Working Paper 4I.

GARM III Biological Reference Point

Gulf of Maine Winter Flounder

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4I. Gulf of Maine (GM) winter flounder

1.0 Background

Gulf of Maine winter flounder was assessed in GARM II with ADAPT VPA model with catch through 2004 (NEFSC 2005). The GARM II assessment concluded that the stock is not overfished and overfishing is not occurring. Spawning stock biomass was estimated to be at 3,400 mt and fully recruited F = 0.13 in 2004. SSB at Bmsy was estimated to be at 4,100 mt and Fmsy = 0.43. The GARM II VPA possessed a severe retrospective pattern in F and a large overestimation of SSB. GARM II concluded that VPA results are too uncertain as a basis for performing projections.

Commercial and recreational landings were re-estimated from 1990 to 2006. Discards were re-estimated for the large mesh trawl and gillnet fisheries using discarded winter flounder to sum kept all species ratios from 1989-2006. The catch at age and catch at length was re-estimated through 2006. The utility of an updated VPA, SCALE and AIM models for the Gulf of Maine winter flounder assessment were examined.

2.0 Fishery

Commercial landings were near 1,000 mt from 1964 to the mid 1970s. Thereafter commercial landings increased to a peaked of 2,793 mt in 1982, and then steadily declined to 350 mt in 1999. Landings have been near 500 mt from 2000 to 2004. Landings have declined to a record low of 200 mt in 2006 (Table I1, Figures I1 to I5). The primary gear used was the otter trawl from 1964-1985 that accounted for an average of 95% of the landings. Otter trawl accounted for an average of 75% of the landings from 1986- 2001 with an increase in the proportion of the landings coming from gillnets (average of 20% from 1986-2001). Since 2001 the gillnet proportion has decreased slightly with an average of 15% of the landings (Figure I5). Gillnet landings has also shifted from occurring mostly in the first half of the year to a greater proportion of the gillnet landings coming from the second half. Since 1999 around 95% percent of the landings are taken in Massachusetts from statistical area 514 (Figure I4).

Recreational landings reached a peak in 1981 with 2,554 mt but declined substantially thereafter (Table I2, Figure I6). Landings have been less than 100 mt since 1995, with the lowest estimated landings in 2004 of 19 mt. Recreational landing weight was re-estimated using the expanded numbers at length and a length weight relationship by halfyear for input to the Scale and Aim models.

In the commercial fishery, annual sampling intensity varied from 6 to 310 mt landed per sample during 1982-2004. Overall sampling intensity was adequate, however temporal and market category coverage in some year was poor (Table I3). Samples were pooled by halfyear when possible. In 1982 mediums were pooled with unclassified by halfyear, in 1985, 1995,

2005, and 2006 smalls were pooled with mediums, the large samples from adjacent years were used for the lack of samples in 1996, 1999, and 2001. Sampling coverage may have been poor but length frequency samples appeared relatively constant over time and there was a substantial amount of overlap between market categories which help justify the pooling used in the assessment. Lengths of kept fish from observer data were used to supplement length data of unclassified fish. Kept fish lengths taken from gillnet trips in the observer data were used to characterize the gillnet proportion of the landings (Table I4). The decline in landings has made it difficult to get samples from the medium and large market categories in recent years. Catch at length was also estimated using only observe kept length measurements from 1999 to 2006. Characterization of the landings using the observer data produced expanded catch at length distributions similar to the length expansions using the port samples by market category for years which had relatively good port sampling (Figures I7 and I8).

Discards were estimated for the large mesh trawl (1982-2006), gillnet (1986-2006), and northern shrimp fishery (1982-2006) (Table I5 through I7). The survey method was used in estimating both the discard and proportion discards at length for the large mesh trawl fishery from 1982-1988 (Mayo et al. 1992). Observer discard to landings of all species ratios were applied to corresponding commercial fishery landings to estimate discards in weight from 1989 to 2006. VTR large mesh otter trawl discards to landings of winter flounder ratios were updated but were no longer used to estimate the discards. The Fishery Observer length frequency samples were judged inadequate to characterize the proportion discarded at length from 1989 to 1998 for the large mesh trawl fishery and the length proportion from the survey method was used to characterize the size distribution of discarded fish. Observer length sampling increased in 1999 and were used to characterize the large mesh trawl discards from 1999 to 2006. The Fishery observer sum discarded to landing of all species ratios were used for estimating gillnet discard rates. Observer sum discarded to days fished ratios were used of the northern shrimp fishery since landing of winter flounder in the shrimp fishery is prohibited. The observer length frequency data for gillnet and the northern shrimp fishery were used to characterize the proportion discarded at length. The sample proportion at length, converted to weight, was used to convert the discard estimate in weight to numbers at length. As in the southern New England stock (NEFSC 1999), a 50% mortality rate was applied to all commercial discard data (Howell et al., 1992). Numbers at ages were determined using NEFSC/MDMF spring and NEFSC fall survey age-length keys.

A discard mortality of 15% was assumed for recreational discards (B2 category from MRFSS data), as assumed in Howell et al. (1992). Discard losses peaked in 1982 at 140,000 fish. Discards have since declined to 6,000 fish in 2005 and 2006 (Table I2, Figure I6). Since 1997, irregular sampling of the recreational fisheries by state fisheries agencies has indicated that the discard is usually of fish below the minimum landing size of 12 inches (30 cm). For 1982-2004, the recreational discard has been assumed to have the same length frequency as the catch in the MDMF survey below the legal size and above an assumed hookable fish size (13 cm). The recreational discard for 1982-2004 is aged using NEFSC/MDMF spring and NEFSC fall survey age-length keys.

A summary of how the catch at age was constructed can be seen in Table I8. The re-estimated discards for the large mesh trawl and gillnet fisheries are on the same order of magnitude with

the previous GARM II estimates (Figure I9). However, discard estimates from 1998 to 1992 using the survey filter method were higher than estimates from the new discard to kept all observer ratios. The predicted landings using the kept to landing of all species ratio are also on the same order of magnitude with the dealer landings (Table I9, Figure I10). Decreases in the catch at age components are shown in Table I10 and I11 and Figure I11. Mean weights at age and the total catch at age are given in Figures I12 and I13.

3.0 Research Surveys

Mean number per tow indices for the NEFSC and the Massachusetts Division of Marine Fisheries (MDMF) spring and fall time series are presented in Table I12 and Figures I14 through I17. All of the indices generally show a slight decrease in the population in the late 1980s from a high in the early 1980s with low abundance remaining through the early 1990s. All of the indices show signs of increase abundance starting in 1998 and 1999. Since 2001 the indices indicate a decrease in abundance. The MDMF survey catchability is on the order of 60 to 100 fish per tow while NEFSC survey catchability is on the order of 4 to 14 fish per tow. Age data for the MDMF fall survey are not available. The NEFSC fall ages where used to age the MDMF fall index.

Maine and New Hampshire have been conducting an inshore bottom trawl survey in the Spring since 2001 and in the Fall since 2000 (Figures I18 to I21). These survey indices are relatively flat over the time series with slightly higher abundance in 2004 (Figure I21). Comparison of the Spring and Fall surveys show similar trends. Age information for this index will not be available for the GARM III assessment.

The Seabrook Nuclear Power Plant in New Hampshire has conducted a monthly bottom trawl survey at 3 fixed sites since 1985. The monthly survey was broken down to a spring and fall survey. No survey was conducted in 1993. This survey also shows an increase in the number of fish in the late 1990s (Figure I22). However this survey does not show as much of a recent decline in the stock as the NEFSC and MDMF surveys. The Seabrook fall index is not used in for tuning due to a lack of sampling in more recent years at one of the three stations because of the presences of lobster gear. Only age 1 and age 2 indices estimated by length slicing was used in the Scale model from this survey. Very few fish over 30 cm are caught in this survey. Some correspondence between the estimated age 1 and 2 indices can be seen in the indices (weak 1999 and strong 2003 yearclass) (Figure I23).

Normandeau Associates, Inc. (2000-2006) and the Massachusetts Division of Marine Fisheries (1995-1999) conducted an area swept estimate of winter flounder in the Western Cape Cod Bay to assess impacts of the Pilgrim Nuclear power plant. Thousands of fish were measured in each year from 1995 to 2007 from a spatially limited area. A difference in the size distributions by sex is evident in the data (Figure I24).

An examination of the survey catch per tow at length was conducted to determine the ability of the survey in tracking cohorts. Surveys catch per tow at length were plotted with alternating Spring and Fall surveys over time (Figures I25 to I26). Yearclasses were eyeballed using the growth information. The growth of cohorts in the younger ages can be seen in the MDMF

spring and Fall surveys. The younger length modes are more difficult to observe in the NEFSC survey which has a lower catchability. However the MDMF survey appears to have lower catchability at larger sizes (30+cm) which was also reflected in the GARM II VPA estimates of Qs for the older fish. The NH/ME survey catches relatively few fish over 30 cm (Figure I27). Length modes also did not appear to match the MDMF survey for young fish. Aging of the NH/ME samples will be needed to determine if slower growth exists in inshore waters north of Massachusetts. Uncertainty in the age structure makeup of this survey precludes its use in the assessment models at this time. There was relatively good correspondence between the estimated age index by slicing the survey length frequencies and the actual index at age for both the NEFSC and MDMF surveys (Figures I28 through I31). The raw length frequency data suggests the occurrence of a strong 1998 yearclass evident in both the MDMF and NEFSC surveys. However the detection of this yearclass as it growths above legal size is more difficult to discern (Figure I32 and I33). A relatively weak 1999 and stronger 2003 yearclasses can also be seen in the indices.

4.0 VPA and SCALE Model Results

Both the VPA and SCALE model suffer from unstable estimates of fishing mortality and population abundance. There are conflicting trends between the relativity stable age 1 and 2 recruitment indices and a large decline in the catch over the time series. A decline in the 4+ age indices at the end of the time series also contributes to the estimation difficulties.

Abundance indices at age were available from several research surveys: NEFSC spring bottom trawl ages 1-8+, NEFSC fall ages 1-8+ (advanced to tune January 1 abundance of ages 2-8+), 1-5, Massachusetts spring ages 1-8+, and Massachusetts fall ages 0-8+ (advanced to tune January 1 abundance of ages 1-8+) (Figures I34 through I36). GARM II assessment survey indices were selected for inclusion in VPA tuning based on consideration of the partial variance in a VPA trial run including all indices, residual error patterns from the various trail runs, and on the significance of the correlation among indices and with VPA abundance estimates from the trail run including all indices. The same VPA configuration used in the GARM II 2004 assessment was used for the updated GARM III assessment.

The updated assessment showed a severe pattern in the residuals (Figure I37). The VPA also exhibits a severe retrospective pattern in F, recruitment, and a large overestimation of SSB (Figure I38). Splitting all of the surveys between 1993 and 1994 did improve the retrospective pattern (Figure I39). A residual pattern still exists within each survey block (1982-1993 & 1994-2006) for the younger ages (Figure I37). Splitting the surveys allows the model to estimate further declines in abundance with higher F at the end of the time series (Figures I40 and I41). The split survey model is less constrained by the conflicts between the large decline in the catch and the surveys abundance of the older fish (4+) at the end of the time series.

The use of a simple forward projecting model that tunes to length data for larger fish and indices of recruitment at age (SCALE) was investigated as an alternative model. Recruitment indices at age were estimated by length slicing due to questions of smearing across ages in the age length keys. The assumed negligible error in the catch for the VPA was questioned with the poor sampling of the commercial landings data. The SCALE modeled the population with

the sexes separated (Figure I42). Females grow larger and appear to have a lower natural mortality rate than males (Figures I43 and I44). A natural mortality of 0.2 was assumed for females and 0.3 for males. There was little change in the female 3 year moving average maturity using MDMF spring survey (Figure I45). A logistic maturity estimate using all years combined (1982-2007) from the spring MDMF survey was used for both the VPA and SCALE model (Figure I46).

The retrospective pattern in the SCALE model was very similar to the retrospective pattern seen in the VPA (Figure I47). The scale model can not fit the age 1 and 2 recruitment indices along with the trends in the catch, 30+ cm abundance indices and 30+ cm survey length frequencies. Lower weights on the recruitment indices and a low penalty on recruitment variation were used to allow the model to produce a lack of fit to the recruitment indices so that a larger initial population in 1982 can be estimated by the model. The model needs to estimate a declining trend in recruitment to fit the trend in the catch and the adult abundance in the surveys. Splitting the surveys had the same effect as in the VPA (Figure I48). This allowed the model to estimate further declines in the recruitment indices to produce a closer fit to the catch. Comparisons between the non-split and split survey SCALE runs can be seen in table I13 and Figure I49 through I51. The splitting of the survey results in about a doubling of the survey qs (Table I14). SCALE model results for the split run are given in Appendix I1.

5.0 Biological reference points (BRPs)

Stock recruit relationships from the split VPA and SCALE model are shown in Figure I52. Stock recruit reference points were not developed because of a poor stock recruit relationship and uncertainty with the estimated recruitment at the beginning of the time series. The VPA appears to produce a linear relationship between stock and recruitment. Empirical biological reference points were developed with $F_{40\%}$ as a proxy for F_{msy}. An age based yield per recruit model estimated F_{40} at 0.27 (Figure I53). The average of 2002 to 2006 partial recruitment, and mean weights were used as inputs to the age based yield per recruit. F_{40} was also estimated within the SCALE model so that the two sex model will be consistent with the reference points. F_{40} was estimated with the sexes combined using a female maturity vector. F_{40} was also estimated for a female only B_{msy} reference point and a two sex msy yield (Figure I54). The scale model estimated F_{40} at 0.44 with both sexes and 0.36 for just the Females (Figure I55). Differences in the estimated selectivity between the age based VPA model and the SCALE model are reflected in the estimated reference points.

B_{msy} and msy were estimated in agepro using the models cdf of age 1 recruitment and the estimated F_{40} estimate for the F_{msy} proxy. Average partial recruitment and mean weights from 2002-2006 were used to estimate the VPA reference points. For SCALE the length based selectivity was converted to an age based vector by sex (Figure I56). Mean weights of the population and the catch was estimated by sex (Figure I57). Agepro was run separately for each sex and subsequently combined. Estimated reference points and 2006 terminal year F and SSB are summarized in table I15 and Figure I58. The female only F_{msy} references point is lower than the combine sex F_{msy} reference point which results in a change the overfishing status.

Both the split VPA and split SCALE model produce very similar trends in recruitment and biomass. The split SCALE model is presently the preferred model to assess Gulf of Maine winter flounder stock because it allows for error in the catch for a stock which as poor sampling coverage. The SCALE model can also account for the sexually dimorphic growth and mortality observed in the data.

References

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Mayo, R.K., L. O'Brien, and N. Buxton. 1992. Discard estimates of American plaice, *Hippoglossoides platessoides*, in the Gulf of Maine northern shrimp fishery and the Gulf of Maine-Georges Bank large-mesh otter trawl fishery. SAW 14 Res. Doc. 14/3. 40 pp.

NEFSC. 2003 Report of the 36th Northeast Regional Stock Assessment Workshop (36th SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. Ref. Doc 03-06. February 2003.

Witherell, B. and J. Burnett. 1993. Growth and maturation of winter flounder, *Pleuronectes americanus*, in Massachusetts. Fishery Bulletin. 91:816-820.

Table I1. Winter flounder commercial landings (metric tons) for Gulf of Maine stock (U.S. statistical reporting areas 512 to 515). Landings from 1964-1977 is taken from SARC 21, 1982-1993 is re-estimated from the wodets data, 1994-2007 is estimated using the trip based allocated AA tables.

Year	metric tons	Year	Metric tons
1964	1,081	1990	1,116
1965	665	1991	1,008
1966	785	1992	825
1967	803	1993	611
1968	864	1994	543
1969	975	1995	707
1970	1,092	1996	606
1971	1,113	1997	569
1972	1,085	1998	643
1973	1,080	1999	350
1974	885	2000	535
1975	1,181	2001	698
1976	1,465	2002	683
1977	2,161	2003	754
1978	2,194	2004	623
1979	2,021	2005	335
1980	2,437	2006	199
1981	2,407	2007	
1982	2,793		
1983	2,096		
1984	1,699		
1985	1,582		
1986	1,188		
1987	1,140		
1988	1,250		
1989	1,253		

Table I2. Estimated number (000's) and MRFSS estimated weight and predicted weight from length frequencies (mt) of Gulf of Maine winter flounder caught, landed, and discarded in the recreational fishery.

	Number (000's)				Metric tons	
	Catch A+B1+B2	Landed A+B1	Released B2 Landed	15% Release Mortality	MRFSS Landed A+B1	Predicted
1981	6,200	5,433	767	115	2,554	2,270
1982	8,207	7,274	933	140	1,876	3,024
1983	2,169	1,988	181	27	868	817
1984	2,477	2,285	191	29	1,300	1,103
1985	3,694	3,220	474	71	1,896	1,629
1986	946	691	255	38	523	411
1987	3,070	2,391	679	102	1,809	1,443
1988	953	841	111	17	345	537
1989	1,971	1,678	294	44	620	1,035
1990	786	652	134	20	370	344
1991	213	154	59	9	91	86
1992	186	137	48	7	90	77
1993	398	249	150	22	140	134
1994	232	145	88	13	83	77
1995	150	83	67	10	40	40
1996	183	98	86	13	56	52
1997	192	64	129	19	43	32
1998	109	65	44	7	30	27
1999	109	65	44	7	33	34
2000	146	59	87	13	32	31
2001	173	72	102	15	45	37
2002	101	61	40	6	42	35
2003	86	52	34	5	32	29
2004	61	41	20	3	19	29
2005	79	40	39	6	25	24
2006	94	53	41	6	34	35
2007						

Table I3. Number of lengths, samples, and metric tons per sample for Gulf of Maine winter flounder. Number of samples and calculations of metric tons per samples does not include observer data or gillnet landings from 1990-2006. * = redistributed according to market category and halfyear proportions. Bold numbers have additional lengths from observer trawl data but are not included in the number of samples.

	Number of lengths.						Number of samples						mt/samples					
year	half	lg	sm	med	un	total	half	lg	sm	med	un	total	half	lg	sm	med	un	total
1982	1	102	101		455		1	1	1		4		1	838	453		46	
	2	84	81		106	929	2	1	1		1	9	2	396	691		231	310
1983	1	380	100	99	407		1	4	1	1	4		1	120	510		53	
	2	115	1344		106	2551	2	2	11		1	24	2	125	44	64	95	87
1984	1	438	503		221		1	5	4		2		1	74	95			
	2	126	813	100		2201	2	1	6	1		19	2	189	67	114	124	89
1985	1	665	735				1	6	5				1	54				
	2	121			80	1601	2	2			1	14	2	87		182	176	113
1986	1	237	109	109	266		1	3	1	1	3		1		242	126	48	
	2		500	193	89	1503	2		6	2	1	17	2	113	37	31	56	70
1987	1				113		1				1		1					
	2	47	251	272		683	2	1	3	3		8	2	257	137	75	249	143
1988	1	102	258	706	*		1	1	3	7	*		1		108	23		
	2		169	107	*	1342	2		2	1	*	14	2	340	164	96		89
1989	1	113		91	**234**		1	1		1	**1**		1			168		
	2		95	220	**32**	785	2		1	2		6	2	313	435	42	**254**	209
1990	1	328	301		102		1	3	4		1		1	64	48			
	2	117	197	97		1142	2	1	2	1		12	2	83	90	144	111	75
1991	1	188	254	205	**143**		1	2	2	2	**2**		1	91	72			
	2	236	349			1375	2	3	3			14	2	32	62	95	57	65
1992	1	246	100	93	**107**		1	3	1	1			1					
	2	57	74	253		930	2	1	1	3		10	2	54	126	35		66
1993	1	100		288	**91**		1	1		3			1	84		17		
	2	80	55	157	**51**	822	2	1	1	2		8	2	47	178	30		59

Table I3. Continued.

		Number of lengths.						Number of samples						mt/samples					
year	half	lg	sm	med	un	total		half	lg	sm	med	un	total	half	lg	sm	med	un	total
1994	1		71	92				1		1	1			1			57		
	2	94		235	*		492	2	1		3		6	2	118	157	18		64
1995	1	101		474	**33**		474	1	1		5			1			29		
	2			414	**609**		1631	2			4		10	2	94		59		52
		↑																	
1996	1		378					1		4				1		29			
	2		795	338	**112**		1623	2		7	4		15	2		23	16		31
		↓																	
1997	1		127	75	*			1		2	1	*		1		34	33		
	2	407	1014	218	*		1841	2	5	11	3	*	22	2	20	11	19		18
1998	1		299	280	*			1		5	3	*		1		16	16		
	2	69	746	110	*		1504	2	1	9	1	*	19	2	51	12	32		17
		↑							↑										
1999	1			275	**122**			1			3			1					
	2		80		**430**		907	2		2			5	2		42	15		50
		↓					552												
2000	1	104	4331	250	**1046**			1	1	59	4			1	19	1			
	2	244	344		**130**		6449	2	4	6		**1**	75	2	7	20	24		6
		↑																	
2001	1		89	474	**795**			1		1	6			1		66	10		
	2		254	250	**1756**		3618	2		3	3		13	2		35	47		41
		↓																	
2002	1	28	507	173	**573**			1	1	7	2	**1**		1		7	34	**59**	
	2		982	133	**2734**		5130	2		14	2	**2**	29	2	57	14	48	**35**	21
2003	1		744		**2410**			1	1	10	1	**2**		1		11		**48**	
	2	384	818	110	**914**		5380	2	12	19	1	**6**	52	2	3	9	28	**18**	11
2004	1	223	692	86	**1915**			1	7	14	1	**6**		1		6		**12**	
	2	7	706		**2955**		6584	2	1	12		**4**	45	2	18	9	48	**6**	11
2005	1		269		**3202**			1		4		**11**		1		16.8		**1**	
	2	600	807		**5696**		10574	2	10	7		**11**	43	2	11	10		**1**	6
2006	1		732		**2330**			1		3		**11**		1		7		**1**	
	2	341	281		**823**		4507	2	4	3		**9**	30	2	14	14		**3**	5
2007	1							1						1		####		####	
	2						0	2					0	2	####	####	####	####	####

Table I4. Number of kept observer lengths, trips, and gillnet metric tons landed per 100 lengths sampled for Gulf of Maine winter flounder.

year	half	lengths	trips	gillnet landings	Mt/100 lengths
1990	1	500	90	185	
	2	78	1	29	
		578	91	215	37
1991	1	167	6	85	
	2	30	8	12	
		197	14	97	49
1992	1	1925	39	135	
	2	172	25	25	
		2097	64	160	8
1993	1	1990	63	97	
	2	375	20	42	
		2365	83	139	6
1994	1	330	22	75	
	2	207	10	25	
		537	32	100	19
1995	1	1132	20	156	
	2	275	23	28	
		1407	43	184	13
1996	1	930	26	114	
	2	118	17	22	
		1048	43	136	13
1997	1	656	18	105	
	2	42	4	29	
		698	22	134	19
1998	1	1163	19	145	
	2	431	8	31	
		1594	27	176	11
1999	1	747	5	84	
	2	538	12	17	
		1285	17	101	8
2000	1	911	8	104	
	2	259	4	18	
		1170	12	122	10
2001	1	862		124	
	2	42		36	
		904		160	18
2002	1	237		37	16
	2	691		45	7
		928		82	9
2003	1	1702		89	5
	2	3041		96	3
		4743		185	4
2004	1	2255		62	3
	2	4605		75	2
		6860		137	2
2005	1	635		26	4
	2	3982		41	1
		4617		67	1
2006	1	385		25	7
	2	174		21	12
		559		47	8
2007	1				0
	2				0
				0	0

Table I5. Gulf of Maine winter flounder estimated discard ratios in the shrimp fishery (total discard kg / total days fished estimated from NEFSC and MA Observer data by shrimp season). Ratio for 1982-1988 is the average ratio from 1989-1992. Total shrimp fishery days fished and estimated discards are also shown. A 50% mortality is used for estimating dead discards. Dotted line indicates the introduction of the Nordmore grate.

Year	trips	tows	ratio	Shrimp df	discard wt (kg)	dead discards (kg)
1982			*13.5*	970	13,120	6,560
1983			*13.5*	1157	15,646	7,823
1984			*13.5*	1754	23,721	11,860
1985			*13.5*	2081	28,149	14,074
1986			*13.5*	2395	32,391	16,196
1987			*13.5*	3708	50,149	25,075
1988			*13.5*	2815	38,072	19,036
1989	12	24	3.5	2840	10,023	5,011
1990	25	53	13.1	3205	41,853	20,927
1991	38	94	16.3	2588	42,265	21,132
1992	72	225	21.2	2313	48,978	24,489
1993	63	178	7.0	1902	13,401	6,700
1994	63	183	5.8	1982	11,586	5,793
1995	58	136	4.8	3376	16,186	8,093
1996	40	92	4.0	3243	13,126	6,563
1997	21	55	7.5	3661	27,391	13,695
1998	3	6	3.9	2204	8,526	4,263
1999	4	5	1.4	1217	1,696	848
2000	4	10	7.7	793	6,091	3,046
2001	4	6	6.1	673	4,095	2,048
2002	1	2	2.4	246	581	291
2003	18	36	8.7	532	4,628	2,314
2004	11	47	8.5	304	2,588	1,294
2005			15.9	313	4,973	2,486
2006			12.7	483	6,133	3,066

Table I6. Gulf of Maine winter flounder re-estimated large and small mesh trawl and gillnet discard ratios (discard/sum all species kept), CVs, and estimated metric tons.

	Discard Ratio			CV			Metric Tons		
	trawl			trawl			trawl		
year	lg mesh	sm mesh	gillnet	lg mesh	sm mesh	gillnet	lg mesh	sm mesh	gillnet
1989	0.0011	0.0032	0.0006	0.51	0.54	0.34	23	6	9
1990	0.0004	0.0001	0.0027	0.55	1.00	0.44	11	0	44
1991	0.0011	0.0010	0.0005	0.45	0.61	0.23	34	2	7
1992	0.0005	0.0002	0.0020	0.37	0.86	0.15	14	0	25
1993	0.0003	0.0042	0.0023	0.79	0.92	0.17	8	10	38
1994	0.0000	0.0000	0.0009			1.42	0		13
1995	0.0009	0.0091	0.0015	0.53	0.43	0.46	16	21	23
1996	0.0003	0.0008	0.0008	1.69	0.29	0.56	4	2	12
1997	0.0001	0.0098	0.0061	0.61	0.02	0.58	2	19	75
1998	0.0011	0.0000	0.0011	0.45		0.43	15		14
1999	0.0016	0.0081	0.0010	0.38	0.30	0.50	18	14	8
2000	0.0004	0.0000	0.0030	0.84		0.39	6		24
2001	0.0016	0.0017	0.0008	0.38	1.91	0.64	27	2	6
2002	0.0021	0.0077	0.0014	0.37	0.43	0.43	33	10	9
2003	0.0014	0.0016	0.0008	0.33	0.50	0.32	25	1	5
2004	0.0023	0.0064	0.0010	0.29	0.40	0.30	62	2	7
2005	0.0025	0.0072	0.0003	0.28	1.10	0.23	47	2	2
2006	0.0018	0.0038	0.0001	0.33	0.44	0.42	20	2	1

Table I7. Gulf of Maine winter flounder updated number of trips in the large and small mesh trawl and gillnet fishery in the dealer and observer data.

	Large Mesh Trawl						Small Mesh Trawl						Gillnet					
	Dealer trips		Ob trips		Dealer	Ob	Dealer trips		Ob trips		Dealer	Ob	Dealer trips		Ob trips		Dealer	Ob
YEAR	half 1	half 2	half 1	half 2	sum	sum	half 1	half 2	half 1	half 2	sum	sum	half 1	half 2	half 1	half 2	sum	sum
1989	105,164	85,152	16	21	190,316	37	1,061	10,321	7	16	11,382	23	62,067	87,886		84	149,952	84
1990	100,659	91,373	10	16	192,032	26	321	12,384		8	12,705	8	60,170	102,906	64	56	163,076	120
1991	119,499	106,244	12	36	225,743	48	396	13,905		29	14,301	29	55,164	78,681	153	648	133,845	801
1992	131,273	104,500	33	11	235,773	44	291	19,427	3	12	19,718	15	49,030	78,145	357	539	127,175	896
1993	108,243	101,322	9	8	209,565	17	314	17,162	2	4	17,476	6	55,144	93,844	251	309	148,988	560
1994	88,950	61,405	4	2	150,356	6	745	9,029			9,774		42,555	63,675	55	30	106,230	85
1995	64,850	53,353	18	7	118,203	25	994	2,802		30	3,796	30	40,987	56,676	23	46	97,663	69
1996	59,537	51,512	8	3	111,049	11	268	3,789	2	38	4,057	40	32,990	45,074	21	25	78,064	46
1997	53,697	42,004	4	1	95,701	5	542	3,735	3		4,276	3	28,906	36,957	13	20	65,863	33
1998	59,039	45,854	6		104,893	6	236	2,689			2,925		30,234	34,076	29	49	64,309	78
1999	41,248	46,507	1	20	87,755	21	186	3,220		11	3,406	11	20,067	24,447	18	55	44,514	73
2000	48,204	50,184	48	31	98,387	79	349	2,176			2,524		21,613	30,685	41	40	52,298	81
2001	50,659	51,722	37	76	102,381	113	498	2,497	1	3	2,996	4	24,426	32,695	25	22	57,121	47
2002	44,086	56,806	28	121	100,892	149	213	2,374	1	34	2,587	35	16,513	32,746	23	57	49,259	80
2003	37,226	60,664	117	136	97,890	253	169	941	7	12	1,110	19	18,954	34,893	93	202	53,846	295
2004	31,568	51,904	70	188	83,471	258	146	945	12	55	1,091	67	16,860	33,270	156	619	50,130	775
2005	29,099	44,132	171	327	73,231	498	347	681	20	49	1,027	69	14,209	38,823	138	513	53,031	651
2006	24,765	34,470	143	63	59,235	206	223	1,034	14	10	1,257	24	15,359	35,986	74	54	51,344	128

Table I8. GARM III Gulf of Maine winter flounder catch at age component summary.

Catch at age component	years	halfyear	length data	age data
trawl and other commercial landings	82-98	mix	commercial and observer (unclassified)	commercial
trawl and other commercial landings	99-06	whole & halfyear	Observer (Trawl kept)	commercial
gillnet commercial Landings	90-06	whole & halfyear	observer (gillnet kept)	commercial
recreational Landings	82-06	halfyear	MRFSS	combine NEFSC and MA DMF ages by halfyear
recreational Discards	82-06	halfyear	spr & fall MA DMF	combine NEFSC and MA DMF ages by halfyear
large mesh trawl discards (survey filter)	82-88	whole year	survey method (spr & fall MA DMF)	combine NEFSC spr & fall survey
large mesh trawl disc (obs disc/keptall)	89-06	whole year	survey method (89-00) observer disc (01-06)	combine NEFSC spr & fall survey
gillnet discards (obs disc/keptall)	86-06	Whole	observer discards	combine spr NEFSC and MA DMF ages
shrimp discards (obs disc/days fished)	82-04	shrimp season	observer (discards)	combine spr NEFSC and MA DMF ages

Table I9. Gulf of Maine winter flounder large and small mesh trawl and gillnet kept ratios (kept/sum all species kept), CVs, and estimated landings in metric tons.

