Working document No. 21

by

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Icelandic haddock.

1. Catch.

Table 1.1. Icelandic haddock. Landings by nation.

Country	1978	1979	1980	1981	1982	1983	1984	1985
Belgium	807	1010	1144	673	377	268	359	391
Faroe Islands	2116	2161	2029	1839	1982	1783	707	987
Iceland	40552	52152	47916	61033	67038	63889	47216	49553
Norway	13	11	23	15	28	3	3	+
€UK								
Total	43488	55334	51112	63560	69425	65943	48285	50933

HADDOCK Va

Country	1986	1987	1988	1989	1990	1991	1992	1993
Belgium	257	238	352	483	595	485	361	458
Faroe Islands	1289	1043	797	606	603	773	757	754
Iceland	47317	39479	53085	61792	66004	53516	46098	46932
Norway		1	+					
UK								
Total	48863	40761	54234	62881	67202	53774	47216	48144

HADDOCK Va

Country	1994	1995	1996	1997	1998	1999	2000	2001
Belgium	248							
Faroe Islands	911	758	664	340	639	624	968	609
Iceland	58408	60061	56223	43245	40795	44557	41199	39038
Norway	1	+	4					
UK								
Total	59567	60819	56891	43585	41434	45481	42167	39647

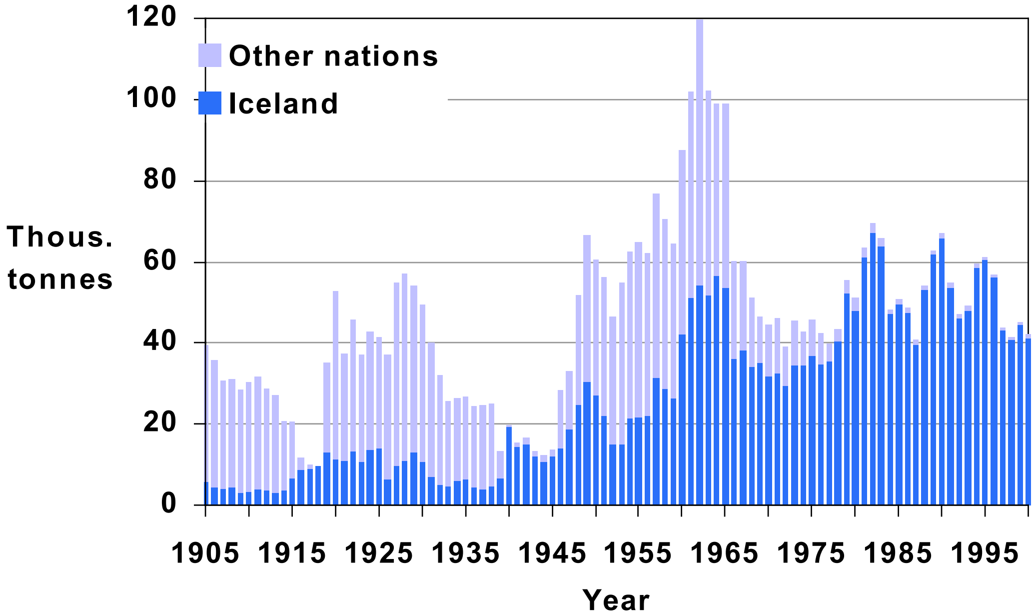


Figure 1.1. Icelandic haddock. Total landings.

Landings of Icelandic haddock in the year 2001 were 40,000 tonnes decreasing from 42,000 tonnes in 1999. Most of the catches were taken by bottom trawl (22 kt) and longline (13 kt) but the share of longline was high as in 1999 and 2000 as seen in figure 1.2.

Age compositions of the catches was as predicted last year with the 1998 yearclass most abundant in the catches (38% in numbers) followed by the 1997 second (25%) and 1995 yearclass (20%). (Figure 1.3)

Weight at age in the catches was similar to the year 2000, some agegroups lighter and other heavier. Weight at age is though low compared to the eighties as seen in table 1.3 and figure 1.6

Catchcurves are shown in figure 1.4. They indicate high mortality in the last decade or Z=1 for the oldest fish. The 1976 yearclass is shown for comparison but that yearclass had much lower mortality than recent yearclasses, but the fishing mortality of Icelandic haddock was low around 1980 as shown in a paper by Lorna Taylor for NWWG in 1999. ($F_{4\text{-}7}$ was around 0.4 when lowest) This low fishing mortality was caused by foreigners leaving Icelandic waters and the very strong 1976 yearclass appearing in the catches relatively soon after that.

Lorna calculated cach in number back to 1959 using those data to calculate F_{med}. In the period since 1959 fishing mortality was lowest around 1980.

Maturity at age in the catches was high in 2001 as it has been for more than a decade. (Table 1.4, figure 1.5).

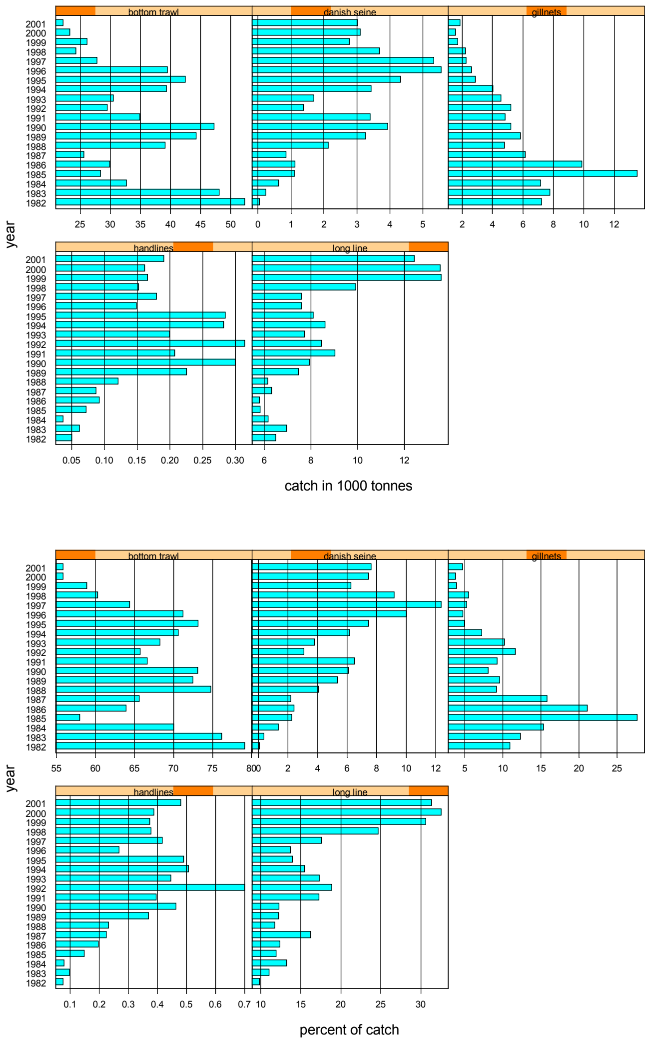
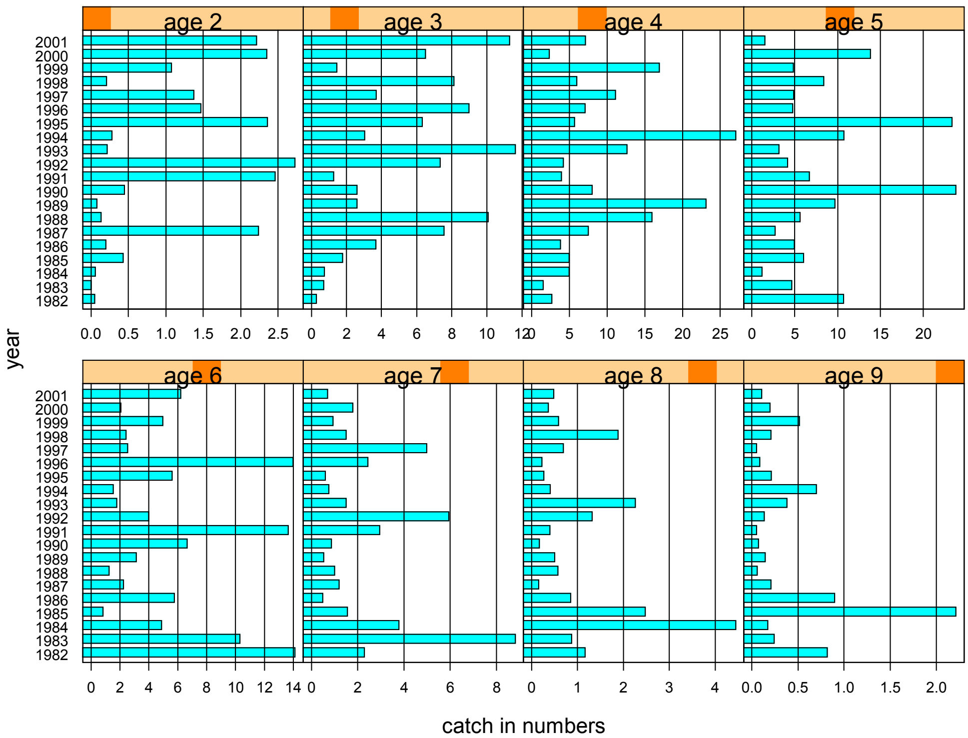


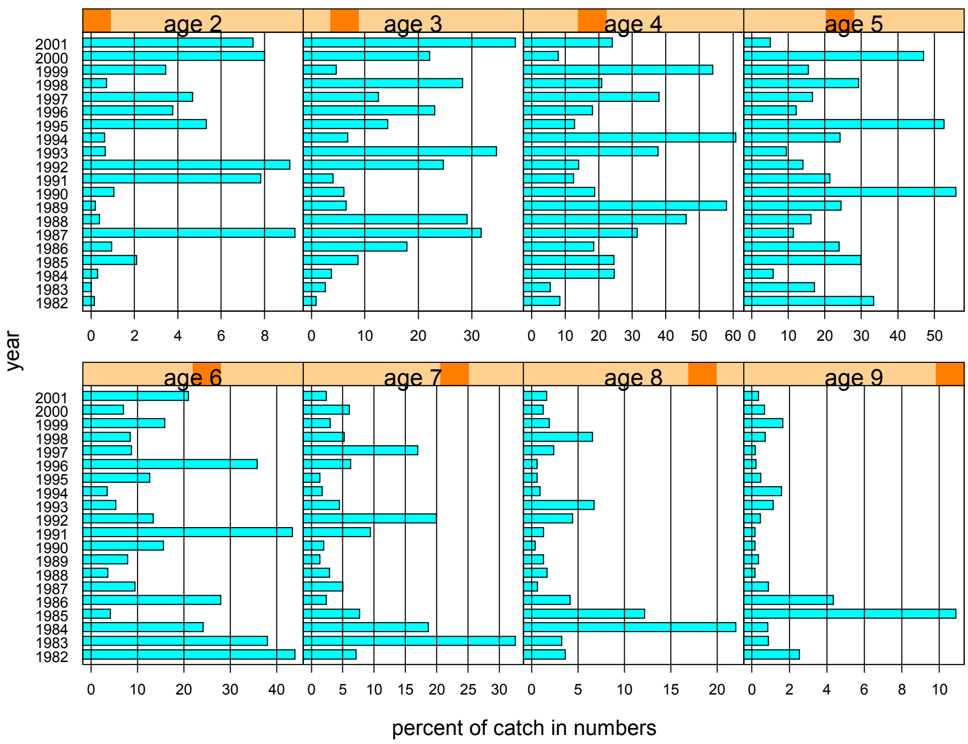
Figure 1.2 Landings of haddock split by fleets. Upper figure shows landings in 1000 tonnes but the lower figure percent of total.

Table 1.2 Icelandic haddock. Annual landings by gear.

year	bottom trawl	danish seine	gillnets	hand lines	long line
1982	52.3	0	7.2	0	6.5
1983	48	0.2	7.8	0.1	7
1984	32.6	0.6	7.2	0	6.2
1985	28.3	1.1	13.5	0.1	5.8
1986	29.9	1.1	9.9	0.1	5.8
1987	25.6	0.9	6.2	0.1	6.3
1988	39.1	2.1	4.8	0.1	6.2
1989	44.2	3.3	5.8	0.2	7.5
1990	47.2	3.9	5.2	0.3	7.9
1991	34.9	3.4	4.8	0.2	9
1992	29.5	1.4	5.2	0.3	8.5
1993	30.5	1.7	4.6	0.2	7.7
1994	39.3	3.4	4	0.3	8.6
1995	42.4	4.3	2.9	0.3	8.1
1996	39.5	5.6	2.6	0.1	7.6
1997	27.8	5.3	2.3	0.2	7.6
1998	24.2	3.7	2.2	0.2	9.9

1999	26.1	2.8	1.7	0.2	13.6
2000	23.3	3.1	1.6	0.2	13.5
2001	22.1	3	1.9	0.2	12.4





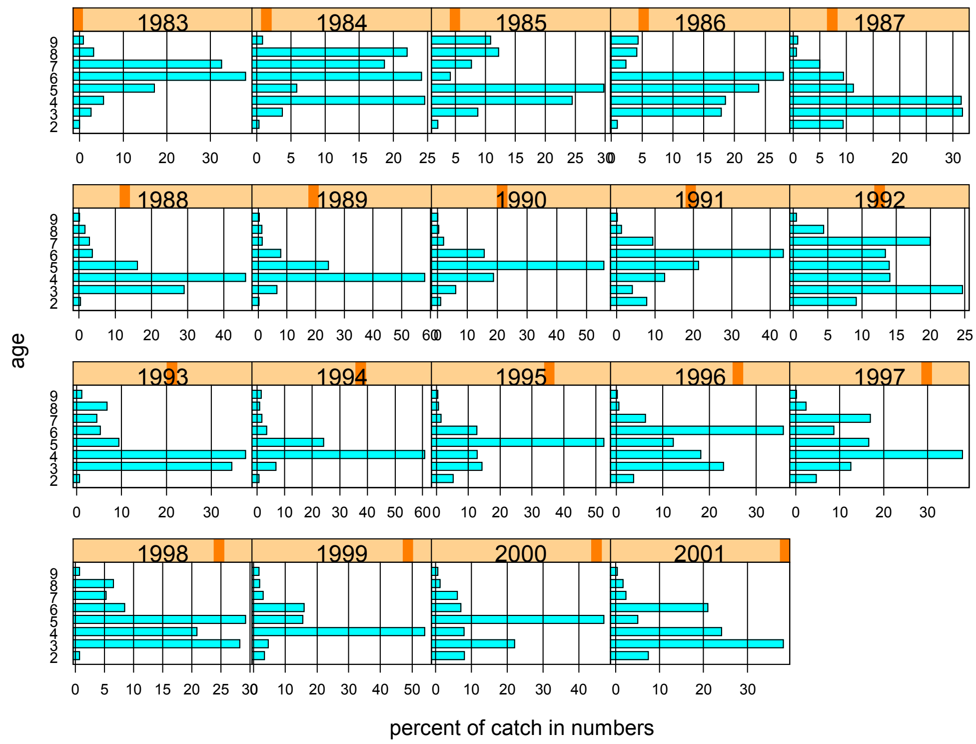


Figure 1.3 Catch in numbers by year and age.

