SEDAR

Southeast Data, Assessment, and Review

Complete Assessment and Review Report

of

South Atlantic Vermillion Snapper

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

SEDAR2-SAR2

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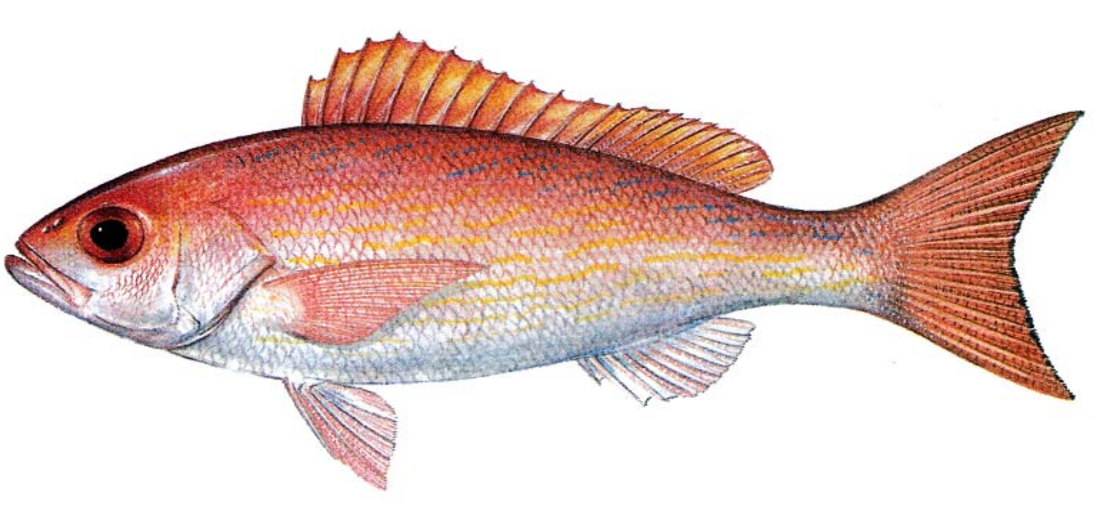
Report of Vermilion Snapper Assessment Workshop

Second SEDAR Process

Beaufort, North Carolina

January 6-10, 2003



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Executive Summary

The SEDAR stock assessment workshop (AW)[1] was convened by the South Atlantic Fishery Management Council and the NMFS Southeast Fisheries Science Center at the NOAA Center for Coastal Fisheries and Habitat Research, Beaufort, North Carolina on Monday, January 6. The workshop's objectives were to conduct an assessment of the vermilion snapper, *Rhomboplites aurorubens*, stock of the southeastern U.S. and to conduct stock projections based on several possible management regimes (terms of reference, Appendix A). Participants in the workshop (Appendix B) included state, federal, and university scientists, as well as observers from the Council. The AW worked at Beaufort until January 10 and continued its work by email through February 14. All decisions regarding stock assessment methods and acceptable data were made by consensus of participants.

Available data on vermilion snapper included abundance indices and recorded data on landings, including size and age compositions of some landings and indices. Four abundance indices were developed by the preceding data workshop: one from the NMFS headboat survey and three from the SC MARMAP fishery–independent monitoring program. Landings data were available from all recreational and commercial fisheries. Abundance indices showed neither marked increase nor decline during the assessment period (1976–2001).

A forward-projecting model of catch at length was formulated for this stock. Two other models were applied, but neither could provide estimates: a similar forward-projecting model of catch at age and an age-aggregated production model. Consequently, this assessment is based on the catch-at-length model, which was applied in a base run and eight sensitivity runs. The base run estimated that the spawning stock size has increased over the assessment period and that recruitment has been variable, poorly correlated to spawning-stock size, and on average has neither increased nor decreased.

Estimates of stock status from this assessment are quite uncertain. The base run estimated that the stock is not overfished (to use the terminology of the Sustainable Fisheries Act), but most sensitivity runs estimated that the stock is overfished. More technically put, spawning-stock biomass in this assessment was characterized by total egg production $\mathcal{E}$. The base run estimated that the stock status is above $\mathcal{E}_{\mathrm{MSY}}$, and thus above the SFA limit reference point MSST. However, most sensitivity runs estimated that the population is below $\mathcal{E}_{\mathrm{MSY}}$ and also below MSST.

Although still quite uncertain, estimates of fishery status (level of F relative to reference points) were more consistent. All runs estimated that F is excessive by SFA standards (overfishing is occurring). More technically, F was estimated by the base run and all sensitivity runs as substantially above F_{MSY}, and thus also above MFMT, the SFA limit reference point for F.

Stock projections estimated no marked change in stock status or yield with changes in F of $\pm 25\%$. However, given the highly variable recruitment of this stock and the difficulty in estimating reference points, it is difficult to place much confidence in the projection results.

[1]Abbreviations and acronyms used in this report are defined in Appendix C on page 40.

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1 Place, time, and tasks

The vermilion snapper and black seabass stock assessment workshop (Second SEDAR AW)[2] 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 Assessment Workshop (AW) met from 9:00 a.m. on Monday, January 6, to 12:00 noon on Friday, January 10, 2003. The AW continued its work through February 13, aided by e-mail communications. Participation in the workshop (Appendix B) included scientists from the states of Florida, North Carolina, and South Carolina; from NMFS laboratories and offices in Beaufort, St. Petersburg (FL), and Miami; 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 assessments of the stocks of vermilion snapper, *Rhomboplites aurorubens*, and black seabass, *Centropristis striata*, off the southeastern US, and to conduct stock projections under various management regimes (terms of reference, Appendix A). The AW received data and recommendations from the data workshop (DW) convened in October by the Council and the Center. Some of the decisions regarding data made at the DW were refined during the AW. At both workshops, all decisions affecting the assessment were made by consensus of all participants.

This report describes data and analyses for vermilion snapper only.

[2]Abbreviations, acronyms, and mathematical symbols used in the report are listed in Appendix C on page 40.

2 Stock and fishery characteristics

2.1 Natural history

The following description incorporates some material excerpted and expanded from Grimes (1978), Zhao et al. (1997), and Potts et al. (1998).

Vermilion snapper, *Rhomboplites aurorubens*, a small to moderate-sized reef fish, is the most frequently caught snapper along the southeastern United States. The species inhabits depths of 18 to 122 m but is most abundant at depths less than 55 m. This assessment describes the stock off the U.S. Atlantic coast from North Carolina through the Atlantic side of the Florida Keys, including landings from North Carolina (NC), South Carolina (SC), Georgia (GA), and the east coast of Florida (FL). Tagging studies show neither long-range migrations nor extensive local movements (unpublished MARMAP data), and there is no circumstantial or anecdotal information to suggest such movements.

Vermilion snapper is a gonochorist (a species of distinct sex throughout the life span) that spawns from April to September, with peak spawning occurring during July and August. Eggs and larvae are pelagic; however, the length of time before settling out of the water column is unknown. All vermilion snapper are sexually mature by age 2 and total length of 201 mm. Mature gonads were found in 69% of females at age 0, 84% at age 1, and 100% at all older ages.

2.2 Landings

Three major fisheries catch this stock of vermilion snapper: commercial, recreational, and headboat (larger for-hire boats that accept individual anglers and charge per person). Those fisheries were further subdivided for assessment purposes, but are discussed in this section without subdivision (Figure 1). The most common commercial gear

Figure 1. Landings of vermilion snapper, total (a) and by major fishery groups (b–d). Scale expanded for recreational landings in panel (d).

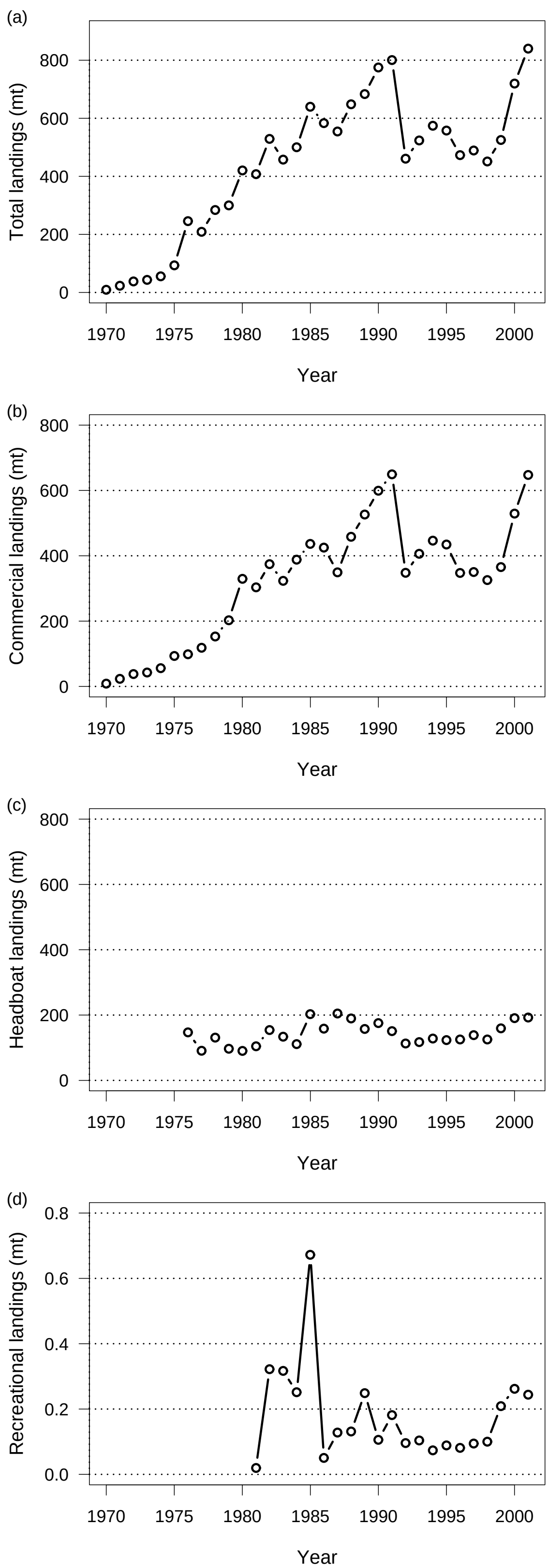


Table 1. Vermilion snapper regulatory history

Period	Amendment	Details
Aug 1983	FMP	4" trawl mesh size to achieve 12" TL minimum size limit
Jan 1989	1	Prohibits trawls
Jan 1992	4	Prohibits fish traps, entanglement nets, and longline gear within 50 fathoms; recreational bag limit of 10 fish per person per day; 10" TL recreational minimum size limit; 12" TL commercial minimum size limit
Dec 1998	8	Limited entry program; transferable permits and 225-pound non-transferable permits
Feb 1999	9	11" TL recreational minimum size limit; vessels with longlines may possess only deepwater species

has been hook and line, with additional commercial landings from trawling. Trawling for vermilion snapper has been banned since January 1989 (SAFMC 1988; Table 1).

The recreational fishery is defined here to include all recreational fishing from private boats and charter boats (for-hire vessels that usually accommodate six or fewer anglers). Recreational fishing from shore does not take vermilion snapper, and any reported landings from shore were considered data errors. The headboat fishery is sampled separately, and for that reason is distinguished here from other recreational fisheries.

Recreational and headboat fisheries, like the commercial fishery, use hook and line gear almost exclusively.

Vermilion snapper landings have increased through the years, but in total have barely exceeded levels seen in the late 1980s (Figure 1a). The commercial fishery accounts for the largest fraction of the landings, with the headboat fishery accounting for about a third of the landings and other recreational fishery components taking very little. This pattern is fairly constant through all years.

The commercial fishery landings have been the most variable through time (Figure 1b). Commercial landings increased from 300 mt in 1980 to over 600 mt in 1991. Landings declined to 375 mt in 1992 in conjunction with the implementation of minimum size limits. Landings rose from about 375 mt in 1998 to greater than 600 mt in 2001. Most (97%) of the fish landed by commercial fishermen were caught by hook and line.

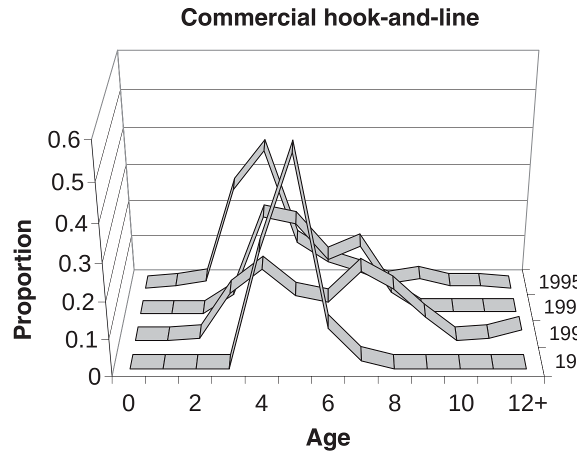
Landings in the headboat fishery exhibit a slight increase through the time series (Figure 1c). Recreational landings (as estimated by MRFSS) are negligible compared to commercial and headboat landings (Figure 1d).

Few sets of age composition data were available for this assessment (Table 2). The age compositions that are available do not show any strong pattern over their limited time spans (Figure 2). Estimated ages were those provided by scientists on the staff of the NOAA Center for Coastal Fisheries and Habitat Research (NOAA Beaufort Lab) and from the MARMAP program.

It appears that the modal length has stayed fairly constant for vermilion snapper landed by the major commercial fishery (Figure 3a). However, the 1992 minimum size regulation of 12" (305 mm) TL commercial and 10" (254 mm) TL recreational resulted in an abrupt cut off in fish less than 280–300 mm TL being landed (Figure 3). After 1992, there was an abrupt decline in the capture of small fish and a shift to a larger modal length (Figure 3).

Figure 2. Age compositions over time from (a) commercial hook and line fishery, (b) headboat fishery.

(a)



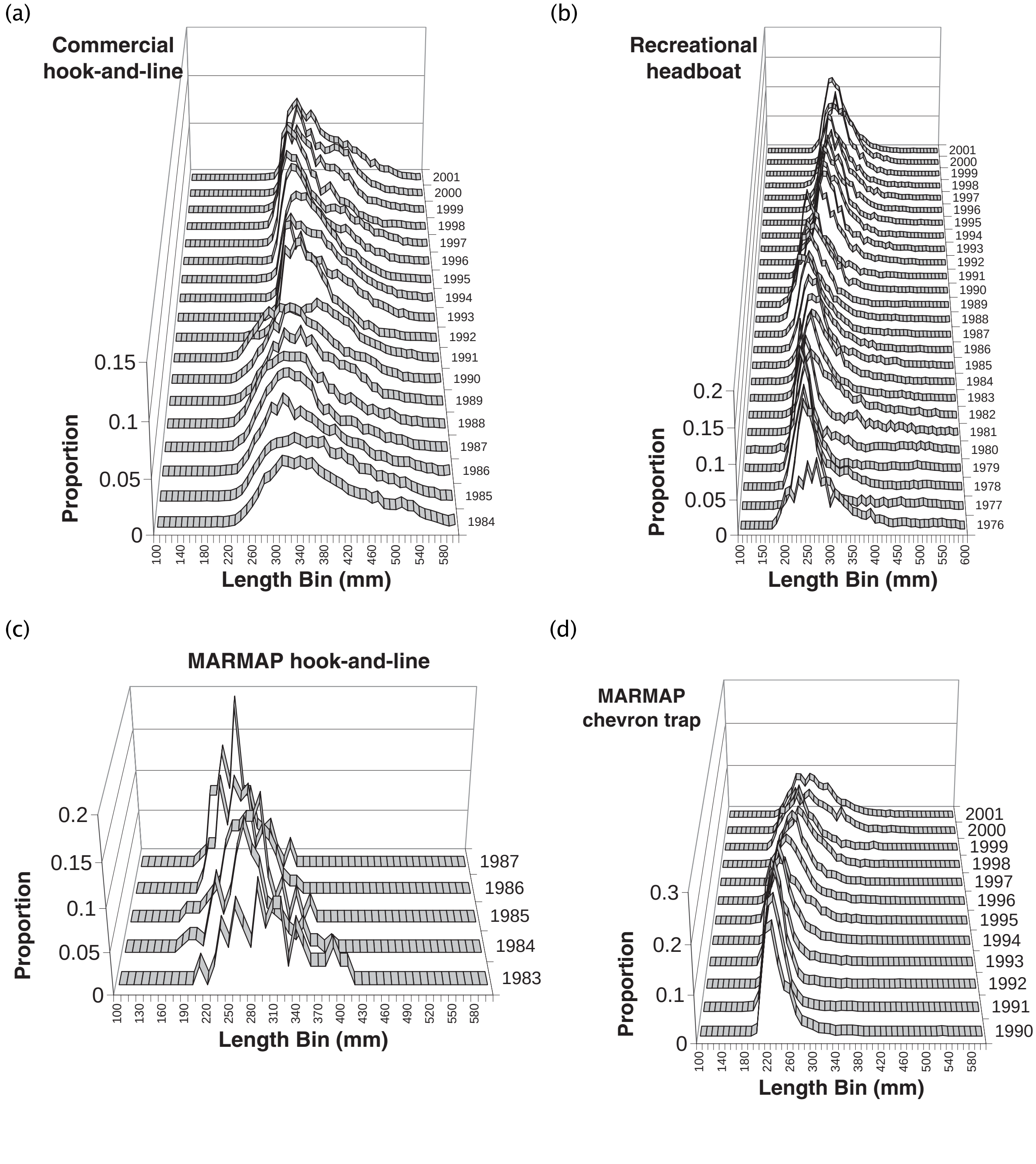
(b)

Length compositions from the recreational fisheries sampled by MRFSS (not shown) are extremely noisy, reflecting relatively low sample sizes of MRFSS. In any event, they would represent an extremely small fraction of the fishery (Figure 1).

Table 2. Sample sizes of length- and age- composition data on vermilion snapper used in this assessment. MARMAP age samples before 1999 were also available, but because of nonrandom sampling, they were not used in the assessment (see §4.1).

	Length samples								Age samples		
	MARMAP			Commercial			Headboat	Recr.	Commercial	Headboat	MARMAP
Year	FL trap	hook–line	chev trap	hook–line	trawl	other	fishery	(MRFSS)	hook–line	fishery	chev trap
1976	—	—	—	—	—	—	1325	—	—	—	—
1977	—	—	—	—	—	—	1038	—	—	—	—
1978	—	—	—	—	—	—	1777	—	—	—	—
1979	—	—	—	—	—	—	1389	—	—	—	—
1980	—	—	—	—	—	—	1348	—	—	—	—
1981	—	—	—	—	—	—	1335	3	—	—	—
1982	—	—	—	—	—	—	2778	22	—	—	—
1983	460	45	—	—	—	—	4482	21	—	—	—
1984	264	130	—	6958	196	16	4545	14	—	—	—
1985	394	91	—	9704	—	96	5894	17	—	—	—
1986	267	106	—	7594	276	669	6160	19	—	—	—
1987	225	122	—	7158	616	157	6327	36	—	—	—
1988	—	—	—	5195	640	434	4759	145	—	—	—
1989	—	—	—	5295	—	330	4768	80	—	—	—
1990	—	—	830	4995	—	1017	5308	66	—	—	—
1991	—	—	3066	9379	—	1454	4029	50	—	160	—
1992	—	—	1514	5915	—	341	2828	114	45	46	—
1993	—	—	1326	7778	—	518	3318	75	168	46	—
1994	—	—	3350	6984	—	508	5724	77	164	252	—
1995	—	—	2495	11850	—	585	4799	74	144	124	—
1996	—	—	2745	6137	—	241	3858	16	—	—	—
1997	—	—	1805	5914	—	261	4133	68	—	—	—
1998	—	—	1240	6178	—	497	4239	76	—	—	—
1999	—	—	735	12274	—	153	4306	194	—	—	386
2000	—	—	1637	18871	—	358	4469	214	—	—	299
2001	—	—	1369	16470	—	1709	3387	400	—	—	350

Figure 3. Length compositions over time from (a) commercial hook and line fishery, (b) headboat fishery, (c) MARMAP (fishery-independent) hook-and-line samples, (d) MARMAP chevron trap samples.