	Kept Ratio			CV			Metric Tons		
	trawl			trawl			trawl		
year	lg mesh	sm mesh	gillnet	lg mesh	sm mesh	gillnet	lg mesh	sm mesh	gillnet
1989	0.006	0.015	0.007	0.38	0.45	0.58	131	27	107
1990	0.001	0.000	0.015	0.47	0.77	0.44	42	1	244
1991	0.019	0.001	0.003	0.44	0.54	0.22	572	2	43
1992	0.008	0.001	0.013	0.49	0.58	0.13	227	4	163
1993	0.004	0.027	0.014	0.76	0.53	0.14	93	68	236
1994	0.001		0.006	0.83		0.88	14	0	84
1995	0.032	0.000	0.005	1.03		0.28	575	0	83
1996	0.017	0.000	0.007	2.32		0.41	305	0	99
1997	0.001	0.040	0.021	2.01	0.33	0.51	12	76	262
1998	0.005		0.010	0.80		0.37	65	0	136
1999	0.110	0.000	0.007	0.66		0.45	1241	0	57
2000	0.012		0.023	0.40		0.39	179	0	183
2001	0.025	0.000	0.011	0.25		0.72	410	0	85
2002	0.028	0.005	0.045	0.29	0.51	0.40	446	7	295
2003	0.021	0.013	0.033	0.19	0.54	0.18	369	7	220
2004	0.031	0.034	0.025	0.21	0.72	0.13	841	13	176
2005	0.021	0.018	0.012	0.16	0.38	0.15	404	6	78
2006	0.017	0.003	0.002	0.27	0.39	0.41	189	1	12

Table I10. Gulf of Maine winter flounder composition of the catch by number.

	Landings		Discards				
year	recreational	commercial	recreational	gillnet	lg mesh	shrimp	Total
1982	7,274	5,282	140		1,397	56	14,149
1983	1,988	3,842	27		428	67	6,353
1984	2,285	3,992	29		249	102	6,657
1985	3,220	2,965	71		340	121	6,717
1986	691	2,055	38	45	253	139	3,221
1987	2,391	2,086	102	45	308	216	5,146
1988	841	2,210	17	45	406	164	3,682
1989	1,678	2,329	44	16	42	61	4,171
1990	652	1,981	20	84	20	113	2,870
1991	154	1,844	9	12	64	165	2,247
1992	137	1,620	7	44	27	241	2,078
1993	249	1,440	22	70	16	83	1,880
1994	145	1,153	13	24	23	86	1,443
1995	83	1,501	10	31	29	94	1,748
1996	98	1,228	13	21	8	59	1,427
1997	64	1,101	19	128	18	175	1,504
1998	65	1,147	7	24	28	53	1,323
1999	65	605	7	7	31	11	725
2000	59	940	13	39	11	38	1,100
2001	72	1,160	15	9	52	25	1,333
2002	61	1,126	6	11	72	3	1,279
2003	51	1,269	5	8	52	25	1,410
2004	41	993	3	12	137	15	1,200
2005	40	549	6	4	94	26	718
2006	53	317	6	1	40	27	445

Table I11. Gulf of Maine winter flounder composition of the catch by weight (mt).

	Landings		Discards				
year	recreational	commercial	recreational	gillnet	lg mesh	shrimp	Total
1981	2,270						
1982	3,024	2,793	11		343	7	6,178
1983	817	2,096	2		112	8	3,035
1984	1,103	1,699	3		67	12	2,883
1985	1,629	1,582	8		93	14	3,327
1986	411	1,185	5	12	63	16	1,692
1987	1,443	1,140	12	12	81	25	2,713
1988	537	1,250	2	12	106	19	1,927
1989	1,035	1,253	6	4	11	5	2,315
1990	344	1,116	3	22	5	21	1,511
1991	86	1,008	1	3	17	21	1,136
1992	77	825	1	12	7	24	947
1993	134	611	3	19	4	7	778
1994	77	543	2	6	6	6	640
1995	40	707	1	12	8	8	776
1996	52	606	2	6	2	7	674
1997	32	569	3	38	5	14	660
1998	27	643	1	7	7	4	689
1999	34	350	1	4	9	1	399
2000	31	535	2	12	3	3	587
2001	37	698	3	3	14	2	756
2002	35	682	1	5	17	0	740
2003	29	754	1	3	13	2	801
2004	29	623	0	4	31	1	687
2005	24	335	1	1	23	2	387
2006	35	199	1	0	10	3	249

Table I12. NEFSC and MDMF survey indices of abundance for Gulf of Maine winter flounder. Indices are stratified mean number and mean weight (kg) per tow. NEFSC indices are for inshore strata (58,59,60,61,65,66) and offshore strata (26,27,38,39,40). NEFSC indices are calculated with trawl door conversion factors where appropriate. MA DMF uses strata 25-36.

	NEFSC spring		NEFSC fall		MA spring		MA fall	
year	number	weight	number	weight	number	weight	number	weight
1978					98.556	20.772	59.152	12.741
1979	4.487	1.730	6.003	2.602	71.834	15.787	134.251	32.837
1980	5.586	2.391	13.141	6.553	72.142	19.108	83.805	17.868
1981	6.461	2.122	4.179	3.029	106.341	30.383	50.847	13.595
1982	7.670	3.022	4.201	1.924	61.612	14.713	108.203	24.418
1983	12.367	5.653	10.304	3.519	112.487	28.984	76.658	15.143
1984	5.155	1.979	7.732	3.106	68.949	16.716	39.541	12.212
1985	3.469	1.418	7.638	2.324	54.210	15.302	48.677	8.288
1986	2.342	0.998	2.502	0.938	68.984	16.352	44.646	6.920
1987	5.609	1.503	1.605	0.488	85.180	18.640	54.434	8.018
1988	6.897	1.649	3.000	1.030	54.039	11.266	38.419	8.237
1989	3.717	1.316	6.402	2.013	64.696	13.940	39.249	8.602
1990	5.415	2.252	3.527	1.177	82.125	14.375	67.661	13.218
1991	4.517	1.436	7.035	1.467	46.630	11.513	101.716	17.580
1992	3.932	1.160	10.447	3.096	79.000	15.356	87.581	15.089
1993	1.556	0.353	7.559	1.859	78.018	12.051	93.527	15.109
1994	3.481	0.891	4.870	1.319	72.578	9.779	67.789	13.246
1995	12.185	3.149	4.765	1.446	89.361	14.960	76.736	15.092
1996	2.736	0.732	10.099	3.116	70.494	12.082	77.006	13.144
1997	2.806	0.664	10.008	2.950	85.396	12.959	78.402	14.438
1998	2.001	0.527	3.218	0.987	77.771	13.473	98.450	15.454
1999	6.510	1.982	10.921	3.269	80.776	14.957	125.742	23.204
2000	10.383	2.885	12.705	5.065	162.190	34.160	99.953	25.100
2001	5.242	1.663	8.786	3.133	89.743	24.510	81.072	17.743
2002	12.066	3.692	10.691	4.003	91.083	22.391	65.812	16.264
2003	7.839	2.544	10.182	4.315	83.693	17.323	90.477	15.801
2004	3.879	1.103	2.763	0.867	79.115	11.201	107.591	14.091
2005	6.920	2.056	8.807	2.314	94.044	11.980	78.591	11.812
2006	4.173	1.211	7.117	2.346	85.548	14.434	86.985	15.463
2007	2.500	0.717	6.378	1.820	53.583	10.060	76.669	11.599

Table I13. SCALE results for the non-split and split index runs for Gulf of Maine winter flounder. Recruitment indices were down weighted (0.1). Length frequency weights are in terms of effective sample size. The survey length frequency fits were down weighted in the split run (25). Residuals are residual sums of squares. Both runs model the population with the sexes separated (female m=0.2 & male m=0.3).

	SCALE Not Split			SCALE Split		
	weight	qs	Residuals or parameters	weight	qs	Residuals or parameters
total objective function			137.76			71.46
total catch	7		3.33	5		2.09
catch len freq 1+	500		24.24	400		18.28
Variation in recruit penalty	0.01		12.16	0.01		28.95
MDMF Spr 1 1982-1994	0.1	0.0000024	4.42	0.1	0.0000019	4.93
MDMF Spr 2 1982-1994	0.1	0.0000053	6.03	0.1	0.0000036	4.19
MDMF Fall 11982-1994	0.1	0.0000049	7.18	0.1	0.0000036	6.22
MDMF Fall 2 1982-1994	0.1	0.0000050	4.98	0.1	0.0000035	3.89
NEFSC Spr 1 1982-1994	0.1	0.0000002	2.06	0.1	0.0000002	1.81
NEFSC Spr 2 1982-1994	0.1	0.0000004	3.09	0.1	0.0000003	1.62
NEFSC Fall 1 1982-1994	0.1	0.0000003	4.52	0.1	0.0000002	5.30
NEFSC Fall 2 1982-1994	0.1	0.0000007	5.67	0.1	0.0000005	4.38
Seabrook Spr 1 1998-2006	0.1	0.0000005	1.65	0.1	0.0000008	2.02
Seabrook Spr 2 1998-2006	0.1	0.0000011	1.42	0.1	0.0000016	1.53
MDMF Spr 1 1995-2006	-	-	-	0.1	0.0000043	0.87
MDMF Spr 2 1995-2006	-	-	-	0.1	0.0000108	0.94
MDMF Fall 11995-2006	-	-	-	0.1	0.0000095	1.24
MDMF Fall 2 1995-2006	-	-	-	0.1	0.0000099	0.63
NEFSC Spr 1 1995-2006	-	-	-	0.1	0.0000003	0.98
NEFSC Spr 2 1995-2006	-	-	-	0.1	0.0000007	1.39
NEFSC Fall 1 1995-2006	-	-	-	0.1	0.0000004	0.87
NEFSC Fall 2 1995-2006	-	-	-	0.1	0.0000012	1.30
MDMF Spr 30+ 1982-1994	3	0.0000041	2.02	3	0.0000031	0.97
MDMF Fall 30+ 1982-1994	3	0.0000031	3.82	3	0.0000020	2.04
NEFSC Spr 30+ 1982-1994	3	0.0000008	2.21	3	0.0000006	0.93
NEFSC Fall 30+ 1982-1994	3	0.0000009	3.97	3	0.0000006	1.22
MDMF Spr 30+ 1995-2006	-	-	-	3	0.0000067	0.57
MDMF Fall 30+ 1995-2006	-	-	-	3	0.0000060	0.14
NEFSC Spr 30+ 1995-2006	-	-	-	3	0.0000012	1.07
NEFSC Fall 30+ 1995-2006	-	-	-	3	0.0000017	1.20
MDMF Spr 30+ len freq	10		0.93	10		0.86
MDMF Fall 30+ len freq	10		1.33	10		1.29
NEFSC Spr 30+ len freq	100		25.01	25		6.12
NEFSC Fall 30+ len freq	100		18.19	25		4.53
Pilgrim Nuclear 35+ Len freq	100		4.48	25		0.84
Fstart			0.56			0.56
recruitment year 1 (1982, million)			11.27			13.33
Selectivity Alpha (L50) 1982-1984			29.31			29.29
Selectivity Beta (slope) 1982-1984			0.37			0.38

Table I14. Summary of the estimated change in q in the split VPA and SCALE runs. The change in q is summarized as 2nd series divided by the fist.

VPA Split Index	Q Ratio (2nd/1st)
NEFSC spr 1	2.76
NEFSC spr 2	2.11
NEFSC spr 3	2.44
NEFSC spr 4	3.27
NEFSC spr 5	2.79
NEFSC spr 6	3.11
NEFSC spr 7	2.61
NEFSC spr 8	2.94
NEFSC Fall 3	3.09
NEFSC Fall 4	3.44
NEFSC Fall 5	3.89
NEFSC Fall 6	8.31
NEFSC Fall 7	3.51
MDMF Spr 1	3.14
MDMF Spr 2	3.59
MDMF Spr 3	2.31
MDMF Spr 4	1.73
MDMF Spr 5	2.58
MDMF Spr 6	3.14
MDMF Spr 7	3.03
MDMF Spr 8	2.47
MDMF Fall 1	4.16
MDMF Fall 2	3.60
MDMF Fall 3	3.13
MDMF Fall 4	3.41
MDMF Fall 5	5.12

SCALE Split Index	Q Ratio (2nd/1st)
MDMF Spr 1	2.24
MDMF Spr 2	3.03
MDMF Fall 1	2.66
MDMF Fall 2	2.85
NEFSC Spr 1	1.88
NEFSC Spr 2	2.16
NEFSC Fall 1	1.92
NEFSC Fall 2	2.40
MDMF Spr 30+	2.15
MDMF Fall 30+	3.04
NEFSC Spr 30+	2.10
NEFSC Fall 30+	3.07

Table I15. Non-parametric empirical biological reference points and stock status for Gulf of Maine Winter flounder.

	VPA Split	SCALE Split Both sexes	SCALE Split Female only
F40%	0.27	0.44	0.36
YPR	0.2172	0.1702	0.1626
SSBR	0.8721	0.6517	0.4817
Mean Recruit million	4.046	5.498	2.749
MSY	854	910	871
SSBMSY	3,557	3,138	2,310
SSB06	806	1,206	749
F06	0.49	0.39	0.39
SSB06/SSBMSY	23%	38%	32%
F06/FMSY	190%	88%	108%

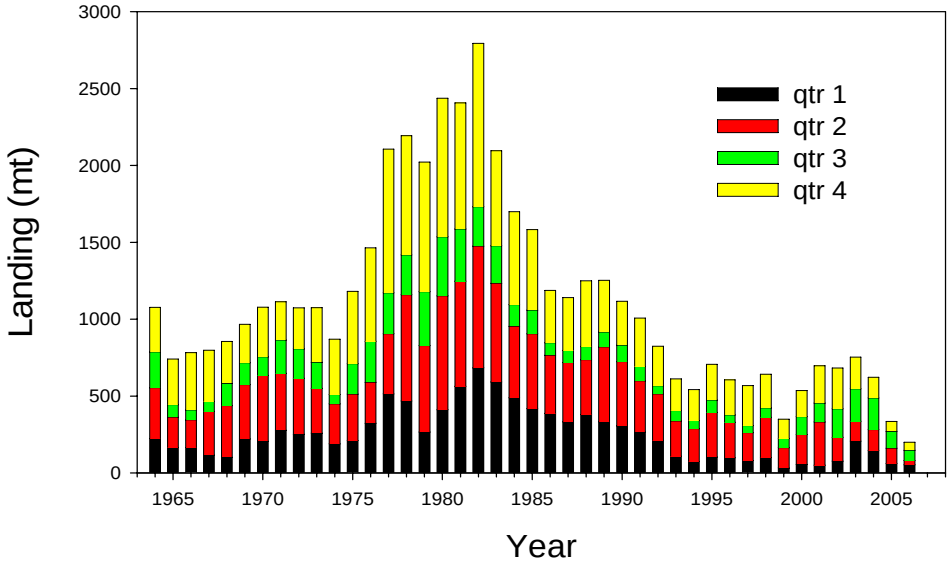


Figure I1 Gulf of Maine winter flounder commercial landings by quarter from 1964-2006.

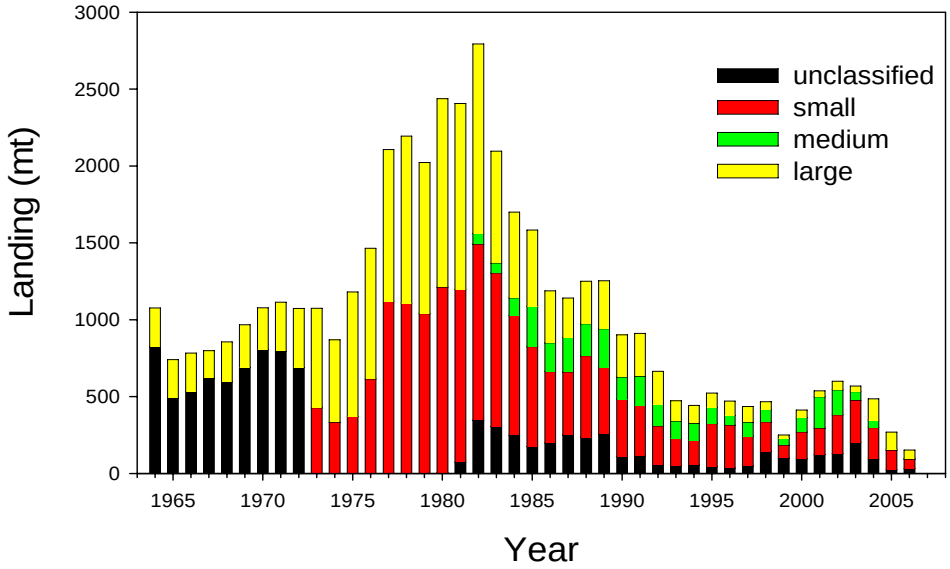


Figure I2 Gulf of Maine winter flounder commercial landings by market categor from 1964-2006.

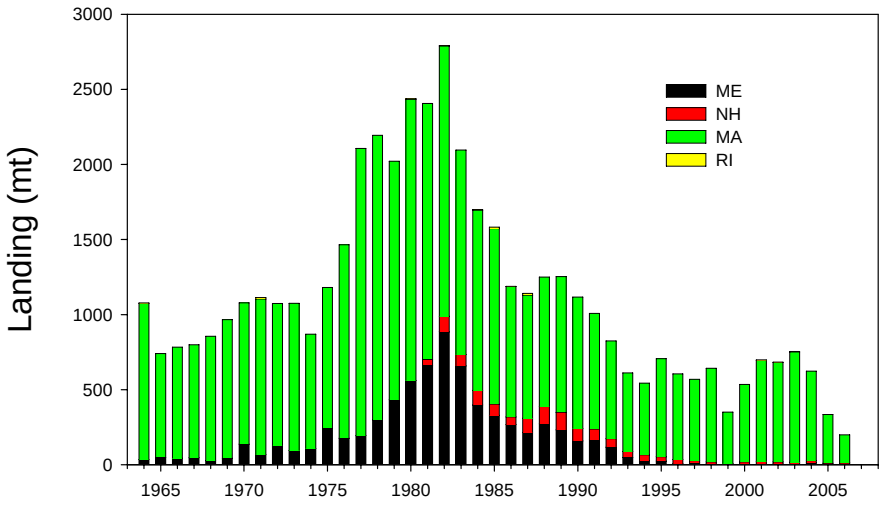


Figure I3. Commercial landings by state from 1964-2006.

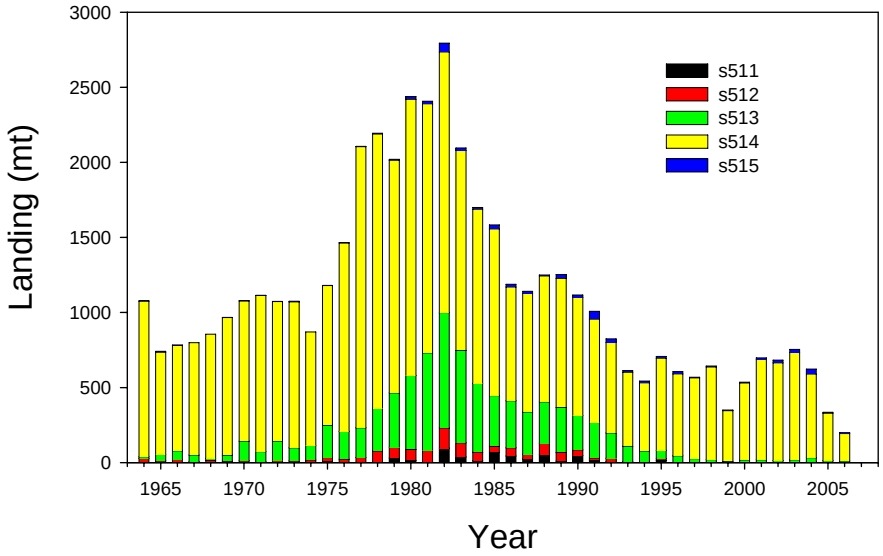
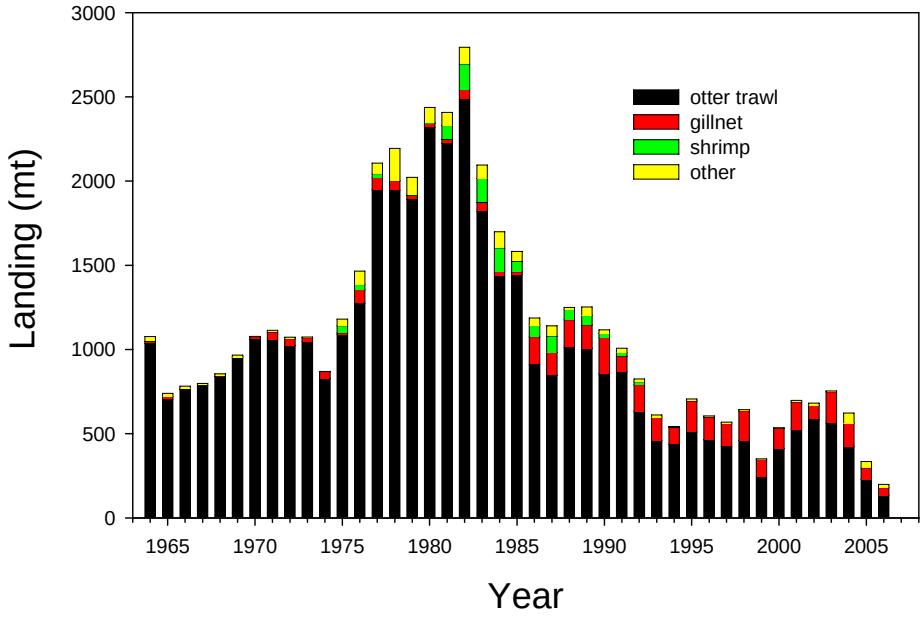


Figure I4. Commercial landings by statistical area from 1964-2006.



FigureI5. Commercial landings by gear 1964-2006.

Gulf of Maine Winter Flounder Recreational landings and b2 Catch

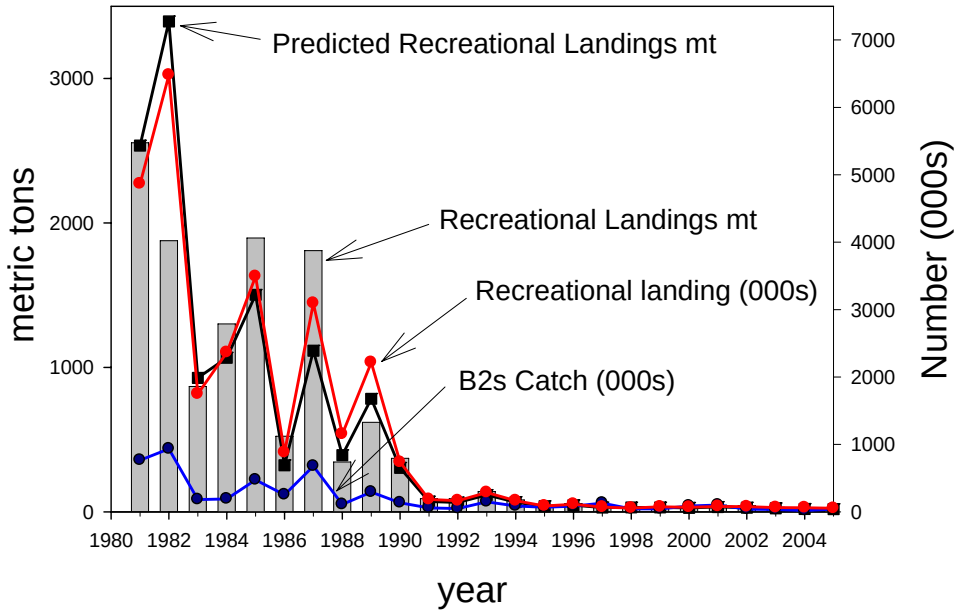


Figure I6 . Recreational landings in numbers and metric tons for Gulf of Maine winter flounder. B2 catch in numbers is also shown.

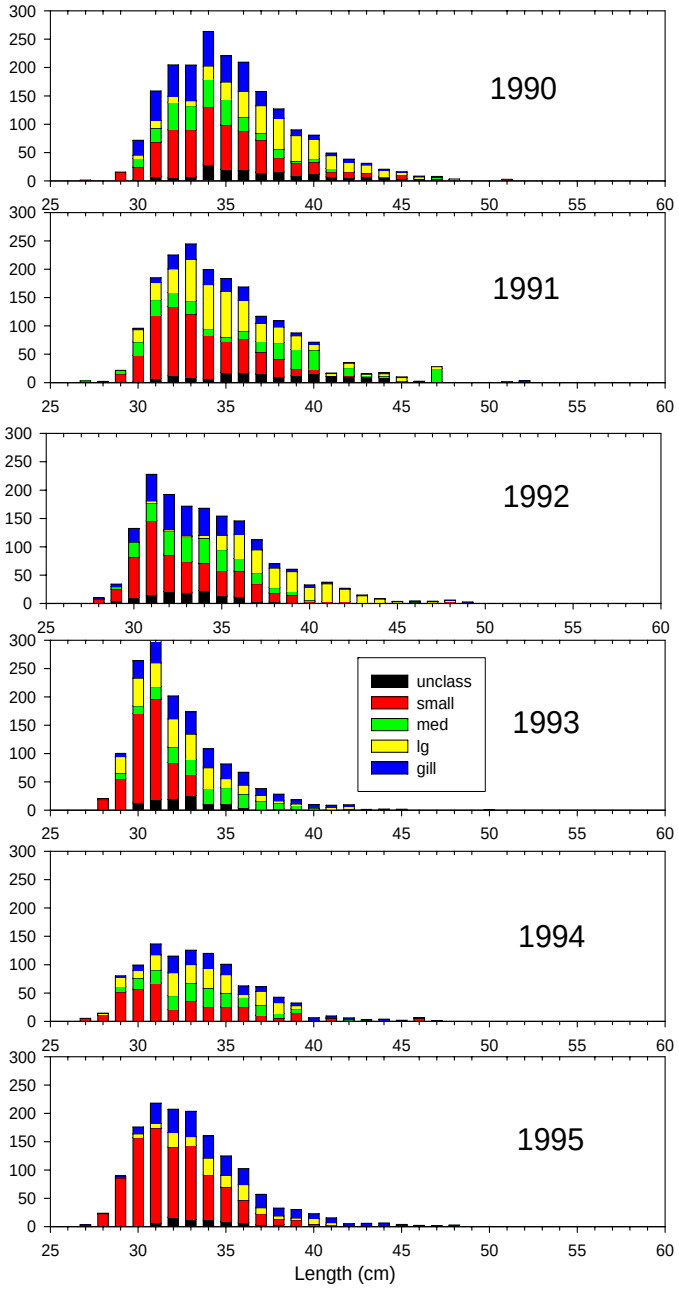


Figure I7. Expanded landing length distribution using port sampling data.

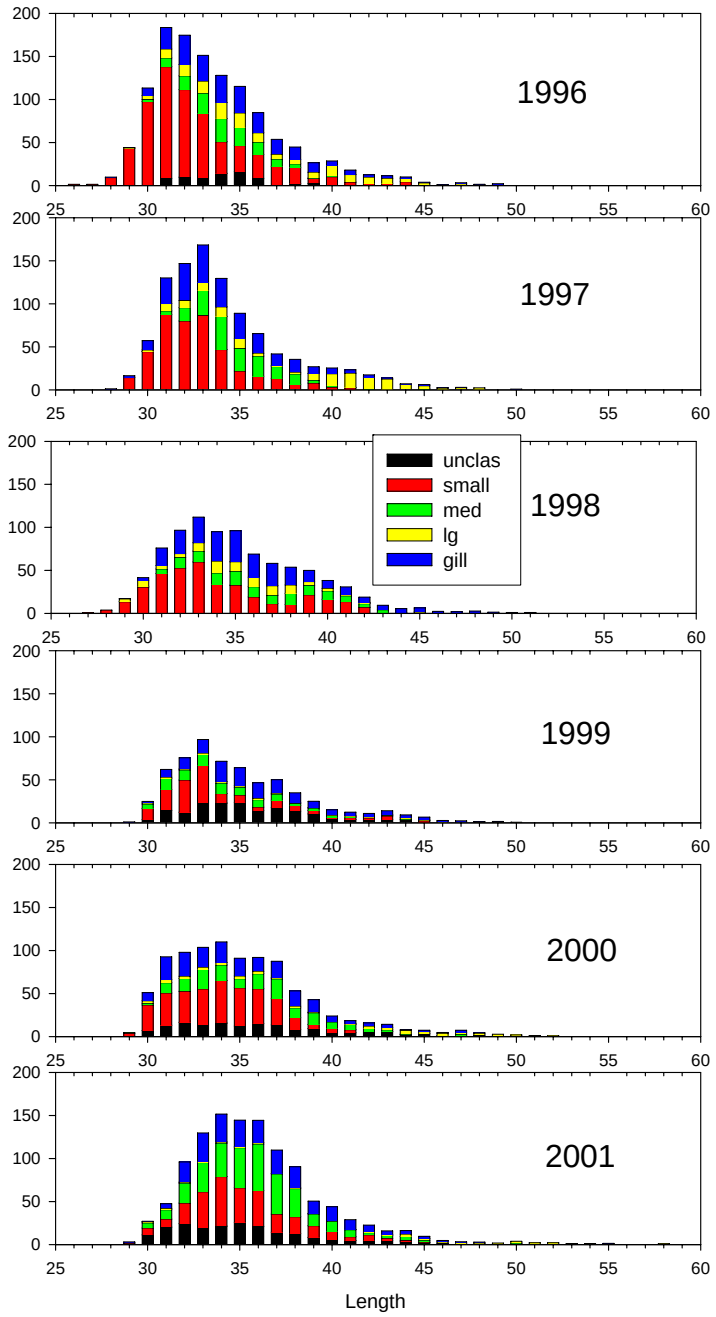


Figure I7. Cont.

