GARMIII Biological Reference Point Working Paper 4.F   (revised 4/30/08)

Gulf of Maine Cod

By

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1.0 Background

The Gulf of Maine Atlantic cod stock was last assessed in 2005 at the August 2005 Groundfish Assessment Review Meeting (GARM II) (NEFSC 2005; Mayo and Col 2006). The methodology applied in the present default assessment is the same as in the 2005, 2002 assessment and the 2001 assessment as described in Mayo *et al.* (2002).

In the 2005 assessment, fully recruited fishing mortality (ages 4+) in 2004 was estimated to be 0.58. This was a result of a very high estimate of F on age 4. Spawning stock biomass was estimated to have increased from a low point of about 11,000 mt 1997 and 1998 to about 25,000 mt in 2002 followed by a slight decline to 20,500 mt in 2004. The strength of several recent recruiting year classes (1999, 2000 and 2002) was estimated to be below average. The 2001 year class was estimated to be slightly above average and the 2003 year class appeared to be equivalent to the 1987 year class, the largest in the assessment series dating back to 1982. 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 continuing through 2004.

2.0 The Fishery

The following tables and figures provide updated information on Gulf of Maine cod commercial landings, commercial discards, recreational landings through 2006, and NEFSC and MADMF survey results through 2007.

Commercial landings: Revised landings by stock were derived for the 1994-2006 (Table F1) period using the preferred allocation scheme reviewed at the GARMIII Data Meeting, October, 2007. Length and age samples (Table F2) associated with each allocated trip were also assigned to the corresponding stock. Both approaches required that landings at age (Tables F3 and F4) be re-estimated from 1994 onward.

Commercial discards: Commercial discards (Table F5, Figure F2) were re-estimated for the 1989-2006 period using two SBRM methods (cod discard/all kept) and cod discard/cod kept). Both methods show similar trends except in 1990 and 1999. Using all kept in the denominator tends to provide a smoother overall trend in discards over time compared to using cod kept. However, in 1999, when extremely low trip limits were imposed on the fishery, the magnitude of

discards estimated by the former method remained low compared to the subsequent year when the trip limits were higher. We, therefore, elected to use the results based on using cod kept in the denominator. These discards estimates were then used to generate the discards at age from 1999 to present (Table F6).

Recreational catches: Recreational catches (Table F7) were re-estimated and partitioned by Gulf of Maine and Georges Bank stocks for the 1981-2006 period using revised MRFSS data and a revised site list (Steinbak and Thunberg, pers. comm.). The length and age composition of the numbers of kept (A+B1s) cod (Tables F8 and F9) were derived using available length measurements from the MRFSS database assigned to the Gulf of Maine area and a combination of age/length keys derived from commercial, survey (NEFSC and MADMF) and the cod industry-based survey (2004 and 2005 only).

Total catches: Estimates of the total catch at age (Table F10) and weighted estimates of mean weight (kg) and mean length (cm) at age (Table F11) were derived from the various components. Most of the revisions occurred since 1994, but some differences are noted back to 1982 because of the changes in the estimates of recreational landings at age.

Commercial landings of Gulf of Maine cod declined to 1, 370 metric tons (mt) in 1999, a 66 % decline from 1998 (Table F5; Figure F1). Commercial landings have since increased to 4,151 mt in 2001, fluctuated between 3,100 and 3,600 mt between 2000 and 2005, but declined to 2,788 mt in 2006. The revised discard estimates were derived on a gear-quarter basis from 1989 through 2006 based on NEFSC Observer Program data using SBMR methods incorporating cod discard/cod kept ratios; these results indicate a substantial increase in the overall discard /kept ratio in 1999 compared to previous years (Tables F5). Ratios calculated for years after 1999 were lower, but still remain substantially greater than the 1991-1998 ratios. Discards estimated from the Observer Program data have ranged from 97 mt in 1998 to 3,092 in 1990.

The number of commercial port samples for this stock declined from 89 in 1997 to 50 in 1998 to 10 in 1999 (Table F2). Port sampling has since improved, increasing to 74 samples in 2000 and over 300 samples in 2005 and 2006; 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. Nevertheless, the number of fish sampled increased from a low of 733 in 1999 to over 10,000 since 2003. 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. Landings from this fishery had been dominated by age 3 and 4 fish through 2001. Since then, however,, the fishery has been dominated by age 4-6 fish, and the age structure of the landings appears to have expanded compared to the late 1990s (Table F3a).

The estimated recreational catch of Gulf of Maine cod (retained component only) has varied considerably over the past decade ranging from 337 mt in 1997 to 4,218 mt in 1981 (Table F7). Recreational landings at age (Table F8a) exhibit the same age structure as the commercial landings, with ages 4 and 5 always dominant and age 6 often replacing age 3 as the next most prevalent age.

3.0 Research Vessel Surveys

NEFSC has conducted research vessel bottom trawl surveys off the northeast coast of the United States since 1963 (autumn) and 1968 (spring). The NOAA research vessels Albatross IV and Delaware II have been used exclusively during these surveys. Gear and door changes have occurred during the survey period. Vessel and door calibration coefficients have been applied to the data as described below Tables F12-14. The Commonwealth of Massachusetts has also conducted research vessel bottom trawl surveys during spring and autumn primarily in state waters in the southwest portion of the Gulf of Maine since 1978. These surveys are conducted in relatively shallow water and, as such do not provide an abundance index of the stock as a whole. However they do provide an abundance index of recruiting year classes.

Bottom trawl surveys: Results (stratified mean number and weight [kg] per tow) from bottom trawl surveys conducted by NEFSC were updated through 2007 (Tables F12-14, Figures F4-F6) and MADMF were recalculated over the entire time period beginning in 1978 (Tables F15 -F17).

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 F15; Figure F4). 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. Spring indices have increased since 2005, but the autumn indices have remained relatively low through 2007.

Recruitment indices for the 1994-1997 year classes derived from the NEFSC and Mass. DMF bottom trawl surveys are among the lowest in the respective series, although indices for the 1998 and 1999 year classes appear to be above the recent average (Figures F5 and F6). The 2000 year class appears to be the extremely weak in all surveys. More recently, there are indications in both NEFSC and MA DMF surveys that the 2003 year class may be relatively strong compared those produced over the past decade. The 2005 year class also appears to be strong especially at age 2 in the spring 2007 NEFSC survey, but the indices for all ages increased over 2006, suggesting a year effect in this survey. High indices at age 0 and 1 in the MADMF surveys also suggest improved recruitment (2003, 2005 and possibly 2006 year classes).

Maturity data collected on NEFSC spring surveys were also analyzed in order to construct a series of maturity at age moving windows over the assessment time period. This was accomplished so that a smoother transition in the maturity schedule used to determine spawning stock biomass. Annual, 3-year, and 5-year windows were examined and based on the extent of smoothing evident in the A50s, we elected to use the 3-year moving window.

4.0 Assessment

Input Data and Analyses

The present assessment represents more than a three-year update to the previous assessment (Mayo and Col 2006). As noted above, each component of the total catch at age has changed since the 2005 GARMII assessment. This required re-estimation of the landings at age from 1994 to present, the recreational catch from 1981 to present and the observer based discards since 1989.

The same VPA formulation used in the previous assessment was evaluated and continues to perform well and was again employed in the present update. Catch at age data were revised over the 1982 to present assessment time period to account for the data changes described above. NEFSC survey abundance indices (stratified mean number per tow at age) were updated through autumn 2007. Massachusetts DMF spring and autumn survey indices were recalculated over the entire period since 1978 due to slight changes in the strata boundaries that affected the stratified mean calculations. Differences were minor in most cases. The formulation in the present assessment is: catch at age from 1982-2006, estimation of age 2-6 stock sizes in terminal year+1, calibration included NEFSC spring and autumn age 2-6 indices, Massachusetts DMF spring age 2-4 and autumn age 2 indices. As in recent VPAs, commercial CPUE indices were included only through 1993.

Precision of the 2006 spawning stock biomass and fully recruited fishing mortality were derived from 1,000 bootstrap replicates of the VPA. Retrospective analyses of terminal year estimates of stock sizes, fully recruited fishing mortality and SSB were also carried out.

Assessment Results

Fully recruited fishing mortality (ages 4+) in 2006 is estimated at 0.34 (Table F18b; Figure F7), a substantial decrease since 2004. The 2004 year class is estimated to be equivalent to the 1998 year class (approximately 7-8 million fish), and the 2003 year class (13.1 million fish) is about twice the long term average (Table F18a). The 2000 year class (1.2 million fish) is by far the lowest in the entire VPA series and the 2002 year class (2.1 million fish) is the second lowest (6.3 million fish). Spawning stock biomass increased to 22,600 mt in 2001, but declined to 13,700 mt in 2005 as a result of the above average 1998 year class being removed from the population followed by subsequent poor recruiting yearclass of 2000 and 2002 (Table F18c; Figure F7). Spawning stock biomass increased substantially to 24,000 mt in 2006 on the strength of the 2003 year class becoming partially mature.

VPA Diagnostics and Uncertainty

The 2007 NLLS stock size estimates were relatively precise, with CVs ranging from 23% (age 4 to 35% (age 2) (Table F19). The bootstrapped estimates of bias were also relatively low ranging from 2.7% (age 4) to 10.9% (age 2) (Table F20). Residual patterns from the NEFSC and MADMF survey data used to calibrate the VPA appear for the most part random, although these are some instances of 3-4 year blocks of positive and negative residuals (Figure F8). A weak retrospective pattern is evident in the estimates of terminal F whereby fully recruited F alternates

between over- and under-estimation in the terminal year. The same pattern is evident for SSB (Figure F9). The bootstrap analysis provides an 80% CI about the 2006 SSB estimate (24,000 mt) of 20,740 mt – 29,027 mt and an 80% CI about the 2006 fully recruited F estimate (0.34) of 0.28 – 0.44 (Figure F10).

Alternative Model Results

The same data that were included in the VPA were also used in 2 formulations of ASAP, a forward projection assessment model. Both formulations of the model incorporated the same set of lambdas, but the first formulation was set to estimate a single logistic selectivity pattern and the second formulation was set to estimate a double logistic pattern for two time periods. The selectivity patterns estimated by each formulation of the model are:

Selectivity	Single Logistic Fit	Double Logistic Fit	
		period 1	period 2
age 1	0.01	0.01	0.00
2	0.08	0.09	0.03
3	0.52	0.53	0.39
4	0.93	0.95	1.00
5	0.99	1.00	0.92
6	1.00	0.62	0.61
7	1.00	0.06	0.28

Results from both formulations were similar to each other and differed from the VPA results to a larger extent. Fcurrent estimates are lower than the VPA derived Fcurrent (0.34), but the overall trend in fully recruited F are very similar except for a few years in the mid-1990s (Figure F11). Reference points are similar in magnitude, although those based on the double logistic fit are relatively high compared to those obtained from the single logistic fit and the VPA.

Reference Points	single logistic fit	2 period double logistic fit
F0.1	0.23	0.46
Fmax	undefined	1.50
F30%SPR	0.35	0.47
F40%SPR	0.23	0.33
Fmsy	0.19	0.35
Fcurrent	0.24	0.28

Retrospective analyses of the fully recruited F estimates derived from each formulation of ASAP differ considerably (Figure F12). The pattern displayed by the single logistic formulation was similar to the pattern displayed by the VPA, but the pattern displayed by the double logistic formulation appears problematic.

5.0 Biological Reference Points

The existing biological reference points first developed by the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish (NEFSC 2002) are:

> Bmsy   82,830 mt
> Fmsy   0.225
> MSY   16,600 mt

<u>Parametric Approach</u>

Biomass and F reference points were estimated under two scenarios.   The first analysis was based on the conclusions of the Working Group on Re-estimation of Biological Reference Points for New England Groundfish (NEFSC 2002). The Working Group compared the results of 10 formulations of Ricker and Beverton-Holt stock-recruitment functions, including priors and not including priors. The working group concluded that the limited range of stock and recruit data for Gulf of Maine cod favored the use of a model without priors. In this formulation of the parametric approach, we performed the analysis using the Beverton-Holt S/R function without a prior on recruitment.

The spawning biomass and age 1 recruitment results obtained from the VPA were included in a model (SRFIT) that also included life history and fishery parameters using the Sissenwine-Shepherd approach (See Brodziak and Legault 2005). Catch and stock mean weights at age and the maturity at age schedule were averaged over the 2002-2006 time period. Partial recruitment at age was taken as the average of the 2002-2006 time period Fs from the VPA results as:

Age 1: 0.0000, Age 2: 0.0043, Age 3: 0.2418, Ages 4 and older: 1.0000.

The stock-recruit model results are given in Table 21. The S-R model with no prior on recruitment estimated the following:

> Fmsy   0.28
> SSBmsy   60,304 mt.
> MSY   15,691 mt

Steepness of the S/R curve was estimated to be 0.87. This is within 1 SE of the informative prior distributions for Atlantic cod reported in NEFSC (2002). Parameters of the Beverton-Holt stock recruitment function were estimated as follows:

> Alpha   10,982.3
> Beta   7,879.1
> Sigma   0.626

A stochastic age-based projection program (AGEPRO) was used to project 100 year scenarios to obtain equilibrium SSBmsy and MSY estimates based on the Beverton-Holt alpha and beta parameters and the estimated sigma squared from SRFIT as the variance term. The same mean weights, maturity schedule and partial recruitment parameters were used in the projection as in

SRFIT analysis. A constant F strategy was employed setting F at the estimate of Fmsy (0.28) obtained from SRFIT. Results from this approach provide the following estimates (Figure F13):

SSBmsy   78,413 mt
MSY   18,886 mt

Non-Parametric Approach

In the non-parametric empirical approach, a Yield and SSB per recruit analysis was conducted using the same life history and fishery parameters that were incorporated into the parametric Beverton-Holt model approach. Yield and SSB per recruit input and results are given in Table F22. A proxy for Fmsy taken from this analysis is F40% MSP = 0.23.

Again, a stochastic projection program (AGEPRO) was used to project 100 year scenarios to obtain equilibrium SSBmsy and MSY estimates based on the cumulative distribution function of age 1 recruits from the 1981-2004 year classes obtained from the current VPA. The same mean weights, maturity schedule and partial recruitment parameters were used in the projection as in the YPR and SRFIT analyses. A constant F strategy was employed setting F at an Fmsy proxy F40% MSP (0.23) obtained from the SSB per recruit analysis. Results from this approach provide the following estimates (Figure F14):

SSBmsy   71,150 mt
MSY   14,936 mt

6.0 Summary

Fishing mortality in 2006 is estimated to be 0.34 and current spawning stock biomass in 2006 is estimated to be 24,000 mt.

7.0 References

Brodziak JKT, Legault CM. 2005. Model averaging to estimate rebuilding targets for overfished stocks. Can. J. Fish. Aquat. Sci. 62:544-562.

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.

Mayo, R.K., and L. Col. 2006. The 2005 Assessment of the Gulf of Maine Atlantic Cod Stock.. Northeast Fisheries Science Center Reference Document 06-02, 109p.

NEFSC 2002. Report of the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish, NMFS, Northeast Fisheries Science Center Reference Document 02-04, 254 p.

NEFSC 2005. Assessment of 19 Northeast Groundfish Stocks Through 2004. 2005 Groundfish Assessment Review Meeting (2005 GARM), Northeast Fisheries Science Center, Woods Hole, Massachusetts, 15-19 August, 2005. by R.K. Mayo and M Terceiro, editors. (NEFSC Reference Document 05-13).

Table 1.   Commercial landings (metric tons, live) of Atlantic cod from the Gulf of Maine (NAFO Division 5Y), 1960 - 2007.[1]

Year	Gulf of Maine				
	USA	Canada	USSR	Other	Total
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*	7964	-	-	-	7964
1995*	6454	-	-	-	6454
1996*	6915	-	-	-	6915
1997*	5397	-	-	-	5397
1998*	4021	-	-	-	4021
1999*	1370	-	-	-	1370
2000*	3656	-	-	-	3656
2001*	4151	-	-	-	4151
2002*	3462	-	-	-	3462
2003*	3615	-	-	-	3615
2004*	3268	-	-	-	3268
2005	3106	-	-	-	3106
2006	2788	-	-	-	2788
2007					

* Provisional

[1] USA 1960-1993 landings from NMFS, NEFSC Detailed Weighout Files and Canvass data.
[2] USA 1994-2006 landings from NMFS, NEFSC Detailed Weighout Files estimated by allocating landings on a trip basis from Vessel Trip Reports.

Table F2.   USA sampling of commercial Atlantic cod landings from the Gulf of Maine cod stock (NAFO Division 5Y), 1982 - 2006.

| | 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 |
Year	No.	No. Fish Measured	No.	No. Fish Aged	Q1	Q2	Q3	Q4	∑	Q1	Q2	Q3	Q4	∑	Q1	Q2	Q3	Q4	∑					
1982	48	3848	48	866	6	7	6	6	25	4	3	7	4	18	0	2	1	2	5					266
1983	71	5241	67	1348	14	10	10	4	38	4	10	6	2	22	1	3	5	2	11					197
1984	55	3925	55	1224	7	5	6	7	25	4	3	5	6	18	1	6	3	2	12					193
1985	69	5426	66	1546	5	6	7	5	23	8	6	7	4	25	7	5	3	6	21					155
1986	53	3970	51	1160	5	5	6	3	19	5	6	8	2	21	1	5	4	3	13					182
1987	43	3184	42	939	4	4	3	4	15	5	5	3	5	18	4	2	3	1	10					175
1988	34	2669	33	741	4	3	4	4	15	1	5	3	5	14	1	2	2	0	5					234
1989	32	2668	32	714	3	3	3	3	12	4	1	5	4	14	2	2	1	1	6					325
1990	39	2982	38	789	3	7	3	5	18	4	7	4	3	18	0	2	1	0	3					387
1991	56	4519	56	1152	2	10	4	3	19	5	11	11	3	30	0	3	3	1	7					318
1992	51	4086	51	1002	2	8	6	3	19	6	7	7	3	23	3	1	1	4	9					214
1993	23	1753	23	447	3	3	3	1	10	1	2	4	1	8	1	1	2	1	5					360
1994	29	2575	33	649	0	2	2	3	7	1	5	3	6	15	0	2	3	2	7					275
1995	31	2557	32	682	4	3	2	4	13	2	8	2	2	14	0	3	0	1	4					208
1996	71	6486	66	1380	5	4	7	9	25	6	9	11	11	37	1	2	3	3	9					97
1997	89	7559	80	1643	7	13	3	10	33	12	11	10	9	42	2	8	2	2	14					61
1998	50	4536	46	992	4	7	0	3	14	9	9	9	5	32	1	0	2	1	4					80
1999	10	733	10	195	5	0	0	0	5	2	1	1	0	4	1	0	0	0	1					137
2000	74	5737	74	1680	15	6	4	7	32	13	14	5	9	41	0	0	0	1	1					49
2001	109	6895	107	2436	4	4	4	7	19	4	9	8	15	36	2	15	18	19	54					38
2002	129	5263	124	2405	4	2	0	1	7	15	3	6	5	29	50	8	16	19	93					29
2003	248	11479	231	5630	5	1	17	8	31	14	8	25	19	66	50	34	34	33	151					15
2004	221	11031	162	3467	17	11	6	22	56	18	21	15	15	69	37	20	11	25	95					15
2005	364	10073	256	3486	23	29	33	16	101	13	15	20	19	67	20	41	68	63	192					9
2006	322	10735	255	4309	15	8	8	3	34	17	20	18	12	67	48	48	62	60	218					9

Table F3a. Commercial landings (Numbers, 000s) of Gulf of Maine cod by age.

