Bluefish 2011 Stock Assessment Update

Coastal/Pelagic Working Group

Northeast Fisheries Science Center

National Marine Fisheries Service

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Executive Summary

The updated stock assessment was completed by adding catch and indices through 2010 to the previous 1982-2009 assessment. Catch information consisted of commercial landings and length frequencies from Maine to Virginia collected by the Northeast Fisheries Science Center, North Carolina landings and length information collected by NC Division of Marine Fisheries, Florida landings and length information collected by FL Fish and Wildlife Research Institute, and recreational landings and discards from Maine to Florida collected in the NMFS recreational fisheries survey. The catch data were combined with fisheries independent survey data from the Northeast Fisheries Science Center, DE DNR, NJ DEP, CT DEP, coast-wide recreational catch per angler, as well as juvenile indices from the SEAMAP program in the South Atlantic, in a forward projecting catch at age model (ASAP). Fishery dependent and independent information was partitioned into ages using a 2010 age-length key developed by Old Dominion University.

The result of the analysis shows that bluefish is not overfished or experiencing overfishing. Fishing mortality in 2010 was 0.14, below the biological reference point (F_{MSY}) of 0.19. Fishing mortality steadily declined from 0.34 in 1987 to 0.12 in 1999 and has remained steady since 2000 with an average F=0.14. Recent total stock biomass estimates peaked in 1982 at 318.2 thousand MT, then declined to 79.6 thousand MT by 1996 before increasing to the 2010 level of 140.3 thousand MT. Recruitment estimated in the ASAP model has remained relatively constant since 2002 at around 21.4 million age-0 bluefish, with the exception of a relatively large 2006 cohort estimated as 37.3 million fish. However, the 2009 and 2010 recruitment estimates were well below average at 11.2 and 6.7 million fish, respectively. There was no significant retrospective bias in the results. A projection of the abundance through 2013, under five different fishing scenarios between F=0.10 and F=0.19, suggest that continue to biomass will decline due to poor incoming year classes. Changes in the NMFS survey, limited age information, discard size data and model configuration all contribute to the uncertainty in the assessment.

Introduction

The Atlantic coast stock of bluefish (*Pomatomus saltatrix*), distributed from Maine through eastern Florida, is jointly managed by the Atlantic States Marine Fisheries Commission (ASMFC) and the Mid-Atlantic Fishery Management Council (MAFMC). A total annual quota is established and allocations given to commercial and recreational fisheries. The management plan requires a distribution of 80% to recreational and 20% to commercial, with provisions to shift unused recreational quota to commercial fisheries.

A bluefish stock assessment was presented for peer-review at the Northeast Fisheries Science Center Stock Assessment Review Committee meeting (NEFSC SARC 41). The reviewers accepted the assessment for use in management decisions although there were some reservations about the modeling approach. Since the review, the bluefish stock assessment sub-committee (SASC) has produced annual updates while maintaining the basic model settings from the approved assessment. The current assessment is a continuation of the model update with the addition of 2010 catch at age and indices at age information.

Life History

Bluefish, *Pomatomus saltatrix*, is a coastal, pelagic species found in temperate and tropical marine waters throughout the world (Goodbred and Graves 1996; Juanes et al. 1996). Bluefish spawn in offshore waters (Kendall and Walford 1979; Kendall and Naplin 1981). Larvae develop into juveniles in continental shelf waters and eventually move to estuarine and nearshore shelf habitats (Marks and Conover 1993; Hare and Cowen 1994; Able and Fahay 1998; Able et al. 2003). Bluefish are highly migratory along the U.S. Atlantic coast and seasonally move between the U.S. south Atlantic and Middle-Atlantic, traveling as far north as Maine (Shepherd et al., 2006).

Several studies show bluefish to be a moderately long-lived fish with a maximum age of 14 years (Hamer 1959; Lassiter 1962; Richards 1976; Barger 1990; Chiarella and Conover 1990; Terceiro and Ross 1993; Austin et al. 1999; Salerno et al. 2001; Sipe and Chittenden 2002). Bluefish up to 88 centimeter (cm) fork length (FL) have been aged (Chiarella and Conover 1990; Salerno et al. 2001), although Terceiro and Ross (1993) noted considerable variation in mean bluefish size-at-age. Scale ages have been used to estimate von Bertalanffy growth parameters (Lassiter 1962; Barger 1990; Terceiro and Ross 1993; Salerno et al. 2001). The values for L_∞ from these studies (87-128 cm FL) match closely to the largest individuals in catch data and growth rates do not differ between sexes (Hamer 1959; Salerno et al. 2001).

Bluefish grow nearly one-third of their maximum length in their first year (Richards 1976, Wilk 1977). Variation in growth rates or sizes-at-age among young bluefish is evident from the appearance of intra-annual cohorts. Lassiter (1962) identified a spring-spawned cohort and a summer-spawned cohort from the bimodal appearance of size at Annulus I for fish aged from North Carolina and the seasonal cohorts can differ in age by two to three months. Summer-spawned larvae and juveniles grow faster than spring-spawned larvae and juveniles (McBride and Conover 1991) although size differences at annual age diminish greatly after three to four years (Lassiter 1962).

Spawning occurs offshore in the western North Atlantic Ocean, from approximately Massachusetts to Florida (Norcross et al. 1974; Kendall and Walford 1979; Kendall and Naplin 1981; Collins and Stender 1987). Bluefish are characterized as multiple spawners with indeterminate fecundity which spawn continuously during their spring migration (Robillard et al. 2008). In addition to distinctive spring and summer cohorts, Collins and Stender (1987) identified a fall-spawned cohort, demonstrating the potential of an extended bluefish spawning season.

Bluefish in the western North Atlantic are managed as a single stock (NEFSC 1997; Shepherd and Packer 2006). Genetic data support a unit stock hypothesis (Graves et al. 1992; Goodbred and Graves 1996; Davidson 2002). For management purposes, the ASMFC and MAFMC define the management unit as the portion of the stock occurring along the Atlantic Coast from Maine to the east coast of Florida.

Fisheries Dependent Data

Annual catch information was developed for five components of the commercial fishery. Commercial landings from Maine to Virginia, North Carolina commercial landings, Florida commercial landings, coast-wide recreational landings and coast-wide recreational discards.

Commercial fisheries from Maine to Virginia were sampled as part of the NEFSC data collection program. Lengths were sampled from a variety of gears and market categories. Expansion of length data was completed by market category and quarter of the year, with the results merged into half year periods. In 2010 a total of 4,930 measurements from 91 samples were collected across all market categories from total landings of 1,601 mt (50% of all commercial landings; Table 1). Market category/quarter with inadequate length samples were filled with length information from adjacent quarters within the same market category or from NC samples if necessary.

North Carolina commercial landings were expanded using length samples collected by NC Division of Marine Fisheries. A total of 1,042 measurements from 24 samples were collected from landings of 1,463 mt (Table 1). Expansion of landings at length were done by quarter, market category and gear type then combined into half year totals. Length samples from Florida 2010 commercial landings were also available. A total of 706 lengths from 53 samples were used to expand commercial landings of 143 mt (Table 1). No landings were reported for South Carolina or Georgia. Total coast-wide commercial landings in 2010 were 3,206 mt, an increase of 55 mt from 2009 (Figure 1).

Length frequencies from commercial fisheries are characterized by a multi-modal distribution (Figure 2). In 2010 the distribution was strongly bimodal with one peak at 38 cm and a second around 70 cm. There were few fish below 25 cm. In comparison, the 2006 and 2008 distribution included a third mode around 55 cm. The 2009 distribution, as well as previous years, was similarly bimodal.

Recreational landings are sampled for length as part of the MRFSS program. The 2010 recreational landings were 8,184 mt, an increase from 6,161 mt in 2009 (Table 2, Figure 3). The MRFSS 2010 length samples (N=2,968) were used to expand recreational landings per half year. Recreational discards in 2010 were estimated at 16,059 mt, however after adjusting for a 15% mortality rate, the resulting discard loss was 2,409 mt. A recent publication (Fabrizio et al 2008) shows that mortality may be higher and the 15% should be reevaluated in the next benchmark assessment. Length sampling for bluefish discards in MRFSS at-sea sampling of recreational party boats provided lengths of 195 discarded bluefish. In addition, lengths of bluefish tagged and released in the American Littoral Society tagging program (by definition B2 catches) were included in the length distribution (n=960). Total combined (commercial and recreational) length frequencies are presented in Figure 5.

Age data (n=393) were provided by Virginia Marine Resources Commission and Old Dominion University ageing lab. Since the age key developed from the VA samples was the only 2010 age information available, it was applied to both fishery dependent and independent length data. Age data was provided by cm, fork length by half year. In previous years the age key was provided for fish measured to total length, inches while the length frequencies were measured in fork length to the nearest cm. Consequently, previous length frequencies were converted to TL, inches using the following equation:

$$TL(in) = 0.245(FL(cm)) + 0.440$$

For the assessment update, the age keys for 2004-2010 were made available in FL, cm. Previous years data were updated (which included updating catch totals) and length frequencies expanded using the revised age-length keys. In addition, the length frequencies by age were converted to weight for calculation of annual weights at age (beginning with 2004) (Table 3 Figure 6). Length-weight equations from the spring and fall NEFSC bottom trawl survey were used for calculating weights at age. Due to low sample size in spring surveys, all years beginning with 1993 were used in the equation (n=205, a=-11.289, b=2.985). Fall equations were estimated from combined 2004-2010 length-weight data (n=3334, a=-11.621, b=3.096).

The previous catch at age through 2009 and the updated catch at age through 2010 are presented in table 4a and 4b. As in previous bluefish assessments the ages are summarized in a plus category for ages 6 and above to reduce the effect of aging error.

Fisheries Independent Data

Survey indices as used in the previous bluefish assessment were updated for 2010. These indices include SEAMAP juvenile (age 1) indices, Northeast Fisheries Science Center (NEFSC) bottom trawl survey indices for ages 0 to 6+, NJ bottom trawl survey indices of ages 0 to 2, DE bottom trawl survey indices for ages 0 to 2 and Marine Recreational Fisheries Statistics Survey (MRFSS) recreational catch per angler trip

(CPA) for ages 0 to 6+. The CT survey in 2008 and 2010 were not conducted during the month of September, therefore these indices were treated as missing data. The NEFSC survey in 2009 was modified by the replacement of the FV Albatross IV with the FSV Henry B. Bigelow. The consequence of the replacement was a change in the areas surveyed and the efficiency of the survey due to a change in net size and towing speed (as well as other intangibles associated with a different vessel). Beginning in 2009 only the outer third of the inshore strata set was sampled by the Bigelow. In addition, a conversion coefficient of 1.16 was used to convert Bigelow mean number per tow into equivalent Albatross units (Miller et al., 2010).

Among these survey indices, there were no consistent trends in total abundance. The total NEFSC index (ln re-transformed stratified mean number per tow) declined to 6.66 in 2010 from 12.8 in 2008 (Table 5). The series arithmetic average index equaled 26.6 (geometric mean of 13.89). The 2010 Delaware survey index of ages 0 to 2 was 0.481 fish per tow, and below the time series average (0.520 per tow; Table 6). New Jersey trawl survey indices of ages 0 to 2 for 2010 (1.64 fish/tow) was also below the time series average of 6.3 per tow (Table 6). No indices of bluefish abundance in Long Island Sound from the CT DEP survey were available from 2010 however, ages 0 to 6+ in 2009 (32.86 per tow) were about average for the series (33.42 per tow; Table 7). Recreational catch per angler trip showed a small increase to 0.978 fish per angler trip in 2010, an increase from 0.832 in 2009 (Table 8). The recreational catch per angler was modeled in a general linear model using a negative binomial error structure. The year coefficient partitioned into ages (assuming the same proportion as the recreational catch) was used in the ASAP model as a relative index of abundance.

