G. Witch Flounder by **S. Wigley and L. Col**

1.0 Background

Witch flounder, *Glyptocephalus cynoglossus*, are assessed as a unit stock from the Gulf of Maine southward. An analytical assessment was last conducted for this species in 2003 (Wigley et al. 2003) for SAW/SARC 37 (NEFSC 2003). The 2003 assessment indicated average fishing mortality (ages 8-9, unweighted) increased from 0.26 in 1982 to 0.67 in 1985, declined to 0.22 in 1992, increased to 1.13 in 1996, then declined to 0.41 in 2002. Spawning stock biomass declined from 16,897 tons in 1982 to about 3,800 tons in 1996 and then increased sharply to 18,296 mt in 2002. Since 1982, recruitment at age 3 has ranged from approximately 3 million fish (1984 year class) to 67.6 million fish (1997 year class) with a mean (1979 – 2000 year classes) of 19.6 million fish.

This report updates catch through 2004, survey indices through spring 2005, and estimates 2004 fishing mortality and spawning stock biomass for stock status determination.

2.0 Assessment Data

The Fishery

Significant proportions of the U.S. nominal catch have been taken from both the Georges Bank and Gulf of Maine regions. Canadian landings from both areas have been minor (not more than 68 mt annually). USA landings generally increased from the early 1960s, peaked in 1984 at 6,666 mt. Subsequently, landings declined and have fluctuated about 2,300 mt. In 2004, landings were 2,917 mt (Table G.1 and Figure G.1).

Sampling intensity of landings during 2003 and 2004 increased over recent years (Table G.2), however, as in previous years, it was necessary to pool some quarters for some market categories. To estimate landings at age and mean weights at age, quarter, semi-annual or annual age-length keys were applied to corresponding commercial landings length frequency data by market category.

Discard estimation

Discards-at-age were updated using the same estimation methods used in the 2003 assessment for the northern shrimp fishery and the large-mesh otter trawl fishery (Wigley et al 2003).

Discards from the northern shrimp fishery were estimated using two methods: when no observer data were available (1982-1988, 1998-2002), a regression of age 3 fish in the autumn NEFSC survey and observed discard rates were used to estimate ratios of discard weight to days fished (d/df) ratios. When observer was available (1989-1997, 2003-2004), d/df ratios were calculated by fishing zone (a surrogate for depth). To estimate discard weight, the mean discard ratio (weighted by days fished in each fishing zone) was expanded by the days fished in the northern shrimp fishery.

For 2003 and 2004, witch flounder discards in the northern shrimp fishery were estimated to be

near zero. This is attributed to the short northern shrimp season and the shift in effort to near-shore waters, inshore of the witch flounder distribution

Witch flounder discarded in the northern shrimp fishery range in age from 0 to 6, with the majority at ages 1-3. The number of fish discarded in the shrimp fishery is small compare to the landings (Figure G.2).

The estimation of large-mesh otter trawl discards is based upon two methods. For 1982 to 1994, a method which filters survey length frequency data through a commercial gear retention ogive and a culling ogive was used and then a semi-annual ratio estimator of survey-filtered 'kept' index to semi-annual numbers landed was used to expand the estimated 'discard' survey index to numbers of fish discarded at length. For 1989 to 2004, discard weight to kept weight ratios (d/k) were calculated from observer data on a semi-annual basis. Total discard weight was derived by multiplying the d/k ratio by the commercial landings. Given the limited sample size (number of trips) prior to 1995, discards at age were estimated from 1995 onward. Observed discard length frequencies are used to estimate discarded fish at length. Semi-annual numbers of fished discarded were apportioned to age using the corresponding seasonal NEFSC survey age/length key. Witch flounder discarded in the large mesh otter trawl fishery range in age from 0 to 6, with the majority at ages 4 to 5. The number of fish discarded in the large-mesh otter trawl fishery is small compare to the landings (Figure G.2).

The total catch (landings + otter trawl discards + shrimp trawl discards) at age is presented in Table G.3 and Figure G.2. The age composition data reveal strong 1979- 1981 year classes; the 1989 and 1993 year classes also appear strong. The poor 1984 year class is also evident as well as a truncated age-structure since the early 1990's. As observed in recent years, the mean weights-at-age in the catch continue to decline (Figure G.3).

Research Vessel Survey Indices

The NEFSC bottom trawl survey indices generally declined from the early 1960s to record low levels in the late 1980s and early 1990s. Since then survey indices increased but have exhibited a declining trend since 2000 (Table G.4, Figure G.4a-b). Survey age compositions (mean number per tow at age)are presented in Table G.5. The survey mean weights and mean lengths at age show a similar decline as reported in the commercial landings. Survey maturity-at-age has remained stable in recent years.

3.0 Assessment Results

Since the last assessment, minor VPA software changes have occurred and additional age and length data have become available. These changes had only a minor impact on the SARC 37 assessment results (Table G.6). For the current assessment, the VPA formulation is the same as the 2003 assessment and uses catch (landings and discards) through 2004 and NEFSC spring and autumn survey indices through 2005 and 2004, respectively, to estimate stock sizes for ages 3 to 10. The VPA had a mean square residual of 0.81, the coefficients of variation (CVs) for estimated ages ranged between 27% and 65% (Table G.6), and the CVs for survey catchability coeffiecients (q) were consistent, ranging from 11% to 25%.

VPA results indicate average fishing mortality (ages 8-9, unweighted) increased from 0.26 in 1982 to 0.68 in 1985, declined to 0.22 in 1992, increased to 1.12 in 1996, then declined to 0.20 in 2004 (Tables G.7 and G.8, Figure G.5). Spawning stock biomass declined steadily from 16,897 mt in 1982 to 3,901 mt in 1996, and has increased to 21,175 mt in 2004 (Tables G.7 and G.8, Figure G.6). Since 1982, recruitment at age 3 has ranged from approximately 3 million fish (1984 year class) to 45 million fish (1997 year class) with a mean of 15.5 million fish (median of 14 million; Table G.7, Figure G.6). The addition of the 2000 to 2002 year classes to the stock-recruit data continued the negative trend observed in this relationship in the previous assessment. The current age composition of the spawning stock is approaching the equilibrium age composition. However, given the recent poor year classes (2000-2002), spawning stock biomass will eventually decline as these poor classes enter the fishery (Figure G.6).

The retrospective analysis indicates that average F was underestimated in the late 1990s and early 2000s (Figure G.7a) and spawning stock biomass was consistently overestimated (Figure G.7b). The retrospective analysis indicated a pattern of relatively consistent estimates of the number of age 3 recruits, with the notable exception of the 1992, 1993 and 1996 year classes, which were considerably overestimated (Figure G.7c).

Bootstrap results suggest that the estimates of F and spawning stock biomass are relatively precise with CVs of 30% and 14%, respectively. The 80% confidence interval for $F_{2004}=0.20$ was 0.15 and 0.28, and for $SSB_{2004} = 21,175$ mt the 80% confidence interval was 18,192 mt and 26,121 mt.

4.0 Biological Reference Points

Based on yield and spawning stock biomass per recruit analyses and the arithmetic mean of the VPA age 3 recruitment (NEFSC 2003), the biological reference points are:

SSBmsy = 25,248 mt
Fmsy = F40% = 0.23
MSY = 4,375 mt.

The 2004 spawning stock biomass (21,175 mt) was above ½ SSBmsy (12,624 mt), the overfished threshold, and 2004 fishing mortality (0.20) was below Fmsy (0.23), the overfishing threshold; therefore, witch flounder was not overfished and overfishing was not occurring in 2004.

Amendment 13 Projections and current status

There is no formal rebuilding program required for witch flounder, thus there is not a rebuilding biomass trajectory. Amendment 13 is designed to end overfishing of witch flounder; a spawning stock biomass trajectory at Fmsy was conducted for Amendment 13. The spawning stock biomass estimates from this assessment are below what was projected for the Amendment 13. The fishing mortality estimated for 2004 is below the Fmsy used in the Amendment 13 projections (Figure G.8).

5.0 Panel Comments

The Panel discussed the adequacy of the age-length information used to estimate the commercial landings-at-age. There is now sufficient information for some of the years to develop estimates by quarter and market category, and given continued adequate sampling, this should be continued in the future. This may be important as the fishery has apparently shifted from peewees and smalls to smalls and mediums. There is some caution about simply using the number of samples as an indication about sample size. In the past, a sample normally consisted of about 100 fish. With potentially smaller catches, this criterion for sampling has been relaxed in order to get samples. Given that witch flounder is very slow growing, the pooling effect may not be as much of an issue.

There was some discussion of the apparent expansion in age structure of the discards beginning in 1995. It was suggested that this may be an artifact of the change in estimation method beginning in 1995. However, another expansion of the age structure was apparent in 2002 with the same method. Observed discards of large fish may be due to the inclusion of trips from other fisheries that do not require use of a DAS, although trips targeting *Loligo* were excluded.

The panel discussed the recent declines in mean weights. It is possible that fishing patterns have changed in relation to the distribution of the stock to areas that are less favorable for growth. The distribution of the fishery and survey should be investigated in the future.

The short term decline in size at maturity in the late 1980s was discussed. This short term decline coincided with very low biomass. It was not possible to examine the decline on an annual basis due to low sampling (sparse data).

The difference in current estimate of 2004 biomass compared to the estimate projected from the last assessment may be due to an increase in the estimate of realized F being higher than that used in the projections, lower recruitment than expected and a retrospective underestimate of SSB.

The Panel noted that the recent increase in SSB has been mostly driven by the good recruitment of the 1996-1998 year classes. If catches remain constant, SSB will eventually decline as the following poor year classes enter the fishery.

Projection Advice - The Panel recommended using an average of the mean weights from 2002-2004 for projections. The same years are suggested for the partial recruitment and maturity (5 year average of 2001-2005) vectors. Given the declining trend in recruitment, the panel recommended using the estimated value of the 2002 year class although it was an uncertain estimate. For 2006-2008, the panel suggested re-sampling just the 2000-2002 year classes (not the entire series). Given that witch flounder is long-lived and late maturing, the values of recruitment should not be influential in the projections.

6.0 Sources of Uncertainty

•   Low frequency of samples across market category and quarter results in imprecise mean

weights at age and estimates of numbers at age.

- Lack of data to support direct estimates of discards at age requires use of various surrogate survey-based methods.

- Retrospective patterns suggest that estimates of SSB may be overestimated (e.g. future assessments may have lower estimates of SSB).

- The research bottom trawl survey catches very few witch flounder; in most years, the stratified mean number per tow of witch flounder is less than 5 fish. Abundance of witch flounder in the late 1980s and early 1990's may have gone below levels that provide reliable estimates of trends in abundance and biomass

7.0 Acknowledgments

8.0   References

Burnett, J. and S.H. Clark. 1983. Status of witch flounder in the Gulf of Maine – 1983. NMFS/NEFC, Woods Hole Laboratory Ref. Doc. No. 83-36, 31 p.

