Report of the First SEDAR

Stock Assessment
of
South Atlantic Red Porgy

Prepared for

South Atlantic Fishery Management Council

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October 28, 2002 Minor errors were corrected in the Reference section.

Executive Summary

The red porgy stock assessment workshop (SAW)[1] was convened by the South Atlantic Fishery Management Council at the NOAA Center for Coastal Fisheries and Habitat Research, Beaufort, North Carolina on Monday, April 8. The SAW's objectives were to conduct an updated stock assessment of the red porgy, *Pagrus pagrus*, stock off 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 SAW worked at Beaufort until April 12 and continued its work, communicating by email and conference call, through May 6. All decisions regarding stock assessment methods and acceptable data were made by a consensus of all participants.

Available data on red porgy include abundance indices and recorded data on landings, including data on size and age distributions of some landings and indices. Four abundance indices were developed by the preceding data workshop (DW): two indices derived from catch per unit effort (CPUE) in the NMFS headboat survey (1976–1991 and 1992–1998) and two derived from CPUE observed by the SC MARMAP fishery-independent monitoring program ("Florida" trap index, 1983–1987; and chevron trap index, 1990–2001). Landings data are available from all recreational and commercial fisheries.

In addition to this report, a CD–ROM was produced that contains all data used in the assessments, reports of the DW, detailed explanation of data used, model runs and results, and computer code that was used for projection and the detailed projection results. The CD–ROM supplements this report by providing complete technical detail of the assessment and SAW process.

The SAW applied both age-structured and age-aggregated models to available data. The age-structured model was considered the primary model, as recommended by the DW.

Results of both models depict a heavily exploited stock with considerable decline over the period examined. Based on results of the base-case run of the age-structured model, the 2001 spawning stock size is estimated at about 43% of B_{MSY} while the 2001 fishing mortality rate is estimated at about 45% of F_{MSY}. Thus by standards of the Sustainable Fisheries Act and given the Council's definition of MSST = $0.775B_{\mathrm{MSY}}$, the stock is estimated as overfished (55% of MSST), but not presently undergoing overfishing. The latter state reflects the restrictions imposed by Amendment 12. Estimates from sensitivity runs of the age-structured model and from several runs of the production model are quite similar. The picture of stock status is also consistent with the most recent previous assessment of the stock.

Stock projections were used to estimate the years in which the stock would have at least a 50% probability of reaching B_{MSY} under four possible management policies. Results are: under $F = 0$, by 2010; under a moratorium (bycatch mortality only), by 2013; under Amendment 12, by 2018; under Amendment 9, not within the 25–year span of the projections.

[1] Abbreviations and acronyms used in this report are defined in Appendix D on page 41.

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1 Place, time, and tasks

The red porgy stock assessment workshop (SAW)[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 SAW met from 3:00 p.m. on Monday, April 8, to 12:00 noon on Friday, April 12, 2002, with the SAW continuing its work through May 1, aided by e-mail and conference-call 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, Miami, Pascagoula (MS), Silver Spring, and Woods Hole; 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 SAW.

The SAW's major objectives were to conduct an assessment of the stock of red porgy, *Pagrus pagrus*, off the southeastern US, and to conduct stock projections under various management regimes (terms of reference, Appendix A). In support of those tasks, the SAW received data and recommendations from the red porgy data workshop (DW) that was convened in March by the Council and the Center. The DW was designed to be the first step in the assessment process, bringing together state and federal biologists with the needed expertise to decide which data were appropriate for use in the assessment. The SAW was designed to follow the DW, with many of the same state and federal biologists participating. Some of the decisions regarding data made at the DW were refined during the SAW. At both the DW and the SAW, all decisions affecting the assessment were made by consensus of all participants.

[2] Abbreviations, acronyms, and mathematical symbols used in the report are listed in Appendix D on page 41.

2 Stock and fishery characteristics

The following material is excerpted and expanded from the description of the stock and fishery in Vaughan and Prager (2002).

Red porgy have an extensive range in warm waters of the Atlantic Ocean and adjacent seas: they occur off the southeastern U.S. Atlantic coast; in the Gulf of Mexico; off the South American Atlantic coast from Brazil to Argentina; off Portugal and Spain; in the Mediterranean Sea; off west Africa south to the Cape Verde Islands; and around the Azores, Madeira, and Canary Islands. The stock unit analyzed here includes fish from U.S. Atlantic waters off North Carolina (NC) south of Cape Hatteras, South Carolina (SC), Georgia (GA), and the east coast of Florida (FL), including the Atlantic side of the Florida Keys (Monroe County). Within that stock definition, red porgy have been most abundant in NC and SC waters. Tagging studies show neither long-range migrations nor extensive local movements of adult red porgy (Manooch and Hassler 1978), and there is no circumstantial or anecdotal information to suggest such movements.

Peak spawning occurs in March and April (Manooch 1976). Red porgy eggs and larvae are pelagic, hatch 28 to 38 h after fertilization, and can survive transport by ocean currents for 30 days or more (Manooch et al. 1981). Thus, the population off the U.S. Atlantic coast could in theory receive eggs or larvae from the Gulf of Mexico. However, because of the distances involved and the variability of ocean currents, the likelihood of regular population mixing in this way seems small.

Red porgy attain maximum size slowly and live

relatively long (an 18-year-old specimen is the oldest on record), but maturity occurs at younger ages. Roumillat and Waltz (1993) collected red porgy, 1979–87, along the continental shelf between Cape Fear, NC, and Cape Canaveral, FL, using trawl nets, traps, and hook-and-line. Life history information was obtained from 7,104 red porgy; 5,820 otoliths were examined (including 134 from historical or port samples), of which 5,491 had discernible rings; estimation of sex composition was based on 6,044 red porgy. The vast majority of females were mature by age 2.

Red porgy are protogynous hermaphrodites. Thus, females predominate at smaller size intervals, but males occur in all age groups.

Three major fisheries catch this stock of red porgy: commercial, recreational, and headboat. The fisheries were further subdivided for assessment purposes, but are discussed here without that subdivision. The most common commercial gear has been hook and line, with occasional commercial landings also from trawls and traps. Trawling for red porgy has been banned since January 12, 1989 (SAFMC 1988) (Table 1).

The recreational fishery is defined here to include all recreational fishing from shore, from private boats and from charter boats (for-hire vessels that usually accommodate six or fewer anglers as a group). The headboat fishery (larger for-hire vessels that charge per angler) is sampled separately, and for that reason is distinguished here from other recreational fisheries. Recreational and headboat fisheries, like the commercial fishery, use hook-and-line gear almost exclusively.

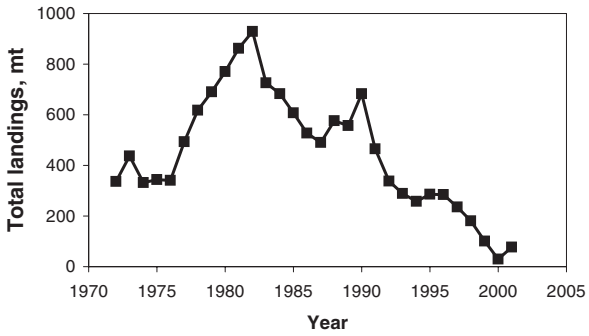
Total landings increased during the 1970s and early 1980s as the commercial fishery expanded, rising from about 335 mt in 1972 to over 900 mt in 1982. Except for a brief spike in 1988–1990, landings declined steadily from the 1982 peak to the low of under 30 mt in 2000 (Figure 1).

Table 1. Red porgy regulatory history

Period	Amendment	Details
to 1992	—	No size, bag, or trip limits or seasonal closures
Jan 1989 to present	1	Trawl gear banned
1992 to Jan 99	4	12" TL minimum size
Feb 99 to Aug 99	9	14" TL minimum size; 5-fish bag limit in recreational fishery; seasonal closure (March–April) of commercial fishery
Sep 99 to Aug 00	M[a]	No landings allowed
Aug 00 to present	12	1-fish bag limit in recreational fishery; seasonal closure (January–April) of commercial fishery; 50-lb trip limit in commercial fishery

[a] Moratorium

Figure 1. Total landings of red porgy.



The headboat fishery was predominant, 1972–1977, accounting for 64% on average of landings

Figure 2. Landings of red porgy by major fishery.

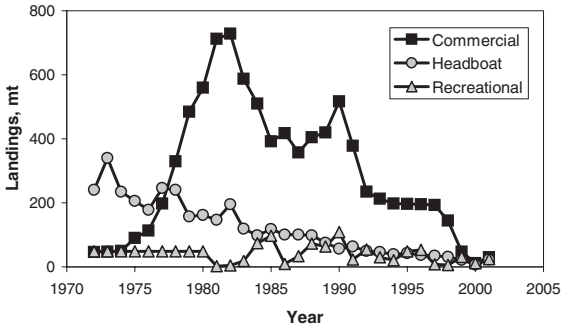
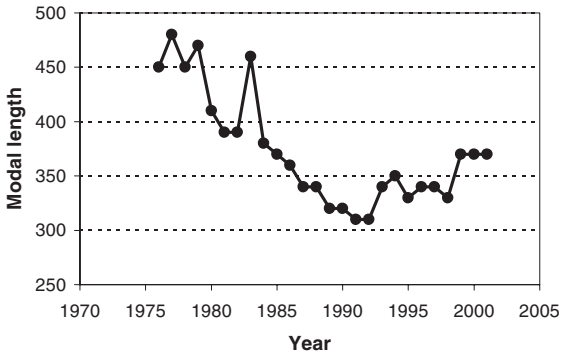


Figure 3. Modal lengths in commercial hook-and-line fishery.



in weight (Figure 2). From 1978, onward the commercial fishery predominated, representing 53–82% of annual landings. Recreational fisheries seldom landed more than 10% of the total until 1999–2001, when they represented 34% of total weight landed.

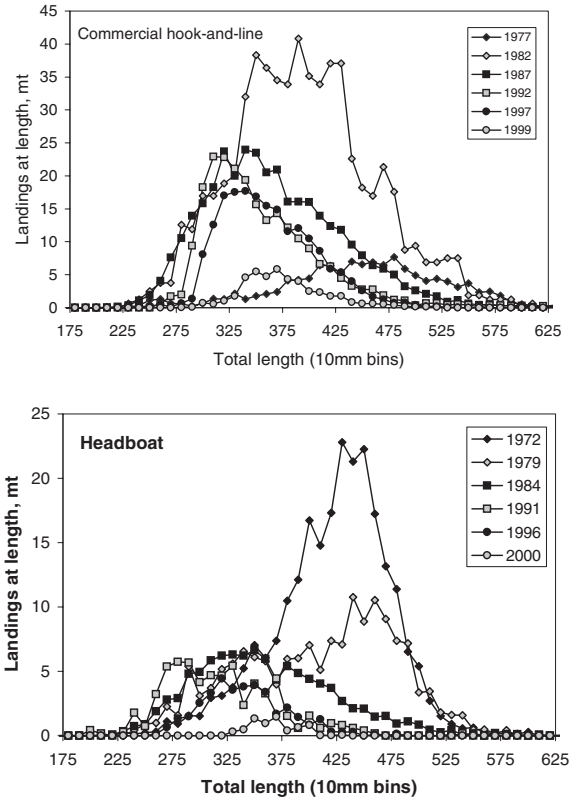
Commercial landings rose steeply during the 1970s, from 47 mt in 1972 to 729 mt in 1982, then declined to around 400 mt in the late 1980s (Figure 2). Landings during the 1990s averaged around 200 mt until falling again in 1997. Hook and line gear accounted for about 90% of commercial landings overall, although trawl landings accounted for as much as 25% of the annual total during some years in the early 1980s. Trawl landings soon declined considerably, and trawl gear was prohibited as of January 12, 1989, by Amendment 1 to the Fishery Management Plan (Table 1) (SAFMC 1988).

Length–frequency data show that the decline in total commercial landings was largely a decline in landings of large fish, accompanied by a decline in modal length. Those patterns are illustrated by the hook-and-line fishery, in which length–frequency data are available continuously since 1976. (Other commercial gear length–frequencies are only available sporadically through the time series). Modal length peaks in 1977 at 480 mm, then declines to 310 mm in 1992 (Figure 3). Increases and stability from 1993–1998 and 1999–2001 were the result of size limit restrictions. A 12" size limit was implemented on January 1, 1992 (SAFMC 1991), and a 14" size limit was implemented on February 24, 1999 (SAFMC 1998).

Expanding the commercial length–frequencies by annual landings shows considerable declines in landings of large fish over time. Most landings in 1977, before commercial fishery expansion, were distributed between 400 and 500 mm. By 1982, when commercial landings peaked, the mode dropped to just below 400 mm and landings dropped sharply at lengths above 430mm (Figure 4).

Total landings declined after 1982, with the 1987 length distribution revealing a large decline in landings over 330 mm as compared to the 1982 peak. This pattern continues into 1992, when the mode reached the series low of 310 mm and there was a further decline in landings above the mode. The mode increased to 340 mm during 1993–1998, reflecting an increase in minimum size of possession, with the 1997 distribution illustrating further drops in landings, due to declining harvest of fish below the minimum size. The 1999 distribution reflects both an ad-

Figure 4. Landings at length over time in two red porgy fisheries.



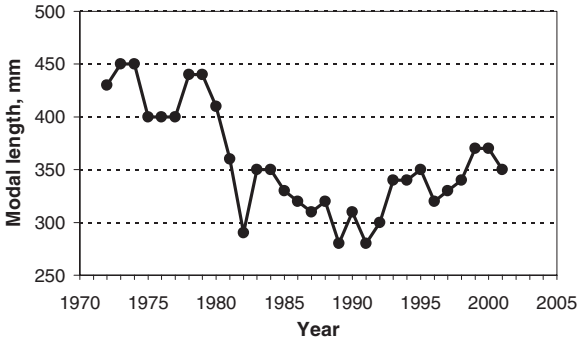
ditional minimum size increase (shown as an increase in the mode to 370 mm), and increased harvest restrictions (shown as overall reduction in landings across all size categories).

Recreational landings show no consistent trend, averaging about 38 mt per year from 1981–2000, with a few years of 50 to 100 mt from 1984–1996 (Figure 2). Catch by mode of fishing has been highly variable from year to year, but on average landings in weight are evenly split between private/rental and the charter boat categories. No adequate length–frequency data are available from recreational fisheries (other than the headboat fishery), because sampling has been insufficient.

Headboat landings declined steadily through the series, from 400 mt in 1973 to around 100 mt per year in the 1980s and then to fewer than 50 mt per year in the 1990s (Figure 2). Most headboat landings have come from NC and SC.

Length–frequency data available from the headboat fishery for 1972–2001 show trends similar to the commercial hook and line length frequency. Modal lengths vary without trend between 400 and 450 mm from 1972–1979, then decline steadily to a low of 280 mm in 1991 (Figure 5). Regulatory related increases are apparent in the 1990s although generally less pronounced here than in the commercial hook and line data.

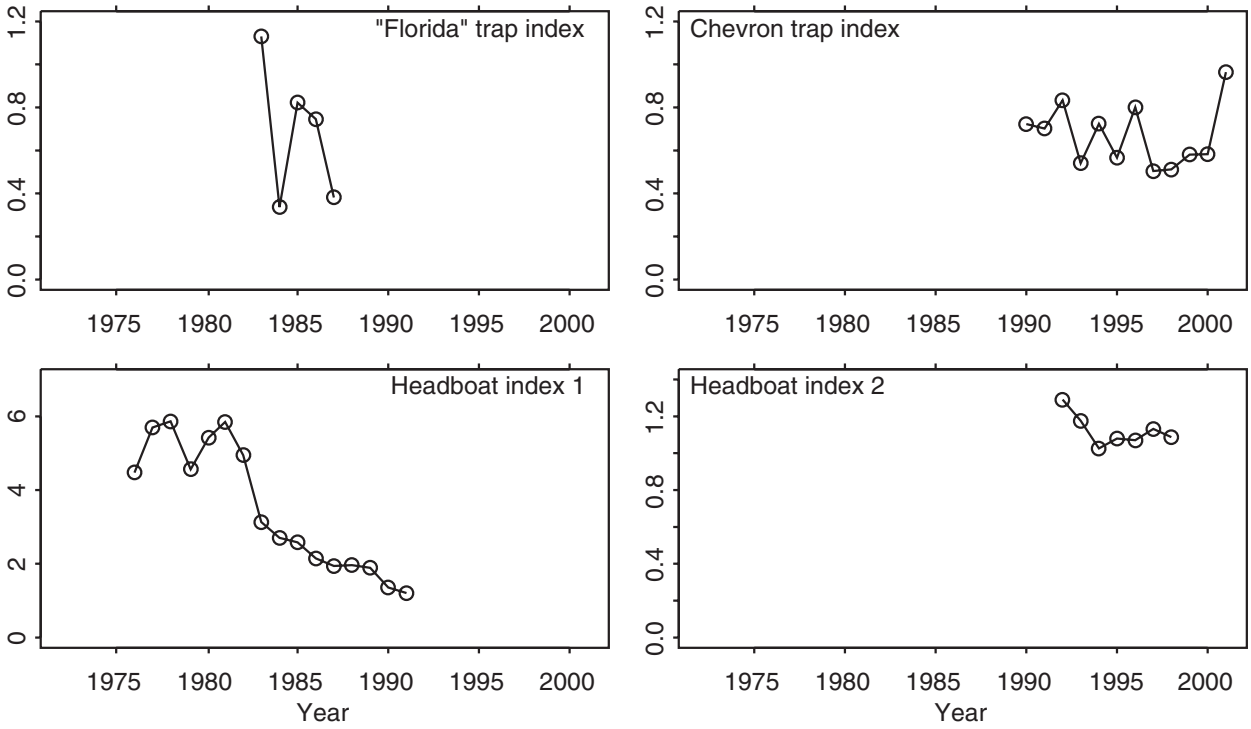
Figure 5. Modal lengths in headboat fishery.



The trend in landings at length reflects both a decline in total landings and a shift toward smaller lengths through the series (Figure 4). Landings at length in 1972 were tightly centered around the mode from 430–450 mm. Initial declines in landings through 1979 did not show truncation of older ages or modal shifts, but by 1984 truncation was becoming apparent and the mode declined to 350 mm. In 1991 the mode declines further to 280 mm and landings at higher sizes decline further. The mode increased in 1996 and again in 1999, with landings declines apparent at lower sizes over this period.

Taken together, the abundance indices exhibit a pattern of long-term decline, with some indication of increase in recent years (Figure 6). The

Figure 6. Abundance indices for red porgy.



"Florida" trap index, considered alone, appears noisy; nonetheless, its highest value is in its first year (1983) and its second–lowest value in its last year. The chevron trap index declines slowly, with an increase in abundance in the final year. The two headboat indices show a long–term period of decline (by perhaps 80%), followed by a slight increase in abundance in the final years of the second index.

3 Data workshop

Data for this assessment were prepared by a Data Workshop (DW) that met for that purpose during the week of March 11, 2002, in Charleston, SC. Additional questions that arose during initial model development and testing before the SAW were resolved at the SAW 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 Red Porgy 2002 CD–ROM) and are summarized here.

3.1 Findings of life-history working group

Unit stock The group agreed that red porgy in the South Atlantic Bight form a unit stock.

Age–length keys It was noted that aging by the NOAA Beaufort (NC) Lab and the SCDNR Lab differs markedly. The decision not to use Virtual Population Analysis (defined here as a catch-at-age model that is solved backwards by cohort) made moot any discussion of the different age–length keys derived from the two labs' aging. Nonetheless, length-to-age conversion is

an important aspect of any age–structured assessment. An otolith exchange program was initiated to provide data for computation of an age–conversion matrix to be used in the age–structured model planned for the stock assessment. That allowed the assessment to be conditioned on either group's aging estimates.

Natural mortality rate The group recommended a natural mortality rate M in the range 0.20–0.25/yr.

Release mortality The group recommended assuming release mortality of 35% (of fish caught and released) for all fisheries except the recreational fishery (MRFSS "B2" catches), for which 8% release mortality should be used. This recommendation was based on the study of Collins (1996).

Maturity schedules The DW stated that data from fishery-independent sampling are the best maturity data available and recommended that they be used in the assessment. Given the plasticity in maturity exhibited over time, gear- and period-specific maturity curves for females should be used except for 1984–89 data from blackfish and "Florida" traps (a type of trap, also called snapper trap, whose use is not limited to the waters off Florida), which could be pooled. For males, maturity data were pooled by gear for hook and line, blackfish trap, and Florida trap. Data from chevron trap samples were not pooled.

Spawning–stock biomass The issue of how to compute spawning–stock biomass is complicated by the species' protogyny. The DW recommended performing the assessment with two alternative methods of estimating spawning biomass, female biomass and total spawning biomass.

3.2 Findings of recreational fisheries working group

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

Headboat landings Headboat landings are available from 1972 to present from North Carolina and South Carolina, and the majority of red porgy landings in the South Atlantic are from those states. Minor landings were reported for the Cape Hatteras area from 1973–1976 (around 1000–3500 fish/yr from area 1), but those landings were deleted on the recommendation of the DW, because the northern limit of the stock has been specified as below Cape Hatteras.

Landings from Georgia and northeast Florida are available, 1976–present. That landings series was extended back to 1972 through the use of regressions of Georgia and north Florida landings on Carolina landings. Similarly, landings from south FL, available since 1981, were extended back, 1972–1980, with zero-intercept regression of southeast Florida landings on NC and SC landings. These landing adjustments are relatively small, and any biases are unlikely to affect assessment results.

Before 1976, red porgies were reported in the general category "porgies" in Carolina landings. Data 1976–1980 were used to estimate the area-specific proportion of red porgy to combined porgies and the ratio was expanded based on correct data from the earlier period.

Size distributions of headboat catches Headboat samplers measure length and weight of the fish that they encounter. Those measurements are available for the same time periods as headboat landings data, with one exception: measurements are available from southeast FL, 1978–1980, prior to availability of landings data from the area. The group recommended that lengths be combined across areas. Lengths were applied to the estimated catch in numbers by year, area, and wave (months 1–5, 6–8, 9–12).

Headboat abundance indices Headboat catch rates were standardized with a general linear model (GLM) run on catch in numbers divided by anglers at the trip level (full day trips only) separately for 1976–1991 and 1992–1998. Class variables were year, month, area (2, 3, 5, 9, 10 and 2 combined with area 3)[3]. Breaking the time series between 1991 and 1992 accounted for the introduction of the 12" TL minimum size limit with Amendment 4.

MRFSS landings The Marine Recreational Fisheries Statistics Survey (MRFSS) began in 1979; however, the Data Workshop 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 early years, but those data were removed from the MRFSS database because the NMFS Headboat Survey covers that sector more completely.)

Red porgy are rarely encountered near shore; thus, landings from the shore-based mode of MRFSS were excluded by the DW. Mean landings by private and charter boats from 1981–1990 were used to extend those landings series back to 1972. In estimating landings in weight, occasionally no fish were weighed in a given stratum (year, subregion, state, mode, area). 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 8% from Collins (1996) 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 (ranging from about 20% up to almost 60%. A suggested alternate approach may be to apply an appropriate smoother (running average or lo(w)ess).

MRFSS catch rates The group recommended not using catch rates from MRFSS because few intercepts either caught or targeted red porgy. Similarly, the small numbers of red porgy encountered by MRFSS samplers precluded using length measurements from MRFSS.

3.3 Findings of working group on commercial landings

Red porgy landings data were not consistently reported as red porgy in the earlier years; some were placed in an “unclassified porgies” category. To extract red porgy from the unclassified category, the group examined reporting categories for all porgies by state. It is believed that red porgy from SC have been classified accurately from 1989 to the present. In NC, accurate reporting of red porgy began in 1994. In GA and FL, accurate reporting began in 1993.

To correct inaccurate reporting, years with accurate reporting were used to determine the ratio of red porgy to all porgies in each state. This ratio was then applied to all porgies in the past to compute the total landings of red porgy. How-

[3]The final analysis was done at the SAW.

ever, size restrictions can decrease the ratio of red porgy to all porgy. The regulatory history of red porgy involves a 12" minimum size limit implemented in 1992 and a 14" minimum size limit in 1999. South Carolina is the only state which was believed to accurately report red porgy before the 12" minimum size limit; therefore, the group used the ratio of red porgy to all porgy for 1989–1991 as the correction factor for previous red porgy data in SC. For NC, GA, and FL, the group used the ratio of ratios (red porgy:all porgy from SC in 1989–1991):(red porgy:all porgy from SC in 1992–1997) to compute the pre-size-restriction ratio of red porgy to all porgy for those states. Landings from SC and NC in the "all porgy" category were obtained from state records, while those from FL and GA were obtained from the NMFS general canvass database.

In NC, there have been landings of "unclassified porgies" from north of Cape Hatteras. Such landings, which are known to be composed entirely of scup, were not used in computing NC red porgy landings. Furthermore, there are some "unclassified porgy" reported from shrimp trawls, and such landings, which are known to be pinfish, were omitted.

Length data on red porgy from commercial fisheries, 1983–2001, were extracted directly from the NMFS TIP database. The group believes that all relevant data for that time period have been accumulated into that database.

3.4 Findings of MARMAP working group

The MARMAP working group at the Data Workshop addressed fishery-independent indices of abundance that could be derived from the South Carolina MARMAP survey program. MARMAP has conducted reef-fish related sampling since 1979.

The group recommended two separate abundance indices for use in the assessment: a "Florida" trap index, 1983–1987, and a chevron-trap index, 1990–2001. The group also calculated an abundance index from research hook-and-line data, but recommended against using it because of known variations in sampling procedures and low catch rates. A fourth abundance index, based on black seabass traps, was not recommended, as catch rates of red porgy in those smaller traps were low.

