SEDAR

Southeast Data, Assessment, and Review

Complete Assessment and Review Report

of

South Atlantic Black Sea Bass

Results of a series of workshops
convened between October, 2002 and February 2003

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Report of Black Seabass Stock Assessment Workshop
Second SEDAR Process
Beaufort, North Carolina
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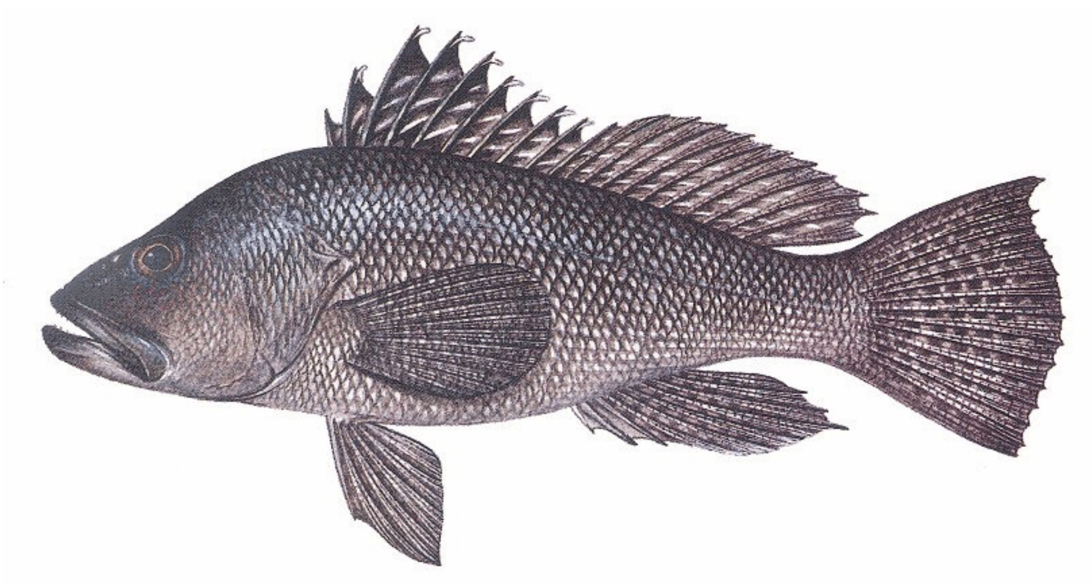

Prepared for South Atlantic Fishery Management Council
Charleston, South Carolina
14 February 2003

Executive Summary

The SEDAR II stock assessment workshop (AW) (*Appendix A*, Abbreviations and Symbols) was convened by the South Atlantic Fishery Management Council and NMFS Southeast Fisheries Science Center at the NOAA Center for Coastal Fisheries and Habitat Research, Beaufort, North Carolina on Monday, January 6, 2003. The AW's objectives were to conduct an assessment of the black seabass, *Centropristis striata*, stock off the southeastern U.S. and to conduct stock projections based on several possible management regimes (*Appendix B*, Terms of Reference). Participants in the workshop (*Appendix C*) included state, federal, and university scientists, as well as observers from the Council. All decisions regarding stock assessment methods and acceptable data were made by a consensus of participants

Available data on black seabass included abundance indices and recorded data on landings, including size and age compositions of some landings and indices. Six abundance indices were developed by the preceding data workshop (DW): one from the NMFS headboat survery, one from the Marine Recreational Fisheries Statistical Survey (MRFSS), and four derived from the South Carolina MARMAP fishery independent monitoring program. The MRFSS index was dropped from most model runs because of concern by the AW that it was based on directed trips only. Landings data are available from all recreational and commercial fisheries. Abundance indices suggest that the stock declined between the 1980s and 1990s.

The AW applied both age-structured and age-aggregated models to available data. The age-structured model was considered the primary model, as recommended by the DW. Although there is considerable uncertainty in the application of these models, the status of stock depicted by these models is very consistent. That is, both model approaches depict a heavily exploited stock with considerable decline over the period examined. Based on the weighted mean results from a range of sensitivity runs of the age-structured model, the 2002 spawning stock size is estimated at about 22% of SSB_{MSY} while the 2001 fishing mortality rate is estimated at about 628% of F_{MSY}. Thus by standards of the Sustainable Fisheries Act and given the Council's usual definition of MSST as $(1-M)*SSB_{MSY}$, the stock is estimated at 30% of MSST, and therefore is overfished. Also F relative to F_{MSY} indicates that the stock is presently undergoing overfishing.

Stock projections were used to evaluate the level of F required to rebuild the stock to SSB_{MSY} and determine rebuilding time frames. Considerable reductions in fishing mortality from current levels are indicated by the suite of projections. To rebuild in the appropriate time frame, estimates of necessary reductions in F from current levels range from 50-90%, with the exception of one sensitivity run that indicated no rebuilding was necessary. Rebuilding duration ranged from 10 to 25 years, with the one exception. In the age-structured model, when fishing mortality is reduced to the rebuilding level, projected yields are initially lower than current levels, but exceed current yields within a few years.

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1 Place, time, and tasks

The SEDAR II assessment workshop (AW) (*Appendix A*, Abbreviations and Symbols) was convened at the NOAA Center for Coastal Fisheries and Habitat Research, Beaufort, North Carolina, by the South Atlantic Fishery Management Council (the Council) and the NMFS Southeast Fisheries Science Center (the Center). The AW met from 9:00 p.m. on Monday, January 6, to 12:00 noon on Friday, January 10, 2003. Participation in the workshop (*Appendix C*) included scientists from the states of Florida, North Carolina, and South Carolina; from NMFS laboratories and offices in Beaufort, Miami and St. Petersburg; representatives of the Council and its Scientific and Statistical Committee; and scientists from Virginia Polytechnic Institute and State University, including Dr. James Berkson, who chaired the AW.

The AW's major objectives were to conduct an assessment of the stocks of black seabass, *Centropristis striata*, and vermilion snapper, *Rhomboplites aurorubens*, off the southeastern US, and to conduct stock projections (*Appendix B,* Terms of Reference). In support of those tasks, the AW received data and recommendations from the data workshop (DW) that was convened in October 2002 by the Council and the Center. The DW was designed to be the first step in the assessment process, bringing together state, federal and university biologists with the needed expertise to decide which data were appropriate for use in the assessment. The AW was designed to follow the DW, with many of the same state and federal biologists participating. Some of the decisions regarding data made at the DW were refined during the AW. At both the DW and the AW, all decisions affecting the assessment were made by consensus of all participants. This report is concerned only with data and analyses for black seabass.

2 Stock and fishery characteristics

The following material is excerpted and expanded from the description of the stock and fishery in Hardy 1978; McGovern et al. 2002; Vaughan et al. 1995, 1996, 1998; Wenner et al. 1986.

2.1 Life History

The black seabass (BSB), *Centropristis striata*, is a protogynous serranid that occurs along the U.S. Atlantic coast from Cape Cod, Massachusetts, to Cape Canaveral, Florida, and in the Gulf of Mexico. Two populations, separated by Cape Hatteras, North Carolina, have been reported to occur along the Atlantic coast, although, genetic similarities suggests that this is one stock (Robert W. Chapman, pers. com.). Black seabass in the Gulf of Mexico are considered to be a separate subspecies. This assessment will focus on the stock unit south of Cape Hatteras, including fish from North Carolina (NC), South Carolina (SC), Georgia (GA), and the east coast of Florida (FL). Black seabass occur in depths of 2 to 120 m, but most adults are found in 20 to 60 m. Although black seabass north of Cape Hatteras are migratory, tagging studies indicate movements of black seabass south of Cape Hatteras are limited and less well-defined (Ansley and Davis 1981, Collins et al. 1996).

Black seabass spawn from January through July along the southeastern U.S. coast. Some spawning does occur in October-November, however, fall spawning is not observed every year. The greatest percentage of females in spawning condition occurs during March through May. Historic fecundity studies assumed that the number of eggs that were spawned was fixed prior to the spawning season (determinate spawning). Recent data show that black seabass probably recruit new eggs throughout the spawning season (indeterminate spawning), indicating that previous fecundity estimates should not be used for assessment purposes. Based on the presence of hydrated oocytes and post-ovulatory follicles, black seabass spawn every 3.4 days or 27 times during the 92 day spawning season (March-May). Fertilized eggs are round and clear with a diameter of 0.9 to 1.0 mm. Eggs are pelagic and hatch in 75 hours at 16^{o}C and 38 hours at 23^{o}C. Larvae are also pelagic and have been found in inlets, bays and offshore waters. Larvae become demersal at approximately 13-mm TL. Juveniles have been recorded from bays, estuaries, inlets and nearshore waters.

Black seabass are protogynous (changing sex from female to male). Individuals undergoing transition from female to male occur throughout the year, however, the percentage of transitionals is much lower during the spawning season and highest when spent and resting individuals are collected. According to McGovern et al. (2002): “Most black seabass undergoing transition were 160-259 mm SL (94%) and ages 2-4 (92%).” Males occur in all size and age groups, but are most frequent at sizes greater than 250 mm TL and ages of 4 and older. Black seabass live for at least 10 years.

2.2 Fisheries

Black seabass north of Cape Hatteras are managed as a separate stock by the MAFMC, black seabass south of Hatteras are managed by the SAFMC with a unit stock from Cape Hatteras to Florida. Three major fisheries catch this stock of black seabass: recreational, headboat, and commercial. Landings trends for black seabass for these fisheries are shown in Figure 2.1.

The recreational fishery is defined here to include all recreational fishing from shore, private boats, and charter boats (for-hire vessels that usually accommodate six or fewer anglers as a group). The recreational fishery uses hook and line gear almost exclusively. The recreational fishery shows high and quite variable values in the 1980's, peaking in 1984 at 1,014 mt (2.2 million pounds), and declining to lower and less variable values in the 1990's (averaging 300 mt, or 0.7 million pounds since 1990).

The headboat fishery (larger for-hire vessels that charge per angler) is sampled separately, and for that reason is distinguished here from other recreational fisheries. The headboat fishery also uses hook and line gear almost exclusively. Landings are initially high, peaking in 1982 at 334 mt (0.7 million pounds), then decline to lower values in the 1990's (averaging 85 mt, or 0.2 million pounds since 1990).

The most common commercial gear has been traps (or pots), with additional commercial landings from hook and line and trawling. Trawling for black seabass has been banned since January 1989 (SAFMC 1988) (Table 2.1). The black seabass commercial fishery peaked in 1981 at 543 mt (1.2 million pounds) and since then has fluctuated between 250 and 450 mt (0.6 to 1.0 million pounds) (Figure 1).

During the assessment time period (1978-2001), commercial trap landings peaked in 1981 (at 455 mt), but have generally averaged around 236 mt (0.5 million pounds) with little trend over the last 20 years (Figure 2.2). Commercial line landings have averaged about 90 mt (0.2 million pounds) with little trend, while the “other” category (includes trawl and miscellaneous gears) has averaged only 8 mt (0.02 million pounds), also with little trend.

During the early 1980’s, before commercial data were available by species, the for-hire and recreational sectors contributed about the same amount to the black seabass catch and represented about 75% of the total. In recent years, the commercial catch and recreational landings are approximately equal (Figure 2.3).

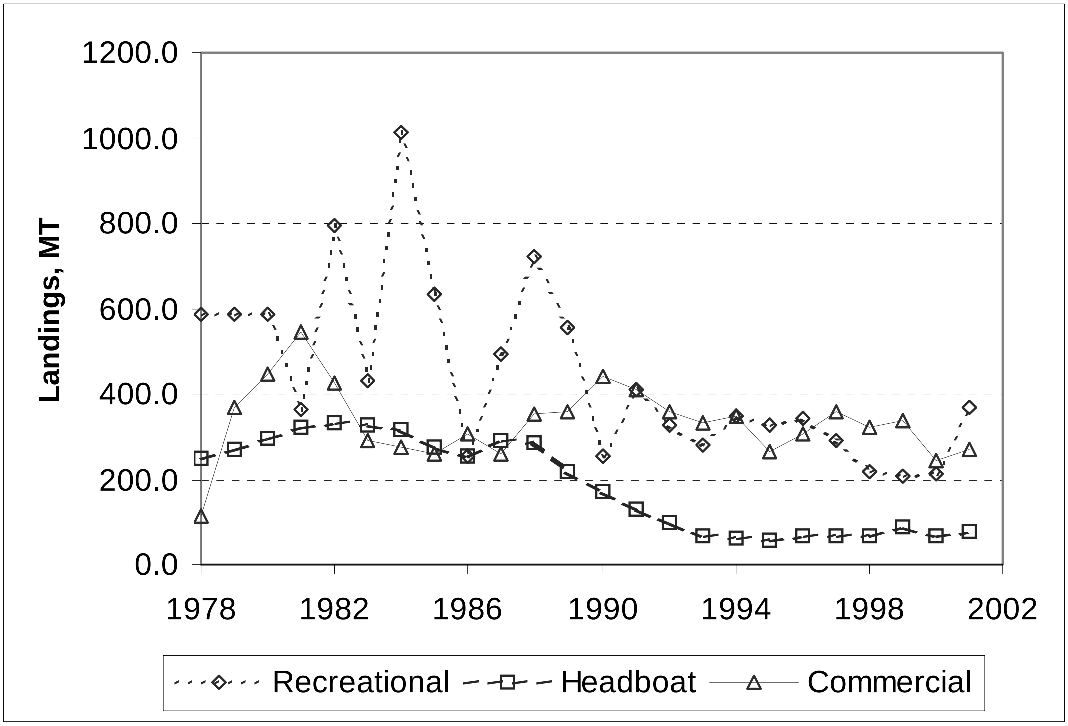

Figure 2.1. Landed catch (mt) of black seabass since 1978 by the 3 major fisheries.

Table 2.1. Black seabass regulation history.

Date	Amendment	Regulation
August 31 1983	Original FMP	8" TL minimum size limit and 4" trawl mesh size
January 12 1989	Amend. 1	Prohibits trawls
January 1 1992	Amend. 4	Prohibits fish traps, entanglement nets, and longline gear within 50 fathoms; black seabass pot gear and identification requirements
December 1998	Amend. 8	Limited entry program; transferable permits and 225-pound non-transferable permits
February 24 1999	Amend. 9	10" TL minimum size limit and 20 fish bag limit; escape panel

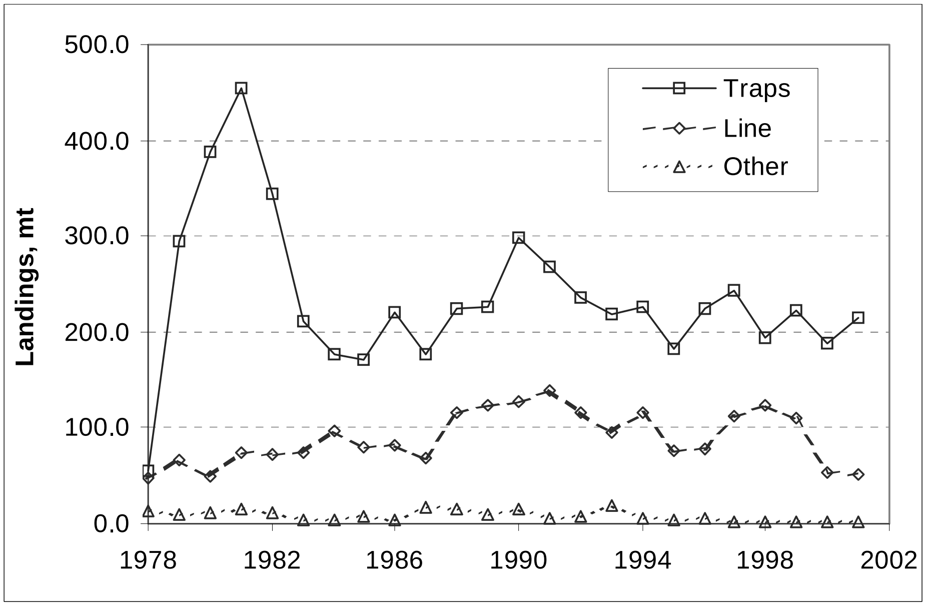

Figure 2.2. Black seabass commercial landings (mt) by gear.

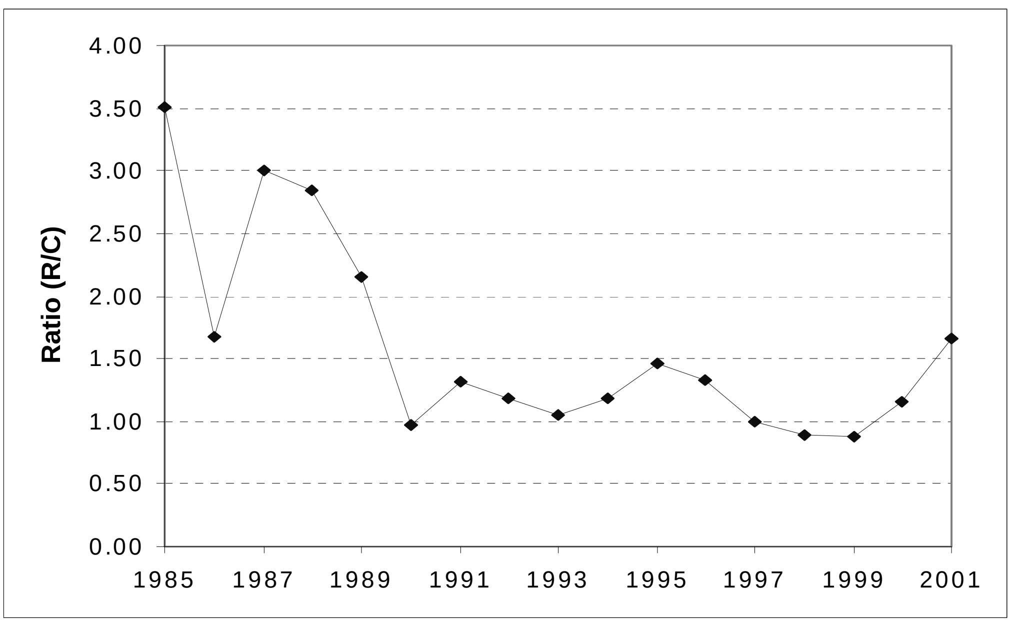

Figure 2.3. Ratios of recreational landings (including headboat) to commercial landings of black seabass.

3 Data workshop

Data for this assessment were prepared by a SEDAR-Data Workshop (SEDAR II - DW) that met for that purpose during the week of October 7, 2002 in Charleston, SC. Participants assembled into three working groups: life-history, recreational, and commercial. Each working group at SEDAR II - DW proposed recommendations on data to be used in this assessment, and then decisions regarding the recommendations were made by a consensus of all DW participants. Those recommendations are found in complete form in the documents of the Data Workshop and are summarized here. Additional questions that arose during initial model development and testing before SEDAR II-AW were resolved at AW (see Section 4). Furthermore, the DW concluded that the assessment modeling approach for black seabass and vermilion snapper should be the age-structured model. All DW recommendations described below were followed, except where indicated.

3.1 Findings of life-history working group

Unit stock The group agreed that black seabass in the South Atlantic Bight form a unit stock.

Age determination All ages used in the assessment were for black seabass sampled by MARMAP from 1978-1998. All black seabass sampled between 1978-1981 were aged. Since1982 a subsample of 16-26 individuals per 20-mm SL size class from 120-200 mm SL were randomly selected and aged from each size class. All individuals larger than 200 mm SL or smaller than 120 mm SL were aged. About 400 fish were aged from each year for 1982-1998.

Natural mortality rate The group recommended a natural mortality rate M=0.3/yr with a range of 0.2–0.4.

Release mortality The group recommended using an estimate of release mortality of 15% with a range of 10-20% (of fish caught and released) for all fisheries.

Maturity schedules Although there were temporal decreases in the size at maturity during 1979-1982 and 1983-1989 for fishery-independent blackfish traps, Florida snapper traps, and hook and line, the group recommended a single maturity schedule for each gear type for the entire period. Maturity schedules for 1990-2001 were based on chevron trap samples only.

Spawning–stock biomass The issue of how to compute spawning–stock biomass is complicated by the species' protogyny. The DW recommended performing the assessment with total spawning biomass, but considered the possibility of using only female spawning biomass.

Fishery-independent surveys The South Carolina MARMAP survey program, which has conducted reef-fish related sampling since 1979, is the only source of fishery-independent data. The group recommended four separate abundance indices for use in the assessment: a hook-and-line index (n=4,296), 1981-1987; a blackfish trap index (n=15,872), 1981-87; a FL snapper trap index (n=10,823), 1981–1987; and a chevron trap index (n=55,306), 1990–2001. The sample size, n, represents the number of fish lengths available from each gear type for the time frame given

3.2 Findings of recreational fisheries working group

Two sources of recreational information are available for use in the black seabass stock assessment: the National Marine Fisheries Service (NMFS) Headboat Survey and the NMFS Marine Recreational Fisheries Statistics Survey (MRFSS).

3.2.1 MRFSS

• DW recommended to split out headboat from MRFSS based on 1979-1985 intercepts by state (proportional to intercepts) for black seabass.

• DW recommended lumping the various MRFSS fisheries (shore-based, charter and private boats).

• DW also recommended post-stratification of black seabass catches from North Carolina (at Cape Hatteras) using intercepts to stratify effort from north and south of Cape Hatteras. In this way, the appropriate catch is obtained from multiplying respective effort by CPUE.

• DW recommended checking for missing mean weight of individual fish by cells (sorted by mode of fishing, year, state, 2-month wave, area) when converting MRFSS retained catch in numbers to retained catch in weight

• DW recommended against adjusting catches to include estimates for Monroe County, FL because these catches for black seabass were considered trivial and may include landings from Gulf of Mexico stock.

• DW recommended use of shore-based, private and charter boat estimates for black seabass. Likewise, DW recommended use of MRFSS measured mean weights from 1981-89 used for black seabass landings estimates for 1978-1980.

• The MRFSS CPUE data for black seabass were provided by MRFSS staff based on directed effort indicators. DW recommended consideration of these data in the assessment. The AW later dropped this index from the assessment (see Section 4).

• DW recommended incorporation of South Carolina supplemental intercept (length measurements of individual fish) data (1988-1995) for black seabass into the assessment.

• DW recommended weighting for individual lengths from MRFSS and South Carolina based on retained catch in numbers for MRFSS from 1981-2001 (by mode, state, wave, and area). Equal weightings were used for 1979-80 lengths. This recommendation was adopted for the assessment. Total samples size for 1979-2001 was 8,940 fish measurements.

3.2.2 Headboat

• DW noted that black seabass landings prior to 1976 were mixed with other seabasses and only reported from North and South Carolina, but since then landings are species specific and include expanded geographic coverage. Headboat landings for the assessment begin with 1978. Prior to 1981, black seabass landings were recorded only by weight, but since then landings are recorded in both numbers and weight. Mean weights for 1978-1980 were estimated by sampling area to convert catch in kilograms to catch in numbers by area, and then summed over area.

• DW recommended use of headboat CPUE in numbers/weight for black seabass. DW also recommended standardizing the headboat CPUE by delta-lognormal general linear model. Species-specific catch records for this analysis were available for 1973-2001. Categorical independent variables were year, month and area. (Because South Carolina inshore and offshore areas were combined by the survey personnel from 1988 on, a new area was defined for South Carolina from 1988-2001 for modeling.) The advantage of the delta-lognormal formulation is that it explicitly models both proportion of trips with nonzero catches and the catch per trip observed in those trips.

• DW recommended weighting for individual lengths from the headboat based on catch in numbers from 1978-2001 by sampling area and season.

• Total sample size of lengths from headboat biostatistical database was 101,943 fish.

3.3 Findings of the commercial fisheries working group

3.3.1 Landings issues

• The DW recommended separating North Carolina landings by management unit based on gear, with no trawl landings, 92% of trap landings, and all remaining gear-type landings assumed harvested in the Southern region.

• Historically, seabass were at times landed as mixed species under 'seabass unclassified' category.

• Based on trip ticket reports from Florida (1995-2001) and North Carolina (1994-2001), early period mixed seabass landings are adjusted by the percentage of black seabass to other seabasses from recent time period. The adjustment for North Carolina is 99.8%; and for Florida it is 98%.

• South Carolina landings were reported to species and are generally considered free of bias due to species mixing. There is no monitoring of other seabass species or sampling beyond the basic TIP requirements available to test this assumption.

• Georgia landings data were available only through the NMFS website. No adjustments were made.

• Commercial landings of black seabass are available since 1950. Between 1950 and 1983 data were collected through the NMFS General Canvass, and coverage was incomplete and variable across states and years. The TIP program began in 1984 and expanded the dealer coverage for landings records over the General Canvass. North Carolina instituted mandatory reporting in 1994 with their Trip Ticket Program; Florida instituted mandatory reporting in 1985, but did not become official landings until 1986.

• Landings can be condensed into three categories: Traps (pots and traps), Lines (hook and line, electric reels, longlines, trolling), and Other (gill nets, trawls, gigs, spears etc). Trap and line categories represent 95% of the total landings on average for 1972 – 2001 and 99% of the total landings since 1997.

3.3.2 Length Distributions

• The TIP program also included length sampling. NC and FL collect length samples beyond the TIP targets.

•Length measurements are based on total length (TL). Landings from SC in some years coded as fork length (FL) are measured as the center line of the tail and are treated as TL measurements without conversion (assumed coding error because black seabass have no fork).

• Length frequencies were tabulated annually in 10 mm length categories, from 100 to 500 mm.

• Sample sizes for length data from all sources are shown in Table 3.1. Length distributions by year are shown in Figure 3.1 and Figure 3.2.

Table 3.1. Sample sizes of length data from fishery-independent and fishery dependent sources.

	MARMAP				Commercial			Recreational	
Year	Hook-and-line	Blackfish trap	FL snapper trap	Chevron trap	Traps	Hook-and-line	Trawl+ other	Headboat	MRFSS
1978								2357	
1979								1655	361
1980								2420	158
1981	439	1772	1088					3035	194
1982	728	1671	2423					3686	417
1983	950	3384	1378					5734	173
1984	694	2860	1760		870	1453	29	6091	285
1985	680	2972	1798		654	1124	14	5860	488
1986	411	1719	1444		41	1393	968	6551	380
1987	394	1494	932		761	1274	34	6443	668
1988					1260	981	304	4256	595
1989					369	706	15	3836	651
1990				6771	770	1256	201	6200	417
1991				4105	1172	1684	157	5381	223
1992				4667	1482	1450	26	5186	612
1993				4544	395	1144	783	3941	349
1994				4772	1019	997	680	4215	323
1995				4518	218	600	338	3325	314
1996				3698	213	713	376	3212	315
1997				4324	935	1009	261	3678	306
1998				4324	428	1638	54	4365	357
1999				4779	868	1749	2	4114	419
2000				4589	448	1083	173	3419	367
2001				4215	587	1880	417	2983	568

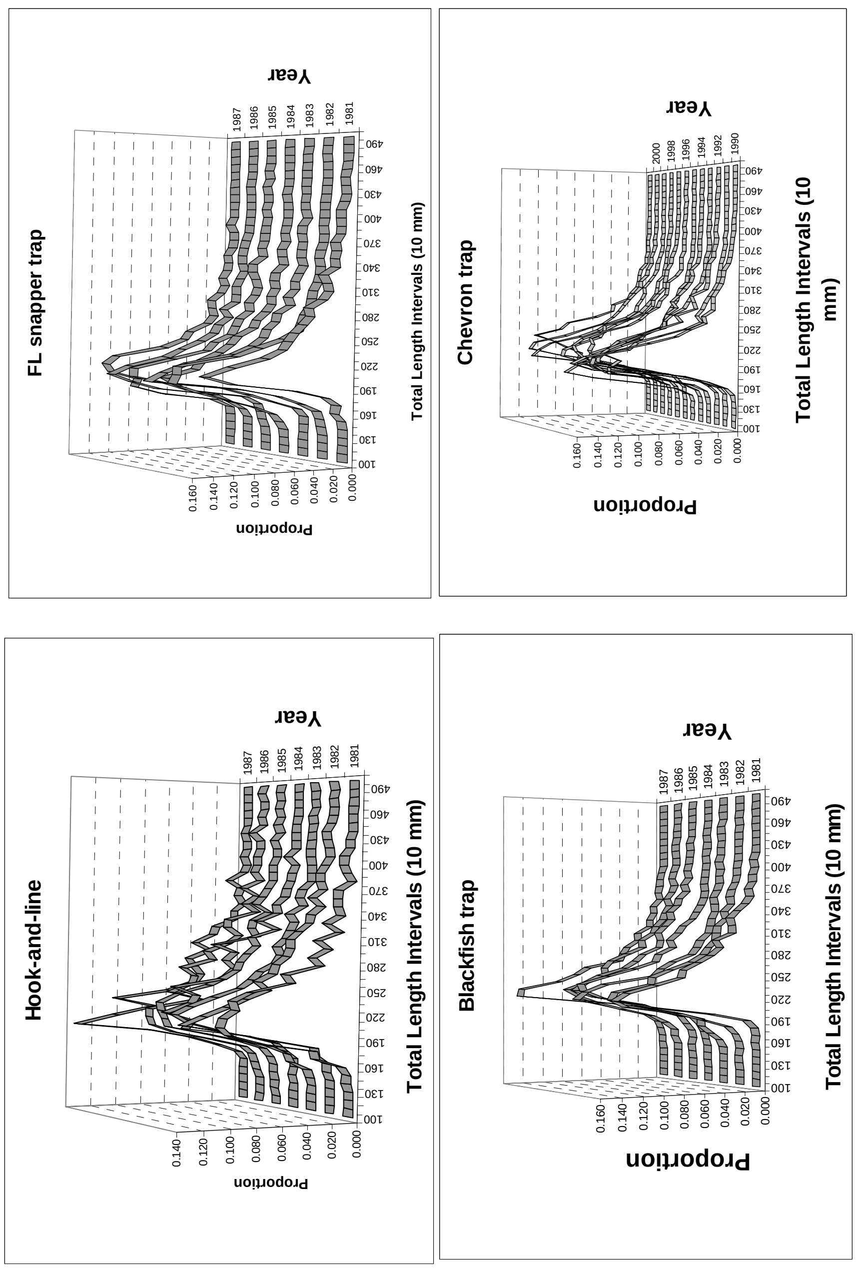

Figure 3.1. Length distributions from fishery-independent sources (MARMAP).

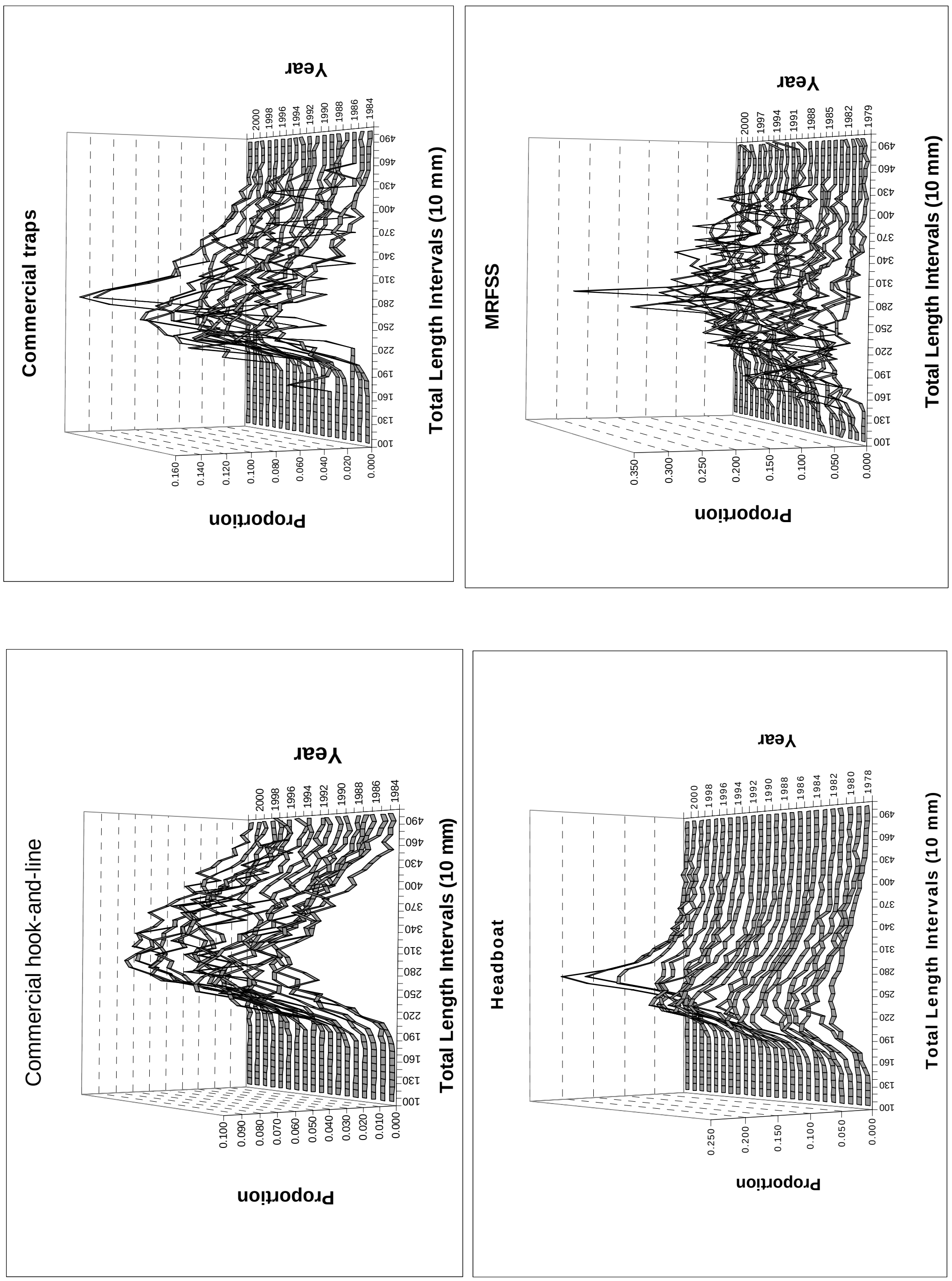

Figure 3.2. Length distributions from fishery-dependent sources.