Standardized recruitment indices (age 0) were developed using Z scores to compare the relative 2010 indices to time series averages. Indices from NEFSC, DE, NJ, and the Recreational CPA were all below average (Table 9, Figure 7).

ASAP Model

The initial ASAP model (version 2.0.20) was run with the previous 1982-2009 input file updated for 2010 total catch, catch at age, weight at age and indices at age. The fishery was modeled as a single fleet with selectivity fixed as a bimodal pattern with full recruitment at age 1 (coded age 2). Model weighting factors remained the same as previous assessments with the model heavily weighted towards the fishery total catch rather than survey indices. Natural mortality was fixed at 0.2 and maturity at age was held constant with full maturity at age 3. The updated model was run using the same parameter settings while substituting the updated catch and weight at age matrices. The modifications to the input matrices had little influence on the resulting trends in population number or biomass (Appendix I).

The results of the updated ASAP model showed a decrease in total abundance since 2006, declining from 97.9 million to 72.2 million fish (Table 10, Figure 8). The decline is primarily the result of poor 2009 and 2010 year classes. Prior to 2009 and 2010, recruitment had remained relatively constant since 2000 at 21.4 million age-0 bluefish, with the exception of a large 2006 cohort estimated as 37.3 million fish. The 2009 recruitment estimate was below average at 11.2 million fish compared to the series average of 22.8 million (Figure 9). Estimated recruitment in 2010 was the lowest in the time series at 6.7 million. However among other age groups, the estimate of age 6-plus bluefish continued to be large at 12.9 million, the second highest since 1990. Total mean biomass in 2010 equaled 140,297 mt, a slight decrease since 2009. (Figure 10, Table 11). Corresponding spawning stock biomass (SSB) in 2010 was 134,065 mt (Figure 10). Updates to the mean weight at age has occurred in the current assessment, consequently direct comparison of biomass estimates to previous bluefish assessments updates is not appropriate.

Fishing mortality estimates in ASAP are based on a separability assumption with F at age the product of F_{MULT} and selectivity. Full selectivity is fixed at age 1. The 2010 F_{MULT} value equals 0.14 (Figure 8). Fishing mortality steadily declined from 0.34 in 1987 to 0.12 in 1999 and has remained steady since 2000 with an average F=0.14.

Retrospective bias for the final model was examined for F, total abundance, recruitment (age 0) and total biomass. The analysis shows little evidence of bias in the estimates (Figure 11). The variation in the final model results for F and SSB was determined using a Monte Carlo Markov chain with 1000 iterations and a thinning factor of 100. The MCMC results of variation around F ranged from 0.114 to 0.159, with the

80% CI between 0.128 and 0.147. Estimates for SSB ranged from 114,623 to 158,030 mt, with an 80% CI between 124,044 mt and 140,788 mt. (Figure 12).

Projections

Bluefish abundance and biomass through 2013 were examined for a range of fishing scenarios with a stochastic projection in AGEPRO software. Weight at age in 2011-2013 was assumed equal to 2010, recruitment was derived from a random draw of 28 empirical estimates of age 0 abundance since 1982 and initial population size was drawn from the output of the MCMC run. Fishing mortality for 2011 was assumed equal to targeted F of 0.15. Five projection scenarios were examined: F =0.10, F=status quo (0.14) (equivalent to F equal to 75% of F_{MSY} (0.14)), F_{target} (0.17) which equals 90% of F_{MSY} as defined in FMP, $F_{0.1}$ (0.16) from the yield per recruit, and F_{MSY} (0.19)

Results of the projections show a decrease in mean biomass and SSB for each scenario including a reduced F (F=0.10) (Table 12, Appendix II). However, abundance could continue to increase in all 5 cases. Yield through 2013 would be projected as lower for F scenarios of status quo or less. Under status quo F (0.14), projected 2012 yield would increase to 13,953 mt, which includes commercial and recreational landings as well as recreational discards losses.

Biological Reference Points

The current biological reference points for bluefish were determined in SARC 41 and are F_{MSY} (0.19) and B_{MSY} (147,052 mt). The basis for the reference points was the Sissenwine-Shepherd method using the Beverton-Holt stock recruitment parameters and SSB per recruit results generated by the SARC 41 ASAP model results. B_{MSY} was calculated using mean weights at age and is therefore comparable to mean biomass in year *t*. The 2010 estimate of mean total biomass is 140,297 mt ($\pm$1 std. dev. of 6,671 mt), which is slightly below B_{MSY} but well above ½ B_{MSY} of 73,526 mt. The 2010 estimate of fishing mortality (0.14) remains below F_{MSY}. An alternative approach to estimating B_{MSY} is calculation of an equilibrium bluefish biomass when fished at F_{MSY}, using a long term projection. This biomass, determined from a 50 year projection with re-sampling of

1982-2010 recruitment estimates, equaled 105,699 mt (Table 13). The comparable 2010 biomass estimate (140,297 mt) is 1.33 times greater than this alternative B_{MSY}.

Model Uncertainty

Model uncertainty can be characterized using the MCMC simulations to produce a distribution of possible outcomes given the model input parameters. However, these results do not capture the uncertainty from variations in the model input parameters. Forward projecting catch at age models are extremely flexible in applying weighting factors to emphasize either catch data or survey data. To illustrate the impact of changes to these weightings, as well as other factors, an ASAP model was run with changes to the effective sample size and changes to index lambdas and CVs to force the model to fit closer to the annual indices (Table 14). The resulting fishing mortality in 2010 was 0.19 with an SSB estimate of 94,362 mt, outside the 80% confidence interval associated with the MCMC simulation for the base model.

Conclusion

The conclusion of the updated assessment is that the Atlantic coast bluefish stock continues above B_{MSY} while remaining below F_{MSY} and is not considered overfished or experiencing overfishing. The estimates of the model show little variation or significant retrospective patterns. The lack of variation is due in part to the fixed parameters for selectivity. Nevertheless, uncertainty remains in several aspects of the assessment input data. Age data continues to be limited to one age key from a limited set of samples. The assumption that this age information is applicable to all areas remains untested. Length samples from recreational discards are limited and contribute to the uncertainty as does the lack of commercial discard estimates. Changes in the NEFSC inshore survey series, from both vessel changes and sample area adjustments, significantly alter indices. Strata inshore of 15 fathoms are currently sampled as part of the NEMAP survey, but the time series is not yet adequate to provide a tuning index.

The highly migratory nature of bluefish populations and the recruitment dynamics of the species create a unique modeling situation. Migration creates seasonal fisheries with unique selectivity patterns resulting in a bimodal partial recruitment pattern. This pattern has been identified in previous assessments as a source of uncertainty in the results and has been held constant in the model. The migratory pattern in bluefish also results in several recruitment events. A spring cohort, originating south of Cape Hatteras, NC during spring migrations, and a summer cohort originating in the offshore Mid-Atlantic Bight result in a bimodal age-0 size distribution. It has been hypothesized that the success of the spring cohort controls the abundance of adult bluefish. Future assessments should include any additional information that could index seasonal abundance of incoming recruitment.

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Table 1. Commercial landings (mt) by state groupings used in length expansions.

	ME - VA	NC	SC-FL	Total
1982	4,137	1,946	914	6,997
1983	3,421	3,061	685	7,166
1984	3,046	1,615	720	5,380
1985	4,199	1,634	289	6,122
1986	4,559	1,562	531	6,651
1987	3,805	2,069	705	6,578
1988	4,277	2,286	599	7,161
1989	2,793	1,493	455	4,740
1990	3,684	2,076	489	6,250
1991	3,709	1,778	673	6,160
1992	3,423	1,288	495	5,205
1993	3,039	1,226	543	4,808
1994	3,071	809	424	4,304
1995	2,034	1,365	229	3,628
1996	2,654	1,496	62	4,212
1997	2,165	1,815	129	4,109
1998	2,257	1,327	155	3,739
1999	1,921	1,252	157	3,330
2000	2,057	1,525	64	3,647
2001	2,038	1,844	63	3,945
2002	2,025	1,054	37	3,116
2003	1,739	1,574	45	3,358
2004	1,885	1,707	56	3,647
2005	1,844	1,122	71	3,037
2006	1,851	1,146	45	3,042
2007	2,282	909	76	3,267
2008	1,766	762	57	2,585
2009	1,959	1,096	97	3,151
2010	1,601	1,463	143	3,206

Table 2. Commercial landings, recreational landings, recreational discard loss and total catch for bluefish, ME-FL.

Year	Commercial Landings (mt)	Commercial Landings (000 lbs)	Recreational Landings (mt)	Recreational Discard (mt)	Recreational Catch (mt)	Total Landings (mt)	Total Catch (mt) (w/o commercial discards)
1974	4,538	10,005					
1975	4,402	9,705		**assumes same**			
1976	4,546	10,022		**mean wt**			
1977	4,802	10,587		**as landings**			
1978	4,986	10,992					
1979	5,693	12,551					
1980	6,857	15,117					
1981	7,465	16,457	43,222	*2,001*	*45,223*		52,688
1982	6,997	15,426	37,651	*832*	*38,483*	44,648	45480
1983	7,166	15,798	40,425	*1,280*	*41,705*	47,591	48871
1984	5,380	11,861	30,597	*1,260*	*31,857*	35,977	37237
1985	6,122	13,497	23,821	*599*	*24,420*	29,943	30542
1986	6,651	14,663	42,133	*1,544*	*43,677*	48,784	50328
1987	6,578	14,502	34,769	*1,615*	*36,384*	41,347	42962
1988	7,161	15,787	21,873	*1,146*	*23,019*	29,034	30180
1989	4,740	10,450	17,808	*989*	*18,797*	22,548	23537
1990	6,250	13,778	13,860	*929*	*14,789*	20,110	21039
1991	6,160	13,580	14,967	*1,194*	*16,161*	21,127	22320
1992	5,205	11,475	11,011	*979*	*11,990*	16,216	17195
1993	4,808	10,600	9,204	*1,013*	*10,217*	14,012	15025
1994	4,304	9,488	7,049	*1,128*	*8,177*	11,353	12481
1995	3,628	7,998	6,489	*1,003*	*7,492*	10,117	11120
1996	4,113	9,066	5,328	*1,010*	*6,338*	9,441	10451
1997	4,064	8,960	6,487	*1,287*	*7,774*	10,551	11838
1998	3,739	8,242	5,595	*999*	*6,594*	9,334	10333
1999	3,330	7,341	3,744	*1,191*	*4,935*	7,074	8264
2000	3,647	8,040	4,811	*1,675*	*6,486*	8,458	10132
2001	3,945	8,697	6,001	*1,857*	*7,858*	9,946	11803
2002	3,116	6,869	5,158	*1,448*	*6,606*	8,274	9721
2003	3,358	7,403	5,958	*1,331*	*7,289*	9,316	10647
2004	3,647	8,041	7,179	*1,761*	*8,940*	10,826	12587
2005	3,187	7,026	8,225	*1,915*	*10,140*	11,412	13327
2006	2,926	6,450	7,663	*1,860*	*9,523*	10,589	12449
2007	3,267	7,182	9,608	*2,653*	*12,261*	12,874	15527
2008	2,585	5,655	8,573	*2,443*	*11,016*	11,158	13601
2009	3,151	6,990	6,161	*960*	*7,121*	9,312	10273
2010	3,206	7,069	8,184	*2,409*	*10,593*	11,390	13799

Table 3. Bluefish mean weight at age (kg), 1982-2010.

catch weight at age (kg)

