-1} \right] \quad \text{(Eq. 2)}$$

Equation 1 is a plain average of two numbers. Equation 2 is continuous over $SSB_t/B_{trigger}$, so the rule does not lead to very different TAC when SSB_t is slightly below or above $B_{trigger}$ (Magnusson 2013).

8.7 State of the stock

The results of the principal stock quantities (Table 8.8 and Figure 8.8) show that the reference biomass declined by a quarter from 2004 to 2009, but has increased since then, and is now above the long-term average. The harvest rate peaked around 30% in the mid 1990s, but has fluctuated around 22% since 1998 (fishing mortalities 0.44 and 0.28). SSB has been stable at a relatively high level during the last ten years, having declined to its historical minimum in the mid 1990s.

Year classes 1999-2000 and 2002 were large, but recruitment since then has been around the long-term average. 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.

he landings for the ongoing calendar year are predicted based on the HCR, with the calendar year landings consisting of 2/3 of the ongoing fishing year's TAC and 1/3 of the next fishing year's TAC. This results in a predicted harvest rate similar to last year (u_{2013}=19% and u_{2014}=19%).

ollowing the HCR, the predicted landings in 2015 are 57 kt, corresponding to F=0.24 in 2015. The resulting SSB in 2016 is predicted to be 157 kt.

8.9 Uncertainties in assessment and forecast

The assessment of Icelandic saithe is relatively uncertain due to fluctuations in the survey data, as well as irregular changes in the fleet selectivity. The internal consistency in the spring bottom trawl survey is very low for saithe. This is not surprising, considering the nature of the species that is partly pelagic, schooling, and relatively widely migrating. There are also indications of time-varying selectivity, so changes in the commercial catch at age may not reflect changes in the age dstribution of the population. The retrospective pattern (Figure 8.9) reveals some of the assessment uncertainty. The harvest control rule evaluation incorporated uncertainties about assessment estimates, among other sources of uncertainty (Hjorleifsson and Bjornsson 2013).

he results from the default separable assessment model are compared to alternative model runs, involving ADAPT, TSA, and SAM, Further comparison with other assessment models was carried outin order to explore the overall uncertainty in the assessment. The comparison involved four models which differ mainly in the way the commercial catch-at-age variability and F-matrix is modelled:

	Model	Family	CA variability	F matrix
1	ADSEP (default)	separable	observation error	multiplicative in 3 periods
2	ADAPT	vpa	process error	no constraints

3	TSA	state-space (kalman filter)	observation & process error	orthogonal polynomials
4	SAM	state-space (random effects)	observation & process error	correlated random walk

The results from the model comparison (Figure 8.10) show that the default model estimates the current stock larger than the other models, which has also been the case for saithe assessments in recent years.

8.10 Comparison with previous assessment and forecast

Compared to last year's assessment the estimated reference biomass B_{4+} in 2013 has decreased from 321 to 298 kt, SSB 2013 has decreased from 158 to 143 kt, the harvest rate u_{2012} has increased from 17% to 18% (fishing mortality 0.19 to 0.21), and the stock numbers at ages 5 to 7 have all decreased as shown below.

	NWWG2013	NWWG2014
B4+(2013)	321	298
SSB(2013)	158	143
u(2012)	17%	18%
F4-9(2012)	0.19	0.21
N5(2013)	34	31
N6(2013)	19	16
N7(2013)	12	10

8.11 Ecosystem considerations

Changes in the distribution of large pelagic stocks (blue whiting, mackerel, Norwegian spring-spawning herring, Icelandic summer-spawning herring) may affect the propensity of saithe to migrate off shelf and between management units. Saithe is a migrating species and makes both vertical and long-distance feeding and spawning migrations (Armannsson et al. 2007, Armannsson and Jonsson 2012, i Homrum et al. 2013). 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

According to the stock assessment model fit to the commercial catch-at-age data, the fleet is targeting younger fish since around 2004, compared to earlier periods. This can be partly explained by reduced use of gillnets in the saithe fishery.

8.13 References

Armannsson, H. and S.T. Jonsson. 2012. Vertical migrations of saithe (*Pollachius virens*) in Icelandic waters as observed with data storage tags. ICES J. Mar. Sci. 69:1372-1381.

Armannsson, H., S.T. Jonsson, J.D. Neilson, and G. Marteinsdottir. 2007. Distribution and migration of saithe (*Pollachius virens*) around Iceland inferred from mark-recapture studies. ICES J. Mar. Sci. 64:1006-1016.

Gudmundsson, G. 2013. Fish stock assessment by time series analysis. ICES NWWG WD29.

Hjorleifsson, E. and H. Bjornsson. 2013. Report of the evaluation of the Icelandic saithe management plan. ICES CM 2013/ACOM:60.

i Homrum, E., B. Hansen, S.T. Jonsson, K. Michalsen, J. Burgos, D. Righton, P. Steingrund, T. Jakobsen, R. Mouritsen, H. Hatun, H. Armannsson, and J.S. Joensen. 2013. Migration of saithe (*Pollachius virens*) in the Northeast Atlantic. ICES J. Mar. Sci. 70:782-792.

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.

Magnusson, A. 2012. Icelandic saithe: New model to predict current weight at age. ICES NWWG WD30.

Magnusson, A. 2013. Mathematical properties of the Icelandic saithe HCR. ICES NWWG WD 31.

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.

Thordarson, G. 2012. Sampling of demersal fish stocks from commercial catches and surveys: Flatfish and elongated species. Report for the Marine Research Institute.