Table 1.3. Icelandic haddock. Catch in number by year and age.

year/age	2	3	4	5	6	7	8	9
1981	0	0.5	4.9	17	6	2.8	1.81	0.17
1982	0	0.3	2.7	10.7	14.1	2.3	1.17	0.82
1983	0	0.7	1.5	4.6	10.3	8.8	0.87	0.24
1984	0.1	0.8	5	1.2	4.9	3.8	4.45	0.17
1985	0.4	1.8	5	6.1	0.8	1.6	2.48	2.21
1986	0.2	3.7	3.8	4.9	5.8	0.5	0.85	0.9
1987	2.2	7.6	7.5	2.7	2.2	1.2	0.15	0.21
1988	0.1	10.1	15.9	5.6	1.3	1	0.58	0.06
1989	0.1	2.6	23.1	9.7	3.1	0.5	0.51	0.14
1990	0.4	2.6	8	23.8	6.7	0.9	0.17	0.07
1991	2.5	1.3	3.9	6.7	13.6	3	0.4	0.05
1992	2.7	7.3	4.2	4.2	4	5.9	1.31	0.13
1993	0.2	11.6	12.6	3.2	1.8	1.5	2.26	0.38
1994	0.3	3	27	10.7	1.6	0.8	0.4	0.7
1995	2.4	6.3	5.7	23.4	5.6	0.6	0.26	0.21
1996	1.5	9	7.1	4.8	14	2.4	0.23	0.09
1997	1.4	3.7	11.1	4.9	2.5	5	0.69	0.05
1998	0.2	8.1	6	8.4	2.4	1.5	1.88	0.21
1999	1.1	1.5	16.9	4.8	5	0.9	0.59	0.51
2000	2.4	6.5	2.3	13.8	2.1	1.8	0.36	0.2
2000	2.2	11.3	7.1	1.5	6.2	0.7	0.48	0.1

Table 1.4. Icelandic haddock. Maturity at age in the catches in January – May.

year/age	2	3	4	5	6	7	8	9
1981	0	13	30	46	68	86	96	100
1982	0	13	30	46	68	86	96	100
1983	0	13	30	46	68	86	96	100
1984	0	13	30	46	68	86	96	100
1985	1	10	40	43	72	67	92	89
1986	2	19	43	66	83	87	95	99
1987	2	11	41	52	79	78	100	96
1988	1	22	38	77	79	93	90	100
1989	4	20	53	72	80	100	100	100
1990	11	28	59	81	84	92	90	100
1991	4	20	58	75	82	91	94	100
1992	4	14	42	77	86	87	71	100
1993	12	33	47	66	88	97	93	85
1994	25	32	57	78	86	100	90	100
1995	16	49	43	78	83	69	100	100
1996	17	36	58	65	78	73	96	98
1997	9	44	66	71	75	86	89	100
1998	3	48	68	78	76	85	91	100
1999	5	39	68	72	76	90	77	92
2000	10	25	62	80	87	87	100	100
2001	10	32	51	76	82	87	92	100

Table 1.5 Icelandic haddock. Total mortality calculated from catch curves using a Poisson glm model.

	Catch		Survey		
Yearclass	Z6-9	Z5-7	Z6-9	Z3-5	Z4-9
1976	0.59				
1977	0.79				
1978	0.98	0.43			
1979	0.82	0.42			
1980	1.28	0.59	0.93		
1981	0.89	0.79	1.38		
1982	1	0.79	0.5		0.79
1983	1.09	0.82	1.51	0.4	0.93
1984	0.87	0.55	1.3	0.64	0.76
1985	0.92	0.66	0.79	0.34	0.75
1986	1.04	0.69	1.33	0.32	0.79
1987	0.96	0.85	1	0.26	0.75
1988	1.01	0.79	1.41	0.54	0.98
1989	1.02	0.72	0.83	0.53	0.98
1990	1.04	0.7	1.18	0.61	0.84
1991	0.76	0.59	0.87	0.42	0.64
1992		0.79	1.31	0.66	1.09
1993		0.71		0.8	
1994				0.65	
1995				0.58	
1996				0.97	

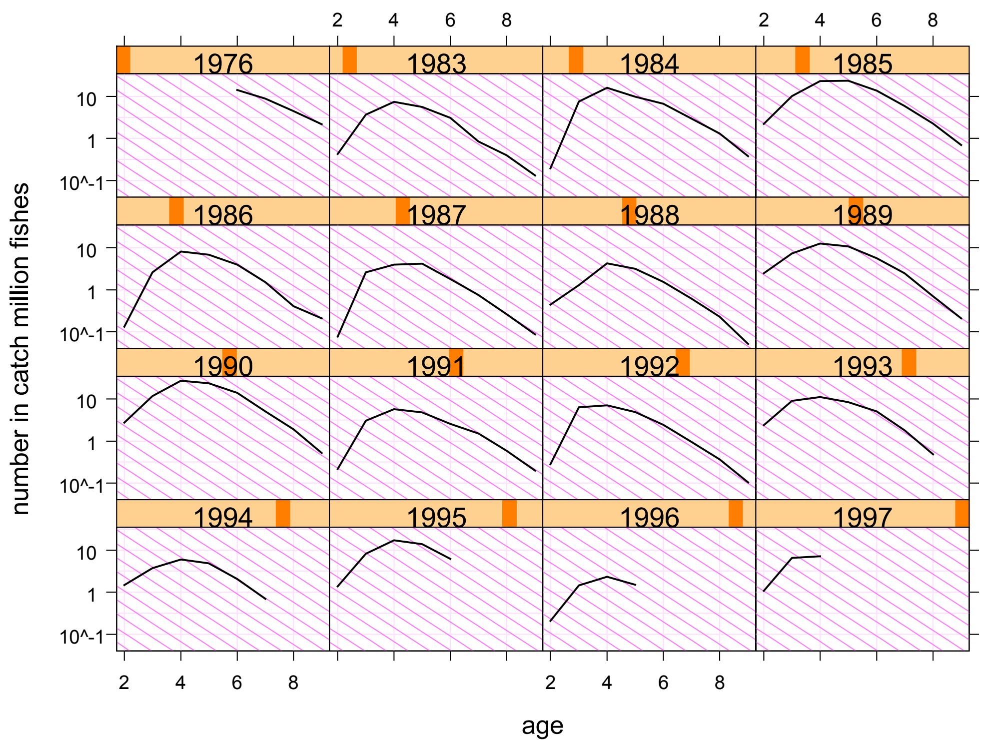


Figure 1.4 Catch curves of Icelandic haddock. Grey lines show Z = 1.

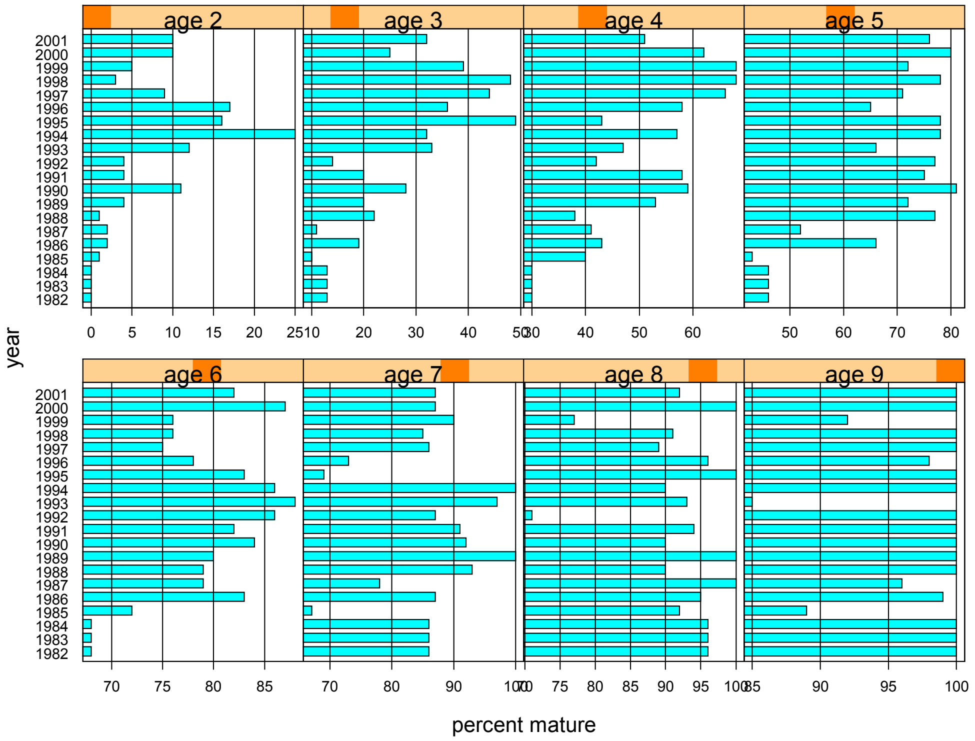


Figure 1.5. Icelandic haddock. Maturity at age in the catches.

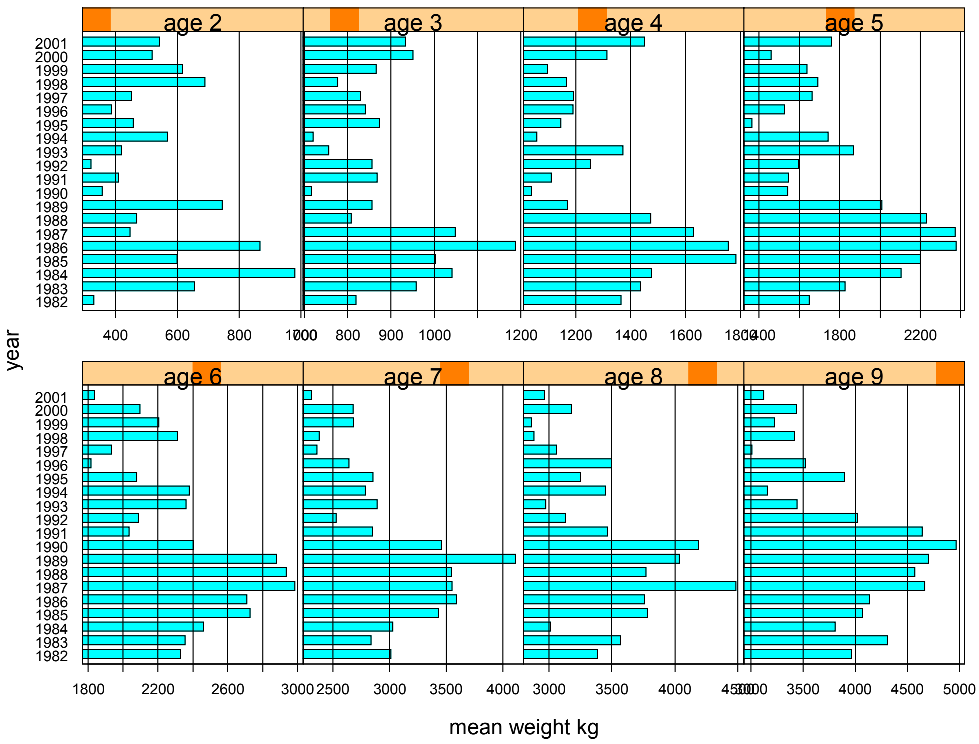


Figure 1.6. Weight at age in the catches.

Table 1.5 Icelandic haddock. Weight at age in the catches.

Year/age	2	3	4	5	6	7	8	9
1981	584	693	1081	1656	2283	3214	3409	4046
1982	330	819	1365	1649	2329	3012	3384	3965
1983	655	958	1436	1827	2355	2834	3569	4308
1984	980	1041	1476	2105	2460	3028	3014	3807
1985	599	1002	1783	2201	2727	3431	3783	4070
1986	867	1187	1755	2377	2710	3591	3760	4135
1987	446	1048	1629	2373	2984	3550	4483	4667
1988	468	808	1474	2230	2934	3545	3769	4574
1989	745	856	1170	2010	2879	4109	4035	4706
1990	357	716	1039	1542	2403	3458	4186	4969
1991	409	868	1111	1546	2035	2849	3464	4642
1992	320	856	1253	1597	2088	2529	3133	4022
1993	420	756	1372	1870	2360	2888	2975	3442
1994	568	720	1058	1742	2380	2785	3447	3156
1995	457	874	1145	1366	2079	2853	3251	3899
1996	387	841	1189	1528	1816	2641	3499	3526
1997	450	829	1192	1663	1934	2360	3059	3010
1998	689	777	1166	1692	2312	2379	2882	3417
1999	616	866	1096	1638	2205	2681	2863	3229
2000	518	951	1314	1461	2096	2679	3181	3438
2001	542	933	1451	1759	1836	2309	2966	3123

2. *Catch per unit effort and effort.*

Figure 2.1. Catch per unit effort in the most important gear types. The figure is based on locations where more than 50% of the catch is haddock.

CPUE in the most important gear types is shown in figure 2.1. CPUE in bottom trawl increased a little from 2000 but CPUE in the other gear was similar to what is was in the year 2000.