The snapper-trap index is based on sampling at fixed stations that primarily sampled the nearshore South Carolina area. The chevron-trap series, in contrast, sampled the Florida–North Carolina area out to 50 fathoms. Examination of many subsets of the data in space and time revealed no important differences from patterns seen in the candidate indexes using the entire data sets.

Because of the different gear types, different survey designs, and different geographic ranges, the working group recommended the chevron and snapper trap survey indices be used as separate time series, rather than being combined into one extended index. There were attempts to conduct paired trap stations in 1988–89, but because of variations in sampling procedures those years (tying traps to the vessel), closeness of the paired deployments, and differences in range between the surveys, the group recommended against development of a calibration factor to link the two surveys. Because gear efficiency was believed to be strongly affected by tying the traps to the vessel, the group also recommended against using 1988–89 observations as part of either time series.

Size– and age– composition data from the MARMAP database were brought forward for use in the assessment.

4 Data issues resolved at SAW

The SAW 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 SAW follows.

4.1 General data issues

- The DW specified a range for natural mortality, $M = 0.2$–0.25/yr. The SAW decided to run the age-structured model at the average value in the range, $M = 0.225$, and to make sensitivity runs at $M = 0.2$ and $M = 0.25$.

- For MRFSS private and charter landings, 1972–1980, the SAW used the 10-year average of landings, 1981–1990, to fill in otherwise missing values.

- For charter landings in 1981 (reported as zero by MRFSS), the SAW used value 0.0001 mt as a computational convenience. This was also done for the commercial trawl landings reported as zero in 1974. This decision simplifies programming but seems extremely unlikely to affect the assessment results.

- The SAW used a minimum sample size of 50 fish/yr for length frequencies in the trawl and trap fisheries. Smaller samples were omitted from these analyses. (These values are used in the age-structured model to characterize the length distribution of landings.)

- Fish lengths were aggregated into 10 mm bins (size categories) for better sampled fisheries (i. e., those with larger sample sizes), into 20 mm bins for less well sampled fisheries.

- The data workshop recommended using an abundance index based on headboat catch per unit effort (CPUE), 1972–1991, as the management regime changed in 1992. The SAW decided also to use a similar abundance index for 1992–1998, which reflects a period of consistent (but different) management, including a size limit but no bag limit. The two indices had selectivity and catchability estimated separately.

- The SAW used headboat abundance indices in weight per unit effort, for consistency with other data series.

- Additional fish length distributions for SC, 1976–1983, were provided by SCDNR between the DW and the SAW, and they were incorporated into the assessment data base.

- Florida commercial landings data for 1972–1973 were reported as zero by the DW. Corrected values were substituted from the NMFS general canvass data base, adjusted for “other porgies” as in other years.

- Length frequencies from MRFSS were dropped because of small sample sizes and to reduce model complexity; instead, MRFSS fisheries (charter and private boats) were assumed to have the same aggregate selectivity as headboats.

- The SAW noted that NC inshore and offshore catch rates for the headboat fishery were found similar by the DW, and no difference in trends was found. Only offshore catch rates were used in computing abundance indices from the SC headboat fishery.

- In the weeks preceding the SAW, narrow gaps were found in reported MARMAP and TIP length distributions. The gaps were attributed to rounding of reported lengths and

subsequent length conversions (fork length to total length). The issue was resolved by redistributing measured fish across their own length bins and forming a new length distribution that does not display narrow gaps between well-represented lengths.

- Aging differs between NC and SC investigators. Two correction matrices were developed that allowed the analysis to be done based on either SC or NC aging. Maturity schedules were adjusted correspondingly for the age-structured model.

- The Data Workshop recommended computing spawning–stock biomass in two ways, total mature population and based on females only. Computations at the SAW were made in total mature biomass, but because of time constraints, it was not possible to make complete parallel computations and analyses in female biomass only. Even if such analyses had been possible, their interpretation would be problematic, as the relative importance of males and females to population spawning success is not known.

4.2 Determination of CVs for modeling

The forward-projection model requires annual estimates of the coefficient of variation (CV) of various data series used for fitting. The SAW spent considerable time discussing the best approach to take in specifying these, and reached the following conclusions:

Headboat landings Headboat landings are considered among the most reliable landings data available; they are considered a census and are adjusted for missed records. In a SC study conducted through the Atlantic Coastal Cooperative Statistics Program, excellent agreement was found between logbook data and validation data (R. Dixon, pers. comm.). The group decided to use the following ranges of CVs for headboat landings: for 1972–1981, 0.1–0.15; for 1982–2001, 0.05–0.1.

Commercial landings For commercial landings data from the NMFS general canvass and adjusted by the DW and SAW, the group decided to use the following ranges of CVs: for 1972–1983, 0.25–0.50; for 1984–93, 0.10–0.15; for 1994–2001, 0.05 (no range).

Headboat abundance indices For the two abundance indices based on CPUE in the headboat fishery, the group agreed to rescale the CVs from the estimation procedure that generated the indices to the range of 0.2–0.5, as the raw CVs from the estimation procedure seemed too large. Annual variation in CV was thus retained, while the average CV was adjusted to be comparable to those assumed for other data.

Fishery-independent (MARMAP) abundance indices The group decided to take the same approach as for the headboat abundance indices. The CVs computed for these abundance indices were rescaled to the range 0.2–0.5.

5 Description of assessment models

5.1 Age-structured model

The data workshop recommended use of a forward-projecting statistical age-structured model as the primary assessment tool for red porgy in 2002. This recommendation was made in preference to tuned virtual population analysis (VPA) for the following reasons:

- Forward–projecting models are more flexible in formulation. Here, the ability to

use length–composition data without externally estimating the corresponding age-compositions was thought useful, especially because there is uncertainty about age determinations in this species, as described above.

- Forward–projecting models have not been observed to result in retrospective patterns; such patterns are common in virtual population analyses (the other major form of age-structured model), and were problematic in VPA analyses in the last red porgy assessment (Vaughan and Prager 2002).

The essence of forward–projecting age–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 Methot's stock–synthesis model and very similar in structure to models used for assessment of Gulf of Mexico cobia (Williams 2001) and Gulf of Alaska sablefish (Sigler et al. 1997).

Age–structured forward-projecting models share many attributes with ADAPT–style tuned VPAs. The two types of model are compared in Table 2.

5.1.1 Properties of age-structured model

The forward-projecting statistical age-structured model for this assessment was implemented in the AD Model Builder software (Otter Research 2000) on a microcomputer. The specific model formulation and implementation used in this assessment is here designated RPM2002. Its formal definition is found in a computer file provided separately on CD-ROM. The formulation's major characteristics can be summarized as follows:

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

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

Selectivity of fishery-independent gear The two fishery-independent abundance indices are assumed to have individual time–constant selectivity vectors; the corresponding selectivity vectors are estimated internally by RPM2002.

Selectivity of fishery-dependent gear Each fishery is assumed to have constant selectivity during each period of constant regulation and time-varying selectivity in the absence of regulation. The corresponding selectivity vectors are estimated internally by RPM2002 and applied to the corresponding fisheries and any abundance indices derived from them.

Selectivity functions Selectivity was fit parametrically, using logistic models (most gears) or double–logistic models (surveys using trap gear),

Table 2. Comparison of tuned VPA (ADAPT formalism) and forward-projecting age-structured models (as used in this assessment)

Model property	Tuned VPA (ADAPT)	Forward-projecting model
Catch equation	Baranov	Baranov
Order of computations	Backward by cohort	Forward by year
Natural mortality rate	Usually assumed constant	Same
Effort required to extend model	Moderate to high	Low to moderate
Data preprocessing prior to model application	Moderate to extensive	Much less
Estimated parameters	Few to several	Several to very many
Catch fitting	Tries to match previously estimated catch at age, influenced by abundance indices	Tries to match total catch and size composition, influenced by abundance indices
Separability	Varies; ADAPT not separable	Usually, and may vary over time
Length-at-age model	External to model	Estimated in model
Recruitment model	Fit from age-structured model results	Can be fit internally to age-structured model
Periods of imprecision	Retrospective patterns often observed in final years	Earliest years' estimates tend to be imprecise
Typical fixed parameters	F or N at age in last year, selectivity of oldest age	Earliest recruitments or stock sizes, possibly B/B_{MSY} in first year
Objective function	Total sum of squares on $N_{a,y}$ and indices	Total likelihood on size composition, total catch, indices, other data

rather than estimating independent selectivity values for each age. That approach reduces the number of estimated parameters and imposes theoretical structure on the estimates.

Growth A von Bertalanffy growth model, constant over time, was estimated internally to the model from length-composition and age-composition data. A set of standard deviation-at-age parameters were estimated for determining the variance of length-at-age, assuming normal distributions.

Recruitment A Beverton–Holt recruitment model was estimated internally, and estimated recruitments were loosely conditioned on that model. The strength of that conditioning was agreed upon by the SAW after examining a wide range of alternatives, which gave similar results.

Biological benchmarks The benchmarks F_{MSY} and B_{MSY} were estimated internally by the model using the method of Shepherd (1982). In that method, the point of maximum yield is identified from the recruitment curve and other biological parameters, such as those for growth and ma-

turity. Selectivity at age must also be specified; here, the model incorporated the catch–weighted selectivities at age estimated for the last three years (1999–2001).

Fishing Six fisheries were modeled individually: commercial hook-and-line, commercial trawl, commercial trap; recreational headboat, recreational charterboat, recreational private boat. Separate fishing mortality rates were estimated for each fishery.

Abundance indices The model used four separately modeled indices of abundance, as described above. They were two fishery-independent indices ("Florida" trap, 1983–1987; and chevron trap, 1990–2001) and two fishery-dependent indices (headboat, 1976–1991 and headboat, 1992–1998)

Fitting criterion The fitting criterion was a total likelihood approach in which total catch was fit almost exactly, and the observed age– and length–compositions, as well as the abundance index patterns, were fit to the degree that they are compatible. Relative statistical weighting of each likelihood component for the base case was chosen by the SAW after examining many candidate model runs. The criteria for choice were a balance of reasonable fit to all available data and a good degree of biological realism in estimated population trajectory.

5.2 Age-aggregated production model

The age-aggregated production model used was the (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. By conditioning on catch, the landings data are assumed more precise than the abundance indices. The model fits more than one abundance index by assuming they are correlated measures of stock abundance and that differences between indices can be considered sampling error.

Two forms of the production model were fit. The first was the Schaefer (1954; 1957) model, which assumes $B_{\mathrm{MSY}} = 0.5K$, where K is the carrying capacity of the stock (virgin stock size). The Schaefer form is often used as a default because of its theoretical simplicity and because it is considered a central case among possible shapes of production model. The second form was the Fox (1970) production model, which assumes $B_{\mathrm{MSY}} = 0.368K$. The Fox model was used because of the recent theoretical finding (Thompson 1992) that in stocks with a nondeclining stock–recruitment curve, B_{MSY} should be less than $0.5K$. While that finding lacks empirical verification, its conclusion seems worthy of investigation, especially when a nondeclining (Beverton–Holt) recruitment curve is explicitly assumed, as in the age-structured modeling here.

To fit the production models, a revised version of the ASPIC software of Prager (1995) was used. The main revision compared to the implementation of Prager (1995) was the added ability to fit the Fox model.

6 Model application and results

6.1 Age-structured model

6.1.1 Description of base run and sensitivity runs

Several runs of the age-structured model were made, a base run (considered by the SAW the most likely case), and a number of additional runs to examine sensitivity of results to vari-

ous assumptions. The base run used the data from the Data Workshop with all adjustments described above. The base run used $M = 0.225$/yr, length-to-age conversion data from South Carolina, and the high end of the range of coefficients of variation (CVs) for landings data.

In addition to the base run, analyses were run examining the effects of using the lower end of the CVs for commercial and headboat landings, North Carolina length-to-age conversion data, alternative natural mortality rates, a truncated time series of data (1984–2001), and approximate discard levels in recent years.

In the base run, the SC aging information was chosen because in a comparison of ages read by both groups from the same (approximately 100) otoliths, the SC researchers identified some fish as ages 0 and age 1, while the NC researchers identified no fish younger than age 2. The group was concerned that the NC aging might be compressed to an unrealistically small group of ages, although there was no way of determining at the DW or SAW which, if either, set of age determinations is correct. This issue is mentioned again as a research recommendation in Section 9.

Both commercial and headboat landings reports are assumed to be censuses, and as such there is no uncertainty estimated for the reported landings. However, issues of misidentification, discards, and other sources of uncertainty that would be ignored if we assumed that the landings are known without error. Therefore, the SAW approximated uncertainty in the commercial and headboat landings by using different coefficients of variation, the years with the earliest (1972–1984) landings having higher CV ranges, intermediate CVs for the middle period (1985–1993), and lower CVs for the recent years (1994–2001), as described in Section 4.2.

Another sensitivity analysis used only data from the shorter period 1984–2001 to evaluate whether the more recent, higher quality data would capture the same biological signal as the longer time series did. That analysis was not intended to be used as an estimate of stock status. A final sensitivity run included estimates of discarded fish not included in landings data.

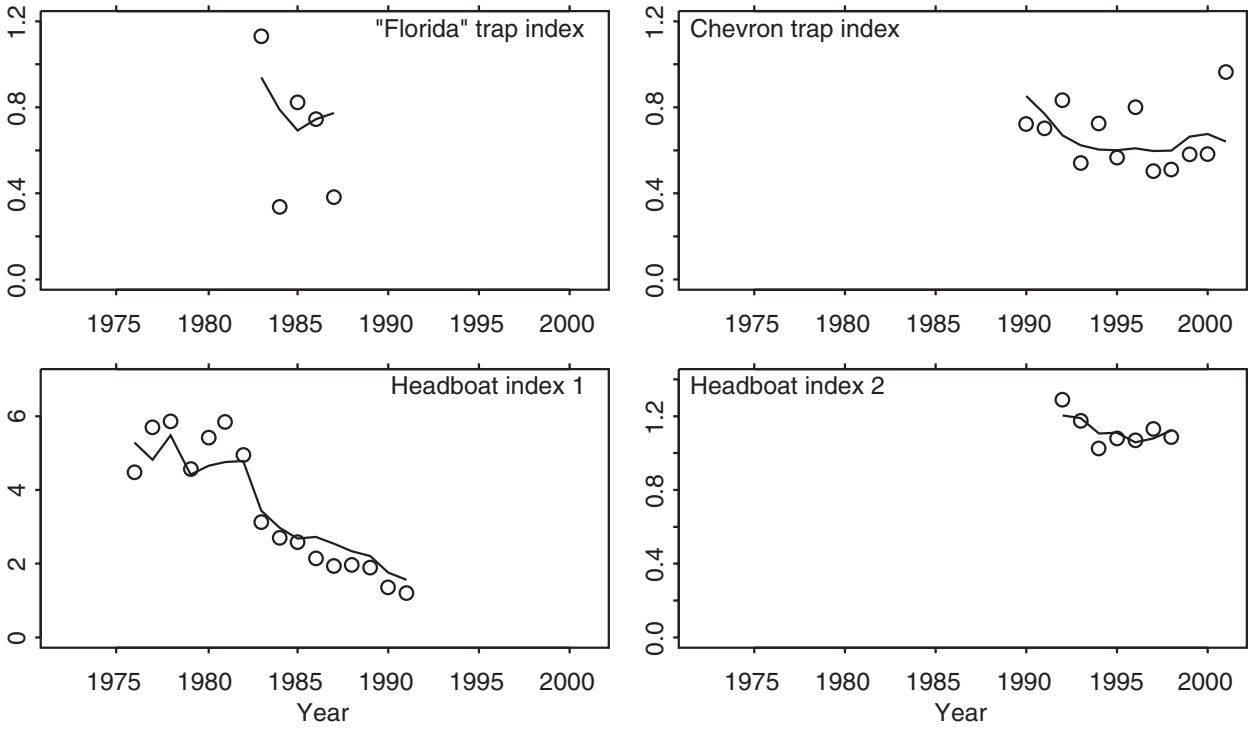
6.1.2 Results of base run

Fits of the RPM2002 model to the abundance indices were good (Figure 7), and the model was able to match observed catches almost exactly. Selectivities in the fisheries were estimated to have shifted towards smaller fish, but to have shifted back towards larger fish with recent management measures (Figure 8).

The model estimates that SSB has declined to about 10% of its 1972 value and that resulting recruitment has declined to about one-third of its 1972 value (Figure 9). It is important to consider that forward-projection models tend towards greatest uncertainty in the earliest years, and that catch sampling and catch statistics are thought least reliable from that time, as well. The interpretation of Figure 9 is that the stock in 1972 had many large fish that were gradually removed by the fisheries and not replaced as fishing mortality rates increased.

The estimated stock–recruitment relationship shows the usual scatter about the fitted Beverton–Holt recruitment curve (Figure 10). The apparent lack of fit for large SSB occurs because the model was required to generate large recruitments in a pre–1972 initialization period to account for the many large fish represented in the length compositions from the early years. Available data are consistent with Figures 9 and 10, but because of the nature of the model (Table 2), the earliest years' estimates represented in those figures may be inaccurate.

Figure 7. Observed (circles) and predicted (lines) abundance indices, from base run of age-structured model (RPM2002).



Exploitation rate over time is estimated to have peaked around 1990 at about 35% in weight (about 18% in numbers), and has dropped in recent years to less than 10% in numbers or in weight (Figure 11). The rate is higher in weight than numbers because the smallest fish are not taken in the fishery.

Table 3 presents additional estimates from the base run and sensitivity runs of RPM2002 and also results from the production models. Results of runs conducted strictly to check model function or decide on weighting are not tabulated. Estimates from the base run suggest that the moratorium (September, 1999–August, 2000) and Amendment 12 (September 2000–present) have lowered the fishing mortality rate to about 45% of F_{MSY} in 2001, but that 2001 spawning biomass was still only about 43% of SSB_{MSY}, which is below MSST, which the SAFMC has set at MSST = 0.775 B_{MSY} (Table 3, Figure 12). In the terms of the Sustainable Fisheries Act, the results imply that the fishery in 2001 was not undergoing overfishing (which the SAW believes is defined as $F > F_{MSY}$), but that the red porgy stock was overfished (depleted) in that year.

Confidence intervals in Table 3 are underestimates of uncertainty in the assessment, as the intervals reflect estimation error only, not uncertainty about the input quantities. Confidence intervals on RPM 2002 estimates were derived from delta-method (Normal) approximation.

6.1.3 Results of sensitivity runs

Lower CVs The run using the lower range of the commercial and headboat CVs on landings instead of the upper ranges (run x57) produced essentially the same estimates as the base run (Table 3).

Table 3. Summary of estimates from RPM2002 age-structured model and Schaefer and Fox production models applied to red porgy, with 80% confidence intervals given below corresponding estimates. Differences in assumptions from the base runs are boxed. Abbreviations and acronyms are listed in Appendix D on page 41.

	Input assumption				Estimate					
Run	*M*	Aging	CV	Years	F_{MSY}	SSB_{MSY}	MSST	MSY	F_{2001}/F_{MSY}	SSB_{2001}/SSB_{MSY}
RPM2002 model—base run										
x47b	0.225	SC	high	1972–2001	0.19	3050	2364	375	0.45	0.44
					0.18–0.20	2924–3175	2266–2461	365–385	0.41–0.46	0.42–0.49
RPM2002 model—sensitivity runs										
x57	0.225	SC	low	1972–2001	0.19	2935	2275	364	0.44	0.46
					0.18–0.20	2818–3053	2184–2366	355–374	0.43–0.48	0.41–0.48
x60	0.2	SC	high	1972–2001	0.20	2888	2238	397	0.43	0.43
					0.19–0.22	2761–3014	2140–2336	388–406	0.41–0.46	0.40–0.46
x61	0.25	SC	high	1972–2001	0.18	3221	2496	374	0.48	0.41
					0.17–0.19	3082–3360	2389–2604	365–385	0.39–0.44	0.44–0.52
x58	0.225	NC	high	1972–2001	0.22	2719	2107	439	0.40	0.41
					0.21–0.24	2571–2866	1992–2221	429–450	0.38–0.44	0.37–0.43
x59	0.225	NC	low	1972–2001	0.22	2684	2080	427	0.39	0.43
					Confidence intervals could not be estimated for run x59.					
x62	0.225	SC	high	1984–2001	0.16	2741	2124	301	0.39	0.59
					0.15–0.18	2573–2909	1994–2254	288–313	0.35–0.43	0.54–0.64
x63[1]	0.225	SC	high	1972–2001	0.19	3049	2363	376	0.57	0.43
					0.18–0.20	2923–3175	2266–2461	366–386	0.52–0.61	0.40–0.45
Production model[2]										
Logistic (base run)				1972–2001	0.13	3598	2788	471	0.35	0.45
					0.06–0.19	2725–5326	2112–4128	287–535	0.28–0.54	0.35–0.56
Logistic				1984–2001	0.10	4695	3639	475	0.38	0.48
					0.04–0.14	3043–8597	2358–6663	335–882	0.30–0.64	0.20–0.66
Fox				1972–2001	0.11	3361	2605	362	0.41	0.51
					0.05–0.14	2552–5172	1978–4008	204–393	0.33–0.82	0.29–0.82

[1] Run with estimated discards in headboat and commercial fisheries, 1999–2001

[2] Production model estimates are in terms of total biomass, rather than spawning biomass. Absolute estimates of B, F, B_{MSY}, and F_{MSY} from production models are considered less reliable than estimates of ratios, e.g., F/F_{MSY} and B/B_{MSY}. The absolute estimates are generally not recommended for management use.

Figure 8. Selectivities over time in two major fisheries for red porgy, estimated from base case of RPM2002 model.

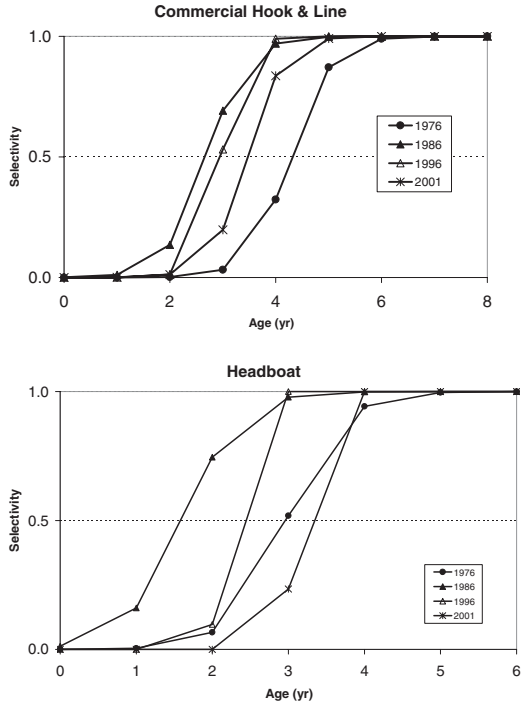


Figure 9. Trajectories of SSB and recruitment of red porgy, estimated from base case of RPM2002 model.

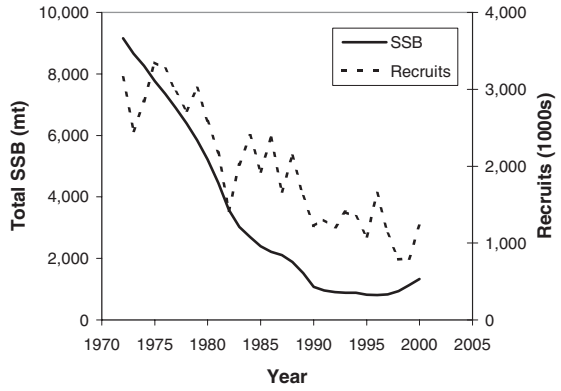


Figure 10. SSB and recruitment of red porgy estimated from RPM2002 model with estimated Beverton–Holt recruitment model.

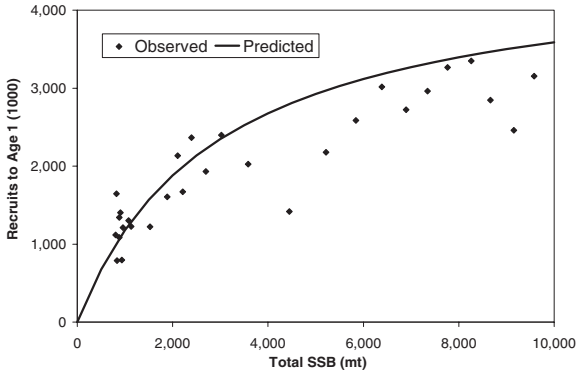
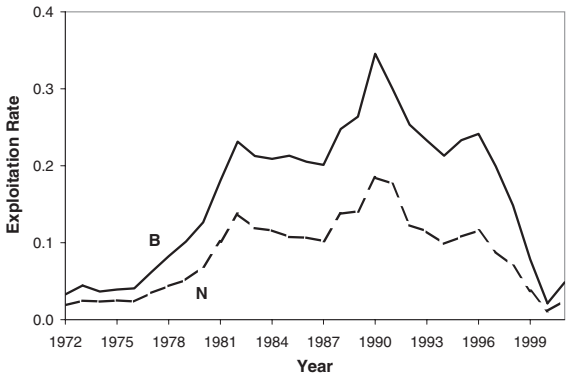
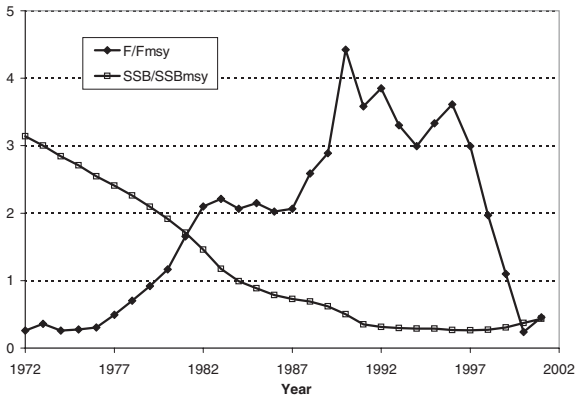


Figure 11. Exploitation rates (proportion of stock harvested per year) estimated by base run of age-structured model. B = rate in biomass; N = rate in numbers.