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

	Belgium	Faroe Islands	France	Germany	Iceland	Norway	UK (E/W/NI)	UK (Scotland)	UK	Total
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
2012		940			50 843					51 783
2013		925			57 077					58 002

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
2012	1.183	4.816	3.514	2.417	0.903	0.432	0.883	1.015	0.354	0.277	0.173	0.099
2013	1.163	5.538	6.366	2.963	1.610	0.664	0.375	0.537	0.460	0.124	0.118	0.078

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	1160	1668	2369	3347	4430	5486	6161	6448	7220	8054	8147	8901
2013	1056	1675	2219	3244	4529	5628	6397	7055	7378	7955	8400	8870
2014	1130	1525	2319	3042	4163	5568	6913	6656	7150	7683	8272	8910
2015	1130	1525	2319	3042	4163	5568	6913	6656	7150	7683	8272	8910
2016	1130	1525	2319	3042	4163	5568	6913	6656	7150	7683	8272	8910
Avg80-13	1359	1936	2614	3445	4418	5496	6614	7564	8476	9307	10251	10923

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
1985	0.000	0.093	0.202	0.385	0.607	0.793	0.904	1.000	1.000	1.000	1.000	1.000
1986	0.000	0.082	0.181	0.354	0.575	0.770	0.892	1.000	1.000	1.000	1.000	1.000
1987	0.000	0.073	0.163	0.325	0.544	0.746	0.879	1.000	1.000	1.000	1.000	1.000
1988	0.000	0.066	0.149	0.302	0.516	0.725	0.867	1.000	1.000	1.000	1.000	1.000
1989	0.000	0.061	0.138	0.283	0.494	0.707	0.856	1.000	1.000	1.000	1.000	1.000
1990	0.000	0.058	0.131	0.271	0.479	0.695	0.849	1.000	1.000	1.000	1.000	1.000
1991	0.000	0.056	0.128	0.267	0.474	0.690	0.846	1.000	1.000	1.000	1.000	1.000
1992	0.000	0.057	0.130	0.270	0.477	0.693	0.848	1.000	1.000	1.000	1.000	1.000
1993	0.000	0.060	0.136	0.280	0.490	0.704	0.854	1.000	1.000	1.000	1.000	1.000
1994	0.000	0.065	0.147	0.298	0.512	0.722	0.865	1.000	1.000	1.000	1.000	1.000
1995	0.000	0.073	0.164	0.326	0.544	0.747	0.879	1.000	1.000	1.000	1.000	1.000
1996	0.000	0.085	0.187	0.362	0.584	0.776	0.895	1.000	1.000	1.000	1.000	1.000
1997	0.000	0.100	0.215	0.404	0.626	0.805	0.911	1.000	1.000	1.000	1.000	1.000
1998	0.000	0.117	0.247	0.447	0.666	0.831	0.924	1.000	1.000	1.000	1.000	1.000
1999	0.000	0.135	0.278	0.487	0.701	0.853	0.935	1.000	1.000	1.000	1.000	1.000
2000	0.000	0.151	0.305	0.520	0.728	0.868	0.942	1.000	1.000	1.000	1.000	1.000
2001	0.000	0.163	0.324	0.542	0.745	0.879	0.947	1.000	1.000	1.000	1.000	1.000
2002	0.000	0.170	0.336	0.556	0.756	0.884	0.950	1.000	1.000	1.000	1.000	1.000
2003	0.000	0.174	0.342	0.562	0.760	0.887	0.951	1.000	1.000	1.000	1.000	1.000
2004	0.000	0.173	0.340	0.560	0.759	0.886	0.950	1.000	1.000	1.000	1.000	1.000
2005	0.000	0.168	0.333	0.552	0.753	0.883	0.949	1.000	1.000	1.000	1.000	1.000
2006	0.000	0.161	0.321	0.539	0.743	0.877	0.946	1.000	1.000	1.000	1.000	1.000
2007	0.000	0.152	0.307	0.523	0.730	0.870	0.943	1.000	1.000	1.000	1.000	1.000
2008	0.000	0.143	0.292	0.505	0.716	0.862	0.939	1.000	1.000	1.000	1.000	1.000
2009	0.000	0.135	0.279	0.488	0.702	0.853	0.935	1.000	1.000	1.000	1.000	1.000
2010	0.000	0.128	0.267	0.473	0.689	0.846	0.931	1.000	1.000	1.000	1.000	1.000
2011	0.000	0.123	0.257	0.461	0.679	0.839	0.928	1.000	1.000	1.000	1.000	1.000
2012	0.000	0.118	0.249	0.450	0.669	0.833	0.925	1.000	1.000	1.000	1.000	1.000
2013	0.000	0.114	0.242	0.441	0.661	0.828	0.922	1.000	1.000	1.000	1.000	1.000
2014	0.000	0.111	0.235	0.432	0.652	0.823	0.920	1.000	1.000	1.000	1.000	1.000
2015	0.000	0.111	0.235	0.432	0.652	0.823	0.920	1.000	1.000	1.000	1.000	1.000
2016	0.000	0.111	0.235	0.432	0.652	0.823	0.920	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	3.96	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
2013	0.01	0.12	4.27	7.43	6.78	4.65	2.57	1.12	0.30	0.44	0.36	0.26	0.13	0.01
2014	0.01	0.03	0.39	3.84	3.78	2.04	0.86	0.42	0.15	0.11	0.18	0.18	0.07	0.09

Table 8.6. Saithe in division Va. Commercial catch-at-age residuals log(obs/fit) from the model.