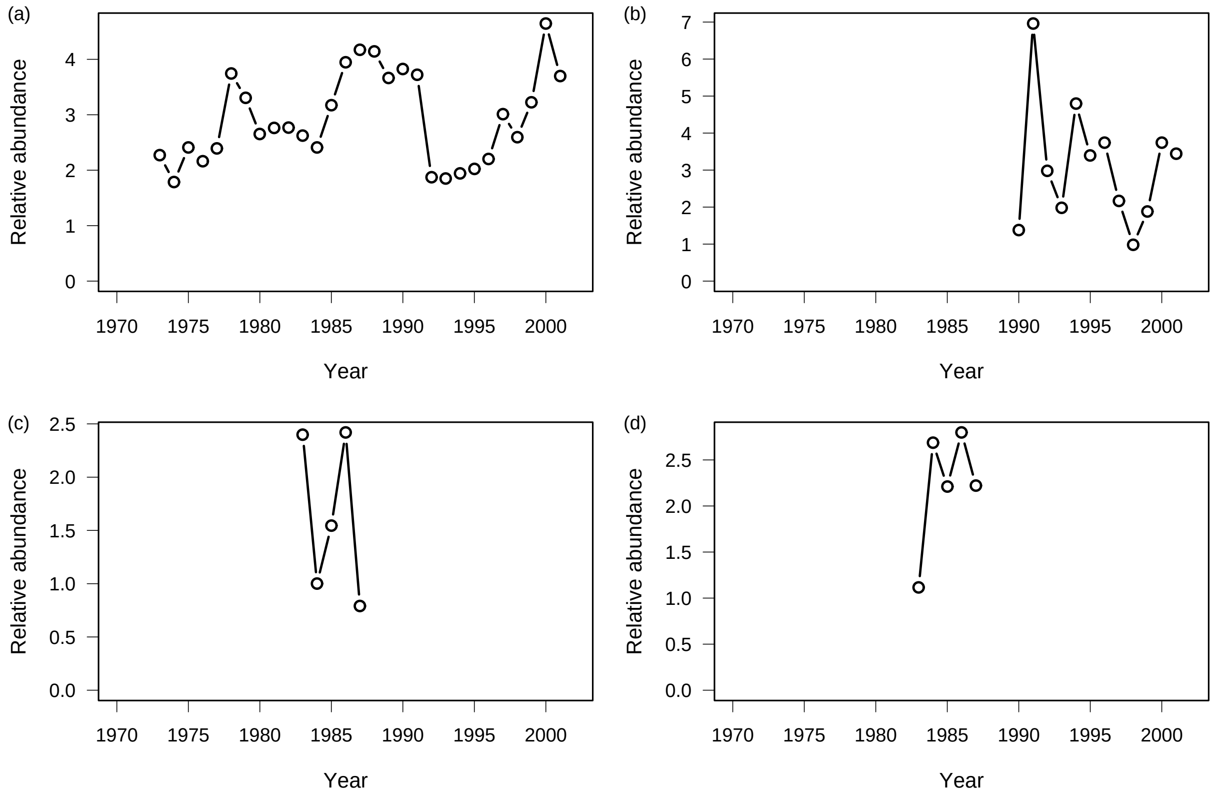


2.3 Relative abundance

This section describes patterns in abundance indices developed at the Data Workshop. Such indices were developed through statistical models described below.

The headboat abundance index shows little change between 1973 and 1984 (Figure 4a). Catch rates are high, 1986–1991, and drop markedly in 1992 with introduction of minimum sizes (Ta-

Figure 4. Abundance indices for vermilion snapper. Panel (a), headboat index; (b), MARMAP chevron trap index; (c), MARMAP "Florida" trap index; (d), MARMAP hook-and-line index.



ble 1). The index then rises steadily from 1992 through 2000, with a decline in 2001.

Several indices are from data of the MARMAP program, and are thus fishery-independent indices of abundance. The MARMAP chevron trap index (Figure 4b) shows similar trends to the headboat index, in that there was an apparent decline in catch rate during the early 1990s, followed by a gradual increase after 1998. The overall picture is one of a population that may be increasing slightly. The MARMAP "Florida" trap and hook-and-line indices (Figure 4c, d) show a good bit of fluctuation during the short time period that they represent (1983–1987).

An additional index of relative abundance was provided by the MRFSS program. However, AW participants decided not to use it because it omits trips with zero catches. This is described in more detail below.

2.4 Ages

Ages were available for 2,891 otoliths from fishery independent sampling and 1,149 from fishery dependent sampling. Estimation of sex composition was based on 4,276 vermilion snapper that were collected by the MARMAP program.

3 Data workshop

Data for this assessment were evaluated, selected, and prepared by a Data Workshop (DW) that met for that purpose during the week of October 7, 2002, in Charleston, SC. Additional questions that arose during initial model development and testing before the AW were resolved at the AW itself. Each working group at the DW made recommendations on data to be used in this assessment. All recommendations regarding the data were made by a consensus of all DW participants. Those recommendations are found in complete form in the documents of the Data Workshop (on the SEDAR 2003 CD-ROM) and are summarized here.

3.1 Findings of life-history and MARMAP working group

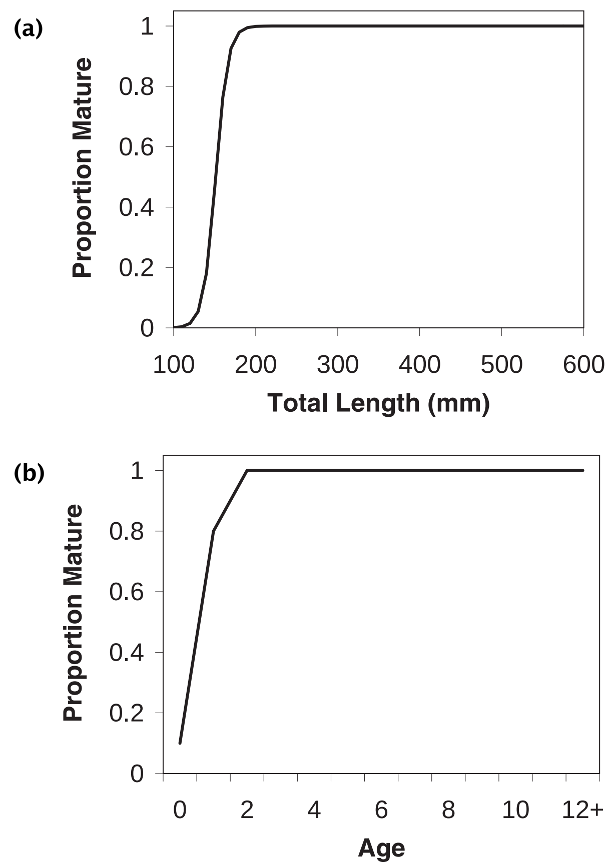
Unit stock The working group agreed that vermilion snapper in the South Atlantic Bight form a unit stock, and recommended that the extent of the analysis should be from the North Carolina coast south through the Atlantic coast of Florida, as described in Section 2.1.

Aging error matrix The group recommended that a number of otoliths be aged both by SCDNR and at the NOAA Beaufort Lab. That would provide an aging-error matrix for use in age- and length-structured assessment models.

Natural mortality rate The working group recommended using $M = 0.25$/yr with a range of 0.2–0.3/yr.

Release mortality Release mortality for vermilion snapper has been estimated at 17% of fish caught at depths of 43–55 m (Collins et al. 1999) and 27% of headboat catches (Dixon and Huntsman, unpublished data). The commercial fishery typically operates at greater depths than the headboat fishery, which the group believes would result in higher discard mortality rates. For that reason and based on the previous estimates, release mortality rates of 40% and 25% were recommended by the group for the commercial hook-and-line and headboat fisheries, respectively.

Figure 5. Maturity of vermilion snapper (a) at length and (b) at age.



Maturity schedules The group recommended data from fishery-independent sampling as the best maturity data available and recommended that they be used in the assessment. Maturity curves (Figure 5) were derived from fishery–independent trawl data. Limited temporal samples did not reveal any time trends, and the group recommended using the same maturity–at–length relationship for all years in the assessment.

Sex ratio A high degree of consistency in sex ratio over time was noted for each gear type. A

Figure 6. Batch fecundity of vermilion snapper at length.

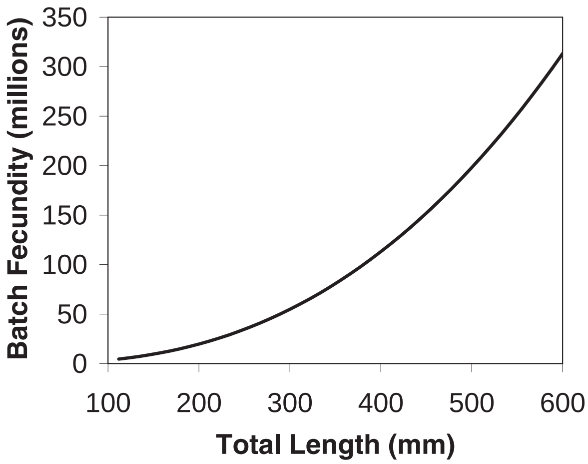
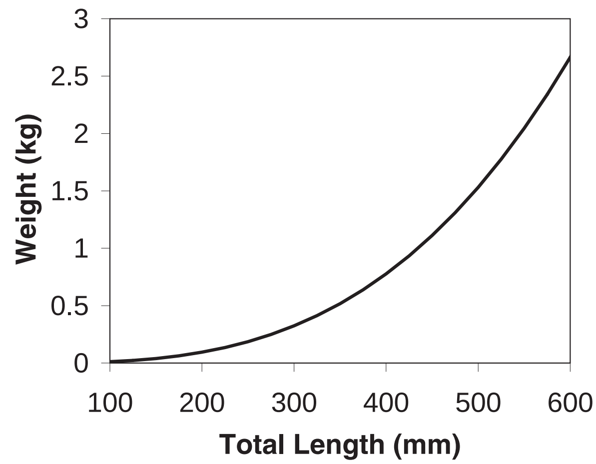


Figure 7. Weight of vermilion snapper at length.



percentage of females between 60–70% was noted by Cuellar et al. (1996). No decision was made about assumptions on sex ratio for assessment purposes.

Spawning–stock size The DW recommended using total population egg production (represented in this report by $\mathcal{E}$) as a measure of spawning–stock size, based on the analysis of Cuellar et al. (1996). Total egg production for this batch spawning species was based on the relationship in Figure 6 and an average annual batch number of 35.

MARMAP catch rates The group discussed fishery-independent indices of abundance that could be obtained from the South Carolina Department of Natural Resources Marine Resources Monitoring, Assessment and Prediction program (MARMAP). MARMAP has conducted reef-fish sampling since 1979.

The data workshop recommended three MARMAP abundance indices for use in the assessment: a "Florida" (snapper) trap index, 1983–1987, a hook-and-line index, 1983–1987, and a chevron trap index, 1990–2001 (Figures 4b–d). An additional abundance index, based on an inshore survey using blackfish traps, was not recommended for use in the vermilion snapper assessment, because vermilion snapper are rarely caught in such traps. The "Florida" trap index is based on sampling at four shelf edge locations (30 fathoms) off South Carolina. The chevron trap index, in contrast, is based on sampling the area off Florida and North Carolina to 50 fathoms. Examination of subsets of data in time and space (depth, latitude) revealed no important differences from patterns seen in the entire data sets.

Size, age, and reproductive data from the MARMAP database were brought forward for use in the assessment (Figures 6, 7).

3.2 Findings of headboat and recreational fisheries working group

Two sources of data on recreational and headboat fisheries were available for use in the stock assessment: the National Marine Fisheries Service (NMFS) Headboat Survey and the NMFS Marine Recreational Fisheries Statistics Survey (MRFSS).

Headboat landings Vermilion snapper landings in numbers and weight were available from 1973 through the present from North Carolina and South Carolina. Landings from Georgia and the Atlantic coast of Florida, north of Cape Canaveral, were available starting in 1976, and are a major part of vermilion snapper headboat landings. Preliminary landings data were available for southeast Florida from 1978. Landings for 1976–1977 were estimated by regressing Georgia and north Florida observations against south Florida observations of landings in numbers and weight. Apparent errors in mean weights recorded for some months were corrected using the mean weights from adjacent months for the same area. Headboat landings are shown in Figure 1c on page 6.

Size distributions of headboat landings Headboat samplers measure length and weight of the fish that they encounter. The group recommended that length measurements be weighted by landings in numbers when computing length compositions for use in the assessment model.

Headboat abundance indices Headboat catch rates in numbers and weight were available for 1973–2001 for vermilion snapper. Headboat catch rates were standardized with a delta–lognormal general linear model of catch in numbers divided by anglers at the trip level, based on full-day trips only (Figure 4a). Categorical independent variables were year, month, and area. (Because areas 2 and 3 were combined by survey personnel from 1988 on, area 3 from 1988–2001 was denoted area 13 for modeling.) The advantage of the delta–lognormal formulation is that it explicitly models both the proportion of trips with nonzero catches and the catch per trip observed in those trips.

MRFSS landings data The Marine Recreational Fisheries Statistics Survey (MRFSS) began in 1979; however, the group recommended excluding the first two years, as MRFSS revised their data collection and estimation procedures. The survey collects information from shore-based, private-boat and charter-boat anglers. Headboat landings were included in the MRFSS database through 1985, but those data were removed for this assessment based on the proportion of intercepts that were headboat intercepts for each year and state.

Vermilion snapper are rarely encountered near shore; thus, landings from the shore-based mode of MRFSS were excluded. Mean landings by private and charter boats, 1981–1989, were used to extend recreational landings back to 1976. Occasionally, no fish were weighed in a given stratum (year, subregion, state, mode, area), and such missing weights were filled in using mean weight of fish from neighboring strata, based first on wave, then state, and worst case, adjacent year. The estimated release mortality rate of 25% of Dixon and Huntsman (unpublished data) was used to modify catch of released fish. Concern continues about large variability in year-to-year estimates of private and charter boat landings and generally large proportional standard errors. However, because such landings of vermilion snapper are minimal (Figure 1d), that concern is not great for this species.

3.3 Findings of working group on commercial landings

Commercial landings data are available through the NMFS general canvass and Trip Interview Program (TIP) databases, 1958–2001. Data categories include those reported to species and those reported as “snapper, unclassified.” State-maintained records were used for allocation of landings by gear type. Such records are available since 1972 from North Carolina and South Carolina, and since 1970 from Florida. No state records are available for Georgia.

Vermilion snapper landings have been variably recorded to species level and as unclassified snappers, especially in earlier years. Reporting to species is more prevalent in recent years, and the proportion of total snapper landings reported as unclassified declines over time. Total vermilion snapper landings were estimated for each state by combining landings reported to species and a portion of the unclassified snapper landings. In general, the ratio of vermilion snapper landings to total snapper landings reported by species was used as a multiplier to estimate the proportion of vermilion snapper landings in the unclassified category. For years in which no landings were reported by species, the time series average proportion of vermilion snapper was used to estimate the proportion of vermilion snapper in the unclassified category.

Vermilion snapper were partially recorded as "unclassified snapper" in North Carolina and South Carolina. In both states, state records were used to identify the proportion of unclassified snappers assigned to vermilion snapper. As no state records were available from Georgia, Georgia landings are taken from the NMFS commercial statistics website, based on the vermilion snapper category. Florida landings are from the Atlantic coast only, including all of Monroe county before 1986 and only Atlantic portions of Monroe County after 1986. All vermilion snapper landings are recorded to species in the Florida database, so no adjustments of unclassified landings were required.

Landings by gear are available since 1992 from Florida, since 1978 from North Carolina, and since 1972 from South Carolina. Between 1992 and 2001 (i.e., during the period when all three states recorded their landings by gear), 99% of vermilion snapper were landed by hook and line. However, substantial trawl landings were made in the 1970s and 1980s, especially in SC. Trawling for vermilion snapper has been prohibited since 1989 (Table 1). Therefore, three gear categories were established for use in this assessment: (1) hook and line (including ordinary hook-and-line and electric or "bandit" reels), (2) trawl, and (3) all others combined (longlines, gill nets, spears/gigs, traps and pots, etc.). For North Carolina and South Carolina, where landings are adjusted for the unclassified snapper category, adjusted vermilion snapper landings were allocated to gear categories based on the observed gear associated with landings reported to species and gear. No gear information was available for Georgia; therefore, landings were allocated into gear categories in the same annual proportion by category as for South Carolina, 1972–2001. In Florida, the average proportions by gear, 1992–2001, were used to allocate 1970–1991 landings to gear.

Length samples were obtained from the TIP database for 1984–2001 (Table 2). An average of 9,111 lengths were recorded annually: 8,592 in the hook-and-line category and 519 in the "other" category. Lengths were tabulated into 10 mm bins centered on lengths from 100 to 600 mm, combined across all areas but separated by gear type.

4 Data issues resolved at Assessment Workshop

The 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.

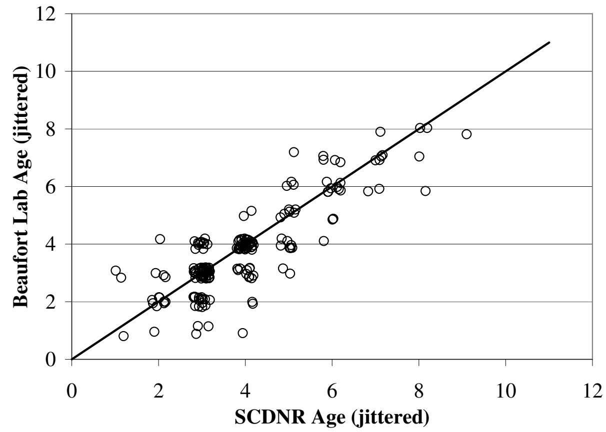
4.1 General data issues

- The DW recommended using a forward-projecting statistical age-structured model of catch at age as the primary assessment methodology for vermilion snapper. However, there is extremely poor correlation between length and age in the species, and age sampling has been quite limited. Thus, the AW concluded that use of a forward-projecting length-structured model would be preferable to using an age-structured model. The major difference is that in the length-structured model, fecundity, maturity, and selection are all modeled as functions of length. In addition, the AW decided to apply an age-aggregated production model to supplement the length-structured model.

- The AW decided not to use the MRFSS catch rate as an index of abundance for the base run of the catch-at-length model. This decision was made because of concerns that the method of accounting for targeting used by MRFSS personnel in computing the index might bias the results, as only positive trips were used.

- Aging data for fishery-independent (MARMAP) samples from 1979–1994 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. However, fishery-independent samples from 1999–2001 were collected in a suitable manner and were used in the assessment.

Figure 8. Determined ages of 198 fish aged both by scientists at the NMFS Beaufort Lab and by scientists at South Carolina Department of Natural Resources.



- The comparison of ages from the NMFS Beaufort lab and SCDNR lab demonstrated good agreement (Figure 8).

- Examination of sex-ratio data (§3.1) by size and age revealed a possible increase in proportion female with size, but the group was hesitant to accept that increase (1) for lack of biological mechanism, and (2) because the perception of increase was highly dependent on a few points in the data set. After discussion, the group decided to adopt the assumption of a constant proportion female of 67%

- The group decided to use the MARMAP hook and line catch rate for 1983–1987 as a third fishery-independent abundance index.

4.2 Stock–recruitment model

The model incorporates a Beverton–Holt stock–recruitment model of the form that includes a steepness parameter h and a parameter R_0 representing theoretical recruitment level in the unfished equilibrium state. The steepness parameter strongly affects estimates of management benchmarks related to maximum sustainable yield. In exploratory model runs used to arrive at a base run, h was not well estimated. To provide biologically reasonable estimates of the stock–recruitment curve, including h, the parameter R_0 was constrained to be close to the average recruitments estimated for the period 1983–1998. Sensitivity runs were therefore incorporated to investigate the implications of different assumed values of steepness on model estimates.

