

F. Gulf of Maine Cod by R.K. Mayo and L. Col

1.0 Background

The Gulf of Maine Atlantic cod stock was last assessed in 2002 at the 2002 Groundfish Assessment Review Meeting (GARM I) (Mayo and Col 2002). The methodology applied in the present assessment is the same as in the 2002 assessment and the 2001 assessment as described in Mayo *et al.* (2002). Since 2002, there have been changes in the software implementation of the ADAPT/VPA method, and some minor changes in the estimation of the stock specific MRFSS catches and the availability of additional commercial age samples from 2000 and 2001. As well, the NEFSC spring and autumn abundance survey indices at age were recalculated over the entire series to reconcile results in years when both Albatross IV and Delaware II were employed during to conduct a portion of a single survey. Changes in the survey indices were minor.

In the 2002 assessment, fully recruited fishing mortality (ages 4+) in 2001 was estimated to be 0.47, and the 2000 F was estimated to be 0.56. Spawning stock biomass was estimated to have declined to 10,600 mt in 1997 and 1998, a decline from a recent high of 14,600 mt in 1995 and a series high of 24,200 mt in 1990. The strength of the most recent recruiting year classes was estimated to be very low. The 1993, 1994 and 1995 year classes were estimated as the lowest in the VPA series dating back to 1982 (1980 year class). The recruit/SSB survival ratios for these most recent year classes were also estimated to be very low compared to previous year classes. NEFSC spring and autumn research vessel bottom trawl survey indices for Gulf of Maine cod had declined to record low levels in the mid-1990s; indices from both surveys fluctuated at relatively low levels but had begun to increase in 2001 and 2002. The 1994-1996 year classes derived from the NEFSC and Commonwealth of Massachusetts surveys were also among the lowest in the respective series, but the Mass. DMF survey and the 2001 and 2002 NEFSC surveys indicated the 1998 year class to be larger than the recent average.

2.0 The Fishery

Commercial landings of Gulf of Maine cod declined to 1,636 metric tons (mt) in 1999, a 61 % decline from 1998 (Table F1; Figure F1). Commercial landings increased to 4,423 mt in 2001 and have since fluctuated between 3,800 and 4,100 mt. Discard estimates have been derived on a gear-quarter basis from 1989 through 2004 based on NEFSC Observer Program data; these results indicate a substantial increase in the overall discard /kept ratio in 1999 compared to previous years (Table F2). Ratios calculated for years after 1999 were lower, but still remain substantially greater than the pre-1999 ratios. Recent discards estimated from the Observer Program data have ranged from 856 mt in 2004 to 2,630 mt in 1999. Discards have also been estimated based on Vessel Trip Reports, filtered to exclude vessels that do not report discards. Discards based on these data have ranged from 456 mt in 2004 to 3,390 mt in 2004.

The number of commercial port samples for this stock declined from 78 in 1997 to 46 in 1998 to 15 in 1999. Port sampling has since improved, increasing to 62 samples in 2000 and 113 samples in 2001. In 2003 and 2004, the number of port samples exceeded 190 (Table F3); however a large part of this increase is due to acquisition of more 'Large' market category

samples, many consisting of as few as 4-5 fish. Sampling was not well distributed among quarters and market categories in 1999 and 2000, as only 1 biological sample was taken in the 3rd and 4th quarter of 1999, requiring substantial pooling over quarter. In 1999 and 2000 samples from each market category were pooled on an annual basis, but improved sampling beginning in 2001 allowed a return to the traditional quarterly or semi-annual pooling of samples within each market category.

The estimated recreational catch of Gulf of Maine cod (retained component only) has varied considerably over the past decade ranging from 353 mt in 1997 to 2,826 mt in 2001 (Table F4). The total catch (including commercial landings and discard and recreational landings) from this fishery had been dominated by age 3 and 4 fish through 2001 (Table F5a). During the most recent three years, the fishery has been dominated by age 4-6 fish, and the age structure of the catch appears to have expanded compared to the late 1990s. The fishery in 2004 was supported, to a large extent, by two relatively weak year classes (1999 and 2000). Mean weights of the catch have been relatively stable over time, except for a slight increase in the mean weight of age 2, 3 and 4 fish since 1999 (Table F5b).

3.0 Research Vessel Surveys

NEFSC research vessel bottom trawl survey abundance and biomass indices for Gulf of Maine cod remained relatively low through autumn 1999 and spring 2000 (Table F6; Figure F2). The autumn 1999 indices increased slightly from 1998, while the spring 2000 indices decreased slightly from the 1999. However, biomass indices began to increase substantially in 2001 and spring 2002, but the large apparent increase evident in autumn 2002 resulted from a single large haul unduly influencing the stratified mean. Spring indices in 2003, 2004 and 2005 suggest a substantial decline in biomass since 2002 to levels evident during the mid-1990s. Autumn indices through 2004 suggest that biomass remains above the mid-1990s lows.

Recruitment indices for the 1994-1997 year classes derived from the NEFSC (Tables F7 and F8, Figure F3) and Massachusetts DMF (Table F9, Figure F4) bottom trawl surveys are among the lowest in the respective series, although indices for the 1998 year class appear to be above the recent average. The 2000 year class appears to be the extremely weak in all surveys. More recently, there are indications in both NEFSC and MA DMF survey that the 2003 year class may be relatively strong compared those produced over the past decade.

Total mortality (Z) estimates derived from the NEFSC spring and autumn surveys show elevated rates during the period since 1980 compared to the 1960s and 1970s (Figure F5). Both surveys also indicate a declining trend since the mid 1990s with a recent increase in Z indicated by the spring survey.

4.0 Assessment

Input Data and Analyses

The present assessment represents a three-year update to the previous assessment (Mayo and Col 2002). The same VPA formulation used in the previous assessment was employed in the present

update. Catch at age data were updated for 2002, 2003 and 2004 with the inclusion of commercial discards (1,500 mt in 2002 and 1,000 mt in 2003 and 2004), revised 1994-2001 recreational catch at age, and revised 2000 and 2001 commercial landings at age based on additional length and age samples. NEFSC and Mass. DMF survey abundance indices (stratified mean number per tow at age) were updated through spring 2005. As in recent VPAs, commercial CPUE indices were included only through 1993.

Comparisons between the software and data used in the 2002 GARM VPA with updated software and revised data as indicated above (Table F10) revealed only minor effects on estimates of terminal populations and their Cvs.

Precision of the 2004 spawning stock biomass and fully recruited fishing mortality were derived from 1,000 bootstrap replicates of the VPA. Survey residuals are given in Figure F6. A retrospective analysis of terminal year estimates of stock sizes, fully recruited fishing mortality and SSB were also carried out (Figure F9).

Assessment Results

Fully recruited fishing mortality (ages 4+) in 2004 is estimated at 0.63 (Table F11; Figure F7), a substantial increase since 2002. Spawning stock biomass increased to 23,800 mt in 2001, but SSB has since declined to 18,800 mt in 2004 (Table F11; Figure F8). The 1998 year class is estimated to be equivalent to the 1992 year class (approximately 8-9 million fish), and the initial estimate of the 2003 year class (22 million fish) suggests it may be the largest since the 1987 year class. The 2000 year class (1 million fish) is by far the lowest in the entire VPA series and the 1999 year class (4.4 million fish) is below the long term mean (6.3 million fish), and the 1993-1995 year classes are about ½ the long term average (Table F11).

VPA Diagnostics and Uncertainty

With the current VPA formulation, a retrospective pattern is evident in the estimates of terminal F whereby fully recruited F now appears to have again been underestimated in 2002 and 2003 as was the case from 1994-1997. The opposite pattern is evident for SSB and recruitment strength (Figure F9).

Based on the variability indicated by the survey residuals, the bootstrap analysis suggests that there is a 90% probability that 2004 fully recruited fishing mortality is greater than 0.50, and 2004 SSB is less than 22,600 mt (Figure F10).

Sensitivity Analyses

The estimate of the strength of the 2003 year class is very sensitive to the MA DMF 2004 autumn age 1 index, included as the 2005 age 2 index in the VPA calibration. Exclusion of this single datum results in an estimate of 15 million fish vs. 22 million fish at age 1 in 2004. This value does not substantially affect the estimate of 2004 spawning stock biomass, but does influence starting conditions for projections. Precision of the age 2 population estimate in 2005

is only slightly reduced from 33% when the index is included to 34% when excluded. The recruitment retrospective pattern remains unchanged.

5.0 Biological Reference Points

The following biological reference points were obtained from an age-structured production model (NEFSC 2002) performed on yield and SSB/recruit analyses and the VPA estimates of SSB and age 1 recruitment obtained from the 2001 assessment (Mayo et al. 2002):

MSY	16,600 mt
SSB _{MSY}	82,830 mt
F _{MSY}	0.225 (fully recruited)

6.0 Summary

Fishing mortality appears to have declined considerably between 1998 and 2002, but has since increased once again. Spawning biomass increased substantially in 2001, in large part due to maturation of the above-average 1998 year class at age 3. SSB remained high in 2002 but declined in 2003 and 2004 as F on the fully recruited ages began to increase. Fishing mortality increased sharply in 2004 because the fully recruited ages (4 and 5) that supported the fishery in 2004 correspond to 2 very poor year classes (1999 and 2000).

Comparisons between the projected and realized fishing mortality rates, spawning stock biomass, and catch during 2002-2004 are illustrated in Figure F11. Realized F exceeded the target Fs by a wide margin in 2003 and 2004. The target Fs were outside of the interquartile range in both years. Similarly, SSB declined between 2003 and 2004 below the interquartile range of the projected 2004 SSB. Realized catches exceeded the 75th percentile of the projected catches in each of the three years.

It is now clear that the sharp increase in the autumn 2002 NEFSC survey index was an artifact resulting from a very large catch at a single station influencing the overall mean. This also appears to be the case with the spring 2002 index to a lesser extent.

Overall, there is evidence that the biomass of Gulf of Maine cod increased in 2001 and 2002. The following excerpt from the 2002 GARM report (Mayo and Col 2002) is still relevant, perhaps more so, with respect to the 2003 year class:

“Further increases in biomass may occur if fishing mortality is reduced to maximize the contribution of the 1998 year class to the spawning stock. Based on the current maturity ogive, this year class will be fully mature at age 4 in 2002. But given the expected relatively poor strength of the 1999 and 2000 year classes, rebuilding of the stock may plateau unless additional average or above average year classes recruit in the next several years.”

Based on the results from the present assessment, the F in 2004 (0.63) is above F_{msy} and spawning stock biomass in 2004 (18,800 mt) is below ½ B_{msy}. Thus, overfishing is still occurring and the stock remains in an overfished condition.

7.0 GARM Comments

There was discussion on the method of estimating discards compared to how discards were estimated for 1999-2000 and presented at SAW 33. Although sensitivity runs of bracketing the discard estimate by 500 mt increments were presented at SAW 33, the final assessment accepted by the SARC panel had one set of discard estimates. The same methodology was applied in the VPA model formulation for the assessment at the GARM in 2002 and again in 2005. This is consistent with the model results that were applied in the A13 projections.

Regulations for the party charter vessels imposed stricter bag limits for cod in 2002. A summary of landings from the party charter VTR records may possibly reflect this shift in regulation.

The total catch (mt) in the recreational catch at age differs from the MFRSS estimate of total catch. The difference is due to the different methods for deriving the mean weight at age by MRFSS and in the assessment. The assessment mean weight is based on the sampled length frequency whereas the MRFSS estimate is an overall mean.

The 2003 year class is estimated to be very strong, close in size to the very strong 1987 year class. This estimate is sensitive, however, to the age 2 Massachusetts survey index and is reduced by 32% when the index is excluded from the VPA calibration. In addition, the year class appears smaller at age 1 than at age 0 in the Massachusetts autumn survey. A retrospective pattern in recruits shows that year classes are generally over-estimated in this model formulation. The 2003 year class will influence the rebuilding of the stock and if it is over estimated, the projection is likely to overestimate future biomass.

Projection Advice - Mean weight at age, partial recruitment, and the maturity ogive will be averaged over 2002-2004 for the projection analysis. The 2004 year class at age 1 will be set at the geometric mean of 6.3 million. Recruitment will be estimated from the stock recruit relationship.

Research Recommendation - For the 2008 benchmark assessment use biological data from the industry based survey in the Gulf of Maine.

8.0 Sources of Uncertainty

- Commercial landings may have been underestimated in 2004 due to a change to a self-reporting dealer system.
- The recent retrospective pattern in VPA is now suggesting that F is being underestimated and spawning biomass and recruitment is being overestimated in the terminal year in 2002 and 2003.
- The 2003 year class may be overestimated as age 1 based on diagnostics from the VPA given the impact of the Massachusetts age 2 autumn survey indices.

9.0 References

- Mayo, R.K., E.M. Thunberg, S.E. Wigley and S.X. Cadrin. 2002. The 2001 Assessment of the Gulf of Maine Atlantic Cod Stock.. Northeast Fisheries Science Center Reference Document 02-02, 154p.
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Table F1. Commercial landings (metric tons, live) of Atlantic cod from the Gulf of Maine (NAFO Division 5Y), 1960 - 2004.¹

Year	Gulf of Maine				Total
	USA	Canada	USSR	Other	
1960	3448	129	-	-	3577
1961	3216	18	-	-	3234
1962	2989	83	-	-	3072
1963	2595	3	133	-	2731
1964	3226	25	-	-	3251
1965	3780	148	-	-	3928
1966	4008	384	-	-	4392
1967	5676	297	-	-	5973
1968	6360	61	-	-	6421
1969	8157	59	-	268	8484
1970	7812	26	-	423	8261
1971	7380	119	-	163	7662
1972	6776	53	11	77	6917
1973	6069	68	-	9	6146
1974	7639	120	-	5	7764
1975	8903	86	-	26	9015
1976	10172	16	-	-	10188
1977	12426	-	-	-	12426
1978	12426	-	-	-	12426
1979	11680	-	-	-	11680
1980	13528	-	-	-	13528
1981	12534	-	-	-	12534
1982	13582	-	-	-	13582
1983	13981	-	-	-	13981
1984	10806	-	-	-	10806
1985	10693	-	-	-	10693
1986	9664	-	-	-	9664
1987	7527	-	-	-	7527
1988	7958	-	-	-	7958
1989	10397	-	-	-	10397
1990	15154	-	-	-	15154
1991	17781	-	-	-	17781
1992	10891	-	-	-	10891
1993	8287	-	-	-	8287
1994*	7877	-	-	-	7877
1995*	6798	-	-	-	6798
1996*	7194	-	-	-	7194
1997*	5421	-	-	-	5421
1998*	4156	-	-	-	4156
1999*	1636	-	-	-	1636
2000*	3730	-	-	-	3730
2001*	4423	-	-	-	4423
2002*	4096	-	-	-	4096
2003*	4028	-	-	-	4028
2004*	3798	-	-	-	3798

* Provisional

¹ USA 1960-1993 landings from NMFS, NEFSC Detailed Weighout Files and Canvass data.

² USA 1994-2004 landings estimated by prorating NMFS, NEFSC Detailed Weighout data by Vessel Trip Reports.

Table F2 Discard and total commercial catch estimates (metric tons, live) for Gulf of Maine cod by otter trawl, shrimp trawl, and sink gillnet gear derived from 1989-2004 NEFSC Sea Sample data.