	3	4	5	6	7	8	9	10	11	12	13	14
1980	-0.78	-0.59	0.25	0.15	-0.08	0.21	-0.04	0.22	-0.30	-0.41	-0.69	-0.04
1981	-0.51	-0.25	-0.55	0.36	-0.16	0.06	0.11	0.28	-0.84	0.92	1.18	1.85
1982	0.82	-0.24	0.12	-0.36	0.23	-0.02	0.36	-0.35	-1.18	-1.13	-0.52	-0.10
1983	-2.44	0.92	-0.66	0.11	0.45	0.20	-0.01	-0.79	-2.39	-2.75	-5.09	-3.77
1984	-4.17	-1.59	-1.27	0.22	0.47	0.78	-0.44	0.42	0.95	1.01	3.42	4.83
1985	-0.28	1.22	0.57	0.08	0.27	-0.19	-1.15	-0.74	-1.38	-3.02	0.64	2.43
1986	2.24	-0.71	0.24	-0.32	-0.08	0.10	-0.40	0.91	-1.08	-1.37	-1.81	-1.73
1987	-0.98	0.15	0.31	0.22	0.09	0.07	0.06	-0.17	-0.08	-2.87	-1.88	-0.24
1988	0.91	-0.31	0.06	0.04	-0.14	0.19	0.78	-0.65	0.47	-1.67	-3.22	-6.78
1989	-0.83	0.60	0.00	0.23	-0.57	0.04	0.27	-0.18	0.70	0.36	-1.11	-3.67
1990	-1.75	-0.53	0.08	0.00	0.34	0.06	0.11	-0.37	0.07	-0.77	0.16	-1.59
1991	-1.93	-1.09	0.06	0.32	0.03	-0.08	0.01	0.70	0.22	-1.36	-3.87	-3.89
1992	-0.21	0.57	1.04	0.42	0.06	-0.81	-0.24	-0.40	-0.28	-1.16	0.47	-0.88
1993	0.96	-0.15	-0.33	-0.14	-0.20	-0.08	0.39	0.04	0.32	0.73	0.63	-1.27
1994	1.07	0.96	-0.12	-0.68	-0.43	-0.46	0.20	0.40	0.50	0.78	1.84	1.76
1995	1.56	0.27	0.10	-0.02	0.04	-0.08	-0.20	-0.19	-0.25	-0.86	-0.67	-1.81
1996	1.43	0.16	-0.12	-0.50	-0.34	0.18	0.27	0.03	0.39	-0.14	1.31	2.37
1997	0.26	0.33	-0.30	0.08	-0.03	0.29	-0.10	-0.40	-0.32	0.34	-1.11	0.18
1998	-0.35	-0.06	-0.46	-0.75	0.18	0.00	0.83	0.68	1.22	1.14	1.54	0.82
1999	0.39	0.04	0.00	0.07	-0.01	-0.19	-0.34	0.33	-0.64	-0.55	0.32	0.18
2000	-0.06	-0.20	0.11	0.07	-0.16	0.47	-0.48	-0.27	-0.21	-0.90	-0.06	-1.08
2001	-0.10	0.23	-0.27	-0.14	-0.03	-0.18	0.38	0.06	0.13	0.06	0.39	1.03
2002	-0.62	-0.09	0.17	0.35	-0.17	0.12	-0.26	-0.34	-0.08	-1.16	-0.05	-0.30
2003	0.38	-0.28	0.41	-0.03	-0.02	-0.60	0.04	-0.18	0.05	-1.24	0.30	1.27
2004	-0.16	-0.42	-0.05	0.28	-0.12	0.22	0.55	0.38	-0.10	-0.50	0.72	-0.25
2005	-0.40	-0.34	-0.25	0.42	0.32	-0.26	-0.16	0.00	0.28	-0.05	-0.27	-0.38
2006	-0.67	-0.19	-0.27	-0.03	0.52	0.04	-0.34	-0.07	0.76	0.98	1.12	0.22
2007	0.79	0.20	0.20	0.25	-0.16	-0.09	-0.41	-0.43	-0.78	0.37	0.35	-0.12
2008	0.06	0.34	0.25	0.22	-0.13	-0.28	-0.27	-0.25	-0.54	0.19	2.81	1.84
2009	0.66	0.43	-0.02	-0.25	-0.18	0.25	-0.36	-0.08	0.14	0.53	1.23	2.70
2010	0.39	0.20	0.16	-0.42	0.03	-0.15	0.46	-0.38	0.10	0.04	0.99	1.38
2011	0.06	-0.11	-0.02	-0.29	-0.02	0.28	0.13	0.42	-0.21	0.08	0.63	1.61
2012	-0.35	-0.44	-0.22	-0.23	-0.26	0.05	0.65	0.58	1.38	0.17	0.65	1.07
2013	-0.34	0.16	0.32	-0.06	-0.27	-0.18	0.26	0.14	-0.38	0.36	-0.47	0.11

Table 8.7. Saithe in division Va. Survey catch-at-age residuals log(obs/fit) from the model.