4 Data issues resolved at the Assessment Workshop

AW considered additional data issues that arose during development and preliminary application of the age-structured assessment model. A brief description of those issues and the resolution chosen by the AW follows.

4.1 General data issues

• AW decided to run the age-structured model at the intermediate natural mortality value, M = 0.3, and to make sensitivity runs at M = 0.2 and M = 0.4.

• AW selected a fixed sex ratio based on pooled trap and hook & line MARMAP data (n=11,015). Female maturity was estimated for three time periods reference by the DW from pooled trap and hook & line MARMAP data (1978-82: n=3,023; 1983-89: n=965; and 1990-01: n=1,289). Sex ratios and female maturity schedules are summarized in Table 4.1. AW recommended that all males age 1 and older be considered mature.

• The AW selected parameters for the von Bertalanffy growth function estimated by McGovern et al.: L_∞ = 398 mm SL, K = 0.16, and t_0 = -1.29. The estimate of L_∞ was converted from SL to 526.5 mm TL based on relation given in McGovern et al. (2002).

• AW recommended use of a weight-length relationship developed from headboat data with sample size (n=103,019 from 1975-2001): $W = exp(-16.932+2.79*ln(TL))$.

• AW decided to run the age-structured model at the intermediate value (0.15) of release mortality.

• AW selected the delta-lognormal standardized CPUE for application with Headboat data from 1973-2001 for this assessment.

• Fish lengths were aggregated into 10 mm bins (size categories) for all fisheries.

• AW decided to structure the age-based assessment model in a manner that accounted for fishery management changes over the history of the fishery. AW decided to model the effects of management change by estimating different fishery-specific selectivities. By modeling changes in selectivity, the model will respond to management measures, such as changes in size limits, that affect the length distribution of the landings. These time periods were 1978-1982, 1983-1998, and 1999-2001.

• The data workshop participants recommended using a suite of relative abundance indicators for the assessment. These are shown in Figure 4.1. After further discussion of the analytical approach for standardization of the MRFSS CPUE data, the AW participants decided that further research into the use of targeting measures from these data was warranted. The AW noted that the divergence in pattern observed between

MRFSS and the Headboat and Chevron trap indices (Figure 4.1) could be explained by inadequate analytical treatment of targeting effects in the MRFSS data. For this reason, the AW decided to eliminate the MRFSS index from the base assessment model applications for black seabass.

Table 4.1. Estimated weight of black seabass, proportion female and female maturity at age based on life history sample collections and applied in the assessment model. Weight for age 0 is estimated at mid-year, while weight for older ages is estimated at start of year (calculated from weight-length relation and von Bertalanffy growth equation).

Age	Weight (kg)	Proportion female	Female maturity		
			1978-1982	1983-1989	1990-2001
0	0.04	1	0	0	0
1	0.06	0.87	0.56	0.98	0.83
2	0.14	0.75	0.89	1	0.93
3	0.25	0.44	0.99	1	0.99
4	0.36	0.29	1	1	1
5	0.49	0.13	1	1	1
6	0.61	0.05	1	1	1
7	0.74	0.02	1	1	1
8	0.85	0	1	1	1
9	0.96	0	1	1	1
10	1.06	0	1	1	1
11+	1.14	0	1	1	1

• AW used abundance indices in weight per unit effort for the production model (lumped biomass), for consistency with model assumptions.

• The recreational hook-and-line fisheries (MRFSS and headboat) were assumed to have the same selectivity to simplify modeling and relatively low sample size from the MRFSS.

• DW recommended computing spawning–stock biomass based on two different measures: total mature biomass (preferred) and mature female biomass (as a sensitivity run). The interpretation of these analyses continues to be problematic, as the relative importance of males and females to population spawning success is not known.

• Aging data for fishery-independent (MARMAP) samples were excluded, as specimens had not been randomly selected for aging, but rather to provide detail in all length classes for use in age-length keys. The resulting age-composition estimates were therefore not representative of the entire sample and were considered inappropriate for use as age-composition data with this model.

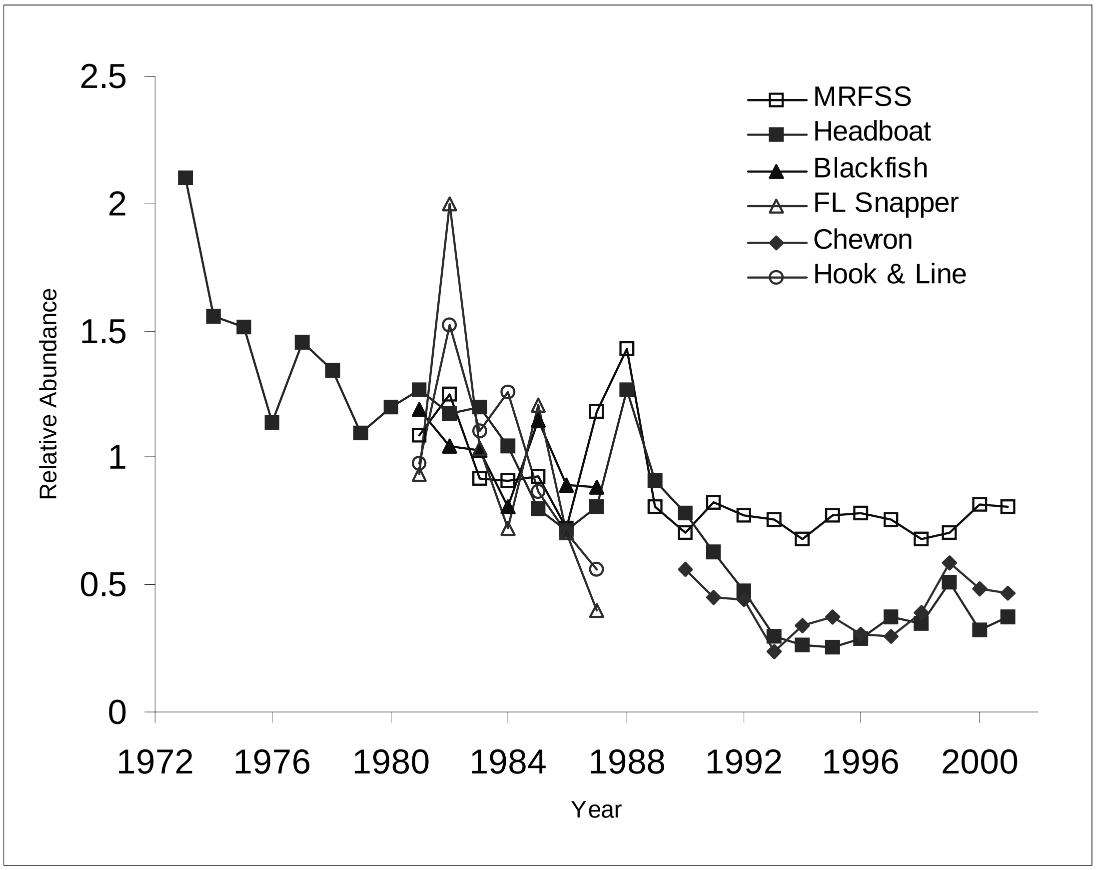

Figure 4.1. Comparative patterns of relative abundance estimated from the data sources indicated. Values are scaled to the means of the individual time series during the period 1981-1987, with the exception of the Chevron series, which is scaled to the mean of the rescaled Headboat time series from 1990-2001.

4.2 Stock-recruitment curve

The model uses a Beverton-Holt stock recruitment curve of the form that includes a parameter for steepness and a parameter R_0 representing the theoretical level of recruitment in an unfished equilibrium state. Both parameters strongly influence estimates of management benchmarks. Consequently, a range of values for steepness (detailed in section 6.1.1) was examined for its effect on model results and R_0 was constrained to biologically reasonable values.

4.3 Additional contraints

Additional constraints were placed on the model to maintain biologically reasonable solutions. Constraints took the form of penalties added to the total objective function.

• Deviations of estimated recruitments from the estimated stock-recruitment model were penalized.

• Recruitment deviations in the model initialization period carried an extra penalty. The initialization period (1967-1977) was required to provide estimates of numbers at age in the first model year (1978).

• Recruitment in the first year of the initialization period was constrained to follow the estimated stock-recruitment curve.

• Recruitment deviations from the estimated stock-recruitment curve in the final three model years (least complete cohorts) were penalized.

• Variances of size-at-age were constrained to ensure that estimates for adjacent ages were similar.

• Full Fs in the final five model years were penalized for deviation from each other.

• Double-logistic selectivities were constrained to be realistic by adding a penalty if the declining slope of older ages was very steep.

• As described in section 6.1.3, several model runs required two additional constraints: one on R_0 and one on full F. A penalty was added if R_0 was greater than twice the mean of recruitments estimated in the first three years (1967-1969). A penalty was added if full F in any year was greater than five.

5 Description of assessment models

5.1 Age-structured model

5.1.1 Properties of age-structured model

The forward-projecting statistical age-structured model for this assessment was implemented in the AD Model Builder software (Otter Research 2000) on a microcomputer. The specific model formulation and implementation used in this assessment is here designated BSB2003. The formulation's major characteristics can be summarized as follows:

Natural morality rate The natural mortality rate was assumed constant over age and time.

Stock dynamics The standard Baranov catch equation was applied. This assumes exponential decay in population size due to fishing and natural mortality processes.

Growth A von Bertalanffy growth model, constant over time, was fixed according to the relationship given in McGovern et al. (2002). Distribution of lengths at age were assumed normally distributed, with mean based on the growth model and variance estimated.

Recruitment A Beverton–Holt recruitment model was estimated internally. Estimated recruitments were loosely conditioned on that model.

Biological benchmarks The benchmarks F_{MSY} and SSB_{MSY} were estimated internally by the model using the method of Shepherd (1982). In that method, the point of maximum yield is identified from the recruitment curve and other biological parameters, such as those for growth and maturity. Selectivity at age must also be specified; here, the model incorporated the catch–weighted selectivities at age estimated for the last three years (1999–2001), a period of unchanging regulations.

Fishing Five fisheries were modeled individually: commercial hook-and-line, commercial traps, commercial other; recreational headboat, and recreational (shore-based, private and charter boats). Separate fishing mortality rates were estimated for each fishery.

Selectivity functions Selectivity was fit parametrically, using a logistic model or double–logistic model (MARMAP trap gear), rather than estimating independent selectivity values for each age. That approach reduces the number of estimated parameters and imposes theoretical structure on the estimates.

Selectivity of fishery-dependent gear Each fishery is assumed to have constant selectivity during each period of constant regulation. Commercial other, the least substantial fishery, was assumed to have constant selectivity across regulation periods. That assumption was relaxed for the remaining fisheries (commercial trap, commercial hook-and-line, headboat, and MRFSS) by allowing selectivity to vary with changes in regulations. The selectivity vectors are estimated internally by BSB2003.

Selectivity of fishery-independent gear The four fishery-independent abundance indices are assumed to have individual time–constant selectivity vectors; the corresponding selectivity vectors are estimated internally by BSB2003.

Discards Discarded fish are routinely estimated in the MRFSS and are accounted for in the estimate of total landings in the model. However, no discard information was made available for any of the other fisheries by the DW. An approximate measure of the discards from commercial hook-and-line, commercial trap, and headboat fisheries, which account for the majority of landings, was modeled with separate selectivity curves. The discard selectivity curve was estimated as the greater of zero or the difference between selectivity before and after size regulations, which represents likely discards of under-sized fish during the periods of size regulation. This is viewed as an underestimate of discards, because the implicit assumption is that no discarding occurred before the size regulations were in place, and that discards only result from the size limit. Any regulation, such as trap escape vents, that reduce size based discards are not specifically modeled.

Discard mortality rates were then estimated by assuming release mortality rates of 0.15, as recommended by DW. The product of release mortality, the estimate of fishing mortality rate, and the estimated discard selectivity curve provided age-specific instantaneous discard mortality rates.

Abundance indices The model used four separately modeled indices of abundance, as described above. They were three fishery independent indices (hook-and-line, 1981-1987; blackfish trap, 1981–1987; FL snapper trap, 1981-1987; and chevron trap, 1990–2001) and one fishery dependent index (headboat, 1973-2001).

Fitting criterion The fitting criterion was a total likelihood approach in which total catch was fit almost exactly, and the observed age– and length–compositions, as well as the abundance index patterns, were fit to the degree that they are compatible. Landings data and abundance index data were fit using a lognormal likelihood, the value of which is inversely related to the coefficient of variation (CV). CVs of abundance indices were provided or calculated; CVs of landings data were assumed equal among fisheries (CV=0.05). Composition data were fit using a multinomial likelihood. In addition, penalties were added to the total likelihood for deviation from realistic biological or fishery characteristics (e.g., recruitments or F's fluctuating greatly from year to year). Relative statistical weighting of each likelihood component for the central case was chosen by the AW after examining many candidate model runs. The criteria for choice were a balance of reasonable fit to all available data and a good degree of biological realism in estimated population trajectory.

5.2 Age-aggregated production model

The age-aggregated production model used was the Graham–Schaefer logistic surplus-production model (Schaefer 1954, 1957; Prager 1994) . This is a continuous time formulation, conditioned on catch, that does not assume equilibrium conditions. By conditioning on catch, the landings data are assumed more precise than the abundance indices. The model fits more than one abundance index by assuming they are correlated measures of stock abundance and that differences between indices can be considered sampling error.

One form of the production model was fit: the Schaefer (1954; 1957) model, which assumes $B_{\mathrm{MSY}} = 0.5K$, where K is the carrying capacity of the stock (virgin stock size). The Schaefer form is often used as a default because of its theoretical simplicity and because it is considered a central case among possible shapes of production model. To fit the production models, a revised version of the ASPIC software of Prager (1995) was used.

Three applications of ASPIC were made using the extended landings for 1950-1977 presented in Section 2. Three assumptions were evaluated concerning the level of recreational landings relative to commercial landings during the period period for which recreational landings data were not available (Figure D.2). These assumptions were that recreational landings were equal to commercial landings (R=C), 2 times commercial landings (R=2C), and 3 times commercial landings (R=3C). The AW recommended that the middle assumption (R=2C) be considered the base run.

6 Model application and results

6.1 Age-structured model

6.1.1 Description of central run and matrix of sensitivity runs

A large number of preliminary runs of the age-structured model were made. A central run was chosen by the AW based on a suite of residual pattern diagnostics. The central run used the data from the Data Workshop with all adjustments described above. The AW was concerned that model predicted uncertainty in the central assessment run would tend to underestimate the uncertainty in the assessment, especially relating to key parameters such as natural mortality rate and steepness in the stock-recruit relationship.

Because of these concerns, eight additional runs were chosen to examine sensitivity of results to these two key parameters. The AW decided to use the range of results from the central run and a matrix of sensitivity runs upon which to base status of stock and to characterize uncertainty in the assessment, rather than to adopt a single run as best representing the condition of the stock. Based on the results of Rose *et al.* (2001), the AW defined a range of steepness values from 0.4-0.8, values which capture the main part of the distribution of steepness estimated for life history strategies similar to black seabass. Steepness (*h*) was fixed at an endpoint of the Rose *et al.* range, or else was estimated internally (labeled “free”). The range in natural mortality rate (*M* = 0.2, 0.3, 0.4) and range in steepness (*h* = 0.4, free, 0.8) resulted in a 3x3 matrix representing uncertainty in the assessment. A set of marginal probabilities were assigned by consensus of the AW to *M* (0.25, 0.5, 0.25) and to *h* (0.25, 0.5, 0.25) based on a triangular distribution giving more weight to the central value compared to smaller but equal weights to each tail. The probabilities for each cell were based on the product of these marginal probabilities (e.g., *M* = 0.3 and steepness = 0.4 has a probability associated with it of 0.5 x 0.25 = 0.125 as in Table 6.1 below).

Table 6.1. Sensitivity runs for natural mortality (M) and steepness (h) and their AW-designated probability weightings.

			Steepness (*h*)		
			0.4	Free	0.8
		Marginal Probability	1/4	1/2	1/4
Natural mortality (*M*)	0.2	1/4	1/16	1/8	1/16
	0.3	1/2	1/8	1/4	1/8
	0.4	1/4	1/16	1/8	1/16

Hence, this “central run” is not considered to be a “base run” as typically used. It is simply the most likely as represented by the cell probabilities (0.25) given in Table 6.1, and results from the central values (M=0.3 and h=free) of the marginal distributions having greatest probability. The AW recommended that overall status of the stock be determined from a weighted average of a given status variable from each cell in the above 3x3 matrix.

Sensitivities to other model assumptions and parameter assignments were also examined as variations of the central run. These variations are: 1) SSB based only on females, 2) SSB based only on females with steepness fixed near that estimated by the central run, 3) MRFSS CPUE included, and 4) an alternative likelihood weighting scheme along with growth parameters estimated internally.

Uncertainty predicted by the model only reflects uncertainty in the fit of the model to the data. Uncertainty illustrated in the sensitivity runs only reflects uncertainty in those parameters that are varied. What can not be directly evaluated are errors resulting from the assumptions needed to develop the full data input and inadequacies in the input data series, such as poor temporal coverage of fishery-independent surveys, insufficient biological sampling of the fisheries, and incomplete tabulation of total removals by the fisheries.

6.1.2 Results of central run

The model was configured to match observed catches almost exactly (Figure 6.1 and 6.2). Fits of the central run of the BSB2003 model to the abundance indices are shown in Figures 6.3 and 6.4. Reasonably good fits were found to the blackfish and chevron trap indices. The Florida snapper trap and MARMAP hook-and-line indices are highly variable with little trend, patterns which the model fits poorly. The headboat index, a long time series with pronounced trend, is fit quite well by the model.

Selectivities of the four major fisheries are shown in Figure 6.5. Selectivities estimated from the headboat and recreational fisheries show a slight shift towards larger, older fish with the imposition of minimum size limits in 1983 (8" TL) and 1999 (10" TL). The selectivity for commercial trap and lines was initially around age 3 for the first period (1978-1982) when there was no minimum size limit. During the second period, when the 8" TL minimum size limit was in effect, a lower selectivity was estimated for both gears. In the final period (1999-2001), when the 10" TL minimum size limit was in effect, the commercial traps showed only minimal increase in selectivity at age, while the commercial lines showed an increase in selectivity back to a level similar to the first period.

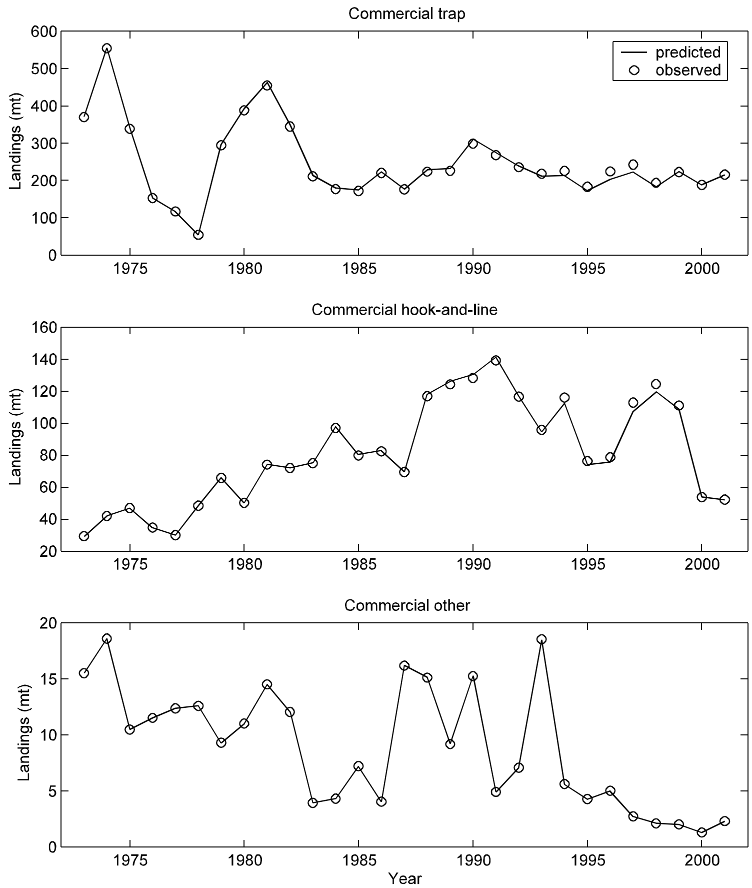

Figure 6.1. Observed (circles) and predicted (lines) commercial landings from central run of BSB2003.

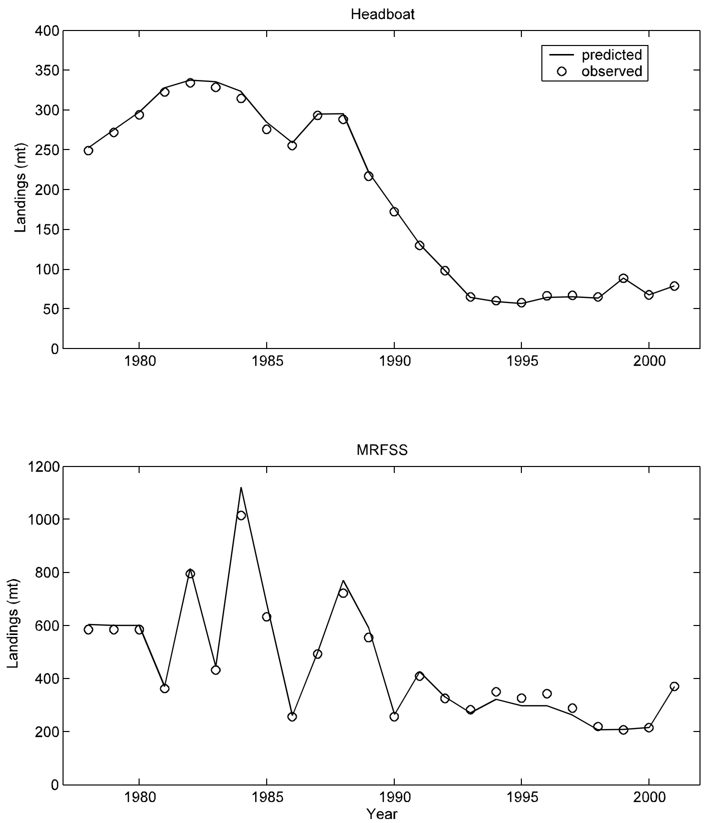

Figure 6.2. Observed (circles) and predicted (lines) recreational landings from central run of BSB2003.

Discards are estimated for headboat and commercial landings based on the change in selectivity relative to the first time period. Because higher selectivity was found with the commercial gears (trap and lines) for the first period relative to the later periods, no discard is estimated.

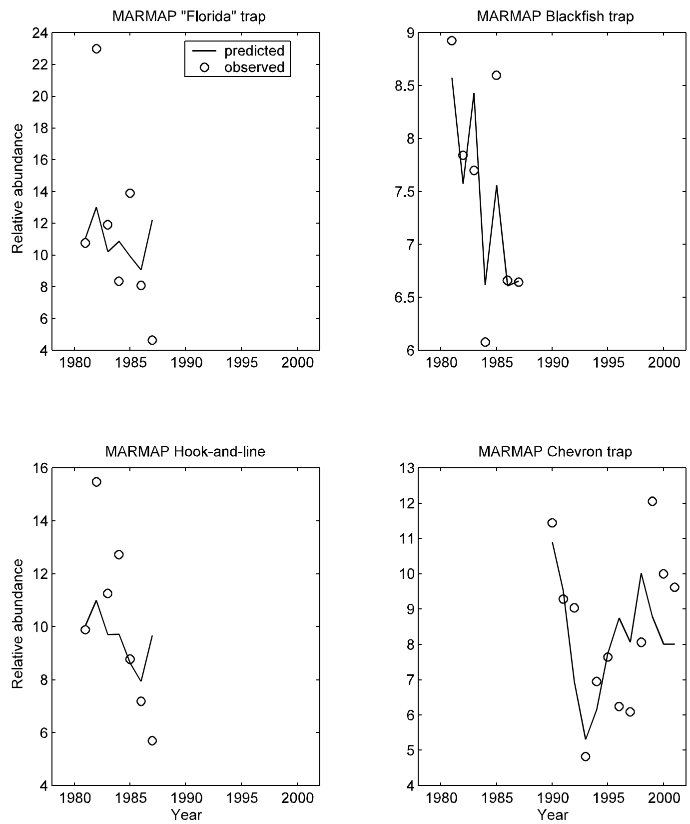

Figure 6.3. Observed (circles) and predicted (lines) fishery independent abundance indices, from central run of BSB2003.

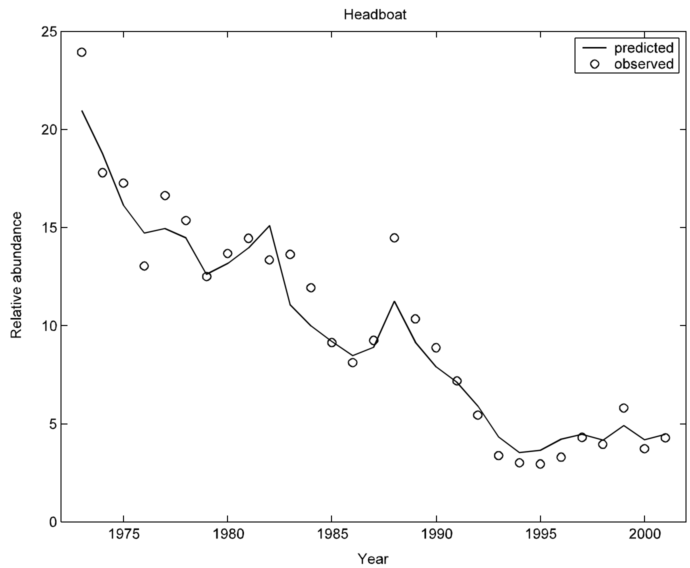

Figure 6.4. Observed (circles) and predicted (lines) fishery-dependent abundance index, from central run of BSB2003.

Based on the central run, the model estimates that SSB (mature biomass) had declined to about 30% of its 1978 value by 1995, and remaining low through 2002 (Figure 6.6). Values of SSB in the early years of the assessment were at or above 4000 mt, and declined sharply in the early 1990s to values generally below 2000 mt.

The model estimates that resulting recruitment has declined to about 55% of its average 1978-85 level (averaging 10.3 million seabass) in the recent period (1995-2001, averaging 5.7 million seabass) period. The decline in estimated recruits precedes the decline in estimated SSB.

The estimated stock–recruitment relationship shows the usual scatter about the fitted Beverton–Holt recruitment curve (Figure 6.7). The ranges of SSB and resulting recruitment in this table are less than those suggested at MSY (SSB_{MSY} = 13,518 mt and R_0 = 27 million). This implies that the stock during the assessment period has been low relative to its potential. Note that benchmarks change with changing overall selectivity of the fishery. Estimates of benchmarks presented in this report are based on selectivity from the final time period (1999-2001) when selectivity was assumed constant across fisheries.

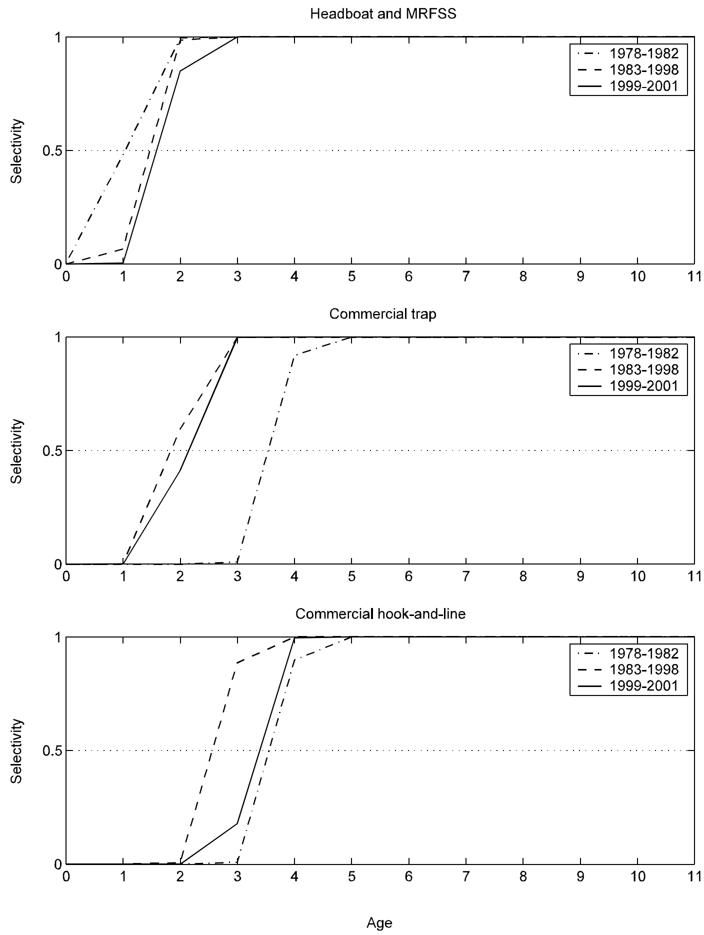

Figure 6.5. Estimated selectivity for the central run of BSB2003 by fishery over time.

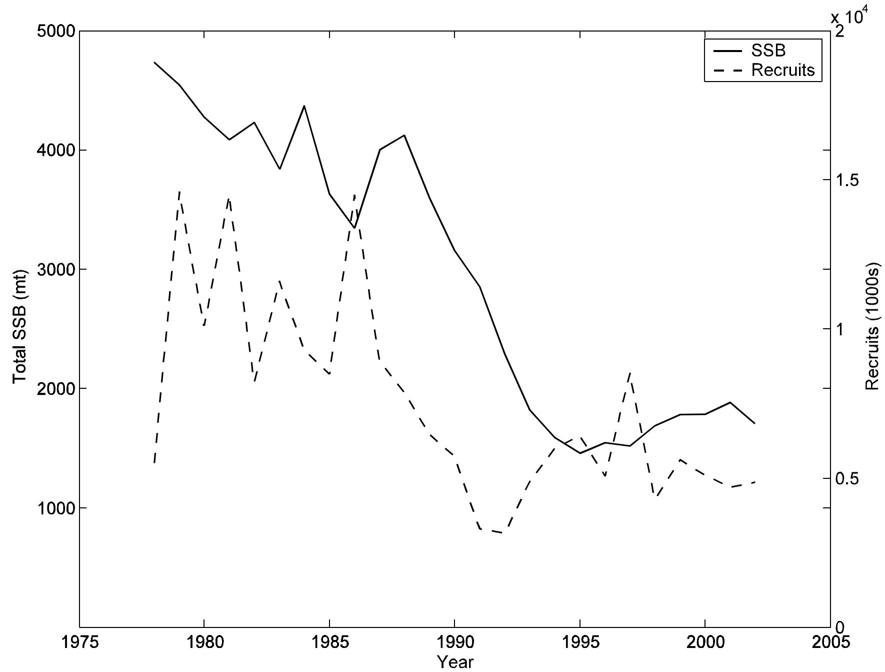

Figure 6.6. Estimated time trend of mature biomass and age 0 recruits of black seabass over the period 1978-2001 from the central run of BSB2003.

These results are consistent with the existence of a substantial fishery for black seabass in the 1960's as evidenced by the landings data shown in Appendix D. The model, however, does not directly consider the more historical landings and for that reason, the estimates relative to benchmarks could differ if more historic landings data were incorporated.

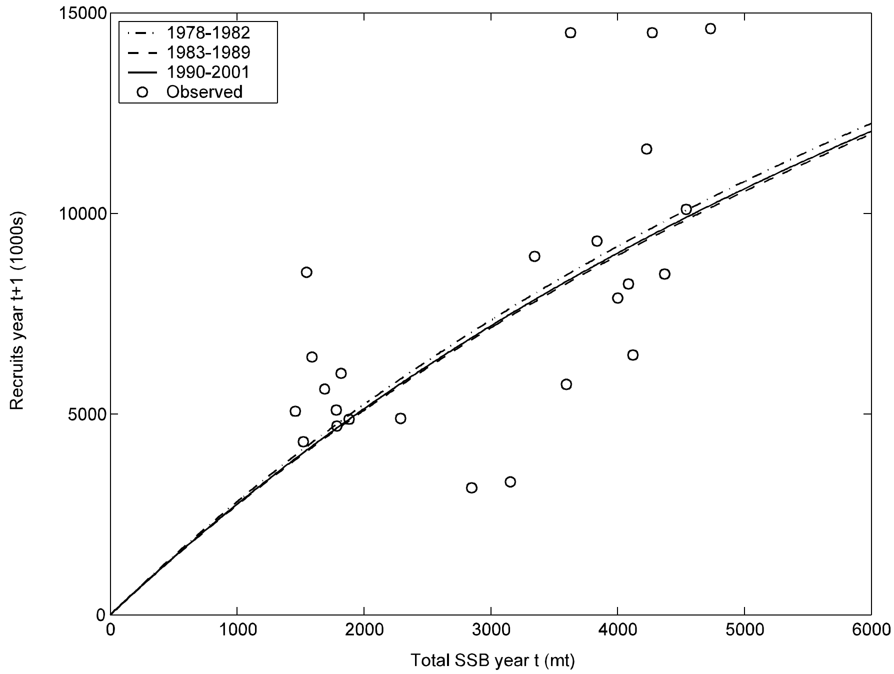

Figure 6.7. SSB and recruitment of black seabass estimated from the central run of BSB2003 with estimated Beverton–Holt recruitment model. The three curves correspond to time periods of different female maturity schedules: 1978-1982, 1983-1989, 1990-2001.

Fishing mortality rate relative to F_{MSY} is fairly constant until about 1993, at which time it increases sharply, peaking in 1999 at about 10 times F_{MSY} (Figure 6.8). Fishing mortality F in 2001 is estimated to have been reduced to about 5 times F_{MSY}. Spawning stock biomass relative to SSB_{MSY} at the start of the assessment period is about 35%, and declines during the early 1990s to about 11% in 1995, with some small improvement since then to about 13% in 2002.

