June 23, 2010

Summer Flounder
Assessment Summary for 2010

Stock Assessment Workshop (SAW)
Southern Demersal Working Group (SDWG)

National Marine Fisheries Service (NMFS)
Northeast Fisheries Science Center (NEFSC)
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Woods Hole, MA 02543

SUMMER FLOUNDER ASSESSMENT SUMMARY FOR 2010

State of Stock: The summer flounder stock is not overfished and overfishing is not occurring relative to the biological reference points established in the 2008 SAW 47 assessment (NEFSC 2008). The stock is currently under a rebuilding program with a deadline of January 1, 2013 (corresponding to the November 1, 2012 estimate of SSB). Fishing mortality (F) calculated from the average of the currently fully recruited ages (3-7+) ranged between about 1.0 and 2.0 during 1982-1996. The fishing mortality rate has declined to below 1.0 since 1997 and was estimated to be 0.237 in 2009, below the threshold fishing mortality reference point FMSY = F35% = 0.310 (Figures 1 & 2). There is a 50% probability that the fishing mortality rate in 2009 was between 0.224 and 0.250 (Figure 3).

Spawning stock biomass (SSB) decreased from about 25,000 mt in the early 1980s to about 7,000 in 1989, then increased to above 40,000 mt by 2002. SSB was estimated to be 53,458 mt in 2009, about 89% of the SSBMSY = SSB35% reference point = 60,074 mt (Figures 1 & 4). There is a 50% chance that SSB in 2009 was between 50,560 and 55,998 mt (Figure 5).

The arithmetic average recruitment from 1982 to 2009 is 42 million fish at age 0. The 1981 and 1982 year classes are the largest in the historical assessment time series, at 73 and 81 million fish; the 1988 year class is the smallest at 13 million fish. The 2008 year class is estimated to be about 49 million fish, 17% above the average. The 2009 year class is currently estimated to be about 82 million fish, about twice the average, and is the largest in the assessment time series (Figures 4 & 6).

The summer flounder stock assessment model has historically exhibited a retrospective pattern of underestimation of F and overestimation of SSB; the causes of this pattern have not been determined (Figures 7 & 8). A recent pattern of overestimation in recruitment is also evident (Figure 9). Over the last 7 years, the annual internal model retrospective error in fishing mortality has ranged from +11% in the 2006 terminal year to -35% in 2003, while the annual internal model retrospective error in SSB has ranged from -13% in 2006 to +45% in 2003. Over the last 3 terminal years, the annual internal model retrospective error in recruitment has ranged from +54% for the 2008 year class to +80% for the 2006 year class. Comparison of the estimates for SSB, R and F over the last three assessments indicates consistency of those estimates in line with the most recent internal retrospective pattern of the 2010 assessment model (Figures 10-12).

Projections for 2009-2010: The stochastic projections do not explicitly account for the recent retrospective pattern in the assessment, as per the 2006 S&T Peer Review (Terceiro 2006) recommendation. The projected recruitment was drawn from the distribution of 1982-2009 ASAP SCAA model estimates.

If the landings in 2010 equal the TAL = 10,038 mt = 22.13 million lbs and the 2010 discards are 1,720 mt = 3.79 million lbs, the projections estimate a median (50% probability) F in 2010 = 0.241 and a median SSB on November 1, 2010 of 72,367 mt, above the biomass target of SSBMSY = SSB35% = 60,074 mt.

Fishing at Ftarget = F40% = 0.255 during 2011-2012 is projected to maintain the stock above SSBMSY = SSB35% = 60,074 mt through 2012 (Figure 13). The projections indicate that fishing at Ftarget = 0.255 in 2011 could provide landings that exceed MSY (13,122 mt landings = 28.93 million lbs) in 2011.

Landings, Discards, and Spawning Stock Biomass (SSB) in metric tons

		2011	
Ftarget = 0.255	Landings	Discards	SSB
25%ile	12,663	1,904	72,433
50%ile	13,371	2,028	76,201
75%ile	14,304	2,176	80,973

Fishing at Fthreshold = F35% = 0.310 during 2011-2012 is projected to maintain the stock above SSBMSY = SSB35% = 60,074 mt through 2012. The projections indicate that fishing at Fthreshold = 0.310 in 2011 could provide landings that exceed MSY (13,122 mt landings = 28.93 million lbs) in 2011.

Landings, Discards, and Spawning Stock Biomass (SSB) in metric tons

		2011	
Fthreshold = 0.310	Landings	Discards	SSB
25%ile	15,055	2,274	70,034
50%ile	15,899	2,422	73,678
75%ile	17,008	2,598	78,271

Fishing at 75% of Fthreshold = 0.233 during 2011-2012 is projected to maintain the stock above SSBMSY = SSB35% = 60,074 mt through 2012, with landings about 6% less than MSY (13,122 mt landings = 28.93 million lbs) in 2011.

Landings, Discards, and Spawning Stock Biomass (SSB) in metric tons

		2011	
0.75* Fthreshold = 0.233	Landings	Discards	SSB
25%ile	11,674	1,752	73,420
50%ile	12,327	1,867	77,237
75%ile	13,186	2,003	82,085

Catch and Status Table (weights in 000s mt, recruitment in millions, arithmetic means)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Max[1]	Min[1]	Mean[1]
Commercial landings	5.1	5.0	6.6	6.5	8.2	7.8	6.3	4.5	4.1	4.8	17.1	4.0	8.1
Commercial discards	0.7	0.5	0.5	0.5	0.2	0.2	0.3	0.3	0.3	0.1	1.5	0.1	0.6
Recreational landings	7.5	5.3	3.6	5.3	4.8	4.7	5.0	4.4	3.6	2.9	12.7	1.4	5.2
Recreational discards	1.0	1.3	0.8	0.9	1.0	1.0	0.8	1.1	1.3	1.2	1.2	0.1	0.6
Catch used in assessment	14.2	12.0	11.4	13.1	14.3	13.8	12.3	10.4	9.3	9.0	26.5	8.0	14.4
Commercial quota	5.0	4.9	6.6	6.3	7.6	8.1	6.4	4.7	4.3	4.9	8.1	4.3	7.3
Recreational harvest limit	3.4	3.2	4.4	4.2	5.1	5.5	4.3	3.1	2.9	3.2	5.5	2.9	4.8
Spawning stock biomass[2]	31.3	37.1	42.1	45.9	46.8	45.6	46.6	45.5	45.0	53.5	53.5	7.1	26.5
Recruitment (age 0)	40.2	37.7	44.2	34.4	54.5	28.6	29.6	29.8	48.9	81.8	81.8	12.8	42.0
F (ages 3-7+)	0.67	0.49	0.43	0.41	0.44	0.45	0.34	0.26	0.24	0.24	1.98	0.24	1.03

1: Over the period 1982-2009
2: On November 1 annually

Stock Distribution and Identification: The Mid-Atlantic Fishery Management Council (MAFMC) and Atlantic States Marine Fisheries Commission (ASMFC) Fishery Management Plan for summer flounder defines the management unit as all summer flounder from the southern border of North Carolina northeast to the US-Canada border. The results of a summer flounder genetics study (Jones and Quattro 1999) are consistent with the definition of the current management unit. The definition of Wilk et al. (1980) of a unit stock extending from Cape Hatteras north to New England has been accepted in this and previous assessments. The conclusions of a study of summer flounder stock structure incorporating tagging data (Kraus and Musick, 2001) are consistent with this assessment unit.

