G. Witch flounder

by S.E. Wigley and L. Col

Additional details and supporting information can be found in the Appendix of the GARM-III Report (NEFSC 2008).

1.0 Background

Witch flounder, *Glyptocephalus cynoglossus*, is assessed as a unit stock from the Gulf of Maine southward (Figure G1). An analytical assessment was last conducted for this species in 2005 at the Groundfish Assessment Review Meeting (GARM 2005; NEFSC 2005). Witch flounder was not overfished and overfishing was not occurring in 2004. The 2005 assessment indicated 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. Spawning stock biomass declined steadily from 16,897 mt in 1982 to 3,901 mt in 1996 and then increased to 21,175 mt in 2004. 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 (1979 – 2002 year classes) of 15.5 million fish. The retrospective analysis indicates that average F was underestimated in the late 1990s and early 2000s, spawning stock biomass was consistently overestimated and recruitment was relatively consistently estimated, with notable exceptions of the 1995, 1996 and 1997 year classes which were considerably overestimated. 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. Biological reference points were updated at the SARC 37 benchmark assessment in 2003 (NEFSC 2003, Wigley et al. 2003).

This report updates catch through 2007, survey indices through spring 2008, and estimates 2007 fishing mortality and spawning stock biomass. Biological reference points are estimated. Commercial witch flounder landings were updated for the 1994 to 2007 period, with negligible changes occurring for this unit stock species. The NEFSC and Massachusetts inshore survey indices have been revised using re-audited (NEFSC) and re-stratified (MA inshore) survey data.

Discards from the large-mesh otter trawl fishery have been re-estimated using a discard to kept ratio for 1989 to 2007 and discards from the small-mesh otter fishery have been estimated for 1989 to 2007.

2.0 Fishery

Commercial landings

Significant proportions of the U.S. nominal catch have been taken from both the Georges Bank and Gulf of Maine regions. The majority of the landings are taken by otter trawl gear (Table G2). Canadian landings from both areas have been minor (not more than 68 mt annually). USA landings generally increased from the early 1960s, peaking in 1984 at 6,660 mt. Subsequently, landings declined and have fluctuated about 2,300 mt. In 2007, landings were 1,075 mt (Table G1 and Figure G2).

Sampling of landings has increased in recent years (Table G3). When sampling was low, 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. Number of fish landed at age and mean weights at age of landed fish are presented in Tables G4 and G5, respectively.

Discard estimation

Discards have been estimated for three fleets: northern shrimp trawl, large-mesh (>=5.5 inch) otter trawl, and small-mesh (<5.5 inch) otter trawl (Table G6 and Figure G3). The majority of discards occur between ages 1 to 6, and the discards are a small component of total catch (Figure G2). The methods used to estimate fleet specific discards are given below.

Discards from the northern shrimp fishery were estimated using two methods used in a previous assessment (Wigley et al. 2003): 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 was used to estimate ratios of discard weight to days fished (d/df) ratios. When observer data were available (1989-1997, 2003-2007), 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 to 2005, witch flounder discards in the northern shrimp fishery were estimated to be near zero. This is attributed to the short duration of the northern shrimp season in 2003-2004, the shift in effort to near-shore waters inshore of witch flounder distribution, and the relative low abundance of juvenile witch flounder in these years. For 2006 and 2007, witch flounder discards were estimated to be very small and are associated primarily with the 2004 year class. Witch flounder discarded in the northern shrimp fishery range in age from 0 to 6, with the majority at ages 1-3. The estimated discard weight of witch flounder from the shrimp fishery is small compared to the other trawl fleets (Table G6).

The estimation of large-mesh otter trawl discards is based upon two methods. For 1982 to 1988, 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 (Wigley et al. 2003). For 1989 to 2007, an annual combined ratio of witch flounder discard weight to kept weight of all species ratios (d/k_{all}) was calculated from observer data. Total discard weight was derived by multiplying the d/k_{all} ratio by the commercial large-mesh otter trawl landings. Observed discard length frequencies are used to estimate discarded fish at length. Semi-annual numbers of fish discarded were apportioned to age using the corresponding seasonal NEFSC survey age/length key. Discards from the large-mesh otter trawl fishery account for the majority of total discards (Table G6). 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. Discards at age and mean weights at age from the large-mesh otter trawl and northern shrimp trawl fleets are presented in Tables G7 and G8 and Figure G3.

Witch flounder discards from the small-mesh otter trawl fisheries were also estimated using an annual combined ratio for this fleet and expanded to total discards by commercial landings of small-mesh otter trawls (Table G6). The small-mesh otter trawl discard length frequencies for 1989 to 2007 were too sparse to estimate discarded fish at length. Given the possession regulations for this fleet, the commercial catch at age was used to apportion the small-

mesh otter trawl discard weight to discards at age.

The total catch (landings + large-mesh otter trawl discards + shrimp trawl discards+ small-mesh discards) at age and mean weight at age are presented in Tables G9 and G10, and Figure G4. 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 in the late-1990's and again in the mid-2000s. For fish age 6 and older, mean weights at age declined between 1992 and 2003 and have steadily increased since, however the current mean weights at age remain below the time series average (Figure G5)

3.0 Research Vessel Surveys

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 G11, Figures G6a-b). Survey age compositions (mean number per tow at age) are presented in Table G12, Figure G7. The survey mean weights at age show a similar pattern of decline and then increase as reported for the commercial landings (Appendix Figure G1; NEFSC 2008). A 5-year moving window of pooled maturity data from the NEFSC spring survey is used to estimate median age at maturity. The survey maturity-at-age has remained stable in recent years, with median A50 at approximately age 6 (Figure G8) for females.

Both the Massachusetts inshore survey (Appendix Table G1 and Appendix Figure G2; NEFSC 2008) and the Atlantic States Marine Fisheries Commission summer shrimp survey (Appendix Table G2. and Appendix Figure G3; NEFSC 2008) show similar trends in abundance and biomass to the NEFSC surveys.

4.0 Assessment

Input Data and analysis

The Virtual Population Analysis (VPA) is calibrated using the NOAA Fisheries Toolbox (NFT) ADAPT VPA version 2.7.7. Since the last assessment, only minor changes in software and data have occurred. The VPA formulation is the same as the previous assessment and uses catch (landings and discards for ages 3 to 11+) through 2007 and NEFSC spring and autumn survey abundance indices (ages 3 to 11+) through 2008 and 2007, respectively, to estimate stock sizes for ages 3 to 10. All indices are given equal weighting. Autumn survey indices are lagged forward one year and one age to calibrate with beginning year population sizes of the subsequent year. A flat-top partial recruitment vector is assumed, with full fishing mortality on ages 8 and older. The F on ages 10 and 11+ in all years prior to the terminal year is derived from the weighted estimates of Z on ages 8 and 9. Instantaneous rate of natural mortality (M) is assumed to be 0.15. Spawning stock biomass (SSB) is calculated at time of spawning (March) and mean weights at age calculated by the Rivard method. Annual maturity ogives are estimated using NEFSC spring maturity at age data through 2008, pooled by 5-year moving time blocks.

During the GARM 2008 Assessment Model Meeting, the panel concluded that there was sufficient data for an age-structured model that assumes negligible error in the catch-at-age. The panel also recommended exploring the retrospective pattern that has been present in previous assessments. VPA analyses were performed for a BASE case and a SPLIT case, where the survey time series was split between 1994 and 1995. This time split corresponds to changes in

the commercial reporting methods as well as other regulatory management changes. Summary statistics of the two runs, as well as from the previous assessment, are given in Table G13.

NEFSC spring and autumn relative abundance indices at age were transformed into swept area absolute abundance indices and used as tuning indices to explore changes in survey catchabilities (q) between the BASE RUN and the SPLIT RUN. Survey catchabilities from the BASE and SPLIT runs are given in Figure G9. In the BASE RUN, the swept area survey qs range between 0.02 and 0.21. In the SPLIT RUN, the 1982-1994 series qs ranged between 0.01 and 0.24 and the 1995-2007 qs ranged between 0.05 and 0.30. The magnitude and pattern of increasing survey catchabilities at age for younger fish and a general level pattern at older ages in the BASE and SPLIT runs appear reasonable. The causes of the increased qs between the 1982-1994 and 1995-2007 series in the SPLIT RUN remain unknown.

Selection of a final VPA run

As will be discussed below, the precision of the stock size estimates are similar between the two formulations. Both VPA formulations have retrospective patterns: the BASE RUN has a consistent pattern while the SPLIT RUN exhibits a 'flip' (change in direction) pattern. The combination of: 1) the contraction of the age structure observed in the survey indices at age and the commercial catch at age; 2) the low NEFSC survey abundance and biomass indices in recent years; and 3) the magnitude of the 2004 year class at age 3 relative to the age 3 abundance indices over the entire time series (Appendix Figure G4; NEFSC 2008), indicates a strong 2004 cohort but not exceptional year class, all seem to suggest that the VPA SPLIT RUN more accurately characterizes the witch flounder population. Additionally, the Mohn rho statistics of the VPA SPLIT run indicate that the respective pattern is less severe then the VPA BASE RUN. The VPA SPLIT RUN is selected as the final run to use for biological reference point calculations and for stock status determination. For transparency, subsequent analyses based on both VPA formulations have been brought forward.

VPA BASE RUN results

The VPA BASE run had a mean square residual of 0.85, the coefficients of variation (CVs) for estimated stock size at age ranged between 26% and 67% (Table G13), and the CVs for survey catchability coefficients (q) were consistent, ranging from 13% to 26%. Residual patterns from the NEFSC survey tuning indices are given in Figure G10. The patterns appear random for most ages; however, for ages 7 and 10 there appear to be blocks of positive and negative residuals.

VPA results indicate average fishing mortality (ages 8-9, unweighted) increased from 0.26 in 1982 to 0.70 in 1988, declined to 0.23 in 1992, increased to 1.14 in 1996, then declined to 0.14 in 2007 (Table G14 and Figure G11). Spawning stock biomass declined steadily from 16,903 mt in 1982 to 3,888 mt in 1996, and has increased to 7,354 mt in 2007 (Tables G14 and Figure G11). Since 1982, recruitment at age 3 has ranged from approximately 3 million fish (1984 year class) to 48 million fish (2004 year class) with a mean of 13.6 million fish (Table G14 and Figure G11). The addition of the 2003 to 2005 year classes to the stock-recruit data continued the negative trend observed in this relationship in the previous assessment (Figure G11).

The retrospective analysis indicates that average F was underestimated (Figure G12) and spawning stock biomass was consistently overestimated (Figure G13). The retrospective analysis indicated a pattern of relatively consistent estimates of the number of age 3 recruits,

with the notable exception of the 1998 to 2002 year classes, which were considerably overestimated (Figure G14).

Mohn rho statistic (Mohn 1999; GARM 2008) was derived by taking the average of seven (2000 – 2007) relative differences between the quantity (e.g. F, SSB and Age 3) from the reduced time series assessment and the same quantity from the full assessment. The BASE RUN Mohn rho statistics for F, SSB and Age 3 was -0.31, 0.91 and 0.56, respectively (Table G15).

The precision of the 2008 stock size at age, F at age in 2007, and SSB in 2007 from the VPA BASE RUN was evaluated using bootstrap techniques (Efron 1982). Bootstrap results suggest that the estimates of F and spawning stock biomass are relatively precise with CVs of 27% and 14%, respectively. The 80% confidence interval for F_{2007}= 0.14 was 0.10 and 0.20, and for SSB_{2007} = 7,354 mt the 80% confidence interval was 6,337 mt and 9,045 mt. The range of the bootstrap estimates and the probability of the individual values are presented in Figure G15.

VPA SPLIT RUN results

The VPA SPLIT RUN had a mean square residual of 0.730, the coefficients of variation (CVs) for estimated stock size at age ranged between 34% and 63% (Table G16), and the CVs for survey catchability coefficients (q) were consistent, ranging from 15% to 43%. Similar to the BASE RUN, residual patterns from the NEFSC survey tuning indices from the SPLIT RUN are given in Figure G16. The patterns appear random for most ages; however, for ages 7 and 10 there appear to be blocks of positive and negative residuals.

VPA results indicate average fishing mortality (ages 8-9, unweighted) increased from 0.26 in 1982 to 0.70 in 1988, declined to 0.23 in 1992, increased to 1.14 in 1996, then declined to 0.29 in 2007 (Tables G16 and G17; Figure G17). Spawning stock biomass declined steadily from 16,903 mt in 1982 to 3,877 mt in 1996, and has increased to 6,874 mt in 2000 and then declined to 3,434 mt in 2007 (Tables G16 and G17; Figure G17). Since 1982, recruitment at age 3 has ranged from approximately 2 million fish (2002 year class) to 26 million fish (2004 year class) with a mean of 11.1 million fish (Tables G16 and G17; Figure G17). The addition of the 2003 to 2005 year classes to the stock-recruit data continued the negative trend observed in this relationship in the previous assessment (Figure G17).

The retrospective analysis of the VPA SPLIT RUN indicates a pattern of overestimation of average F prior to 2003 and then underestimation for average F from 2003 onward (Figure G18). A similar 'flip' pattern is also evident for spawning stock biomass. Spawning stock biomass was underestimated prior to 2001 and then overestimated from 2001 onward (Figure G19). The retrospective analysis for Age 3 recruits indicates an overestimation prior to 2001 and then an underestimation from 2002 onward (Figure G20). The SPLIT RUN Mohn rho statistics for F, SSB and Age 3 was -0.02, 0.43 and -0.13, respectively (Table G15). The magnitude of the average relative difference for F, SSB and Age3 are all lower in the SPLIT RUN than the VPA BASE RUN (Table G15).

Bootstrap results of the VPA SPLIT RUN suggest that the estimates of F and spawning stock biomass are relatively precise with CVs of 27% and 15%, respectively. The 80% confidence interval for F_{2007}=0.29 was 0.21 and 0.42, and for SSB_{2007} = 3,434 mt the 80% confidence interval was 2,930 mt and 4,262 mt. The range of the bootstrap estimates and the probability of the individual values are presented in Figure G21.

5.0 Biological Reference Points

During the SAW/SARC 37 (NEFSC 2003), biological reference points were updated for witch flounder using yield and spawning stock biomass per recruit analyses (Thompson and Bell 1934) and the arithmetic mean of the VPA Age 3 recruitment (NEFSC 2003). The biological reference points from that analysis are:

SSB_{MSY} = 25,248 mt;
F_{MSY} = F40% = 0.23; and
MSY = 4,375 mt.

For this assessment, yield and spawning stock per recruit analysis were performed using 5-year (2003-2007) averages for partial recruitment, stock weights, catch weights and maturity (2004-2008; Table G18). Based on yield and SSB per recruit analyses, a proxy of F_{MSY} is F40%MSP = 0.20 for both the BASE and SPLIT runs (Table G19).

Two long-term (100 year) stochastic projections (AGEPRO v3.1.3) were performed to estimate spawning stock biomass and MSY under equilibrium conditions. The same partial recruitment vectors, mean weights at age and maturity vectors used in the yield and SSB per recruit analysis were also used in the projections. A constant F scenario was used ($F = F_{MSY}$ = 0.20). Estimates of Age 3 recruitment used in the projections were derived by re-sampling the cumulative density function based on the empirical observations during 1982 to 2008 (1979 to 2005 year classes) from the BASE RUN and the SPLIT RUN (Table G18). The proportions of F and M which occurs before spawning equals 0.1667 (March 1); M equals 0.15. Comparisons of current (SARC 37) and updated (GARM2008) biological references points are given in Table G19.

BASE RUN
SSB_{MSY} = 12,180 mt
MSY = 2,528 mt

SPLIT RUN
SSB_{MSY} = 11,447 mt
MSY = 2,352mt

Trends of the age structure of the spawning stock biomass and the age structure under MSY conditions are given in Figure G22. As reported above, SSB in 2007 is well below SSB_{MSY}, and the distribution of spawning biomass at age is concentrated at younger ages in 2007, indicating a truncated age structure.

6.0 Projections

Short term projections of catch and spawning stock biomass in 2009 were conducted under two F scenarios using bootstrapped VPA SPLIT RUN calibrated stock sizes in 2008. The partial recruitment, maturity ogive, and mean weights at age (Table G20) are the same as described for biological reference points (using 5 year average mean weight and the full entire series of Age 3 recruitment) and an assumed natural mortality of 0.15.

Short-term median estimates of catch and spawning stock biomass in 2009 are given in Table G20. When 2008 catch is assumed equal to 2007 catch, the projection forecasts F in 2008 = 0.31 and spawning biomass to be 3,876 mt. If 2009 fishing mortality is held at F status quo (F=0.29), then 2009 spawning stock biomass is forecast to be 4,792 mt. If 2009 fishing mortality is held at F_{MSY} (F=0.20), then 2009 spawning stock biomass is forecast to be 4,838 mt.

Projections to estimate $F_{REBUILD}$ in 2009- 2018 that will rebuild the spawning biomass to SSB_{MSY} = 11,447 mt by 2018 with a 50% probability indicate that $F_{REBUILD}$ = 0.194. Catches in 2009 are estimated to be 896 mt (Table G20).

7.0 Summary

Witch flounder fishing mortality and spawning stock biomass in 2007 are summarized, relative to the biological reference points, for the SPLIT RUN, the BASE RUN, and the rho-adjusted BASE RUN (where F and SSB are adjusted by the Mohn's rho for F and SSB, -0.31 and 0.91 respectively; Figure G23). The final accepted VPA run is the SPLIT RUN. Based on the VPA SPLIT run, the 2007 spawning stock biomass was 3,434 mt, 30% below SSB_{MSY} (11,447 mt) and 2007 fishing mortality was 0.29, 45% above F_{MSY} (F=0.20); therefore, witch flounder was overfished and overfishing occurred in 2007 (Figure G23).

The 2007 witch flounder assessment reveals that discards continue to be a minor component of the total catch. Total catch has declined slightly in recent years and is below the time series average. Fishing mortality has declined substantially since 1996 and is currently near the low levels estimated in the early 1990s. Spawning stock biomass has shown a declining trend between 1982 and 1996 and a slight increasing trend until 2000, following by a declining trend through 2007; spawning stock biomass remains below the time series average. Age 3 recruits has averaged 11.1 million fish over the time series. The three most recent year classes (2003 – 2005 year classes) are at or above the average, and the 2004 year class appears to be very strong.

Based on yield per recruit analyses, F_{MSY} = F40%MSP = 0.20. SSB_{MSY} and MSY were estimated using a long-term stochastic projection. SSB_{MSY} = 11,447 mt and MSY = 2,352 mt. The 2007 spawning stock biomass age structure remains truncated compared to the conditions under MSY (Figure G22).

Changes from last assessment

Changes from the last assessment were minor and include: minor revisions to landings, use of re-audited historical NEFSC survey, re-estimation of large-mesh otter trawl discards from 1989-onward and the estimation of small-mesh otter trawl discards.

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.
- The research bottom trawl survey catches very few witch flounder; in many 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.

8.0 Panel Discussion/Comments

Conclusions

The BASE VPA model put forth by the NEFSC exhibited a moderate retrospective pattern and lack of model fit, as determined by the residuals, on the youngest age classes. The VPA using the split survey time series reduced the retrospective pattern and reduced the residuals on the younger ages but not for older ages. Therefore, the Panel accepted the VPA with the survey time series split as Final and the best available estimate of stock status and a sufficient basis for management advice.

As noted elsewhere in this report, the Panel was concerned that the split in the survey time series reduces the retrospective pattern, yet the underlying mechanism for its cause remains unknown. It should also be noted that even with the split in the survey time series, the retrospective pattern "flips" back and forth from over-estimating SSB and underestimating F to the reverse. This highlights the uncertainties in the determination of the stock status and projections of this resource.