	0	1	2	3	4	5	6+
1982	0.140	0.490	1.520	2.050	3.200	4.232	4.958
1983	0.100	0.420	0.990	2.150	3.160	4.417	5.577
1984	0.100	0.410	0.930	1.830	2.910	4.483	5.650
1985	0.100	0.400	0.970	1.930	2.820	3.991	5.053
1986	0.120	0.490	1.200	2.320	3.150	4.303	4.848
1987	0.120	0.300	1.180	2.020	2.960	3.927	4.984
1988	0.170	0.400	1.000	2.050	2.840	3.564	4.623
1989	0.130	0.300	1.060	2.120	3.640	4.106	4.720
1990	0.210	0.500	0.880	1.730	3.240	4.177	4.474
1991	0.140	0.330	0.700	1.730	2.810	3.963	4.965
1992	0.160	0.390	1.040	1.890	2.800	3.303	5.107
1993	0.180	0.590	0.950	2.460	2.730	3.237	4.880
1994	0.120	0.400	0.900	1.880	3.040	3.757	4.093
1995	0.170	0.440	0.980	1.730	2.850	4.058	4.696
1996	0.170	0.440	0.980	1.730	2.850	4.058	4.696
1997	0.113	0.483	1.048	2.360	3.301	4.411	6.005
1998	0.173	0.570	0.891	2.314	3.387	4.079	5.906
1999	0.133	0.511	0.890	2.111	3.577	4.168	5.960
2000	0.160	0.430	0.959	2.692	3.508	3.659	5.851
2001	0.134	0.383	0.830	2.339	3.608	3.846	4.926
2002	0.143	0.495	1.119	2.284	2.922	3.872	5.158
2003	0.101	0.556	1.007	2.308	2.774	4.170	5.011
2004	0.069	0.371	1.049	1.949	2.779	3.639	4.488
2005	0.135	0.564	0.980	2.316	3.434	4.310	5.529
2006	0.160	0.525	1.125	2.081	3.379	3.664	5.317
2007	0.066	0.421	1.168	2.408	3.018	3.476	5.006
2008	0.151	0.407	1.263	2.359	3.169	3.747	4.756
2009	0.081	0.450	1.270	2.394	3.444	3.690	4.880
2010	0.098	0.384	0.975	1.580	3.470	4.017	4.979

Table 4(a). Total bluefish catch at age (000s), original 1982-2009, ME to FL, with updated 2010.

	Age							
CAA (000s)	0	1	2	3	4	5	6+	total
1982	11164.1	9747.9	2850.8	2439.3	795.3	1213.5	3736.3	31947.2
1983	4778.4	7666.7	8686.1	3022.0	970.6	1325.3	4778.4	31227.5
1984	7121.3	6807.3	6718.5	2039.9	895.1	744.7	3176.7	27503.5
1985	4676.7	6468.8	5773.3	2925.5	1328.5	520.0	2377.1	24069.9
1986	5169.3	8070.7	8728.0	2801.7	1056.4	1703.1	4465.0	31994.2
1987	3127.1	5419.5	5177.8	5757.4	2009.3	1083.0	3948.2	26522.3
1988	1709.8	2083.6	2524.0	1588.6	1984.1	1598.6	2740.4	14229.1
1989	3473.6	5672.6	3221.1	992.1	395.9	1168.5	2409.8	17333.6
1990	2726.7	7185.8	1840.7	687.2	381.8	431.6	2478.6	15732.4
1991	3694.6	5292.6	7391.9	1590.7	310.9	224.7	2136.5	20641.9
1992	2131.3	9633.3	1709.8	2352.9	583.4	479.2	967.2	17857.1
1993	1194.1	2081.6	1566.9	593.0	1040.8	669.0	1178.9	8324.3
1994	1970.8	3144.3	1313.3	368.1	296.7	849.5	1073.1	9015.8
1995	1822.8	3371.4	735.7	137.7	214.1	695.7	1057.8	8035.2
1996	1701.5	2145.1	631.5	202.2	207.2	545.0	1411.8	6844.3
1997	1634.1	4299.3	1496.2	510.5	196.6	93.4	1212.3	9442.4
1998	683.5	2754.1	2786.1	861.3	261.0	308.0	458.8	8112.8
1999	1638.5	1946.1	2096.7	572.8	174.7	352.5	482.8	7264.1
2000	667.4	4396.5	2693.3	717.7	96.9	536.0	155.9	9263.7
2001	1414.3	4466.7	3466.2	1151.9	198.3	608.0	243.5	11548.9
2002	587.1	5145.6	1661.6	542.6	340.3	236.8	415.9	8929.9
2003	819.3	2646.0	3975.0	774.6	377.9	319.8	644.0	9556.6
2004	434.4	5270.8	2289.6	1265.2	435.4	473.5	662.8	10831.7
2005	3262.8	2560.5	4179.2	1389.9	411.9	585.4	494.7	12884.4
2006	2718.6	3489.6	2975.5	1090.2	301.9	283.5	662.6	11521.9
2007	695.0	3065.0	5390.0	1548.2	852.7	582.7	1375.2	13508.8
2008	893.1	3725.3	4011.6	463.1	615.1	239.1	396.3	10343.6
2009	144.5	3083.9	2857.8	482.1	354.2	236.5	599.9	7758.9
2010	275.7	3234.7	4089.7	706.0	611.2	375.0	812.2	10104.5

Table 4(b). Revised bluefish catch at age (000s), 1982-2010, Maine to Florida.

	Age							
CAA (000s)	0	1	2	3	4	5	6+	total
1982	11164.1	9747.9	2850.8	2439.3	795.3	1213.5	3736.3	31947.2
1983	4778.4	7666.7	8686.1	3022.0	970.6	1325.3	4778.4	31227.5
1984	7121.3	6807.3	6718.5	2039.9	895.1	744.7	3176.7	27503.5
1985	4676.7	6468.8	5773.3	2925.5	1328.5	520.0	2377.1	24069.9
1986	5169.3	8070.7	8728.0	2801.7	1056.4	1703.1	4465.0	31994.2
1987	3127.1	5419.5	5177.8	5757.4	2009.3	1083.0	3948.2	26522.3
1988	1709.8	2083.6	2524.0	1588.6	1984.1	1598.6	2740.4	14229.1
1989	3473.6	5672.6	3221.1	992.1	395.9	1168.5	2409.8	17333.6
1990	2726.7	7185.8	1840.7	687.2	381.8	431.6	2478.6	15732.4
1991	3694.6	5292.6	7391.9	1590.7	310.9	224.7	2136.5	20641.9
1992	2131.3	9633.3	1709.8	2352.9	583.4	479.2	967.2	17857.1
1993	1194.1	2081.6	1566.9	593.0	1040.8	669.0	1178.9	8324.3
1994	1970.8	3144.3	1313.3	368.1	296.7	849.5	1073.1	9015.8
1995	1822.8	3371.4	735.7	137.7	214.1	695.7	1057.8	8035.2
1996	1701.5	2145.1	631.5	202.2	207.2	545.0	1411.8	6844.3
1997	1634.1	4299.3	1496.2	510.5	196.6	93.4	1212.3	9442.4
1998	683.5	2754.1	2786.1	861.3	261.0	308.0	458.8	8112.8
1999	1638.5	1946.1	2096.7	572.8	174.7	352.5	482.8	7264.1
2000	667.4	4396.5	2693.3	717.7	96.9	536.0	155.9	9263.7
2001	1414.3	4466.7	3466.2	1151.9	198.3	608.0	243.5	11548.9
2002	587.1	5145.6	1661.6	542.6	340.3	236.8	415.9	8929.9
2003	819.3	2646.0	3975.0	774.6	377.9	319.8	644.0	9556.6
2004	420.9	4445.2	2683.8	1276.9	429.5	507.0	816.4	10579.8
2005	2756.1	2139.9	3953.0	1907.3	563.0	629.7	576.5	12525.4
2006	1291.6	3212.1	2554.9	1844.1	1392.2	419.2	845.7	11559.8
2007	639.0	5181.4	4255.6	1529.3	927.1	300.3	679.1	13511.7
2008	839.8	4242.2	3327.5	878.9	762.1	424.3	523.0	10997.9
2009	94.5	2858.7	2783.3	682.3	490.3	320.1	633.2	7862.4
2010	254.5	2925.0	3924.7	631.5	640.5	377.9	836.2	9590.2

Table 5. NEFSC bluefish indices by age using fall inshore strata and re-transformed $\log_e$ stratified mean number per tow. * indices changed with conversion factor=1.16.

	0	**1**	**2**	**3**	**4**	**5**	**6+**	**total**
1982	18.768	10.788	0.064	0.053	0.011		0.023	29.71
1983	8.189	16.695	0.845	0.034	0.004	0.017	0.068	25.85
1984	81.356	40.869	1.257	0.201	0.120	0.052	0.147	124.00
1985	17.473	9.703	0.925	0.428	0.096	0.036	0.088	28.75
1986	21.055	0.923	0.042	0.060	0.024	0.028	0.033	22.17
1987	7.589	1.768	0.167	0.238	0.098	0.049	0.158	10.07
1988	9.493	0.067	0.009	0.010	0.028	0.006	0.023	9.64
1989	237.573	1.254	0.113	0.130		0.014	0.119	239.20
1990	6.186	3.637	0.006	0.016	0.016		0.084	9.95
1991	7.878	0.154	0.050	0.026	0.001		0.001	8.11
1992	6.625	0.637	0.016	0.022	0.002	0.002	0.008	7.31
1993	1.109	0.123	0.044	0.003	0.034	0.023		1.34
1994	6.580	0.760	0.010	0.019	0.030	0.021	0.006	7.43
1995	9.222	4.122	0.115	0.015	0.015	0.025	0.062	13.58
1996	9.643	1.638	0.211	0.144	0.027	0.021	0.019	11.70
1997	4.179	0.482	0.217	0.107	0.002	0.007	0.013	5.01
1998	4.793	0.387	0.074	0.045	0.017			5.32
1999	15.266	1.528	0.061	0.051	0.018	0.002	0.008	16.93
2000	2.485	1.517	0.157	0.017	0.015	0.006		4.20
2001	8.819	0.754	0.148	0.020	0.002	0.001	0.003	9.75
2002	7.815	1.210	0.042	0.037				9.10
2003	48.332	3.085	0.277	0.019	0.006	0.022	0.043	51.78
2004	7.048	5.307	0.372	0.079	0.008	0.012	0.031	12.86
2005	24.086	0.705	0.107	0.098	0.031	0.030	0.012	25.07
2006	36.300	1.017	0.714	0.016				38.05
2007	8.837	7.064	0.583	0.082	0.012	0.004	0.009	16.59
2008	7.444	4.543	0.797	0.012	0.010	0.009	0.026	12.84
2009*	*1.050*	*5.385*	*0.503*	*0.013*	*0.011*	*0.000*	*0.037*	7.00
2010*	*2.559*	*3.352*	*0.527*	*0.029*	*0.069*	*0.028*	*0.093*	6.66

Table 6. Bluefish survey indices by age (stratified geometric mean number per tow) from Delaware and New Jersey trawl surveys.