Catch: Total landings peaked in 1983 at 26,100 mt. During the late 1980s and into 1990, landings declined markedly, reaching 4,200 mt in the commercial fishery in 1990 and 1,400 mt in the recreational fishery in 1989. Total landings were only 6,500 mt in 1990. The principal gear used in commercial fishing for summer flounder is the otter trawl. Reported 2009 landings in the commercial fishery were 4,848 mt, about 1% under the commercial quota. Commercial discard losses in the otter trawl and scallop dredge fisheries are estimated from fishery observer data and have recently accounted for 5%-10% of the total commercial catch, assuming a discard mortality rate of 80%. Estimated 2009 landings in the recreational rod-and-reel fishery were 2,856 mt, about 12% under the recreational harvest limit. Recreational discard losses have recently accounted for 15%-20% of the total recreational catch, assuming a discard mortality rate of 10%. Total commercial and recreational landings in 2009 were 7,704 mt, and total catch was estimated at 9,017 mt (Figure 2).

Data and Assessment: The assessment model for summer flounder changed in the 2008 SAW 47 assessment (NEFSC 2008) from a virtual population analysis (ADAPT VPA) to a statistical catch at age model (ASAP SCAA; NFT 2008a). A new value for natural mortality was also adopted, changing from a constant value of M = 0.20 to age- and sex-specific values that result in a mean value of M = 0.25. Biological reference points were therefore also revised, and the proxy for FMSY changed from Fmax to F35%, with F40% recommended as Ftarget. The fishery catch is modeled as two fleets; total landings and total discards. Indices of recruitment and stock abundance from the NEFSC winter, spring, and autumn; Massachusetts spring and autumn; Rhode Island autumn and monthly; Connecticut spring and autumn; Delaware; and New Jersey trawl surveys were used in the ASAP SCAA model calibration. Recruitment indices from surveys conducted by the states of North Carolina, Virginia, and Maryland are also used in the calibration. The 2010 assessment uses the same model configuration as the 2008 SAW 47 (NEFSC 2008) and 2009 (Terceiro 2009) assessments, with input fishery and survey data updated through 2009.

Biological Reference Points: The current biological reference points for summer flounder were established in the 2008 SAW 47 assessment (NEFSC 2008), based on yield and SSB per recruit and projection models in the NOAA NFT framework (NFT 2006, 2008b; Thompson and Bell 1934). The threshold fishing mortality reference point is FMSY = F35% = 0.310. Maximum Sustainable Yield (MSY) at F35% is estimated to be 13,122 mt of landings (28.9 million lbs) and 1,510 mt of discards (3.33 million lbs) for a total catch of 14,362 mt (32.26 million lbs). The SSB reference point is estimated as the projection of Jan 1, 2008 stock sizes at F35% = 0.310 and average (1982-2007) recruitment of 41.6 million fish per year. SSBMSY = SSB35% is estimated to be 60,074 mt (132.4 million lbs), and the biomass threshold of one-half SSBMSY is estimated to be 30,037 mt (66.2 million lbs). The 2008 SAW47 Panel recommended that F40% = 0.255 be used as Ftarget for management.

Fishing Mortality: Fishing mortality calculated from the average of the currently fully recruited ages (3-7+) ranged between 1.0 and 2.0 during 1982-1996. The fishing mortality rate has declined to below 1.0 since 1997 and was estimated to be 0.237 in 2009, below the threshold fishing mortality reference point FMSY = F35% = 0.310 (Figure 1). There is a 50% probability that the fishing mortality rate in 2009 was between 0.224 and 0.250 (Figure 3). The summer flounder stock

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Spawning Stock Biomass: Spawning stock biomass (SSB) decreased from about 25,000 mt in the early 1980s to about 7,000 in 1989, then increased to above 40,000 mt by 2002. SSB was estimated to be 53,458 mt in 2009, about 89% of the SSBMSY = SSB35% reference point = 60,074 mt (Figures 1 & 4). There is a 50% chance that SSB in 2009 was between 50,560 and 55,998 mt (Figure 5). The assessment has historically exhibited a retrospective pattern of overestimation of SSB; the causes of this pattern have not been determined (Figure 8). Over the last 7 years, the annual internal model retrospective error in SSB has ranged from -13% in the 2006 terminal year to +45% in 2003.

Recruitment: The arithmetic average recruitment from 1982 to 2009 is 42 million fish at age 0. The 1981 and 1982 year classes are the largest in the historical assessment time series, at 73 and 81 million fish; the 1988 year class is the smallest at 13 million fish. The 2008 year class is estimated to be about 49 million fish, 17% above the average. The 2009 year class is currently estimated to be about 82 million fish, about twice the average, and is the largest in the assessment time series (Figures 4 & 6). A recent pattern of overestimation in recruitment is evident (Figure 9). Over the last 3 years, the annual internal model retrospective error in recruitment has ranged from +54% for the 2008 year class to +80% for the 2006 year class.

Special Comment: Landings that correspond to fishing at or near the threshold fishing mortality rate (FMSY = F35% = 0.310) may result in overfishing if the previous retrospective pattern of underestimation of fishing mortality occurs in the future.

Sources of Information

Jones, W.J., and J. M. Quattro. 1999. Genetic structure of summer flounder (*Paralichthys dentatus*) populations north and south of Cape Hatteras. Marine Biology 133: 129-135.

Kraus, R.T., and J. A. Musick. 2001. A brief interpretation of summer flounder, *Paralichthys dentatus*, movements and stock structure with new tagging data on juveniles. Mar. Fish. Rev. 63(3): 1-6.

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NOAA Fisheries Toolbox (NFT) 2006. Age Structured Projection Model (AGEPRO), version 3.1.3. [Internet address: http://nft.nefsc.noaa.gov].

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Terceiro, M. 2006. Summer flounder assessment and biological reference point update for 2006. http://www.nefsc.noaa.gov/nefsc/saw/2006FlukeReview/BRP2006_Review.pdf

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Thompson, W.F., and F.H. Bell. 1934. Biological statistics of the Pacific halibut fishery. 2. Effect of changes in intensity upon total yield and yield per unit of gear. Rep. Int. Fish. (Pacific halibut) Comm. 8: 49 p.

Wilk, S.J., W. G. Smith, D.E. Ralph and J. Sibunka. 1980. The population structure of summer flounder between New York and Florida based on linear discriminant analysis. Trans. Am. Fish. Soc. 109:265-271.

Figure 1. Spawning stock biomass (SSB; 000s metric tons), fishing mortality (ages 3-7+), and the 2008 SAW 47 biological reference points for summer flounder.