3. Survey.

Haddock is one of the most abundant fishes in the Icelandic groundfish survey appearing in large number at age 1 and becoming fully recruited at age 2 or 3. The survey indices seem to be good indices of the stock and the relationship between number in stock and index seems to be linear for all agegroups. (figures 3.7 and 3.8) A Shephard Nicholson model gives a CV of 25% for ages 1 to 7 but 38% if ages 8 and 9 are included.

The total biomass indices from the survey is shown in figure 3.1 showing a rise from 1986 to 1987 caused by a large yearclass from 1985, a drop from 1985 to 2000 but a rapid rice from 2001 to 2001 caused by the strong yeaclasses 1998-2000.

The survey indicates that the 1996 and 1997 are weak, yearclasses 1998-2000 seem to be strong and yearclass 2001 weak.

Catch curves from the survey are shown in figure 3.6. It appears from the curves that the older fish has total mortality of more than 1. The survey catchcurves show show the increased availability of haddock in the 2002 survey compared to 2001, exemplified by little or no reduction in number of yearclasses 1995-1997 between 2001 and 2002.

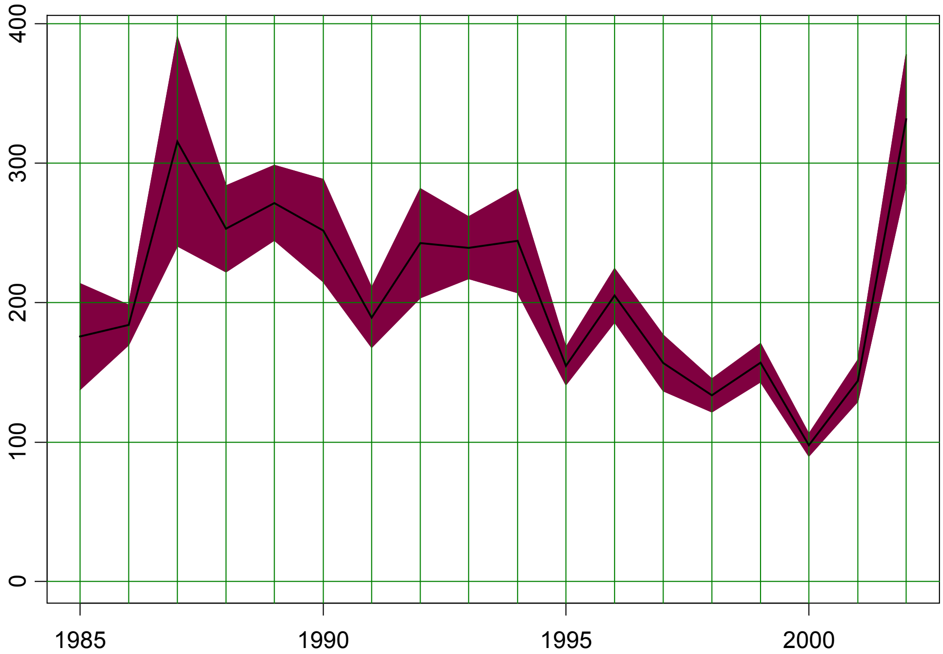


Figure 3.1 Icelandic haddock. Total biomass index from the groundfish survey. 1000 tonnes. The shaded area shows show the standard error in the estimate of the indices.

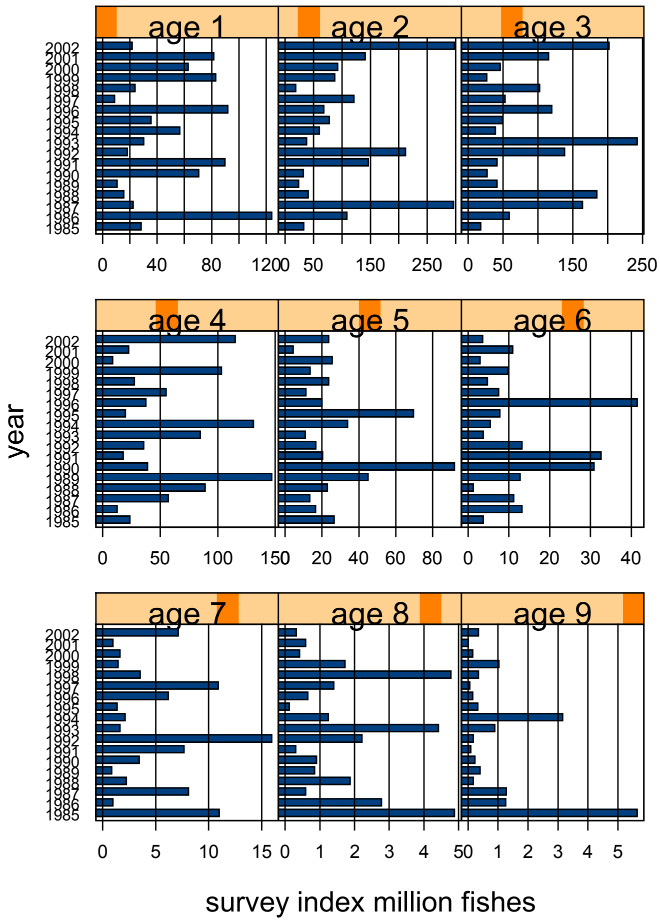


Figure 3.2. Icelandic haddock. Indices from the groundfish survey in million fishes.

Table 3.1 Icelandic haddock. Age disaggregated survey indices

year/ age	1	2	3	4	5	6	7	8	9
1985	28.18	32.72	18.35	23.66	26.55	3.73	10.98	4.88	5.64
1986	123.99	108.52	59.09	12.81	16.39	13.21	0.98	2.77	1.26
1987	22.23	296.28	163.65	57.09	13.17	11.17	8.09	0.58	1.28
1988	15.77	40.71	184.79	88.88	22.87	1.36	2.25	1.87	0.18
1989	10.59	23.36	41.55	146.77	44.92	12.74	0.85	0.84	0.41
1990	70.5	31.88	27.28	39.12	91.83	30.88	3.44	0.9	0.23
1991	89.73	145.96	41.59	17.86	20.28	32.56	7.67	0.3	0.1
1992	18.11	211.44	138.55	35.63	16.57	13.15	15.94	2.21	0.18
1993	30.18	37.55	242.46	84.8	10.85	3.73	1.65	4.42	0.89
1994	56.54	60.33	39.17	130.8	33.84	5.48	2.12	1.24	3.15
1995	35.44	77.41	49.36	19.8	69.52	7.79	1.34	0.12	0.33
1996	91.76	67.55	119.69	37.57	19.76	41.43	6.17	0.65	0.15
1997	8.7	120.52	52.78	55.17	11.23	7.51	10.9	1.4	0.06
1998	23.81	18.28	102.62	27.53	23.52	4.78	3.56	4.78	0.35
1999	82.9	86.8	26.8	103.07	13.41	9.81	1.45	1.73	1.03
2000	62.67	92.12	45.91	8.78	25.42	3	1.64	0.41	0.15
2001	81.36	140.37	115.63	22.7	4.22	10.97	0.97	0.58	0
2002	21.72	297.95	202.34	114.99	23.66	3.6	7.13	0.32	0.35

Table 3.2 Icelandic haddock. Weight at age in the survey.

year/ age	1	2	3	4	5	6	7	8	9
1985	36	244	568	1187	1673	2371	2766	3197	3331
1986	35	239	671	1134	1943	2399	3190	3293	3728
1987	31	162	550	1216	1825	2605	3030	3642	3837
1988	37	176	457	974	1830	2695	3102	3481	3318
1989	26	182	441	887	1510	2380	3009	3499	3195
1990	29	184	457	840	1234	1965	2675	3052	3267
1991	31	176	501	1003	1406	1884	2496	3755	3653
1992	28	157	503	894	1365	1891	2325	2936	3682
1993	41	168	384	878	1492	1785	2562	2573	3266
1994	33	181	392	680	1235	1766	1717	2977	2131
1995	37	167	440	755	1065	1857	2689	5377	1306
1996	41	174	453	813	1076	1477	2171	2426	4847
1997	50	174	424	817	1221	1425	1915	2390	3692
1998	41	203	415	753	1241	1747	1996	2342	3076
1999	33	206	480	715	1189	1956	2366	2782	2922
2000	29	179	552	889	1159	1767	2612	2917	3132
2001	36	190	490	1056	1437	1509	2169	2765	
2002	67	172	475	889	1460	1949	2137	1990	3709

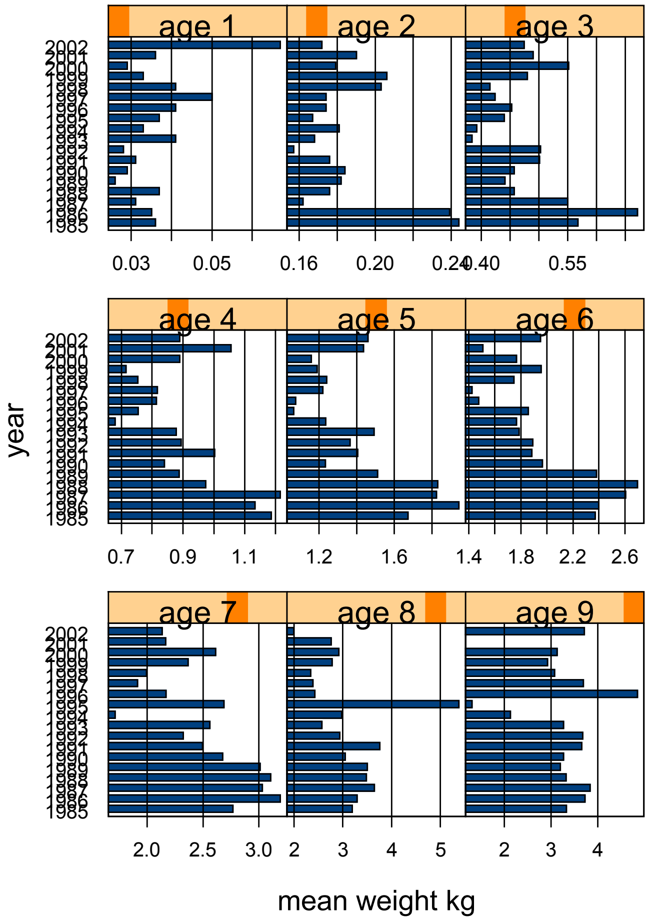


Figure 3.3. Icelandic haddock. Weights at age in the groundfish survey.

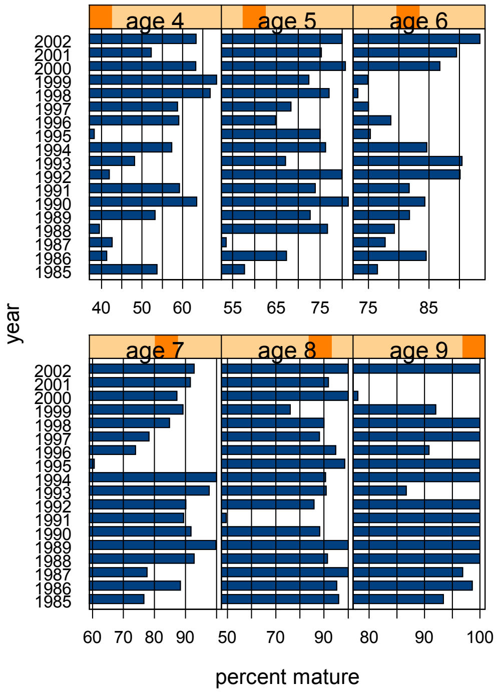


Figure 3.4 Maturity at age in the survey.

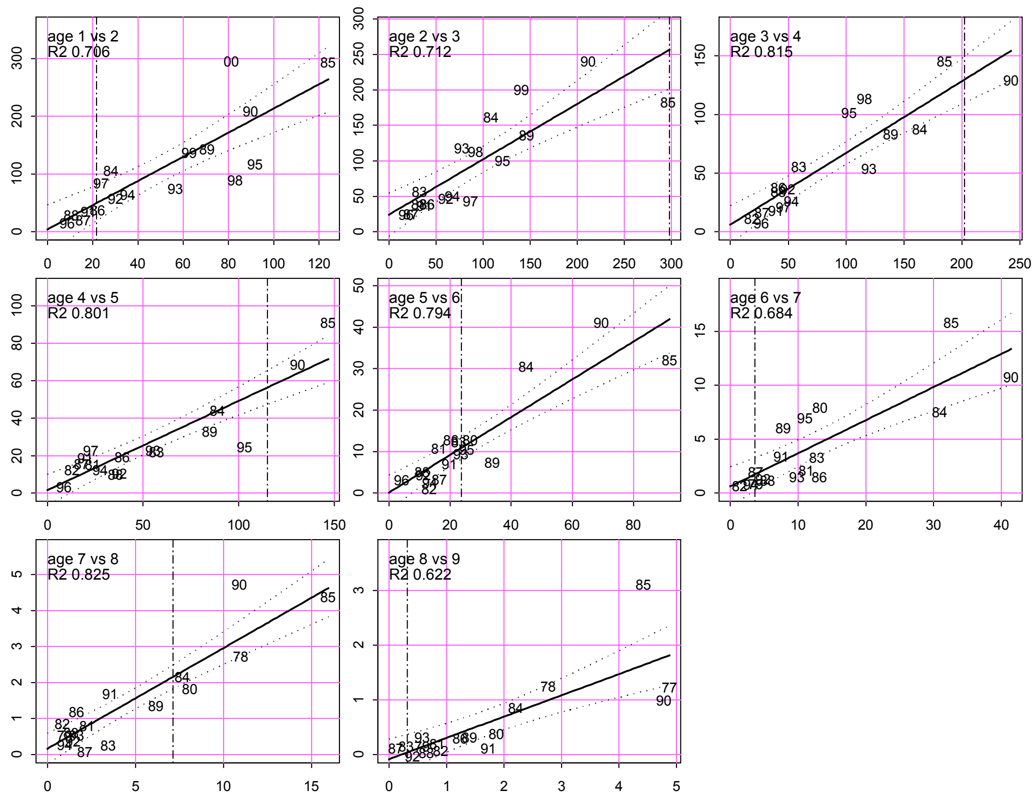


Figure 3.5 Icelandic haddock. Survey indices plotted against survey indices of the same yearclass one year earlier. (Hjörleifsson-Pálsson plot)