	2	3	4	5	6	7	8	9	10
1985	-0.45	-1.53	-0.44	0.56	0.20	0.35	-0.15	0.85	-0.97
1986	0.75	-0.61	-0.68	-0.78	-0.49	-0.36	-0.45	-0.65	-0.36
1987	-0.64	0.86	0.74	0.75	0.45	1.12	0.75	0.55	0.28
1988	-0.37	-2.14	-1.46	-0.94	-0.28	-0.46	-0.38	-1.28	-0.55
1989	1.92	0.85	-0.03	-0.32	-0.59	0.49	0.34	0.37	-5.68
1990	-0.14	0.35	0.46	0.34	0.91	0.47	0.89	0.67	-0.43
1991	0.13	-0.28	-0.25	-0.34	-1.16	-0.62	-1.43	-3.06	-2.22
1992	-0.66	0.03	0.75	1.24	0.47	0.65	0.00	-0.67	-1.11
1993	1.98	2.61	0.33	1.08	0.81	1.01	0.46	1.71	1.00
1994	0.85	-0.43	-0.07	0.31	0.19	-0.12	0.85	1.33	2.35
1995	0.40	0.12	-0.54	-1.45	-1.22	-0.96	-1.01	-0.18	-0.05
1996	-0.63	-1.28	0.26	-0.39	-0.07	0.52	1.36	-0.84	0.04
1997	1.20	-0.12	0.71	0.45	-0.05	-0.32	-0.02	-0.44	-0.10
1998	-1.50	1.36	0.38	0.13	-0.40	0.33	0.25	-0.03	-0.13
1999	0.70	0.85	0.09	-0.22	0.10	-0.64	-0.54	-2.19	-0.99
2000	-0.73	0.11	-0.20	-0.27	-0.19	-0.55	-0.04	-0.83	-1.08
2001	0.08	-0.61	-0.19	-0.61	-1.08	-1.03	-0.05	-0.79	-0.16
2002	0.11	-0.61	-0.70	0.11	0.21	0.43	0.63	0.38	0.42
2003	-2.23	0.94	-0.26	-0.58	-0.38	-0.33	0.42	-1.30	-0.34
2004	-0.08	-0.12	0.32	0.09	0.36	0.37	0.49	0.84	0.66
2005	-0.90	-0.01	-0.05	0.28	0.34	0.29	0.44	0.31	0.91
2006	-6.50	-0.16	-0.06	-0.02	1.07	0.70	0.26	-0.27	0.15
2007	-2.15	-1.52	-1.00	-0.66	-0.48	-0.22	-0.45	-0.84	-0.44
2008	-2.34	0.33	-0.04	-0.17	0.17	-0.12	-0.35	-0.73	-1.10
2009	-1.23	-0.10	-0.49	-0.90	-0.91	-0.94	-1.26	-1.05	-1.15
2010	-2.78	-0.92	0.17	0.13	-0.42	-0.71	-0.87	-1.33	-1.36
2011	-1.62	0.14	-0.07	-0.20	-0.25	-0.28	-0.54	-0.47	0.13
2012	-3.84	-0.51	0.89	0.69	0.16	-0.37	-0.67	-0.10	0.08
2013	-0.80	0.63	0.59	0.38	0.71	0.68	0.95	0.45	0.46
2014	-3.10	-1.18	-0.08	-0.02	-0.53	-0.66	-0.80	-0.93	-0.32

Table 8.8. Saithe in division Va. Main population estimates from the fitted model. The recruitment column is aligned so that the 2000 cohort is shown in the year 2000, but that cohort size is the estimated N at age 3 in 2003.

	B4+	SSB	Cohort	Y	F4–9	HR
1980	312	122	32	58	0.29	19%
1981	304	130	42	59	0.26	19%
1982	294	149	35	69	0.30	23%
1983	270	147	67	58	0.24	22%
1984	287	149	92	63	0.23	22%
1985	299	140	50	57	0.25	19%
1986	318	137	32	65	0.28	20%
1987	335	128	21	81	0.35	24%
1988	416	124	29	77	0.32	19%
1989	398	127	15	82	0.31	21%
1990	378	134	20	98	0.35	26%
1991	336	143	18	102	0.37	30%
1992	288	135	30	80	0.37	28%
1993	230	113	25	72	0.40	31%
1994	187	94	17	64	0.45	34%
1995	152	70	9	49	0.46	32%
1996	148	61	30	40	0.41	27%
1997	155	62	31	37	0.37	24%
1998	152	67	53	32	0.30	21%
1999	130	71	62	31	0.32	24%
2000	140	72	72	33	0.33	24%
2001	159	78	26	32	0.28	20%
2002	215	94	73	42	0.31	20%
2003	274	118	42	52	0.30	19%
2004	315	139	19	65	0.27	21%
2005	280	149	28	69	0.29	25%
2006	307	157	44	76	0.31	25%
2007	278	152	45	64	0.28	23%
2008	249	149	57	70	0.32	28%
2009	228	137	45	61	0.30	27%
2010	237	129	42	54	0.26	23%
2011	256	127	18	51	0.22	20%
2012	281	131	32	52	0.21	18%
2013	298	143	33	58	0.22	19%
2014	296	150	33	58	0.23	19%