	Delaware				New Jersey			
	0	**1**	**2**	**total**	**0**	**1**	**2**	**total**
1982	0.025							
1983	0.024							
1984	0.039							
1985	0.022							
1986	0.081							
1987	0.073							
1988	0.114				26.066	0.411	0.002	26.48
1989	0.267				7.041	0.544	0.026	7.61
1990	0.082	0.683	0.015	0.780	5.947	0.299	0.005	6.25
1991	0.132	0.209	0.004	0.345	3.652	0.009	0.020	3.68
1992	0.071	0.211	0.003	0.285	3.747	0.582	0.040	4.37
1993	0.063	0.220	0.013	0.296	2.483	0.085	0.109	2.68
1994	0.103	0.295	0.004	0.401	11.179	0.231	0.017	11.43
1995	0.093	0.376	0.031	0.500	5.055	0.238	0.050	5.34
1996	0.081	0.426	0.017	0.524	2.483	0.096	0.015	2.59
1997	0.147	0.317	0.023	0.486	3.930	0.075	0.034	4.04
1998	0.080	0.581	0.107	0.768	1.719	0.243	0.154	2.12
1999	0.097	0.439	0.034	0.570	1.710	0.350	0.035	2.10
2000	0.113	0.365	0.047	0.525	1.410	0.395	0.102	1.91
2001	0.290	0.555	0.107	0.952	0.400	0.068	0.090	0.56
2002	0.159	1.210	0.047	1.416	7.924	3.469	0.077	11.47
2003	0.038	0.224	0.012	0.274	6.793	0.196	0.077	7.06
2004	0.074	0.836	0.030	0.940	2.217	0.510	0.422	3.15
2005	0.060	0.127	0.009	0.195	6.075	0.286	0.180	6.54
2006	0.039	0.070	0.020	0.129	6.520	0.175	0.102	6.80
2007	0.093	0.321	0.021	0.436	9.161	3.750	0.326	13.24
2008	0.087	0.172	0.016	0.275	8.629	1.213	0.070	9.91
2009	0.031	0.282	0.029	0.342	2.907	0.286	0.016	3.21
2010	0.031	0.383	0.066	0.481	1.392	0.215	0.033	1.64

Table 7. Bluefish survey indices by age (stratified geometric mean number per tow) from CT DEP trawl survey.

CT trawl

	0	1	2	3	4	5	6+	total
1982								
1983								
1984	52.101	0.800	0.760	0.298	0.054	0.014	0.041	54.068
1985	36.368	1.573	1.075	0.498	0.244	0.044	0.131	39.933
1986	8.727	0.547	0.352	0.083	0.053	0.028	0.018	9.808
1987	14.357	2.229	0.951	0.279	0.213	0.131	0.070	18.230
1988	13.122	0.851	0.567	0.358	0.234	0.173	0.106	15.411
1989	47.873	1.900	0.732	0.205	0.347	0.282	0.072	51.411
1990	28.027	3.499	0.742	0.106	0.141	0.200	0.024	32.739
1991	36.482	5.233	2.078	0.194	0.135	0.164	0.075	44.361
1992	24.585	3.359	1.750	0.172	0.152	0.283	0.005	30.306
1993	25.810	1.241	2.161	0.877	0.385	0.107		30.581
1994	30.018	1.410	0.752	0.512	0.386	0.251	0.010	33.339
1995	26.588	6.967	1.313	0.303	0.168	0.202	0.034	35.575
1996	42.334	0.491	1.031	0.360	0.060	0.036	0.159	44.471
1997	40.413	0.586	0.536	0.140	0.051	0.022	0.058	41.806
1998	34.831	1.453	0.512	0.130	0.058	0.011	0.025	37.020
1999	44.950	5.617	0.287	0.188	0.046	0.049	0.079	51.216
2000	22.593	3.652	1.408	0.178	0.021	0.016	0.029	27.897
2001	34.050	2.294	2.180	0.283	0.026	0.021	0.042	38.896
2002	12.419	4.926	0.578	0.135	0.045	0.048	0.063	18.214
2003	27.307	0.357	0.655	0.104	0.024	0.034	0.044	28.525
2004	20.134	3.944	3.315	1.336	0.071	0.160	0.171	29.131
2005	29.687	0.047	0.243	0.099	0.037	0.021	0.007	30.141
2006	14.353	0.719	0.558	0.030				15.660
2007	25.680	16.460	0.940	0.260	0.040	0.010	0.040	43.430
2008	no september sampling							
2009	30.217	1.702	0.733	0.107	0.067	0.006	0.029	32.860
2010	mechanical failure							

Table 8. Recreational catch per angler trip for bluefish, ME-FL, by age predicted from General Linear Model with negative binomial transformation.

	Recreational Catch per angler			age				
	0	1	2	3	4	5	6+	total
1982	0.110	0.100	0.027	0.022	0.010	0.016	0.048	0.332
1983	0.040	0.058	0.063	0.025	0.008	0.011	0.042	0.246
1984	0.087	0.069	0.056	0.025	0.011	0.008	0.041	0.297
1985	0.080	0.097	0.097	0.050	0.018	0.008	0.040	0.390
1986	0.055	0.068	0.084	0.035	0.013	0.019	0.054	0.327
1987	0.036	0.067	0.065	0.068	0.024	0.015	0.054	0.329
1988	0.022	0.027	0.031	0.023	0.028	0.022	0.042	0.195
1989	0.059	0.090	0.046	0.017	0.005	0.015	0.040	0.271
1990	0.038	0.114	0.033	0.012	0.006	0.005	0.029	0.236
1991	0.044	0.056	0.057	0.027	0.005	0.003	0.027	0.217
1992	0.016	0.049	0.033	0.054	0.013	0.004	0.024	0.193
1993	0.021	0.047	0.023	0.012	0.024	0.016	0.015	0.158
1994	0.042	0.063	0.029	0.010	0.006	0.012	0.018	0.180
1995	0.026	0.081	0.015	0.004	0.006	0.015	0.013	0.158
1996	0.055	0.062	0.017	0.007	0.007	0.008	0.023	0.179
1997	0.050	0.101	0.035	0.011	0.004	0.002	0.029	0.231
1998	0.031	0.077	0.066	0.029	0.010	0.007	0.018	0.237
1999	0.106	0.090	0.065	0.026	0.007	0.008	0.015	0.318
2000	0.034	0.180	0.088	0.028	0.003	0.011	0.007	0.352
2001	0.060	0.157	0.094	0.035	0.006	0.012	0.008	0.373
2002	0.029	0.210	0.064	0.019	0.005	0.006	0.015	0.348
2003	0.034	0.092	0.129	0.024	0.007	0.010	0.019	0.316
2004	0.018	0.157	0.088	0.051	0.013	0.016	0.024	0.368
2005	0.101	0.071	0.106	0.036	0.009	0.014	0.012	0.349
2006	0.194	0.151	0.146	0.031	0.012	0.006	0.027	0.568
2007	0.022	0.086	0.148	0.042	0.024	0.018	0.038	0.377
2008	0.036	0.147	0.137	0.014	0.016	0.006	0.012	0.367
2009	0.008	0.133	0.119	0.019	0.014	0.006	0.020	0.319
2010	0.012	0.120	0.143	0.022	0.021	0.013	0.029	0.361

Table 9. Standardized Z scores of bluefish age 0 recruitment indices.

	age 0 NMFS	DE	NJ trawl	CT	Rec CPA
1982	0.20				1.79
1983	-0.03				0.00
1984	1.60			2.24	1.20
1985	0.17			0.87	1.03
1986	0.25			-1.54	0.38
1987	-0.05			-1.05	-0.09
1988	-0.01		4.16	-1.16	-0.44
1989	5.09		0.58	1.87	0.49
1990	-0.08	0.14	0.38	0.14	-0.04
1991	-0.04	0.93	-0.06	0.88	0.11
1992	-0.07	-0.03	-0.04	-0.16	-0.61
1993	-0.19	-0.15	-0.27	-0.05	-0.48
1994	-0.07	0.47	1.36	0.31	0.07
1995	-0.01	0.32	0.21	0.01	-0.36
1996	0.00	0.13	-0.27	1.38	0.40
1997	-0.12	1.16	0.00	1.22	0.26
1998	-0.11	0.10	-0.42	0.73	-0.23
1999	0.12	0.38	-0.42	1.61	1.69
2000	-0.16	0.63	-0.48	-0.33	-0.13
2001	-0.02	3.41	-0.67	0.66	0.51
2002	-0.04	1.35	0.75	-1.22	-0.26
2003	0.86	-0.55	0.54	0.08	-0.15
2004	-0.06	0.02	-0.32	-0.55	-0.56
2005	0.32	-0.21	0.40	0.28	1.56
2006	0.59	-0.53	0.48	-1.05	3.95
2007	-0.02	0.32	0.98	-0.07	-0.45
2008	-0.05	0.21	0.88		-0.10
2009	-0.19	-0.66	-0.20	0.33	-0.82
2010	-0.16	-0.66	-0.48		-0.70

Table 10. Abundance at age (000s) for bluefish from ASAP model.

	Jan 1 abundance 000s							
	0	1	2	3	4	5	6+	total
1982	44491	43653	13363	7147	7128	12892	47941	165,868
1983	34231	34364	30080	9301	5391	5501	42894	155,109
1984	44680	26203	23060	20419	6927	4122	33203	155,254
1985	24650	34383	17861	15886	15321	5326	25963	137,967
1986	20972	18952	23375	12274	11905	11769	21768	120,860
1987	14654	15396	11238	14122	8618	8726	20973	94,214
1988	20722	10700	8985	6688	9841	6283	18250	81,976
1989	45734	15303	6456	5519	4736	7256	15466	101,206
1990	19465	34338	9697	4153	4000	3551	14993	90,787
1991	23343	14686	22078	6323	3031	3014	12301	85,285
1992	10886	17271	8911	13631	4489	2239	9663	67,541
1993	12834	8184	10989	5754	9898	3371	7822	59,249
1994	19839	9670	5242	7139	4191	7449	7444	61,397
1995	16069	15066	6338	3480	5258	3179	10200	59,978
1996	16202	12390	10329	4390	2618	4050	9401	59,689
1997	14449	12537	8584	7225	3320	2024	9560	57,958
1998	19829	11196	8722	6028	5474	2570	8225	62,363
1999	23179	15421	7873	6188	4591	4254	7754	69,585
2000	15019	18245	11238	5776	4793	3612	8920	67,853
2001	27631	11758	13083	8120	4440	3750	9167	78,191
2002	21500	21360	8123	9127	6132	3429	9154	79,049
2003	24790	16862	15400	5900	7034	4806	9244	84,185
2004	15759	19416	12108	11143	4538	5506	10305	78,862
2005	23924	12208	13496	8496	8439	3512	11288	81,342
2006	37303	18651	8646	9639	6492	6574	10696	97,925
2007	23535	29174	13335	6231	7399	5074	12636	97,200
2008	29158	18238	20299	9366	4721	5729	12627	99,882
2009	11187	22828	13081	14672	7200	3694	13439	85,855
2010	6701	8863	16956	9771	11468	5702	12893	72,181

Table 11. Total stock biomass for bluefish as estimated from ASAP model results.

	-1 Std Dev		+1 Std Dev	**000s mt**
1982	304,094	318,218	332,342	318.2
1983	276,892	289,671	302,450	289.7
1984	241,602	252,429	263,256	252.4
1985	210,783	219,342	227,901	219.3
1986	202,609	210,440	218,271	210.4
1987	162,215	169,447	176,679	169.4
1988	127,273	133,555	139,837	133.6
1989	116,490	122,605	128,720	122.6
1990	103,025	108,285	113,545	108.3
1991	88,092	93,198	98,304	93.2
1992	87,957	93,100	98,243	93.1
1993	84,792	89,743	94,695	89.7
1994	75,520	80,009	84,499	80.0
1995	77,609	82,368	87,127	82.4
1996	75,050	79,637	84,225	79.6
1997	88,829	94,370	99,911	94.4
1998	88,109	93,447	98,784	93.4
1999	91,240	96,585	101,930	96.6
2000	96,909	102,304	107,699	102.3
2001	91,840	96,761	101,681	96.8
2002	100,199	105,421	110,643	105.4
2003	104,097	109,356	114,615	109.4
2004	98,750	103,736	108,722	103.7
2005	122,259	128,481	134,703	128.5
2006	121,890	127,945	134,000	127.9
2007	119,564	125,530	131,496	125.5
2008	128,053	134,286	140,519	134.3
2009	139,095	145,822	152,550	145.8
2010	133,627	140,297	146,968	140.3

Table 12. Projection results for bluefish through 201 under various fishing scenarios.