Total Commercial Landings in Numbers (000's) at Age

	1	2	3	4	5	6	7+	Total
1982	30	1380	1633	1143	633	69	230	5118
1983	0	866	2357	1058	638	422	155	5496
1984	4	446	1240	1500	437	194	136	3957
1985	0	407	1445	991	630	128	136	3737
1986	0	84	2164	813	250	177	95	3583
1987	2	216	595	1109	277	66	79	2344
1988	0	160	1443	953	406	43	30	3035
1989	0	337	1583	1454	449	81	56	3960
1990	0	205	3425	2064	430	157	99	6380
1991	0	344	934	4161	851	143	79	6512
1992	0	313	530	484	2018	202	84	3631
1993	0	76	1487	641	129	457	36	2825
1994	0	37	1089	1109	305	69	122	2731
1995	18	218	874	1022	220	26	35	2413
1996	0	68	509	1730	362	36	6	2711
1997	0	78	441	425	798	68	9	1819
1998	0	92	393	527	145	175	31	1363
1999	0	3	182	175	81	16	26	482
2000	0	100	251	493	120	68	16	1047
2001	0	45	470	313	205	66	53	1153
2002	0	1	109	422	166	102	61	863
2003	0	7	45	191	369	117	87	816
2004	0	0	133	115	196	156	93	693
2005	0	1	34	379	56	159	117	747
2006	0	1	109	177	283	20	109	700
2007								

Table F3b. Commercial landings (Weight, mt) of Gulf of Maine cod by age.

Total Commercial Landings in Weight (Tons) at Age

	1	2	3	4	5	6	7+	Total
1982	24.0	1595.0	2717.0	3160.0	3019.0	461.0	2606.0	13582.0
1983	0.0	1009.0	3913.0	2619.0	2410.0	2518.0	1512.0	13981.0
1984	3.0	516.0	2071.0	4080.0	1607.0	1145.0	1384.0	10816.0
1985	0.0	513.0	2523.0	2816.0	2814.0	705.0	1322.0	10693.0
1986	0.0	110.0	3976.0	2375.0	1153.0	1072.0	978.0	9664.0
1987	2.0	283.0	1001.0	3641.0	1340.0	451.0	809.0	7527.0
1988	0.0	203.0	2715.0	2311.0	2097.0	295.0	337.0	7958.0
1989	0.0	420.0	2811.0	4351.0	1737.0	325.0	683.0	10397.0
1990	0.0	219.0	5794.0	4687.0	1834.0	1200.0	1361.0	15095.0
1991	0.0	388.0	1463.0	10455.0	3520.0	1045.0	910.0	17781.0
1992	0.0	480.0	1019.0	1313.0	6175.0	1011.0	892.0	10891.0
1993	0.0	99.0	2809.0	1611.0	561.0	2819.0	387.0	8286.0
1994	0.0	52.2	2049.0	3364.5	1051.9	438.6	1011.2	7967.4
1995	4.9	302.9	1619.6	2833.2	1129.3	154.4	408.2	6452.6
1996	0.0	105.0	1130.0	4065.2	1281.8	265.4	69.9	6917.1
1997	0.0	138.6	989.6	1314.3	2531.4	333.0	90.0	5396.9
1998	0.0	122.2	807.4	1518.7	611.4	755.5	205.3	4020.5
1999	0.0	4.3	329.4	438.8	298.1	91.8	206.0	1368.4
2000	0.0	167.0	631.2	1796.8	556.2	394.3	115.7	3661.2
2001	0.0	82.8	1171.6	1054.2	1000.5	418.0	424.6	4151.8
2002	0.0	2.0	280.5	1401.9	687.7	620.1	467.0	3459.3
2003	0.0	11.8	107.7	607.9	1544.7	624.7	719.1	3615.9
2004	0.0	0.6	336.9	409.1	809.6	890.4	822.1	3268.7
2005	0.0	2.0	75.5	1148.6	253.4	740.5	886.7	3106.7
2006	0.0	2.2	266.6	578.8	1071.4	97.7	773.4	2790.1
2007								

Table F4a. Mean weight at age (kg) of commercial landings of Gulf of Maine cod.

Total Commercial Landings Mean Weight (kg) at Age

	1	2	3	4	5	6	7+	Total
1982	0.801	1.156	1.664	2.764	4.770	6.739	11.330	2.654
1983	0.000	1.164	1.660	2.475	3.778	5.962	9.755	2.544
1984	0.589	1.159	1.670	2.721	3.677	5.898	10.176	2.731
1985	0.000	1.260	1.746	2.840	4.466	5.525	9.721	2.861
1986	0.000	1.304	1.837	2.923	4.619	6.067	10.295	2.698
1987	1.028	1.313	1.684	3.283	4.831	6.824	10.241	3.212
1988	0.000	1.268	1.881	2.426	5.166	6.767	11.233	2.622
1989	0.000	1.247	1.776	2.993	3.864	4.872	12.200	2.626
1990	0.000	1.071	1.692	2.271	4.265	7.645	13.747	2.366
1991	0.000	1.130	1.568	2.512	4.136	7.309	11.449	2.731
1992	0.000	1.533	1.922	2.714	3.061	5.000	10.614	2.999
1993	0.000	1.293	1.889	2.513	4.353	6.174	11.063	2.933
1994	0.000	1.402	1.882	3.033	3.452	6.321	8.314	2.917
1995	0.274	1.387	1.853	2.773	5.139	5.842	11.827	2.674
1996	0.000	1.544	2.221	2.350	3.540	7.345	11.590	2.552
1997	0.000	1.781	2.244	3.092	3.173	4.881	10.325	2.968
1998	0.000	1.323	2.056	2.880	4.203	4.321	6.693	2.949
1999	0.000	1.483	1.811	2.513	3.695	5.720	7.911	2.838
2000	0.000	1.674	2.516	3.647	4.637	5.814	7.119	3.496
2001	0.000	1.844	2.492	3.363	4.876	6.357	8.006	3.602
2002	0.000	1.348	2.564	3.319	4.150	6.057	7.609	4.010
2003	0.000	1.805	2.408	3.175	4.181	5.339	8.258	4.430
2004	0.000	1.483	2.538	3.572	4.121	5.721	8.860	4.720
2005	0.000	1.878	2.199	3.034	4.491	4.647	7.585	4.161
2006	0.000	2.394	2.437	3.277	3.790	4.788	7.063	3.988
2007								

Table F4b. Mean length at age (cm) of commercial landings of Gulf of Maine cod.

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| | Total Commercial Landings Mean Length (cm) at Age | | | | | | | |
	1	2	3	4	5	6	7+	Total
1982	43.2	48.3	53.8	63.4	76.8	86.1	101.6	59.9
1983		48.6	53.8	61.4	70.8	82.4	95.1	59.8
1984	39.0	48.4	54.1	63.4	69.7	81.8	98.0	61.6
1985		49.8	55.1	64.6	74.9	80.3	96.7	62.8
1986		50.3	55.9	65.0	75.4	82.6	98.4	61.6
1987	47.0	50.4	54.4	67.8	76.9	86.5	98.4	65.4
1988		50.1	56.4	61.1	78.7	86.4	103.1	61.4
1989		49.8	55.5	65.7	71.5	76.7	103.6	61.7
1990		47.5	54.8	60.0	73.7	90.0	108.8	59.2
1991		47.7	52.6	61.8	72.6	88.6	102.2	62.2
1992		53.1	56.6	62.9	65.6	77.0	100.4	64.3
1993		50.5	56.8	61.7	74.2	83.7	101.6	63.5
1994	0.0	51.8	56.6	65.8	68.3	83.3	90.8	63.8
1995	30.4	50.4	56.2	63.7	78.7	78.1	103.6	61.6
1996	0.0	52.8	59.6	60.4	68.6	88.6	103.3	61.6
1997	0.0	55.4	59.8	66.0	66.3	76.2	98.4	64.7
1998	0.0	50.7	58.1	64.4	73.0	73.3	81.5	64.1
1999	0.0	53.0	55.9	62.0	69.2	78.6	89.9	62.9
2000	0.0	54.6	61.8	70.1	76.1	82.3	87.4	68.4
2001	0.0	56.1	62.0	68.1	77.4	84.6	91.0	68.8
2002	0.0	51.3	62.4	68.0	72.8	83.2	89.2	71.5
2003	0.0	56.2	61.5	66.9	73.2	79.5	91.7	73.8
2004	0.0	53.0	62.6	70.0	73.0	81.3	93.8	75.1
2005	0.0	57.0	59.8	66.2	75.3	76.1	88.4	72.2
2006	0.0	62.0	61.8	67.9	71.0	76.3	85.7	71.2
2007								

Table F5. Discard estimates (weight, mt) and measures of precision (coefficient of variation) with a comparison of estimates derived for GARMII in 2005.

| | cod D/all | | cod D/cod | | | 2005 |
	K	CV	K	CV	d/k ratio	est.
1989	761.6	26.9%	1157.8	32.3%	0.1114	1545.0
1990	2063.3	23.1%	3092.5	37.0%	0.2041	3598.0
1991	873.0	25.7%	1012.9	28.1%	0.0570	1049.0
1992	824.0	27.5%	660.7	17.9%	0.0607	603.0
1993	446.1	32.0%	421.0	26.2%	0.0508	329.0
1994	186.8	40.0%	217.8	18.8%	0.0273	239.0
1995	314.5	20.9%	307.4	22.5%	0.0476	426.0
1996	228.6	25.7%	182.6	20.7%	0.0264	199.0
1997	81.1	36.6%	103.7	56.5%	0.0192	179.0
1998	96.5	24.1%	96.9	37.8%	0.0241	154.0
1999	1129.9	39.6%	2624.2	25.1%	1.9155	2630.0
2000	1333.1	22.3%	998.5	17.7%	0.2731	1170.0
2001	1991.9	42.3%	1376.2	18.8%	0.3315	1621.0
2002	1648.9	21.3%	1538.0	16.2%	0.4443	1950.0
2003	1005.5	16.7%	1224.1	19.4%	0.3386	1486.0
2004	698.2	16.3%	469.5	21.1%	0.1437	575.0
2005	277.2	11.7%	269.0	9.5%	0.0866	
2006	450.6	38.1%	454.1	34.9%	0.1629	

Table F6. Commercial discards (Numbers, 000s and Weight, mt) of Gulf of Maine cod by age.

Commercial Discard in Numbers (000's) at Age

	1	2	3	4	5	6	7+	Total
1999	0	5.56225	350.793	336.7401	155.5721	30.93609	50.22327	929.8268
2000	0	27.23837	68.47936	134.4909	32.74171	18.51201	4.436846	285.8992
2001	0	14.89154	155.8516	103.9151	68.01521	21.7982	17.57972	382.0514
2002	0	0.663094	48.59252	187.6517	73.61701	45.4844	27.26576	383.2745
2003	0	2.215548	15.14796	64.82477	125.0933	39.61791	29.48354	276.3831
2004	0	0.062501	18.97231	16.37247	28.08287	22.24669	13.26319	99.00003
2005	0	0.091366	2.972173	32.76633	4.883208	13.7918	10.1174	64.62227
2006	0	0.151214	17.8127	28.76062	46.03577	3.32287	17.82966	113.9128
2007								

Commercial Discard in Weight (mt) at Age

	1	2	3	4	5	6	7+	Total
1999	0	6.703101	615.5764	943.8967	651.6182	177.2833	396.555	3048.313
2000	0	20.82786	164.3105	501.1503	144.4944	105.9886	37.23238	999.8171
2001	0	31.64706	406.5366	366.9972	355.6836	159.76	148.1098	1489.381
2002	0	0.943433	108.004	652.0984	306.2286	267.3663	225.9698	1468.727
2003	0	5.242844	36.35653	203.2558	535.8734	215.1225	271.9032	1030.085
2004	0	0.092689	48.15172	58.48247	115.7295	127.2733	117.5169	467.2466
2005	0	0.171585	6.535809	99.41303	21.93048	64.09051	76.74327	268.8847
2006	0	0.362007	43.40956	94.24856	174.4756	15.9099	125.9352	454.3408

Table F7. Recreational catch estimates for Gulf of Maine cod using revised site lists for partitioning total cod estimates into Gulf of Maine and Georges Bank stocks.

Gulf of Maine (me,ma,nh)

	tot n a,b1,b2 gm_totn lnd	tot wt mt ab1b2 tot wt mt	n retain a,b1 gm_lnded	wt retain mt a,b1 ab1 mt
1981	2841.9	4523.3	2650.0	4218.0
1982	1943.9	3412.6	1849.2	3246.4
1983	1488.2	2110.3	1257.8	1783.7
1984	1107.5	1728.3	910.8	1421.3
1985	1833.5	2348.9	1633.9	2093.2
1986	1111.6	2059.8	990.1	1834.6
1987	2597.8	4308.1	2031.1	3368.3
1988	1448.7	2626.7	1272.3	2306.9
1989	1775.1	3763.5	1203.0	2550.5
1990	1727.1	3659.6	1254.5	2658.1
1991	1788.2	3711.7	1377.8	2859.9
1992	560.7	1097.4	321.6	629.5
1993	1517.8	2762.8	766.6	1395.3
1994	1272.2	2333.4	542.6	995.2
1995	1192.3	2116.8	509.6	904.8
1996	801.4	1816.3	350.6	794.6
1997	440.0	1060.0	139.8	336.7
1998	577.3	1585.3	194.3	533.5
1999	724.7	2338.6	248.9	803.2
2000	1443.8	4306.8	522.8	1559.5
2001	2330.3	6079.1	1018.3	2656.5
2002	1640.6	5050.7	551.4	1697.6
2003	1721.0	7095.2	613.0	2527.1
2004	1427.6	4897.2	531.9	1824.5
2005	1859.0	6237.5	584.2	1960.3
2006	909.4	3824.9	226.7	953.6
2007				

Table F8a. Recreational landings (Numbers, 000s) of Gulf of Maine cod by age

Recreational Landings in Numbers (000's) at Age

	1	2	3	4	5	6	7+	Total
1982	41.4	600.9	787.3	279.1	114.1	8.1	11.3	1842.1
1983	11.3	458.4	560.6	131.0	49.2	30.6	16.8	1258.0
1984	20.7	355.5	341.5	136.5	33.1	13.6	6.9	907.9
1985	44.3	657.5	742.8	146.1	37.5	5.2	0.6	1634.0
1986	12.8	102.0	592.8	116.6	27.0	22.9	84.0	958.1
1987	94.3	673.6	726.0	396.8	69.4	25.5	45.5	2031.0
1988	2.4	389.1	685.0	164.1	22.8	6.3	3.1	1273.0
1989	3.8	182.5	697.6	261.7	39.0	11.8	6.7	1203.0
1990	0.0	48.6	700.6	391.9	93.3	19.6	0.0	1254.0
1991	0.0	94.5	407.1	749.7	79.6	15.8	8.1	1354.6
1992	0.0	25.3	57.1	47.9	170.4	17.1	3.7	321.5
1993	0.0	51.8	544.8	142.0	10.4	16.8	1.2	767.0
1994	0.9	16.5	393.7	102.9	25.5	1.5	1.9	543.0
1995	0.0	55.7	285.0	157.3	10.1	1.8	0.1	510.0
1996	0.0	21.3	117.5	192.8	18.9	0.3	0.2	351.0
1997	0.0	6.4	50.6	28.4	51.5	3.1	0.0	140.0
1998	0.0	13.7	86.5	64.4	12.5	15.7	1.1	194.0
1999	1.2	13.6	113.8	57.0	36.8	11.1	15.4	249.0
2000	0.0	71.9	209.4	192.5	35.6	11.4	2.2	523.0
2001	0.0	86.4	544.4	258.5	98.0	19.3	11.4	1018.0
2002	0.0	0.8	95.0	258.4	100.0	51.7	45.1	551.0
2003	0.0	7.2	55.2	172.4	247.7	67.6	60.9	611.0
2004	0.0	0.3	182.8	100.2	155.9	65.5	26.1	530.9
2005	0.0	6.1	86.5	348.1	25.5	70.5	47.3	584.0
2006	0.0	0.4	34.6	55.6	88.0	6.3	42.1	227.0
2007								

Table F8b. Recreational landings (Weight, mt) of Gulf of Maine cod by age

Recreational Landings in Weight (Tons) at Age

	1	2	3	4	5	6	7+	Total
1982	22.0	606.2	1201.4	676.2	505.6	46.1	73.3	3130.7
1983	5.1	397.6	784.6	282.4	168.0	208.9	209.9	2056.4
1984	9.5	301.8	480.7	335.8	113.6	61.0	68.9	1371.3
1985	20.6	545.9	980.3	339.7	113.2	17.6	2.5	2019.9
1986	5.1	98.7	976.0	307.8	108.2	131.5	1477.0	3104.4
1987	17.8	563.6	1041.5	1073.2	326.2	203.9	482.3	3708.5
1988	0.8	326.1	982.5	345.3	88.6	23.3	21.5	1788.0
1989	2.6	202.7	1117.2	683.1	138.8	74.7	52.6	2271.7
1990	0.0	55.4	1160.4	961.2	357.4	107.9	0.0	2642.3
1991	0.0	130.2	604.6	1491.7	207.6	133.3	74.1	2641.5
1992	0.0	45.8	125.9	145.3	566.3	82.5	26.8	992.6
1993	0.0	53.0	891.4	266.6	27.9	70.5	11.3	1320.6
1994	0.1	22.2	630.1	224.4	53.2	6.6	16.4	953.2
1995	0.0	84.8	461.8	302.7	31.4	3.3	0.3	884.2
1996	0.0	32.9	212.4	376.4	45.0	2.4	3.1	672.3
1997	0.0	11.0	100.9	67.6	123.1	8.6	0.1	311.3
1998	0.0	23.6	186.2	165.5	41.7	49.3	3.8	470.2
1999	0.4	17.1	222.8	173.9	177.2	67.1	105.8	764.3
2000	0.0	109.4	404.0	517.4	126.2	56.0	7.6	1220.5
2001	0.0	148.3	1233.4	752.6	422.1	115.8	71.4	2743.6
2002	0.0	1.1	215.3	813.0	371.6	276.9	465.7	2143.5
2003	0.0	15.0	132.5	494.6	894.4	348.9	577.2	2462.5
2004	0.0	0.5	391.3	268.7	444.2	247.5	219.6	1571.6
2005	0.0	9.3	172.1	896.0	98.3	295.0	371.2	1841.9
2006	0.0	0.8	84.1	178.7	316.6	31.5	345.6	957.2
2007								

Table F9a. Mean weight at age (kg) of recreational landings of Gulf of Maine cod.