4.3 Additional constraints

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

- Deviations of estimated recruitments from the estimated stock–recruitment model were weakly penalized.
- Recruitment deviations in the model initialization period (used to provide estimates of N at length in the first model year) were penalized more heavily, to prevent large fluctuations. This is necessary because the data are least complete in the initialization period.
- Recruitment deviations in the final three years were penalized more heavily. This is done because cohorts in the final years have been fished for only a few years and thus provide less certain information on recruitment (initial cohort strength).
- Parameters of the variance–of–length vs. age relationship were constrained to ensure that estimated variances of adjacent lengths were similar.

5 Description of assessment models

5.1 Length-structured model

The data workshop recommended use of a forward-projecting statistical model of catch at age as the primary assessment tool for vermilion snapper in this assessment. The AW revised that recommendation slightly, and used a similar model based on catch at length (rather than age). As noted above, this decision was based on the weak relationship observed in this stock between age and length, the relative scarcity of data on age composition, and difficulties in fitting an age-based model.

The essence of forward-projecting age- or length-structured models is to simulate a population that is projected forward in time like the population being assessed. Aspects of the fishing process (i. e., gear selectivity) are also simulated. Quantities to be estimated are systematically varied from starting values until the simulated population's characteristics match available data on the real population as closely as possible. Such data include total catch by fishery and year; observed length composition of catches by year and gear; estimated age compositions of catches by year and gear; and observed indices of abundance, along with their age and length compositions.

The method of forward projection has a long history in fishery models. It was introduced by Pella and Tomlinson (1969) for fitting production models and then used by Methot (1989) in his stock–synthesis model. The model developed for this assessment is an elaboration of the work of Sullivan et al. (1990); Quinn et al. (1998); Fu and Quinn (2000).

5.1.1 Properties of length-structured model

The forward-projecting length-structured model for this assessment was implemented in the AD Model Builder software (Otter Research 2000) on a microcomputer. The formulation's major characteristics can be summarized as follows:

Natural mortality rate The natural mortality rate was assumed constant across ages and over time.

Stock dynamics The standard Baranov catch equation was assumed to apply. This implies exponential and competing fishing and natural mortality processes.

Selectivity of fishery–independent gear The three fishery–independent (MARMAP) abundance indices were assumed to have individual time–constant selectivity functions, whose parameters were estimated internally in the course of model fitting.

Selectivity of fishery gear Each fishery was assumed to have constant selectivity during each period of constant regulation. The corresponding selectivity parameters were estimated internally and applied to the corresponding fisheries and any abundance indices derived from them. The scarcity of length samples in the MRFSS database prevented estimation of selectivity for the (very small) recreational fishery. Therefore, estimated selectivity of the headboat fishery was used for the recreational fishery. With that exception, separate selectivity patterns were estimated for each fishery component.

Form of selectivity functions Selectivity was fit parametrically, using logistic curves for most gears, but double-logistic curves (which are potentially dome shaped) for surveys using trap gear.

Growth A von Bertalanffy growth model, constant over time, was estimated internally during model fitting from length–composition and age–composition data. Two standard deviation parameters were estimated for determining the variance of length at age, assumed normal.

Recruitment Parameters of a Beverton–Holt recruitment model were estimated internally.

Biological benchmarks The benchmarks F_{MSY} and $\mathcal{E}_{\text{MSY}}$ were estimated internally by the model using the method of Shepherd (1982). (The quantity $\mathcal{E}_{\text{MSY}}$ is the amount of egg production $\mathcal{E}$, a measure of spawning stock size, that can provide maximum sustainable yield.) 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 formed a catch-weighted average of estimated selectivities at age by fishery for the final three years (1999–2001), a period of unchanging regulations.

Fishing mortality Five fishery components were modeled individually: commercial hook-and-line, commercial trawl, commercial "other"; headboat, and (MRFSS) recreational. Separate fishing mortality rates were estimated for each component.

Abundance indices The model used four separate indices of abundance (§2.3, Figure 4). They were three fishery-independent indices (MARMAP hook and line, 1983–1987; "Florida" trap, 1983–1987; and chevron trap, 1990–2001) and one fishery-dependent index (headboat, 1976–2001).

Discards Discarded fish are routinely estimated in the MRFSS and are included in the estimate of total landings in the model. However, no time series of discard data are available for other fisheries. An approximate measure of discards from the commercial hook-and-line and headboat fisheries, which account for the majority of landings (Figure 1), were modeled with separate selectivity curves. The discard selectivity curves were estimated from the difference between selectivity before and after size regulations in order to represent likely discards of undersized fish during periods of size regulation. This is viewed as an underestimate of discards, since the implicit assumption is that no discarding occurred before size regulations were in place.

Discard mortality rates were then estimated by assuming release mortality rates of 40% and 25% for the commercial hook-and-line and headboat fisheries, respectively. The product of release mortality rate, the estimated fishing mortality rate of kept fish, and the estimated discard selectivity curve provided length specific instantaneous mortality rates to estimate the number of discards using the Baranov catch equation.

CVs of landings The assessment model accommodates coefficients of variation (CVs) of each landings series. Where CVs were provided in data bases (i. e., MRFSS data only), those CVs were used. Where no CVs were provided (headboat survey and general canvass data), a CV of 0.05 was assumed.

Fitting criterion The fitting criterion was a total likelihood approach in which total catch was fit almost exactly and observed age and length-compositions, as well as abundance indices, were fit to the degree that they are compatible with each other and with other model components. Relative statistical weighting of each likelihood component 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.

Table 3. Statistical weights used in averaging model estimates for vermilion snapper.

	Steepness, h		
M	0.5	0.7	free (h = 0.9)
0.20	1/16	1/16	1/8
0.25	1/8	1/8	1/4*
0.30	1/16	1/16	1/8

* base run

5.2 Age–aggregated production model

The age-aggregated production model used was the (Prager 1994) form of the Graham–Schaefer surplus-production model. This is a continuous-time formulation, conditioned on catch, that does not assume equilibrium conditions. 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. To fit the production model, the ASPIC software of Prager (1995) was used.

6 Application of length-structured model

6.1 Specification of base and sensitivity runs

All model runs used the data from the Data Workshop with all adjustments described above. The base run used $M = 0.25$/yr, and had a fitted steepness value of $h = 0.90$.

In addition to the base run, analyses were run to examine the effects of using different fixed steepness values and other values of the natural mortality rate. The values used included the steepness values $h = \{0.5, 0.7\}$ and the natural mortality rate values of $M = \{0.2, 0.3\}$.

Considering the three values of M and three values of h, nine model runs were conducted in total. The AW also decided to tabulate weighted averages of estimates of management quantities from the nine runs, with statistical weights as given in Table 3.

6.2 Results of base run

Estimates from base and sensitivity runs of the length-structured model are summarized in Table 4. In that table, the base run chosen by the AW is labelled D and is set off by rules. Figures and results that follow reflect results of that base run, except when specified otherwise.

The length-structured model was able to match observed catches almost exactly (Figure 9), as expected. More importantly, fits to abundance indices were good (Figure 10). The only systematic lack of fit noted was failure of the estimated length compositions of the MARMAP chevron trap to match observed length compositions, particularly in later years (e.g., Figure 11). The observed length compositions from this gear exhibit increased contribution of larger fish near the end of the time series (Figure 3d). The group was unsure what caused the broadening of the observed length compositions during that period.

Estimated selectivity curves of fishery–independent (MARMAP) gears indicate that of the two trap gears, only the chevron trap is estimated to have dome-shaped selectivity (Figure 12). The hook-and-line selectivity curve was specified as logistic, not dome-shaped.

Estimated selectivity curves of commercial gears show the expected changes from minimum size regulations listed in Table 1 (Figure 13). Implementation of the 12" (305 mm) TL minimum size limit in 1992 for the commercial fishery resulted in a shift in selection to larger fish in the hook-and-line fishery. The trawl fishery operated prior to any size limits and captured significantly smaller fish than other commercial fisheries, although the 4" mesh size regulation (Table 1) was implemented with the goal of not catching fish

Figure 9. Observed (solid circles) and predicted (open squares) landings from base run of length-structured model of vermilion snapper. Note that symbols are entirely overlaid in panel (c).

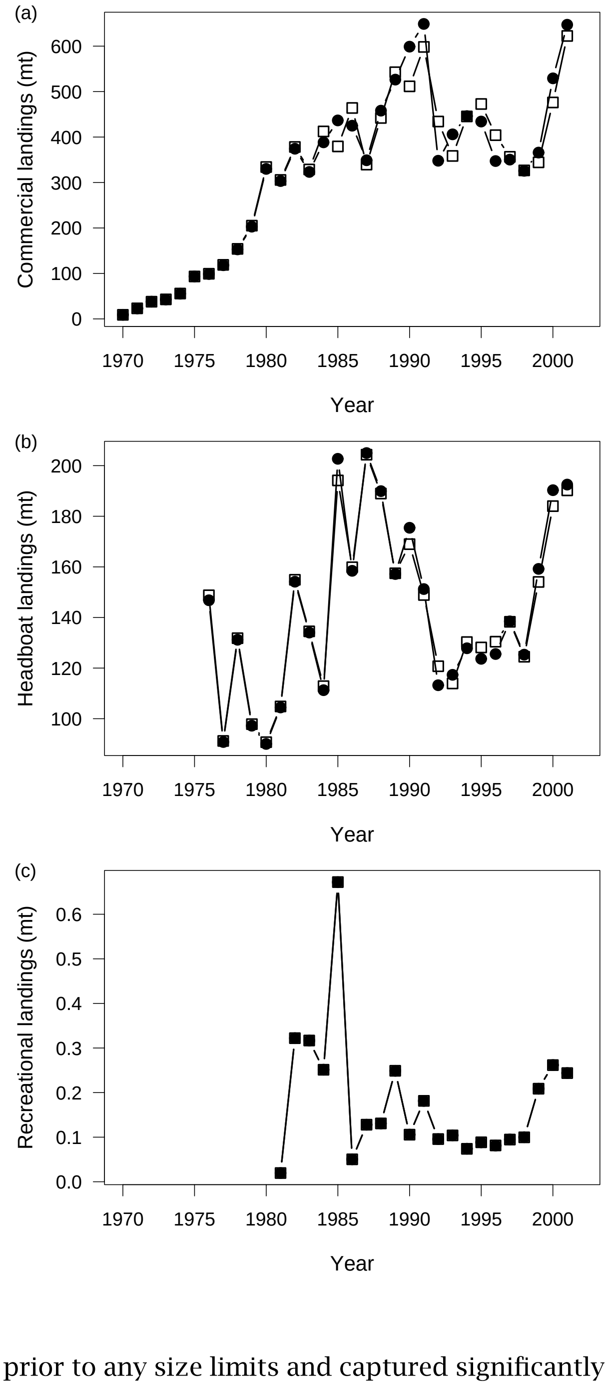


Figure 10. Observed (solid circles) and predicted (open circles) abundance indices from base run of length-structured model of vermilion snapper. Panel (a), headboat index; (b), MARMAP chevron trap index; (c), MARMAP "Florida" trap index; (d), MARMAP hook-and-line index.

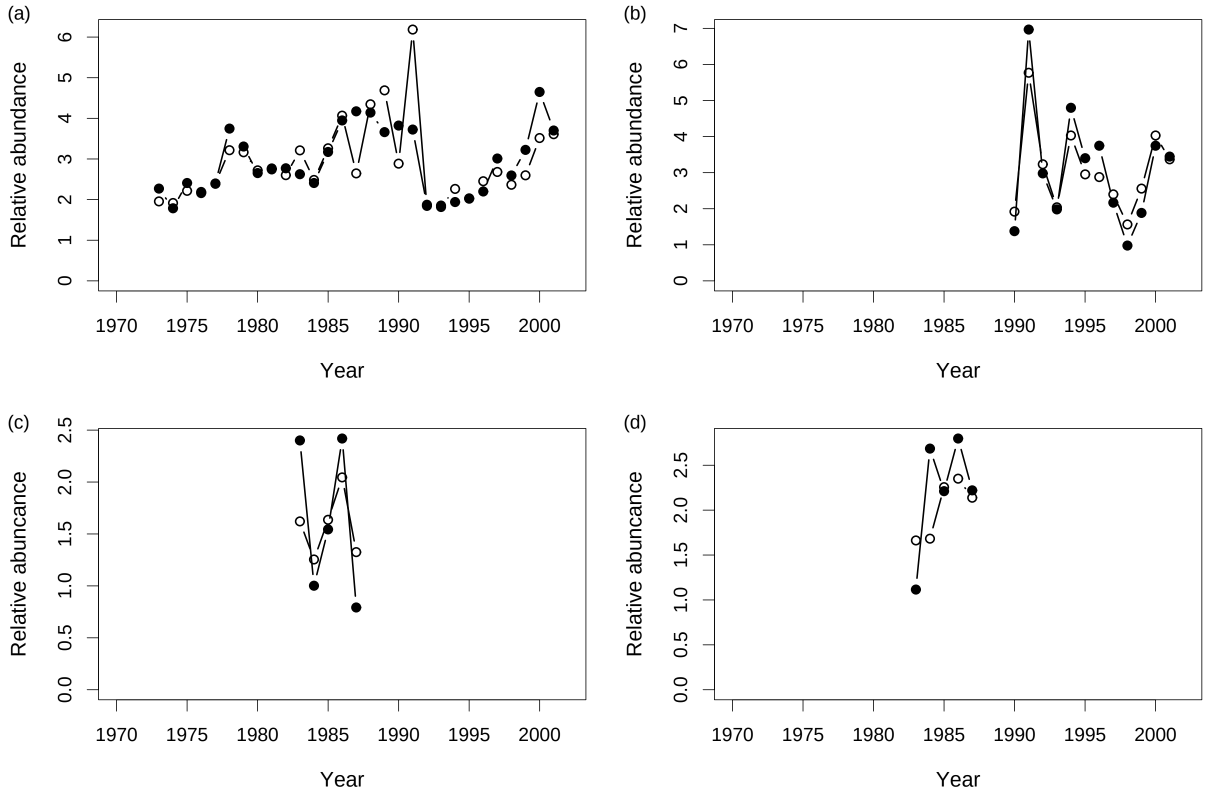
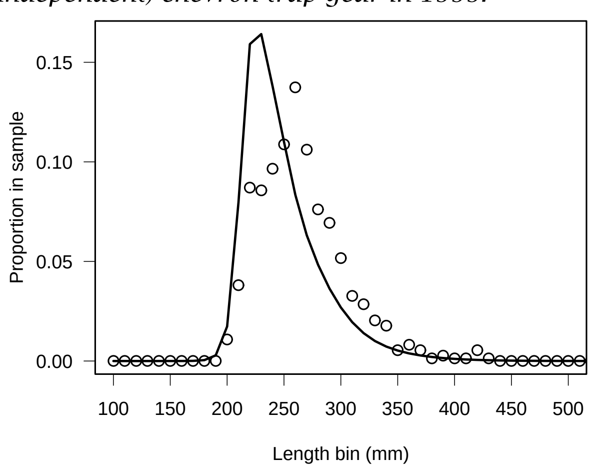


Figure 11. Observed (circles) and modeled (line) length composition of MARMAP (fishery-independent) chevron trap gear in 1999.



smaller than 12" TL. The combined "other" commercial fisheries did not appear affected by the minimum size regulation in 1992, and they appear to capture larger fish above that minimum size limit (Figure 13c).

Estimated selectivity curves of the headboat fishery show the changes expected due to the implementation of the 10" (254 mm) TL minimum size limit in 1992. The change to an 11" (279 mm) TL minimum size limit in 1999 does not appear to have further affected estimated selectivity to any degree (Figure 14 on page 23). Indeed, the estimated selectivity curve for 1999–2001 suggests a lack of compliance with the 11" TL minimum size regulation.

Estimated fully-selected fishing mortality rates

Table 4. Summary of estimates from length-structured model of vermilion snapper. Symbols, abbreviations, and acronyms are listed in Appendix C on page 40. Vertical rules mark base case.

	Run									
Quantity	A[1]	B	C	D[1,2]	E	F	G[1]	H	J	avg[3]
Input conditions										
M	0.20	0.20	0.20	0.25	0.25	0.25	0.30	0.30	0.30	—
h	0.93	0.70	0.50	0.90	0.70	0.50	0.95	0.70	0.50	—
Estimates										
F_{2001}	0.56	0.56	0.55	0.51	0.56	0.55	0.53	0.54	0.54	0.54
F_{MSY}	0.30	0.24	0.16	0.32	0.27	0.18	0.34	0.28	0.20	0.27
$F_{2001}/F_{\mathrm{MSY}}$	1.89	2.37	3.45	1.60	2.10	3.06	1.55	1.93	2.78	2.13
$F_{0.1}$	0.20	0.21	0.22	0.23	0.24	0.23	0.23	0.25	0.25	0.23
$F_{40\%}$	0.27	0.28	0.29	0.32	0.34	0.33	0.35	0.37	0.37	0.32
$F_{\max}$	0.32	0.33	0.35	0.35	0.36	0.36	0.35	0.37	0.37	0.35
MFMT	0.26	0.18	0.0002	0.32	0.22	0.001	0.34	0.28	0.007	0.21
F_{proj}[4]	0.45	0.50	0.49	0.44	0.50	0.49	0.46	0.48	0.48	—
$\mathcal{E}_{\mathrm{MSY}} \times 10^9$	396	466	257 000	247	504	56 500	276	338	15 200	24 300
MSST $\times 10^9$	317	373	206 000	185	378	42 400	193	237	10 600	19 010
$\mathcal{E}_{2002}/\mathcal{E}_{\mathrm{MSY}}$	0.69	0.62	0.001	1.23	0.61	0.01	1.13	0.92	0.02	0.71
MSY, mt	756	743	294 000	465	848	69 586	542	571	19 364	28 730
MSY, lb.	1667	1638	648 159	1025	1970	153 410	1195	1259	42 699	63 339

Notes: [1] Runs with steepness h freely estimated. [2] Base run. [3] Weighted average of runs. [4] Geometric mean, used in projections, of estimated F for 1998–2001.

reflect the relative landings of the various fisheries (Figures 1, 15). The largest sources of fishing mortality are the commercial hook-and-line fishery and the headboat fishery. The recreational (MRFSS), commercial trawl, and commercial "other" fisheries contribute small or negligible fractions of the fishing mortality. It appears that the fully selected fishing mortality rate has recently (1996–2001) remained relatively stable at between 0.4/yr and 0.5/yr. Fully-selected F is complex to interpret because of changes in selectivity over time (Figures 13–14) and the changing contributions of different fishery components, which changes the overall selectivity pattern. This is also true of fully selected F compared to F_{MSY} (Figure 16). Periods of consistent regulation are marked by dotted vertical lines in Figure 16, and examining F within such periods removes one of the two main sources of confounding.

Spawning stock as measured by total egg production $\mathcal{E}$ is estimated to have increased substantially from its 1976 value (Figure 17a on page 25). The time trajectory of spawning–stock biomass shows the same pattern (Figure 17b). Although $\mathcal{E}$ has shown a significant ($P = 0.004$) increasing trend, no trend is apparent in the recruitment estimates (Figure 17c). Recruitment appears highly variable since 1983, with the largest variation occurring between 1983–1994. Forward-projection models tend towards greatest uncertainty in the

Figure 12. Estimated selectivity of fishery-independent (MARMAP) gear estimated for vermilion snapper (base case model run). Dotted line, chevron trap; dashed line, hook-and-line; dot–dash line, "Florida" trap.