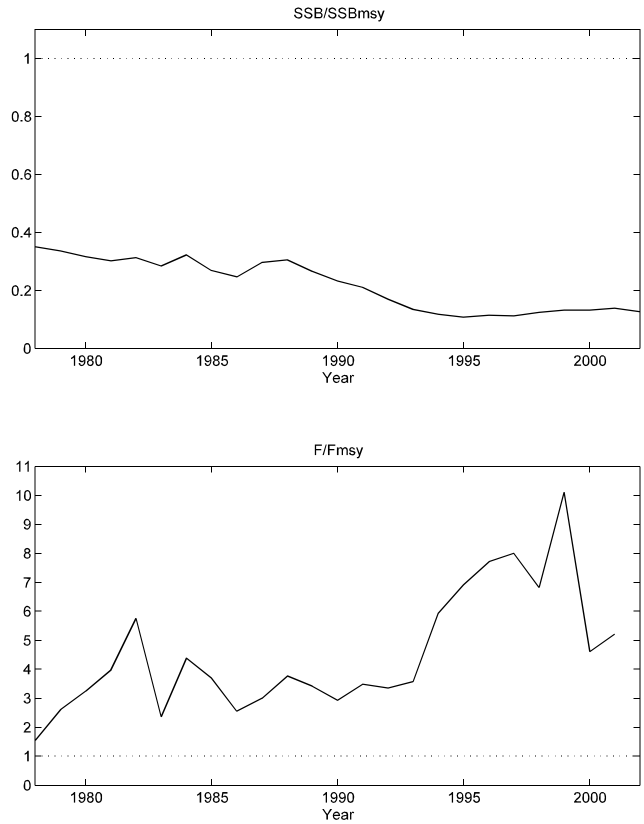

Figure 6.8. Time-trajectories SSB/SSB_{MSY} and F/F_{MSY} from the central run of the age-structured assessment model.

6.1.3 Results of sensitivity and alternative runs

Sensitivity runs were made based on the matrix of values for natural mortality (*M*) and steepness (*h*) as described in Section 6.1.1. Results of the various assessments of black seabass are tabulated in Table 6.2 and summarized in the form a schematic fishery control rule (Figure 6.9). The suite of sensitivity runs show a wide range of values for various benchmarks and other variables. F_{MSY} varies from 0.09 to 0.99 with the central value of 0.20 and weighted mean value of 0.27. SSB_{MSY} varies from 3,050 mt to 38,300 mt with the central value of 13,500 mt and weighted mean value of 14,500 mt. Other variables in Table 6.2 also show a wide range with central values similar to weighted mean values. Both central and weighted means suggested the stock is overfished (SSB/SSB_{MSY}) and overfishing (F/F_{MSY}) is occurring.

In the control rule plot (Figure 6.9), F/F_{MSY} is plotted against SSB/SSB_{MSY} with thresholds and targets shown on the same plot. The fishing mortality control rule (MFMT) is defined so that for SSB greater than MSST (= $(1\text{-}M)SSB_{MSY}$), then MFMT = F_{MSY}; and for SSB less than MSST, then MFMT = F_{MSY}*SSB/MSST, or line drawn from the origin to the point (F_{MSY}, MSST). Virtually every run shows that the stock is overfished and overfishing is occurring. The only exception is the sensitivity run where *M*=0.4 and *h*=0.8. That single run suggests a species that is highly resilient to fishing.

Table 6.2. Summary of estimates from central age-structured model and sensitivity runs. Asterisk (*) indicates additional constraints required for optimization procedure (full $F \leq 5$ and $R0 \leq 2$ times mean recruitment from first three model years). Weighted mean of F_{max} uses 2.0 for values greater than 2.0.

	Fmsy	F0.1	Fmax	MFMT	SSBmsy	MSST	MSY	F(2001)/ Fmsy	SSB(2002)/ SSBmsy	steepness (*h*)	R0
M=0.2, steep=0.4*	0.09	0.19	0.40	0.002	3.83E+04	3.07E+04	2.63E+03	22.23	0.02	fixed	3.43E+07
M=0.2, steep=free*	0.20	0.19	0.40	0.01	2.53E+04	2.02E+04	3.58E+03	9.51	0.06	0.67	2.73E+07
M=0.2, steep=0.8*	0.26	0.19	0.40	0.07	7.94E+03	6.35E+03	1.41E+03	5.63	0.21	fixed	9.36E+06
M=0.3, steep=0.4*	0.14	0.29	0.83	0.02	1.83E+04	1.28E+04	1.73E+03	6.91	0.08	fixed	3.44E+07
M=0.3, steep=free	**0.20**	**0.29**	**0.83**	**0.04**	**1.35E+04**	**9.46E+03**	**1.73E+03**	**5.22**	**0.13**	**0.49**	**2.72E+07**
M=0.3, steep=0.8	0.47	0.29	0.83	0.36	4.02E+03	2.82E+03	9.87E+02	2.13	0.54	fixed	1.00E+07
M=0.4, steep=0.4	0.22	0.41	>2.0	0.07	1.07E+04	6.44E+03	1.33E+03	4.42	0.19	fixed	3.59E+07
M=0.4, steep=free	0.19	0.41	>2.0	0.06	1.18E+04	7.05E+03	1.31E+03	4.67	0.17	0.38	3.87E+07
M=0.4, steep=0.8	0.99	0.41	>2.0	0.99	3.05E+03	1.83E+03	9.93E+02	0.94	0.89	fixed	1.37E+07
Weighted Mean	**0.27**	**0.29**	**1.01**	**0.14**	**1.45E+04**	**1.06E+04**	**1.78E+03**	**6.28**	**0.22**		
Alternative Runs:											
Female SSB	0.28	0.29	0.83	0.18	2.61E+03	1.83E+03	1.04E+03	3.66	0.46	0.30	1.34E+07
Female SSB, steep=0.5	0.52	0.29	0.83	0.52	2.02E+03	1.41E+03	9.86E+02	1.92	0.70	fixed	9.65E+06
w/ MRFSS CPUE	0.21	0.29	0.85	0.04	1.32E+04	9.24E+03	1.74E+03	4.29	0.15	0.50	2.67E+07
Alt. weighting, growth estimated	0.15	0.41	>2.0	0.08	1.33E+04	9.32E+03	1.02E+03	2.06	0.39	0.34	4.01E+07

Other alternative runs were also made as summarized in Table 6.2. These include two runs using mature female biomass only (steepness free and fixed at 0.5). The runs based on female biomass are more optimistic than those based on total mature biomass, but still suggest that the stock is overfished and overfishing is occurring.

Additional runs with total mature biomass were made, including a run with the MRFSS CPUE in addition to the other CPUE indices, and a run estimating growth parameters using an alternative weighting approach and growth estimated by the model. Results from the run that included the MRFSS CPUE is very similar to the central run that it parallels. The other run with alternative weighting approach and estimated growth is somewhat more optimistic than the central run relative to benchmarks.

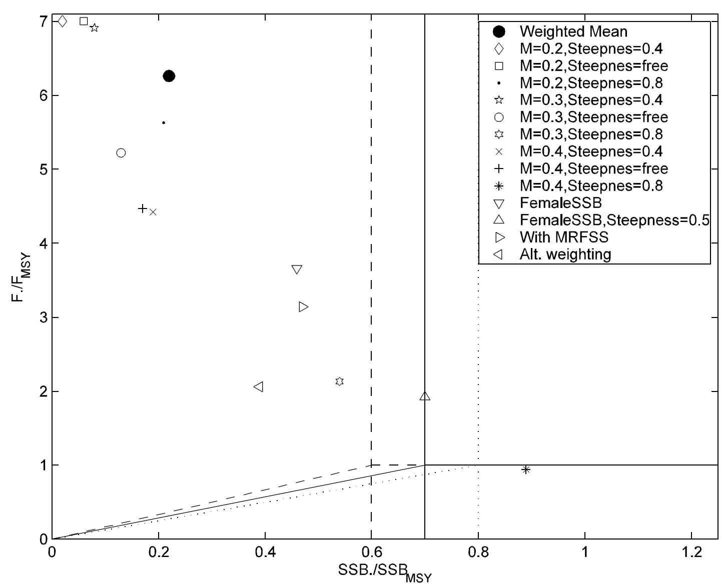

Figure 6.9. Results of the various runs of the stock assessment. F ratios in excess of 7 are set to 7 for graphical purposes. Dotted lines represent MSST and MFMT corresponding to M=0.2, solid lines for M=0.3, dashed lines for M=0.4. Natural mortality M=0.3 unless otherwise indicated in the key. Cental run is represented by the solid circle.

6.2 Age-aggregated production model

6.2.1 Application of production model

Data used for production modeling were total landings and four abundance indices described in Sections 2, 3 and 4 and Appendix D. Indices of abundance used in this approach included CPUE estimates from headboat and MARMAP hook & line, blackfish and chevron traps. The AW chose as more complete the catch data series that included the reconstructed time-series for the period 1950-1977 (see Appendix D), continuing on with the data from 1978-2001 as used in the age-structured assessment. Three assumptions were examined relative to the recreational landings compared to commercial landings during the earlier time period (Appendix D).

6.2.2 Results of production model

Unlike some applications of age-aggregated production models, it was not necessary to fix the value of B_1/K to obtain estimates. Fits to the four indices of abundance (3 MARMAP and 1 Headboat CPUE) for base production model run (R=2C) are shown in Figure 6.10.

Relative population trajectories (B/B_{MSY}) are most divergent between R=C and R=2C, especially during the late 1970s and early 1980s (Figure 6.11). Trajectories of relative fishing mortality rate (F/F_{MSY}) differed even less (Figure 6.11). There is a notable difference in stock status relative to both SSB and F in the 1970s coincident with the shift in assessment data series (1950-1977 and 1978-2001). However, the status at the end of the time series (2001) is similar among the three sensitivity runs.

Estimates of management quantities from the production model describe the stock in 2002 as overfished (B/B_{MSY}) and undergoing overfishing in 2001 (F/F_{MSY}) (Table 6.3). Confidence intervals, derived from bootstrapping, tend to underestimate the uncertainty in the analyses, as is true of most confidence intervals reported for fisheries model estimates. This is for many of the reasons discussed above for the age-structured model.

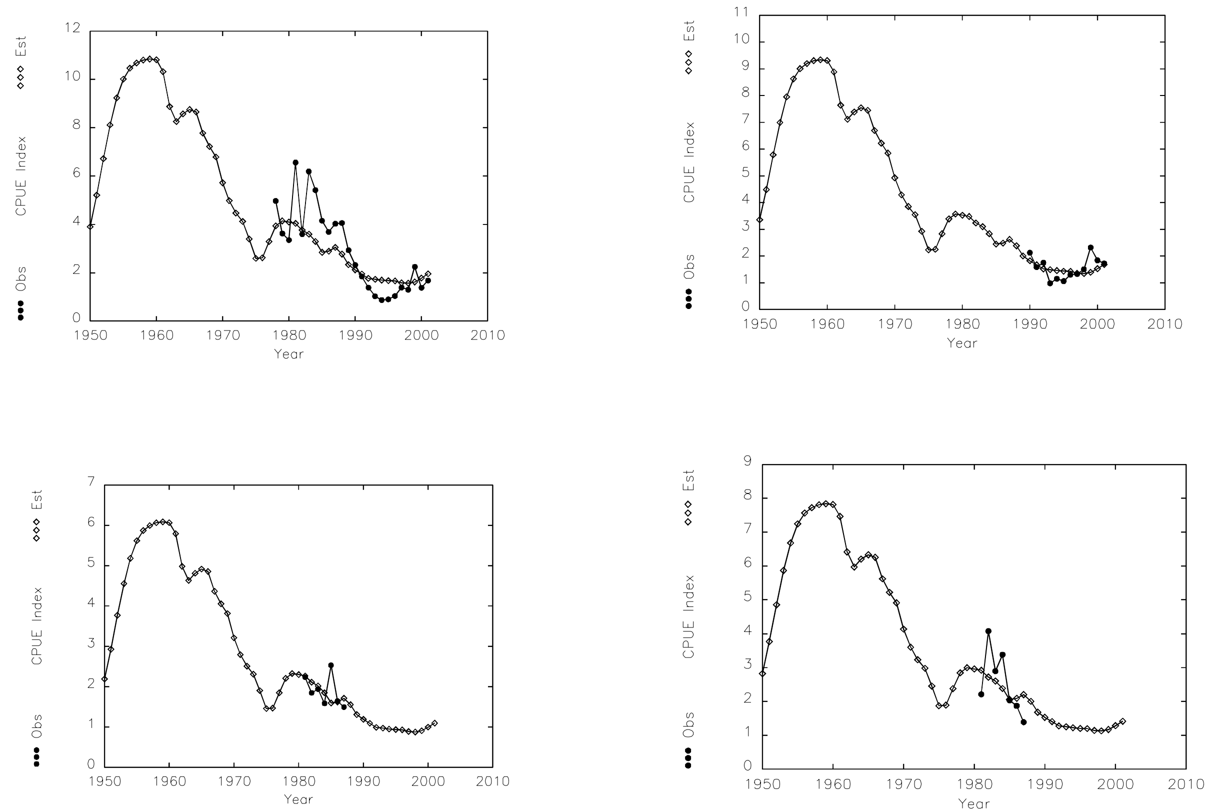

Figure 6.10. Fit of base production model (R=2C) against Headboat (upper left) and MARMAP (chevron trap, upper right; blackfish trap, lower left; hook & line, lower right) CPUE.

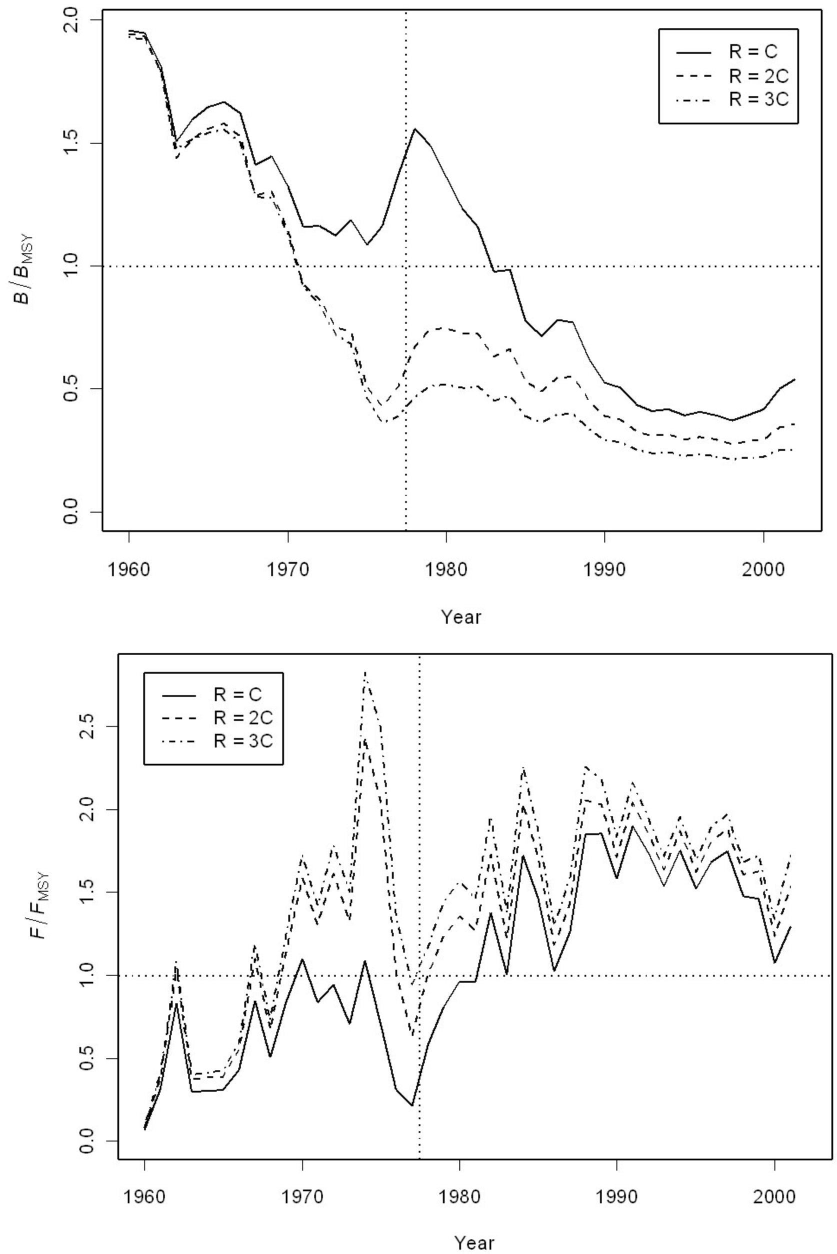

Figure 6.11. Trajectories of B/B_{MSY} and F/F_{MSY} from production model of black seabass. Three trajectories are shown, representing estimates conditioned on different assumptions about the volume of catch prior to 1978. R=C represents the assumption that pre-1978 recreational catch was the same volume as recorded commercial catch; R=2C represents the assumption that pre-1978 recreational catch was twice the recorded commercial catch; and R=3C represents the assumption that pre-1978 recreational catch was 3 times the recorded commercial catch.

Table 6.3. Summary of estimated benchmarks and stock status from application of the production model to black seabass off the southeastern U.S. for 3 levels of recreational harvest relative to commercial harvest during 1950-1977. Bootstrapped 80% confidence intervals presented for base case (R =2C). Note that Ye is equilibrium yield available in 2002.

Benchmark or status indicator:	R = C	R = 2C	R = 3C
MSY (mt)	1070	1344 (1335, 1351)	1658
B_{2002}/B_{MSY}	0.54	0.36 (0.25, 0.48)	0.25
F_{2001}/F_{MSY}	1.30	1.53 (1.19, 2.01)	1.73
Ye (mt)	841	791 (602, 988)	728
Ye_{2002}/MSY	0.79	0.59 (0.44, 0.73)	0.44

6.3 Comparison of models

Estimated trends of stock status and fishery status from the two models are qualitatively similar (Figure 6.12). It is important to note that total stock biomass, not SSB, is estimated in the production model. For direct comparison (Figure 6.12), B/B_{MSY} was calculated for the age-structured model. The trends in relative biomass (B/B_{MSY}) are similar between the two model approaches, although the production model is more optimistic relative to the degree that the stock is overfished over the comparable time period, including 2002. The trend in F/F_{MSY} differ importantly during the 1990s where the age-structured model suggests a large increase in F during the late 1990s followed by a decline in the most recent years. This pattern is not captured by the production model. The age-structured model estimates are fully-selected F in numbers, while the production model estimates are average *F* of the exploited fraction, in weight.

Because the age-structured model incorporates far more information on the stock's biology and on the characteristics of the fishery, the AW considers the BSB2003 age-structured model the more reliable assessment tool. As such, its estimates are considered more likely to be accurate, and the production models and sensitivity runs are considered to give less definitive views of the population. Nonetheless, both models give the same basic picture of the stock's status in 2001 (Tables 6.2 and 6.3): the stock was overfished, being reduced to about 22%of SSB_{MSY} for the age-structured models (weighted mean of values) versus 36% for the base production model, and it was undergoing overfishing, as F_{2001} was about 630% of F_{MSY} for the age-structured models and about 153% for the base production model.

Given the different assumptions used by each type of model and the lack of age structure in the production models, the similarity of trends in both models and relative stock status increases the AW's confidence that the stock is overfished and overfishing is occurring.

6.4 Comparison to previous assessments

Results from this assessment are qualitatively consistent with results from earlier black seabass stock assessments (Vaughan et al. 1995, 1996). Both of these earlier assessments are based on tuned VPA (FADAPT). The first assessment, which included data through 1990 (Vaughan et al.1995), suggested that fishing mortality during the 1980s was slightly above the $F_{30\%}$ SPR target/threshold. However, the second assessment, with data through 1995 (Vaughan et al. 1996), suggested that a somewhat greater level of overfishing might be occurring in the early 1990s relative to the $F_{30\%}$ SPR target/threshold. Levels of static SPR estimated in the first two assessments were generally in the 20-30% range for 1979-1995. This assessment estimates static SPR at slightly higher values, on the order of 25-35% (Figure 6.13). The current assessment suggests that the level of fishing mortality that is appropriate as a threshold (F_{MSY} = 0.27 in Table 6.2) is considerably lower than $F_{30\%}$ (0.7 in Table 10 from Vaughan et al. 1996). Our estimate of F_{MSY} is equivalent to static SPR of about 55%. This suggests that the static SPR proxy of 30% may not adequately protect the stock (see Section 7.1).

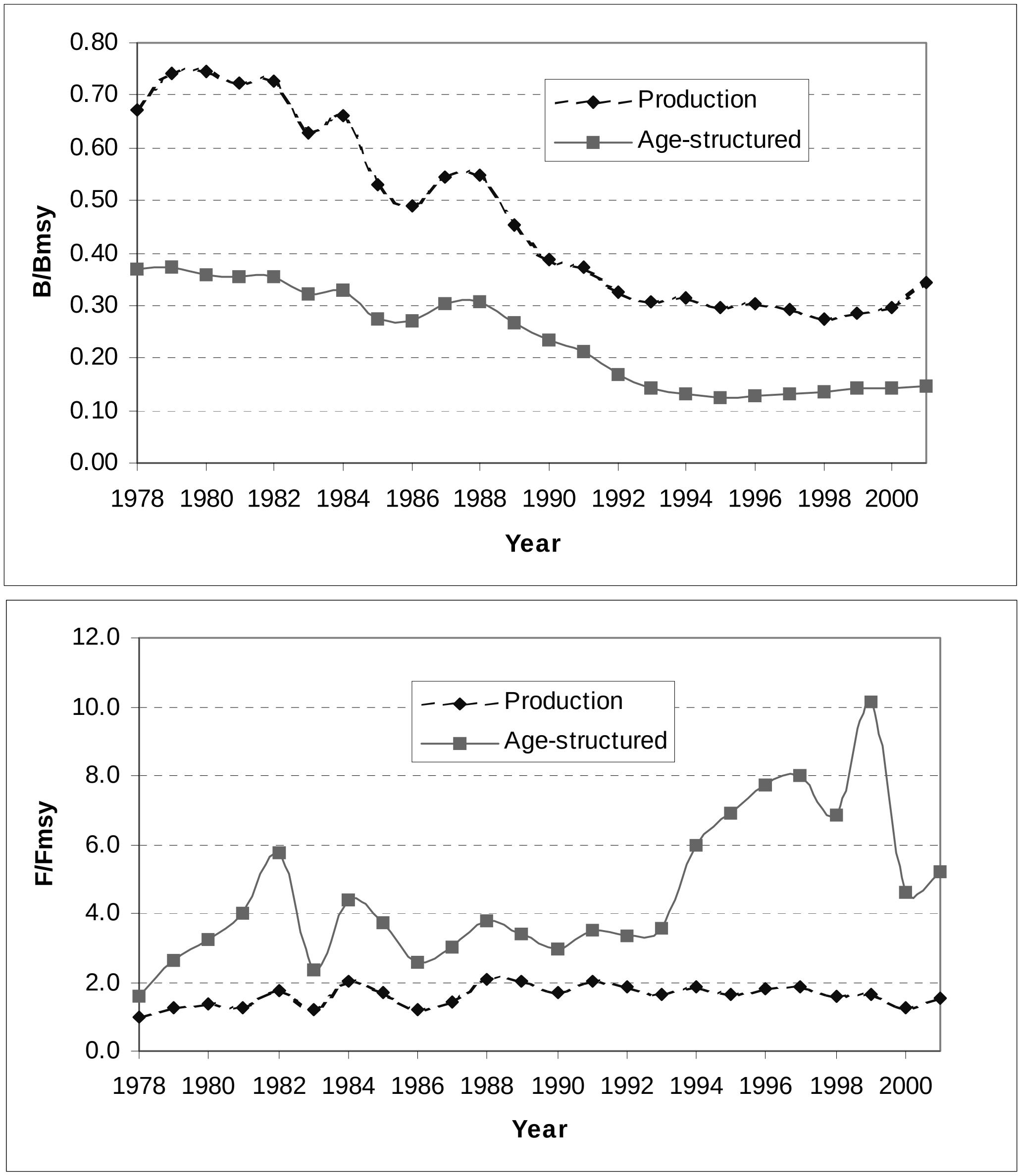

Figure 6.12. Comparison of estimated stock and fishery status from the central run (M=0.3, h=free) of the age-structured model and the base run (R=2C) of the production model.

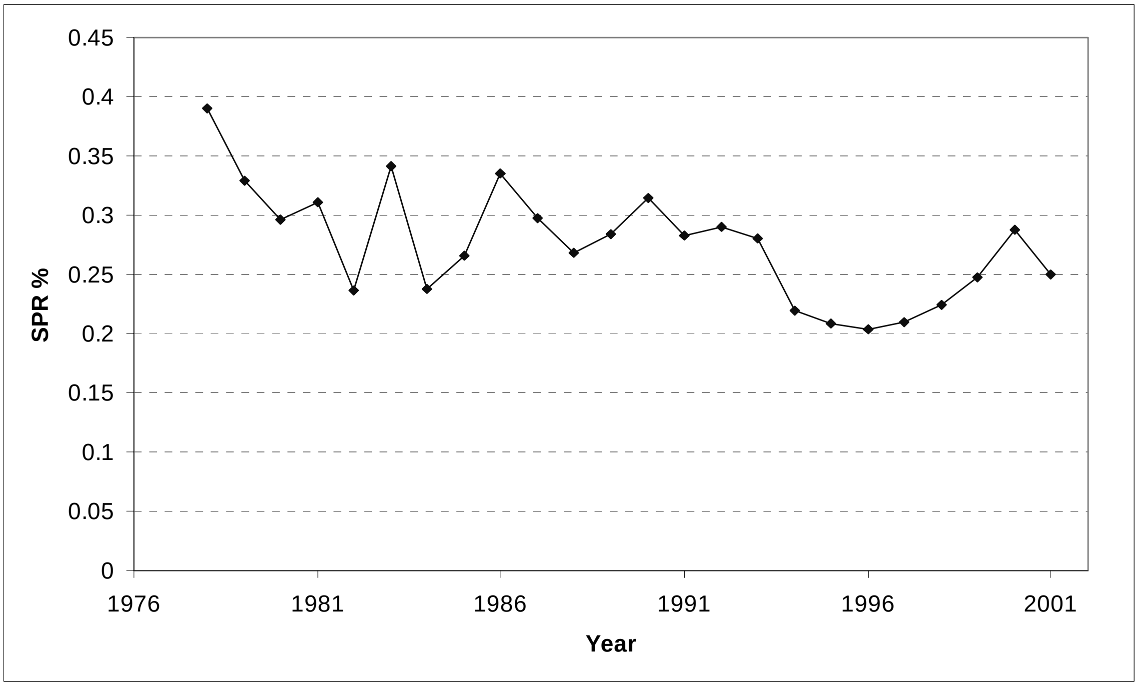

Figure 6.13. Annual estimates of static spawning potential ratio (%SPR) for the central run of BSB2003.

7 Biological reference points

7.1 Proxies and estimated reference points

Concern by the AW of uncertainty in the model fits, the assumption of natural mortality (*M*), and difficulty in estimating steepness (*h*), led to a recommendation to base the scientific advice on the weighted average of estimates of F_{MSY}, SSB_{MSY}, and related quantities. Weighting is given in the matrix of *M* and *h* combinations from Table 6.1. This assessment provides direct estimates of the required management benchmarks which should be used instead of current proxies. For determining status of the stock, the AW recommends consideration of the weighted average of the status indicators F_{2001}/F_{MSY} and SSB_{2002}/SSB_{MSY}.

Proxies for management benchmarks are typically developed from SPR and YPR plots as shown here for the central run (Figure 7.1). Static SPR proxies are based on levels of *F* that will provide a certain level of spawning biomass relative to the maximum level at *F*=0. YPR proxies are based on maximizing yield and do not provide protection of the spawning stock. Typical proxies from YPR include F_{max} and $F_{0.1}$. The latter proxy has been used in Canada and Europe, and was developed to be somewhat more conservative than F_{max}. As shown in Figure 7.1, F_{MSY} (0.2) is somewhat lower than $F_{0.1}$ (0.3), and considerably lower than F_{max} (0.8). All of these values are below the estimated *F* in the terminal year (1.1).

The existing proxies, which are based on spawning potential ratio (SPR), have not proven sufficiently restrictive to maintain the stock (Vaughan et al. 1996, and this report). Even though prior assessments and this assessment have estimated SPR values similar to the proxy threshold/target over the assessment period, the SSB has declined (Figure 6.6). No firm theoretical basis is known for deriving an SPR value to maintain high sustainable yields without having detailed knowledge of the species' population characteristics, knowledge that is often sufficient to compute actual benchmarks. Several levels of SPR have been recommended in the fisheries literature as general cases, and those levels have tended to increase as empirical experience has accumulated. For example, Goodyear (1993) recommended 20% to 30% as "critical levels," Clark (1993) recommended 40% (an increase from his earlier recommendation of 35%), and Mace (1994) recommended using 40% SPR as a default in many conditions. Clark (2002) found that "at low …levels of resiliency, the *F*40% strategy results in undesirably low levels of biomass and recruitment by present-day standards." Based on this assessment, even these levels above do not appear to be sufficiently restrictive, and that a threshold level of static SPR for black seabass may be above 50% (Figure 7.1). Although SPR proxies can be useful approximations when management quantities cannot be estimated, the use of SPR proxies for black seabass is now unnecessary, and use of estimated benchmarks has a firmer biological basis.

7.2 Protogyny and reference points

The protogynous nature of black seabass creates complications in management not encountered with gonochoristic species (non-sex switcher). Protogynous species may switch from female to male as they age. Selective removal of fish by size, either smaller females or larger males, will affect the reproductive potential of the population in ways we do not fully understand. SSB in this assessment combines mature males and females and therefore assumes both sexes have equal contributions to production of recruits.

Examination of SSB by sex indicates a long-term decline in male SSB coupled with a sudden decline in female SSB in the early 1990s (based on central run in Figure 7.2). The decline in male SSB is reflective of sustained high mortality rates truncating the age structure over time. The decline in females may have been triggered by a shift in selectivity by the commercial gear and was likely exacerbated by poor recruitment. Estimated selectivity for the primary commercial gears (traps and lines) shifted toward younger fish during the period when an 8" TL minimum size was imposed, which is contrary to the intended effect of a size limit and could be a result of market demand or availability. The lowest recruitment values of the series are observed within a few years after female SSB begins to drop; the lack of recruitment into the population drives SSB down even further. Both male and female SSB stabilize by 1995, although lower and apparently less productive in terms of recruitment.

The female spawning biomass was reduced at a slower rate particularly after imposition of minimum size limits. In such a situation, a target fishing mortality with large minimum sizes in the fishery is likely to result in differential mortality between the sexes. Consequently, the target fishing mortality may achieve the target SSB while the corresponding sex ratio of the population may not be optimal for sustaining yield. For that reason, Vaughan et al. (1992) recommended use of total mature biomass, rather than female mature biomass, in estimation of reference points based on spawning biomass. The effect of fishing on the transition rate from female to male has not been well studied. In devising management measures to rebuild the spawning stock, the size and sex structure of the target SSB should be considered as well as its total biomass.

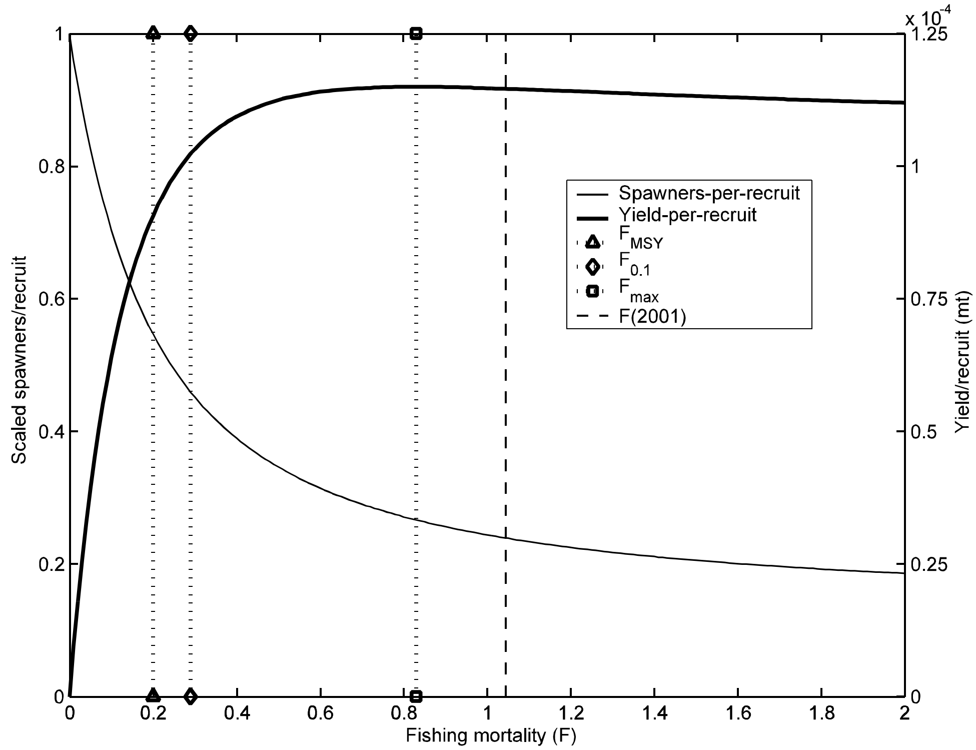

Figure 7.1. Static SPR and YPR based on the central run with selectivity for 1999-2001. Vertical lines represent various benchmark mortality levels, including F_{MSY}, $F_{0.1}$, F_{max} and F_{now}.