Age determination When the length-to-age information from North Carolina, which tends to assign older ages, was used (run x58, Table 3), the estimate of F_{MSY} increased slightly and the estimate of the ratio F_{2001}/F_{MSY} declined slightly. The estimate of stock status (B_{2001}/B_{MSY}) did not change appreciably; the most marked change was that MSY was estimated somewhat higher than in the base run. Use of NC aging in combination with low CVs (run x59) produced essentially the same results (Table 3).

Figure 12. Stock status and fishery status estimated from base run of age-structured model.



Natural mortality rate Model runs with a lower natural mortality rate ($M = 0.2$/yr, run x60) or higher mortality rate ($M = 0.25$/yr, run x61) resulted in estimates similar to those of the base run (Table 3).

Truncated data set This run was made to explore what our impression of stock status might be if we had only recent data. In that case (run x62), the estimate of stock status would be somewhat more optimistic than it is from the full data set, but MSY would be estimated somewhat lower (Table 3).

Approximated discards When an approximation for regulatory discards in recent years was added to commercial and headboat landings (run x63, Table 3), most results were not appreciably different from the base run. The exception is that fishing mortality rate in 2001 was estimated to be a substantially higher than in the base run.

6.1.4 Summary of age-structured model results

The sensitivity runs encompassed many changes to input data or model assumptions, yet the model estimates of stock status and fishery status did not change very much. The SAW believes that this occurred because the signal in the abundance indices (Figure 7) and patterns of size composition over time (Figures 3–5) are so strong that only one interpretation is consistent with the observed data. That interpretation is a severe decline in abundance of the stock over time, with signs of increase from the recent moratorium and Amendment 12.

6.2 Production model

6.2.1 Application of production model

Data used for production modeling were total landings and the four abundance indices described in Sections 3.2 and 3.4. Because the abundance indices were all given the same relative statistical weights by the SAW in the base age-structured model run, they were given equal weighting for the production model, as well.

In stocks that display a sharp initial decline, production model results can be sensitive to the value assumed for B_1/K, where B_1 is the biomass at the start of the time series, and K is the carrying capacity. Ideally B_1/K can be freely estimated as a parameter of the production model, but in some cases it can be quite poorly determined, and in such cases a frequently used technique is to fix the value of B_1/K (Punt 1990). To examine any such sensitivity, model fits were made with fixed B_1/K in the set of values $\{0.65, 0.75, 0.85, 0.95\}$ and B_1/K freely estimated.

6.2.2 Results of production model

Using the logistic (Schaefer) production model, fits to the index data series were generally good, with the rather ragged “Florida” trap series proving most difficult to fit. That seems a consequence of noise in the series, rather than model

Figure 13. Trajectories of B/B_{MSY} and F/F_{MSY} from logistic production model of red porgy. Plots with open circles represent B_1/K freely estimated [top curve in (a)] or fixed at values 0.95, 0.85, 0.75, 0.65. Plot with filled diamonds is from shorter data series, starting in 1984.

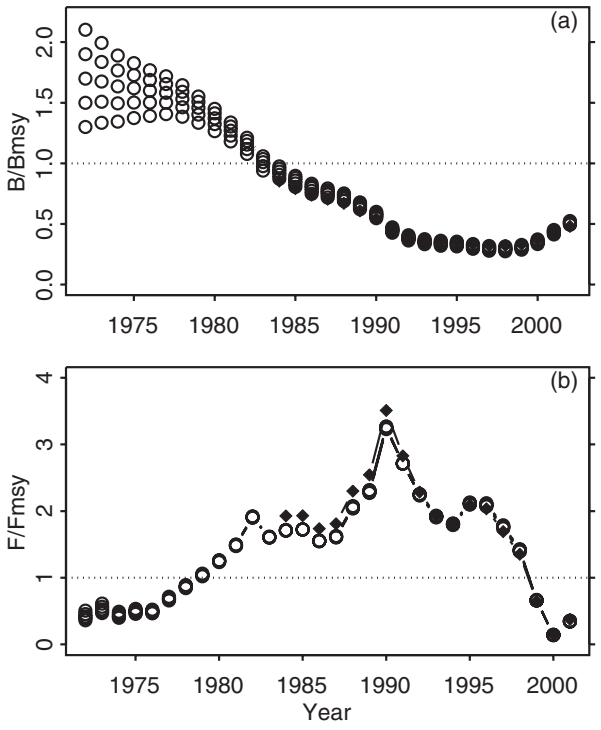
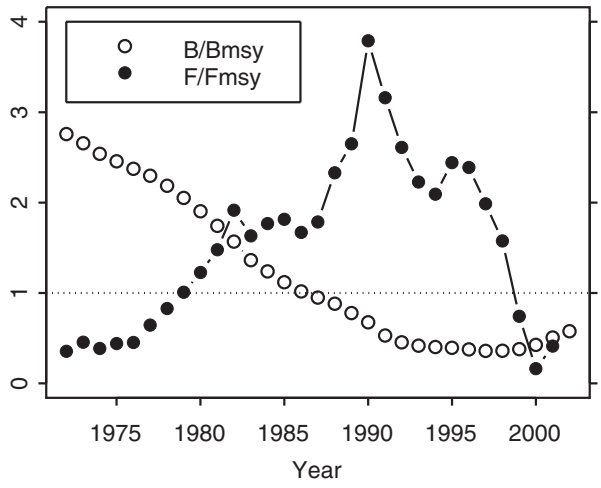


Figure 14. Trajectories of B/B_{MSY} and F/F_{MSY} from Fox (1970) production model of red porgy.



insufficiency.

Results from the logistic model were not sensitive to the value of B_1/K specified (or estimated), and estimated population trajectories for all values were indistinguishable after about 1990 (Figure 13a). Trajectories of relative fishing mortality rate differed even less (Figure 13b). The run with B_1/K freely estimated resulted in a reasonable population trajectory, and since model results were not sensitive to the value of B_1/K, the run with B_1/K freely estimated was chosen as most representative (base run for the production model).

Estimates of management quantities from the logistic production model are similar to those of the base age-structured model (Table 3). Like the age-structured model, this model describes the stock in 2001 as overfished (depleted) but not undergoing overfishing. The confidence intervals reported for production–model estimates (Table 3) tend to underestimate the uncertainty in the analyses, as is true of most confidence intervals reported for fisheries model estimates. Confidence intervals for the production model were derived from bootstrapping.

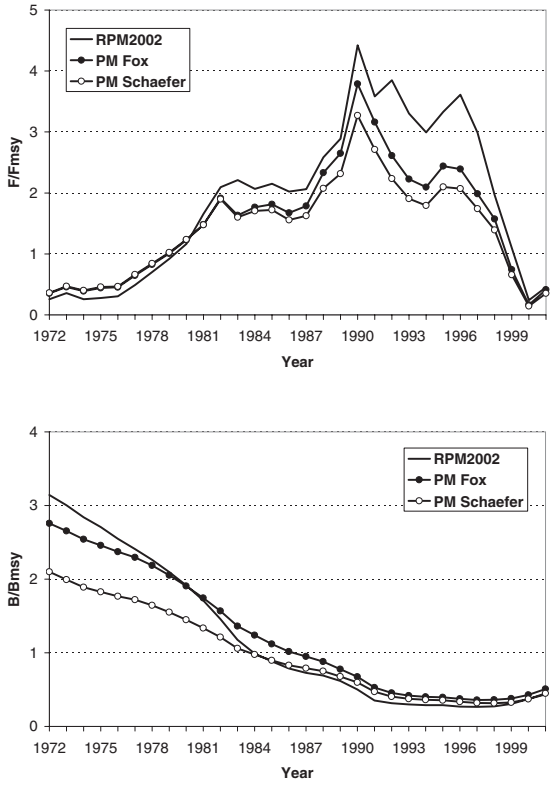
Trajectories estimated from the Fox production model were similar to those estimated from the Schaefer model (Figure 14), but slightly more optimistic in terms of present status. However, the estimates of MSY and F_{MSY} are both lower than from the logistic model (Table 3). As discussed below, some estimates from the Fox model are more similar to those from the age-structured model than are corresponding estimates from the Schaefer model.

6.3 Comparison of models

Estimated trajectories of stock status and fishery status from the models used in this assessment

agree remarkably well, especially in the most recent years (Figure 15). Given the different assumptions used by each type of model and the lack of age structure in the production models, this degree of agreement increases the SAW's confidence in the assessment results.

Figure 15. Comparison of estimated fishery and stock trajectories from age-structured model (RPM2002) and Fox and Schaefer (logistic) production models.



Like the trajectories, estimates of management quantities are quite similar between the production models and the age-structured model (Table 3). As noted above, for theoretical reasons the Fox model may be more consistent with the use of a Beverton–Holt recruitment model by the age-structured model used. It is therefore interesting to see that, of the two production models, the Fox model provides estimates of management quantities that agree more closely to those from the RPM2002 model.

Because the age-structured model incorporates far more information on the stock's biology and on the characteristics of the fishery, the SAW considers the RPM2002 age-structured model (in particular, base run x47b) the more reliable assessment tool. As such, its estimates are considered most likely to be accurate, and the production models and sensitivity runs are considered to give less definitive views of the population. Nonetheless, all models give the same basic picture of the stock's status in 2001: the stock was overfished (depleted), being reduced to about 44% of SSB_{MSY}, yet it was not undergoing overfishing, as F_{2001} was about 45% of F_{MSY}. The production-model estimates vary from those figures by about ±5%, but are essentially the same.

6.4 Comparison to previous assessments

Results from the base run of RPM2002 are qualitatively consistent with results from earlier red porgy stock assessments and stock-status update reports. In an update report using age-aggregated and age-structured production models, Vaughan et al. (2001) concluded that the red porgy stock was in poor condition, i.e., that the fishing mortality rate in 2000 was well below MFMT (about 34%–44% of F_{MSY}), and stock biomass was well below MSST (about 13%–25% of SSB_{MSY}). Corresponding estimates from the present assessment for 2000 are F/F_{MSY} = 24% and B/B_{MSY} = 37%. The present results thus agree qualitatively with the results of the stock update report, but are more optimistic about the degree of stock depletion.

A full assessment using data through 1997 and a natural mortality rate of 0.28/yr (Vaughan and Prager 2002) estimated average F/F_{MSY} for

1992–1996 in the range 2.7–3.6 and B/B_{MSY} for the same period in the range 0.28–0.39. Those ranges of estimates include the average estimates of $F/F_{MSY} = 3.4$ and $B/B_{MSY} = 0.29$ for the same time period from the present assessment. Similarly, the previous assessment estimated a decline in spawning biomass of 89% from 1975 to 1997, which is essentially the same as the estimate of 88% from the present assessment (Figure 12). Estimates of other management quantities from the RPM2002 base run differ somewhat from the earlier assessment. Again, the two assessments are in good qualitative agreement, but quantitatively, they differ slightly.

The main differences between previous assessments and this assessment were the extensive data preparation by DW and SAW and the use of an age-structured model not subject to excessive recent-year uncertainty due to retrospective patterns. The data-preparation process was time consuming and labor intensive, yet because almost every data issue was resolved, the assessment could take place with more certainty. The use of RPM2002 instead of VPA allows much better presentation of results, which do not have to be averaged across recent years; and it is not necessary to dismiss the resulting estimates of fishing mortality rate or stock numbers in the most recent years as questionable.

6.5 Additional information on CD–ROM

The Red Porgy 2002 CD–ROM produced by DW and SAW participants contains additional information about the RPM2002 model as used in this assessment. Specifically, the CD–ROM includes code, input files, output files, graphs, tables, and similar technical material, as well as all data used in the assessment. The CD–ROM also contains input and output files from production modeling.

7 Biological reference points

7.1 Proxies and estimated reference points

The SAW's scientific advice is that estimates of F_{MSY}, B_{MSY}, and related quantities, from the base run of this assessment (Table 3 on page 20) be used instead of current proxies for MFMT and MSST. In particular the SAW recommends consideration of the status indicators F_{2001}/F_{MSY} and B_{2001}/B_{MSY}. There is no need to use proxies, because the actual quantities have been estimated. Also, existing proxies, which are based on spawning potential ratio (SPR), have not proven sufficiently restrictive to maintain the stock (Vaughan and Prager 2002, and this report).

Unfortunately, no firm theoretical basis is known for deriving an SPR value to maintain high sustainable yields without having detailed knowledge of the species' population characteristics, knowledge that is sufficient to compute actual benchmarks. Several levels of SPR have been recommended in the fisheries literature as general cases, and those levels have tended to increase as empirical experience has accumulated. For example, Goodyear (1993) recommended 20% to 30% as "critical levels," Clark (1993) recommended 40% (an increase from his earlier recommendation of 35%), and Mace (1994) recommended using 40% SPR as a default in many conditions. Clark (2002) found that "at low …levels of resiliency, the $F_{40\%}$ strategy results in undesirably low levels of biomass and recruitment by present-day standards."

In summary, SPR proxies can be useful approximations when management quantities cannot be estimated. For red porgy, the use of SPR proxies is unnecessary, and use of actual benchmarks has a firmer biological basis.

7.2 Relationship of F_{MSY} to M

The estimate of F_{MSY} from the base run model is 0.19/yr, which is about 16% less than the value $M = 0.225$/yr assumed for the natural mortality rate. Knowledge of the theoretical and practical relationships among biological reference points is still evolving in fishery science. Nonetheless, studies and reviews in the last 25 yr have concluded that M is best considered an upper bound for F_{MSY} and that assuming $F_{MSY} = M$ will lead to unsustainable fishing in some stocks (Francis 1974; Deriso 1982; Thompson 1993; Quinn and Deriso 1999). The estimate of F_{MSY} from the base case is consistent with those studies.

7.3 Protogyny and reference points

The protogynous nature of red porgy creates complications in management not encountered with gonochoristic species. Protogynous species may switch from female to male as they age. Selective removal of larger fish, predominantly males, can effect the reproductive potential of the population to some unknown degree. SSB in this assessment combines males and females and therefore assumes both sexes have equal contributions to production of recruits. Preliminary examination of SSB by sex indicates the fast drop in SSB in the early years of the fishery was due to the removal of large males and male spawning biomass. The female spawning biomass was reduced at a slower rate particularly after imposition of minimum size limits.

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

8 Stock projections

To evaluate the likely effects of possible future management measures, simulations were used to project the stock forward, starting with stock status estimated by the base run. That stock status was projected ahead 25 years into the future based upon each of four fixed–F management regimes derived from recent regulations (Table 1). Projections under each management regime were repeated 1000 times. Details of projections are in spreadsheet file `rp_rebuild.xls` on the CD–ROM.

8.1 Structure of simulations

Projections used a simulated age-structured population with a stochastic spawner–recruit model to generate recruitments. Stochastic fishing mortality was applied in each of the 25 years of each simulation.

The 25–year projection under each management regime was repeated 1000 times, with different stochastic recruitment and fishing-mortality values applied for each realization. The rebuilt state was defined as the stock's reaching $SSB_{MSY} = 3049.5$ mt, a value estimated by the base case run (Table 3). The proportion of realizations that reached or exceeded the rebuilt state in each projection year was used as an estimate of the stock's probability of attaining the

rebuilt state by January 1 of that year under that management regime.

Initial stock size and *F* Initial (2001) stock sizes at age were as estimated by the base run from this assessment. Each projection applied the estimated F from run x63 (the sensitivity run with estimated discards; Table 3) to the first year (2001) of the calculations.

Life-history parameters Proportions mature at age, sex ratios at age, and release mortality rates (35% commercial, 8% recreational) were those provided by the Data Workshop.

Stock–recruitment model Population projections require a stock–recruitment model. Here, the Beverton–Holt model and its parameters as estimated in the base run were used. The model was stochastic, as described below.

Biological reference points Biological reference points (MSY, F_{MSY}, B_{MSY}) were those estimated within the base run.

Stochasticity All projections carry an element of uncertainty greater than assessment itself; in these projections, stochasticity (randomness) was incorporated in two places, recruitment and fishing mortality.

Stochastic recruitments were simulated from the estimated stock–recruitment relationship with a nonparametric bootstrap procedure. In that procedure, predicted recruitments were based on the model's predicted recruitment, with a multiplicative error (variation) defined by the logarithm of a randomly-chosen residual from the stock–recruitment model fit. Thus, a degree of variation about the ideal stock–recruitment curve was maintained, similar in magnitude to the variation in the estimated SSB and recruitment values from the assessment.

Fishery management is thought to exercise imperfect control of fishing mortality rate; thus, implementation uncertainty of management is an important consideration. This was incorporated into the simulations by drawing each year's value of F from a random distribution. The distribution used was a uniform distribution with range 0.5 to 1.5 times the nominal value of F. In the following, the phrase "fixed F" is used to signify that this *nominal* value of F did not change from year to year. The realized value did change, in accordance with the stochastic procedure just described.

8.2 Fishing mortality rates for projections

Each projection began in 2001 by applying the fishing mortality rate estimated from the sensitivity run with discards (Table 3, run x63) for that year to population sizes estimated for the same year. In the remaining years of each projection, constant nominal F over time was applied, based on one of four management regimes. The regimes considered were:

1. $F = 0$
2. F = bycatch mortality only (moratorium)
3. F as in Amendment 9
4. F as in Amendment 12

Determining a nominal value of F to represent each of the preceding regimes was not completely straightforward. The exception was the $F = 0$ regime, which is trivial (no catch, bycatch, or catch-and-release mortality). However, setting F for the other regimes was more difficult.

8.2.1 Initial approach

An initial approach produced an approximation of F due to Amendment 12 much higher than the fishing mortality rate estimated by the base-case assessment for 2001, the only complete year in which Amendment 12 was in place. Therefore, the initial approach was modified to take into account the estimates from the base case.

The initial approach for the three management regimes with $F \neq 0$ was based on estimating proportional reductions in F, or *savings* (to the stock), due to the moratorium or Amendment 9 or 12. (The procedure is described in detail in Appendix C.) The raw savings proportion was calculated relative to average fishing mortality rates in 1992–1998, when Amendment 4 was in place (Table 1).

Raw savings proportions (Table 4 on page 40) were multiplied by $(1 - R_i)$ by fishery, where R_i is the catch-and-release mortality rate for fishery i, to compute net savings proportions. This step simply reduces the projected savings to the stock by the catch-and-release mortality rate, under the assumption that fishermen are unable to avoid catching fish, but release them in accordance with the management regime in place. The complement of net savings proportion P_i for fishery i is defined as $1 - P_i$. Multiplying the complements, weighted by fishery, by the mean F for 1992–1998 from the base run gave the overall approximation $F = 0.326$/yr for fishing under Amendment 12.

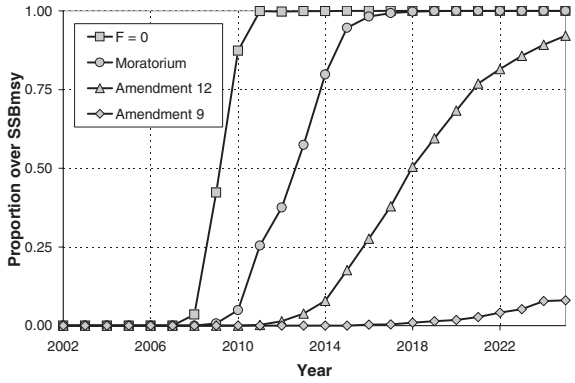
8.2.2 Final approach

Amendment 12 When considering the above approximation of $F = 0.326$/yr for Amendment 12, the SAW noted that F for 2001 (when Amendment 12 was in place) was estimated to be much lower (0.09/yr) by the base assessment. This discrepancy suggested that greater reductions in F were realized by Amendment 12 than were formalized in the initial calculations. The SAW decided, however, that simply using the estimate of F_{2001} from the base assessment would understate F under Amendment 12, because considerable unreported discarding is believed to have taken place under Amendment 12. An age-structured model sensitivity run was made with approximated increased discards during 1999–2001 (run x63, Table 3), and the SAW selected $F_{2001} = 0.107$/yr from that run as the most appropriate value for use in projections under Amendment 12.

Amendment 9 Because Amendment 9 was in place only from February through August of 1999, there is no estimate of F from the base run that would characterize Amendment 9. The SAW proceeded by assuming that the initial approach was biased in estimating F for Amendment 9 similarly to its bias in estimating F for Amendment 12. The SAW then made a proportional increase to the base-case F for Amendment 12 to arrive at F for Amendment 9.

To approximate the F under Amendment 9, then, the initial calculation of savings from Amendment 9 was adjusted by release mortality and then averaged across fisheries, giving overall savings of 11.1% (14.4% before adjustment for release mortality). Averaging savings by fishery and using the base-run mean F for 1992–1998 gives the initial approximation $F = 0.527$/yr. Applying the proportional reduction actually gained by Amendment 12, the SAW arrived at the approximate value $F = 0.527 \times 0.107/0.326 = 0.173$/yr for use in projections under Amendment 9.

Figure 16. Projections of the red porgy stock for 25 years. Annual probabilities of attaining rebuilt state under four management regimes.



Moratorium Fishing mortality under a moratorium would be composed solely of catch-and-release mortality. Unfortunately, there are no data that would allow approximation of the number of fish caught and released under a moratorium. Because of this uncertainty in knowing the gain from a moratorium, F for this situation was assumed to be one-half of that for Amendment 12, or 0.0535/yr.

8.3 Projection results

The first year of all projections applied the fishing mortality rate in 2001 (F_{2001}) to the stock biomass in that year (B_{2001}). In that sense, the first year was a direct extension of the assessment model, rather than a projection. That procedure estimates a slight increase in spawning-stock size during 2001, from 1326 mt to 1379 mt, or about 4%, equivalent to SSB_{2002}/SSB_{MSY} = 45.2%.

Under $F = 0$, the probability of attaining the target is essentially zero until 2008, when it reaches about 3.5%. The probability first exceeds 50% in 2010, when it is 87% (Figure 16). Under a moratorium, the probability of reaching the rebuilt state is about 5% in 2010 and first exceeds 50% in 2013, when it is 57%. Under Amendment 12, the probability of reaching the rebuilt state is about 4% in 2013 and first exceeds 50% in 2018, when it is 51%. Under Amendment 9, the probability of reaching the rebuilt state rises to 8% in 2025, the last year of the projections.

A more detailed picture of the projection results is given by looking at the 5th, 50th (median), and 95th percentiles of outcomes for each management regime by year (Figure 17). In particular, it can be seen that gradual stock building is predicted under Amendment 12, and an even more gradual stock building is predicted under Amendment 9. Projections are by nature uncertain, but these projections represent the SAW's best estimates of possible stock building scenarios for the four management options requested.

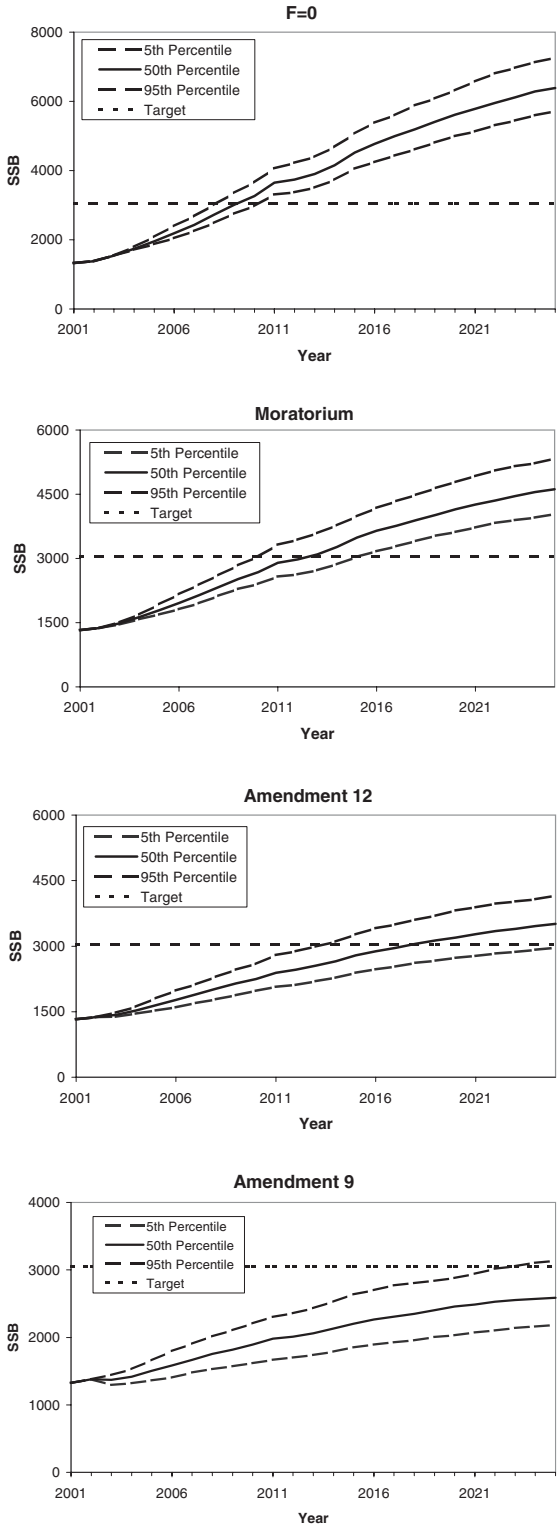
9 Research recommendations

The SAW 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 red porgy.