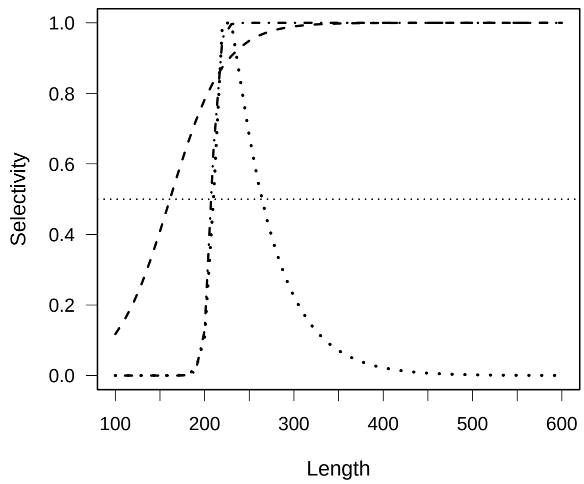
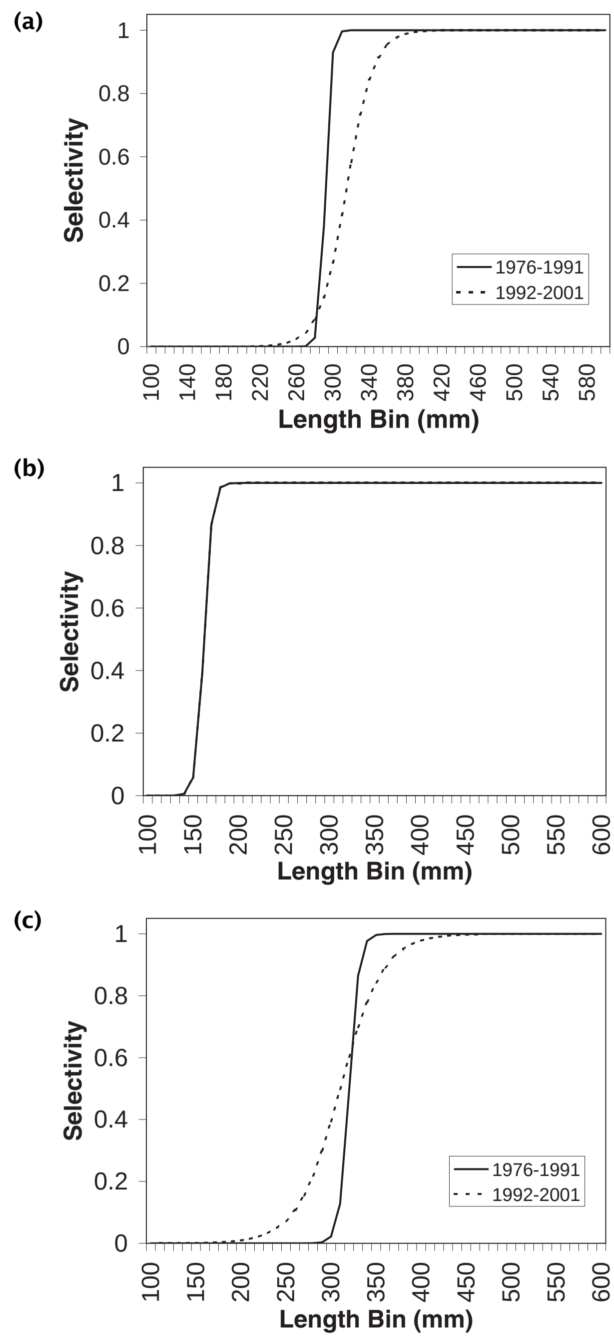


Figure 13. Estimated selectivity of commercial gears fishing for vermilion snapper (from base model run): (a) hook and line; (b) trawl; (c) other gears.



earliest and latest years. For that reason, the constraints on those years' recruitment values were highest, and the near-constant recruitment in the recent three years may be an artifact of that procedure.

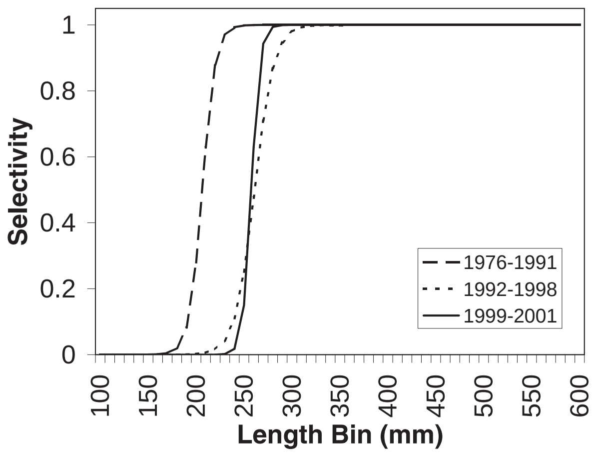
The estimated spawner–recruitment relationship (using egg production $\mathcal{E}$ as the measure of spawning-stock size) shows the usual scatter about the fitted Beverton–Holt recruitment curve (Figure 18).

6.3 Results of sensitivity runs

Table 4 on page 21 contains estimates of management quantities from the base run and sensitivity runs of the length-structured model. Results of runs conducted strictly to check model function or decide on weighting are not tabulated.

In runs with steepness h freely estimated, estimated values of h tended to be high, ranging from $h = 0.9$ to the upper bound allowed in this model, $h = 0.95$ (Table 4). Steepness itself has its theo-

Figure 14. Estimated selectivity in headboat fishery for vermilion snapper.



retical upper bound of $h = 1.0$, which would be considered an infeasible result. In fitting stock-recruit models, h often tends toward extremely high or low values when there is very little contrast in the abundance time series, as is the case here. Therefore, sensitivity runs with fixed lower values of steepness were also run. The lowest fixed values for steepness, $h = 0.5$, resulted in unreasonably high estimates of R_0, which in turn resulted in much lower estimates of $\mathcal{E}_{2002}/\mathcal{E}_{\text{MSY}}$, accompanied by much higher estimates of MSY and $\mathcal{E}_{\text{MSY}}$ (Table 4).

The general pattern observed in the sensitivity runs is for estimates of F_{MSY} to be positively related to values of M and h, but for the ratio F_{2001}/F_{MSY} to be negatively related to values of M and h. The estimates of F_{2001}/F_{MSY} range from 1.55 to 3.45 (Table 4). Estimates of $\mathcal{E}_{\text{MSY}}$ were negatively related to steepness and showed a tendency toward a negative relationship with M. Estimates of the dimensionless status indicator $\mathcal{E}_{2002}/\mathcal{E}_{\text{MSY}}$ ranged from 0.001 to 1.23, with the base run having the highest value of all runs (Table 4).

Model runs with a lower steepness showed increases in F_{MSY} as steepness decreased, while MSY and $\mathcal{E}_{\text{MSY}}$ increased towards unrealistic levels (Table 4). Thus, the sensitivity runs demonstrate that the lowest steepness value examined, $h = 0.5$, seems incompatible with the other data and assumptions of this assessment. The middle steepness value examined $h = 0.7$ is lower than the value of steepness freely estimated, but also appears consistent with the model, data, and assumptions used.

6.4 Biological reference points

Management benchmarks in the U.S. are currently based on the theory of maximum sustainable yield. That means that target and limit reference points depend on the size- and age-selectivities of the fisheries. The estimates of reference points given here assume the same catch–weighted selectivities that have been observed during the past three years of constant regulation.

All estimates of MSY and related benchmarks also depend on a stock–recruitment relationship, either one explicitly estimated (as in this report), or one implicitly estimated (as in fitting an age-aggregated production model). When that relationship cannot be estimated with confidence, the corresponding estimates of MSY–related benchmarks are estimated with limited confidence as well. Probably the weakest part of this assessment is the estimated stock–recruitment relationship (Figure 18), which exhibits a wide range in recruitment corresponding to a rather limited range of spawning-stock sizes (the latter measured as eggs produced). The observed data do not preclude the existence of an underlying stock–recruitment relationship, masked by noise, but they make accurate estimation of its form quite unlikely. Because of the scatter in the stock–recruitment data, all MSY–related benchmarks estimated in this assessment must be considered

Figure 15. Estimates of full fishing mortality rate F by major fishery, from base run of length-structured model. The recreational fishery is inconsequential ($F \ll 0.01$) and is not plotted.

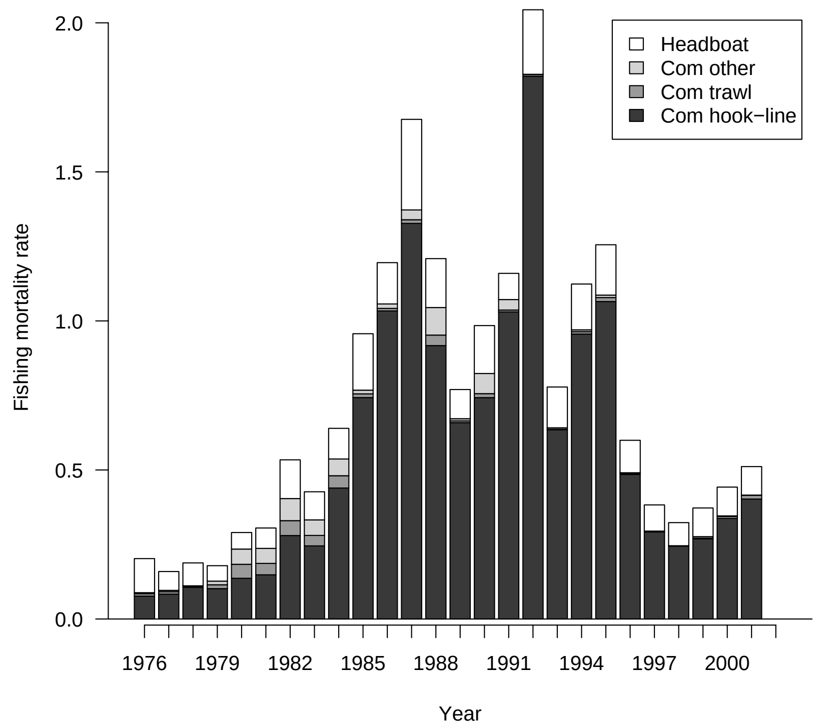


Figure 16. Estimates of full fishing mortality rate F relative to F_{MSY}, from base run of length-structured model. Comparison among years is best made during periods of consistent regulation, which are separated by vertical dotted lines.

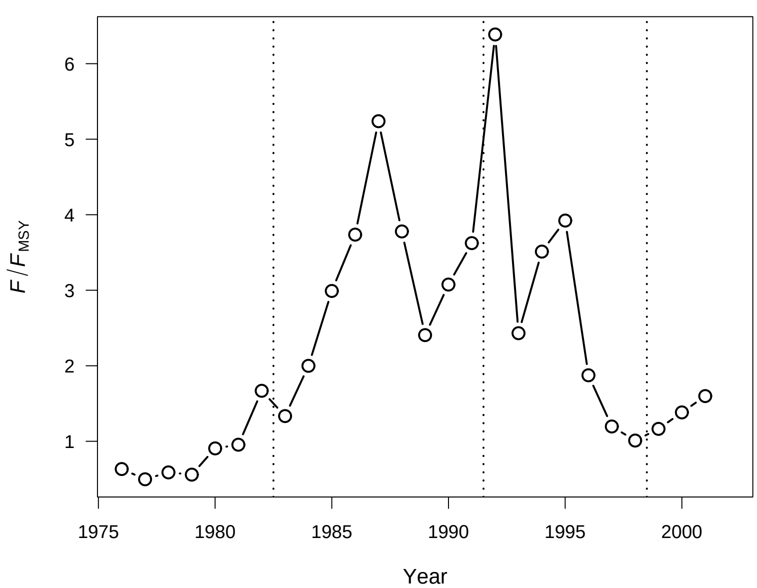


Figure 17. Trajectories of (a) population egg production $\mathcal{E}$, (b) spawning–stock biomass, and (c) recruitment, estimated from base case of length-structured model. Dotted line in (a) is level of egg production $\mathcal{E}_{\text{MSY}}$ at which MSY can be attained.

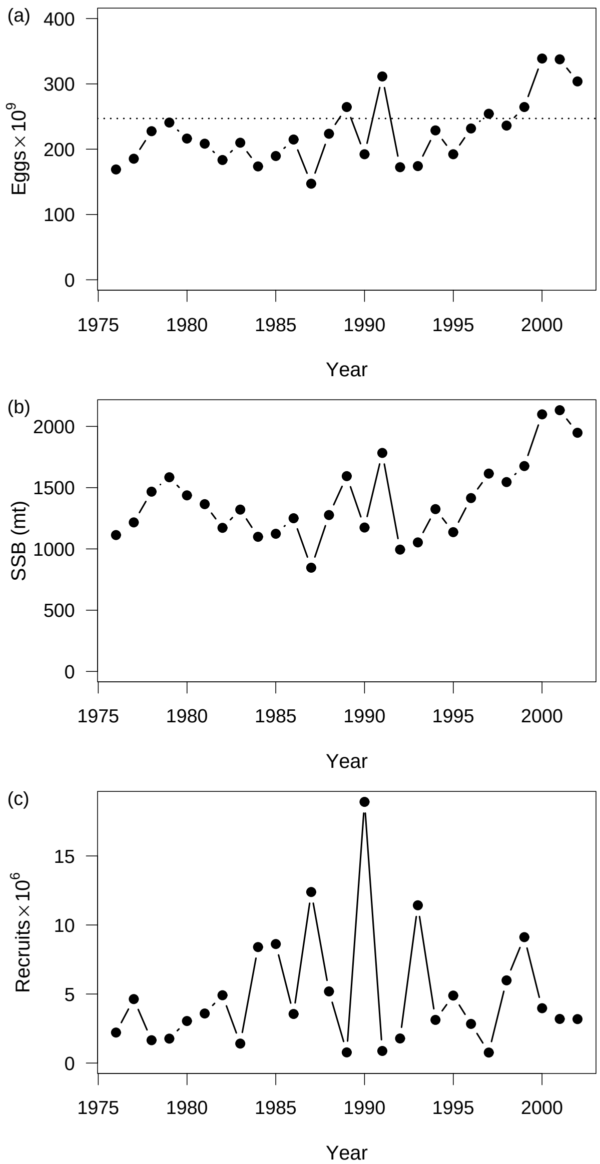
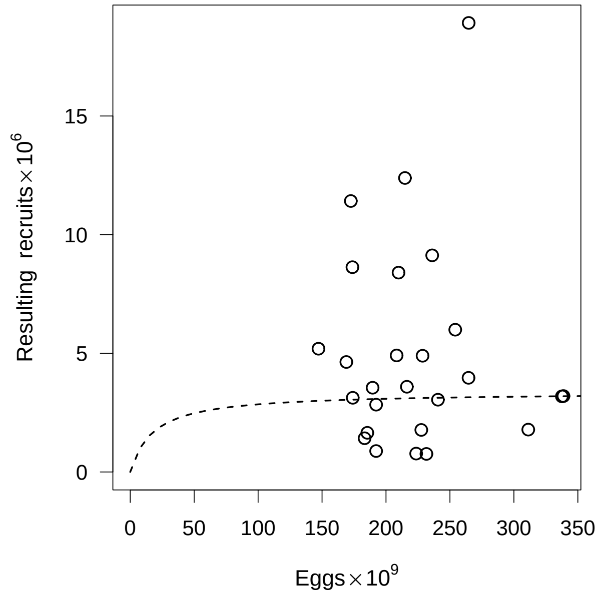


Figure 18. Population egg production $\mathcal{E}$ and recruitment of vermilion snapper estimated from length-structured model with integrated Beverton–Holt recruitment model.

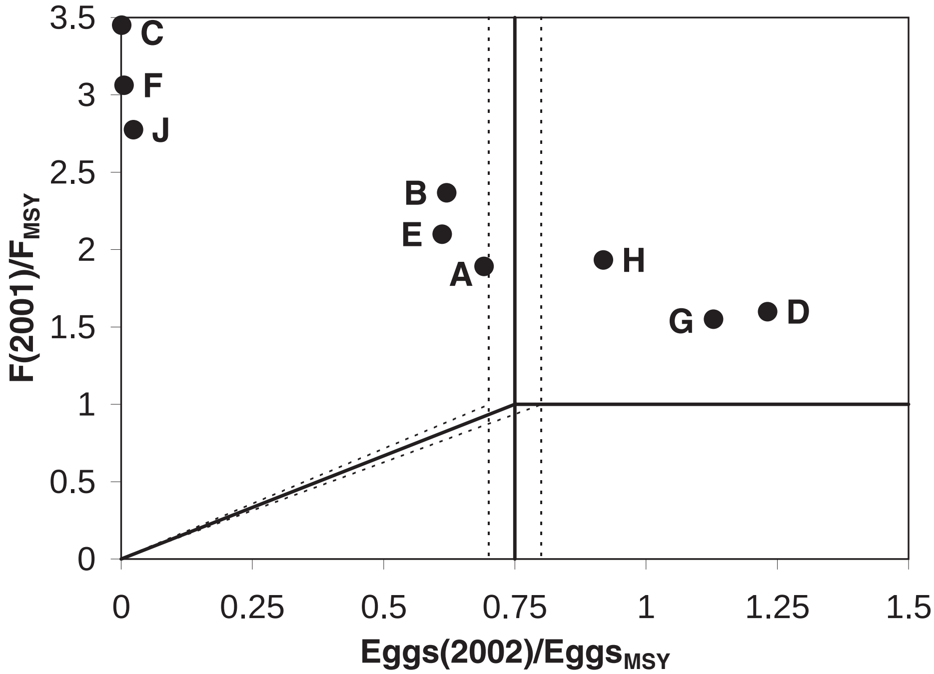


quite uncertain.

In this report, egg production $\mathcal{E}$ is used as the measure of spawning stock size, and MSST is measured in terms of egg production. Using the Council's customary formulation of MSST = $(1 - M)\mathcal{E}_{\text{MSY}}$, MSST for the base run would be $\mathcal{E} = 185 \times 10^9$ eggs. The base run is the most optimistic of all runs made (Table 4), and the estimate of spawning stock status from the base run is $\mathcal{E}_{2002}/\mathcal{E}_{\text{MSY}} = 1.23$. Most other sensitivity runs estimate that current egg production is below $\mathcal{E}_{\text{MSY}}$ (Figure 19, Table 4).

The limit reference point in fishing mortality rate is the maximum fishing mortality threshold, or MFMT. The value of MFMT depends on the MSY control rule adopted by the Council. Here, the default control rule recommended by Restrepo et al. (1998) is used. In that case, MFMT is a variable, and depends on the current stock size. If stock size is at or above MSST, the MFMT is equal to F_{MSY}. However, if the stock size is below MSST, the MFMT declines linearly to zero (Figure 19). Under the base case assessment, the stock is estimated to be above MSST, and the corresponding estimate of MFMT is $F_{\text{MSY}} = 0.32/\text{yr}$. Present F is estimated to exceed F_{MSY} by about 60% (Fig-

Figure 19. Phase plot of status indicators estimated from length-structured model. Letters correspond to run labels in Table 4. Base run is point **D**. *Solid vertical line is MSST for $M = 0.25$. Dotted vertical lines are MSST for $M = 0.2$ (right) and $M = 0.3$ (left). Solid horizontal and oblique lines are MFMT for $M = 0.25$. Dotted oblique and horizontal lines are MFMT for $M = 0.2$ (lower) and $M = 0.3$ (upper line), according to default MSY control rule of Restrepo et al. (1998).*



ure 19, Table 4). All runs (base and sensitivity) estimate that current F is above F_{MSY} and consequently above MFMT.