		F	1-Jan Abundance (000s)	Mean Biomass (000s mt)	SSB (000s mt)	Yield mt
F low	2011	0.15	74,643	141.8	135.5	14,925
	2012	0.10	76,544	137.8	128.9	10,124
	2013	0.10	79,375	132.5	121.1	10,684

		F	1-Jan Abundance (000s)	Mean Biomass (000s mt)	SSB (000s mt)	Yield mt
F status quo and 75% Fmsy	2011	0.15	74,643	141.8	135.5	14,925
	2012	0.14	76,544	135.9	127.0	13,953
	2013	0.14	77,849	126.8	115.7	14,282

		F	1-Jan Abundance (000s)	Mean Biomass (000s mt)	SSB (000s mt)	Yield mt
F0.1	2011	0.15	74,643	141.8	135.5	14,925
	2012	0.16	76,544	134.9	126.0	15,823
	2013	0.16	77,104	124.1	113.1	15,951

		F	1-Jan Abundance (000s)	Mean Biomass (000s mt)	SSB (000s mt)	Yield mt
Ftarget	2011	0.15	74,643	141.8	135.5	14,925
	2012	0.17	76,544	134.4	125.6	16,747
	2013	0.17	76,736	122.7	111.8	16,754

		F	1-Jan Abundance (000s)	Mean Biomass (000s mt)	SSB (000s mt)	Yield mt
Fmsy	2011	0.15	74,458	141.8	135.5	14,925
	2012	0.19	76,350	133.5	124.7	18,572
	2013	0.19	75,856	120.1	109.3	18,301

Table 13. Biological Reference Points under different data and model configurations.

	2009	simple update	**final update**	MCMC base	new model
Fcurrent	0.10	0.14	**0.14**	0.14	0.19
SSBcurrent	129,359	138,824	**134,065**	130,762	91,755
F0.1	0.18	0.17	**0.16**	0.16	0.16
Fmax	0.28	0.26	**0.25**	0.25	0.24
F30% SPR	0.25	0.24	**0.24**	0.24	0.23
F40% SPR	0.18	0.17	**0.17**	0.17	0.16

Fmsy=0.19	SSBmsy	95.353
Fproj 50 yrs	**Bmsy**	**105,699**
	MSY	14,647

Table 14. Results of alternative model configuration which includes variable ESS, changes in index lambdas and changes in index CVs.

	Unweighted F	SSB	N	Observed Recruits (000s)
1982	0.26	186,143	165,831	54,406
1983	0.29	172,047	156,006	43,316
1984	0.27	154,113	153,979	51,884
1985	0.25	142,239	135,072	30,195
1986	0.42	145,457	114,319	22,574
1987	0.46	117,447	85,374	16,380
1988	0.42	88,755	72,753	22,116
1989	0.35	77,709	87,130	41,889
1990	0.33	61,820	78,414	20,985
1991	0.44	53,422	73,916	24,289
1992	0.38	52,161	55,618	11,434
1993	0.38	49,570	47,646	13,324
1994	0.36	43,449	47,649	17,354
1995	0.30	41,664	46,382	15,385
1996	0.28	39,531	48,518	17,634
1997	0.27	47,534	47,673	14,943
1998	0.25	46,979	49,123	17,019
1999	0.19	50,262	55,255	21,341
2000	0.21	56,080	55,509	15,625
2001	0.26	54,759	65,407	26,414
2002	0.18	59,667	64,997	19,746
2003	0.18	64,432	69,646	22,935
2004	0.23	64,390	65,233	15,109
2005	0.20	80,237	67,989	22,898
2006	0.19	78,272	78,800	30,144
2007	0.22	78,429	80,846	23,688
2008	0.18	83,522	82,981	26,649
2009	0.13	94,706	72,989	13,156
2010	0.19	94,362	62,118	7,950

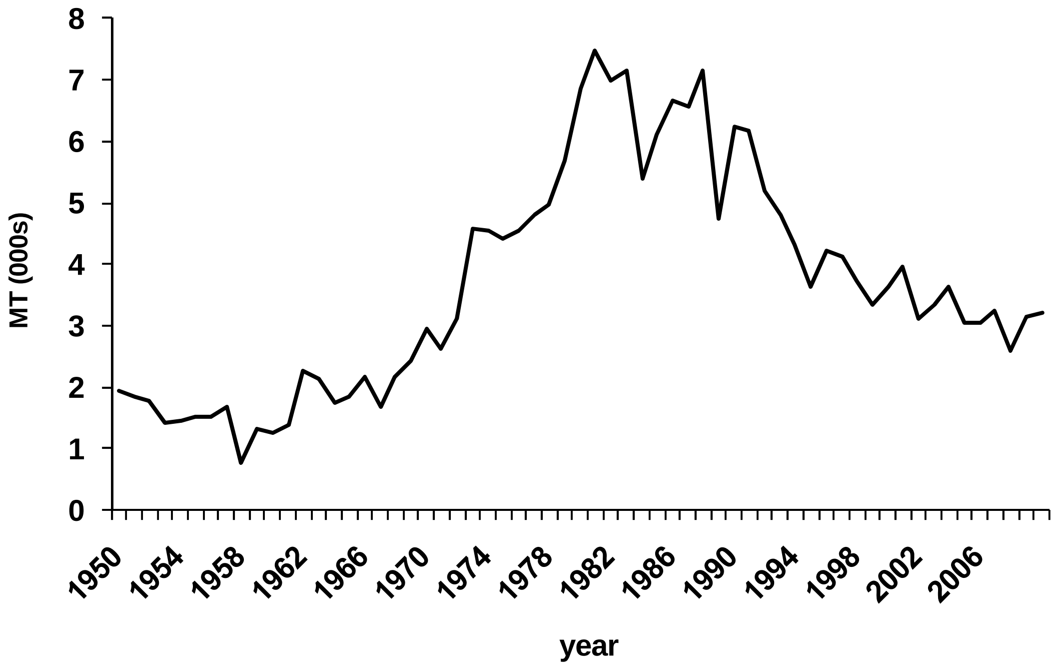


Figure 1. Atlantic coast commercial bluefish landings (mt), 1950-2010.

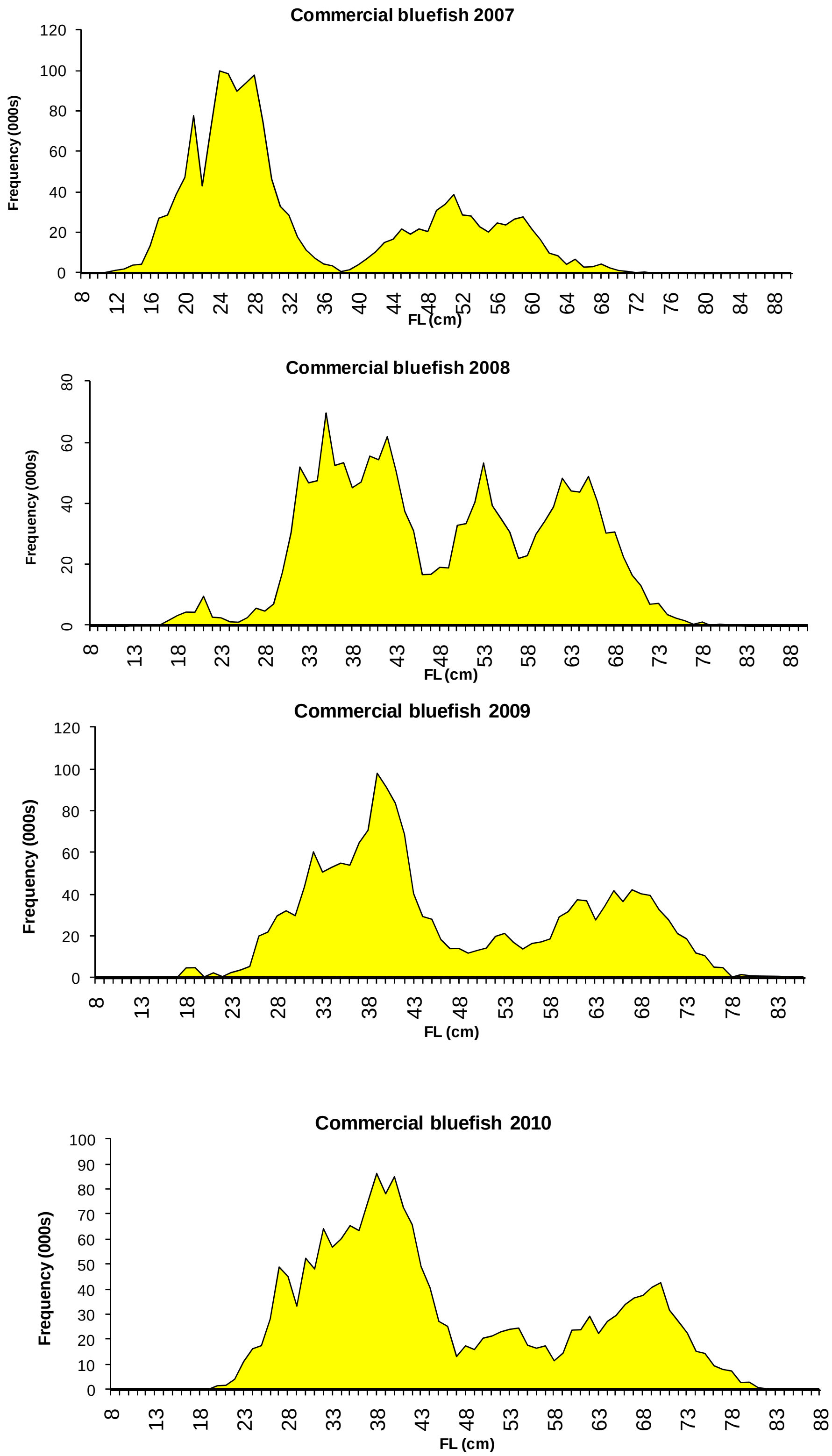


Figure 2. Length frequency distribution of commercial bluefish landings, ME-FL, 2007-2010.

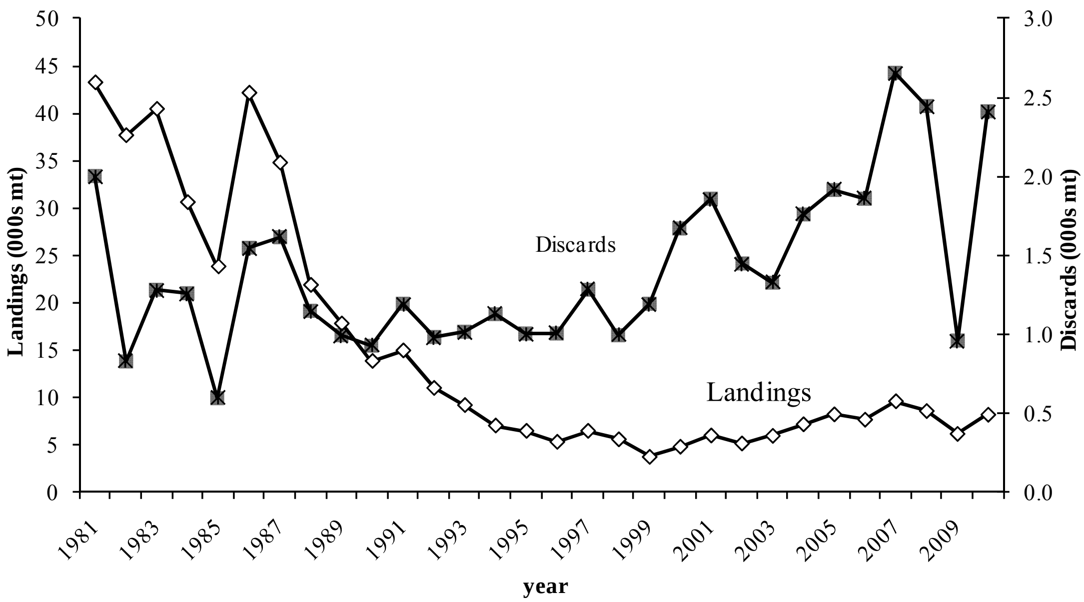


Figure 3. Recreational landings (mt) and recreational discard losses (MRFSS B2 estimates * 15%), ME-FL.