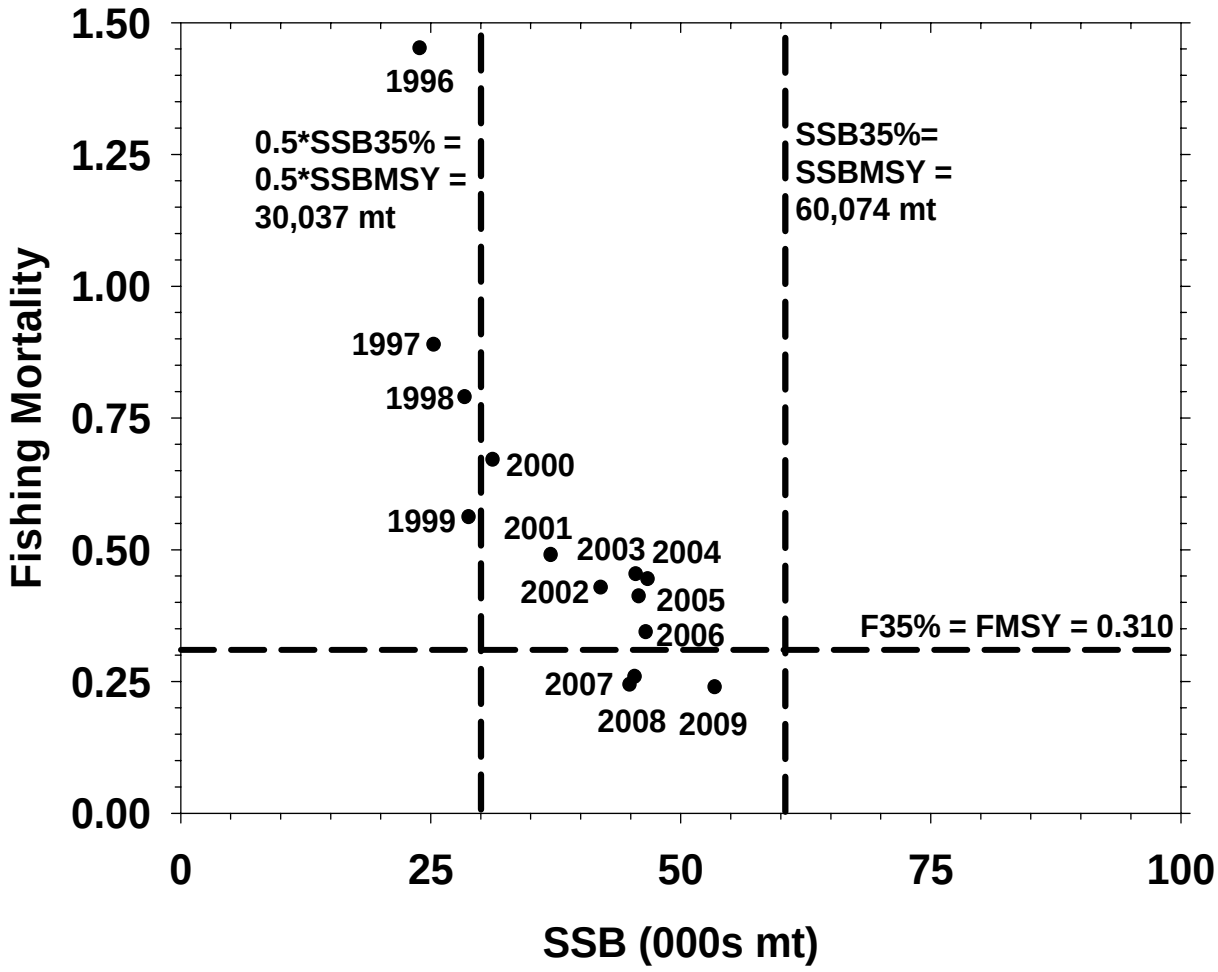

Figure 2. Total catch (landings and discards, metric tons) and fishing mortality rate (F, ages 3-7+) for summer flounder.

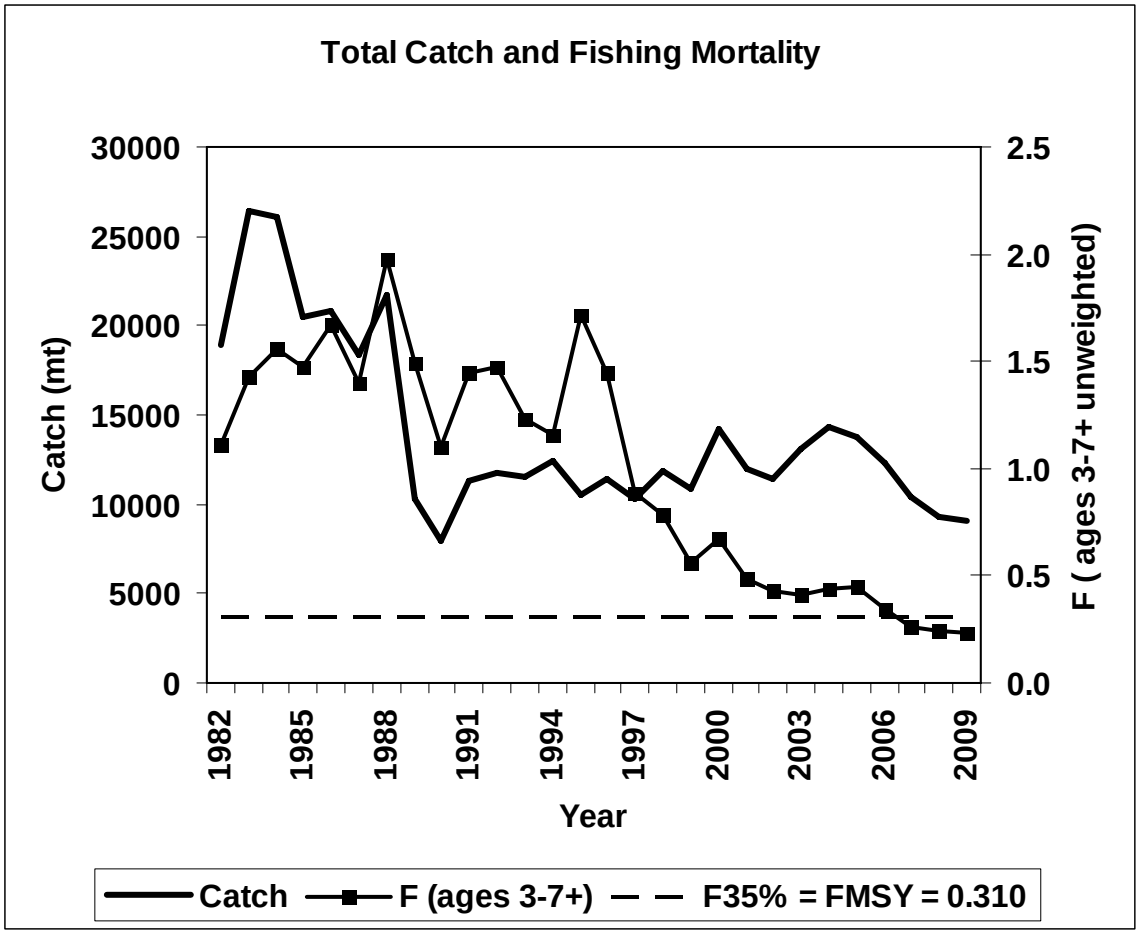

Figure 3. MCMC (Markov Chain Monte Carlo) distribution of instantaneous fishing mortality (F) in 2009 for summer flounder.