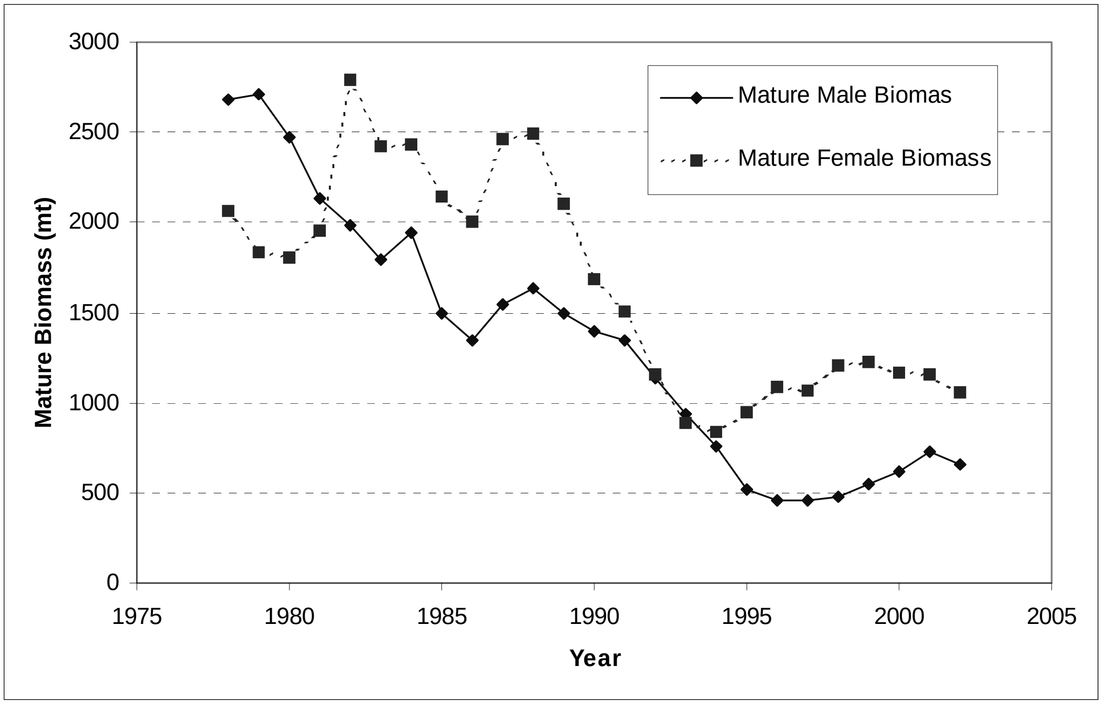

Figure 7.2. Mature SSB by sex from the central run of BSB2003.

8 Stock projections

8.1 Age-structured projections

To evaluate the likely odds of recovery under a range of possible future management measures, simulations were used to project the stock forward for each of the sensitivity runs (Table 6.1). The mean of the sensitivity runs was developed based on the weighting probabilities for combinations of *M* and *h* as assigned by the AW for status of stock.

8.1.1 Structure of simulations

The age-structured model was used to project the population forward 25 years under several different management regimes. Recruitment in each year was generated with the stochastic spawner–recruit model estimated by that particular sensitivity run. The 25–year projection was repeated 2000 times for each of the sensitivity runs and under each management regime.

The rebuilt state for each sensitivity run was defined as a 50% probability that the stock reaches the SSB_{MSY} specific to that run (Table 4). The proportion of realizations that reached or exceeded the rebuilt state in each projection year was used as an estimate of the stock's probability of attaining the rebuilt state by January 1 of that year under that management regime.

Initial stock size and *F* Initial (2001) stock sizes at age were as estimated by the various runs used in characterizing the uncertainty in the assessment. Selectivity and geometric mean F for the period 1999-2001 were used to represent current fishing mortality (F_{now}) and provided a basis for determining F that can rebuild the stock in the prescribed time frame.

Life-history parameters Proportions mature at age, sex ratios at age, and release mortality rates were those provided by the Data Workshop for the most recent period.

Stock–recruitment model Population projections used an empirical bootstrap method to implement a stochastic stock–recruitment model. Each sensitivity run provided its own set of parameter estimates for the Beverton–Holt model and a vector of residuals for the model years 1978-2001. Deterministic recruitment values for projections were generated by the fitted stock-recruitment model specific to the pertinent sensitivity run. Stochasticity was implemented by adding residuals chosen at random from the residuals vector to the deterministic recruitment values.

Spawning stock biomass The SSB_{MSY} against which projections are measured is specific to each sensitivity run (Table 6.1).

Generation Time Calculation of generation time is based on Goodyear (1995) as presented in the Technical Guidance document (modified from Restrepo et al. 1998):

$$G = \frac{\sum_{a=1}^{A} a W_a O_a N_a}{\sum_{a=1}^{A} W_a O_a N_a}$$

Weight at age (W_a) is used in place of fecundity at age. Numbers at age, adjusted for total mature individuals at age (O_aN_a), is based on declining population size (N_a) for a range in natural mortality rate (M = 0.2, 0.3, 0.4) as adjusted for total maturity at age (O_a). Maximum age (a) is set at 50 (A) as recommended by the AW. Estimated generation times were 7.0 yrs for M=0.3 with range of 5.5 yrs (M=0.4) and 9.7 yrs (M=0.2). Values were rounded up to whole integer values for determining F that will rebuild SSB to SSB_{MSY} in the rebuilding period in the projections.

8.1.2 Fishing mortality rates for projections

Projections begin with the year 2002, after the final year of model fitting. Projections begin with model year 2002, the terminal year for which the assessment model produces population estimates for January 1 of that year. The stock is projected to the year 2026 for each sensitivity run using three different values of fishing mortality rate. All sensitivity runs were projected using $F = 0$ and the run-specific F_{now}. Sensitivity runs were also projected using $F_{rebuild}$ if benchmark estimates indicated rebuilding is necessary [i.e., $SSB<(1-M)SSB_{MSY}$], as with eight of the nine sensitivity runs**.** Only the case of $M = 0.4$ and $h = 0.8$ did not require rebuilding, and for this sensitivity run, only two fishing mortality values are projected. For the other eight cases, $F_{rebuild}$ was determined by the following method: 1) Project the stock forward using $F = 0$; 2) if SSB has at least a 50% chance of rebuilding to SSB_{MSY} within 10 yrs, then the allotted rebuilding time is 10 yrs; 3) if the $F = 0$ projection requires more than 10 yrs to rebuild, then the duration required plus one generation time becomes the allotted time frame; and 4) $F_{rebuild}$ is the F that provides a 50% chance of rebuilding to SSB_{MSY} in the allotted time frame (10 or more years).

Any changes in F begin with the projection in 2002. Although management measures can not take effect until 2003 or later, it is the duration of the rebuilding period that is being estimated, rather than the specific start and stop years. Rebuilding projections will be optimistic if there is further decline in the population prior to the imposition of additional management.

8.1.3 Projection results

Separate projections were made for each element of the matrix and for the various values of F. Table 8.1 summarizes those results. Summaries of the SSB projections for current F, F=0, and rebuilding F are presented for the central run and other sensitivity runs (Table 8.1). Note that the sensitivity run for M = 0.4 and h = 0.8 was unique in that it did not depict a stock that required rebuilding, and consequently there is no corresponding rebuilding F projections.

Table 8.1. Summary of age-structured projections for black seabass.

Sensitivity Runs	Current F (F_{now}*)	No. years to rebuild with F=0**	No. years allotted for rebuilding***	F that rebuilds in allotted time ($F_{rebuild}$)	$F_{rebuild}$ /F_{now}
M=0.2, steep=0.4	1.36	15	25	0.18	0.13
M=0.2, steep=free	1.75	11	21	0.21	0.12
M=0.2, steep=0.8	1.56	6	10	0.20	0.13
M=0.3, steep=0.4	0.99	15	22	0.10	0.10
M=0.3, steep=free	1.13	11	18	0.16	0.14
M=0.3, steep=0.8	1.13	2	10	0.49	0.43
M=0.4, steep=0.4	1.10	11	17	0.15	0.14
M=0.4, steep=free	1.00	12	18	0.13	0.13
M=0.4, steep=0.8	1.08	NA	NA	NA	NA

* F_{now}=geometic mean of F(1999), F(2000), F(2001)
** Rebuild to SSB_{MSY}
*** Must rebuild in ten years if possible, otherwise one generation plus no. years with F=0 (Generation times: 10 yrs for M=0.2, 7 yrs for M=0.3, 6 yrs for M=0.4)

Projections of SSB from the central run are shown in Figure 8.1 (additional sensitivity runs can be found in Appendix E). The summary across the nine separate projection runs based on weighting in Table 6.1 is shown in Figure 8.2. For F=F_{now} the SSB remains low relative to SSB_{MSY}. Timing of rebuilding is variable, depending on the sensitivity run and level of F (F=0 or F=$F_{rebuild}$).

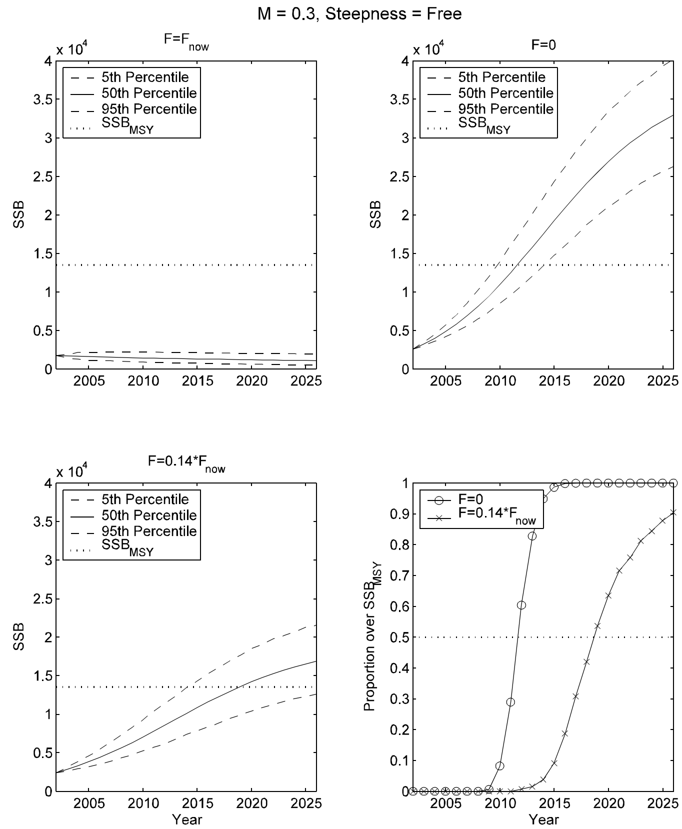

Figure 8.1. SSB projections for the central run (M = 0.3, steepness = free). $F_{rebuild}$ is $F=0.14*F_{now}$. .

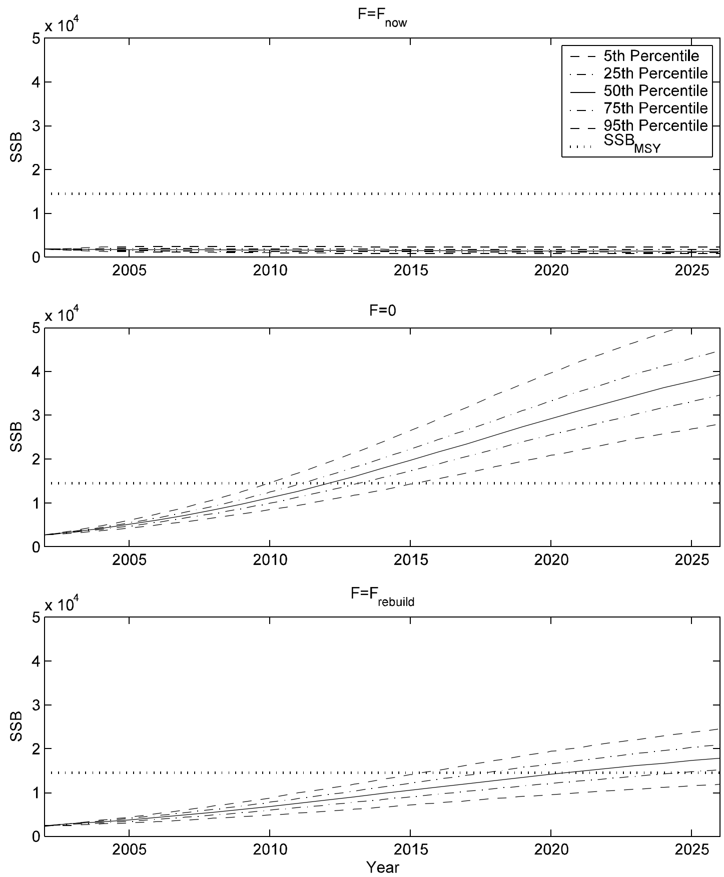

Figure 8.2. Weight Mean of SSB projections for F_{now}, F=0, and $F_{rebuild}$. Note that panel C excluded the case of M = 0.4 and steepness = 0.8 because it required no rebuilding; weightings of the remaining eight cases were rescaled to sum to one.

According to the projections, SSB will remain low and may decline further if fishing mortality is not reduced. The low stock abundance and continued poor recruitment will constrain yields in spite of high levels of F. If fishing mortality is initially reduced to the rebuilding level, yields will initially be low, but within a few years, yields will exceed current yields based on both the central run (Figure 8.3) and the weighted representation (Figure 8.4).

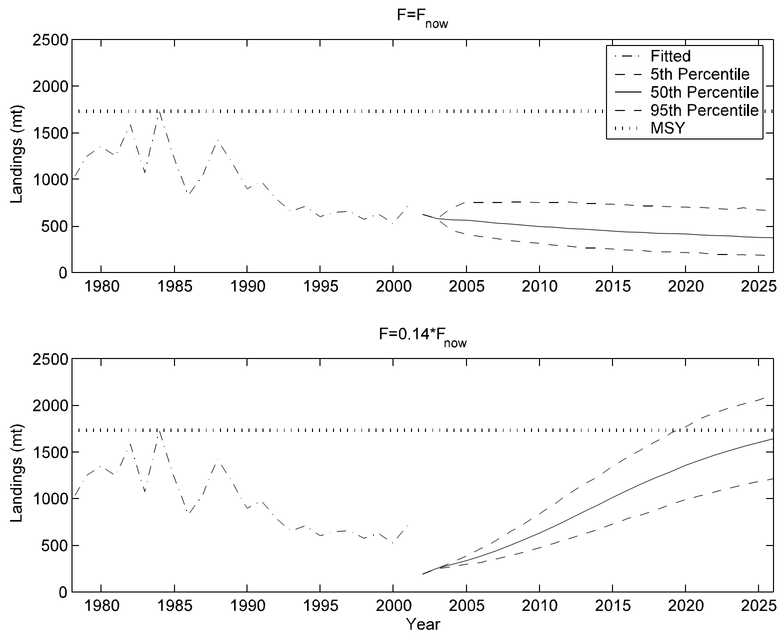

Figure 8.3. Yield projections for the central run (M = 0.3, steepness = free). $F_{rebuild}$ *is* $F=0.14*F_{now}$*. Historical predicted yields from the assessment are shown for 1978-2001.*

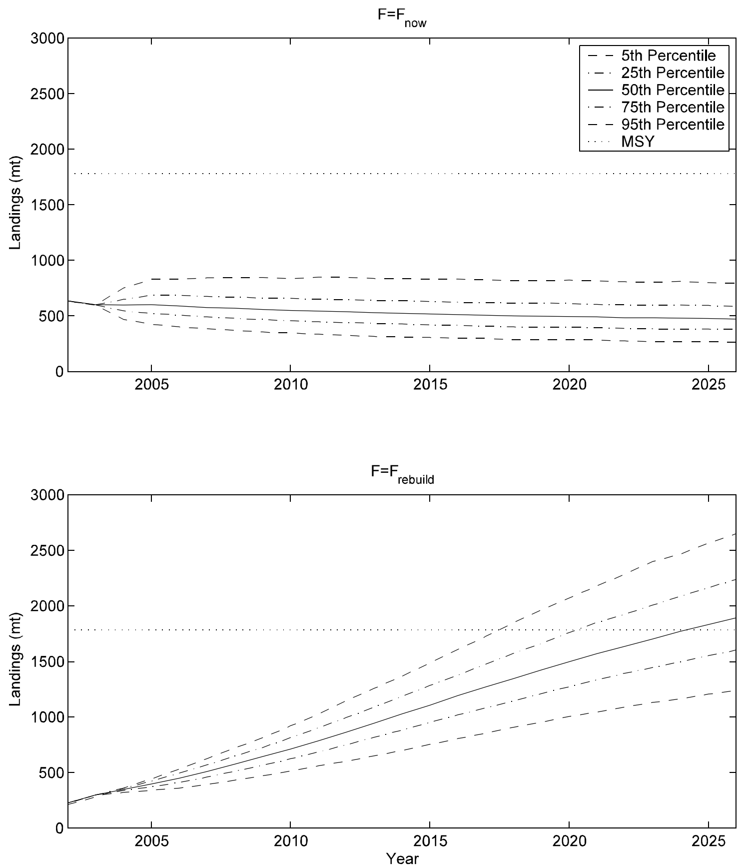

Figure 8.4. Weighted mean landings across all sensitivity projections. Note that second panel excluded the case of M = 0.4 and steepness = 0.8 because it required no rebuilding; weightings of the remaining eight cases were rescaled to sum to one.

The central run suggests that an 86% decrease in fishing mortality from current levels is necessary to rebuild the stock in 18 years (Table 8.1). Although this appears to be drastic, it is only because the current level of F is estimated to be high (1.13), and not that the rebuilding F is exceedingly low (0.16). Long-term threshold for F for the central run is 0.2, somewhat higher than the rebuilding F.

8.2 Age-aggregated production model

Projections were made from the base production model run (R=2C) for three levels of F: F=0, F=60% of F_{now}, and F=100% of F_{now}. Projections of B/B_{MSY} are shown in Figure 8.5. For F=0, recovery is rapid, and for F=100% of *F*now recovery does not occur within the projection time frame. However, recovery within 10 years occurs for F=60% of F_{now}.

A comparison of projected yields at F=60% of F_{now} and F=100% of F_{now} is shown in Figure 8.6. Yield from 60% of F_{now} quickly exceeds that of 100% of F_{now} (after 4 yrs). This comparison between F_{now} and 60% of F_{now} show that considerable gains in yield could be obtained within 4 yrs if fishing mortality is reduced by 40%.

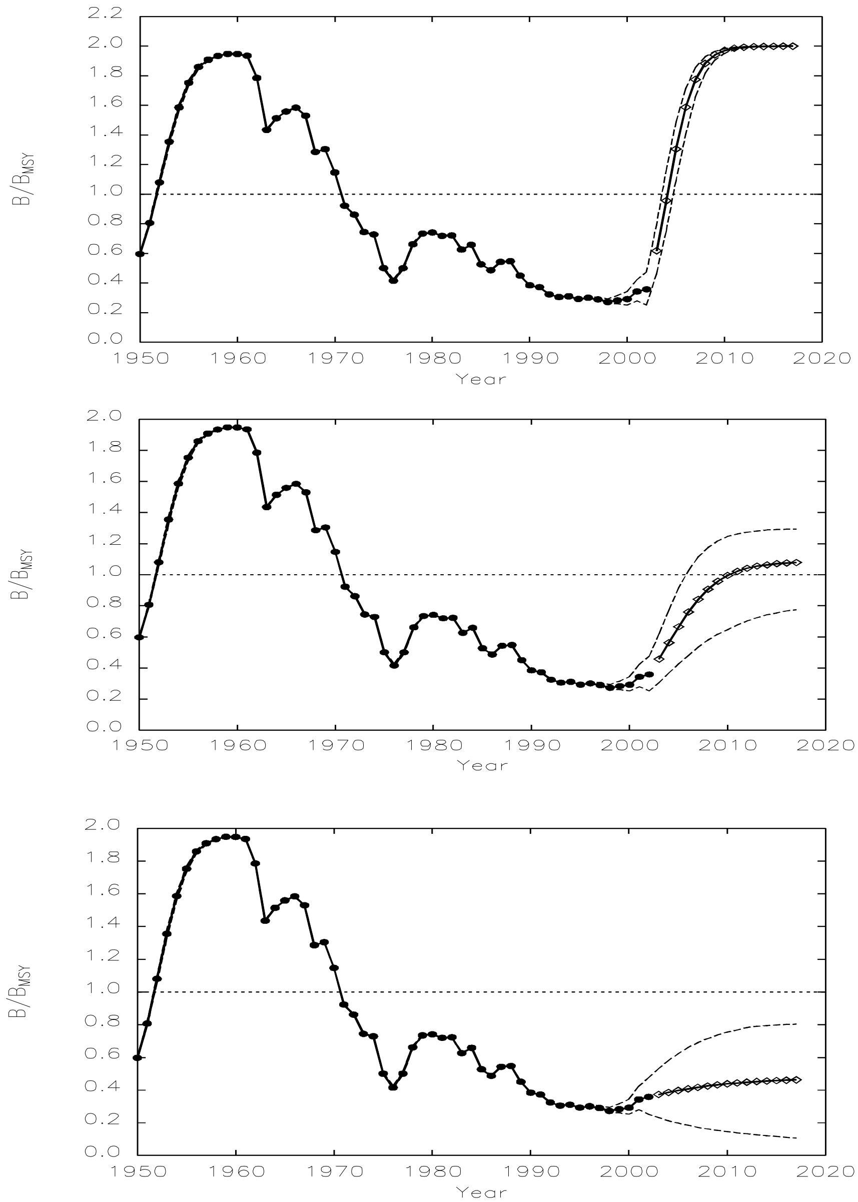

Figure 8.5. Relative population biomass projected for three levels of F: F = 0; F = 0.6 F_{now}; and F = F_{now}.

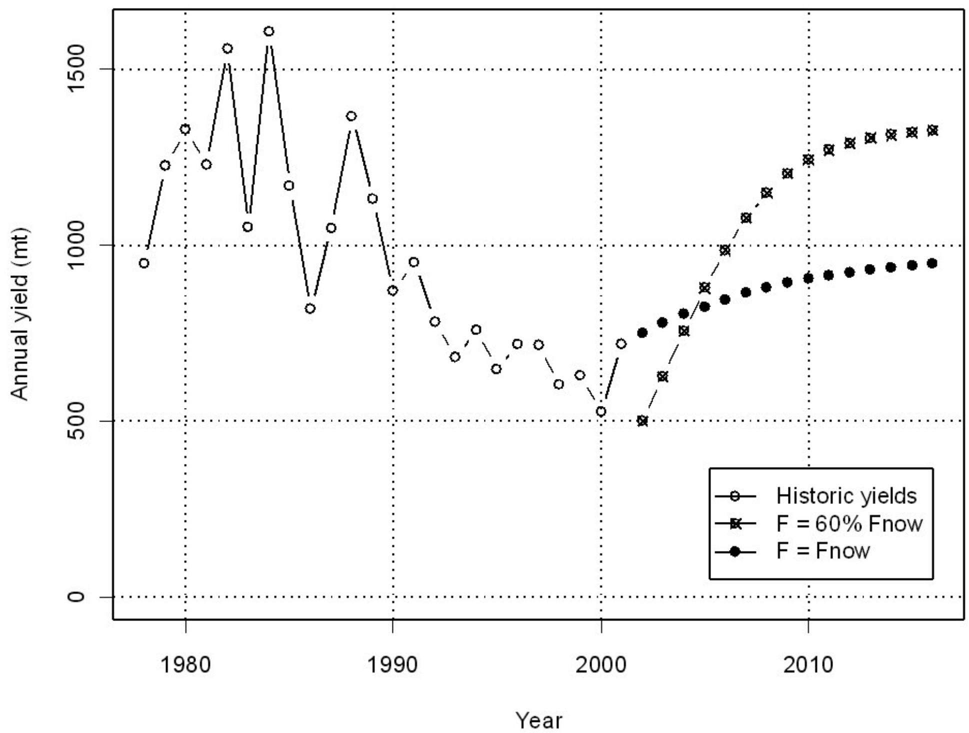

Figure 8.6. Projection of yield with current F and 60% of current F.

9 Research recommendations

The AW discussed aspects of the biology, sampling, and assessment of this population that make accurate and precise assessment more difficult. Execution of the following recommendations for research and data management could improve future assessments of black seabass.

1. Representative age sampling is needed (proportional); also commercial age sampling.
2. Increases in fishery independent sampling.
3. Development of logbook indices is recommended.
4. Information about fecundity is needed (batch fecundity and frequency at age and/or size).
5. Further consideration of implications of change in sex for fishery management.
6. Further development of analytical models to incorporate historical catch information.

Future research should be conducted to further develop age-structured models that could account for historic landings. Specifically, methods that allow scaling of uncertainty in landings records over time are needed. We need to include more historical records which are more uncertain than current records, this may be done by changing CVs over time as opposed to constant CV for a data series.

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APPENDICES

Appendix A. Abbreviations and symbols

Symbol	Meaning
ADAPT	A type of tuned VPA often used in assessment of North Atlantic fish stocks
AW	Assessment Workshop for black seabass
B	Total biomass of stock
B_{MSY}	Total stock biomass at which MSY can be attained (in production models)
BSB2003	The forward-projecting age-structured assessment model used here; see §5.1
CPUE	Catch per unit effort; used after adjustment as an index of abundance
DW	Data Workshop for black seabass
F	Instantaneous rate of fishing mortality
F_{MSY}	Fishing mortality rate at which MSY can be attained
FL	State of Florida
GA	State of Georgia
K	Average size of stock when not exploited by man; carrying capacity
M	Instantaneous rate of natural (non-fishing) mortality
MARMAP	Marine Resources Monitoring, Assessment, and Prediction Program, a fishery independent data collection program of SC DNR
MFMT	Maximum fishing-mortality threshold; a limit reference point used in U.S. fishery management; often set to F_{MSY}
MRFSS	Marine Recreational Fisheries Statistics Survey, a data-collection program of NMFS
MSST	Minimum stock-size threshold; a limit reference point used in US fishery management. The SAFMC has defined MSST for black seabass as $(1 - M)B_{MSY} = 0.7B_{MSY}$.
MSY	Maximum sustainable yield
mt	Metric tons(s)
NC	State of North Carolina
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration; parent agency of NMFS
R	Recruitment
SAFMC	South Atlantic Fishery Management Council
SC	State of South Carolina
SCDNR	Department of Natural Resources of SC
SFA	Sustainable Fisheries Act
SSB	Spawning-stock biomass
SSB_{MSY}	Spawning-stock biomass at which MSY can be attained (in age-structured models)
TIP	Trip Interview Program, a fishery-dependent biodata collection program of NMFS
TL	Total length (of a fish), as opposed to FL (fork length)
VPA	Virtual population analysis, an age-structured assessment model characterized by cohort-wise computations backward in time; “tuned” VPA also employs abundance indices to influence the estimates
yr	Year(s)

Appendix B. Terms of reference for Assessment Workshop

The Assessment Workshop's task is to produce a stock assessment for the Black Seabass and Vermilion Snapper stocks in the SAFMC's area of jurisdiction. This work is done with reference to the U.S. Sustainable Fisheries Act and its National Standards, which govern the Council's management. A written final report (using word or wordperfect software), providing an overview of the analyses, general findings, and recommendations of the workshop, will be available by conclusion of the workshop. A detailed technical addendum on the models used will be available and distributed on or before January 27, 2003.

1. Identify modeling approaches appropriate to the available data and management questions (e.g., production models, age-structured models, hybrids). The Data Workshop recommended the Forward Projection Model approach.

2. Determine all SFA-required benchmarks (MSY, BMSY, MSST, MFMT, and FMSY). Other standard benchmarks should also be provided (e.g., F0.1, Fmax, etc).

3. Estimate stock status (biomass) and fishery status (fishing mortality rate) relative to appropriate SFA benchmarks. Is the stock overfished; is overfishing occurring?

4. If the stock(s) are overfished, identify and conduct rebuilding analyses (projections of rebuilding to MSST and BMSY; yield streams over the rebuilding time-frame). The rebuilding analyses should include: (a) F=0, (b) F=current management measures, and (c) other possible scenarios.

5. Provide recommendations for future research (field and assessment) and data collection necessary to improve assessment results.

Additional specific questions from the Council may be developed and if so, it will be presented to the Assessment Workshop at its meeting.

Appendix C. Workshop attendees

Dagger (†) denotes attendance at Data Workshop only; asterisk (*) denotes attendance at Assessment Workshop only; others attended both workshops.

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Appendix D. Historical black seabass landings prior to assessment (1950-1977).

To develop perspective for the status of stock at the start of the assessment period (1978-2001), relevant data sets prior to the assessment (1950-1977) were explored during the AW. These data were not used explicitly in the age-structured modeling. However, these data, with the assumptions given below, were used to extend the time frame for application of the production modeling approach.

Commercial landings of black seabass made from the U.S. south Atlantic were obtained prior to the time-series used in the assessment (Figure D.1). Additionally, recreational landings were found to have been considerable during the pre-assessment period. The 1960, 1965 and 1970 Saltwater Angling Surveys (Clark 1962, Deuel and Clark 1968, Deuel 1993) indicated recreational landings of about 295 mt, 770 mt, and 5600 mt of black seabass, respectively, by anglers from the South Atlantic Region (Cape Hatteras to Florida). These estimates are higher than the commercial landings documented from the region for those years. During the assessment period, the ratio of recreational landings to commercial landings of black seabass from the region ranged from 1-3 (Figure 2.2). To evaluate potential effects of pre-assessment period landings on the assessment, total annual landings prior to 1978 were estimated by assuming recreational landings ranged from being equal to commercial to 3 times the commercial values (Figure D.2).

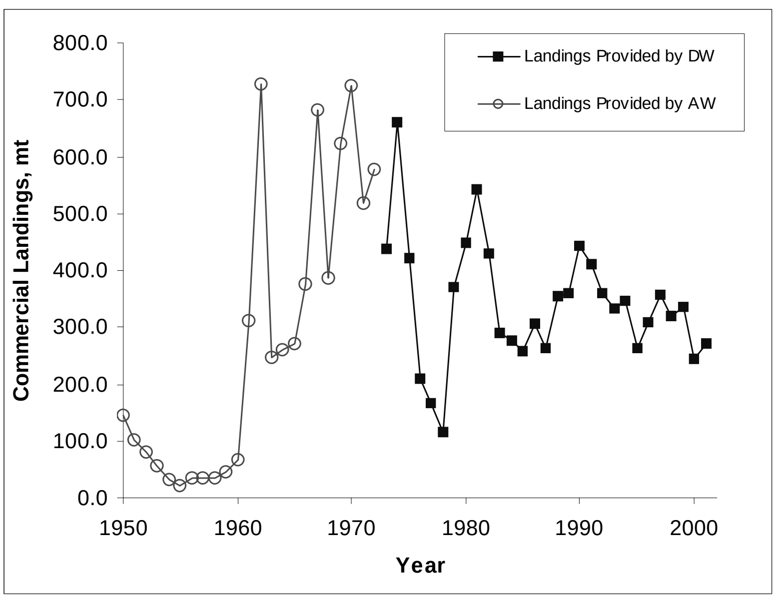


Figure D.1. Commercial landings of black seabass from the southeastern US Atlantic management unit. Closed squares represent the commercial landings information provided by the DW (1973-2001). Open circles represent commercial landings development from the NMFS website during the AW (1950-1972).

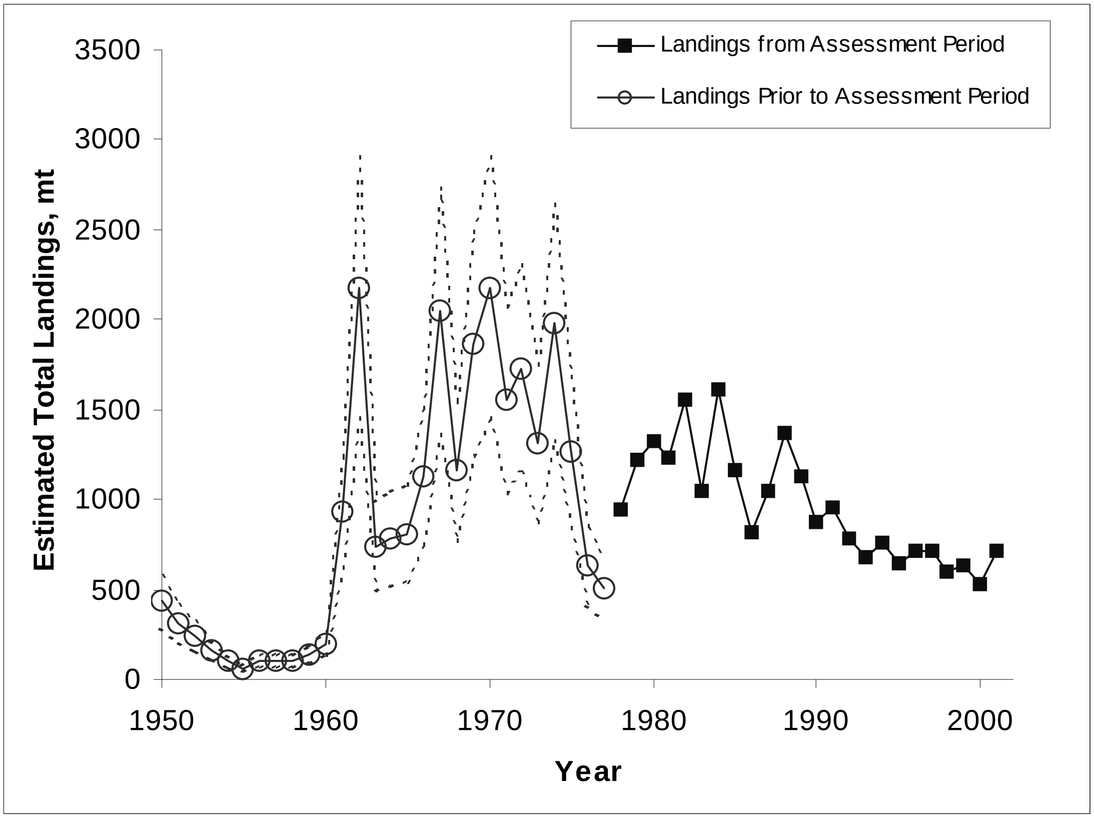


Figure D.2. Estimated total landings of black seabass assuming that recreational landings were twice, on average, the commercial landings in the period prior to the time series used in the assessment (open circles). Also shown are estimated pre-assessment total landings assuming that recreational landings were equal to commercial landings in the pre-assessment period and estimated total landings assuming recreational landings were 3 times the commercial landings in the pre-assessment period (upper and lower dashed lines).

Appendix E. Results from the matrix of sensitivity runs other than the central run.