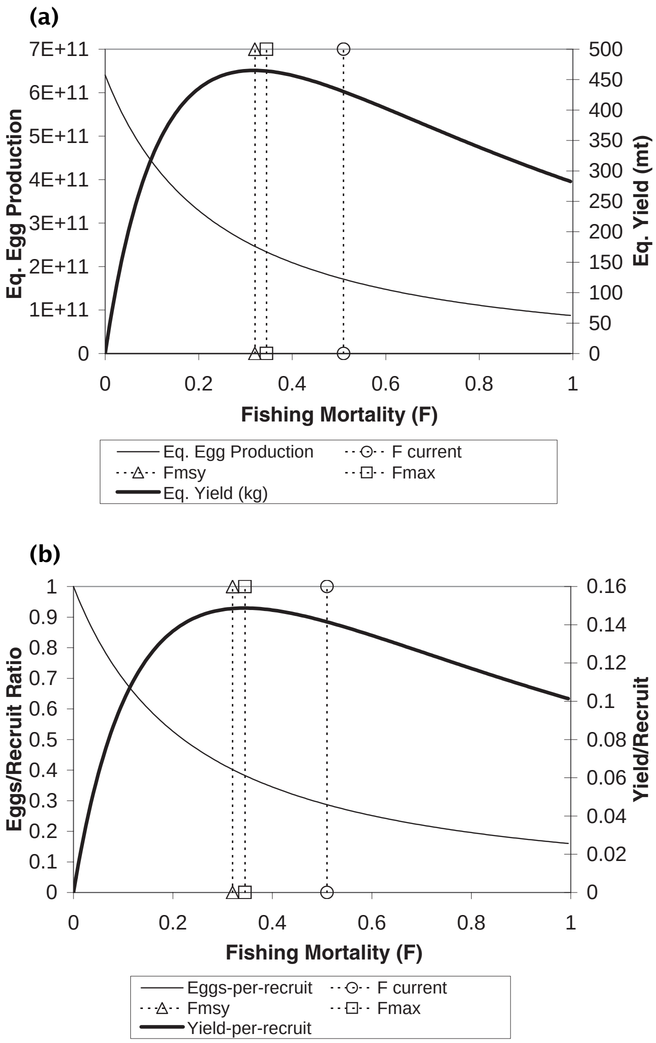
6.4.1 Equilibrium yield and egg production per recruit

Equilibrium yield and yield-per-recruit as functions of F show distinct maxima corresponding to F_{MSY} and $F_{\max}$ in panels a and b, respectively, of Figure 20. The value of F_{MSY} corresponds closely to $F_{40\%}$. Present F is estimated to be above the value that would maximize yield per recruit. The implication of that estimate is that decreasing the fishing mortality rate could increase average yield from the fishery, assuming that recruitment remains approximately stable.

6.5 Summary of length-structured model results

In general, the base run and eight sensitivity runs in Tables 3 and 4 resulted in similar fits and estimated population trends, despite wide variation in estimates of management quantities (Table 4, Figure 19). In all cases, fits to landings and abundance indices were good and were better than fits to length– and age–composition samples. All runs estimated an increasing trend in egg production $\mathcal{E}$ during the last third of the modeled time period, along with highly variable recruitment during 1983–1994. This resulted in spawner–recruit scatter plots in all cases very similar to the one pictured in Figure 18, i. e., quite noisy with little guidance as to the underlying relationship. The uncertainty about the spawner–recruit relation-

Figure 20. (a) Equilibrium total-population egg production $\mathcal{E}$ and yield as a function of F. (b) Egg production relative to unfished state and yield, both on per–recruit basis. All from base run of length-structured model.



ship, in turn, necessarily caused great uncertainty in benchmark estimates.

Because of the uncertainty in benchmarks, status of the stock is uncertain, and it is not clear from the assessment whether it is overfished (in the technical sense) or not. The base case suggests it is not, but most sensitivity runs estimate that it is overfished. Status of the fishery (level of F) is uncertain but is consistently estimated by all runs as excessive by SFA standards (overfishing occurring). The yield-per-recruit analysis (Figure 20b) does not depend on the spawner–recruit model, but is characterized by uncertainty stemming from the weak relationship between age and size and other assumptions. It estimates that yield per recruit could be increased by decreasing the fishing mortality rate.

7 Application of production model

Data used for production modeling were total landings and the four abundance indices described above. Because the abundance indices were all given the same relative statistical weights in the base age-structured model run, they were given equal weighting for the production model, as well.

It proved impossible to obtain successful parameter estimation using the production model. The AW concluded that data available for vermilion snapper were not sufficiently informative for successful implementation of the production model, and it was not considered further.

8 Comparison to previous assessment

A previous assessment of vermilion snapper from the southeastern United States was conducted by Manooch et al. (1998). That study applied an age-structured, untuned separable virtual population analysis (SVPA) to landings in estimated numbers at age over two time periods of constant selectivity: 1986–1991 and 1992–1996. The natural mortality rate was fixed at four levels ($M = 0.2, 0.25, 0.3, 0.35$), and age at full recruitment to the fishery was assumed to be age-3 and age-4 for the 1986–1991 and 1992–1996 time periods, respectively. Manooch et al. (1998) estimated full fishing mortality rate for 1992–1996, assuming $M = 0.25$, as $F = 0.55$/yr. Their per–recruit analysis assumed knife–edged selection and given the estimated F's from the SVPA, resulted in %SPR values of 21% to 27% for 1996. Their recommendation was that %SPR should be raised to 30% to 40%. No attempt was made by Manooch et al. (1998) to estimate a stock-recruit curve or MSY based benchmarks.

Several differences between the Manooch et al. (1998) and this analysis make meaningful comparisons difficult. All analyses in the present assessment use estimated domed or logistic selection functions, rather than the knife-edged selection in the per-recruit analyses of Manooch et al. (1998) or the individually estimated selectivities at age of their SVPA. These selectivity differences are particularly important because both assessments report full F, which is the maximum F exerted on any size or age. The present assessment does not consider selectivity, maturity, and fecundity as functions of age, as in Manooch et al. (1998), but rather as functions of length, which is believed to be the more accurate approach. The current analysis also models release mortality in the commercial hook-and-line and the headboat fisheries, assumed zero in the Manooch et al. (1998) analysis. Recognizing those limitations, some comparison is made. Our mean estimate of full F for the period 1992–1996 is 1.2/yr, which corresponds roughly to %SPR of 40% (an extrapolation from Figure 20b). That value can be compared to the 17% SPR estimate of Manooch et al. (1998) for the same period.

9 Stock projections

To evaluate the likely effects of possible future management measures, simulations were used to project the stock forward. These projections were made separately for each of the nine runs listed in Table 4. For each, corresponding parameter estimates were used, and the projection began with current stock status estimated by that run.

9.1 Structure of projections

Projections employed a population simulation model following the same equations used in the length-structured assessment model. In each projection year, the spawner–recruit model with randomly sampled recruitment residuals from the fitted model (using years 1983–1998) were used to forecast future recruitment levels. An important assumption of this method is that past recruitment patterns will continue into the future. Future fishing mortality rate was fixed at three values, the geometric mean of the last three years' estimates from the assessment model (termed F_{proj}) and $F = F_{\text{proj}} \pm 25\%$. Values of F_{proj} are included in Table 4 on page 21.

Under each of the three values of F, the simulated population was projected forward, 2001–2011, for 1000 trials (each with randomly selected recruitments). The corresponding trajectories of egg production $\mathcal{E}$ and yield were recorded for each simulation.

The 1000 ten-year projections were made for each of nine run scenarios (base run and eight sensitivity runs) listed in Tables 3 and 4. Results of each scenario were then summarized at the 5th, 25th, 50th (median), 75th, and 95th percentiles. As requested by the Assessment Workshop, weighted averages of the model scenario percentiles were then computed, and are summarized along with projection results for the base-case assessment in Figures 21–23.

Figure 21. Projected yields under three management scenarios. (a) and (b) weighted average and base-run projections, respectively, under current F; (c) and (d) same at 75% of current F; (e) and (f) same at 125% of current F. Current F for projections is computed as geometric mean of last 3 years (Table 4).

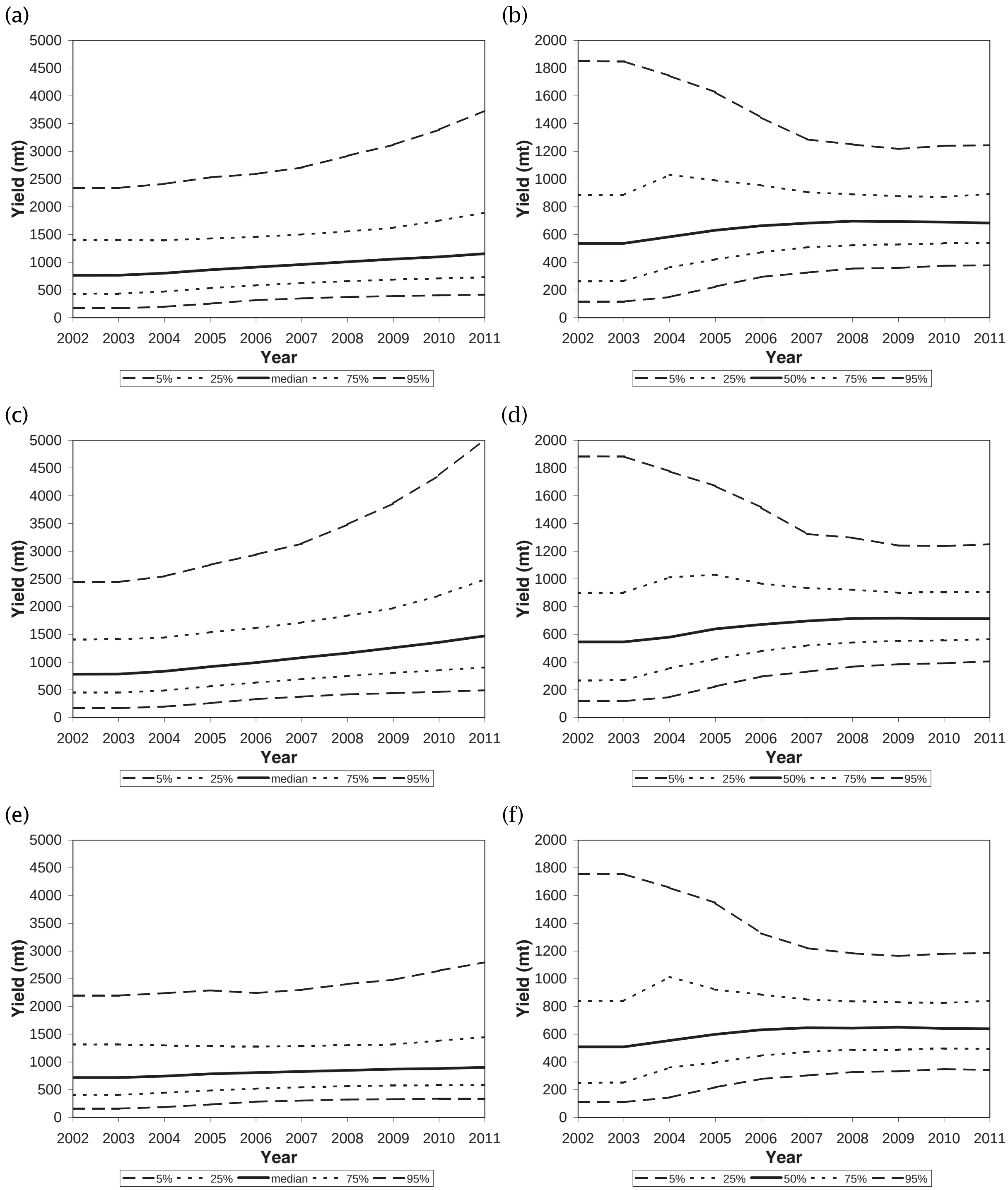


Figure 22. Projected eggs production (a measure of spawning stock size under three management scenarios. (a) and (b) weighted average and base-run projections, respectively, under current F; (c) and (d) same at 75% of current F; (e) and (f) same at 125% of current F. Current F for projections is computed as geometric mean of last 3 years (Table 4).

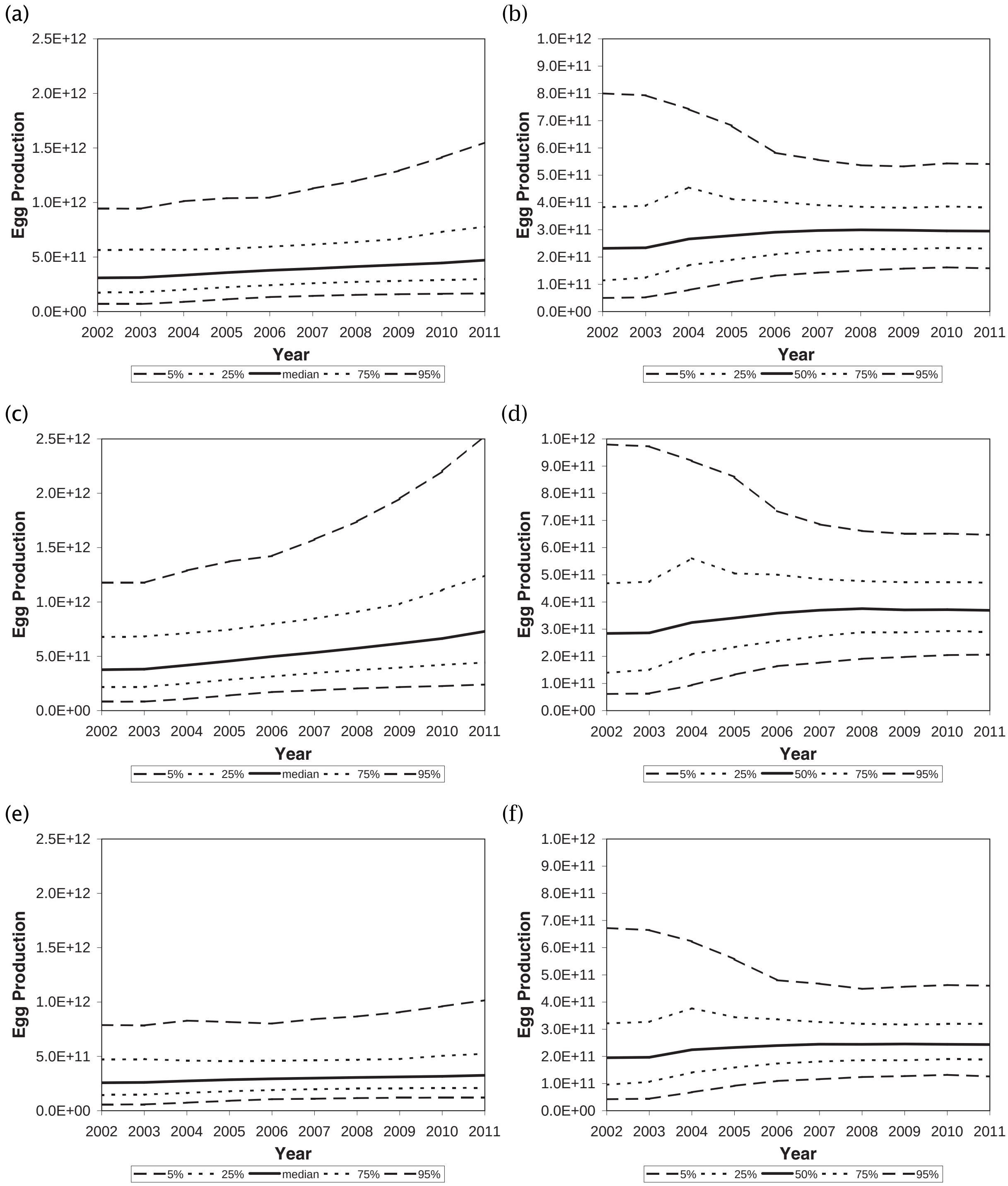
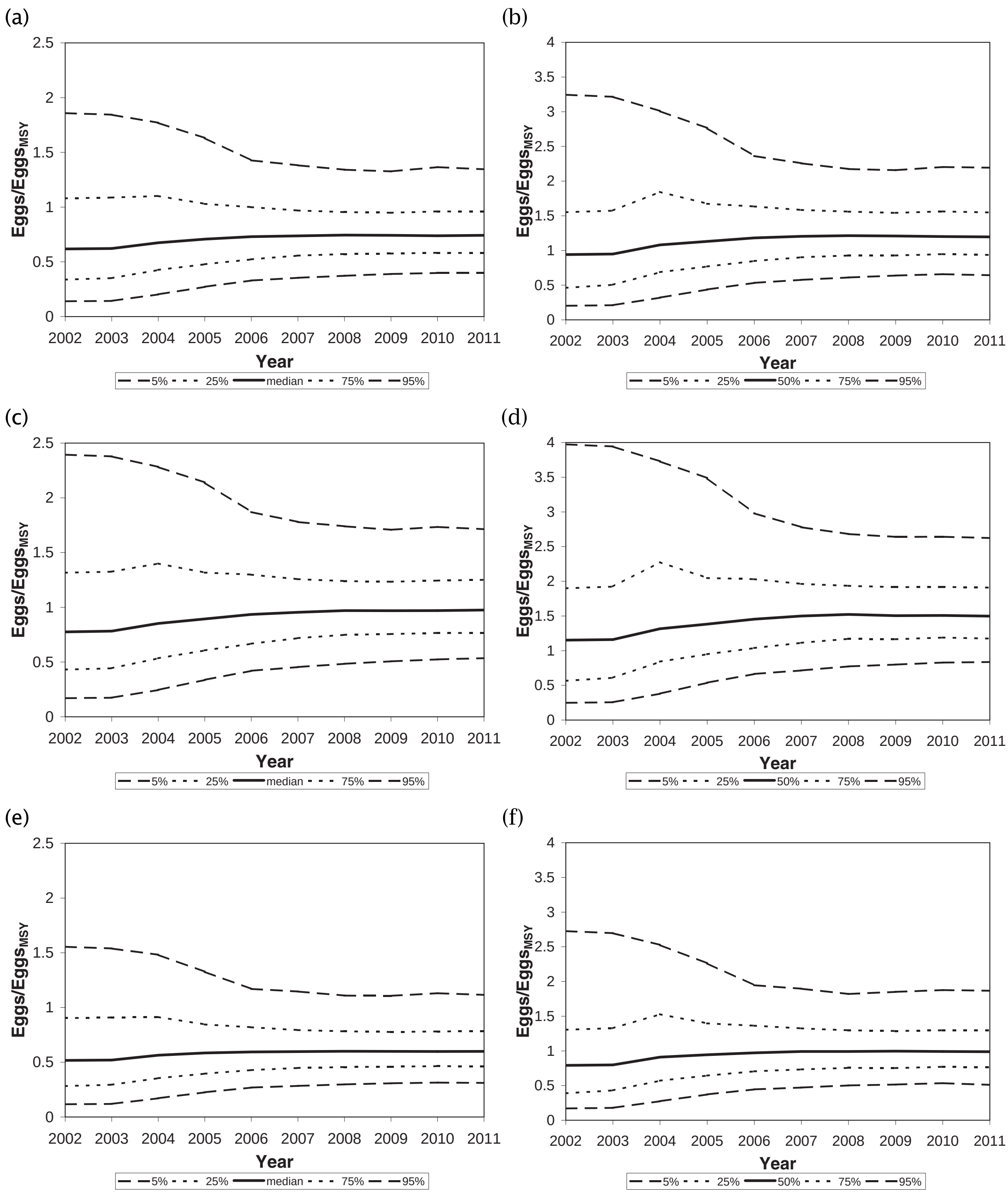


Figure 23. Projected egg production $\mathcal{E}$ relative to $\mathcal{E}_{MSY}$, under three management scenarios. (a) and (b) weighted average and base-run projections, respectively, under current F; (c) and (d) same at 75% of current F; (e) and (f) same at 125% of current F. Current F for projections is computed as geometric mean of last 3 years (Table 4).