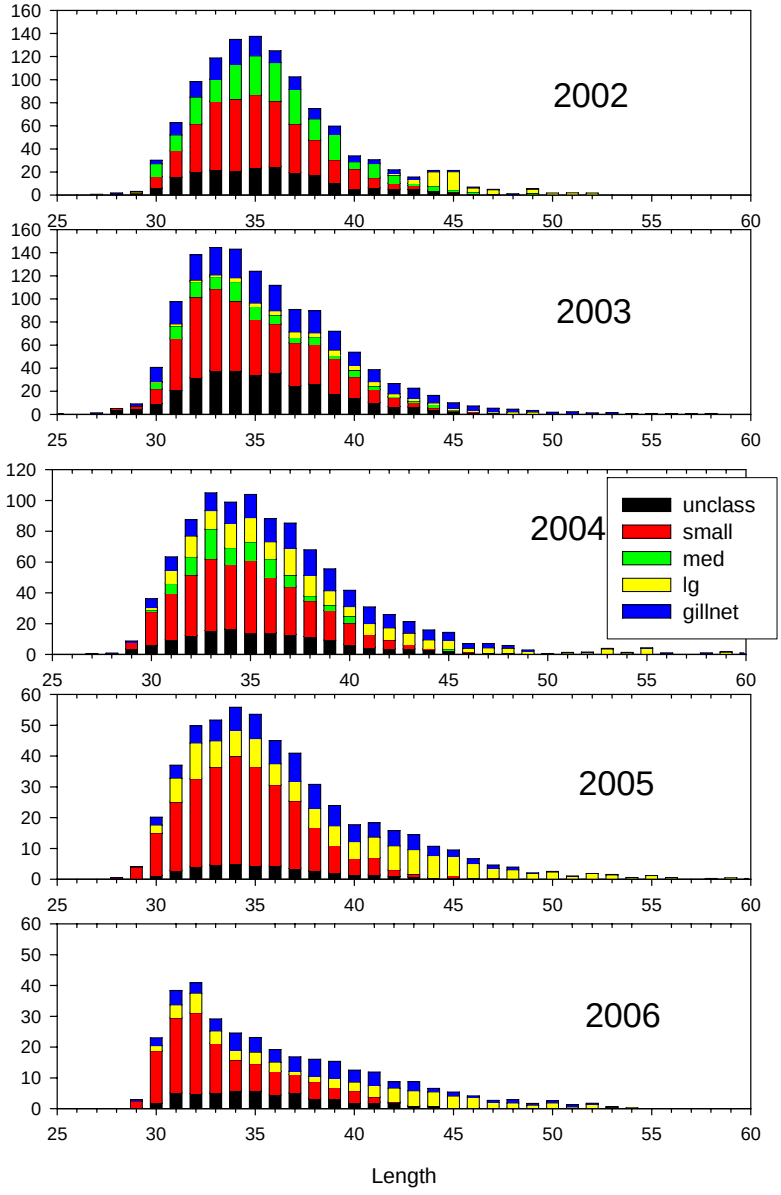


Figure I7. Cont.

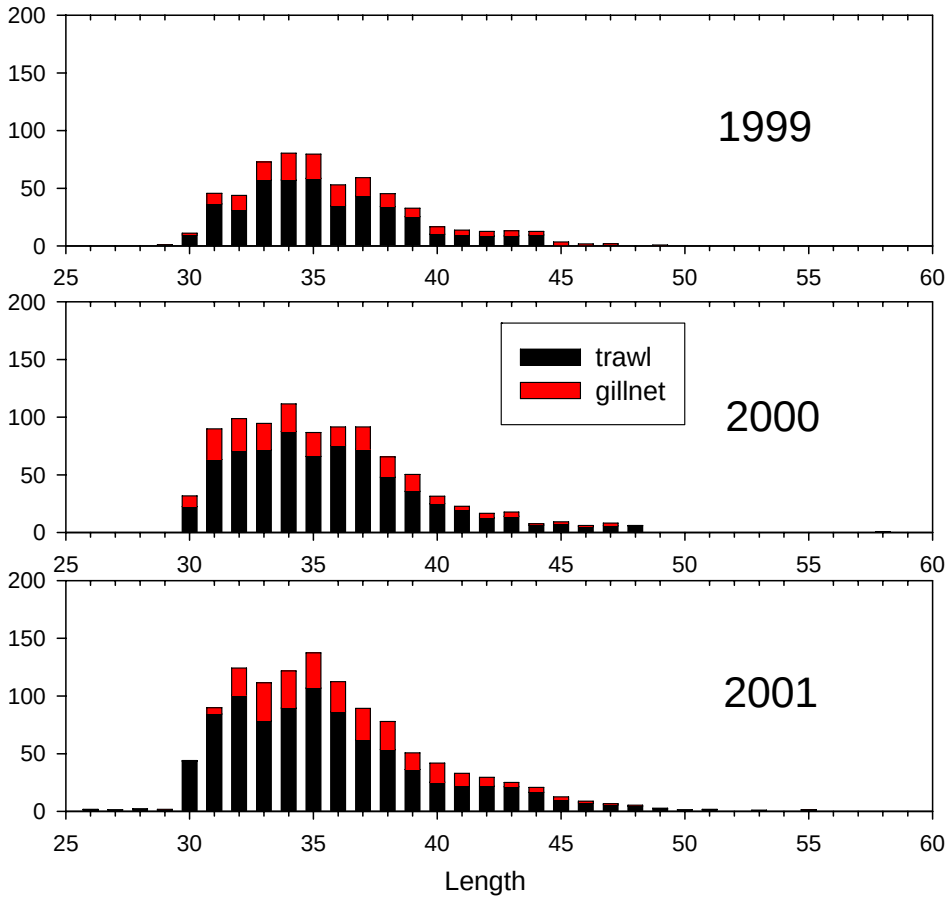


Figure I8. Expanded landing length distribution using observer data.

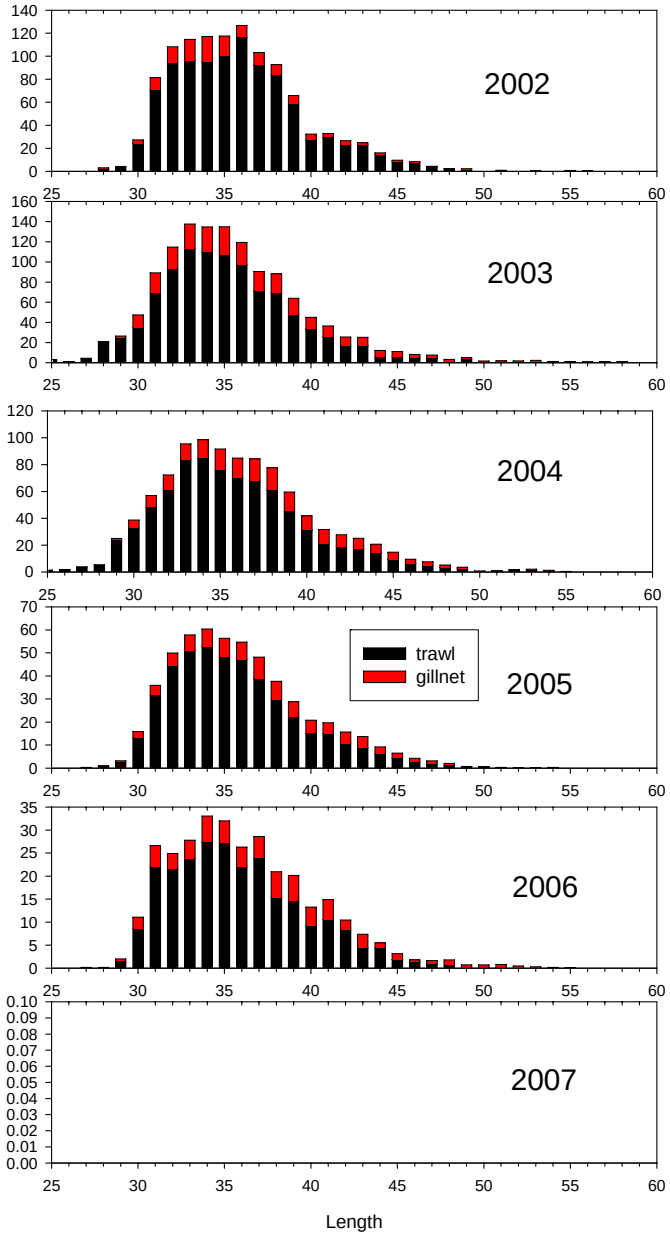


Figure I8. Cont.

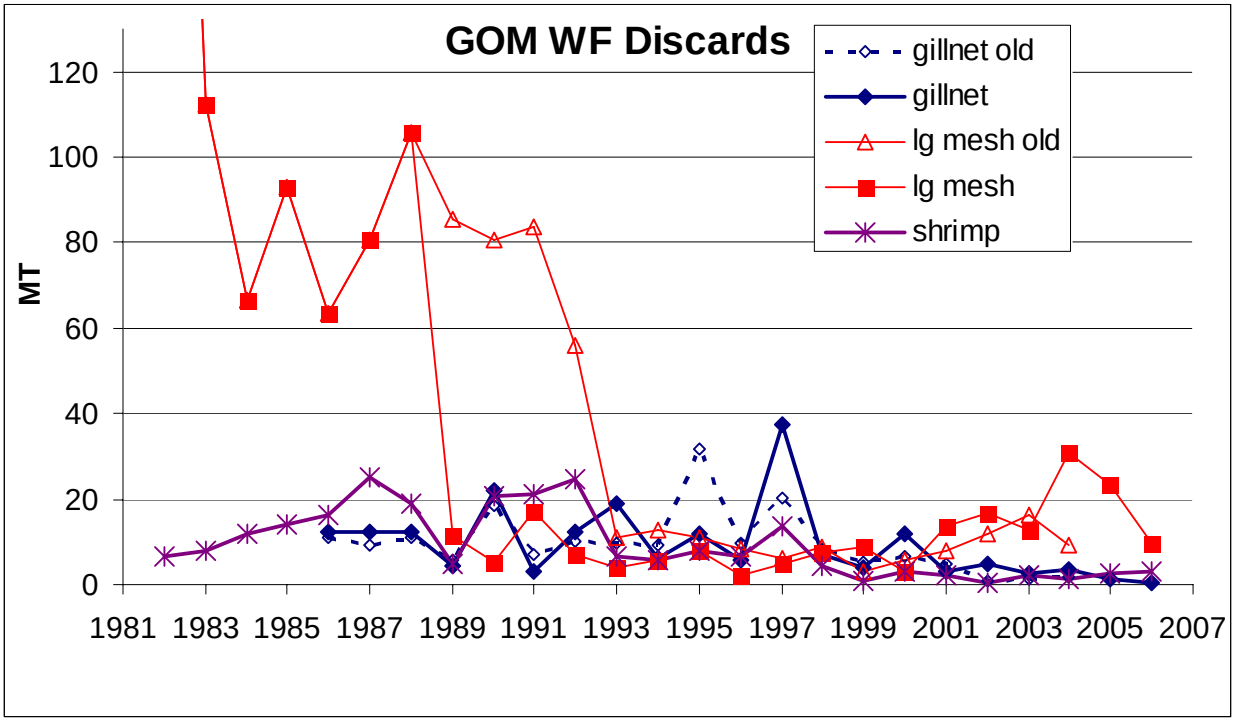


Figure I9. Estimated discards using the GARM II method and updated GARM III method.

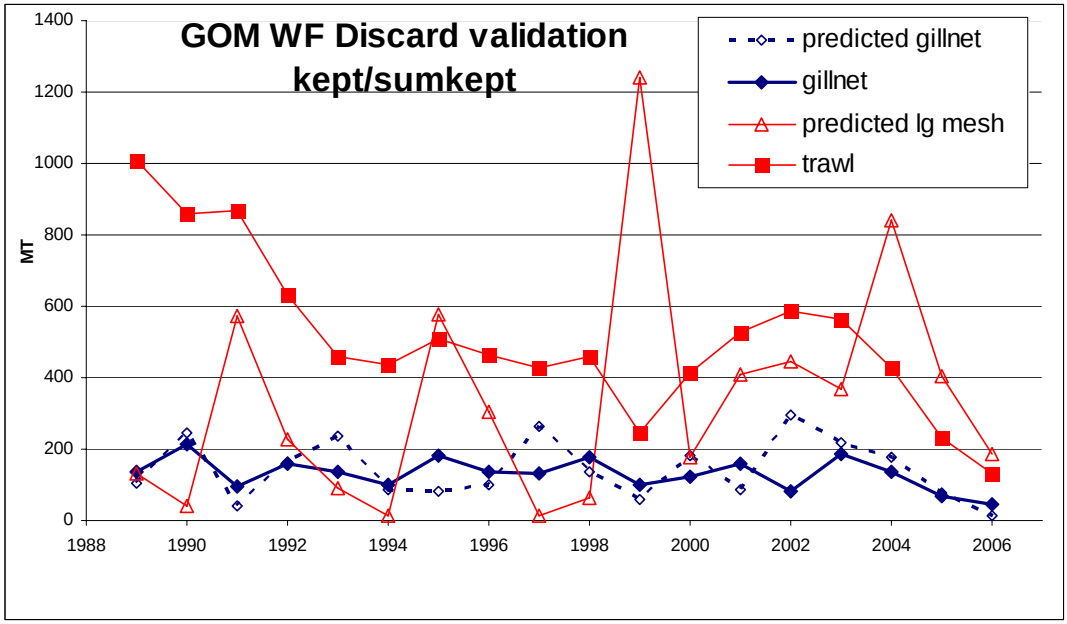


Figure I10. Estimated landings using the kept to sum all species ratio and the actual landings by fleet.

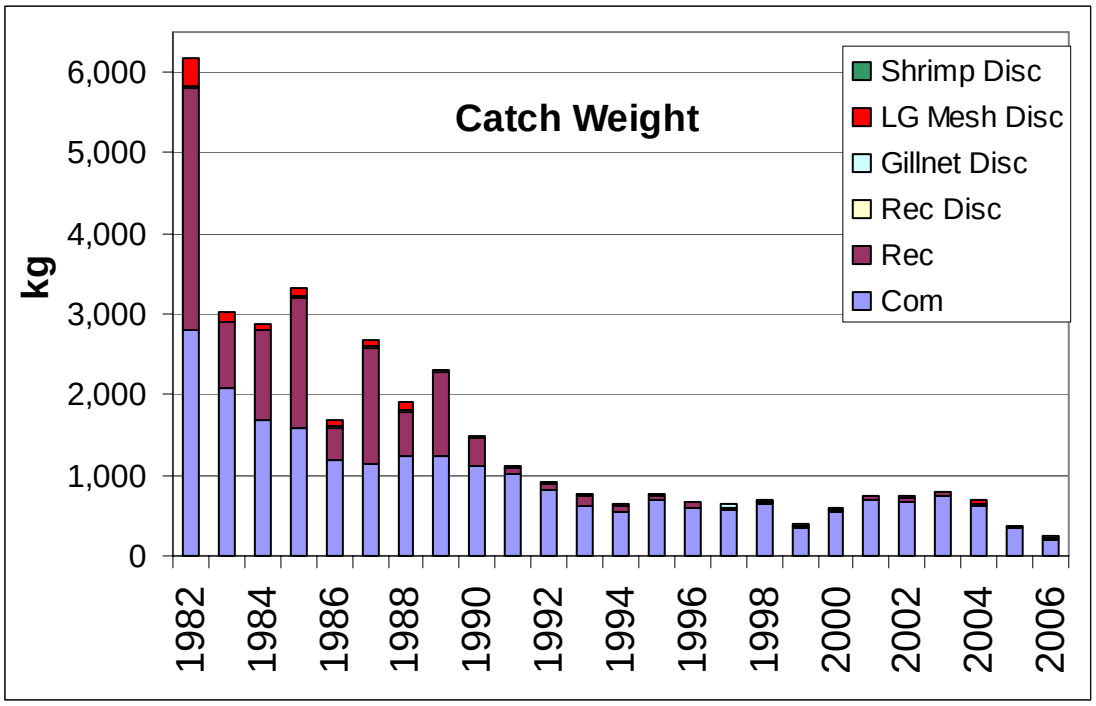


Figure I11. Gulf of Maine winter flounder composition of the catch by weight.

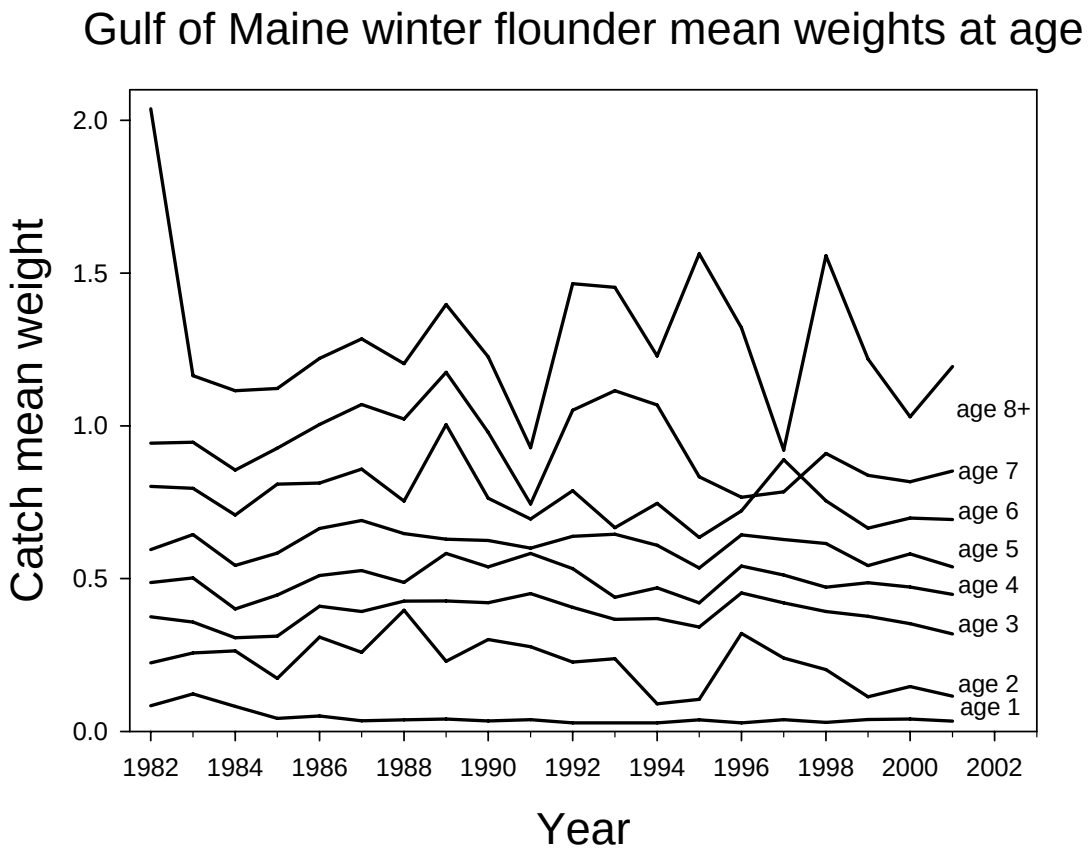


Figure I12. Gulf of Maine winter flounder mean catch weights at age.

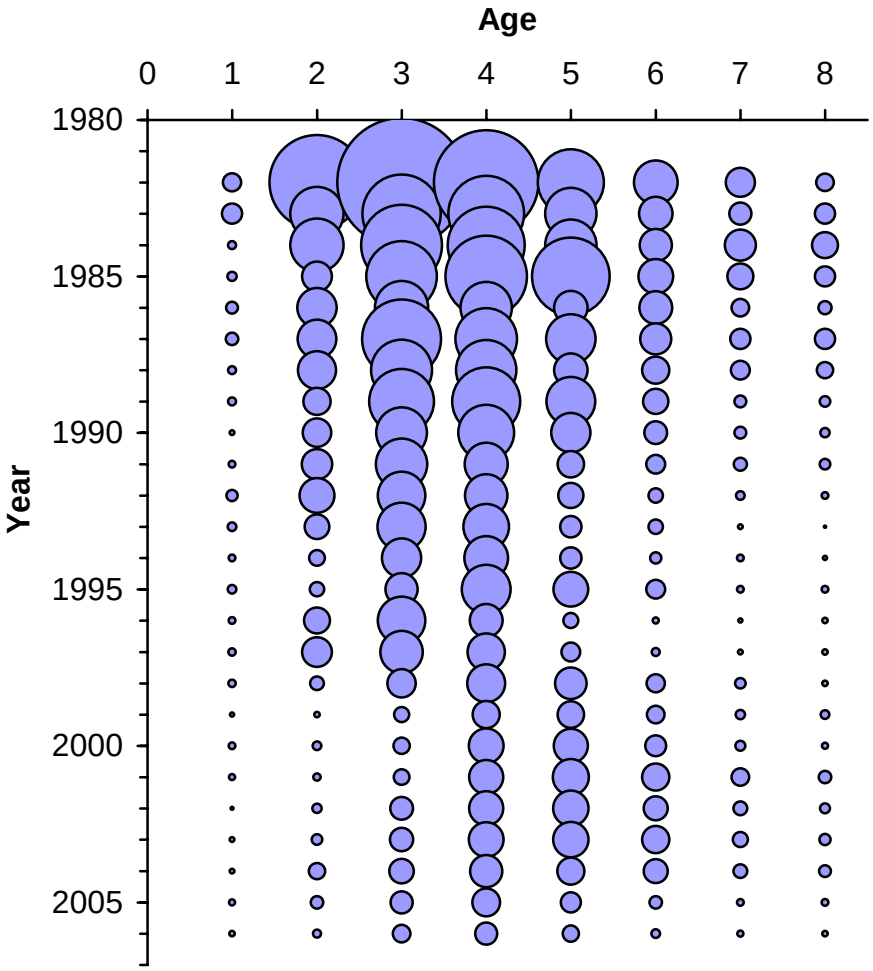


Figure I13. Gulf of Maine winter flounder bubble plot of the catch at age.

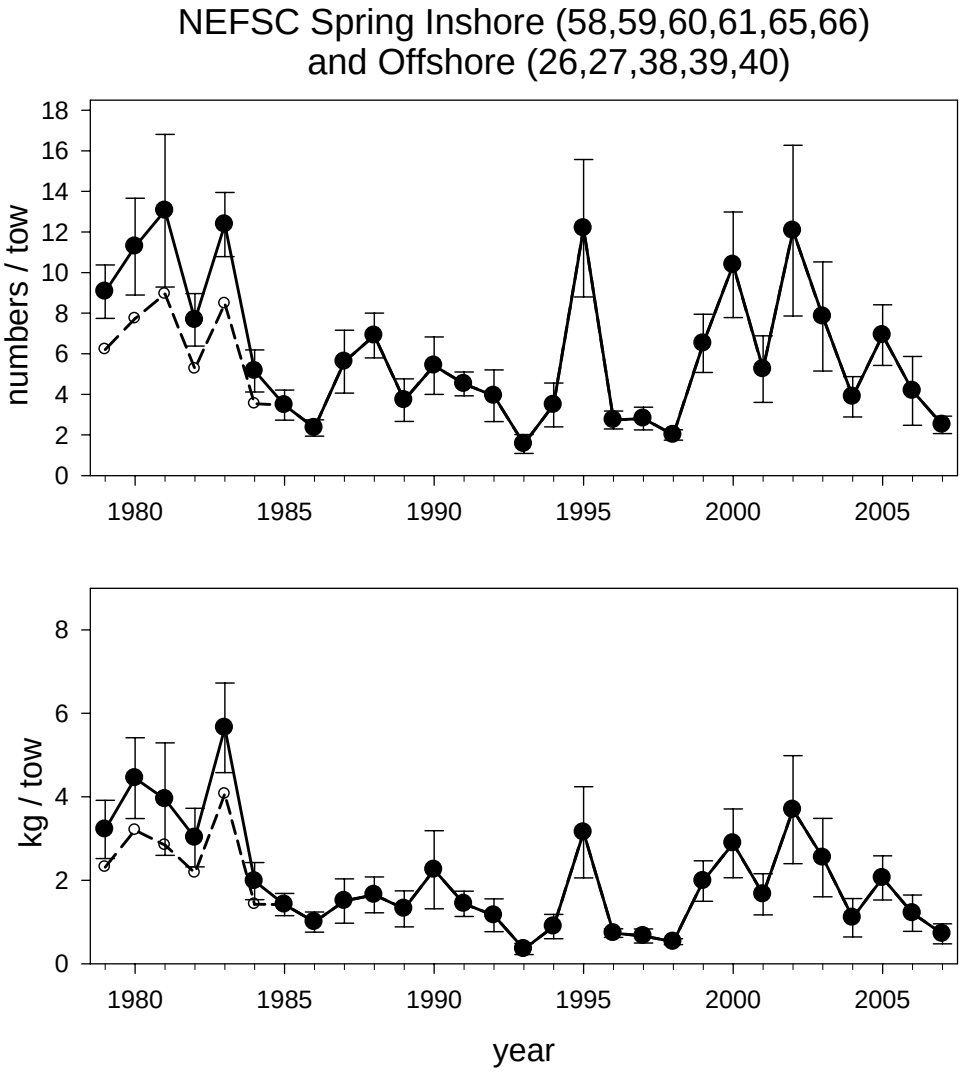


Figure I14. NEFSC Spring survey stratified mean numbers and mean weight (kg) per tow for Gulf of Maine winter flounder. Trawl door conversion factors are use where appropriate. Dotted lines are the unconverted indices.

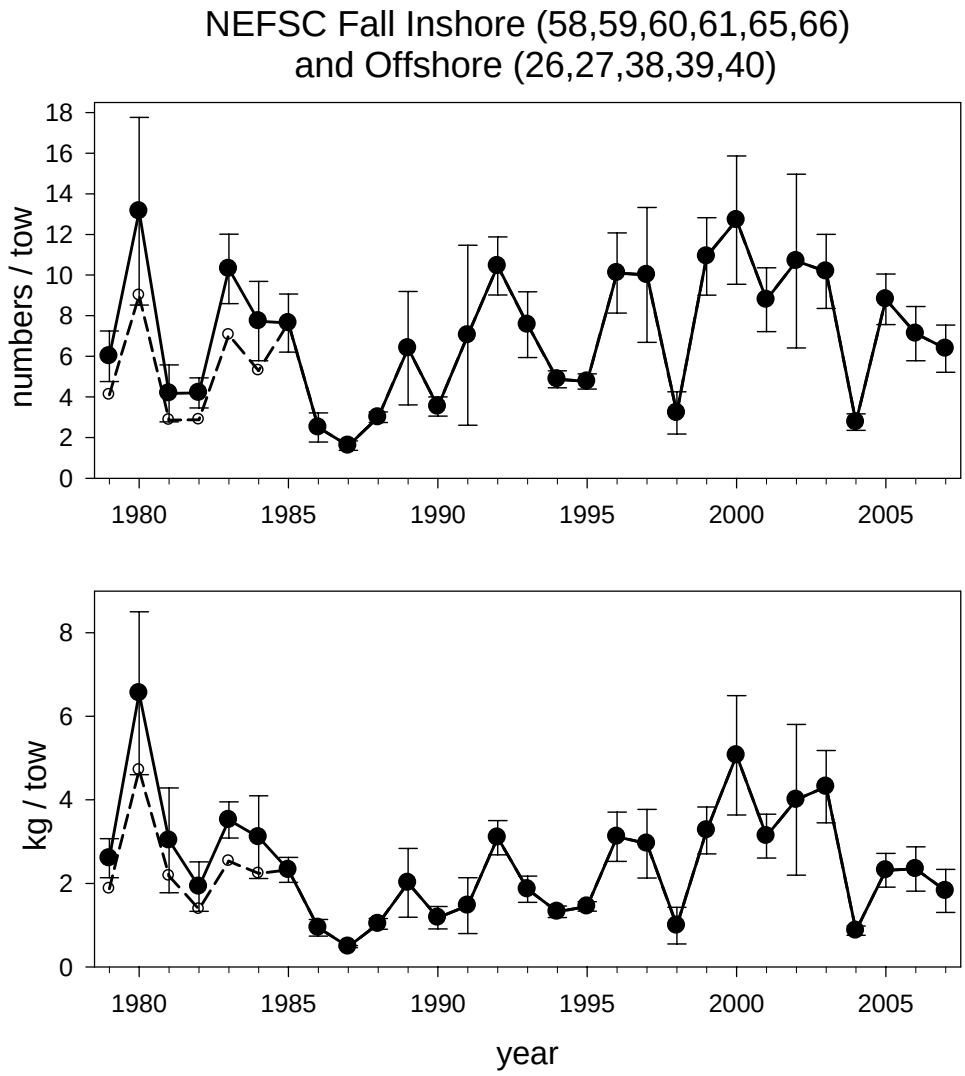


Figure I15. NEFSC Fall survey stratified mean numbers and mean weight (kg) per tow for Gulf of Maine winter flounder. Trawl door conversion factors are use where appropriate. Data for 2007 is preliminary. Dotted lines are the unconverted indices.

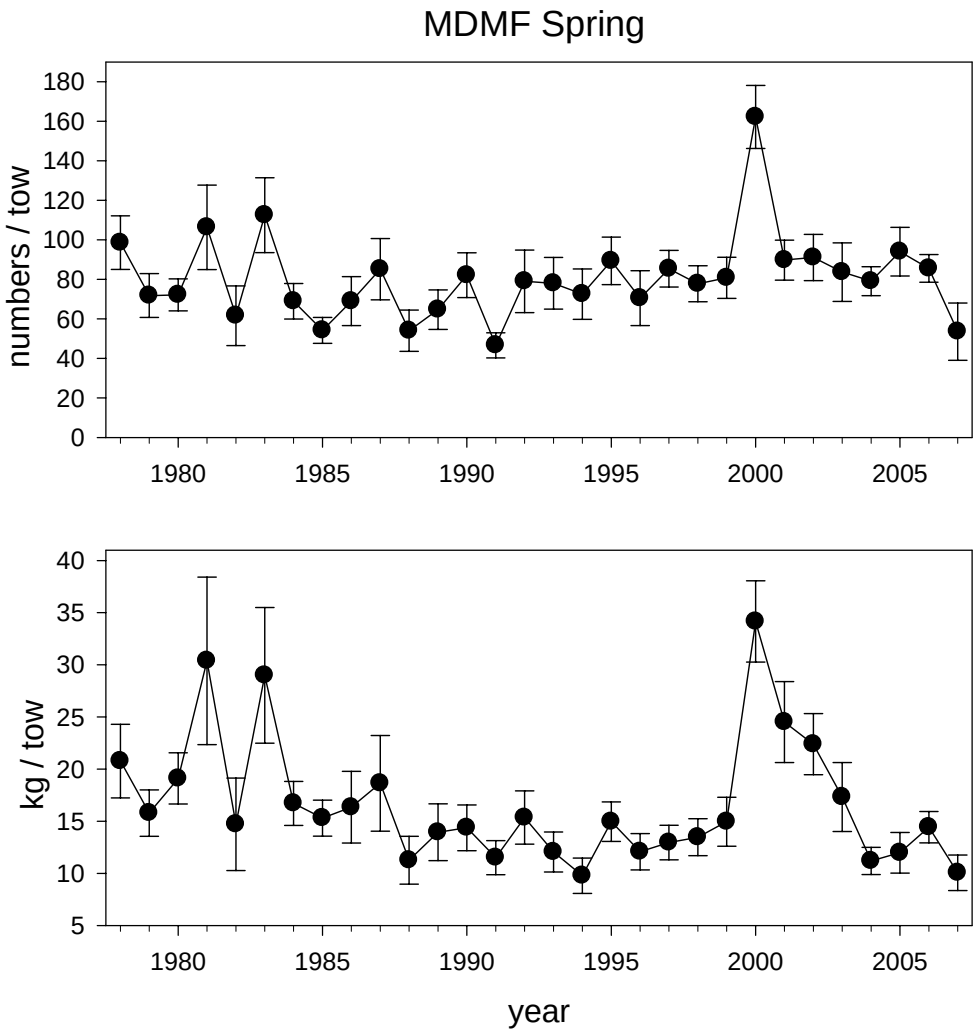


Figure I16. Massachusetts Division of Marine Fisheries (MDMF) Spring survey stratified mean numbers and mean weight (kg) per tow for Gulf of Maine winter flounder.