Lange, A.M.T. and F.E. Lux. 1978. Review of the other flounder stocks (winter flounder, American plaice, witch flounder, and windowpane flounder) off the northeast United States. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 78-44, 53 pp.

NEFSC [Northeast Fisheries Science Center]. 2003. Report of the 37th Northeast Regional Stock Assessment Workshop (37th SAW), Stock Assessment Review Committee (SARC) consensus summary of assessments. Northeast Fish. Sci. Cent. Ref. Doc. 03-16, 597 p.

Wigley, S.E., J. K.T. Brodziak, and L. Col. 2003. Assessment of the Gulf of Maine and Georges Bank witch flounder stock for 2003. Northeast Fish. Sci. Cent. Ref. Doc. 03-14, 186 p.

Table G.1.   Witch flounder landings, discards and catch (metric tons, live) by country, 1937-2004
            [1937-1959 provisional landings reported in Lange and Lux, 1978; 1960-1963 reported to
            ICNAF/NAFO (Burnett and Clark, 1983)].

			LANDINGS					
Year	USA Subarea 4, 5 & 6	USA Subarea 3	USA Total	CAN	Other	Total	USA Discards	USA Catch
1937			*5000*			*5000*		
1938			*3600*			*3600*		
1939			*3100*			*3100*		
1940			*3000*			*3000*		
1941			*2000*			*2000*		
1942			*1800*			*1800*		
1943			*1000*			*1000*		
1944			*1000*			*1000*		
1945			*1000*			*1000*		
1946			*1500*			*1500*		
1947			*1500*			*1500*		
1948			*1000*			*1000*		
1949			*3600*			*3600*		
1950			*3000*			*3000*		
1951			*2600*			*2600*		
1952			*3700*			*3700*		
1953			*4200*			*4200*		
1954			*4000*			*4000*		
1955			*2400*			*2400*		
1956			*2000*			*2000*		
1957			*1000*			*1000*		
1958			*1000*			*1000*		
1959			*1000*			*1000*		
1960	1255		1255			1255		
1961	1022		1022	2		1024		
1962	976		976	1		977		
1963	1226		1226	27	121	1374		
1964	1381		1381	37		1418		
1965	2140		2140	22	502	2664		
1966	2935		2935	68	311	3314		
1967	3370		3370	63	249	3682		
1968	2807		2807	56	191	3054		
1969	2542		2542		1310	3852		
1970	3112		3112	19	130	3261		
1971	3220		3220	35	2860	6115		
1972	2934		2934	13	2568	5515		
1973	2523		2523	10	629	3162		
1974	1839		1839	9	292	2140		
1975	2127		2127	13	217	2357		
1976	1871		1871	5	6	1882		
1977	2469		2469	11	13	2493		
1978	3501		3501	18	6	3525		
1979	2878		2878	17		2895		
1980	3128		3128	18	1	3147		
1981	3442		3442	7		3449		

Table G.1. continued.   Witch flounder landings, discards and catch (metric tons, live).

	LANDINGS							
Year	USA Subarea 4, 5 & 6	USA Subarea 3	USA Total	CAN	Other	Total	USA Discards	USA Catch
1982	4906		4906	9		4915	48	4954
1983	6000		6000	45		6045	162	6162
1984	6660		6660	15		6675	100	6760
1985	6130	255	6385	46		6431	61	6191
1986	4610	539	5149	67		5216	25	4635
1987	3450	346	3796	23		3819	47	3497
1988	3262	358	3620	45		3665	60	3322
1989	2068	297	2365	13		2378	133	2201
1990	1465	2	1467	12		1479	184	1649
1991	1777		1777	7		1784	95	1872
1992	2227		2227	7		2234	171	2398
1993	2601		2601	10		2611	376	2977
1994	2665		2665	34		2699	422	3087
1995	2209		2209	11		2220	193	2402
1996	2087		2087	10		2097	254	2341
1997	1771		1771	7		1778	300	2071
1998	1848		1848	10		1858	286	2134
1999	2121		2121	19		2140	213	2334
2000	2439		2439	53		2492	115	2554
2001	3019		3019	32		3051	224	3243
2002	3188		3188	34		3222	279	3467
2003	3124		3124	30		3154	381	3505
2004	2917		2917			2917	233	3150

Table G.2. Summary of USA commercial witch flounder landings (mt), number of length samples (n), number of fish measured (len) and number of age samples (age) by market category and quarter for all gear types, 1981 - 2004. The sampling ratio represents the amount of landings per length sample.

Year		Quarter 1			Quarter 2			Quarter 3			Quarter 4			All	Sampling Ratio
		Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	Small	Med.	Large		
1981	mt	260	7	517	269	32	694	242	13	607	230	0	453	3324	
	n	.	.	.	.	1	1	.	1	.	1	.	1	5	
	len	.	.	.	.	101	103	.	89	.	105	.	100	498	
	age	.	.	.	.	.	26	.	25	.	25	.	25	101	
1982	mt	348	1	726	342	73	886	287	170	739	278	201	669	4720	
	n	5	2	6	1	2	2	2	2	6	3	4	2	37	128
	len	527	194	626	126	209	216	189	210	514	307	393	189	3700	
	age	128	55	150	30	55	50	50	50	150	81	105	50	954	
1983	mt	475	250	910	471	286	1037	298	154	758	257	169	613	5678	
	n	5	2	3	5	1	5	8	3	8	6	3	.	49	116
	len	680	232	265	685	96	520	1008	123	981	677	344	.	5611	
	age	135	30	55	131	16	125	152	0	159	180	75	.	1058	
1984	mt	462	322	1036	513	393	1000	403	248	653	429	286	586	6331	
	n	5	9	4	7	1	7	8	1	2	4	2	1	51	124
	len	804	1112	400	970	117	775	1045	106	191	615	243	91	6469	
	age	154	250	76	186	25	180	210	28	53	105	44	25	1336	
1985	mt	465	377	613	697	453	850	526	291	553	433	310	408	5976	
	n	12	1	2	5	4	7	7	7	6	8	2	4	65	92
	len	1530	105	229	657	426	698	795	800	684	824	264	349	7361	
	age	319	29	50	106	77	153	97	138	113	161	25	29	1297	
1986	mt	384	309	356	654	421	595	375	238	354	312	212	238	4448	
	n	6	3	5	5	4	5	4	3	4	5	3	2	49	90
	len	662	307	515	558	410	413	302	364	406	416	337	233	4923	
	age	123	60	89	106	97	129	63	75	100	87	75	52	1056	

Table G.2. continued.

Year		Quarter 1			Quarter 2			Quarter 3			Quarter 4		All	Sampling Ratio
		Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	Small	Med.	Large		
1987	mt	349	211	228	432	317	387	296	203	247	298	203	202	3373	69
	n	1	1	2	4	2	3	5	5	4	2	3	2	34	
	len	85	145	200	323	228	316	354	583	400	204	261	178	3277	
	age	25	25	50	77	47	76	78	113	95	48	64	51	749	
1988	mt	424	304	271	436	393	389	184	176	208	140	140	131	3196	65
	n	5	4	5	5	5	3	5	4	3	3	4	3	49	
	len	335	407	465	344	544	429	396	359	295	229	402	356	4561	
	age	70	89	106	71	110	77	70	100	75	61	95	69	993	
1989	mt	230	174	148	255	264	251	98	145	156	85	107	103	2016	112
	n	1	2	2	2	2	1	2	2	1	1	2	.	18	
	len	94	201	222	230	236	27	150	206	100	125	202	.	1793	
	age	25	50	49	50	46	25	40	51	25	25	47	.	433	
1990	mt	113	125	107	147	168	147	100	119	129	84	79	85	1403	40
	n	1	2	3	6	3	1	6	2	2	7	2	.	35	
	len	134	199	199	335	296	100	349	247	145	381	201	.	2586	
	age	15	40	45	81	70	25	69	41	50	103	48	.	587	
1991	mt	71	56	58	219	151	167	192	142	184	168	108	121	1637	40
	n	5	2	3	7	2	1	4	2	3	5	4	3	41	
	len	262	224	401	537	239	125	212	165	249	300	410	274	3398	
	age	53	50	80	93	45	25	49	49	52	66	97	58	717	
1992	mt	180	86	82	466	163	174	205	115	138	212	97	116	2034	68
	n	4	2	2	7	1	2	7	1	1	2	.	1	30	
	len	259	241	185	501	125	235	477	121	117	129	.	46	2436	
	age	42	46	52	78	25	25	86	25	25	27	.	23	454	

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Table G.2.

Year		Quarter 1			Quarter 2			Quarter 3			Quarter 4			All	Sampling Ratio
		Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	Small	Med.	Large		
1993	mt	350	112	110	442	192	161	263	122	150	331	96	106	2435	76
	n	7	1	.	7	1	1	9	1	5	.	.	.	32	
	len	830	100	.	741	107	100	728	85	499	.	.	.	3190	
	age	55	25	.	56	27	26	74	.	73	.	.	.	336	
1994	mt	403	143	98	505	183	154	390	122	117	383	91	80	2670	72
	n	.	.	.	3	5	6	5	5	1	5	3	4	37	
	len	.	.	.	560	532	749	356	648	105	342	368	407	4067	
	age	.	.	.	59	104	134	44	113	26	56	60	82	678	
1995	mt	336	91	77	586	117	100	399	61	70	304	48	40	2212	85
	n	3	3	3	6	3	5	.	.	.	2	.	1	26	
	len	208	348	347	459	367	517	.	.	.	217	.	94	2557	
	age	53	84	89	81	75	135	.	.	.	27	.	25	569	
1996	mt	313	57	36	545	86	60	458	56	44	363	42	28	2088	50
	n	5	2	3	5	2	1	5	4	4	5	3	3	42	
	len	504	218	292	331	240	127	494	464	468	343	277	348	4106	
	age	59	45	78	53	50	26	59	86	101	60	70	69	756	
1997	mt	313	40	25	478	86	41	398	55	27	265	31	16	1775	34
	n	6	3	3	9	4	3	9	3	1	9	1	1	52	
	len	557	350	351	812	418	309	783	308	107	505	128	50	4678	
	age	77	68	70	108	73	77	98	81	20	73	18	23	786	
1998	mt	372	39	19	587	79	31	380	40	20	239	26	14	1849	80
	n	5	2	1	4	1	1	5	3	1	.	.	.	23	
	len	339	206	128	238	88	135	484	186	100	.	.	.	1904	
	age	45	50	19	30	.	29	47	22	.	.	.	.	242	
1999	mt	386	48	19	616	79	31	436	67	30	353	38	18	2121	51
	n	3	.	.	4	.	.	17	2	3	11	1	.	41	
	len	282	.	.	308	.	.	1110	201	306	775	109	.	3091	
	age	15	.	.	62	.	.	143	.	32	91	16	.	359	

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Table G.2. continued.