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	48.0	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	62.4	39.3	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	52.8	51.1	32.2	17.4	12.2	11.8	14.8	7.5	1.9	1.4	0.6	0.2	0.1	0.1
1984	99.7	43.3	41.9	26.0	13.3	8.6	7.5	9.0	4.3	1.1	0.8	0.4	0.1	0.1
1985	137.0	81.7	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	75.3	112.2	66.9	28.6	25.8	14.1	6.0	3.4	2.6	3.0	1.4	0.4	0.3	0.1
1987	47.6	61.6	91.8	53.9	21.6	17.8	8.7	3.5	1.8	1.5	1.6	0.8	0.2	0.2
1988	31.0	39.0	50.5	73.7	39.8	14.3	10.3	4.6	1.7	0.9	0.7	0.9	0.4	0.1
1989	44.0	25.4	31.9	40.6	55.0	26.9	8.5	5.6	2.3	0.9	0.5	0.4	0.5	0.2
1990	22.0	36.0	20.8	25.7	30.4	37.4	16.2	4.7	2.9	1.2	0.5	0.3	0.2	0.3
1991	29.5	18.0	29.5	16.7	19.0	20.2	31.4	8.6	2.3	1.5	0.6	0.2	0.1	0.1
1992	26.2	24.1	14.8	23.6	12.3	12.4	11.3	16.2	4.0	1.1	0.7	0.3	0.1	0.1
1993	44.3	21.5	19.8	11.8	17.4	8.0	7.0	5.9	7.7	2.0	0.5	0.4	0.2	0.1
1994	37.9	36.2	17.6	15.8	8.6	11.2	4.4	3.5	2.7	3.6	0.9	0.3	0.2	0.1
1995	24.9	31.0	29.7	14.0	11.4	5.4	5.8	2.1	1.5	1.2	1.5	0.4	0.1	0.1
1996	12.7	20.4	25.4	23.7	10.0	7.0	2.8	2.7	0.8	0.6	0.5	0.7	0.2	0.1
1997	44.6	10.4	16.7	20.3	17.2	6.4	3.8	1.4	1.2	0.4	0.3	0.2	0.3	0.1
1998	45.9	36.5	8.5	13.2	14.4	11.2	3.8	2.1	0.7	0.6	0.2	0.1	0.1	0.2
1999	79.3	37.6	29.9	6.8	9.6	9.8	7.1	2.2	1.1	0.3	0.3	0.1	0.1	0.1
2000	93.0	64.9	30.8	23.7	4.9	6.4	6.1	4.1	1.2	0.5	0.2	0.1	0.0	0.0
2001	107.0	76.2	53.2	24.4	17.0	3.3	4.0	3.4	2.1	0.6	0.3	0.1	0.1	0.0
2002	38.1	87.6	62.4	42.4	17.9	11.7	2.1	2.4	1.9	1.1	0.3	0.1	0.0	0.0
2003	108.8	31.2	71.7	49.6	30.7	12.0	7.3	1.2	1.2	0.9	0.6	0.2	0.1	0.0
2004	62.7	89.1	25.5	57.1	36.1	20.8	7.6	4.3	0.6	0.6	0.5	0.3	0.1	0.0
2005	28.4	51.3	72.9	20.0	37.9	22.9	12.9	4.8	2.7	0.4	0.4	0.3	0.1	0.0
2006	42.4	23.3	42.0	56.8	13.0	23.5	13.8	7.8	2.9	1.5	0.2	0.2	0.1	0.1
2007	66.2	34.7	19.1	32.6	36.5	7.9	13.9	8.2	4.7	1.6	0.8	0.1	0.1	0.1
2008	67.2	54.2	28.4	14.9	21.4	22.8	4.8	8.5	5.0	2.7	0.9	0.4	0.1	0.0
2009	84.7	55.0	44.4	22.0	9.5	12.9	13.3	2.8	5.0	2.8	1.4	0.4	0.2	0.0
2010	67.1	69.4	45.1	34.6	14.3	5.9	7.8	8.1	1.7	2.9	1.5	0.7	0.2	0.1
2011	61.9	54.9	56.8	35.3	23.2	9.2	3.7	4.9	5.1	1.0	1.7	0.8	0.4	0.1
2012	26.6	50.7	44.9	44.8	24.3	15.4	6.0	2.4	3.2	3.2	0.6	0.9	0.4	0.2
2013	48.3	21.8	41.5	35.5	31.2	16.3	10.1	3.9	1.6	2.0	2.0	0.4	0.5	0.3
2014	49.6	39.6	17.8	32.7	24.5	20.7	10.6	6.6	2.6	1.0	1.2	1.1	0.2	0.3

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	0.01	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	0.19	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	0.47	0.57	0.69	0.64	0.69	0.57	0.57	0.57	0.57
1996	0.02	0.12	0.25	0.41	0.50	0.61	0.56	0.61	0.50	0.50	0.50	0.50
1997	0.04	0.14	0.23	0.31	0.42	0.53	0.57	0.56	0.57	0.57	0.57	0.57
1998	0.03	0.12	0.19	0.26	0.34	0.43	0.47	0.46	0.47	0.47	0.47	0.47
1999	0.03	0.12	0.20	0.27	0.36	0.45	0.49	0.48	0.49	0.49	0.49	0.49
2000	0.03	0.13	0.21	0.29	0.38	0.48	0.52	0.51	0.52	0.52	0.52	0.52
2001	0.03	0.11	0.18	0.24	0.32	0.40	0.44	0.43	0.44	0.44	0.44	0.44
2002	0.03	0.12	0.19	0.26	0.35	0.44	0.48	0.47	0.48	0.48	0.48	0.48
2003	0.03	0.12	0.19	0.26	0.34	0.43	0.47	0.46	0.47	0.47	0.47	0.47
2004	0.05	0.21	0.25	0.28	0.27	0.28	0.31	0.38	0.46	0.46	0.46	0.46
2005	0.05	0.23	0.28	0.31	0.30	0.30	0.34	0.41	0.50	0.50	0.50	0.50
2006	0.05	0.24	0.29	0.32	0.32	0.32	0.36	0.44	0.53	0.53	0.53	0.53
2007	0.05	0.22	0.27	0.30	0.29	0.29	0.33	0.40	0.49	0.49	0.49	0.49
2008	0.06	0.25	0.31	0.34	0.33	0.33	0.38	0.46	0.56	0.56	0.56	0.56
2009	0.05	0.23	0.28	0.31	0.30	0.30	0.35	0.42	0.51	0.51	0.51	0.51
2010	0.04	0.20	0.24	0.27	0.26	0.26	0.30	0.36	0.44	0.44	0.44	0.44
2011	0.04	0.17	0.21	0.23	0.23	0.23	0.26	0.32	0.39	0.39	0.39	0.39
2012	0.04	0.16	0.20	0.22	0.21	0.21	0.24	0.30	0.36	0.36	0.36	0.36
2013	0.04	0.17	0.21	0.23	0.23	0.23	0.26	0.31	0.38	0.38	0.38	0.38
2014	0.04	0.18	0.22	0.24	0.24	0.24	0.27	0.33	0.40	0.40	0.40	0.40