Recreational Landings Mean Weight (kg) at Age

	1	2	3	4	5	6	7+	Total
1982	0.531	1.009	1.526	2.423	4.431	5.686	6.487	1.700
1983	0.446	0.867	1.399	2.156	3.412	6.831	12.510	1.635
1984	0.459	0.849	1.408	2.460	3.428	4.476	10.044	1.510
1985	0.466	0.830	1.320	2.326	3.021	3.370	3.9510	1.236
1986	0.399	0.968	1.646	2.641	4.014	5.740	17.591	3.240
1987	0.189	0.837	1.435	2.705	4.704	8.009	10.601	1.826
1988	0.318	0.838	1.434	2.104	3.881	3.669	6.873	1.405
1989	0.680	1.111	1.601	2.610	3.555	6.351	7.914	1.888
1990	0.421	1.141	1.656	2.453	3.830	5.508	8.500	2.107
1991	0.421	1.378	1.485	1.990	2.609	8.450	9.178	1.950
1992	0.421	1.810	2.205	3.030	3.323	4.827	7.213	3.087
1993	0.421	1.023	1.636	1.877	2.681	4.207	9.685	1.722
1994	0.131	1.342	1.601	2.182	2.086	4.300	8.644	1.755
1995	0.482	1.523	1.620	1.924	3.120	1.798	5.833	1.734
1996	0.582	1.542	1.808	1.952	2.387	8.127	12.664	1.915
1997	0.421	1.733	1.992	2.381	2.388	2.806	6.365	2.224
1998	0.456	1.718	2.151	2.570	3.332	3.140	3.489	2.423
1999	0.334	1.253	1.958	3.048	4.820	6.032	6.853	3.070
2000	0.421	1.521	1.929	2.688	3.543	4.898	3.491	2.334
2001	0.421	1.716	2.266	2.912	4.308	6.000	6.288	2.695
2002	0.421	1.381	2.265	3.147	3.716	5.357	10.316	3.890
2003	0.421	2.083	2.402	2.869	3.611	5.159	9.473	4.031
2004	0.421	1.459	2.14	2.681	2.849	3.78	8.402	2.960
2005	0.421	1.523	1.99	2.574	3.857	4.187	7.843	3.154
2006	0.421	1.943	2.429	3.211	3.598	5.042	8.211	4.217
2007								

Table F9b. Mean length at age (cm) of recreational landings of Gulf of Maine cod.

Recreational Landings Mean Length (cm) at Age

	1	2	3	4	5	6	7+	Total
1982	36.3	44.8	51.5	60.1	74.4	81.0	85.8	52.0
1983	34.5	42.8	50.2	57.9	67.4	85.4	102.7	50.4
1984	34.4	42.3	50.1	60.1	67.4	72.6	94.7	49.5
1985	35.0	42.0	48.9	59.9	65.5	68.7	73.2	47.2
1986	34.0	44.3	53.2	62.0	71.5	81.2	118.2	59.9
1987	25.9	41.8	50.4	62.9	75.2	90.0	99.9	51.3
1988	32.0	42.4	50.5	57.7	70.1	67.1	85.6	49.4
1989	40.0	46.6	52.7	61.9	68.3	84.3	92.0	54.8
1990	33.7	47.3	53.3	60.9	71.0	81.1	95.0	57.2
1991	33.7	50.6	51.6	56.9	61.6	93.2	97.0	55.8
1992	33.7	54.9	58.1	64.6	66.7	75.6	86.7	64.6
1993	33.7	45.2	53.3	55.8	61.8	69.0	98.0	53.7
1994	23.6	49.3	52.9	58.1	57.4	70.9	93.5	54.2
1995	36.0	52.1	53.1	55.9	65.5	54.6	83.0	54.1
1996	38.0	52.3	55.0	56.4	60.0	89.9	107.0	56.0
1997	33.7	54.5	57.0	60.1	60.0	62.8	85.4	58.8
1998	35.0	54.2	58.4	61.7	66.9	65.3	68.3	60.3
1999	33.0	47.9	56.4	65.0	75.6	81.5	85.5	63.6
2000	33.7	52.1	56.1	62.3	68.2	76.3	67.6	59.1
2001	33.7	54.1	59.2	64.0	73.6	82.6	83.8	62.1
2002	33.7	51.1	59.2	66.1	69.6	79.0	96.5	69.2
2003	33.7	58.0	60.6	64.0	68.5	76.9	95.1	70.0
2004	33.7	51.6	58.5	62.9	63.9	69.2	89.9	63.8
2005	33.7	51.6	57.0	61.8	70.4	72.1	87.9	64.7
2006	33.7	56.1	60.7	66.5	68.8	76.0	88.7	70.9
2007								

Table F10a. Total catch (Numbers, 000s) of Gulf of Maine cod by age including commercial landings, recreational landings and commercial discards (1999-present).

Total Catch in Numbers (000's) at Age

	1	2	3	4	5	6	7+	Total
1982	71	1981	2420	1422	747	77	241	6960
1983	11	1324	2918	1189	687	453	172	6754
1984	25	802	1582	1637	470	208	143	4865
1985	44	1065	2188	1137	667	133	137	5371
1986	13	186	2757	930	277	200	179	4541
1987	96	890	1321	1506	346	91	124	4375
1988	2	549	2128	1117	429	49	33	4308
1989	4	520	2281	1716	488	93	63	5163
1990	0	254	4126	2456	523	177	99	7634
1991	0	438	1341	4911	931	159	87	7867
1992		338	587	532	2188	219	88	3953
1993	0	128	2032	783	139	474	37	3592
1994	1	54	1482	1212	330	71	124	3274
1995		274	1159	1179	230	28	35	2923
1996		89	626	1923	381	36	6	3062
1997		84	492	453	849	71	9	1959
1998		106	479	592	158	191	32	1557
1999	1	22	646	568	273	58	92	1661
2000		199	529	820	188	98	23	1856
2001		146	1170	676	371	107	82	2553
2002		3	253	868	339	200	134	1797
2003		16	115	429	742	224	177	1704
2004		1	335	231	380	243	132	1322
2005		7	124	759	87	244	174	1395
2006		2	162	261	417	30	169	1040

Table F10b. Total catch (Weight, mt) of Gulf of Maine cod by age including commercial landings, recreational landings and commercial discards (1999-present).

Total Catch in Weight (Tons) at Age

	1	2	3	4	5	6	7+	Total
1982	46.0	2201.2	3918.4	3836.2	3524.6	507.1	2679.3	16712.7
1983	5.1	1406.6	4697.6	2901.4	2578.0	2726.9	1721.9	16037.4
1984	12.5	817.8	2551.7	4415.8	1720.6	1206.0	1452.9	12187.3
1985	20.6	1058.9	3503.3	3155.7	2927.2	722.6	1324.5	12712.9
1986	5.1	208.7	4952.0	2682.8	1261.2	1203.5	2455.0	12768.4
1987	19.8	846.6	2042.5	4714.2	1666.2	654.9	1291.3	11235.5
1988	0.8	529.1	3697.5	2656.3	2185.6	318.3	358.5	9746.0
1989	2.6	622.7	3928.2	5034.1	1875.8	399.7	735.6	12668.7
1990	0.0	274.4	6954.4	5648.2	2191.4	1307.9	1361.0	17737.3
1991	0.0	518.2	2067.6	11946.7	3727.6	1178.3	984.1	20422.5
1992	0.0	525.8	1144.9	1458.3	6741.3	1093.5	918.8	11883.6
1993	0.0	152.0	3700.4	1877.6	588.9	2889.5	398.3	9606.6
1994	0.1	74.4	2679.1	3588.9	1105.2	445.3	1027.6	8920.6
1995	4.9	387.7	2081.4	3135.8	1160.7	157.7	408.6	7336.8
1996	0.0	137.9	1342.4	4441.6	1326.8	267.8	72.9	7589.4
1997	0.0	149.7	1090.4	1381.9	2654.4	341.6	90.1	5708.2
1998	0.0	145.8	993.7	1684.2	653.1	804.8	209.1	4490.7
1999	0.4	28.1	1167.8	1556.6	1126.9	336.2	708.4	5181.0
2000	0.0	297.2	1199.4	2815.3	826.9	556.3	160.5	5881.5
2001	0.0	262.8	2811.6	2173.9	1778.2	693.6	644.1	8384.8
2002	0.0	4.0	603.7	2867.0	1365.5	1164.4	1158.7	7071.5
2003	0.0	32.0	276.6	1305.7	2974.9	1188.8	1568.2	7108.5
2004	0.0	1.2	776.3	736.3	1369.5	1265.1	1159.2	5307.6
2005	0.0	11.5	254.1	2144.1	373.7	1099.6	1334.6	5217.5
2006	0.0	3.4	394.1	851.7	1562.5	145.1	1244.9	4201.7
2007								

Table F11a. Mean weight (kg) at age of total catch of Gulf of Maine cod including
commercial landings, recreational landings and commercial discards (1999-present).

Total Catch Mean Weight (kg) at Age

	1	2	3	4	5	6	7+	Total
1982	0.644	1.111	1.619	2.698	4.718	6.577	11.104	2.401
1983	0.446	1.062	1.610	2.440	3.751	6.025	10.024	2.375
1984	0.506	1.020	1.613	2.698	3.660	5.808	10.170	2.505
1985	0.466	0.995	1.601	2.775	4.385	5.424	9.693	2.367
1986	0.399	1.122	1.796	2.886	4.554	6.020	13.718	2.812
1987	0.206	0.952	1.546	3.131	4.811	7.161	10.372	2.568
1988	0.318	0.964	1.738	2.378	5.097	6.450	10.821	2.262
1989	0.680	1.199	1.722	2.934	3.844	4.309	11.742	2.454
1990	0.441	1.082	1.686	2.300	4.187	7.407	13.747	2.323
1991	0.441	1.182	1.542	2.433	4.006	7.421	11.302	2.596
1992	0.441	1.554	1.950	2.741	3.080	4.991	10.475	3.007
1993	0.441	1.189	1.821	2.398	4.225	6.099	10.717	2.674
1994	0.441	1.384	1.807	2.961	3.346	6.277	8.319	2.725
1995	0.441	1.415	1.796	2.660	5.051	5.580	11.817	2.510
1996	0.441	1.543	2.144	2.310	3.483	7.351	11.632	2.479
1997	0.441	1.777	2.218	3.048	3.125	4.791	10.316	2.914
1998	0.441	1.374	2.073	2.846	4.134	4.224	6.583	2.883
1999	0.334	1.271	1.806	2.739	4.128	5.786	7.725	3.119
2000	0.441	1.494	2.269	3.435	4.391	5.690	7.021	3.169
2001	0.441	1.797	2.402	3.216	4.791	6.491	7.858	3.285
2002	0.441	1.374	2.386	3.302	4.024	5.835	8.661	3.935
2003	0.441	2.008	2.404	3.046	4.008	5.301	8.835	4.173
2004	0.441	1.473	2.320	3.186	3.599	5.199	8.770	4.013
2005	0.441	1.579	2.053	2.823	4.305	4.514	7.655	3.739
2006	0.441	2.265	2.435	3.263	3.749	4.841	7.348	4.038
2007								

Table F11b. Mean length (cm) at age of total catch of Gulf of Maine cod including commercial landings, recreational landings and commercial discards (1999-present).

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Total Catch Mean Length (cm) at Age

	1	2	3	4	5	6	7+	Total
1982	39.2	47.2	53.0	62.8	76.4	85.6	100.9	57.8
1983	34.5	46.6	53.1	61.0	70.6	82.6	95.8	58.0
1984	35.2	45.7	53.2	63.1	69.5	81.2	97.8	59.3
1985	35.0	45.0	53.0	64.0	74.4	79.8	96.6	58.1
1986	34.0	47.0	55.3	64.6	75.0	82.4	107.7	61.3
1987	26.3	43.9	52.2	66.5	76.6	87.5	99.0	58.9
1988	32.0	44.6	54.5	60.6	78.2	83.9	101.4	57.9
1989	40.0	48.7	54.6	65.1	71.2	77.7	102.4	60.1
1990	33.3	47.5	54.5	60.1	73.2	89.0	108.8	58.9
1991	33.3	48.3	52.3	61.0	71.7	89.1	101.7	61.1
1992	33.3	53.2	56.7	63.1	65.7	76.9	99.8	64.3
1993	33.3	48.4	55.9	60.6	73.3	83.2	101.5	61.4
1994	23.6	51.5	56.1	65.9	67.3	82.4	97.5	62.7
1995	33.3	53.9	56.0	62.4	78.0	90.0	107.1	60.9
1996	33.3	54.1	58.1	60.3	68.8	88.9	103.6	61.1
1997	33.3	55.0	59.4	65.1	66.0	74.4	104.6	64.3
1998	33.3	50.6	58.4	64.7	72.4	72.1	96.7	63.9
1999	33.0	50.0	55.7	63.6	72.2	80.9	89.8	64.7
2000	33.3	52.4	59.3	68.3	74.4	81.5	87.1	65.7
2001	33.3	55.0	60.7	66.7	76.7	85.1	90.3	66.4
2002	33.3	51.5	60.6	67.6	71.9	81.8	89.8	70.5
2003	33.3	57.8	61.0	65.7	71.7	78.8	92.8	71.8
2004	33.3	52.7	60.5	67.1	69.5	78.1	92.9	70.8
2005	33.3	52.4	57.8	64.2	73.9	74.9	88.3	69.0
2006	33.3	60.3	61.6	67.6	70.6	76.3	86.5	71.2
2007								

Table F12. 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 MaineNEFSC strata 01260-01300 and 01360-01400), 1963 - 2007 [a,b,c].

Year	Spring no/tow	Spring wt/tow (kg)	Autumn no/tow	Autumn wt/tow
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	1.338	2.87
2006	1.363	2.70	3.594	4.23
2007	12.393	15.81	1.992	2.71

[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 F13. 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), 1968-2007. [a,b]

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                                                        Age Group                                                          Totals            Standardized
                                                                                                                                             Mean Wt/tow
Year  --------------------------------------------------------------------------------------------------------  ------------------------------  --------
[c,d,e]  0      1      2      3      4      5      6      7      8      9     10     11     12     13    14+      0+     4+     5+     6+        (Kg)

  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  2.191  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  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  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  7.525  2.350  1.718  1.370      18.81
  1974 0.000  0.475  0.103  1.503  0.172  0.235  0.075  0.028  0.057  0.033  0.045  0.043  0.081  0.000  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  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  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  3.872  2.998  1.073  0.962       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  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  0.000  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  2.155  1.133  0.994  0.756       6.23
  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  4.832  2.272  0.930  0.600      10.65
  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  3.763  1.907  1.251  0.264       8.62
  1983 0.013  0.632  0.949  0.997  0.465  0.404  0.212  0.068  0.016  0.071  0.018  0.008  0.030  0.000  0.030  3.912  1.322  0.857  0.453      10.96
  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  3.667  1.182  0.359  0.147       6.14
  1985 0.000  0.029  0.231  0.662  0.663  0.662  0.103  0.091  0.052  0.000  0.026  0.000  0.000  0.000  0.000  2.517  1.596  0.933  0.272       7.65
  1986 0.000  0.537  0.248  0.754  0.237  0.091  0.035  0.038  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  0.030  0.460  0.199  0.231  0.074  0.000  0.066  0.008  0.000  0.000  0.000  0.000  0.000  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  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  2.112  0.768  0.168  0.077       2.42
  1990 0.000  0.000  0.208  1.365  0.637  0.102  0.032  0.018  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  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  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  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  0.027  0.022  0.018  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  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  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  0.000  0.000  0.000  0.000  0.000  0.000  0.000  2.192  1.502  1.238  0.362       5.62
  1998 0.000  0.018  0.224  0.330  0.517  0.142  0.421  0.023  0.037  0.000  0.000  0.000  0.000  0.000  0.000  1.710  1.139  0.622  0.481       4.18
  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  0.000  0.011  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  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  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  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  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  0.981  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  1.765  0.917  0.309  0.294       2.70
  2006 0.028  0.186  0.227  0.434  0.060  0.189  0.021  0.131  0.073  0.000  0.013  0.000  0.000  0.000  0.000  1.363  0.487  0.428  0.238       2.70
  2007 0.000  0.092  3.480  2.890  4.346  0.538  0.944  0.065  0.038  0.000  0.000  0.000  0.000  0.000  0.000 12.393  5.931  1.585  1.047      15.81
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[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, 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 (NESFC 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

Table F14. 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), 1963-2007. [a,b]

Year [c,d]	\ 0	\ 1	\ 2	\ 3	\ 4	\ 5	Age Group\ 6	\ 7	\ 8	\ 9	\ 10	\ 11	\ 12	\ 13	\ 14+	Totals\ 0+	\ 3+	\ 4+	\ 5+	Standardized Mean Wt/tow (Kg)
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	0.000	0.016	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	0.209	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	0.035	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	1.232	0.424	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	0.872	0.490	0.313	0.140	1.87
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	0.843	0.376	0.262	0.069	1.50
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	1.807	0.984	0.398	0.155	3.51
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	2.604	1.079	0.686	0.178	4.65
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	0.018	1.980	1.788	1.035	0.566	7.33
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	5.328	4.979	4.615	1.818	24.66
2003	0.542	0.455	0.198	0.185	0.529	0.450	0.073	0.077	0.000	0.011	0.000	0.011	0.000	0.000	0.000	2.529	1.335	1.150	0.622	5.99
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
2005	0.034	0.153	0.381	0.080	0.450	0.022	0.092	0.082	0.023	0.021	0.000	0.000	0.000	0.000	0.000	1.338	0.690	0.241	0.219	2.87
2006	0.064	1.251	0.580	1.033	0.248	0.286	0.034	0.050	0.030	0.006	0.014	0.000	0.000	0.064	0.000	3.594	0.666	0.418	0.133	4.23
2007	0.011	0.146	0.831	0.384	0.528	0.023	0.069	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.992	0.620	0.092	0.069	2.71

[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 F15. Stratified mean number per tow and weight per tow (kg) of Atlantic cod in MADMF inshore spring and autumn research vessel bottom trawl surveys in the Gulf of Maine (Mass regions 4 and 5), 1978-2007

| | Spring | | | Autumn | |
Year	Mean No per Tow	Mean Wt per Tow		Mean No per Tow	Mean Wt per Tow
1978	47.89	11.05		156.06	1.51
1979	96.56	14.28		8.92	1.05
1980	65.98	14.51		12.53	1.28
1981	69.41	18.69		9.29	3.64
1982	25.84	12.16		6.12	0.66
1983	54.85	18.75		1.68	0.09
1984	10.33	7.24		10.55	0.13
1985	8.46	4.77		2.87	0.07
1986	24.09	7.84		2.75	0.25
1987	17.21	7.87		313.15	0.35
1988	22.24	7.70		8.87	0.37
1989	52.24	16.82		4.15	0.22
1990	32.41	15.88		12.71	0.76
1991	13.70	8.73		7.48	0.48
1992	16.92	8.77		27.50	0.27
1993	92.66	5.86		51.50	1.35
1994	15.96	3.89		49.00	2.00
1995	23.36	3.99		4.66	0.81
1996	12.96	3.15		7.01	0.08
1997	17.89	2.50		1.46	0.01
1998	27.57	3.25		4.33	0.36
1999	161.06	9.00		8.01	0.31
2000	50.77	20.60		0.68	0.27
2001	41.84	26.45		49.55	0.76
2002	24.34	11.16		3.30	3.99
2003	1120.37	10.98		122.28	1.85
2004	131.59	8.15		57.62	5.58
2005	193.26	10.40		40.35	0.21
2006	1077.03	9.18		7.50	1.94
2007	61.58	8.43		7.92	2.94

Table F16. Stratified mean number per tow at age of Atlantic cod in MADMF inshore spring research vessel bottom trawl surveys in the Gulf of Maine (Mass regions 4 and 5), 1978-2007