1. The discrepancy between SC and NC aging is a major one that must be resolved, preferably before the next assessment. The SAW recommends that as soon as possible, the NC and SC investigators meet and share age readings techniques, to resolve the systematic discrepancies in age determinations, if possible. The SAW further recommends that research be undertaken that will accomplish verification of aging in red porgy.

2. The protogyny of red porgy is a life-history feature that complicates assessment and management. The SAW recommends that

Figure 17. Projections of the red porgy stock for 25 years under four management regimes.



sampling for sex ratio at length be instituted in each fishery and that population sampling for sex ratio at length be continued by the MARMAP program. The SAW further recommends that research be instituted into assessment and population-projection methods that can make better use of sex-ratio data that exist now and that may exist in the future.

3. Under many forms of management, considerable discarding of red porgy could be expected to occur. The SAW recommends that sampling programs be initiated to quantify discard rates, especially in the commercial fishery, where the discard mortality rate is believed higher, and to estimate discard mortality rates. The SAW recommends that research be instituted on management strategies that could reduce discard mortality and also research to illustrate the effects of discard mortality. The SAW also recommends that socioeconomic research be considered on educational measures to assist fishery participants in minimizing discard mortality and understanding the value of doing so.

4. Fishery-independent data collected by the MARMAP program have served an important role in understanding the dynamics of this population, 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 have been criticized by some as not having ideal extent, both in area coverage and in sampling intensity, for red porgy. The SAW recommends that the MARMAP program expand its coverage as needed.

5. During the DW and SAW, it was noted that some incomplete, or misleading data have been entered in the NMFS general canvass data base. In particular, some data are available only under aggregated categories (e. g., porgies), even when accepted corrections to provide estimates of red porgy landings exist. The SAW recommends that state agencies contact and work with NMFS personnel maintaining the general canvass data base to make sure that data in that central data base are at the most disaggregated level possible and as accurate as possible. The goal is that future red porgy assessment should be able to use data from the general canvass data base with confidence and without further corrections.

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Appendix A Terms of reference for red porgy SAW

The Stock Assessment Workshop's task is to produce an assessment of the red porgy stock, including analyses of stock rebuilding. This work should be done with reference to the U.S. Sustainable Fisheries Act and its National Standards, which govern the Council's management. A written final report, 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 no later than one week following the workshop.

1. Identify modeling approaches appropriate to the available data and management questions (e.g., production models, age-structured models, hybrids).

2. Determine suitability of current proxies for SFA benchmarks and suitable approaches for estimating actual SFA benchmarks.

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

4. Identify and conduct rebuilding analyses comparing management options from Amendment 9, Amendment 12, Moratorium, for $F = 0$, and for other possible scenarios.

5. Provide recommendations for future research (field and assessment).

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 Stock Assessment Workshop only; others attended both workshops.

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Appendix C Initial approximation of effects of management measures

C.1 Introduction

Prior to 1992, no regulations on red porgy were in place. In 1992, a 12" TL minimum size limit was put in place, followed by a 14" TL minimum size limit in 1999. Amendment 12 to the SAFMC Fishery Management Plan for the Snapper–Grouper Complex consists of the following regulations concerning red porgy. For the recreational fisheries (charter and private boat and headboat) there was a 1–fish bag limit. For the commercial fishery (primarily lines and traps), there was a four–month closure (Jan–Apr) and 50-lb trip limit (May–Dec).

For the purpose of adjusting age-specific fishing mortality rates from a base period (e. g., 1992–1998 during which there was the 12" TL minimum size limit), savings from the above regulations are calculated based on the legal size fish (red porgy 14" TL), because savings are applied relative to F on legal size fish, while release mortality is used to reduce F on sublegal size fish.

Because comparisons are to a base period (1992–1998), it was assumed that the population size was approximately constant during the base period and that reductions in landings (as proportions) were proportional to reduction in average F for the base period.

C.2 Recreational fisheries

Charter and private boat data are from MRFSS; headboat data are from Beaufort Laboratory Headboat Program.

Because savings from the 1-fish bag limit are calculated conditioned on historical trip data (1992–1998) with information on size of fish captured, a subset of trips for which at least 1 fish was measured form the basis of this analysis. There were 79 trips representing 418 anglers from charter boats, 29 trips representing 77 anglers from private boats (no data for 1998), and 607 trips representing 24,533 anglers from headboats that met this criteria for 1992–1998. Because not all fish landed from a trip were measured, it was necessary to proportionally expand the observed size frequency for the subset of measured fish to all fish caught in a trip. The percent of red porgy measured for trips with at least one fish measured was 35% of fish landed for charter boat trips, 31% for private boats, and 10% for headboats. Thus, while there were a greater number of trips and anglers represented in the headboat data, expansion for unmeasured fish was significantly greater for the headboat analysis.

In addition, fish landed during a trip may represent landings from multiple anglers (especially for headboat). To convert these trips to angler-trips, two alternate approaches were used depending on the number of red porgy landed compared to the number of anglers on the trip. When the number of anglers for a trip equaled or exceeded the number of red porgy landed, then the landings per angler-trip was one fish and the number of trips equal to the number of red porgy landed (these trips would be unaffected by the one-fish bag limit). When the number of red porgy landed exceeded the number of anglers, then the number of legal fish under a one-fish bag limit was equal to the number of anglers. The proportion of red porgy saved by the one-fish bag limit would be the number of fish caught minus the number of fish landed with a one-fish bag limit divided by the number of fish landed. To separate savings due to the one-fish bag limit

from that of the 14" TL minimum size limit, the above calculations were based only on the expanded number of fish landed greater or equal to 14" TL.

C.2.1 Charterboat fishery

There were 79 trips between 1992 and 1998 for which at least one red porgy was measured. Associated with these trips were 418 anglers and 816 red porgy landed. Because of the 14" TL minimum size limit, the number of fish per angler-trip, savings (unadjusted for release mortality) was calculated based on red porgy greater than or equal to 14" TL. For 1992–1998, 795 red porgy were landed, of which 147 were greater than or equal to 14" TL. If a 1-fish bag had been in place, then 95 red porgy would have been retained legally, or a savings of 35.1% $[100 \times (147 - 95)/147]$. Annual estimates range from 0% in 1997 (only 1 fish over 14" TL) to 63.6% in 1995 (39 fish over 14" TL and 14 landed under a 1-fish bag limit). Note that of the 5 trips and 46 fish reported caught in 1998, none of the fish measured were greater than or equal to 14" TL.

C.2.2 Private boat fishery

There were 29 trips between 1992 and 1998 for which at least one red porgy was measured. Associated with these trips were 77 anglers and 203 red porgy landed. Because of the 14" TL minimum size limit, the number of fish per angler-trip, savings (unadjusted for release mortality) was calculated based on red porgy greater than or equal to 14" TL. For 1992–1998, 203 red porgy were landed, of which 102 were greater than or equal to 14" TL. If a 1–fish bag had been in place, then 15 red porgy would have been retained legally, or a savings of 85.4% $[100 \times (102 - 15)/102]$. Annual estimates range from 0% in 1993 and 1995 (only 1 fish over 14" TL in each year) to 96.3% in 1996 (81 fish over 14" TL and 3 landed under a 1-fish bag limit).

C.2.3 Headboat fishery

There were 607 trips between 1992 and 1998 for which at least one red porgy was measured. Associated with these trips were 24,533 anglers and 30,746 red porgy landed. Because of the 14" TL minimum size limit, the number of fish per angler-trip, savings (unadjusted for release mortality) was calculated based on red porgy greater than or equal to 14" TL. For 1992–1998, 30,746 red porgy were landed, of which 11,650 were greater than or equal to 14" TL. If a 1-fish bag had been in place, then 8,478 red porgy would have been retained legally, or a savings of 27.2$[100 \times (11650 - 8478)/11650]$. Annual estimates range from 14.4% in 1996 (1,804 fish over 14" TL and 1,544 fish landed under a 1-fish bag limit) to 34.5% in 1992 (1,860 fish over 14" TL and 1,218 landed under a 1-fish bag limit).

C.3 Commercial fishery

A similar approach was used for the commercial fishery as for the recreational fisheries. Savings from 50-lb trip limit and seasonal closure were calculated from logbook data from 1992–1998 (logbook data for 1992 was based on 20% selection versus 100% selection for 1993-1998). Where necessary, gutted weight were converted to whole weight (whole = 1.04 $\times$ gutted). Because of the difficulty associated with merging the logbook data base (trip information) with the TIP data base (size information), an alternate approach was used for reducing the trip estimates from the logbook data for fish less than 14" TL. Length information from the TIP data base was converted to weight based on the weight-length

relationship determined from the MARMAP Aging Data Base (1979–1994). Stratifying the TIP data base by gear (lines and traps), year, month, and state, the weight was summed over fish less that 14" TL and fish greater than or equal to 14" TL. The proportion of fish greater than or equal to 14" TL was then applied to the trip estimates from the logbook within the same stratum. When this proportion was not available for a particular stratum, the following pooling was used. First, TIP data were pooled over months. This was sufficient for all of the line gears (the great majority of landings). For the trap data it was necessary in some cases to pool within a year, and finally the overall proportion for 1992–1997 was applied to 1998 when no trap lengths were available. Savings were calculated from both trip limit and seasonal closure jointly based on gutted weight.

For the period 1992–1998, total commercial landings of 2,324,125 pounds whole weight was landed as reported by logbook. A total of 1,534,293 pounds was landed that were greater than or equal to 14" TL, of which 412,757 pounds would have been landed with the closed season and a 50–lb trip limit, giving a savings of about 73.1%. Annual savings from closed season and trip limit ranged between 63.5% in 1998 and 77.8% in 1994.

Estimated savings from the recreational and commercial fisheries are summarized by year and overall in Table 4. Similar calculations were done for Amendment 9 and included in Table 5. These calculations consist of the same 14" TL minimum size limit, but with a 5-fish bag limit for recreational fisheries and a 2–month closed commercial season (Mar–Apr).

Table 4. Computed savings of red porgy from Amendment 12 for legal size fish (14" TL) compared to 1992–1998 base period. Recreational controls also include a 1-fish bag limit; commercial controls are a 4-month closure (Jan–Apr) and 50-lb trip limit (May–Dec).

Year	Charter	Private	Headboat	Comml.
1992	6.9%	52.9%	34.5%	71.3%
1993	38.0%	0.0%	24.5%	74.6%
1994	21.7%	54.5%	34.0%	77.8%
1995	63.6%	0.0%	27.6%	76.0%
1996	40.0%	96.3%	14.4%	70.7%
1997	0.0%	36.8%	29.8%	71.0%
1998	N/C	N/A	29.8%	63.5%
Overall	35.1%	85.4%	27.2%	73.1%

Note: see file `Recreation Bag Size.xls` for more detail on recreational calculations, and `Commercial Trip&Size.xls` for more detail on commercial calculations.

Table 5. Computed savings of red porgy from Amendment 9 for legal size fish (14" TL) compared to 1992–1998 base period (12" minimum size). Recreational controls also include a 5-fish bag limit; commercial control is a 2-month closure (Mar–Apr).

Year	Charter	Private	Headboat	Comml.
1992	0.0%	0.0%	0.6%	18.1%
1993	0.0%	0.0%	0.0%	15.1%
1994	0.0%	0.0%	0.0%	16.8%
1995	27.0%	0.0%	2.1%	20.3%
1996	10.0%	86.2%	0.0%	13.6%
1997	0.0%	0.0%	0.0%	13.2%
1998	N/C	N/A	0.3%	15.0%
Overall	9.2%	68.3%	0.4%	16.1%

Note: see file `Recreation Bag Size.xls` for more detail on recreational calculations, and `Commercial Trip&Size.xls` for more detail on commercial calculations.

Appendix D—Abbreviations and symbols

Table 6. Acronyms, abbreviations, and mathematical symbols used in this report

Symbol	Meaning
ADAPT	A type of tuned VPA often used in assessment of North Atlantic fish stocks
B	Total biomass of stock
B_{MSY}	Total stock biomass at which MSY can be attained (in production models)
CPUE	Catch per unit effort; used after adjustment as an index of abundance
DW	Data Workshop for red porgy
F	Instantaneous rate of fishing mortality
F_{MSY}	Fishing mortality rate at which MSY can be attained
FL	State of Florida
GA	State of Georgia
K	Average size of stock when not exploited by man; carrying capacity
M	Instantaneous rate of natural (non-fishing) mortality
MARMAP	Marine Resources Monitoring, Assessment, and Prediction Program, a fishery-independent data collection program of SCDNR
MFMT	Maximum fishing-mortality threshold; a limit reference point used in U.S. fishery management; often set to F_{MSY}
MRFSS	Marine Recreational Fisheries Statistics Survey, a data-collection program of NMFS
MSST	Minimum stock-size threshold; a limit reference point used in US fishery management. The SAFMC has defined MSST for red porgy as $(1 - M)B_{MSY} = 0.775B_{MSY}$.
MSY	Maximum sustainable yield
mt	Metric tons(s)
NC	State of North Carolina
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration; parent agency of NMFS
R	Recruitment
RPM2002	The forward-projecting age-structured assessment model used here; see §5.1
SAFMC	South Atlantic Fishery Management Council
SAW	Stock Assessment Workshop for red porgy
SC	State of South Carolina
SCDNR	Department of Natural Resources of SC
SSB	Spawning-stock biomass
SSB_{MSY}	Spawning-stock biomass at which MSY can be attained (in age-structured models)
TIP	Trip Interview Program, a fishery-dependent biodata collection program of NMFS
TL	Total length (of a fish), as opposed to FL (fork length)
VPA	Virtual population analysis, an age-structured assessment model characterized by cohort-wise computations backward in time; "tuned" VPA also employs abundance indices to influence the estimates
yr	Year(s)

Doc Number XX-02

Report of the 1st Southeast Atlantic Regional Fisheries Stock Assessment Workshop

Stock Assessment Review Committee (SARC) Consensus Summary of Assessment

Meeting Overview.

The SARC met at the Holiday Inn-Brownstone Hotel in Raleigh, N.C. May 14-16, 2002 to review the red porgy assessment produced by the 1st Southeast Atlantic Regional Stock Assessment Workshop (SA-SAW). As this was the first SARC for the Region, it was based on the approach developed by Northeast Regional Stock Assessment meetings and documents. The meeting was chaired by Dr. Bob Mohn (CIE), and the SARC was comprised of Council staff, NMFS Northeast and Southeast staff, members from Universities and the fishing industry. The only assessment on the agenda was red porgy. However, considerable time was spent discussing the structure and functions of future SA-SAWs and SARCs.

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SARC Composition.

SARC CHAIR:	Dr. Bob Mohn, Center of Independent Experts
NMFS SEFSC:	Dr. Steve Turner
NMFS NEFSC:	Ms. Kathryn Sosebee
SAFMC:	Gregg Waugh
SNAPPER GROUPER AP:	Mark Marhefka
NGO/SSC REPRESENTATIVE:	Dr. Andy Cooper
SSC REPRESENTATIVE:	Debra Murie

List of Participants.

Presenters:

Data Workshop/SAW Chair - Dr. Jim Berkson, VPI
(Technical Support to Chair - Michelle Davis, VPI Student)
SAW Coordinator - Dr. Michael Prager, NMFS Beaufort Lab

SAW/SARC Support Staff:

Dr. John Merriner, NMFS SEFSC Beaufort Lab
Dr. Erik Williams, NMFS SEFSC Beaufort Lab
Dr. Scott Nichols, NMFS SEFSC
Dr. Doug Vaughan, NMFS SEFSC Beaufort Lab
John Carmichael, NC DMF and SSC

Meeting Support Staff & Observers:

Kerry O'Malley, SAFMC Staff
Megan Peabody, SAFMC Staff
Wayne Lee, Chair SAFMC Snapper Grouper Committee
Louis Daniel, SAFMC Snapper Grouper Committee & NC DMF
Dr. Nancy Thompson, NMFS Southeast Center Director
Dr. Pete Eldridge, NMFS SERO
Michelle Duval, Environmental Defense

SARC Process.

Prior to the SARC review, NMFS, South Atlantic Council and State personnel convened a Data Workshop (DW) to assemble, review and edit/correct data for subsequent assessment. The Stock Assessment Workshop (SAW) was then held to decide on methodology and prepare documents for SARC review. The SARC members have a dual role; panelists are both reviewers of assessments and drafters of management advice. More specifically, although the SARC's primary role is peer review of the tabled assessments, the committee also prepares a report with advice for fishery managers and a consensus documents of their review and the approved assessment.

Agenda and Reports.

TUESDAY - May 14, 2002 - 1:00 PM

1. Welcome and Background - John Merriner
2. Introductions: John Merriner
   - Panel Members and Presenters
   - SAW Personnel Contributors
   - Public Audience
3. Terms of Reference - John Merriner
   - Expected Reports & Products

4. Chair Discussion with Panel members - Bob Mohn
   Procedures, evening sessions?
   Breaks? General schedule
5. Presentation of Stock Assessment - Jim Berkson and Mike Prager
6. Initial Discussions of Stock Assessment - Chair and Panel
   Requests for Additional Analyses, if feasible at meeting or later
   Continue -----

5:30 PM - Adjourn for Evening

WEDNESDAY - May 15, 2002 8:30 AM - 5:30 PM

7. Continue Discussions of Stock Assessment
   Develop Initial Consensus Positions
8. Develop Initial Inputs for SARC Advisory Report

THURSDAY - May 16, 2002 8:30 AM - 3:00 PM

9. Discuss and Finalize Consensus Red Porgy Stock Assessment Report
10. Discuss and Finalize SARC Advisory Report on Red Porgy
11. ????

Adjourn at 3:30 PM

SARC documentation includes two reports, one containing the assessment(s) and the SARC comments and research recommendations (this report, the SARC Consensus Document), and another that summarizes the status of stocks and management advice (SARC Advisory Report). (Northeast now lists where the drafts will be publicly available and a reference for the Document Series under which they are published)

Executive Summary.

The status of red porgy was reviewed and terminal year (2001) and both age-structured and age-aggregated abundance and spawning stock estimates were provided. Fishing mortality was also assessed and long-term projections were conducted to evaluate relative trajectories of stock biomass and catch under various fishing mortality scenarios. The SARC consensus was that the assessment was good at representing the condition of the resource and that the resource is increasing under current management.

The 2002 assessment used commercial and recreational catch and catch rate data. Size composition from commercial and recreational boats was also used. MARMAP trap data was also incorporated into the analysis. This assessment updates the most recent red porgy assessment, Vaughn and Prager (2002).

The SARC concluded that the assessment well represented the status of the red porgy stock, which has fallen and is currently overfished but overfishing is not occurring. The current index of spawning stock biomass is low; the 2001 spawning stock size is estimated at about 43% of SSBmsy and 55% of MSST. The 2001 fishing mortality rate is estimated at about 45% of Fmsy. Recruitment, as measured by the model, has trended down from 1972 with an upturn in 2001. The size structure of the stock has been reduced after a period of high fishing mortality.

There is considerable uncertainty in future rates of recovery due to: uncertainty about the biology of the species, model uncertainty, and quality of the data available. Projections simulating current fishing mortality (Amendment 12 regulations) show less than 50% probability of achieving SSBmsy in 2016 which is the last year of the Council's 18 year rebuilding program. See Figure 4. The projections show a 50% probability of exceeding the MSST in 2011. Projections simulating no directed fishing or by-catch (F = 0) would achieve SSBmsy in 2009 but the mortality from discards would increase.

Terms of Reference.

The SARC was given the following Terms of Reference. A brief response to each follows in Italics.

> The SARC will evaluate the red porgy assessment, its input data, assessment methods, and model results as put forward by the SAW. Specifically, the SARC will:

1. Evaluate the adequacy and appropriateness of fishery-dependent and fishery-independent data used in the assessment (i.e. was the best available data used in the assessment?);

   The SARC concluded that the data used in the assessment were adequate and appropriate and that the assessment was based on the best available data. See recommendation below on extending data sources by sampling deeper water.

2. Evaluate the adequacy, appropriateness, and application of models used to assess red porgy and to estimate population benchmarks (MSY, Fmsy, Bmsy and MSST, i.e. SFA items);

   The SARC concluded that the models used were adequate and appropriate. Further investigations were recommended into model structure for future assessments. The SAW report did not include the MSST values although these could be calculated from material included. The SARC has included these values and suggest this be done in future SAWs.

3. Evaluate the adequacy, appropriateness, and application of models used for rebuilding analyses;

Although the SARC felt that the age-structured model was not adequate for predicting the probability of achieving rebuilding by 2016, the model provided sufficient information for the SARC to recommend that fishing mortality should not be increased over 2001 levels.

4. Develop recommendations for future research for improving data collection and the assessment;

See Recommendations Section below.

5. Prepare a Consensus Stock Assessment Report from the Draft Stock Assessment Workshop Report provided by the SAW and presented to the SARC by the SAW Chair. An example of the format and content of the report is available on NMFS, Northeast Fisheries Science Center's web site (http://www.nefsc.nmfs.gov/nefsc/publications); see year 2001 item entitled "Report of the Northeastern Regional Stock Assessment Workshop (33rd SAW) Consensus Summary of Assessments". This red porgy report will be completed by May 31, 2002;

Done. The format of the report differs from the NEFSC format because the format of the SAW report had not been defined in advance and time was limited.

6. Prepare a SARC Advisory Report including a summary of stock-status, management recommendations and forecast for the upcoming year. An example of the format and content is shown within "Report of the 33rd SAW" document (see item 5 above). This red porgy report will be completed by May 31, 2002.

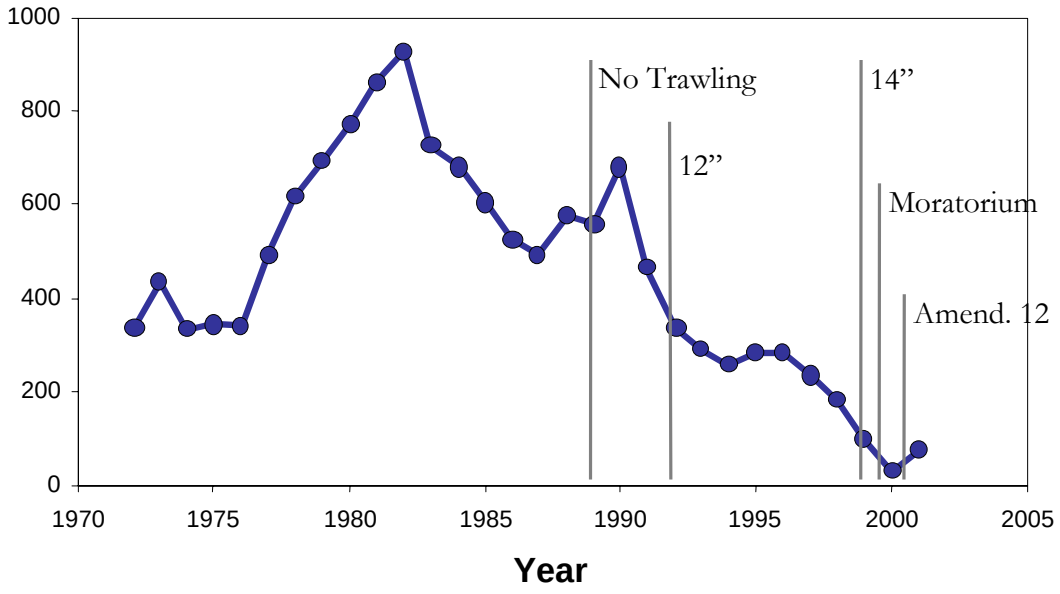
Done. The format of the report differs from the NEFSC format because the format of the SAW report had not been defined in advance and time was limited.

Attending NMFS scientific staff will provide editorial assistance to the review panel during the meeting and assist the panel in preparation of the reports (items 5 and 6 above). The reports shall be provided to Dr. Nancy Thompson, SEFSC Director, 75 Virginia Beach Drive, Miami, FL 33149.

Materials Supplemental to SAW report.

This Section of the Consensus Document contains additional analyses, explanations and details to those supplied in the SAW document. They are in the form of numbered figures and items. In many instances, the SARC needed more detail to evaluate the red porgy assessment than was presented in the SAW document. Because of time constraints and the lack of familiarity with the requirements for document production specified in Terms of reference 5 and 6, a provisional format has been used for this report. The format of this section will be annotated tables and figures. This is not meant to set a precedent for future documents. Indeed, this Consensus Document is of a makeshift nature and is offered as the minimum standard of documentation of the SARC. **It is recommended that** future SARC reports be integrated up into a single document based on the SAW report(s) and following a format to be determined. The Woods Hole SARC may provide a useful template.

Figure 1. The SARC requested that the major management interventions be superimposed on the catch history. This figure was later used in the Advisory document.



Item 1. Table of catch by year by fishery (metric tons).