Concerns were raised that the negative stock – recruitment relationship observed in the VPA time series implies that higher SSB would lead to lower recruitment, an issue that would need to be addressed in the stock and rebuilding plan projections. An analysis of the stock – recruitment relationship based upon the survey data alone (not shown in this report) did not support this negative relationship. Consequently, the Panel agreed to the BRP and projections which were consistent with the GARM III 'BRP' review.

Research Recommendations

The Panel had no specific research recommendations for this stock.

9.0 Acknowledgments

We thank all those who diligently collected data from the commercial fisheries (dock-side and at-sea) and the research vessel surveys. We thank J. Burnett for providing the age determinations used in the assessment. We thank all the members of the Groundfish Assessment Review Meetings for their review and helpful comments.

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Table G1. Witch flounder landings, discards and catch (metric tons, live) by country, 1937-2007 [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		

continued.

Table G1 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 Total 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	76	2144
1990	1465	2	1467	12		1479	96	1561
1991	1777		1777	7		1784	217	1994
1992	2227		2227	7		2234	212	2439
1993	2601		2601	10		2611	224	2825
1994	2670		2670	34		2704	339	3009
1995	2209		2209	11		2220	203	2412
1996	2087		2087	10		2097	207	2294
1997	1772		1772	7		1779	209	1981
1998	1848		1848	10		1858	198	2046
1999	2121		2121	19		2140	277	2398
2000	2439		2439	53		2492	178	2617
2001	3020		3020	32		3052	307	3327
2002	3188		3188	34		3222	225	3413
2003	3124		3124	30		3154	334	3458
2004	2917		2917	33		2950	309	3226
2005	2652		2652	18		2670	150	2802
2006	1863		1863	15		1878	87	1950
2007	1075		1075	17		1091	97	1172

Table G2. Witch flounder landings (metric tons, live) by gear type, 1964-2007.

YEAR	Otterl Trawl	Shrimp Trawl	Gillnet	Unknown	Other	Total
1964	99.9	.	.	.	0.1	100.0
1965	99.8	.	.	.	0.2	100.0
1966	99.7	.	.	.	0.3	100.0
1967	100.0	.	.	.	0.0	100.0
1968	99.9	.	.	.	0.1	100.0
1969	100.0	.	.	.	0.0	100.0
1970	100.0	.	0.0	.	0.0	100.0
1971	97.7	.	0.0	.	2.3	100.0
1972	97.4	.	0.0	.	2.6	100.0
1973	98.6	.	0.0	.	1.3	100.0
1974	99.7	.	0.0	.	0.3	100.0
1975	97.0	2.5	0.1	.	0.4	100.0
1976	98.8	0.8	0.1	.	0.3	100.0
1977	97.2	1.5	0.1	.	1.3	100.0
1978	98.0	.	0.1	.	1.8	100.0
1979	97.8	0.2	0.4	.	1.7	100.0
1980	96.6	0.6	0.2	.	2.6	100.0
1981	97.2	0.8	0.2	.	1.8	100.0
1982	96.8	0.8	0.4	.	2.0	100.0
1983	95.9	0.6	0.1	.	3.4	100.0
1984	96.1	0.4	0.0	.	3.4	100.0
1985	95.0	1.1	0.1	.	3.8	100.0
1986	95.4	1.1	0.2	.	3.3	100.0
1987	95.4	1.1	0.8	.	2.8	100.0
1988	96.0	0.8	0.6	.	2.6	100.0
1989	95.3	0.4	1.4	.	2.9	100.0
1990	92.8	0.6	2.5	.	4.1	100.0
1991	94.9	0.4	1.0	.	3.7	100.0
1992	96.1	0.1	0.9	.	2.9	100.0
1993	94.1	0.0	2.9	.	3.0	100.0
1994	96.1	0.0	2.6	0.2	1.1	100.0
1995	96.5	0.0	2.1	0.5	1.0	100.0
1996	97.1	0.0	2.0	0.2	0.8	100.0
1997	96.9	0.3	1.4	0.0	1.4	100.0
1998	97.1	0.1	1.5	0.0	1.3	100.0
1999	97.3	0.1	2.1	0.1	0.4	100.0
2000	97.7	0.0	1.6	0.0	0.7	100.0
2001	98.3	0.0	1.2	0.1	0.3	100.0
2002	97.4	0.0	1.2	0.8	0.6	100.0
2003	97.6	0.0	1.3	0.0	1.1	100.0
2004	95.2	0.0	1.0	2.0	1.8	100.0
2005	90.4	0.0	1.7	5.3	2.6	100.0
2006	94.1	0.1	1.5	1.9	2.3	100.0
2007	95.7	0.3	3.4	0.2	0.5	100.0

Dealer Electronic Reporting (DER) was implemented in 2004.

Table G3. 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 - 2007. The sampling ratio represents the amount of landings per length sample.

		Quarter 1			Quarter 2			Quarter 3			Quarter 4			Total	Sampling
Year		Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	All	Ratio
1981	mt	260	7	517	269	32	694	242	13	607	230	0	453	3324	
	n	.	.	.	.	1	1	.	1	.	1	.	1	5	665
	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	
1987	mt	349	211	228	432	317	387	296	203	247	298	203	202	3373	
	n	1	1	2	4	2	3	5	5	4	2	3	2	34	69
	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	
	n	5	4	5	5	5	3	5	4	3	3	4	3	49	65
	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	
	n	1	2	2	2	2	1	2	2	1	1	2	.	18	112
	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	

Table G3 continued. Summary of commercial sampling for witch flounder.

		Quarter 1			Quarter 2			Quarter 3			Quarter 4			Total	Sampling
Year		Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	All	Ratio
1990	mt	113	125	107	147	168	147	100	119	129	84	79	85	1403	
	n	1	2	3	6	3	1	6	2	2	7	2	.	35	40
	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	
	n	5	2	3	7	2	1	4	2	3	5	4	3	41	40
	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	
	n	4	2	2	7	1	2	7	1	1	2	.	1	30	68
	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	
1993	mt	350	112	110	442	192	161	263	122	150	331	96	106	2435	
	n	7	1	.	7	1	1	9	1	5	.	.	.	32	76
	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	2669	
	n	.	.	.	3	5	6	5	5	1	5	3	4	37	72
	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	2229	
	n	3	3	3	6	3	5	.	.	.	2	.	1	26	85
	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	
	n	5	2	3	5	2	1	5	4	4	5	3	3	42	50
	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	
	n	6	3	3	9	4	3	9	3	1	9	1	1	52	34
	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	1846	
	n	5	2	1	4	1	1	5	3	1	.	.	.	23	80
	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	
	n	3	.	.	4	.	.	17	2	3	11	1	.	41	51
	len	282	.	.	308	.	.	1110	201	306	775	109	.	3091	
	age	15	.	.	62	.	.	143	.	32	91	16	.	359	

Table G3 continued. Summary of commercial sampling for witch flounder.

		Quarter 1			Quarter 2			Quarter 3			Quarter 4			Total	Sampling
Year		Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	Small	Med.	Large	All	Ratio
2000	mt	477	53	17	583	93	27	555	89	28	451	50	16	2439	
	n	31	2	.	47	.	.	17	1	.	5	5	2	110	22
	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	
	n	8	4	2	3	3	2	8	2	3	5	3	.	43	70
	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	
	n	5	1	2	3	5	3	5	2	3	3	2	2	36	89
	len	363	121	107	212	518	209	389	150	194	262	226	115	2866	
	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	
	n	4	6	6	10	5	10	11	6	16	7	7	13	101	31
	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	
	n	5	13	23	8	5	8	5	5	2	19	5	15	113	26
	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	
2005	mt	603	69	14	639	101	18	618	96	21	433	34	6	2652	
	n	15	8	11	10	7	9	8	8	12	9	8	15	120	22
	len	727	525	309	798	523	288	542	369	329	512	422	445	5789	
	age	78	65	104	117	113	93	130	92	165	92	99	229	1377	
2006	mt	619	67	14	418	52	8	367	46	12	232	24	4	1863	
	n	9	6	14	11	5	16	11	5	26	11	5	29	148	13
	len	501	538	765	837	433	255	584	268	392	577	444	334	5928	
	age	90	114	246	146	118	119	129	75	282	119	106	238	1782	
2007	mt	264	26	5	267	37	7	226	40	8	173	19	3	1075	
	n	10	6	40	12	2	12	11	15	24	10	5	19	166	6
	len	516	480	400	653	203	304	605	279	237	605	232	177	4691	
	age	106	144	343	132	51	172	136	133	189	107	76	159	1748	

Table G4. USA commercial landings at age (thousands of fish), of witch flounder, 1982 – 2007.

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

	Age											
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11+**
1982	0.000	0.000	0.000	117.900	826.600	1119.900	1454.300	665.200	656.000	399.500	239.400	1578.400
1983	0.000	0.000	0.000	219.800	768.600	1033.700	1567.300	1590.200	977.800	737.700	510.400	1675.500
1984	0.000	0.000	0.000	90.600	1012.400	1808.700	1734.300	1486.500	1497.500	696.700	375.100	1718.800
1985	0.000	0.000	0.000	0.000	985.100	2026.800	1933.800	1524.900	1247.900	606.000	400.400	1359.200
1986	0.000	0.000	0.000	6.300	298.500	1441.600	2772.600	1566.900	834.900	412.700	222.800	758.200
1987	0.000	0.000	0.000	0.000	81.500	321.600	1276.000	1574.700	870.900	480.600	252.400	489.400
1988	0.000	0.000	0.000	0.000	50.800	176.000	654.700	1382.700	1154.100	401.500	266.700	597.500
1989	0.000	0.000	0.000	0.000	7.290	49.690	314.330	759.350	882.120	349.650	123.390	348.000
1990	0.000	0.000	0.000	0.000	181.570	574.320	255.610	273.860	471.070	333.930	81.350	177.490
1991	0.000	0.000	0.000	0.000	179.540	732.880	519.430	235.770	244.550	292.110	313.560	257.770
1992	0.000	0.000	0.000	0.000	509.310	839.430	935.490	716.980	201.640	177.880	120.040	377.010
1993	0.000	0.000	0.000	0.000	422.170	1022.890	917.660	597.190	585.560	218.770	278.530	390.480
1994	0.000	0.000	0.000	0.000	201.639	1431.828	1288.414	828.243	197.021	540.057	113.680	324.838
1995	0.000	0.000	0.000	0.000	23.690	763.000	1597.430	848.700	267.450	97.220	269.490	156.840
1996	0.000	0.000	0.000	0.000	45.790	467.720	1263.830	1430.480	263.230	215.480	57.050	113.620
1997	0.000	0.000	0.000	0.000	212.263	528.139	1049.873	1014.449	591.550	83.179	49.808	70.112
1998	0.000	0.000	0.000	0.000	18.090	487.960	1213.510	1583.010	370.510	141.350	15.540	70.300
1999	0.000	0.000	0.000	0.000	185.149	585.733	1391.764	1178.302	763.150	251.266	31.571	54.361
2000	0.000	0.000	0.000	0.000	75.400	261.550	1072.960	1671.410	1004.050	558.090	93.130	234.600
2001	0.000	0.000	0.000	0.000	18.818	379.952	931.284	1683.679	1455.521	632.495	427.485	309.590
2002	0.000	0.000	0.000	0.000	169.070	648.660	1233.240	2107.400	1269.990	640.020	94.100	201.150
2003	0.000	0.000	0.000	0.000	56.790	517.680	1222.550	1760.820	1535.500	741.010	433.590	347.010
2004	0.000	0.000	0.000	0.000	188.530	696.460	1221.100	1403.550	1122.510	785.000	313.390	285.050
2005	0.000	0.000	0.000	0.000	75.118	637.827	1702.245	1746.227	818.771	408.738	234.635	132.335
2006	0.000	0.000	0.000	0.000	36.197	177.392	571.614	1519.138	869.397	355.919	132.599	73.028
2007	0.000	0.000	0.000	0.000	15.045	48.587	219.968	851.389	594.379	167.352	96.877	42.672

Table G5. USA commercial landings mean weight (kg) at age of witch flounder, 1982 – 2007.

USA Commercial Landings Mean Weight (kg) at Age

						Age						
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11+**
1982	-	-	-	0.216	0.275	0.345	0.424	0.550	0.727	0.886	0.983	1.406
1983	-	-	-	0.195	0.257	0.322	0.410	0.518	0.613	0.795	0.977	1.357
1984	-	-	-	0.212	0.268	0.346	0.422	0.539	0.664	0.817	0.922	1.339
1985	-	-	-	0.000	0.253	0.311	0.429	0.565	0.691	0.842	0.964	1.326
1986	-	-	-	0.084	0.227	0.306	0.408	0.533	0.676	0.853	0.975	1.321
1987	-	-	-	-	0.272	0.342	0.434	0.561	0.686	0.828	0.980	1.303
1988	-	-	-	-	0.310	0.367	0.435	0.538	0.668	0.819	0.980	1.326
1989	-	-	-	-	0.260	0.344	0.425	0.574	0.682	0.818	0.968	1.358
1990	-	-	-	-	0.308	0.323	0.438	0.586	0.688	0.849	1.049	1.454
1991	-	-	-	-	0.286	0.371	0.443	0.578	0.702	0.836	0.974	1.420
1992	-	-	-	-	0.328	0.383	0.459	0.614	0.739	0.822	0.882	1.243
1993	-	-	-	-	0.292	0.364	0.432	0.535	0.666	0.882	1.023	1.335
1994	-	-	-	-	0.308	0.357	0.430	0.534	0.691	0.832	0.909	1.266
1995	-	-	-	-	0.284	0.367	0.448	0.561	0.690	0.911	0.974	1.243
1996	-	-	-	-	0.260	0.355	0.435	0.554	0.708	0.856	0.974	1.232
1997	-	-	-	-	0.318	0.357	0.407	0.495	0.628	0.871	1.037	1.293
1998	-	-	-	-	0.235	0.331	0.382	0.492	0.585	0.871	0.978	1.206
1999	-	-	-	-	0.325	0.355	0.406	0.516	0.584	0.628	0.917	0.872
2000	-	-	-	-	0.319	0.326	0.376	0.455	0.535	0.624	0.704	0.915
2001	-	-	-	-	0.291	0.325	0.384	0.468	0.550	0.645	0.647	0.840
2002	-	-	-	-	0.355	0.344	0.416	0.477	0.553	0.652	0.826	0.941
2003	-	-	-	-	0.275	0.315	0.355	0.433	0.507	0.567	0.621	0.810
2004	-	-	-	-	0.288	0.317	0.369	0.451	0.543	0.613	0.698	0.873
2005	-	-	-	-	0.291	0.327	0.371	0.449	0.558	0.634	0.725	0.909
2006	-	-	-	-	0.290	0.327	0.372	0.465	0.551	0.655	0.719	0.932
2007	-	-	-	-	0.292	0.323	0.394	0.480	0.564	0.679	0.742	0.906
Mean												
2003-2007	-	-	-	-	0.287	0.322	0.372	0.456	0.545	0.630	0.701	0.886
1982-2007	-	-	-	-	0.287	0.340	0.412	0.520	0.633	0.773	0.890	1.170

Table G6. The number of observed trips, witch flounder discards (in metric tons) and coefficient of variation (CV) by the large-mesh otter trawl, small-mesh otter trawl and northern shrimp trawl fleets, 1982 – 2007.

	Large-mesh Otter Trawl			Small-mesh Otter Trawl			Shrimp Trawl		Total used in VPA	
YEAR	trips	mt	CV	trips	mt	CV	trips	mt	mt	CV
1982		42						6	48	
1983		149						13	162	
1984		89						11	100	
1985		49						12	61	
1986		12						13	25	
1987		26						22	47	
1988		26						34	60	
1989	55	56	0.46	45	2	0.44	36	19	76	0.45
1990	46	55	0.41	22	12	0.92	47	29	96	0.37
1991	72	184	0.42	41	3	0.87	62	29	217	0.41
1992	62	193	0.31	28	1	5.29	110	18	212	0.31
1993	29	215	0.39	11	0	3.41	104	9	224	0.39
1994	25	318	0.50	2	*5*		98	16	339	0.49
1995	48	159	0.16	34	10	0.25	88	34	203	0.15
1996	23	144	0.56	44	50	0.38	50	14	207	0.43
1997	19	191	0.38	7	5	13.15	28	13	209	0.49
1998	9	117	1.51	1	*62*			18	198	0.99
1999	32	146	0.53	16	120	0.67		12	277	0.42
2000	93	126	0.24	7	44	0.61		8	178	0.24
2001	139	239	0.17	14	63	0.37		4	307	0.16
2002	205	211	0.18	51	13	0.84		1	225	0.18
2003	372	281	0.12	43	53	0.22	15	0	334	0.11
2004	425	288	0.12	96	20	0.39	12	0	309	0.11
2005	1097	126	0.07	157	24	0.18	17	0	150	0.07
2006	519	72	0.09	48	15	0.34	20	1	87	0.10
2007	526	48	0.15	32	49	0.28	14	2	97	0.16

Due to small sample sizes in 1994 and 1998 in the small-mesh otter trawl fleet, the boxed values represent an average discard weight of the preceding and following years.

Table G7. Witch flounder discards at age (thousands of fish) from the large-mesh otter trawl and northern shrimp trawl fleets, 1982 - 2007.

Discards in Numbers (1000's) at Age

	Age											
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11+**
1982	0.030	0.060	1.719	72.590	237.874	87.770	21.102	0.000	0.000	0.000	0.000	0.000
1983	0.000	0.020	4.283	117.310	577.567	487.062	7.822	0.000	0.000	0.000	0.000	0.000
1984	0.000	0.334	0.884	56.013	453.907	194.004	5.286	0.000	0.000	0.000	0.000	0.000
1985	0.000	0.338	3.470	123.580	191.020	91.412	2.437	0.000	0.000	0.000	0.000	0.000
1986	0.000	0.532	3.859	16.649	78.567	75.193	2.745	0.000	0.000	0.000	0.000	0.000
1987	2.084	18.918	79.933	22.250	99.755	145.459	4.060	0.000	0.000	0.000	0.000	0.000
1988	0.417	14.659	130.291	600.271	89.115	88.302	3.567	0.000	0.000	0.000	0.000	0.000
1989	0.737	11.107	52.609	89.660	303.471	104.106	0.000	0.000	0.396	0.000	0.000	0.000
1990	1.187	5.176	116.983	303.232	200.684	200.585	0.000	0.000	0.000	0.000	0.000	0.000
1991	2.958	17.794	78.958	496.264	450.987	348.944	129.780	0.000	0.000	0.000	0.000	0.000
1992	2.706	43.408	136.916	161.856	460.095	273.947	130.037	12.009	0.000	0.000	0.000	0.000
1993	112.060	78.837	108.179	86.473	584.190	395.440	5.872	2.206	0.000	0.000	0.000	0.000
1994	8.058	1368.463	498.455	67.221	439.211	629.888	59.437	119.237	2.287	2.786	0.000	7.859
1995	2.680	49.949	658.585	640.868	354.387	278.294	108.050	2.413	0.993	0.284	0.000	0.000
1996	5.206	32.683	51.477	141.832	327.193	418.024	61.442	0.000	0.000	0.000	0.000	0.000
1997	8.683	74.911	106.806	124.289	485.868	366.753	155.794	5.404	1.367	0.781	0.000	0.248
1998	49.780	392.321	278.498	220.996	283.455	240.982	70.956	10.156	0.318	0.238	0.000	0.000
1999	32.110	253.018	188.874	146.512	275.888	340.571	51.780	15.455	1.912	0.804	0.000	0.000
2000	21.610	169.950	121.192	122.168	291.153	297.891	74.732	17.516	2.878	0.000	0.000	0.000
2001	12.330	96.960	66.280	65.071	310.455	645.812	176.741	43.068	0.143	0.143	0.000	0.000
2002	2.320	19.121	15.755	32.539	406.974	471.164	125.103	34.891	5.906	2.781	1.127	1.068
2003	0.000	1.429	6.686	31.990	226.211	585.743	379.425	120.428	23.726	6.433	1.328	1.408
2004	0.000	0.148	9.622	32.951	169.061	476.762	383.720	116.846	31.664	15.111	13.510	7.967
2005	0.000	5.920	14.598	15.318	109.137	196.146	158.955	53.816	9.365	4.596	1.313	0.854
2006	0.000	2.598	20.379	47.230	36.226	61.067	136.839	36.599	9.802	3.726	2.121	1.770
2007	0.000	2.072	19.077	69.653	69.752	52.922	37.439	18.101	1.989	1.884	0.000	0.539

Table G8. Witch flounder discard mean weight (kg) at age in the large-mesh otter trawl and northern shrimp trawl fleets, 1982 - 2007.