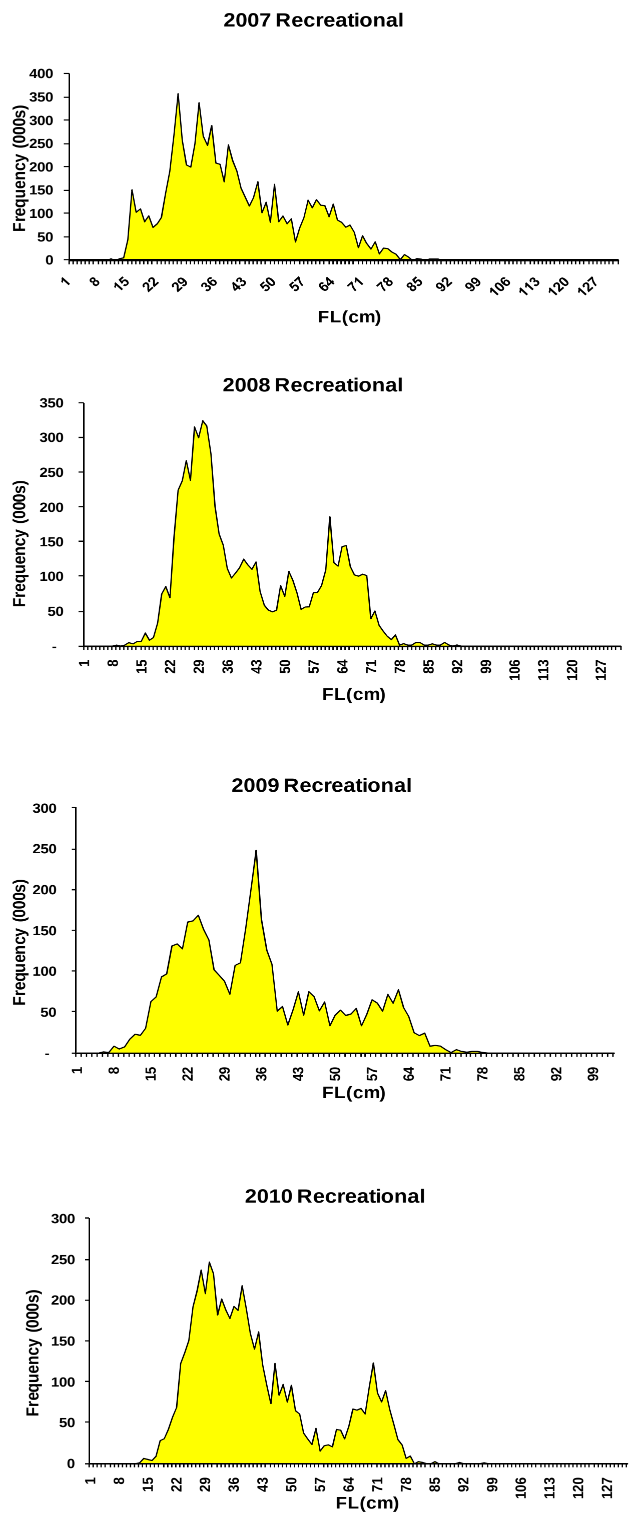


Figure 4. Length frequency distribution of recreational bluefish landings, ME-FL, 2007-2010.

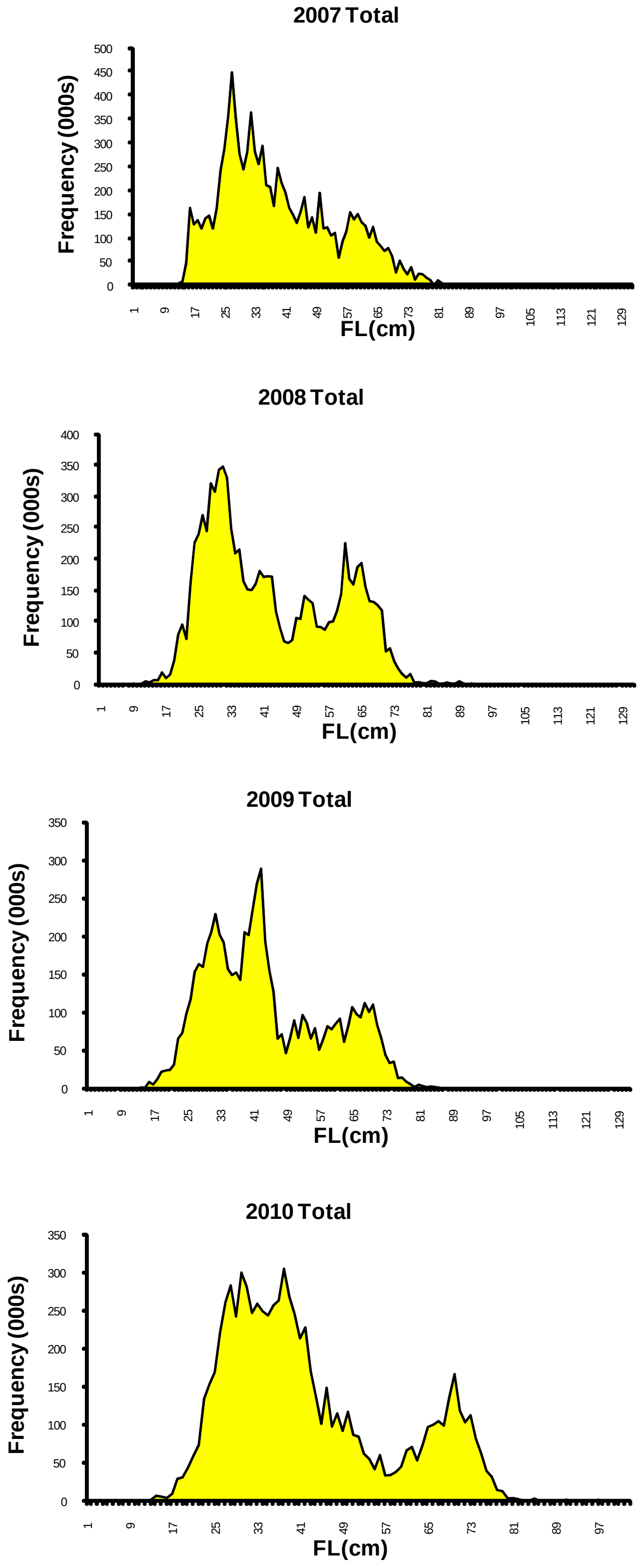


Figure 5. Total length frequencies of combined bluefish commercial and recreational fisheries, 2007-2010.

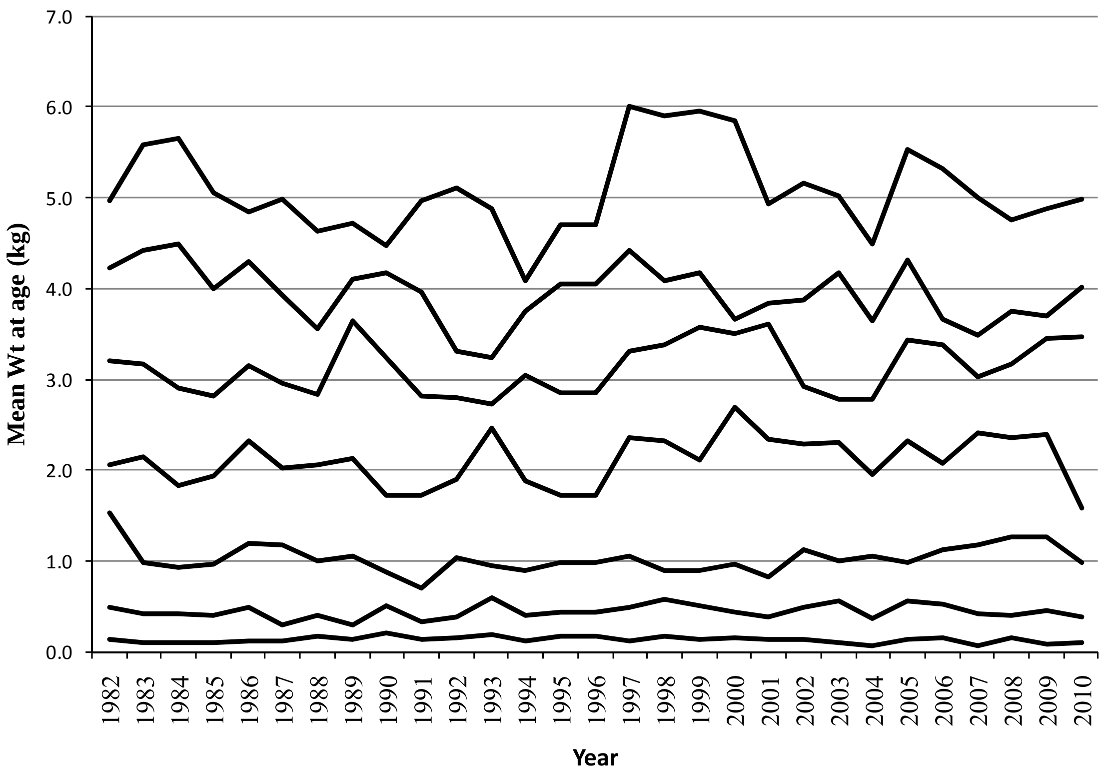


Figure 6. Bluefish mean weights (kg) at ages 0-6+, 1982-2010

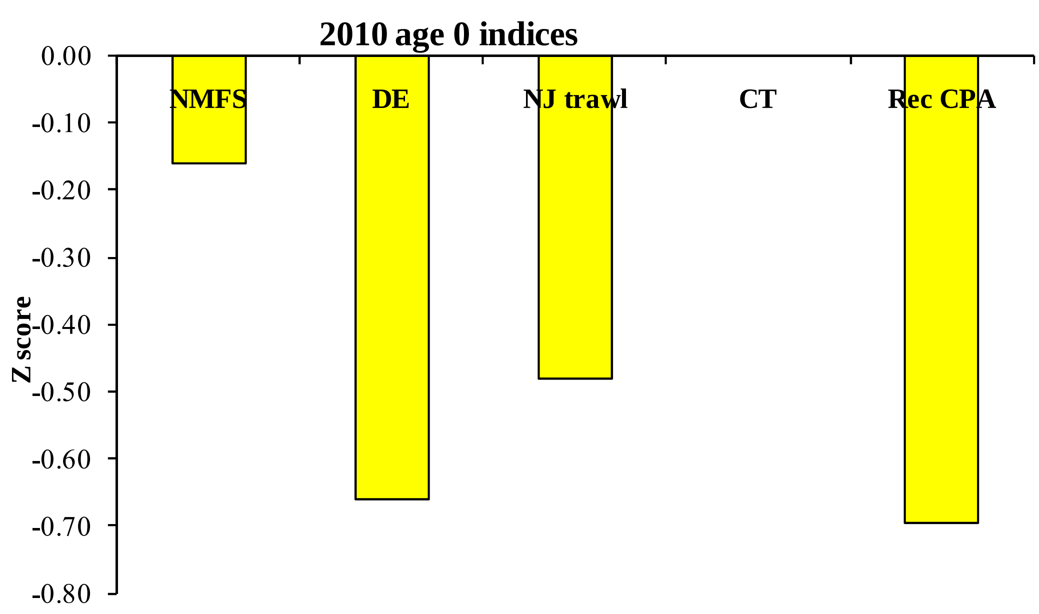


Figure 7. Standardized age 0 recruitment indices for 2010 by program.