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total	0+	1+	2+	3+
1978	31.43	6.33	2.59	3.61	2.00	1.76	0.07	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.89	47.87	16.44	10.11	7.52
1979	69.49	19.62	2.07	0.56	2.41	1.02	1.27	0.02	0.11	0.00	0.00	0.00	0.00	0.00	0.00	96.56	96.57	27.08	7.46	5.39
1980	9.03	42.81	10.45	1.80	0.22	0.89	0.40	0.35	0.00	0.04	0.00	0.00	0.00	0.00	0.00	65.98	65.99	56.96	14.15	3.70
1981	26.48	23.01	12.52	6.15	0.96	0.15	0.02	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	69.41	69.41	42.93	19.92	7.40
1982	1.71	13.29	7.17	2.41	0.87	0.22	0.08	0.04	0.05	0.00	0.00	0.00	0.00	0.00	0.00	25.84	25.84	24.13	10.84	3.67
1983	0.77	34.75	14.61	2.86	1.50	0.25	0.03	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	54.85	54.84	54.07	19.32	4.71
1984	0.26	1.96	5.15	2.07	0.70	0.05	0.05	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.33	10.32	10.06	8.10	2.95
1985	1.09	1.79	2.77	2.27	0.45	0.05	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.46	8.45	7.36	5.57	2.80
1986	1.14	9.26	11.68	1.23	0.68	0.07	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.09	24.09	22.95	13.69	2.01
1987	0.78	8.29	4.71	2.96	0.22	0.09	0.06	0.03	0.00	0.07	0.00	0.00	0.00	0.00	0.00	17.21	17.21	16.43	8.14	3.43
1988	1.88	10.05	6.35	2.45	1.45	0.01	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.24	22.25	20.37	10.32	3.97
1989	0.18	21.59	20.51	8.76	1.06	0.10	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52.24	52.24	52.06	30.47	9.96
1990	4.92	4.63	5.45	14.75	2.31	0.31	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32.41	32.41	27.49	22.86	17.41
1991	0.35	5.01	2.69	1.57	3.66	0.40	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.70	13.69	13.34	8.33	5.64
1992	1.51	4.50	5.13	3.67	0.75	1.26	0.09	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.92	16.93	15.42	10.92	5.79
1993	79.84	2.99	6.11	2.55	0.90	0.09	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	92.66	92.65	12.81	9.82	3.71
1994	4.63	4.79	4.07	1.75	0.49	0.16	0.01	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	15.96	15.94	11.31	6.52	2.45
1995	12.03	5.83	1.92	2.76	0.78	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.36	23.37	11.34	5.51	3.59
1996	8.94	0.64	0.52	1.08	1.49	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.96	12.97	4.03	3.39	2.87
1997	12.47	2.88	0.98	0.93	0.17	0.42	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.89	17.90	5.43	2.55	1.57
1998	23.48	1.49	0.83	0.70	0.75	0.06	0.24	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.57	27.56	4.08	2.59	1.76
1999	143.00	11.68	2.39	2.31	0.78	0.64	0.07	0.18	0.01	0.00	0.00	0.00	0.00	0.00	0.00	161.06	161.06	18.06	6.38	3.99
2000	2.15	35.14	7.02	2.89	2.20	0.71	0.49	0.09	0.08	0.00	0.00	0.00	0.00	0.00	0.00	50.77	50.77	48.62	13.48	6.46
2001	25.99	0.08	4.50	4.97	3.52	2.07	0.42	0.26	0.03	0.00	0.00	0.00	0.00	0.00	0.00	41.84	41.84	15.85	15.77	11.27
2002	0.92	19.29	0.26	1.23	1.41	0.56	0.30	0.16	0.13	0.03	0.03	0.00	0.01	0.00	0.00	24.34	24.33	23.41	4.12	3.86
2003	1097.97	6.20	12.70	0.28	1.43	1.33	0.29	0.13	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1120.37	1120.37	22.40	16.20	3.50
2004	116.15	9.21	1.56	2.58	0.46	0.90	0.64	0.04	0.04	0.01	0.00	0.00	0.00	0.00	0.00	131.59	131.59	15.44	6.23	4.67
2005	180.85	1.06	7.15	0.57	2.07	0.18	0.95	0.35	0.08	0.00	0.00	0.00	0.00	0.00	0.00	193.26	193.26	12.41	11.35	4.20
2006	1053.70	14.89	3.67	3.38	0.54	0.69	0.01	0.06	0.07	0.00	0.00	0.00	0.00	0.00	0.00	1077.03	1077.01	23.31	8.42	4.75
2007	49.35	4.37	3.36	1.84	1.75	0.32	0.54	0.04	0.01	0.00	0.00	0.00	0.00	0.00	0.00	61.58	61.58	12.23	7.86	4.50

Table F17. Stratified mean number per tow at age of Atlantic cod in MADMF inshore autumn research vessel bottom trawl surveys in the Gulf of Maine (Mass regions 4 and 5), 1978-2007

							Age Group											Totals			
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	total	0+	1+	2+	3+
1978	151.81	3.95	0.02	0.07	0.01	0.09	0.02	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	156.06	156.06	4.25	0.30	0.28
1979	5.72	2.93	0.20	0.00	0.04	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.92	8.92	3.20	0.27	0.07
1980	6.00	5.46	1.06	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.53	12.54	6.54	1.08	0.02
1981	1.45	6.20	1.25	0.36	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.29	9.28	7.83	1.63	0.38
1982	4.59	1.14	0.31	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.12	6.12	1.53	0.39	0.08
1983	1.27	0.28	0.10	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.68	1.68	0.41	0.13	0.03
1984	10.30	0.16	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.55	10.54	0.24	0.08	0.01
1985	2.65	0.19	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.87	2.87	0.22	0.03	0.01
1986	1.80	0.55	0.37	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.75	2.75	0.95	0.40	0.03
1987	311.72	1.40	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	313.15	313.14	1.42	0.02	0.00
1988	5.53	3.10	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.87	8.87	3.34	0.24	0.00
1989	3.94	0.02	0.10	0.07	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.15	4.15	0.21	0.19	0.09
1990	7.81	4.22	0.31	0.32	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.71	12.71	4.90	0.68	0.37
1991	5.04	2.00	0.36	0.02	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.48	7.49	2.45	0.45	0.09
1992	26.42	0.99	0.04	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.50	27.49	1.07	0.08	0.04
1993	49.43	1.53	0.36	0.17	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	51.50	51.51	2.08	0.55	0.19
1994	40.01	5.36	3.45	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	49.00	49.01	9.00	3.64	0.19
1995	2.93	0.80	0.41	0.49	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.66	4.65	1.72	0.92	0.51
1996	6.90	0.08	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.01	7.01	0.11	0.03	0.02
1997	1.43	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.46	1.46	0.03	0.00	0.00
1998	3.27	0.64	0.32	0.04	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.33	4.32	1.05	0.41	0.09
1999	7.33	0.59	0.07	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.01	8.00	0.67	0.08	0.01
2000	0.05	0.40	0.17	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.68	0.63	0.23	0.06
2001	49.19	0.01	0.13	0.13	0.04	0.05	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	49.55	49.56	0.37	0.36	0.23
2002	0.96	1.09	0.13	0.25	0.36	0.44	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.30	3.29	2.33	1.24	1.11
2003	120.17	1.60	0.14	0.05	0.20	0.11	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	122.28	122.28	2.11	0.51	0.37
2004	44.67	9.94	0.92	1.19	0.19	0.45	0.25	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	57.62	57.62	12.95	3.01	2.09
2005	39.47	0.61	0.24	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.35	40.35	0.88	0.27	0.03
2006	2.08	4.35	0.42	0.48	0.06	0.08	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.50	7.50	5.42	1.07	0.65
2007	7.61	0.16	0.13	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.92	7.91	0.30	0.14	0.01

Table F18a. VPA estimates of population size for Gulf of Maine cod.

```
JAN-1 Population Numbers
    AGE      1982       1983       1984       1985       1986

     1       7769.      7539.     10464.      7005.     10164.
     2      10892.      6281.      6160.      8545.      5691.
     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.     23232.     24684.

    AGE      1987       1988       1989       1990       1991

     1      12544.     25273.      4295.      4124.      6970.
     2       8298.     10233.     20687.      3512.      3370.
     3       4471.      5973.      7908.     16457.      2609.
     4       2507.      2378.      2954.      4408.      9678.
     5        483.       673.       907.       882.      1462.
     6        125.        97.       158.       304.       281.
     7        153.        65.       106.       191.       158.
   =========================================================
   Total    28582.     44692.     37015.     29878.     24528.

    AGE      1992       1993       1994       1995       1996

     1       6316.      9190.      3095.      3616.      3510.
     2       5702.      5171.      7524.      2533.      2961.
     3       2354.      4352.      4096.      6111.      1826.
     4        916.      1385.      1755.      2012.      3955.
     5       3447.       274.       422.       340.       581.
     6        341.       846.        97.        46.        71.
     7        136.        69.       170.        57.        12.
   =========================================================
   Total    19211.     21286.     17159.     14716.     12915.

    AGE      1997       1998       1999       2000       2001

     1       5741.      5153.      7879.      4649.      1176.
     2       2874.      4701.      4219.      6450.      3806.
     3       2343.      2277.      3753.      3434.      5101.
     4        929.      1474.      1430.      2487.      2333.
     5       1498.       350.       671.       657.      1295.
     6        131.       458.       143.       302.       367.
     7         16.        76.       226.        71.       282.
   =========================================================
   Total    13532.     14488.     18322.     18050.     14360.

    AGE      2002       2003       2004       2005       2006       2007

     1       5398.      2140.     13119.      7125.     27160.      6405
     2        963.      4419.      1752.     10741.      5834.     22237
     3       2984.       785.      3604.      1434.      8787.      4775
     4       3117.      2214.       539.      2648.      1062.      7048
     5       1299.      1766.      1425.       232.      1481.       633
     6        724.       756.       774.       822.       112.       835
     7        485.       598.       421.       588.       637.       434
   =====================================================================
   Total    14969.     12680.     21634.     23591.     45072.     42367
```

Table F18b. VPA estimates of instantaneous fishing mortality for Gulf of Maine cod.

```
Fishing Mortality Calculated
    AGE       1982        1983        1984        1985        1986
```

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	1.0082
5	0.5819	0.9646	1.0915	1.0322	1.0967
6	0.6578	0.8983	0.8774	1.1147	1.0271
7	0.6578	0.8983	0.8774	1.1147	1.0271

AGE	1987	1988	1989	1990	1991
1	0.0036	0.0003	0.0013	0.0019	0.0008
2	0.1287	0.0578	0.0287	0.0971	0.1585
3	0.4315	0.5041	0.3845	0.3309	0.8471
4	1.1155	0.7637	1.0084	0.9038	0.8325
5	1.4076	1.2480	0.8940	0.9448	1.2564
6	1.1572	0.8522	0.9803	0.9106	0.8788
7	1.1572	0.8522	0.9803	0.9106	0.8788

AGE	1992	1993	1994	1995	1996
1	0.0000	0.0001	0.0004	0.0000	0.0000
2	0.0702	0.0330	0.0079	0.1273	0.0339
3	0.3308	0.7080	0.5108	0.2352	0.4764
4	1.0073	0.9891	1.4409	1.0429	0.7708
5	1.2049	0.8327	2.0079	1.3727	1.2917
6	1.1601	0.9615	1.5284	1.0843	0.8241
7	1.1601	0.9615	1.5284	1.0843	0.8241

AGE	1997	1998	1999	2000	2001
1	0.0000	0.0000	0.0001	0.0000	0.0000
2	0.0329	0.0253	0.0058	0.0347	0.0434
3	0.2638	0.2648	0.2112	0.1865	0.2925
4	0.7760	0.5866	0.5783	0.4529	0.3859
5	0.9851	0.6913	0.5972	0.3810	0.3810
6	0.8999	0.6059	0.5843	0.4374	0.3842
7	0.8999	0.6059	0.5843	0.4374	0.3842

AGE	2002	2003	2004	2005	2006
1	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0033	0.0040	0.0005	0.0008	0.0003
3	0.0984	0.1767	0.1082	0.1003	0.0206
4	0.3680	0.2408	0.6423	0.3813	0.3169
5	0.3407	0.6244	0.3498	0.5332	0.3725
6	0.3599	0.3932	0.4219	0.3927	0.3447
7	0.3599	0.3932	0.4219	0.3927	0.3447

Table F18c. VPA estimates of spawning stock biomass for Gulf of Maine cod.

```
Spawning Stock Biomass

   AGE       1982        1983        1984        1985        1986
   _____
    1         414.        150.         37.         20.        178.
    2        2996.       1249.        822.       2064.       2332.
    3        3918.       5080.       3840.       4488.       6822.
    4        5180.       3313.       5564.       3026.       2841.
    5        6319.       3109.       1880.       3198.       1307.
    6         812.       3612.       1489.        767.       1394.
    7        5274.       2587.       2247.       1720.       3590.
   ================================================================
  Total     24911.      19100.      15878.      15283.      18464.

   AGE       1987        1988        1989        1990        1991
   _____
    1          35.        160.        157.        322.        158.
    2        1888.       1835.       4304.       1462.        596.
    3        4929.       6286.       7487.      15420.       1500.
    4        4775.       3843.       5291.       6276.      13037.
    5        1376.       2111.       2285.       2402.       3202.
    6         568.        452.        609.       1306.       1269.
    7        1267.        586.       1022.       2160.       1478.
   ================================================================
  Total     14838.      15274.      21154.      29349.      21239.

   AGE       1992        1993        1994        1995        1996
   _____
    1          98.        133.          7.          0.         22.
    2         857.        792.       1079.        284.        775.
    3        1538.       3587.       4373.       8333.       2557.
    4        1201.       2137.       3069.       3586.       6783.
    5        6943.        761.        827.       1012.       1378.
    6        1190.       2990.        376.        162.        363.
    7        1121.        606.       1059.        541.        120.
   ================================================================
  Total     12948.      11005.      10790.      13918.      11998.

   AGE       1997        1998        1999        2000        2001
   _____
    1          14.         78.        108.        138.         26.
    2         392.       1269.       1038.       1709.        911.
    3        3170.       3316.       3975.       3882.       5430.
    4        1997.       3150.       2784.       5058.       4916.
    5        3303.       1070.       1974.       2006.       4577.
    6         444.       1455.        616.       1304.       1762.
    7         137.        440.       1535.        447.       2009.
   ================================================================
  Total      9456.      10778.      12030.      14543.      19630.

   AGE       2002        2003        2004        2005        2006
   _____
    1         205.         75.        385.         40.        613.
    2         297.       1527.        410.        954.       1804.
    3        3998.        898.       4064.        806.      10463.
    4        6867.       4825.        998.       4244.       2169.
    5        4056.       5376.       3874.        685.       4203.
    6        3418.       3132.       3060.       2942.        460.
    7        3792.       4790.       3294.       4039.       4276.
   ================================================================
  Total     22632.      20624.      16084.      13710.      23990.
```

Table F19. Stock size estimates from the NLLS Solution from the Gulf of Maine cod VPA

```
Stock Numbers Predicted in Terminal Year Plus One (2007)
 Age     Stock Predicted      Std. Error        CV

   2           22236.552    0.782439E+04    0.351871E+00
   3            4774.904    0.127142E+04    0.266271E+00
   4            7048.101    0.159402E+04    0.226164E+00
   5             633.289    0.170379E+03    0.269038E+00
   6             835.251    0.236830E+03    0.283544E+00

Catchability Values for Each Survey Used in Estimate
 INDEX      Catchability     Std. Error        CV

   1        0.582404E-04    0.860239E-05    0.147705E+00
   2        0.126160E-03    0.142872E-04    0.113246E+00
   3        0.214783E-03    0.223468E-04    0.104044E+00
   4        0.288356E-03    0.375643E-04    0.130271E+00
   5        0.388208E-03    0.652349E-04    0.168041E+00
   6        0.522207E-04    0.660338E-05    0.126451E+00
   7        0.113745E-03    0.134878E-04    0.118580E+00
   8        0.224243E-03    0.241392E-04    0.107647E+00
   9        0.374588E-03    0.452155E-04    0.120707E+00
  10        0.510921E-03    0.543947E-04    0.106464E+00
  11        0.685336E-03    0.102783E-03    0.149974E+00
  12        0.529229E-03    0.456272E-04    0.862144E-01
  13        0.442035E-03    0.515860E-04    0.116701E+00
  15        0.123752E-03    0.376908E-04    0.304567E+00
  18        0.142527E-04    0.172798E-05    0.121239E+00
  19        0.239785E-04    0.136277E-05    0.568330E-01
  20        0.246309E-04    0.111451E-05    0.452483E-01
  21        0.254867E-04    0.694829E-06    0.272624E-01
```

Table F20. Bootstrap estimates of precision and bias from the Gulf of Maine cod VPA

```
Bootstrap Output Variable: Stock Estimates (2007)


                NLLS            Bootstrap       Bootstrap       C.V. For
                Estimate        Mean            Std Error       NLLS Soln.

N   2           22237.          24662.          12247.          0.4966
N   3            4775.           5032.           1715.          0.3408
N   4            7048.           7248.           1788.          0.2466
N   5             633.            650.            183.          0.2818
N   6             835.            864.            243.          0.2808

                                                NLLS
                                                Estimate        C.V. For
                Bias        Bias        Per Cent    Corrected   Corrected
                Estimate    Std. Error  Bias        For Bias    Estimate

N   2           2425.        395.       10.9059      19811.      0.6182
N   3            257.         55.        5.3776       4518.      0.3796
N   4            200.         57.        2.8397       6848.      0.2611
N   5             17.          6.        2.6574        616.      0.2972
N   6             29.          8.        3.4264        807.      0.3008

                LOWER           UPPER
                80. % CI        80. % CI
N   2           11590.          40219.
N   3            3077.           7147.
N   4            5084.           9604.
N   5             427.            881.
N   6             566.           1173.
```

Table F21. Estimates of biological reference points from the parametric approach (SRFIT) using a Beverton-Holt stock/recruitment model.