9.2 Projection results

Although starting conditions for the projections were taken from the assessment model, there is a difference in the method of computing spawning stock size $\mathcal{E}$ in 2002 (the first projection year). In both models, population numbers are computed at the start of each year (January 1). In the assessment proper, population size estimates for 2002 were calculated from N_{2001}, F_{2001}, landings for 2001, and a deterministic forecast of recruitment, using the Beverton–Holt spawner–recruit model estimated by the assessment model. As part of those population size estimates, an estimate of $\mathcal{E}_{2002}$ is shown in Table 4. However, in projections, a *stochastic* recruitment was computed in 2002. Also, to simplify computations in the limited time available, F_{2001} in the projections was set to the same value used in other projection years (Table 4). For those reasons, and because median values are shown in Figures 21–23, the values of $\mathcal{E}$ and $\mathcal{E}/\mathcal{E}_{\mathrm{MSY}}$ in 2002 in Figures 21–23 differ from those in Table 4.

Projection results indicate that the population and yield are not expected to change markedly under any scenario considered. Substantial uncertainty in the projections is apparent from the range of the computed percentiles. It is also apparent that the distribution of egg production and yield is skewed toward higher values. The projections are considered somewhat optimistic because the years (1983–1998) chosen by the AW as the basis of recruitment in the projections are years of higher than average recruitment variability, and thus (given the approximately lognormal distribution of recruitment) years of higher than average recruitment. This explains the difference between the projection results and the per–recruit analysis (Figure 20b), which estimated that a reduction in F would lead to slightly higher yield under constant average recruitment.

10 Research recommendations

The group 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 vermilion snapper.

1. The statistical weights assigned various data sources in the assessment model can influence the results. At present, weights are determined heuristically to provide a balance of fit to all data sources. The group recommends further research to investigate methods of weighting data sources, e. g., based on their apparent significance, relevance, or reliability.

2. Fishery-independent data collected by the MARMAP program are used in many stock assessments in this region, and the National Research Council has recommended that fishery-independent data play a more important role in stock assessment generally. However, the MARMAP sampling programs do not having ideal extent, either in area coverage or in sampling intensity, for vermilion snapper. The group recommends that the MARMAP program expand its coverage, particularly into deeper water, as needed.

3. Under many forms of management, considerable discarding of vermilion snapper could be expected to occur. The group recommends that sampling programs be strengthened to quantify discard rates, especially in the commercial fishery, where the discard mortality rate is believed higher, and to estimate discard mortality rates better. The group recommends that research be instituted on management strategies that could reduce discard

mortality.

4. Data have been recorded from commercial catch logbooks since 1993. However, logbook data have not been incorporated into stock assessments in the South Atlantic because of apparent difficulties in analyzing the data. The DW and AW both recommended that an investigation be undertaken to determine the feasibility of and best methodology for using commercial logbooks to develop an abundance index for the commercial fishery for vermilion snapper.

5. An important data element for stock assessment, including vermilion snapper, is routinely collected age-composition data for major fisheries. The DW and AW recommend that regular statistical sampling and analysis of vermilion snapper for aging is needed, in both the commercial hook-and-line and headboat fisheries. A minimum sample size of 500 ages per year is recommended from each fishery.

6. Abundance indices for vermilion snapper indicate only minor fluctuations in population abundance during the model time period. This low population contrast is partly responsible for the large uncertainty in estimates derived from the model. The AW recommends that alternative age-structured models be investigated for vermilion snapper and other low contrast populations to determine whether more robust population estimates might be achieved.

7. Recreational landings estimates for vermilion snapper (and other species) in the MRFSS database are often highly variable, resulting in large year-to-year swings in the estimates. Those swings apparently reflect sampling error, rather than true fluctuations in fishery landings. Such large year-to-year changes can influence assessment models in undesirable ways. The AW recommends that smoothing techniques be investigated to potentially reduce some of those large year-to-year changes. This will be particularly important for other species, many of which are taken in larger fractions by the recreational fisheries sampled by MRFSS.

8. Although an age-structured model was ultimately not used in this assessment of vermilion snapper, it was noticed when developing this model that fecundity estimates were available only by length and not by age. The AW recommends that fecundity estimates at age be developed for future use in age-structured models.

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Appendix A Terms of reference for the second SEDAR 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, B_{MSY}, MSST, MFMT, and F_{MSY}). Other standard benchmarks should also be provided (e.g., $F_{0.1}$, $F_{\max}$, 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 [sic] and B_{MSY}; 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.

A list of additional specific questions from the Council may be developed and if so, it will be presented to the Stock Assessment Workshop at its meeting.

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

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Appendix C—Abbreviations and symbols

Table 5. Acronyms, abbreviations, and mathematical symbols used in this report

Symbol	Meaning
AW	Assessment Workshop (here, for vermilion snapper)
B	Total biomass of stock
CPUE	Catch per unit effort; used after adjustment as an index of abundance
DW	Data Workshop (here, for vermilion snapper)
$\mathcal{E}$	Population egg production, a measure of spawning-stock size
$\mathcal{E}_{\mathrm{MSY}}$	Level of $\mathcal{E}$ at which MSY can be attained
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
lb	Pound(s)
M	Instantaneous rate of natural (non-fishing) mortality
MARMAP	Marine Resources Monitoring, Assessment, and Prediction Program, a fishery-independent data collection program of SCDNR
MFMT	Maximum fishing-mortality threshold; a limit reference point used in U.S. fishery management; often based on F_{MSY}
mm	millimeter(s)
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 vermilion snapper as $(1-M)\mathcal{E}_{\mathrm{MSY}} = 0.75\mathcal{E}_{\mathrm{MSY}}$.
MSY	Maximum sustainable yield
mt	Metric tons(s)
N	Number of fish in the population at the start of a time period
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
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)

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April 2, 2003

MEMORANDUM FOR: Nancy Thompson

CC: Alex Chester
John Merriner
Gerald Scott

FROM: Michael Prager

SUBJECT: SEDAR Vermilion Snapper and Black Seabass Corrections

As you are aware, a data transcription error was identified after the review of the recent SEDAR assessment of vermilion snapper in the Atlantic. The error occurred when recreational (MRFSS) landings data were scaled from kilograms to metric tons, although they were already in metric tons. Therefore, the assessment model was run on data that under-represented the MRFSS landings. The results in the Assessment Workshop report reflect that error, as it was discovered after completion of the SEDAR peer review.

When we became aware of the error, the Population Dynamics team in Beaufort recomputed the base run and sensitivity runs on the corrected data set. This memorandum is to advise you of the results of the corrected model runs.

We also reviewed the input data files used for both assessment models against the data files supplied by data holders during or following the Data Workshop. A few other issues were identified. Among them were use of standard error rather than coefficient of variation for weighting the MARMAP hook-and-line index (vermilion snapper); use of the 1984–1989 maturity vector rather than the 1978–1983 vector for 1983 (black seabass); a weakly determined selectivity specification for the early years (black seabass); and a penalty on large deviations in F over the last 5 vs. last 3 years (black seabass). In all these cases, model sensitivities were examined, and the resulting estimates of stock status and benchmarks demonstrated little, if any, difference. The sensitivity runs are included on the SEDAR CD along with the wide range of other sensitivities considered by SEDAR participants.

A major goal of the SEDAR process is quality assurance of stock assessments. In light of the issues noted above, we have devised new procedures to strengthen quality assurance in future SEDAR assessments. Those procedures are described for your approval in a separate memorandum.

Vermilion Snapper Landings Data Correction

Corrected MRFSS landings of vermilion snapper represent about 21% of the Atlantic landings of vermilion snapper off the southeast U.S. (Table 1, Figures 1 and 2).

Table 1. Landings (mt) of vermilion snapper in the southeast U.S. Atlantic Ocean.

Year	Commercial hook-and-line	Commercial trawl	Commercial other	Headboat	Recreational MRFSS
1970	7.8	1.0	0.0	--	--
1971	20.5	2.7	0.0	--	--
1972	28.7	3.5	5.6	--	--
1973	36.2	5.0	1.8	--	--
1974	49.8	5.3	0.4	--	--
1975	83.5	9.4	0.4	--	--
1976	84.3	11.0	3.4	146.8	--
1977	101.0	12.3	4.8	90.8	--
1978	144.8	6.6	1.4	131.2	--
1979	160.4	25.0	17.5	97.2	--
1980	187.3	78.1	64.4	90.0	--
1981	185.6	60.6	57.1	104.5	19.6
1982	252.1	62.8	59.4	154.2	322.1
1983	221.4	52.6	49.3	134.0	316.8
1984	298.9	47.5	41.9	111.3	251.2
1985	415.8	14.4	6.5	202.7	672.2
1986	406.8	11.0	7.3	158.5	50.3
1987	330.4	9.6	9.1	205.0	128.0
1988	369.8	46.7	41.3	189.9	130.8
1989	509.5	10.4	6.3	157.2	248.9
1990	539.6	15.5	43.8	175.4	105.6
1991	614.0	12.6	22.4	151.2	181.4
1992	341.8	5.8	0.3	113.2	95.8
1993	401.4	1.7	2.8	117.3	104.0
1994	431.7	11.6	3.1	127.8	73.9
1995	415.1	15.4	3.9	123.7	88.5
1996	340.0	5.0	2.3	125.6	81.5
1997	346.0	2.2	2.3	138.5	94.7
1998	323.9	1.1	0.6	125.3	99.7
1999	354.1	5.0	6.6	159.2	208.7
2000	510.1	16.0	2.9	190.3	261.7
2001	615.6	31.0	0.5	192.5	243.7

Figure 1. Atlantic landings (mt) of vermilion snapper off the southeast U.S.

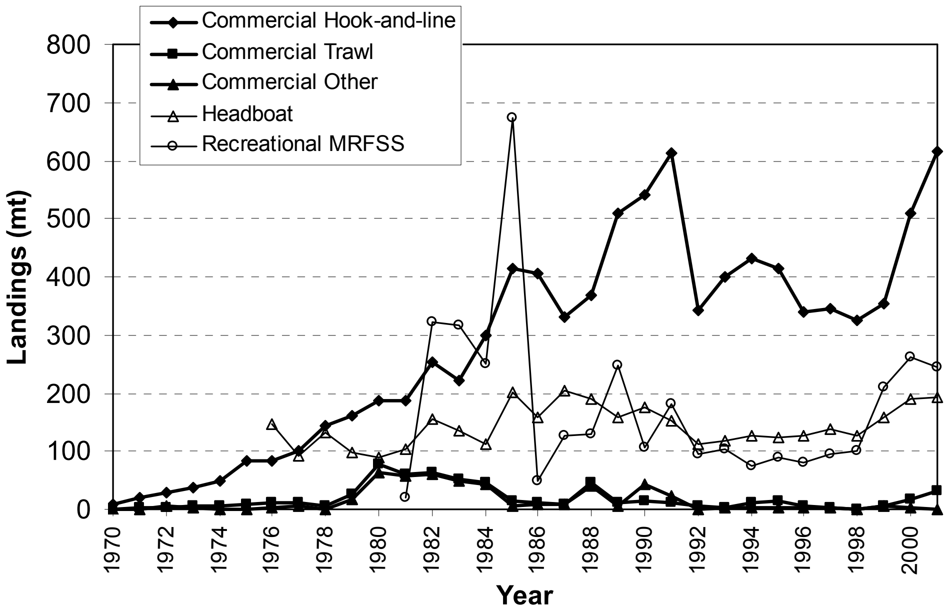
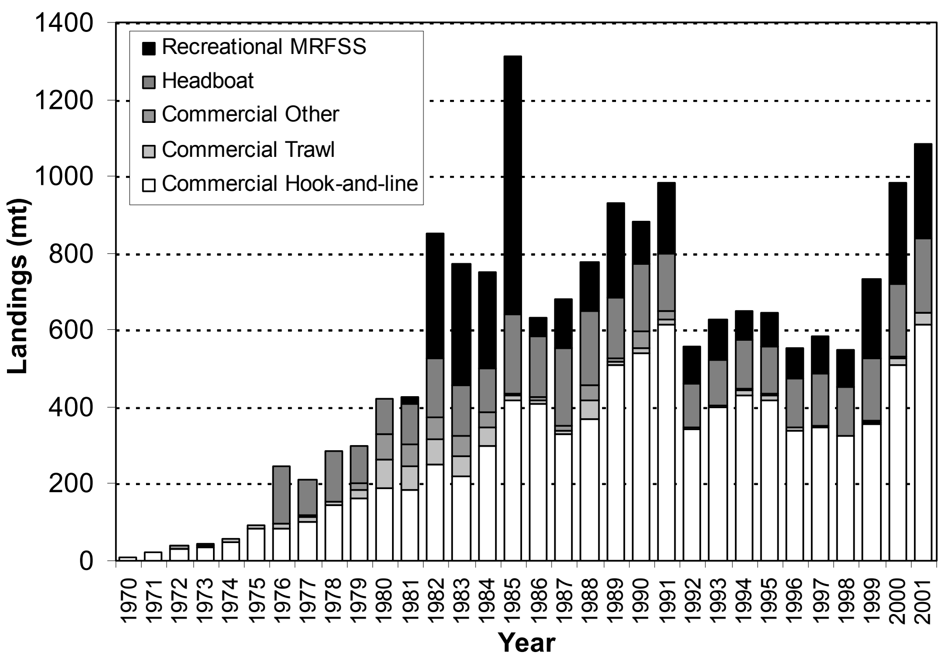


Figure 2. Total landings (mt) of vermilion snapper in the southeast U.S. Atlantic Ocean



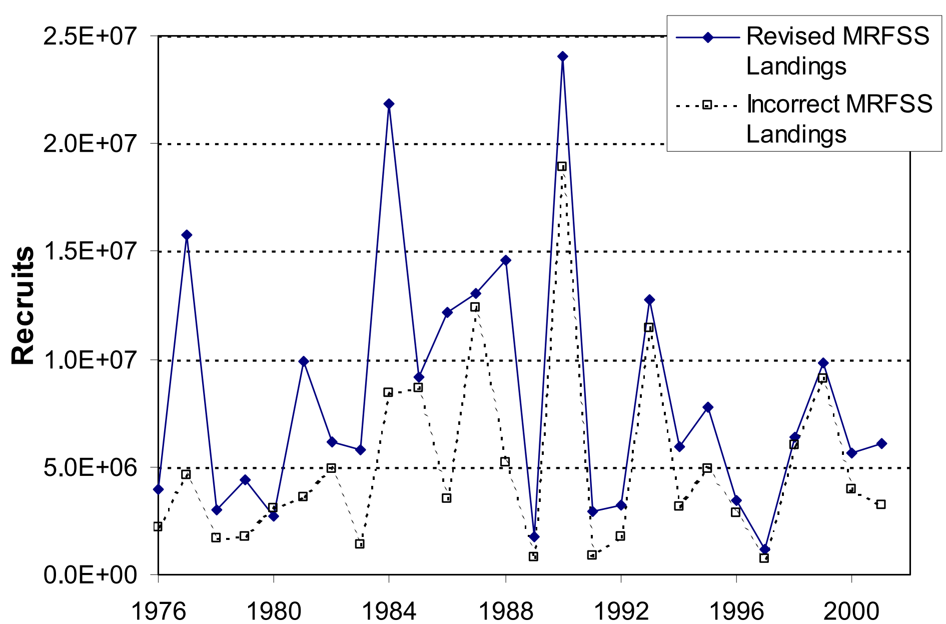
Revised assessment results

Revised runs of the vermilion snapper model were made with corrected MRFSS landings but no other changes. Results of the corrected base run (M=0.25/yr and steepness estimated) are compared to the original base run in the following figures. Comparison of corresponding sensitivity runs can be made by examining Table 2 and Figure 7.

Recruitment

Annual estimates of recruitment were higher in the corrected run, as would be expected from the increase in landings data, but the general pattern in recruitment was similar to the original run (Figure 3). Estimated recruitment in 1984 differed the most between runs, which is probably a result of the unusually large landings estimate by MRFSS in 1985 (Figure 1). Estimates from MRFSS in the mid-1980s have appeared irregular in a number of species.

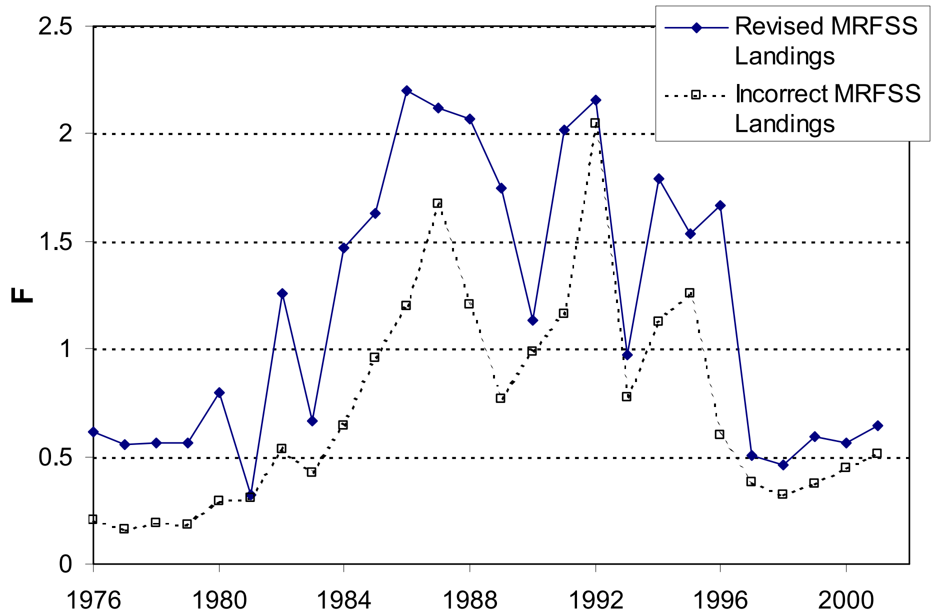
Figure 3. Recruitment estimates from the base run vermilion snapper model.



Fishing Mortality Rate

Estimates of fully-selected fishing mortality rate F were higher in the corrected run, and again the general pattern estimated was similar to that of the original analysis (Figure 4). Estimates of F for the most recent years differed least between runs (Figure 4).

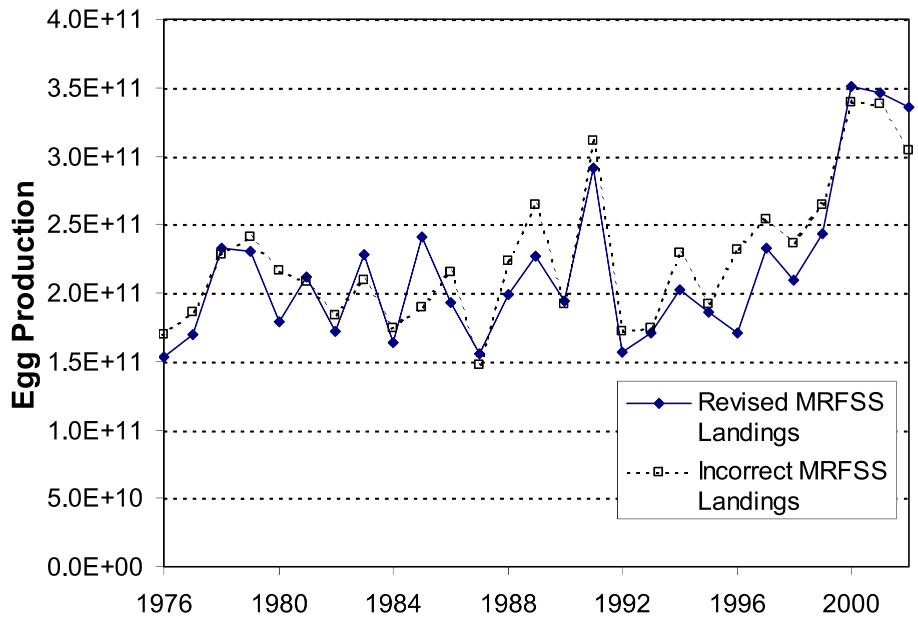
Figure 4. Fishing mortality rate (F) estimates from the base run vermilion snapper model.