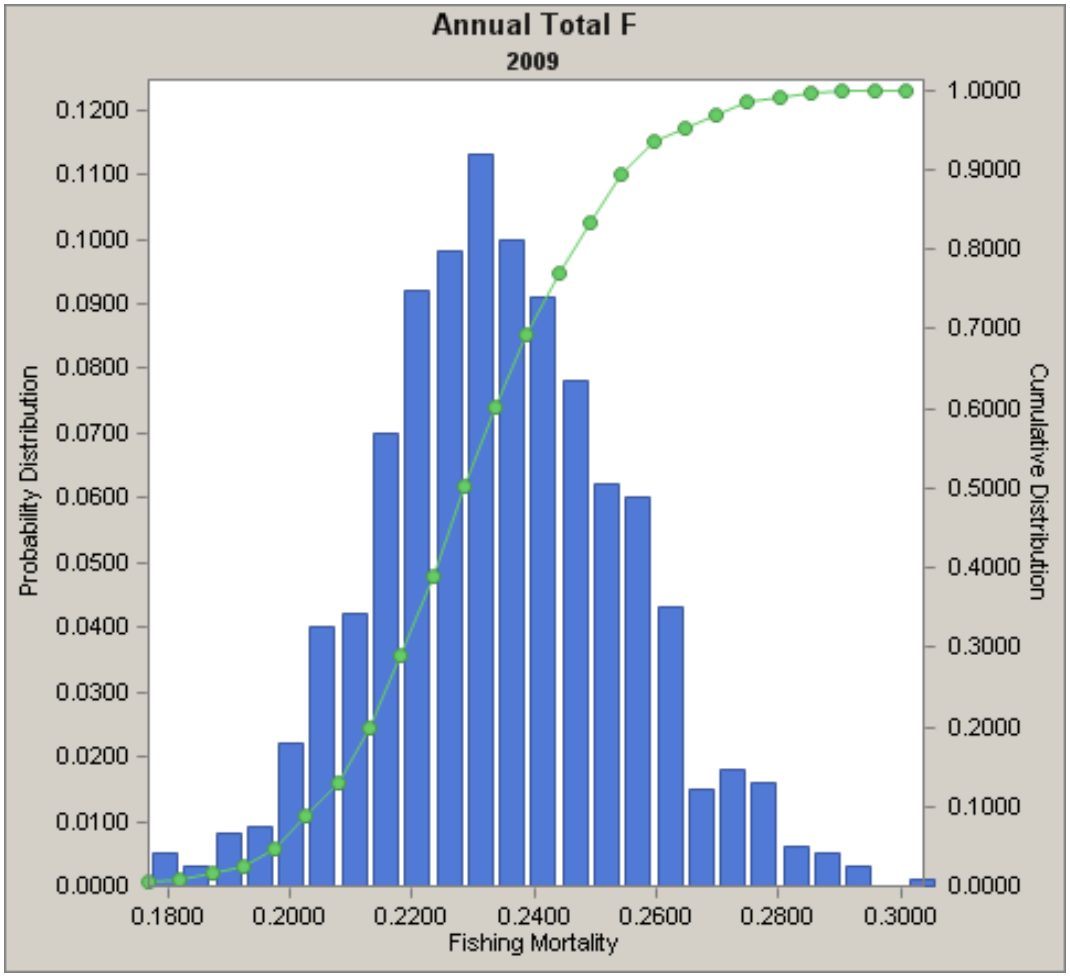

Figure 4. Spawning stock biomass (SSB, metric tons) and recruitment (R, age 0, 000s) for summer flounder.

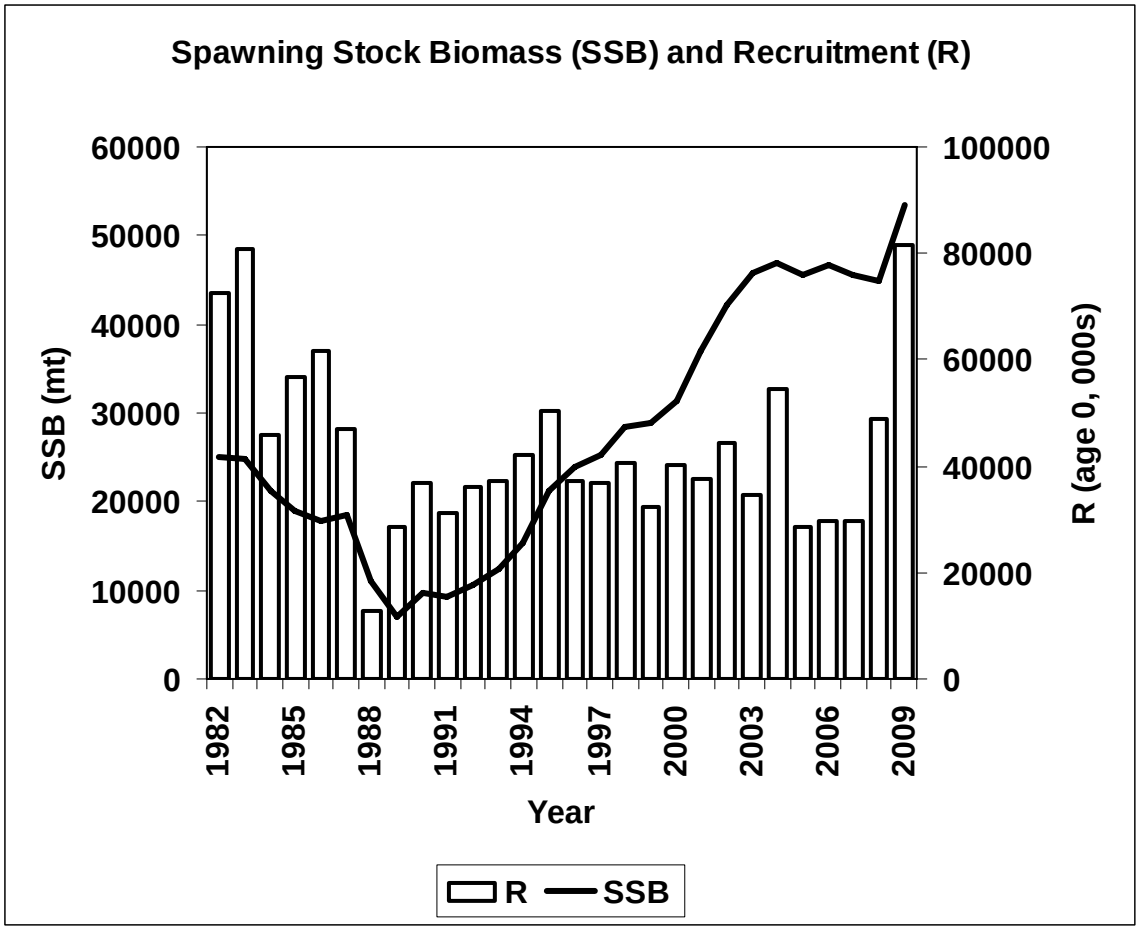

Figure 5. MCMC (Markov Chain Monte Carlo) distribution of Spawning Stock Biomass (SSB) in 2009 for summer flounder.