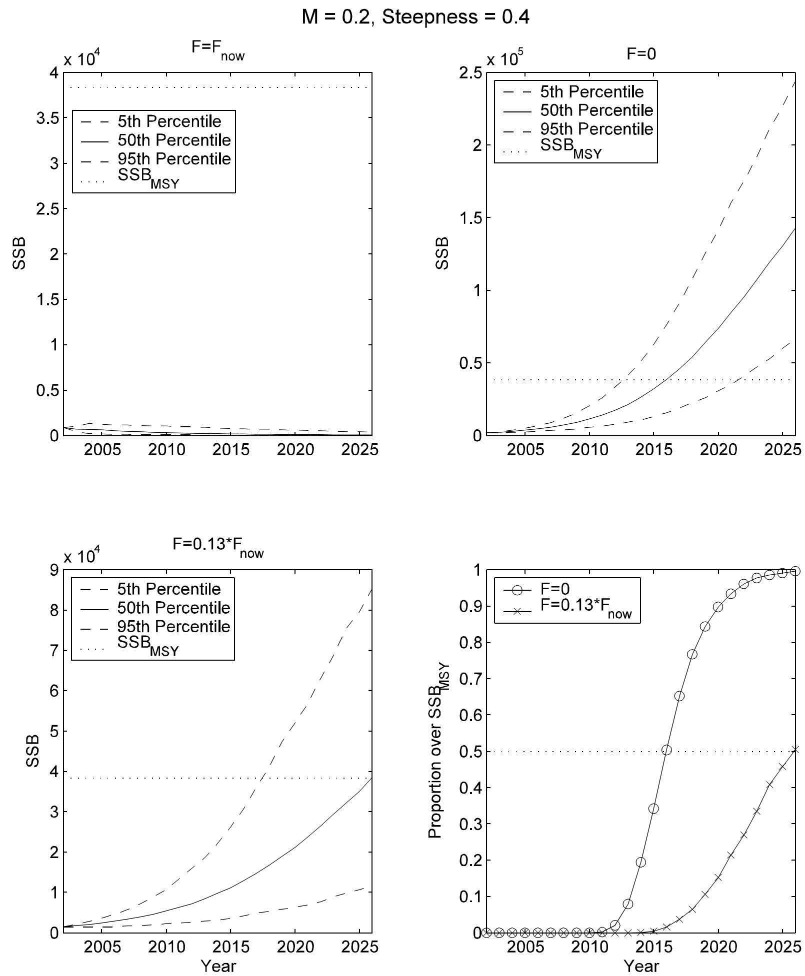


Figure E.1. SSB projections for M=0.2, steepness = 0.4. $F_{rebuild}$ is $F=0.13*F_{now}$.

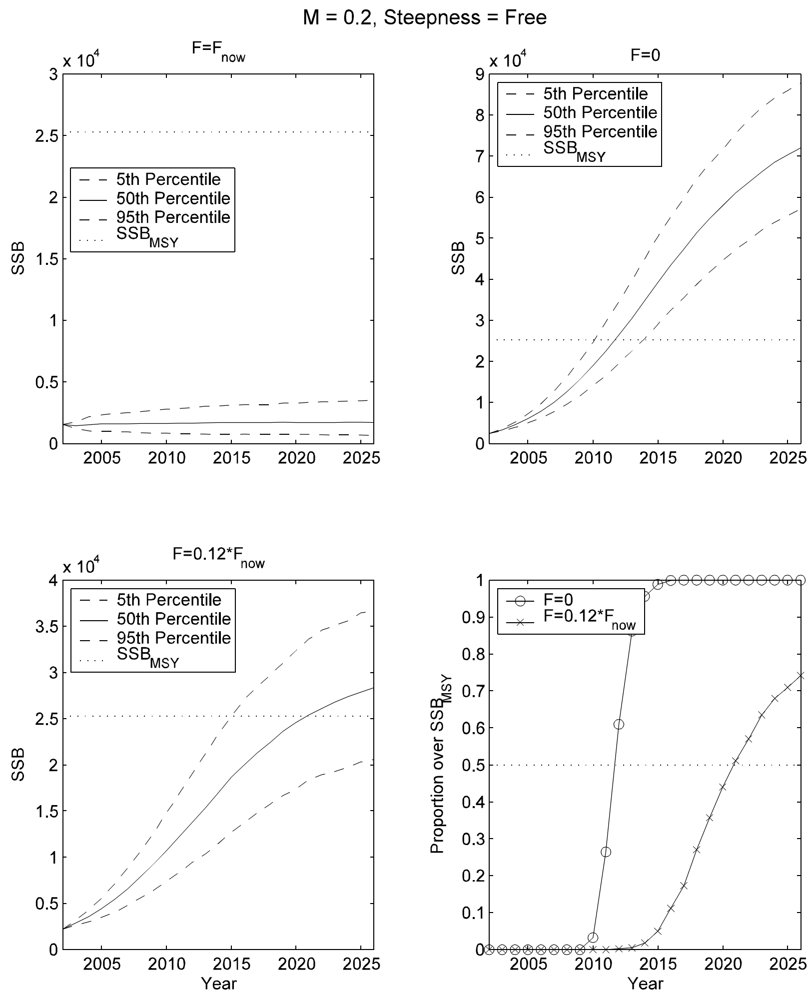


Figure E.2. SSB projections for M = 0.2, steepness = free. $F_{rebuild}$ is $F=0.12*F_{now}$.

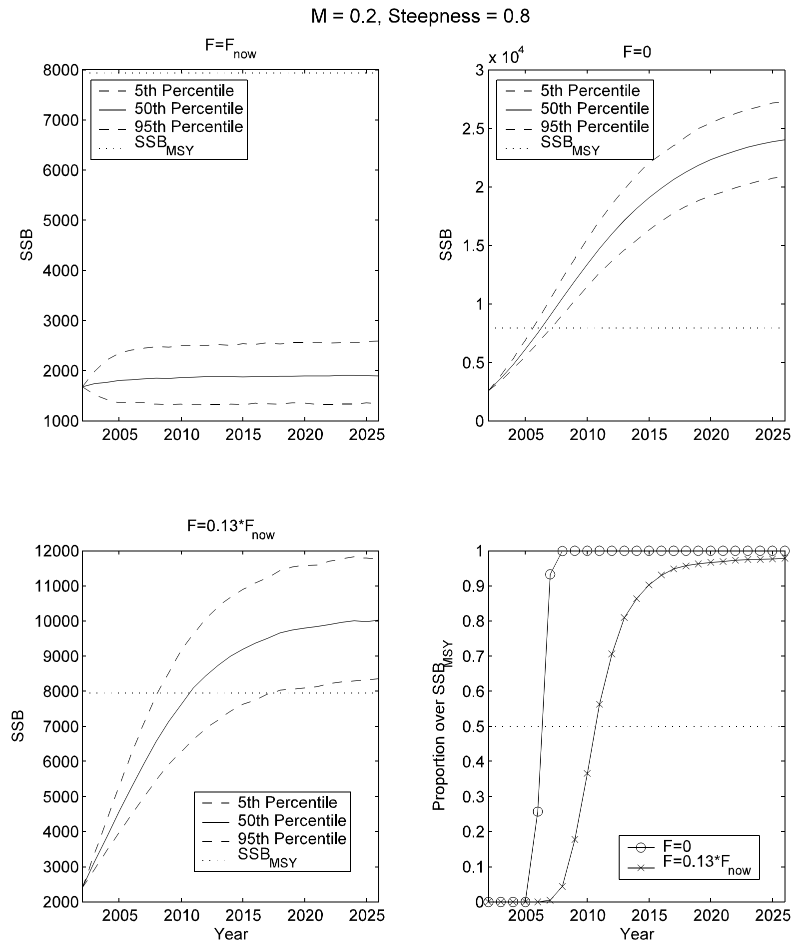


Figure E.3. SSB projections for M = 0.2, steepness = 0.8. $F_{rebuild}$ *is* $F=0.13*F_{now}$.

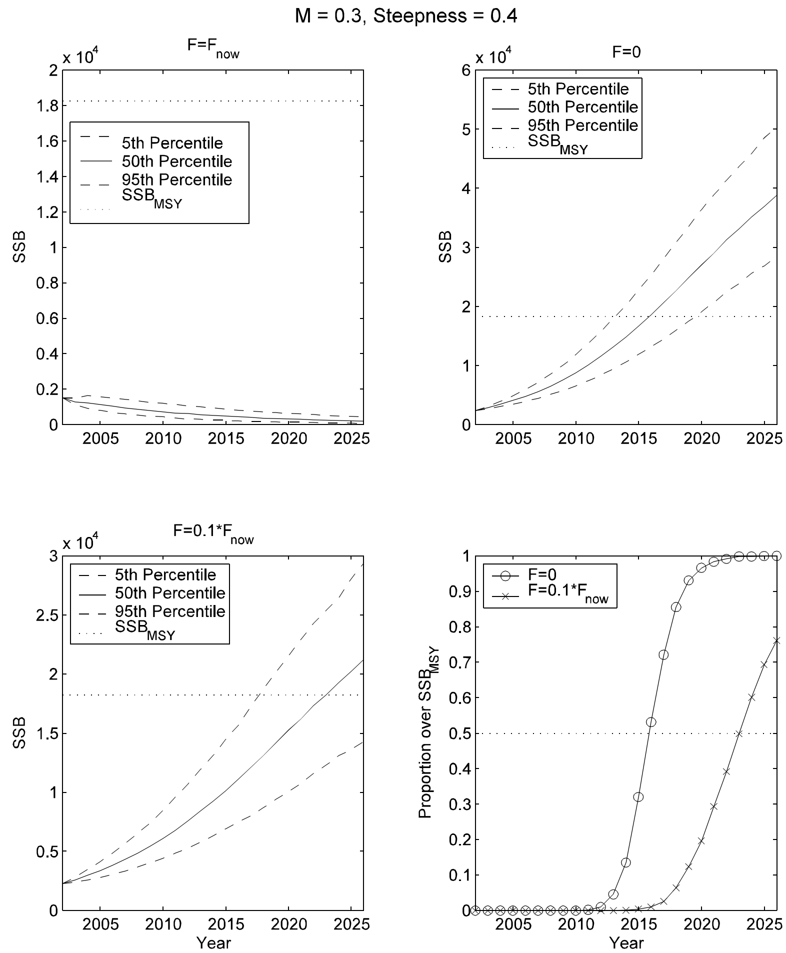


Figure E.4. SSB projections for M = 0.3, steepness = 0.4. $F_{rebuild}$ *is* $F=0.1*F_{now}$.

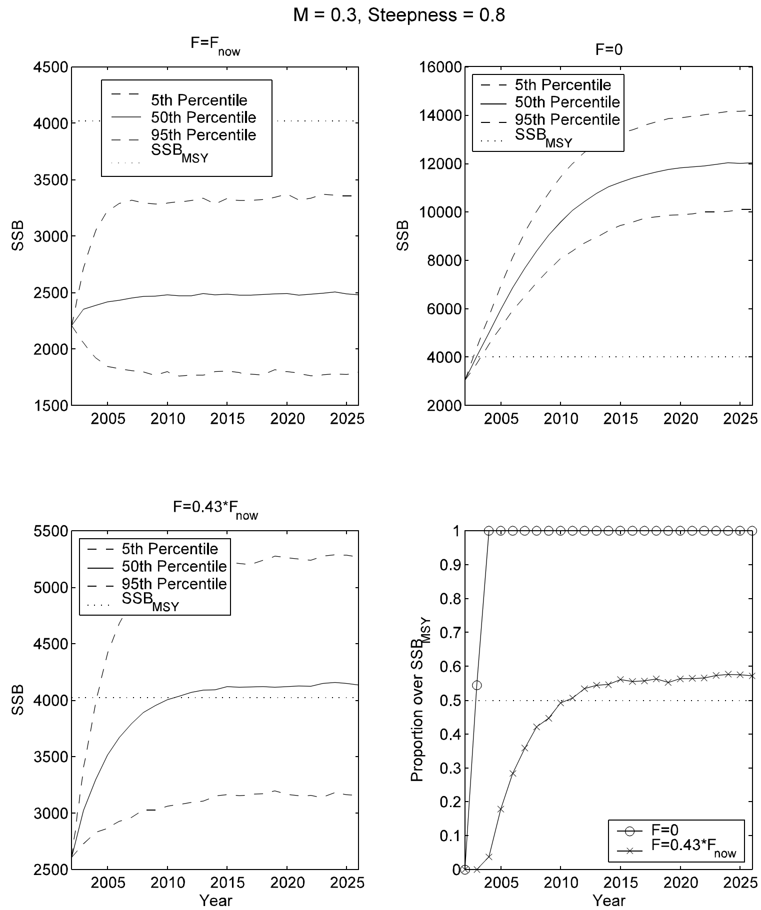


Figure E.5. SSB projections for M = 0.3, steepness = 0.8. $F_{rebuild}$ *is* $F=0.43*F_{now}$.

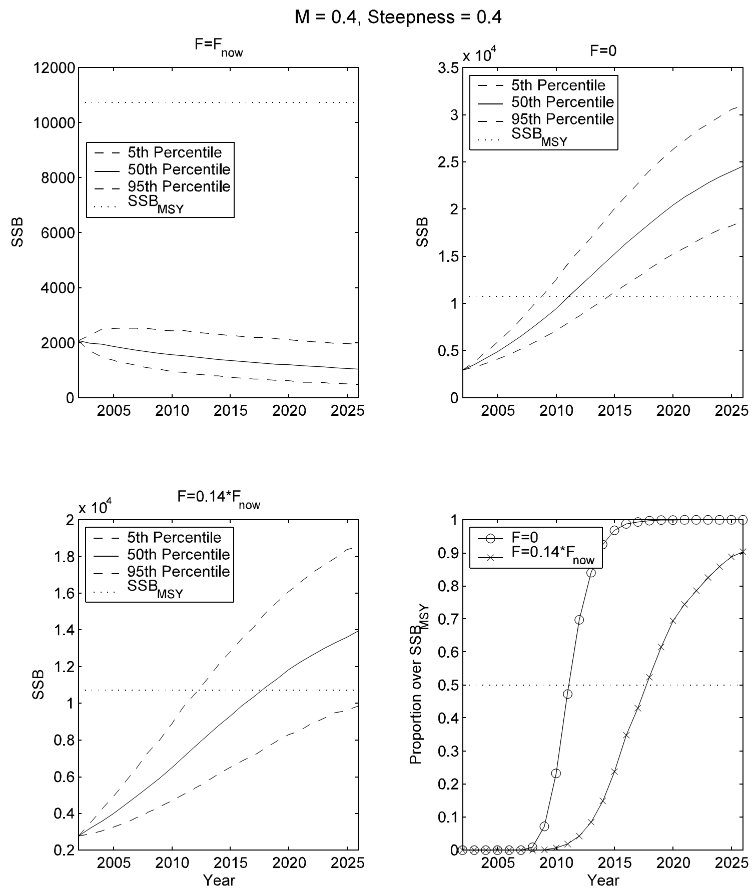


Figure E.6. SSB projections for M = 0.4, steepness = 0.4. $F_{rebuild}$ is $F=0.14*F_{now}$.

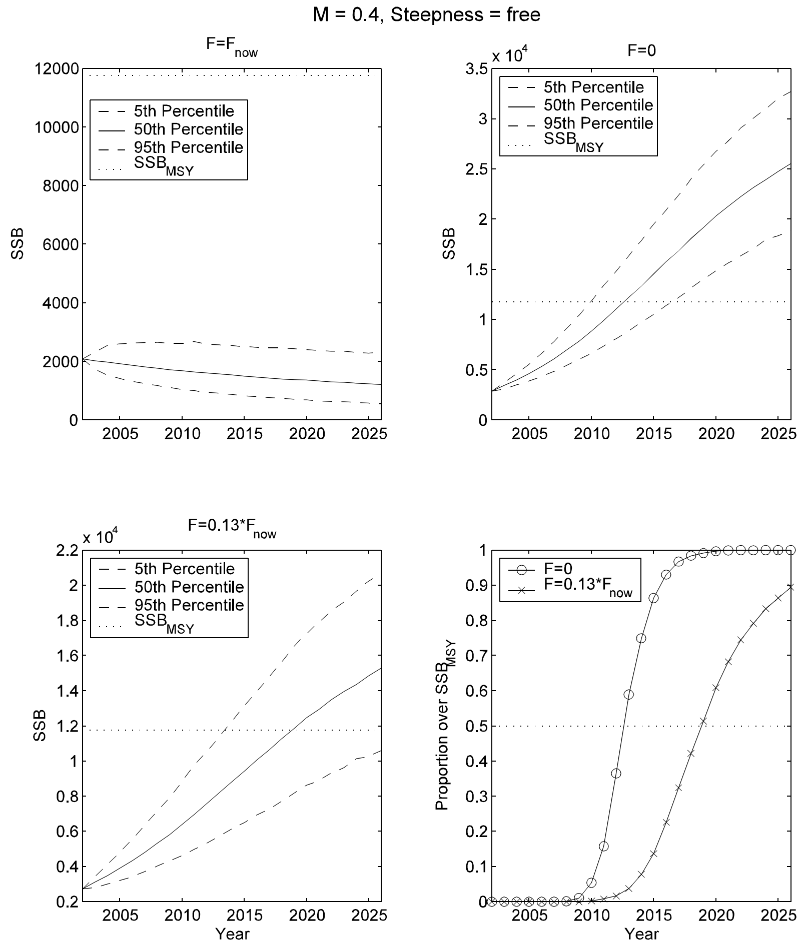


Figure E.7. SSB projections for M = 0.4, steepness = free. $F_{rebuild}$ is $F=0.13*F_{now}$.

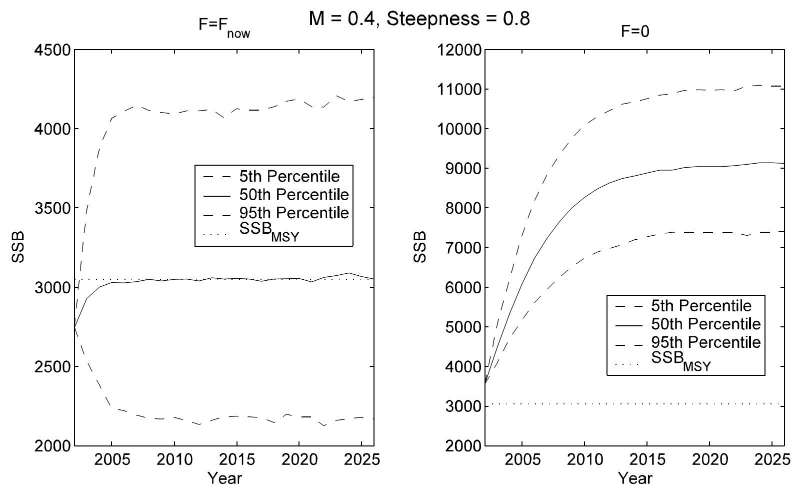


Figure E.8. SSB projections for M= 0.4, steepness = 0.8. No rebuilding required.

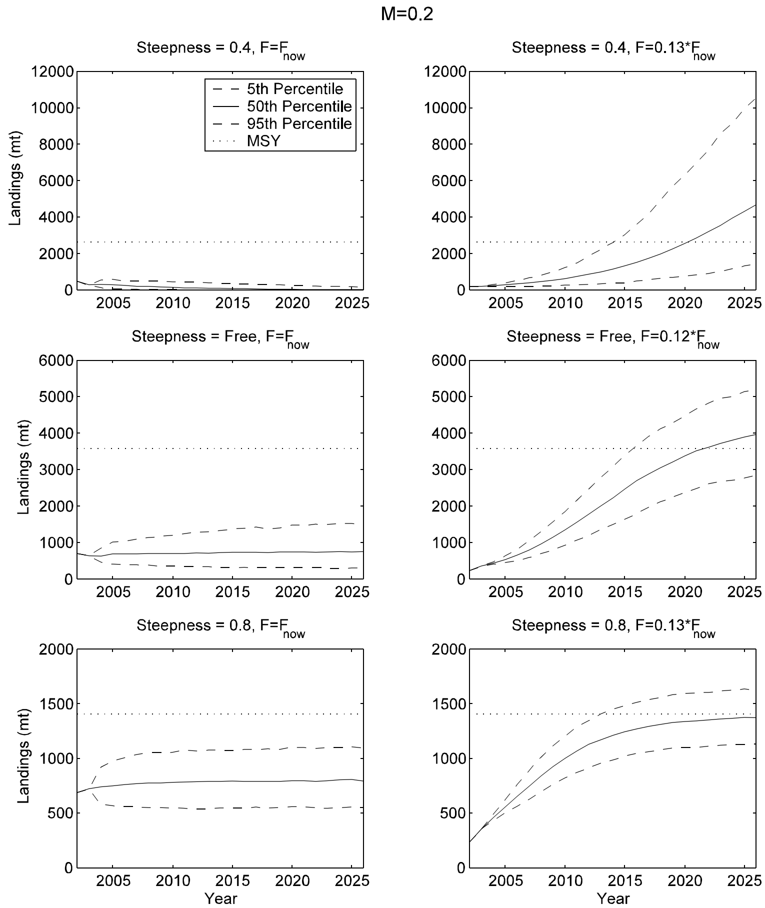


Figure E.9. Projected landings with M=0.2. Left column: $F = F_{now}$. Right column: $F = F_{rebuild}$, expressed as a proportion of F_{now}.

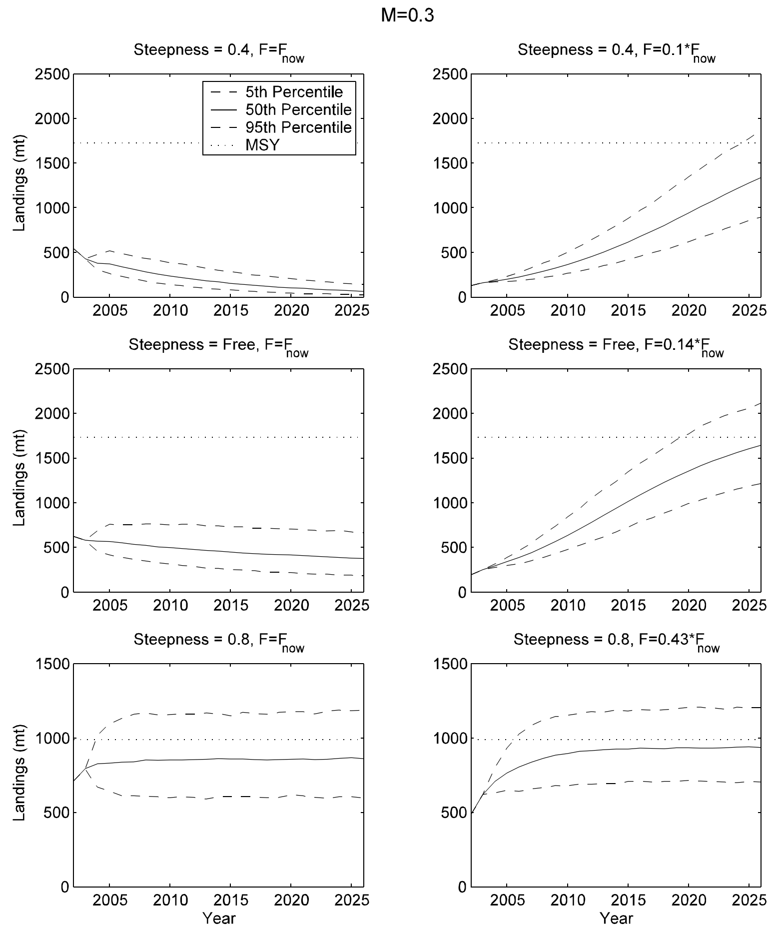


Figure E.10. Projected landings with M=0.3. Left column: $F = F_{now}$. Right column: $F = F_{rebuild}$, expressed as a proportion of F_{now}.

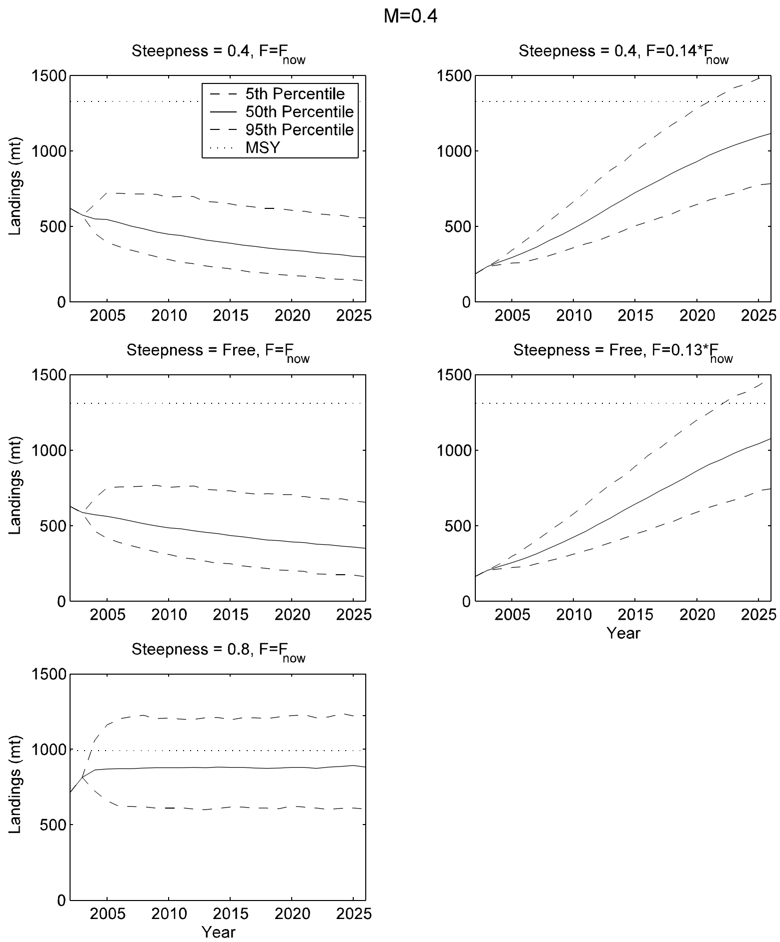
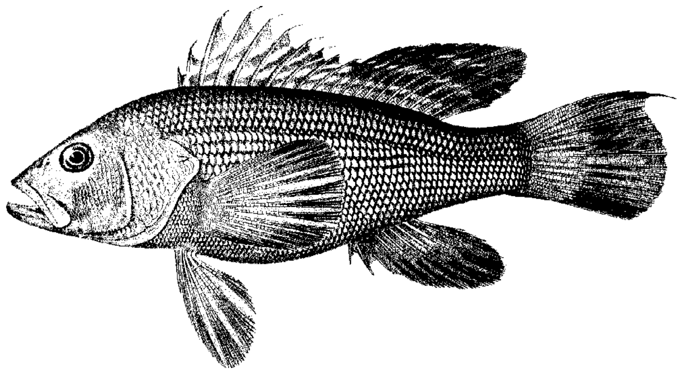


Figure E.11. Projected landings with M=0.4. Left column: $F = F_{now}$. Right column: $F = F_{rebuild}$, expressed as a proportion of F_{now}. No rebuilding was required for the case of steepness = 0.8.

Appendix F. Summary of Mid-Atlantic Black Seabass Status

(Appended PDF file provided by Gary Shepherd)



Last Revised: January 2000

Summary Status

Landings and Abundance Trends

Landings Data

Black Sea Bass

by
Gary Shepherd

Black sea bass, *Centropristis striata*, occur along the entire U.S. Atlantic coast. Two stocks have been recognized, one north and the other south of Cape Hatteras, North Carolina. The northern group winters along the 100 m (55 fathom) depth contour off Virginia and Maryland, and then migrates north and west into inshore waters, where it becomes associated with structured bottom habitat (reefs, oyster beds, and wrecks, for example.

Spawning begins in March off North Carolina and occurs progressively later (until October) further north. Most black sea bass begin life as females and later transform into males, and most individuals (both sexes) attain sexual maturity by age 3. Transformation from female to male generally occurs between ages 2 and 5. Females are rarely found older than 8 years (>35 cm or 14 in.), while males may live up to 15 years (>60 cm or 24 in.). Black sea bass are omnivorous, feeding on crustaceans, molluscs, echinoderms, fish, and plants.

The principal commercial fishing gears used to catch black sea bass are otter trawls and fish pots. Recreational fishing is significant. Black sea bass are managed under Amendment 12 to the Summer Flounder Fishery Management Plan or FMP (now known as the Summer Flounder, Scup, and Black Sea Bass FMP). Management measures under the FMP include a moratorium on new permits, gear restrictions and minimum fish sizes, a coastwide commercial quota and a recreational harvest limit.

Total nominal catch north of Cape Hatteras decreased from 4,300 mt in 1996 to 1,800 mt in 1998. Commercial landings fluctuated around 2,600 mt from 1887 until 1948 and then increased to 9,900 mt in 1952 before declining to only 600 mt in 1971. Between 1980 and 1993, commercial landings averaged 1,500 mt per year. Landings averaged 1,100 mt between 1994 and 1997 and totaled 1,200 mt in 1998. Landings since 1998 have been restricted by quota regulations. There has been no foreign fishing on this stock other than for a reported catch of 1,500 mt by distant-water fleets in 1964.

Estimated recreational landings, occurring primarily in the middle Atlantic states, are comparable in magnitude to those from the commercial fishery. Recreational landings averaged 2,000 mt per year between 1981 and 1997, and accounted for 31 to 79% of the total annual landings of black sea bass during those years. Recreational landings declined to 600 mt in 1998, a 68% decline from 1997. The decrease was partially attributable to an increase in minimum size from 9 in. to 10 in. total length.

The NEFSC spring bottom trawl survey biomass index increased during the early 1970s, peaking in 1977, but declined sharply between 1979 and 1982 to record-low levels. The index has increased somewhat since 1997 suggesting increased levels of biomass. Young of year (age 0) indices from the NEFSC autumn bottom trawl survey indicate that above-average year classes occurred in 1985, 1986, 1994 and 1995. Recruitment in 1999 appeared to be above average. Size composition data from commercial landings indicate that black sea bass recruit fully to the trap and trawl fisheries by ages 2 and 3, respectively.

Definitive estimates of fishing mortality are not available for 1998. Survey index values have increased somewhat in recent years, but remain well below the minimum biomass threshold (0.9 kg/tow). The stock is overfished and at a low biomass level.

For further information

Musick, J. A. and L. P. Mercer. 1977. Seasonal distribution of black sea bass, *Centropristis striata*, in the Mid-Atlantic Bight with comments on the ecology of fisheries of the species. *Trans. Am. Fish. Soc.* 106(1):12-25.

NEFSC [Northeast Fisheries Science Center]. 1997. [Report of the] 25th Stock Assessment Workshop (25th SAW), Stock Assessment Review Committee (SARC) consensus summary of assessments. *Northeast Fish. Sci. Cent. Ref. Doc*. 97-14:143p.

Shepherd, G. R. and J. S. Idoine. 1993. Length-based analyses of yield and spawning stock biomass per recruit for black sea bass, *Centropristis striata*, a protogynous hermaphrodite. *Fish. Bull.*, U.S. 91:328-337.