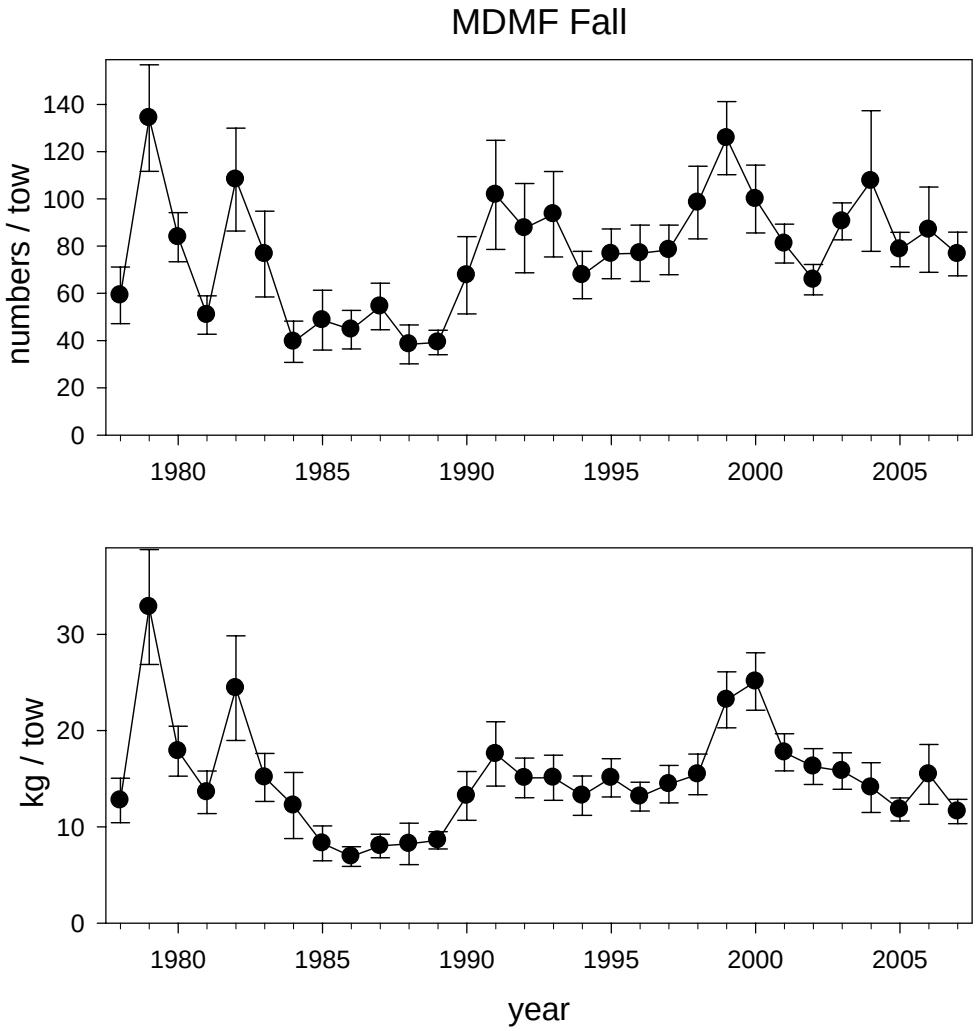


Figure I17. Massachusetts Division of Marine Fisheries (MDMF) Fall survey stratified mean numbers and mean weight (kg) per tow for Gulf of Maine winter flounder.

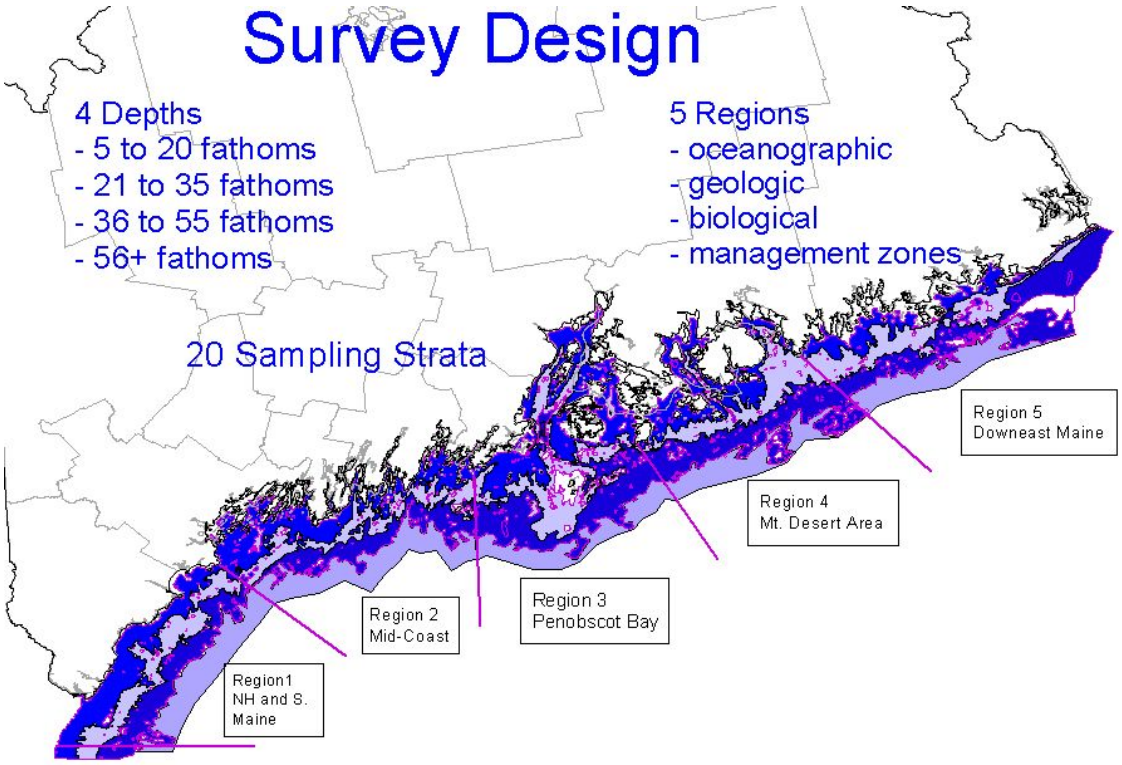


Figure I18. Survey strata for the NH/ME bottom trawl survey.

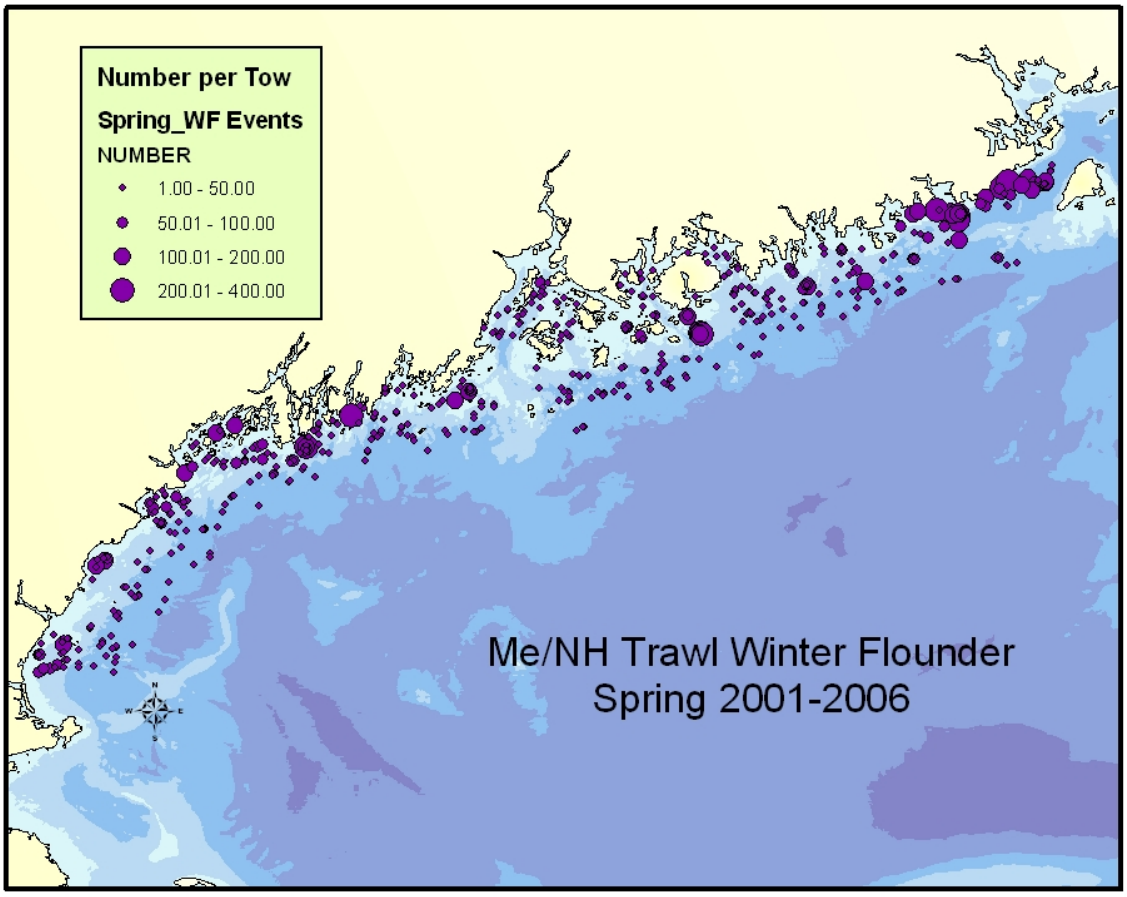


Figure I19. Spring ME/NH bottom trawl survey winter flounder distribution.

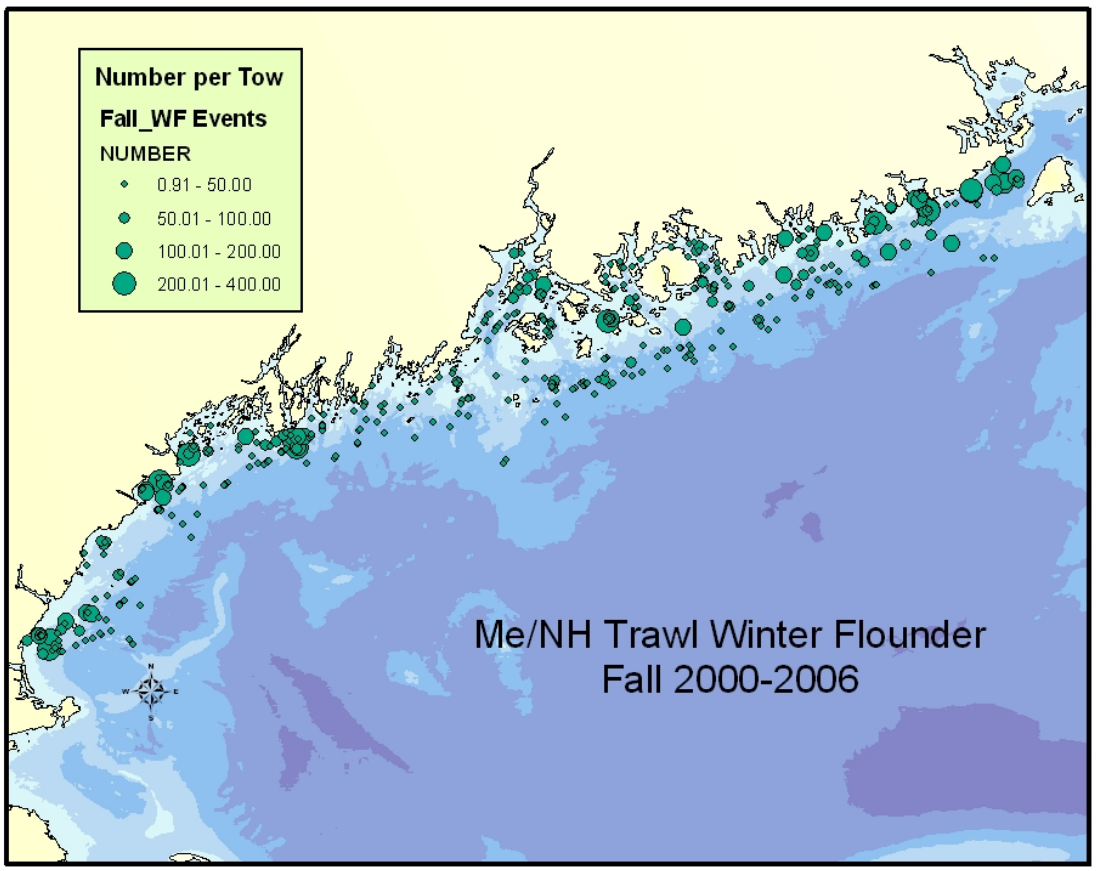
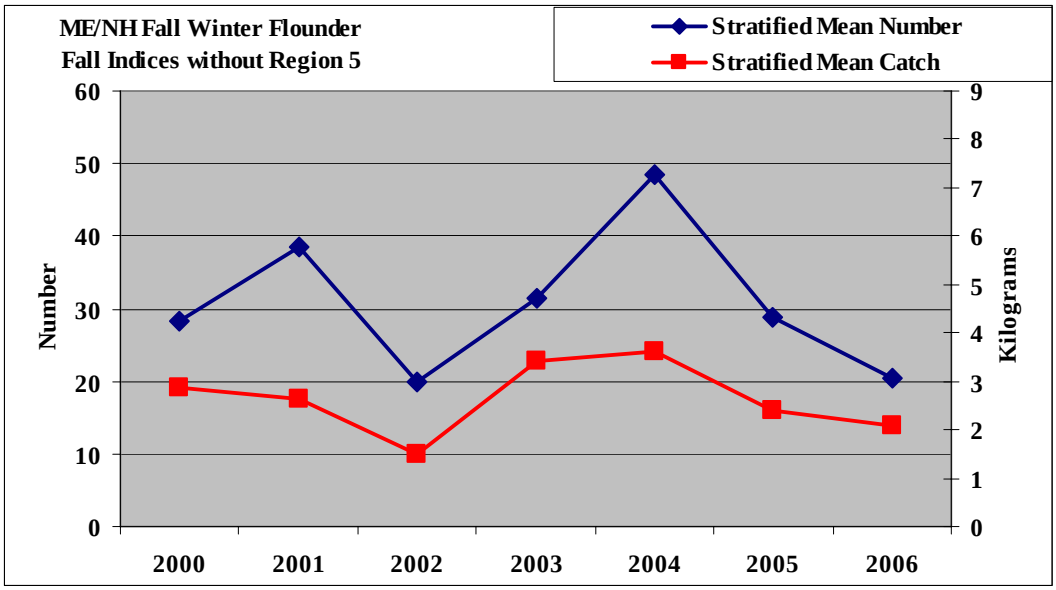


Figure I20. Fall ME/NH bottom trawl survey winter flounder distribution.



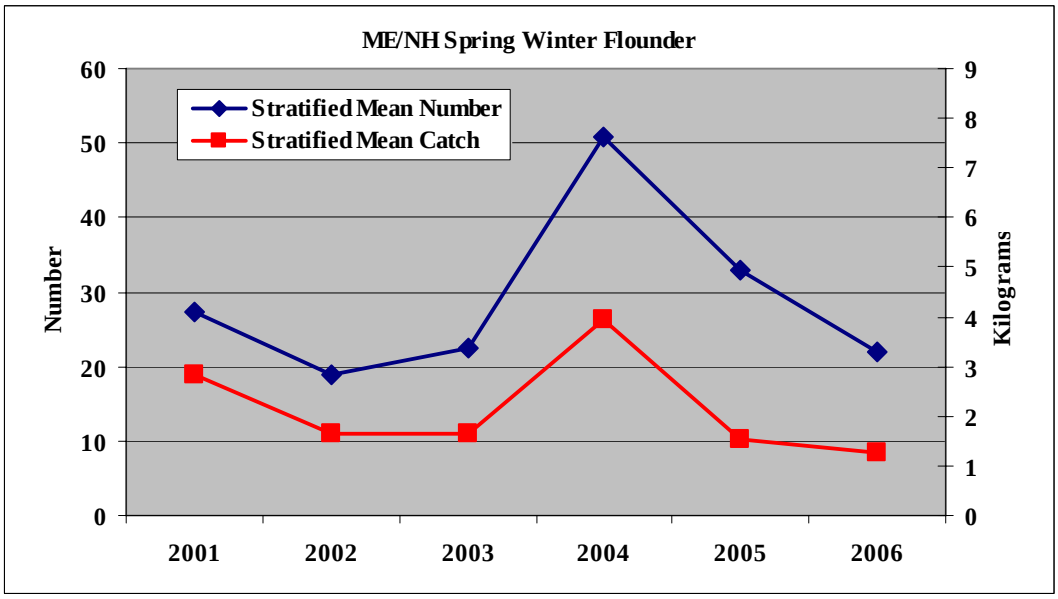


Figure I21. Spring and Fall ME/NH bottom trawl survey winter flounder indices.

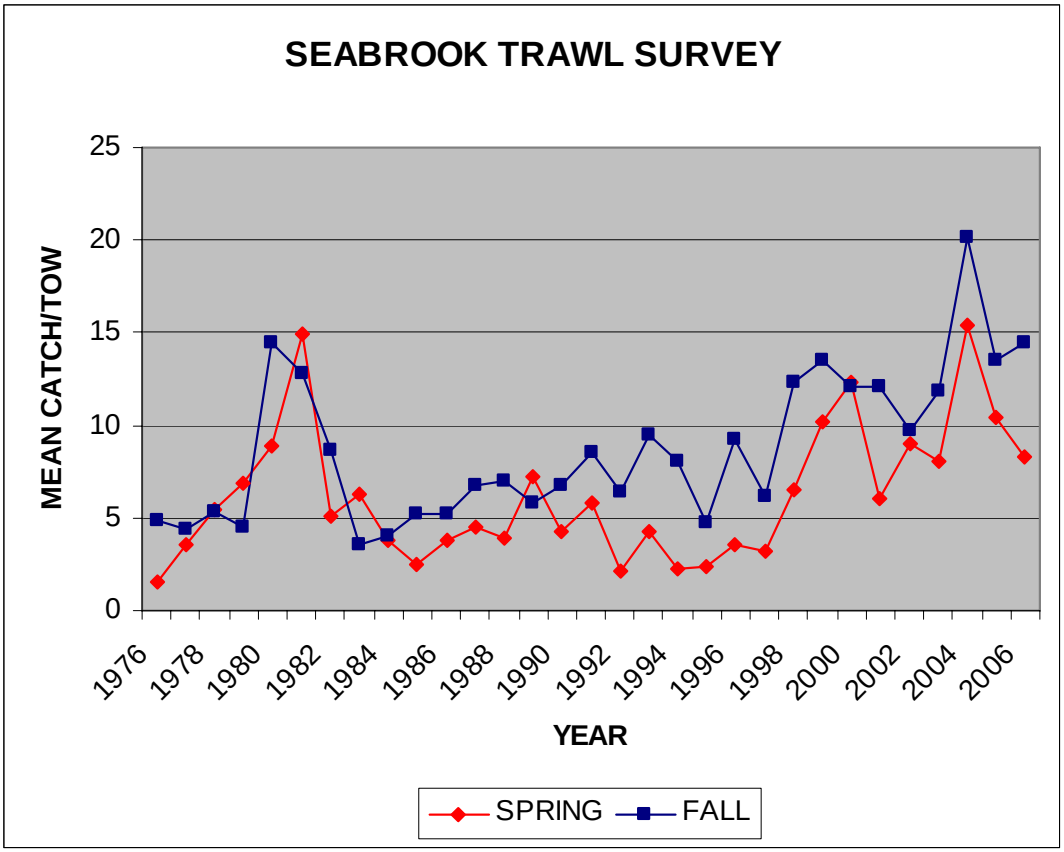


Figure I22. Seabrook Nuclear Plwer Plant in New Hampshire Spring and Fall survey mean number per tow for Gulf of Maine winter flounder.

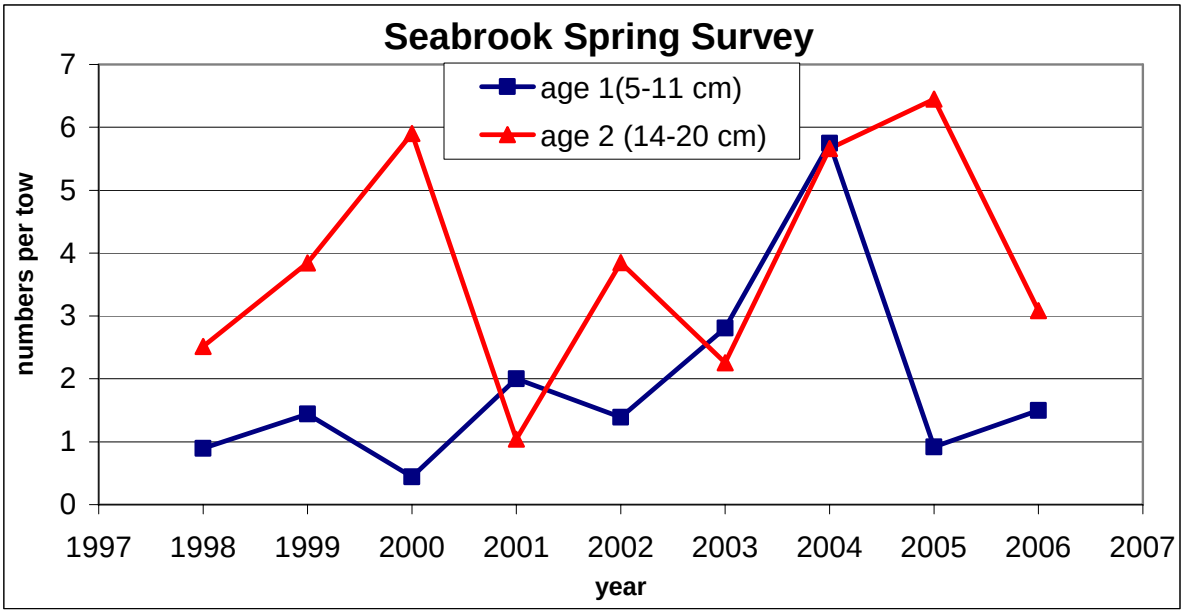


Figure I23. Estimated Seabrook age 1 and 2 index using length slicing.

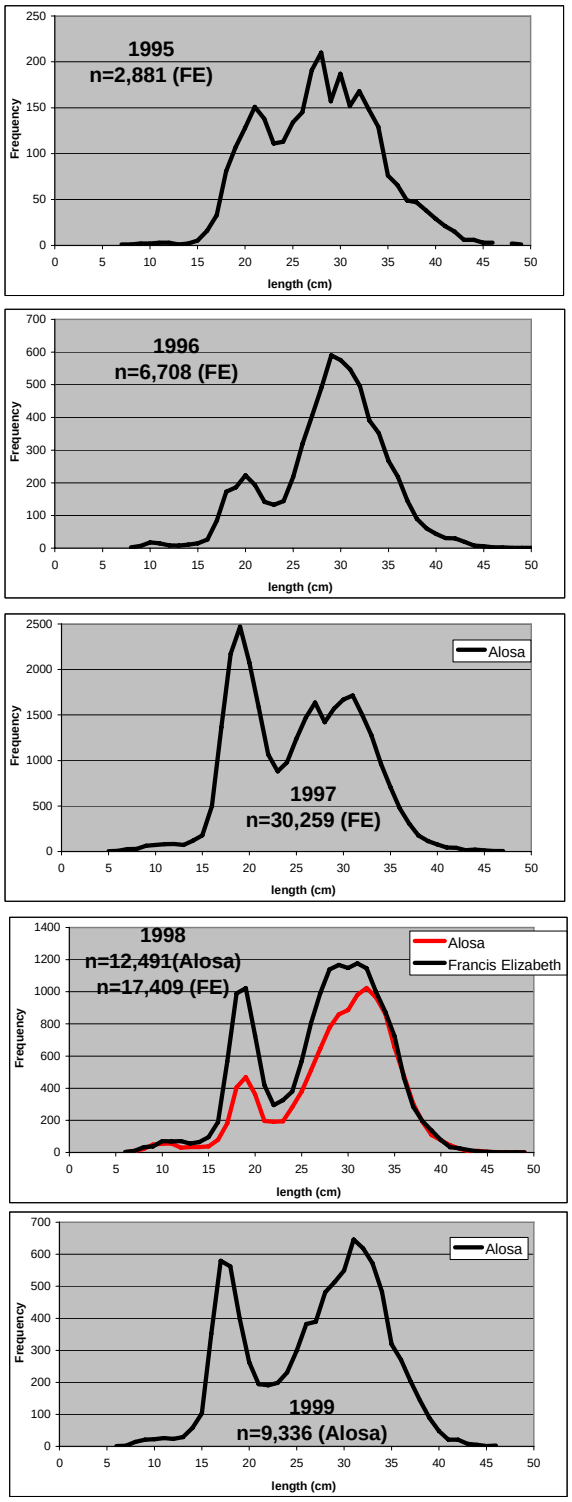


Figure I24. Length frequency distributions from the Pilgrim Nuclear power plant winter flounder area swept study in Western Cape Cod Bay. 1998 and 1999 had an additional vessel (FV Alosa) contracted for the survey.

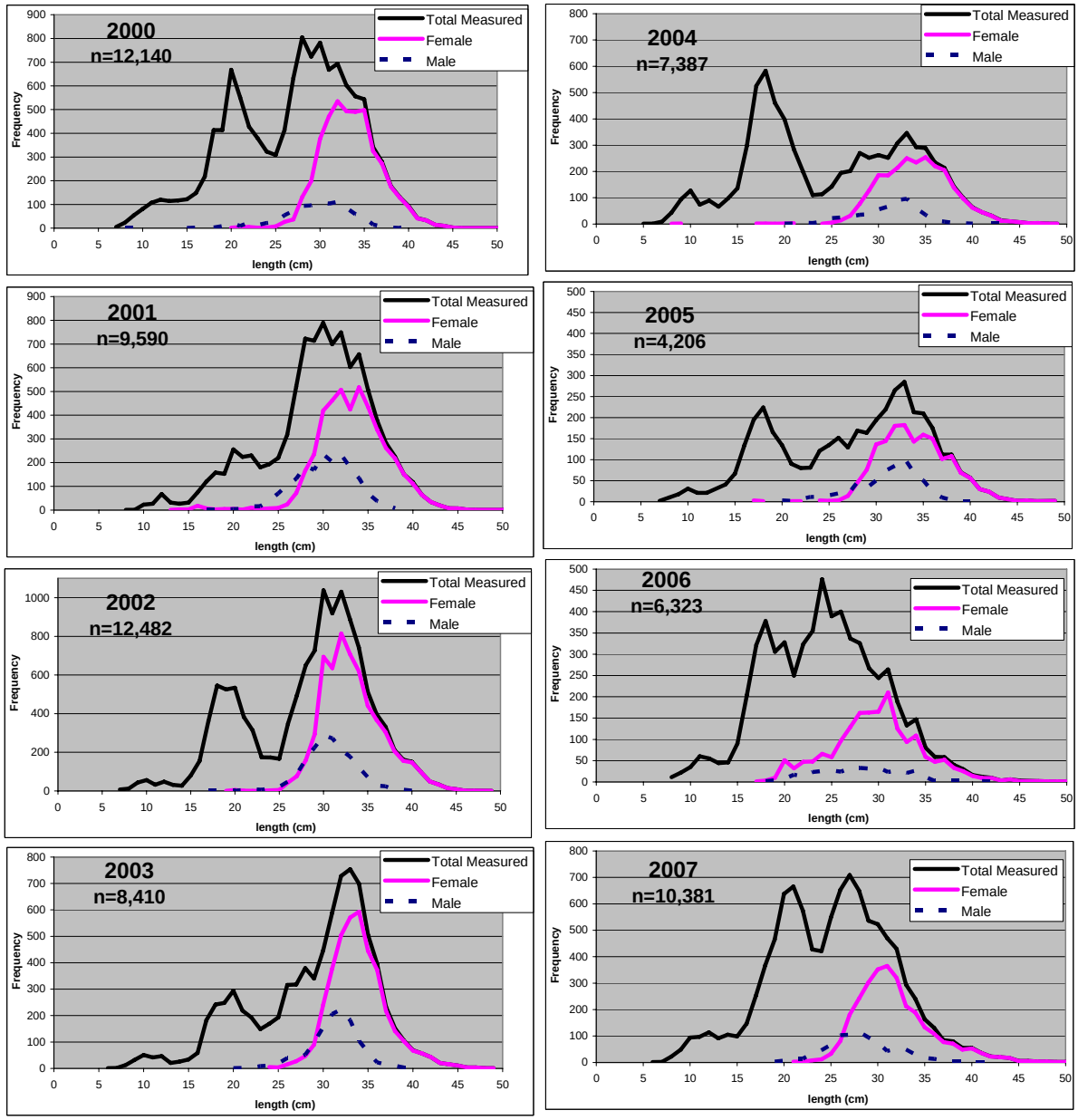


Figure I 24. Cont.