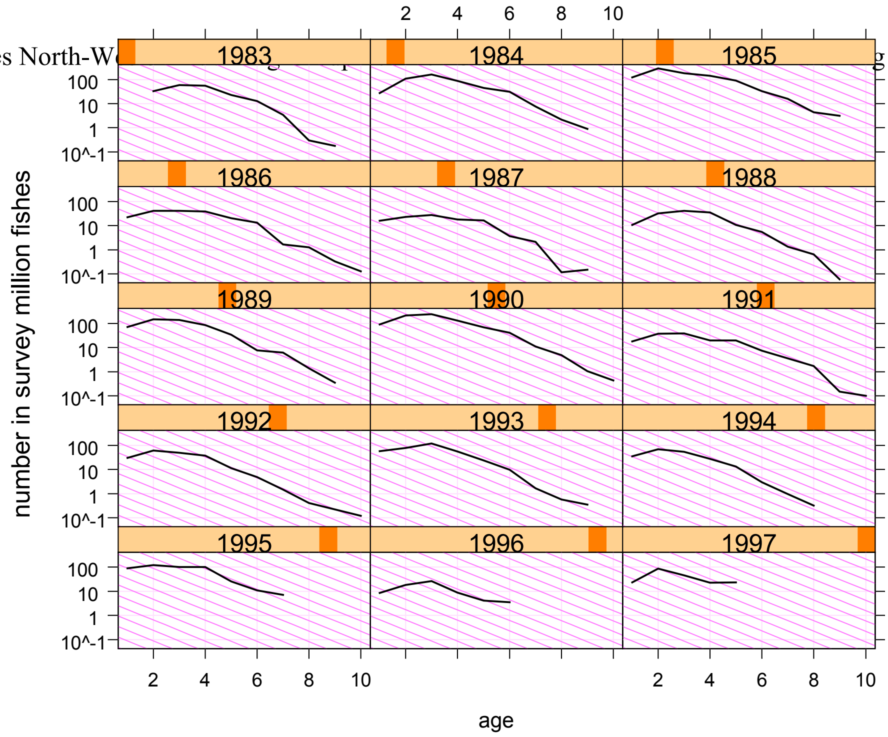


Figure 3.6 Icelandic haddock. Catchcurves from the survey.

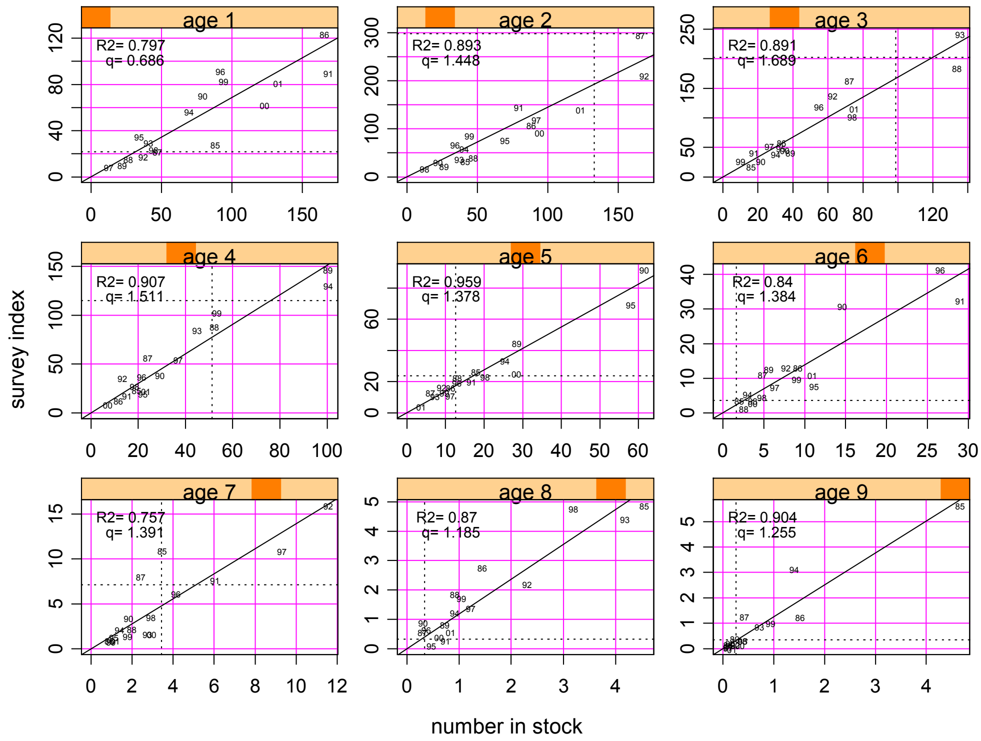


Figure 3.7 Icelandic haddock. Survey indices vs. number in stock. Line fitted through origin on original scale.

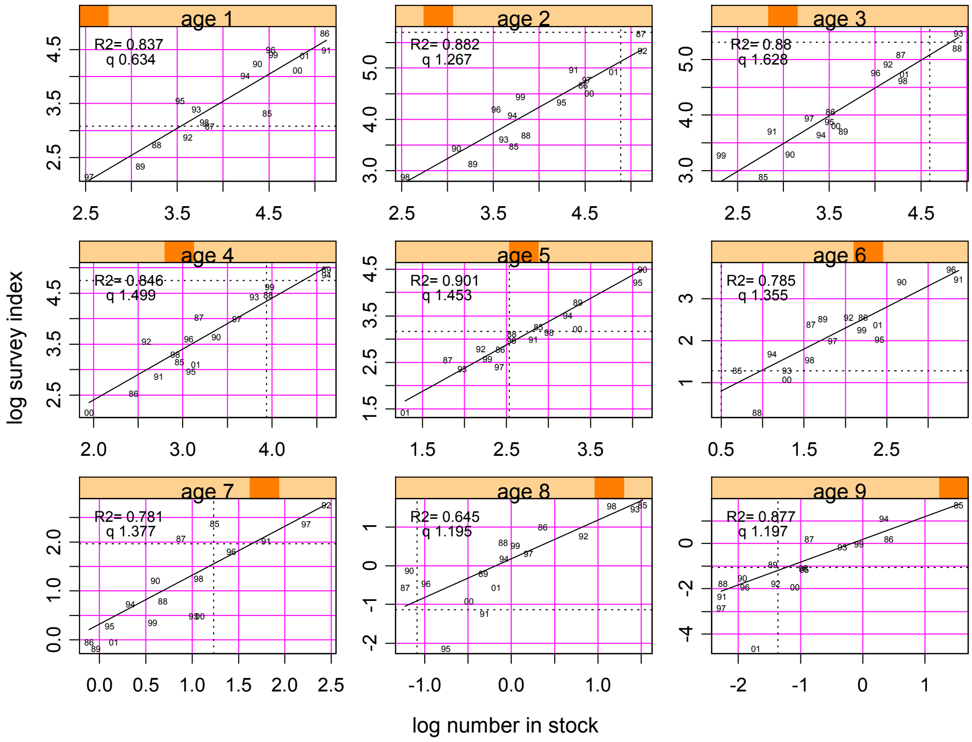


Figure 3.8 Icelandic haddock. Survey indices vs. number in stock on log scale. Fitted line with slope 1 (proportional relationship) shown in the figure .

4. Assessment.

Assessment was done with the same settings as last year using the groundfish survey in March as a tuning fleet

4.1 Default XSA run from last year.

Table 4.1.1 Tuning input for XSA, same fleet as used last year (default run):

Groundfish survey age 2 1985 – 2001

Year/age	2
1985	32.7
1986	108.5
1987	296.3
1988	40.7
1989	23.4
1990	31.9
1991	146.0
1992	212.3
1993	37.2
1994	61.2
1995	83.2
1996	71.3
1997	120.4
1998	18.2

1999	86.5
2000	91.0
2001	140.4

Groundfish survey age 2-8 shifted.

Year/age	2	3	4	5	6	7	8
1984	18.4	23.7	26.6	3.7	11.0	4.9	5.6
1985	59.1	12.8	16.4	13.2	1.0	2.8	1.3
1986	163.6	57.1	13.2	11.2	8.1	0.6	1.3
1987	184.8	88.9	22.9	1.4	2.2	1.9	0.2
1988	41.6	146.8	44.9	12.7	0.8	0.8	0.4
1989	27.3	39.1	91.8	30.9	3.4	0.9	0.2
1990	41.6	17.8	20.3	32.5	7.7	0.3	0.1
1991	138.7	35.6	16.6	13.2	15.9	2.2	0.2
1992	252.9	88.8	11.3	3.9	1.7	4.5	0.9
1993	40.6	162.8	46.1	7.2	2.9	1.4	4.1
1994	48.8	20.7	68.4	8.1	1.4	0.1	0.4
1995	118.4	34.3	18.7	40.4	6.2	0.6	0.1
1996	49.6	54.6	10.4	7.0	11.2	1.4	0.1
1997	110.4	28.4	23.4	4.6	3.5	4.6	0.3
1998	25.8	98.2	12.9	9.6	1.4	1.7	1.0
1999	45.5	8.6	24.7	2.9	1.6	0.4	0.2
2000	115.2	22.2	4.1	10.6	0.9	0.6	0.0
2001	202.3	115.0	23.7	3.6	7.1	0.3	0.4

Table 4.1.2 XSA Tuning diagnostic output:

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Lowestoft VPA Version 3.1

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 Extended Survivors Analysis

 Icelandic Haddock. Run 3.

 CPUE data from file hadvaef.dat

 Catch data for  21 years. 1981 to 2001. Ages  2 to   9.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 2ara CPU            ,   1985, 2001,   2,     2,  0.170,  0.250
 SUR CPU             ,   1984, 2001,   2,     8,  0.990,  1.000


 Time series weights :

      Tapered time weighting not applied


 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    7


 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   2 years or the   2 oldest ages.
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     S.E. of the mean to which the estimates  are shrunk =   0.500

     Minimum standard error for population
     estimates derived from each fleet =   0.300

     Prior weighting not applied


Tuning converged after   17 iterations


Regression weights
      , 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000

Fishing mortalities
   Age,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001

     2, 0.018, 0.006, 0.008, 0.038, 0.048, 0.016, 0.018, 0.027, 0.028, 0.020
     3, 0.137, 0.098, 0.116, 0.234, 0.197, 0.164, 0.128, 0.170, 0.224, 0.181
     4, 0.419, 0.369, 0.348, 0.331, 0.447, 0.400, 0.436, 0.425, 0.452, 0.410
     5, 0.704, 0.657, 0.619, 0.579, 0.515, 0.646, 0.602, 0.778, 0.753, 0.594
     6, 0.837, 0.768, 0.810, 0.793, 0.849, 0.579, 0.797, 0.914, 0.940, 0.959
     7, 0.797, 0.923, 0.911, 0.916, 1.037, 0.874, 0.836, 0.867, 1.064, 1.044
     8, 0.971, 0.838, 0.689, 0.999, 1.152, 0.992, 1.036, 0.980, 1.053, 0.986
     9, 0.937, 0.862, 0.684, 0.993, 1.182, 0.924, 0.968, 0.932, 1.141, 1.052


XSA population numbers (Thousands)

                              AGE
YEAR            2        3        4        5        6        7        8        9

1992     1.70E+05 6.35E+04 1.35E+04 9.09E+03 7.78E+03 1.19E+04 2.34E+03 2.40E+02
1993     3.75E+04 1.37E+05 4.53E+04 7.27E+03 3.68E+03 2.76E+03 4.41E+03 7.25E+02
1994     4.12E+04 3.05E+04 1.02E+05 2.57E+04 3.09E+03 1.40E+03 8.97E+02 1.56E+03
1995     7.04E+04 3.35E+04 2.22E+04 5.88E+04 1.13E+04 1.12E+03 4.60E+02 3.69E+02
1996     3.45E+04 5.55E+04 2.17E+04 1.31E+04 2.70E+04 4.19E+03 3.68E+02 1.39E+02
1997     9.29E+04 2.69E+04 3.73E+04 1.13E+04 6.39E+03 9.45E+03 1.22E+03 9.53E+01
1998     1.28E+04 7.48E+04 1.87E+04 2.05E+04 4.87E+03 2.93E+03 3.23E+03 3.69E+02
1999     4.49E+04 1.03E+04 5.39E+04 9.90E+03 9.19E+03 1.80E+03 1.04E+03 9.37E+02
2000     9.47E+04 3.58E+04 7.09E+03 2.89E+04 3.72E+03 3.02E+03 6.18E+02 3.20E+02
2001     1.23E+05 7.54E+04 2.34E+04 3.69E+03 1.11E+04 1.19E+03 8.53E+02 1.77E+02

Estimated population abundance at 1st Jan 2002

         0.00E+00 9.85E+04 5.15E+04 1.27E+04 1.67E+03 3.49E+03 3.43E+02 2.61E+02

Taper weighted geometric mean of the VPA populations:

   ,    4.72E+04,3.59E+04,2.61E+04, 1.64E+04, 8.35E+03, 3.18E+03, 1.25E+03, 3.92E+02,

Standard error of the weighted Log(VPA populations) :

   ,       0.7806,  0.7468,  0.7446,  0.8448,   0.8339,  0.8830,   0.9630,   1.0408,


Log catchability residuals.