Beverton Holt Stock Recruitment Relationship
Multiplicative Uncorrelated Lognormal Errors
23 Number_of_data_points 23
3 Number_of_parameters 3
221.829 Fit_negloglikelihood 221.829
0 Penalty_steepness 0
0 Penalty_slope 0
0 Penalty_unfished_R 0
221.829 Negative_loglikelihood 221.829
450.921 Bias-corrected_AIC 450.921
453.064 BIC
453.064

Parameter   Point_Estimate
****
15691.3 MSY 15691.3
0.28 FMSY 0.28
60303.6 SMSY 60303.6
10982.3 alpha 10982.3
0 log(alpha) 0
7879.1 beta 7879.1
0.86765 steepness 0.86765
8350.52 R_at_input_SMAX 8350.52
25000 Input SMAX 25000
198733 unfished_S 198733
10563.5 unfished_R 10563.5
0.626361 sigma 0.626361
N/A phi N/A
N/A sigmaw N/A
N/A last_residual_R N/A
N/A last_logresidual_R N/A
1.21673 expected_lognormal_error_term 1.21673
N/A prior_mean_steepness N/A
N/A prior_se_steepness N/A
N/A prior_mean_slope N/A
N/A prior_se_slope N/A
N/A prior_mean_unfished_R
N/A
N/A prior_se_unfished_R N/A
****

Table F22. Estimates of biological reference points from the non-parametric approach using a yield and SSB per recruit model.
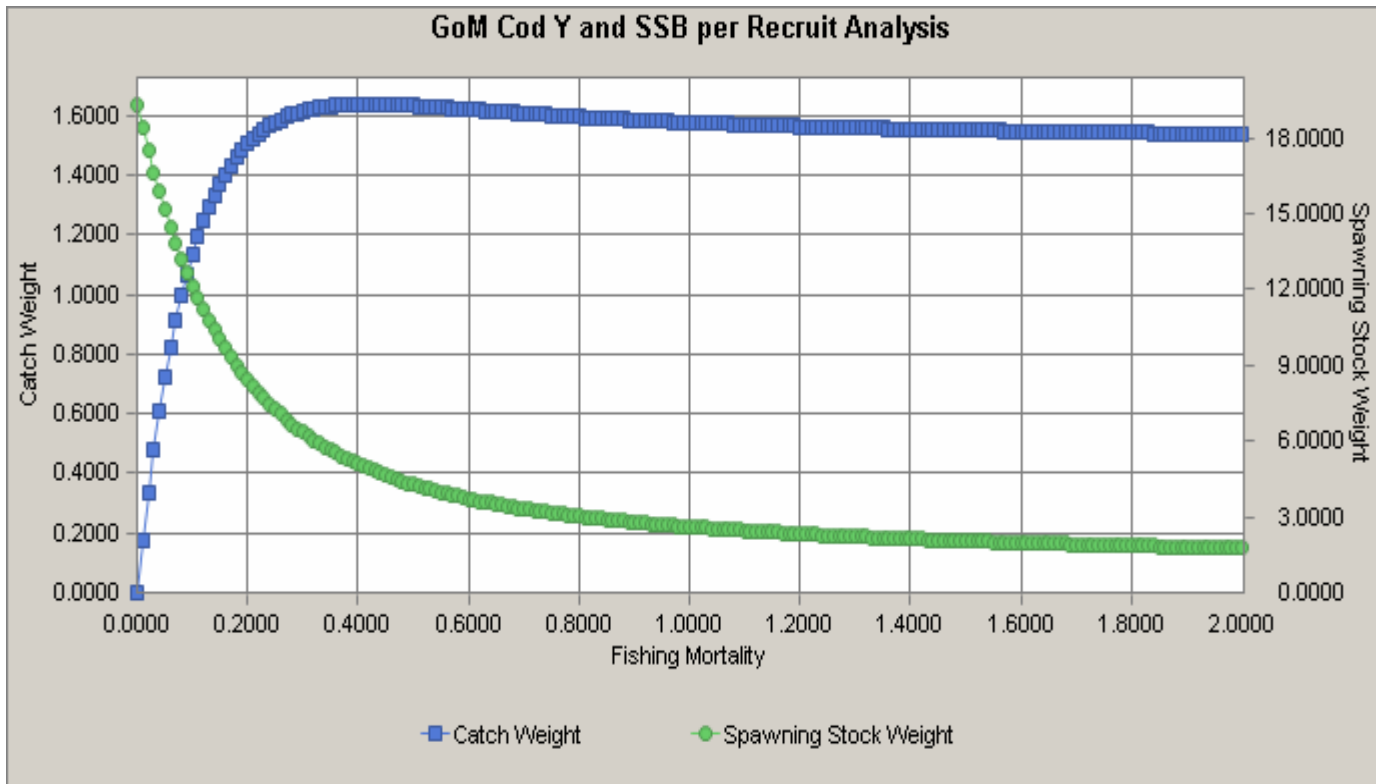
Yield and SSB per Recruit Input Data

Age	Partial Recruitment	Sel on M	Mean Wts Stock	Mean Wts Catch	Mean Wts SpStock	Maturity			
1	0	1	0.197	0.416	0.197	0.08			
2	0.0043	1	0.842	1.721	0.842	0.32	M = 0.2		
3	0.2418	1	1.941	2.333	1.941	0.73	Prop F	Prespawn	0.1667
4	0.9349	1	2.689	3.118	2.689	0.91	Prop M	Prespawn	0.1667
5	1	1	3.493	3.933	3.493	0.97			
6	1	1	4.606	5.143	4.606	0.99			
7	1	1	5.971	6.571	5.971	1			
8	1	1	7.895	9.037	7.895	1			
9	1	1	9.844	10.596	9.844	1			
10	1	1	11.322	12.348	11.322	1			
11+	1	1	14.119	14.119	14.119	1			

Yield and SSB per Recruit Results

	F	YpR	SSBpR	TBpR	Mean Age	Mean Gen	Exp Spws
F Zero	0	0	19.34094	21.19479	4.73072	8.7577	2.60448
F0.1	0.2033	1.50973	8.35096	10.07131	3.43996	6.73017	1.64303
Fmax	0.4174	1.63766	4.9258	6.54206	2.87597	5.33585	1.20274
F40%	0.2279	1.54953	7.73866	9.44366	3.34799	6.52869	1.57349

Gulf of Maine Cod
Total Commercial Landings

Figure F1. Total commercial landings of Gulf of Maine cod (NAFO Div. 5Y), 1893-2006

.
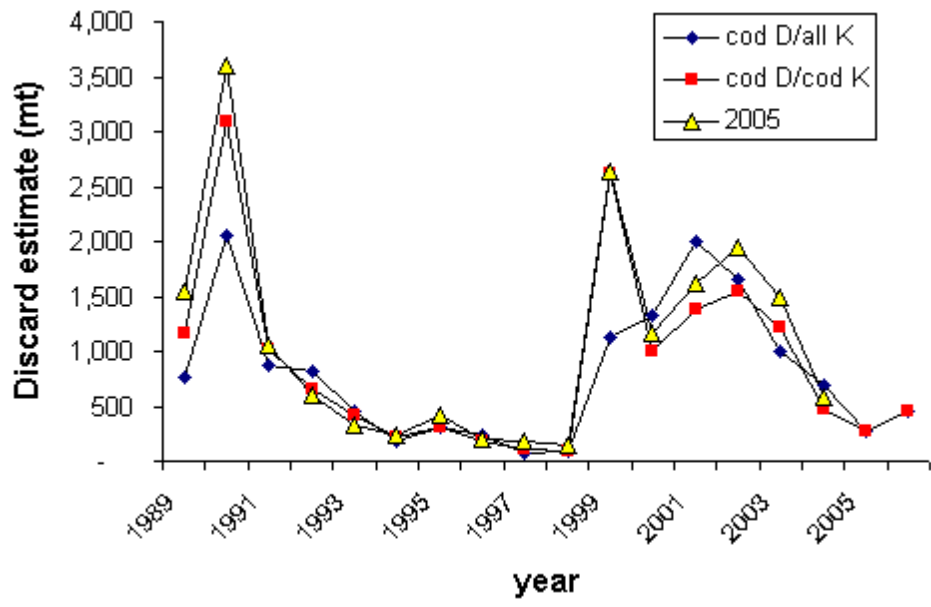
Figure F2. Discards estimates (mt) of Gulf of Maine cod using two SBRM methods
(cod discard/all kept and cod discard/cod kept) and a comparison with discards estimates
derived for GARMII in 2005.
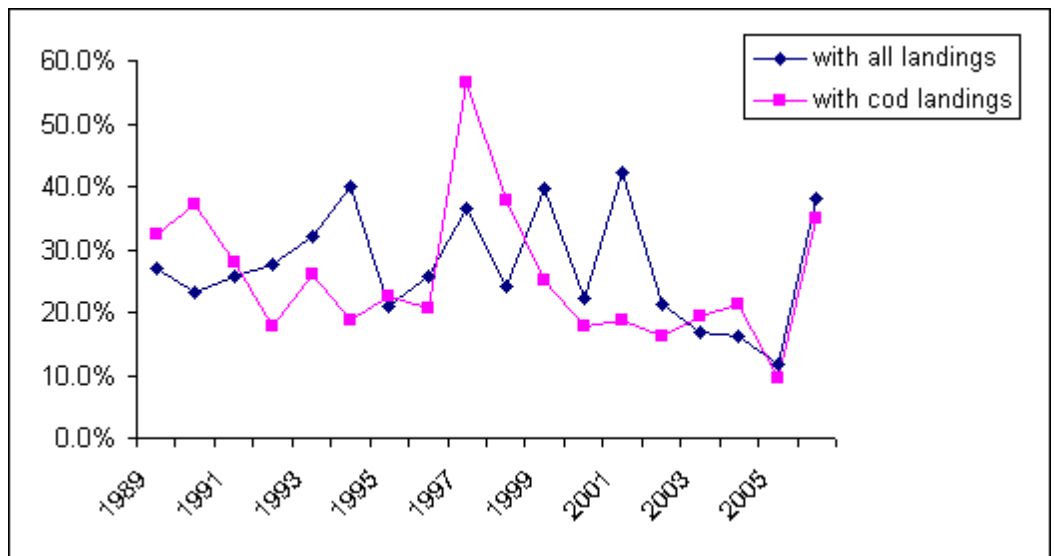
Figure F3. Precision of discards estimates (mt) of Gulf of Maine cod using two SBRM methods
(cod discard/all kept and cod discard/cod kept)

Gulf of Maine Cod
NEFSC Spring and Autumn Biomass Indices
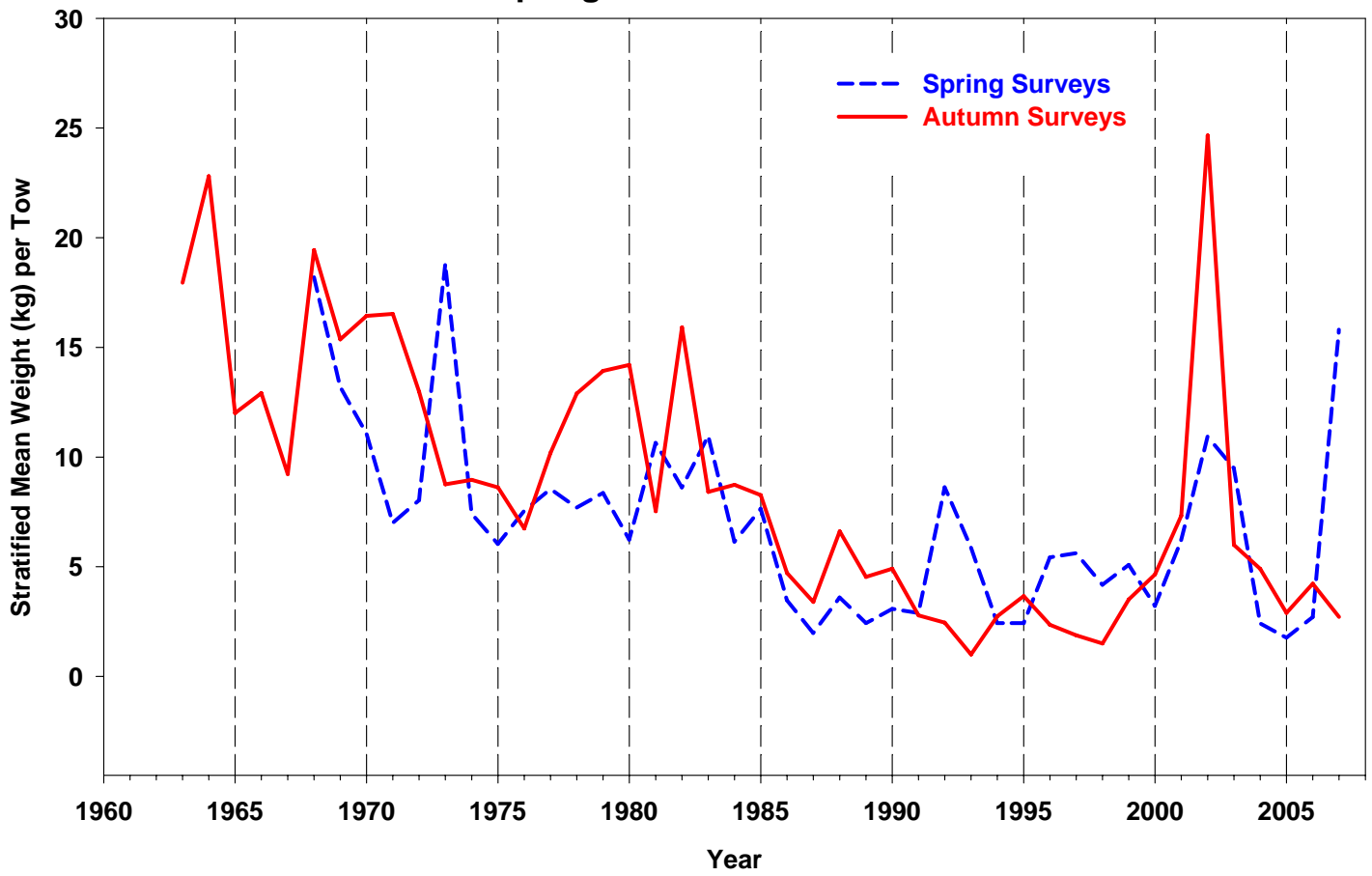
Figure F4. Biomass indices (stratified mean weight per tow) for Gulf of Maine cod from NEFSC autumn bottom trawl surveys.

Gulf of Maine Cod Autumn Survey Indices by Age
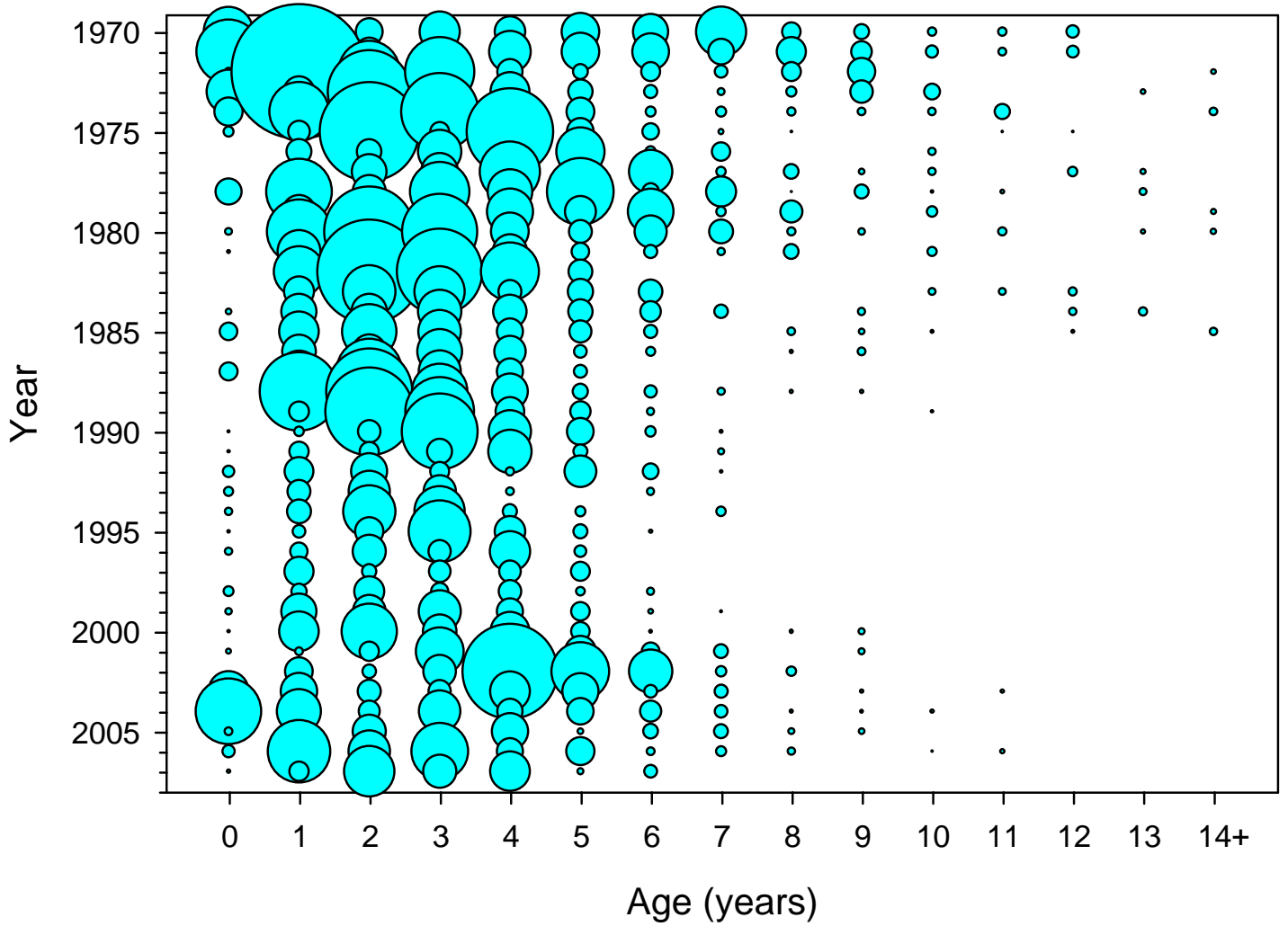
Figure F5. Relative age composition of Gulf of Maine cod taken in NEFSC autumn bottom trawl surveys.

NEFSC Autumn Survey: Yearclass Strength at Age 1
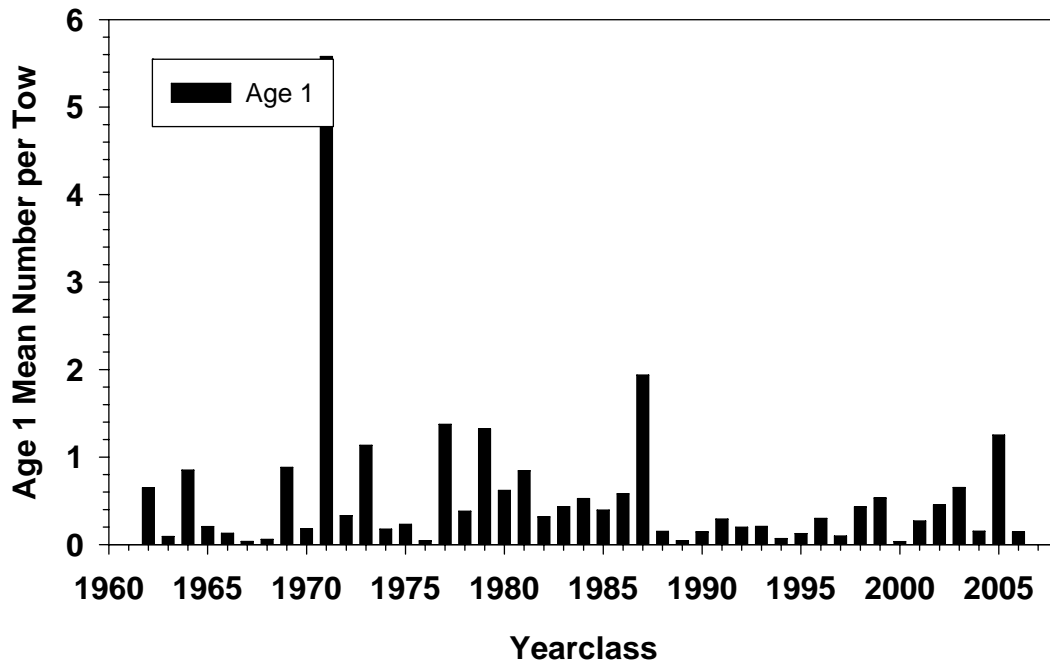
NEFSC Autumn Survey: Yearclass Strength at Age 2
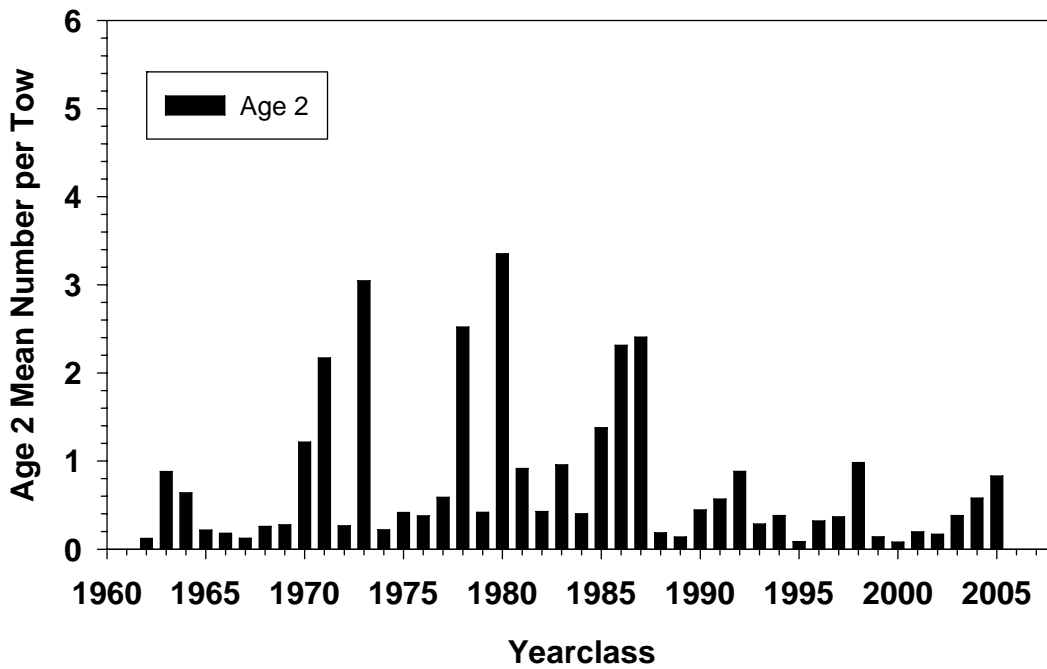
Figure F6.   Recruitment indices at age 1 and 2 for Gulf of Maine cod from NEFSC autumn bottom trawl surveys.