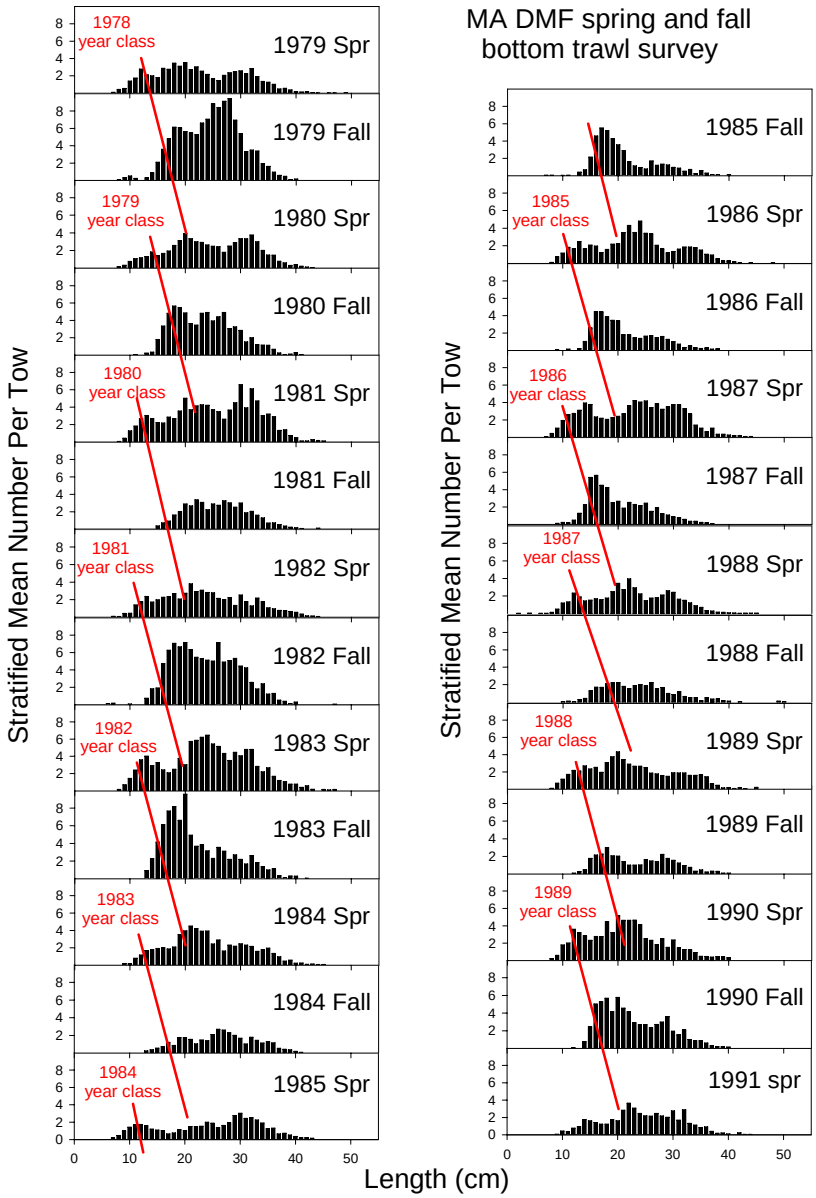


Figure I25. Spring and Fall MDMF bottom trawl survey Gulf of Maine winter flounder catch per tow at length.

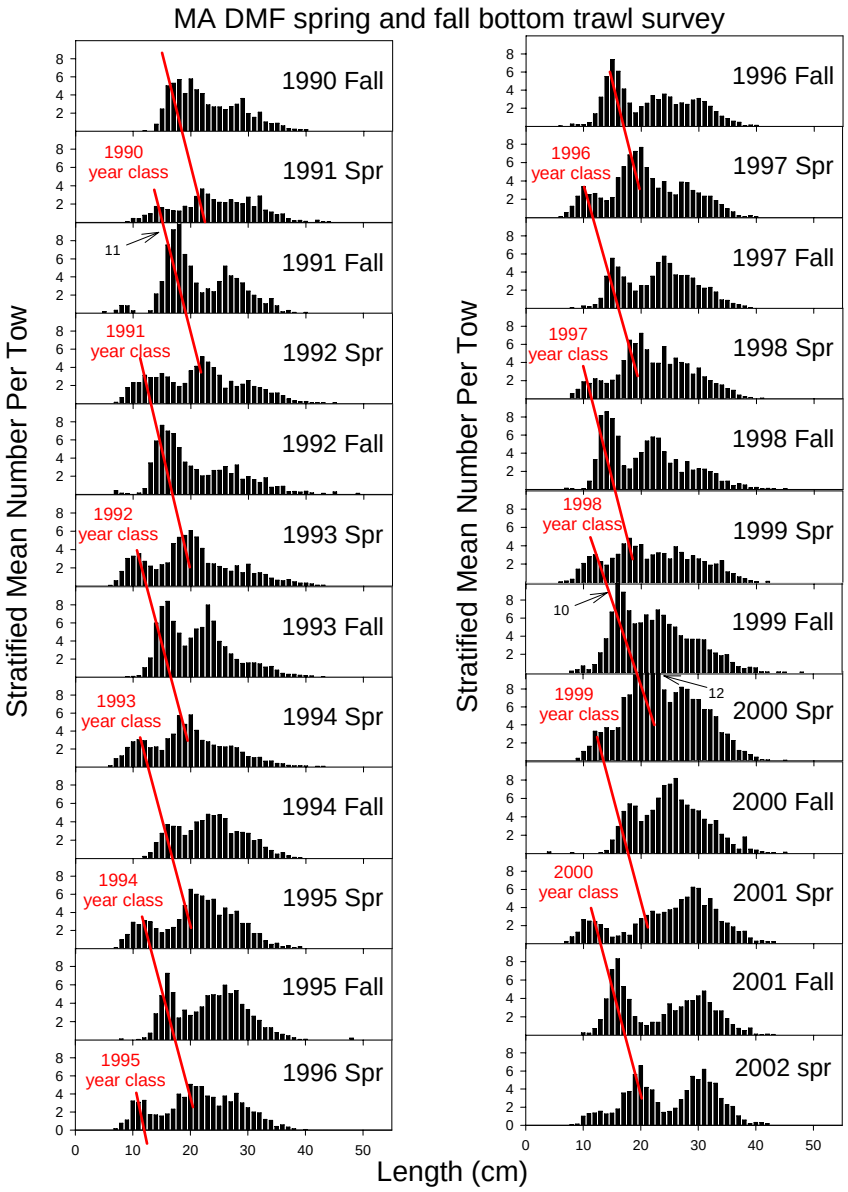


Figure I25. Cont.

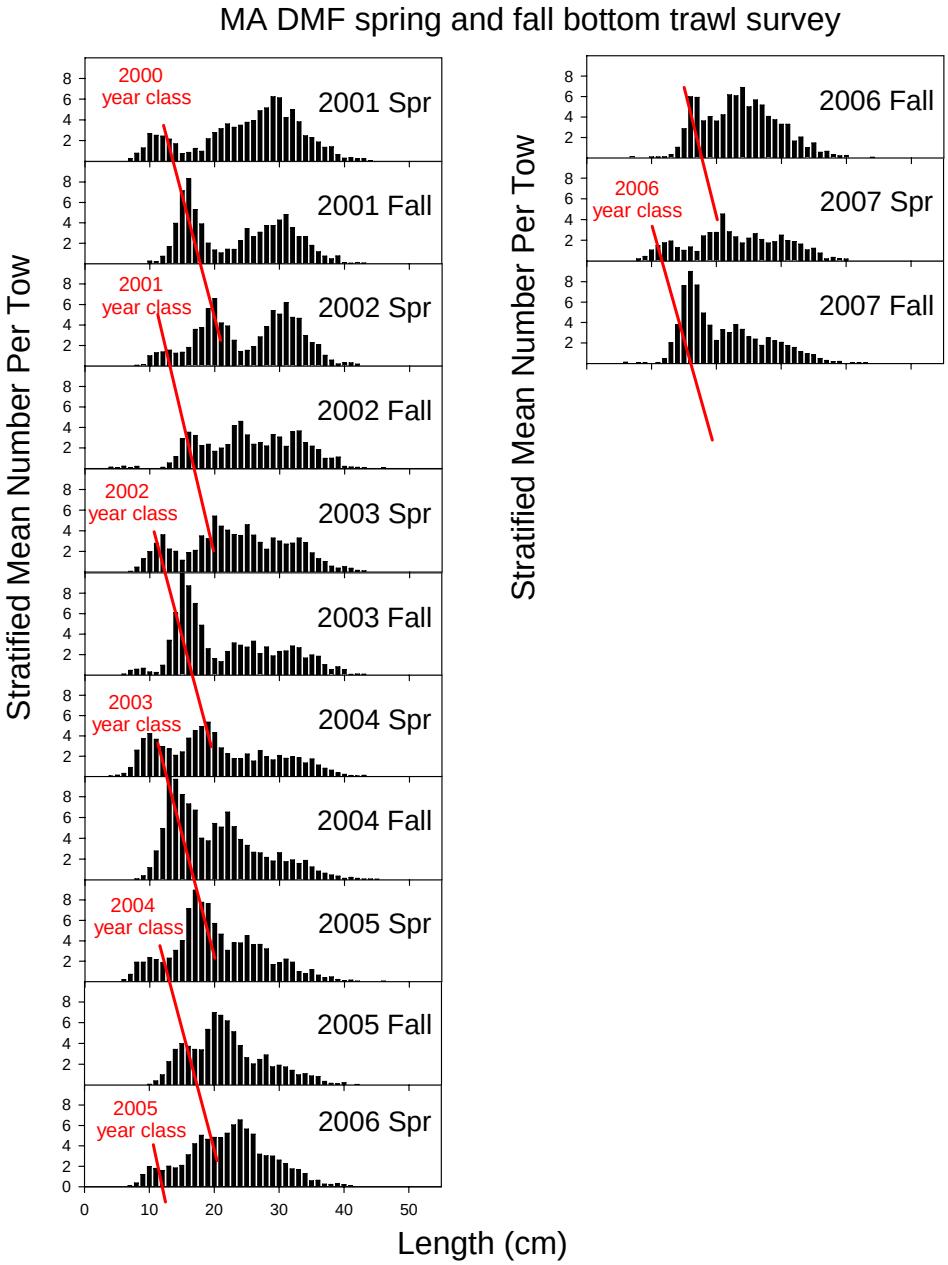


Figure I25. Cont.

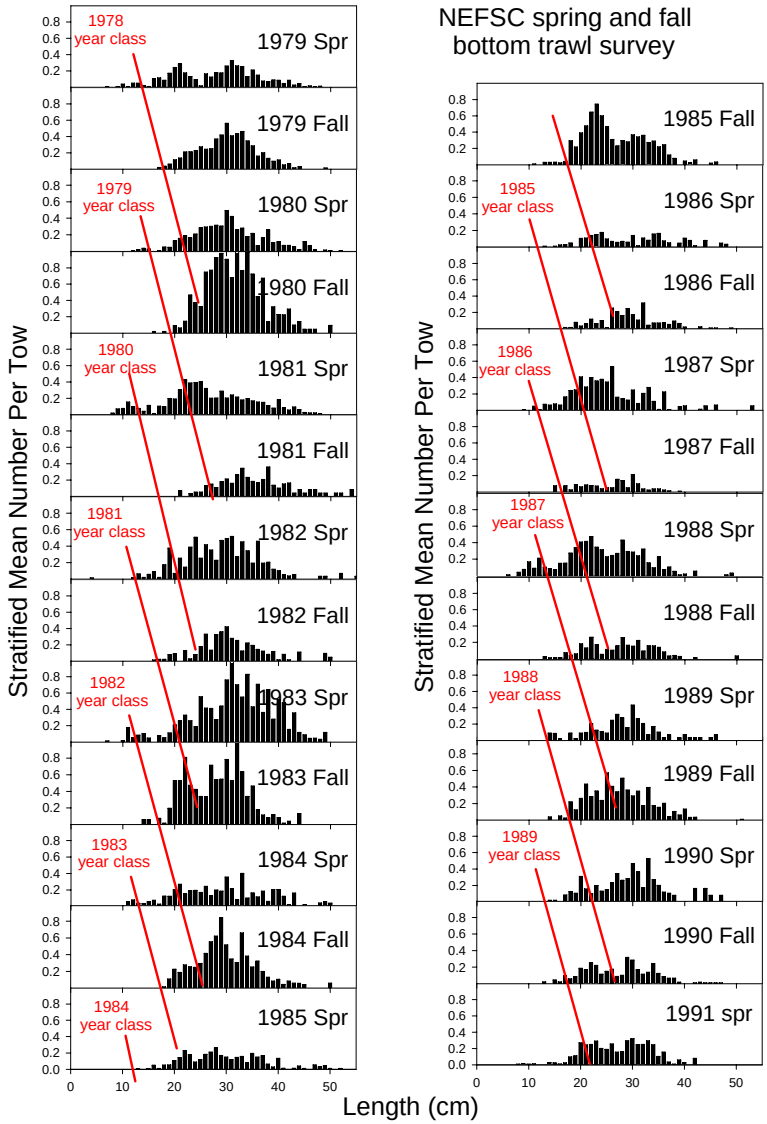


Figure I26. Spring and Fall NEFSC bottom trawl survey Gulf of Maine winter flounder catch per tow at length.

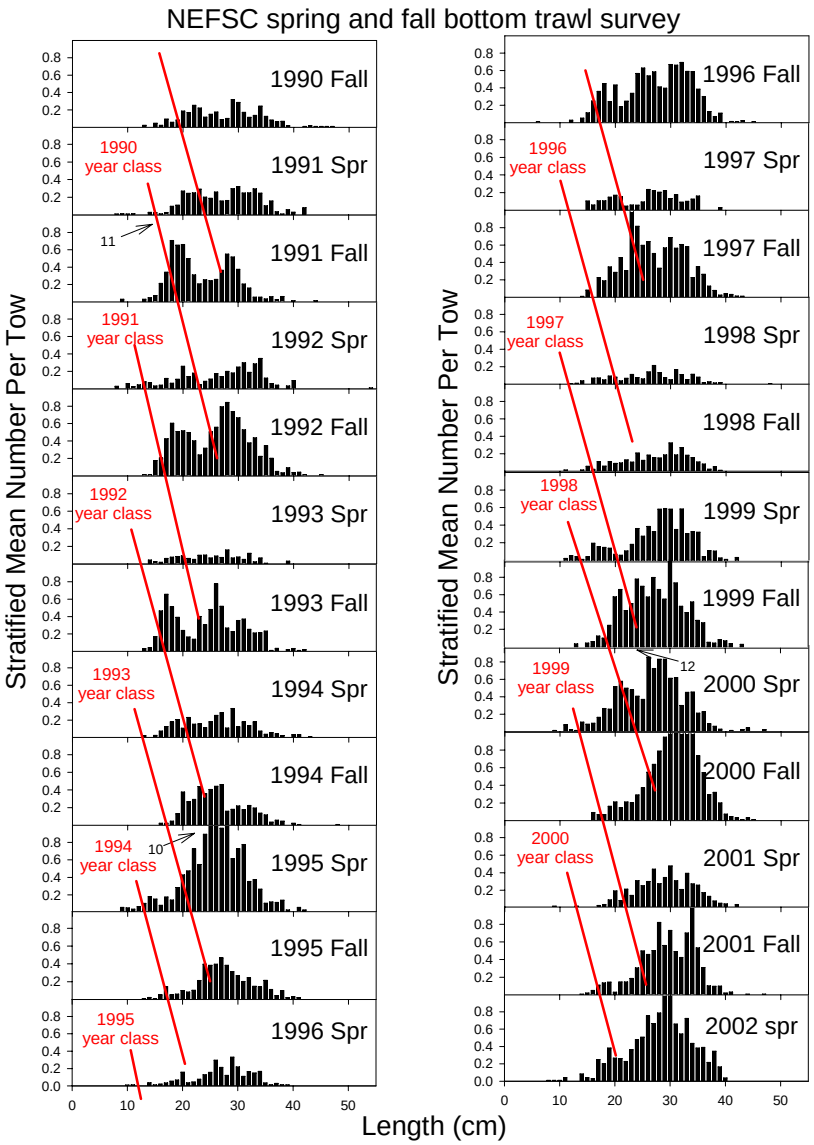


Figure I26. Cont.

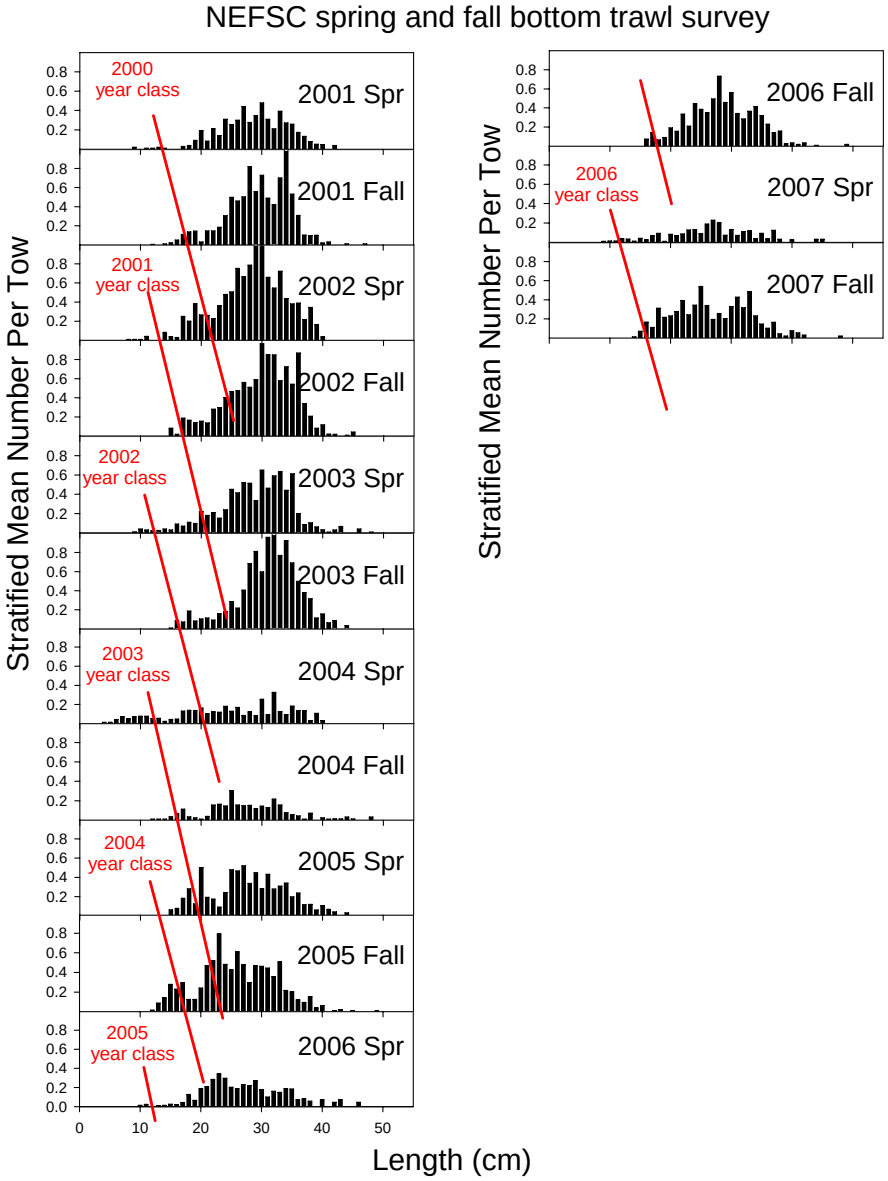


Figure I26. Cont.

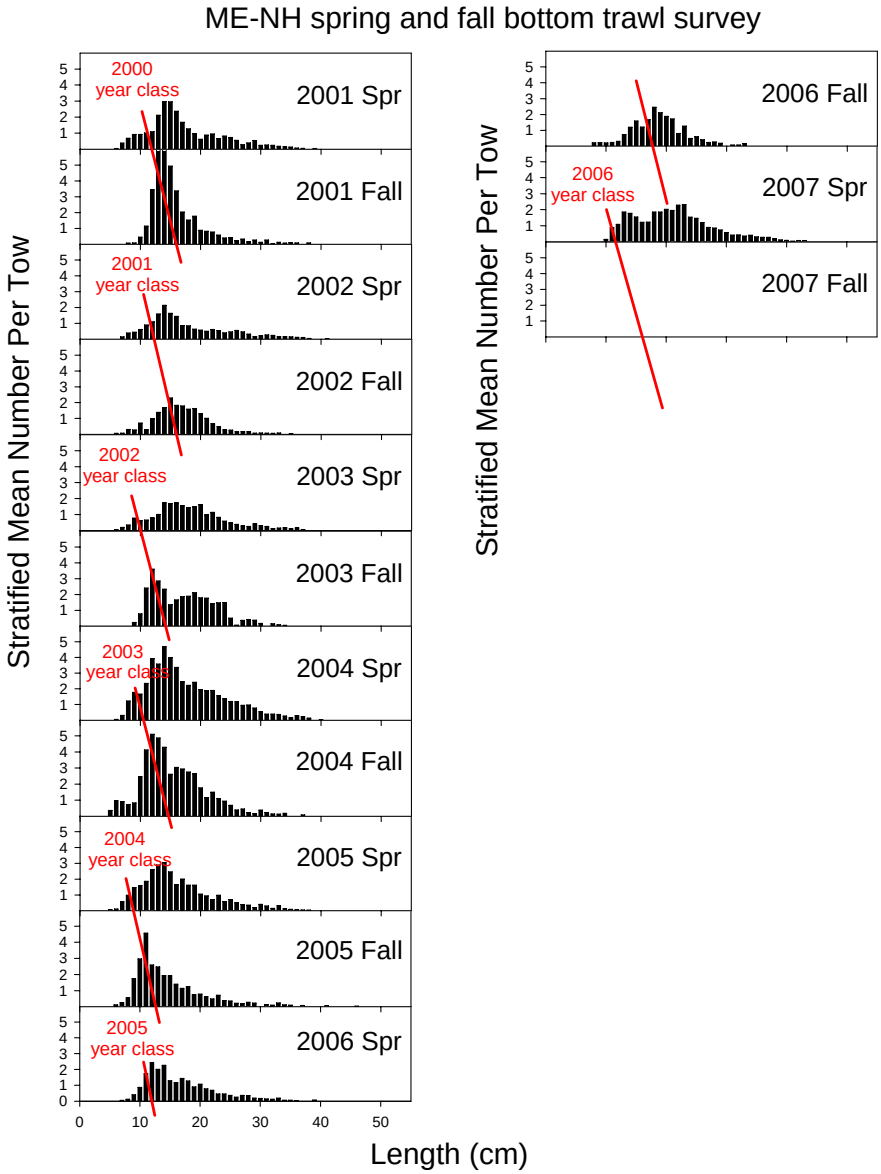


Figure I27. Spring and Fall ME/NH bottom trawl survey Gulf of Maine winter flounder catch per tow at length.

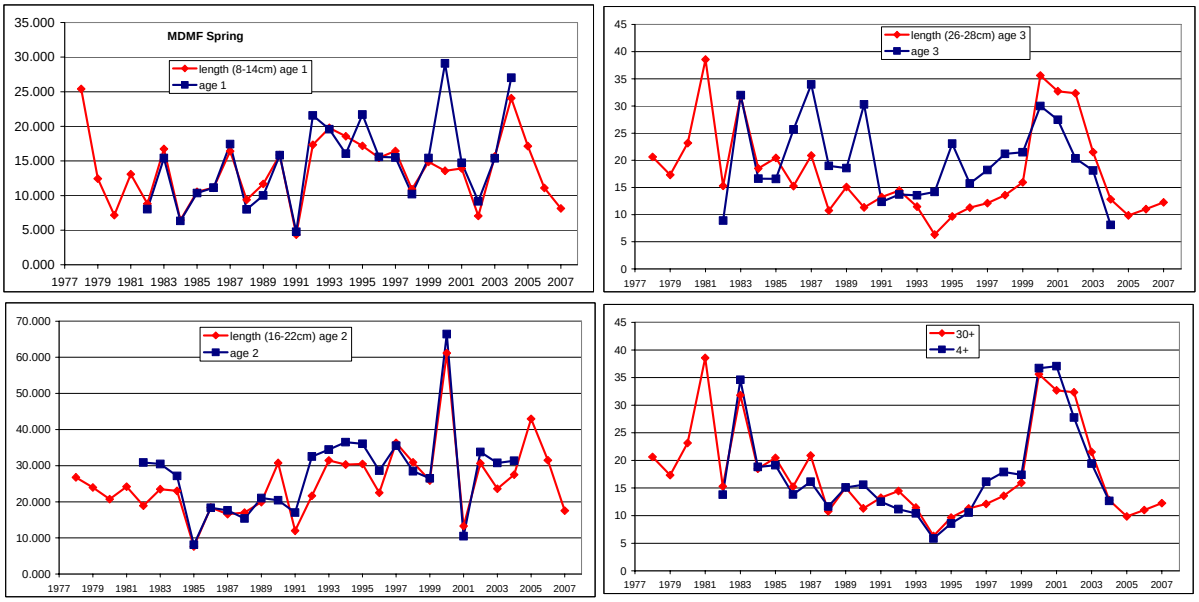


Figure I28. MDMF Spring comparison of indices at age with the estimated index at age from slicing of length modes from the catch per tow at length distributions.

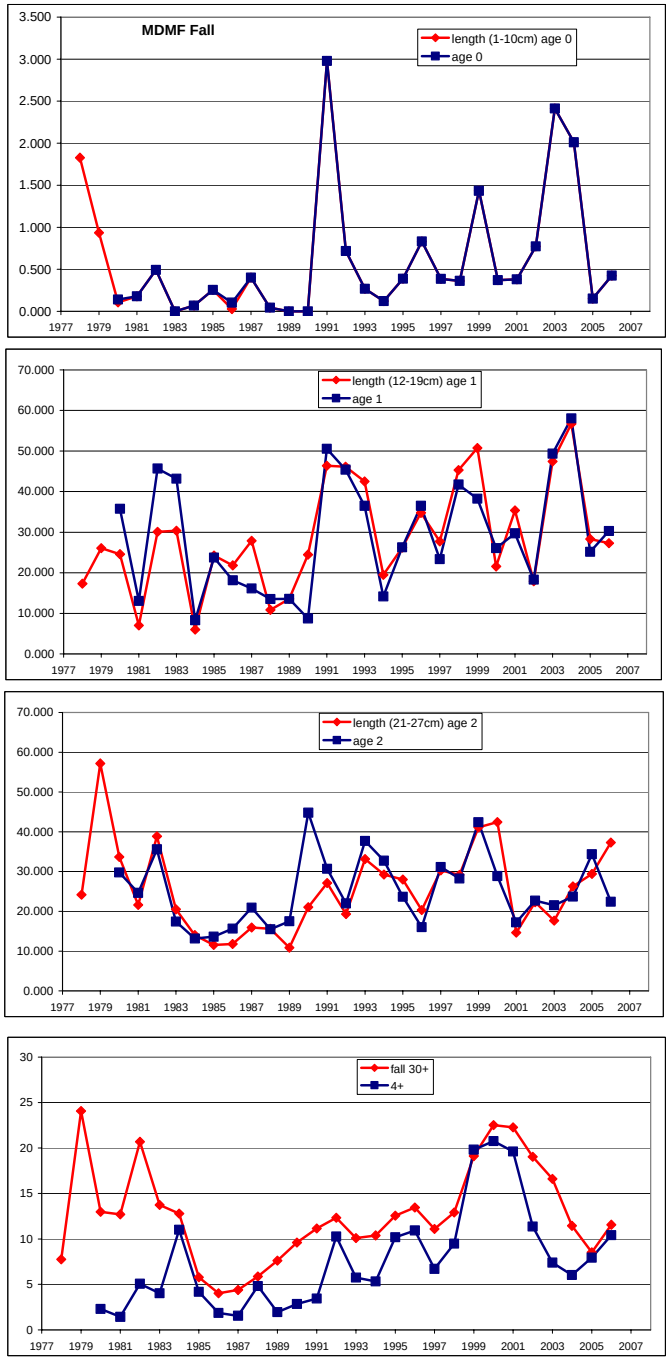


Figure I29. MDMF Fall comparison of indices at age with the estimated index at age from slicing of length modes from the catch per tow at length distribution.

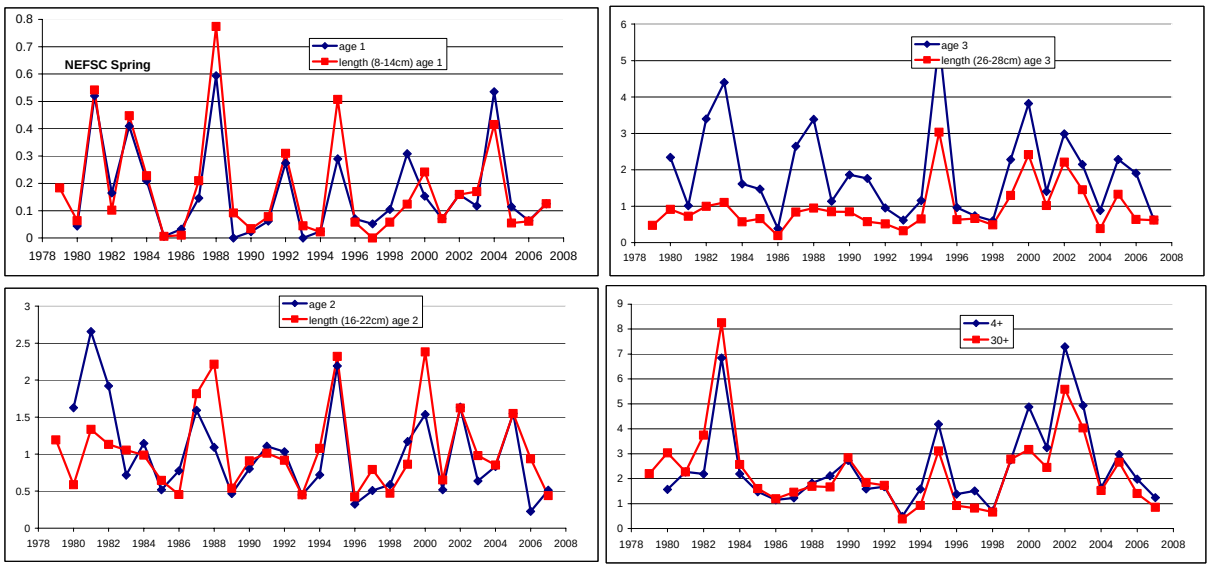


Figure I30. NEFSC Spring comparison of indices at age with the estimated index at age from slicing of length modes from the catch per tow at length distribution.

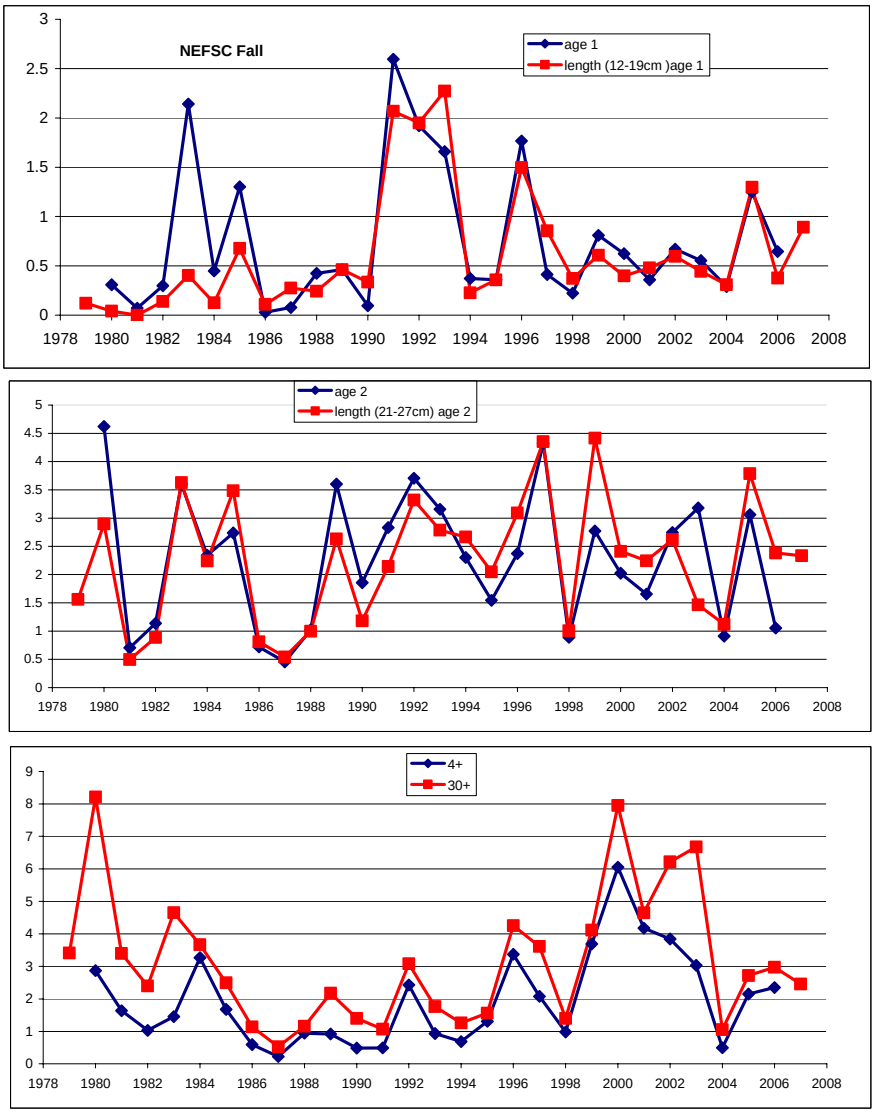


Figure I31. NEFSC Fall Spring comparison of indices at age with the estimated index at age from slicing of length modes from the catch per tow at length distribution.