Year	Total Landings	Discard Estimates			Total Discard	Total Catch
		Included Landings	Discard Estimate	Discard to Landings Ratio		
1989	10397	10182	1513	0.1486	1545	11942
1990	15154	14827	3521	0.2375	3598	18752
1991	17781	17374	1025	0.0590	1049	18830
1992	10891	10511	582	0.0554	603	11494
1993	8287	8058	320	0.0397	329	8616
1994	7877	7522	228	0.0303	239	8116
1995	6798	6500	408	0.0627	426	7224
1996	7194	6837	189	0.0277	199	7393
1997	5421	4974	164	0.0330	179	5600
1998	4156	3760	139	0.0370	154	4310
1999	1636	1332	2141	1.6074	2630	4266
2000	3730	3401	1067	0.3137	1170	4900
2001	4424	4068	1491	0.3665	1621	6045
2002	4096	3825	1821	0.4761	1950	6046
2003	4028	3799	1401	0.3688	1486	5514
2004	3798	3602	812	0.2254	856	4654

Table F3 USA sampling of commercial Atlantic cod landings from the Gulf of Maine cod stock (NAFO Division 5Y), 1982 - 2004.

Year	Number of Samples				Number of Samples, by Market Category & Quarter												Annual Sampling Intensity						
	Length Samples		Age Samples		Scrod				Market				Large				No. of Tons Landed/Sample						
	No. Measured	No. Fish Aged	No.	No. Fish Aged	Q1	Q2	Q3	Q4	Σ	Q1	Q2	Q3	Q4	Σ	Q1	Q2	Q3	Q4	Σ	Scrod	Market	Large	Σ
1982	48	3848	48	866	6	7	6	6	25	4	3	7	4	18	0	2	1	2	5	134	348	792	266
1983	71	5241	67	1348	14	10	10	4	38	4	10	6	2	22	1	3	5	2	11	106	294	318	197
1984	55	3925	55	1224	7	5	6	7	25	4	3	5	6	18	1	6	3	2	12	85	319	245	193
1985	69	5426	66	1546	5	6	7	5	23	8	6	7	4	25	7	5	3	6	21	95	229	132	155
1986	53	3970	51	1160	5	5	6	3	19	5	6	8	2	21	1	5	4	3	13	124	242	170	182
1987	43	3184	42	939	4	4	3	4	15	5	5	3	5	18	4	2	3	1	10	83	224	225	175
1988	34	2669	33	741	4	3	4	4	15	1	5	3	5	14	1	2	2	0	5	147	271	391	234
1989	32	2668	32	714	3	3	3	3	12	4	1	5	4	14	2	2	1	1	6	209	430	311	325
1990	39	2982	38	789	3	7	3	5	18	4	7	4	3	18	0	2	1	0	3	300	378	966	387
1991	56	4519	56	1152	2	10	4	3	19	5	11	11	3	30	0	3	3	1	7	250	313	519	318
1992	51	4086	51	1002	2	8	6	3	19	6	7	7	3	23	3	1	1	4	9	104	232	375	214
1993	23	1753	23	447	3	3	3	1	10	1	2	4	1	8	1	1	2	1	5	177	453	527	360
1994	30	2696	33	665	0	2	2	4	8	1	4	4	6	15	0	2	3	2	7	180	284	272	263
1995	31	2568	32	662	4	2	2	4	12	2	7	1	2	12	0	5	0	2	7	133	300	202	219
1996	77	7027	71	1483	6	5	7	9	27	7	9	10	12	38	1	3	3	5	12	62	116	79	93
1997	78	6657	74	1521	7	10	3	9	29	11	9	9	7	36	1	8	2	2	13	37	91	71	69
1998	46	4205	46	912	4	7	0	3	14	8	9	9	3	29	0	0	2	1	3	53	81	321	90
1999	15	1305	16	350	6	0	1	0	7	4	2	0	0	6	2	0	0	0	2	36	144	245	109
2000	62	4881	62	1490	11	5	3	4	23	11	14	5	8	38	0	0	0	1	1	14	62	1131	61
2001	113	7326	105	2436	4	4	4	7	19	7	9	8	15	39	3	16	18	18	55	18	58	32	39
2002	137	5999	138	2800	4	4	0	2	10	16	5	8	4	33	53	9	15	17	94	17	64	19	30
2003	191	9043	234	5820	6	1	13	0	20	13	10	24	4	51	49	34	28	9	120	8	37	16	22
2004	201	10383	156	3375	11	9	6	20	46	16	20	15	14	65	35	19	11	25	90	2	24	22	19

Source: 1982-1985 from Serchuk and Wigley (1986); 1986-2004 from NEFSC files.

Table F4. Estimated number (000's) and weight (metric tons, live) of Atlantic cod caught by marine recreational fishermen from the Gulf of Maine stock, 1979 - 2004.¹

Year	Total Cod Caught		Total Cod Retained (excluding those caught and released)				
	No. of Cod (000's)	Wt. of Cod (mt)	No. of Cod (000's)	Wt. of Cod (mt)	Sample Mean Weight (kg)	Number Measured	Percent of Total Landings
1979	2698	3466	not estimated		-----	not estimated	-----
1980	2254	6860	not estimated		-----	not estimated	-----
1981	2933	5944	2738	5549	1.595	380	30.7
1982	1833	2138	1736	2025	1.554	377	13.0
1983	1455	1388	1237	1180	1.568	882	7.8
1984	1098	1705	905	1405	1.497	596	11.5
1985	1671	1964	1471	1729	1.263	295	13.9
1986	1114	967	993	862	2.871	75	8.2
1987	2625	2317	2054	1813	1.680	320	19.4
1988	1487	2114	1300	1848	1.497	407	18.8
1989	1769	2690	1193	1814	1.824	404	14.9
1990	1725	3882	1247	2806	1.838	206	15.6
1991	1770	3635	1419	2914	1.987	370	14.1
1992	585	1154	332	655	2.725	922	5.7
1993	1564	2378	772	1174	1.799	290	12.4
1994	VTR P/C 1599	3129	VTR P/C 651	1274	1.756	477	13.9
1995	393	1486	247	632	1.736	928	11.9
1996	278	906	174	395	1.920	959	12.5
1997	208	585	123	166	2.222	458	6.1
1998	299	782	119	257	2.416	508	20.6
1999	226	842	143	284	3.054	117	35.3
2000	241	1615	160	555	2.337	89	29.6
2001	1880	6828	778	2826	2.692	68	39.0
2002	1421	4704	409	1354	3.885	70	24.8
2003	1389	7771	468	2619	4.017	300	39.4
2004	1041	3467	372	1239	2.954	493	24.6

¹ 1981-2004 from Revised Marine Recreational Fishery Statistics Survey database expanded catch estimates.

² VTR P/C are estimates of the number of cod caught and retained derived from VTR records of Part/Charter vessels.

³ 1994-2001 catches were re-estimated using a revised port stratification scheme to better reflect sampling allocation.

Table F5a. Total (commercial and recreational) landings at age (thousands of fish; metric tons) of Atlantic cod from the Gulf of Maine stock (NAFO Division 5Y), 1982 - 2004. (Input data for Virtual Population Analysis)

Year	Age							Total
	1	2	3	4	5	6	7+	
<u>Total Landings at Age in Numbers (000's)</u>								
1982	88	1995	2350	1386	717	75	242	6853
1983	14	1337	2896	1184	685	448	169	6733
1984	24	813	1572	1636	469	205	142	4861
1985	49	989	2111	1122	665	133	137	5206
1986	26	208	2750	929	275	197	190	4575
1987	41	907	1418	1525	330	79	97	4397
1988	6	520	2140	1149	434	51	34	4334
1989	5	530	2284	1698	485	91	61	5154
1990	7	294	4195	2373	488	167	105	7629
1991	5	447	1349	4948	946	151	85	7931
1992	-	350	600	526	2184	218	86	3962
1993	1	152	1998	787	140	481	39	3597
1994	1	49	1488	1258	319	74	88	3277
1995	-	287	1233	1348	206	14	34	3123
1996	-	89	716	1955	368	45	10	3184
1997	-	61	498	469	893	72	8	2000
1998	-	112	505	627	182	214	11	1652
1999 ¹	1	16	580	550	270	81	109	1606
2000 ²	-	194	540	856	198	97	23	1908
2001 ³	-	121	1065	643	375	102	84	2389
2002 ⁴	-	2	276	863	334	214	135	1824
2003 ⁵	-	14	111	430	786	240	189	1768
2004 ⁶	-	1	303	245	402	273	153	1376
<u>Total Landings at Age in Weight (Tons)</u>								
1982	50	2151	3735	3719	3392	494	2738	16279
1983	6	1421	4664	2891	2568	2691	1680	15921
1984	12	820	2551	4412	1710	1192	1462	12169
1985	18	1007	3442	3121	2929	725	1327	12549
1986	11	213	4946	2679	1252	1186	2225	12512
1987	13	917	2185	4752	1564	547	998	10976
1988	1	513	3764	2736	2204	321	363	9902
1989	3	628	3922	4979	1861	386	726	12575
1990	1	299	6941	5414	2046	1266	1424	17391
1991	1	507	2045	12204	3807	1093	944	20601
1992	-	536	1149	1432	6684	1080	911	11793
1993	1	172	3650	1903	594	2927	428	9675
1994	-	70	2730	3845	1055	450	871	9020
1995	-	466	2261	3575	1036	100	455	7894
1996	-	147	1486	4555	1318	336	110	7951
1997	-	105	1097	1388	2804	326	70	5790
1998	-	151	1063	1833	748	877	109	4780
1999 ¹	-	19	1052	1511	1117	468	840	5008
2000 ²	-	290	1222	2937	867	552	158	6025
2001 ³	-	218	2580	2089	1812	663	663	8019
2002 ⁴	-	3	659	2838	1348	1262	1139	7195
2003 ⁵	-	27	267	1322	3190	1275	1643	7406
2004 ⁶	-	2	730	816	1530	1472	1338	5898

1. Includes 2,500 mt of estimated discards.
 2. Includes 1,000 mt of estimated discards.
 3. Includes 1,500 mt of estimated discards.

4. Includes 1,500 mt of estimated discards.
 5. Includes 1,000 mt of estimated discards.
 6. Includes 1,000 mt of estimated discards.

Table F5b. Mean weight (kg) and mean length (cm) at age of total landings (commercial and recreational) of Atlantic cod from the Gulf of Maine stock (NAFO Division 5Y), 1982 - 2004. (Input data for Virtual Population Analysis)

Year	Age							Average
	1	2	3	4	5	6	7+	
<u>Total Landings Mean Weight (kg) at Age</u>								
1982	0.568	1.078	1.589	2.683	4.731	6.587	11.314	2.375
1983	0.429	1.063	1.610	2.442	3.749	6.007	9.941	2.365
1984	0.500	1.009	1.623	2.697	3.646	5.815	10.296	2.503
1985	0.367	1.018	1.621	2.782	4.405	5.451	9.686	2.410
1986	0.423	1.024	1.799	2.884	4.553	6.020	11.711	2.735
1987	0.317	1.011	1.541	3.116	4.739	6.924	10.289	2.496
1988	0.167	0.987	1.759	2.381	5.078	6.294	10.676	2.285
1989	0.600	1.185	1.717	2.932	3.837	4.242	11.902	2.440
1990	0.143	1.017	1.655	2.282	4.193	7.581	13.562	2.280
1991	0.171	1.134	1.516	2.466	4.024	7.238	11.106	2.598
1992	0.390	1.531	1.915	2.722	3.060	5.000	10.593	2.977
1993	0.390	1.132	1.627	2.418	4.243	6.085	10.974	2.690
1994	0.390	1.429	1.835	3.056	3.307	6.081	9.898	2.753
1995	0.390	1.624	1.834	2.652	5.029	7.143	13.687	2.528
1996	0.390	1.662	2.075	2.330	3.582	7.412	10.657	2.497
1997	0.390	1.736	2.203	2.959	3.140	4.553	8.738	2.895
1998	0.625	1.348	2.105	2.923	4.110	4.098	9.528	2.893
1999	0.346	1.188	1.814	2.744	4.143	5.758	7.706	3.118
2000	0.390	1.498	2.261	3.432	4.385	5.691	6.994	3.158
2001	0.390	1.804	2.422	3.251	4.833	6.496	7.891	3.357
2002	0.390	1.360	2.389	3.289	4.041	5.888	8.427	3.944
2003	0.390	1.968	2.409	3.075	4.060	5.313	8.676	4.190
2004	0.390	1.525	2.406	3.336	3.803	5.390	8.749	4.285
<u>Total Landings Mean Length (cm) at Age</u>								
1982	37.1	46.6	52.7	62.6	76.5	85.6	101.4	57.4
1983	33.5	46.6	53.1	61.0	70.5	82.5	95.6	58.0
1984	28.5	45.5	53.3	63.1	69.5	81.2	98.1	59.3
1985	32.0	45.4	53.3	64.1	74.5	79.9	96.6	58.5
1986	33.7	45.1	55.3	64.6	75.0	82.4	105.9	61.1
1987	26.4	45.1	52.1	66.4	76.2	86.4	98.4	58.8
1988	26.2	45.0	54.7	60.6	78.1	83.2	100.5	58.1
1989	38.4	48.5	54.6	65.1	71.2	77.5	103.1	60.0
1990	23.7	46.2	54.1	60.0	73.2	89.7	108.9	58.3
1991	24.9	47.5	51.9	61.3	71.8	88.1	100.7	61.1
1992	31.3	52.9	56.4	62.9	65.5	76.9	100.1	64.1
1993	38.0	47.4	55.9	60.8	73.5	83.2	101.7	61.4
1994	30.8	53.3	57.1	66.0	67.3	82.2	97.3	63.3
1995	30.8	54.4	57.3	63.2	77.9	88.6	107.0	61.9
1996	30.8	52.8	58.4	61.2	69.7	88.8	103.0	62.1
1997	30.8	54.6	59.3	65.2	66.5	75.0	104.5	64.2
1998	30.8	50.7	58.6	65.0	73.0	73.7	96.0	64.1
1999	30.8	51.1	56.3	63.7	71.4	80.5	91.7	65.7
2000	30.8	52.3	59.3	68.3	74.3	81.5	86.9	65.6
2001	30.8	55.1	61.0	67.0	77.0	85.2	90.6	66.9
2002	30.8	51.4	60.8	67.7	72.0	82.1	91.2	70.7
2003	30.8	57.9	61.1	65.9	72.1	79.0	92.5	72.1
2004	30.8	53.4	61.2	68.0	70.7	79.2	93.3	72.4

Table F6. Standardized stratified mean catch per tow in numbers and weight (kg) for Atlantic cod from NEFSC offshore spring and autumn research vessel bottom trawl surveys in the Gulf of Maine (NEFSC strata 01260-01300 and 01360-01400), 1963 - 2005 [a,b,c].