Discards Mean Weight (kg) at Age

						Age						
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11+**
1982	0.000	0.002	0.038	0.048	0.126	0.127	0.181					
1983		0.009	0.038	0.064	0.130	0.158	0.248					
1984		0.017	0.040	0.053	0.141	0.162	0.253					
1985		0.017	0.023	0.128	0.153	0.166	0.231					
1986		0.017	0.026	0.090	0.125	0.173	0.229					
1987	0.006	0.015	0.033	0.081	0.125	0.201	0.232					
1988	0.004	0.006	0.017	0.045	0.142	0.200	0.276					
1989	0.010	0.012	0.032	0.058	0.145	0.225						
1990	0.004	0.010	0.032	0.049	0.134	0.191						
1991	0.004	0.014	0.038	0.057	0.154	0.235	0.239					
1992	0.003	0.007	0.021	0.067	0.178	0.264	0.292					
1993	0.003	0.009	0.022	0.096	0.199	0.235	0.316					
1994	0.005	0.004	0.019	0.083	0.179	0.226	0.364					
1995	0.005	0.007	0.025	0.052	0.151	0.222	0.253	0.473	0.595	0.702		
1996	0.004	0.019	0.031	0.064	0.134	0.208	0.251					
1997	0.004	0.023	0.034	0.065	0.157	0.197	0.245	0.498	0.471	0.702		
1998	0.003	0.006	0.024	0.061	0.161	0.203	0.222	0.230	0.355	0.370		
1999	0.003	0.006	0.024	0.067	0.162	0.219	0.283	0.407	0.423	0.495		
2000	0.003	0.006	0.025	0.070	0.146	0.185	0.253	0.238	0.256			
2001	0.003	0.006	0.023	0.084	0.166	0.207	0.227	0.257	0.309	0.309		
2002	0.003	0.007	0.030	0.099	0.172	0.201	0.231	0.259	0.427	0.556	0.566	0.404
2003		0.008	0.039	0.069	0.136	0.195	0.237	0.263	0.317	0.416	0.422	0.681
2004		0.009	0.053	0.099	0.156	0.205	0.241	0.289	0.407	0.527	0.510	0.776
2005		0.020	0.065	0.114	0.171	0.211	0.251	0.299	0.390	0.486	0.504	0.754
2006		0.012	0.050	0.097	0.163	0.203	0.232	0.271	0.343	0.351	0.523	0.694
2007		0.015	0.038	0.109	0.177	0.220	0.245	0.304	0.449	0.607		0.816
mean												
2003-2007		0.013	0.049	0.097	0.161	0.207	0.241	0.285	0.381	0.477	0.490	0.744
1982-2007	0.004	0.011	0.032	0.076	0.153	0.202	0.251	0.316	0.395	0.502	0.505	0.687

Table G9. Total USA commercial catch [landings + shrimp trawl discards + small-mesh otter trawl discards + large-mesh otter trawl discards] in numbers (thousands of fish) at age of witch flounder, 1982 - 2007.

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

	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	0.74	11.12	52.66	89.74	311.05	153.94	314.62	760.05	883.33	349.97	123.50	348.32
1990	1.20	5.22	117.92	305.65	385.30	781.09	257.65	276.04	474.83	336.59	82.00	178.91
1991	2.96	17.82	79.08	497.05	631.52	1083.53	650.24	236.14	244.94	292.57	314.06	258.18
1992	2.71	43.43	137.00	161.96	970.00	1114.06	1066.18	729.44	201.76	177.99	120.11	377.24
1993	112.07	78.85	108.19	86.48	1006.47	1418.48	923.63	599.46	585.62	218.79	278.56	390.52
1994	8.07	1370.81	499.31	67.34	641.95	2065.25	1350.16	949.10	199.65	543.77	113.87	333.27
1995	2.69	50.16	661.31	643.52	379.64	1045.61	1712.55	854.64	269.56	97.91	270.61	157.49
1996	5.32	33.40	52.61	144.96	381.21	905.28	1354.51	1462.04	269.04	220.23	58.31	116.13
1997	8.70	75.09	107.06	124.59	699.82	897.06	1208.59	1022.33	594.36	84.16	49.93	70.53
1998	51.34	404.65	287.25	227.94	311.02	751.85	1324.83	1643.24	382.48	146.04	16.03	72.51
1999	33.80	266.33	198.81	154.22	485.29	975.04	1519.49	1256.56	805.31	265.33	33.23	57.22
2000	21.98	172.82	123.24	124.23	372.75	568.90	1167.10	1717.48	1023.95	567.53	94.70	238.57
2001	12.57	98.84	67.57	66.33	335.65	1045.64	1129.50	1760.21	1483.88	644.90	435.77	315.59
2002	2.33	19.19	15.82	32.66	578.26	1124.13	1363.56	2150.52	1280.80	645.27	95.59	202.99
2003	0.00	1.45	6.79	32.49	287.43	1120.69	1627.05	1910.69	1583.63	759.14	441.73	353.87
2004	0.00	0.00	9.68	33.16	359.88	1180.74	1615.10	1530.13	1161.57	805.24	328.99	294.89
2005	0.00	5.97	14.73	15.45	185.87	841.30	1877.55	1815.86	835.41	416.97	238.02	134.36
2006	0.00	2.62	20.54	47.60	72.99	240.31	713.96	1567.83	886.04	362.44	135.77	75.38
2007	0.00	2.16	19.92	72.72	88.52	105.97	268.72	907.71	622.58	176.68	101.14	45.11

Table G10. USA commercial catch mean weight (kg) at age of witch flounder, 1982 - 2007.

USA Commerical Catch Mean Weight (kg) at Age

					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	0.010	0.012	0.032	0.058	0.147	0.263	0.425	0.574	0.682	0.818	0.968	1.358
1990	0.004	0.010	0.032	0.049	0.217	0.289	0.438	0.586	0.688	0.849	1.049	1.454
1991	0.004	0.014	0.038	0.057	0.192	0.327	0.402	0.578	0.702	0.836	0.974	1.420
1992	0.003	0.007	0.021	0.067	0.257	0.354	0.439	0.610	0.739	0.822	0.882	1.243
1993	0.003	0.009	0.022	0.096	0.238	0.328	0.431	0.534	0.666	0.882	1.023	1.335
1994	0.005	0.004	0.019	0.083	0.219	0.317	0.427	0.527	0.690	0.833	0.909	1.264
1995	0.005	0.007	0.025	0.052	0.160	0.328	0.436	0.561	0.690	0.910	0.974	1.243
1996	0.004	0.019	0.031	0.064	0.149	0.286	0.426	0.554	0.708	0.856	0.974	1.232
1997	0.004	0.023	0.034	0.065	0.206	0.291	0.386	0.495	0.628	0.869	1.037	1.291
1998	0.003	0.006	0.024	0.061	0.165	0.289	0.373	0.490	0.585	0.870	0.978	1.206
1999	0.003	0.006	0.024	0.067	0.228	0.305	0.402	0.515	0.584	0.628	0.917	0.872
2000	0.003	0.006	0.025	0.070	0.182	0.251	0.368	0.453	0.534	0.624	0.704	0.915
2001	0.003	0.006	0.023	0.084	0.173	0.250	0.359	0.463	0.550	0.645	0.647	0.840
2002	0.003	0.007	0.030	0.099	0.226	0.284	0.399	0.473	0.552	0.652	0.823	0.938
2003		0.008	0.039	0.069	0.164	0.251	0.327	0.422	0.504	0.566	0.620	0.809
2004			0.053	0.099	0.226	0.272	0.338	0.439	0.539	0.611	0.690	0.870
2005		0.020	0.065	0.114	0.220	0.300	0.361	0.445	0.556	0.632	0.724	0.908
2006		0.012	0.050	0.097	0.227	0.295	0.345	0.460	0.549	0.652	0.716	0.927
2007		0.015	0.038	0.109	0.198	0.269	0.372	0.476	0.564	0.678	0.742	0.905
mean												
2003-2007		0.014	0.049	0.097	0.207	0.277	0.349	0.448	0.542	0.628	0.698	0.884
1982-2007	0.004	0.011	0.032	0.087	0.204	0.296	0.400	0.518	0.632	0.772	0.890	1.170

Table G11. 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), 1963-2007, spring 2008 provisional.

	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	2.09	44.2	0.724
1965	-	-	-	-	3.94	2.29	40.6	0.580
1966	-	-	-	-	7.89	4.61	41.2	0.585
1967	-	-	-	-	3.00	1.99	43.7	0.666
1968	4.71	3.27	42.3	0.693	4.82	3.52	44.8	0.731
1969	3.73	2.59	45.3	0.695	5.81	4.21	43.5	0.725
1970	6.39	4.50	44.7	0.705	4.89	3.68	45.0	0.753
1971	2.74	2.04	46.5	0.747	4.32	2.96	42.1	0.686
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	5.05	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	2.33	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	5.10	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	5.91	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	0.170	7.94	1.71	32.3	0.216
2002	8.10	1.61	31.4	0.199	4.31	1.06	33.2	0.246
2003	5.20	1.30	34.2	0.250	2.66	0.79	35.4	0.298
2004	3.80	1.08	35.5	0.283	3.82	1.03	33.3	0.271
2005	3.36	0.89	34.6	0.265	1.93	0.38	27.8	0.197
2006	3.09	0.72	32.2	0.235	2.03	0.46	30.5	0.226
2007	2.37	0.58	32.9	0.245	2.74	0.57	31.6	0.208
2008	7.45	1.40	31.3	0.188				

No significant survey conversion factors for witch flounder.

Table G12. Stratified mean number per tow at age of witch flounder in NEFSC bottom trawl spring and autumn surveys (Strata 22-30, 36-40), 1980 – 2007, 2008 provisional.

	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
2006	0.000	0.043	0.460	0.347	0.138	0.207	0.683	0.568	0.410	0.145	0.069	0.015	0.000	0.000	0.000	3.087
2007	0.000	0.000	0.178	0.571	0.263	0.241	0.228	0.546	0.154	0.158	0.000	0.031	0.000	0.000	0.000	2.370
2008	0.000	0.011	0.372	0.847	2.833	1.341	0.646	0.724	0.550	0.088	0.036	0.000	0.000	0.000	0.000	7.448

Table G12 continued. Stratified mean number per tow at age of witch flounder.

	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
2005	0.132	0.635	0.087	0.023	0.131	0.181	0.269	0.340	0.055	0.052	0.012	0.000	0.000	0.016	0.000	1.933
2006	0.066	0.103	0.540	0.322	0.046	0.104	0.298	0.286	0.138	0.071	0.042	0.014	0.000	0.000	0.000	2.030
2007	0.000	0.065	0.162	1.206	0.478	0.188	0.220	0.261	0.069	0.078	0.000	0.000	0.014	0.000	0.000	2.740

Table G13. Parameter estimates (with coefficient of variation) and estimates of terminal F from ADAPT VPA formulations for witch flounder, stock size (N) in '000 of fish.

	GARM 2005 BASE RUN	GARM 2008 BASE RUN	GARM 2008 SPLIT RUN
Software	NFT 231	NFT VPA 2.7.7	NFT VPA 2.7.7
Catch-At-Age	1982-2004 3-11+	1982-2007 3-11+	1982-2007 3-11+
Est.Ages	3-10	3-10	3-10
NMFS-s	3-11+	3-11+	3-11+
NMFS-a	3-11+	3-11+	3-11+
Residual Sum Sq.	322.2	378.1	324.1
Mean Sq.Residual	0.811	0.851	0.730
N3 (cv)	3,902 (.65)	26,824 (.67)	11,992 (.63)
N4 (cv)	4,053 (.46)	41,562 (.47)	22,123 (.45)
N5 (cv)	9,206 (.39)	9,973 (.39)	5,433 (.37)
N6 (cv)	14,614 (.35)	2,239 (.35)	1,220 (.34)
N7 (cv)	19,943 (.32)	2,630 (.34)	1,442 (.35)
N8 (cv)	17,315 (.30)	3,903 (.36)	2,074 (.39)
N9 (cv)	8,815 (.27)	2,031 (.38)	957 (.44)
N10 (cv)	2,245 (.37)	4,367 (.26)	1,354 (.36)
F 3	0.006	0.002	0.003
F 4	0.032	0.008	0.015
F 5	0.066	0.043	0.077
F 6	0.069	0.090	0.159
F 7	0.077	0.195	0.339
F 8	0.114	0.249	0.470
F 9	0.284	0.037	0.114
F10	0.199	0.143	0.292
F11+	0.199	0.143	0.292
Avg F 8-9	0.199	0.143 (.27)	0.292 (.27)
SSB (mt)	21,175	7,354 (.14)	3,434 (.15)
Age 3 in terminal yr	4,737	48,367	25,781

SPLIT survey indices are: 1982-1994 and 1995 - onward.

Table G14. Summary of witch flounder spawning stock biomass (mt), fully recruited fishing mortality (F8-9), and recruitment (age 3, millions fish) and year class from VPA **BASE RUN**, 1982 to 2007.

Year	SSB (mt)	Avg F8-9	Recruits Age 3	Year Class
1982	16,903	0.26	15.409	1979
1983	13,439	0.50	17.706	1980
1984	11,543	0.63	16.371	1981
1985	10,433	0.68	7.670	1982
1986	9,550	0.50	5.438	1983
1987	8,951	0.60	3.137	1984
1988	8,313	0.70	9.302	1985
1989	7,361	0.44	6.070	1986
1990	6,334	0.25	7.542	1987
1991	6,952	0.25	8.660	1988
1992	7,054	0.23	12.162	1989
1993	5,833	0.45	8.920	1990
1994	4,352	0.60	13.237	1991
1995	4,073	0.62	11.907	1992
1996	3,888	1.14	16.094	1993
1997	4,179	1.07	14.561	1994
1998	5,242	0.65	15.835	1995
1999	6,242	0.53	14.609	1996
2000	7,109	0.55	13.814	1997
2001	7,256	0.86	23.664	1998
2002	7,213	0.48	14.740	1999
2003	7,249	0.60	12.951	2000
2004	6,733	0.58	5.864	2001
2005	7,351	0.36	3.774	2002
2006	7,100	0.21	13.624	2003
2007	7,354	0.14	48.367	2004
			26.825	2005
min	3,888	0.14	3.137	
max	16,903	1.14	48.367	
mean	7,616	0.53	13.639	
geomean			11.548	
median			13.237	

Table G15. Mohn rho statistic (average of relative differences) for fishing mortality (F 8-9), spawning stock biomass (SSB) and Age 3 recruits (Age 3) for the VPA BASE RUN and VPA SPLIT RUN.

		2000	2001	2002	2003	2004	2005	2006	Mean
BASE	F 8-9	0.13	-0.36	-0.13	-0.42	-0.45	-0.57	-0.42	**-0.31**
	SSB	0.50	0.85	1.34	1.38	1.36	0.65	0.31	**0.91**
	Age 3	2.05	1.92	0.45	-0.24	0.00	-0.05	-0.17	**0.56**
SPLIT	F 8-9	0.96	0.03	0.34	-0.18	-0.35	-0.48	-0.48	**-0.02**
	SSB	-0.24	0.19	0.57	0.76	1.01	0.43	0.31	**0.43**
	Age 3	0.44	0.35	-0.18	-0.54	-0.29	-0.32	-0.36	**-0.13**

Table G16. Summary of witch flounder spawning stock biomass (mt), fully recruited fishing mortality (F8-9), and recruitment (age 3, millions fish) and year class from VPA **SPLIT RUN**, 1982 to 2007.

Year	SSB (mt)	Avg F8-9	Recruits Age 3	Year Class
1982	16,903	0.26	15.409	1979
1983	13,439	0.50	17.706	1980
1984	11,543	0.63	16.371	1981
1985	10,433	0.68	7.670	1982
1986	9,550	0.50	5.437	1983
1987	8,951	0.60	3.137	1984
1988	8,312	0.70	9.301	1985
1989	7,360	0.44	6.070	1986
1990	6,333	0.25	7.541	1987
1991	6,952	0.25	8.659	1988
1992	7,054	0.23	12.158	1989
1993	5,833	0.45	8.909	1990
1994	4,351	0.60	13.138	1991
1995	4,070	0.62	11.855	1992
1996	3,877	1.14	15.781	1993
1997	4,150	1.07	14.063	1994
1998	5,181	0.66	15.040	1995
1999	6,114	0.54	13.104	1996
2000	6,874	0.56	12.039	1997
2001	6,831	0.90	15.032	1998
2002	6,429	0.53	12.083	1999
2003	5,941	0.71	9.073	2000
2004	4,835	0.81	3.697	2001
2005	4,575	0.63	2.175	2002
2006	3,696	0.47	7.495	2003
2007	3,434	0.29	25.781	2004
			11.992	2005
min	3,434	0.23	2.175	
max	16,903	1.14	25.781	
mean	7,039	0.58	11.138	
geomean			9.805	
median			11.992	

Table G17. Estimates of beginning year stock size (‘000 of fish), instantaneous fishing mortality and spawning stock biomass (mt) for witch flounder estimated from the virtual population analysis, 1982-2007 VPA **SPLIT RUN**.

JAN-1 Population Numbers

AGE	1982	1983	1984	1985	1986
3	15409.	17706.	16371.	7670.	5437.
4	12176.	13086.	14927.	13955.	6487.
5	9564.	9495.	10017.	11491.	10922.
6	7830.	7115.	6766.	6771.	7932.
7	4290.	5376.	4669.	4218.	4041.
8	2752.	3077.	3160.	2648.	2225.
9	2102.	1763.	1747.	1344.	1132.
10	1101.	1440.	839.	862.	600.
11	7260.	4728.	3844.	2927.	2040.
Total	62485.	63786.	62340.	51884.	40818.

AGE	1987	1988	1989	1990	1991
3	3137.	9301.	6070.	7541.	8659.
4	4659.	2680.	7449.	5142.	6208.
5	5234.	3842.	2177.	6124.	4069.
6	7998.	4073.	3062.	1731.	4548.
7	4270.	5700.	2897.	2344.	1252.
8	2036.	2225.	3629.	1792.	1762.
9	1146.	951.	856.	2308.	1104.
10	594.	545.	449.	414.	1675.
11	1152.	1220.	1267.	904.	1377.
Total	30227.	30535.	27856.	28300.	30654.