Year		Quarter 1			Quarter 2			Quarter 3			Quarter 4		All	Sampling Ratio
		Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	Small	Med.	Large		
2000	mt	477	53	17	583	93	27	555	89	28	451	50	16	2439	21
	n	31	2	.	47	.	.	17	1	.	5	5	2	110	
	len	2253	91	.	2445	.	.	994	105	.	308	558	217	6971	
	age	393	10	.	463	.	.	224	20	.	67	92	51	1320	
2001	mt	583	71	17	824	99	30	699	98	28	507	50	13	3019	70
	n	8	4	2	3	3	2	8	2	3	5	3	.	43	
	len	744	422	134	237	352	159	594	209	213	313	232	.	3609	
	age	125	64	42	48	48	64	126	34	46	61	49	.	707	
2002	mt	740	79	18	774	103	26	849	114	29	400	45	9	3186	89
	n	5	1	2	3	5	3	5	2	3	3	2	2	35	
	len	363	121	107	212	518	209	389	150	194	262	226	115	2815	
	age	75	16	50	65	73	64	88	34	62	49	30	49	655	
2003	mt	603	70	17	684	108	30	865	125	36	533	43	10	3124	31
	n	4	6	6	10	5	10	11	6	16	7	7	13	101	
	len	324	423	162	881	482	433	943	531	552	654	632	525	6542	
	age	57	93	60	131	64	174	172	91	246	99	120	191	1498	
2004	mt	609	76	16	598	90	23	758	113	30	546	45	13	2917	26
	n	5	13	23	8	5	8	5	5	2	19	5	15	113	
	len	480	1244	1813	675	549	576	541	356	48	1838	420	83	8623	
	age	73	226	505	151	96	169	58	95	10	49	72	.	1504	

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Table G.3. **Total USA commercial catch** [landings + shrimp trawl discards + large-mesh otter trawl discards using survey filter and FOP] in numbers, (thousands of fish), mean weight (kg) and mean length (cm) at age of witch flounder, 1982 - 2004.

AGE

USA Commercial Catch in Numbers (1000's) at Age

Year	0	1	2	3	4	5	6	7	8	9	10	11+
1982	0.03	0.06	1.72	190.49	1064.47	1207.67	1475.40	665.20	656.00	399.50	239.40	1578.40
1983	0.00	0.02	4.28	337.11	1346.17	1520.76	1575.12	1590.20	977.80	737.70	510.40	1675.50
1984	0.00	0.33	0.88	146.61	1466.31	2002.70	1739.59	1486.50	1497.50	696.70	375.10	1718.80
1985	0.00	0.34	3.47	123.58	1176.12	2118.21	1936.24	1524.90	1247.90	606.00	400.40	1359.20
1986	0.00	0.53	3.86	22.95	377.07	1516.79	2775.35	1566.90	834.90	412.70	222.80	758.20
1987	2.08	18.92	79.93	22.25	181.26	467.06	1280.06	1574.70	870.90	480.60	252.40	489.40
1988	0.42	14.66	130.29	600.27	139.91	264.30	658.27	1382.70	1154.10	401.50	266.70	597.50
1989	0.85	10.69	50.32	447.05	436.25	65.16	314.33	759.35	882.12	349.65	123.39	348.00
1990	1.46	6.29	95.30	343.93	634.14	1103.15	255.61	273.86	471.07	333.93	81.35	177.49
1991	3.06	17.90	23.26	441.77	405.76	863.74	575.43	235.77	244.55	292.11	313.56	257.77
1992	2.84	44.35	159.43	399.46	1255.56	859.20	935.96	716.98	201.64	177.88	120.04	377.01
1993	113.76	85.80	129.59	417.23	1807.30	1418.95	918.12	597.19	585.56	218.77	278.53	390.48
1994	8.06	1368.48	496.44	41.97	1001.80	2759.91	1287.99	826.85	196.69	539.15	113.49	324.29
1995	2.68	49.95	655.51	628.79	370.28	1041.23	1714.50	851.35	268.54	97.53	269.49	156.84
1996	5.21	32.68	50.83	121.89	524.44	1207.69	1362.86	1430.48	263.23	215.48	57.05	113.62
1997	8.68	74.91	102.92	135.29	1058.45	1015.95	1293.41	1019.07	593.77	84.55	49.79	70.08
1998	49.78	392.89	294.20	331.23	556.89	1063.74	1415.46	1611.62	371.44	142.05	15.54	70.30
1999	32.11	252.94	194.45	160.92	526.08	1095.77	1461.98	1201.10	765.34	252.52	31.57	54.36
2000	21.61	169.95	119.51	103.50	286.46	451.20	1168.80	1689.67	1009.04	558.09	93.13	234.60
2001	12.33	96.96	66.42	69.93	343.22	938.11	1088.86	1715.57	1455.26	632.43	427.38	309.51
2002	2.32	20.24	17.42	40.96	744.95	1226.69	1394.91	2141.29	1276.60	642.49	95.14	201.85
2003	0.00	2.40	11.21	50.07	391.72	1308.71	1743.54	1909.68	1565.83	749.60	435.29	348.74
2004	0.00	0.00	7.41	25.36	325.78	1078.47	1538.12	1500.94	1146.27	797.89	324.36	291.65

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Table G.3. continued.   **Total USA commercial catch** (landings + shrimp trawl discards + LM otter trawl discards).

USA Commerical Catch Mean Weight (kg) at Age

Year	0	1	2	3	4	5	6	7	8	9	10	11+
1982	0.000	0.002	0.038	0.152	0.242	0.329	0.421	0.550	0.727	0.886	0.983	1.406
1983		0.009	0.038	0.149	0.202	0.270	0.409	0.518	0.613	0.795	0.977	1.357
1984		0.017	0.040	0.151	0.229	0.328	0.421	0.539	0.664	0.817	0.922	1.339
1985		0.017	0.023	0.128	0.237	0.305	0.429	0.565	0.691	0.842	0.964	1.326
1986		0.017	0.026	0.089	0.206	0.299	0.408	0.533	0.676	0.853	0.975	1.321
1987	0.006	0.015	0.033	0.081	0.191	0.298	0.433	0.561	0.686	0.828	0.980	1.303
1988	0.004	0.006	0.017	0.045	0.203	0.311	0.434	0.538	0.668	0.819	0.980	1.326
1989	0.009	0.012	0.034	0.122	0.170	0.321	0.425	0.574	0.682	0.818	0.968	1.358
1990	0.004	0.012	0.029	0.062	0.186	0.257	0.438	0.586	0.688	0.849	1.049	1.454
1991	0.004	0.014	0.035	0.062	0.199	0.344	0.420	0.578	0.702	0.836	0.974	1.420
1992	0.003	0.007	0.026	0.103	0.230	0.379	0.459	0.614	0.739	0.822	0.882	1.243
1993	0.003	0.009	0.027	0.122	0.202	0.318	0.432	0.535	0.666	0.882	1.023	1.335
1994	0.005	0.004	0.019	0.070	0.202	0.280	0.430	0.534	0.691	0.832	0.909	1.266
1995	0.005	0.007	0.024	0.051	0.158	0.328	0.435	0.561	0.690	0.910	0.974	1.243
1996	0.004	0.019	0.031	0.060	0.149	0.265	0.422	0.554	0.708	0.856	0.974	1.232
1997	0.004	0.023	0.033	0.070	0.189	0.274	0.376	0.495	0.627	0.868	1.037	1.293
1998	0.003	0.006	0.024	0.070	0.163	0.260	0.359	0.487	0.584	0.869	0.978	1.206
1999	0.003	0.006	0.024	0.068	0.217	0.291	0.400	0.514	0.584	0.627	0.917	0.872
2000	0.003	0.006	0.024	0.066	0.196	0.272	0.368	0.453	0.534	0.624	0.704	0.915
2001	0.003	0.006	0.023	0.089	0.176	0.256	0.362	0.464	0.550	0.645	0.647	0.840
2002	0.003	0.007	0.032	0.110	0.219	0.279	0.395	0.474	0.552	0.652	0.823	0.940
2003		0.008	0.039	0.070	0.157	0.243	0.320	0.420	0.503	0.565	0.620	0.809
2004			0.053	0.098	0.232	0.277	0.342	0.440	0.540	0.612	0.692	0.871
Mean												
1982-2004	0.004	0.010	0.030	0.091	0.198	0.295	0.406	0.526	0.642	0.787	0.911	1.203
2000-2004	0.003	0.007	0.034	0.086	0.196	0.265	0.357	0.450	0.536	0.619	0.697	0.875

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Table G.4. Stratified mean number, weight (kg), length (cm), and individual weight (kg) per tow of witch flounder in NEFSC offshore spring and autumn bottom trawl surveys in Gulf of Maine-Georges Bank region (strata 22-30,36-40), 1963-2005.