Year	Spring		Autumn	
	no/tow	wt/tow (kg)	no/tow	wt/tow (kg)
1963	No Survey Conducted		5.914	17.95
1964	No Survey Conducted		4.015	22.799
1965	No Survey Conducted		4.5	12.005
1966	No Survey Conducted		3.784	12.916
1967	No Survey Conducted		2.56	9.225
1968	5.583	18.195	4.374	19.437
1969	3.247	13.194	2.758	15.368
1970	2.191	11.077	4.905	16.442
1971	1.429	6.996	4.361	16.527
1972	2.057	8.029	9.301	12.988
1973	7.525	18.807	4.452	8.758
1974	2.902	7.418	4.328	8.959
1975	2.512	6.039	6.143	8.619
1976	2.782	7.556	2.148	6.74
1977	3.872	8.541	3.073	10.199
1978	2.05	7.697	5.773	12.899
1979	3.993	8.363	3.142	13.927
1980	2.154	6.232	7.034	14.202
1981	4.831	10.65	2.349	7.533
1982	3.763	8.616	7.768	15.919
1983	3.912	10.962	2.786	8.416
1984	3.667	6.143	2.449	8.735
1985	2.517	7.645	2.821	8.264
1986	1.957	3.476	1.95	4.715
1987	1.083	1.976	2.996	3.394
1988	3.127	3.603	5.903	6.616
1989	2.112	2.424	4.553	4.535
1990	2.362	3.076	2.986	4.912
1991	2.393	2.891	1.252	2.781
1992	2.435	8.626	1.433	2.448
1993	2.507	5.875	1.232	1.002
1994	1.271	2.427	2.13	2.737
1995	1.93	2.431	2.008	3.665
1996	2.465	5.427	1.327	2.351
1997	2.192	5.615	0.872	1.872
1998	1.71	4.18	0.843	1.5
1999	2.301	5.089	1.807	3.505
2000	3.083	3.211	2.604	4.652
2001	2.147	6.216	1.98	7.325
2002	3.724	10.933	5.328	24.659
2003	3.677	9.495	2.529	5.993
2004	0.981	2.414	3.53	4.90
2005	1.765	2.703		

- [a] Indices in all years have been recalculated and may differ slightly from those reported previously (e.g., Mayo et al. 2002) due to a better accounting of vessel effects in years when Albatross IV and Delaware II were used to conduct a portion of the same survey (e.g. 1979 and 1987).
- [b] Spring surveys during 1973-1981 were conducted with a '41 Yankee' trawl; in all other years, spring surveys were conducted with a '36 Yankee' trawl. No adjustments have been made to the catch per tow data for these differences.
- [c] During 1963-1984, BMV oval doors were used in the spring and autumn surveys; since 1985, Portuguese polyvalent doors have been used in both surveys. Adjustments have been made to the 1963-1984 catch per tow data to standardize these data to polyvalent door equivalents. Conversion coefficients of 1.56 (numbers) and 1.62 (weight) were used in the standardization (NEFSC 1991).
- [d] In the Gulf of Maine, spring and autumn surveys were conducted primarily by R/V ALBATROSS IV. During several periods since 1979, however, surveys were conducted either entirely or in part by R/V DELAWARE II. Adjustments have been made to the R/V DELAWARE II catch per tow data to standardize these to R/V ALBATROSS IV equivalents. Conversion coefficients of 0.79 (number) and 0.67 (weight) were used in the standardization (NEFSC 1991).

Table F7 Standardized [for both door and gear changes] stratified mean number per tow at age and standardized stratified mean weight (kg) per tow of Atlantic cod in NEFSC offshore spring research vessel bottom trawl surveys in the Gulf of Maine (Strata 26-30 and 36-40), 1968-2005. [a,b]

Year [c,d,e]	Age Group																				Totals					Standardized Mean Wt./Tow (kg)
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	0+	4+	5+	6+							
1968	0.128	0.613	1.234	1.407	0.846	0.538	0.207	0.129	0.111	0.059	0.165	-	-	-	-	5.438	2.056	1.211	0.673	18.20						
1969	0.000	0.000	0.036	0.307	0.880	0.807	0.633	0.256	0.144	0.089	0.101	-	-	-	-	3.253	2.909	2.030	1.223	13.19						
1970	0.000	0.159	0.124	0.053	0.091	0.271	0.465	0.611	0.094	0.059	0.098	0.100	0.042	0.012	0.012	0.012	1.911	1.855	1.764	1.494	11.08					
1971	0.000	0.026	0.151	0.105	0.286	0.048	0.084	0.300	0.206	0.154	0.058	0.013	0.000	0.000	0.000	0.000	1.429	1.148	0.862	0.814	7.00					
1972	0.000	0.371	0.135	0.521	0.195	0.181	0.044	0.124	0.093	0.229	0.056	0.056	0.034	0.000	0.017	0.017	2.057	1.030	0.835	0.653	8.03					
1973	0.000	0.035	4.250	0.890	0.632	0.348	0.194	0.096	0.221	0.261	0.198	0.075	0.106	0.132	0.088	0.088	7.525	2.350	1.718	1.370	18.81					
1974	0.000	0.475	1.031	1.503	0.172	0.235	0.075	0.028	0.045	0.033	0.045	0.043	0.081	0.000	0.051	0.051	2.902	0.820	0.648	0.413	7.42					
1975	0.006	0.096	0.686	0.131	1.105	0.269	0.079	0.000	0.006	0.018	0.028	0.026	0.062	0.000	0.000	0.000	2.512	1.593	0.488	0.219	6.04					
1976	0.000	0.051	0.265	1.104	0.137	0.902	0.090	0.095	0.027	0.000	0.011	0.000	0.074	0.027	0.000	0.000	2.782	1.362	1.225	0.323	7.56					
1977	0.000	0.025	0.297	0.553	1.925	0.111	0.831	0.011	0.083	0.000	0.000	0.000	0.000	0.000	0.038	0.038	2.998	1.073	0.622	0.323	8.54					
1978	0.000	0.048	0.110	0.308	0.351	0.744	0.095	0.252	0.013	0.107	0.000	0.022	0.000	0.000	0.000	0.000	2.050	1.584	1.233	0.488	7.70					
1979	0.044	0.484	1.630	0.219	0.449	0.299	0.587	0.102	0.112	0.013	0.031	0.000	0.000	0.025	0.025	0.025	3.993	1.617	1.168	0.869	8.36					
1980	0.070	0.037	0.423	0.492	0.138	0.238	0.304	0.317	0.000	0.122	0.014	0.000	0.000	0.000	0.000	0.000	4.832	2.272	0.930	0.600	10.65					
1981	0.000	1.075	0.644	0.841	1.342	0.331	0.264	0.116	0.121	0.100	0.000	0.000	0.000	0.000	0.000	0.000	3.763	1.907	1.251	0.264	8.62					
1982	0.014	0.359	1.007	0.476	0.655	0.988	0.087	0.112	0.000	0.026	0.039	0.000	0.000	0.000	0.000	0.000	3.667	1.322	0.857	0.453	10.96					
1983	0.013	0.632	0.949	0.997	0.465	0.404	0.212	0.068	0.016	0.000	0.000	0.008	0.030	0.000	0.030	0.030	3.912	1.582	0.359	0.147	6.14					
1984	0.000	0.151	1.312	1.023	0.823	0.212	0.047	0.100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.517	1.596	0.933	0.272	7.65					
1985	0.000	0.029	0.231	0.622	0.663	0.662	0.103	0.091	0.052	0.000	0.026	0.000	0.000	0.000	0.000	0.000	1.957	0.419	0.182	0.090	3.48					
1986	0.000	0.537	0.248	0.754	0.237	0.091	0.035	0.038	0.000	0.000	0.000	0.000	0.018	0.000	0.000	0.000	1.957	0.419	0.182	0.090	3.48					
1987	0.000	0.300	0.460	0.199	0.231	0.254	0.092	0.065	0.008	0.000	0.000	0.000	0.000	0.000	0.015	0.015	1.083	0.394	0.163	0.088	1.98					
1988	0.029	0.717	0.923	0.823	0.218	0.254	0.092	0.065	0.000	0.007	0.000	0.000	0.000	0.000	0.000	0.000	3.127	0.635	0.417	0.163	3.60					
1989	0.000	0.017	0.605	0.723	0.600	0.091	0.063	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.112	0.768	0.168	0.077	2.42					
1990	0.000	0.000	0.208	1.365	0.637	1.020	0.032	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.362	0.789	0.152	0.050	3.08					
1991	0.000	0.038	0.068	0.234	1.717	0.299	0.020	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.393	2.054	0.337	0.038	2.89					
1992	0.000	0.050	0.226	0.242	0.282	1.328	0.226	0.069	0.000	0.012	0.000	0.000	0.000	0.000	0.000	0.000	2.435	1.917	1.635	0.307	8.63					
1993	0.000	0.201	0.497	0.799	0.334	0.091	0.484	0.055	0.023	0.000	0.000	0.023	0.000	0.000	0.000	0.000	2.507	1.010	0.676	0.585	5.88					
1994	0.000	0.015	0.316	0.388	0.215	0.094	0.049	0.127	0.022	0.018	0.000	0.000	0.000	0.000	0.000	0.000	1.271	0.553	0.338	0.244	2.43					
1995	0.000	0.050	0.179	1.116	0.372	0.145	0.028	0.000	0.011	0.000	0.000	0.000	0.000	0.028	0.000	0.000	1.930	0.585	0.213	0.068	2.43					
1996	0.000	0.057	0.022	0.593	1.331	0.403	0.059	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.465	1.793	0.463	0.059	5.43					
1997	0.000	0.159	0.132	0.399	0.264	0.876	0.242	0.120	0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.192	1.502	1.238	0.362	4.18					
1998	0.000	0.188	0.224	0.330	0.517	1.142	0.421	0.023	0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.710	1.139	0.622	0.481	5.09					
1999	0.000	0.166	0.344	0.713	0.345	0.315	0.134	0.273	0.000	0.000	0.000	0.000	0.011	0.000	0.000	0.000	2.301	1.078	0.733	0.418	5.09					
2000	0.026	1.184	0.725	0.439	0.457	0.107	0.101	0.024	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.083	0.710	0.253	0.146	3.21					
2001	0.000	0.029	0.323	0.716	0.497	0.354	0.064	0.098	0.055	0.000	0.011	0.000	0.000	0.000	0.000	0.000	2.146	1.078	0.581	0.227	6.22					
2002	0.000	0.340	0.045	0.524	1.601	0.614	0.362	0.164	0.057	0.016	0.000	0.000	0.000	0.000	0.000	0.000	3.724	2.814	1.213	0.598	10.93					
2003	0.000	0.069	0.831	0.063	0.708	1.089	0.395	0.321	0.103	0.073	0.027	0.000	0.000	0.000	0.000	0.000	3.677	2.715	2.007	0.918	9.50					
2004	0.000	0.136	0.045	0.221	0.118	0.191	0.232	0.014	0.014	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.981	0.579	0.461	0.270	2.41					
2005	0.000	0.020	0.726	0.101	0.608	0.015	0.145	0.130	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.765	0.917	0.309	0.294	2.70					

[a] Indices from 1970-2001 have been recalculated and may differ slightly from those reported previously (Mayo et al. 2002) due to slight modifications to the age-length keys and a better accounting of vessel effects in 1979 and 1987.

[b] Spring catch per tow at age indices for 1968-1969 were obtained by applying combined 1970-1981 age-length keys to stratified mean catch per tow at length distributions from each survey. Calculations were carried out only to age 10+.

[c] Spring surveys during 1973-1981 were accomplished with a '41 Yankee' trawl; in all other years, spring surveys were accomplished with a '36 Yankee' trawl. No adjustments have been made to the catch per tow data for these differences.

[d] During 1963-1984, BMW oval doors were used in the spring and autumn surveys; since 1985, Portuguese polyvalent doors have been used in both surveys. Adjustments have been made to the 1963-1984 catch per tow data to standardize these data to polyvalent door equivalents. Conversion coefficients of 1.56 (numbers) and 1.62 (weight) were used in this standardization (NEFSC 1991).

[e] In the Gulf of Maine, spring surveys during 1980-1982, 1989-1991, 1994 and 2003, were conducted aboard R/V DELAWARE II; in all other years, the surveys were conducted aboard R/V ALBATROSS IV except in 1979 and 1987 when both vessels were deployed on portions of the survey. Adjustments have been made to the R/V DELAWARE II catch per tow data to standardize these to R/V ALBATROSS IV equivalents. Conversion coefficients of 0.79 (numbers) and 0.67 (weight) were used in this standardization (NEFSC 1991).

Table F8. Standardized [for both door and gear changes] stratified mean number per tow at age and standardized stratified mean weight (kg) per tow of Atlantic cod in NEFSC offshore autumn research vessel bottom trawl surveys in the Gulf of Maine (Strata 26-30 and 36-40), 1963-2004. [a,b]