AGE	1992	1993	1994	1995	1996
3	12158.	8909.	13138.	11855.	15781.
4	6993.	10314.	7588.	11245.	9607.
5	4759.	5121.	7946.	5936.	9327.
6	2502.	3067.	3099.	4933.	4143.
7	3313.	1173.	1788.	1426.	2667.
8	859.	2178.	459.	668.	445.
9	1290.	553.	1334.	211.	327.
10	680.	946.	275.	648.	92.
11	2136.	1326.	804.	377.	183.
Total	34689.	33586.	36429.	37299.	42572.

AGE	1997	1998	1999	2000	2001
3	14063.	15040.	13104.	12039.	15032.
4	13448.	11989.	12734.	11136.	10247.
5	7916.	10927.	10031.	10511.	9239.
6	7190.	5983.	8709.	7731.	8520.
7	2317.	5071.	3926.	6091.	5575.
8	955.	1054.	2850.	2221.	3658.
9	136.	279.	555.	1710.	970.
10	80.	40.	106.	234.	948.
11	113.	183.	182.	589.	687.
Total	46220.	50567.	52196.	52261.	54875.

JAN-1 Population Numbers

AGE	2002	2003	2004	2005	2006
3	12083.	9073.	3697.	2175.	7495.
4	12876.	10370.	7779.	3152.	1858.
5	8508.	10547.	8659.	6362.	2541.
6	6985.	6283.	8041.	6361.	4697.
7	6288.	4752.	3906.	5428.	3743.
8	3175.	3430.	2331.	1953.	2998.
9	1783.	1554.	1497.	940.	913.
10	246.	940.	640.	550.	425.
11	523.	753.	574.	310.	236.
Total	52467.	47701.	37124.	27231.	24906.

AGE	2007	2008
3	25781.	11992.
4	6407.	22123.
5	1531.	5433.
6	1964.	1220.
7	3383.	1442.
8	1779.	2074.
9	1763.	957.
10	452.	1354.
11	191.	414.
Total	43252.	47009.

Fishing Mortality Calculated

AGE	1982	1983	1984	1985	1986
3	0.0134	0.0207	0.0097	0.0175	0.0046
4	0.0987	0.1172	0.1116	0.0950	0.0646
5	0.1459	0.1888	0.2416	0.2206	0.1616
6	0.2261	0.2713	0.3226	0.3661	0.4693
7	0.1823	0.3813	0.4172	0.4894	0.5357
8	0.2953	0.4162	0.7050	0.6995	0.5132
9	0.2282	0.5928	0.5561	0.6571	0.4945
10	0.2657	0.4770	0.6494	0.6850	0.5069
11	0.2657	0.4770	0.6494	0.6850	0.5069

AGE	1987	1988	1989	1990	1991
3	0.0077	0.0720	0.0160	0.0446	0.0638
4	0.0428	0.0578	0.0460	0.0840	0.1158
5	0.1009	0.0769	0.0791	0.1475	0.3363
6	0.1887	0.1907	0.1171	0.1743	0.1668
7	0.5020	0.3014	0.3305	0.1354	0.2264
8	0.6110	0.8055	0.3026	0.3344	0.1618
9	0.5944	0.6000	0.5750	0.1704	0.3344
10	0.6050	0.7394	0.3492	0.2388	0.2248
11	0.6050	0.7394	0.3492	0.2388	0.2248

AGE	1992	1993	1994	1995	1996
3	0.0144	0.0105	0.0055	0.0602	0.0099
4	0.1614	0.1109	0.0954	0.0370	0.0436
5	0.2893	0.3523	0.3268	0.2097	0.1102
6	0.6079	0.3897	0.6265	0.4648	0.4311
7	0.2696	0.7880	0.8343	1.0151	0.8769
8	0.2904	0.3402	0.6252	0.5647	1.0313
9	0.1605	0.5501	0.5725	0.6824	1.2535
10	0.2104	0.3793	0.5857	0.5917	1.1195
11	0.2104	0.3793	0.5857	0.5917	1.1195

AGE	1997	1998	1999	2000	2001
3	0.0096	0.0165	0.0128	0.0112	0.0048
4	0.0576	0.0283	0.0419	0.0367	0.0359
5	0.1299	0.0769	0.1104	0.0600	0.1297
6	0.1991	0.2713	0.2075	0.1770	0.1537
7	0.6375	0.4263	0.4199	0.3600	0.4129
8	1.0825	0.4916	0.3609	0.6781	0.5688
9	1.0661	0.8187	0.7139	0.4393	1.2219
10	1.0804	0.5516	0.4106	0.5672	0.6747
11	1.0804	0.5516	0.4106	0.5672	0.6747

Fishing Mortality Calculated

AGE	2002	2003	2004	2005	2006
3	0.0029	0.0039	0.0097	0.0077	0.0069
4	0.0495	0.0303	0.0511	0.0656	0.0432
5	0.1532	0.1213	0.1585	0.1533	0.1073
6	0.2352	0.3253	0.2429	0.3804	0.1783
7	0.4560	0.5622	0.5430	0.4435	0.5939
8	0.5645	0.6792	0.7585	0.6108	0.3808
9	0.4901	0.7366	0.8515	0.6425	0.5528
10	0.5371	0.6968	0.7938	0.6210	0.4184
11	0.5371	0.6968	0.7938	0.6210	0.4184

AGE	2007
3	0.0030
4	0.0150
5	0.0774
6	0.1590
7	0.3393
8	0.4696
9	0.1140
10	0.2918
11	0.2918

Average Fishing Mortality For Ages 8- 9

Year	Average F	N Weighted	Biomass Wtd	Catch Wtd
1982	0.2618	0.2663	0.2630	0.2699
1983	0.5045	0.4805	0.4919	0.4921
1984	0.6306	0.6520	0.6454	0.6577
1985	0.6783	0.6852	0.6833	0.6857
1986	0.5039	0.5069	0.5060	0.5070
1987	0.6027	0.6050	0.6042	0.6051
1988	0.7027	0.7439	0.7349	0.7524
1989	0.4388	0.3546	0.3635	0.3799
1990	0.2524	0.2421	0.2345	0.2664
1991	0.2481	0.2283	0.2352	0.2558
1992	0.2254	0.2124	0.2078	0.2295
1993	0.4451	0.3827	0.3913	0.3973
1994	0.5988	0.5860	0.5840	0.5866
1995	0.6235	0.5930	0.5993	0.5961
1996	1.1424	1.1255	1.1364	1.1313
1997	1.0743	1.0804	1.0799	1.0805
1998	0.6551	0.5599	0.5787	0.5819
1999	0.5374	0.4185	0.4247	0.4484
2000	0.5587	0.5742	0.5659	0.5929
2001	0.8953	0.7057	0.7241	0.7666
2002	0.5273	0.5378	0.5348	0.5396
2003	0.7079	0.6971	0.6988	0.6978
2004	0.8050	0.7949	0.7983	0.7966
2005	0.6267	0.6211	0.6223	0.6214
2006	0.4668	0.4210	0.4274	0.4308
2007	0.2918	0.2926	0.2766	0.3910

Spawning Stock Biomass

AGE	1982	1983	1984	1985	1986
3	20.	21.	38.	8.	6.
4	107.	132.	185.	127.	91.
5	376.	459.	580.	685.	994.
6	1116.	1241.	1244.	1585.	1918.
7	1544.	1884.	1715.	1720.	1638.
8	1634.	1544.	1559.	1388.	1219.
9	1632.	1172.	1088.	878.	781.
10	949.	1207.	629.	666.	487.
11	9525.	5779.	4505.	3376.	2416.
Total	16903.	13439.	11542.	10433.	9550.

AGE	1987	1988	1989	1990	1991
3	13.	31.	16.	13.	16.
4	176.	143.	188.	111.	98.
5	846.	703.	329.	552.	380.
6	2475.	1301.	969.	406.	941.
7	1796.	2526.	1308.	1004.	497.
8	1084.	1161.	2038.	1007.	1009.
9	758.	629.	561.	1648.	757.
10	479.	423.	368.	360.	1417.
11	1324.	1395.	1583.	1232.	1837.
Total	8950.	8313.	7360.	6334.	6951.

AGE	1992	1993	1994	1995	1996
3	25.	22.	31.	11.	11.
4	137.	162.	137.	163.	98.
5	473.	479.	685.	629.	860.
6	585.	712.	652.	1291.	1167.
7	1362.	422.	622.	546.	1061.
8	501.	1228.	235.	354.	228.
9	921.	393.	872.	146.	199.
10	550.	794.	218.	516.	70.
11	2500.	1621.	899.	414.	183.
Total	7053.	5833.	4350.	4069.	3875.

AGE	1997	1998	1999	2000	2001
3	6.	18.	21.	26.	45.
4	104.	157.	204.	167.	164.
5	582.	976.	776.	801.	621.
6	1826.	1305.	1873.	1447.	1410.
7	905.	1823.	1377.	1958.	1655.
8	459.	500.	1344.	943.	1474.
9	87.	173.	288.	917.	439.
10	62.	33.	86.	137.	520.
11	119.	196.	145.	478.	503.
Total	4150.	5181.	6113.	6874.	6831.

Spawning Stock Biomass

AGE	2002	2003	2004	2005	2006
3	72.	30.	26.	21.	45.
4	292.	218.	179.	99.	46.
5	574.	744.	556.	551.	180.
6	1096.	867.	1075.	949.	644.
7	1686.	1177.	870.	1297.	849.
8	1225.	1196.	755.	680.	1058.
9	892.	682.	626.	428.	430.
10	155.	498.	321.	302.	245.
11	437.	529.	427.	248.	199.
Total	6431.	5942.	4834.	4574.	3695.

AGE	2007
3	172.
4	130.
5	98.
6	272.
7	783.
8	637.
9	906.
10	275.
11	161.
Total	3434.

Table G18. Witch flounder input vectors for biological reference points (yield and spawning biomass per recruit analyses and long-term stochastic projections).

BASE RUN

Age	Partial recruitment	Sel. on M	Mean Stock wts	Mean Catch wts	Mean SpStock wts	Maturity
3	0.009	1	0.068	0.097	0.068	0.09
4	0.075	1	0.140	0.207	0.140	0.16
5	0.236	1	0.242	0.277	0.242	0.29
6	0.427	1	0.312	0.349	0.312	0.45
7	0.891	1	0.398	0.448	0.398	0.63
8	1.000	1	0.493	0.542	0.493	0.78
9	1.000	1	0.582	0.628	0.582	0.88
10	1.000	1	0.659	0.698	0.659	0.94
11+	1.000	1	0.884	0.884	0.884	1.00

SPLIT RUN

Age	Partial recruitment	Sel. on M	Mean Stock wts	Mean Catch wts	Mean SpStock wts	Maturity
3	0.009	1	0.068	0.097	0.068	0.09
4	0.076	1	0.140	0.207	0.140	0.16
5	0.225	1	0.242	0.277	0.242	0.29
6	0.427	1	0.312	0.349	0.312	0.45
7	0.849	1	0.398	0.448	0.398	0.63
8	1.000	1	0.493	0.542	0.493	0.78
9	1.000	1	0.582	0.628	0.582	0.88
10	1.000	1	0.659	0.698	0.659	0.94
11+	1.000	1	0.884	0.884	0.884	1.00

BASE RUN

year	Age - 3 ('000 fish)
1982	15,409
1983	17,706
1984	16,371
1985	7,670
1986	5,438
1987	3,137
1988	9,302
1989	6,070
1990	7,542
1991	8,660
1992	12,162
1993	8,920
1994	13,237
1995	11,907
1996	16,094
1997	14,561
1998	15,835
1999	14,609
2000	13,814
2001	23,664
2002	14,740
2003	12,951
2004	5,864
2005	3,774
2006	13,624
2007	48,367
2008	26,825
mean	13,639

SPLIT RUN

year	Age - 3 ('000 fish)
1982	15,409
1983	17,706
1984	16,371
1985	7,670
1986	5,437
1987	3,137
1988	9,301
1989	6,070
1990	7,541
1991	8,659
1992	12,158
1993	8,909
1994	13,138
1995	11,855
1996	15,781
1997	14,063
1998	15,040
1999	13,104
2000	12,039
2001	15,032
2002	12,083
2003	9,073
2004	3,697
2005	2,175
2006	7,495
2007	25,781
2008	11,992
mean	11,138

Table G19. Witch flounder yield and spawning stock biomass per recruit results and corresponding biological reference points. For SARC37, the F_{MSY}, SSB_{MSY} and MSY were based on yield and spawning stock biomass per recruit and mean 3 age recruitment.

For GARM 2008, the F_{MSY} = F40%MSP is based on yield per recruit analyses, while the SSB_{MSY} and MSY estimates are based on long-term stochastic projections using the VPA BASE RUN and the VPA SPLIT RUN. (*Note: mean age 3 recruitment values are not used in the calculations of GARM2008 SSB_{MSY} and MSY estimates*).

				Mean Age 3	Y/R and SSB/R		Agepro Projections	
	Fmsy F40%	Y/R (kg)	SSB/R (kg)	Recruitment (fish,millions)	SSBmsy (mt)	MSY (mt)	SSBmsy (mt)	MSY (mt)
SARC 37	0.23	0.2232	1.2882	19.6	25,248	4,375		
GARM 2008 (using data through 2006)								
BASE RUN	0.22	0.1982	0.9890	13.2			12,687	2,578
SPLIT RUN	0.22	0.1987	0.9889	10.9			10,863	2,195
GARM 2008								
BASE RUN	0.20	0.1939	0.9347	13.6			12,180	2,528
SPLIT RUN	0.20	0.1943	0.9346	11.1			11,447	2,352

Table G20. Short-term projected median estimates of catch (mt) and spawning stock biomass (mt) of witch flounder in 2009 under three fishing mortality scenarios: F status quo, F_{MSY} and F-rebuild based on the VPA **SPLIT RUN**. Projections assumed 2008 catches = 2007 catches; initial 2008 stock sizes for ages 3 to 11+ are from the calibrated VPA, average 2003-2007 partial recruitment, average 2003-2007 mean weights and maturation ogive representing 2004-2008 maturities are given below.

Projection input vectors:

age	VPA SPLIT RUN partial recruitment	Selectivity On M	Stock wts	Catch wts	Spawning wts	2006 Maturity
3	0.009	1	0.0678	0.0975	0.0678	0.09
4	0.076	1	0.1399	0.2067	0.1399	0.16
5	0.225	1	0.2423	0.2773	0.2423	0.29
6	0.427	1	0.3125	0.3487	0.3125	0.45
7	0.849	1	0.3979	0.4484	0.3979	0.63
8	1.000	1	0.4926	0.5424	0.4926	0.78
9	1.000	1	0.5820	0.6279	0.5820	0.88
10	1.000	1	0.6588	0.6985	0.6588	0.94
11+	1.000	1	0.8838	0.8838	0.8838	1.00

Projection results based on SPLIT RUN:

2007			2008		2009	
Catch	SSB	F	Catch	SSB	Catch	SSB
1,172	3,434	Fsq= 0.29	*1,172*	3,876	1,297	4,792
		Fmsy= 0.20			921	4,838
		Frebuild = 0.194			896	4,853

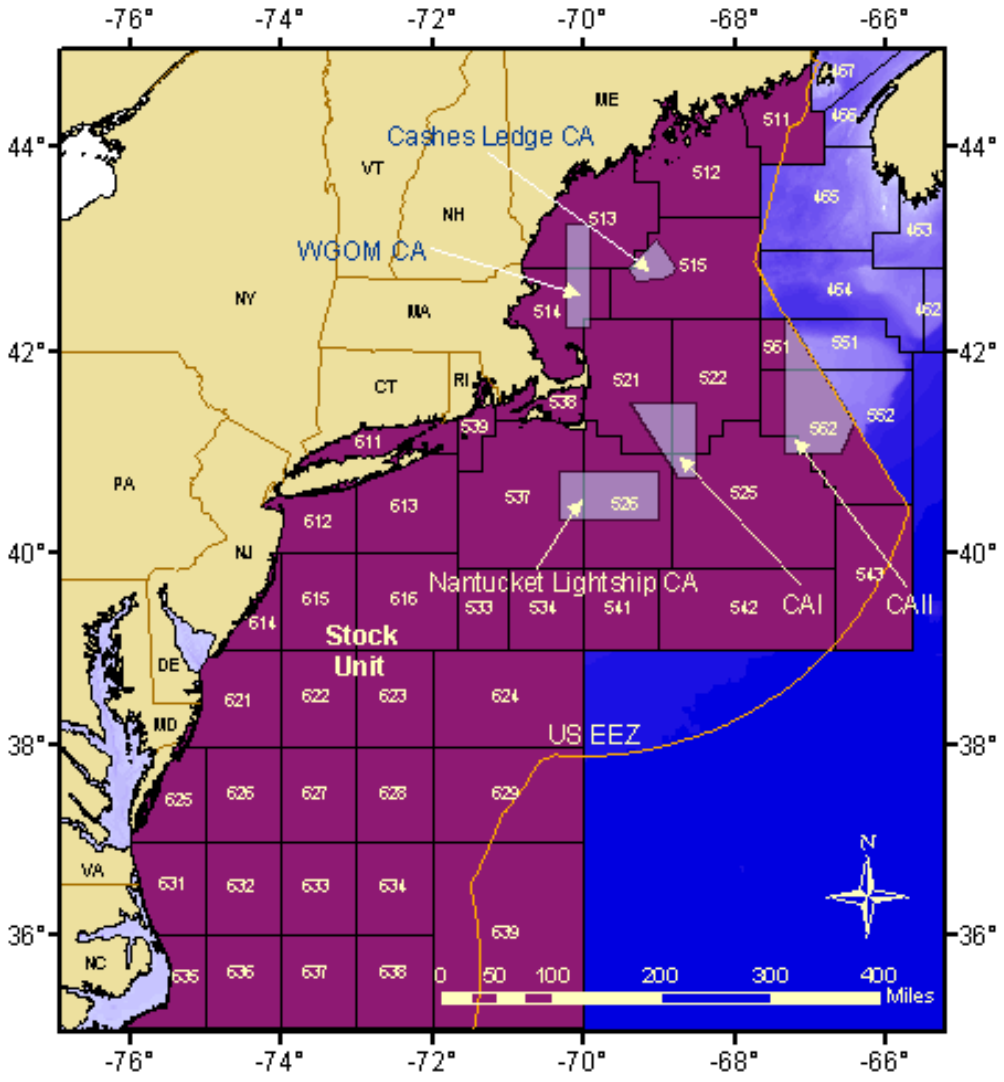

Figure G1. Statistical areas used to define the witch flounder stock.