YEAR	Comm.				Recr.	Recr.	TOTAL
	H&L	Trap	Trawl	HeadBoat	Charter	Private	
1972	32.83	13.37	0.31	240.39	18.75	29.94	289.08
1973	38.23	3.81	5.87	339.84	18.75	29.94	388.53
1974	37.57	11.57	0.00	234.67	18.75	29.94	283.37
1975	71.81	17.88	0.52	205.27	18.75	29.94	253.97
1976	79.39	16.63	17.81	177.49	18.75	29.94	226.19
1977	122.10	8.82	67.35	245.89	18.75	29.94	294.58
1978	325.98	0.13	3.37	240.17	18.75	29.94	288.87
1979	444.28	1.86	37.70	157.31	18.75	29.94	206.00
1980	417.17	4.51	137.96	162.42	18.75	29.94	211.12
1981	564.44	9.43	138.81	147.31	0.00	2.54	149.85
1982	620.25	4.94	103.32	195.93	2.15	2.91	200.98
1983	525.68	9.96	52.12	118.59	18.18	0.66	137.43
1984	466.96	10.12	33.19	98.45	69.41	4.83	172.70
1985	379.13	3.05	9.53	118.11	0.03	97.56	215.71
1986	397.28	13.76	6.83	100.74	1.28	7.61	109.64
1987	342.54	10.10	4.39	100.01	9.57	24.46	134.04
1988	381.48	12.30	11.30	97.76	32.21	41.17	171.14
1989	405.65	13.64		74.87	45.72	17.66	138.24
1990	474.79	41.66		56.82	8.95	100.02	165.79
1991	329.13	48.45		63.88	6.61	17.03	87.51
1992	228.86	5.43		49.83	33.45	20.32	103.60
1993	200.39	12.84		45.83	19.24	11.25	76.32
1994	190.19	7.74		39.72	10.61	10.02	60.35
1995	189.28	6.71		42.20	44.15	4.07	90.42
1996	189.71	5.16		37.29	16.35	36.40	90.04
1997	189.14	3.96		34.16	4.99	3.32	42.47
1998	140.78	3.45		31.42	3.62	2.14	37.17
1999	45.40	2.29		22.13	24.48	6.28	52.89
2000	11.07	0.82		6.46	7.19	4.40	18.05
2001	29.68	0.34		22.73	16.60	7.90	47.23

Figures 2-4. Additional information on the maturation and sex reversal for Red Porgy. Figures 2 and 3 are maturity at size and age from various sources. Further questions were posed about how maturity was defined and are sex specific data available. Figure 4 is sex ratio at size and age.

Figure 2. MARMAP data of maturity at size and age.

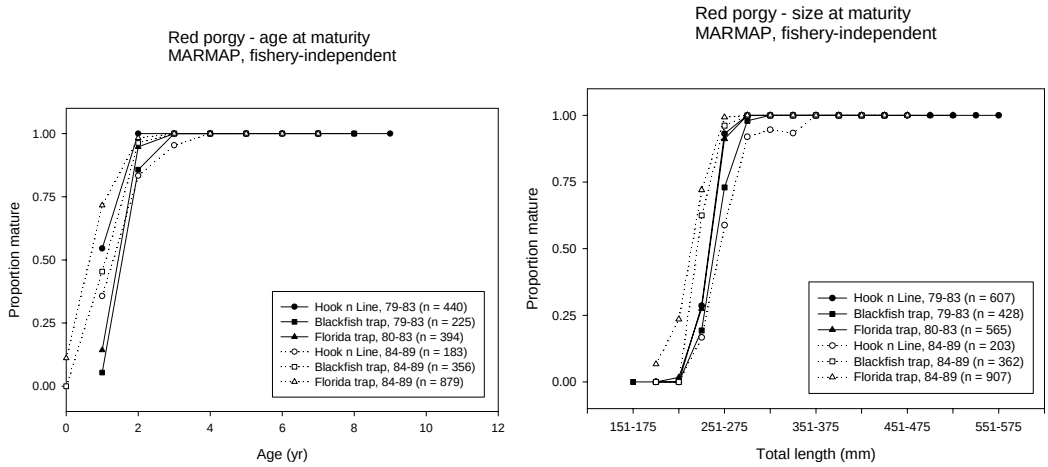


Figure 3. MARMAP data of age and size of maturity from Chevron traps.

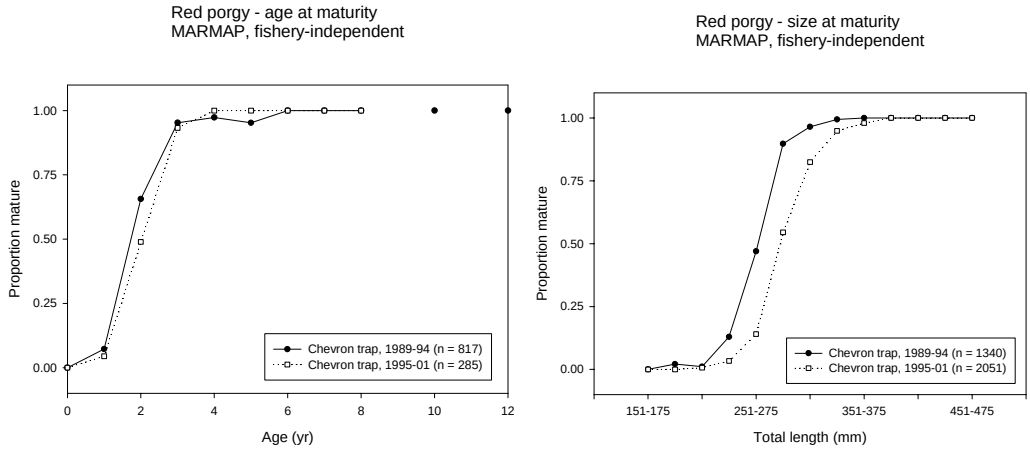


Figure 4. Sex ratio by age and size.

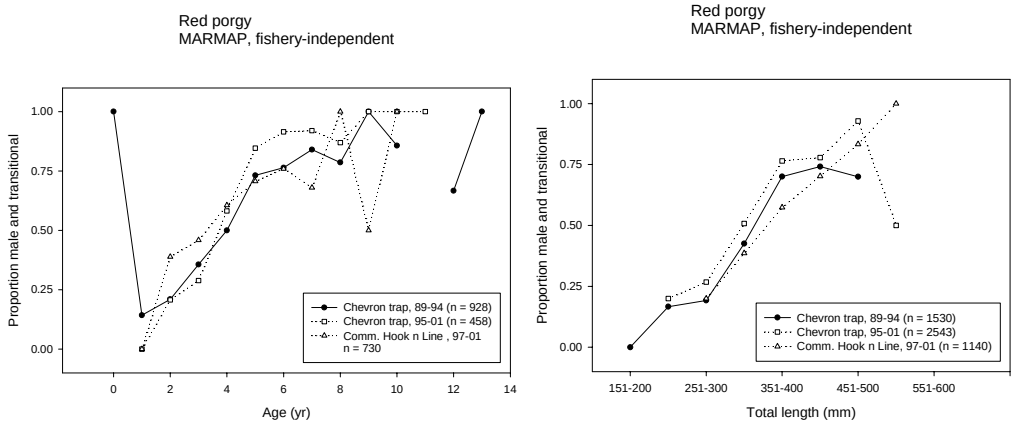


Figure 5. Disagreement between North Carolina and South Carolina aging was noted in the SAW document. The SARC requested a summary of the 289 fish aged by both laboratories, which is shown in the following figure. It was observed in the sensitivity runs that this poor agreement did not have much of an effect on the assessment results. The need to resolve the aging protocols is a Research Recommendation (below).

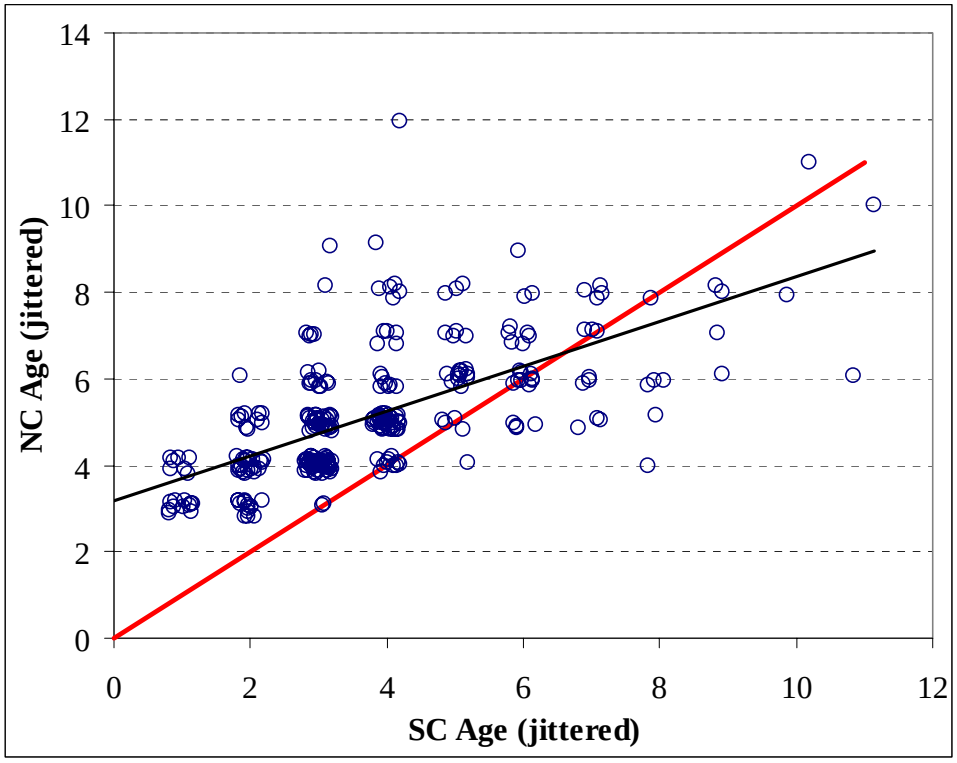
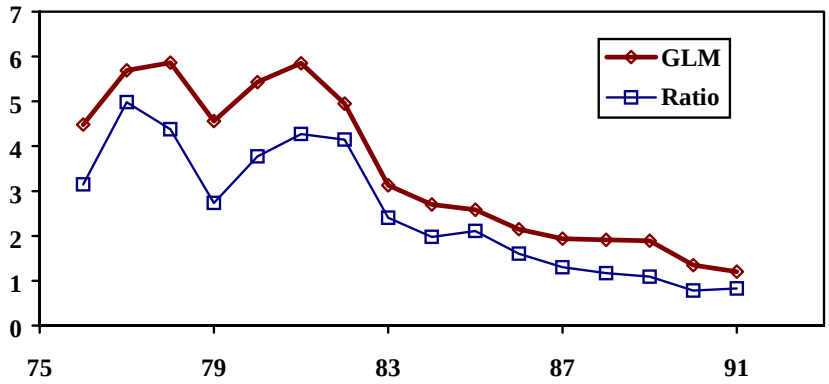
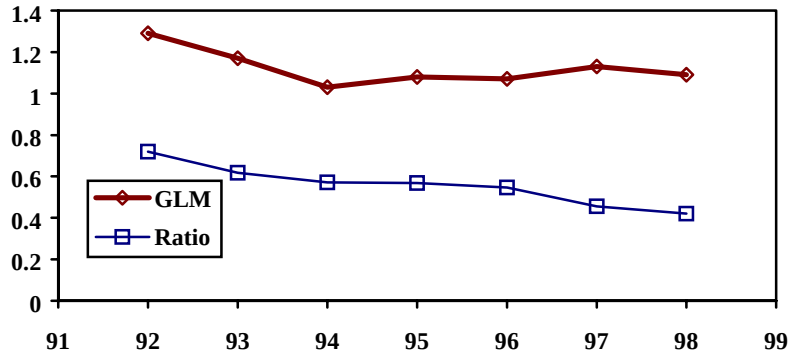


Figure 6. The Headboat CPUE data were analyzed using a GLM model for two periods (1976-1991, 1992-1998). The SAW document did not show the effect of the GLM, which the SARC requested. In the earlier time period, the model results show a very similar pattern. The difference in scale does not affect the model results. In 1992-1998, the GLM results have less of a decline over the data period. It was recommended that future analyses examine catch rates including unsuccessful effort.



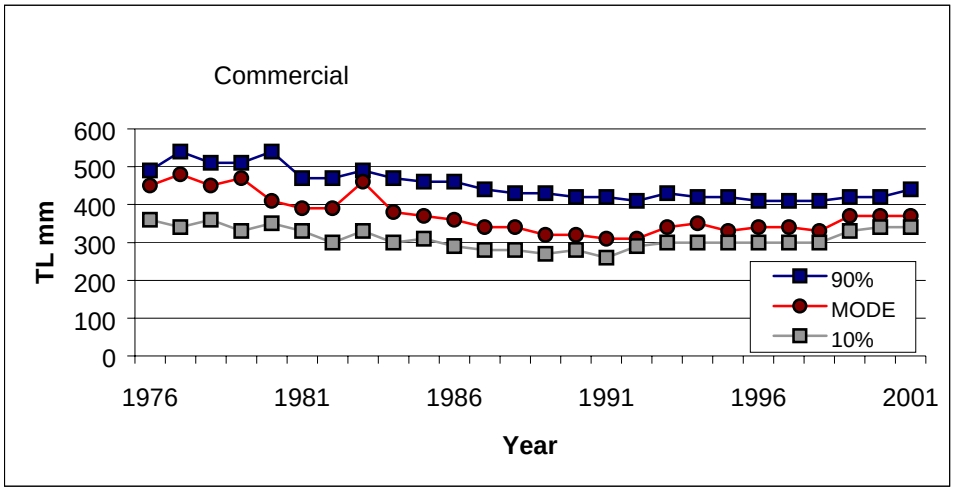


Item 2. A point form explanation of how the discard losses were estimated in the commercial fishery was requested. It was explained that an Analysis of Covariance model was fitted where the log of the red porgy landings was predicted from the log of gag and vermilion snapper landings. The data were disaggregated by state and month. Using this model, the red porgy landings were then predicted for 1999 to 2001 and the difference between the predicted and the observed was used as an estimate of the releases due to the management measures imposed in 1999. It was further assumed that 35% of these releases died.

Item 3. Summary of F used in projections. Four rebuilding scenarios were used in projections of the stock abundance. The moratorium estimate is half of the Amendment 12 estimate; it assumes that under Amendment 12 half of the removals are bycatch. The Amendment 9 estimate is also based on the Amendment 12 estimate which is multiplied by the ratio of estimated saving under each Amendment. See the SAW document ofr more details. They are in order of increasing F:

1) No catch or bycatch of red porgy. (F = 0)
2) Moratorium (bycatch only). (F = 0.054)
3) Amendment 12. (F = 0.107)
4) Amendment 9. (F = 0.173)

Figure 7. Time series of the mode, 10th and 90th percentiles of the length distributions for commercial hook and line and Headboat data. Commercial length frequencies show effects from management with mode moving towards size limit. In the commercial data, the mode moved closer to the 10th percentile in the early 1990s perhaps reflecting the effects of the imposition of management restrictions on harvest. In the headboat distributions, the 10th percentile responds to the management measures but the mode does not act as it did in the commercial data. An explanation was not offered for the difference in responses.



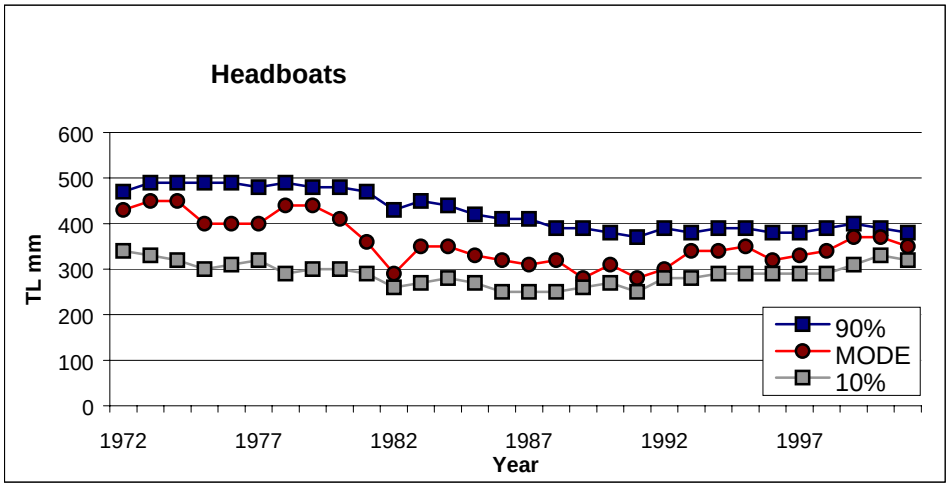
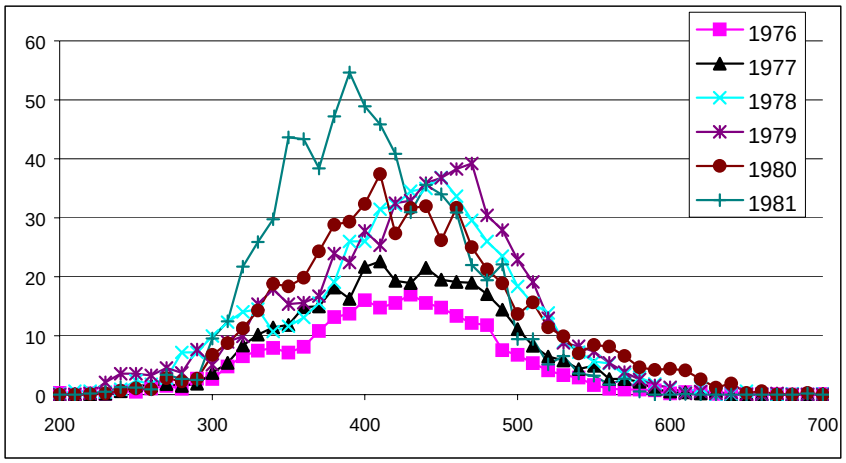
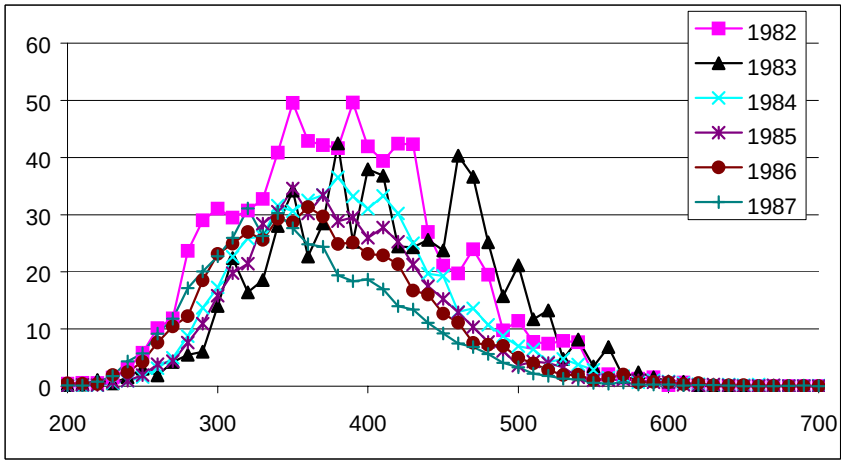
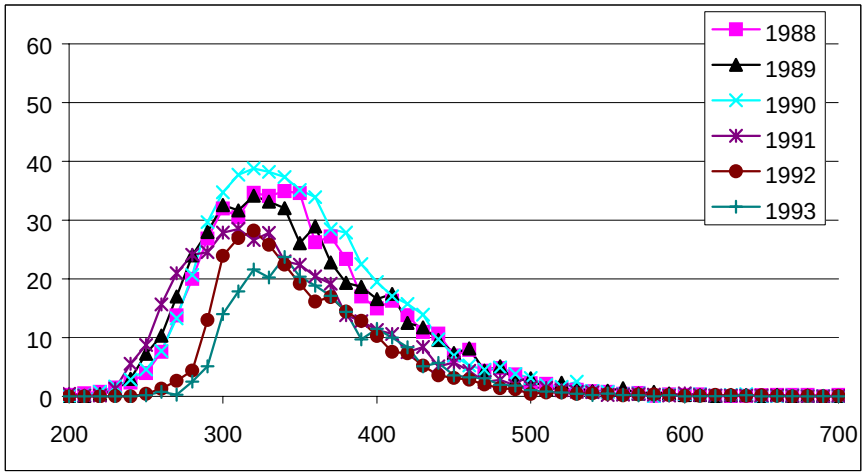


Figure 8. Length frequencies from Commercial (H&L) and Headboat fisheries. The most recent time period shows the effects of more restrictive management measures, especially 1999-2001.







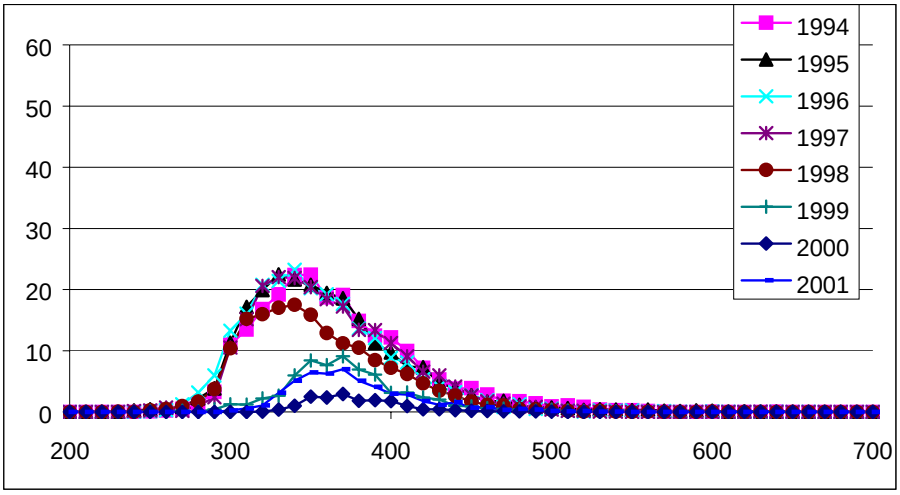

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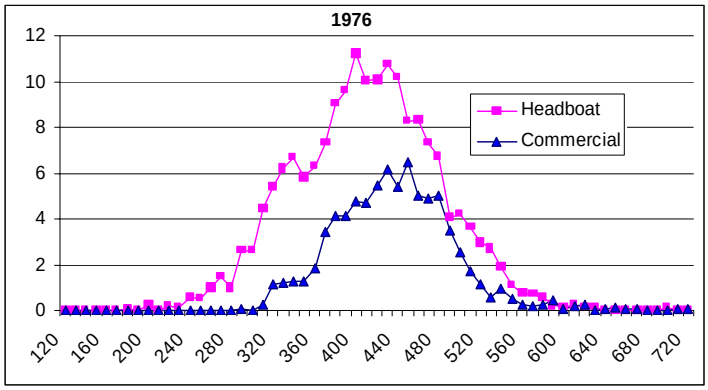
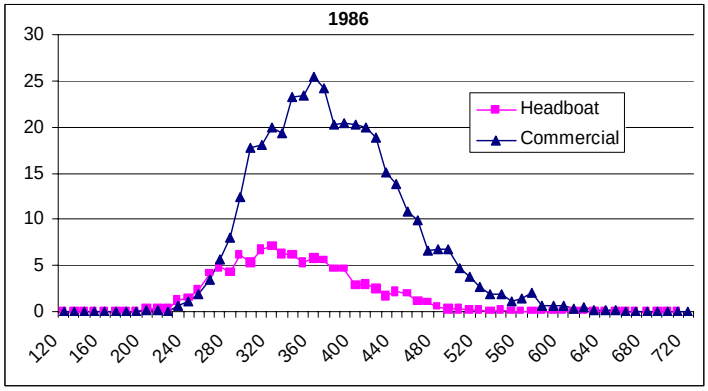
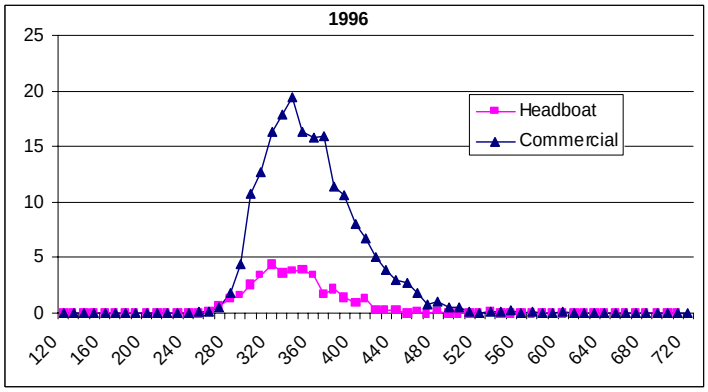
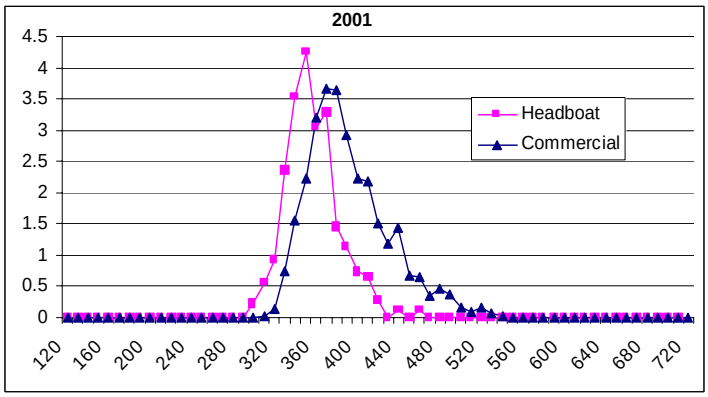
Figure 9. Commercial (hook and line) and Headboat length frequency data from selected years (1976, 1986, 1996 and 2001).