	SPRING					AUTUMN			
Year	Number per tow	Weight per tow	Length per tow	Ave. wt. per tow		Number per tow	Weight per tow	Length per tow	Ave. wt. per tow
1963	-	-	-	-		5.52	3.46	39.7	0.627
1964	-	-	-	-		2.89	2.00	44.2	0.691
1965	-	-	-	-		3.94	2.27	40.6	0.577
1966	-	-	-	-		7.80	4.56	41.2	0.584
1967	-	-	-	-		3.01	2.02	43.7	0.673
1968	4.83	3.35	42.3	0.695		4.82	3.49	44.8	0.724
1969	3.74	2.53	45.3	0.676		5.81	4.40	43.5	0.757
1970	6.39	4.49	44.7	0.702		4.89	3.71	45.0	0.760
1971	2.70	2.04	46.5	0.756		4.32	2.95	42.1	0.683
1972	5.35	4.01	45.8	0.749		3.24	2.42	43.9	0.747
1973	8.20	6.21	44.8	0.758		3.18	2.05	43.6	0.646
1974	6.23	3.62	39.3	0.581		2.38	1.58	41.0	0.666
1975	3.72	2.75	43.9	0.739		1.66	1.03	39.8	0.621
1976	5.50	3.70	42.3	0.673		1.34	0.94	41.9	0.699
1977	4.20	1.96	37.2	0.467		5.06	3.38	42.0	0.669
1978	3.87	2.56	41.7	0.662		4.04	2.94	42.8	0.727
1979	2.91	1.71	38.2	0.587		1.94	1.62	45.2	0.838
1980	8.46	3.89	36.0	0.460		2.62	2.04	43.7	0.777
1981	8.14	4.05	38.0	0.497		3.66	2.19	40.4	0.600
1982	3.64	1.87	37.2	0.513		0.99	0.83	44.7	0.842
1983	6.41	2.74	36.3	0.427		4.72	2.12	36.7	0.448
1984	3.00	1.66	39.9	0.554		4.37	2.34	39.7	0.534
1985	5.18	2.75	40.3	0.531		2.76	1.59	41.9	0.577
1986	2.07	1.35	44.1	0.650		1.59	1.09	43.3	0.683
1987	1.01	0.65	43.4	0.646		0.48	0.37	43.9	0.774
1988	1.43	0.85	42.3	0.590		1.38	0.57	35.2	0.414
1989	1.95	0.74	35.8	0.382		0.89	0.38	31.4	0.423
1990	0.63	0.24	35.2	0.378		2.00	0.40	24.7	0.200
1991	1.68	0.57	31.5	0.341		2.08	0.54	29.2	0.258
1992	1.26	0.48	34.8	0.383		0.94	0.24	29.5	0.254
1993	1.47	0.36	30.3	0.245		5.15	0.54	17.0	0.105
1994	3.13	0.53	27.4	0.170		2.21	0.42	24.9	0.191
1995	1.88	0.47	30.6	0.248		4.74	0.62	25.7	0.132
1996	1.36	0.28	30.5	0.204		5.38	1.02	29.7	0.189
1997	2.22	0.43	31.0	0.195		5.11	0.77	24.9	0.150
1998	4.27	0.77	29.0	0.179		3.70	0.47	24.2	0.127
1999	3.15	0.48	28.1	0.153		5.92	0.88	26.3	0.148
2000	3.45	0.52	27.3	0.151		6.63	1.11	27.1	0.167
2001	4.41	0.75	29.5	0.171		7.94	1.71	32.3	0.216
2002	8.10	1.62	31.4	0.199		4.31	1.06	33.2	0.247
2003	5.20	1.30	34.2	0.250		2.66	0.79	35.4	0.298
2004	3.80	1.08	35.5	0.285		3.82	1.03	33.3	0.271
2005	3.36	0.89	34.6	0.264					

Note: No significant differences in catchability were found for witch flounder between BMV and polyvalent doors, no significant differences were found between research vessels, therefore no adjustment have been made (Byrne and Forrester, MS 1991). Spring surveys during 1973-1981 were accomplished with a 41 Yankee trawl; in all other years, a 36 Yankee trawl was used. No adjustments have been made.

Table G.5. Stratified mean number per tow at age of witch flounder in NEFSC bottom trawl spring and autumn surveys (Strata 22-30, 36-40), 1980 - 2005.

AGE

SPRING	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	Total
1980	0.000	0.060	0.230	0.950	1.520	0.720	1.200	1.020	0.380	0.400	0.310	0.300	0.120	0.160	1.100	8.460
1981	0.000	0.000	0.050	0.820	0.930	2.000	1.020	0.760	0.670	0.420	0.130	0.200	0.240	0.220	0.900	8.400
1982	0.000	0.044	0.042	0.610	0.484	0.377	0.237	0.609	0.362	0.093	0.259	0.175	0.026	0.033	0.292	3.642
1983	0.000	0.000	0.071	0.531	1.262	1.293	0.541	0.716	0.632	0.475	0.214	0.166	0.075	0.054	0.376	6.407
1984	0.000	0.000	0.103	0.012	0.307	0.778	0.401	0.310	0.202	0.196	0.115	0.173	0.117	0.023	0.266	3.001
1985	0.000	0.000	0.000	0.017	0.459	1.057	1.199	0.908	0.412	0.148	0.149	0.044	0.072	0.027	0.691	5.182
1986	0.000	0.000	0.000	0.000	0.044	0.240	0.529	0.412	0.172	0.194	0.079	0.038	0.063	0.055	0.248	2.073
1987	0.000	0.000	0.000	0.000	0.059	0.114	0.133	0.259	0.185	0.009	0.061	0.023	0.000	0.000	0.163	1.007
1988	0.000	0.023	0.023	0.062	0.000	0.072	0.300	0.379	0.239	0.137	0.086	0.084	0.029	0.000	0.000	1.434
1989	0.000	0.023	0.013	0.036	1.004	0.105	0.073	0.081	0.327	0.081	0.015	0.056	0.056	0.019	0.056	1.945
1990	0.000	0.008	0.000	0.038	0.091	0.319	0.000	0.042	0.009	0.050	0.018	0.009	0.011	0.000	0.030	0.626
1991	0.000	0.042	0.000	0.781	0.108	0.087	0.209	0.033	0.101	0.083	0.138	0.018	0.022	0.000	0.064	1.684
1992	0.000	0.054	0.009	0.187	0.373	0.085	0.111	0.152	0.045	0.149	0.015	0.016	0.046	0.000	0.019	1.260
1993	0.000	0.149	0.112	0.137	0.472	0.320	0.058	0.085	0.000	0.015	0.015	0.000	0.068	0.000	0.037	1.469
1994	0.000	0.107	0.698	0.541	0.644	0.810	0.164	0.027	0.028	0.070	0.008	0.000	0.000	0.016	0.016	3.129
1995	0.000	0.041	0.120	0.581	0.316	0.179	0.312	0.116	0.110	0.042	0.000	0.038	0.028	0.000	0.000	1.883
1996	0.000	0.017	0.036	0.244	0.394	0.346	0.218	0.073	0.000	0.000	0.000	0.032	0.000	0.000	0.000	1.359
1997	0.000	0.072	0.066	0.152	0.693	0.617	0.437	0.084	0.083	0.014	0.000	0.000	0.000	0.000	0.000	2.219
1998	0.000	0.112	1.079	0.712	0.388	0.798	0.713	0.214	0.154	0.076	0.000	0.000	0.000	0.028	0.000	4.274
1999	0.000	0.106	0.376	0.974	0.797	0.482	0.164	0.182	0.031	0.014	0.023	0.000	0.000	0.000	0.000	3.149
2000	0.000	0.007	0.250	1.194	0.692	0.660	0.239	0.253	0.116	0.000	0.035	0.000	0.000	0.000	0.000	3.446
2001	0.000	0.105	0.099	0.713	1.476	1.020	0.401	0.293	0.163	0.113	0.028	0.000	0.000	0.000	0.000	4.409
2002	0.000	0.023	0.060	0.897	2.627	2.263	0.822	0.683	0.351	0.192	0.103	0.014	0.000	0.029	0.037	8.101
2003	0.000	0.000	0.000	0.150	0.808	1.646	1.017	0.869	0.387	0.197	0.046	0.060	0.000	0.016	0.009	5.204
2004	0.000	0.009	0.060	0.074	0.428	0.648	0.809	0.883	0.368	0.158	0.161	0.135	0.000	0.000	0.067	3.799
2005	0.000	0.011	0.160	0.146	0.220	0.737	0.760	0.574	0.383	0.245	0.086	0.018	0.000	0.021	0.000	3.362

Table G.5. continued.   Stratified mean number per tow at age of witch flounder in NEFSC bottom trawl spring and autumn surveys (Strata 22-30, 36-40), 1980-2004.

AGE

AUTUMN	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14+	Total
1980	0.040	0.000	0.020	0.000	0.200	0.260	0.280	0.360	0.170	0.150	0.270	0.040	0.160	0.120	0.570	2.620
1981	0.030	0.070	0.030	0.240	0.440	0.610	0.460	0.270	0.260	0.180	0.210	0.170	0.040	0.130	0.480	3.660
1982	0.020	0.000	0.000	0.058	0.013	0.027	0.076	0.241	0.132	0.015	0.027	0.032	0.009	0.039	0.301	0.991
1983	0.000	0.008	0.011	0.507	1.596	0.758	0.548	0.444	0.084	0.137	0.073	0.114	0.025	0.000	0.415	4.718
1984	0.000	0.000	0.000	0.093	0.943	0.991	0.605	0.535	0.310	0.149	0.126	0.073	0.041	0.132	0.375	4.373
1985	0.000	0.000	0.009	0.059	0.076	0.610	0.684	0.482	0.270	0.103	0.122	0.029	0.015	0.089	0.217	2.763
1986	0.009	0.000	0.000	0.000	0.051	0.266	0.353	0.309	0.160	0.112	0.009	0.010	0.021	0.052	0.237	1.590
1987	0.000	0.000	0.023	0.000	0.011	0.023	0.046	0.192	0.071	0.000	0.009	0.000	0.000	0.023	0.085	0.482
1988	0.000	0.007	0.000	0.725	0.055	0.012	0.036	0.215	0.048	0.046	0.045	0.079	0.011	0.043	0.055	1.376
1989	0.174	0.018	0.018	0.082	0.301	0.009	0.021	0.017	0.084	0.078	0.024	0.000	0.026	0.000	0.037	0.888
1990	0.481	0.088	0.137	0.380	0.507	0.219	0.024	0.023	0.023	0.025	0.000	0.000	0.009	0.055	0.034	2.005
1991	0.224	0.021	0.177	0.661	0.329	0.290	0.145	0.067	0.059	0.030	0.052	0.028	0.000	0.000	0.000	2.083
1992	0.097	0.029	0.109	0.259	0.224	0.054	0.061	0.000	0.000	0.019	0.009	0.019	0.000	0.019	0.042	0.940
1993	2.541	0.672	0.154	0.544	0.777	0.219	0.058	0.022	0.081	0.000	0.019	0.042	0.000	0.011	0.014	5.154
1994	0.432	0.156	0.287	0.532	0.165	0.395	0.037	0.106	0.000	0.043	0.009	0.000	0.005	0.000	0.042	2.209
1995	0.512	0.203	0.764	1.624	0.858	0.472	0.229	0.000	0.000	0.011	0.054	0.000	0.000	0.000	0.009	4.736
1996	0.232	0.092	0.261	0.785	1.988	1.386	0.441	0.066	0.065	0.037	0.000	0.033	0.000	0.000	0.000	5.384
1997	0.892	0.339	0.979	0.522	0.871	0.770	0.383	0.329	0.000	0.000	0.000	0.000	0.020	0.000	0.000	5.105
1998	0.639	0.082	0.520	1.363	0.465	0.303	0.165	0.110	0.043	0.012	0.000	0.000	0.000	0.000	0.000	3.701
1999	0.323	0.521	1.178	1.514	1.044	0.600	0.364	0.275	0.050	0.037	0.009	0.000	0.000	0.000	0.000	5.915
2000	0.943	0.096	0.719	1.408	1.746	0.674	0.589	0.229	0.152	0.049	0.000	0.000	0.026	0.000	0.000	6.630
2001	0.000	0.039	0.210	0.952	3.156	1.886	0.813	0.612	0.159	0.058	0.056	0.000	0.000	0.000	0.000	7.940
2002	0.000	0.000	0.275	0.431	1.475	0.997	0.532	0.331	0.148	0.071	0.000	0.046	0.005	0.000	0.000	4.311
2003	0.018	0.000	0.038	0.075	0.307	0.580	0.770	0.315	0.129	0.222	0.083	0.021	0.046	0.019	0.038	2.660
2004	0.276	0.072	0.014	0.086	0.453	0.987	0.826	0.498	0.355	0.054	0.105	0.072	0.000	0.000	0.019	3.816

Table G.6. Parameter estimates (with associated statistics) and estimates of terminal F from ADAPT VPA formulations for witch flounder; stock sizes in '000s.