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

2014	3	4	5	6	7	8	9	10	11	12	13	14
N	17.8	32.7	24.5	20.7	10.6	6.6	2.6	1.0	1.2	1.1	0.2	0.3
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	0.111	0.235	0.432	0.652	0.823	0.920	1.000	1.000	1.000	1.000	1.000
w	1.130	1.525	2.319	3.042	4.163	5.568	6.913	6.656	7.150	7.683	8.272	8.910
sel	0.099	0.452	0.551	0.607	0.593	0.599	0.679	0.824	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
2015	3	4	5	6	7	8	9	10	11	12	13	14
N	32.4											
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	0.111	0.235	0.432	0.652	0.823	0.920	1.000	1.000	1.000	1.000	1.000
w	1.130	1.525	2.319	3.042	4.163	5.568	6.913	6.656	7.150	7.683	8.272	8.910
sel	0.099	0.452	0.551	0.607	0.593	0.599	0.679	0.824	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
2016	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	0.111	0.235	0.432	0.652	0.823	0.920	1.000	1.000	1.000	1.000	1.000
w	1.130	1.525	2.319	3.042	4.163	5.568	6.913	6.656	7.150	7.683	8.272	8.910
sel	0.099	0.452	0.551	0.607	0.593	0.599	0.679	0.824	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.

F2013 = 0.22

2014			
B4+	SSB	Fbar	Landings
296	150	0.23	58

2015				2016		
B4+	SSB	Fbar	Landings	B4+	SSB	Rationale
272	157	0.24	57	259	157	20% HCR

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

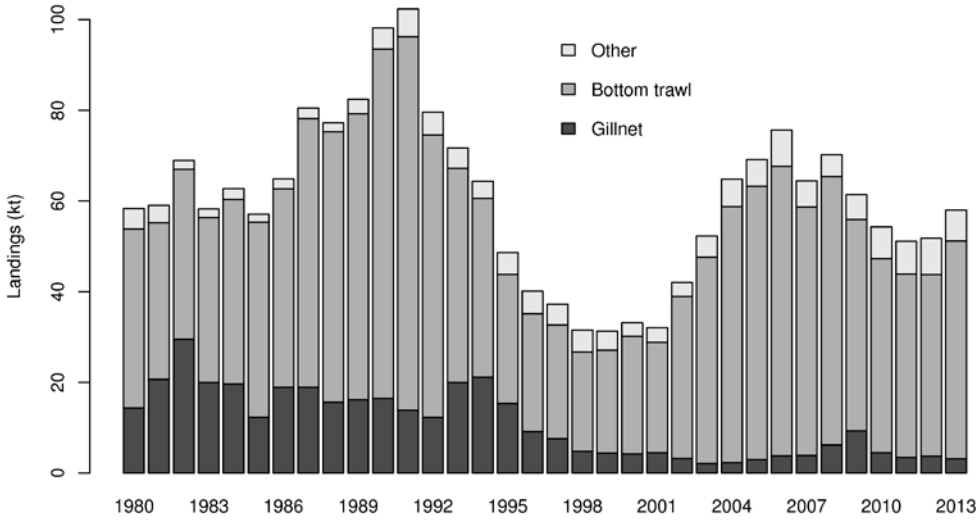

Figure 8.1 Saithe in Division Va. Landings by gear.

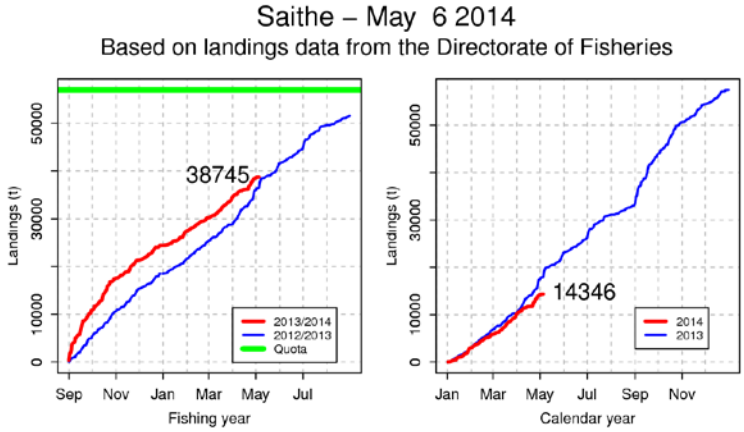

Figure 8.2 Saithe in division Va. Cumulative landings in the current fishing year (left) and calendar year (right). The vertical (green line) in the left figure shows the quota for the current fishing year.

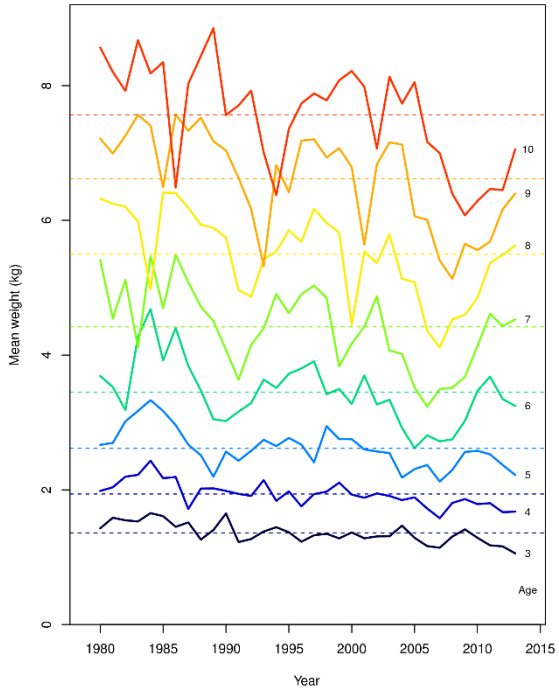

Figure 8.3 Saithe in division Va. Weight at age in the catches. The dotted lines show a linear regression trend on a log-scale.