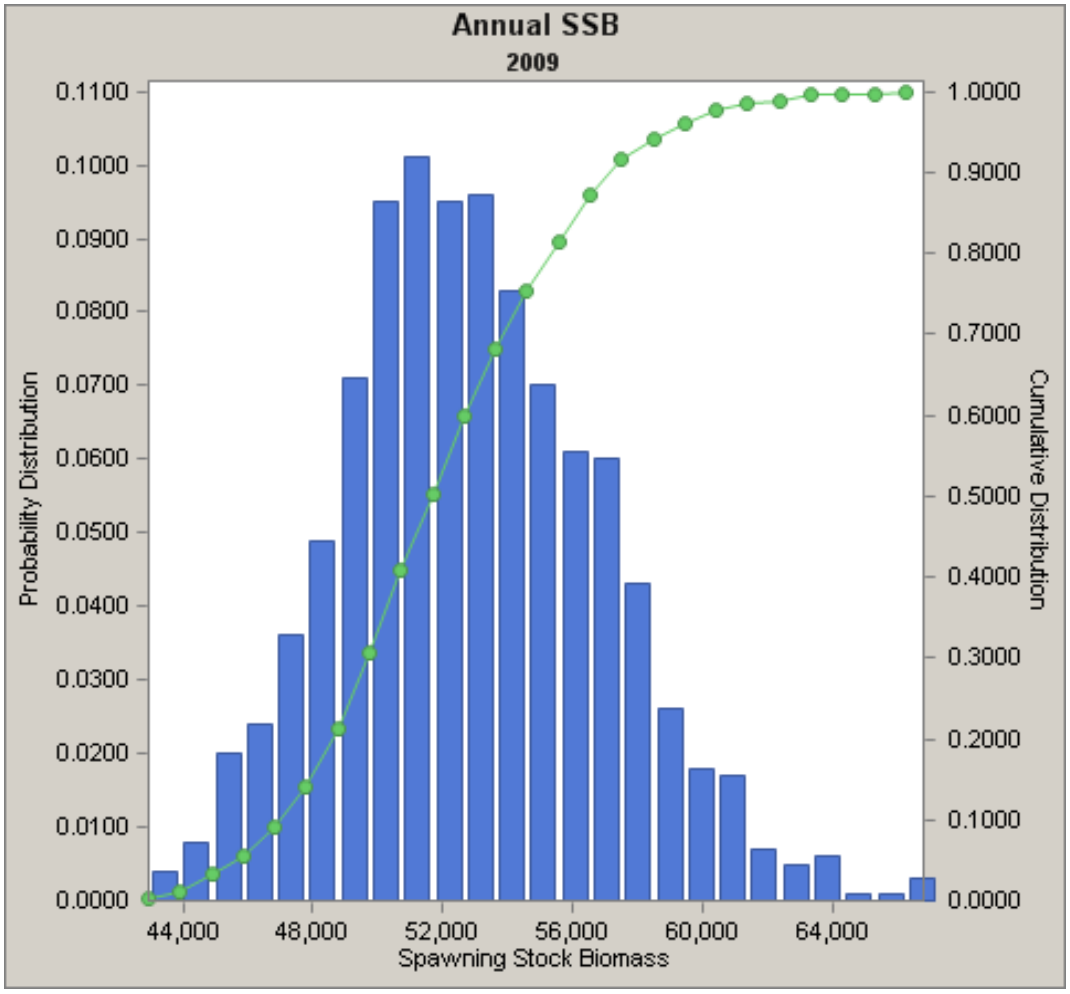

Figure 6. Spawning stock biomass (SSB, metric tons) and recruitment (R, age 0, 000s) scatterplot for summer flounder; 1983-2009 year classes.

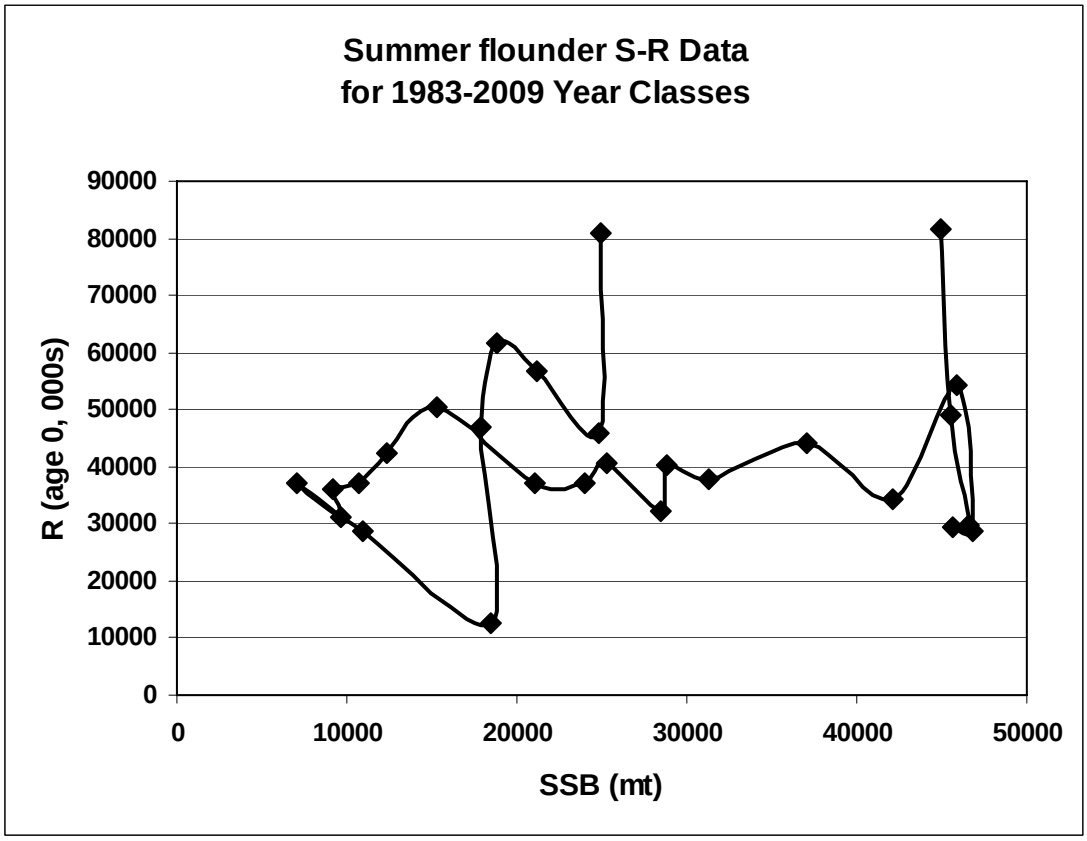

Figure 7. Retrospective analysis of Fishing Mortality for summer flounder. Note that model ages 4-8 are true ages 3-7+.