Fleet : 2ara CPU

 Age  ,  1984,  1985,  1986,  1987,  1988,  1989,  1990,  1991
    2 , 99.99, -0.48, -0.05,  0.33, -0.40, -0.37,  0.12,  0.36
    3 , No data for this fleet at this age
    4 , No data for this fleet at this age
    5 , No data for this fleet at this age
    6 , No data for this fleet at this age
    7 , No data for this fleet at this age
    8 , No data for this fleet at this age

 Age  ,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001
    2 , -0.02, -0.25,  0.16, -0.07,  0.49,  0.02,  0.12,  0.42, -0.28, -0.10
    3 , No data for this fleet at this age
    4 , No data for this fleet at this age
    5 , No data for this fleet at this age
    6 , No data for this fleet at this age
    7 , No data for this fleet at this age
    8 , No data for this fleet at this age
```

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age ,	2
Mean Log q,	-4.3210,
S.E(Log q),	0.2957,

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
2,	0.98,	0.162,	4.43,	0.86,	17,	0.30,	-4.32,

Fleet : SUR CPU

Age ,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991
2 ,	-0.38,	0.06,	0.31,	-0.19,	-0.44,	-0.28,	0.34,	0.28
3 ,	-0.21,	-0.32,	0.45,	0.12,	-0.04,	-0.12,	-0.26,	0.57
4 ,	0.05,	0.02,	0.43,	0.22,	0.10,	0.05,	-0.16,	0.26
5 ,	0.33,	0.08,	0.55,	-0.88,	0.53,	0.47,	-0.18,	0.26
6 ,	0.89,	-0.14,	0.96,	-0.14,	-0.43,	0.38,	0.00,	0.05
7 ,	-0.05,	0.51,	0.60,	0.63,	-0.01,	0.98,	-0.99,	-0.16
8 ,	0.10,	-0.30,	0.90,	0.53,	0.44,	0.25,	-0.10,	-0.28

Age ,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001
2 ,	0.11,	-0.22,	-0.13,	0.25,	0.11,	-0.11,	0.42,	-0.26,	-0.08,	0.22
3 ,	0.27,	0.07,	-0.47,	0.05,	-0.03,	0.01,	0.19,	-0.21,	-0.46,	0.40
4 ,	0.10,	0.25,	-0.19,	0.02,	-0.43,	-0.21,	-0.07,	-0.49,	-0.23,	0.28
5 ,	-0.21,	0.58,	-0.60,	0.14,	-0.18,	-0.33,	-0.23,	-0.52,	-0.32,	0.50
6 ,	-0.72,	0.50,	-0.01,	0.16,	-0.06,	-0.05,	-0.48,	-0.87,	-0.51,	0.48
7 ,	-0.08,	0.35,	-1.63,	0.39,	0.04,	0.26,	0.39,	-0.53,	-0.45,	-0.23
8 ,	0.12,	0.87,	-0.02,	-0.43,	-0.05,	-0.31,	-0.04,	-0.57,	99.99,	0.33

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8
Mean Log q	-4.1030	-4.2021	-4.2696	-4.3409	-4.3776	-4.5113	-4.5113
S.E(Log q)	0.2654	0.2991	0.2493	0.4447	0.5059	0.6261	0.4336

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
2,	0.99,	0.162,	4.20,	0.89,	18,	0.27,	-4.10,
3,	0.89,	1.230,	4.90,	0.89,	18,	0.26,	-4.20,
4,	1.08,	-0.855,	3.80,	0.88,	18,	0.27,	-4.27,
5,	1.09,	-0.591,	3.88,	0.74,	18,	0.49,	-4.34,
6,	0.88,	0.834,	4.92,	0.75,	18,	0.45,	-4.38,
7,	1.00,	-0.016,	4.50,	0.62,	18,	0.65,	-4.51,
8,	0.95,	0.540,	4.57,	0.87,	17,	0.41,	-4.43,

Terminal year survivor and F summaries :

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 1999

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
2ara CPU ,	88807.,	0.304,	0.000,	0.00,	1,	0.415,	0.022
SUR CPU ,	122297.,	0.300,	0.000,	0.00,	1,	0.428,	0.016

```
  F shrinkage mean  ,     72001.,   0.50,,,,                       0.157,    0.027

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    98526.,      0.20,     0.15,    3,   0.749,  0.020


Age  3   Catchability constant w.r.t. time and dependent on age

Year class = 1998

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
2ara CPU             ,     39080.,  0.304,      0.000,   0.00,   1, 0.286,    0.232
SUR CPU              ,     60260.,  0.215,      0.239,   1.11,   2, 0.583,    0.157

  F shrinkage mean  ,     46666.,   0.50,,,,                       0.131,    0.198

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    51487.,      0.17,     0.15,    4,   0.927,  0.181


Age  4   Catchability constant w.r.t. time and dependent on age

Year class = 1997

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
2ara CPU             ,     19343.,  0.304,      0.000,   0.00,   1, 0.197,    0.288
SUR CPU              ,     11435.,  0.176,      0.229,   1.30,   3, 0.662,    0.447

  F shrinkage mean  ,     11603.,   0.50,,,,                       0.141,    0.442

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    12709.,      0.15,     0.17,    5,   1.129,  0.410


Age  5   Catchability constant w.r.t. time and dependent on age

Year class = 1996

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
2ara CPU             ,      1875.,  0.304,      0.000,   0.00,   1, 0.157,    0.544
SUR CPU              ,      1817.,  0.168,      0.196,   1.17,   4, 0.644,    0.557

  F shrinkage mean  ,      1161.,   0.50,,,,                       0.199,    0.773

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1670.,      0.15,     0.15,    6,   0.983,  0.594


Age  6   Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
2ara CPU             ,      3566.,  0.304,      0.000,   0.00,   1, 0.101,    0.946
SUR CPU              ,      3397.,  0.179,      0.183,   1.02,   5, 0.533,    0.976

  F shrinkage mean  ,      3621.,   0.50,,,,                       0.366,    0.937

Weighted prediction :
```

```
Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     3494.,      0.21,     0.11,    7,   0.528,  0.959


Age  7   Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
2ara CPU             ,       562.,  0.304,      0.000,   0.00,   1, 0.049,    0.753
SUR CPU              ,       277.,  0.231,      0.099,   0.43,   6, 0.395,    1.187

  F shrinkage mean   ,       382.,   0.50,,,,                      0.555,    0.976

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      343.,      0.29,     0.10,    8,   0.351,  1.044


Age  8   Catchability constant w.r.t. time and age (fixed at the value for age)  7

Year class = 1993

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
2ara CPU             ,       244.,  0.304,      0.000,   0.00,   1, 0.022,    1.029
SUR CPU              ,       285.,  0.286,      0.150,   0.52,   7, 0.423,    0.931

  F shrinkage mean   ,       244.,   0.50,,,,                      0.554,    1.028

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      261.,      0.30,     0.09,    9,   0.309,  0.986


Age  9   Catchability constant w.r.t. time and age (fixed at the value for age)  7

Year class = 1992

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
2ara CPU             ,        59.,  0.304,      0.000,   0.00,   1, 0.014,    0.954
SUR CPU              ,        36.,  0.211,      0.091,   0.43,   6, 0.107,    1.290