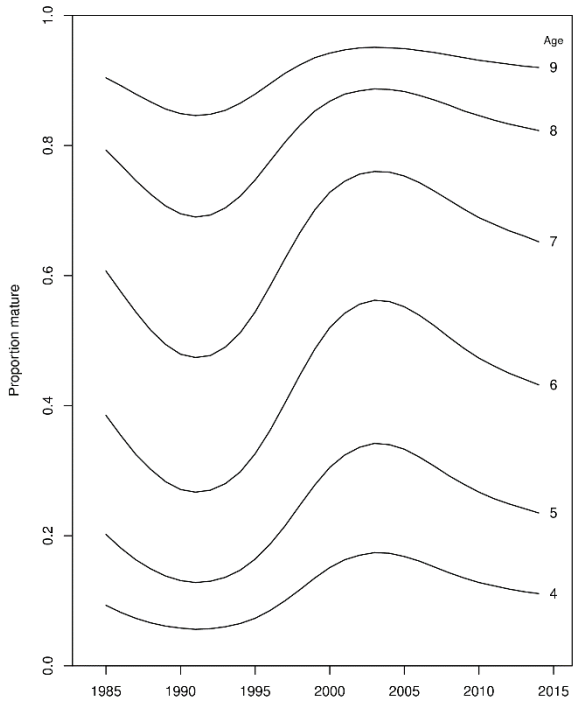

Figure 8.4 Saithe in division Va. Maturity at age used for calculating the SSB.

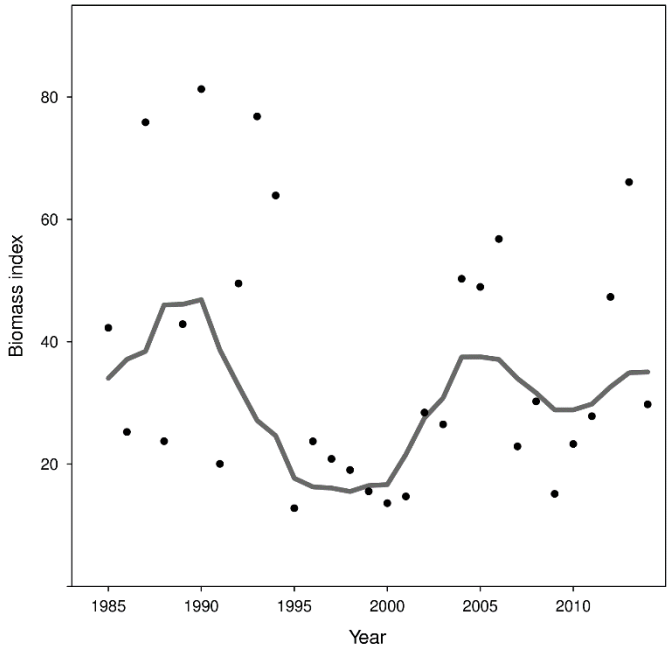

Figure 8.5 Saithe in division Va. Spring survey biomass index and model fit. The vertical lines indicate +/- 1 standard error.

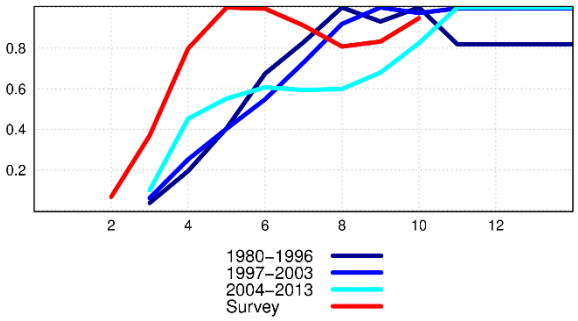

Figure 8.6. Estimated selectivity patterns for the 3 periods.

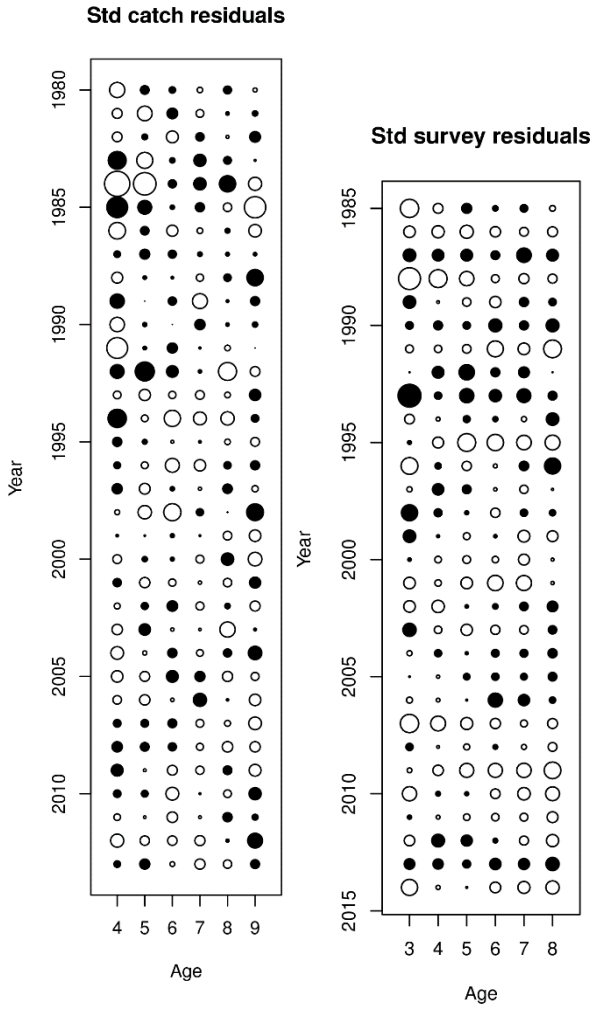

Figure 8.7. Saithe in division Va. Commercial and survey catch-at-age residuals from the fitted model. Filled circles are positive log residuals and hollow circles are negative log residuals.