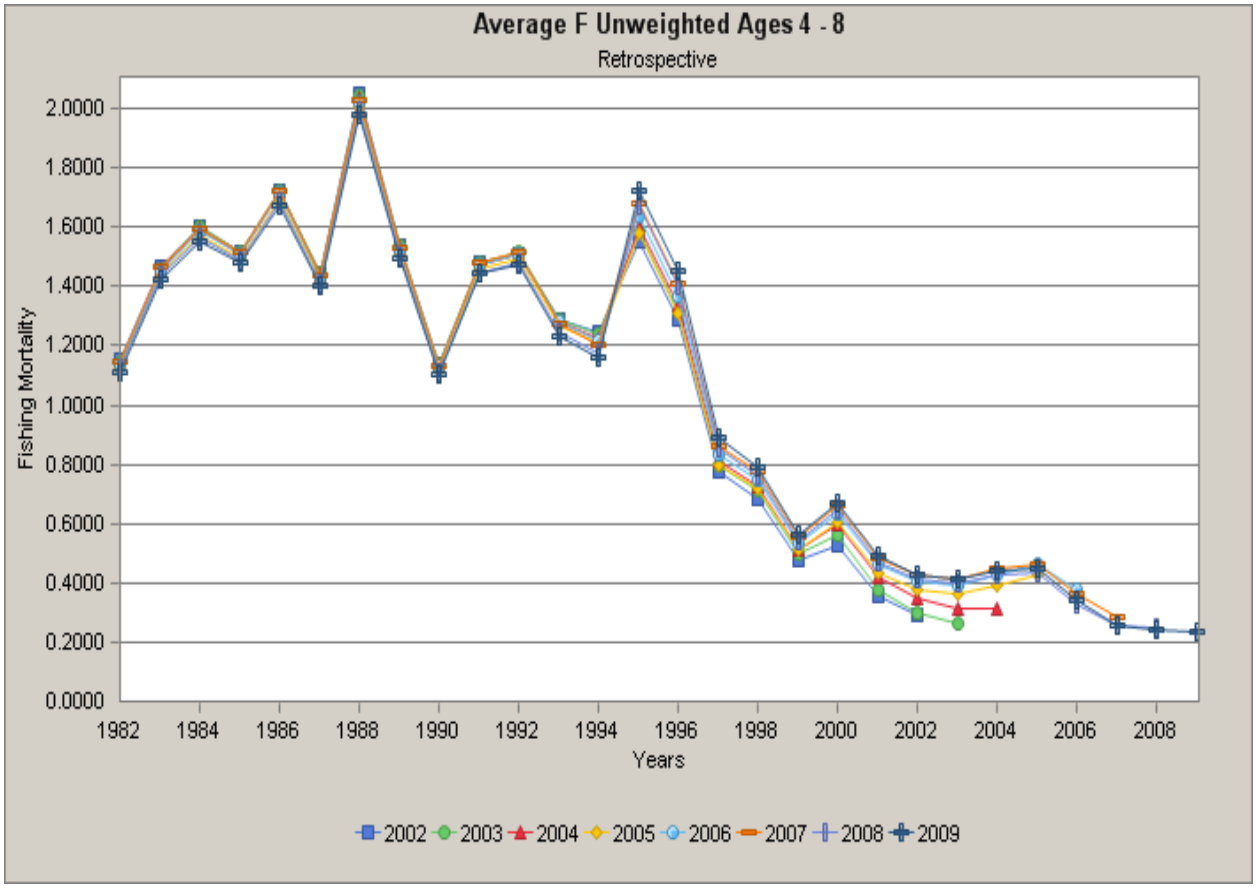

Figure 8. Retrospective analysis of Spawning Stock Biomass (metric tons) for summer flounder.

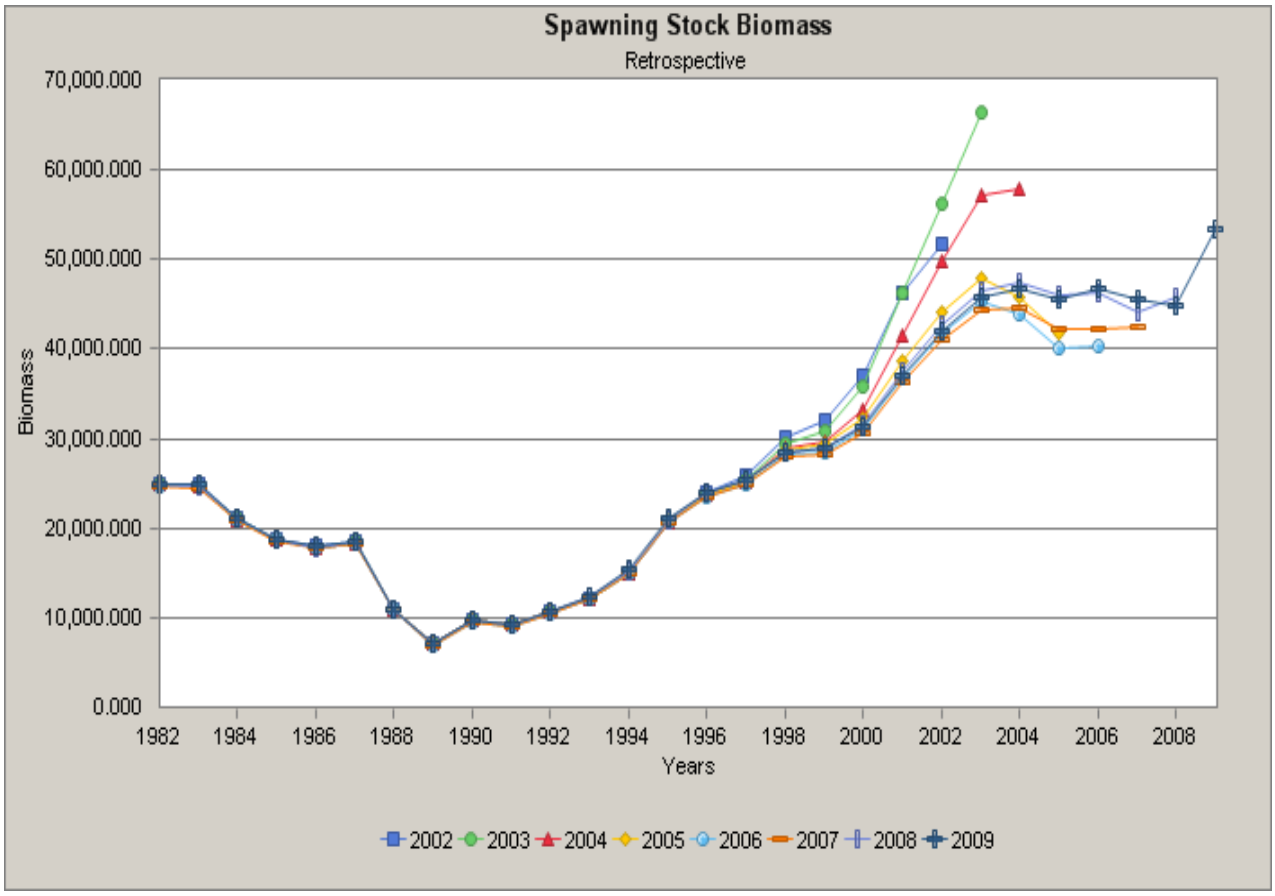

Figure 9. Retrospective analysis of Recruitment (Stock Numbers; 000s age 0 fish) for summer flounder. Note that model age 1 is true age 0.