Average F
Ages 4 - 5

Spawning Stock Biomass
Total
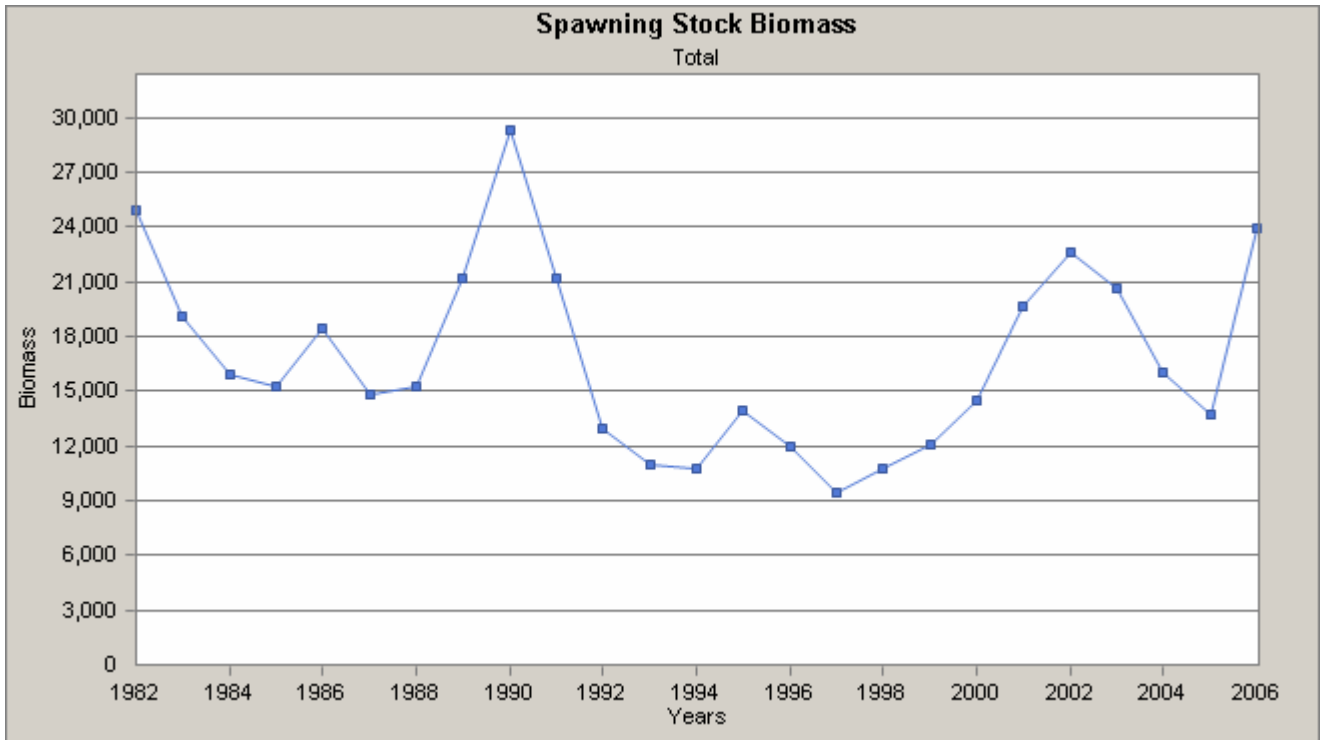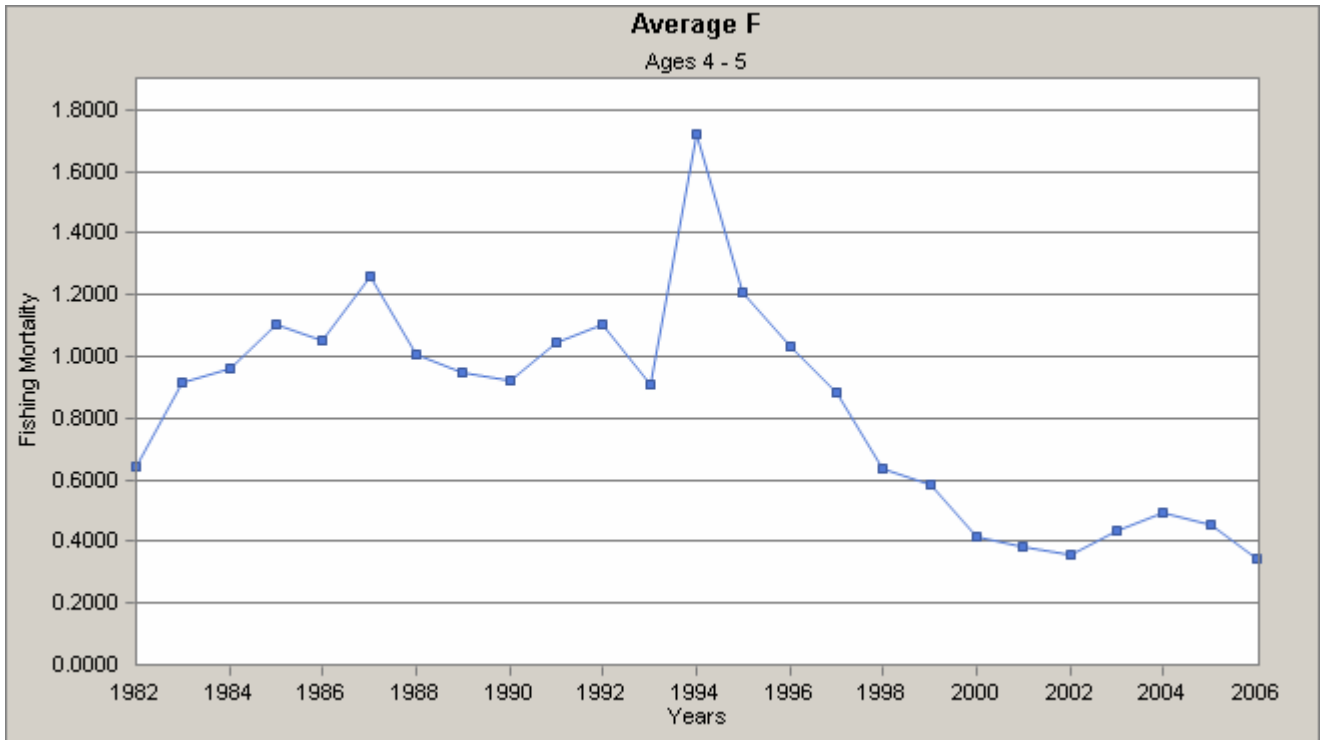
Figure F7. Trends in fully recruited F and spawning stock biomass derived from the VPA.
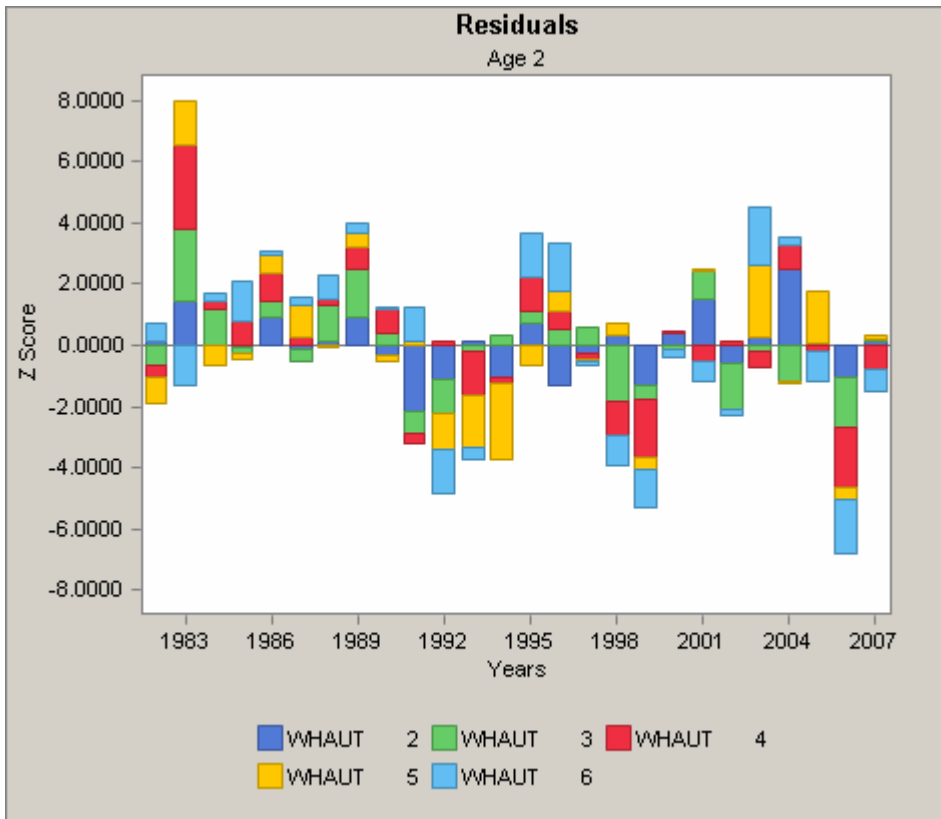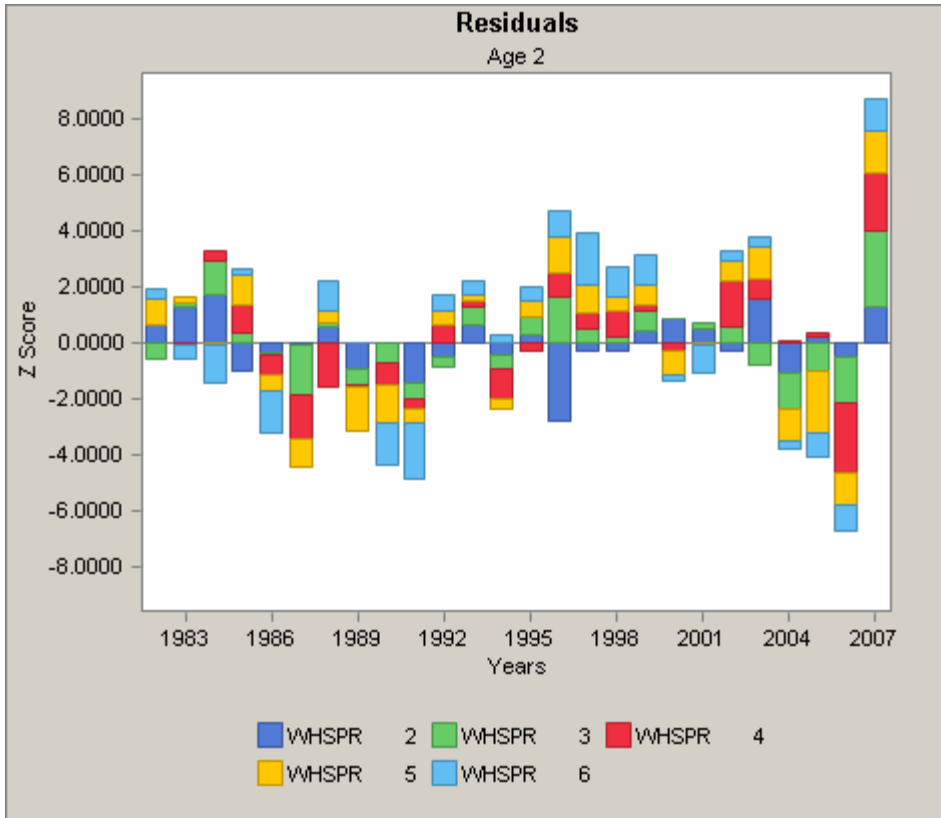
Figure F8a. Residual patterns of NEFSC spring and autumn age 2-6 bottom trawl
survey indices used to calibrate the VPA.
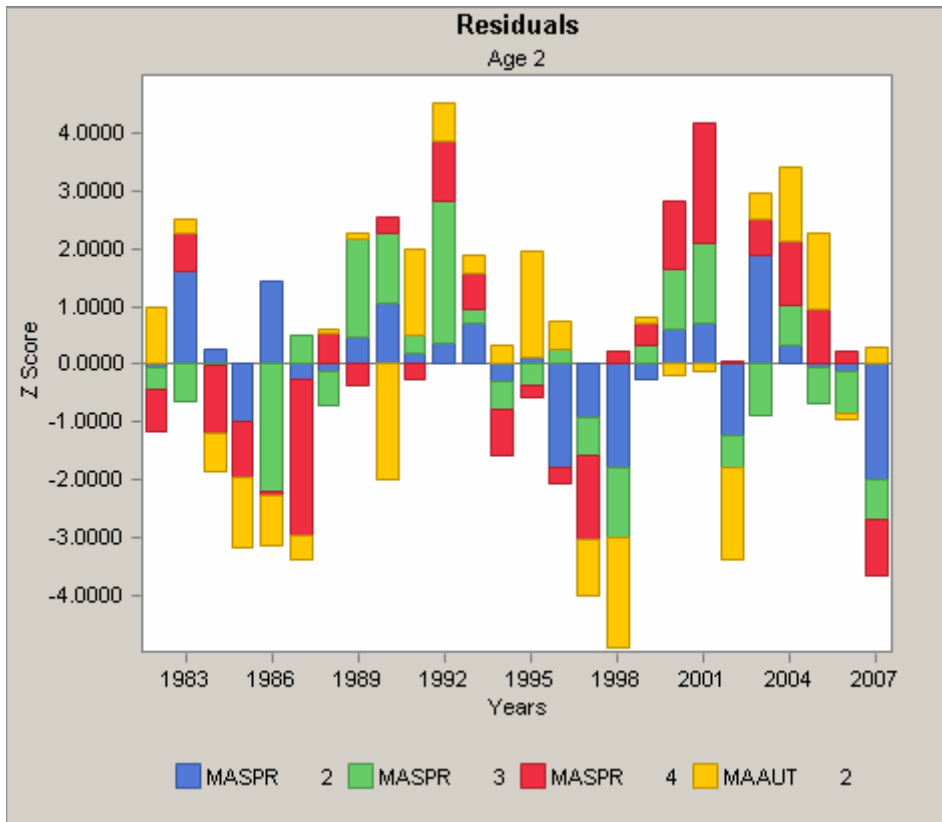
Figure F8b. Residual patterns of MADMF spring and autumn age 2-4 bottom trawl Survey indices used to calibrate the VPA.
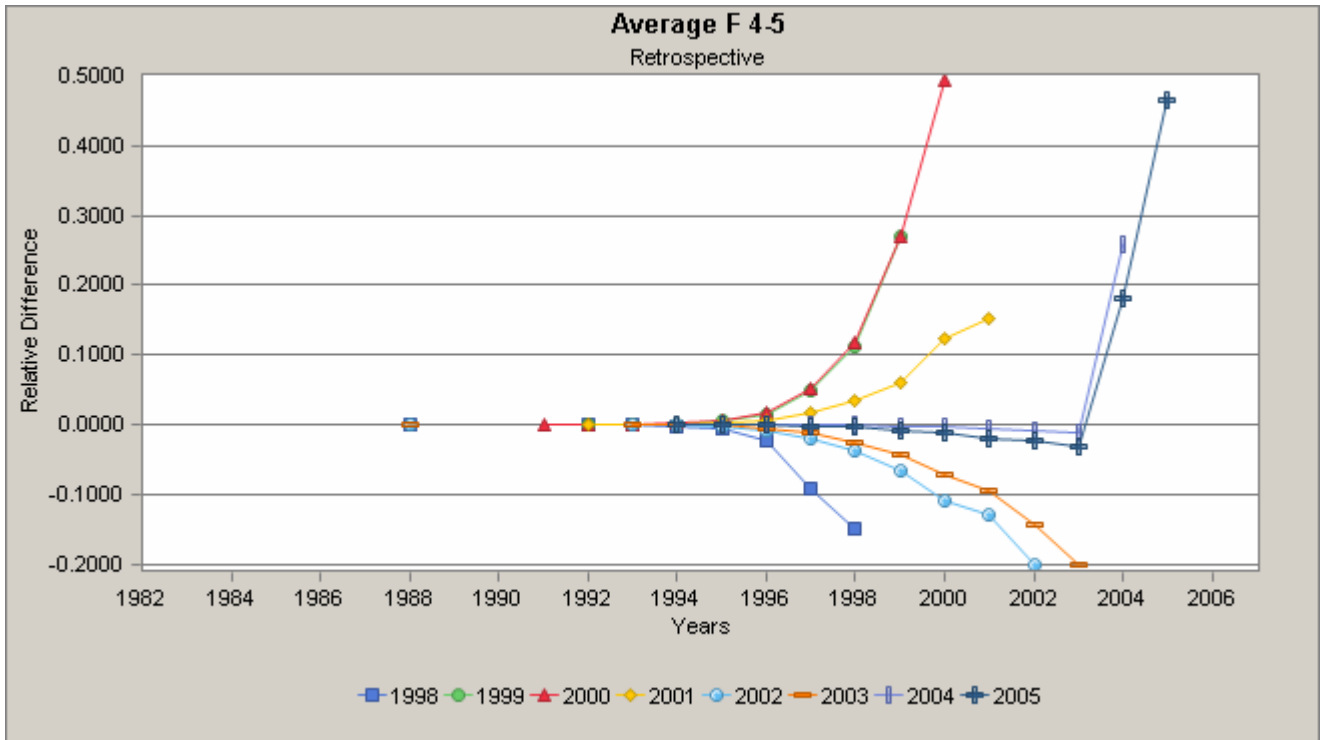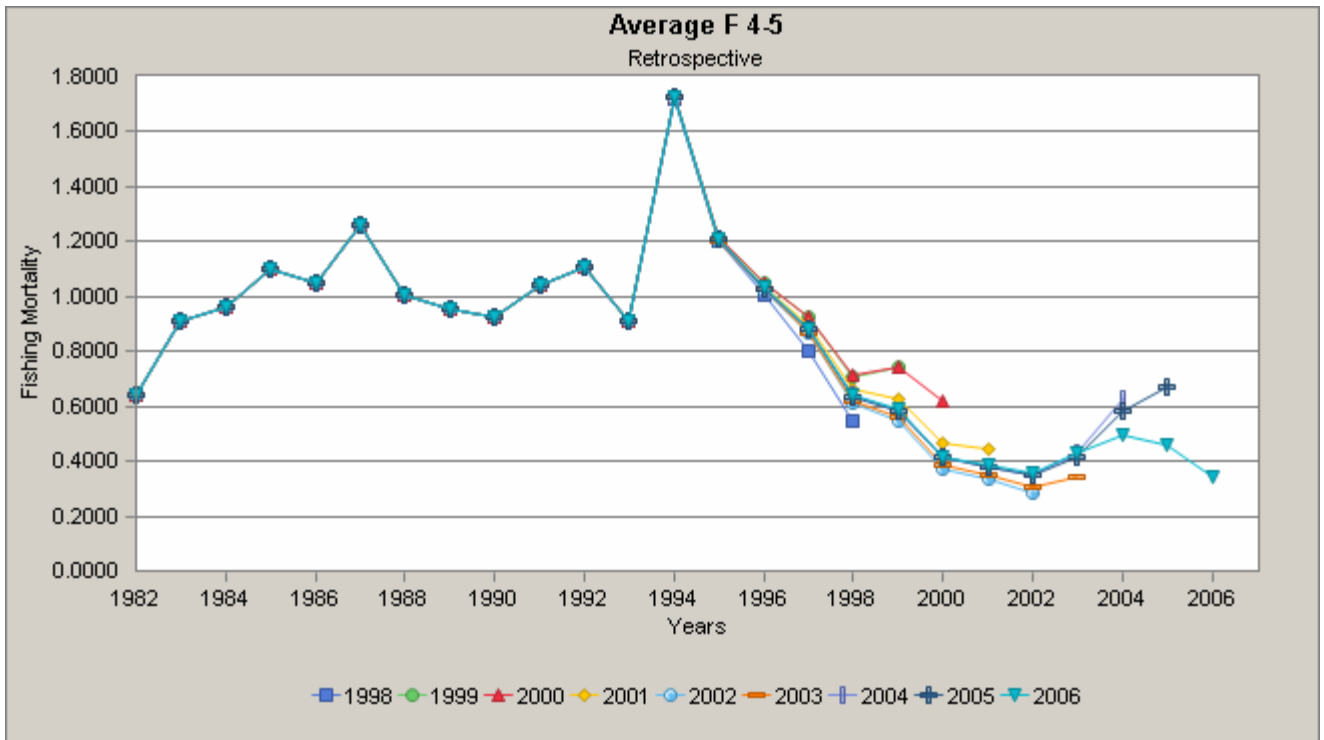
Figure F9a. Retrospective analysis of fully recruited F derived from the VPA.
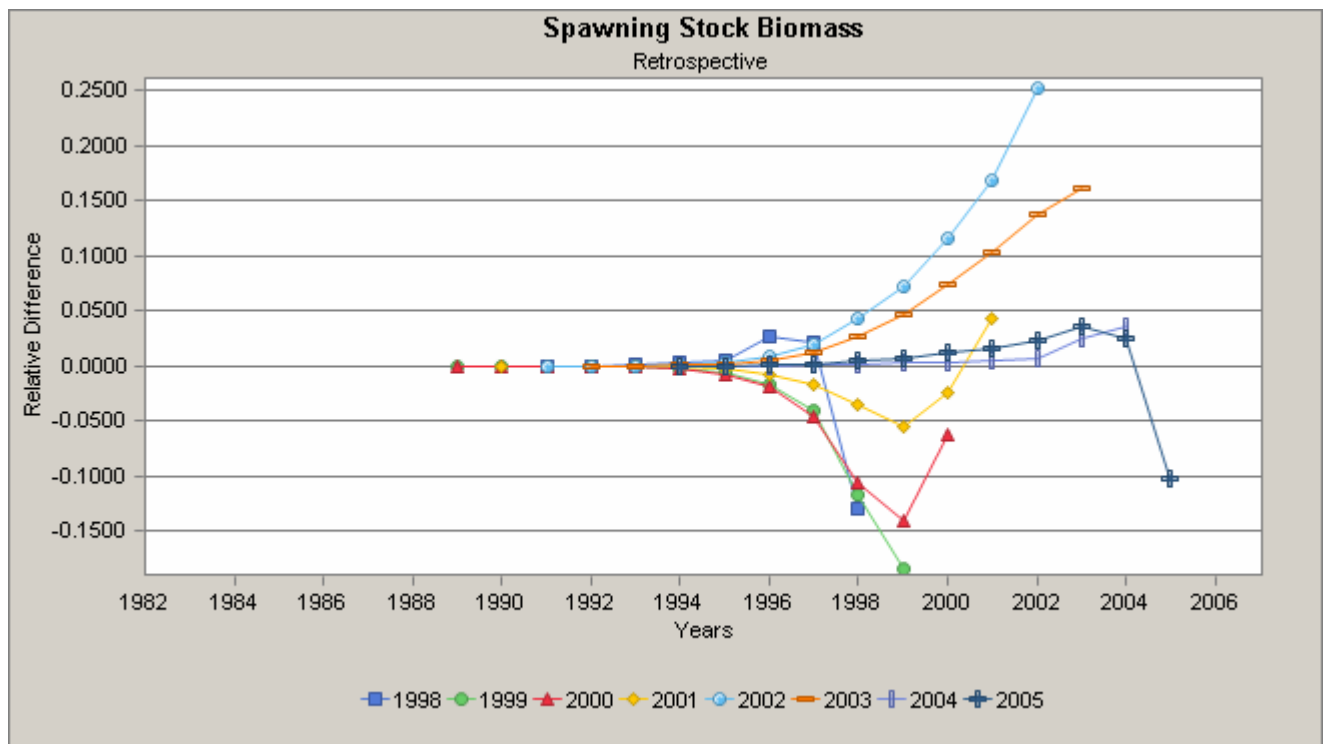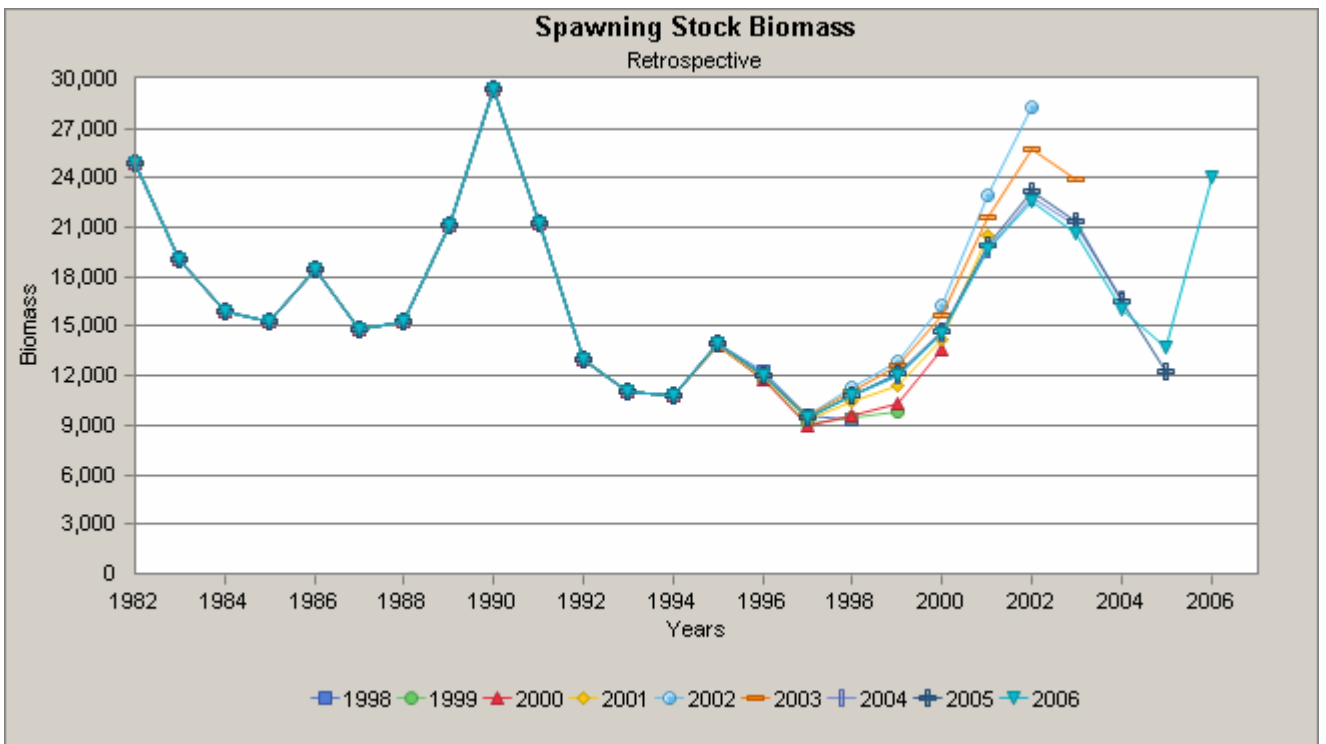
Figure F9b. Retrospective analysis of spawning stock biomass derived from the VPA.
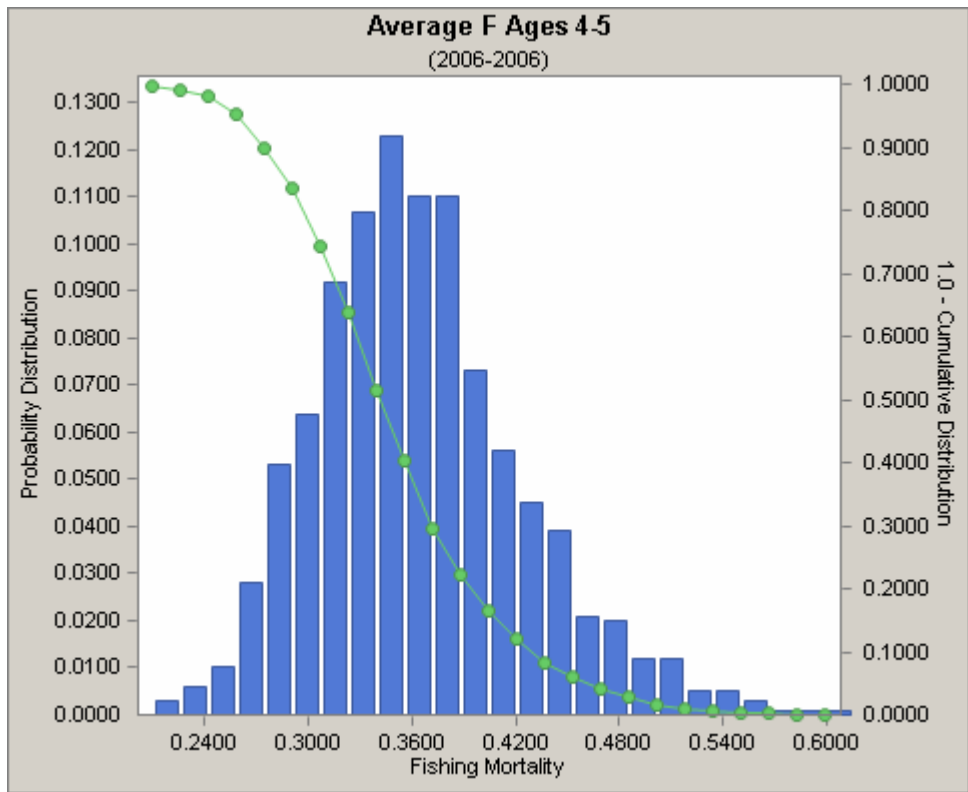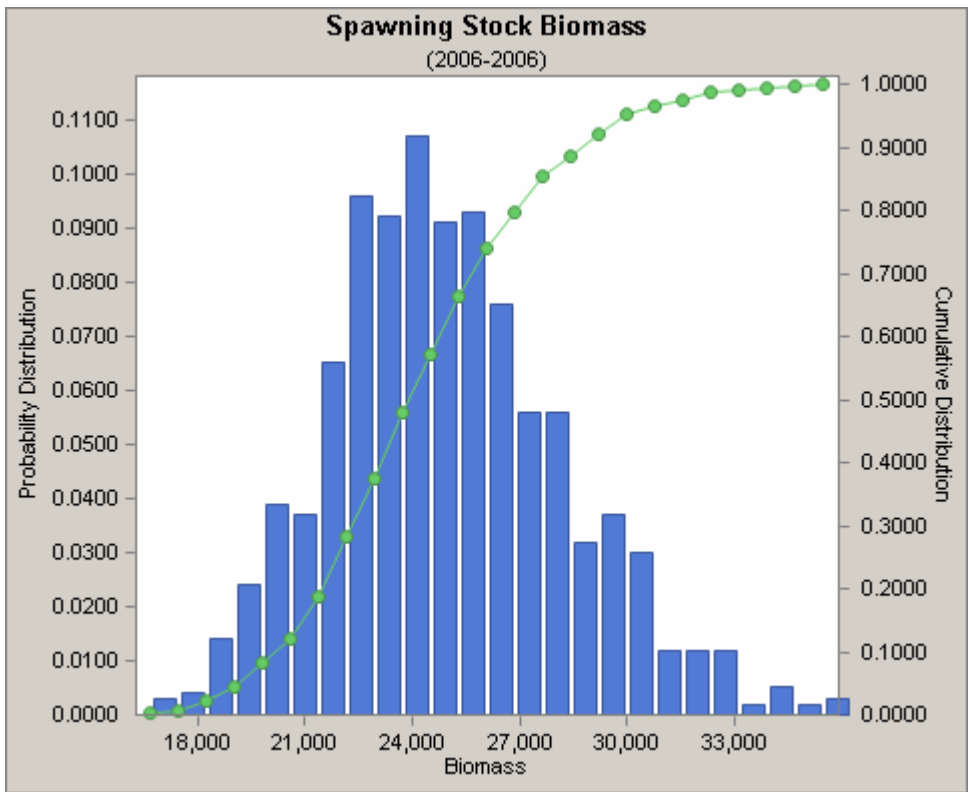
Figure F10. Probability distributions of VPA-based estimates of spawning stock biomass and fully recruited F in 2006.
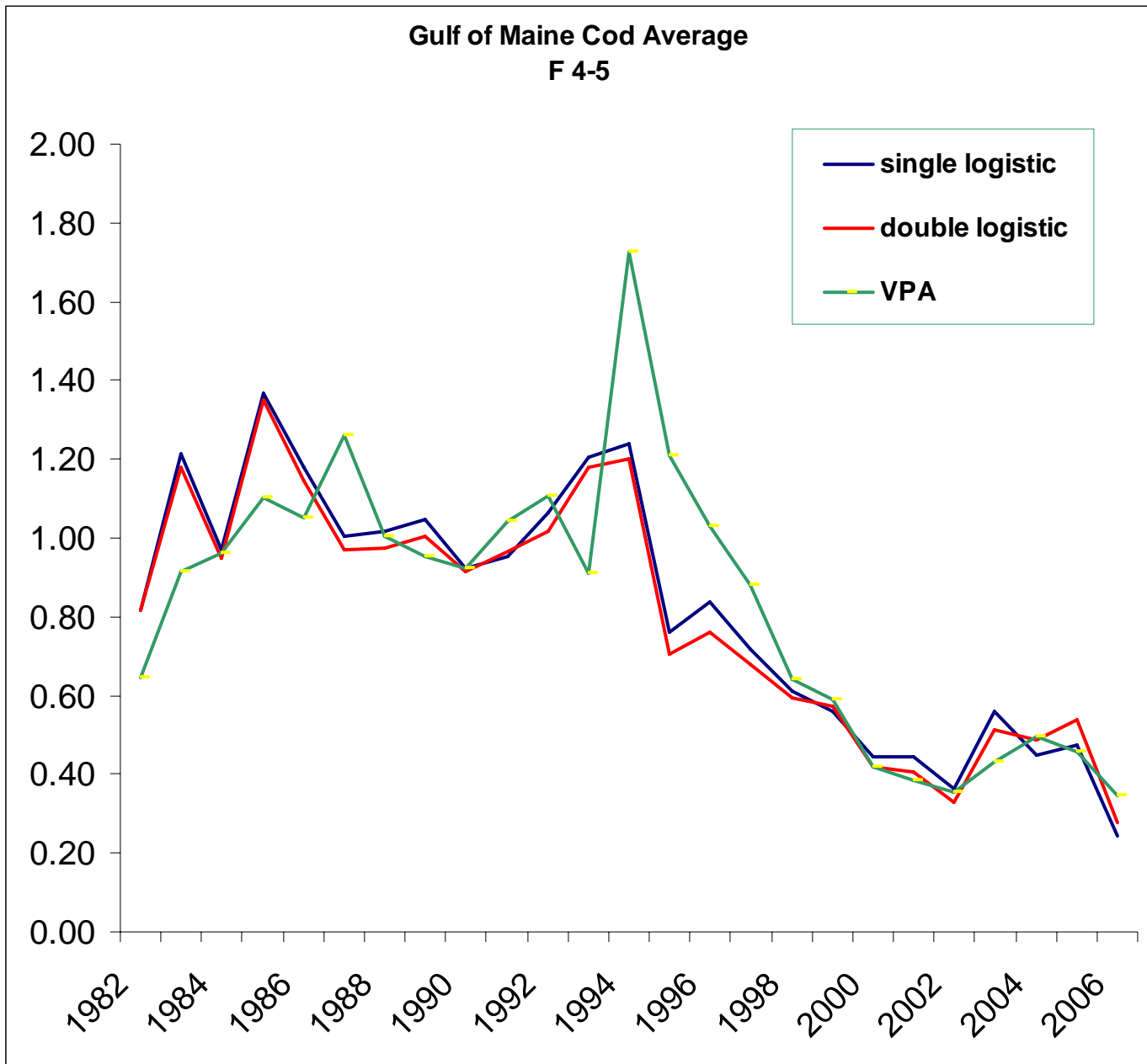
Figure F11. Comparisons of estimates of fully recruited F from the VPA model and the single and double Logistic fit of the ASAP model.