Year [c,d]	Age Group																Totals					Standardized Mean Wt./tow (kg)
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	0+	3+	4+	5+			
1963	0.050	0.649	1.349	1.253	0.849	0.579	0.537	0.300	0.183	0.095	0.075	-	-	-	-	5.917	3.869	2.616	1.767	17.95		
1964	0.000	0.092	0.122	0.417	0.856	0.853	0.783	0.373	0.237	0.114	0.101	-	-	-	-	4.003	3.789	3.318	2.462	22.80		
1965	0.002	0.850	0.880	0.824	0.750	0.496	0.374	0.170	0.080	0.044	0.025	-	-	-	-	4.494	2.763	1.939	1.189	12.01		
1966	0.170	0.204	0.640	0.697	0.718	0.558	0.441	0.192	0.078	0.048	0.036	-	-	-	-	3.783	2.769	2.072	1.354	12.92		
1967	0.012	0.129	0.215	0.574	0.671	0.384	0.268	0.162	0.070	0.041	0.034	-	-	-	-	2.562	2.204	1.630	0.959	9.23		
1968	0.012	0.036	0.179	0.719	1.256	0.973	0.627	0.261	0.156	0.072	0.095	-	-	-	-	4.387	4.159	3.440	2.184	19.44		
1969	0.016	0.059	0.123	0.354	0.630	0.552	0.466	0.220	0.145	0.129	0.062	-	-	-	-	2.758	2.560	2.206	1.576	15.37		
1970	0.802	0.883	0.260	0.538	0.329	0.486	0.425	0.811	0.132	0.094	0.036	0.037	0.073	0.000	0.000	4.905	2.960	2.422	2.093	16.44		
1971	1.319	0.179	0.276	0.219	0.578	0.478	0.455	0.236	0.298	0.163	0.066	0.034	0.061	0.000	0.000	4.361	2.588	2.368	1.790	16.53		
1972	0.031	5.578	1.215	1.528	0.233	0.090	0.140	0.070	0.138	0.262	0.000	0.000	0.000	0.016	0.000	9.301	2.477	0.949	0.716	12.99		
1973	0.638	0.329	2.170	0.139	0.507	0.213	0.077	0.027	0.051	0.183	0.102	0.000	0.000	0.016	0.000	4.452	1.315	1.176	0.669	8.76		
1974	0.283	1.134	0.266	1.876	0.167	0.274	0.051	0.046	0.036	0.033	0.033	0.098	0.000	0.000	0.033	4.328	2.646	0.770	0.603	8.96		
1975	0.047	0.177	3.045	0.138	2.333	0.259	0.109	0.017	0.006	0.000	0.000	0.006	0.006	0.000	0.000	6.143	2.874	2.736	0.403	8.62		
1976	0.000	0.230	0.221	0.633	0.077	0.773	0.052	0.132	0.000	0.000	0.031	0.000	0.000	0.000	0.000	2.148	1.697	1.064	0.988	6.74		
1977	0.000	0.042	0.416	0.465	1.157	0.114	0.629	0.044	0.090	0.022	0.032	0.000	0.044	0.019	0.000	3.073	2.615	2.150	0.994	10.20		
1978	0.248	1.373	0.378	1.135	0.658	1.426	0.109	0.310	0.005	0.083	0.007	0.013	0.000	0.028	0.000	5.773	3.773	2.638	1.980	12.90		
1979	0.002	0.381	0.588	0.145	0.708	0.337	0.688	0.044	0.181	0.000	0.053	0.000	0.000	0.000	0.018	3.142	2.172	2.027	1.319	13.93		
1980	0.027	1.321	2.520	1.780	0.492	0.194	0.360	0.207	0.036	0.025	0.000	0.036	0.000	0.014	0.022	7.034	3.165	1.385	0.894	14.20		
1981	0.010	0.618	0.419	0.539	0.405	0.121	0.076	0.029	0.090	0.000	0.043	0.000	0.000	0.000	0.000	2.349	1.302	0.763	0.358	7.53		
1982	0.000	0.843	3.353	2.275	1.089	0.209	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.769	3.573	1.298	0.529	15.92		
1983	0.000	0.317	0.916	0.828	0.197	0.227	0.210	0.000	0.000	0.000	0.027	0.028	0.037	0.000	0.000	2.786	1.553	0.726	0.529	8.42		
1984	0.022	0.432	0.426	0.631	0.387	0.214	0.163	0.079	0.000	0.030	0.000	0.000	0.030	0.000	0.000	2.449	1.569	0.938	0.551	8.74		
1985	0.121	0.526	0.957	0.609	0.248	0.182	0.075	0.000	0.034	0.021	0.010	0.000	0.010	0.000	0.029	2.821	1.218	0.609	0.361	8.26		
1986	0.000	0.392	0.401	0.657	0.342	0.073	0.041	0.000	0.011	0.034	0.000	0.000	0.000	0.000	0.000	1.950	1.157	0.501	0.159	4.72		
1987	0.128	0.578	1.380	0.592	0.243	0.075	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.996	0.910	0.318	0.075	3.39		
1988	0.000	1.938	2.313	0.990	0.443	0.099	0.065	0.033	0.011	0.011	0.000	0.000	0.000	0.000	0.000	5.903	1.652	0.662	0.219	6.62		
1989	0.000	0.150	2.407	1.502	0.293	0.161	0.033	0.000	0.000	0.000	0.009	0.000	0.000	0.000	0.000	4.553	1.997	0.495	0.202	4.54		
1990	0.006	0.045	0.187	1.829	0.598	0.259	0.052	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.986	2.748	0.919	0.321	4.91		
1991	0.009	0.144	0.139	0.223	0.633	0.081	0.000	0.023	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.252	0.960	0.737	0.104	2.78		
1992	0.059	0.291	0.446	0.140	0.036	0.350	0.104	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.433	0.638	0.498	0.462	2.45		
1993	0.043	0.198	0.568	0.360	0.034	0.000	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.132	1.024	0.064	0.030	1.00		
1994	0.032	0.207	0.883	0.826	0.085	0.051	0.000	0.045	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.130	1.008	0.182	0.096	2.74		
1995	0.008	0.068	0.285	1.228	0.325	0.082	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.008	1.647	0.419	0.093	3.67		
1996	0.029	0.124	0.383	0.188	0.542	0.062	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.327	0.792	0.604	0.062	2.35		
1997	0.000	0.297	0.086	0.177	0.173	0.140	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.843	0.376	0.262	0.069	1.50		
1998	0.050	0.097	0.320	0.115	0.192	0.039	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.807	0.984	0.398	0.155	3.51		
1999	0.025	0.431	0.367	0.586	0.243	0.132	0.016	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.604	1.079	0.686	0.178	4.65		
2000	0.008	0.533	0.984	0.394	0.507	0.134	0.010	0.000	0.011	0.023	0.000	0.000	0.000	0.000	0.000	1.980	1.788	1.035	0.566	7.33		
2001	0.018	0.034	0.141	0.752	0.469	0.337	0.122	0.084	0.000	0.023	0.000	0.000	0.000	0.000	0.000	5.328	4.979	4.615	1.818	24.66		
2002	0.000	0.269	0.081	0.364	2.797	1.096	0.627	0.051	0.043	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.000	0.000	0.622	5.99		
2003	0.542	0.455	0.198	0.185	0.529	0.450	0.073	0.077	0.000	0.011	0.000	0.000	0.000	0.000	0.000	0.000	1.335	1.150	0.522	4.90		
2004	1.380	0.651	0.168	0.581	0.231	0.253	0.168	0.068	0.011	0.010	0.011	0.000	0.000	0.000	0.000	3.533	1.334	0.753	0.522	4.90		

[a] Indices from 1970-2001 have been recalculated and may differ slightly from those reported previously (Mayo et al. 2002) due to slight modifications to the age-length keys and a better accounting of vessel effects in 1979.

[b] Autumn catch per tow at age indices for 1963-1969 were obtained by applying combined 1970-1981 age-length keys to stratified mean catch per tow at length distributions from each survey. Calculations were carried out only to age 10+.

[c] During 1963-1984, BMV oval doors were used in the spring and autumn surveys; since 1985, Portuguese polyvalent doors have been used in both surveys. Adjustments have been made to the 1963-1984 catch per tow data to standardize these data to polyvalent door equivalents. Conversion coefficients of 1.56 (numbers) and 1.62 (weight) were used in this standardization (NEFSC 1991).

[d] In the Gulf of Maine, autumn surveys during 1977-1978, 1980, 1989-1991 and 1993 were conducted aboard R/V DELAWARE II; in all other years, the surveys were conducted aboard R/V ALBATROSS IV except in 1979 when both vessels were deployed on portions of the survey. Adjustments have been made to the R/V DELAWARE II catch per tow data to standardize these to R/V ALBATROSS IV equivalents. Conversion coefficients of 0.79 (numbers) and 0.67 (weight) were used in this standardization (NEFSC 1991).

Table F9 Stratified mean catch per tow in numbers and weight (kg) of Atlantic cod in State of Massachusetts inshore spring and autumn bottom trawl surveys in territorial waters adjacent to the Gulf of Maine (Mass. Regions 4-5), 1978 - 2005. [a]

Year	Age Group											Totals				Stratified Mean Weight/tow (kg)
	0	1	2	3	4	5	6	7	8	9	10+	0+	1+	2+	3+	
Spring																
1978	21.965	12.784	4.162	4.572	0.872	1.028	0.000	0.000	0.023	0.000	0.000	45.406	23.441	10.657	6.495	12.16
1979	56.393	36.630	2.581	1.533	4.659	1.995	0.183	0.000	0.000	0.000	0.069	104.043	47.650	11.020	8.439	20.53
1980	8.156	50.311	12.679	0.971	0.745	0.737	0.080	0.214	0.000	0.025	0.000	73.918	65.762	15.451	2.772	17.71
1981	19.753	24.794	23.884	3.122	1.279	0.041	0.146	0.022	0.000	0.000	0.000	73.063	53.310	28.516	4.632	21.79
1982	1.489	16.235	7.060	3.418	1.147	0.232	0.011	0.057	0.045	0.000	0.000	29.694	28.205	11.970	4.910	13.42
1983	0.453	27.703	18.572	5.331	0.501	1.221	0.142	0.022	0.000	0.000	0.000	53.945	53.492	25.789	7.217	19.77
1984	0.206	2.896	5.408	2.271	0.865	0.138	0.162	0.000	0.000	0.000	0.000	11.946	11.740	8.844	3.436	8.63
1985	0.793	2.711	3.822	2.794	0.692	0.000	0.000	0.000	0.000	0.000	0.000	10.812	10.019	7.308	3.486	6.42
1986	0.957	19.960	3.222	0.887	0.426	0.090	0.019	0.000	0.000	0.000	0.000	25.561	24.604	4.644	1.422	7.77
1987	0.659	8.590	6.997	2.268	0.257	0.147	0.048	0.000	0.000	0.087	0.000	19.053	18.394	9.804	2.807	9.59
1988	1.595	11.841	11.356	2.511	1.370	0.000	0.039	0.000	0.000	0.000	0.000	28.712	27.117	15.276	3.920	9.66
1989	0.157	20.679	25.260	6.580	0.458	0.106	0.124	0.000	0.000	0.000	0.000	53.364	53.207	32.528	7.268	18.26
1990	4.10	6.33	6.89	17.77	2.64	0.18	0.05	0.02	0.000	0.000	0.000	37.980	33.88	27.55	20.66	19.51
1991	0.32	5.88	3.56	2.54	5.03	0.36	0.000	0.000	0.000	0.000	0.000	17.69	17.37	11.49	7.93	11.37
1992	1.36	6.42	6.35	3.58	0.65	1.37	0.12	0.04	0.00	0.00	0.00	19.88	18.53	12.11	5.76	10.10
1993	69.03	3.40	7.76	3.60	1.45	0.30	0.00	0.00	0.00	0.00	0.00	85.59	16.56	13.16	5.40	7.63
1994	3.90	4.45	5.67	2.46	0.52	0.23	0.03	0.06	0.00	0.03	0.00	17.35	13.45	9.00	3.33	4.83
1995	9.84	6.41	1.36	3.89	1.20	0.09	0.00	0.00	0.00	0.00	0.00	22.79	12.95	6.54	5.18	4.49
1996	6.39	1.37	0.65	1.15	2.00	0.38	0.00	0.00	0.00	0.00	0.00	11.96	5.57	4.20	3.55	4.06
1997	10.40	3.66	1.25	1.05	0.22	0.50	0.03	0.00	0.00	0.00	0.00	17.09	6.69	3.03	1.78	2.97
1998	20.72	3.15	1.80	0.99	1.06	0.08	0.46	0.04	0.00	0.46	0.00	28.30	7.58	4.33	2.63	5.76
1999	116.22	14.36	3.57	3.46	1.20	1.08	0.06	0.22	0.04	0.00	0.00	140.08	23.84	9.48	5.91	14.19
2000	1.83	27.99	7.12	2.85	2.60	0.78	0.77	0.06	0.13	0.00	0.00	44.16	42.33	14.34	7.22	22.36
2001	19.00	0.08	7.78	4.81	3.63	1.86	0.41	0.16	0.00	0.00	0.00	32.74	13.74	13.66	10.88	22.33
2002	0.82	16.71	0.441	1.642	2.379	0.879	0.615	0.37	0.286	0.178	0.286	24.11	23.29	6.58	6.14	19.51
2003	801.27	6.2477	9.338	0.366	1.714	1.638	0.365	0.20	0.018	0.000	0.000	821.16	19.89	13.64	4.30	12.32
2004	100.62	12.177	2.049	3.350	0.608	1.310	0.891	0.056	0.097	0.067	0.000	121.22	20.60	8.42	6.37	12.18
2005	145.59	3.236	9.363	0.675	2.575	0.230	1.313	0.474	0.077	0.000	0.000	163.53	17.94	14.70	5.34	13.05
Autumn																
1978	151.533	2.082	0.000	0.120	0.140	0.318	0.000	0.080	0.000	0.000	0.000	154.273	2.740	0.658	0.658	3.02
1979	4.933	3.430	0.042	0.000	0.026	0.000	0.000	0.000	0.000	0.000	0.000	8.431	3.498	0.668	0.026	0.99
1980	5.680	8.834	0.052	0.000	0.000	0.050	0.000	0.000	0.000	0.000	0.000	14.616	8.936	0.102	0.050	1.57
1981	2.018	5.652	7.290	0.729	0.000	0.000	0.000	0.000	0.000	0.000	0.000	15.689	13.671	8.019	0.729	6.65
1982	4.667	2.346	1.005	0.060	0.050	0.000	0.000	0.000	0.000	0.000	0.000	8.128	3.461	1.115	0.110	1.35
1983	1.308	0.651	0.100	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.072	0.764	0.113	0.013	0.18
1984	12.296	0.344	0.022	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	12.675	0.379	0.035	0.013	0.18
1985	2.832	0.419	0.018	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.279	0.447	0.028	0.010	0.09
1986	2.478	1.150	0.833	0.000	0.067	0.000	0.000	0.000	0.000	0.000	0.000	4.528	2.050	0.900	0.067	0.55
1987	389.584	2.386	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	391.990	2.406	0.020	0.000	0.45
1988	4.571	20.490	0.679	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	25.740	21.169	0.679	0.000	1.57
1989	2.971	2.700	0.350	0.210	0.185	0.000	0.000	0.000	0.000	0.000	0.000	6.416	3.445	0.745	0.395	1.27
1990	9.37	9.13	1.74	0.31	0.06	0.03	0.000	0.000	0.000	0.000	0.000	20.638	11.27	2.14	0.40	1.56
1991	4.65	4.20	0.81	0.03	0.05	0.01	0.00	0.00	0.00	0.00	0.00	9.74	5.09	0.89	0.08	0.42
1992	24.30	2.01	0.11	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	26.48	2.18	0.17	0.06	0.42
1993	49.92	3.32	0.61	0.33	0.00	0.01	0.00	0.00	0.00	0.00	0.00	54.21	4.29	0.97	0.36	1.97
1994	33.49	14.13	6.37	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54.26	20.77	6.64	0.27	4.47
1995	2.56	0.64	0.54	0.79	0.02	0.00	0.00	0.00	0.00	0.00	0.00	4.55	1.99	1.35	0.81	0.74
1996	7.59	0.15	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	7.78	0.19	0.04	0.03	0.09
1997	2.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.04	0.02	0.00	0.00	0.00
1998	2.61	1.04	0.62	0.08	0.11	0.00	0.00	0.00	0.00	0.00	0.00	4.46	1.85	0.81	0.19	0.56
1999	6.34	0.98	0.28	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	7.65	1.31	0.33	0.05	0.43
2000	0.04	0.54	0.27	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.91	0.87	0.33	0.06	0.34
2001	44.52	0.06	0.30	0.15	0.09	0.09	0.00	0.00	0.00	0.01	0.00	45.22	0.70	0.64	0.34	1.00
2002	0.99	2.50	0.30	0.55	0.77	0.91	0.08	0.00	0.00	0.08	0.00	6.17	5.18	2.68	2.38	8.66
2003	112.79	3.66	0.33	0.12	0.47	0.15	0.02	0.00	0.00	0.00	0.00	117.54	4.75	1.09	0.76	3.13
2004	39.22	14.38	1.50	2.03	0.33	0.77	0.38	0.01	0.00	0.00	0.00	58.62	19.40	5.02	3.52	8.77

[a] Massachusetts sampling strata 25-36.

Table F10. Comparative Results from ADAPT/VPA runs incorporating data and software updates since the 2002 GARM.