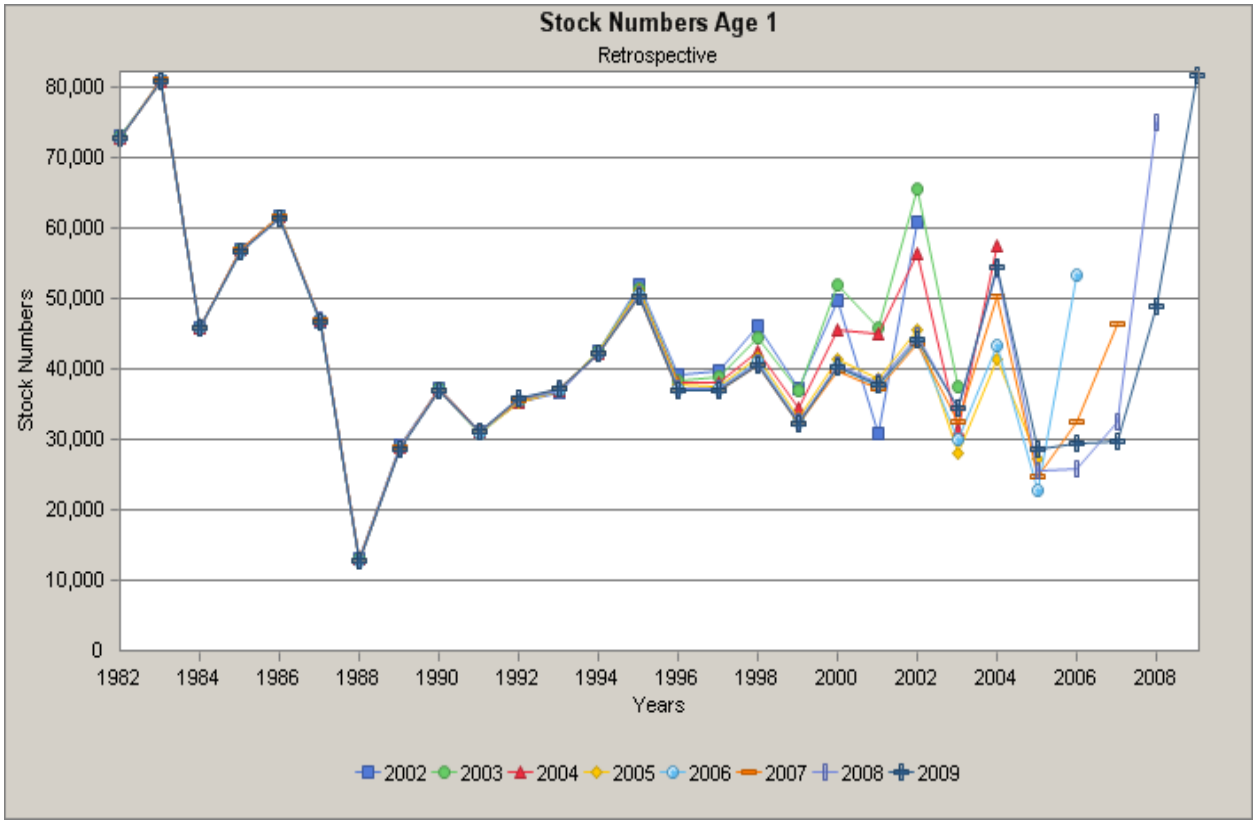

Figure 10. Comparison of Spawning Stock Biomass (SSB; metric tons) estimates from the 2008 SAW47, 2009 updated, and 2010 updated stock assessments for summer flounder.

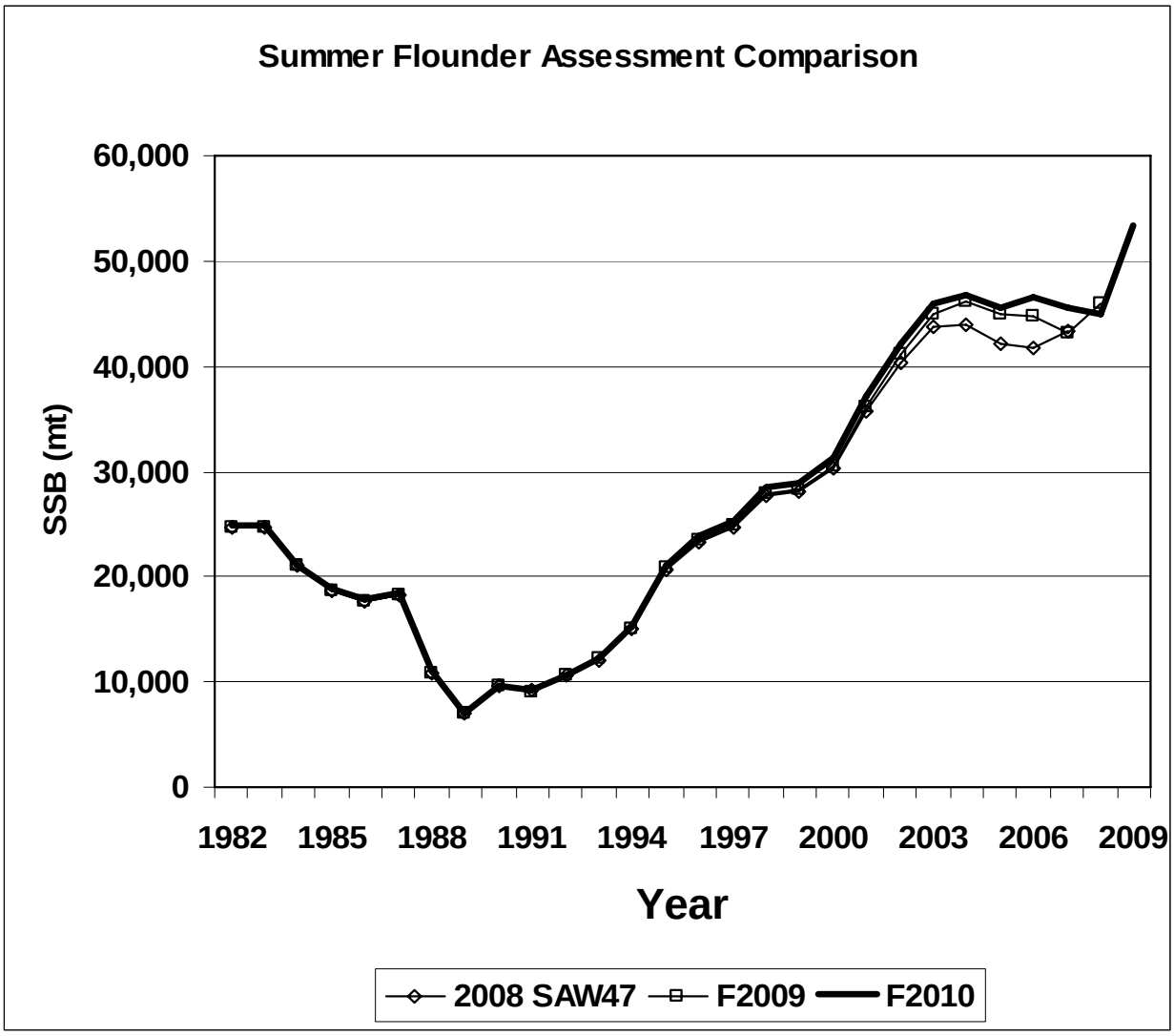

Figure 11. Comparison of Fishing Mortality (F) estimates from the 2008 SAW47, 2009 updated, and 2010 updated stock assessments for summer flounder.