  F shrinkage mean   ,        52.,   0.50,,,,                      0.879,    1.027

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
       50.,      0.44,     0.12,    8,   0.272,  1.052
```

Run title : Icelandic Haddock. Run 3.

At 11/04/2002 11:32

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

Year Age	1981
2	0.0001
3	0.0194

4	0.1046
5	0.3041
6	0.8136
7	0.8630
8	0.7745
9	0.8273
FBAR 4- 7	0.5213

Table 8 Fishing mortality (F) at age

Year age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
2	0.0013	0.0000	0.0033	0.0114	0.0024	0.0148	0.0031	0.0032	0.0223	0.0345
3	0.0404	0.0228	0.0344	0.1284	0.1282	0.1218	0.0856	0.0768	0.1418	0.0824
4	0.1336	0.3061	0.2217	0.3310	0.4473	0.4163	0.4053	0.2880	0.3560	0.3310
5	0.3458	0.3577	0.4207	0.4613	0.6437	0.6655	0.6362	0.4650	0.5457	0.5771
6	0.4482	0.6648	0.8011	0.6064	1.1417	0.6993	0.7759	0.9288	0.6848	0.7100
7	0.8745	0.5638	0.5487	0.6562	0.9160	0.7760	0.8092	0.9544	0.7218	0.7627
8	1.1679	1.0557	0.6290	0.8815	0.9601	0.8229	1.1782	1.4471	0.9217	0.9169
9	1.0329	0.8181	0.5939	0.7597	0.9857	0.6552	0.9142	1.1564	0.8120	0.8572
0 FBAR 4- 7	0.4505	0.4731	0.4981	0.5137	0.7872	0.6393	0.6566	0.6591	0.5771	0.5952

Run title : Icelandic Haddock. Run 3.

At 11/04/2002 11:32

Terminal Fs derived using XSA (With F shrinkage)

Fishing mortality (F) at age

Year Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	FBAR 99-**
2	0.0178	0.0065	0.0075	0.0377	0.0481	0.0165	0.0181	0.0269	0.0278	0.0201	0.0249
3	0.1368	0.0984	0.1164	0.2344	0.1969	0.1643	0.1276	0.1703	0.2241	0.1811	0.1918
4	0.4190	0.3686	0.3480	0.3314	0.4475	0.3995	0.4363	0.4250	0.4523	0.4103	0.4292
5	0.7042	0.6568	0.6194	0.5787	0.5147	0.6461	0.6020	0.7783	0.7528	0.5939	0.7083
6	0.8368	0.7685	0.8099	0.7935	0.8491	0.5789	0.7972	0.9135	0.9400	0.9588	0.9374
7	0.7968	0.9233	0.9110	0.9156	1.0371	0.8741	0.8356	0.8668	1.0638	1.0445	0.9917
8	0.9706	0.8378	0.6889	0.9991	1.1520	0.9922	1.0364	0.9796	1.0526	0.9861	1.0061
9	0.9372	0.8618	0.6840	0.9930	1.1816	0.9237	0.9679	0.9319	1.1414	1.0524	1.0419
0 FBAR 4- 7	0.6892	0.6793	0.6721	0.6548	0.7121	0.6247	0.6678	0.7459	0.8022	0.7519	

1

Run title : Icelandic Haddock. Run 3.

At 11/04/2002 11:32

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year)
Numbers*10**-3
AGE

Year Age	1981	1982	1983	1984	1985	1986
2	9753	42216	30162	19932	41756	89227
3	29682	7984	34518	24694	16265	33800
4	54866	23834	6278	27623	19534	11712
5	71496	40460	17073	3785	18119	11486
6	11953	43189	23442	9775	2034	9353
7	5420	4338	22588	9872	3592	908
8	3711	1872	1481	10524	4669	1526
9	332	1400	477	422	4593	1583
TOTAL	187211	165294	136019	106626	110562	159596

Table 10 Stock number at age (start of year)
Numbers*10**-3

year age	1987	1988	1989	1990	1991	1992	1993	1994	1995
2	168086	47662	26664	22362	80236	170306	37456	41187	70431
3	72876	135593	38902	21760	17905	63465	136968	30469	33468
4	24343	52826	101905	29495	15460	13500	45316	101629	22204
5	6131	13144	28839	62551	16915	9091	7269	25663	58753
6	4941	2580	5696	14832	29675	7777	3681	3086	11309
7	2445	2010	972	1842	6122	11945	2758	1397	1124
8	298	921	733	306	733	2338	4408	897	460
9	478	107	232	141	100	240	725	1562	369
TOTAL	279597	254843	203942	153290	167146	278660	238582	205890	198119

Run title : Icelandic Haddock. Run 3.

At 11/04/2002 11:32

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year)
Numbers*10**-3

	1996	1997	1998	1999	2000	2001	2002	GMST 81-99	AMST 81-99
2	34505	92926	12774	44861	94659	122785	0	43230	56974
3	55531	26923	74837	10271	35755	75373	98526	34544	45574
4	21676	37338	18704	53934	7093	23396	51487	28161	35904
5	13052	11345	20502	9899	28868	3694	12709	17162	23451
6	26969	6387	4868	9194	3722	11133	1670	8587	12144
7	4188	9446	2931	1796	3019	1190	3494	3359	5037
8	368	1215	3227	1041	618	853	343	1329	2144
9	139	95	369	937	320	177	261	414	753

0 TOTAL	156428	185675	138211	131933	174053	238601	168489		

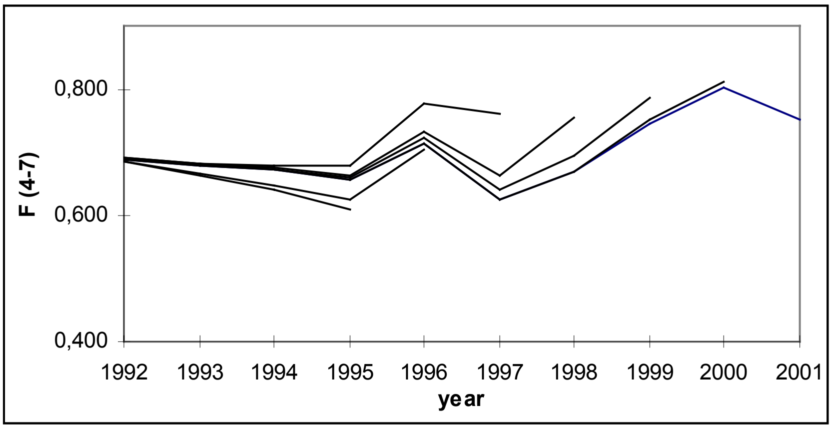
Run title : Icelandic Haddock. Run 3.

At 11/04/2002 11:32

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 2	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 7
1981	9753	216822	103616	63580	0.6136	0.5213
1982	42216	198240	111800	69325	0.6201	0.4505
1983	30162	162056	102033	65943	0.6463	0.4731
1984	19932	125235	79931	48285	0.6041	0.4981
1985	41756	116169	60071	50933	0.8479	0.5137
1986	89227	114951	56443	48863	0.8657	0.7872
1987	168086	131273	41677	40801	0.9790	0.6393
1988	47662	161666	65989	54236	0.8219	0.6566
1989	26664	175174	99652	62979	0.6320	0.6591
1990	22362	151173	110642	67200	0.6074	0.5771
1991	80236	135986	91532	54732	0.5980	0.5952
1992	170306	133987	63532	47212	0.7431	0.6892
1993	37456	137434	69600	48844	0.7018	0.6793
1994	41187	135751	83282	59345	0.7126	0.6721
1995	70431	131693	86912	61131	0.7034	0.6548
1996	34505	113318	68381	56958	0.8330	0.7121
1997	92926	101537	61286	44053	0.7188	0.6247
1998	12774	94613	62142	41434	0.6668	0.6678
1999	44861	92783	59698	45481	0.7619	0.7459
2000	94659	93968	52895	42167	0.7972	0.8022
2001	122785	112554	53165	39647	0.7457	0.7519
Arith. Mean	61902	135066	75442	53007	0.7248	0.6367
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		



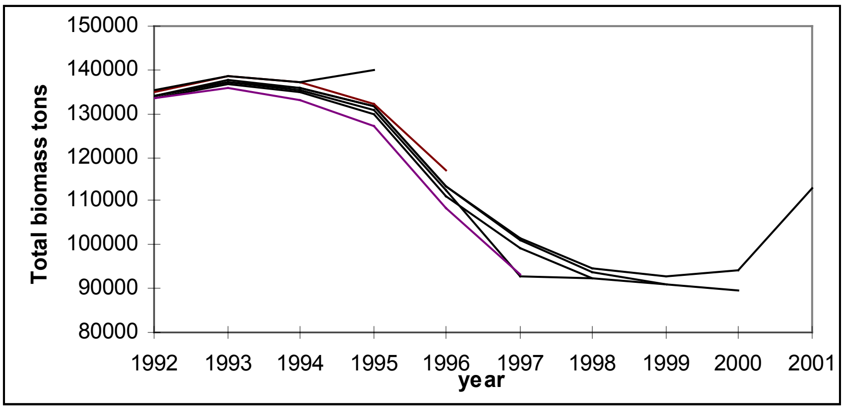


Figure 4.1.1 Retrospective pattern from the default run.

Table 4.1.2 Resulting VPA:

Marine Research Institute Tue Apr 9 11:38:25 2002
Virtual Population Analysis : Stock in numbers, millions

Age	1982	1983	1984	1985	1986	1987	1988
2	41.692	29.833	19.732	41.338	88.348	165.793	47.254
3	7.901	34.090	24.424	16.101	33.459	72.156	133.720
4	23.429	6.211	27.274	19.315	11.584	24.076	52.262
5	39.907	16.750	3.739	17.857	11.339	6.057	12.984
6	42.966	23.060	9.543	2.006	9.189	4.875	2.550
7	4.220	22.521	9.677	3.468	0.894	2.415	1.983
8	1.858	1.418	10.555	4.547	1.442	0.293	0.912
9	1.580	0.486	0.386	4.666	1.519	0.424	0.105
Juvenile	100.930	83.473	66.922	79.766	125.907	245.381	187.237
Adult	62.623	50.897	38.407	29.532	31.868	30.708	64.533
Sum 2- 2	41.692	29.833	19.732	41.338	88.348	165.793	47.254
Sum 3- 9	121.862	104.537	85.597	67.959	69.427	110.296	204.516
Total	163.554	134.370	105.329	109.298	157.775	276.089	251.770

Age	1989	1990	1991	1992	1993	1994	1995
2	26.427	22.146	79.459	168.503	37.169	40.767	69.664
3	38.568	21.566	17.729	62.834	135.497	30.234	33.124
4	100.399	29.228	15.311	13.359	44.826	100.459	22.022
5	28.498	61.454	16.752	8.994	7.186	25.350	57.977
6	5.626	14.635	29.007	7.710	3.651	3.054	11.168
7	0.964	1.832	6.038	11.564	2.758	1.396	1.118
8	0.724	0.308	0.735	2.307	4.177	0.919	0.470
9	0.235	0.145	0.104	0.247	0.720	1.405	0.391
Juvenile	112.516	61.416	106.891	228.868	150.614	100.428	102.964
Adult	88.925	89.897	58.243	46.649	85.370	103.156	92.971
Sum 2- 2	26.427	22.146	79.459	168.503	37.169	40.767	69.664
Sum 3- 9	175.014	129.168	85.675	107.014	198.815	162.817	126.271
Total	201.441	151.314	165.134	275.517	235.983	203.584	195.936

Age	1996	1997	1998	1999	2000	2001	2002
2	34.107	91.821	12.652	44.535	94.276	123.212	133.000
3	54.909	26.600	73.935	10.172	35.490	75.064	98.880
4	21.427	36.868	18.454	53.223	7.017	23.211	51.282
5	12.939	11.198	20.201	9.743	28.420	3.652	12.612
6	26.570	6.338	4.802	9.035	3.657	10.941	1.651
7	4.146	9.315	2.916	1.774	2.964	1.169	3.433
8	0.373	1.221	3.190	1.049	0.614	0.838	0.337
9	0.151	0.103	0.384	0.938	0.336	0.179	0.256
Juvenile	83.961	117.259	62.945	70.935	120.677	171.971	220.385
Adult	70.660	66.206	73.590	59.535	52.096	66.294	81.065

Sum 2- 2	34.107	91.821	12.652	44.535	94.276	123.212	133.000
Sum 3- 9	120.513	91.644	123.884	85.935	78.497	115.053	168.450
Total	154.620	183.465	136.536	130.470	172.773	238.265	301.450

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Virtual Population Analysis : Stock weight 1. Jan. in 1000 x tons

Age	1982	1983	1984	1985	1986	1987	1988
2	7.713	5.519	3.650	10.128	20.673	26.030	8.317
3	3.753	16.193	11.602	8.936	22.652	40.696	60.575
4	21.109	5.596	24.573	22.367	13.067	29.156	50.642
5	56.309	23.634	5.275	29.089	21.874	11.054	23.708
6	86.104	46.213	19.124	4.712	21.788	12.655	6.832
7	10.660	56.888	24.444	9.488	2.815	7.292	6.125
8	5.948	4.540	33.787	14.608	4.674	1.063	3.159
9	5.162	1.588	1.260	15.408	5.603	1.618	0.347
Juvenile	85.445	59.220	44.687	55.384	57.853	88.563	94.512
Adult	111.313	100.951	79.029	59.352	55.292	41.001	65.193
Sum 2- 2	7.713	5.519	3.650	10.128	20.673	26.030	8.317
Sum 3- 9	189.045	154.653	120.065	104.608	92.472	103.534	151.389
Total	196.758	160.172	123.716	114.736	113.145	129.564	159.705

Age	1989	1990	1991	1992	1993	1994	1995
2	4.783	4.053	13.826	26.455	6.356	7.338	11.495
3	16.931	9.640	8.776	31.166	52.166	12.154	14.674
4	88.853	24.230	15.280	12.049	39.178	70.321	16.252
5	42.804	76.080	23.402	12.403	10.722	31.511	61.050
6	13.390	28.713	54.504	14.850	6.597	5.158	20.862
7	2.880	4.924	15.036	27.441	7.217	3.368	2.934
8	2.536	0.949	2.741	6.764	10.943	2.479	1.453
9	0.751	0.481	0.377	0.907	2.410	4.535	1.237
Juvenile	74.561	40.020	43.890	69.648	67.090	51.909	44.290
Adult	98.367	109.049	90.053	62.386	68.500	84.955	85.667
Sum 2- 2	4.783	4.053	13.826	26.455	6.356	7.338	11.495
Sum 3- 9	168.145	145.017	120.117	105.579	129.234	129.526	118.463
Total	172.928	149.070	133.943	132.034	135.590	136.864	129.958

Age	1996	1997	1998	1999	2000	2001	2002
2	6.139	15.793	2.556	9.041	16.875	23.410	22.876
3	25.038	11.279	29.870	4.893	19.591	36.781	46.968
4	18.320	29.790	13.675	38.374	6.266	24.510	45.590
5	13.456	13.382	24.705	11.691	33.109	5.248	18.413
6	38.181	9.032	8.284	17.754	6.494	16.510	3.217
7	9.001	17.875	5.836	4.219	7.765	2.535	7.337
8	1.182	2.847	7.402	2.935	1.786	2.310	0.670
9	0.485	0.379	1.165	2.728	1.054	0.545	0.950
Juvenile	44.411	39.771	31.352	32.702	40.738	59.223	77.308
Adult	67.392	60.605	62.140	58.932	52.203	52.625	68.712
Sum 2- 2	6.139	15.793	2.556	9.041	16.875	23.410	22.876
Sum 3- 9	105.664	84.582	90.936	82.593	76.065	88.438	123.144
Total	111.803	100.375	93.492	91.634	92.941	111.848	146.02

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Virtual Population Analysis : SSB in 1000 x tons

Age	1982	1983	1984	1985	1986	1987	1988
2	0.000	0.000	0.000	0.101	0.413	0.521	0.083
3	0.488	2.105	1.508	0.894	4.304	4.477	13.327
4	6.333	1.679	7.372	8.947	5.619	11.954	19.244
5	25.902	10.872	2.427	12.508	14.437	5.748	18.255
6	58.551	31.425	13.004	3.393	18.084	9.997	5.398
7	9.168	48.924	21.022	6.357	2.449	5.688	5.696
8	5.710	4.358	32.436	13.440	4.440	1.063	2.843
9	5.162	1.588	1.260	13.713	5.547	1.553	0.347
Total	111.313	100.951	79.029	59.352	55.292	41.001	65.193

Age	1989	1990	1991	1992	1993	1994	1995
2	0.191	0.446	0.553	1.058	0.763	1.835	1.839
3	3.386	2.699	1.755	4.363	17.215	3.889	7.190
4	47.092	14.296	8.863	5.061	18.414	40.083	6.988
5	30.819	61.625	17.551	9.550	7.077	24.578	47.619
6	10.712	24.119	44.694	12.771	5.806	4.436	17.316
7	2.880	4.530	13.682	23.873	7.001	3.368	2.025
8	2.536	0.854	2.577	4.802	10.177	2.231	1.453
9	0.751	0.481	0.377	0.907	2.048	4.535	1.237
Total	98.367	109.049	90.053	62.386	68.500	84.955	85.667

Age	1996	1997	1998	1999	2000	2001
2	1.044	1.421	0.077	0.452	1.688	2.107
3	9.014	4.963	14.337	1.908	4.898	13.977
4	10.626	19.661	9.299	26.094	3.885	12.745
5	8.747	9.501	19.270	8.418	26.487	3.936
6	29.781	6.774	6.296	13.493	5.650	14.859
7	6.571	15.372	4.960	3.797	6.756	2.332
8	1.135	2.534	6.735	2.260	1.786	2.125
9	0.476	0.379	1.165	2.509	1.054	0.545
Total	67.392	60.605	62.140	58.932	52.203	52.625