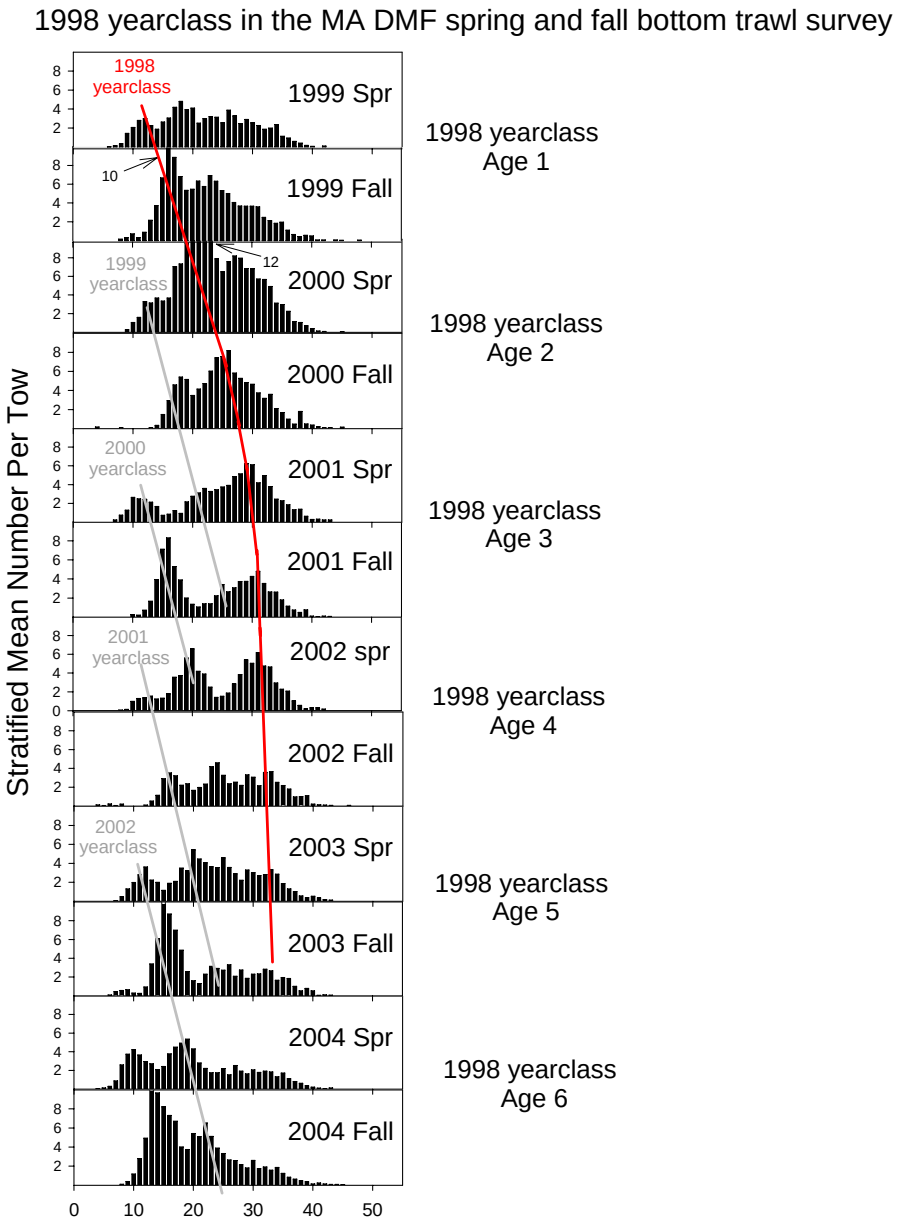


Figure I32. MDMF bottom trawl survey tracking of the 1998 yearclass in the Gulf of Maine winter flounder catch per tow at length distributions.

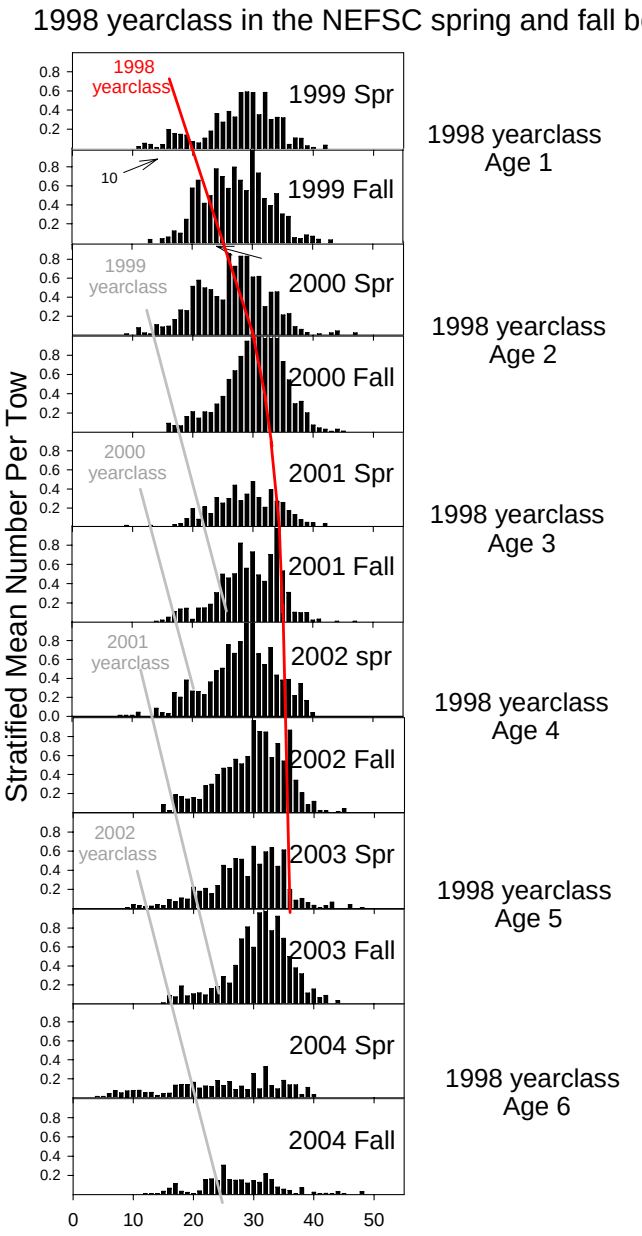


Figure I33. NEFSC bottom trawl survey tracking of the 1998 yearclass in the Gulf of Maine winter flounder catch per tow at length distributions.

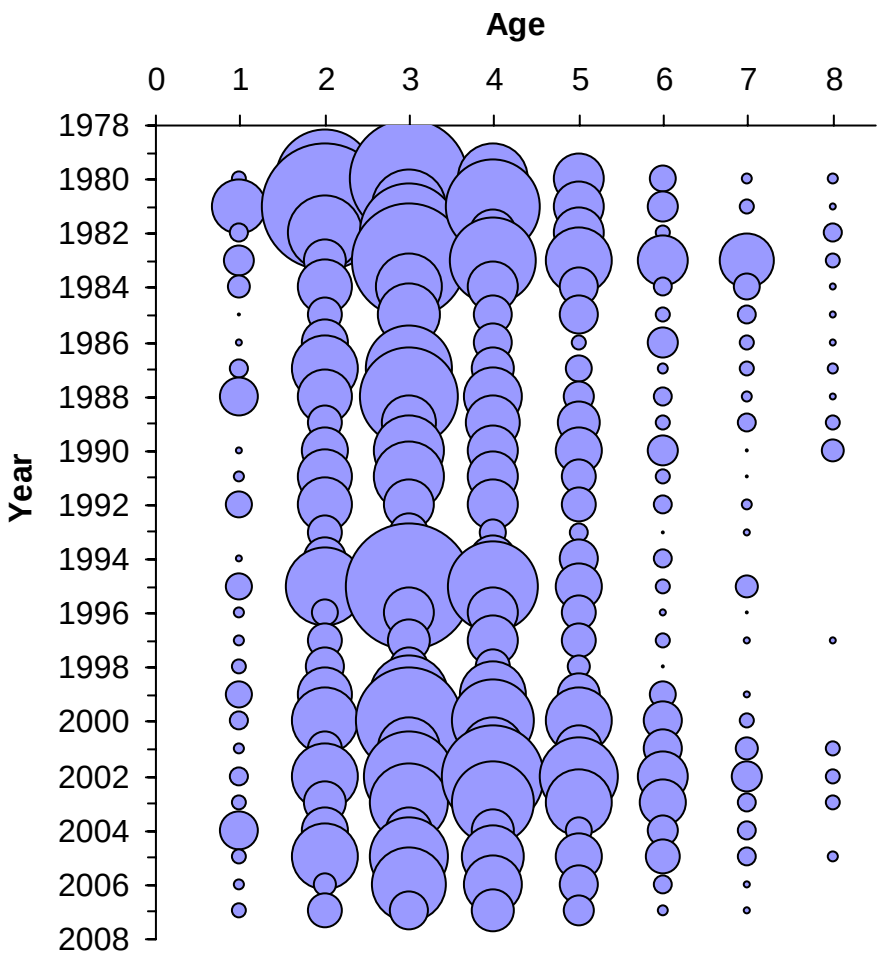


Figure I34. NEFSC Spring bubble plot by age.

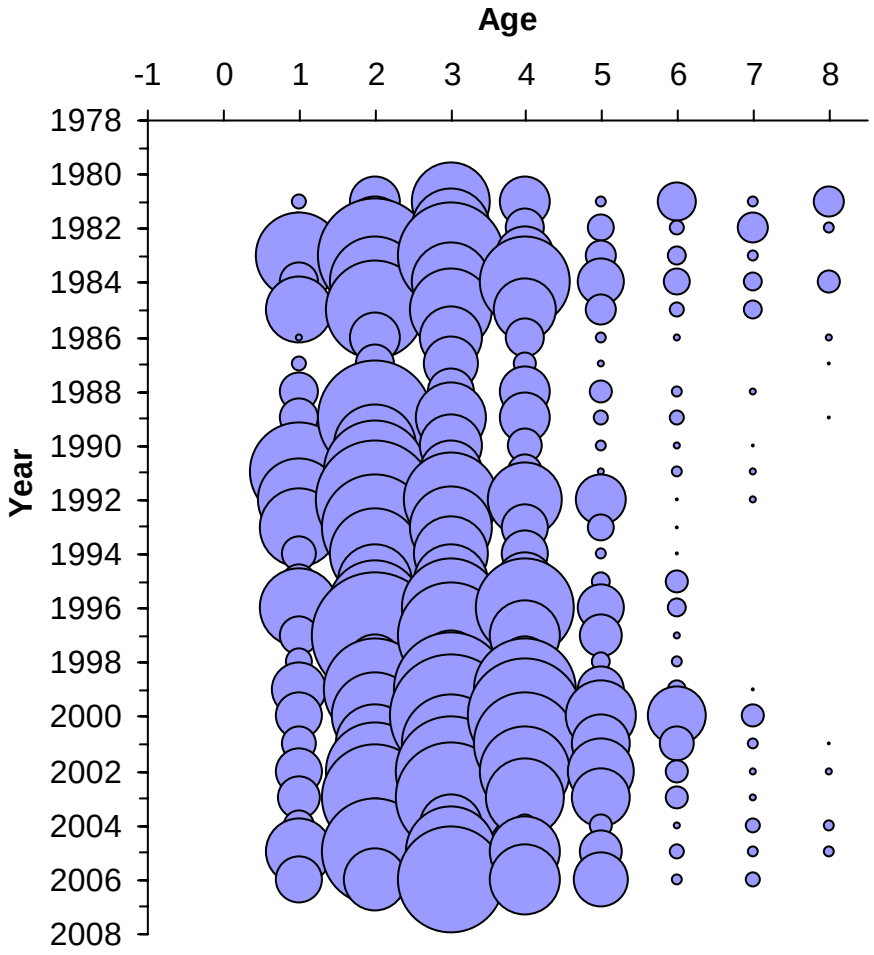


Figure I35. NEFSC Fall bubble plot by age.

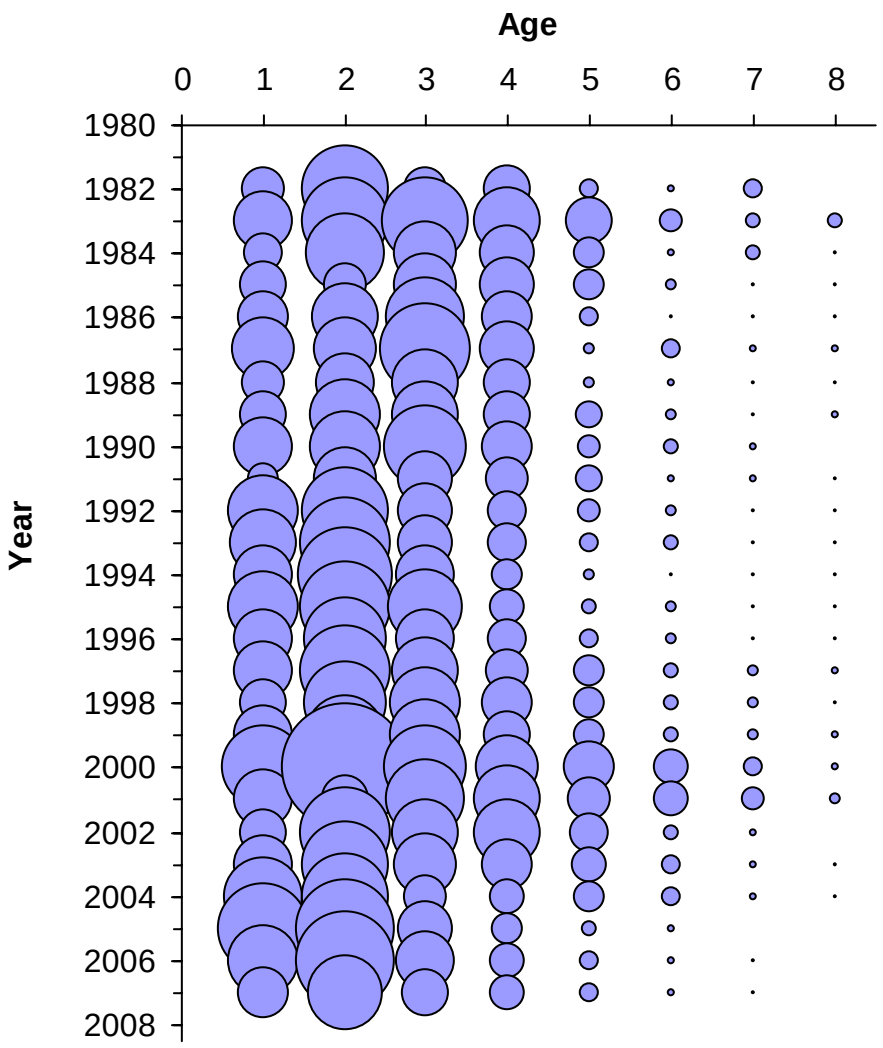


Figure I36. MDMF spring bubble plot by age.

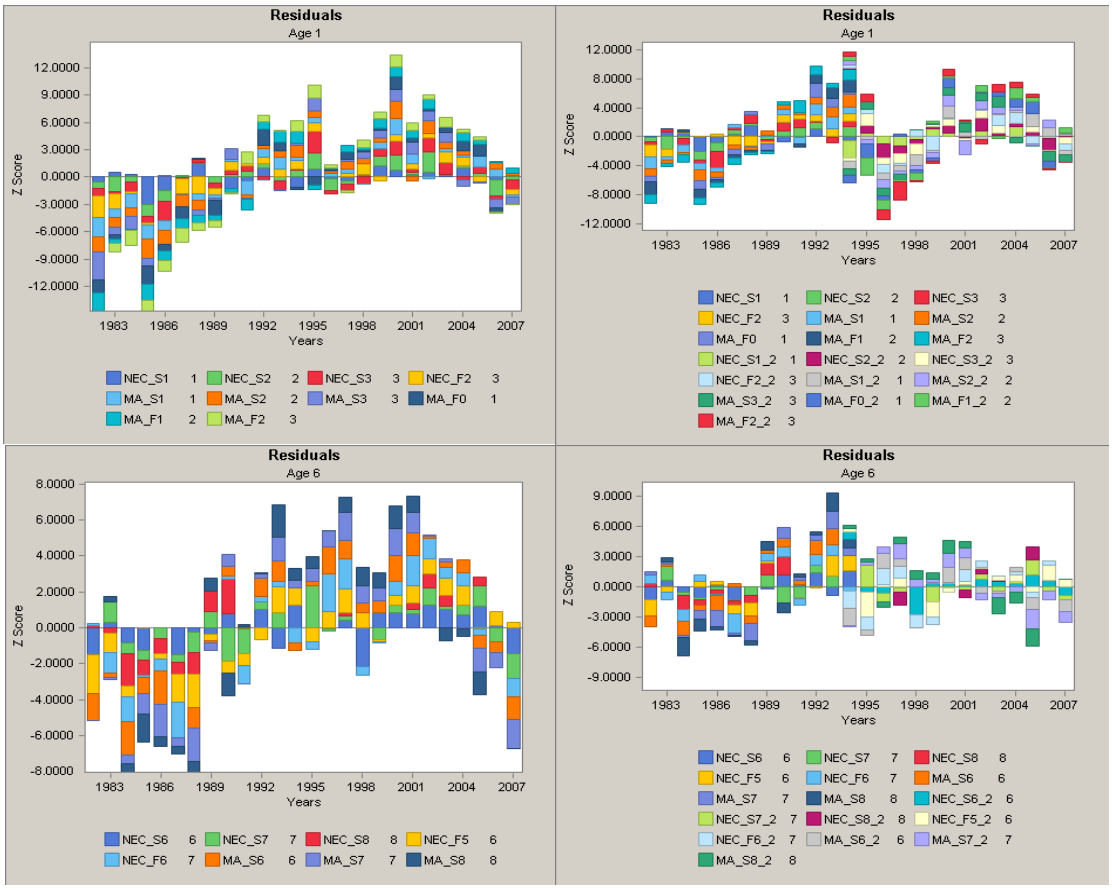


Figure I37. Non-split and split VPA residual pattern. Top plots are residuals for ages 1 through 3 for the non-split (left) and split VPA (right). Bottom plots are residuals patterns for ages 6 through 8+ for the non split (left) and split VPA (right).

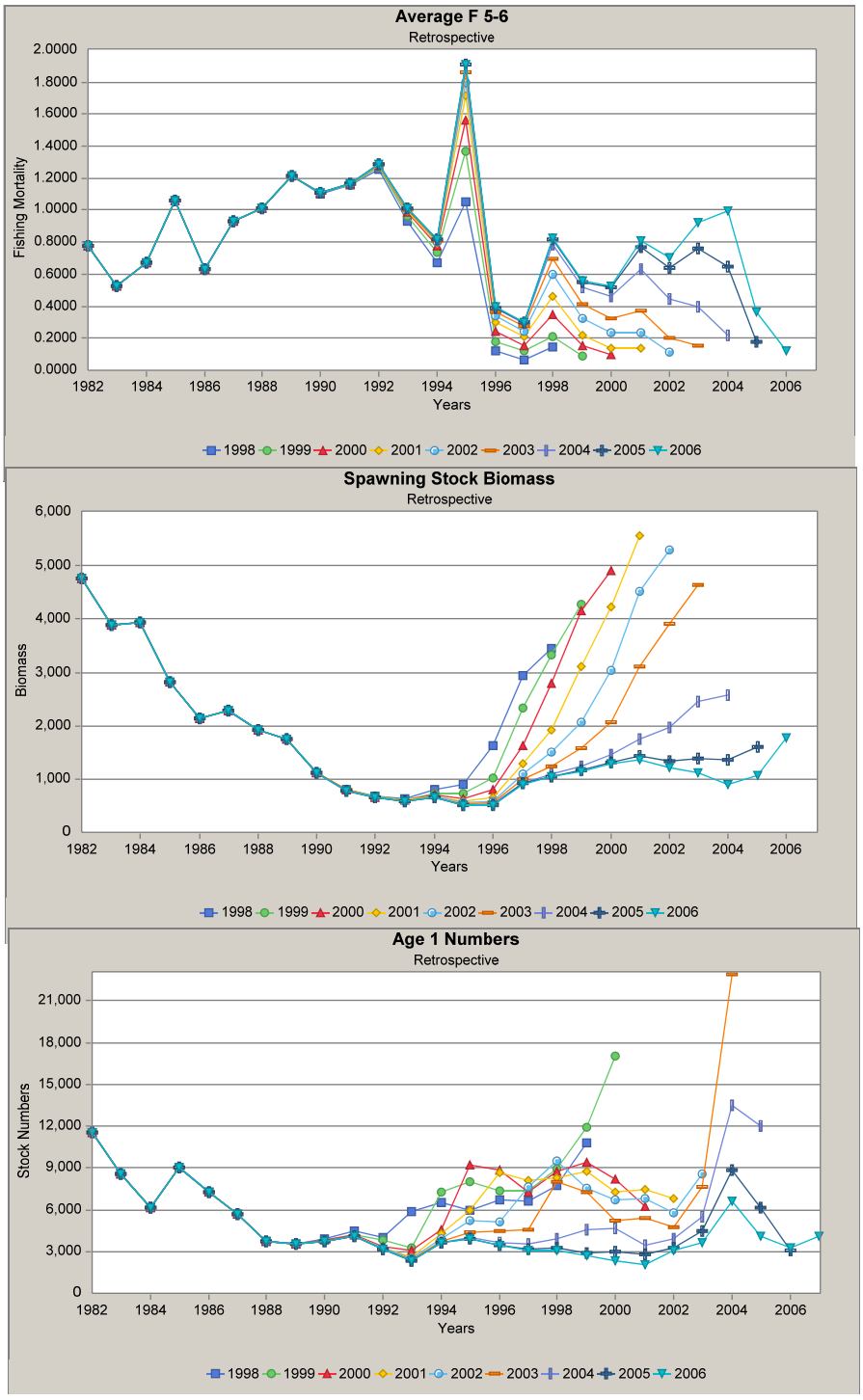


Figure I38. Gulf of Maine winter flounder non-split VPA retrospective.

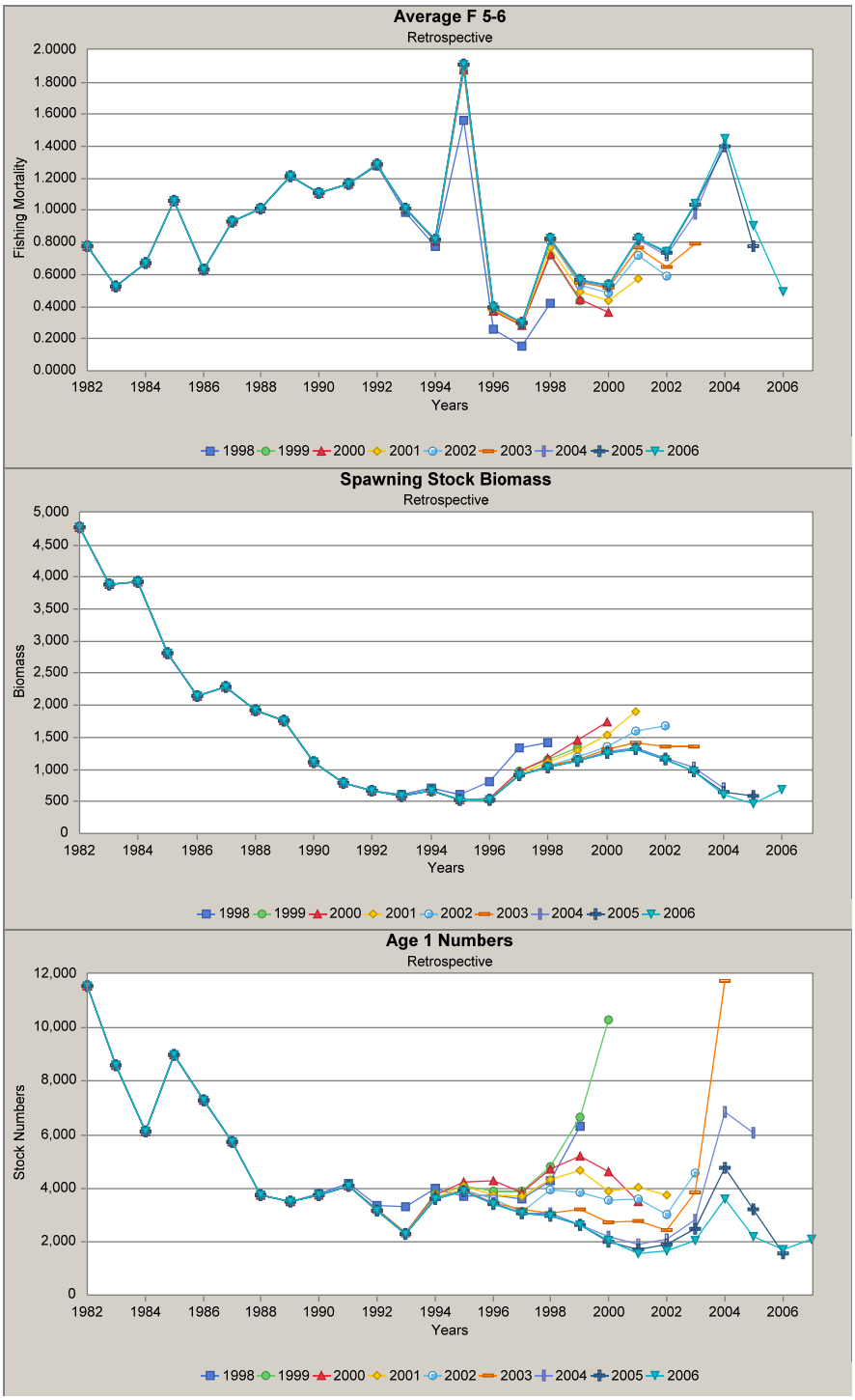


Figure I39. Gulf of Maine winter flounder split VPA retrospective.

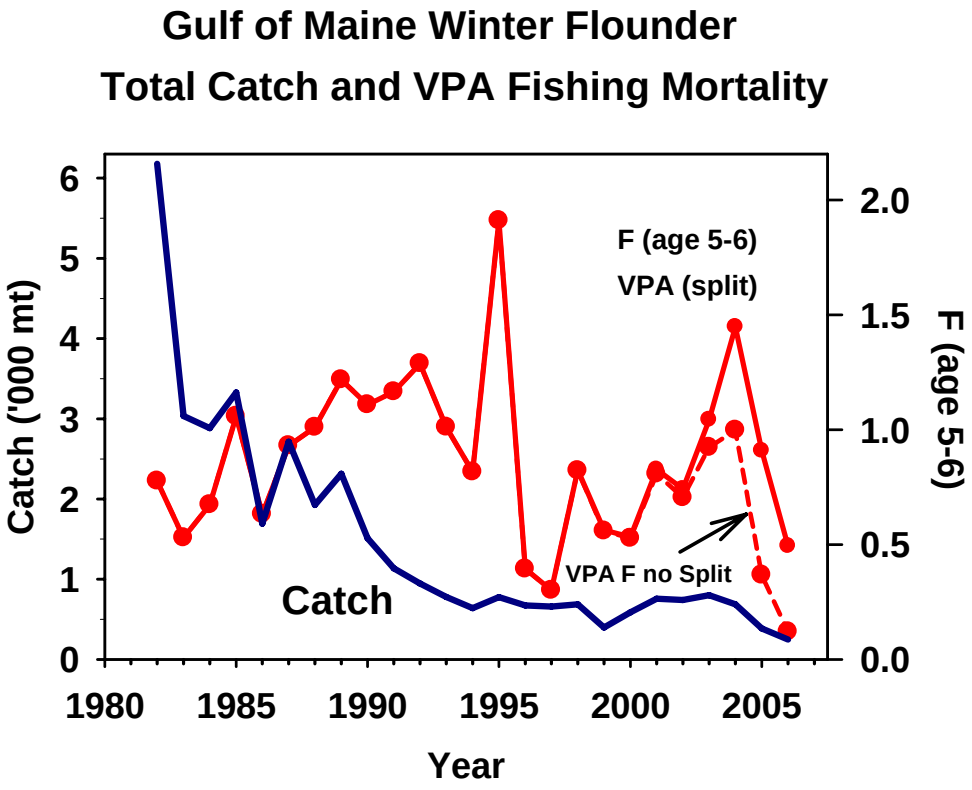


Figure I40. Total catch (landings and discards, thousands of metric tons) and fishing mortality rate (F, ages 5-6) from the split and non-split VPA for Gulf of Maine winter flounder.