Summary Status

Long-term potential catch (MSY)	=	Unknown
Biomass corresponding to MSY	=	Unknown
Minimum biomass threshold[1]	=	0.9 kg/tow
Stock biomass in 1998	=	0.3 kg/tow (Implies an overfished condition)
F_{MSY}[2]	=	F_{MAX} = 0.32
F_{TARGET}	=	F associated with quota
Overfishing definition	=	F_{MSY}
F_{1998}	=	Unknown
Age at 50% maturity	=	2 years
Size at 50% maturity	=	19.0 cm (7.5 in.), males
		19.1 cm (7.5 in.), females
Assessment level	=	Index
Management	=	Summer Flounder, Scup, and Black Sea Bass FMP

M = 0.20 **$F_{0.1}$= 0.18** **F_{max}= 0.32**

[1] Maximum 3 year moving average of NEFSC Spring Survey exploitable biomass index (fish>22cm)

[2] F_{MAX} is used as a proxy for F_{MSY}

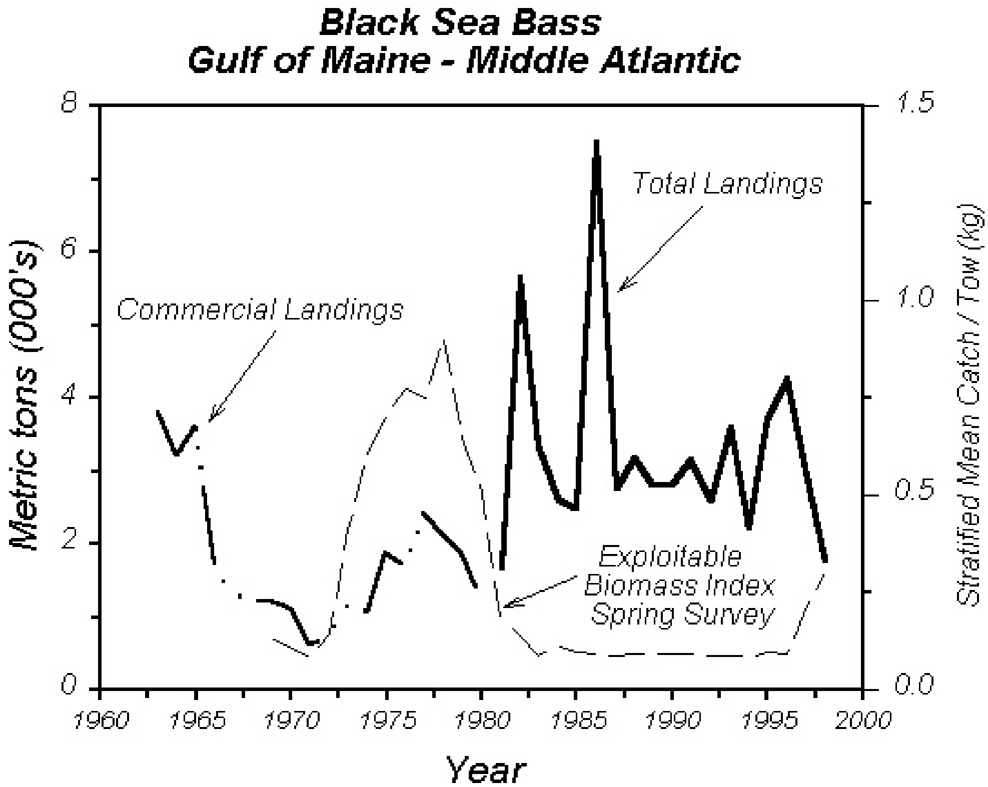


Table 15.1
Recreational and commercial landings (thousand metric tons)

	Year										
Category	1981-88 Average	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
United States	1.6	1.3	1.6	1.3	1.4	1.4	0.9	0.9	1.5	1.2	1.2
Canada	-	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-
Total nominal catch	3.6	2.8	2.9	3.2	2.6	3.6	2.2	3.7	4.3	3.1	1.8

SEDAR Black Sea Bass Stock Assessment Report

ERRATA

Updated results following correction of female maturity vector

Submitted by:

SEFSC/Beaufort Laboratory
Population Dynamics Team

April 1, 2003

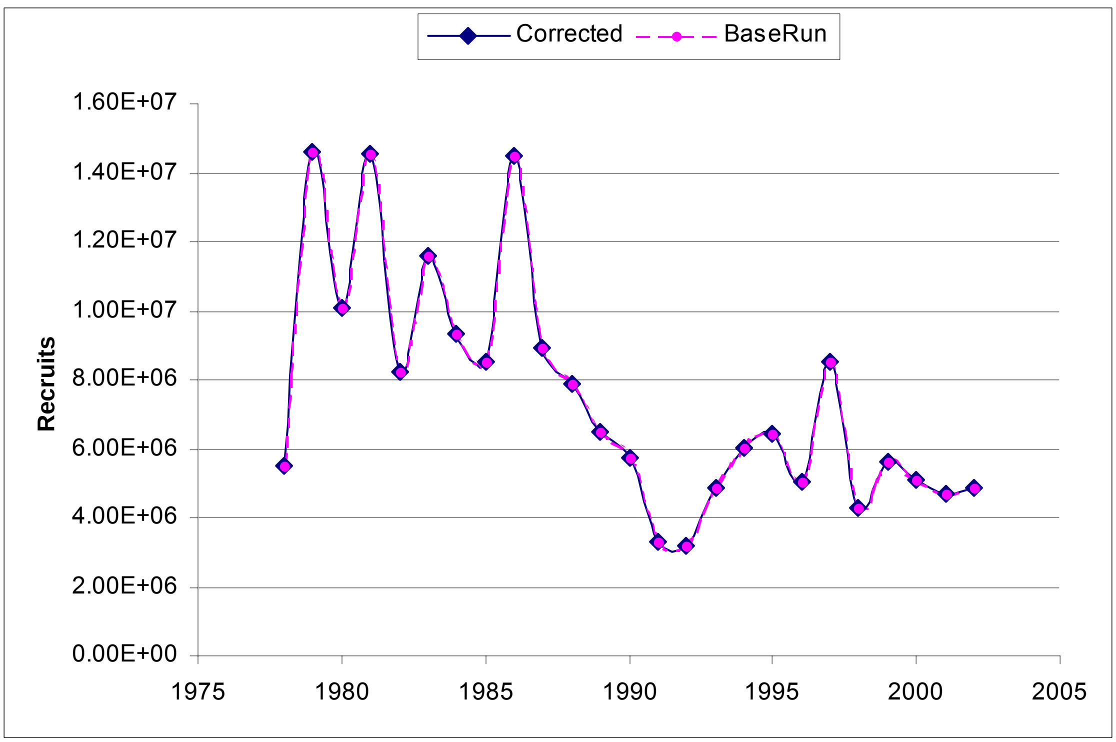
1 April 2003

This report documents an error in the black sea bass data input file, and the effects of that error on the model output. The error was in the female maturity vector for the year 1983. The 1983 vector was specified incorrectly to be the same as years 1984-1989, rather than correctly to be the same as years 1978-1982. Model output based on both input files (correct and incorrect) is summarized below for the "base run". The summary shows that the error had very little impact on model results.

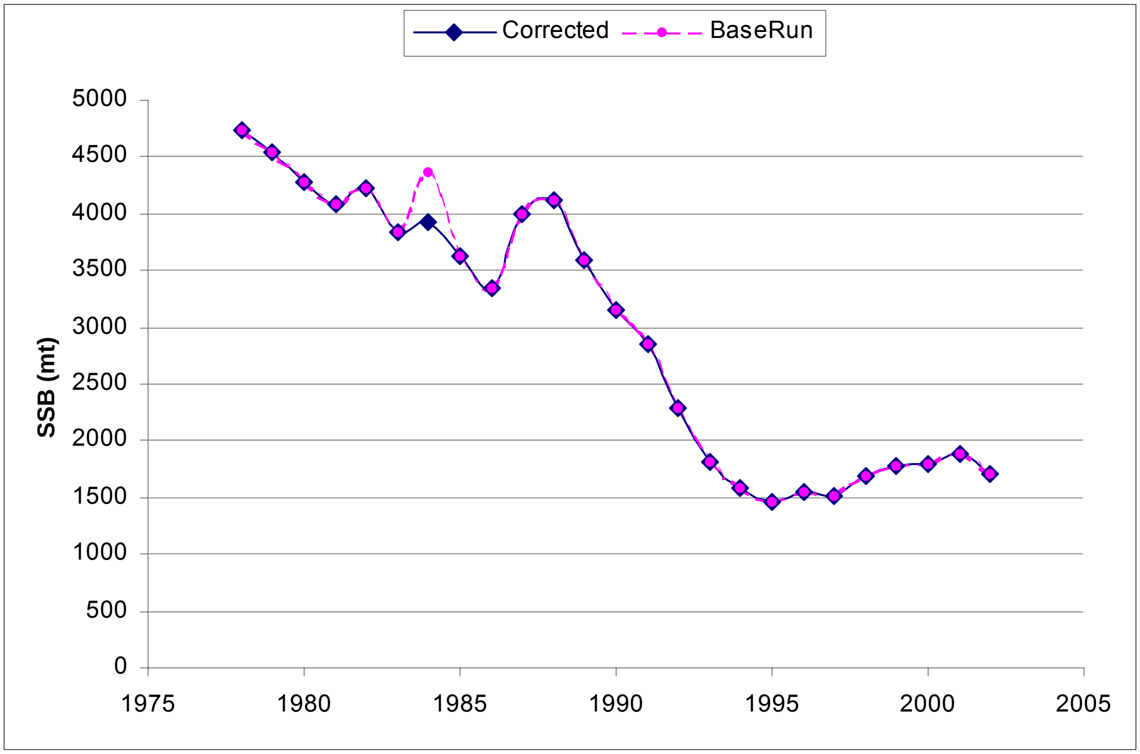
Benchmarks

	Fmsy	SSBmsy	MSY	F(2001)/ Fmsy	SSB(2002)/ SSBmsy	steepness	R0
Corrected	0.196793	13458.6	1730.83	5.20144	0.126902	0.487574	2.71E+07
BaseRun	0.196084	13518.2	1733.29	5.22019	0.126205	0.486551	2.72E+07

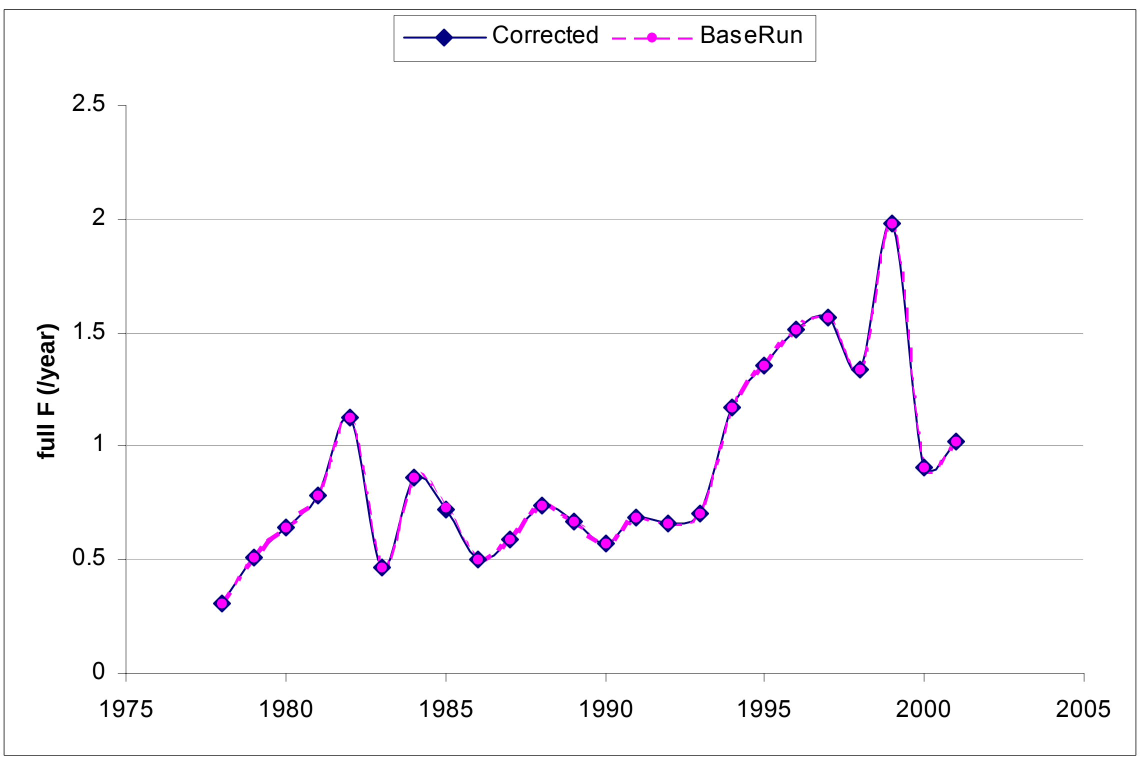
Recruitment



Spawning Stock Biomass



Fishing mortality rate



SEDAR

Black Sea Bass Stock Assessment

<u>**Addendum**</u>

Supplemental Estimates of Variability Around
Black Sea Bass
Benchmark Estimates

Submitted by:

Population Dynamics Team
NMFS/SEFSC
Beaufort Laboratory

April 25, 2004

Variability around black seabass benchmark estimates.

Eighty percent confidence intervals of black sea bass benchmarks were approximated as the 10th and 90th percentiles from the vector of sensitivity run estimates (Table 6.2 from Report of Black Seabass Stock Assessment Workshop, 14 February 2003), weighted by the AW-designated probabilities (Table 6.1). A value with weight = 1/16 was represented in the vector once; a value with weight = 2/16 was duplicated; and a value with weight = 4/16 was quadruplicated.

	Fmsy	MFMT*	SSBmsy	MSST	MSY	F(2001)/ Fmsy	SSB(2002)/ SSBmsy
Base Run	0.2	0.04	1.35E4	9.46E3	1.73E3	5.22	0.13
10th Percentile	0.14	0.01	0.40E4	2.82E3	0.99E3	2.13	0.06
90th Percentile	0.47	0.36	2.53E4	20.2E3	3.11E3	9.51	0.54

*According to the control specified in Restrepo et al. 1998. Technical Guidance On the Use of Precautionary Approaches to Implementing National Standard 1 of the Magnuson-Stevens Fishery Conservation and Management Act.

Second SEDAR Consensus Assessment Report Excerpt : Black Sea Bass

RALEIGH, NC 27605

February 25 – 28, 2003

Conclusion

The SEDAR Review Panel accepted the appropriateness of the data used in the stock assessments for the vermilion snapper and black sea bass stocks and of the models used for stock assessment and projection. However, the Panel noted a number of issues that, if resolved, might improve the quality of future assessments.

1. SEDAR Assessment Review Panel Workshop

The SEDAR Review Panel met at the Holiday Inn-Brownstone Hotel, 1707 Hillsborough Street, Raleigh, NC 27605, from February 25 to 28, 2003, to review the assessments of the stocks of vermilion snapper and black sea bass, which occupy waters off the south eastern coast of the U.S. Members of the Review Panel and attendees of the workshop are listed in Appendix 1.

The initial Terms of Reference, which were considered by the Review Panel and which reflected the terms of reference for the data and assessment workshops, were:

1. Evaluate the adequacy and appropriateness of fishery-dependent and independent data used in the assessment (i.e. was the best available data used in the assessment)
2. Evaluate the adequacy, appropriateness and application of models used to assess these species and to estimate population benchmarks (MSY, Fmsy, Bmsy and MSST, i.e. Sustainable Fisheries Act items);
3. Evaluate the adequacy, appropriateness, and application of models used for rebuilding analyses;
4. Develop recommendations for future research for improving data collection and the assessment;
5. Prepare a report summarizing the peer review panel's evaluation of the black sea bass and vermilion snapper stock assessments. (Drafted during the Review Workshop, with the Final report due two weeks after the workshop- March 14, 2003);
6. Prepare a summary stock status report including management recommendations. (Drafted during the Review Workshop, with the Final report due two weeks later - March 14, 2003.)

A revised version of the terms of reference was received just prior to the SEDAR meeting. This document specified the terms of reference as:

1. Evaluate adequacy and appropriateness of fishery-dependent and fishery-independent data used in the assessment to accurately characterize stock status.
2. Evaluate adequacy, appropriateness, and application of models used to assess black sea bass and vermilion snapper and to estimate population benchmarks (i.e., SFA-required benchmarks of MSY, Fmsy, Bmsy and MSST and MFMT).
3. Evaluate adequacy, appropriateness, and application of models used for rebuilding analyses. Probability of rebuilding (to MSST and MSY) over time under the following fishing mortality scenarios are to be included: (a) F under current management regulations, (b) F=150% Fcurrent, (c) F=125% Fcurrent, (d) F=75% Fcurrent, (e) F=50% Fcurrent, (f) F=25% Fcurrent, (g) F=0, and (h) F=99% Fmsy.
4. Develop recommendations for future research for improving data collection and the assessment;
5. Prepare a Consensus Assessment Report summarizing the peer review panel's evaluation of the black sea bass and vermilion snapper stock assessments. (Drafted during the Review Workshop, Draft available by February 28th; Final report due two weeks after the workshop- March 14);
6. Prepare an Advisory Report to include a summary of stock-status report and forecast for the upcoming year. (Drafted during the Review Workshop; Draft available by February 28th; Final report due two weeks later -March 14)

As the Data and Assessment Workshops had not had the opportunity to run and review the projections for the various rebuilding strategies listed in Item 3, it was inappropriate for the Review Panel to request that these projections be calculated. The stock assessment team from NMFS indicated that it would be appropriate for the SAMFC to submit a request for these additional runs to NMFS and, as with other such requests from the Council, they would endeavor to produce the necessary outputs for the Council's consideration.

2. General

1. The descriptions in the assessment reports of the methods, which were used to collect and to analyze the data used in the assessments, were not sufficiently complete for a thorough and comprehensive review. Similarly, technical descriptions of the model structure, which were provided in the assessment reports, were sketchy and insufficiently complete. Accordingly, members of the Review Panel were obliged to base much of their assessment on the information provided in the verbal presentations. It is possible that the detailed descriptions that were sought by members of the Review Panel may be presented in the reports of the Data or Assessment workshops. However, if not, it is recommended that the assessment reports for future stock assessments should include more detailed descriptions of the methods of data collection, analysis, and the use of these data for stock assessment. Generic descriptions of these methods should be developed, that are broadly applicable to this and future assessments.

2. For future stock assessments, sufficient details of the methods of data collection should be provided to allow the Review Panel to assess the extent to which catches from different spatial or temporal zones or from different fishing sectors have been representatively sampled, how the various samples are combined, and the sampling intensity that has been applied to the different sectors. Standard errors of estimates of landings and of the various abundance indices should be calculated whenever possible, and potential sources of bias should be identified and adjusted for when feasible. It is acknowledged that the data will be adjusted in the model for gear selectivity. In the current assessment, the Review Panel was not able to assess whether samples were representative and, if not, the likely magnitude of bias that would result.
3. The Review Panel considered that minimum levels of sampling intensity and spatio-temporal coverage to achieve acceptable precision for key population parameters should be specified by the assessment team and that sample sizes should be increased if the sampling intensity should fall below this minimum level. The sampling designs of the various data collection methods should be reviewed for statistical adequacy (sampling intensity and spatio-temporal coverage).
4. Data should be reported in tabular as well of graphical format, to allow the Review Panel to explore miscellaneous aspects of the data.
5. For future SEDAR reviews, the biological evidence and scientific motivation that led to the selection of the base parameter case as well as alternate parameter choices that are considered for sensitivity runs should be documented in the Assessment Report. Such selection will most likely take place at the Data Workshop, but any modifications that are made at the Assessment Workshop should also be recorded.

3. Black sea bass

3.1. Adequacy and appropriateness of the data

3.1.1. The Panel accepted that the data used were the most appropriate data that were available and were adequate for the assessment.

3.2. Adequacy and appropriateness of the models

3.2.1. The Panel endorsed the decision to use an age-structured forward projection model for the assessment of the black sea bass stock.

3.2.2. The Panel was of the opinion that the application of a production model for a protogynous species such as the black sea bass might be inappropriate, and recommended that its validity be further researched.

3.2.3. The Panel considered that the assumed abrupt changes in the proportion of females that are mature at each age and the transition from female to male between the three time periods should be linked and replaced by a smoother transition (*e.g.* moving average) in future assessments of the black sea bass stock.

3.2.4. The Panel noted that the index of abundance derived from the headboat data appeared highly influential on the assessment results. The Panel suggested that it would be useful to confirm this perception by eliminating the time series from the objective function and refitting to determine whether the remaining data are sufficient to produce a similar result to that obtained when the headboat data are included. If the headboat data are strongly influential, the Panel noted that this index was fishery-dependent but recognized that the GLM analysis had attempted to adjust for some of the factors that could affect the trends exhibited by this index.

3.2.5. The Panel noted that the Assessment Workshop had not attempted to correct for the likely increase in the effectiveness of fishing effort, and thus the current stock biomass may be lower than has been estimated.

3.2.6. The Panel noted that no commercial discards are calculated by the black sea bass model because larger fish were landed prior to the implementation of the minimum size limit in 1983 (Figure 6.5). The Panel concluded this would result in a slight underestimation of the current fishing mortality.

3.2.7. The Panel recommended that, noting the total biomass included the male portion of the stock, when considering the results from the current assessment, total mature biomass should be used when assessing stock status. The methods used in the current stock assessment to calculate the mature female biomass are possibly inappropriate. The Panel recommended further research on the issue.

3.2.8. The Panel suggested that, in future assessments, the historical landings (landings before 1972) be included in the age-structured model. This would require development of a slightly different model structure.

3.3. Adequacy and appropriateness of the models used to evaluate rebuilding

3.3.1. The Review Panel endorsed the adequacy and appropriateness of the model that the Assessment Workshop had applied to evaluate rebuilding.

3.3.2. The Panel concluded the benchmarks had been adequately calculated and the sensitivity runs adequately bracketed the likely range of variation.

3.4. Research recommendations

The following recommendations have been listed in order of their priority, as perceived by the Review Panel.

3.4.1. The Panel requested that SC DNR expand their MARMAP efforts to conduct a synoptic study of their gear to provide a basis for comparing relative gear efficiencies and thus connecting the several short MARMAP indices available for this assessment.

3.4.2. Commercial fisheries data, including logbooks, should be analyzed to determine whether it is possible to develop a reliable fishery-dependent index of abundance from these data.

3.4.3. The monitoring program should be expanded to collect data on the magnitude, release mortality, and the size/age composition of the black sea bass that are discarded by each fishing sector and from each fishing gear and depth.

3.4.4. Age samples need to be increased and collected appropriately for use in aging the catches of the various fishery sectors. Furthermore, the possibility of determining reliable age compositions from the historical MARMAP age samples needs to be evaluated.

3.4.5. The Panel suggested that a comprehensive study and documentation of the abundance index derived from the headboat data would be useful. For example, consideration might be given to whether changes in fishing operations, including species composition of landings, might reflect changes in catchability of black sea bass that have not been taken into account by the GLM.

3.4.6. The Panel considered that, through more detailed examination, it might be possible to develop an acceptable abundance index from the MRFSS data and suggested that this should be investigated.

3.4.7. An index of recruitment for the stock should be developed.

3.4.8. Research should be initiated to estimate fecundity by female size and age.

3.4.9. The Panel considered the possibility that fish from the assemblages of black sea bass located north and south of Cape Hatteras, NC, might mix and suggested that a research study should be initiated to investigate its magnitude, geographic extent, direction, timing and management implications.

3.4.10. The Panel recommended that the issue of whether it is more appropriate to use total mature biomass, mature female biomass or some other measure of spawning potential for a protogynous hermaphrodite should be investigated.

3.4.11. The Panel concluded that the application of a production model should be investigated as to its appropriateness for a protogynous species.

3.4.12. The behavioral dynamics associated with reproduction in this protogynous species should be investigated with respect to the effects of size selective harvesting.

Appendix 1. Members of the SEDAR Review Panel, Raleigh, February 25-28, 2003.

The following list of names was circulated at the SEDAR Review.

Panel Chair	Dr Norman Hall	Centre for Independent Experts, Western Australia
Review Panelist	Dr Jon Volstad	Centre for Independent Experts, Maryland
Review Panelist	Dr Liz Brooks	NMFS SEFSC
Review Panelist	Gary Shepherd	NMFS NEFSC
Review Panelist	Gregg Waugh	SAFMC
Review Panelists	Mark Marhefka (vermilion snapper) Jodie Gay (black sea bass)	Snapper Grouper Advisor Panel
Review Panelist	Dr Michelle Duval	NGO/SSC Representative, NC Environmental Defense
Review Panelist	Douglas Gregory	SSC Representative, Florida Sea Grant

Apologies: Dr Robert Muller was unable to attend the Review Workshop
Mark Marhefka was unable to attend much of the Review Workshop.

Presenters:

Data/Assessment Workshops Chair - Dr Jim Berkson, VPI
(Technical Support – Michelle Davis,
Mary Tilton, VPI students)
Assessment Workshop Coordinator – Dr Michael Prager, NMFS Beaufort Lab

Assessment Workshop/Review Panel Support Staff:

Dr John Merriner, NMFS SEFSC Beaufort Lab
Dr Erik Williams, NMFS SEFSC Beaufort Lab
Dr Kyle Shertzer, NMFS SEFSC
Dr Doug Vaughan, NMFS SEFSC Beaufort Lab
Joe Geist, NC DMF and SSC
Dr Pat Harris, MARMAP and SSC
Ms Jennifer Potts, NMFS SEFSC

Meeting Support Staff & Other Attendees

Rick DeVictor, SAFMC Staff
Wayne Lee, Chair SAFMC Snapper Grouper Committee
Dr Louis Daniel, SAFMC Snapper Grouper Committee & NC DMF
George Geiger, SAFMC Member
Dr Pete Eldridge, NMFS SERO

Second SEDAR Advisory Report on Stock Status
Excerpt: Black Sea Bass
RALEIGH, NC 27605
February 25 - 28, 2003

Black Sea bass

1. Status of Stock

Overfishing is occurring and the stock is overfished, based upon the best available data used in the assessment.

The best estimate of fully-selected F_{2001} was 1.04/yr (range 0.89 – 2.00/yr). The best estimate of the January 1, 2002 spawning biomass was 1755 mt (range 766 – 2715 mt).

2. Biological Reference Points

Previous Assessment
Existing BRP previously approved by the Council - The timetable for rebuilding black sea bass effectively was reset on December 2, 1999, when the SFA Comprehensive Amendment was implemented in regulations. The regulations require that the black sea bass stock be rebuilt above the B_{msy} level (*i.e*., the biomass must be above the biomass capable of producing the MSY), which was specified as 5.31 million pounds by December 2, 2009 (based on a 10 year rebuilding timeframe). Based on data through 1995, the spawning stock biomass/MSST ratio was estimated at 0.54, which suggested that the stock was below the MSST and therefore overfished. The fishing mortality through 1995 was 0.97/yr, which was above the MFMT (0.72/yr), and therefore black sea bass were experiencing overfishing.

Current assessment
The panel advises the following –
The base-run estimates and their extreme range obtained from the alternative sensitivity runs are reported below. Note that choosing within the range should be done on a run-by-run basis; see Tables 6.2 and 8.1 in the Report of the Black Sea bass Stock Assessment Workshop. Each of the runs is associated with the assigned probability specified in the assessment document (Table 6.1). In general, the range results from the minimum and maximum bounds of the sensitivity runs, some of which may be unlikely to represent the current stock status. The base run represents the central case, and is considered to provide the most likely set of results.

The BRPs varied considerably in the various sensitivity runs:

1. MSY = 1730 mt (range 987 – 3580 mt)
2. MFMT = 0.04/yr (range 0.002 – 0.99), based on the default control rule. If the council were to choose another control rule, the MFMT would need to be re-specified. The Council instead might choose to use F_{rebuild}.
3. MSST = 9460 mt (1830 – 30700 mt)
4. Bmsy = 13500 mt (range of 3050 – 38300 mt)
5. F_{2001}/F_{MSY} = 5.22 (0.94 – 22.23)
6. $\text{SSB}_{2002}/\text{SSB}_{\text{MSY}}$ = 0.13 (0.02 – 0.89)
7. Rebuilding timeframe = 18 years based on the base run with F_{rebuild} = 0.16/yr (range 0.10 – 0.49)

3. Forecast

Using values from the central run as a starting point, the stock could not recover in 10 years with F=0. The rebuilding time calculated from the generation time is 18 years (see Table 8.1)

4. Special Comments

The fisherman on the panel with extensive experience over the past 20 years fishing for black sea bass has not observed similar declines in his catches. Consequently, he does not believe the model results. There may be some mixing of the northern and southern stocks, which should be considered in future assessments.

The commercial data should be examined to determine whether an abundance index based on them would add to the accuracy or precision of future assessments.

The BRPs and projections are based on total mature biomass. There is uncertainty whether mature female biomass, or some other measure of reproductive potential, should be used as an alternative. Further examination of this issue is recommended. The computation of female spawning biomass in the present assessment may be misleading, and methodology for computing female biomass should be reassessed.

Effective monitoring of stock recovery will require adequate data on discards from all fishery segments.

The Council should note that estimated abundance trends over time appear highly dependent on the headboat index, which is a fishery-dependent dataset and is the only long-term index. The fisheries literature contains substantial evidence that fishery-dependent indices can at times underestimate the degree of decline in a stock because they do not follow a simple linear relationship with stock size. By targeting local concentrations (patches) of fish that they find based on their expert knowledge, fishers can often maintain a relatively high catch per unit effort even when the overall abundance is in decline. This is especially the case for species that aggregate in structured habitats (*e.g.*, reef fish), or schooling fish that can be located by sophisticated acoustic fish finding equipment. Well-designed fisheries-independent surveys tend to provide more representative estimates of fish abundance because they cover a wider range of habitats and density levels. For such reasons, the fisheries-independent data should receive higher weighting as the time series increases.

5. <u>Source of Information</u>

Report of Black Seabass Assessment Workshop, January 6-10, 2003.

In addition, a Data Workshop was held during October 7-10, 2002. All data, reports, and results are included on a CD available from the NMFS Beaufort Lab.

Section VI.

Data Workshop Reports

The following are summary reports prepared by the Data Workshop Working Groups

Commercial Landings Working Group Report

Commercial Landings.doc

Black Sea Bass

Commercial landings of black sea bass are available since 1950. Between 1950 and 1983 data were collected through the NMFS General Canvas, and it is suspected that coverage was incomplete and variable across states and years. The TIP program began in 1984, adding length sampling and more complete dealer coverage. Some states only sample BSB through TIP, others collect additional samples and sample more species (e.g. beyond the TIP targets). Landings for the assessment are those provided by each state, based on its current records under TIP (SC) or state trip ticket (NC,FL) sampling. These landings do not exactly match landings provided on NMFS website. One reason is updates to state databases after finalization with NMFS that are not always reported to NMFS. For example, SC applies a 5% rule, if a change is less than 5% of total landings it is not reported to NMFS after the final version.

Data Issues

1. Separation of management unit at Hatteras.

   Black sea bass North of Cape Hatteras are managed as a separate stock by the MAFMC, those South of Hatteras are managed by the SAFMC with a unit stock from Hatteras to Florida.

   Past assessments allocated NC landings into management units by the primary gear categories, under the assumption that trawl landings occur in the Northern unit and pot landings along with all other gear types occur in the Southern area.

   From 1996-1999, NC's Trip Ticket program included an option for fishermen to report landings as North or South of Cape Hatteras; by 1999 most landings (97%) were reported to area and in 2000 this field became mandatory. Landings by gear and area from 1999-2001 are used to evaluate the prior area allocation assumption for 1972-1998 and to allocate landings to area for 1999-2001. Data show 98% trawl landings are north, 92% pot landings are south. Therefore, the prior assumption is validated and a similar approach is used here. Allocation to management unit remains based on gear, with all trawl and 8% of pot landings assumed harvested in the Northern region.

   Also considered logbooks for N-S allocation. Problem exists with varying permit systems in North Carolina due to overlapping management jurisdictions. Some fishermen have Northeast multispecies permits, some have SA snapper grouper permits, and the South Atlantic logbook only apply to those with SA permits.

2. Mixing of species.

   Sea bass were potentially landed as mixed species under 'seabass unclassified'. Florida and North Carolina have trip ticket reporting programs and trip level sampling that allows determination of the proportion of black sea bass in the landings that can be applied to period when seabass are landed as unclassified.

   North Carolina required mandatory reporting to species beginning with 1994. From 1994-2001, an average of 99.8% of sea bass landed were black sea bass, with about 0.2% other sea basses (rock or kelp). Unclassified sea bass landings for 1972-1993 were multiplied by .998 to adjust for mixed species landings. Landings for 1994-2001 were adjusted by the % of the landings that were actually black sea bass.

   Florida required reporting to species through a trip ticket program for 1995-2001. Unclassified seabass landings for 1970-1994 were adjusted by multiplying by the average proportion (98%) of black sea bass observed in 1995-2001 landings reported by species.

Landings for 1995-2001 were adjusted by the annual proportion of landings by gear that were black sea bass.

South Carolina landings are reported to species and are generally considered free of bias due to species mixing. There is no monitoring of other sea bass species or sampling beyond the basic TIP requirements available to test this assumption.

Georgia landings data are only available through the NMFS website. No adjustments are made.

3. Years available

NMFS general canvas landings starting with 1950 are available through the NMFS commercial statistics website. The TIP program began in 1984, expanding the dealers and fishermen covered by the survey and adding biological data collection (ie length, effort information). NC and FL conduct sampling beyond the basic TIP standards and require mandatory reporting.

North Carolina supplemented NMFS catch sampling beginning in 1978. TIP sampling of length data was added in 1984. Mandatory reporting began in 1994 with the Trip Ticket Program. Biological sampling is generally conducted through TIP, but is more comprehensive than minimially required (ie, all species in catch are counted, recorded).

South Carolina landings based on general canvass and TIP.

Georgia landings based on general canvass and TIP. Inconsistent coverage due to lack of port samplers in some years.

Florida added trip ticket reporting in 1995.

4. Landings by Gear.

Landings can be categorized by gear since 1970 for FL, and 1972 for NC and SC. Most black sea bass are landed by pots/traps and hook and line. Gear types were condensed into three categories: Pots (pots and traps), Lines (hook and line, electric reels, longlines, trolling), and Other (gill nets, trawls, gigs, spears etc). Pot and line categories represent 95% of the total landings on average for 1972 – 2001 and 99% of the total landings since 1997.

5. Length Distributions

Length data are available since 1984 through the TIP program. An average of 1071 lengths were taken each year over the entire region combined, including 615 for hook and line categories and 327 for pot trap categories. Length frequencies were tabluated annually in 20mm length categories, from 160 to 500 mm. Measurements are based on Total Length, Some landings from SC in some years coded as Fork Length are measured as the center line of the tail and are treated as Total Length measurements without conversion.

Pot and Line landings were allocated to length based on annual gear specific length samples. The “other” category was allocated based on length distributions for all samples combined. Since 98% of 1984-2001 landings are Pot and Line categories, the bulk of the landings are allocated to length based on gear specific length samples.

North Carolina trawl and pot landings percentage by area (North of Hatteras, South of Hatteras).

YEAR	North % Trawl	South % Pot	% Classified
1995	0%	0%	2%
1996	50%	63%	58%
1997	53%	73%	73%
1998	39%	91%	82%
1999	94%	92%	97%
2000	99%	89%	100%
2001	100%	95%	100%
99-01 avg.	99.4%	91.9%	100%

Total South Atlantic Black Sea Bass Landings Proportion by Primary Gear Categories.

Year	TRAP	LINE	OTHER	Trap/Line
1970	4%	75%	21%	79%
1971	3%	60%	36%	64%
1972	86%	8%	6%	94%
1973	89%	7%	4%	96%
1974	90%	7%	3%	97%
1975	86%	12%	3%	97%
1976	77%	17%	6%	94%
1977	73%	19%	8%	92%
1978	47%	42%	11%	89%
1979	80%	18%	3%	97%
1980	86%	11%	2%	98%
1981	84%	14%	3%	97%
1982	80%	17%	3%	97%
1983	73%	26%	1%	99%
1984	64%	35%	2%	98%
1985	66%	31%	3%	97%
1986	72%	27%	1%	99%
1987	67%	26%	6%	94%
1988	63%	33%	4%	96%
1989	63%	35%	3%	97%
1990	68%	29%	3%	97%
1991	65%	34%	1%	99%
1992	66%	32%	2%	98%
1993	66%	29%	6%	94%
1994	65%	33%	2%	98%
1995	69%	29%	2%	98%
1996	73%	26%	2%	98%
1997	68%	31%	1%	99%
1998	60%	39%	1%	99%
1999	66%	33%	1%	99%
2000	77%	22%	1%	99%
2001	80%	19%	1%	99%

Sampling Intensity, TIP program, South Atlantic Black Sea Bass.