Spawning-stock size (egg production)

Estimates of egg production did not change appreciably with the corrected landings (Figure 5).

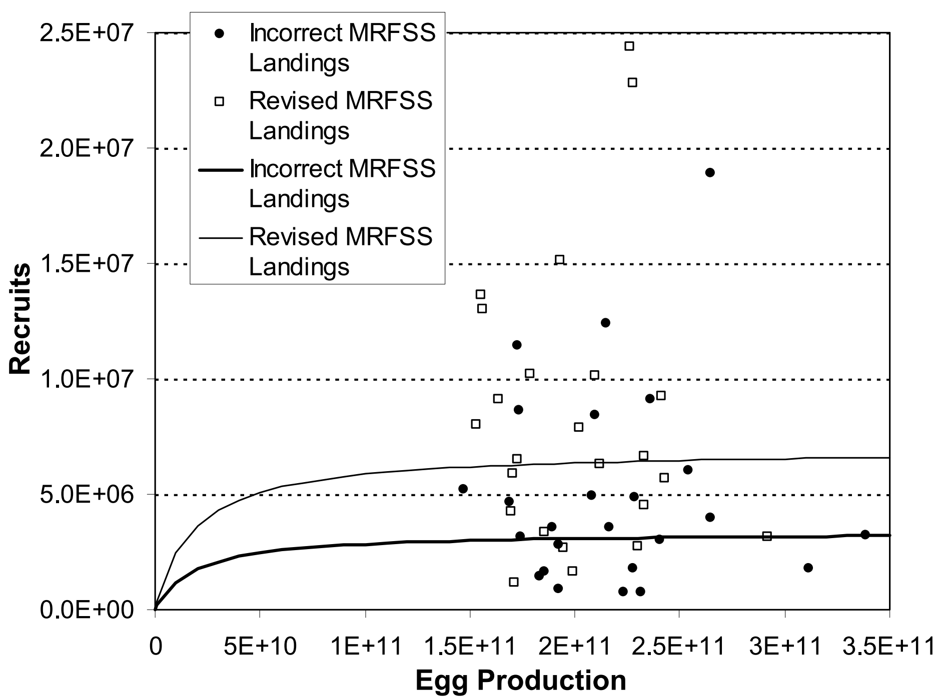
Figure 5. Egg production estimates from the base run vermilion snapper model.



Stock–recruitment curve

The combination of higher recruitment estimates and relatively unchanged egg-production estimates resulted in an increase in the estimated stock–recruit curve (Figure 6). The overall pattern of estimated stock–recruit data was similar. As noted in the Assessment Workshop report, these stock and recruitment data are relatively uninformative about the underlying stock–recruit relationship, a situation that causes substantial uncertainty in estimating maximum sustainable yield (MSY) and its associated benchmarks, F_{MSY} and E_{MSY} (for vermilion snapper, egg production E is used to represent spawning-stock size).

Figure 6. Stock-recruit curve estimates from the base runs of vermilion snapper model.



Benchmarks and status indicators from base runs

The customary SFA benchmarks and status indicators are based on MSY theory, which means that in an age-structured context they depend on the stock–recruitment relationship. As noted above, the stock and recruitment estimates for this stock did not define that relationship very well, either in the original base run or in the corrected base run. Adding to this uncertainty, the estimated steepness parameter (h) of the recruitment curve reached the upper bound of allowed values in the corrected base run, an indication that the data are uninformative about expected recruitment at lower levels of spawning stock size. That result further weakens the credibility of

MSY-based estimates from that run and strengthens the argument for using proxy-based benchmarks and status indicators instead.

Nonetheless, estimates of benchmarks and status indicators in F were similar between the original and corrected base runs (bold rows in Table 2). In particular, Fmsy differed only slightly (an increase from 0.32/yr to 0.36/yr), and the ratio of F in 2001 to Fmsy also increased (from 1.6 to 1.8). Because of the uncertainty in the stock–recruitment curve, the review panel recommended using Fmax as a proxy for Fmsy. Fmax increased slightly (from 0.35 to 0.38) and the ratio of F in 2001 to Fmax also increased (from 1.48 to 1.71; not shown in Table 2) when the data were corrected. Thus, the original run and the run on corrected data both indicate the stock as currently undergoing overfishing, regardless of whether Fmsy or a proxy based on Fmax is used.

The situation is less clear when benchmarks and status indicators in spawning-stock biomass are considered. Although using Fmax as a proxy for Fmsy avoids the uncertainty associated with the stock–recruitment relationship, the expected spawning-stock biomass (or egg production) associated with Fmax still depends on an estimate of average future recruitment. As that is not well estimated from the available data, all estimates of biomass-related benchmarks and status are highly uncertain. Subject to that uncertainty, the original base run estimated that egg production in 2002 was 1.23 of the egg production associated with MSY, while the corresponding estimate from the corrected run was 0.66, which would correspond to the overfished condition. Both the Assessment Workshop report and the review panel (in its Advisory Report on Stock Status) were reluctant to accept estimates of biomass status at face value.

Sensitivity runs and phase plots

Estimates of status indicators from all sensitivity runs (Figure 7) are credible only to the degree that the data in Figure 6 define a meaningful stock–recruitment relationship. In both panels, sensitivity runs C, F, and J resulted from assuming a rather low value of steepness (h=0.5), which was specified as a sensitivity value but not necessarily thought realistic by Data Workshop and Assessment Workshop participants. Taken at their face value, most estimates in Figure 7(b) imply that the stock is in an overfished condition. The sensitivity runs, however, should be considered with no less skepticism than the base runs where MSY-based benchmarks are concerned. As in the base runs, estimates of Fmax are not influenced by uncertainty of the recruitment curve. Estimates of Fmax (the proxy for Fmsy recommended by the review panel) from the corrected runs are similar to those from the original runs (Table 2).

Table 2. Parameter estimates of natural mortality (M), steepness (h), virgin recruitment (R0), fishing mortality (F), maximum fishing mortality threshold (MFMT), egg production (E), and maximum spawning stock threshold (MSST) from the base and sensitivity runs for the vermilion snapper model.

Estimates from Assessment Workshop report

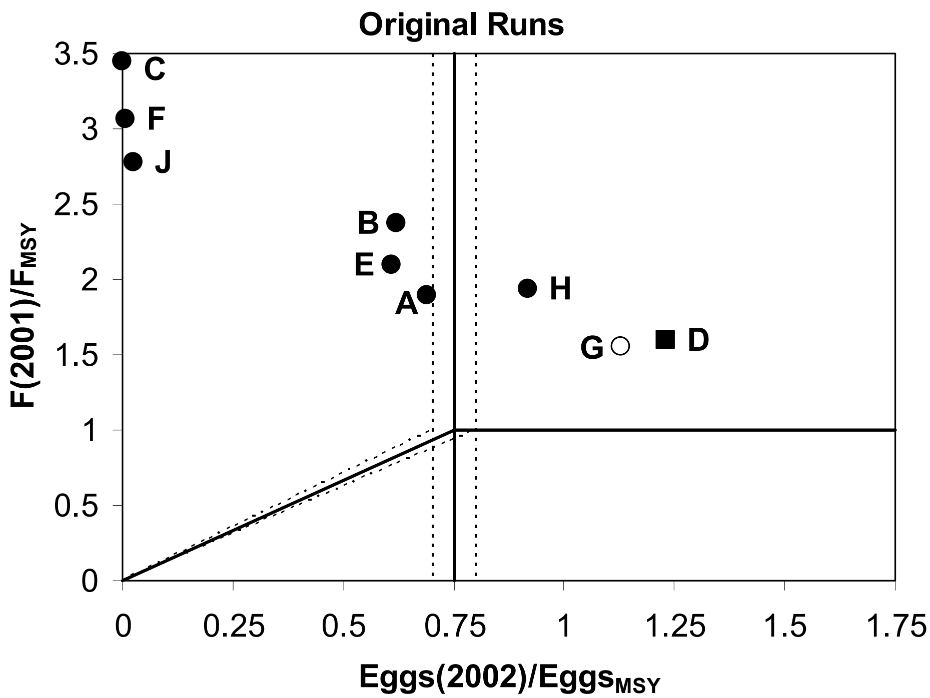
Run	M	h	R0	F(2001)	Fmsy	F(2001)/ Fmsy	F40%	Fmax	MFMT	F(future)	Emsy	E(2002)	E(2002)/ Emsy	MSST
A	0.2	0.93	3.97E+06	0.56	0.295	1.89	0.265	0.315	0.25	0.45	3.96E+11	2.74E+11	0.69	3.17E+11
B	0.2	0.7	4.62E+06	0.56	0.235	2.37	0.28	0.33	0.18	0.50	4.66E+11	2.89E+11	0.62	3.73E+11
C	0.2	0.5	2.47E+09	0.55	0.16	3.45	0.285	0.35	0.00	0.49	2.57E+14	3.15E+11	0.00	2.06E+14
D	**0.25**	**0.9**	**3.27E+06**	**0.51**	**0.32**	**1.60**	**0.32**	**0.345**	**0.32**	**0.44**	**2.47E+11**	**3.04E+11**	**1.23**	**1.85E+11**
E	0.25	0.7	6.37E+06	0.56	0.265	2.10	0.335	0.36	0.22	0.50	5.04E+11	3.08E+11	0.61	3.78E+11
F	0.25	0.5	6.82E+08	0.55	0.18	3.06	0.33	0.355	0.00	0.49	5.65E+13	3.34E+11	0.01	4.24E+13
G	0.3	0.95	4.09E+06	0.53	0.34	1.55	0.345	0.35	0.34	0.46	2.76E+11	3.11E+11	1.13	1.93E+11
H	0.3	0.7	5.16E+06	0.54	0.28	1.93	0.37	0.37	0.28	0.48	3.38E+11	3.11E+11	0.92	2.37E+11
J	0.3	0.5	2.24E+08	0.54	0.195	2.78	0.37	0.37	0.01	0.48	1.52E+13	3.59E+11	0.02	1.06E+13

Estimates with corrected MRFSS landings

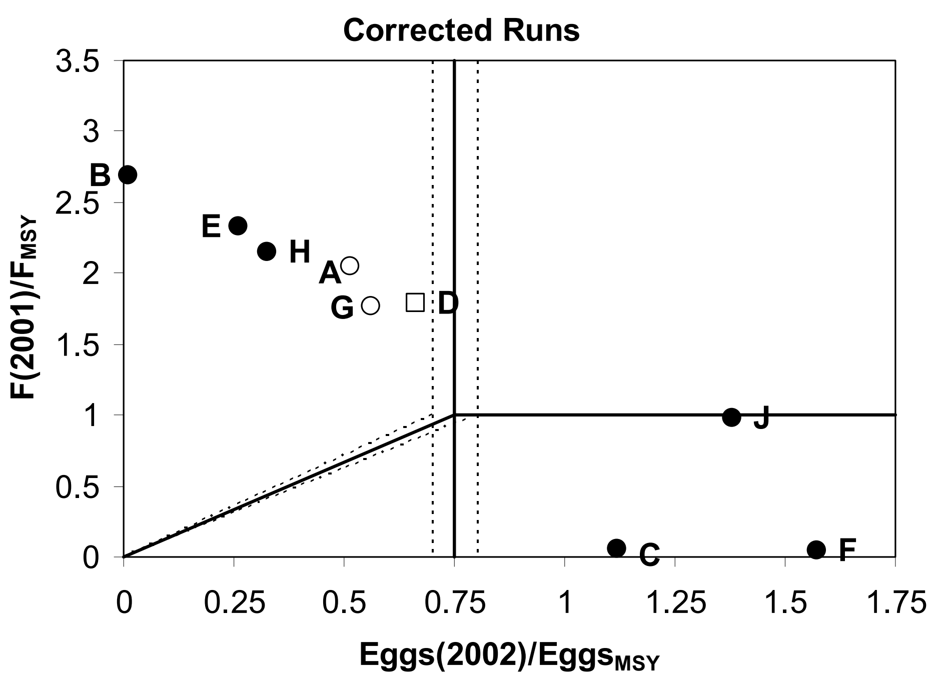
Run	M	h	R0	F(2001)	Fmsy	F(2001)/ Fmsy	F40%	Fmax	MFMT	Ffuture	Emsy	E(2002)	E(2002)/Emsy	MSST
A	0.2	0.95	6.66E+06	0.67	0.325	2.05	0.27	0.34	0.21	0.62	6.28E+11	3.23E+11	0.51	5.02E+11
B	0.2	0.7	3.34E+08	0.65	0.24	2.69	0.275	0.34	0.00	0.60	3.28E+13	4.15E+11	0.01	2.62E+13
C	0.2	0.5	3.04E+08	0.01	0.165	0.05	0.37	0.3	0.17	0.01	2.25E+13	2.52E+13	1.12	1.8E+13
D	**0.25**	**0.95**	**6.84E+06**	**0.64**	**0.36**	**1.78**	**0.33**	**0.375**	**0.32**	**0.60**	**5.06E+11**	**3.35E+11**	**0.66**	**3.8E+11**
E	0.25	0.7	1.83E+07	0.64	0.275	2.33	0.33	0.375	0.10	0.60	1.41E+12	3.72E+11	0.26	1.06E+12
F	0.25	0.5	2.48E+08	0.01	0.175	0.04	0.48	0.295	0.18	0.01	1.70E+13	2.66E+13	1.57	1.27E+13
G	0.3	0.95	9.59E+06	0.68	0.385	1.77	0.365	0.4	0.31	0.63	6.15E+11	3.46E+11	0.56	4.3E+11
H	0.3	0.7	1.83E+07	0.65	0.3	2.15	0.375	0.4	0.14	0.60	1.17E+12	3.79E+11	0.32	8.17E+11
J	0.3	0.5	1.67E+07	0.20	0.2	0.98	0.505	0.345	0.20	0.15	1.01E+12	1.39E+12	1.38	7.05E+11

Figure 7. Relative benchmark estimates for vermilion snapper from original runs (a) and runs with corrected MRFSS landings data (b). Base run in each case is labeled D and shown with a square symbol. Runs with recruitment parameter h (steepness) at a constraint are shown with hollow symbols; others, with solid symbols. Run labels (letters) match Table 2. Vertical lines represent MSST. Horizontal and oblique lines represent MFMT.

(a)



(b)



May 1, 2003

MEMORANDUM FOR: John Carmichael, SAFMC SSC Chair

CC: J. Merriner, G. Scott

FROM: Mike Prager, NOAA Beaufort Lab

SUBJECT: Variability around SEDAR black seabass and vermilion snapper benchmark estimates

This is to follow up on the recent request by the SSC Subcommittee for measures of uncertainty around benchmarks estimated in SEDAR assessments of black seabass and vermilion snapper. In last year's SEDAR assessment of red porgy, 80% confidence intervals were provided around the benchmark estimates, but for technical reasons, it was not possible to compute such confidence intervals for the two more recent assessments. Therefore, we have used a nonparametric method to approximate them. I am happy to forward the following computations from our group. Questions should be addressed to Dr. Kyle Shertzer.

I. Black Seabass

To approximate an 80% confidence intervals, we have tabulated 10th and 90th percentiles from the vector of sensitivity run estimates (Table 6.2 of assessment report, dated 14 Feb 2003), statistically weighted by the probabilities assigned by the Assessment Workshop (Table 6.1). That is, a value with weight 1/16 was represented in the vector once; a value with weight 2/16 was represented twice; and a value with weight 4/16 was represented four times. After the full vector was constructed, percentiles were determined and are tabulated below.

	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

The values for MFMT are based on the default MSY control rule in Restrepo et al. (1998), *Technical Guidance On the Use of Precautionary Approaches to Implementing National Standard 1 . . . .* In that default control rule, MFMT becomes smaller as the stock size declines below MSST. It is our understanding that under the National Standards Guidelines, the Council could specify a different MSY control rule. If they were to specify, for example, MFMT = F_{MSY}, the tabulated statistics for F_{MSY} would also apply to MFMT.

II. Vermilion Snapper

The 80% confidence intervals on vermilion snapper benchmarks were also approximated as the 10th and 90th percentiles from the weighted vector of estimates (with corrected MRFSS landings). They are tabulated below.

Because the Assessment Workshop and Review Workshop expressed little confidence in the estimates of biomass-related benchmarks for vermilion snapper, and the Subcommittee preferred to consider them unknown, we have not given intervals for them. Thus, there are no intervals for B_{MSY} or MSST.

Lacking good estimates of the stock-biomass status relative to the corresponding benchmark, it is not possible to use the default control rule of Restrepo et al. to define MFMT. Therefore, the Council might wish to use MFMT=F_{MSY}. The Review Workshop and SSC Subcommittee recommended using F_{max} as a proxy for F_{MSY}. If the Council adopts that recommendation and uses that control rule, the approximated interval on F_{max} would be the appropriate one to use for MFMT.

	Fmsy	Fmax	F(2001)/ Fmsy	F(2001)/ Fmax
Base Run	0.36	0.375	1.78	1.71
10th Percentile	0.175	0.298	0.045	0.034
90th Percentile	0.373	0.40	2.33	1.94

Excerpt from the Second SEDAR Review Panel Consensus Summary

Vermillion Snapper

Second SEDAR

(South East Data, Assessment and Review)

Consensus Assessment Report

on the assessments of the Status of the Stocks

of

Vermilion Snapper and Black Sea Bass from the south east of the U.S.

Second SEDAR Review Panel Workshop
RALEIGH, NC 27605
February 25 – 28, 2003

Second SEDAR Consensus Assessment Report
Vermilion Snapper and 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 28^{th}; 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 28^{th}; 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. Vermilion Snapper

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 conducting an assessment.

3.1.2. The Panel noted that the limited time series of the indices of abundance appeared to reflect a lack of contrast in the levels of exploitation to which the stock had been subjected in the period covered by the time series. This greatly reduced the information content of the data and led to imprecise estimates of MSY based benchmarks, as stated in the assessment workshop report.

3.1.3. The Panel noted that the headboat index appeared to be strongly influential, but recognized that this index might not adequately represent the entire stock as this fishery does not extend to the deepest waters where vermilion snapper are taken. The Panel expressed the view that an index or indices of abundance should be developed using data from the commercial fishery and that this index should be considered for inclusion in the next stock assessment for this fishery. For commercial logbook data, costs might be reduced by analyzing a representative subset of the full data set or by analyzing the logbooks derived from a selected subset of representative vessels.

3.1.4. The Panel was concerned that the fishery-independent indices of abundance (*i.e.* MARMAP) did not cover the full extent of the offshore range of the stock and were constrained to a period from May to September. The Panel recommended that consideration should be given to developing robust fishery-independent indices of abundance that are likely to be more representative of the spatial distribution of the stock, and representative of all months of the year.

3.1.5. The Review Panel voiced its concern that the MARMAP sampling is being downgraded due to budget constraints.

3.2. Adequacy and appropriateness of the models

3.2.1. The Panel acknowledged that, based on the available information, the implementation of the models was sound and endorsed the decision to use both a production model and a length-structured forward projection model for the assessment of the vermilion snapper stock.

3.2.2. The Panel acknowledged that, because there was only limited information on historical abundances, the Assessment Workshop was unable to fit the production model.

3.2.3. The Review Panel noted that the value estimated for the steepness[1] of the stock-recruitment relationship in the base run of the model was 0.9, a result which would imply that recruitment shows little dependence on egg production.

3.2.4. The Review Panel concurred with the Assessment Workshop's conclusion that the estimate of MSY was uncertain and endorsed the decision that F_{max} should be proposed as an appropriate proxy for F_{msy}. The Review Panel agreed that the estimate of the current level of egg production (a measure of spawning stock size) was poorly estimated, as the sensitivity analyses produced widely disparate estimates of egg production, but noted that the estimates of F and of F_{max} were relatively consistent among the alternative sensitivity runs.

3.2.5. The Panel suggested that, in future assessments, consideration should be given to calculating and presenting estimates of the abundance-at-age weighted fishing mortality to supplement the information that is presented on the fishing mortality for fully-recruited fish.