Notes:	SARC 37	Re-Run of SARC 37	Revised CAA (age and length)		GARM 2005 BASE RUN
Software	NFTv2011	NFTv222	NFTv222/231		NFT 231
CAA	1982-2002 3-11+	1982-2002 3-11+	1982-2002 3-11+		1982-2004 3-11+
Est.Ages	3-10	3-10	3-10		3-10
NMFS-s	3-11+	3-11+	3-11+		3-11+
NMFS-a	3-11+	3-11+	3-11+		3-11+
M.S.R.	.791	.791	.793		.811
N3 (cv)	19,759 (.64)	19,759 (.64)	19,752 (.64)		3,902 (.65)
N4 (cv)	25,441 (.45)	25,441 (.45)	25,432 (.45)		4,053 (.46)
N5 (cv)	42,739 (.37)	42,739 (.37)	42,727 (.37)		9,206 (.39)
N6 (cv)	41,657 (.33)	41,657 (.33)	41,640 (.33)		14,614 (.35)
N7 (cv)	21,203 (.31)	21,203 (.31)	21,204 (.31)		19,943 (.32)
N8 (cv)	10,370 (.32)	10,370 (.32)	10,362 (.32)		17,315 (.30)
N9 (cv)	3,903 (.33)	3,903 (.33)	3,931 (.33)		8,815 (.27)
N10 (cv)	791 (.45)	791 (.45)	792 (.45)		2,245 (.37)
Age 3 in T+1 ('000s)	19,760	19,760	19,752		3,902
F 1	-	-	-		-
F 2	-	-	-		-
F 3	0.0015	0.0015	0.0015		0.0058
F 4	0.0161	0.0161	0.0160		0.0323
F 5	0.0268	0.0268	0.0269		0.0661
F 6	0.0595	0.0595	0.0591		0.0690
F 7	0.1741	0.1741	0.1748		0.0772
F 8	0.2648	0.2648	0.2622		0.1136
F 9	0.5526	0.5526	0.5570		0.2838
F10	0.4087	0.4087	0.4096		0.1987
F11+	0.4087	0.4087	0.4096		0.1987
Ave F 7-9	-	-	-		-
Ave F 8-9	0.4087	0.4087	0.4096		0.1987
SSB ('000 mt)	18,296	18,369	18,370		21,175

Table G.7. Estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality and spawning stock biomass (mt) for witch flounder estimated from virtual population analysis, 1982-2004.

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
3	15405	17701	16343	7652	5417	3002	9745	6215	6673	8835	14374	9743
4	12175	13082	14923	13931	6471	4641	2563	7831	4935	5425	7195	12002
5	9563	9493	10014	11487	10901	5221	3827	2077	6336	3661	4294	5032
6	7830	7114	6765	6769	7929	7980	4061	3049	1727	4434	2354	2902
7	4289	5375	4668	4217	4039	4267	5685	2887	2333	1250	3284	1164
8	2752	3077	3160	2647	2224	2034	2222	3616	1784	1755	858	2164
9	2102	1763	1746	1344	1132	1146	950	854	2298	1100	1284	552
10	1101	1440	839	862	599	594	544	448	413	1669	677	941
11+	7260	4728	3844	2926	2040	1151	1218	1263	900	1372	2128	1319
Total	62477	63773	62302	51835	40752	30036	30815	28240	27399	29501	36448	35819

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
3	14268	12680	18854	19931	19769	32280	44865	41852	25021	12889	4737	3902
4	7999	12242	10332	16114	17029	16708	27634	38520	35957	21498	11047	4054
5	8658	5958	10193	8407	12890	14141	13893	23519	32836	30258	18141	9207
6	3022	4908	4166	7656	6296	10109	11157	11540	19374	27126	24831	14615
7	1651	1416	2644	2329	5394	4111	7349	8521	8925	15384	21733	19948
8	454	662	440	964	1067	3156	2431	4765	5749	5704	11474	17316
9	1322	210	323	137	286	576	2010	1164	2759	3769	3465	8815
10	274	642	91	81	41	116	264	1215	422	1781	2551	2245
11+	783	373	181	114	185	200	665	880	895	1427	1738	3027
Total	38431	39091	47224	55733	62957	81397	110268	131976	131938	119836	99717	83129

Table G.7. continued.

Fishing Mortality

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
3	0.013	0.021	0.010	0.018	0.005	0.008	0.069	0.081	0.057	0.055	0.030	0.047
4	0.099	0.117	0.112	0.095	0.065	0.043	0.061	0.062	0.149	0.084	0.208	0.177
5	0.146	0.189	0.242	0.221	0.162	0.101	0.077	0.034	0.207	0.292	0.242	0.360
6	0.226	0.271	0.323	0.366	0.470	0.189	0.191	0.117	0.173	0.150	0.554	0.414
7	0.182	0.381	0.417	0.490	0.536	0.502	0.302	0.331	0.135	0.226	0.267	0.792
8	0.295	0.416	0.705	0.700	0.514	0.612	0.807	0.303	0.333	0.162	0.291	0.343
9	0.228	0.593	0.556	0.657	0.495	0.595	0.601	0.576	0.170	0.335	0.161	0.551
10	0.266	0.477	0.650	0.685	0.507	0.606	0.741	0.350	0.238	0.225	0.211	0.382
11+	0.266	0.477	0.650	0.685	0.507	0.606	0.741	0.350	0.238	0.225	0.211	0.382

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	0.003	0.055	0.007	0.007	0.018	0.005	0.002	0.002	0.002	0.004	0.006
4	0.145	0.033	0.056	0.073	0.036	0.034	0.011	0.010	0.023	0.020	0.032
5	0.418	0.208	0.136	0.139	0.093	0.087	0.036	0.044	0.041	0.048	0.066
6	0.608	0.468	0.431	0.200	0.276	0.169	0.120	0.107	0.081	0.072	0.069
7	0.764	1.020	0.859	0.630	0.386	0.376	0.283	0.244	0.298	0.143	0.077
8	0.622	0.569	1.013	1.064	0.466	0.301	0.587	0.396	0.272	0.349	0.114
9	0.573	0.686	1.234	1.063	0.754	0.631	0.353	0.865	0.288	0.240	0.284
10	0.585	0.596	1.100	1.064	0.520	0.346	0.474	0.473	0.277	0.304	0.199
11+	0.585	0.596	1.100	1.064	0.520	0.346	0.474	0.473	0.277	0.304	0.199

Table G.7 continued.

Spawning Stock Biomass (mt)

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
3	20	21	39	8	6	18	69	71	18	19	62	36
4	107	132	185	127	91	216	191	238	156	104	145	230
5	376	458	580	684	1020	881	746	360	587	336	464	437
6	1115	1241	1243	1584	1916	2472	1298	965	454	887	582	695
7	1543	1883	1715	1720	1636	1794	2495	1303	999	496	1370	424
8	1634	1544	1559	1388	1218	1072	1148	2010	1003	1004	500	1211
9	1632	1172	1088	878	780	757	628	559	1641	754	917	393
10	949	1207	628	666	487	479	422	367	358	1411	548	789
11+	9521	5781	4505	3374	2414	1323	1392	1578	1227	1830	2491	1612
Total	16898	13439	11542	10428	9569	9012	8389	7451	6444	6842	7079	5827

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	26	11	12	9	31	62	106	161	135	29	21
4	156	162	113	115	247	300	464	646	681	412	205
5	637	606	896	599	1069	1096	1081	1782	2252	2230	1204
6	630	1205	1153	1845	1305	2072	2059	2047	3376	4526	4003
7	585	543	1053	906	1921	1407	2359	2605	2708	4771	6278
8	231	353	226	464	502	1499	1048	1977	2468	2358	4811
9	864	145	197	88	180	303	1082	559	1489	1914	1734
10	217	510	70	62	34	95	156	689	283	1039	1490
11+	876	410	181	120	200	160	549	666	783	1070	1429
Total	4222	3946	3899	4209	5489	6995	8903	11132	14177	18349	21175

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Table G.8. Summary of witch flounder catch (mt), spawning stock biomass (mt), fully recruited fishing mortality, recruitment (age 3, thousands of fish) and the year class.