```
              Marine Research Institute Tue Apr  9 11:38:26 2002
  Virtual Population Analysis : Fishing mortality
```

Age	1982	1983	1984	1985	1986	1987	1988
2	0.001	0.000	0.003	0.011	0.002	0.015	0.003
3	0.041	0.023	0.035	0.129	0.129	0.123	0.087
4	0.136	0.308	0.224	0.333	0.448	0.418	0.406
5	0.348	0.363	0.423	0.464	0.644	0.665	0.636
6	0.446	0.668	0.812	0.608	1.137	0.700	0.773
7	0.890	0.558	0.555	0.677	0.915	0.774	0.808
8	1.140	1.102	0.616	0.896	1.025	0.823	1.156
9	0.826	0.776	0.661	0.727	1.025	0.765	0.912
W.Av 4- 7	0.362	0.525	0.414	0.429	0.720	0.517	0.474
Ave 4- 7	0.455	0.474	0.503	0.521	0.786	0.639	0.656

Age	1989	1990	1991	1992	1993	1994	1995
2	0.003	0.022	0.035	0.018	0.006	0.008	0.038
3	0.077	0.143	0.083	0.138	0.099	0.117	0.236
4	0.291	0.357	0.332	0.420	0.370	0.350	0.332
5	0.466	0.551	0.576	0.702	0.656	0.620	0.580
6	0.922	0.685	0.720	0.828	0.761	0.805	0.791
7	0.941	0.714	0.762	0.818	0.899	0.889	0.899
8	1.408	0.890	0.890	0.964	0.889	0.654	0.937
9	1.090	0.763	0.791	0.870	0.850	0.782	0.876
W.Av 4- 7	0.359	0.519	0.599	0.667	0.455	0.419	0.550
Ave 4- 7	0.655	0.577	0.597	0.692	0.672	0.666	0.651

Age	1996	1997	1998	1999	2000	2001	1995-2000
2	0.049	0.017	0.018	0.027	0.028	0.020	0.029
3	0.198	0.166	0.129	0.171	0.225	0.181	0.187
4	0.449	0.402	0.439	0.427	0.453	0.410	0.417
5	0.514	0.647	0.605	0.780	0.755	0.594	0.647
6	0.848	0.576	0.796	0.915	0.941	0.959	0.811
7	1.022	0.871	0.822	0.862	1.063	1.044	0.923
8	1.088	0.956	1.024	0.939	1.032	0.986	0.996
9	0.986	0.801	0.881	0.905	1.012	0.996	0.910
W.Av 4- 7	0.661	0.531	0.572	0.544	0.742	0.600	0.494
Ave 4- 7	0.708	0.624	0.665	0.746	0.803	0.752	0.699

4.2 TSA

Time Series Analysis (TSA) which for a number of years has been used for assessing the Icelandic cod and saithe was used for the first time to acess the Icelandic haddock stock. The model was run catch in numbers on ages 3-9 and survey indices of ages 2 to 9. The results are shown in tables 4.2.1 and 4.2.2 and the retrospective pattern in figures 4.2.1 and 4.2.2. Fishing mortality is according to TSA is higher than according to the XSA runs (0.835 vs. 0.752).

Table 4.2.1 Stock estimates (3+) from TSA results.

	3	4	5	6	7	8	9	BIOM
1984	24321.	27616.	3736.	10453.	7665.	8964.	367.	111.9
1985	15175.	19093.	18124.	1946.	4140.	3033.	3534.	97.4
1986	33128.	11614.	11745.	9222.	866.	1756.	1219.	93.0
1987	72380.	24115.	6017.	4769.	2717.	269.	556.	104.7
1988	136331.	52522.	12975.	2533.	1883.	1042.	101.	152.9
1989	37964.	101282.	29197.	5631.	966.	677.	357.	170.0
1990	20877.	28604.	61480.	14109.	1837.	295.	193.	143.3
1991	18610.	14952.	16192.	28784.	5640.	651.	103.	117.7
1992	63336.	13626.	8677.	7503.	11295.	2118.	243.	104.0
1993	132850.	45316.	7252.	3549.	2573.	3721.	677.	126.7
1994	30425.	97594.	25703.	3180.	1286.	820.	1181.	127.0
1995	32205.	21939.	56002.	11559.	1141.	402.	268.	116.1
1996	54893.	21215.	12364.	26177.	4350.	387.	131.	104.7

1997	26334.	36530.	11097.	5779.	9554.	1375.	123.	84.2
1998	74848.	17993.	19758.	4925.	2381.	3473.	495.	90.6
1999	10791.	53292.	9519.	8609.	1743.	785.	1137.	81.6
2000	37883.	7456.	28188.	3731.	2810.	541.	237.	76.7
2001	73798.	25619.	3979.	11545.	1165.	755.	145.	91.4
2002	82530.	50745.	14401.	1827.	3934.	331.	214.	127.6

STANDARD DEVIATION OF STOCK ESTIMATES

2001	8360.	2852.	449.	1096.	134.	115.	29.	6.9
2002	11020.	6581.	2043.	302.	739.	84.	60.	11.2

Table 4.2.2 Fishing mortality rates F4-7 from TSA results.

	3	4	5	6	7	8	9	FGBAR	FBAR
1984	0.043	0.221	0.450	0.726	0.727	0.731	0.741	0.553	0.599
1985	0.074	0.288	0.476	0.608	0.657	0.711	0.711	0.550	0.575
1986	0.117	0.453	0.701	1.008	0.968	0.945	0.948	0.808	0.837
1987	0.121	0.415	0.648	0.720	0.734	0.758	0.748	0.657	0.671
1988	0.097	0.385	0.629	0.761	0.815	0.843	0.835	0.688	0.712
1989	0.081	0.299	0.523	0.850	0.936	0.972	0.908	0.692	0.748
1990	0.131	0.365	0.558	0.698	0.738	0.756	0.739	0.623	0.642
1991	0.108	0.343	0.568	0.735	0.779	0.787	0.781	0.640	0.665
1992	0.131	0.409	0.683	0.862	0.905	0.933	0.926	0.757	0.787
1993	0.109	0.360	0.612	0.814	0.944	0.948	0.939	0.730	0.769
1994	0.126	0.354	0.595	0.807	0.937	0.900	0.917	0.713	0.752
1995	0.209	0.363	0.553	0.772	0.877	0.915	0.914	0.696	0.732
1996	0.205	0.437	0.558	0.808	0.952	0.946	0.930	0.741	0.772
1997	0.168	0.410	0.608	0.668	0.802	0.816	0.805	0.666	0.685
1998	0.140	0.418	0.624	0.831	0.909	0.917	0.903	0.739	0.767
1999	0.154	0.436	0.720	0.917	0.970	0.997	0.992	0.807	0.839
2000	0.185	0.421	0.690	0.957	1.112	1.114	1.117	0.853	0.902
2001	0.174	0.376	0.577	0.876	1.058	1.062	1.058	0.780	0.835

STANDARD DEVIATIONS OF LOG(F)

2001	0.22	0.11	0.11	0.13	0.14	0.15	0.16	0.108

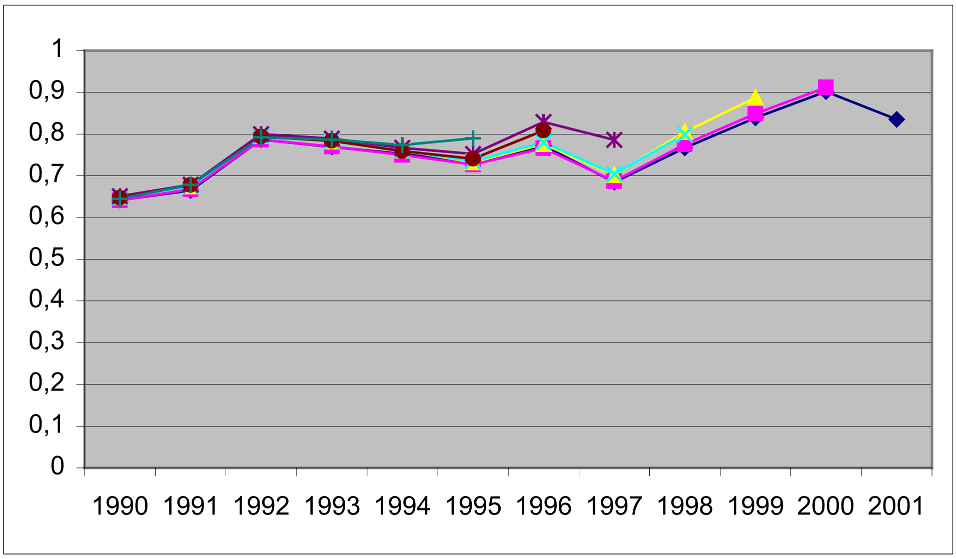

Figure 4.2.1 Haddock in division Retrospective pattern of the mean fishing mortality of ages 4.7 from TSA results.

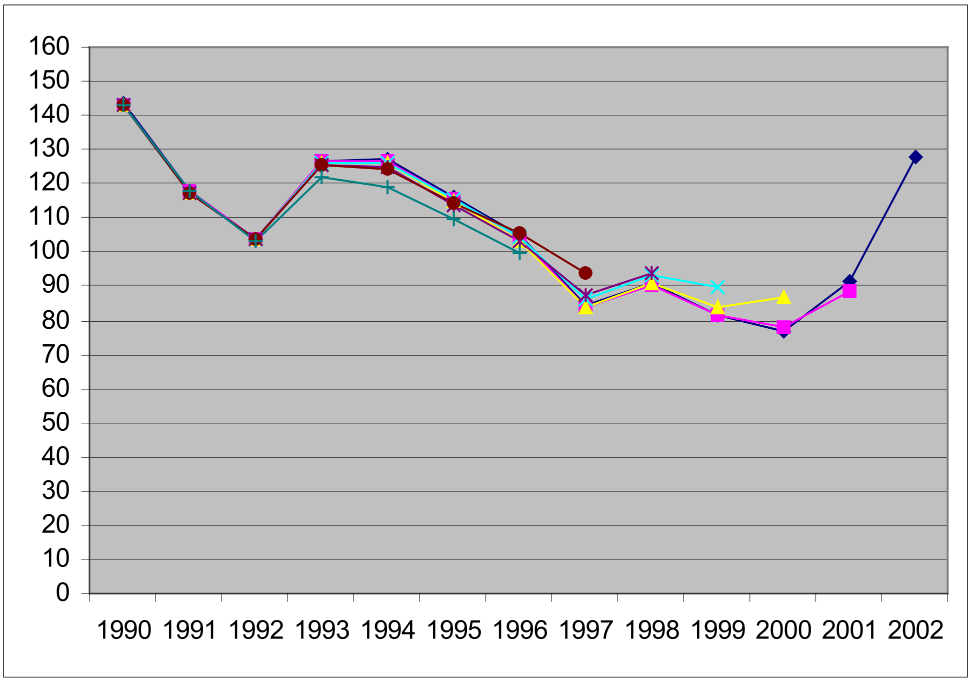

Figure 4.2.2 Retrospective pattern of the catchable biomass (3+) from TSA.

5. Recruitment estimate

The survey indices from the Icelandic groundfish survey in March were used as input in the RTC3 program with. Looking at the results for the 1999 and 2000 yearclasses and comparing them with figures 3.7 and 3.8 the results seem rather strange. Same weight is put on age 1 survey indices as on age 2 and 3 but figures 3.7 and 3.8 indicate that the indices for age 2 and 3 should get more weight. The result is underestimation of the recruitment most notably for the 2000 yearclass. As the final estimate is weighed geometric mean of the different estimates the VPA mean has much effect on the recruitment estimates inspite of low weight on VPA mean.

Recruiment was also estimated using a timeseries method develped by Gudmundur Gudmundsson, adapt and the AD – model builder program discussed in section 4.2. The results differ substantially from the results obtained from RTC3, usually being more optimistic on the recruitment than RCT3. (Table 7.2) The state of the stock now is such that yearclasses 1996 – 1997 are weak and yearclasses 1998-2000 strong, accounting for most of the stock biomass. Therefore it is the recruitment estimate that is most important for short term prognosis, not estimate of the older age groups.

Table 5.1 Haddock in division Va. Inputdata to the RTC3 program