	GARM/FACT	GARM/NFT	NewAges/NFT ¹	Rev. MRFSS/NFT ¹	Rev. Indices/NFT	All Rev/NFT ¹
Terminal Year	2001	2001	2001	2001	2001	2001
RSS	139.865	140.169	139.992	140.117	139.346	139.219
N t+1 age 2 (cv)	463 (0.40)	463 (0.38)	463 (0.38)	466 (0.38)	523 (0.33)	526 (0.33)
N t+1 age 3 (cv)	3009 (0.26)	3007 (0.25)	3002 (0.25)	2990 (0.26)	3022 (0.25)	3004 (0.26)
N t+1 age 4 (cv)	4554 (0.25)	4551 (0.24)	4533 (0.24)	4531 (0.24)	4704 (0.24)	4685 (0.24)
N t+1 age 5 (cv)	1362 (0.28)	1211 (0.27)	1207 (0.27)	1221 (0.27)	1257 (0.26)	1267 (0.26)
N t+1 age 6 (cv)	437 (0.36)	492 (0.35)	492 (0.35)	496 (0.35)	506 (0.34)	510 (0.34)
F age 1	0	0	0	0	0	0
F age 2	0.02	0.0167	0.0179	0.0348	0.0178	0.0358
F age 3	0.18	0.1814	0.1811	0.1937	0.1752	0.1872
F age 4	0.37	0.4039	0.4039	0.3906	0.3906	0.3779
F age 5	0.57	0.519	0.5227	0.518	0.5109	0.51
F age 6	0.47	0.4614	0.4663	0.4543	0.4507	0.4439
F (ages 4-5)	0.47		0.46	0.46	0.45	0.44
SSB (mt)	22,040	21,937	24,328	24,228	25,003	24,801

1. Revised mean weights at age in 2000 and 2001

Table F11. Final VPA Results for Gulf of Maine Cod, 1982-2005

JAN-1 Population Numbers (000's)

AGE	1982	1983	1984	1985	1986
1	7769.	7539.	10464.	7004.	10162.
2	10891.	6281.	6160.	8545.	5690.
3	5359.	7112.	3933.	4307.	6101.
4	3026.	2262.	3202.	1797.	1616.
5	1796.	1223.	780.	1142.	456.
6	170.	822.	382.	214.	333.
7	548.	310.	264.	221.	321.
=====					
Total	29559.	25548.	25185.	23231.	24680.
AGE	1987	1988	1989	1990	1991
1	12538.	25205.	4301.	4031.	7056.
2	8296.	10228.	20630.	3517.	3294.
3	4471.	5972.	7904.	16411.	2613.
4	2507.	2377.	2953.	4404.	9640.
5	483.	673.	907.	881.	1459.
6	125.	97.	158.	303.	280.
7	153.	64.	106.	191.	158.
=====					
Total	28573.	44616.	36958.	29738.	24500.
AGE	1992	1993	1994	1995	1996
1	6658.	9625.	3516.	3688.	3507.
2	5773.	5451.	7879.	2878.	3020.
3	2292.	4410.	4325.	6407.	2096.
4	919.	1334.	1802.	2195.	4130.
5	3416.	276.	380.	337.	577.
6	338.	820.	100.	22.	90.
7	135.	67.	119.	54.	20.
=====					
Total	19530.	21982.	18121.	15581.	13439.
AGE	1997	1998	1999	2000	2001
1	5919.	5106.	7826.	4404.	1050.
2	2871.	4846.	4180.	6406.	3606.
3	2392.	2295.	3866.	3408.	5070.
4	1068.	1508.	1422.	2641.	2302.
5	1612.	450.	667.	667.	1388.
6	140.	512.	204.	302.	367.
7	16.	26.	275.	72.	302.
=====					
Total	14018.	14744.	18441.	17900.	14084.
AGE	2002	2003	2004	2005	
1	7062.	3067.	22082.	6316.	
2	860.	5782.	2511.	18079.	
3	2843.	702.	4721.	2055.	
4	3187.	2078.	474.	3591.	
5	1303.	1828.	1312.	167.	
6	797.	764.	786.	711.	
7	503.	602.	358.	499.	
=====					
Total	16554.	14824.	32244.	31417.	

Table 11 (continued).

Fishing Mortality Calculated

AGE	1982	1983	1984	1985	1986
1	0.0126	0.0021	0.0025	0.0078	0.0028
2	0.2262	0.2682	0.1577	0.1369	0.0412
3	0.6628	0.5979	0.5830	0.7801	0.6894
4	0.7057	0.8642	0.8315	1.1709	1.0083
5	0.5819	0.9646	1.0915	1.0322	1.0968
6	0.6578	0.8983	0.8774	1.1147	1.0271
7	0.6578	0.8983	0.8774	1.1147	1.0271
Avg (4-5)	0.6438	0.9144	0.9615	1.1015	1.0525
AGE	1987	1988	1989	1990	1991
1	0.0036	0.0003	0.0013	0.0019	0.0008
2	0.1288	0.0578	0.0288	0.0969	0.1625
3	0.4316	0.5043	0.3847	0.3320	0.8451
4	1.1156	0.7639	1.0093	0.9050	0.8376
5	1.4077	1.2483	0.8945	0.9471	1.2611
6	1.1573	0.8524	0.9812	0.9119	0.8840
7	1.1573	0.8524	0.9812	0.9119	0.8840
Avg (4-5)	1.2616	1.0061	0.9519	0.9260	1.0493
AGE	1992	1993	1994	1995	1996
1	0.0000	0.0001	0.0003	0.0000	0.0000
2	0.0694	0.0313	0.0069	0.1168	0.0331
3	0.3415	0.6947	0.4784	0.2391	0.4740
4	1.0012	1.0559	1.4756	1.1357	0.7406
5	1.2263	0.8202	2.6326	1.1231	1.2196
6	1.1742	1.0113	1.6026	1.1340	0.7884
7	1.1742	1.0113	1.6026	1.1340	0.7884
Avg (4-5)	1.1138	0.9381	2.0541	1.1294	0.9801
AGE	1997	1998	1999	2000	2001
1	0.0000	0.0000	0.0001	0.0000	0.0000
2	0.0238	0.0259	0.0042	0.0340	0.0378
3	0.2615	0.2786	0.1813	0.1925	0.2642
4	0.6638	0.6156	0.5575	0.4435	0.3692
5	0.9472	0.5916	0.5932	0.3977	0.3548
6	0.8245	0.6100	0.5687	0.4341	0.3638
7	0.8245	0.6100	0.5687	0.4341	0.3638
Avg (4-5)	0.8055	0.6036	0.5753	0.4206	0.3620
AGE	2002	2003	2004		
1	0.0000	0.0000	0.0000		
2	0.0026	0.0027	0.0004		
3	0.1135	0.1921	0.0736		
4	0.3556	0.2597	0.8459		
5	0.3332	0.6445	0.4134		
6	0.3491	0.4217	0.6297		
7	0.3491	0.4217	0.6297		
Avg (4-5)	0.3444	0.4521	0.6297		

Table 11 (continued).

JAN-1 Biomass (mt)

AGE	1982	1983	1984	1985	1986
1	3226.	2109.	3666.	1539.	2780.
2	9607.	4880.	4052.	6096.	3488.
3	6870.	9369.	5165.	5509.	8257.
4	6868.	4455.	6673.	3819.	3495.
5	7541.	3880.	2328.	3935.	1624.
6	948.	4381.	1782.	956.	1715.
7	6200.	3082.	2722.	2140.	3761.
Total	41259.	32155.	26390.	23994.	25120.
AGE	1987	1988	1989	1990	1991
1	2253.	1580.	1982.	205.	510.
2	5426.	5722.	9178.	2747.	1326.
3	5616.	7963.	10289.	22982.	3245.
4	5936.	4554.	6706.	8718.	19476.
5	1785.	2676.	2740.	3089.	4421.
6	700.	528.	734.	1637.	1541.
7	1576.	688.	1261.	2587.	1749.
Total	23292.	23711.	32891.	41966.	32269.
AGE	1992	1993	1994	1995	1996
1	1527.	1964.	673.	700.	649.
2	3195.	3624.	5885.	2291.	2425.
3	3378.	7375.	6234.	10372.	3848.
4	1867.	2870.	4259.	4842.	8537.
5	9383.	940.	1074.	1323.	1779.
6	1518.	3540.	506.	109.	549.
7	1427.	730.	1173.	726.	213.
Total	22294.	21043.	19804.	20362.	18000.
AGE	1997	1998	1999	2000	2001
1	1244.	2315.	1301.	800.	220.
2	2363.	3515.	3602.	4612.	3026.
3	4563.	4388.	6046.	5586.	9656.
4	2648.	3825.	3418.	6589.	6240.
5	4360.	1571.	2321.	2313.	5651.
6	564.	1836.	993.	1465.	1958.
7	136.	251.	2117.	500.	2384.
Total	15877.	17701.	19798.	21865.	29135.
AGE	2002	2003	2004	2005	
1	1228.	606.	4361.	1197.	
2	626.	5068.	1938.	14324.	
3	5923.	1271.	10273.	4158.	
4	9033.	5652.	1345.	10043.	
5	4732.	6710.	4487.	596.	
6	4253.	3549.	3676.	3472.	
7	4228.	5223.	3128.	4295.	
Total	30024.	28078.	29208.	38085.	

Table 11 (Continued).

Spawning Stock Biomass (mt)

AGE	1982	1983	1984	1985	1986
1	218.	143.	248.	59.	108.
2	2327.	1174.	993.	2766.	1608.
3	3629.	5004.	2765.	4444.	6763.
4	5197.	3283.	4945.	3039.	2858.
5	6421.	3099.	1821.	3204.	1308.
6	822.	3648.	1489.	768.	1397.
7	5374.	2566.	2275.	1719.	3065.
Total	23987.	18916.	14536.	16000.	17107.
AGE	1987	1988	1989	1990	1991
1	87.	61.	77.	22.	54.
2	2465.	2631.	4241.	732.	350.
3	4802.	6727.	8867.	11778.	1527.
4	4767.	3878.	5481.	5874.	13270.
5	1365.	2102.	2283.	2373.	3223.
6	559.	443.	602.	1333.	1261.
7	1257.	578.	1036.	2150.	1460.
Total	15302.	16419.	22587.	24261.	21144.
AGE	1992	1993	1994	1995	1996
1	162.	209.	26.	27.	25.
2	855.	976.	2160.	826.	886.
3	1728.	3558.	4955.	8579.	3061.
4	1238.	1886.	3189.	3836.	7225.
5	6880.	737.	670.	1061.	1404.
6	1183.	2835.	375.	87.	465.
7	1135.	597.	869.	581.	180.
Total	13182.	10798.	12244.	14998.	13247.
AGE	1997	1998	1999	2000	2001
1	48.	90.	50.	31.	8.
2	865.	1287.	1323.	1685.	1105.
3	3760.	3606.	5050.	4656.	7954.
4	2270.	3306.	2983.	5859.	5619.
5	3601.	1377.	2033.	2094.	5152.
6	475.	1604.	873.	1318.	1782.
7	114.	219.	1862.	450.	2170.
Total	11134.	11487.	14174.	16094.	23791.
AGE	2002	2003	2004		
1	173.	86.	616.		
2	223.	1803.	690.		
3	3738.	792.	6527.		
4	7172.	4559.	984.		
5	4330.	5828.	4051.		
6	3881.	3200.	3201.		
7	3858.	4709.	2724.		
Total	23375.	20977.	18793.		

Gulf of Maine Cod Total Commercial Landings

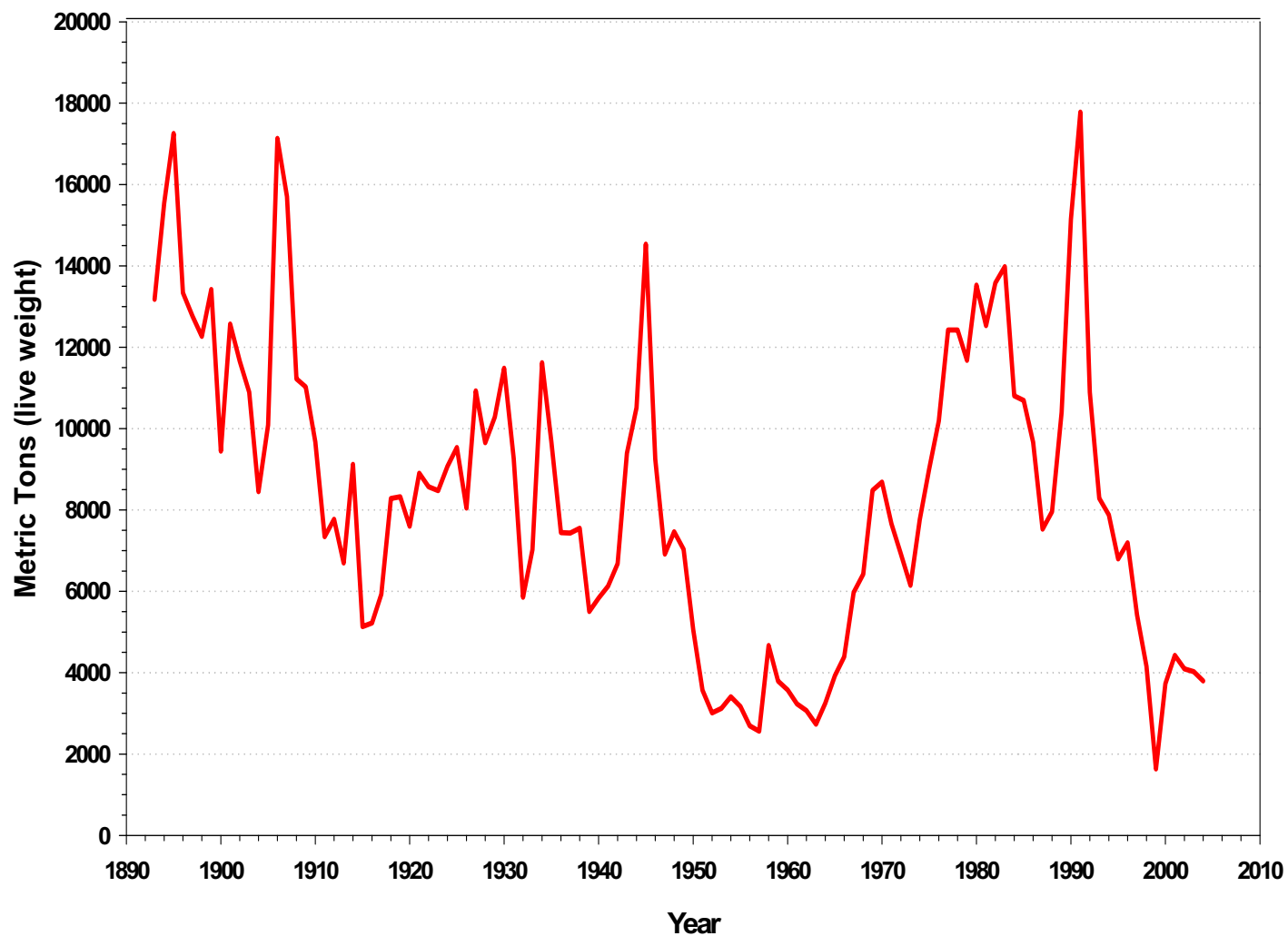


Figure F1. Total commercial landings of Gulf of Maine cod (NAFO Div. 5Y), 1893-2004.