Single Logistic Fit
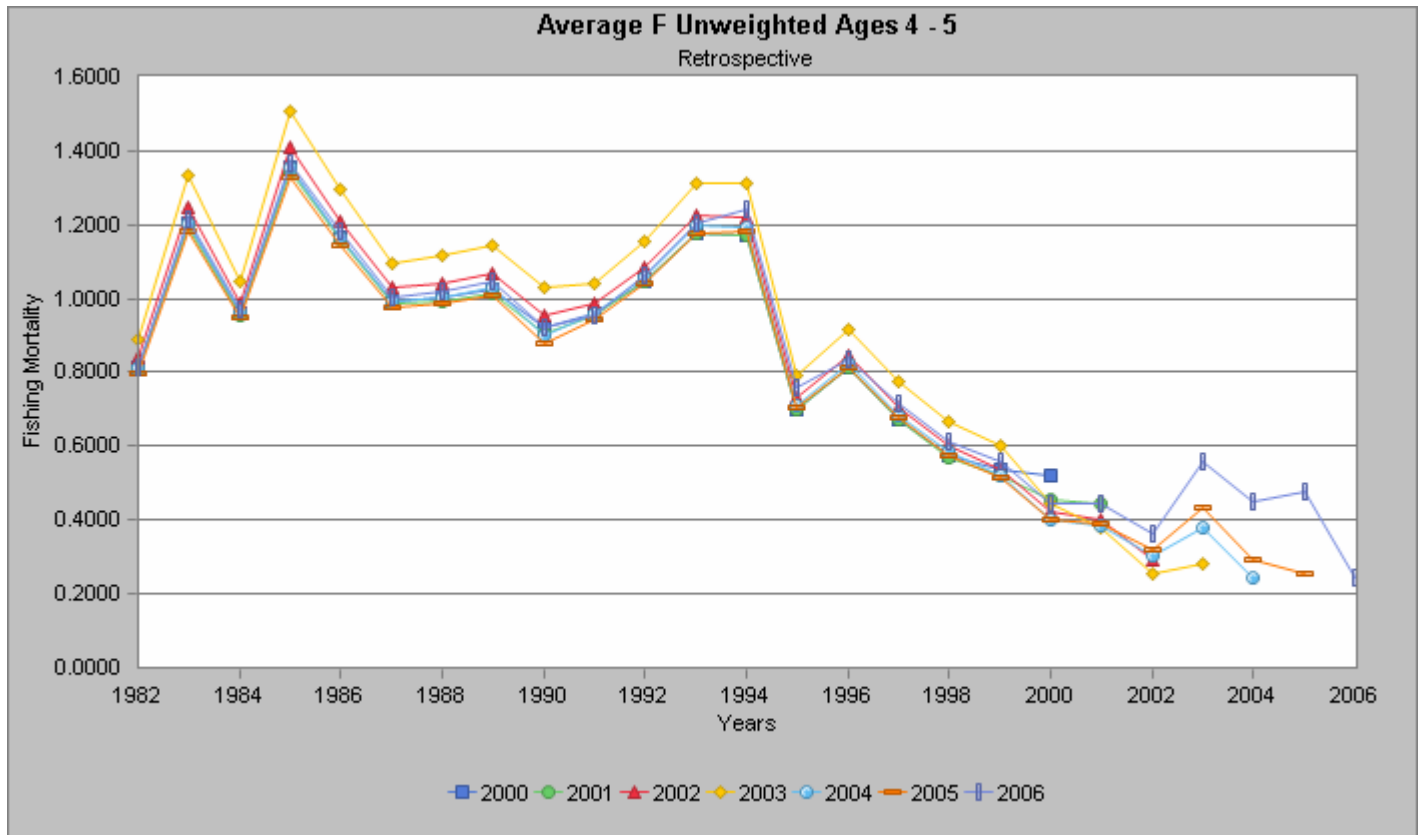
Double Logistic Fit
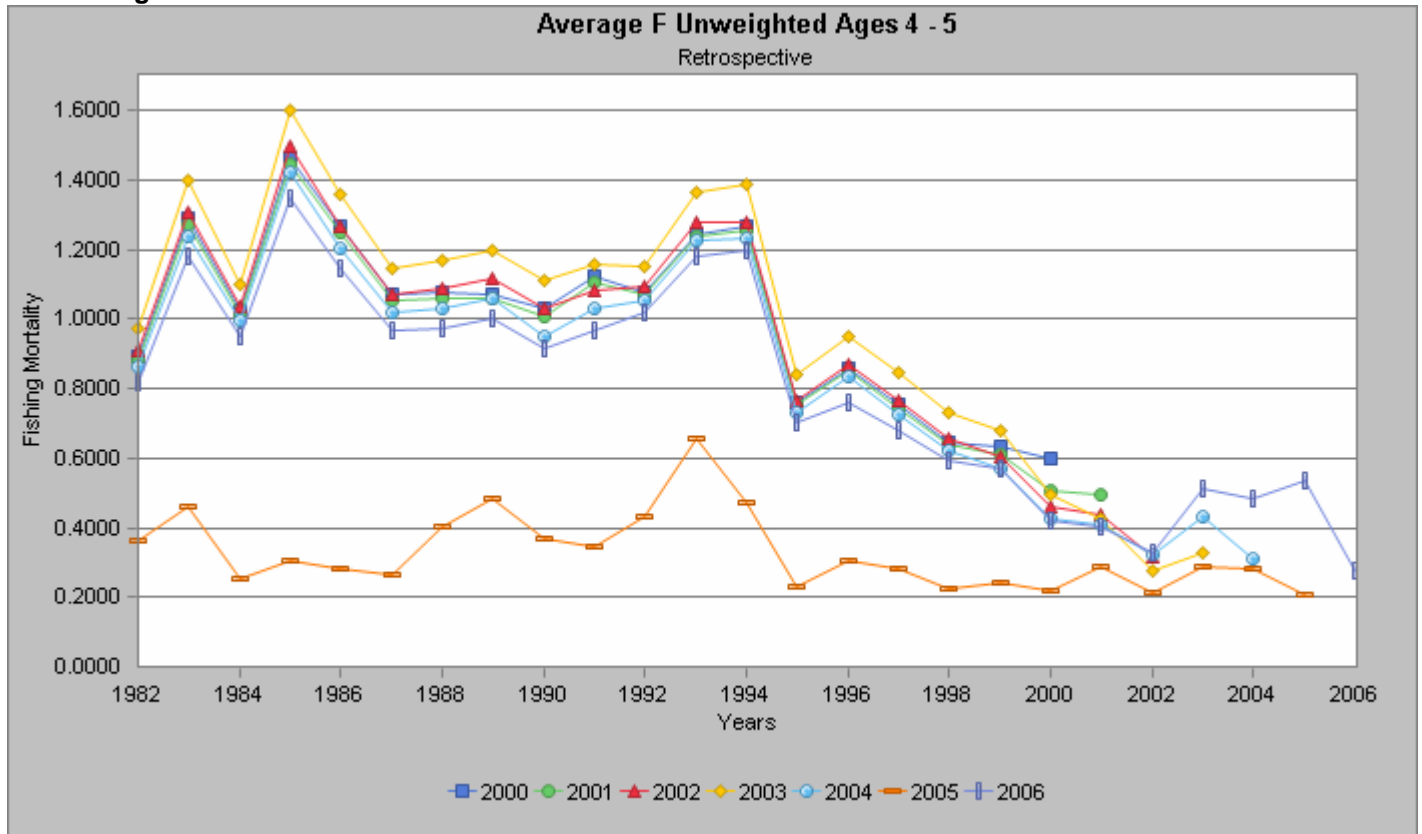
Figure F12. Retrospective analysis of fully recruited F from the ASAP single and double logistic fit