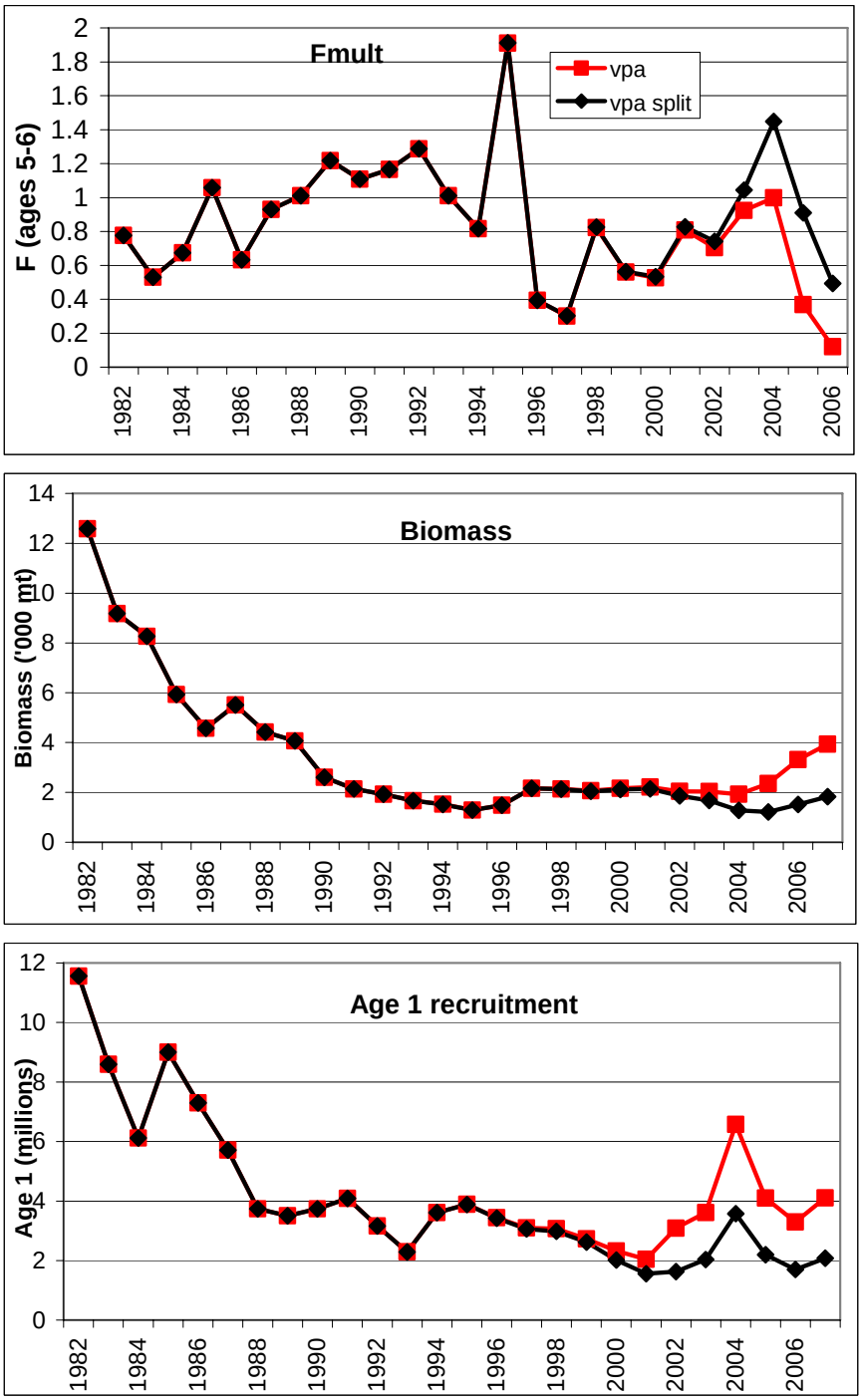


Figure I41. Differences between the non-split and split VPA for F, total biomass, and recruitment.

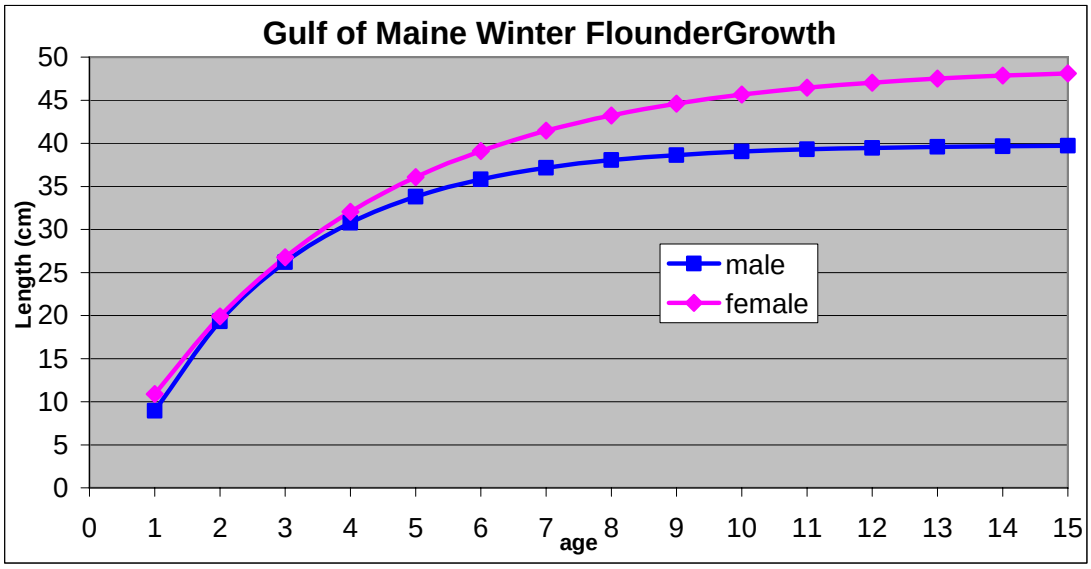
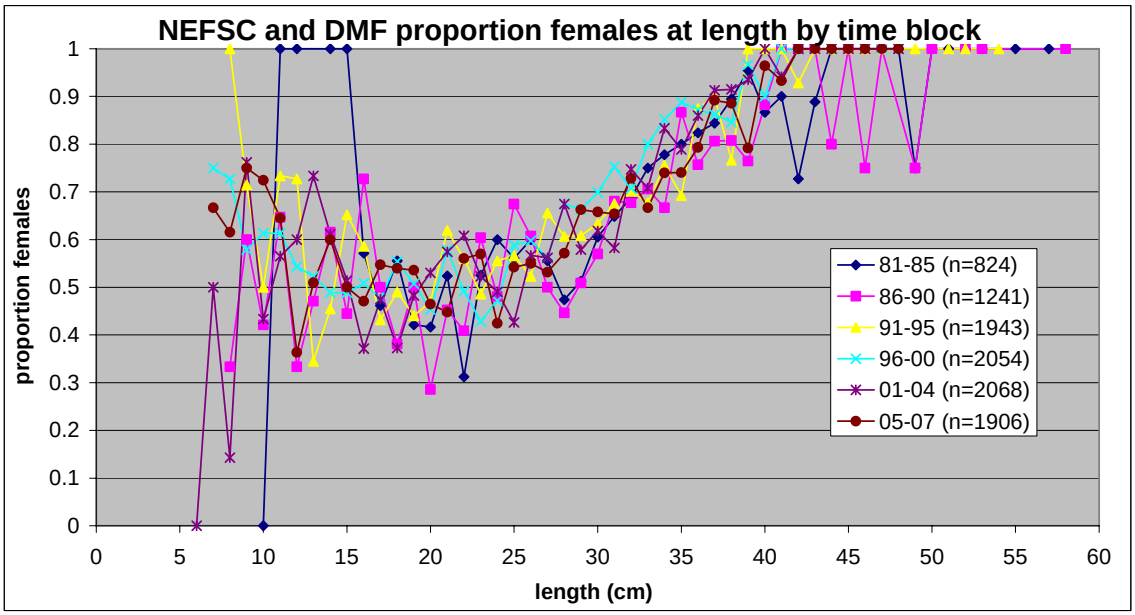


Figure I42. Von Bertalanffy growth curves by sex from Witherell and Burnett (1993).



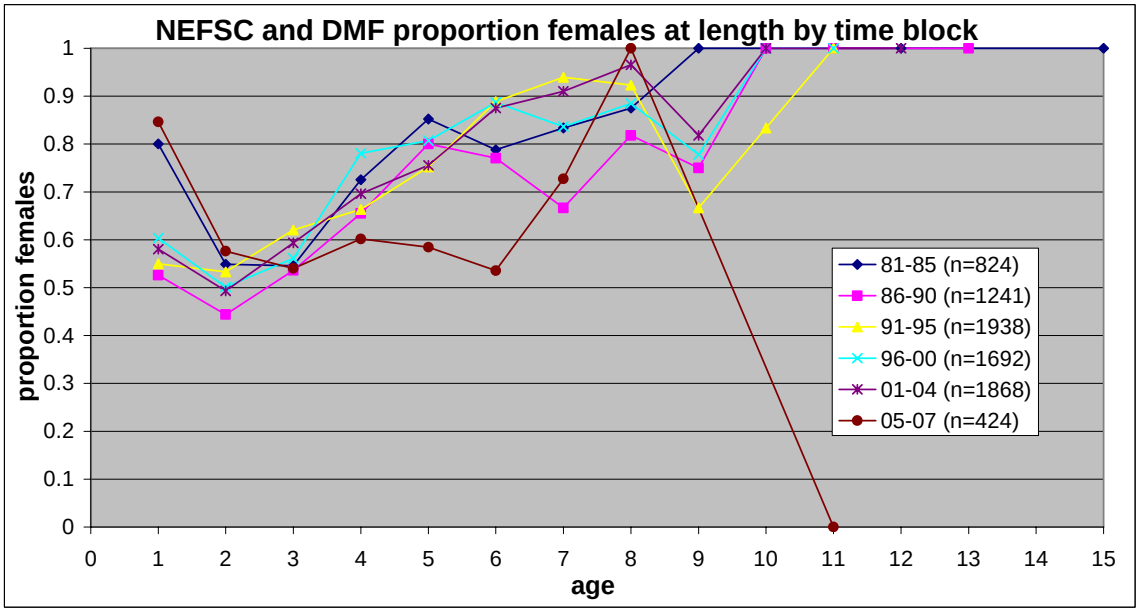
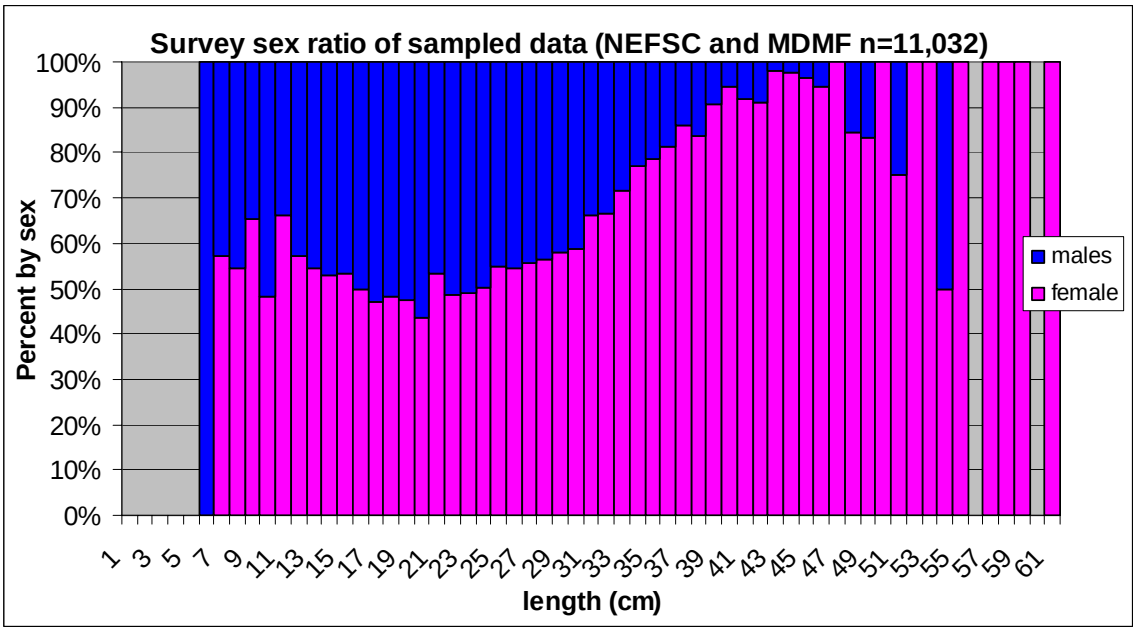


Figure I43. Proportion female by time block in the NEFSC and MDMF survey sample data.



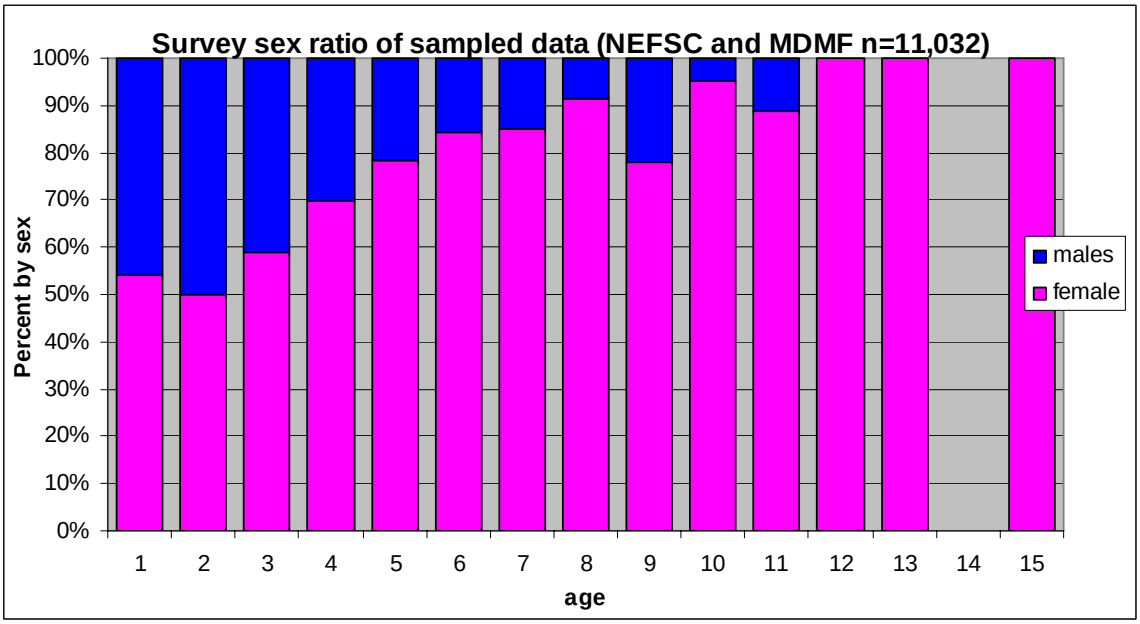


Figure I44. Sex ratio at length and age in the NEFSC and MDMF survey sample data with all year combined (1982-2007).

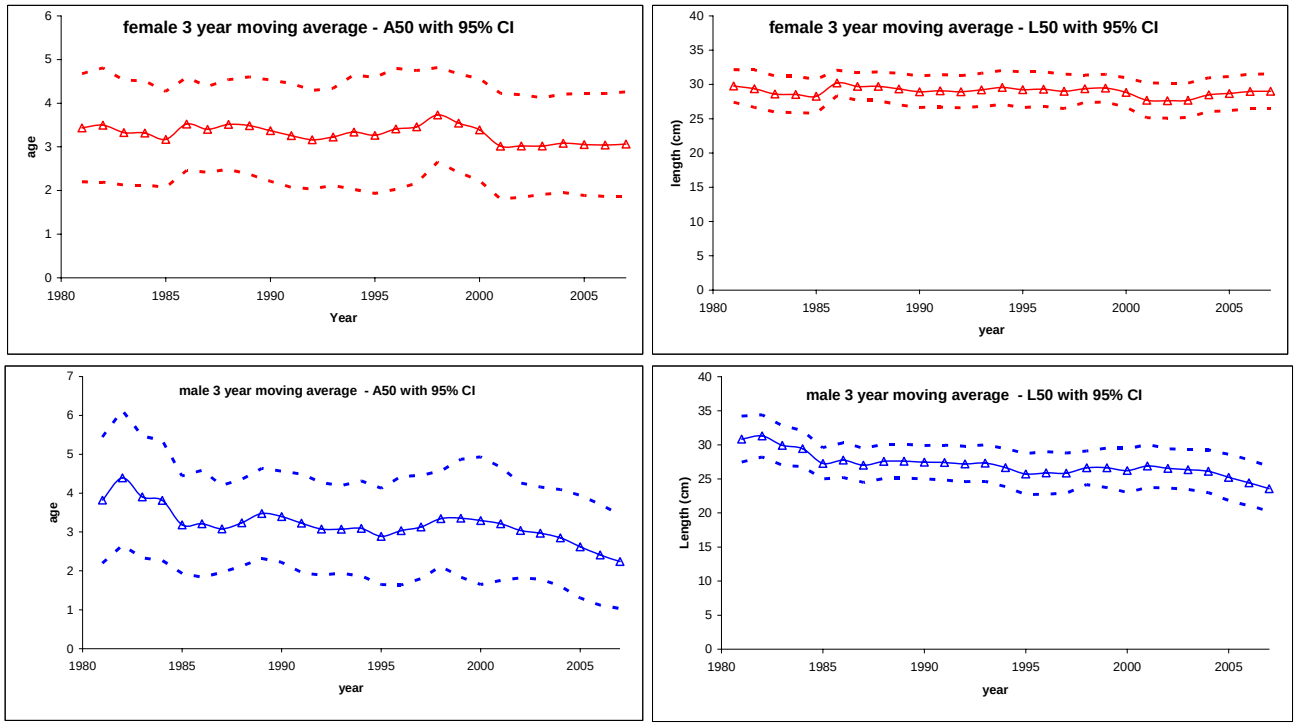
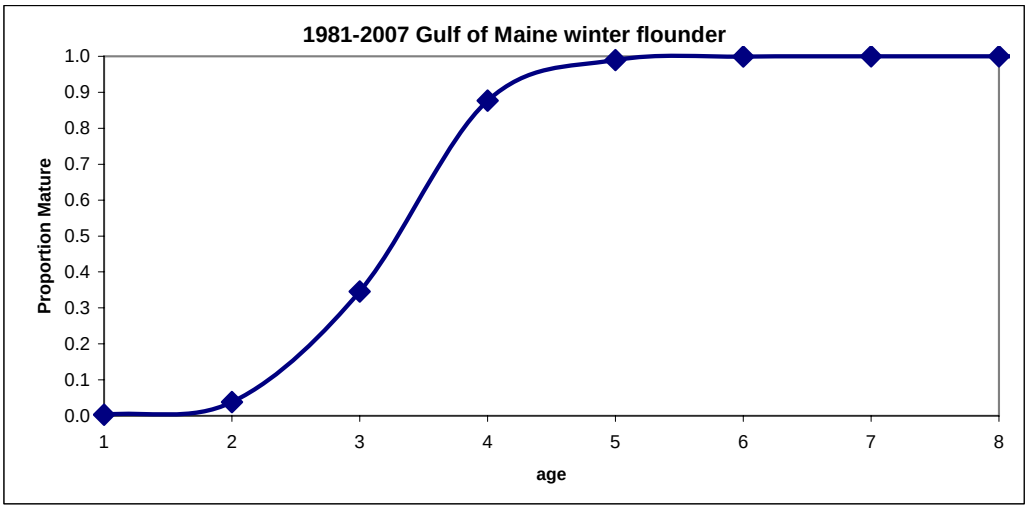


Figure I45. Gulf of Maine winter flounder female and male three year moving average of the A50 and L50 from the spring MDMF survey.



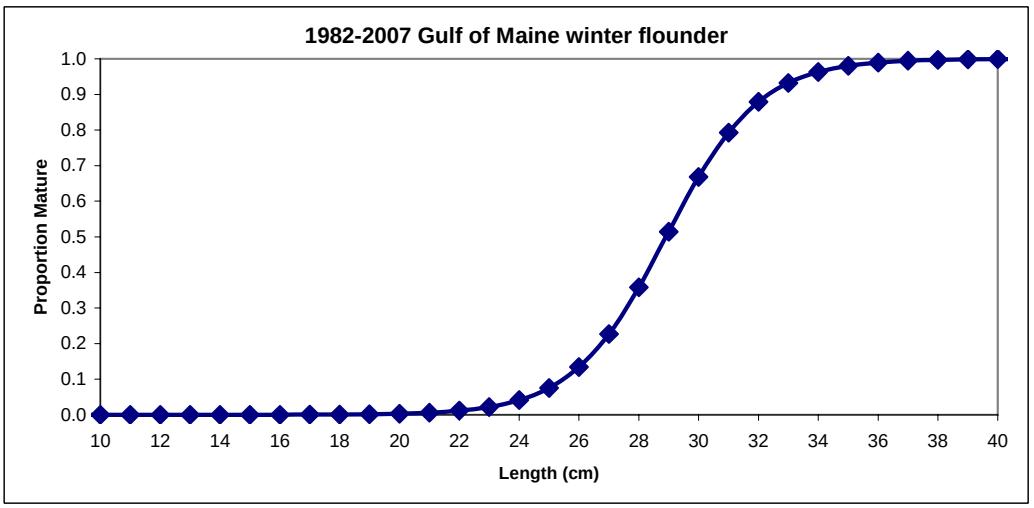


Figure I46. Female Gulf of Maine winter flounder logistic length and age maturity curves estimated with all years combine from the MDMF spring survey.

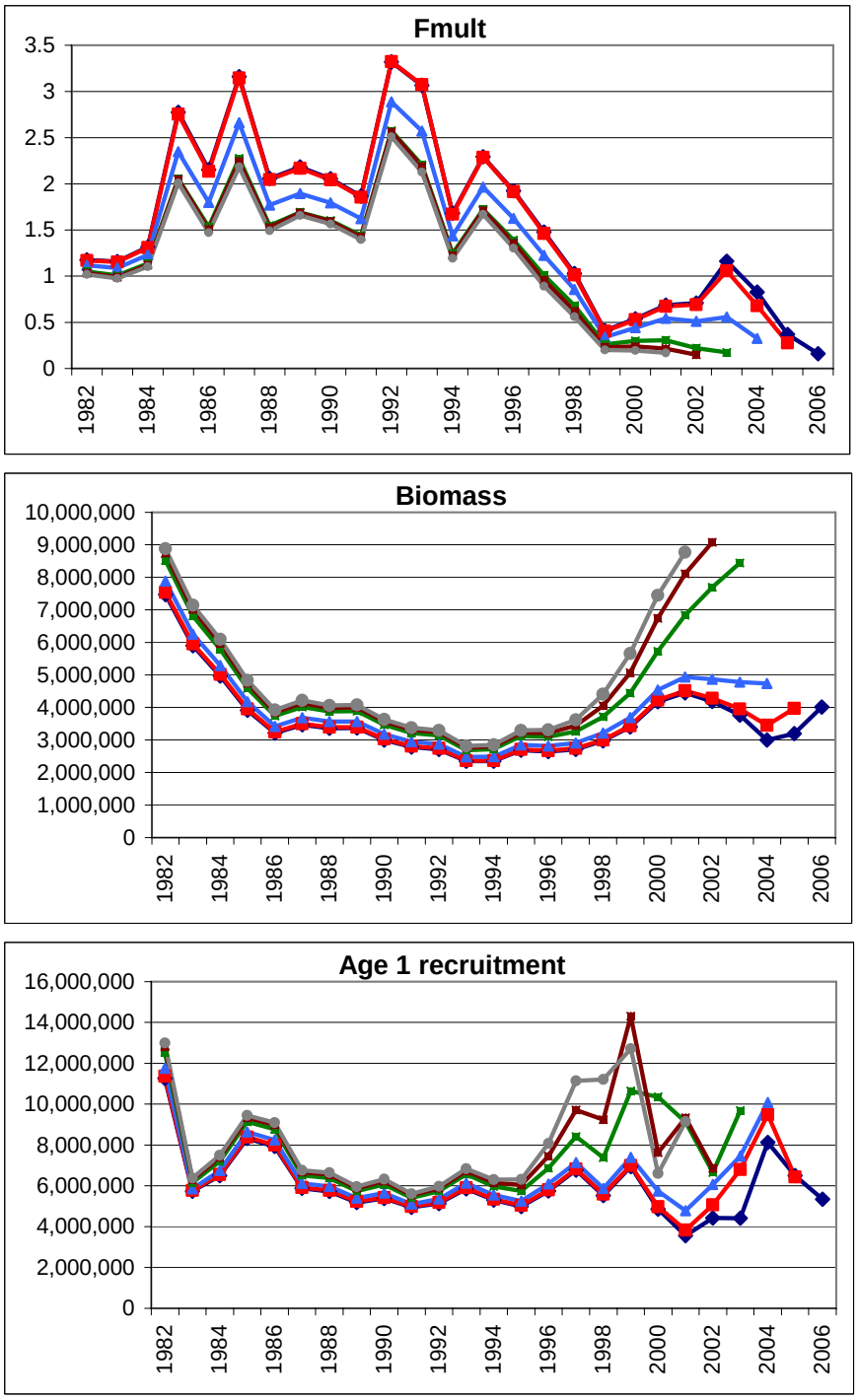


Figure I47. Gulf of Maine winter flounder non-split SCALE run retrospective

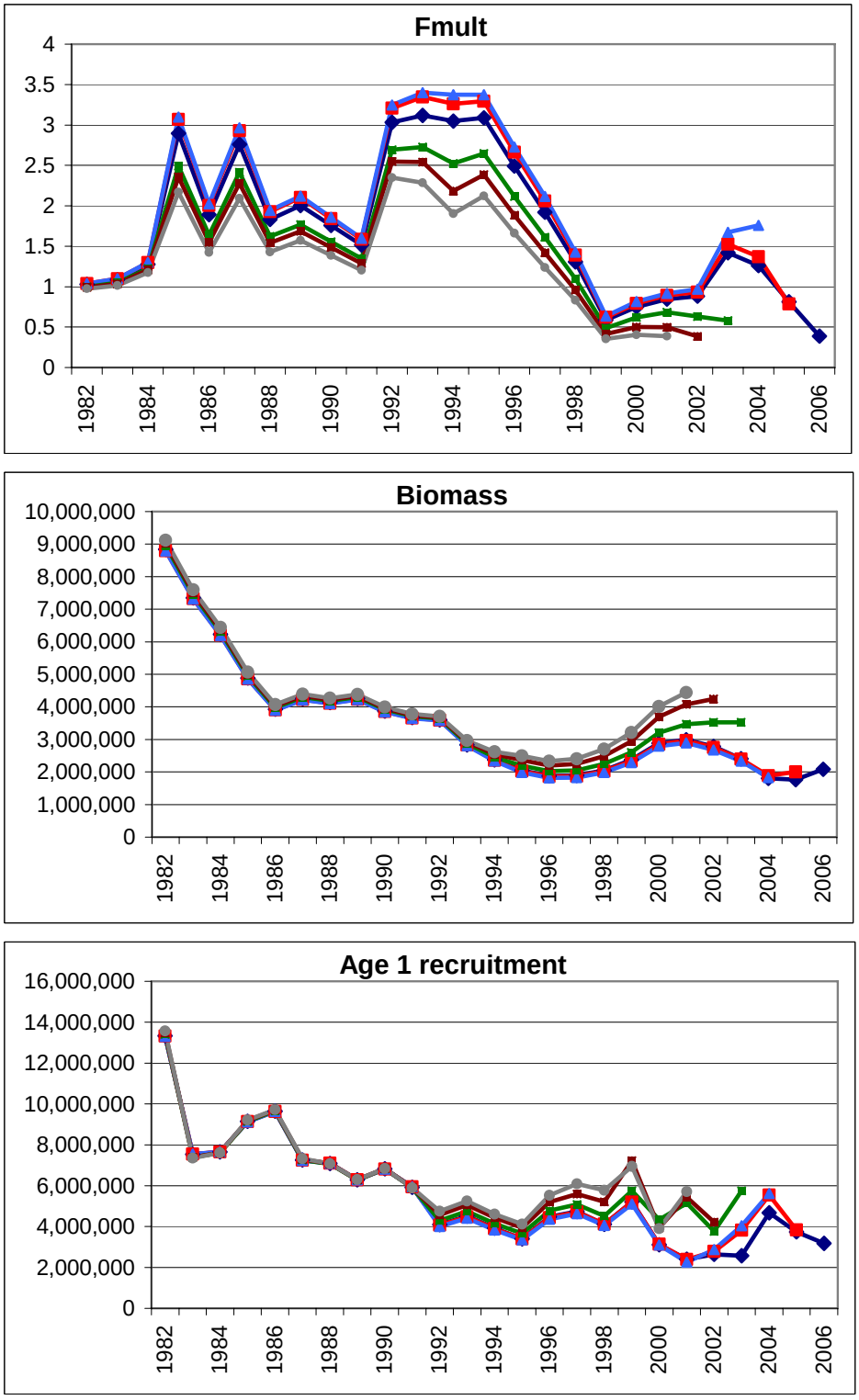


Figure I48. Gulf of Maine winter flounder split SCALE run retrospective.

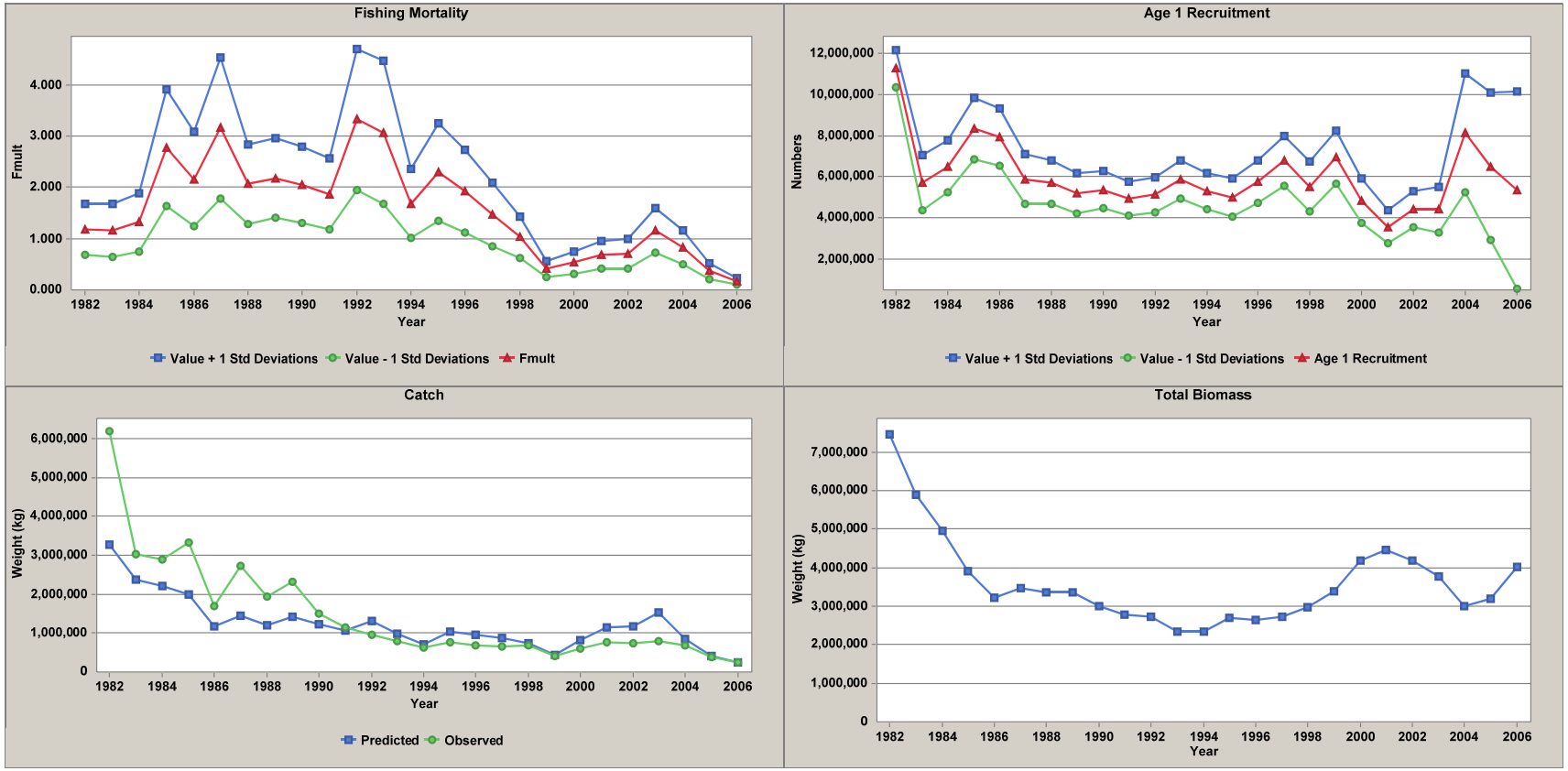


Figure I49. Non-split SCALE model estimated fishing mortality, predicted and observed catch, age 1 recruitment, and total biomass (1+) modeling the population growth with the sexes separated with an m=0.2 on the females and 0.3 for males.