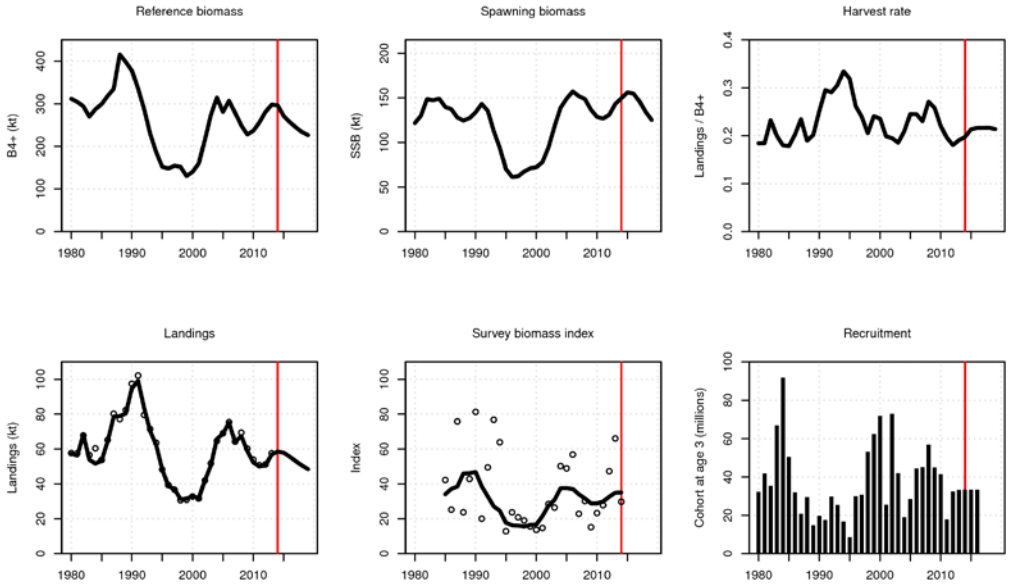

Figure 8.8. Saithe in division Va. Results from the fitted model and short-term forecast. The red line indicates the time of the current assessment.

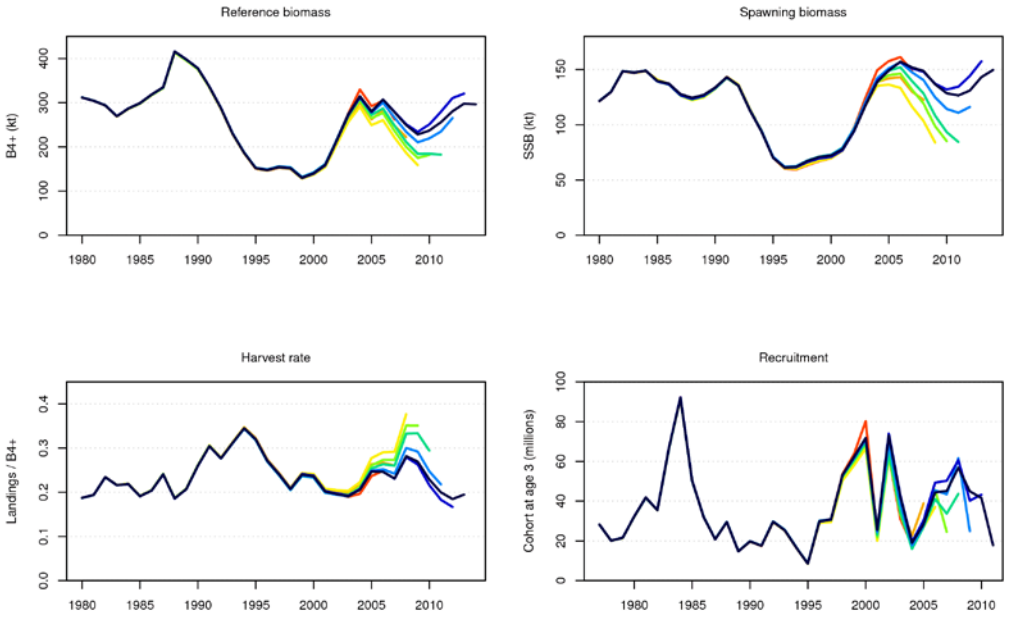

Figure 8.9. Saithe in division Va. Retrospective pattern for the assessment model.

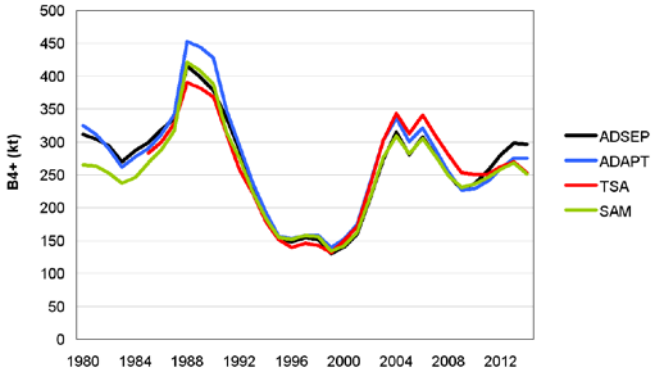

Figure 8.10. Saithe in division Va. Comparison between the default separable model (ADSEP) and alternative assessment models.