Gulf of Maine Cod NEFSC Spring and Autumn Biomass Indices

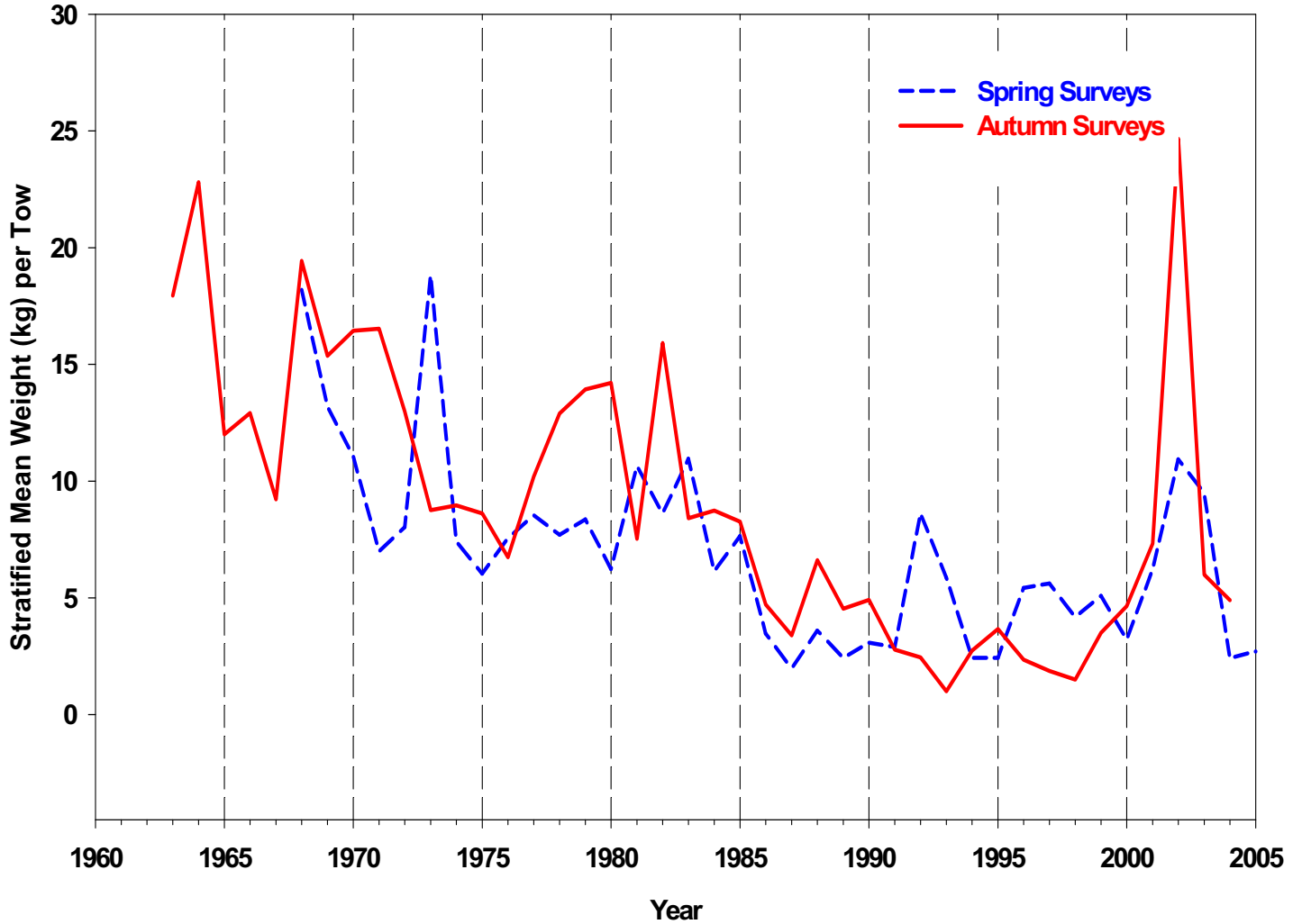
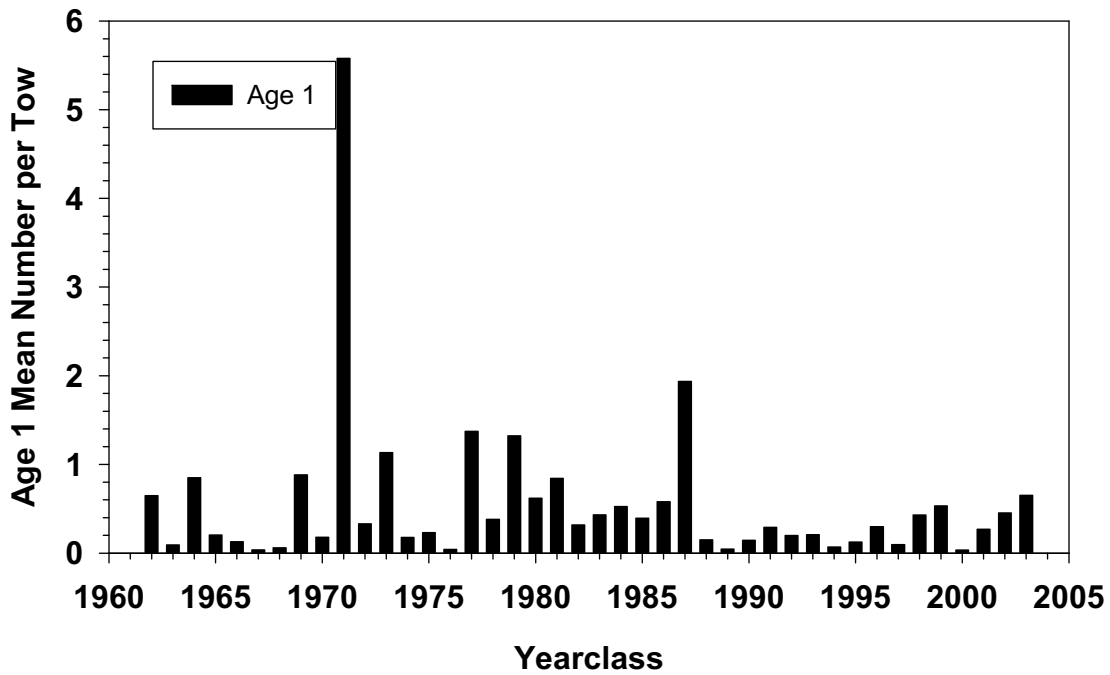


Figure F2. Biomass indices (stratified mean weight per tow) for Gulf of Maine cod from NEFSC autumn bottom trawl surveys.

NEFSC Autumn Survey: Yearclass Strength at Age 1



NEFSC Autumn Survey: Yearclass Strength at Age 2

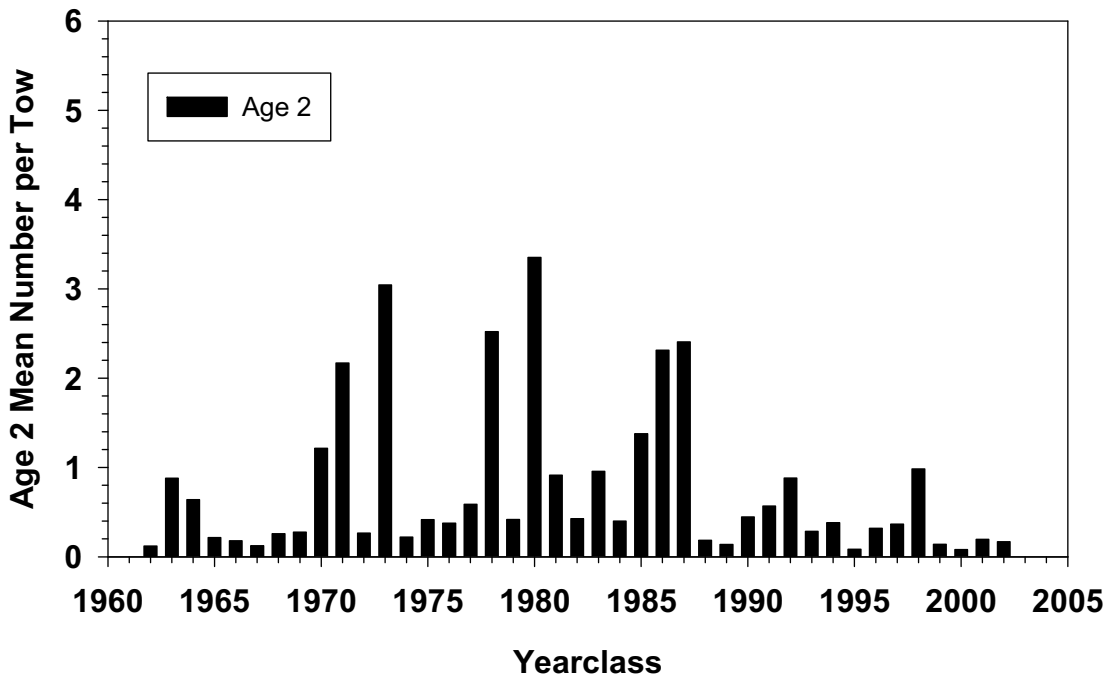
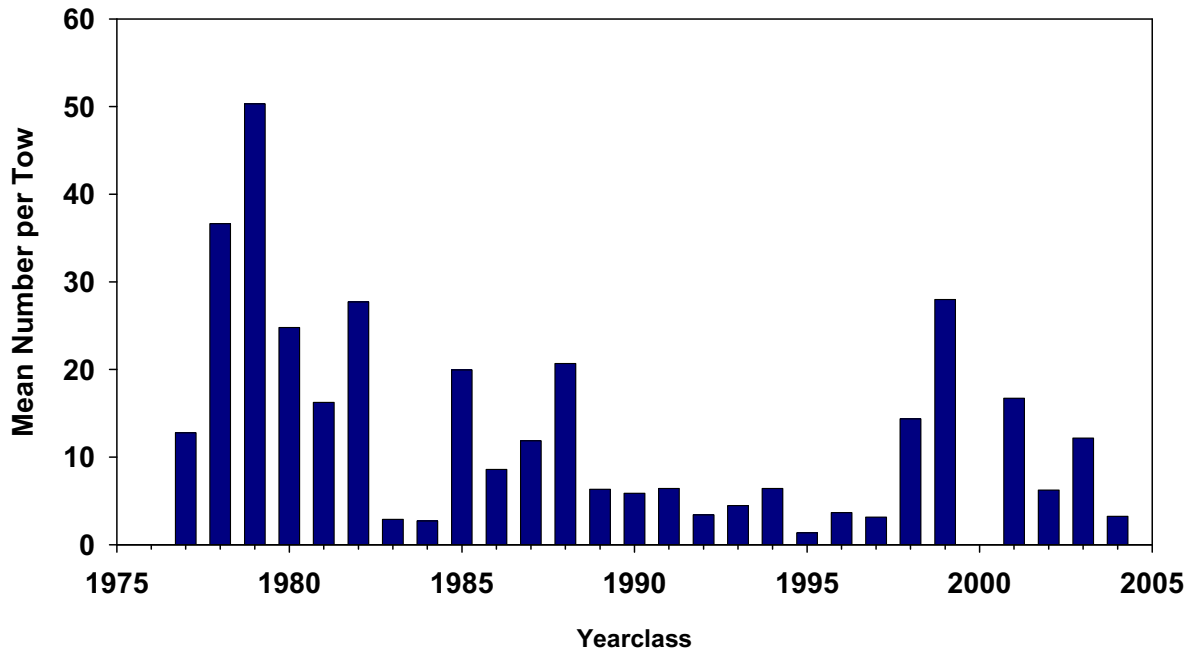


Figure F3. Recruitment indices at age 1 and 2 for Gulf of Maine cod from NEFSC autumn bottom trawl surveys.

Mass Spring Survey: Yearclass Strength at Age 1



Mass Spring Survey: Yearclass Strength at Age 2

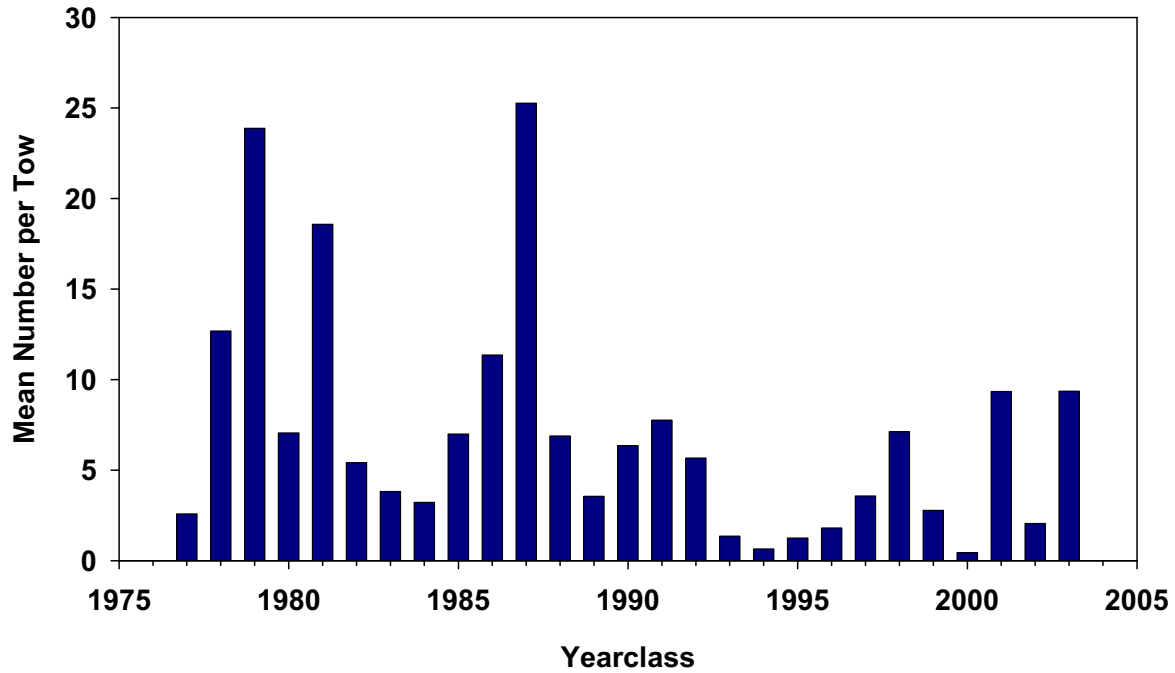
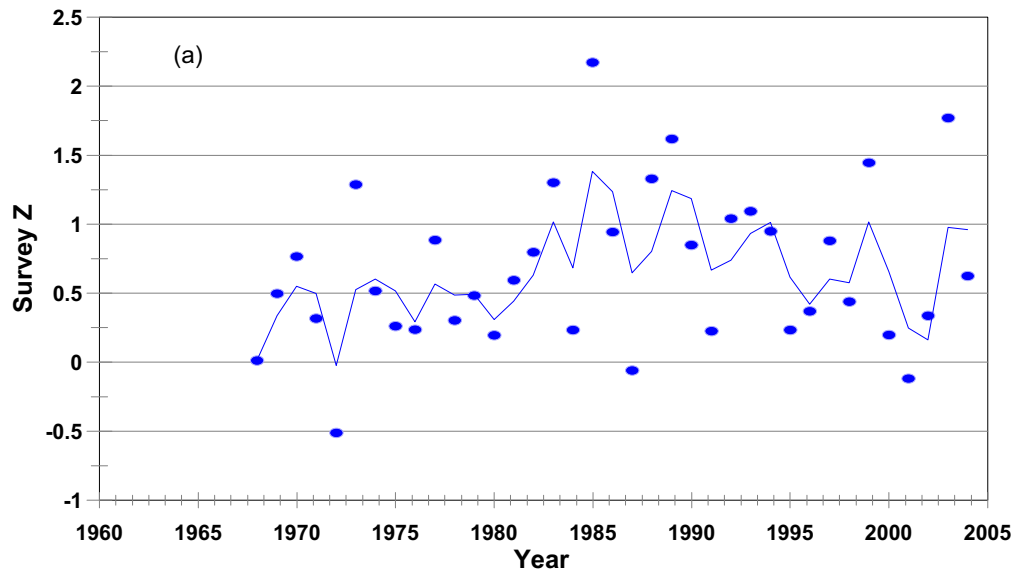


Figure F4. Recruitment indices at age 1 and 2 for Gulf of Maine cod from MA DMF autumn bottom trawl surveys.