```
Iceland     Haddock:    VPA    and    groundfish    survey    data
3    24     2
'Yearcl'  'VPAage2'  'Surv3' 'Surv2' 'Surv1'
1978      37     -11     -11     -11
1979      10     -11     -11     -11
1980      42     -11     -11     -11
1981      30     -11     -11     -11
1982      20     184     -11     -11
1983      41     591     327     -11
1984      88    1636    1085     282
1985     166    1848    2963    1240
1986      47     416     407     222
```

1987	26	273	234	158
1988	22	416	319	106
1989	79	1386	1460	705
1990	169	2425	2114	897
1991	37	392	376	181
1992	41	494	603	302
1993	70	1197	774	565
1994	34	528	676	354
1995	92	1026	1205	918
1996	13	268	183	87
1997	45	459	868	238
1998	-11	1156	921	829
1999	-11	2023	1404	627
2000	-11	-11	2980	814
2001	-11	-11	-11	213

Table 5.2 Haddock in division Va. Output from the RTC3 model.
Analysis by RCT3 ver3.1 of data from file :

rinki.inp

Iceland Haddock: VPA and groundfish survey data

Data for 3 surveys over 24 years : 1978 - 2001

Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as .20
Minimum of 3 points used for regression

Forecast/Hindcast variance correction used.

Yearclass = 1998

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction--------I			
Surv3	1.06	-2.94	.29	.868	16	7.05	4.50	.342	.313
Surv2	.96	-2.33	.28	.876	15	6.83	4.23	.324	.350
Surv1	.94	-1.51	.31	.858	14	6.72	4.80	.373	.264
					VPA Mean =		3.89	.712	.072

Yearclass = 1999

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction--------I			
Surv3	1.07	-3.03	.29	.867	16	7.61	5.10	.377	.278
Surv2	.97	-2.40	.28	.877	15	7.25	4.63	.339	.344
Surv1	.93	-1.50	.30	.862	14	6.44	4.52	.363	.300
					VPA Mean =		3.89	.713	.078

Yearclass = 2000

Survey/ Series	I-----------Regression----------I Slope	Inter- cept	Std Error	Rsquare	No. Pts	I-----------Prediction--------I Index Value	Predicted Value	Std Error	WAP Weights
Surv3									
Surv2	.98	-2.48	.28	.879	15	8.00	5.37	.388	.421
Surv1	.93	-1.49	.30	.866	14	6.70	4.75	.374	.454
					VPA Mean =		3.88	.715	.124

Yearclass = 2001

Survey/ Series	I-----------Regression----------I Slope	Inter- cept	Std Error	Rsquare	No. Pts	I-----------Prediction--------I Index Value	Predicted Value	Std Error	WAP Weights
Surv3									
Surv2									
Surv1	.93	-1.47	.30	.871	14	5.37	3.49	.359	.800
					VPA Mean =		3.87	.717	.200

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1998	84	4.44	.19	.15	.65		
1999	106	4.67	.20	.19	.90		
2000	134	4.90	.25	.34	1.83		
2001	35	3.57	.32	.15	.22		

5. Results from a statictical catch at age model (described in WP # ??)

The following pages summarize results from a statistical catch at age model. The model which is mainly written as a tool to test management strageties (for the Icelandic cod) is written in AD-model builder. It is not really a complete model but rather a collection of routines that have to be compiled and linked.

For the haddock the data are catch in numbers for ages 2-9 1979-1997 and survey indices for ages 1-9 1985-2002. The first estimate of each yearclass is long term mean. Variances on the survey, catch in numbers and long term mean are estimated as is correlation between age groups in the survey. CV on the long term mean is estimated 0.78 and correlation between adjacent agegroups in the survey indices 0.49 . Fishing mortality is not described by a parametric function but estimated for every year and age with penalties on changes.

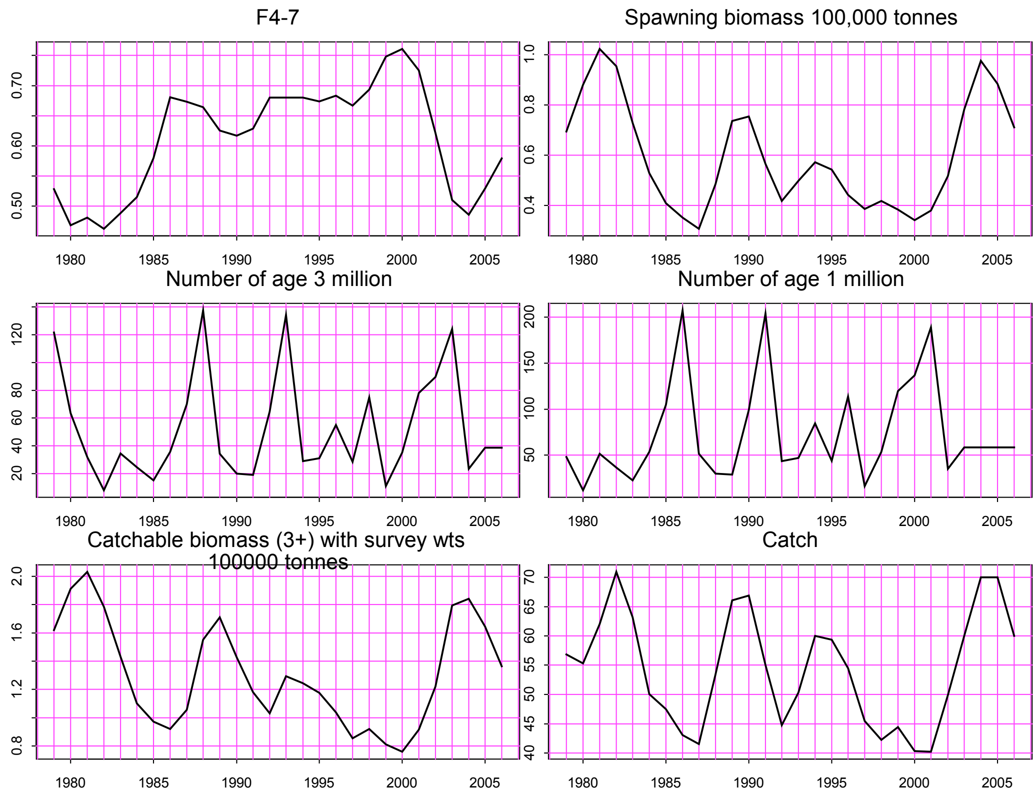

Figure 6.1 Haddock in divison Va. Summary of results from model run. Specified catch after the year 2001.

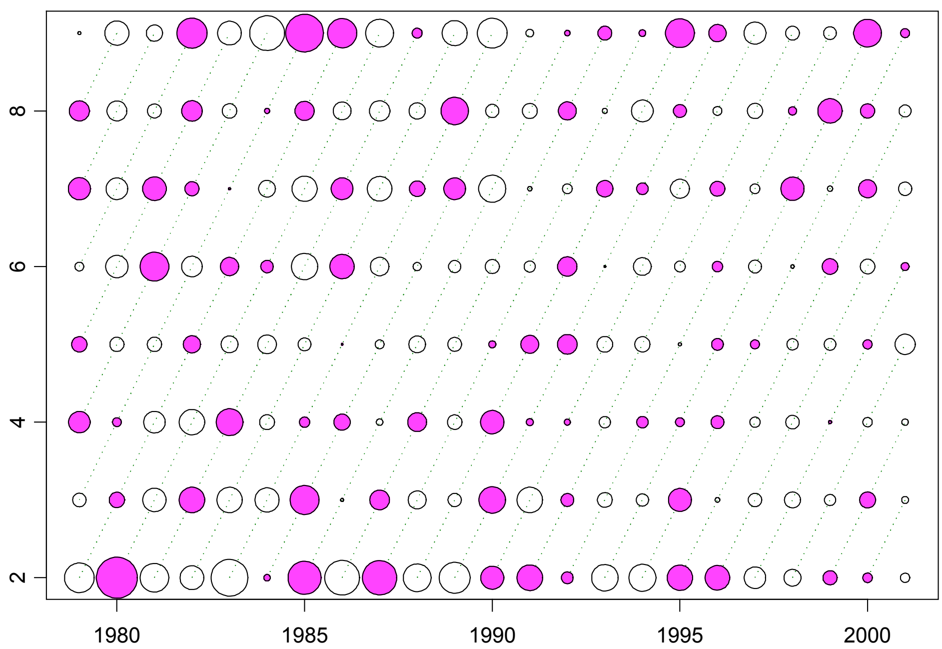

Figure 6.2 Residuals from the fit to catch in numbers data. $\dfrac{\log(C_{ay}+50)}{\log(\hat{C}_{ay}+50)}$ Coloured circles indicate positive residuals (observed > modelled). The largest circle corresponds to a value of 0.57 and residuals are proportional to the area of the circles.

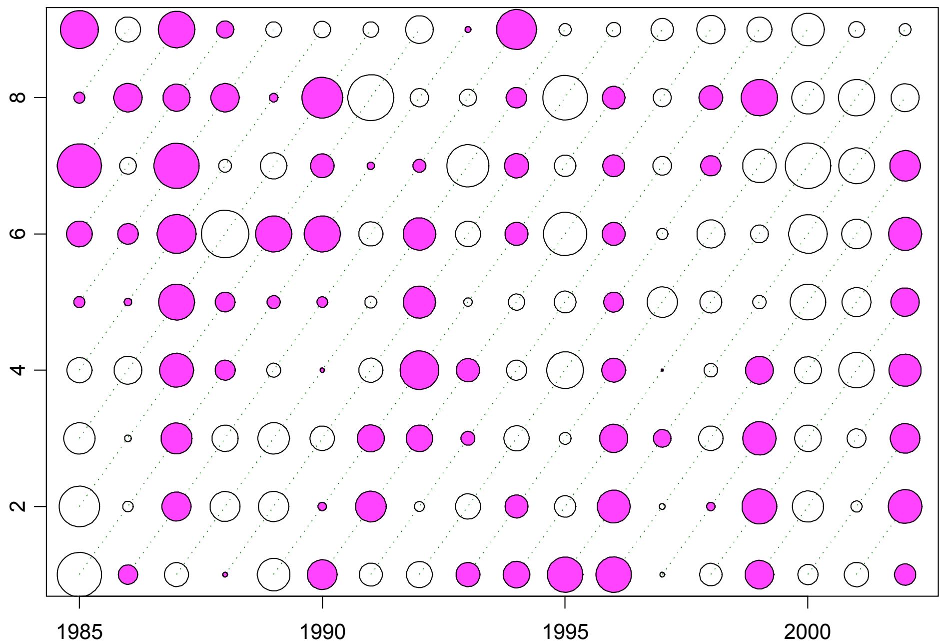

Figure 6.3 Residuals from the fit to catch in numbers data. $\dfrac{\log(I_{ay}+0.3)}{\log(CI_{ay}+0.3)}$ Coloured circles indicate positive residuals (observed > modelled). The largest circle corresponds to a value of 0.68 and residuals are proportional to the area of the circles

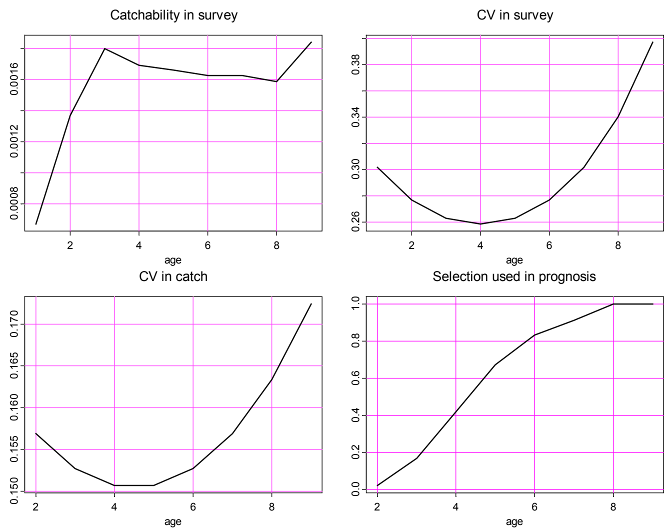

Figure 6.4. Haddock in division Va. Model estimate of selection pattern and variance in survey and in the catch. Selection used in prognosis is the mean of last 5 years.

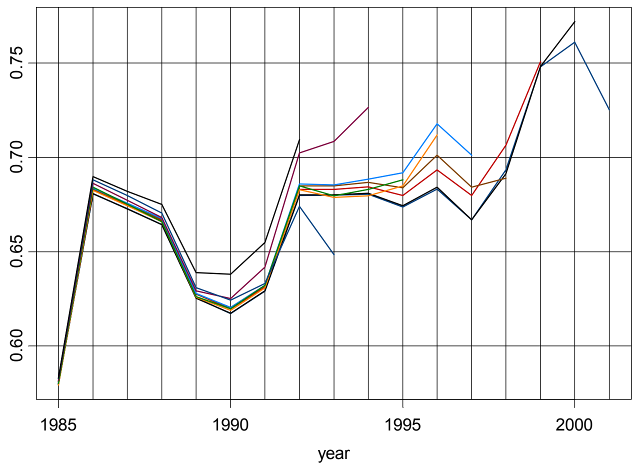

Figure 6.5 Haddock in division Va. Retrospective pattern from AD-model builder program. The figure shows mean fishing mortality of ages 5-7.

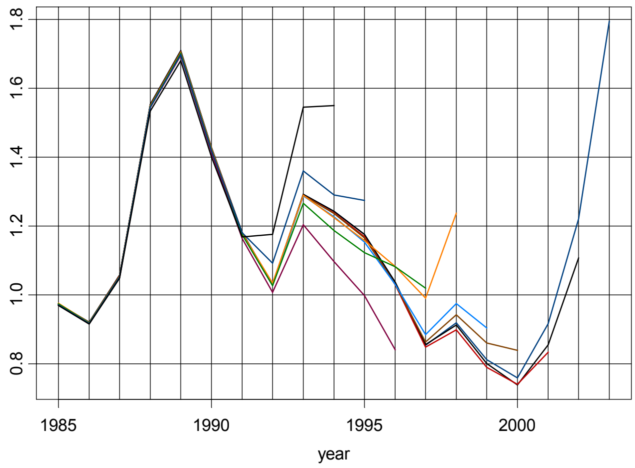

Figure 6.6 Haddock in division Va. Retrospective pattern from AD-model builder program. The figure shows biomass 3+. Note that the retro ends two years later than usual retros so for the assessment done in 1995 based on catch in number until 1994 and the March survey 1995 the estimated biomass in the beginning of the year 1997 is shown.

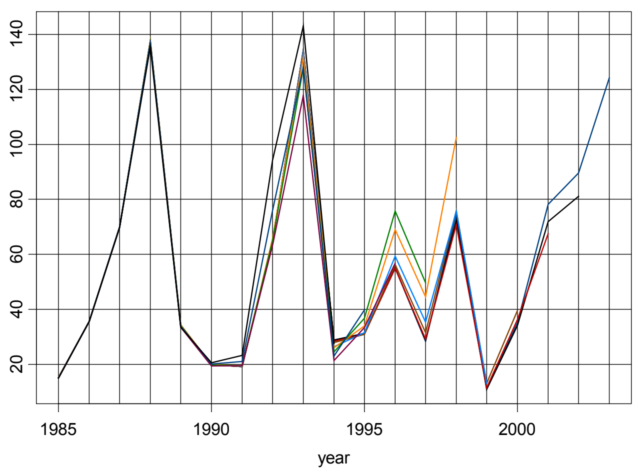

Figure 6.7 Haddock in division Va. Retrospective pattern from AD-model builder program. The figure shows the number of age 3 haddock.

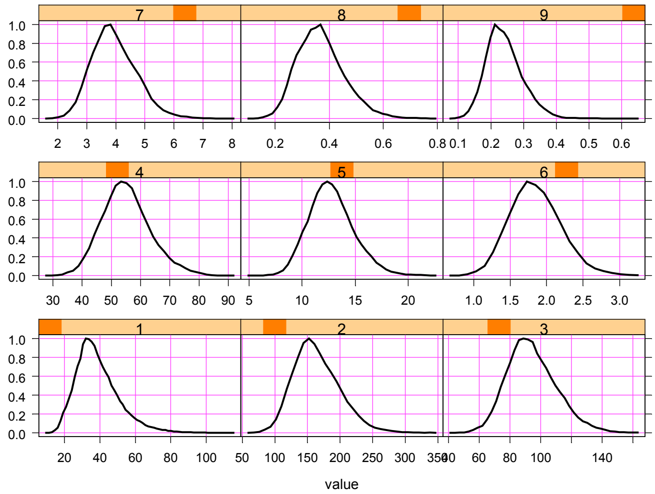

Figure 6.8 Haddock in division Va. Posterior distributions of number in stock in the beginning of the year 2002.

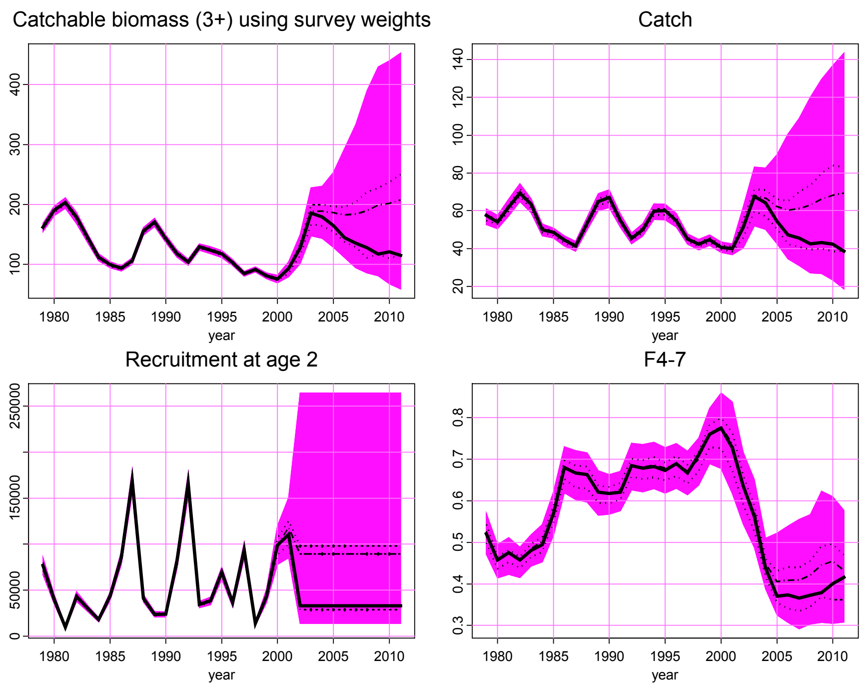

Figure 6.8 Haddock in division Va. Development of the stock using a harvest control law where 35% of biomass 3 years and older is caught each year. 90% of the cases should be within the shaded area and 50% between the dashed lines.

7. Comparison of different methods.

Earlier in this report stock assessment using a number of different methods has been presented. As expected most of the methods give similar results (Table 7.1) but there is though some difference in the estimate of age 4 in 2002 between TSA and the other methods. Recruitment has also been estimated by a number of methods and the variability there is more (Table 7.2) As the incoming yearclasses (1998-2000) are now nearly 80% of the stock biomass estimation of these yearclasses is most important for the prognosis. This non-importance of the older part of the stock in this context is exemplified by the model giving the highest F4-7 also estimating the highest biomass.

Direct estimates from the 2002 survey are 120 million 3 years old and 200 million 2 year old. (Fig 3.7)

Table 7.1 Haddock in division Va. Comparison of stock assessment using different programs (on exactly the same data)

	XSA	TSA	ADAPT	AD-modelbuilder
F4-7 2001	0.75	0.83	0.825	0.73
Biomass 3+	123	127	122	122
N7-2002	3.5	3.9		3.8
N4-2002	51	74	54	54
N3-2002	98	82	91	90

Table 7.2. Recruitment estimates by other methods.

Recruitment (million 2 year old.)						
	EJ	GG	SÞJ	EJ	HB	Mean
yearclass	RTC3	Timeseries	Adapt	XSA	AD-model	
1998	83		99	94	98	93
1999	106	130	114	123	112	117
2000	133	193	165		155	162
2001	35	31	33		29	32