3.3. Adequacy and appropriateness of the models used to evaluate short-term projections

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

3.3.2. There is a high level of uncertainty in determining whether or not the stock is overfished. The SEDAR Review Panel concluded that the stock was

[1] The "steepness" of the stock-recruitment relationship, which was used in the model, is a value that can range from 0.2 to 1.0 and is the fraction of the virgin recruitment that will recruit to the fishery when the spawning stock is reduced to 20% of its virgin level. If steepness is 0.2, recruitment is directly proportional to the size of the spawning stock, whereas if steepness is 1.0, recruitment is constant and independent of the size of the spawning stock.

not overfished by restricting its attention to points E, D, H, and G in the phase plot of status indicators (Figure 19[2]). These four points reflect the uncertainty in the stock-recruitment relationship by spanning a wide range for steepness (0.7-0.95) and the most likely range for natural mortality (0.25-0.3/yr).

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 proposed that MARMAP conduct a synoptic study of their gear to provide a basis for comparing relative gear efficiencies. This would allow a more comprehensive fishery-independent index to be developed.

3.4.2. Age samples from the various fishery sectors need to be increased and collected appropriately for use in stock assessment.

3.4.3. 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.

3.4.4. MARMAP should be expanded into deeper water to assure greater representation of the spatial range of the stock.

3.4.5. A monitoring program should be developed to collect data on the magnitude and the size/age composition of the vermilion snapper that are discarded by each fishing sector and from each fishing gear.

3.4.6. An index of recruitment representative of the entire stock should be developed for vermilion snapper.

3.4.7. The Panel recommended that, as an alternative model that could be applied in parallel with the existing model, consideration might be given to combining the indices of abundance externally and using the resultant combined index in the length-structured model rather than including the separate indices within the model. This suggestion was also made with respect to the black sea bass assessment. The external analysis might provide better understanding of the input data and make the weighting more transparent.

[2] References to tables and figures refer to the tables and figures presented in the corresponding report from the Assessment Workshop.

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

Excerpt from the Second SEDAR Review Panel Advisory Report

Vermillion Snapper

Second SEDAR

(South East Data, Assessment and Review)

Advisory Report

on the status of the stocks of

Vermilion Snapper and Black Sea Bass from the south east of the U.S.

Second SEDAR Review Panel Workshop
RALEIGH, NC 27605
February 25 – 28, 2003

Second SEDAR Advisory Report on Stock Status
Vermilion Snapper and Black Sea Bass
RALEIGH, NC 27605
February 25 - 28, 2003

I. Vermilion Snapper

1. Status of Stock

The assessment indicates that overfishing is occurring but that the stock is not currently overfished. However, SFA benchmarks are estimated from the stock-recruitment relationship, in which the SEDAR Review Panel did not have confidence.

The estimate of the current fishing mortality, F, is taken as the average F over the last 3 years (F_{proj}=0.44/yr). F_{proj} is considered to be a robust prediction of current F because it reduces the influence of uncertainty about recent recruitment. F_{proj} was consistently above the F_{MSY} and F_{max} values under the full range of sensitivity runs.

There is a high level of uncertainty in determining whether or not the stock is overfished. The SEDAR Review Panel concluded that the stock was not overfished by restricting its attention to points E, D, H, and G in the phase plot of status indicators (Figure 19[1]). These four points reflect the uncertainty in the stock-recruitment relationship by spanning a wide range for steepness[2] (0.7-0.95) and the most likely range for natural mortality (0.25-0.3/yr).

2. Biological Reference Points

Previous Assessment
According to the existing pre-SFA overfishing definition, vermilion snapper are overfished if the SPR is less than 30%. The most recent estimate of SPR (prior to the current assessment) was 21-27%, which means that, using this definition, vermilion snapper should be considered overfished.

[1] References to tables and figures refer to the tables and figures presented in the corresponding report from the Assessment Workshop.
[2] The "steepness" of the stock-recruitment relationship, which was used in the model, is a value that can range from 0.2 to 1.0 and is the fraction of the virgin recruitment that will recruit to the fishery when the spawning stock is reduced to 20% of its virgin level. If steepness is 0.2, recruitment is directly proportional to the size of the spawning stock, whereas if steepness is 1.0, recruitment is constant and independent of the size of the spawning stock.

Current assessment
The Review Panel advises the following –
1. Use F_{max} (currently estimated as 0.35/yr) as a proxy for F_{msy} (MFMT);
2. Therefore, the proxy for MSY may be taken as the yield associated with F_{max};
3. Estimates of MSST are poorly determined and range from 185 billion to 378 billion eggs, for values of steepness ranging from 0.7 to 0.95 and of the natural mortality rate ranging from 0.25 to 0.3 per year.

3. Forecast

If recruitment occurs at or above the estimated average levels for the 1983-98 time period (as used in projections), and the fishing mortality rate is maintained at the current level (F_{proj}), then the stock biomass is likely to increase over the next few years. Although F_{proj} was consistently above F_{max}, above average annual recruitment was experienced between 1983-98, thus producing the projected increase in biomass.

4. Special Comments

The estimated abundance indices used in the assessment of this stock are based on a limited spatial coverage that does not fully reflect the entire stock. In the short-term, information from the commercial fishery on the abundance of larger vermilion snapper should be examined. Over the long-term, fishery independent sampling should be expanded. Attention should also be given to developing a recruitment index.

Effective monitoring of stock status will require more and improved data on discards. It is recommended that the bycatch logbook be continued and expanded estimates provided.

5. Source of Information

Report of Vermilion Snapper 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
Vermillion Snapper

Vermillion Snapper
Commercial Landings Documentation

Commercial landings data are available through the NMFS general canvas and TIP databases from 1958-2001. Data categories include those reported to species and those reported as snapper unclassified. State maintained records are available since 1972 for North Carolina and South Carolina, and since 1970 for Florida. No state records are available for Georgia.

Length samples are available since 1984 through TIP samples.

Data Issues
1. Mixing of species.

Vermillion snapper landings are variably recorded to species and as unclassified snappers. Reporting to species is more prevalent in recent years, and the proportion of total snapper landings reported as unclassified declines over time. Total vermillion landings are estimated for each state by combining landings reported to species and a portion of the unclassified snapper landings. In general, the proportion of vermillion landings relative to the total snapper landings reported by species is used as a multiplier to estimate the proportion of vermillion landings in the unclassified category. For years in which there are no landings reported by species, the time series average percent vermillion is used to estimate the portion of vermillion snapper in the unclassified category.

State Specific Details

North Carolina. The proportion of snapper unclassified declines steadily, from 100% for 1972-1977, to 48% for 1978-1984, to 20% for 1985-1988 to 1% for 1989-2001. Vermillion snapper represent 62% of the snappers landed to species for 1978-1983, and 93% for 1984-2001. Annual percentages of vermillion in landings reported to species are used to estimate the proportion of vermillion in the unclassified category for 1978-2001. The average (1978-2001) percentage of vermillion is used to estimate the proportion of vermillion in the unclassified category for 1972-1997. Since the proportion of unclassified landings declines over time, the difference between reported vermillion landings and adjusted landings also declines.

South Carolina. South Carolina landings from 1972-2001 are largely reported to species, with only 2% on average reported as unclassified. From 1972-1979 , 35% of the snapper landed to species are vermillion, increasing to 85% for 1980-2001. Annual percentages of vermillion in landings reported to species are used to estimate the proportion of vermillion in unclassified categories.

Georgia. Georgia landings are taken from the NMFS commercial statistics website, based on the vermillion snapper category.

Florida. Florida landings are based on the Atlantic Coast only, including all Monroe county before 1986 and Atlantic zones after 1986. All vermillion snapper landings are recorded to species in the database, so no adjustments of unclassified landings are required.

2. Gear Categories.

Landings by gear are available since 1992 for Florida, 1978 for North Carolina, and 1972 for South Carolina. Between 1992 and 2001 when all 3 states recorded landings by gear, 99% of vermillion snapper were landed by hook and line gears. However, significant trawl landings exist for the 1970's and 1980's, especially in SC. Trawl harvest of vermillion was outlawed in the late 1980's. Therefore, 3 gear categories were established: Hook and Line(including hook and line and electric or bandit reels), Trawls, and all others combined (longlines, gill nets, spears/gigs, traps and pots etc). For NC and SC where landings are adjusted for the unclassified snapper category, adjusted vermillion landings are allocated to gear categories based on the observed annual landings by gear for those landings reported to species and gear.

North Carolina: Landings by gear are available since 1978, with 99.1% taken by hook and line over the period. Landings for 1972-1997 were all allocated to the hook and line category. Adjusted landings are allocated based on proportion by gear for those landings reported to species.

South Carolina. Landings by gear are available since 1972, therefore landings for each year are allocated to the two gear categories based on annual gear proportions. Adjusted landings are allocated based on proportion by gear for those landings reported to species. Had trawl fishery in 70's and 80's.

Georgia. No gear information is available. Landings are allocated into gear categories based on the annual proportion by category for SC, from 1972-2001. GA assumed to have had a trawl fishery in 70's-80's, therfore assume gear categorization more similar to SC than NC

Florida. Gear information is available since 1992, with 95% landed by hook and line. The 1992-2001 average proportions by gear is used to allocate 1970-1991 landings to gear.

3. Length Distributions.

Length sampling is available through the TIP program for 1984-2001. An average of 4,590 lengths are taken annually, 4398 in the hook and line category and 192 in the other category. Lengths are tabulated into 20mm categories, from 140-500 mm , with all over 500 combined. Length samples are combined for the region. Lengths are also developed in 10mm categories, for trawl, hook and line, and other categories. Hook and line includes hook and line and electric or bandit rig categories from TIP. Other lines, such as troll or long line categories, are included in the other category.

Length sampling intensity, Atlantic Coast vermillion snapper, TIP program.

YEAR	HOOK LINE	OTHER	TOTAL
1984	3312	98	3410
1985	4914	0	4914
1986	3821	456	4277
1987	3558	362	3920
1988	2731	410	3141
1989	2665	157	2822
1990	2596	391	2987
1991	4775	631	5406
1992	3095	36	3131
1993	3942	149	4091
1994	3508	245	3753
1995	5870	237	6107
1996	3151	100	3251
1997	3042	43	3085
1998	3346	43	3389
1999	6220	32	6252
2000	9474	65	9539
2001	9152	0	9152
avg	4398	192	4590

Collection and Processing of Data for Vermilion Snapper Life History Studies
SAFMC / NMFS Data Workshop – October 2002

Sampling

Since 1977, vermilion snapper have been sampled with a variety of fishery-independent gear types from Cape Lookout, NC to Cape Canaveral, FL at depth ranging from 14 to 100 m (mean = 40 m). Specimens were collected primarily during May through August of each year. In addition, otoliths and gonads have been collected from vermilion snapper that were caught by commercial fishermen to estimate fecundity and to verify that increment formation is annual.

Fork length (cm) was recorded for all vermilion snapper collected during 1977-2001 for length frequency. Measurements of vermilion snapper used for life history studies included TL, FL and SL (nearest mm) and weight to the nearest gram (g). Prior to 1986, all vermilion snapper caught at sea were retained for life history studies. During 1986-1993, up to 15 fish from each 1 cm FL size class.

Aging of Fish

Ages were determined for most specimens collected during 1979-2001 (n = 2,891). None of the fish collected during 1994-1998 have been aged. Transverse sections of the left sagitta were 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. That the increments are annuli was validated by Zhao et al. (1997).

Processing of gonad samples

The posterior portion of vermilion snapper gonads (except males in 1993-2000) collected during 1987-2001 (n = 4276) 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. 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 reproductive state were assessed macroscopically during 1977-86 (n = 5233). During 1993-2000, sex only was assessed macroscopically for males.

Description of vermilion snapper age, growth, and reproduction data set

The layout of the data file (merge2.txt) is as follows and can be found in the SAS programs:

```
filename datain 'c:\dbase\vermilion\merge2.txt';
data one;
  infile datain  missover pad lrecl=130;
  input projid  collno  gear  spcode $  specno  tl  fl  sl  fishwt
     month  lat  long  duration  age  bumpage  sex  mat $;
```

A description of these data elements follows:
PROJID = Project identity. “105” - fishery-independent MARMAP data
COLLNO = Collection Number
GEAR = Gear Code (See Table 1).
SPCODE = Species Code. The species code for vermilion snapper is “A252”.
SPECNO = Specimen number.
TL = Total length (mm)
FL = Fork Length (mm)

SL = Standard length (mm)
FISHWT = Whole fish weight (g)
MONTH = Month
LAT = Latitude
LONG = Longitude
DURATION = duration of gear deployment (minutes)
AGE = Age
BUMPAGE = Age after assignment to year class
SEX = Sex (See Table 2).
MAT = Maturity (Table 3 in separate file).

Analysis

Size and age at maturity of males and females (Sex codes = 1, 2):

Raw data file: merge2.txt
Program files: agemat.sas, sizemat.sas
Summary file: maturitysummary.xls
EXCEL files: agemat.xls, sizemat.xls

Immature: reproductive stage = 1
Mature: reproductive stage = 2, 3, 4, 5, 7, 8, B, C, D, E, F, G
Eliminated reproductive stage = 0, 9
Codes for gear, sex, and reproductive stage are defined in Tables 1, 2, and 3 (Table 3 in separate file).

All data are from fishery-independent sampling by MARMAP program. Trawl data were restricted to the months of the spawning season (May - Sep).
1977-1986: macroscopic assessment of sex and reproductive stage
1987- present: histological assessment of sex and reproductive stage with exception of male vermilion snapper (macroscopic assessment of sex only during 1993-2000).

Summary and Recommendation: Gear and period specific maturity curves should be used given the plasticity exhibited over time in trawl data (see agemat.xls and sizemat.xls). Maturity curves were not generated for hook-and-line and traps because those gear types caught very few immature fish (see maturitysummary.xls).

Sex ratio (Sex codes = 1, 2):

Raw data file: merge2.txt
Program files: sexratioage.sas, sexratiolength20.sas
Summary file: sexratiosummary.xls
EXCEL files: sexratiolengthage.xls, sexratio gear vs. size.xls

All specimens with a sex code were included. No reproductive stages were eliminated because doing so would remove from the data set all males collected by MARMAP during 1993-2000, years during which sex was assessed macroscopically for males; therefore, the data set analyzed included immature and mature specimens.

Codes for gear, sex, and reproductive stage are defined in Tables 1, 2, and 3 (Table 3 in separate file).
.
All data are from fishery-independent sampling by MARMAP program.
1977-1986: macroscopic assessment of sex and reproductive stage
1987- present: histological assessment of sex and reproductive stage with exception of male vermilion snapper (macroscopic assessment of sex only during 1993-2000).

Summary and Recommendation: A high degree of consistency in sex ratio over time was noted for each gear type (see sexratiosummary.xls). The lower percentage of females in trawl samples is probably due to the difference in length frequency distributions among gear types (see sexratio gear vs. size.xls). The trawls caught smaller specimens than did hook-and-line-and traps. Data from hook-and-line and traps is viewed as more representative of the population. A percentage of females between 60-70% is consistent with the results of studies done in the 1970s (Grimes and Huntsman, 1980) and 1990s (Cuellar et al., 1996)

Annual fecundity:

Information on the relationship between annual fecundity and age is not available. Regression equations relating batch fecundity to fork length and ovary-free body weight are available in Cuellar et al. (1996) and stated below. **Note** that the range of length (180-330 mm FL) and weight (100-700 g) represented by the equations is rather narrow. Multiplying batch fecundity estimates by 35 (the no. of spawning events per spawning season) will produce estimates of annual fecundity.

Batch fecundity = 0.0438*Fork Length$^{2.508}$; r^2 = 0.44, n = 49, length in mm

Batch fecundity = 14,037 + (112*Ovary-free weight); r^2 = 0.33, n = 49, weight in grams

Conversion to TL: TL = 1.107792*FL + 1.093169; r^2 = 0.99, n = 2287, range of TL = 118-560 mm

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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
070 Trawl - 40/54 fly net
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	UnknownLiterature cited

Literature cited

Cuellar, N.C., G.R. Sedberry, and D.M. Wyanski. 1996. Reproductive seasonality, maturation, fecundity, and spawning frequency of the vermilion snapper, *Rhomboplites aurorubens*, off the southeastern United States. Fish. Bull. 94:635-653.

Grimes, C.B., and G.R. Huntsman. 1980. Reproductive biology of the vermilion snapper, *Rhomboplites aurorubens*, from North Carolina and South Carolina. Fish. Bull. 78:137-146.

Zhao, B., J.C. McGovern, and P.J. Harris. 1997. Age, growth, and temporal change in size at age of the vermilion snapper from the South Atlantic Bight. Trans. Amer. Fish. Soc. 126:181-193.

Summarized by J.C. McGovern and D.M. Wyanski
10 October 2002

Mortality

Natural Mortality – Vermilion snapper live for a maximum of 14 years and aged to 21 in the Gulf of Mexico. The group suggested using a M of 0.25 with a range of 0.2 and 0.3. This value was also used in vermilion snapper assessments conducted by Manooch et al. 1998 and Porch and Cass-Calay 2001.

Release Survival – Release survival for vermilion snapper is estimated to be 83% at 43-55 m by Collins et al. 1999 and 73% for headboat catches by Dixon and Huntsman. 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.

Dixon, R. L. and G.R. Huntsman. Unpublished. Survival rates of released undersized fishes. NMFS Beaufort.

Manooch, C.S., III., J.C. Potts, M.L. Burton, D.S. Vaughan. 1998. Population assessment of the vermilion snapper, *Rhomboplites aurorubens*, from the southeastern United States. NOAA Tech. Mem. NMFS-SEFSC-411.

Porch, C.E. and S.L. Cass-Clay. 2001. Status of the vermilion snapper fishery in the Gulf of Mexico: Assessment 5.0. Southeast Fisheries Division Contribution No. SFD-01/01-129.

Vermilion Snapper Tagging Data

4,076 fish tagged by MARMAP
63 fish recaptured

19 fish recaptured by MARMAP
44 fish recaptured by fishermen

Length Frequency

Program: VERMLF.SAS
Data Set: CPUE

Fork length (cm)was recorded for all vermilion snapper collected during 1983-2001 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 vermilion snapper caught with chevron trap, Florida trap and hook and line gear.

LEN	Frequency	Percent	Cumulative Frequency	Cumulative Percent
12	1	0	1	0
14	5	0	6	0
15	4	0	10	0
16	27	0.1	37	0.1
17	95	0.4	132	0.5
18	504	1.9	636	2.4
19	2327	8.7	2963	11.1
20	4311	16.2	7274	27.3
21	4540	17	11814	44.3
22	3717	13.9	15531	58.2
23	2888	10.8	18419	69.1
24	2078	7.8	20497	76.9
25	1478	5.5	21975	82.4
26	1152	4.3	23127	86.7
27	878	3.3	24005	90
28	664	2.5	24669	92.5
29	520	2	25189	94.5
30	380	1.4	25569	95.9
31	300	1.1	25869	97
32	237	0.9	26106	97.9
33	166	0.6	26272	98.5
34	106	0.4	26378	98.9
35	94	0.4	26472	99.3
36	53	0.2	26525	99.5
37	40	0.2	26565	99.6
38	30	0.1	26595	99.7
39	20	0.1	26615	99.8
40	11	0	26626	99.8
41	12	0	26638	99.9
42	9	0	26647	99.9
43	5	0	26652	99.9
44	4	0	26656	100
45	3	0	26659	100
47	1	0	26660	100
48	1	0	26661	100
49	1	0	26662	100
50	2	0	26664	100
51	2	0	26666	100

Description of MARMAP Sampling

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 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

Gear types chosen for index

The vermilion snapper life history group chose to use the shelf edge index for Florida trap (1983-1987) 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.

<u>Description of the MARMAP monitoring data set</u>

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:\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.

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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