Year	Lines	Pots	Other	Total
1984	764	174	14	952
1985	545	340	4	889
1986	699	25	485	1209
1987	633	393	8	1034
1988	485	605	137	1227
1989	358	194	6	558
1990	627	391	88	1106
1991	906	574	28	1508
1992	688	742	4	1434
1993	543	197	326	1066
1994	490	521	352	1363
1995	300	121	181	602
1996	354	109	170	633
1997	533	461	190	1184
1998	818	188	15	1021
1999	877	425	1	1303
2000	524	219	87	830
2001	930	214	213	1357
mean	615	327	128	1071

Length Frequency
Length Frequency BSB.doc

Program: BSBLF.SAS
Data Set: CPUE

Total length (cm), to the tip of the caudal fin filament, was recorded for all black sea bass collected during 1978-2001 for length frequency.

Length frequency and mean lengths have been determined for all fish caught with Florida trap, blackfish trap and hook and line caught fish in the inshore survey as well as all fish caught with chevron trap during 1990-2001.

Table. Length frequency of all black sea bass caught with chevron trap, blackfish trap, Florida trap and hook and line gear.

The FREQ P rocedure

LEN	Frequency	Percent	Cumulative Frequency	Cumulative Percent
7	1	0	1	0
9	1	0	2	0
10	2	0	4	0
12	4	0	8	0.01
13	14	0.01	22	0.02
14	75	0.07	97	0.1
15	288	0.28	385	0.38
16	1090	1.07	1475	1.45
17	2810	2.76	4285	4.2
18	5502	5.4	9787	9.6
19	7993	7.84	17780	17.43
20	10364	10.16	28144	27.6
21	11171	10.95	39315	38.55
22	11143	10.93	50458	49.48
23	9861	9.67	60319	59.15
24	8120	7.96	68439	67.11
25	6289	6.17	74728	73.28
26	4911	4.82	79639	78.09
27	4111	4.03	83750	82.12
28	3295	3.23	87045	85.36
29	2813	2.76	89858	88.11
30	2428	2.38	92286	90.5
31	1969	1.93	94255	92.43
32	1643	1.61	95898	94.04
33	1311	1.29	97209	95.32
34	1108	1.09	98317	96.41
35	826	0.81	99143	97.22

36	724	0.71	99867	97.93
37	501	0.49	100368	98.42
38	362	0.35	100730	98.78
39	312	0.31	101042	99.08
40	213	0.21	101255	99.29
41	197	0.19	101452	99.48
42	152	0.15	101604	99.63
43	100	0.1	101704	99.73
44	89	0.09	101793	99.82
45	60	0.06	101853	99.88
46	52	0.05	101905	99.93
47	29	0.03	101934	99.96
48	25	0.02	101959	99.98
49	10	0.01	101969	99.99
50	6	0.01	101975	100
51	2	0	101977	100
54	1	0	101978	100
69	1	0	101979	100

Black Seabass Data Workshop
LHrepor.doc

Size and age at maturity of females (Sex codes = 2, 5):

Immature: maturity code = 1
Mature: maturity code = 2, 3, 4, 5, 7, 8, B, C, D, E, F, G
Eliminated maturity codes = 0, 6, 9, A
See tables in MARMAP life history studies.doc.
Raw data file: bsb05.mrg
Excel file: sizemat.xls; agemat.xls
Program files: sizemat.sas

All data are from fishery-independent sampling by MARMAP program. Fishery-dependent samples collected by MARMAP were not used as few immature specimens were present.

mm TL	H&L	H&L num	BFT	BFT num	FLT	FLT num	CHV	Chv num
101-125								
126-150	0.727273	11	0.875	8	0.777778	9	0.454545	33
151-175	0.744048	168	0.962963	81	0.806452	93	0.936	375
176-200	0.907348	626	0.961415	311	0.938144	291	0.992608	947
201-225	0.990485	1051	0.996205	1054	0.997354	378	0.999077	1083
226-250	1	869	1	1007	1	200	0.998839	861
251-275	1	447	1	485	1	61	1	474
276-300	0.990148	203	1	199	1	33	1	175
301-325	1	79	1	78	1	14	1	72
326-350	1	46	1	42	1	8	1	29
351-375	1	22	1	23	1	7	1	9
376-400	1	12	1	16	1	1	1	2
401-425	1	4	1	4	1	1	1	2
426-450					1	1	1	2

There were temporal decreases in the size at maturity during 1979-1983 and 1984-1989 for BFT, H&L, and FLT. There were no trends for CHV during the 1990s.

Age at maturity by gear type

mm TL	H&L	H&L num	BFT	BFT num	FLT	FLT num	CHV	CHV num
0								
1	0.752577	98	0.5	2	0.886792	53	0.901042	192
2	0.886691	534	0.956522	69	0.90604	149	0.989189	555
3	0.989583	887	0.967517	431	0.974194	155	1	374
4	1	288	0.998649	740	1	39	1	130
5	1	58	1	318	1	9	1	31
6	1	7	1	43	1	1	1	7

7			1	8

There were also temporal differences in the age at maturity for BFT, FLT, and H&L. There were no trends in the age at maturity for chevron traps during the 1990s.

Sex ratio (Sex codes = 1, 2, 4, 5):

Eliminated maturity codes = 0, 1, 9, A
See table in MARMAP life history studies.doc.

Raw data file: bsb05.mrg; bsb50.mrg
Excel files: sexratiolength; sexratioage
Program files: sexratio.sas

In calculating the proportion of males, transitional specimens were also considered males because they will likely function as males within a few months. Calculations are also done for fishery dependent data.

Percent males and transitionals at size

mm TL	H&L	H&L num	BFT	BFT num	FLT	FLT num	CHV	CHV num
101-125	0	1	0	4	0	2	0	0
126-150	0	11	0	8	0	8	0	0
151-175	0	150	0	83	0	78	0.16	25
176-200	0.13913	690	0.160112	356	0.105611	303	0.112903	124
201-225	0.150231	1298	0.208302	1325	0.133641	434	0.131579	152
226-250	0.25421	1247	0.356182	1561	0.213439	253	0.28	175
251-275	0.454865	853	0.536398	1044	0.552239	134	0.531469	143
276-300	0.650662	604	0.731444	741	0.554054	74	0.833333	114
301-325	0.811236	445	0.868243	592	0.762712	59	0.932039	103
326-350	0.836806	288	0.906459	449	0.843137	51	0.842105	57
351-375	0.880829	193	0.931751	337	0.840909	44	0.941176	34
376-400	0.904762	126	0.90184	163	0.961538	26	0.933333	15
401-425	0.952381	84	0.96	100	0.888889	9	1	4
426-450	0.981818	55	0.980769	52	0.75	4	1	3
451-475	1	21	1	23	1	3	1	1
476-500	0.9	10	1	6	1	1		0
501-525	1	1	1	1				
526-550			1	1				

Percent males and transitionals at age

age	H&L	H&L num	BFT	BFT num	FLT	FLT num	CHV	CHV num
0	0		0		0		0	
1	0.122807	114	0.166667	78	0.229508	61	0.078212	179
2	0.188513	679	0.362385	654	0.219653	173	0.206442	683
3	0.332111	1364	0.493141	1458	0.209424	191	0.577401	885
4	0.626566	798	0.717082	1124	0.632075	106	0.819444	720
5	0.817073	328	0.903803	447	0.785714	42	0.900322	311
6	0.949275	138	0.962617	214	0.9375	16	0.9375	112
7	0.967742	31	0.964286	28	1	5	1	26
8	1	6	1	34	1	2	1	3
9	1	3			1	1	1	1

There were also temporal trends in the percent of males and transitionals for black sea bass caught with FLT and BFT.

Annual fecundity:

Fecundity data are not available for black sea bass.

Description of MARMAP Sampling
MARMAP CPUE data.doc

For thirty years, the Marine Resources Research Institute (MRRI) at the South Carolina Department of Natural Resources (SCDNR), through the Marine Resources Monitoring, Assessment and Prediction (MARMAP) program, has conducted fisheries-independent research on groundfish, reef fish, ichthyoplankton, and coastal pelagic fishes within the region between Cape Lookout, North Carolina, and Cape Canaveral, Florida. The overall mission of the program has been to determine distribution, relative abundance, and critical habitat of economically and ecologically important fishes of the South Atlantic Bight (SAB), and to relate these features to environmental factors and exploitation activities. Research toward fulfilling these goals has included trawl surveys (from 6-350 m depth); ichthyoplankton surveys; location and mapping of reef habitat; sampling of reefs throughout the SAB; life history and population studies of priority species; tagging studies of commercially important species and special studies directed at specific management problems in the region. Survey work has also provided a monitoring program that has allowed the standardized sampling of fish populations over time, and development of an historical base for future comparisons of long-term trends.

Monitoring of Reef Species

Since 1978, MARMAP has monitored reef fish abundance and collected specimens for life history studies. The primary gear types that have been used to sample reef fishes are Florida traps, blackfish traps, chevron traps, bottom longline, kali pole, vertical longline, and hook and line gear. From 1978 to 1987, Florida traps and blackfish traps baited with cut clupeids were soaked for approximately two hours during daylight at 12 study areas with known live-bottom and/or rocky ridges. In 1988 and 1989, Florida snapper and chevron traps were fished synoptically for approximately 90 minutes from a 33.5 m research vessel that was anchored over a randomly selected reef locations. After 1989, blackfish traps and Florida traps were discontinued. Only chevron traps were deployed at stations randomly selected by computer from a database of approximately 2,500 live bottom and shelf edge locations and buoyed for approximately 90 minutes. This database was compiled from MARMAP visual UWTV studies with additional locations added from catch records from the MARMAP and other MRRI projects. During the 1990s, additional sites were obtained for the North Carolina and south Florida area from scientific and commercial fisheries sources to facilitate expanding the overall sampling coverage.

Sample sites are all located in the central SAB from 27^0 N to 34^0 N. Trapping has occurred to depths as great as 218 m but the majority of trap sampling has occurred at 16 to 91 m. During all years, sampling was conducted during daylight to eliminate light phase as a variable. Night hours were reserved for workup of fishes, steaming time between sites and for tagging and recapture of priority species. CTD profiles were taken after each trap set and before each longline set.

Hook and line stations were fished during dawn and dusk periods, one hour preceding and after actual sunrise and sunset. Rods utilizing Electromate motors powered 6/0 Penn Senator reels and 36 kg test monofilament line were fished for 30 minutes by three anglers. The terminal tackle consisted of three 4/0 hooks on 23 kg monofilament leaders 0.25 m long and 0.3 m apart, weighted with sinkers 0.5 to 1 kg. The top and bottom hooks were baited with cut squid and the middle hook baited with cut cigar minnow (*Decapterus sp.*). This same method of sampling was used between 1978-2001. However, less emphasis has been placed on hook and line sampling during the 1990s to put more effort on tagging of fishes at night and running between stations.

In 1997, we began using two types of longline gear to sample the snapper-grouper complex in depths greater than 90 m. Each type of long line was intended to sample one of two unique bottom types (smooth tilefish grounds or rough bottom). In the tilefish grounds (areas of smooth mud), a horizontal long line was deployed and in areas of rough bottom contours, a short vertical long line was used to follow the bottom profile. The horizontal long line consists of 1676 m of 3.2 mm galvanized cable deployed from a longline reel. A total of 1219 m of the cable is used as groundline and the remaining 457 m is buoyed to the surface. One hundred gangions, comprising of an AK snap, approximately 0.5 m of 90 kg monofilament and a #6 or #7 tuna circle hook, are baited with a whole squid and clipped to the ground cable at intervals of 12 m. The gear is set while running with the current at a speed of 4 - 5 knots. An 11 kg weight is attached to the terminal end and 100 gangions are then attached to the ground line, followed by another weight at the terminal end of the ground line. The remaining cable is pulled off of the reel and buoyed with a Hi-Flyer and a polyball trailer buoy. The gear is soaked for 90 minutes and retrieved by fairleading the cable from a side davit of the vessel back on to the longline reel. A similar bottom longline was deployed by MARMAP during the 1980s, however, red porgy are not taken in the tilefish grounds.

Where bottom type is rough at depths of 90 to 200 m, short vertical relief longlines consisted of 25.6 m of 6.4 mm solid braid dacron groundline dipped in green copper naphenate. The line is deployed by stretching the groundline along the vessel's gunwale with 11 kg weights attached at the ends of the line. Twenty gangions baited with a whole squid were placed 1.2 m apart on the groundline which was then brommelled to an appropriate length of poly warp and buoyed to the surface with a Hi-Flyer. Sets are made for 90 minutes and the gear is retrieved utilizing a pot hauler. This gear type has only been used since 1997 and a long term data set is not available. During the 1980s, kali pole gear was used on deep water reefs at depths ~150-200 m. Catch per unit effort for the longline gear is expressed as the number per 100 hooks.

UWTV recordings were made using a Simrad-Osprey Subsea low light camera attached to a vane stabilized frame during day light hours. The camera is maintained off the bottom 1 - 2 m as the vessel either drifted with the wind and/or current or was towed at low speeds. Recordings for fish identification on bottom habitat and to document new live bottom sites for the MARMAP data base were made on VHS tape and archived for future analysis.

Length-frequency data from the catches (to the nearest 1 cm) were recorded by a shipboard data acquisition system. This comprised of a Limnoterra FMB IV digital measuring board and a Toledo model 8142 digital scale, interfaced by an XT personal computer with customized software. During length frequency, subsample tables for priority species were also kept so specimens could be retained for additional life history studies. During length frequency workup, the only total length was recorded for black sea bass and fork length for vermilion snapper. After length frequency workup, fishes are stored on ice for life history workup during night.

From the 1990s through the present, specimens for life history workup were collected from eight geographical areas designated by each whole degree of latitude from 27^0 N to 34^0 N. South of 32^0 N and north of 33^0 N, fifteen specimens of each 1 cm size class were retained from each trip for *Centropristis striata,* and *Rhomboplites aurorubens*. Fifty specimens for *Pagrus pagrus* and *Balistes capriscus were retained.* In mid latitudes, 32^0 N to 33^0 N, five specimens of each 1 cm size class were retained for *Centropristis striata, Rhomboplites aurorubens, Balistes capriscus, Haemulon aurolineatum* and *Diplectrum formosum*. Ten specimens were retained for *Pagrus pagrus*. All other priority specimens were kept for the entire sampling area. During the 1980s, all priority species (species of commercial and recreational important) caught (including red porgy) were retained for life history workup.

During life history workup, a Limnoterra fish measuring board with 1-mm resolution was used to measure priority species (SL, FL, and TL) with their weights determined by a triple beam balance to the nearest gram. This system was connected to an AT 486-type computer for life history data storage with a paper output as backup.

Mean CPUE of fish caught with traps or hook and line gear is calculated for each year by species as:

$$Mean\,CPUE\,(no.\ fish\ per\ trap\text{-}hr.) = \frac{\sum \frac{no.\ fish\ caught}{soak\ time\,(hr.)}}{no.\ samples}$$

Description of the MARMAP monitoring data set

Included on CD, is a data set in ASCI "CPUE" and Excel format that includes MARMAP monitoring reef fish data since 1978.

```
DATA INITIAL; INFILE 'C:\SAW\BSB\CPUE' LRECL = 421;
INPUT PID 1-3 COLL 4-9 GEAR $10-12 SPECIES $16-19 EST $29 @23 TOTWGT
6.3 NUM 30-34 @35 SUBWGT 5.2 MEAS 40-41 DAY 234-235 MONTH 236-237
YEAR 238-239 VESSEL 244-245 LAT 330-334 LONG 335-339 @287 STRATA
$CHAR4.DEPTH 367-369 DUR 370-372 CC 377 NAME $385-420
   LEN1 43-45 FR1 46-48 LEN2 49-51 FR2 52-54
   LEN3 55-57 FR3 58-60 LEN4 61-63 FR4 64-66
   LEN5 67-69 FR5 70-72 LEN6 73-75 FR6 76-78
   LEN7 79-81 FR7 82-84 LEN8 85-87 FR8 88-90
   LEN9 91-93 FR9 94-96 LEN10 97-99 FR10 100-102
   LEN11 103-105 FR11 106-108 LEN12 109-111 FR12 112-114
   LEN13 115-117 FR13 118-120 LEN14 121-123 FR14 124-126
   LEN15 127-129 FR15 130-132 LEN16 133-135 FR16 136-138
   LEN17 139-141 FR17 142-144 LEN18 145-147 FR18 148-150
   LEN19 151-153 FR19 154-156 LEN20 157-159 FR20 160-162
   LEN21 163-165 FR21 166-168 LEN22 169-171 FR22 172-174
   LEN23 175-177 FR23 178-180 LEN24 181-183 FR24 184-186
   LEN25 187-189 FR25 190-192 LEN26 193-195 FR26 196-198
   LEN27 199-201 FR27 202-204 LEN28 205-207 FR28 208-210
   LEN29 211-213 FR29 214-216 LEN30 217-219 FR30 220-222;
```

A description of these data elements follows:

PID = Project identity. "105" - fishery-independent MARMAP data and "150 – fishery dependent data collected by MARMAP.

COLL = Collection Number

GEAR = Gear Code (See Table 1).

SPECIES = Species Code. The species code for red porgy is "A272". "X999" indicates that no species were taken. Other species codes can be determined from the names.

EST = indicates if subsample was taken. 1 indicates whole catch has length measurements. C indicates that lengths taken from subsample. Red porgy are never subsampled.

TOTWGT = Total weight (kg) of all fish of a certain species in a collection

NUM = Number of fish of a certain species in a collection.

SUBWGT = Weight of subsample if taken. Subsamples were never taken on red porgy or any other priority species.

MEAS = Measurement Code. 00 Total Length; 04 Fork Length. Red porgy are measured in fork length during length frequency workup.

VESSEL = DP = R/V DOLPHIN; OE = R/V Oregon I; PO = R/V Palmetto

DAY = Day

MONTH = Month

YEAR = Year

LAT = Latitude

LONG = Longitude

DEPTH = Depth in meters

DUR = Duration in minutes

CC = Catch Code. 0 = no catch, 1 = catch with finfish, 2 = catch with no finfish, 3 = no catch; gear lost or damaged, 4 = catch mixed or lost, 6 = gear damaged, catch questionable, 7 = NA, 9 = reconnaissance sample.

NAME = Species name.

LEN 1 to 30 = Length of fish

FR 1-30 = Frequency of length.
Table 1. Gear codes for gear used by MARMAP during reef fish cruises.

014 HOOK AND LINE - Personal
041 MINI ANTILLEAN S-TRAP - BAITED
043 SNAPPER REEL, ELECTRIC OR MANUAL, 2 HOOKS
052 MINI ANTILLEAN S-TRAP - UNBAITED
053 BLACKFISH TRAP - BAITED
054 BLACKFISH TRAP - UNBAITED
055 EXPERIMENTAL LARVAL TRAP
056 MINNOW TRAP - COVERED
057 MINNOW TRAP - UNCOVERED
059 FINE MESH TRAP
060 CUBIAN TRAPEZE - 1 X 2M .947MM MESH
061 VERTICAL LONG LINE
073 EXPERIMENTAL TRAP
074 FLORIDA "ANTILLEAN" TRAP
086 KALI POLE STANDARD (MARMAP)
087 BOTTOM LONGLINE
296 25 MM DIA. FILTER
297 THERMISTOR
298 CTD
299 SURFACE HYDRO SAMPLE
300 NISKIN BOTTLES - STANDARD CAST
301 NISKIN BOTTLES - SURFACE AND BOTTOM
305 XBT
324 CHEVRON TRAP (MARMAP)
501 BOTTOM TRIPOD FIXED TV
502 STAT. TV STATION - HORIZONTAL
503 STAT. TV STATION - VERTICAL
504 DRIFT TV TRANSECT - HORIZONTAL
505 DRIFT TV TRANSECT - VERTICAL
506 TOWED TV TRANSECT - HORIZONTAL
507 TOWED TV TRANSECT - VERTICAL
513 PAN & TILT TV

Changes in Vessels

Three research vessels have been used by MARMAP since 1972, the R/V DOLPHIN, R/V OREGON I, R/V PALMETTO. During 1973-1980, MARMAP used the R/V DOLPHIN. This was a 105' converted ocean tugboat. It had a single screw and an active rudder. It was outfitted for trawling, plankton work, hydro casts, trapping and was used by NMFS prior to MARMAP. The R/V OREGON I was used by MARMAP during 1981-1988. It was a 105' vessel that was built by NMFS during WWII to trawl off Alaska. It was outfitted for trawling, plankton work, hydro casts, and trapping. From 1989 to the present, MARMAP has used the R/V PALMETTO. The R/V PALMETTO is 110', maintains a 5 permanent member sea-going crew, 1 or 2 temporary deckhands, and has accommodations for 9 scientists. There is a 200 sq. ft. wet lab on the main deck with counter space, electronics rack, freshwater and seawater, a double stainless sink, 40 cu. ft. chest freezer, small bait freezer, 120 volts AC and 12 volts DC power supplies. The main deck has 1,014-sq. ft. of open deck space, with davits on both sides. There is a Sea Crane 120 on the main deck for loading, distributing and deploying gear, as well as the zodiac. It has two hydraulic long-line reels, two hydraulic reels for CTD casts and plankton work and a pot-hauler for retrieving traps.

Changes in Captains

There has been little change in individuals that were captains on these research vessels. Captain John Causby was the captain of the R/V Dolphin during 1973-1980, captain of the R/V OREGON I, and captain of the R/V PALMETTO during 1989-2000. Captain Julian Mikell who was the mate for John Causby since 1978 took over as captain of the R/V PALMETTO in 2000.

Changes in Investigators and Chief Scientists

The Principal Investigators of MARMAP have been: Victor Burrell, 1972-1976; Fred Berry, 1977-1978; Charlie Barans, 1979-1984; George Sedberry, 1985-1993; and Jack McGovern, 1994-current. **Since 1973, scientific personnel, including chief scientist have varied with each cruise.** Individuals that functioned as chief scientist during the 1980s include (alphabetical order): Charlie Barans, Dan Machowski, Bill Roumillat, George Sedberry, Dave Schmidt, Charlie Wenner, and Dave Wyanski. Individuals that were chief scientist during the 1990s through 2002are: Pat Harris, Dan Machowski, Jack McGovern, Dave Schmidt, George Sedberry, and Dave Wyanski.

Data Documentation for MARMAP CPUE Index Information
MARMAP index BSB.doc

Gear types chosen for index

The black sea bass life history group chose to use the inshore index for blackfish trap and Florida trap as well as the chevron survey for 1990-2001. Samples collected during 1988-1989 are not to be included because the gear were tethered from the boat. There is some talk of using hook and line from the inshore index during 1980-1987.

Florida trap, Blackfish trap, chevron trap and hook and line gear have been the dominant gear types used by MARMAP since 1978. Florida trap, blackfish trap, and hook and line gear had been used consistently from 1981-1987. These gear types were used at 13 study areas that included eight live bottom areas ~20 fathoms distributed from Onlsow Bay, NC to Fernandina Beach, FL during 1981-1987. These live bottom areas were sampled with Florida trap, blackfish trap, and hook and line gear. Four shelf edge areas off SC (30 fathoms) were also sampled with Florida trap and hook and line gear during 1983-1987.

All four gear types were fished synoptically from an anchored research vessel during 1988-1989. The MARMAP group decided that these samples should not be used since they represented a methodological change.

From 1990-2001, chevron traps have been deployed from randomly selected stations from south of Cape Canaveral, FL to Cape Lookout, NC. Trapping and hook and line gear has been used inside of 50 fathoms. Three different surveys have been conducted for reef fishes over the years.

Inshore Live Bottom Survey

Conducted with blackfish traps, Florida traps and hook and line gear from 1981-1987 at 13 areas from NC to northern FL.

Shelf Edge Survey

Conducted with Florida traps and hook and line at four locations off SC.

Chevron trap survey

Conducted with chevron traps and hook and line gear at random locations from NC to FL. Approximately 350-400 random stations sampled from a data base of over 2,000 locations from 1990 to present.

Mean CPUE of fish caught with traps or hook and line gear is calculated for each year by species as:

$$Mean\,CPUE\,(no.\ fish\ per\ trap\text{ - }hr.) = \frac{\sum \dfrac{no.\ fish\ caught}{soak\ time\,(hr.)}}{no.\,samples}$$

CPUE is calculated in a similar manner for hook and line gear with the exception that soak time (duration) is multiplied by three for samples taken before 1988 since three individuals fished on a collection. Only one individual fished on each collection from 1988-2001.

Locations for the shelf edge study areas were: 3215, 7909; 3216, 7909; 3222, 7901 and 3226, 7956. The sites are ~ 50 m deep with a bottom type that consists of rock outcroppings and 1-2 m of relief. Locations of inshore index stations were: 3140, 8020; 3230, 7943; 3215,7943; 3255, 7908; 3248, 7938; 3317, 7826, 3251, 7814; 3329, 7815; 3318, 7853; 3340, 7843; 3344, 7717; 3355, 7746; 3409, 7647.

Description of the MARMAP monitoring data set

Included on CD, is a data set in ASCI "CPUE" that includes MARMAP monitoring reef fish data since 1978. The SAS program used to calculate CPUE is:

```
OPTIONS MISSING=' '  NODATE ERRORS=2;
DATA INITIAL; INFILE 'C:\saw\bsb\CPUE' LRECL = 421;
INPUT PID 1-3 COLL 4-9  GEAR $10-12 SPECIES $16-19 EST $29 @23 TOTWGT
6.3NUM 30-34 @35 SUBWGT 5.2 MEAS 40-41 DAY 234-235 MONTH 236-237
YEAR 238-239 VESSEL 244-245 LAT 330-334 LONG 335-339 @287 STRATA
$CHAR4.
DEPTH 367-369 DUR 370-372 CC 377 NAME $385-420
   LEN1 43-45 FR1 46-48 LEN2 49-51 FR2 52-54
   LEN3 55-57 FR3 58-60 LEN4 61-63 FR4 64-66
   LEN5 67-69 FR5 70-72 LEN6 73-75 FR6 76-78

   LEN7 79-81 FR7 82-84 LEN8 85-87 FR8 88-90
   LEN9 91-93 FR9 94-96 LEN10 97-99 FR10 100-102
   LEN11 103-105 FR11 106-108 LEN12 109-111 FR12 112-114

   LEN13 115-117 FR13 118-120 LEN14 121-123 FR14 124-126
   LEN15 127-129 FR15 130-132 LEN16 133-135 FR16 136-138
   LEN17 139-141 FR17 142-144 LEN18 145-147 FR18 148-150

   LEN19 151-153 FR19 154-156 LEN20 157-159 FR20 160-162
   LEN21 163-165 FR21 166-168 LEN22 169-171 FR22 172-174
   LEN23 175-177 FR23 178-180 LEN24 181-183 FR24 184-186

   LEN25 187-189 FR25 190-192 LEN26 193-195 FR26 196-198
   LEN27 199-201 FR27 202-204 LEN28 205-207 FR28 208-210
   LEN29 211-213 FR29 214-216 LEN30 217-219 FR30 220-222 SITE 400;

* NOTE:  If Hnl before 1988 is used, Duration is times three
         since three people fished on a single collection.;
IF CC > 2 OR CC = 0 THEN DELETE;
 IF GEAR='324';
PROC SORT DATA=INITIAL; BY COLL GEAR;
DATA GL; SET INITIAL; BY COLL GEAR;
DROP SPECIES EST TOTWGT NUM SUBWGT;
IF FIRST.COLL OR FIRST.GEAR;
PROC SORT DATA=GL; BY YEAR SITE GEAR;
```

```
PROC MEANS MEAN SUM N STD; BY YEAR SITE GEAR;
 VAR DUR;
OUTPUT OUT=DURATION MEAN = DURMEAN
                     SUM = DURSUM
                       N = DURN
                     STD = DURSTD;
TITLE 'SAMPLING DURATION STATS BY SITE AND GEAR';
PROC SORT DATA=GL; BY GEAR;
PROC MEANS MEAN SUM N STD; BY GEAR;
 VAR DUR;
OUTPUT OUT=DURAT    MEAN = DURMEAN
                     SUM = DURSUM
                       N = DURN
                     STD = DURSTD;
TITLE 'SAMPLING DURATION STATS BY GEAR';
DATA PA272; SET INITIAL;

IF SPECIES='A177' AND GEAR='074' THEN OUTPUT PA272;
IF SPECIES='A177' AND GEAR='324' THEN OUTPUT PA272;
IF SPECIES='A177' AND GEAR='053' THEN OUTPUT PA272;
PROC SORT DATA=PA272; BY COLL GEAR;
PROC SORT DATA=GL; BY COLL GEAR;
DATA PGA272GL;
MERGE PA272 GL; BY COLL GEAR;
IF SPECIES=' ' THEN TOTWGT=0.0;
IF SPECIES=' ' THEN NUM=0;
IF SPECIES=' ' THEN SPECIES='A177';
IF SITE=. OR SITE=0 THEN DELETE;
MNFWT=TOTWGT / NUM;
WTCPUE = TOTWGT / (DUR / 60);
NUMCPUE = (NUM) / (DUR / 60);
* PROC PRINT;
 TITLE 'FISH INFO A177';
* PROC PRINT;
DATA FISH;SET PGA177GL;
PROC SORT; BY SPECIES SITE;
PROC SORT; BY SITE SPECIES YEAR;
PROC MEANS DATA=FISH MEAN SUM N STD STDERR; BY SITE SPECIES YEAR;
 VAR TOTWGT NUM MNFWT WTCPUE NUMCPUE;
OUTPUT OUT=GOOD1 MEAN = WTMEAN NUMMEAN MNFWTMN WCPUEMN NCPUEMN FLTMN
                  SUM = WTSUM  NUMSUM  MNFWTSUM WCPUSUM NCPUSUM FLTSUM
                    N = WTN    NUMN    MNFWTN   WCPUEN  NCPUEN FLTN
                  STD = WTSTD  NUMSTD  MNFWTSTD WCPUSTD NCPUSTD FLTSTD
               STDERR = WTSERR NUMSERR MNFWTSER WCPUSER NCPUSER FLTSERR;
TITLE 'WEIGHT & NUMBER STATS BY SITE GEAR AND SPECIES';

RUN;
```

Output

The excel output looks like the table below.

2001

Variable	Mean	Sum	N	Std Dev	Std Error
TOTWGT	2.562773	676.572	264	5.943315	0.365786
NUM	14.45833	3817	264	33.81832	2.081374
MNFWT	0.233463	21.24511	91	0.129856	0.013613
WTCPUE	1.616105	426.6517	264	3.735217	0.229887
NUMCPUE	8.997636	2375.38	264	20.8851	1.285389

The variables are TOTWGT = total weight, NUM = number, MNFWT = mean fish weight (TOTWGT/NUM), WTCPUE = the cpue of weight, NUMCPUE = number cpue, N = the number of trap sets. Notice that N is lower for MNFWT since that N represents the number of traps that black sea bass occurred in.

The excel file called bsbcpue has the CPUE indices that the group decided should be used for the assessment.

Another excel file is included entitled "length frequency". This file includes a length frequency of the TL (cm) of black sea bass by gear and year for the three CPUE indices.

Data Collection and Processing of Data for Black Sea Bass Life History Studies
MARMAP Life History.doc

Sampling

Since 1979, black sea bass have been sampled with a variety of fishery-independent gear types from Cape Lookout, NC to Cape Canaveral, FL at depth ranging from 11 to 86 m (mean = 27 m). Specimens were collected primarily during May through August of each year. In addition, otoliths and gonads have been collected from black sea bass that were caught by commercial fishermen to help describe the maturity schedule. Fishery-independent data and fishery-dependent data are included on the CD in a file entitled "bsb05.mrg" and bsb50.mrg. Fishery-independent and fishery-dependent data can be separated by the project ID. PID = "105" for fishery-independent data and PID = "150" for fishery-dependent data.

Total length (cm), to the tip of the caudal fin filament, was recorded for all black sea bass collected during 1978-2001 for length frequency. Measurements of black sea bass used for life history studies included TL and SL (nearest mm) and weight to the nearest gram (g). Prior to 1986, all black sea bass caught at sea were retained for life history studies. During 1986-1993, up to 15 fish from each 20 mm SL size class and all fish less than 120 mm SL or greater than 265 mm SL were kept for life history studies during each year. Since 1994, up to 4 individuals from each 20 mm SL size class and all fish less than 120 mm SL and all fish greater than 265 mm SL were retained for life history studies for each cruise. Black sea bass landed by commercial fishers were also obtained, but only to help describe spawning seasonality and validate the periodicity of increments on otoliths.

Aging of Fish

Ages were determined for most specimens collected during 1978-1981. For fish collected during 1982-1998, common sizes were divided into 20-mm SL size classes and 16-26 individuals were randomly selected from each size class. Otoliths were examined from all individuals larger than 200 mm SL or smaller than 120 mm SL. About 400 fish were aged from each year for 1982-1998. The whole left sagitta was placed in water and examined for annuli (indicated by one translucent and one opaque zone) with transmitted light and a Nikon SMZ-2T dissecting microscope. Aging was done by two individuals, independently, without prior knowledge of the size of the fish or date of capture. If readers disagreed on the age after repeated readings, the fish was not included in analysis. Wenner et al. (1986) and Collins et al. (1996) validated the annual nature of increments on black sea bass otoliths from the SAB.

Table. Age frequency of black sea bass caught in Florida Trap, blackfish trap, chevron trap and hook and line gear.

AGE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
f f f	f f f f f f f f f f f f	f f f f f f f f f f f f	f f f f f f f f f f f f f	f f f f f f f f f f f f f
0	3	0.02	3	0.02
1	703	4.83	706	4.85
2	2740	18.84	3446	23.7
3	4706	32.36	8152	56.05
4	3853	26.49	12005	82.55
5	1671	11.49	13676	94.04
6	667	4.59	14343	98.62
7	144	0.99	14487	99.61
8	50	0.34	14537	99.96
9	6	0.04	14543	100

	Mean	N	Std Dev	Std Error
f f	f f f f f f f f f f f f	f f f f f f f f f f f f	f f f f f f f f f f f f f	f f f f f f f f f f f f

3.4059	14543	1.2710333	0.0105397

Reproduction

The posterior portion of black sea bass gonads collected during 1978-1998 was removed, fixed in 10% seawater buffered formalin for 1-6 weeks then transferred to 50% isopropanol for 1-2 weeks. Gonads were processed, vacuum infiltrated, and blocked in paraffin. Three transverse sections (6-8 µ thick) were cut from each gonad with a rotary microtome, mounted on glass slides, stained with double-strength Gill haematoxylin, and counter-stained with eosin-y. Sex and reproductive condition were assessed according to histological criteria for fish collected during 1978-1998. Specimens with developing, ripe, spent or resting gonads were considered sexually mature. Mature females included individuals with oocyte development at or beyond the cortical granule (alveoli) stage and fish with beta, gamma, or delta stages of atresia. Sex and maturity were determined for 24,613 fish that were caught with Florida trap, blackfish trap, chevron trap and hook and line gear.