Item 4 – Tabular description of the age-structured model (RPM2002)

		No. of parameters
Growth Model (von Bertalanffy)		3
Standard Deviations of Length at Age		15
Recruitments		44
Stock-Recruit Function		2
Fishing Mortality (Commercial Hook-n-line)		31
Selectivity (Commercial Hook-n-line)		22
Fishing Mortality (Commercial Trawl)		18
Selectivity (Commercial Trawl)		2
Fishing Mortality (Commercial Trap)		31
Selectivity (Commercial Trap)		4
Fishing Mortality (Recreational Headboat)		31
Fishing Mortality (Recreational Charter)		31
Fishing Mortality (Recreational Private)		31
Selectivity (Recreational)		26
Index Catchabilities		4
MARMAP Selectivity (Florida Trap)		4
MARMAP Selectivity (Chevron Trap)		4
	SUM	**303**

Item 5. Likelihood contributions from the base age-structured model. Larger likelihoods mean more importance in the fitting of the model. The composition data are fit in multinomial models and can be compared to one another. The rest of the data can also be compared to one another. This table shows that the length composition data is the most important in the model.

	Likelihood
MARMAR “Florida” Trap Index	463
MARMAR Chevron Trap Index	172
Headboat Index (1976-1991)	112
Headboat Index (1992-1998)	-18
Commercial Hook-n-line Length Composition	265088
Commercial Hook-n-line Age Composition (SC)	2042
Commercial Hook-n-line Age Composition (NC)	540
Commercial Hook-n-line Landings	-65
Commercial Trap Length Composition	3301
Commercial Trap Landings	-120
Commercial Trawl Length Composition	6649
Commercial Trawl Landings	-56
Recreational Headboat Length Composition	170121
Recreational Headboat Age Composition (NC)	6196
Recreational Headboat Landings	-132
Recreational Charter Landings	-93
Recreational Private Landings	-83
MARMAR “Florida” Length Composition	8537
MARMAR “Florida” Age Composition (SC)	3673
MARMAR Chevron Length Composition	30382
MARMAR Chevron Age Composition (SC)	5754

Figure 10. Beverton-Holt stock-recruit relationships from the base run and a sensitivity run in which the points before 1972 were not used in fitting the model. Because the points before 1972 were supported by less data concern was expressed over their use in the determination of stock-recruitment, which is important in long term projections. Further it was noted that the residuals are unbalanced for the post 1972 data which also may affect projections.

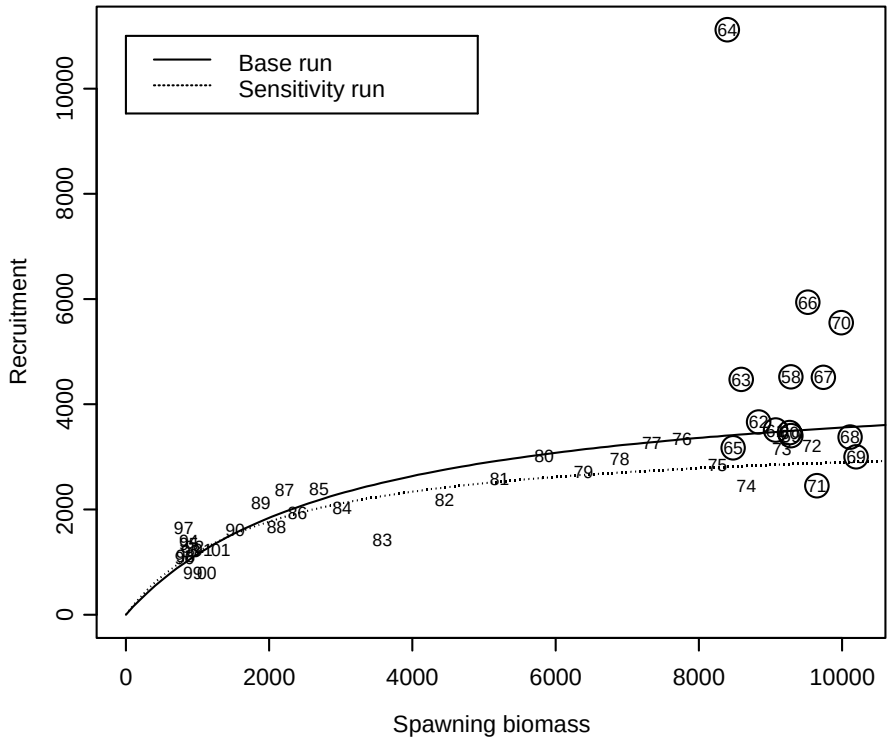


Figure 11. Male and female SSB estimates from the age-structured model. Male SSB has been reduced more than female SSB with unknown affects on reproductives success.

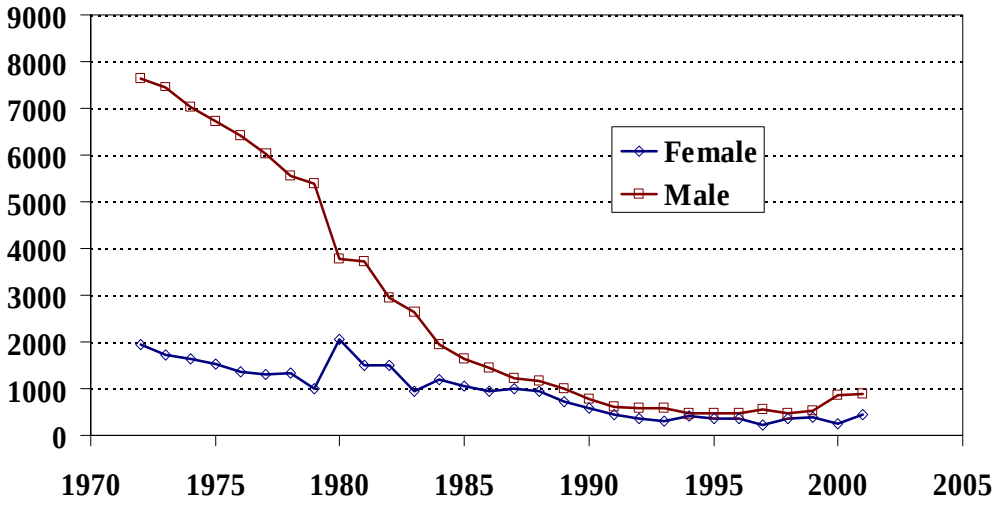
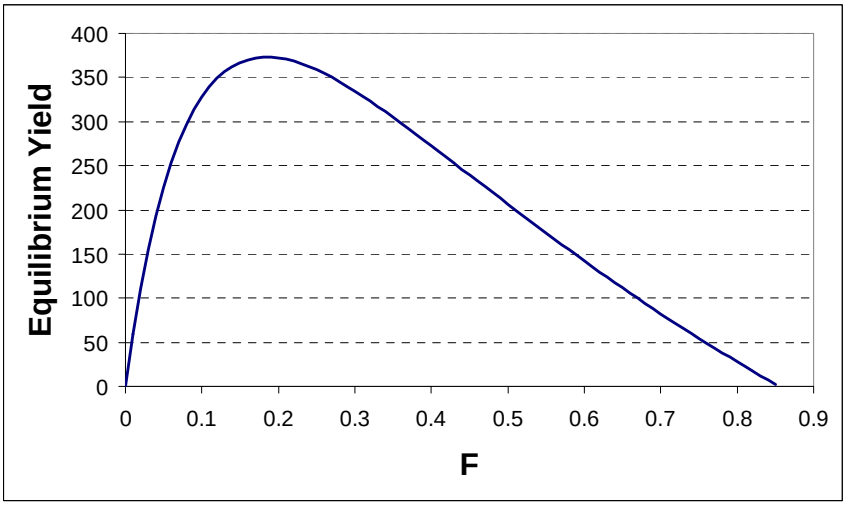


Figure 12. Equilibrium yield curves from the age-structured model. The modeled system shows more resistance to fishing pressure than a Schaefer model.



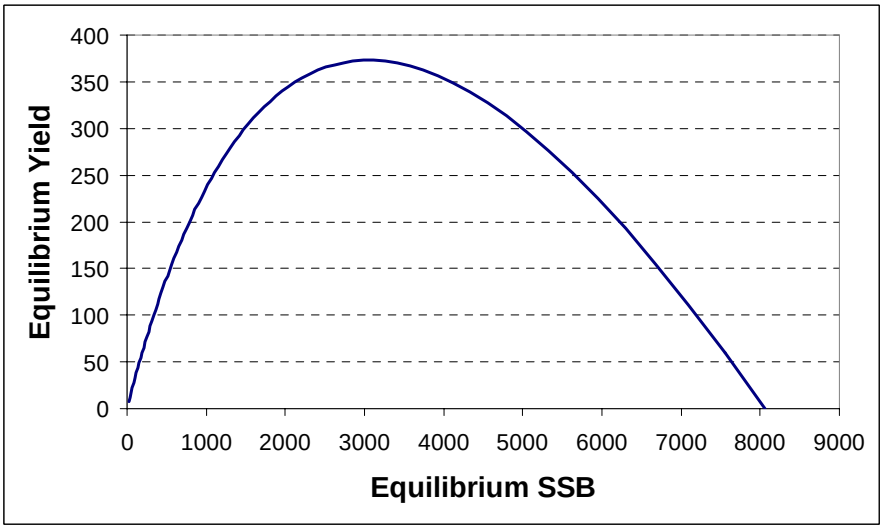
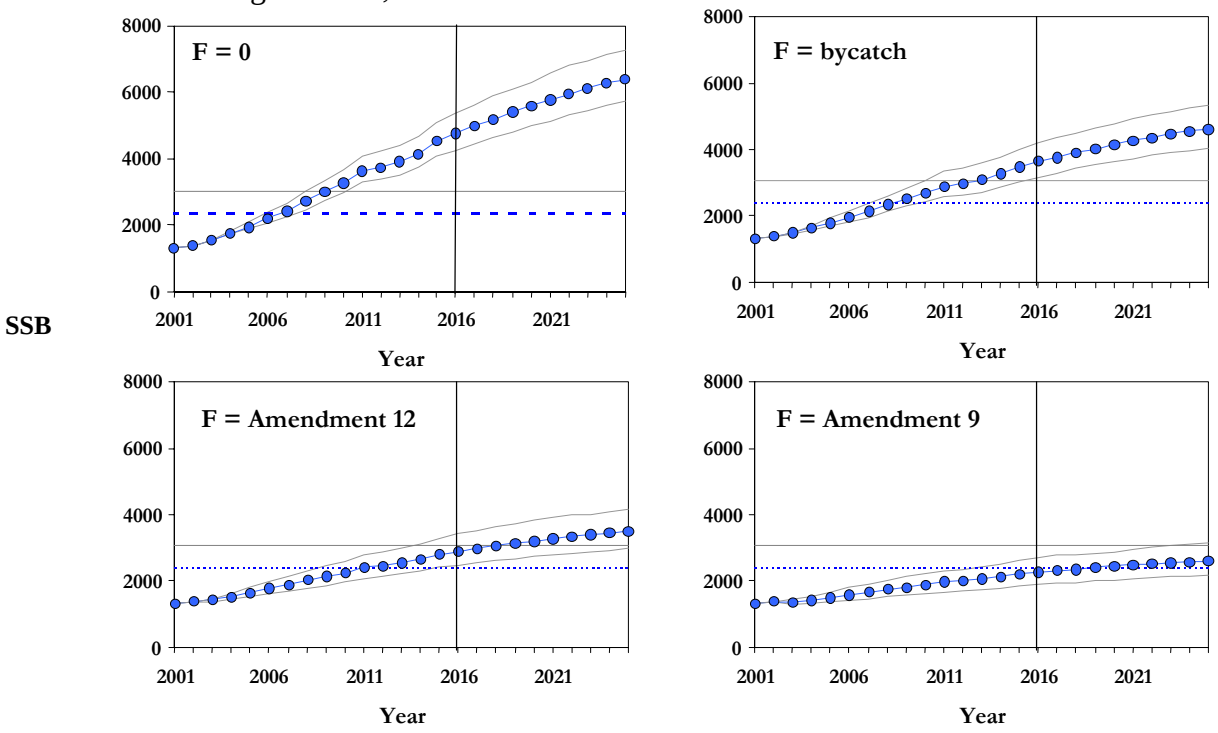


Figure 13 Long term projections (Figures 17 in SAW report) with line for MSST and a line for the rebuilding deadline, 2016.



Figures 14 and 15.These figures were requested by the SARC to compare with the base projection runs in order to explore aspects of uncertainty that were not captured in the base model. Figure 14 is using the age-structured model with the alternative stock-recruit relationship shown in Figure 10. Figure 15 is a projection using the production model. In both cases they show more rapid rebuilding than the base model. Although it was concluded that these models were less probable than the base run, by comparing among models, broader insights are given into the uncertainty.

Figure 14.

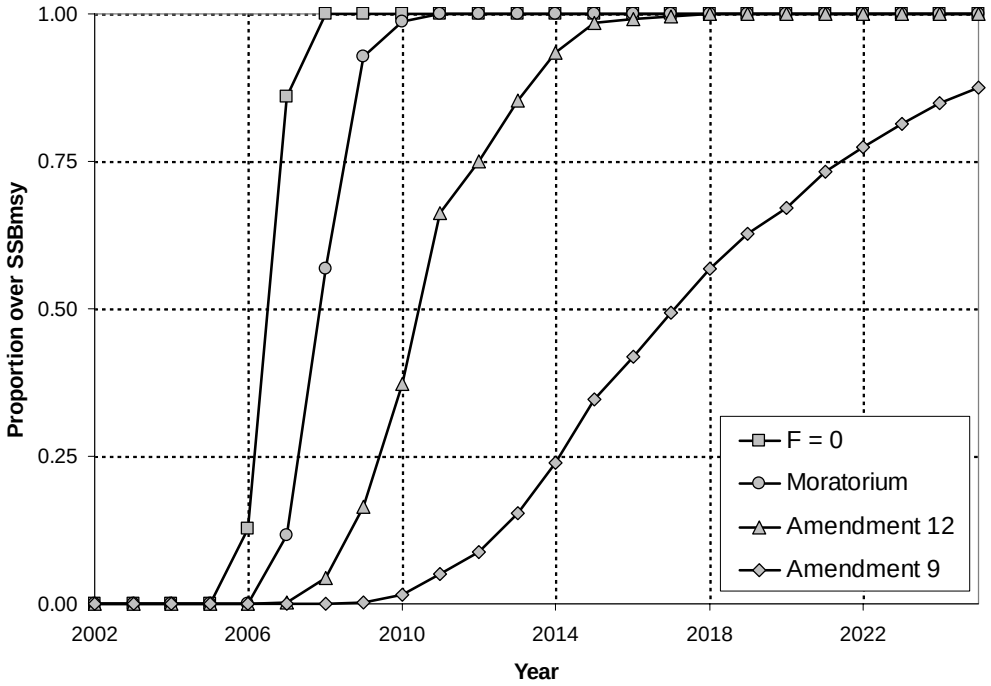
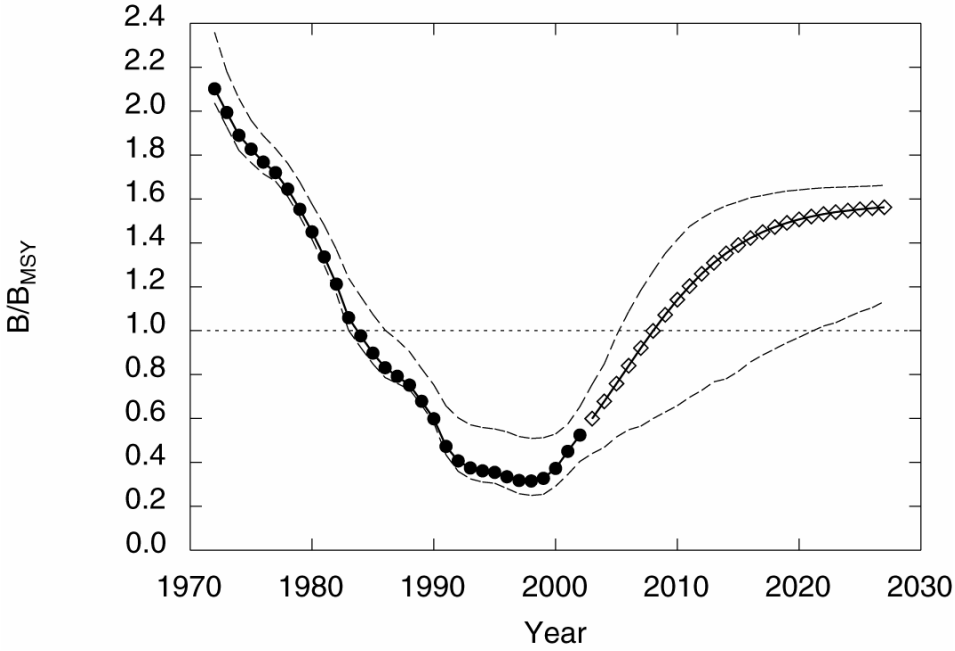


Figure 15.



Item 6. Biological Reference Points: The SARC accepts SAW recommendations. Comparison of actual values to proxy values indicates problems with proxies.

Research recommendations.

The SARC reviewed the research recommendations supplied by the SAW. In each, the relevant SAW research recommendation number is given (SAW-RR#) . The SAW recommendations are appended below for convenience.

1. (SAW-RR #1) Aging - The SARC agrees.
2. (SAW-RR #2) The SARC agrees. In addition, models and evaluations should incorporate this feature. Stock assessment scientists should discuss and develop methods to deal with these species.
   The implications of alternative assumptions about spawning stock definitions (total biomass, female biomass or…..) should be investigated.
3. (SAW-RR #3) The SARC agrees this should be collected from all sectors. At-sea observers are required. This may also be an opportunity to develop a CPUE index.
4. (SAW-RR #4) The SARC agrees.
5. (SAW-RR #5) The SARC did not evaluate this recommendation.
6. A hook and line index of abundance should be developed for deeper water.
7. The aging assumptions and the plus-group assumptions in the age-structured model should be evaluated.
8. Alternative assumptions about M should be evaluated.
9. Sampling of catch by sex from commercial vessels should be initiated.
10. Analyses to develop indices of abundance should consider the effects of unsuccessful effort

SAW Research Recommendations (Copied from SAW Document)

The SAW 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 red porgy.

1.The discrepancy between SC and NC aging is a major one that must be resolved, preferably before the next assessment. The SAW recommends that as soon as possible, the NC and SC investigators meet and share age readings techniques, to resolve the systematic discrepancies in age determinations, if possible. The SAW further recommends that research be undertaken that will accomplish verification of aging in red porgy.

2.The protogyny of red porgy is a life--history feature that complicates assessment and management. The SAW recommends that sampling for sex ratio at length be instituted in each fishery and that population sampling for sex ratio at length be continued by the MARMAP program. The SAW further recommends that research be instituted into assessment and population-projection methods that can make better use of sex-ratio data that exist now and that may exist in the future.

3. Under many forms of management, considerable discarding of red porgy could be expected to occur. The SAW recommends that sampling programs be initiated to quantify discard rates, especially in the commercial fishery, where the discard mortality rate is believed higher, and to estimate discard mortality rates. The SAW recommends that research be instituted on management strategies that could Reduce discard mortality and also research to illustrate the effects of discard mortality. The SAW also recommends that socioeconomic research be considered on educational measures to assist fishery participants in minimizing discard mortality and understanding the value of doing so.

4. Fishery-independent data collected by the MARMAP program have served an important role in understanding the dynamics of this population, 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 have been criticized by some as not having ideal extent, both in area coverage and in sampling intensity, for red porgy. The SAW recommends that the MARMAP program expand its coverage as needed.

5. During the DW and SAW, it was noted that some incomplete, or misleading data have been entered in the NMFS general canvass data base. In particular, some data are available only under aggregated categories (e.\,g., porgies), even when accepted corrections to provide estimates of red porgy landings exist. The SAW recommends that state agencies contact and work with NMFS personnel maintaining the general canvass data base to make sure that data in that central data base are at the most disaggregated level possible and as accurate as possible. The goal is that future red porgy assessment should be able to use data from the general canvass data base with confidence and without further corrections.

Recommendations regarding process. The SARC, both panelists and those in attendance, reviewed the experiences leading up to the SARC and made conclusion and recommendations about the process.

1. The three step process (DW, SAW & SARC) proved to be very useful. It is recommended that more time be allocated between each of these steps. It would be helpful to have this incorporated into the Terms of Reference.

2. If more than one stock is to be assessed per year, substantial additional resources must be provided. Additional funding will be necessary for NMFS and state participants.

3. Participation of industry was a very important part at each step of the process. This practice should be continued.

4. Priorities as to the stocks to be assessed need to be set.

5. Having both NMFS and state scientists participating in the decision process for input data and assumptions for the model was very useful.

6. Input from SARC participants other than on the panel was very useful. This will facilitate exchanges between the SAW and SARC participants.

7. As well as peer review, the SARC was a useful forum for the exchange of technology and ideas.

8. In future, the SARC will draft the Consensus Report at the meeting with a subsequent review.

9. Improved technical support is required; printers, copiers, hard copy of drafts, LAN and other support.

Chairman's Comments.

The participants, both on the SARC panel and the other in attendance, were cooperative and constructive throughout the SARC. As this was the first time, special considerations apply. The first is that the SARC had the added requirement of trying to establish precedents for this process in the Southeast. The Northeast experience served as a template. The second was the unfamiliarity of the participants with the SARC system and its requirements, especially document production.

Future SARCs should be larger; there was no buffer. If a single member left the room, the review was potentially affected. Also, the Chair was required to fill two roles; steering the meeting and as a technical reviewer. Sometimes these roles conflict one another; the Chair wishes to push to consensus, the reviewer wishes to slow things down and take a closer look.

In terms of review, more emphasis should be placed on systematic and structured comparison (figures and tables) with earlier assessments. It is important to be able to answer the question as to what degree changes in perception are due to new models or new data. Also, a more thorough investigation of alternative models would give a better insight into confidence in results.

On a personal note, it was a pleasure to help the first Southeast SARC get off the ground. One of the comments from the audience was that it was beneficial to have the 'system' opened up and a forum for many points of view. It will be a challenge for future Chairs to move the SARCs from developmental to a production basis and keep the meetings open and stimulating. One way to help achieve these objectives is to allot time for scientific exchange and for discussion among participants, both on and off the SARC panel, on the relevance of the proceedings. But of course, time is always at a premium.

RED PORGY ADVISORY REPORT
JUNE 2002

Status of Stock: The stock is overfished but overfishing is not occurring. The current index of spawning stock biomass is low; the 2001 spawning stock size is estimated at about 43% of SSBmsy and 55% of MSST. The 2001 fishing mortality rate is estimated at about 45% of Fmsy. Recruitment, as measured by the model, has trended down from 1972 with an upturn in 2001. The size structure of the stock has been reduced after a period of high fishing mortality.

Management Advice: Fishing mortality should not be increased. Although overfishing is not currently taking place, in the future fishing mortality may need to be reduced to meet the 2016 rebuilding requirement. However, there is very little information associated with the effects of the current management regime (Amendment 12 initiated in 1999) with which to project rebuilding.

Forecast: There is considerable uncertainty in future rates of recovery due to: uncertainty about the biology of the species, model uncertainty, and quality of the data available.

Projections simulating current fishing mortality (Amendment 12 regulations) show less than 50% probability of achieving SSBmsy in 2016 which is the last year of the Council's 18 year rebuilding program. See Figure 4. The projections show a 50% probability of exceeding the MSST in 2011. Projections simulating no directed fishing or by-catch (F = 0) would achieve SSBmsy in 2009 but the mortality from discards would increase.

Landings (metric tons) and Stock Status Table

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Max*	Min*	Mean*
Commercial	234	213	198	196	195	193	144	48	12	30	729	12	294
Headboat	50	46	40	42	37	34	31	22	6	23	340	6	117
Recreational	54	30	21	48	53	8	6	31	12	25	109	3	41
Total	338	290	258	286	285	236	181	101	30	77	929	30	452
SSB	960	908	880	879	820	807	833	933	1132	1326	9580	807	3652
Abundance	4661	4428	4491	4537	4276	4624	4450	4065	3907	4307	18215	3907	9069
Recruits (1000)	1301	1212	1403	1342	1085	1646	1119	787	796	1226	3349	787	2015
F	0.72	0.62	0.56	0.63	0.68	0.56	0.37	0.21	0.04	0.09	0.83	0.04	0.35
F/FMSY	3.81	3.27	2.96	3.30	3.57	2.96	1.95	1.09	0.24	0.45	4.37	0.24	1.86

*Maximum, minimum and mean based on period 1972-2001

Stock Identification and Distribution: Red porgy have an extensive range in warm waters of the Atlantic Ocean and adjacent seas. The management unit analyzed includes fish from U.S. Atlantic waters of North Carolina (NC) south of Cape Hatteras, South Carolina (SC), Georgia (GA), and the east coast of Florida (FL), including the Atlantic side of the Florida Keys (Monroe County). Within that stock definition, red porgy have been most abundant in NC and SC waters. Tagging studies show neither long-range migrations nor extensive local movements of adult red porgy, and there is no circumstantial or anecdotal information to suggest such movements.

Catches: (Figure 1) Three major fisheries catch this stock of red porgy: commercial, recreational, and headboat. The most common commercial gear has been hook and line, with occasional commercial landings also from trawls and traps. Trawling for red porgy has been banned since January 12, 1989. Total landings increased during the 1970s and early 1980s as the commercial fishery expanded, rising from about 335 mt in 1972 to over 900 mt in 1982. Except for a brief spike in 1988-1990, landings declined steadily from the 1982 peak to the low of under 30 mt in 2000.

The headboat fishery was predominant, 1972-1977, accounting for 64% on average of landings in weight. From 1978, onward the commercial fishery predominated, representing 53-82% of annual landings. Recreational fisheries seldom landed more than 10% of the total until 1999-2001, when they represented 34% of total weight landed. Commercial landings increased during the 1970s, from 47 mt in 1972 to 729 mt in 1982.