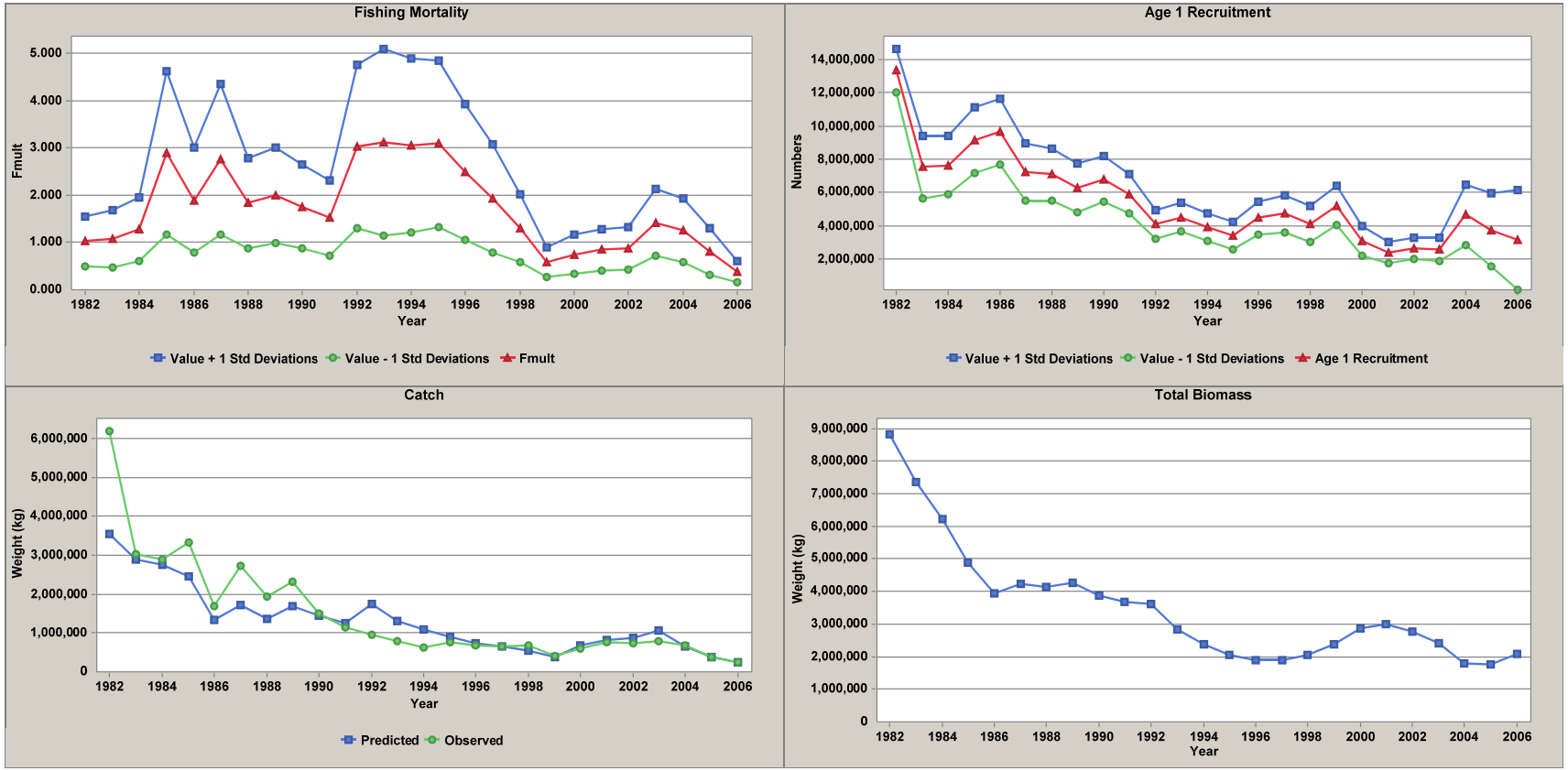


Figure I50. Split SCALE model (1982-1994, 1995-2006) estimated fishing mortality, predicted and observed catch, age 1 recruitment, and total biomass (1+) modeling the population growth with the sexes separated with an m=0.2 on the females and 0.3 for males.

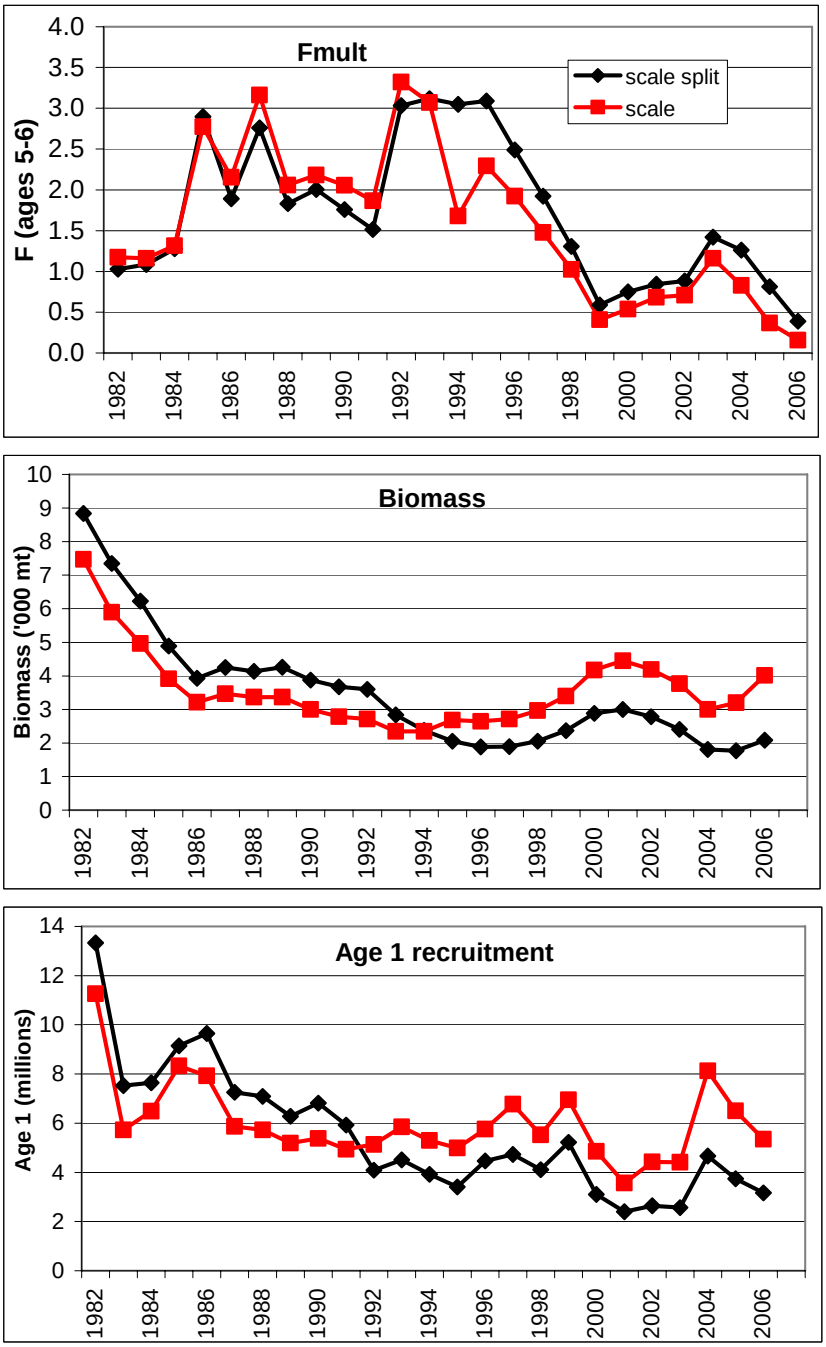
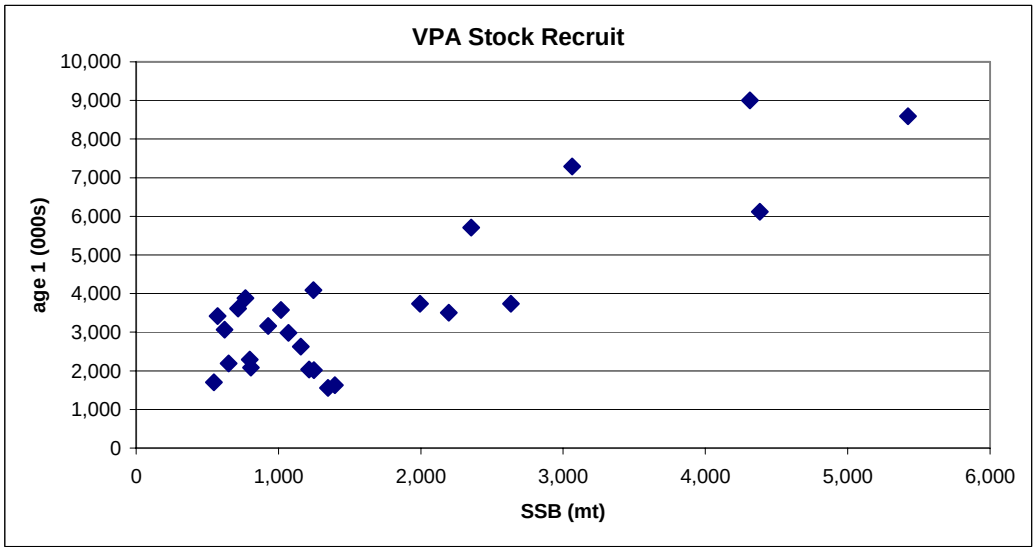


Figure I51. Differences between the non-split and split SCALE for F, total biomass, and recruitment.



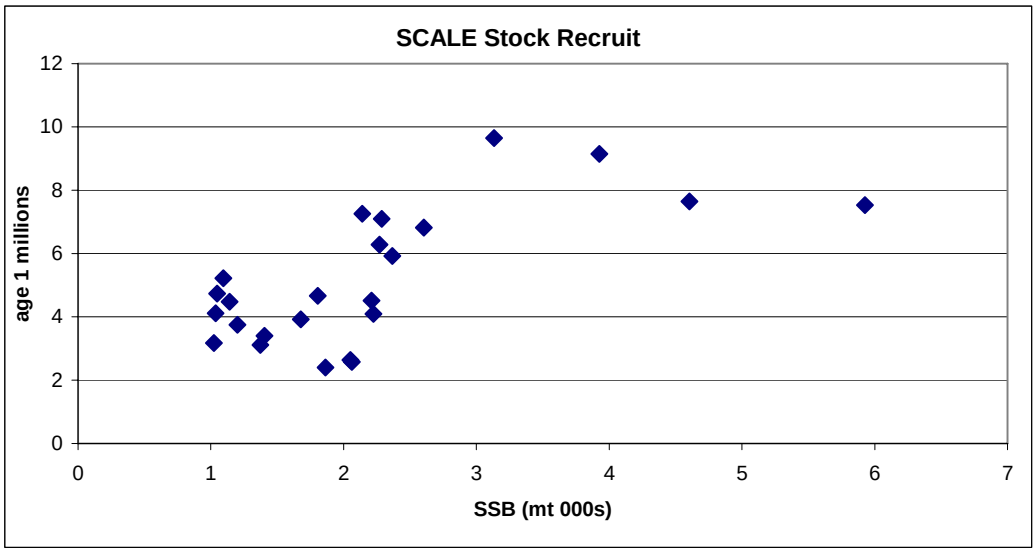


Figure I52. VPA and SCALE stock recruit plots estimated from the split survey runs.

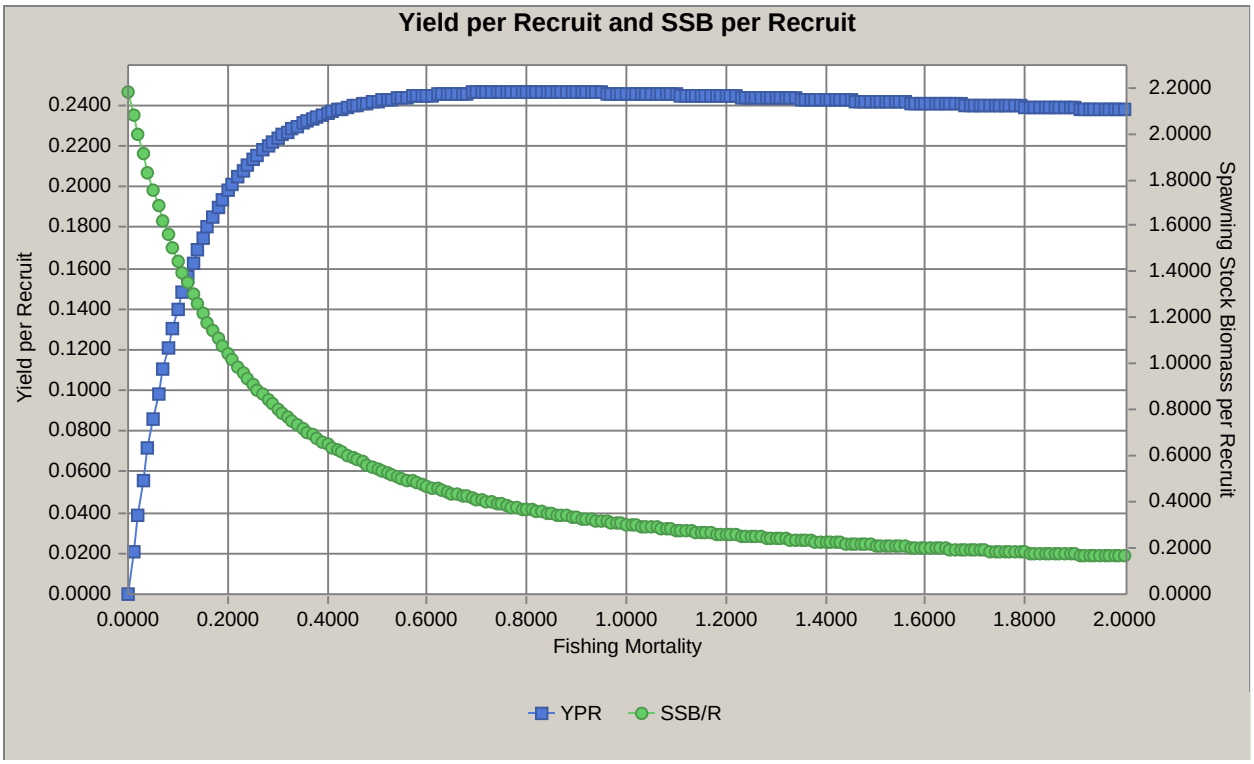


Figure I53. Gulf of Maine winter flounder age based yield per recruit (f40% = 0.27).

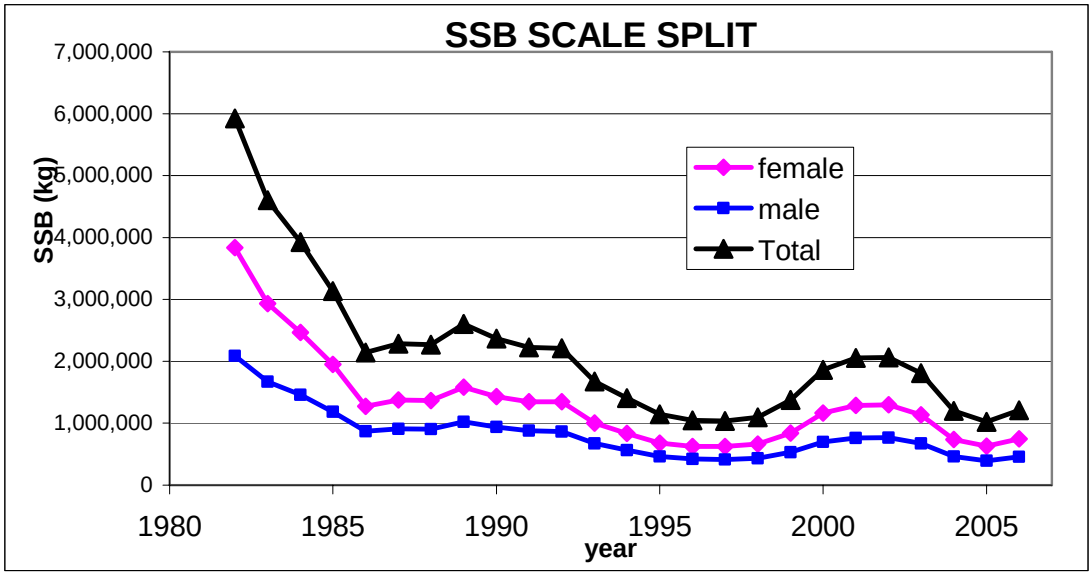


Figure I54. Trends in SSB by sex from the split SCALE run.

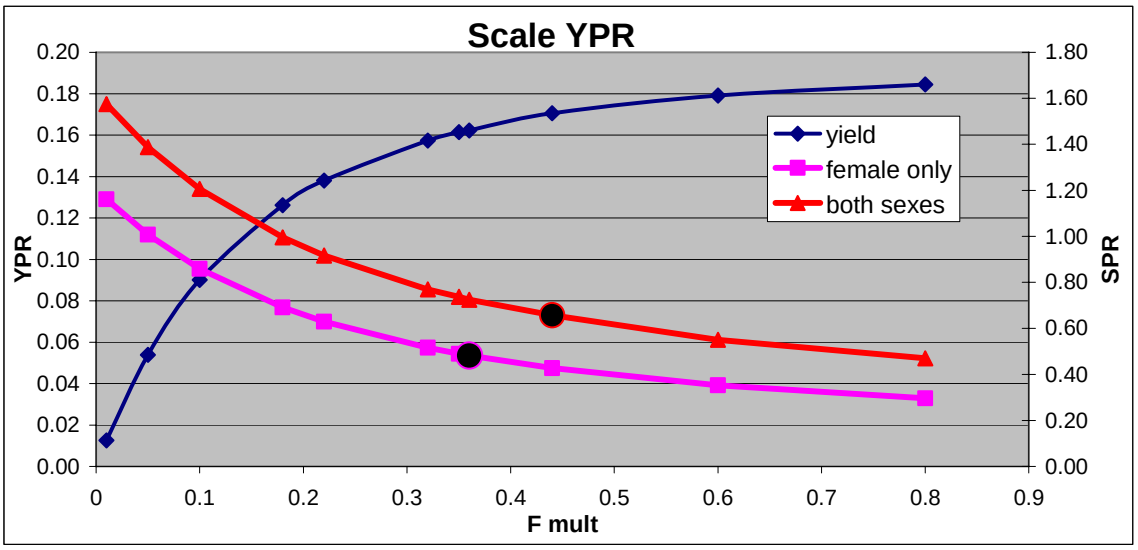
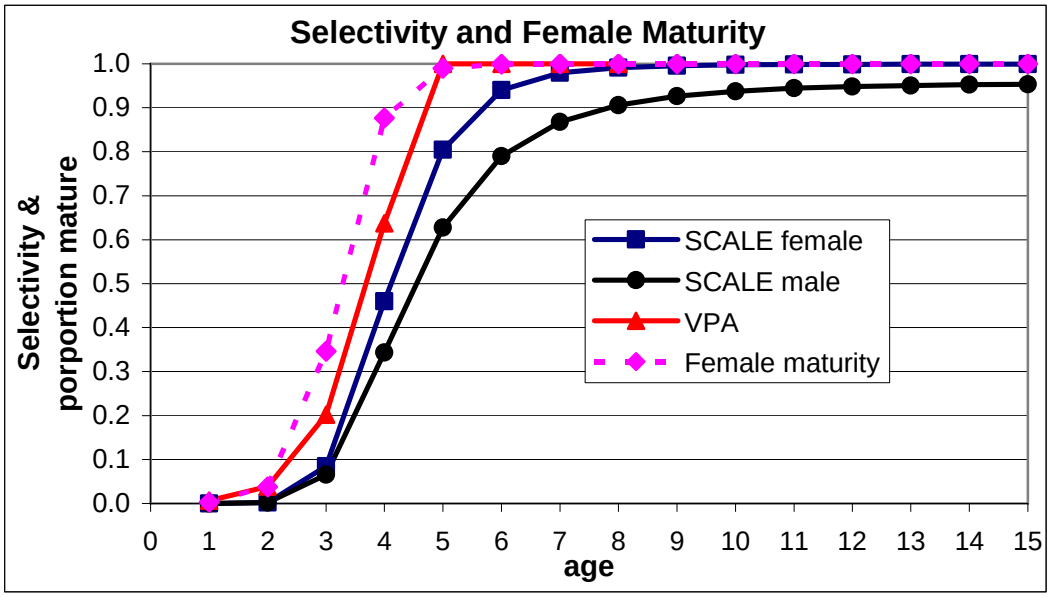


Figure I55. Yield and SPR estimated from the split SCALE run using the SCALE model. F_{40} for the combine sex equals 0.44 and for females only was 0.36.



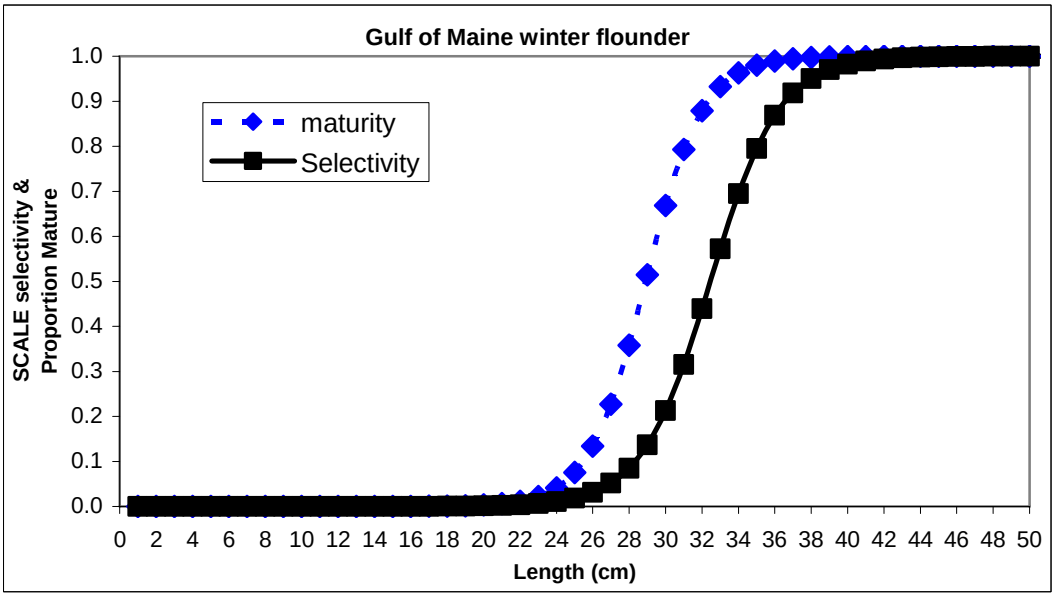


Figure I56. Gulf of Maine winter flounder split VPA and estimated SCALE selectivity by sex and age used as input to agepro for the estimation of BRPs. Maturity vectors and length based selectivity are also shown.

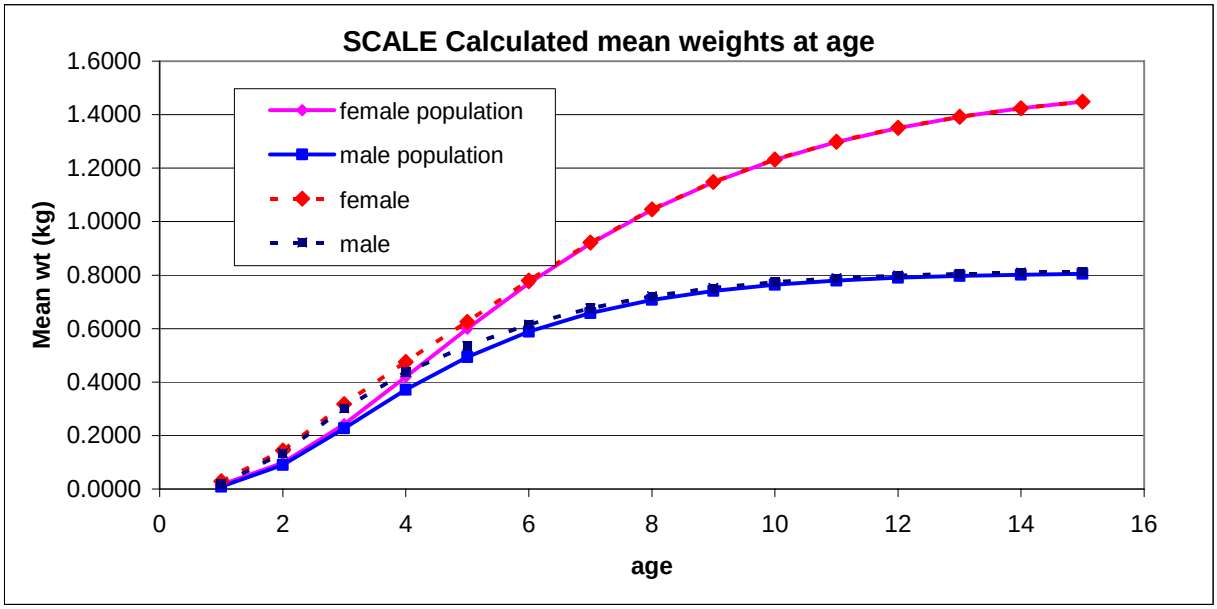


Figure I57. Gulf of Maine winter flounder split SCALE estimated population and catch mean weights at age by sex used as input to agepro for the estimation of BRPs.

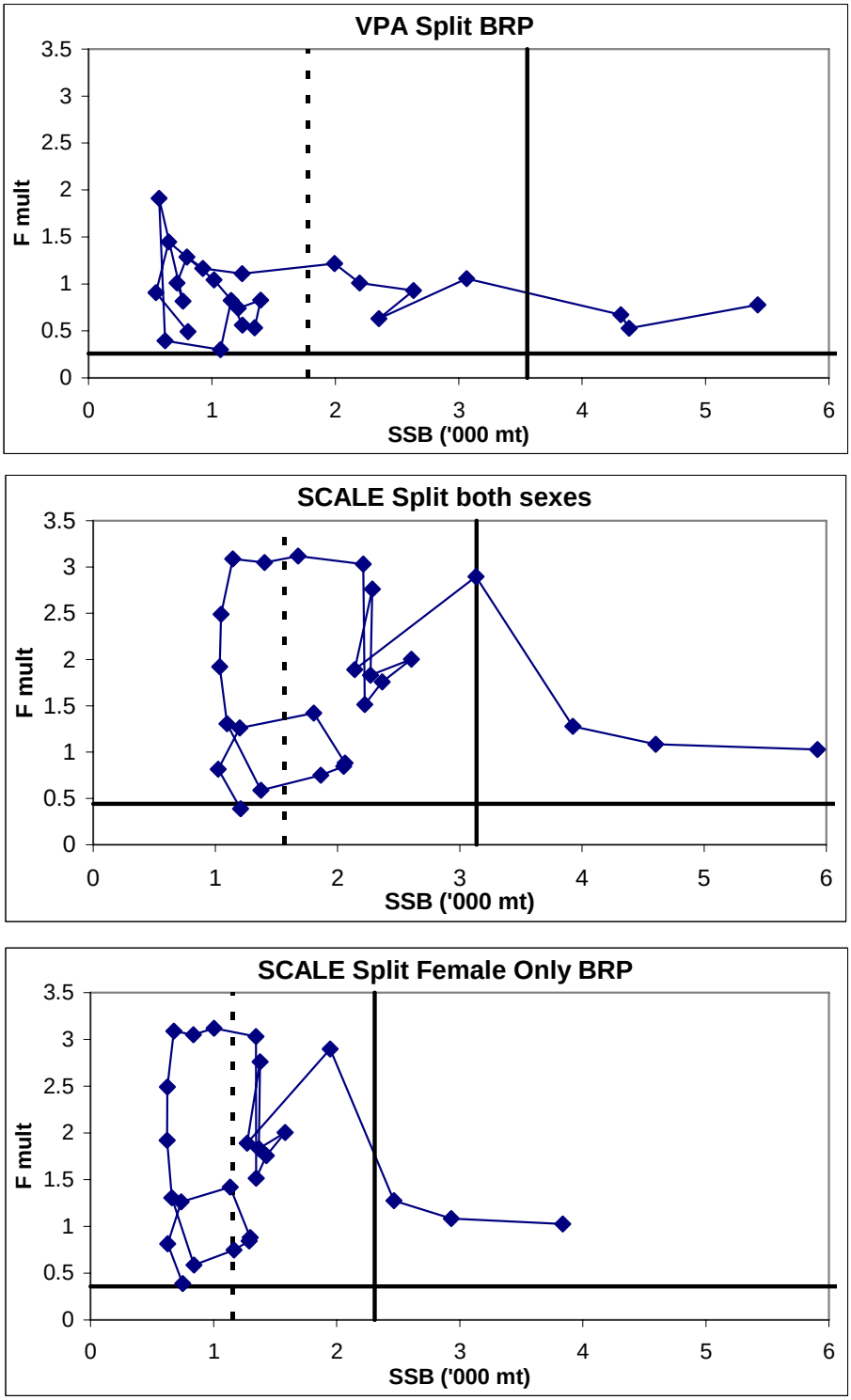


Figure I58. Gulf of Maine winter flounder trends in SSB and fishing mortality for the split VPA and split SCALE model runs. Non-parametric Bmsy and Fmsy are plotted with the solid line. The dashed line is one half Bmsy. The split SCALE run reference point has been plotted with the sexes combine and for female only.