Description of Black Sea Bass Age, Growth, and Reproduction Data Set

Included on CD, is a data set in ASCI "bsb05.mrg" that has fishery independent data and the data set "bsb50.mrg" that has fishery dependent data. The layout for the data is as follows and can be found in file entitled "sizemat.sas":

```
DATA ONE; INFILE 'C:\BSB\BSB05.MRG' LRECL = 421;
INPUT PID 1-3 COLLNO 6-9 YR 4-5 GEAR 10-12 SPECIES $13-16 SPECNO 17-19
AGE 60-61 TL 72-75 SL 80-83 SEX 95 MAT $96 LAT 103-107 DEPTH 113-115;
```

A description of these data elements follows:
PID = Project identity. "105" - fishery-independent MARMAP data and "150" – fishery dependent data collected by MARMAP.
COLLNO = Collection Number
GEAR = Gear Code (See Table 1).
SPECIES = Species Code. The species code for red porgy is "A272".
SPECNO = Specimen number.
AGE = Age
TL = Total length
FL = Fork Length
SL = Standard length
SEX = Sex (See Table 2). A sex code of 5 and mat = 6 is a transitional individual. Juveniles undergoing transition are 8A.
MAT = Maturity (Table 3).
DAY = Day
MO = Month
YEAR = Year
LAT = Latitude
LONG = Longitude
DEPTH = Depth in meters

Table 1. Gear codes for gear used by MARMAP during reef fish cruises.

014 HOOK AND LINE – Personal
022 ¾ YANKEE TRAWL
041 MINI ANTILLEAN S-TRAP - BAITED
043 SNAPPER REEL, ELECTRIC OR MANUAL, 2 HOOKS
052 MINI ANTILLEAN S-TRAP - UNBAITED
053 BLACKFISH TRAP - BAITED
054 BLACKFISH TRAP - UNBAITED
055 EXPERIMENTAL LARVAL TRAP
056 MINNOW TRAP - COVERED
057 MINNOW TRAP - UNCOVERED
059 FINE MESH TRAP
060 CUBIAN TRAPEZE - 1 X 2M .947MM MESH
061 VERTICAL LONG LINE
073 EXPERIMENTAL TRAP
074 FLORIDA "ANTILLEAN" TRAP
086 KALI POLE STANDARD (MARMAP)
087 BOTTOM LONGLINE
296 25 MM DIA. FILTER
297 THERMISTOR
298 CTD
299 SURFACE HYDRO SAMPLE
300 NISKIN BOTTLES - STANDARD CAST
301 NISKIN BOTTLES - SURFACE AND BOTTOM
305 XBT
324 CHEVRON TRAP (MARMAP)
501 BOTTOM TRIPOD FIXED TV
502 STAT. TV STATION - HORIZONTAL
503 STAT. TV STATION - VERTICAL
504 DRIFT TV TRANSECT - HORIZONTAL
505 DRIFT TV TRANSECT - VERTICAL
506 TOWED TV TRANSECT - HORIZONTAL
507 TOWED TV TRANSECT - VERTICAL
513 PAN & TILT TV

Table 2. Sex codes (After Waltz et al. 1979). Revised June 1997.

Code	
0	Undifferentiated. Germ cells not yet developing.
1	Gonad entirely testicular (Triangular in cross-section).
2	Gonad entirely ovarian (Round or oval in cross-section).
3	Hermaphrodite (simultaneous). Testicular and ovarian tissue at the same maturity stage.
4	Hermaphroditic male. Gonad functionally testicular with some traces of ovarian tissue.
5	Hermaphroditic female. Gonad functionally ovarian with some traces of testicular tissue.
6	Ovarian tissue, but ovary wall not present in sufficient quantity to determine presence or absence of testicular tissue.
7	Testicular tissue, but insufficient quantity to determine presence or absence of ovarian tissue.
8	Immature ovarian tissue undergoing sexual transition. Used only in combination with reproductive state code = A (see P. pagrus).
9	Unknown.

Table 1. Histological criteria used to determine reproductive state in black sea bass *Centropristis striata* from Hastings, 1981; Wallace and Selman, 1981; Hunter et al. 1986.

Reproductive state	Male	Female
Immature (virgin)	Small transverse section compared to resting male. Spermatogonia present but little or no spermatocyte development.	Previtellogenic oocytes only; no evidence of atresia. In comparison to resting female, most previtellogenic oocytes < 80 µm diameter, area of transverse section of ovary is smaller, lamellae lack muscle and connective tissue bundles, lamellae are not as elongate, oogonia more abundant along the margin of lamellae,ovarian wall is thinner.
Developing	Development of cysts containing primary and secondary spermatocytes through some accumulation of spermatozoa in lobular lumina and collecting sinuses near ovarian wall.	Oocytes undergoing cortical granule (alveoli) formation through nucleus migration and partial coalescence of yolk globules.
Running ripe	Predominance of spermatozoa in lobules and collecting sinuses. Little or no occurrence of spermatogenesis.	Completion of yolk coalescence and hydration in the most advanced oocytes. Zona radiata becomes thin. Postovulatory follicles sometimes present.
Developing, recent spawn	Not assessed.	Developing stage as described above plus presence of postovulatory follicles.
Spent	No spermatogenesis. Some residual spermatozoa in lobules and collecting sinuses.	More than 50% of vitellogenic oocytes in alpha or beta stage of atresia.
Resting	Little or no spermatocyte development. Empty lobules and sinuses evident.	Perinuclear oocytes only; traces of atresia. In comparison to immature female, most previtellogenic oocytes > 80 µm in diameter, area of transverse section of ovary is larger, lamellae have muscle and connective tissue bundles, lamellae are more elongate and convoluted, oogonia less abundant along margin of lamellae, ovarian wall is thicker.
Mature specimen, state unknown	Mature, but inadequate quantity of tissue or postmortem histolysis prevent further assessment of reproductive state	Mature, but inadequate quantity of tissue or postmortem histolysis prevent further assessment of reproductive state.
Simultaneous	Presence of distinct ovarian and testicular regions in approximately equal amounts and of the same reproductive state (usually inactive). This gonad structure was observed infrequently.	
Transitional	Proliferation of active testicular tissue (spermatogonia through spermatozoa) within alamellar regions along the inner surface of the ovarian wall in spent or resting ovary.	

Mortality

MortalityEstimates1.doc

Natural Mortality – Black sea bass live for a maximum of 10 years. The group suggested using a M of 0.3. This value was also used by Low (1981) and Vaughan et al. (1995) and is in accord with a maximum age of 10. The group agreed with the range of M = 0.2 and 0.4 that was used by Vaughan et al (1995).

Release Survival – Release survival for black sea bass is estimated to be 85% at 20-23 m; 88% at 29-35 m; and 61 % at 43-55 m for fish that have not had the air released from the swimbladders. The group recommended using a release mortality of 15% with a range of 10-20 %.

Citation

Collins, M.R. J.C. McGovern, G.R. Sedberry, H.S. Meister, and R. Pardieck. 1999. Swim bladder deflation in black sea bass and vermilion snapper: potential for increasing postrelease survival. N. Am. J. Fish. Manage. 19:828-832.

Low, R.A., Jr. 1981. Mortality rates and management strategies for black sea bass off the southeast coast of the United States. N. Am. J. Fish. Manage. 1:93-103.

Vaughan, D.S., M.R. Collins, and D.J. Schmidt. 1995. Population characteristics of the black sea bass *Centropristis striata* from the southeastern U.S. Bull. Mar. Sci. 56:250-267.

Black Sea Bass Tagging Information

Total tagged and recaptured during 1993-2001. Includes fish recaptured by MARMAP.

No. Tagged	No. Recap
12,519	926

Data for black sea bass tagged at Gray's Reef during October 1993, 1994, 1995, 1999, 2000, 2001. Recreational recapture data include # recaptured during the first 6 months after tagging (October-April) and the second six months after tagging May-October.

			Recreational Recaptures	
Year	**# Tagged**	**# recap by MARMAP**	**# rec Oct-Apr**	**# rec May-Oct**
1993	786	55	27	6
1994	1677	73	22	4
1995	1971	115	16	2
1999	2131	192	48	17
2000	1224	147	49	11
2001	1704	83	21	6

Total mortality (Z) from tag recaptures reported by recreational fishermen can be estimated by the equation: $Z_i = -(\log_e R_2 - \log_e R_1)$ where R_1 = the number of fish that were recaptured six months (through April) following a tagging event in October of year i and R_2 = the number of fish that were recaptured after April following October tagging in year i.

Growth rate was determined by (recapture TL = Tagged TL)/ # days at large. Growth from tag recaptures = 0.21 mm/d.

SECTION VII.

Reports to the CIE by the CIE appointed reviewer and chair.

(exclusive of appendices duplicating material already enclosed)

Report from the Chair

of the

Second South East Data, Assessment, and Review (SEDAR) Peer Review Panel Workshop

held at the

Holiday Inn-Brownstone Hotel,
1707 Hillsborough Street, Raleigh, NC 27605

on

February 25 to 28, 2003

Norm Hall
Murdoch University, Western Australia, Australia
March 2003

Synopsis/summary of the meeting

The SEDAR Review Panel met at the Holiday Inn-Brownstone Hotel, 1707 Hillsborough Street, Raleigh, NC 27605, from February 25 to 28, 2003. The purpose of the meeting was to review the stock assessments that had been undertaken for the vermilion snapper and black sea bass stocks that lie off the south eastern coast of the U.S. The Statement of Work to be undertaken, which describes the terms of reference for the Review Panel, is presented as Appendix 1.

The 2nd SEDAR Review Panel comprised Dr Jon Volstad (CIE, Maryland), Dr Liz Brooks (NMFS SEFSC), Gary Shepherd (NMFS NEFSC), Gregg Waugh (SAFMC), Mark Marhefka (Snapper Grouper Advisor Panel, vermilion snapper), Jodie Gay (Snapper Grouper Advisor Panel, black sea bass), Dr Michelle Duval (NGO/SSC Representative, NC Environmental Defense), and Douglas Gregory (SSC Representative, Florida Sea Grant) and was chaired by Dr Norman Hall (Murdoch Univ., Australia/CIE).

A list of the assessment reports that were reviewed and discussed by the SEDAR Review Panel is presented in Appendix 2, together with details of other background documents that were made available to the Review Panel. The reports of both the vermilion snapper and black sea bass assessments were introduced by Dr Jim Berkson, who chaired the Data and Assessment workshops, and who presented the Review Panel with an overview of the outcomes of these workshops. Details of the stock assessment of the vermilion snapper fishery were presented by Dr Erik Williams, while Drs Doug Vaughan and Kyle Shertzer reported on the assessment for black sea bass.

The overall conclusion of the Panel was that the assessments had been undertaken very competently, and the Panel acknowledged the efforts of those concerned in the Data and Assessment Workshops and in the model development and exploration.

The draft reports arising from the Second SEDAR Review Workshop are included as Appendices 3 and 4.

A summary of the issues that were discussed for each fishery is presented below.

Vermilion snapper

1. Detail in the assessment reports

   The Review Panel found that, in many cases, the descriptions presented in the assessment report did not record detail that would have assisted in the review. For example, while the assessment report provided details of the range of values of natural mortality that had been accepted at the Data Workshop for use in the assessment, no details were provided of the evidence or studies that had resulted in such estimates. The reasoning at the Data Workshop that had led to the selection of the particular range of values was not reported in the Assessment Report. In such cases, the Review Panel was unable to determine from the Assessment Report alone whether the decision or assumption that had been made was appropriate, or whether the values that had been selected for use were adequate. Fortunately, the presenters were able to advise on many of the missing details.

2. Adequacy of data

Details of the methods that had been used to collect much of the data, and to process them after collection, were not presented in the assessment. Moreover, a detailed evaluation of the coverage, accuracy and precision of the data, with respect to the stock, was not presented in the assessment report. Thus, in determining whether the data were likely to be representative of the stock as a whole, or only of a specific spatio-temporal component of the stock, the Review Panel relied on comments from the various experts present at the Review Workshop (in particular, Dr Pat Harris and Ms Jennifer Potts).

As tables of data had not been presented in the assessment reports, it was not possible for the Review Panel to undertake any exploratory analysis of their own. It would be useful for future reviews that both figures and tables are provided. In particular, it would be valuable to list, in tabular format, all values that were used as input to the models. This would allow the Review Panel to explore these data and to determine whether the results of the models appeared consistent with results from other simple approaches.

The assessment was constrained by the lack of consistent, long-term time series of abundance indices, and in particular, by the lack of a long-term fishery independent series. The index that had been derived from the headboat data appeared likely to be very influential in the assessment, due to its long-term nature. While indices of abundance derived from commercial fisheries data would have been useful, it is likely that they would not have contained a great deal of information. The reason for this is the fact that the commercial fisheries data are unlikely to provide a time series of sufficient length, and thus may only provide information on recent trends. However, it is important that future assessments should attempt to include these data and to ensure that any information contained in the data contributes to the results of these assessments. The adequacy of the coverage of the fishery by the various data sets was an issue with which the Review Panel grappled. It was concluded that there would be value in reviewing the various sampling and data collection regimes to determine how these might be extended to provide data that were more likely to be representative of the stock.

3. Adequacy of models

The models, which had been applied by the Assessment Workshop, appeared appropriate. However, the fact that it was not possible to fit the production model signaled that there was insufficient information present in the abundance indices to determine the magnitude of the biomass with any precision. When the length composition data were added, it became possible to fit a length-based model. However, the resulting biomass estimates for this new model were very dependent on the values of natural mortality and steepness of the stock-recruitment relationship, which had been input. While biomass estimates were still uncertain, estimates of fishing mortality appeared more consistent over the different sets of natural mortality and steepness parameters.

On further consideration, following the meeting, I believe that this result arises because estimates of total mortality are being derived from the information contained in the declining right-hand limbs of the length composition data and thus are relatively well determined. However, because of the lack of information in the abundance indices, the model appears to rely strongly on the values of the parameters that had been input for natural mortality and steepness when estimating the magnitude of the current biomass. For such data, when the model is used to estimate the steepness of the stock-recruitment relationship, the tendency is usually that the steepness estimate will approach unity, or a high value, thus predicting approximately constant recruitment. For such data, it is important that attempts should be made to estimate uncertainty in parameter estimates and outcomes. For the assessments reported by the Assessment Workshop, uncertainty in input values (natural mortality and steepness) had been investigated in the various sensitivity runs, but, because of the large number of parameters in the length-structured model, no attempt had been possible to explore the uncertainty of estimation. There would be value in considering the development of a simpler length-structured model, with fewer parameters, in order that the uncertainty associated with parameter estimation can be explored.

Considerable uncertainty existed in the estimates of biomass and of the biomass-based reference points, and results from the different sensitivity runs were scattered widely over the phase plot. For low values of natural mortality and steepness, the stock would appear to be severely overfished, while for higher values of natural mortality and steepness, and for the estimate that arose from the base run, the stock appeared not to be overfished. Weights had been assigned by the Assessment Workshop to the different sensitivity runs, but the Review Panel recognized that these were arbitrary. The Panel grappled with the issue of whether all of the sets of steepness and natural mortality were appropriate for use, both during the Workshop and afterwards, during an email discussion. Eventually, the Panel concluded that the lower values of natural mortality and steepness were unlikely, and thus they based their assessment of the state of the stock on those sensitivity runs that appeared more appropriate, concluding that the stock was not overfished. However, the wording of the Assessment report was phrased to communicate the uncertainty associated with the estimates of biomass and biomass-based reference points.

4. Adequacy of projections

The methods used for the projection appeared adequate. However, as a consequence of the period from which recruitment estimates were sampled, a slight upward trend was apparent in the average predicted biomass. This appears due to slightly higher than average recruitment being estimated for the period from which the future recruit levels were sampled. Furthermore, this was in spite of the fact that the fishery was assessed to be experiencing overfishing, and despite the fact that the current level of fishing mortality was being used for the projection. On considering this subsequent to the meeting, it is possible that this result also stems partly from the uncertainty that surrounds the estimate of current biomass.

5. Research recommendations

The research recommendations were focused on studies that would improve the quality of the data and by which a longer time series of fisheries independent data might be recovered from the existing data sets. There was a need to analyze the data from the commercial fishery, as this sector believed that their data would be valuable and should be considered in future assessments. Lack of information on the quantity and size/age composition of discards, and of their mortality following release, were also seen as necessary subjects for future research.

Black sea bass

1. Detail in the assessment reports

The assessment report for the black sea bass suffered from the same deficiencies as that for vermilion snapper, in that the descriptions in the Assessment Report lacked sufficient detail.

2. Adequacy of data

Similar problems arose for black sea bass as for vermilion snapper. Here the problem of coverage was associated with the MARMAP study being undertaken at times and locations that might not have recorded the abundance seen by the commercial fishers. Again, commercial fishers were concerned that their logbook and other data were not included as time series in the assessment. Moreover, the commercial fisher on the Review Panel considered that, based on his and other fishers' observations, the abundance had not declined to the extent shown by the headboat index. The Panel considered this issue and acknowledged that the use of GLM to adjust the data for factors such as time and space was appropriate and should remove the impact of any change in the spatial or temporal distribution of fishing by the headboat sector of the fishery. However, further review of these data would be useful to determine whether more subtle factors, such as targeting of different species, were influencing the trend shown by this index. The Panel noted that the effects of increasing fishing efficiency, arising from introduction of technology such as GPS or improved sounders, had not been included in the assessment. It would assist greatly if a longer-term time series could be recovered from the fishery-independent data. The magnitude and composition of the discards from the different fishing sectors, and the release mortality associated with capture and discard, were areas in which the data could be improved.

3. Adequacy of models

   The question was raised as to whether production models would be adequate if applied to a protogynous species such as the black sea bass. The Panel believed that this issue required further research, and set aside the assessment results based on the production model. However, the Panel accepted the age-structured model as an appropriate tool for assessment. They expressed concern regarding the variable that should be used as a measure of spawning potential, and whether this should be based on total or female only biomass. The Panel decided that, for the current assessment, total biomass should be used as the measure from which the status of the stock might be determined.

   The model fit was accepted and the assessment of the status of the stock appeared sound.

4. Adequacy of projections

   The Panel considered that the methods used to project the fishery forward in time were appropriate.

5. Research recommendations

   Similar research recommendations were made to those for vermilion snapper. However, as identified above, the issue of protogyny was of concern for both the production model and for the selection of the variable to be used as a measure of spawning potential in the stock assessment. The point was raised among the Panel that, although the biological process of sex change may be recognized in fishery models, there is little understanding of the behavioral dynamics of the species and of whether change in the sex/size/age composition of the stock is likely to affect the spawning potential of the stock. Although given a low priority, this was considered a useful subject for research.

The meeting process

This workshop represented only the second such cycle of the SEDAR process, and, to some extent, the form of the process is still being developed. However, it was pleasing to note that, in the Statement of Work, a very clear instruction had been given to the Review Panel concerning its responsibility not to undertake or request new assessments at the meeting. Clearly, the results from such assessment would not have received the same level of scrutiny and review as results that had been produced and reviewed in the SEDAR process and would not satisfy the requirements for an open and transparent process.

It would be extremely useful if, as in the case of the SARC reviews for the North Eastern Fisheries Science Center, at future meetings,

1. The organizing committee would supply a rapporteur to record the discussion arising from the presentation of each stock assessment;
2. The Assessment Workshop would produce a first draft of the Advisory Report on Stock Status for each fishery, based on their findings from the assessment;
3. A "SEDAR Leader" would be appointed from among the Review Panel (other than the Chair) for each fishery that is being assessed. This Leader would be responsible for using the rapporteur's notes of the Panel's discussion to produce a first draft of the section of the Consensus Assessment Report concerning the fishery, and to modify the initial draft Advisory Report on Stock Status for the fishery, thereby producing a modified draft that could be considered by the Review Panel as a group.

These modifications to the process would aid the operations of the Review Panel considerably. It is essential that such drafts of the final reports should be available for consideration by the Panel as soon as possible after the presentations regarding each assessment and its associated discussion. It would be ineffective for the Panel to produce those initial draft reports, as these are more effectively produced by an individual before being discussed by the entire Panel.

Discussions at the Review Panel Workshop were open, with participation from both the Panel and other attendees. Thus, the meeting was inclusive and allowed issues to be raised by all present and considered by the Panel. The final decisions on the statements included in the Advisory Report and Consensus Report were made by the Panel Members alone. As a consequence of the open discussion, I believe that the Review accomplished its purpose of a full and transparent review of the assessments.

The materials arrived in time for review. However, as indicated in the Reports and in the discussion above, greater detail would have been desirable.

Drs John Merriner, Mike Prager and Jim Berkson provided invaluable advice regarding the form of the outputs that they sought from the meeting but, of course, left the content to the Review Panel's determination. The intent of the final reports from the meeting was not to duplicate the Assessment Reports that had been produced by the Assessment

Workshop, but to provide an informed evaluation of the methods used and conclusions that had been reached, in order to provide an interpretation of the assessments that might assist the Council.

Other observations

While much of the email discussion concerning the Reports from the Review was focused on editorial comment, the issue of whether or not the vermilion snapper stock was overfished received a reasonable amount of consideration. Such discussion is hidden from the public view as it occurs in a non-transparent forum. The question rises as to whether a mechanism needs to be developed that would provide an open forum for this portion of the process?

Acknowledgements

The success of the meeting was due, in no small part, to the members of the Data and Assessment Workshops, who produced the reports which provided the background for the assessment, to the presenters, Drs Erik Williams, Doug Vaughan and Kyle Shertzer, to the attendees, in particular Dr Pat Harris and Ms Jennifer Potts, and to the members of the Review Panel. Participation in both the meeting and email discussions was strong, and all participants are thanked for their contribution.

Report on the 2003 South East Data, Assessment, and Review (SEDAR) Workshop to Review the Assessments of the Status of the Stocks of Vermilion Snapper and Black Sea Bass from the South east of the U.S.

By

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Executive Summary

The SEDAR II panel review workshop on vermilion snapper and black seabass assessments was competently chaired, and conducted in a spirit of cooperation and teamwork. The assessments, conducted by outstanding stock assessment biologists, were subject to a rigorous and very open peer review process that identified the most likely sources of uncertainty. It was agreed that the assessments were based on appropriate assessment models and used the best available data. However, several potential sources of bias and uncertainty in these data were identified during the review. Uncertainty in the stock assessments relate to the extensive dependence on fisheries-dependent indices of abundance, incomplete spatial coverage, and poor information about discards. Improved monitoring of the stocks will require adequate data on discards from all fishery segments.

The assessment of vermilion snapper was appropriately based on a forward-projecting length-structured model because of limited age sampling of the catches for this species, and bias in available data on age composition from fisheries-dependent samples. Assessment results for this species are uncertain, but indicate that overfishing is occurring but that the stock probably is not overfished now. There is major uncertainty in determining whether or not the stock is overfished because no reliable functional stock-recruitment relationship could be established based on available data. In addition, the estimated abundance indices used in the assessment of vermilion snapper are based on a limited spatial coverage that does not fully reflect the entire stock.

The stock assessment of black seabass was based on an age-structured forward projection model. Results based upon the best available data used in the assessment documents that overfishing is occurring and that the stock is overfished. The spatial coverage of survey data for this species was substantially better than for vermilion snapper. It is recommended that fishery independent sampling be expanded to improve the reliability of stock assessments for both stocks. In addition, improved assessments and monitoring of stock status will require more and improved data on discards.

1. Background

The South East Data, Assessment, and Review (SEDAR) process is a new program that is part of the NMFS- Southeast Fisheries Science Center's program for quality control and assurance of stock assessments in the South East region. The SEDAR is a process conducted by the South Atlantic Fisheries Management Council (SAFMC) in close coordination with NMFS and the Interstate Commissions to ensure the scientific quality and credibility of stock assessments, and to assure that they continue to support effective fishery management. The SEDAR process comprises a Data Workshop, an Assessment Workshop, and a Stock Assessment Review Workshop conducted in sequence. The SEDAR II review panel workshop for black seabass (the component of the stock south of Hatteras, NC) and vermilion snapper stock assessments was held in Raleigh, NC at the Holiday Inn Brownstone Hotel from February 25 to 28, 2003. I agree with the findings and recommendations that are detailed in the SEDAR II workshop review panel consensus and advisory reports. In this report, I evaluate the review process, and briefly summarize the findings and recommendations, with focus on my experience as a reviewer on the panel. This report should be read in conjunction with the two reports prepared by the review panel.

2. Description of Review Activities

The SEDAR Review Workshop to review stock assessment of vermilion snapper and black seabass was chaired and facilitated by Dr. Norman Hall in a very organized and effective manner, and was conducted in a spirit of cooperation and teamwork. Assessment Workshop reports for the two stocks under consideration, vermilion snapper and black seabass, were made available for review a few days before the meeting. During the SEDAR II meeting, each stock assessment was presented by the responsible assessment expert, and reviewed by the panel. The 12-member review panel represented a broad area of expertise in fisheries, and included participants from the:

- NMFS-Southeast Fisheries Science Center
- NMFS-Northeast Fisheries Science Center
- South Atlantic Fisheries Management Council
- Snapper/Grouper Advisory panel
- Non-Government (NC Environmental Defense)
- Center for Independent Experts (chair and reviewer).

Review activities during the workshop involved panel discussions on assessment validity and results, and the development of consensus recommendations and conclusions following the presentation of assessments for each stock. Mr. Greg Waugh, a panel member from the SAFMC, did an excellent job documenting the consensus review comments for inclusion in the reports authored by the panel. The reviews focused on the evaluation of the adequacy and appropriateness of:

- Fishery-dependent and independent data used in the assessment (i.e. was the best available data used in the assessment);
- Application of models used to assess these species and to estimate population benchmarks (MSY, Fmsy, Bmsy and MSST, i.e. Sustainable Fisheries Act items);
- Models used for rebuilding analyses.

During the week following the review meeting, the entire panel took part in the development of the two summary reports by providing input, and by reviewing comments from fellow panel members. Dr. Norman Hall did an outstanding job leading this inclusive process.

2.1. Input-Data

The CIE reviewers did not receive the CD documenting the Data Workshop, and thus the evaluation of the quality of input-data relied entirely on the brief descriptions in the two stock assessment reports, and verbal information provided by the presenters of the stock assessments and by support staff and other attendees. The available information was not sufficient for a comprehensive review. The panel focused on the accuracy and reliability of input-data, and sought information about the availability of additional data that potentially could be used to enhance the stock assessments. Receiving special attention were potential effects related to gear catching efficiency and selectivity, and the spatial and temporal coverage of fisheries-dependent and fisheries-independent (i.e., MARMAP) data used to derive abundance indices and to estimate catch and its characteristics over time.

2.2. Assessment and Projection Models

The models and their specifications were only evaluated in general terms because the technical descriptions of the model structures provided in the assessment reports were sketchy and insufficiently complete for a thorough review. The Review Panel relied heavily on the information provided in the verbal presentations. The appropriateness of the models was evaluated by taking into account the life history and type of data available for each species. The evaluation of projections focused on the likelihood and range of input parameters applied.

3. Summary of Findings

The panel documented its review findings in a Peer Review Panel Consensus Report that includes detailed comments on the individual species assessments and the Panel's findings on the status of the stock and the fishery. The panel also co-authored a Summary Stock Status Report in support of the Fisheries Management Council. I agree with these findings and recommendations, which also incorporated all my input. In the following, I will add some comment about the review process.

In my opinion, this second SEDAR review process clearly supports the Council's objective to continually improve the quality of stock assessments and their relevance to support sound fishery management. The review process was open, and the assessment scientists from the agencies did a great job presenting the assessments to the panel. The panel members had broad and complimentary expertise that covered all the review subjects. The panel greatly benefited from the input from the meeting support staff and other attendees, throughout the review process.

One criticism I have is that the two stock assessment reports that formed the basis for the review provided limited details on the input-data and model specification. I recognize that the stock assessment scientists responsible for the Assessment Workshop reports may have had insufficient time to fully document the methods. However, due to this lack of documentation, the Review Panel was limited to base much of their evaluation on the information provided in the verbal presentations.

It is possible that the detailed descriptions sought by members of the Review Panel are presented in the reports of the Data workshop. However, this information was not made available for the review panel meeting, but should have been.

The data collections to estimate the characteristics of commercial catches were not sufficiently documented to evaluate if catches from different spatial or temporal zones, or from different fishing sectors, have been representatively sampled. Also, information on the sampling intensity by fishing sectors, and the method for combining various catch samples across sectors, is insufficient to evaluate their adequacy and appropriateness.

4. Conclusions and Recommendations

The NMFS assessment scientists and supporting staff did an outstanding job presenting the assessment results, and were very helpful throughout the review meeting by answering questions related to the panel's interpretation of the available data and results. The effectiveness of the review process was substantially enhanced by the contributions from the Assessment Workshop/Review Panel Support Staff and from the South Atlantic Fisheries Management Council Staff and sub-committee members. In most cases, this diverse group of fisheries experts could clarify issues related to assessment models and the available input-data. Although the descriptions in the assessment reports of the model specification and methods used to collect and to analyze the data used in the assessments were not sufficiently complete for a thorough and comprehensive technical review, I feel that the stock assessments were based on suitable methods and the best available data. I support the conclusions and recommendations presented by the review panel in the Second SEDAR assessment consensus report, and will only highlight a few issues here.

I strongly recommended that the assessment reports for future stock assessments include more detailed descriptions of the methods of data collection, analysis, and the use of these data for stock assessment. It is recommended that the assessment reports for future stock assessments include detailed descriptions of the methods of data collection, analysis, and the use of these data for stock assessment. Sufficient details of the methods of data collection should be provided to allow the Review Panel to assess the extent to which catches from different spatial or temporal zones or from different fishing sectors have been representatively sampled, how the various samples are combined, and the sampling intensity that has been applied to the different sectors. Minimum levels of sampling intensity and spatio-temporal coverage to achieve acceptable precision for key population parameters should be specified by during the Data and Assessment Workshops, and those sample sizes should be increased if the sampling intensity should fall below this minimum level. The sampling designs of the various data collection methods should be reviewed for statistical adequacy (sampling intensity and spatio-temporal coverage). It is possible that this was addressed in the Data Workshop. If so, I recommend that this also be summarized in the assessment workshop reports for completeness.

Abundance indices and estimates of population characteristics from fisheries-dependent data currently provide essential information for the assessments of Vermillion snapper and black seabass. Commercial catch-per-unit-effort (CPUE) statistics should be used cautiously to track changes in the stock over time. Fishermen often have the ability to locate areas of high local abundance even when overall stock size is low, and concentrate their fishing effort there. The fisheries literature contains substantial evidence that fishery-dependent indices of abundance can at times underestimate the degree of decline in a stock because they do not follow a simple linear relationship with stock size. By targeting local concentrations (patches) of fish that they find based on their expert knowledge, fishers can often maintain a relatively high catch per unit effort even when the overall abundance is in decline. This is especially the case for species that aggregate in structured habitats (e.g., reef fish), or schooling fish that can be located by sophisticated acoustic fish finding equipment. This is one major reason that CPUE often fail to track the true status of the stock for wide variety of fisheries, as documented by Gunderson (1994) and numerous references therein. Ulltang (1996) shows dicrepancy between VPA and fisheries-independent abundance indices from trawl and acoustic surveys. Pennington and Strømme (1998) discuss the case of Newfoundland Cod, which is one of the gravest examples, and show how CPUE from the commercial fishery indicated a stable stock while the true abundance was declining towards a collapse (the fisheries-independent abundance indices from trawl surveys showed a declining trend during the same period). This has also been observed for logbook data (Baum et al. 2003).

Well-designed fisheries-independent surveys tend to track trends in fish abundance more accurately because they sample habitats and density levels in proportion to their aerial extent. For such reasons, the fisheries-independent data should receive higher weighting as the time series increases. I strongly agree with the panel's proposal that MARMAP conduct a synoptic study of their gear to provide a basis for comparing relative gear efficiencies. This would allow a long time series of fishery-independent abundance indices to be developed. Over time, it is strongly recommended that the assessment assign more weight to fisheries-independent survey indices from the MARMAP program. MARMAP should also be expanded into deeper water to improve the spatial coverage of the stock.

Although fisheries-dependent data have limitations with respect to tracking of trends in abundance, it is recommended that commercial logbook data be evaluated for inclusion as auxiliary information in stock assessments. Their extended use could help build trust with the fishing industry, and could potentially improve stock assessments by providing information about discards, and improving the spatial and temporal coverage of catch data. The usefulness of incorporating catch data from logbooks could potentially be evaluated through a pilot study that applied survey sampling to select a representative sample of logbooks. This could be a cost-effective way to determining whether it is possible to develop a reliable fishery-dependent index of abundance from such data.

The age-based forward projecting method is particularly sensitive to inaccurate information on catches at age, for example related to limited sampling coverage (spatially and temporally) of landings, and unreported discards. If feasible, I recommend that the variability in assessments caused by sampling variability in estimated landings in number by age be evaluated, for example by applying bootstrapping to port sampling data in connection with the model runs. Also, biased assessments (of unknown magnitude) could occur when multiple survey indices are used for "tuning", especially if they are assigned equal weights (during periods of overlap), regardless of spatial coverage and precision. Such bias can be severe when some surveys only cover a limited fraction of the distribution area of a species. One way to reduce or eliminate such bias is to combine the respective survey estimates by using a composite estimator that applied weights that depend on coverage and precision to each abundance series, and then apply the combined series in tuning the model. Additional post-stratification might be appropriate when surveys overlap in sub-area. Examples of the combination of multiple indices are presented in Korn and Graubard (1999) and Vølstad et al. (2003).

The current stock assessment models for vermilion snapper and black seabass apply a large number of parameters that are difficult to track. The external analysis of multiple survey indices of abundance might provide a better understanding of the input data, make the weighting more transparent, and result in a more parsimonious stock assessment model.

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