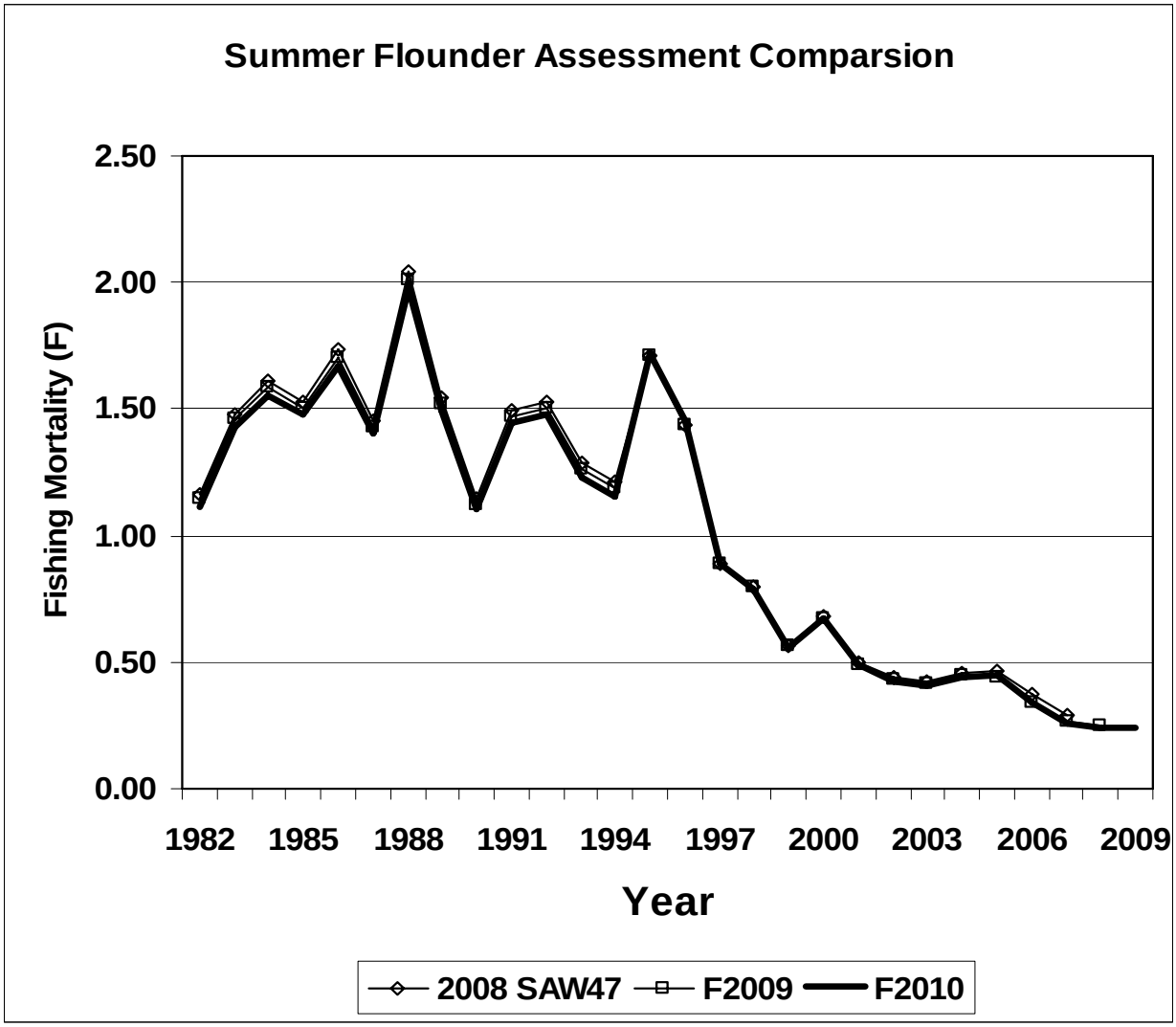

Figure 12. Comparison of Recruitment (000s of age 0 fish) estimates from the 2008 SAW47, 2009 updated, and 2010 updated stock assessments for summer flounder.

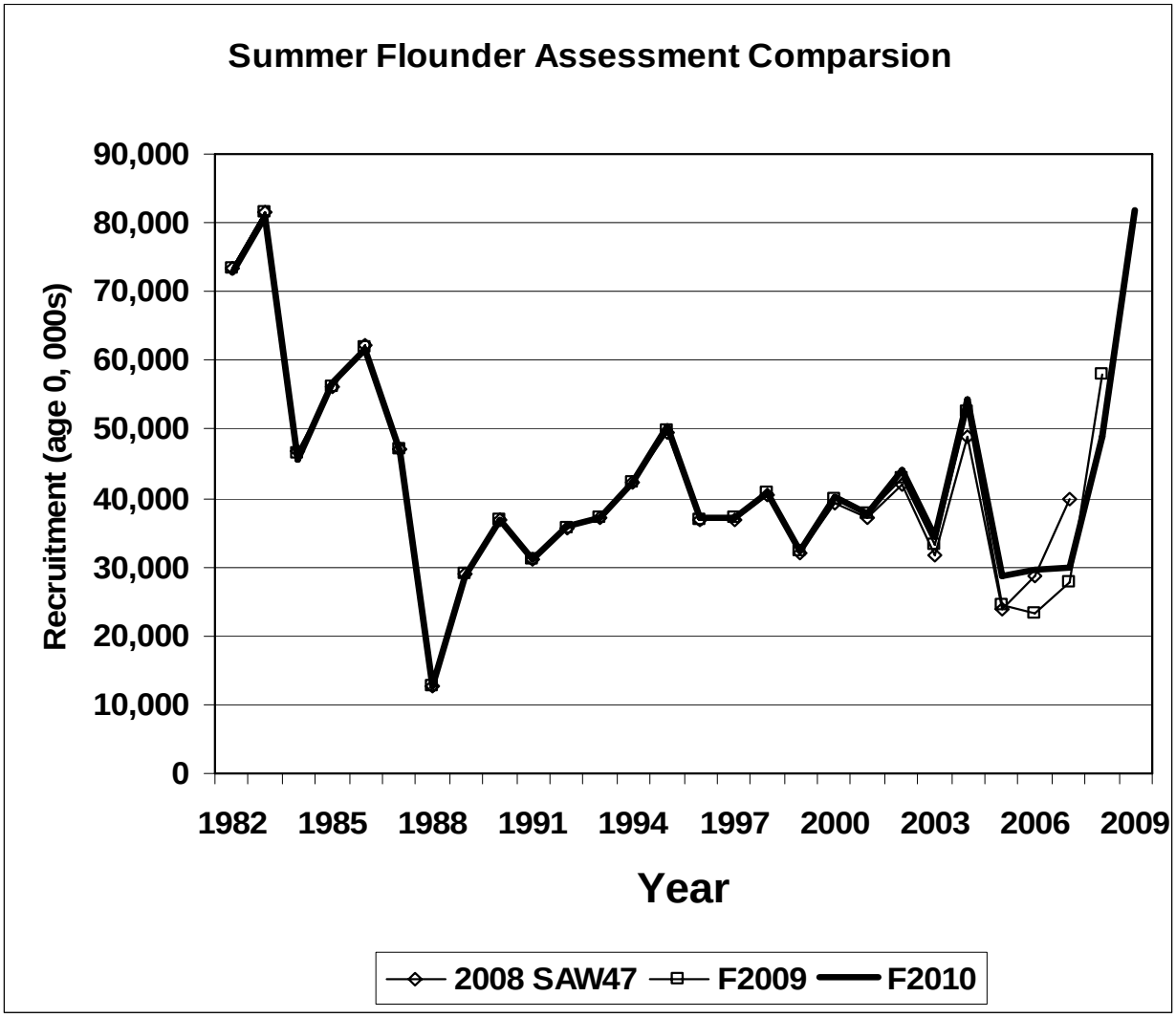

Figure 13. Projection of Landings (top) and Spawning Stock Biomass (bottom) for 2010-2012 at Ftarget = F40% = 0.255.