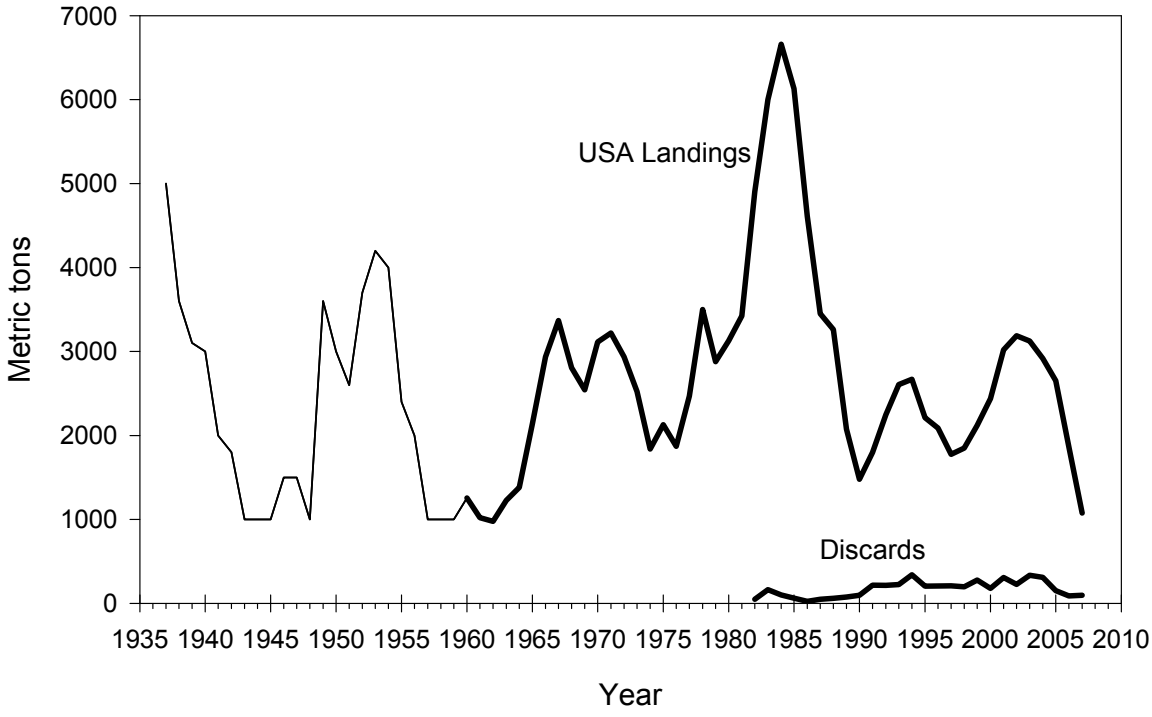

Figure G2. Historical USA witch flounder landings (mt), excluding USA landings from the Grand Banks in the mid-1980's. The thin line represents provisional landings data taken from Lange and Lux (1978). Discards are from the northern shrimp, small-mesh (<5.5 inch) otter trawl and large-mesh (>5.5 inch) otter trawl fisheries.

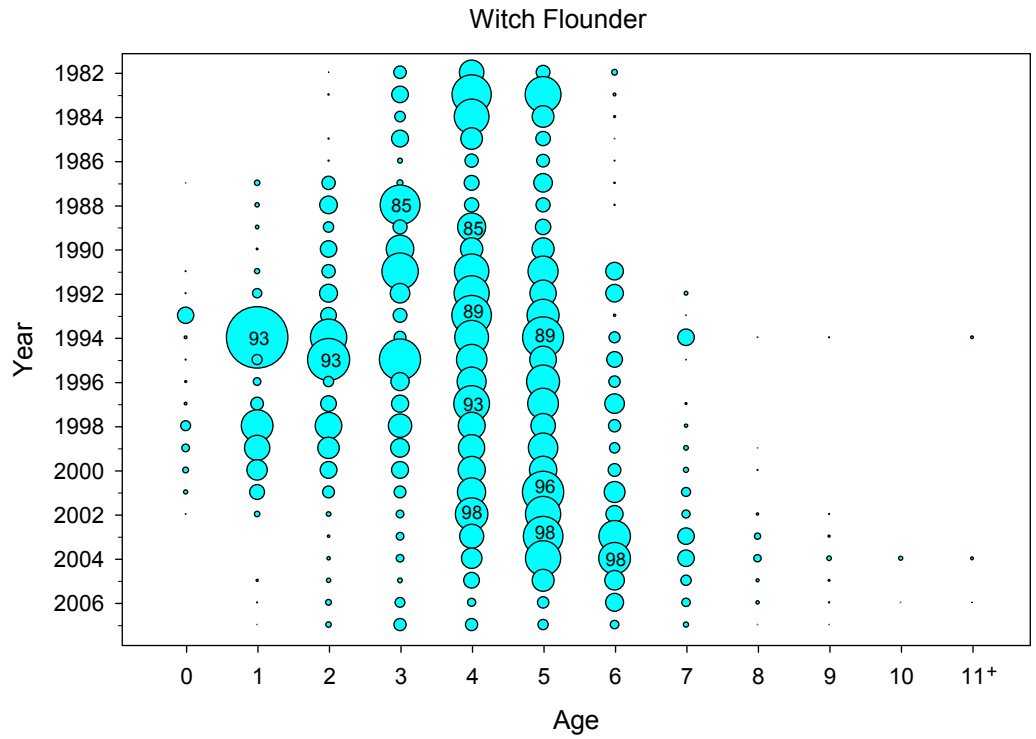

Figure G3. Witch flounder discards at age (in numbers) from the large-mesh otter trawl and northern shrimp trawl fleets, 1982 to 2007; selected cohorts are labeled.

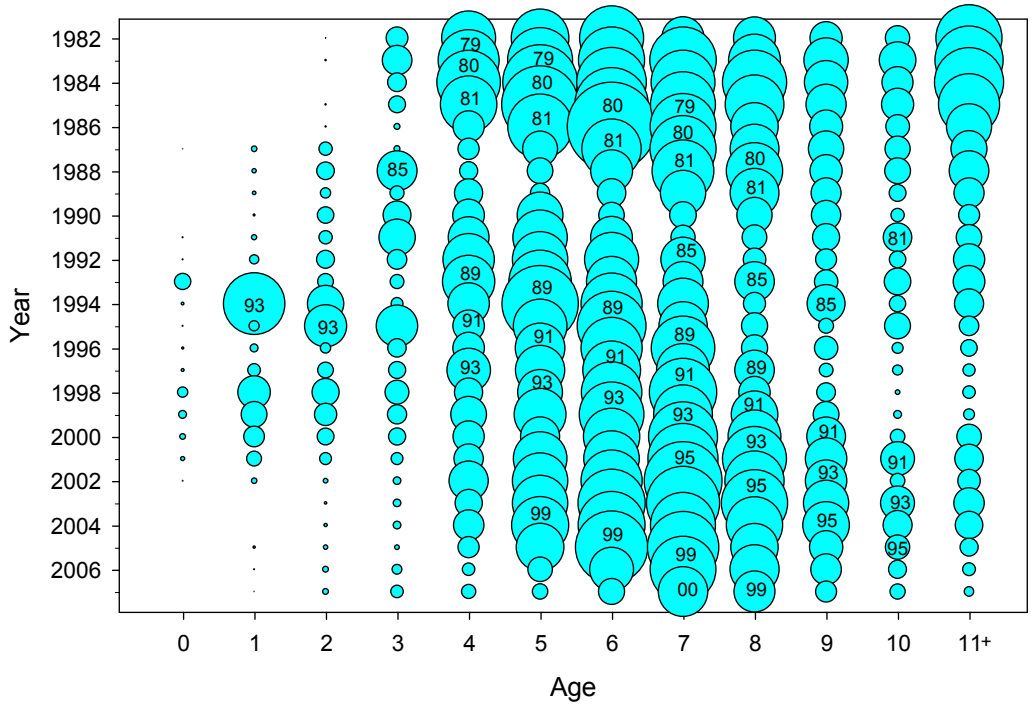

Figure G4. Witch flounder catch at age (in numbers), 1982-2007; selected cohorts are labeled.

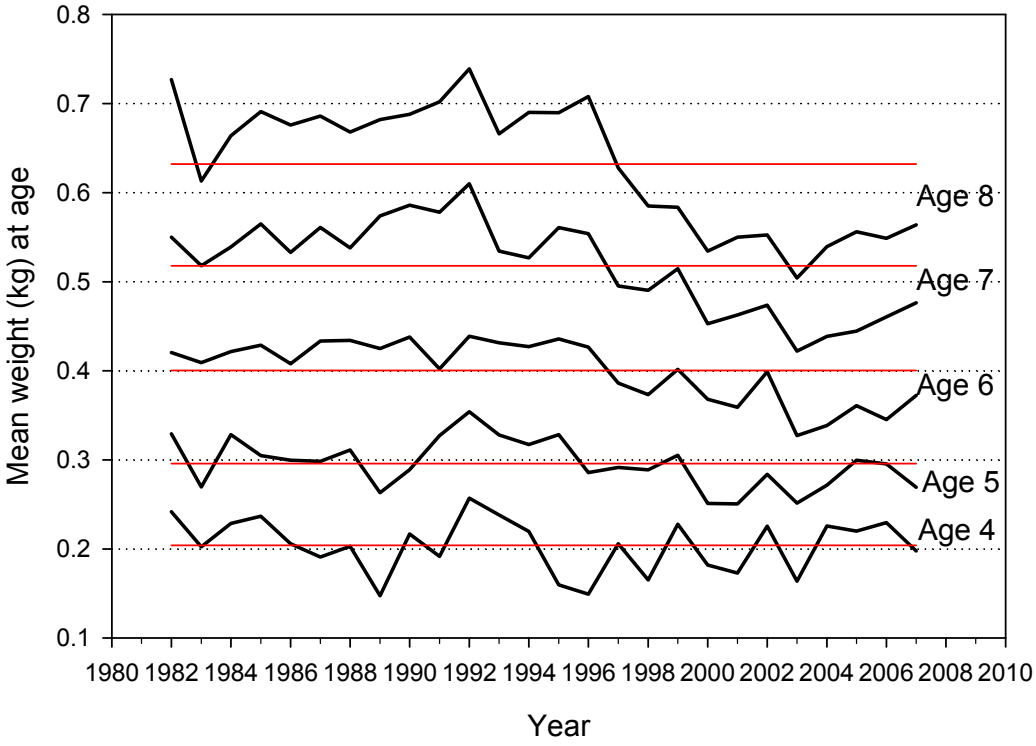

Figure G5. Witch flounder mean weight at age in the catch, 1982 -2007. Horizontal red line represents the 1982-2007 average for each age.

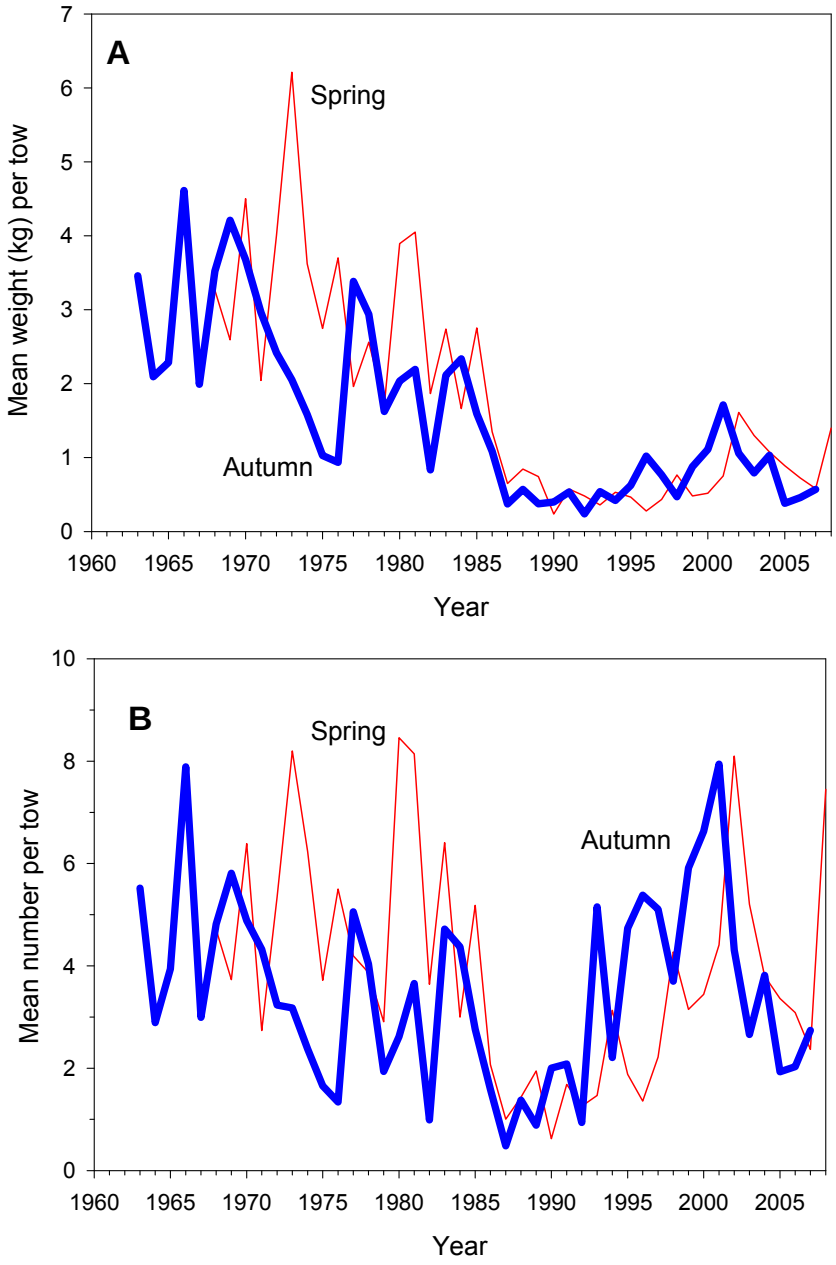

Figure G6. Stratified mean weight (kg) per tow (A) and mean number per tow (B) of witch flounder in the NEFSC spring and autumn bottom trawl surveys, 1963-2007, provisional spring 2008.

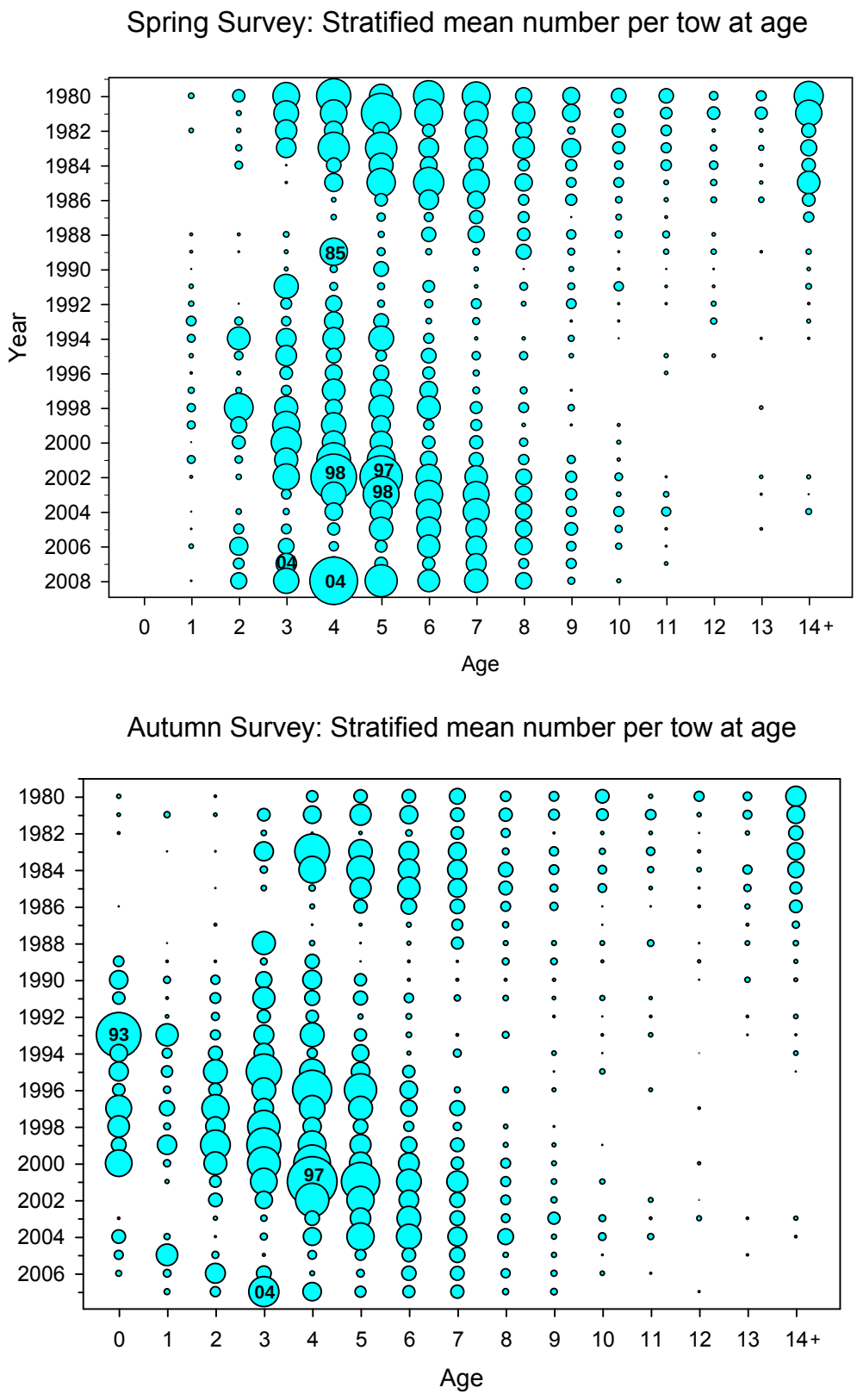

Figure G7. Stratified mean number of witch flounder per tow at age from NEFSC spring (top) and autumn (bottom) surveys, 1982- 2007, provisional spring 2008.

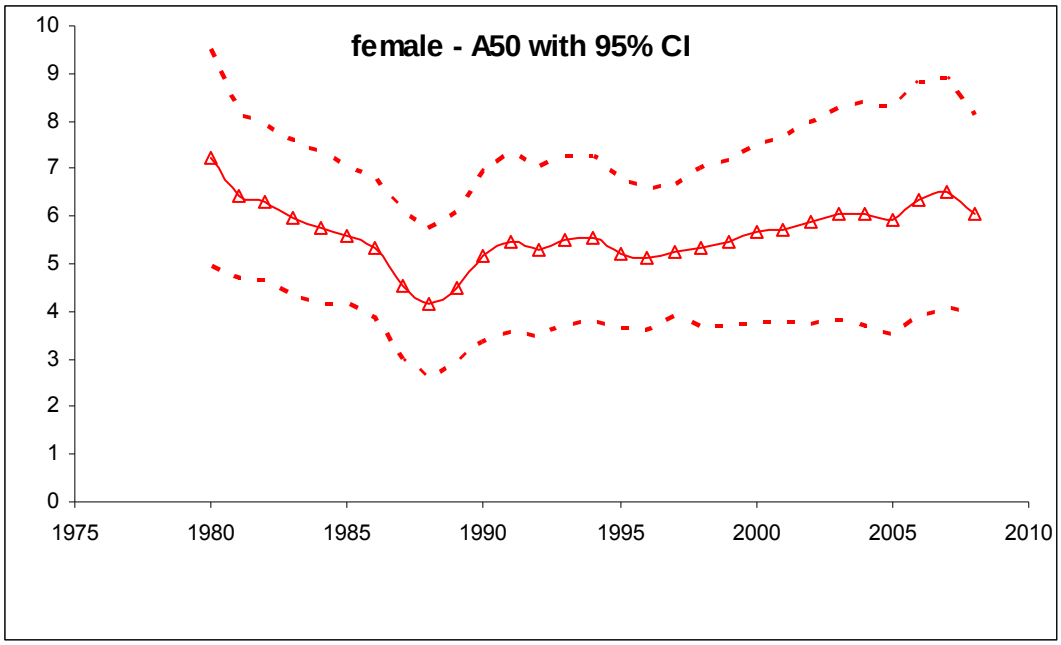

Figure G8. Annual estimates of median age (A50) of female witch flounder maturity derived from a five-year moving time block of maturity observations collected during the NEFSC spring survey, 1980 – 2008.