Year	Catch (mt)	SSB (mt)	Ave F 8-9	Recruits Age 3	Year Class
1982	4954	16897	0.262	15.405	1979
1983	6159	13439	0.505	17.701	1980
1984	6759	11542	0.631	16.343	1981
1985	6192	10429	0.679	7.652	1982
1986	4636	9568	0.504	5.417	1983
1987	3494	9012	0.603	3.002	1984
1988	3320	8389	0.704	9.745	1985
1989	2199	7451	0.440	6.215	1986
1990	1645	6443	0.251	6.673	1987
1991	1870	6841	0.249	8.835	1988
1992	2395	7079	0.226	14.374	1989
1993	2973	5827	0.447	9.743	1990
1994	3073	4222	0.597	14.268	1991
1995	2386	3945	0.627	12.680	1992
1996	2338	3901	1.123	18.854	1993
1997	2065	4208	1.063	19.931	1994
1998	2124	5489	0.610	19.769	1995
1999	2327	6994	0.466	32.280	1996
2000	2550	8904	0.470	44.865	1997
2001	3241	11132	0.631	41.852	1998
2002	3467	14175	0.280	25.021	1999
2003	3506	18349	0.294	12.889	2000
2004	3149	21175	0.199	4.737	2001
2005				3.902	2002
min	1645	3901	0.199	3.002	
max	6759	21175	1.123	44.865	
mean	3340.087	9365.6957	0.516	15.506	
Geomean				12.266	
Median				14.268	
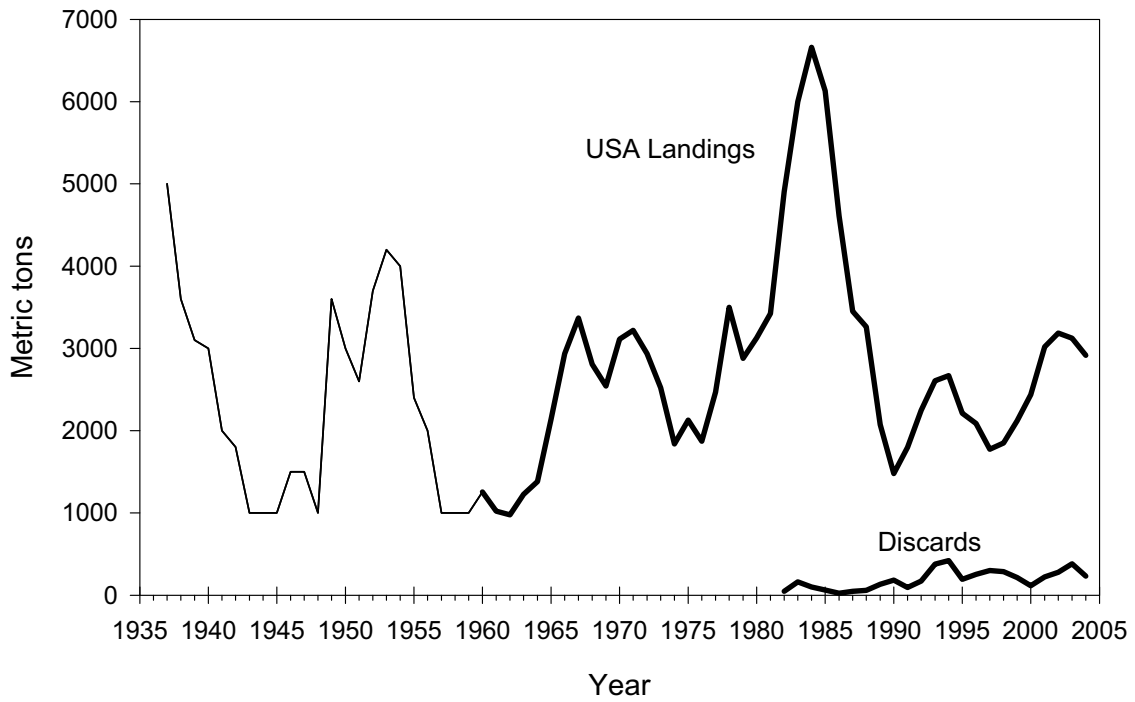
Figure G.1. Historical USA witch flounder landings (mt), excluding USA landings from the Grand Banks in the mid-1980's. The thin line represents provisional landings data taken from Lange and Lux (1978). Discards are from the northern shrimp and large-mesh otter trawl fisheries.

TOTAL CATCH ('000 of fish) AT AGE
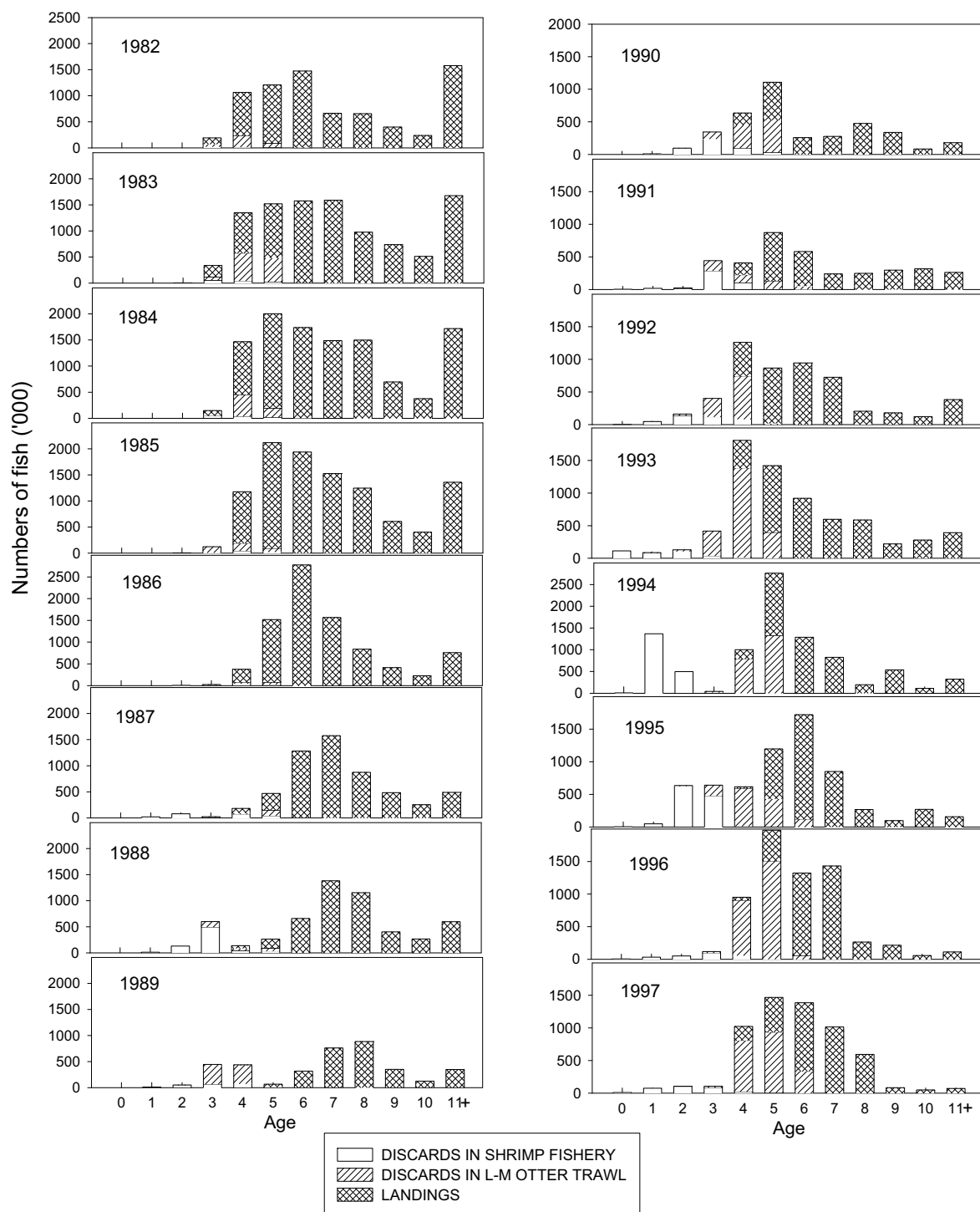
Figure G.2. Number of witch flounder ('000 of fish) at age in the total catch, by fishery, 1982-2004. Open bar represents discards in the shrimp fishery, diagonal bar represents discards in large-mesh fishery and hatched bar represents landings.