Data and Assessment: A Data Workshop was held March 11-14, 2002, and a series of Stock Assessment Workshops took place between April 8 - May 6, 2002. Two models were used to assess stock status: Age structured model and Production model. The age structured model used catch, length composition (Figure 2), age composition, and abundance indices (Figure 3). The production model used catch and abundance indices.

In all analyses, the value of natural mortality used was 0.225.

Biological Reference Points: Three sets of Biological Reference Points are presented: 1) the current definitions using the last assessment's results, 2) the current definitions using results from the 2002 assessment and 3) a proposed set.

Council's Current Definitions (Proxies) from Amendment 12:

A. Maximum fishing mortality threshold (MFMT). A fishing mortality rate (F) corresponding to a 35% Static SPR (previously estimated as F=0.43; estimated in the 2002 assessment as 0.49) based on a 14" TL minimum size limit.

B. Minimum stock size threshold (MSST). The minimum stock size threshold is defined as the maximum of either 0.5 or 1-M (M = natural mortality = previously defined as 0.28; currently defined as 0.225) times SSBmsy proxy. The Council is specifying the minimum stock size associated with 35% Static SPR which was previously estimated as 3,328 metric tons (MSST=(1-0.28)*4,622=3,328 mt) or 7.34 million pounds. The SSBmsy proxy associated with 35% Static SPR estimated in the 2002 assessment was 859 mt.

C. Rebuilding timeframe. Red porgy cannot be rebuilt in less than 10 years (see NMFS SEFSC results as shown in Figure 4) and a generation time is estimated as 8 years. Therefore, the rebuilding timeframe for red porgy is 18 years with 1999 being Year 1 given the emergency closure was implemented on September 8, 1999.

The SARC recommends using the following biological reference points:
The Council's definition of MSST = (1-M) * SSBmsy; MSST was estimated in this assessment to be 2,364 mt.

Fmsy used as per Amendment 12 to determine overfishing; Fmsy was estimated in this assessment to be 0.19.

Amendment 12 defines the rebuilding time period as 18 years with 1999 as Year 1. The rebuilt state was defined as the stock's reaching SSBmsy = 3,049.5 mt. The minimum stock size threshold (MSST) is used to measure whether the stock is overfished.

Fishing Mortality: F from model had an increasing trend from 1972 through 1990 and generally declined until 2000. F exceeds Fmsy from the late 1970s through the late 1990s (Figure 5)**.** Relative fishing mortality rates from the age structure and production models showed similar patterns.

Recruitment: Estimated recruitment generally declined throughout the time series. See Figure 6.

Stock Biomass: The Total SSB (males and females) declined through 1990 with a slight increase in 1999 and 2000. The relative SSB/SSBmsy from the Age-structured and Production models were in agreement (Figure 7). The SSB estimates from the Age-structured model were divided into male and female components (Figure 8). The male SSB declined more than female SSB.

Special Comments:
Red porgy switch sex from females to males. The analytical tools and biological reference points do not take this into consideration. Implications of this are unknown and could have important affects on reference points and estimates of recovery.

Concern was expressed that important information on the status of larger red porgy derived from deeper waters was not available as a separate index for inclusion in the assessment. It is recommended that further consideration be given to developing such indices from commercial and fishery independent data.

Effective monitoring of stock recovery, especially under further fishing mortality reductions, will require information on discards.

Source of Information:
Report of Red Porgy Stock Assessment Workshop, April 8 - May 6, 2002.

In addition, a Data Workshop was held March 11-14, 2002. All data, reports, and results are included on a CD available from the NMFS Beaufort Lab.

Figure 1. History of catches with management events superimposed.

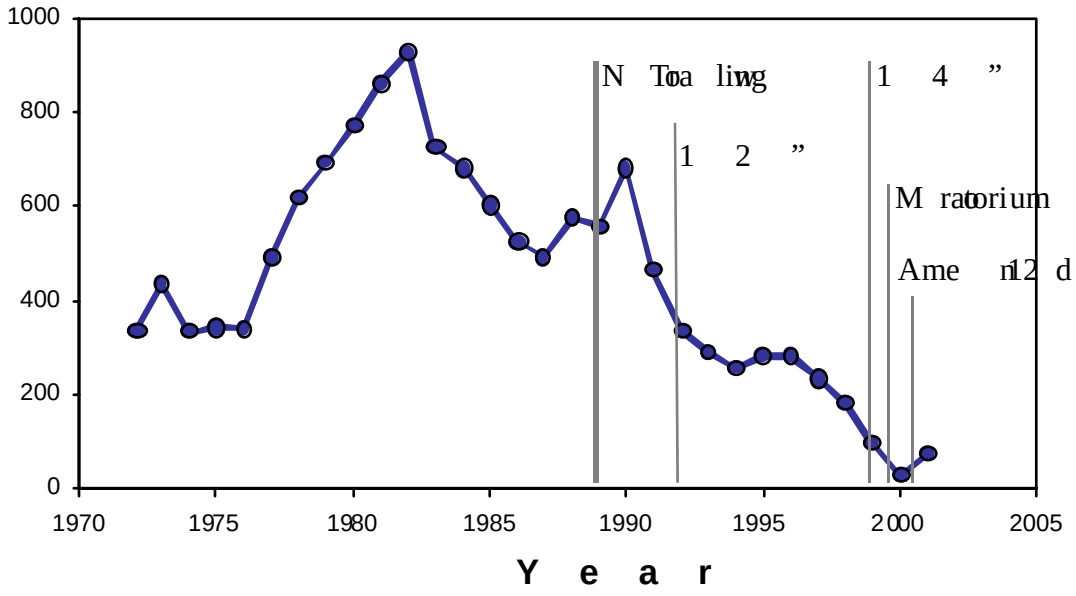


Figure 2. Commercial (hand line) and Headboat length frequency data from selected years (1976, 1986, 1996 and 2001).

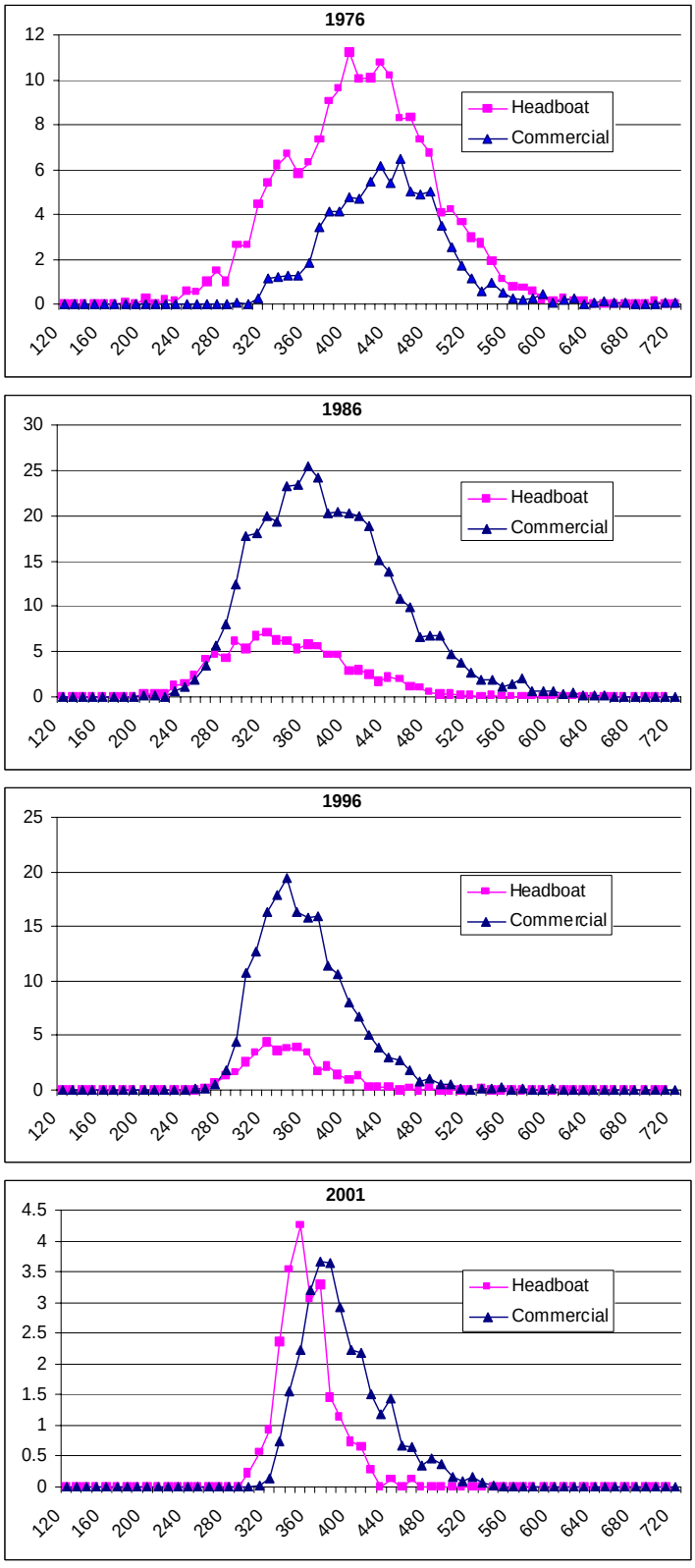


Figure 3. Abundance indices.

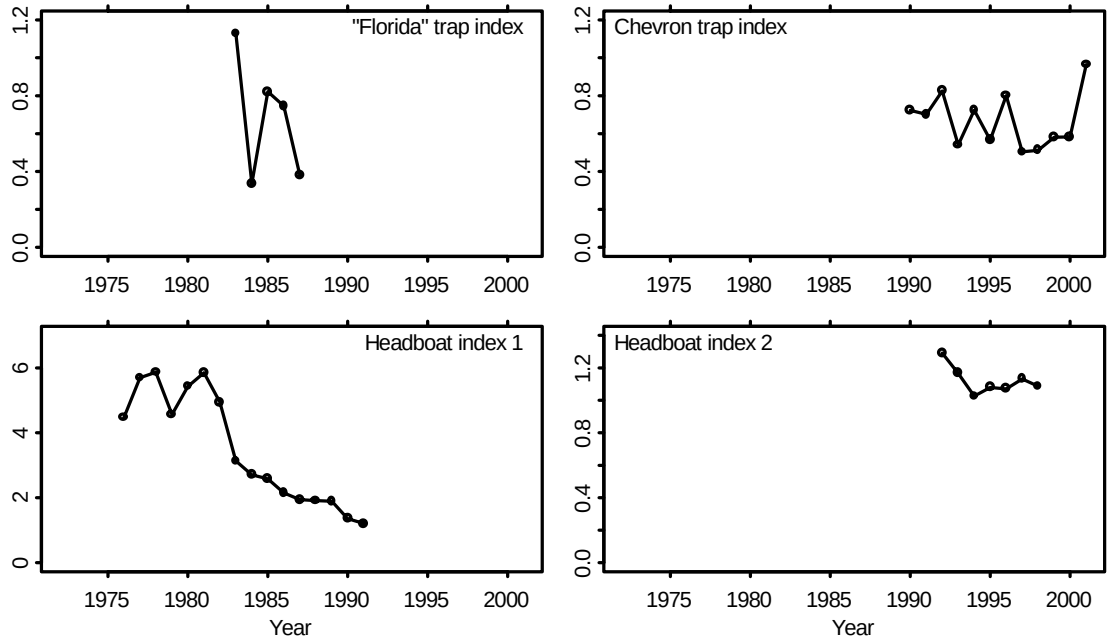


Figure 4. Rebuilding projections under two scenarios no fishing or by-catch (F = 0) and simulating Amendment 12. The horizontal line is BMSY and the dashed line in the upper plot is the MSST and the vertical line as 2016 is the Amendment 12 date for rebuilding.

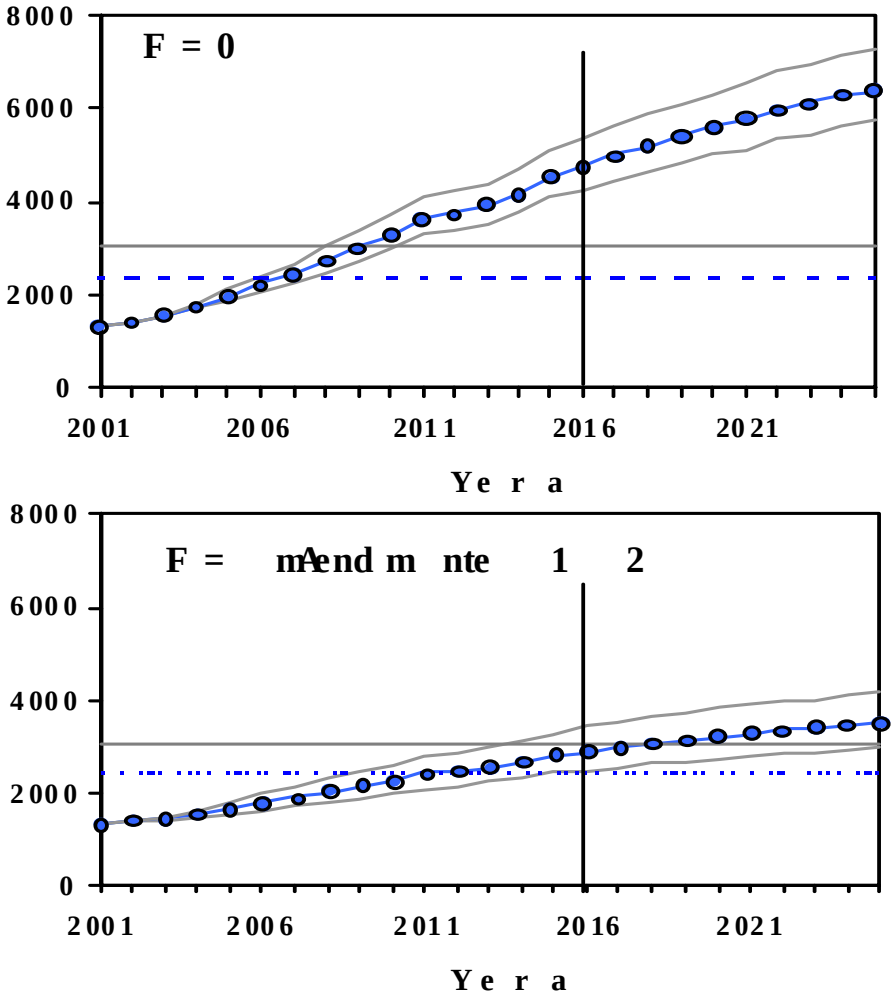


Figure 5. Relative Fishing Mortality Rates (F/FMSY). Solid line is the Age-structured model, line with dots is Production model.

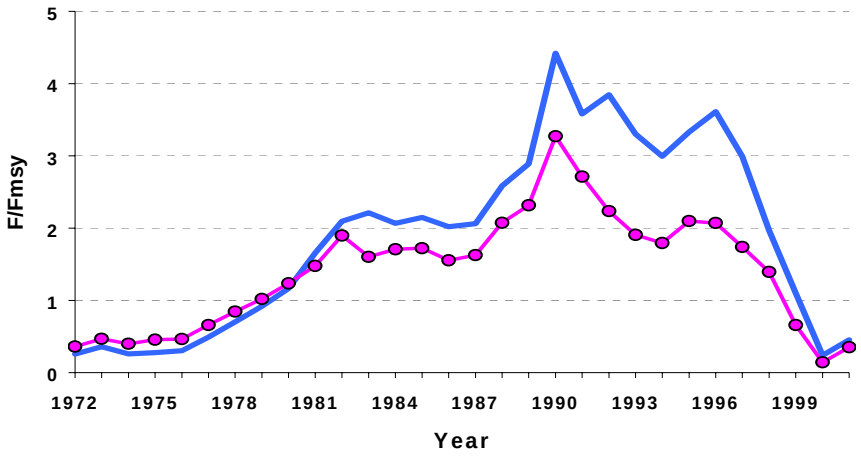


Figure 6. Stock SSB and Recruitment from Age-structured model .

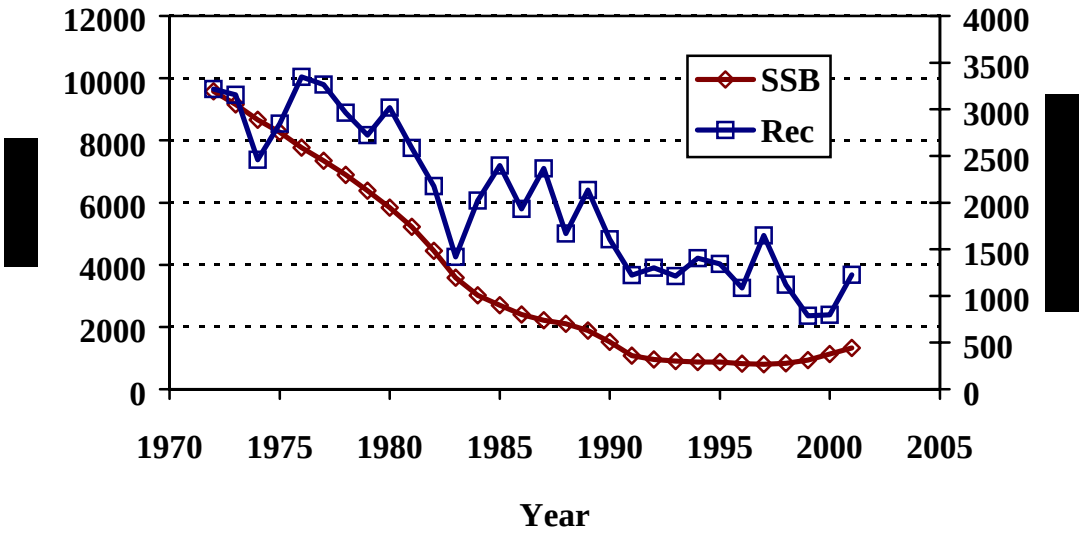


Figure 7. Relative biomass estimates. Solid line is the Age-structured model (SSB/SSBMSY), line with dots is Production model (B/BMSY).

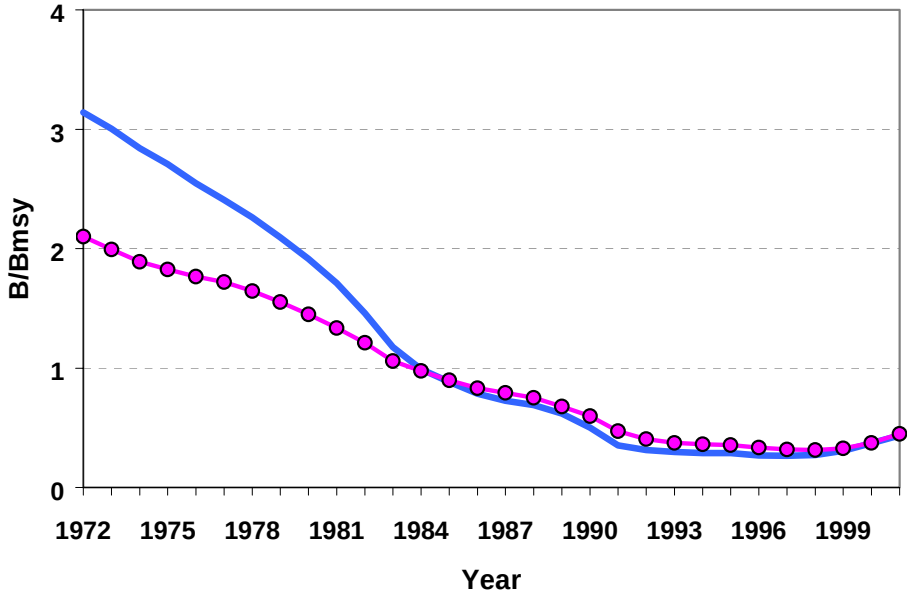
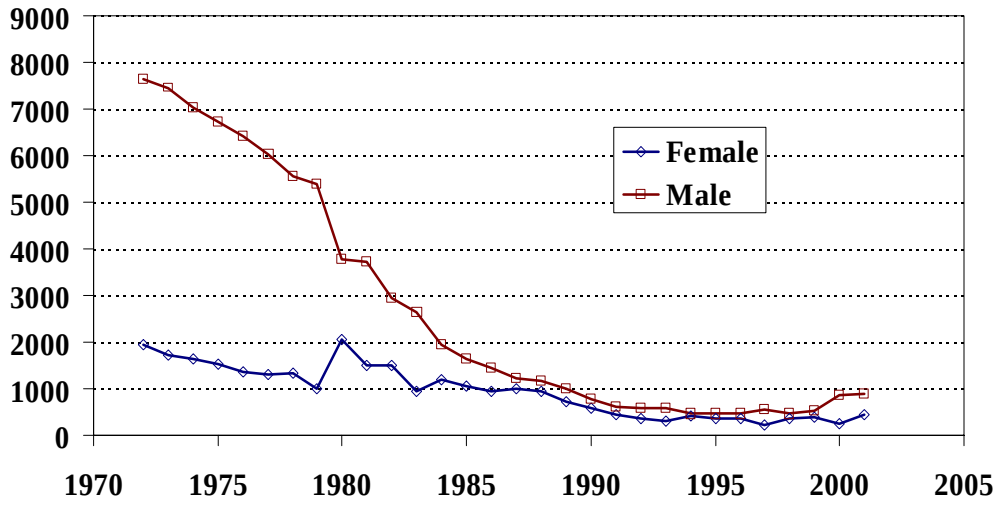


Figure 8. Male and Female SSB



Red Porgy Recovery Projections Under Five Potential Management Strategies

Population Dynamics Team
NOAA Center for Coastal Habitat and Fisheries Research
Beaufort, NC 28516

12 June 2003

Introduction

This report describes new recovery projections of the red porgy population off the Southeastern U.S. under five potential management strategies. The computations, benchmarks, initial status of the stock, and operating model (assumed model of the stock and fishery) are based on the SEDAR assessment report of May 6, 2002. The projections are presented to aid the Council in choosing a recovery strategy for this stock.

The report also presents estimates of annual equilibrium yield (landings plus dead discards) and spawning-stock biomass (SSB) at various levels of fishing mortality rate (F) relative to Fmsy, also based on the red porgy SEDAR assessment of May 6, 2002. These estimates are presented to aid the Council in choosing an optimum yield strategy for this stock.

The five management strategies explored in recovery projections are

Strategy 1: Maximum constant annual landings (total removals) that allow the stock to rebuild by December 31, 2017 (the end of the 18-year recovery period).

Strategy 2: Maximum constant fishing mortality (F) that will allow the stock to rebuild by December 31, 2017.

Strategy 3: F = 75% of F_{MSY} in 2005–2010, followed by the F that will allow the stock to rebuild by December 31, 2017.

Strategy 4: F = F_{MSY} in 2005–2010, followed by the F that will allow the stock to rebuild by December 31, 2017.

Strategy 5: F=50% of current F in 2005–2010, followed by the F that will allow the stock to rebuild by December 31, 2017.

Methods

Projections

Each management strategy was projected with two sets of initial conditions. In the first, the F in 2001 from the base model run was used for 2001–2004; this approach corresponds to the base model run, the run that was selected by the SEDAR Review Workshop. It does not account for a likely recent increase in dead discards. In the second set of initial conditions, F for 2001–2004 was higher, and was taken from the assessment report's sensitivity run that included an adjustment for increased recent dead discards. That projection approach was preferred by Assessment Workshop participants (as more realistic) and was taken in the assessment report.

All projections described here are consistent with recent black seabass projections in using deterministic values of F in each projection year. That differs from the stochastic values of F used in the assessment report. However, any differences due to that change are expected to be minor.

Initial status of the stock was taken from the base run in the assessment report, which also provided needed parameter estimates. Stochastic recruitment (number at age 0) was added to the 2001 population size based on the spawning-stock biomass estimated for 2001. Initial F, which was based on the 2001 estimate and applied to years 2001–2004, was estimated in the assessment report as 0.085/yr for projections based on the base run and 0.107/yr for projections based on the discard-sensitivity run. Selectivity at age in all projections was based on the catch-weighted average selectivity from the component fisheries in the corresponding assessment run.

Projections included considerable stochasticity in the stock–recruit relationship. Recruitment was predicted by the fitted Beverton–Holt function, with random deviation added to each year's predicted recruitment. Each deviation was chosen at random from the 1972–2000 residuals estimated by the assessment model.

The rebuilding criterion used was that the spawning stock biomass (SSB) must reach or exceed the SSB at MSY by December 31, 2017 (or equivalently, January 1, 2018). That criterion is based on the time required to rebuild with F=0 (10 years) plus one generation time (8 years), all under the assumption (as used in the assessment) that M=0.25/yr. Thus in the projections, year 1 of the rebuilding period is 2000; year 18 is 2017.

For each combination of management strategy and initial conditions, 1000 replicate projections were computed, based on 1000 different streams of stochastic recruitments. Across bootstrap replicates, the 5^{th}, 50^{th} (median), and 95^{th} percentiles were computed on spawning stock biomass, fishing mortality rate, and landings or total removals. Rebuilding status was based on the median projected SSB.

Equilibrium yield

Estimates of equilibrium yield (defined as all removals; i.e., landings plus dead discards) at various levels of fishing mortality are also based on the base-run model from the red porgy SEDAR assessment report of May 6, 2002. The calculations were made using the selectivity vectors, recruitment model, and growth model from that assessment.

General

This report follows standard fishery-science conventions in labeling years. For a given year, population size and spawning-stock biomass are reported at the start of the year (nominally, January 1). Yield is reported as a total for the year. The fishing mortality rate is the average value during the year.