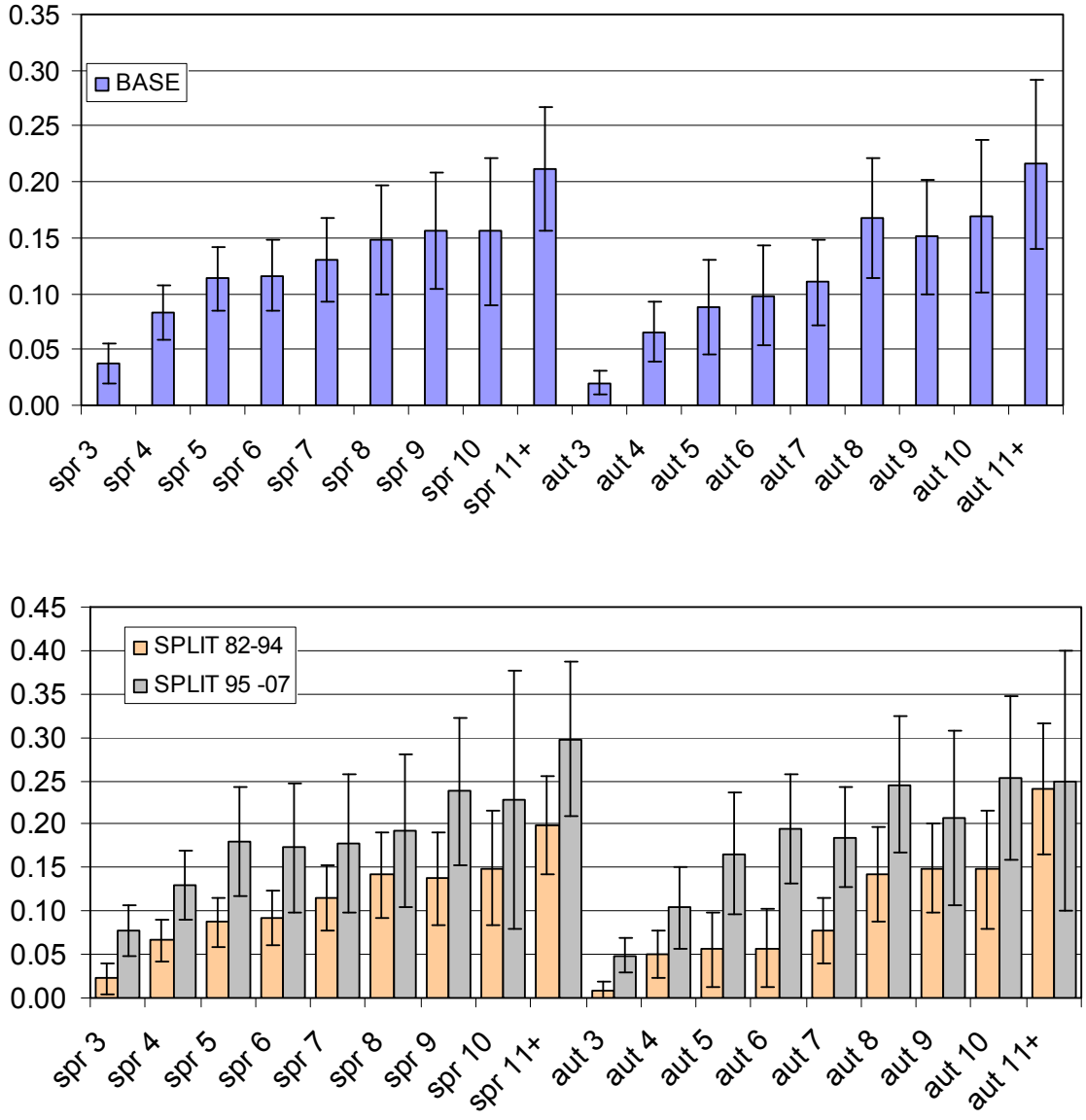

Figure G9. NEFSC swept-area survey catchabilities (q) by age (3 to 11+) and season (spring and autumn) from the VPA BASE RUN (top) and the VPA SPLIT RUN (bottom; survey tuning indices split between 1994 and 1995).

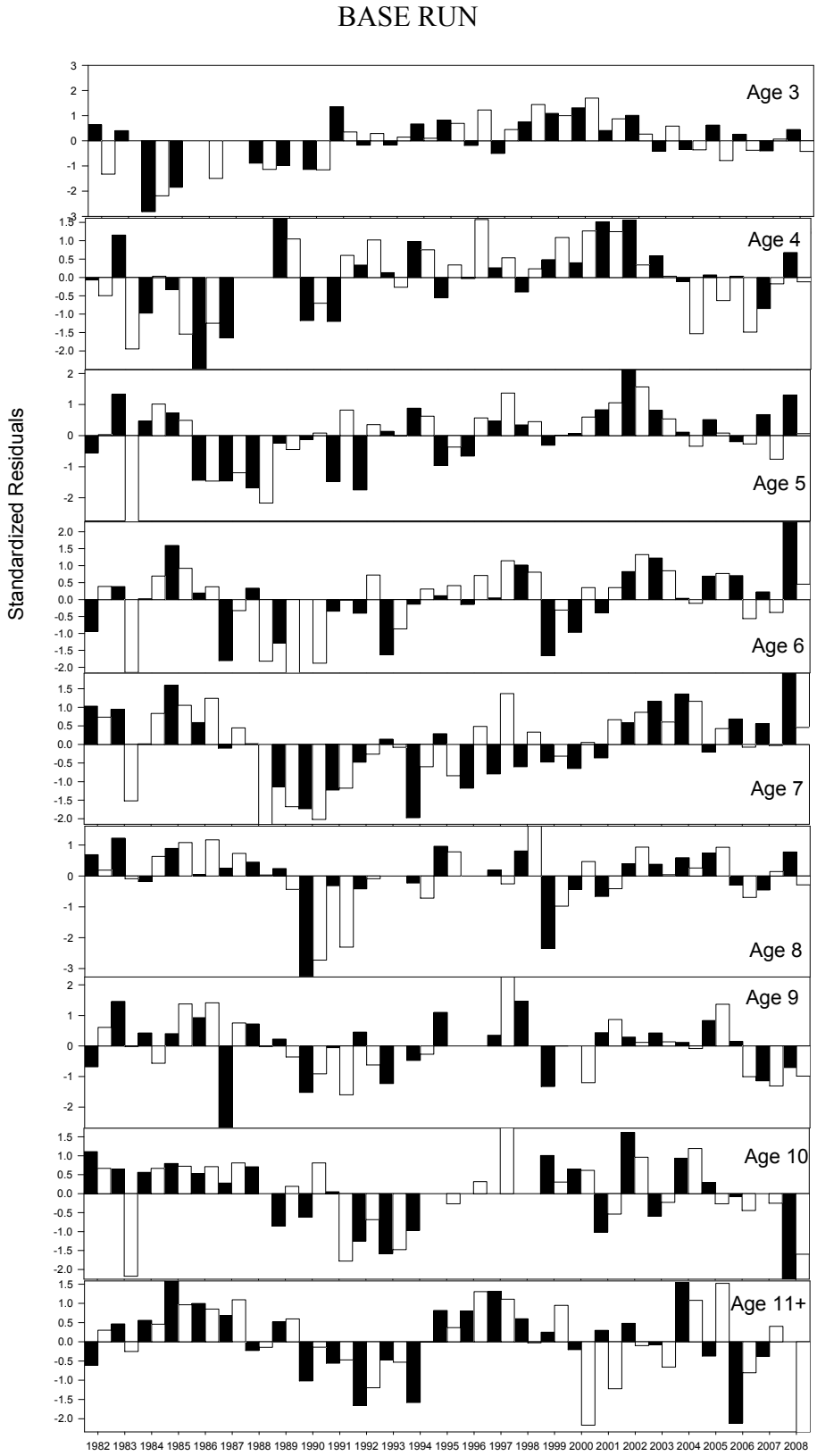

Figure G10. Witch flounder standardized residuals for NEFSC survey indices (spring solid bar and autumn open bar) at age from the VPA **BASE RUN**; 1982-2007.

BASE RUN

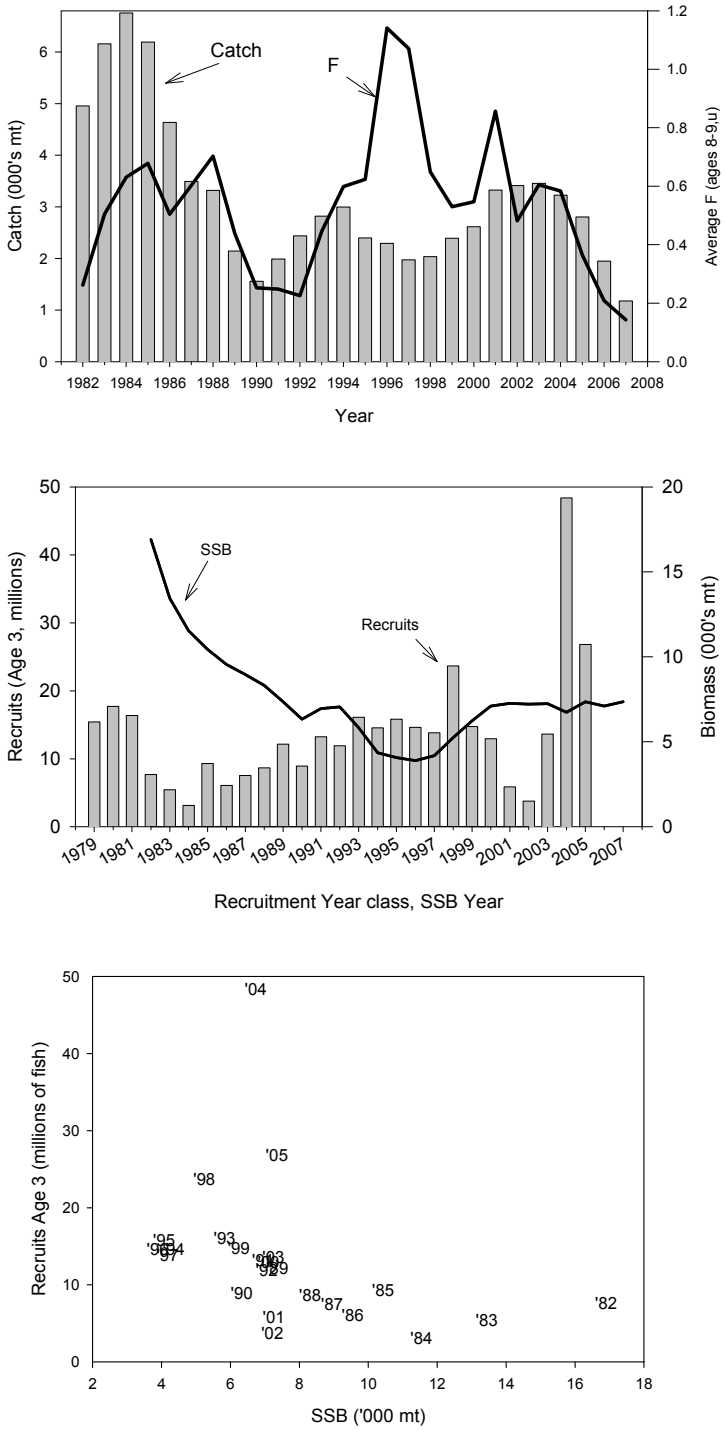

Figure G11. Trends of witch flounder total catch and fishing mortality (top), spawning stock biomass and Age 3 recruitment (middle), and spawning stock biomass (thousands, mt) and recruits (age 3, millions), 1982 – 2005 year classes (bottom) from VPA **BASE RUN,** 1982 – 2007.

VPA BASE RUN

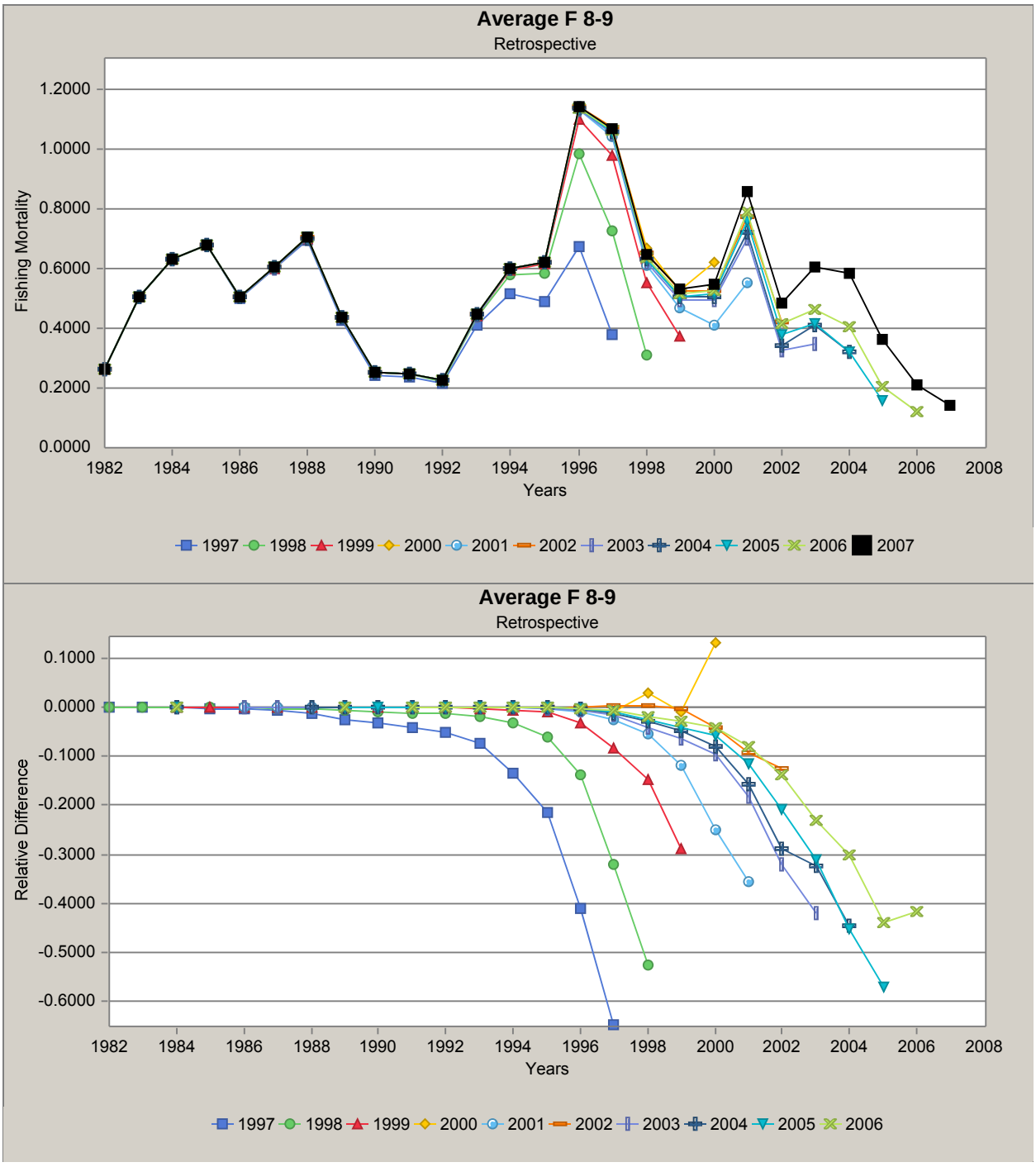

Figure G12. Retrospective analysis results of fishing mortality (top) and relative difference of fishing mortality from the terminal year (bottom) from VPA **BASE RUN**.

VPA BASE RUN

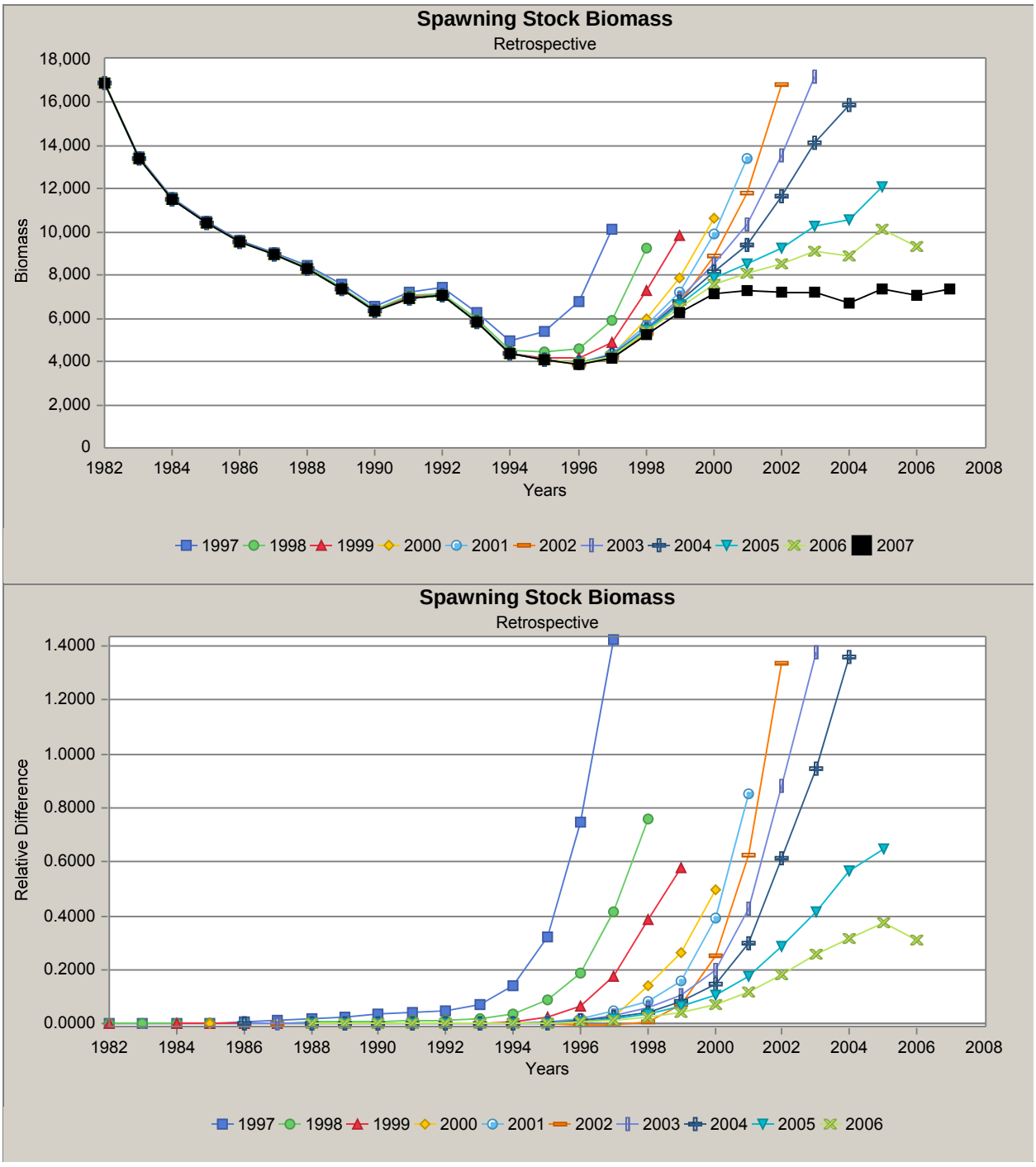

Figure G13. Retrospective analysis results of spawning biomass (top) and relative difference of spawning biomass from the terminal year (bottom) from VPA **BASE RUN**.