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TOTAL CATCH ('000 of fish) AT AGE
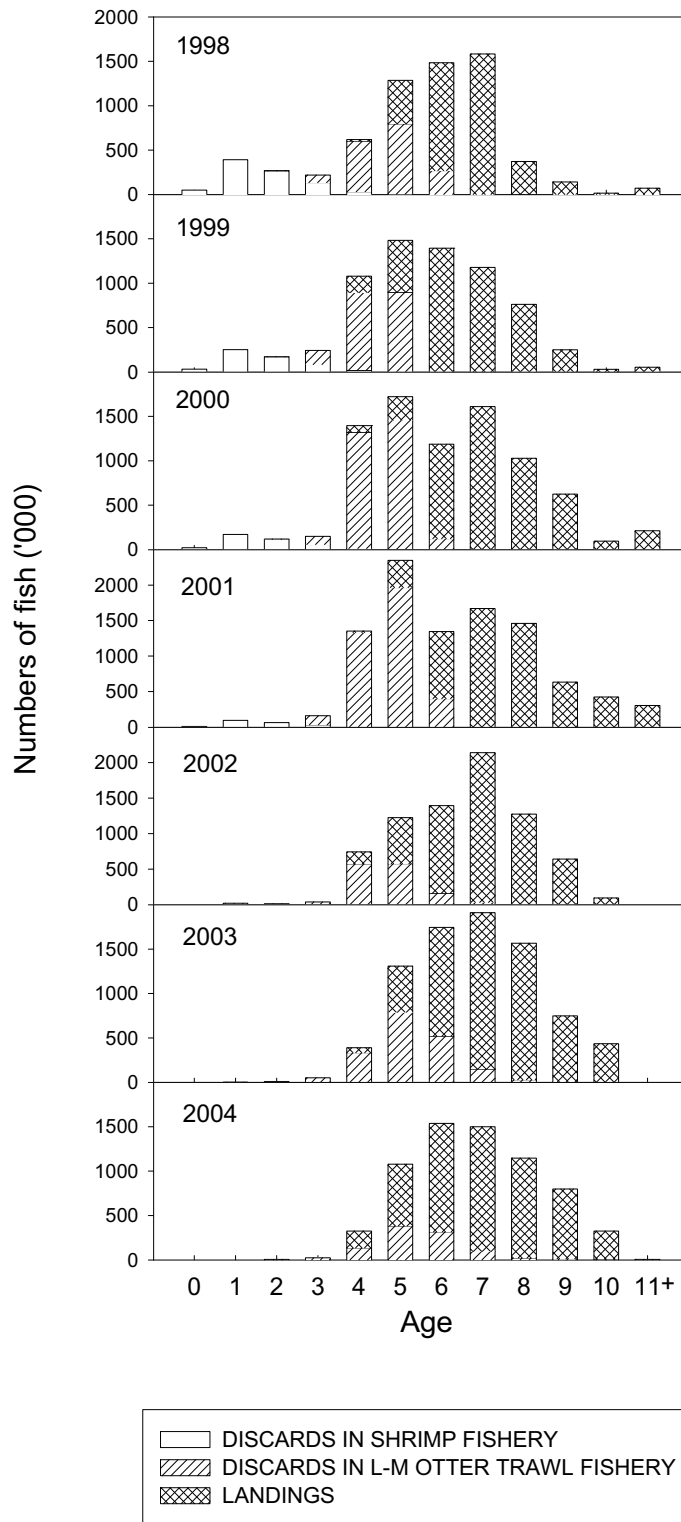
Figure G.2 continued.
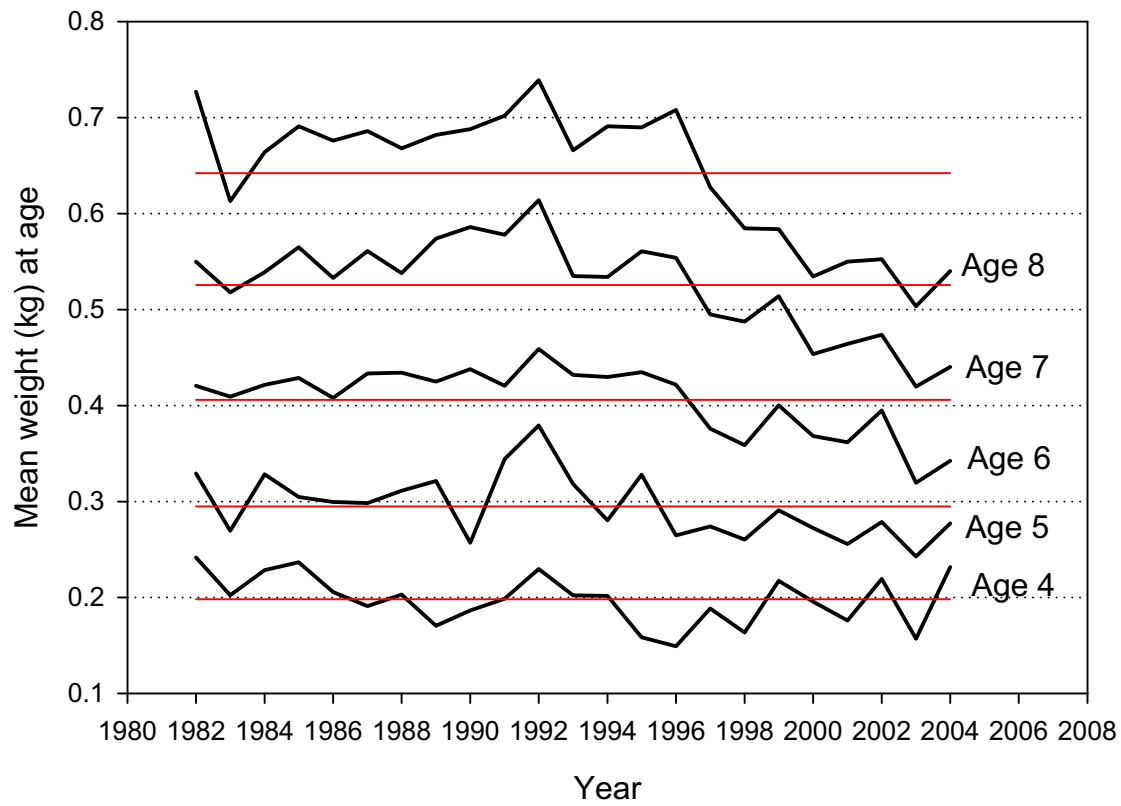
Figure G.3. Witch flounder mean weights at age in the catch, 1982 – 2004.
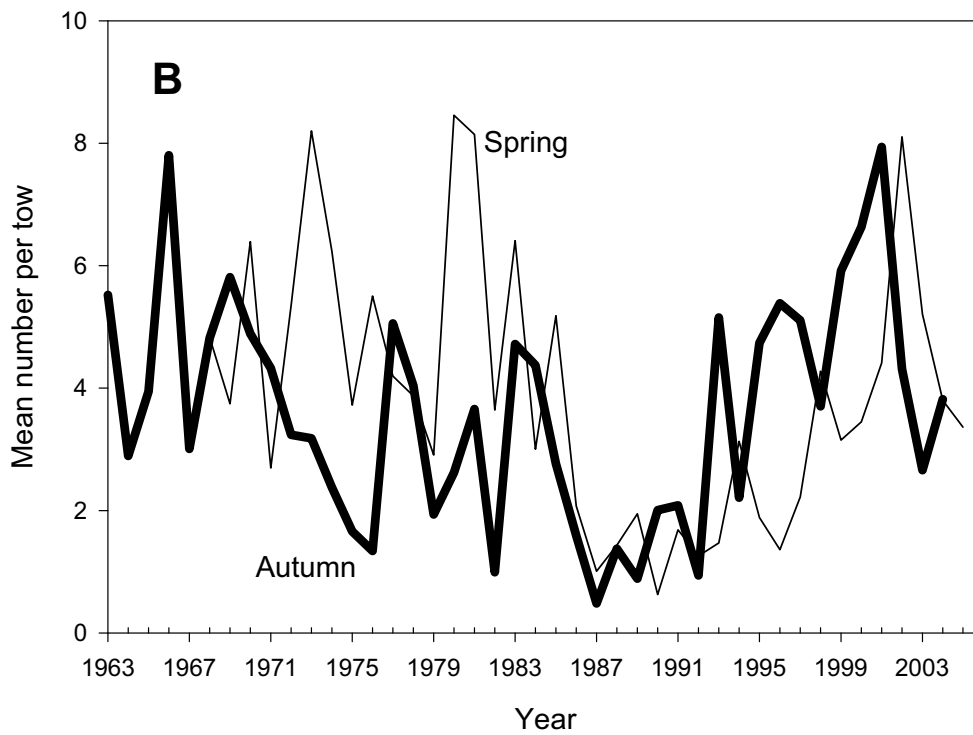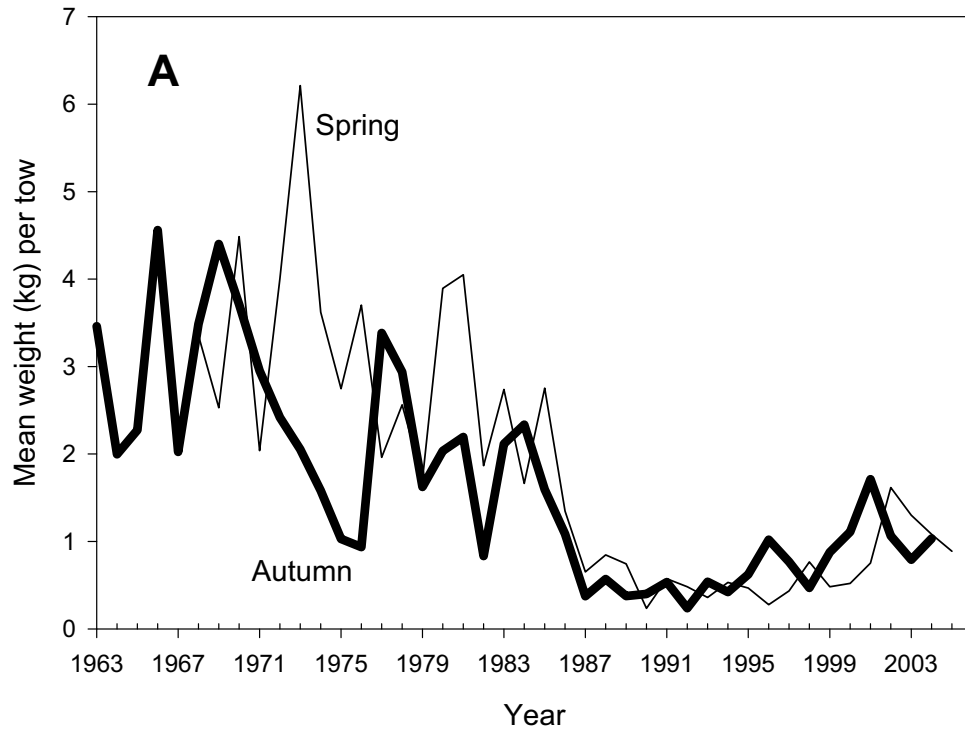
Figure G.4. Stratified mean weight (kg) per tow (A) and mean number per tow (B) of witch flounder in the NEFSC spring and autumn bottom trawl surveys, 1963-2005.
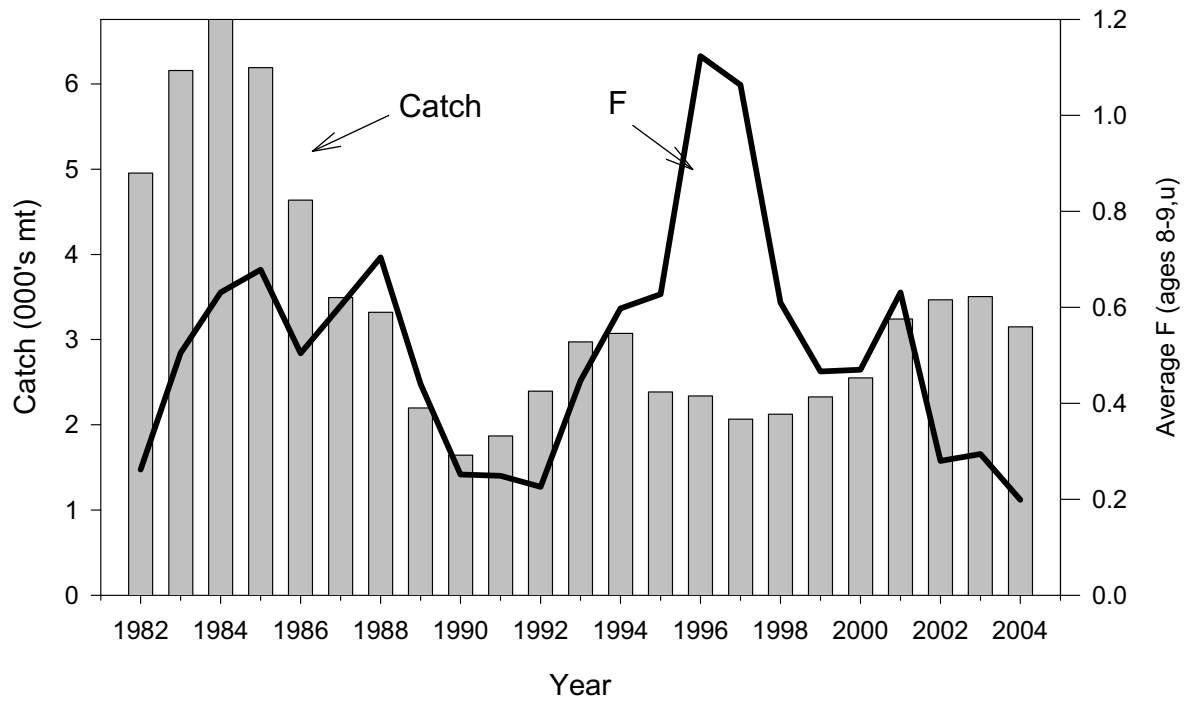
Figure G.5. Trends in total catch and fishing mortality for witch flounder, 1982-2004.
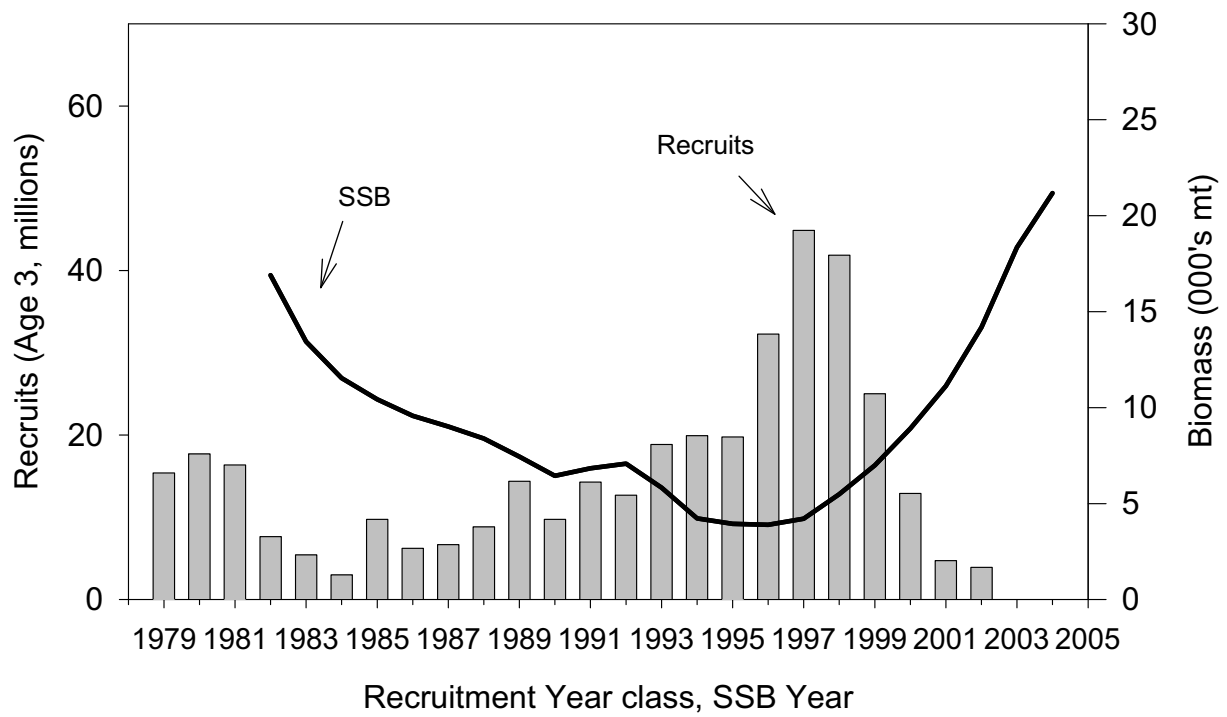
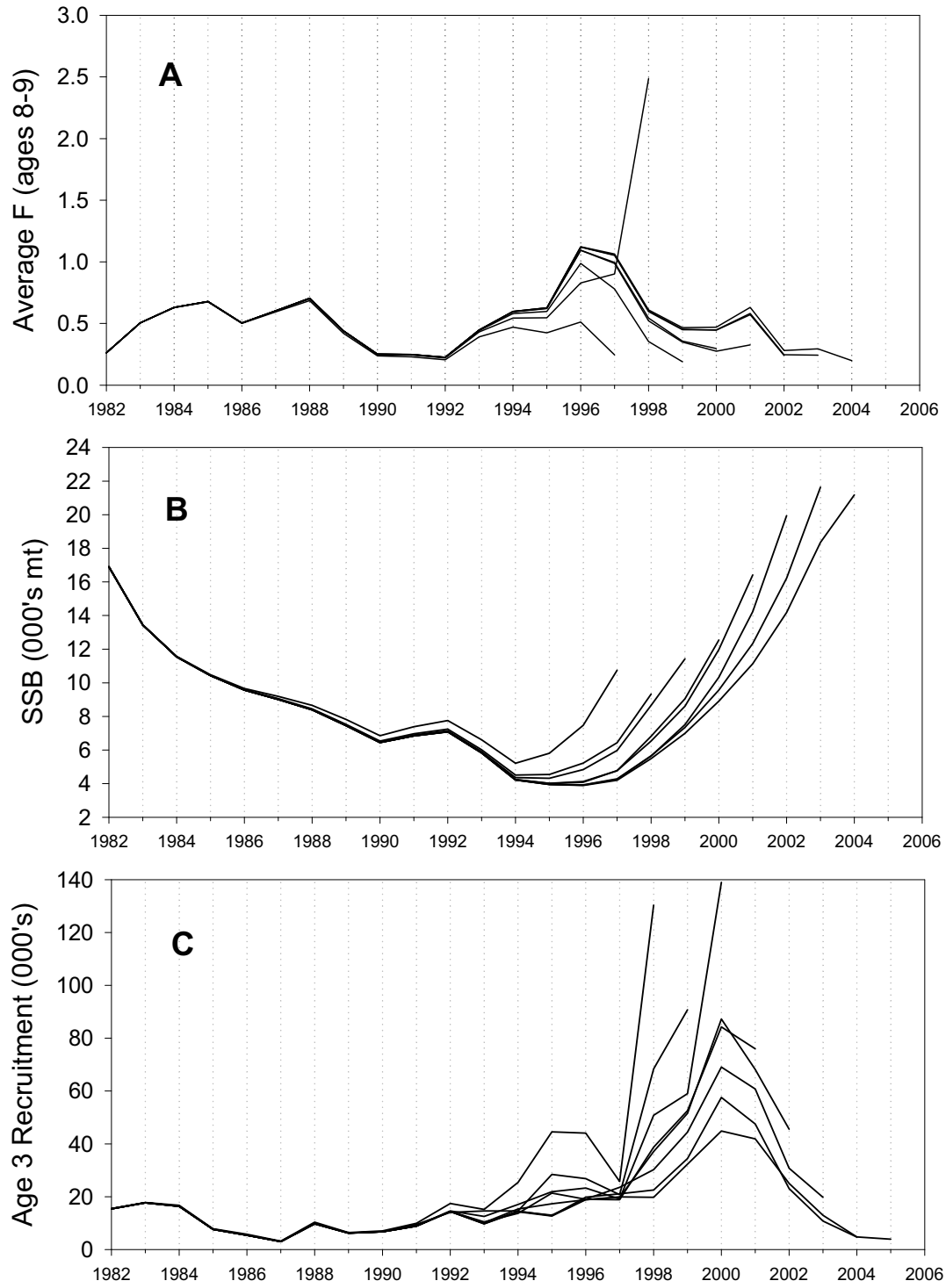Figure G.6. Trends in spawning stock biomass and recruitment (age 3) for witch flounder; 1982 – 2004.