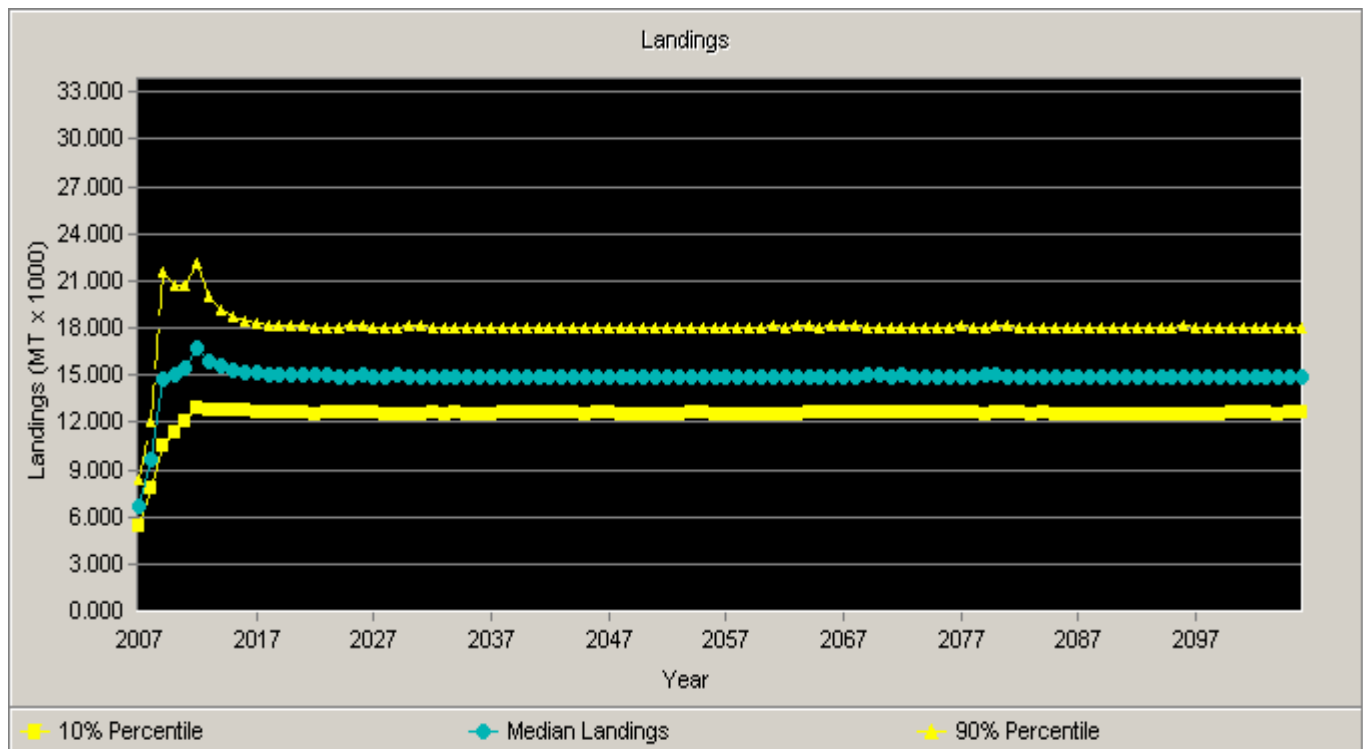Fmsy = 0.28, SSBmsy = 78,413 mt, MSY = 19,673 mt, Median recruitment = 10,971 million million
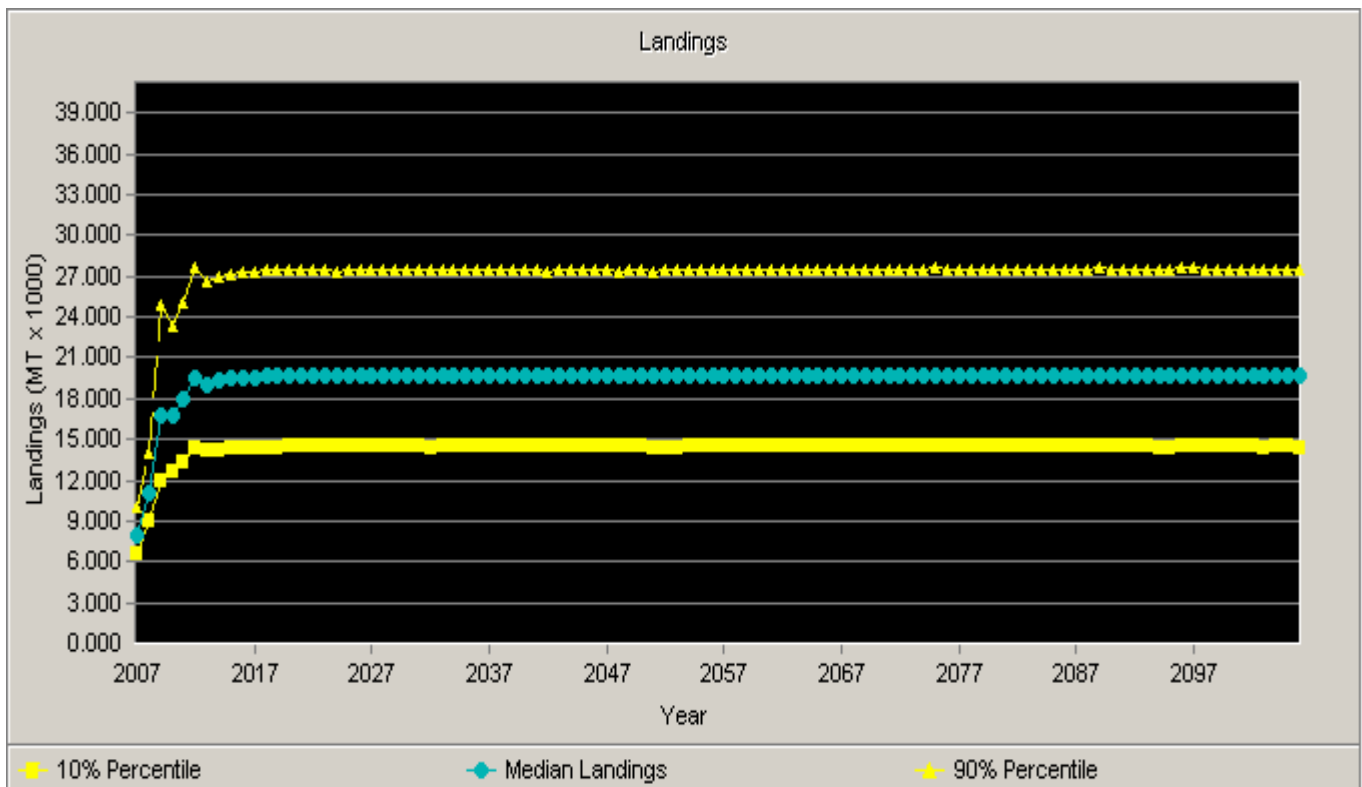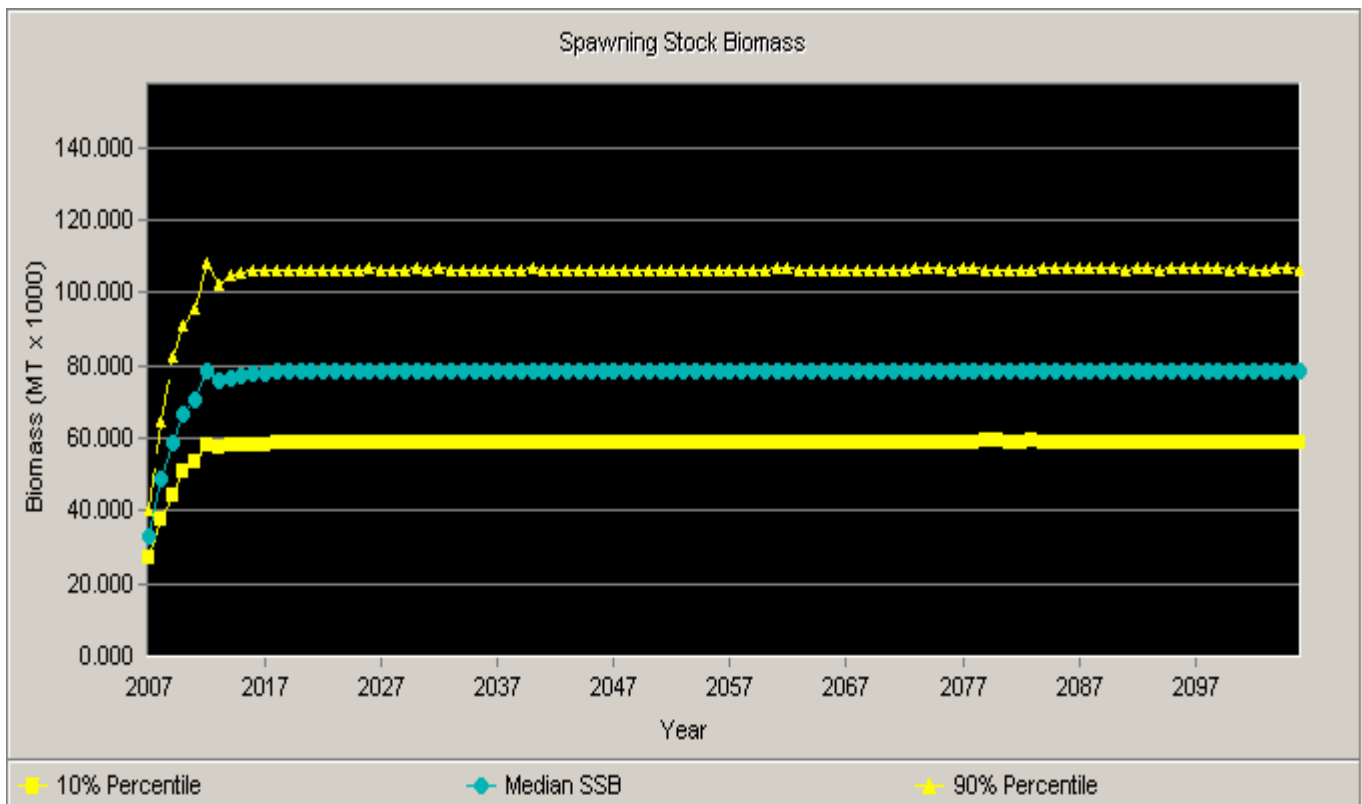
Figure F13. One hundred year equilibrium projections of spawning stock biomass and catches based on input parameters derived using the parametric approach.

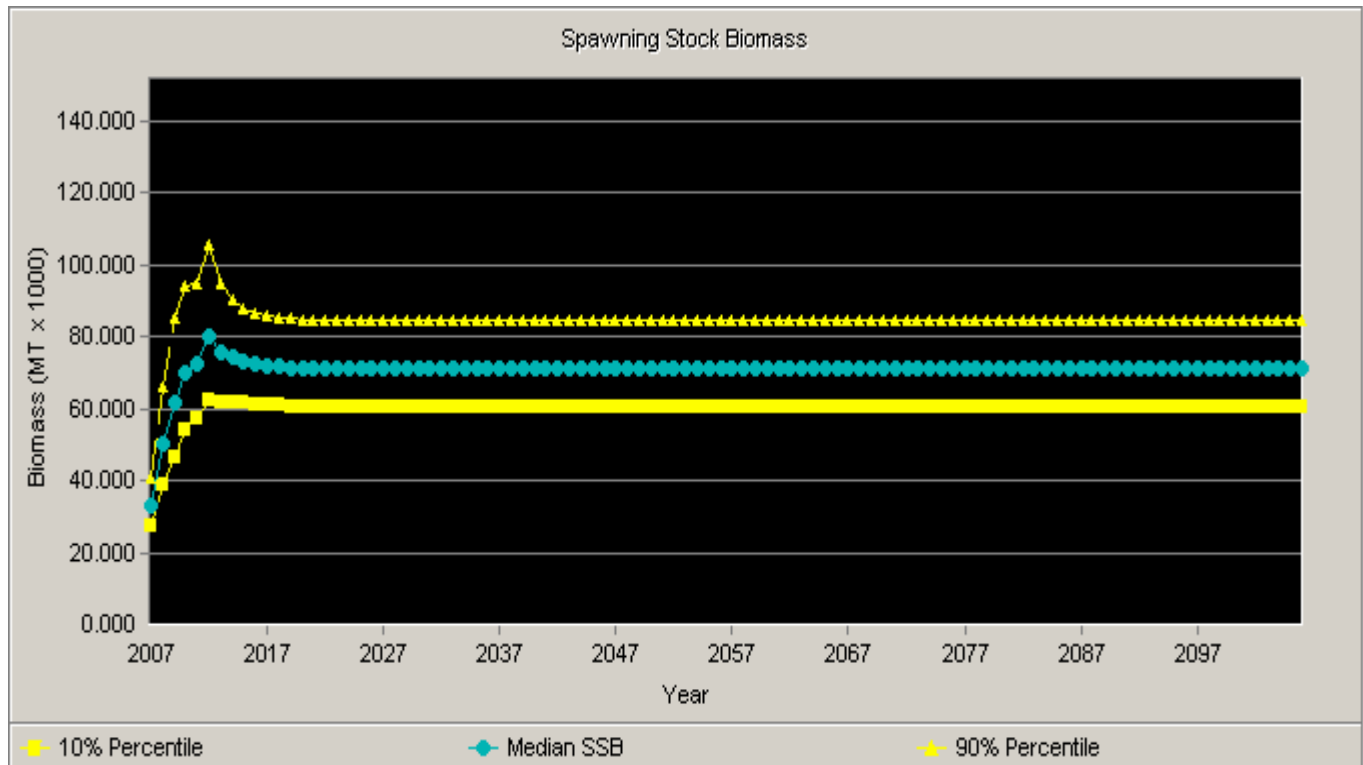Fmsy = 0.23, SSBmsy = 71,150 mt, MSY = 14,936 mt, Median recruitment = 9.466 million

Figure F14. One hundred year equilibrium projections of spawning stock biomass and catches based on input parameters derived using the non-parametric approach.