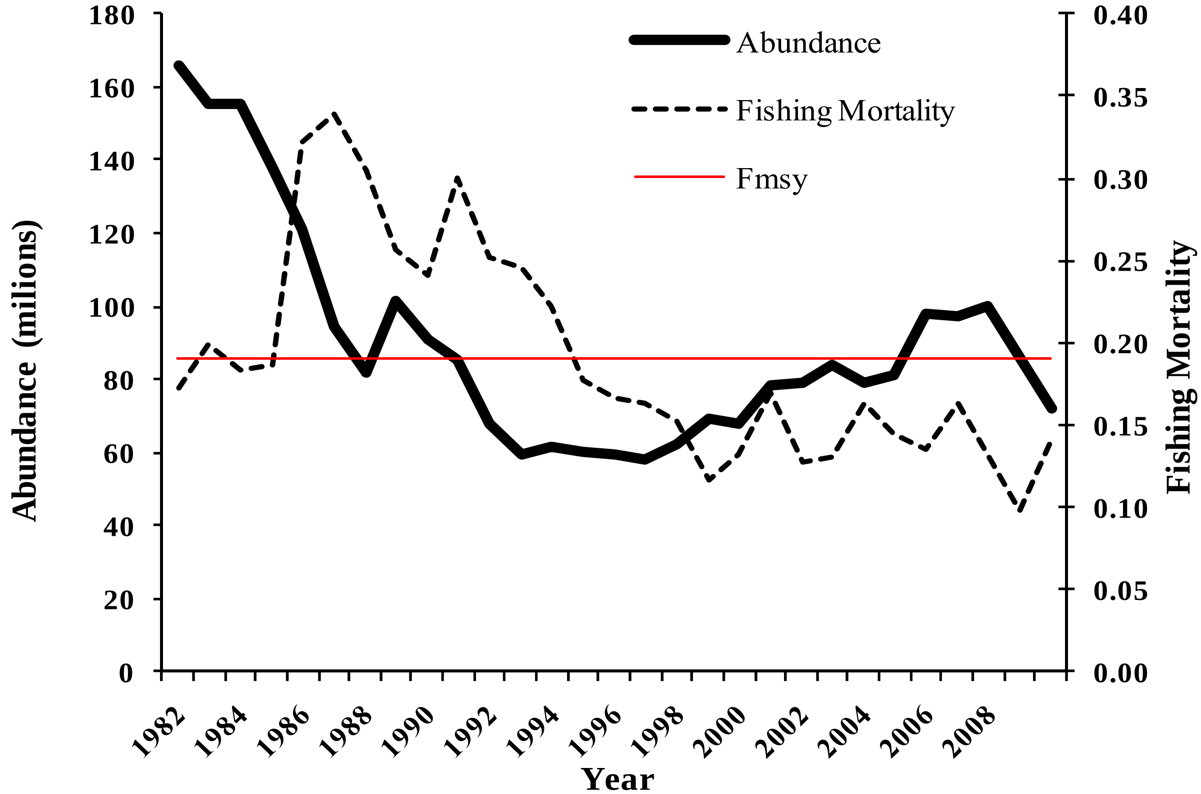


Figure 8. Total bluefish abundance and fishing mortality as estimated in ASAP model. F_{MSY} indicated by solid horizontal line.

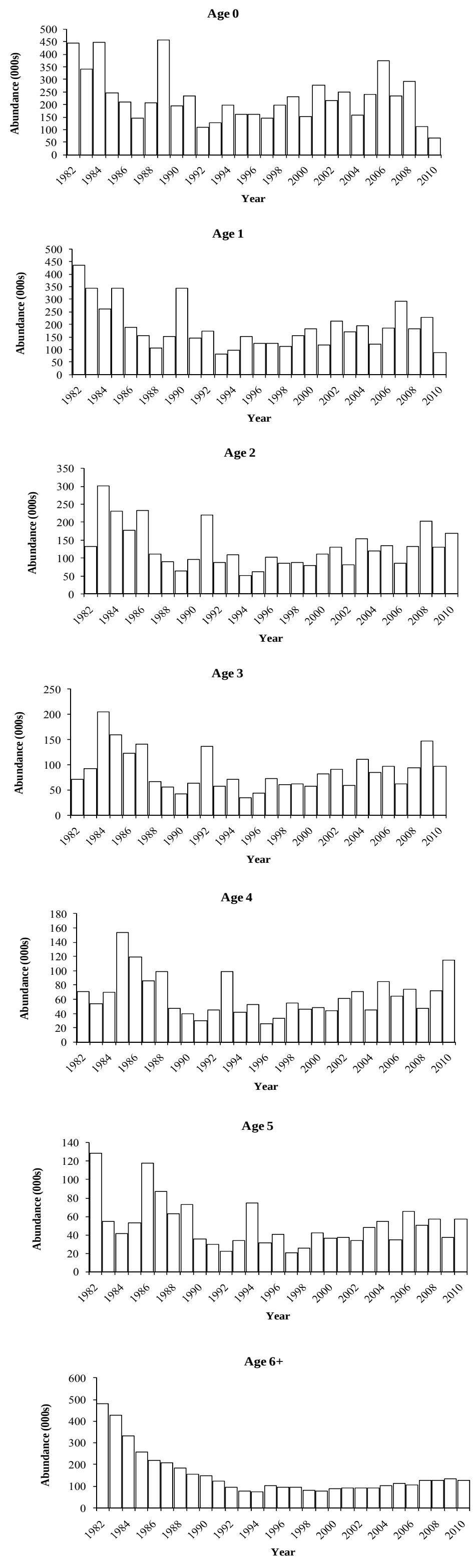


Figure 9. Total bluefish abundance at age from ASAP model results.

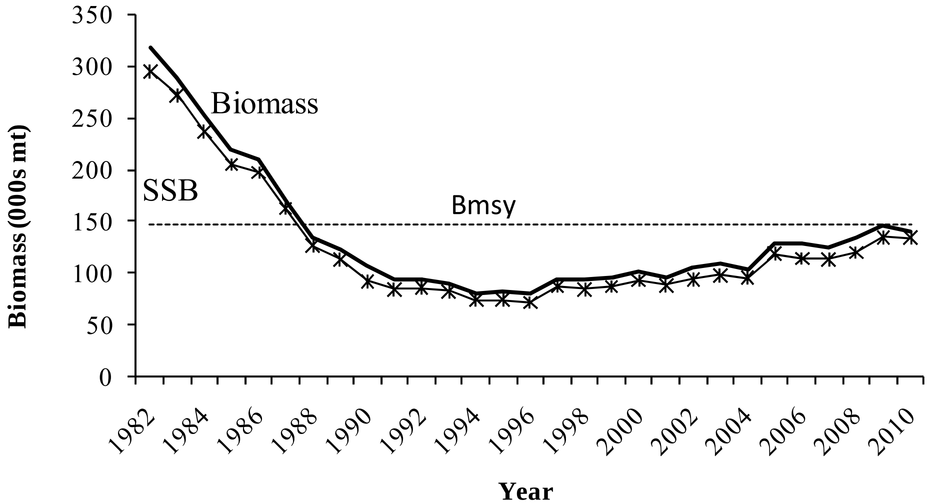


Figure10. Time series of bluefish total mean biomass (000s mt) and spawning stock biomass (000s mt).

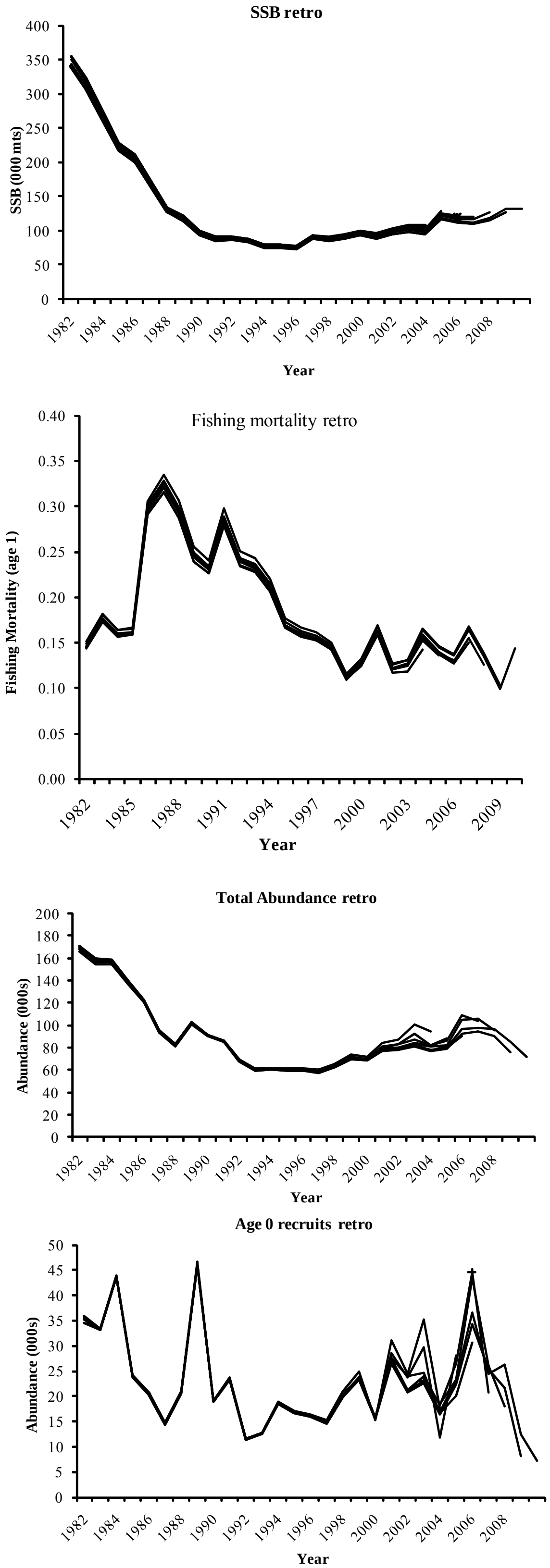
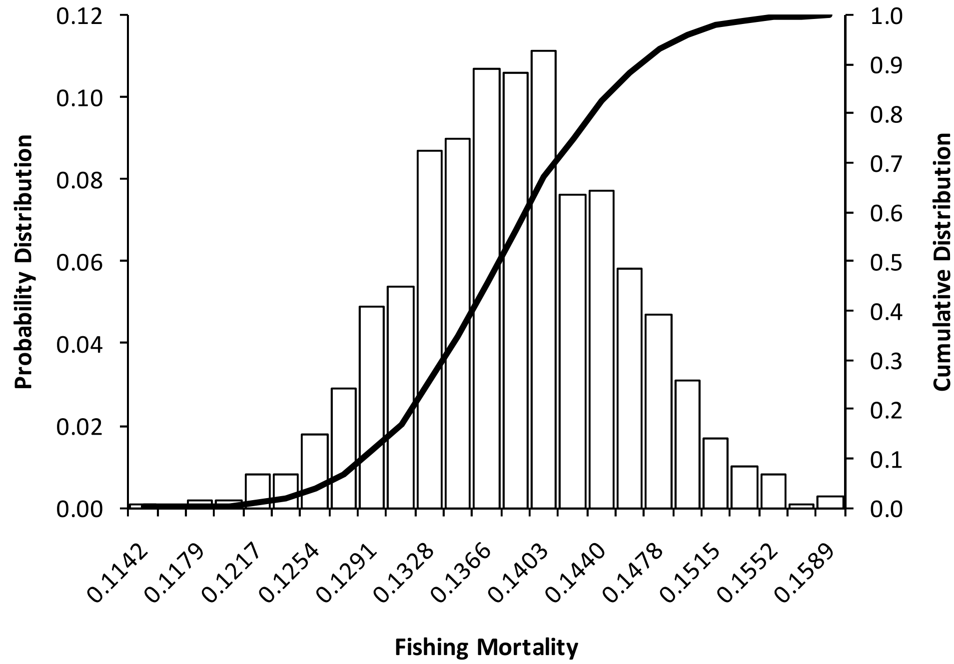


Figure 11. Retrospective bias in bluefish estimates from ASAP model.