Figure G.7. Retrospective analysis results of fishing mortality(A), spawning stock biomass (B), and age 3 recruitment (C) for witch flounder.
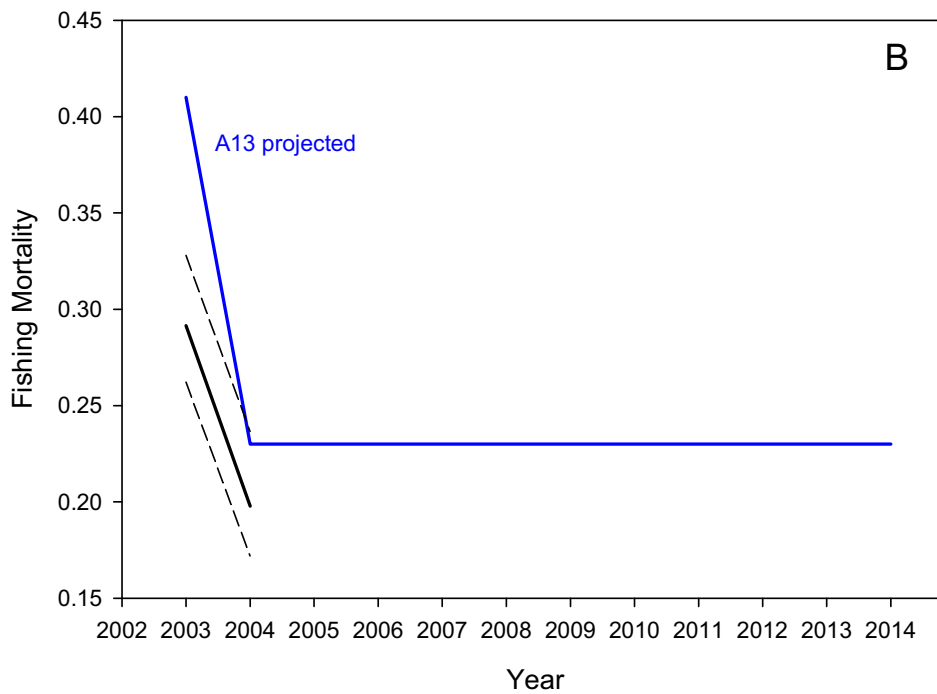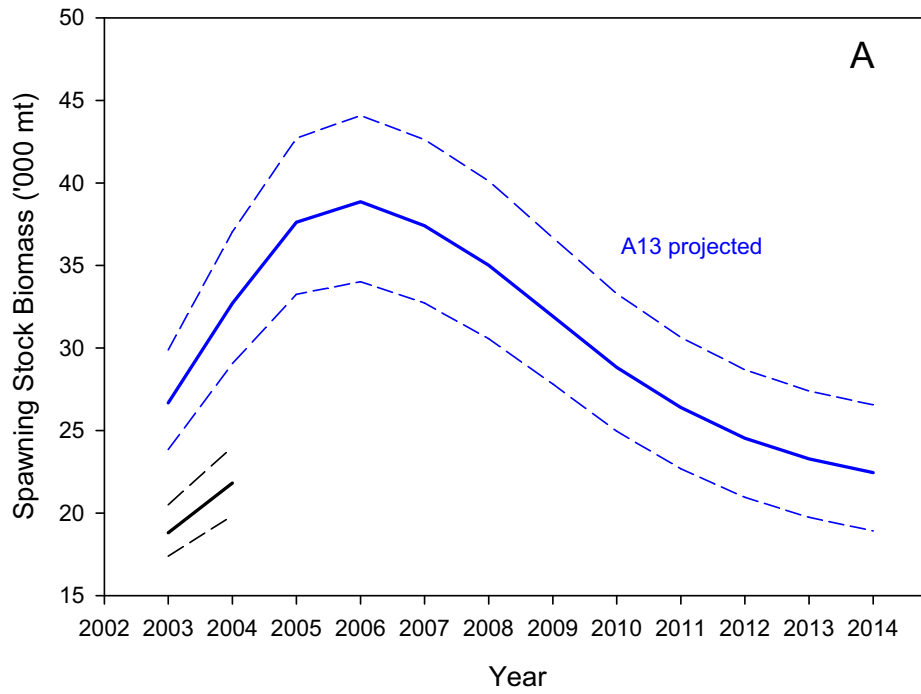
Figure G.8 . Comparisons of Amendment 13 projected and 2004 assessment estimates of witch flounder spawning stock biomass (A) and fishing mortality (B), 2003 - 2014. Solid lines represent the median values and dash lines represent the 25 and 75 percentiles.