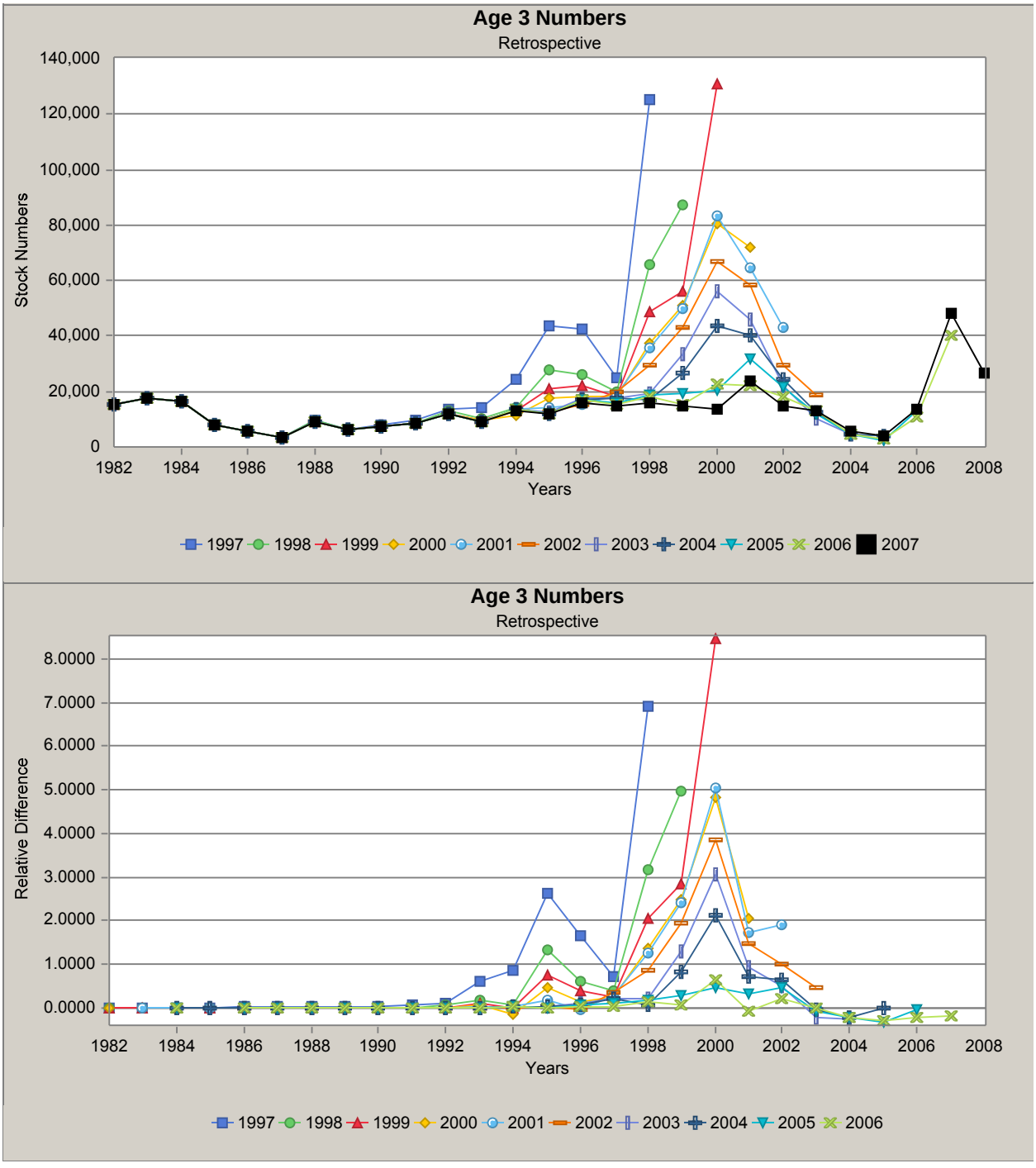

Figure G14. Retrospective analysis results of Age 3 recruitment (top) and relative difference of Age 3 recruitment from the terminal year (bottom) from VPA **BASE RUN**.

BASE RUN

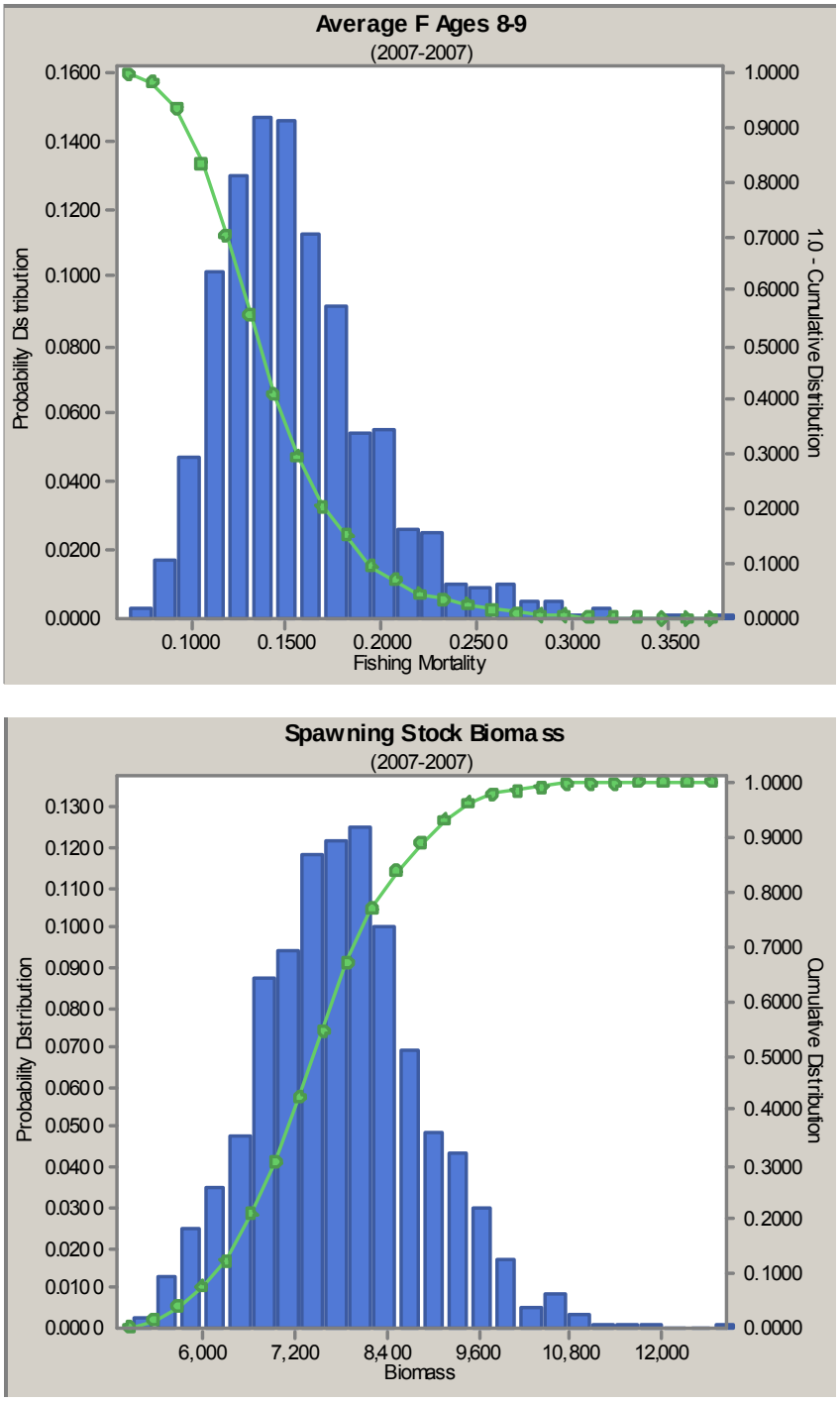

Figure G15 Precision estimates of fishing mortality (top) and spawning stock biomass (mt; bottom) in 2007 from the VPA **BASE RUN**. Vertical bars display both the range of the bootstrap estimates and the probability of the individual values in the range.

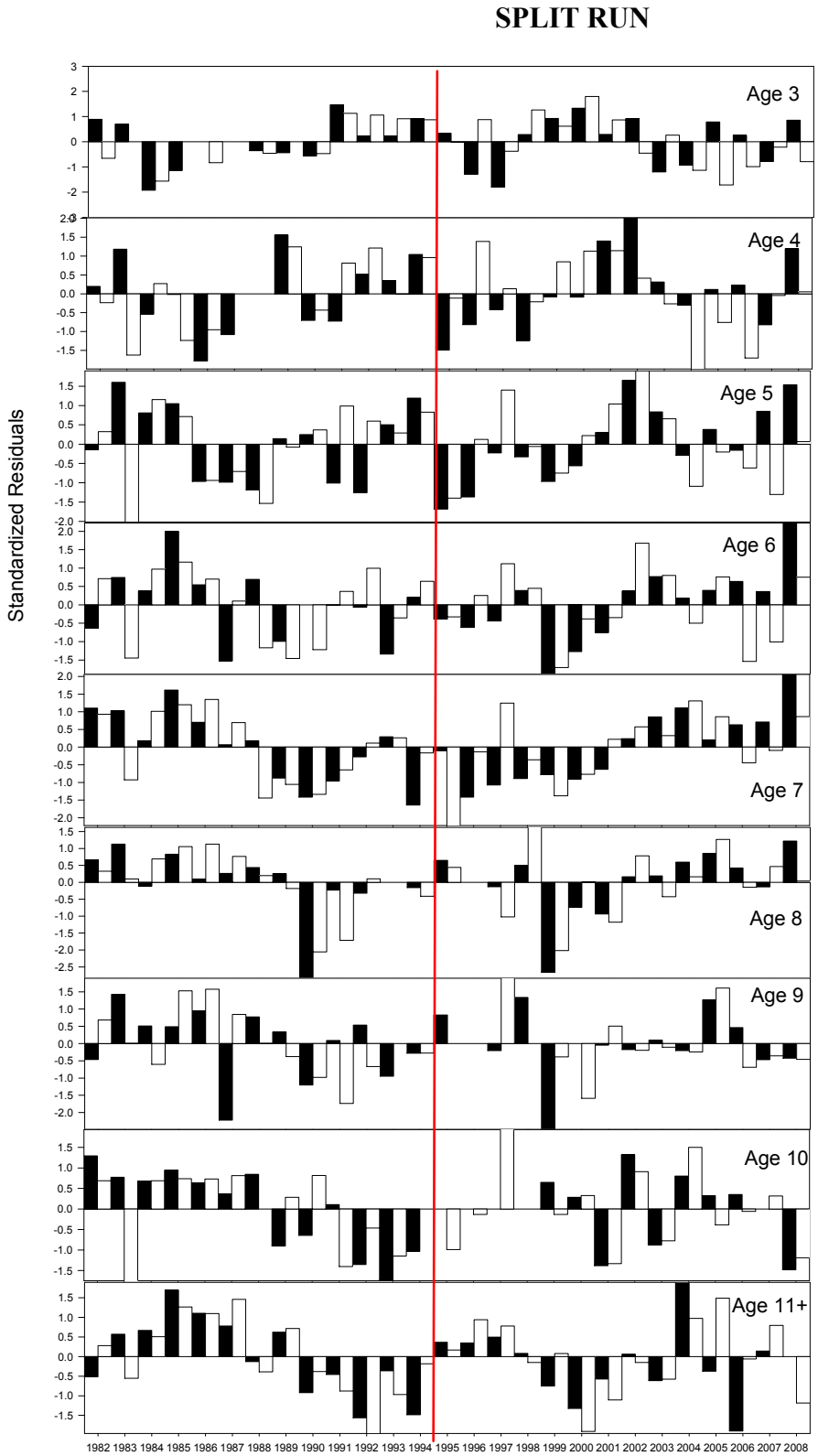

Figure G16. Witch flounder standardized residuals for NEFSC survey indices (spring solid bar and autumn open bar) at age from the VPA **SPLIT RUN**; 1982-2007. Red line indicates the 1994 and 1995 split.

SPLIT RUN

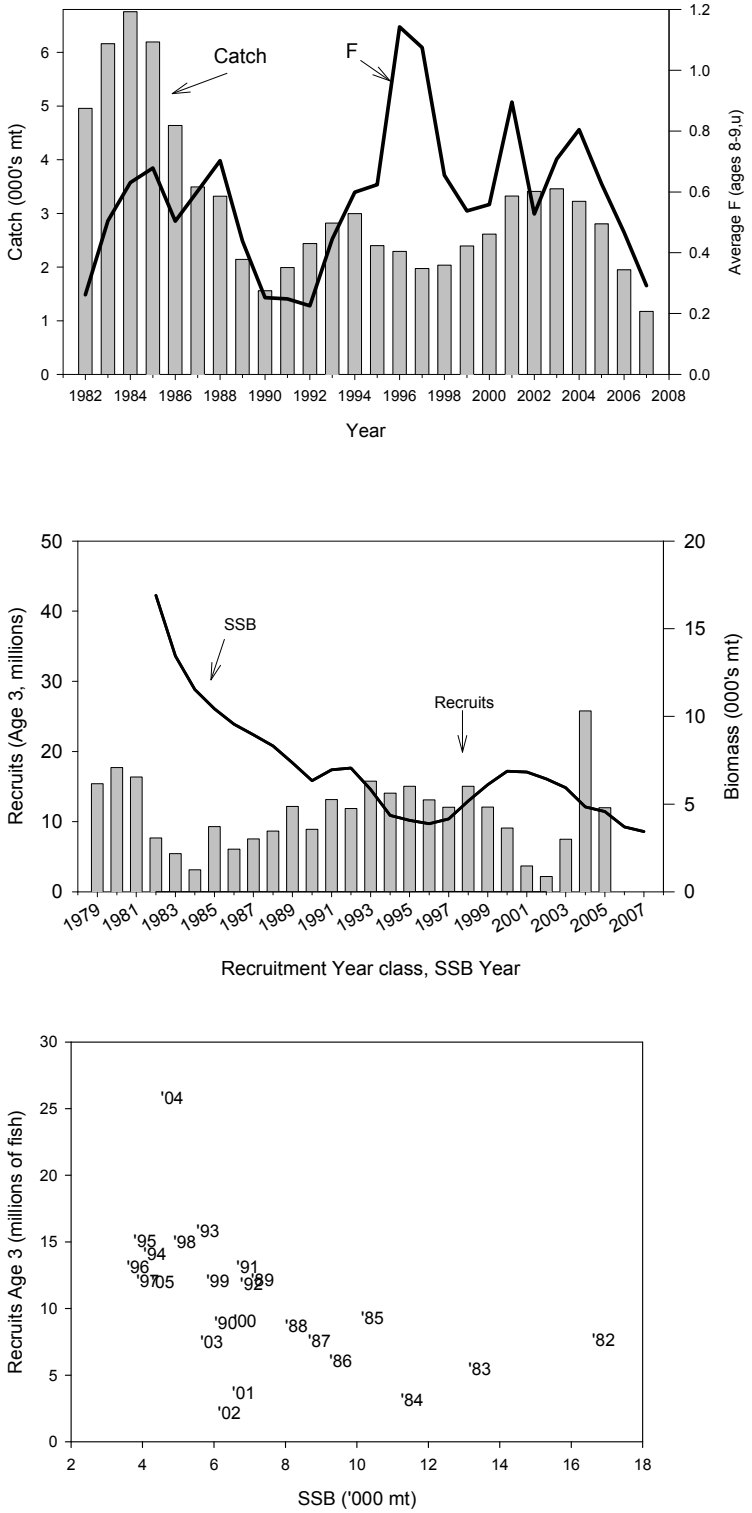

Figure G17. Trends of witch flounder total catch and fishing mortality (top), spawning stock biomass and Age 3 recruitment (middle), and spawning stock biomass (thousands, mt) and recruits (age 3, millions), 1982 – 2005 year classes (bottom) from VPA **SPLIT RUN**.

SPLIT RUN

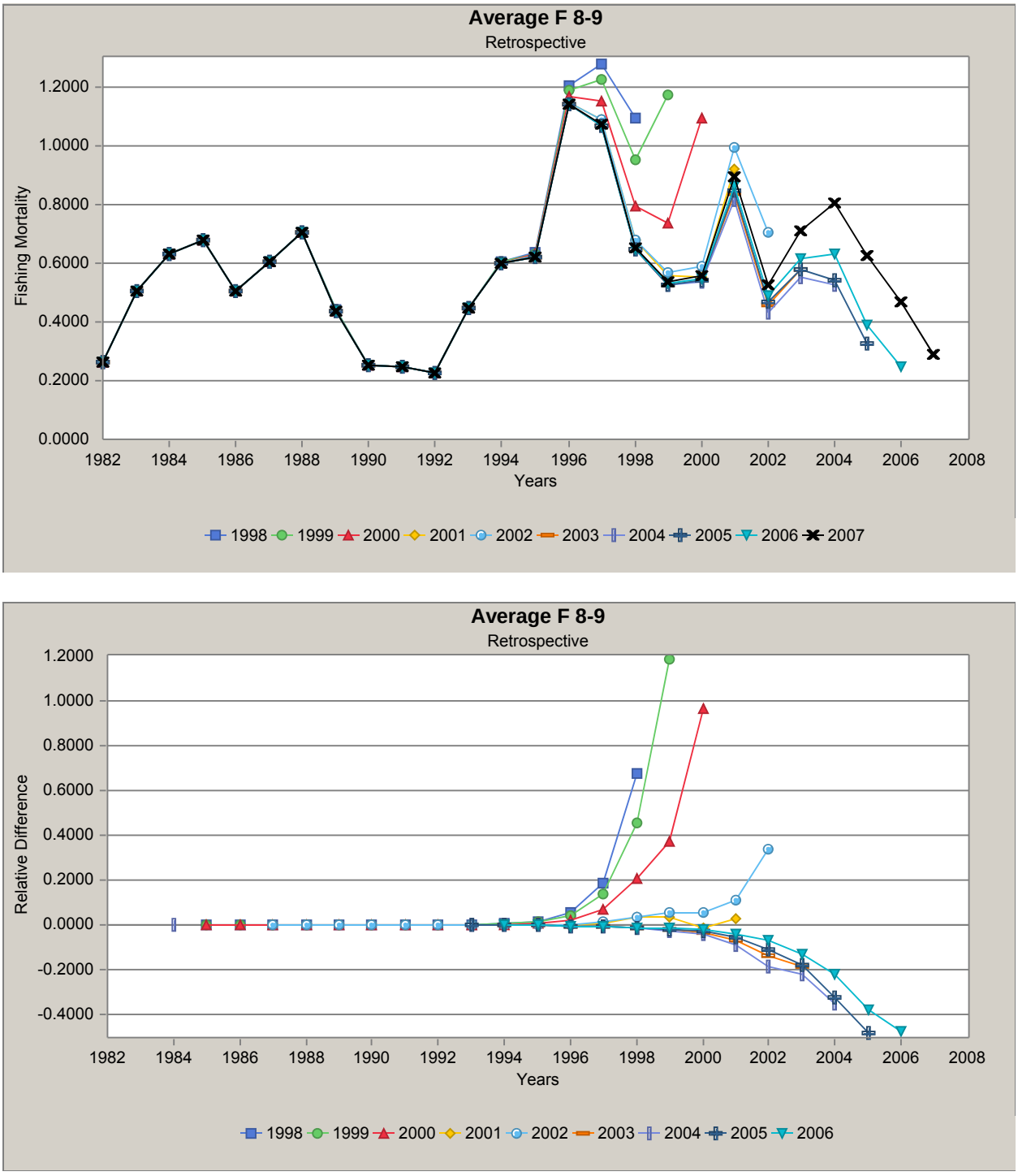

Figure G18. Retrospective analysis results of fishing mortality (top) and relative difference of fishing mortality from the terminal year (bottom) from VPA **SPLIT RUN**, 1982 – 2007.