Gulf of Maine Cod Surveys Zs - Spring



Gulf of Maine Cod Surveys Zs - Autumn

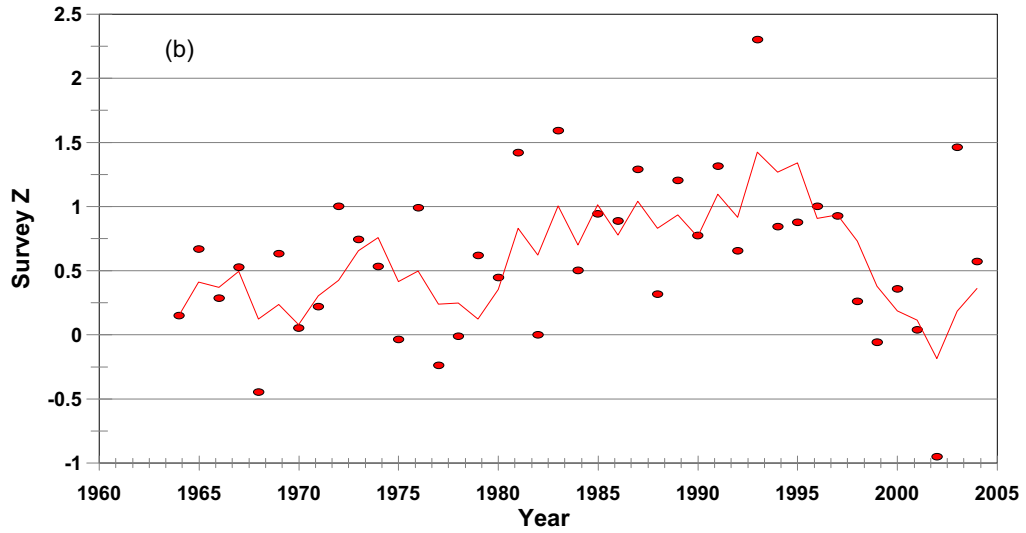


Figure F5. Annual estimates of total instantaneous mortality (Z) for Gulf of Maine cod (points) and 3-year running average (line) from (a) NEFSC spring and (b) NEFSC autumn bottom trawl surveys.

Gulf of Maine Cod Calculated VPA Residuals

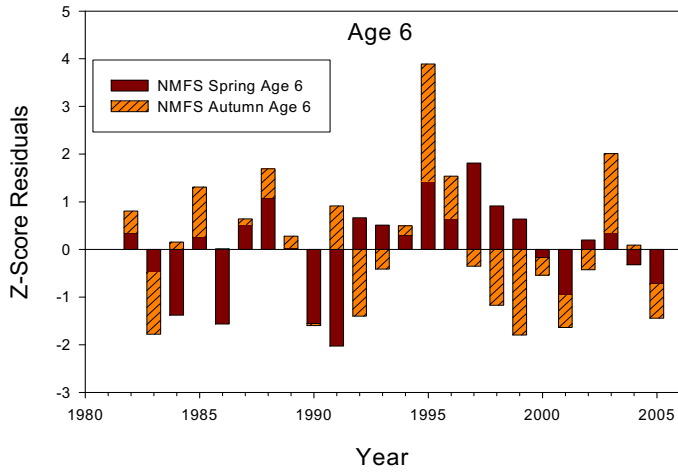
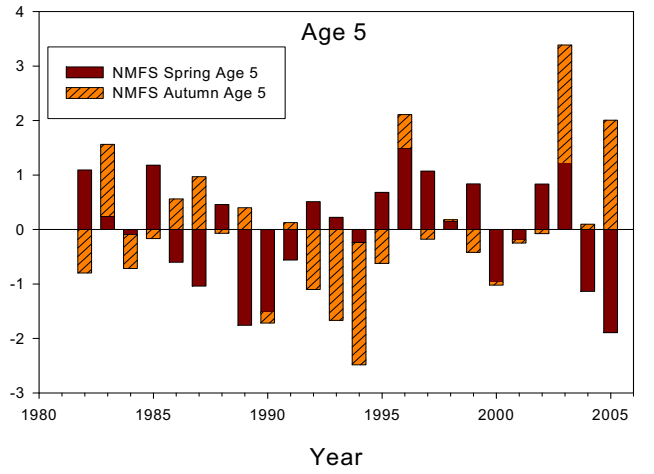
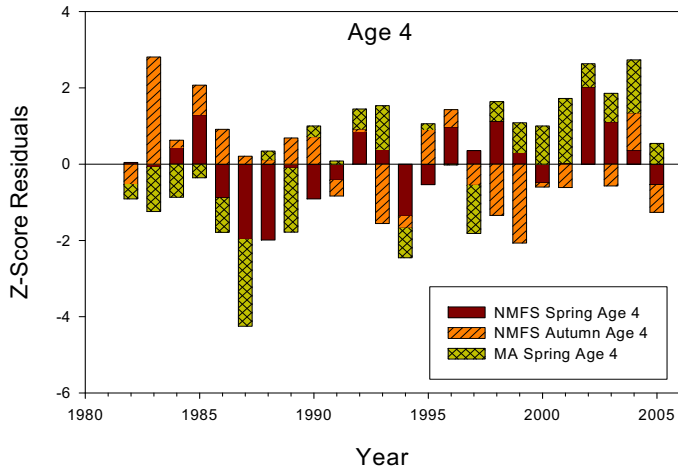
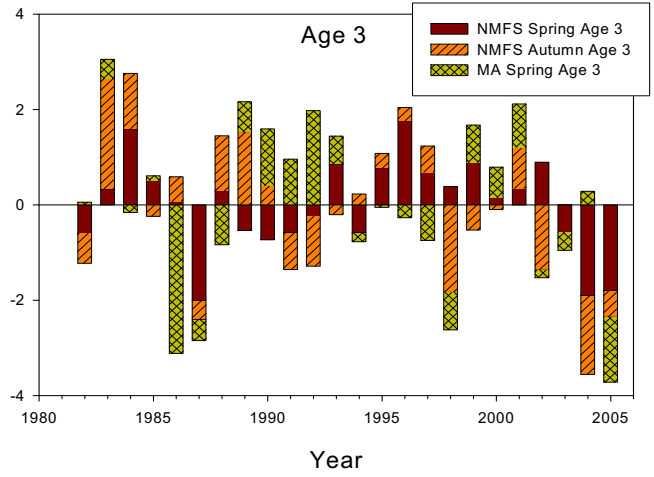
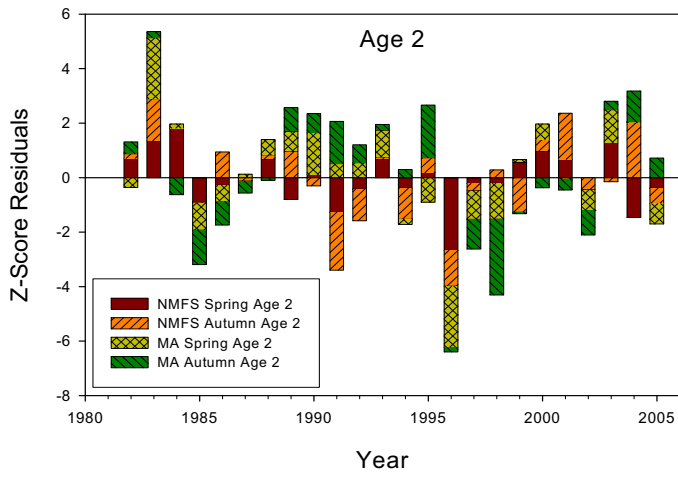


Figure F6. Residual Plots for Gulf of Maine Cod VPA.

Gulf of Maine Cod Trends in Landings and Fishing Mortality

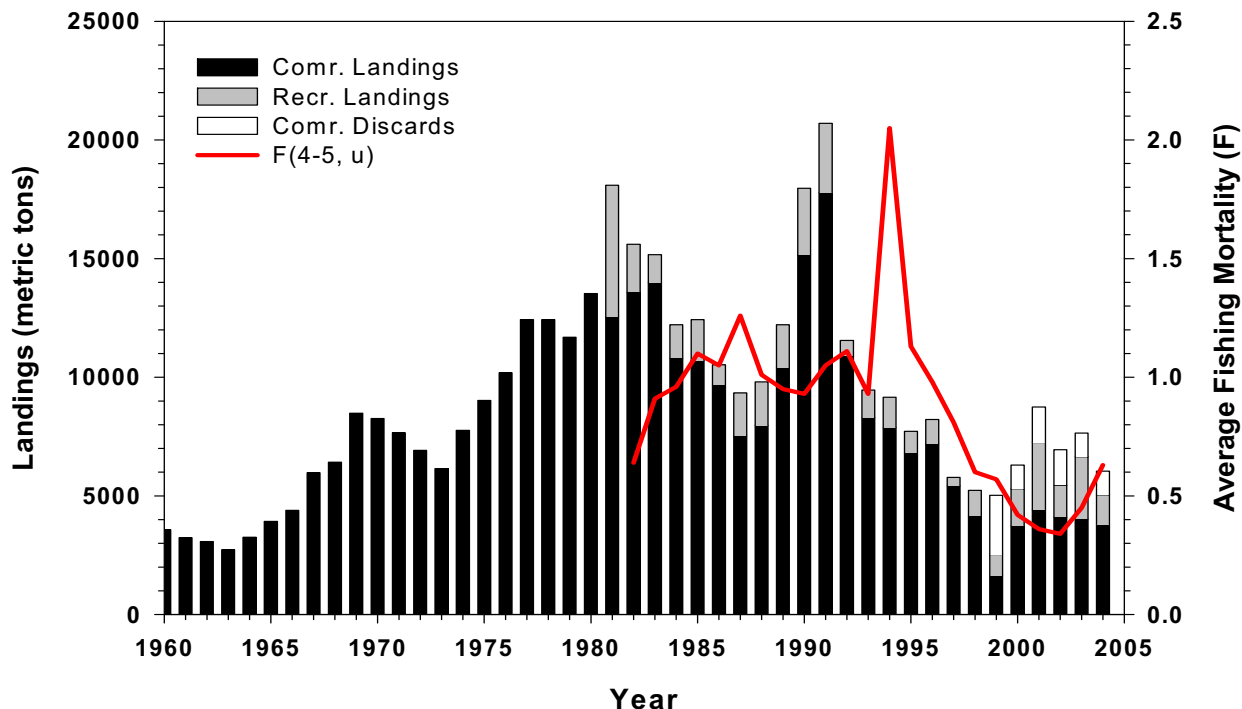


Figure F7. Trends in landings and fishing mortality for Gulf of Maine cod.

Gulf of Maine Cod Trends in Recruitment and Biomass

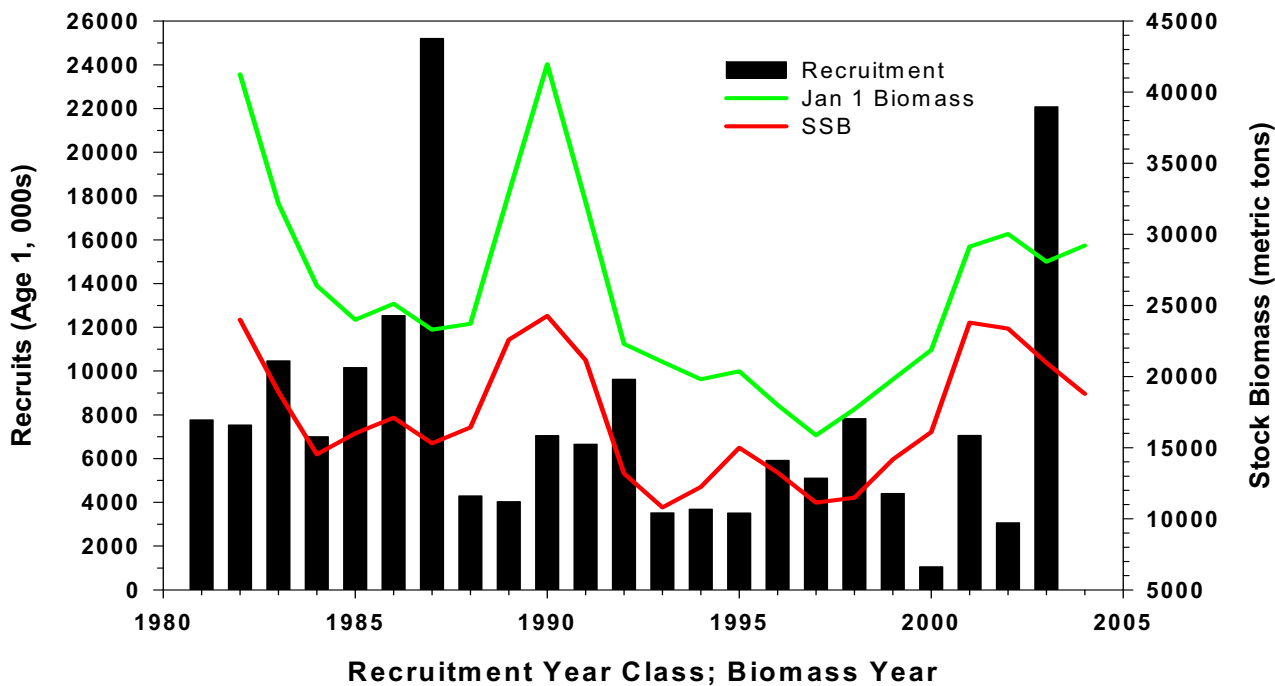
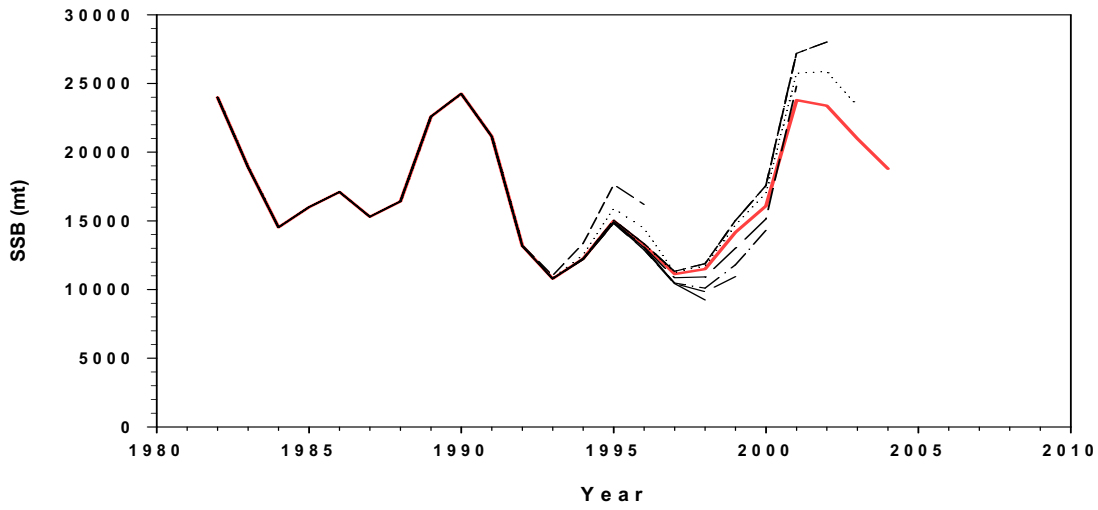


Figure F8. Trends in recruitment (age 1) and biomass for Gulf of Maine cod.