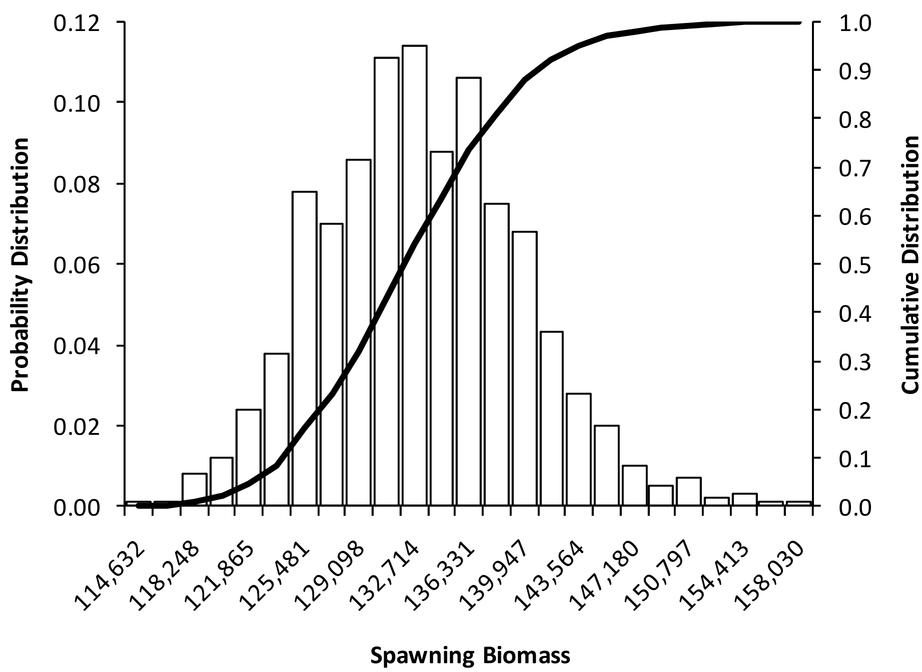
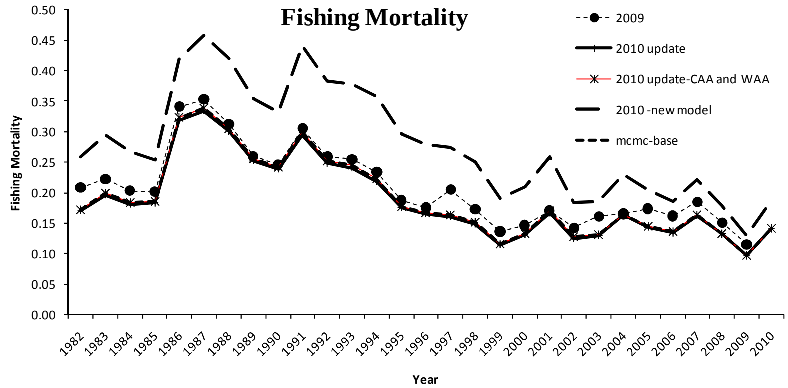
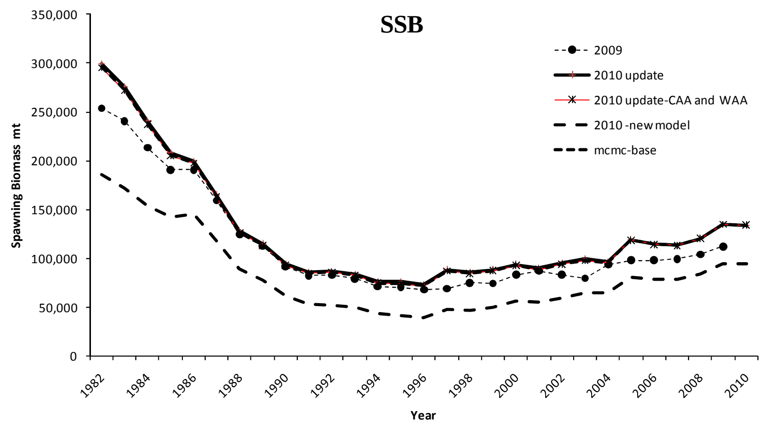
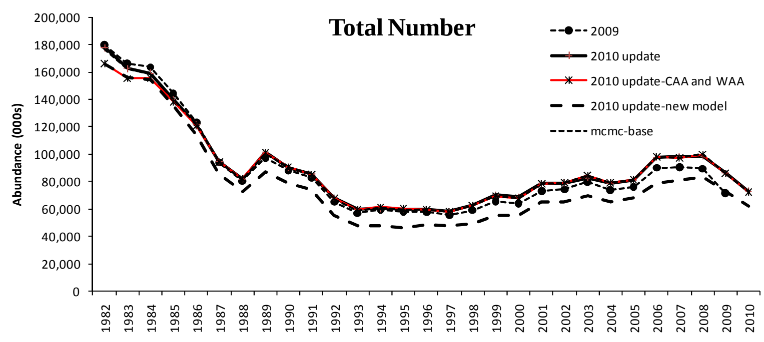


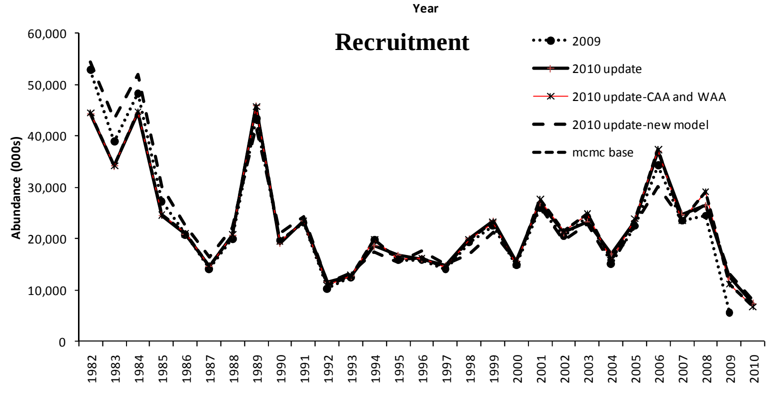
Figure 12. Distribution of bluefish fishing mortality and spawning stock biomass resulting from 1000 MCMC iterations in ASAP model.

Appendix I. Results from alternative model configurations.









Appendix II. Projection results ± 1 std dev.

F=0.10

Mean biomass mt (000s)		- 1 std dev	Average	+ 1 std dev
	2011	135.2	141.8	148.5
	2012	131.7	137.8	143.9
	2013	126.7	132.5	138.4

Total stock biomass mt (000s)		- 1 std dev	Average	+ 1 std dev
	2011	138.6	145.6	152.6
	2012	134.5	140.9	147.3
	2013	128.9	134.6	140.4

SSB mt (000s)		- 1 std dev	Average	+ 1 std dev
	2011	129.1	135.5	142.0
	2012	123.0	128.9	134.7
	2013	116.0	121.1	126.1

Catch mt (000s)		- 1 std dev	Average	+ 1 std dev
	2011	14.2	14.9	15.7
	2012	9.7	10.1	10.6
	2013	10.2	10.7	11.2

median # at age	0	1	2	3	4	5	6+	total
2011	20,821	5,251	6,336	12,168	7,502	8,945	13,620	74,643
2012	20,721	16,199	3,701	4,506	9,284	5,837	16,297	76,544
2013	20,721	16,398	12,000	2,758	3,519	7,347	16,630	79,375

Fsq=0.14

Mean biomas mt (000s)		- 1 std dev	Average	+ 1 std dev
	2011	135.2	141.8	148.5
	2012	129.9	135.9	141.8
	2013	121.2	126.8	132.4

Total stock biomas mt (000s)		- 1 std dev	Average	+ 1 std dev
	2011	138.6	145.6	152.6
	2012	134.5	140.9	147.3
	2013	125.2	130.8	136.4

SSB mt (000s)		- 1 std dev	Average	+ 1 std dev
	2011	129.1	135.5	142.0
	2012	121.2	127.0	132.7
	2013	110.8	115.7	120.5

Catch mt (000s)		- 1 std dev	Average	+ 1 std dev
	2011	14.2	14.9	15.7
	2012	13.3	14.0	14.6
	2013	13.6	14.3	14.9

median # at age	0	1	2	3	4	5	6+	total
2011	20,821	5,251	6,336	12,168	7,502	8,945	13,620	74,643
2012	20,721	16,199	3,701	4,506	9,284	5,837	16,297	76,544
2013	20,721	16,177	11,530	2,656	3,454	7,248	16,063	77,849

F0.1=0.16

Mean biomass mt (000s)	- 1 std dev	Average	+ 1 std dev
2011	135.2	141.8	148.5
2012	129.0	134.9	140.9
2013	118.6	124.1	129.6

Total stock biomass mt (000s)	- 1 std dev	Average	+ 1 std dev
2011	138.6	145.6	152.6
2012	134.5	140.9	147.3
2013	123.4	128.9	134.5

SSB mt (000s)	- 1 std dev	Average	+ 1 std dev
2011	129.1	135.5	142.0
2012	120.3	126.0	131.8
2013	108.4	113.1	117.8

Catch mt (000s)	- 1 std dev	Average	+ 1 std dev
2011	14.2	14.9	15.7
2012	15.1	15.8	16.5
2013	15.2	16.0	16.7

median # at age	0	1	2	3	4	5	6+	total
2011	20,821	5,251	6,336	12,168	7,502	8,945	13,620	74,643
2012	20,721	16,199	3,701	4,506	9,284	5,837	16,297	76,544
2013	20,721	16,013	11,189	2,582	3,406	7,174	15,651	76,736

F75% msy=0.17

Mean biomass mt (000s)	- 1 std dev	Average	+ 1 std dev
2011	135.2	141.8	148.5
2012	128.5	134.4	140.4
2013	117.3	122.7	128.1

Total stock biomass mt (000s)	- 1 std dev	Average	+ 1 std dev
2011	138.6	145.6	152.6
2012	134.5	140.9	147.3
2013	122.5	128.0	133.5

SSB mt (000s)	- 1 std dev	Average	+ 1 std dev
2011	129.1	135.5	142.0
2012	119.9	125.6	131.3
2013	107.1	111.8	116.5

Catch mt (000s)	- 1 std dev	Average	+ 1 std dev
2011	14.2	14.9	15.7
2012	16.0	16.7	17.5
2013	16.0	16.8	17.5

median # at age	0	1	2	3	4	5	6+	total
2011	20,821	5,251	6,336	12,168	7,502	8,945	13,620	74,643
2012	20,721	16,199	3,701	4,506	9,284	5,837	16,297	76,544
2013	20,721	16,013	11,189	2,582	3,406	7,174	15,651	76,736

Fmsy=0.19

Mean biomass mt (000s)

	- 1 std dev	Average	+ 1 std dev
2011	135.2	141.8	148.5
2012	127.6	133.5	139.4
2013	114.7	120.1	125.4

Total stock biomass mt (000s)

	- 1 std dev	Average	+ 1 std dev
2011	138.6	145.6	152.6
2012	134.5	140.9	147.3
2013	120.8	126.2	131.6

SSB mt (000s)

	- 1 std dev	Average	+ 1 std dev
2011	129.1	135.5	142.0
2012	119.0	124.7	130.3
2013	104.8	109.3	113.9

Catch mt (000s)

	- 1 std dev	Average	+ 1 std dev
2011	14.2	14.9	15.7
2012	17.7	18.6	19.4
2013	17.5	18.3	19.2

median # at age

	0	1	2	3	4	5	6+	total
2011	20,821	5,251	6,336	12,168	7,502	8,760	13,620	74,458
2012	20,721	16,199	3,701	4,506	9,284	5,642	16,297	76,350
2013	20,721	15,904	10,968	2,534	3,374	6,974	15,382	75,856