SPLIT RUN

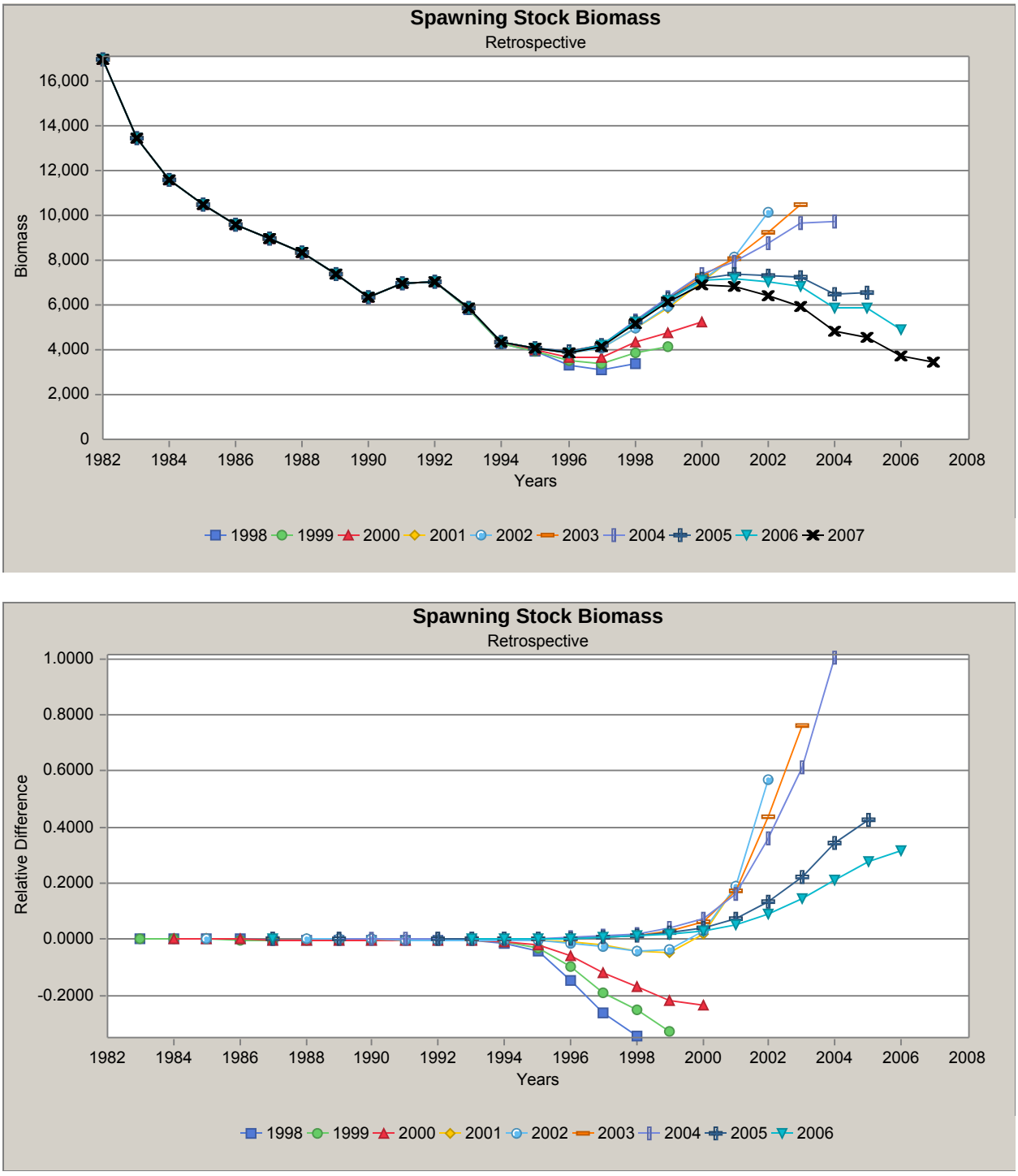

Figure G19. Retrospective analysis results of spawning biomass (top) and relative difference of spawning biomass from the terminal year (bottom) from VPA **SPLIT RUN**, 1982 – 2007.

SPLIT RUN

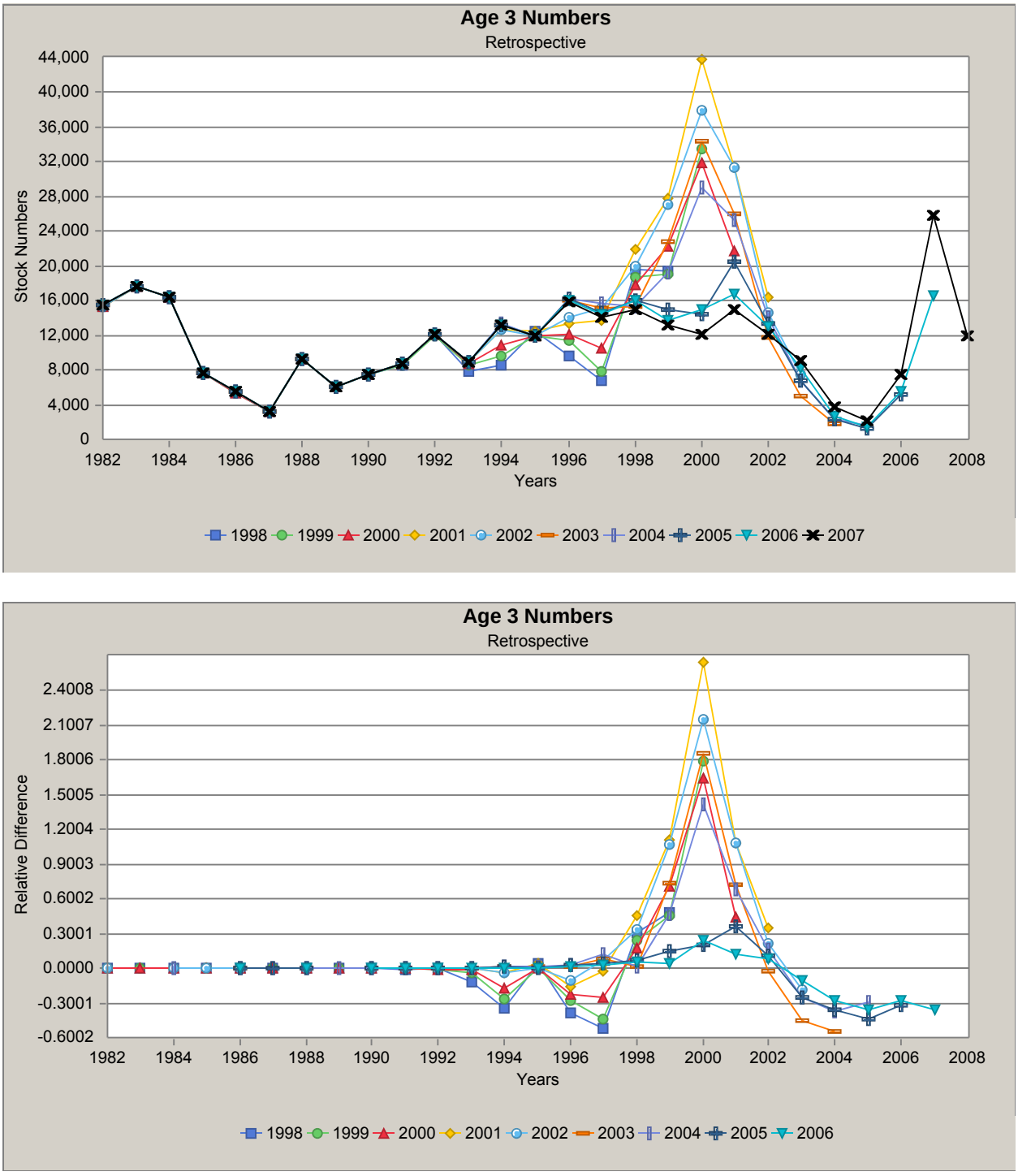

Figure G20. Retrospective analysis results of Age 3 recruitment (top) and relative difference of Age 3 recruitment from the terminal year (bottom) from VPA **SPLIT RUN**, 1982 – 2007.

SPLIT RUN

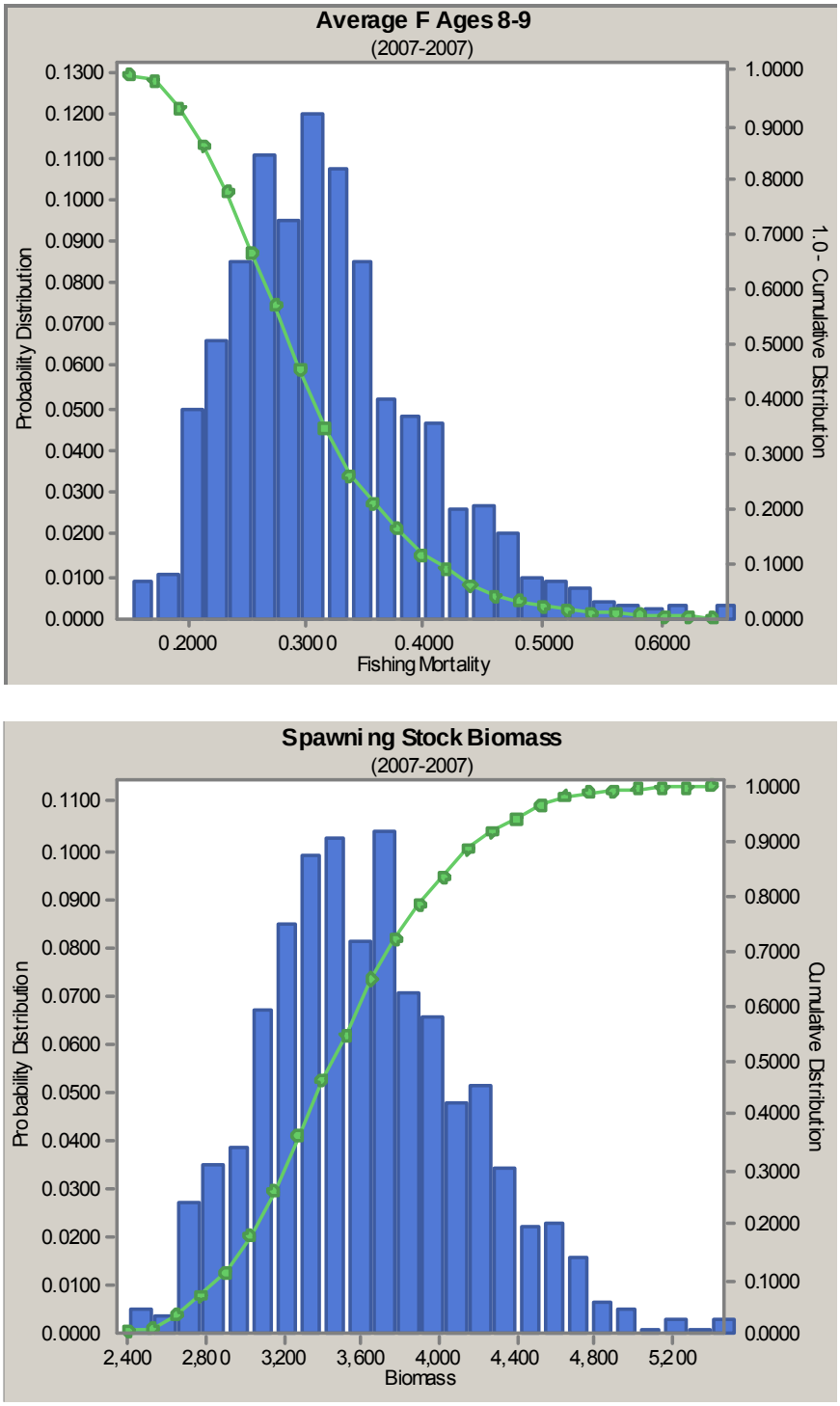

Figure G21. Precision estimates of fishing mortality (top) and spawning stock biomass (mt; bottom) in 2007 from the **SPLIT RUN**. Vertical bars display both the range of the bootstrap estimates and the probability of the individual values in the range.

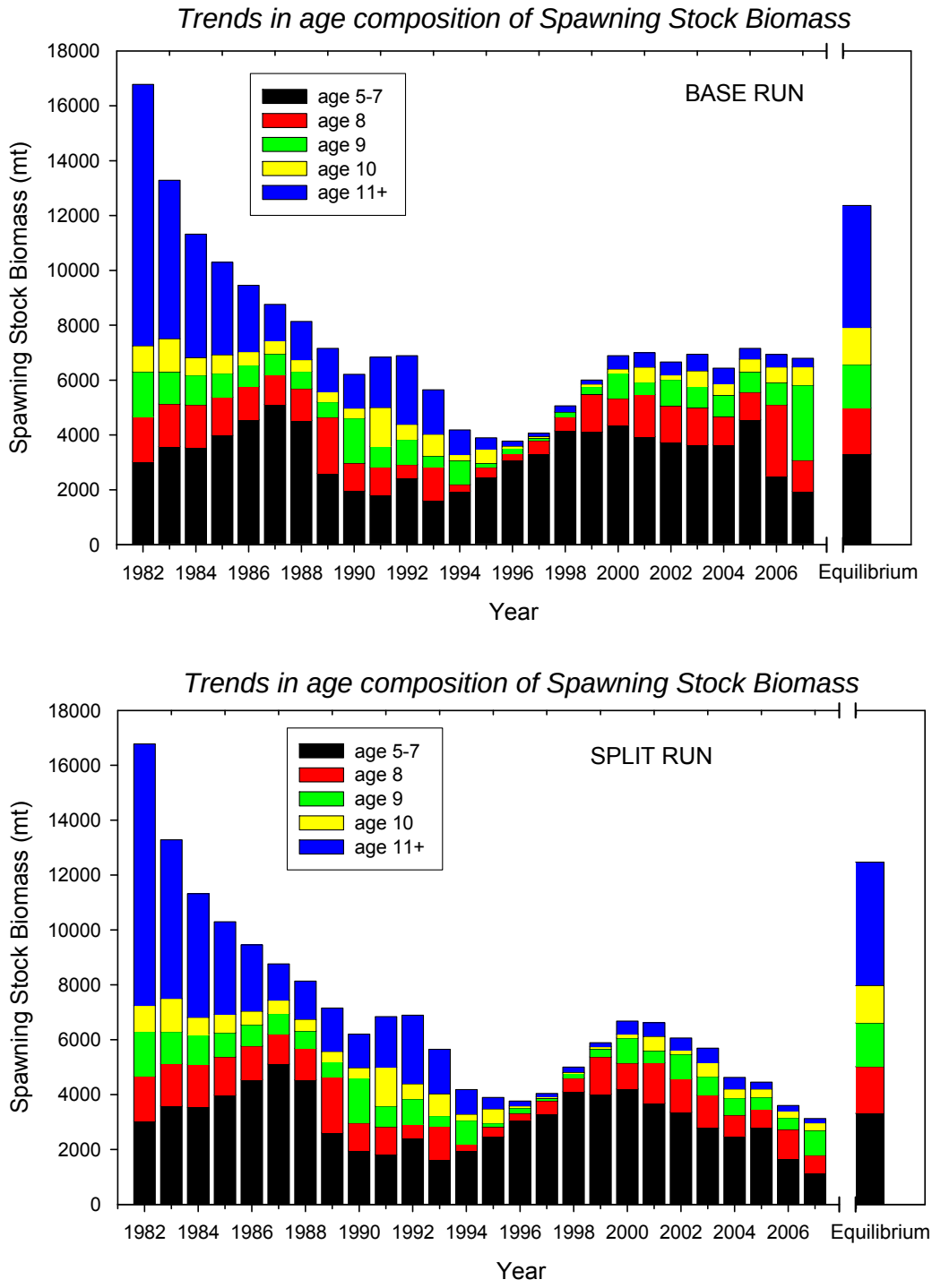

Figure G22. Age distribution of witch flounder spawning stock biomass, 1982-2007, and the expected age distribution at equilibrium, from the BASE RUN (top) and SPLIT RUN (bottom).

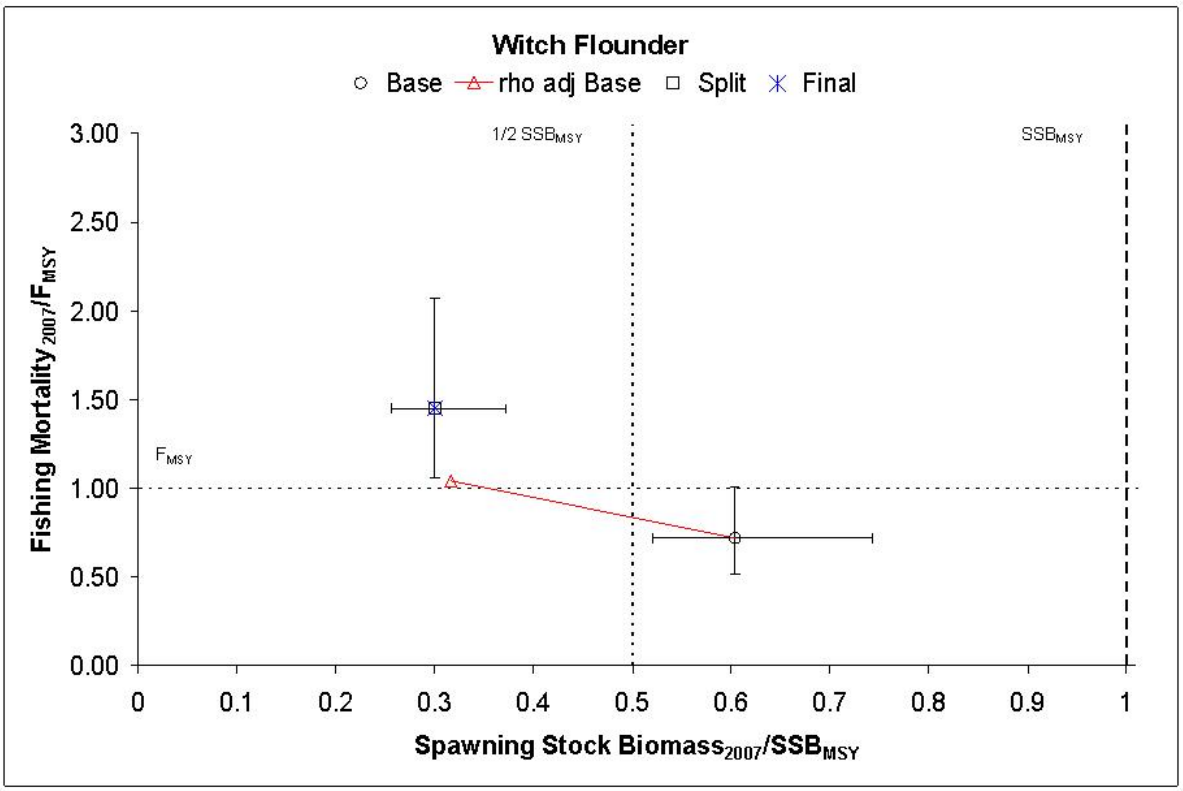

Figure G23. Witch flounder spawning stock biomass and fishing mortality (F8-9) in 2007, with respect to the biological reference points, for the rho-adjusted BASE RUN (triangle) and for the BASE RUN (circle) and SPLIT RUN (square) with 80% confidence interval. The final accepted VPA run (asterisk) is the SPLIT RUN and is used to determine witch flounder stock status in 2007.