Fully Recruited Fishing Mortality



Spawning Stock Biomass



Age 2 Recruits

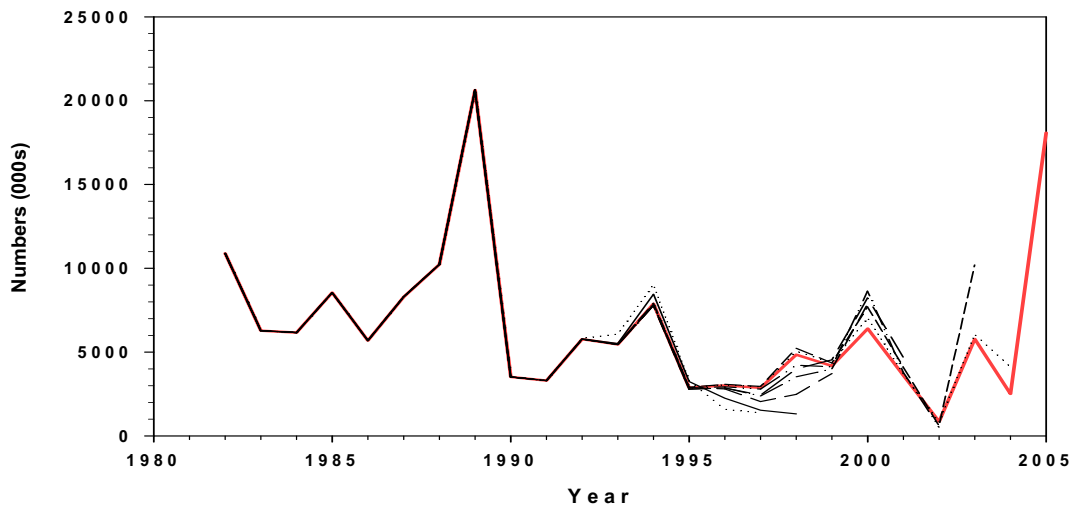
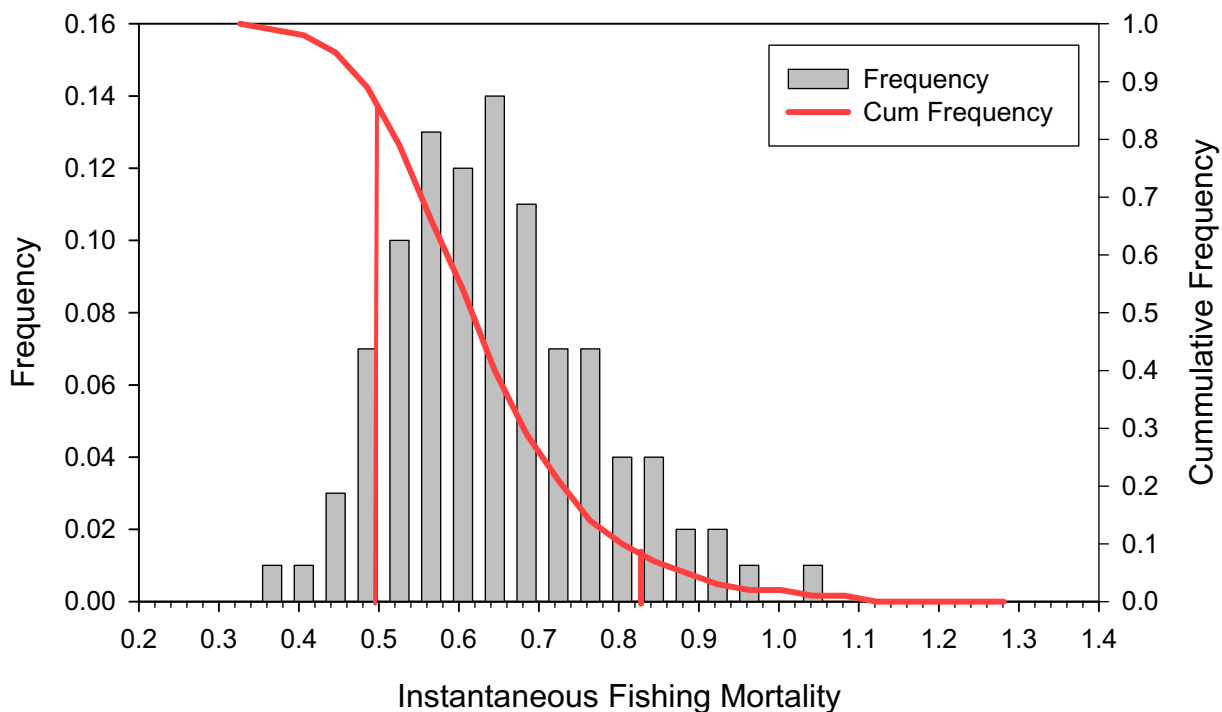


Figure F9. Retrospective analyses for Gulf of Maine Cod.

2004 Fully Recruited Fishing Mortality



2004 Spawning Stock Biomass

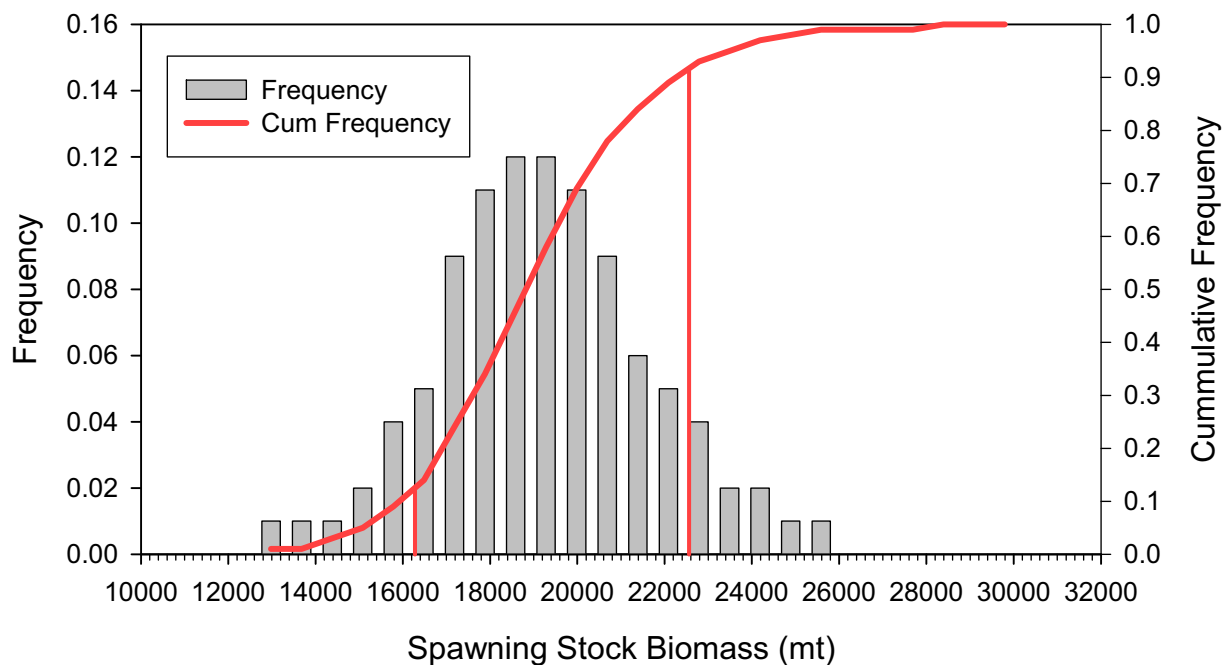
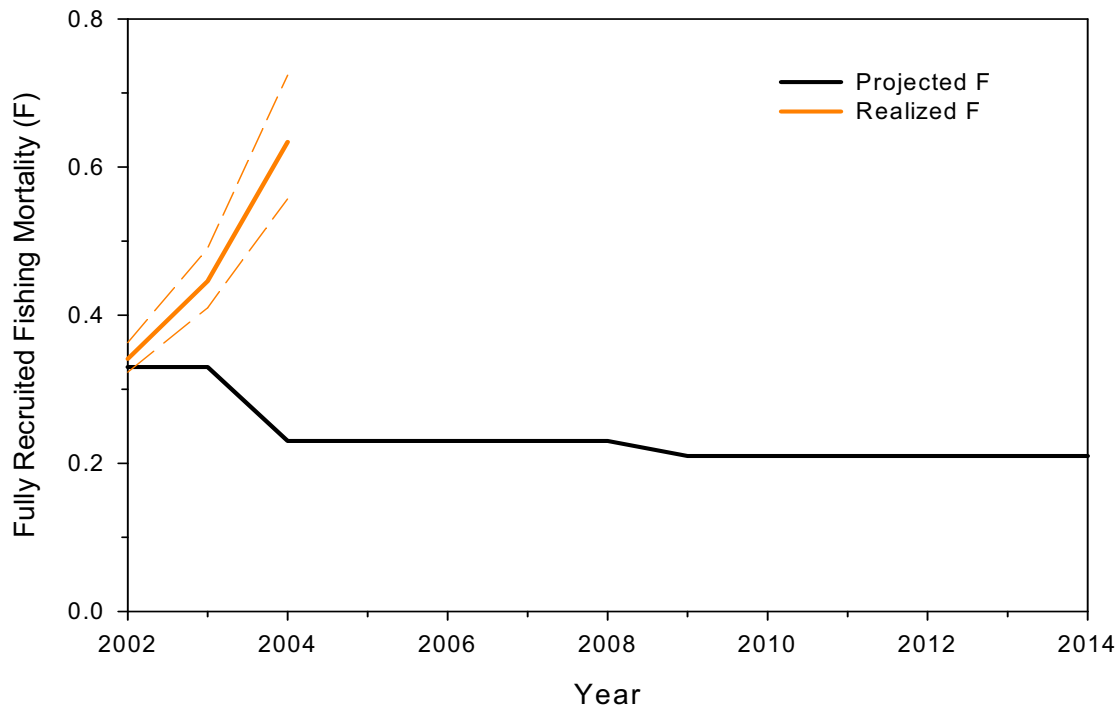


Figure F10. 2004 F and SSB bootstrap results for Gulf of Maine cod.

Gulf of Maine Cod Rebuilding Projections



Gulf of Maine Cod Rebuilding Projections

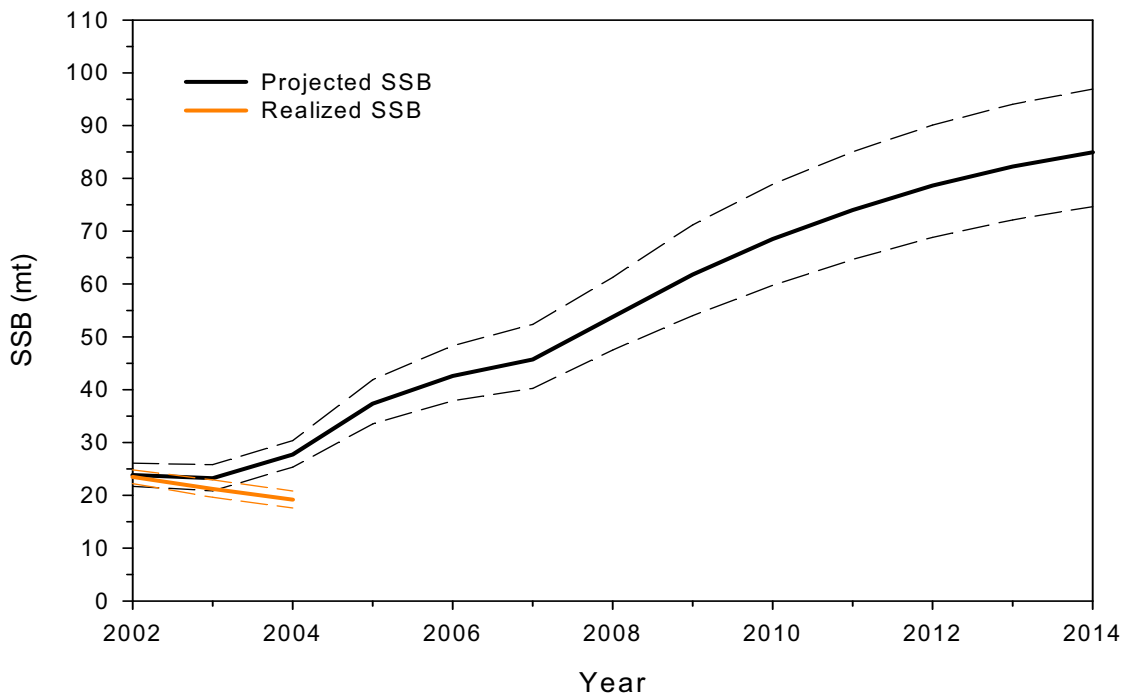


Figure F11. Comparisons between stock projections and recent and current state

Gulf of Maine Cod Rebuilding Projections

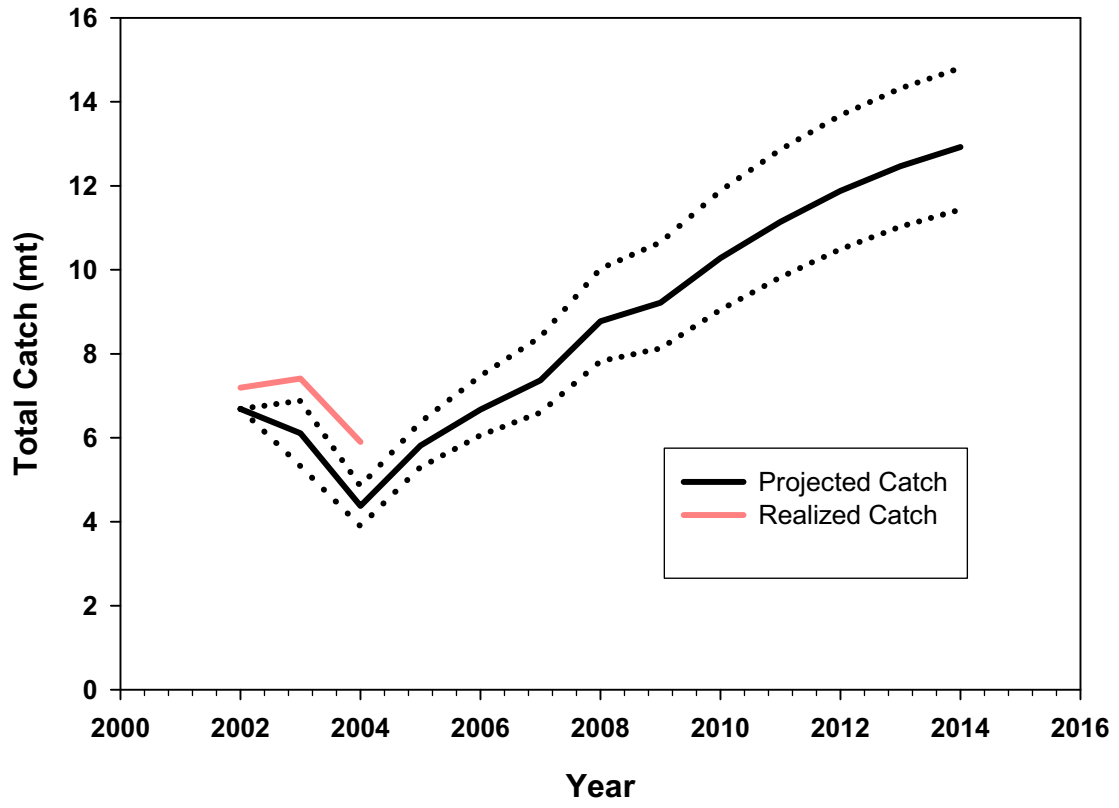


Figure F11 (Continued)