Results and comments

Projections

Recovery occurs at the end of the 18-year period under all strategies examined (Figures 1–10), while corresponding total removals (yield plus dead discards) vary only slightly among management strategies. Removals are tabulated for 2004, representing the earliest year in which changed management might potentially take place, through 2017, the last year of the rebuilding period. Strategy 2 (the constant-catch policy) results in the highest total removals over the rebuilding period when projections are based on the assessment's base run. Strategy 5 (50% initial cut in F) provides the highest yields when projections are based on the discard-sensitivity run. In both cases, the least variability in removals from year to year is provided by strategy 1, the constant-removals strategy (Tables 1 and 2).

The division of removals in Tables 1 and 2 between landings and dead discards in any year will depend on the management measures in place and the population size structure. Depending on the type of management measures used (e.g., size limits), discarding may increase significantly as the stock rebuilds.

If the proportion of the catch discarded increases over time, as might happen with a recovering stock managed with bag and size limits, the portion of Tables 1 or 2 that represents landings will decrease with time. (That assumes that total removals are kept at the levels listed.) To the degree that management measures can avoid dead discards while still controlling fishing mortality, that issue can be alleviated.

A separate issue concerning discards is modeling the likely recent increase in dead discards due to regulatory changes. The minimum size limit was raised to 14 inches in 1999, and bag and trip limits went into effect in 2000 with Amendment 12. Results in Table 2 and Figures 6–10 represent an attempt to account for those discards. The method used, devised by the SEDAR Assessment Workshop, does not account for size-selective discards, but instead simply raised the estimate of total removals (after accounting for release mortality) in recent years, and estimated

recent F under those conditions. That procedure provides only a rough approximation of the effects of discards and is intended to be illustrative, rather than quantitative.

Projections are inherently uncertain. All caveats discussed in the assessment report also apply to these strategies.

Several issues arise in choosing among management strategies. In general, allowing higher fishing mortality rates at first gives higher initial yields, but tends to slow recovery and results in lower yields over the entire recovery period (Figures 1–10). Relatively larger initial reductions in F provide higher yields over the medium to long term (Tables 1, 2).

It is believed that fishing at a lower fishing mortality rate provides more population robustness to environmental perturbations, and thus can be helpful in assuring recovery of a depleted stock and easing restrictions more quickly. If a fishing mortality rate is implemented that is found at the next assessment to have been too low, a dividend should be available in the form of larger allowable catches. If a fishing mortality rate is implemented that is found at the next assessment to have been too high, further reductions in catch will probably be needed at that time.

Equilibrium yield

Estimates of equilibrium yield (landings plus dead discards) and spawning-stock biomass (SSB) at various levels of fishing mortality rate (F) are typical of such analyses (Table 3). The estimated yield decreases relatively slowly as the fishing mortality rate decreases. The corresponding standing spawning-stock size increases at a rate faster than the yield decreases. For example, reducing F from F=Fmsy to F=0.75Fmsy corresponds to a reduction in equilibrium yield from 375 mt/yr (826,700 lb/yr) to 364 mt/yr (802,500 lb/yr), or about a 3% decrease. The corresponding increase in SSB is from 3064 mt (6,755,000 lb) to 3776 mt (8,325,000 lb), or about a 23% increase. As mentioned above in a different context, such an increase could provide a buffer against environmental fluctuations or other causes of future poor year classes.

Table 1. Removals projections (mt, landings plus dead discards), using the base-run assessment model for initialization (no accounting of discards). Results presented are the median of 1000 bootstrap replicates.

Year	Strategy 1	Strategy 2	Strategy 3	Strategy 4	Strategy 5
2004	92	92	92	92	92
2005	180	129	160	208	51
2006	180	137	167	209	57
2007	180	146	175	214	64
2008	180	157	185	221	71
2009	180	167	194	229	78
2010	180	175	203	236	83
2011	180	187	154	111	286
2012	180	190	163	122	268
2013	180	197	171	132	266
2014	180	206	181	142	270
2015	180	217	192	152	279
2016	180	225	200	160	285
2017	180	231	207	168	288
Total	2432	2456	2444	2396	2438

Table 2. Removals projections (mt, landings plus dead discards), using the discard sensitivity assessment model (includes accounting of recent discards). Results presented are the median of 1000 bootstrap replicates.

Year	Strategy 1	Strategy 2	Strategy 3	Strategy 4	Strategy 5
2004	109	109	109	109	109
2005	173	118	151	198	60
2006	173	127	160	201	68
2007	173	137	169	207	76
2008	173	148	179	216	84
2009	173	157	188	223	92
2010	173	166	197	230	98
2011	173	176	142	107	260
2012	173	181	151	118	249
2013	173	187	160	128	248
2014	173	196	169	138	253
2015	173	208	180	148	262
2016	173	216	188	156	269
2017	173	222	195	164	275
Total	2358	2348	2338	2343	2403

Table 3. Estimates of equilibrium yield (landings plus dead discards) and spawning-stock biomass (SSB) at various levels of fishing mortality rate (F) relative to Fmsy. Results are based on the base-run model from the red porgy SEDAR assessment report of May 6, 2002.

Percent of Fmsy	F (/yr)	Yield (mt/yr)	SSB (mt)
100%	0.188	375	3064
95%	0.179	375	3191
90%	0.169	373	3326
85%	0.160	371	3467
80%	0.150	368	3617
75%	0.141	364	3776
70%	0.132	358	3944
65%	0.122	351	4123
60%	0.113	342	4313
55%	0.103	332	4516
50%	0.094	319	4732

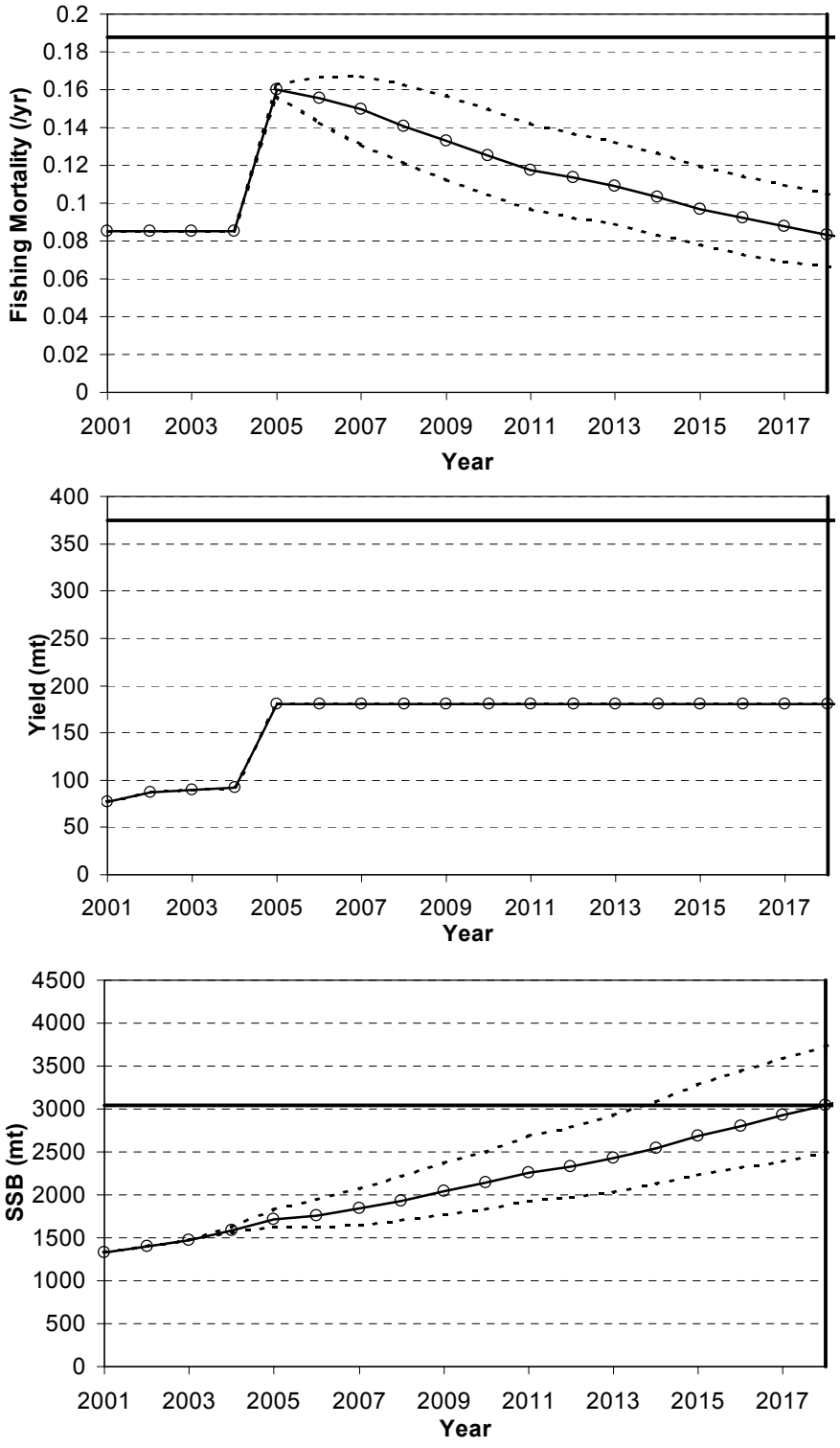


Figure 1. Strategy 1 (base run model) projection results. Results presented for the median (circles), 5th percentile, and 95th percentile (dashed lines) of 1000 bootstrap replicates. The solid horizontal line in the top, bottom, and middle panels corresponds to Fmsy, MSY, and SSBmsy, respectively. Yield includes landings and dead discards.

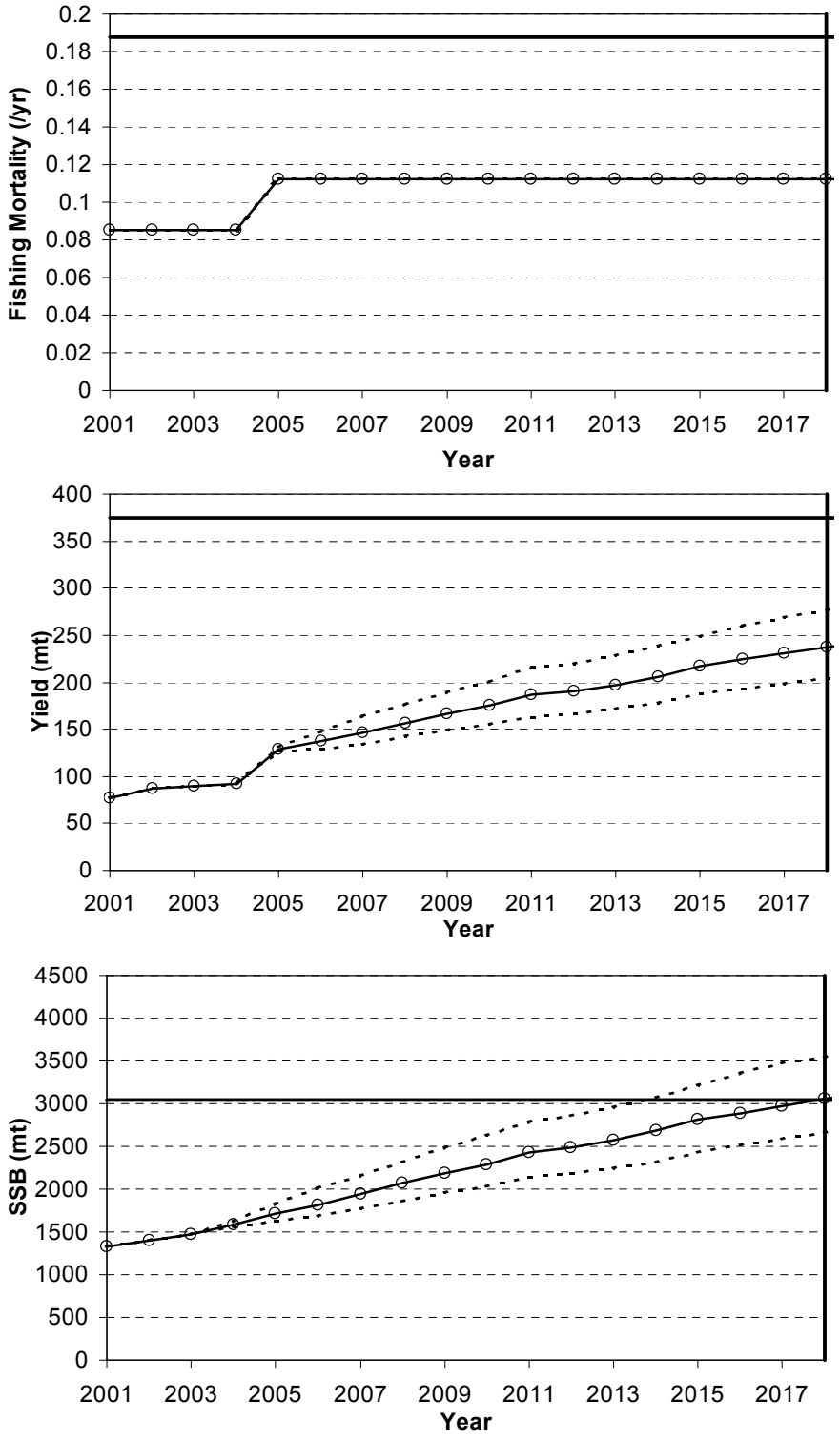


Figure 2. Strategy 2 (base run model) projection results. Results presented for the median (circles), 5th percentile, and 95th percentile (dashed lines) of 1000 bootstrap replicates. The solid horizontal line in the top, bottom, and middle panels corresponds to Fmsy, MSY, and SSBmsy, respectively. Yield includes landings and dead discards.

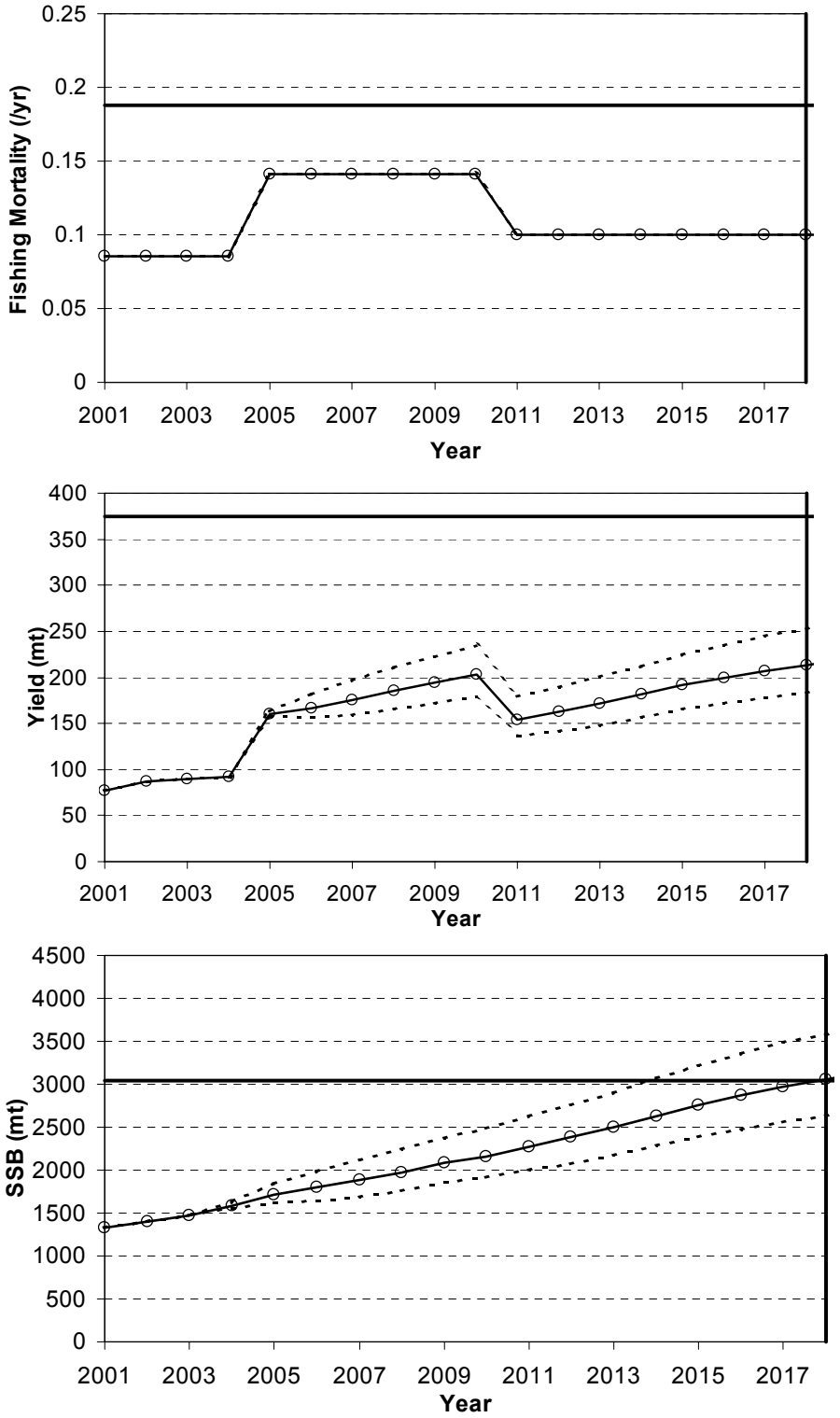


Figure 3. Strategy 3 (base run model) projection results. Results presented for the median (circles), 5th percentile, and 95th percentile (dashed lines) of 1000 bootstrap replicates. The solid horizontal line in the top, bottom, and middle panels corresponds to Fmsy, MSY, and SSBmsy, respectively. Yield includes landings and dead discards.

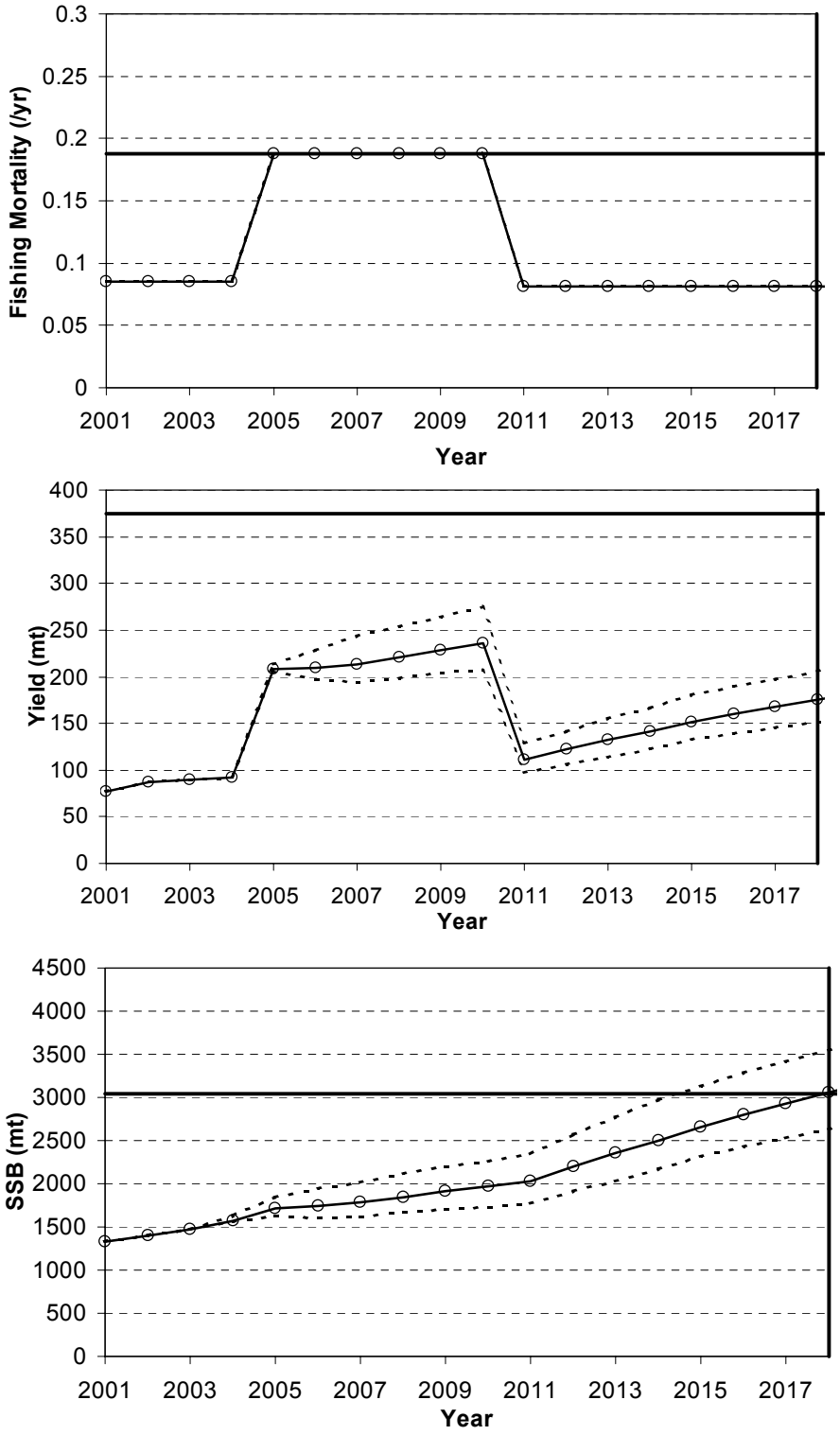


Figure 4. Strategy 4 (base run model) projection results. Results presented for the median (circles), 5th percentile, and 95th percentile (dashed lines) of 1000 bootstrap replicates. The solid horizontal line in the top, bottom, and middle panels corresponds to Fmsy, MSY, and SSBmsy, respectively. Yield includes landings and dead discards.

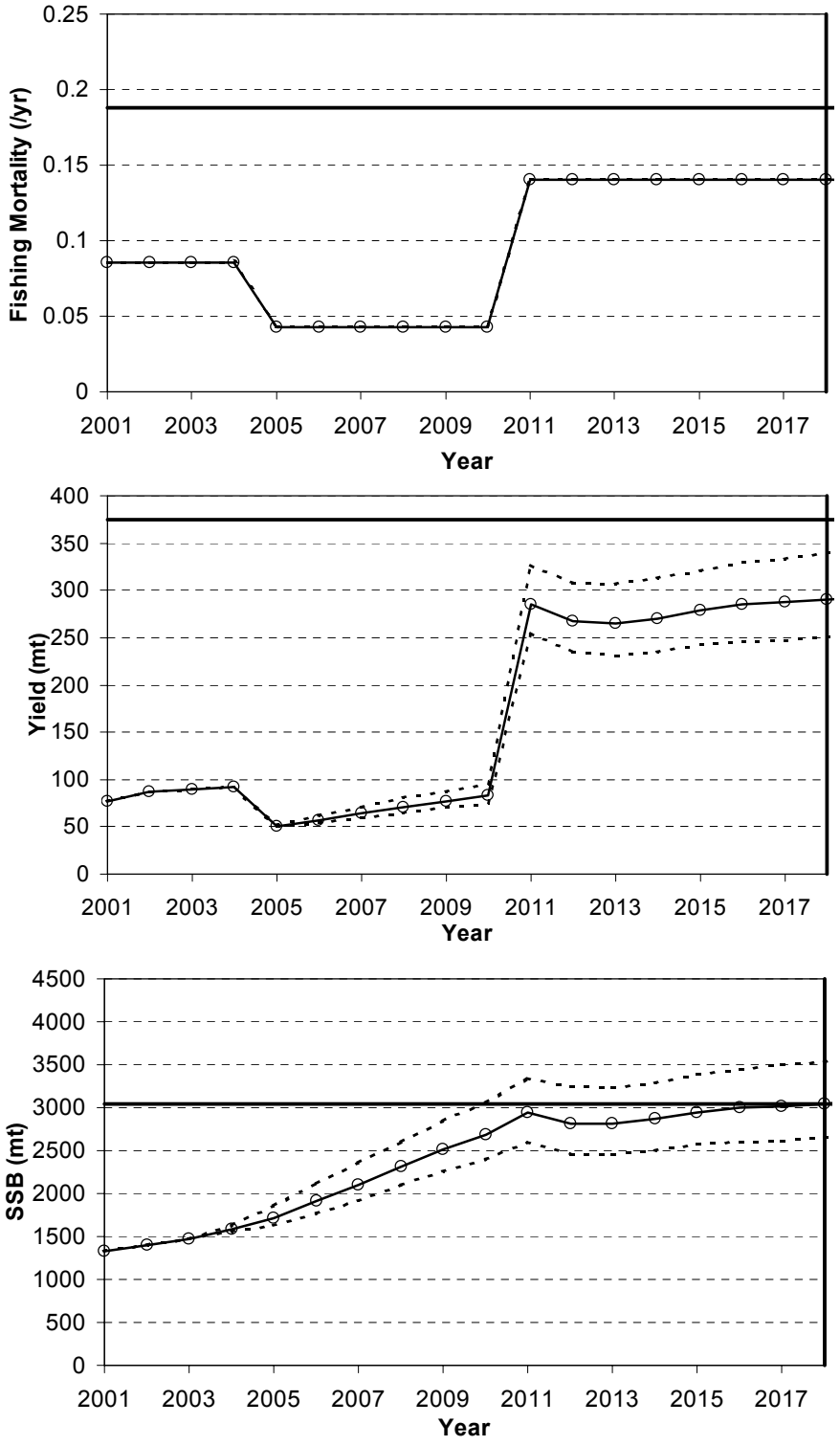


Figure 5. Strategy 5 (base run model) projection results. Results presented for the median (circles), 5th percentile, and 95th percentile (dashed lines) of 1000 bootstrap replicates. The solid horizontal line in the top, bottom, and middle panels corresponds to Fmsy, MSY, and SSBmsy, respectively. Yield includes landings and dead discards.

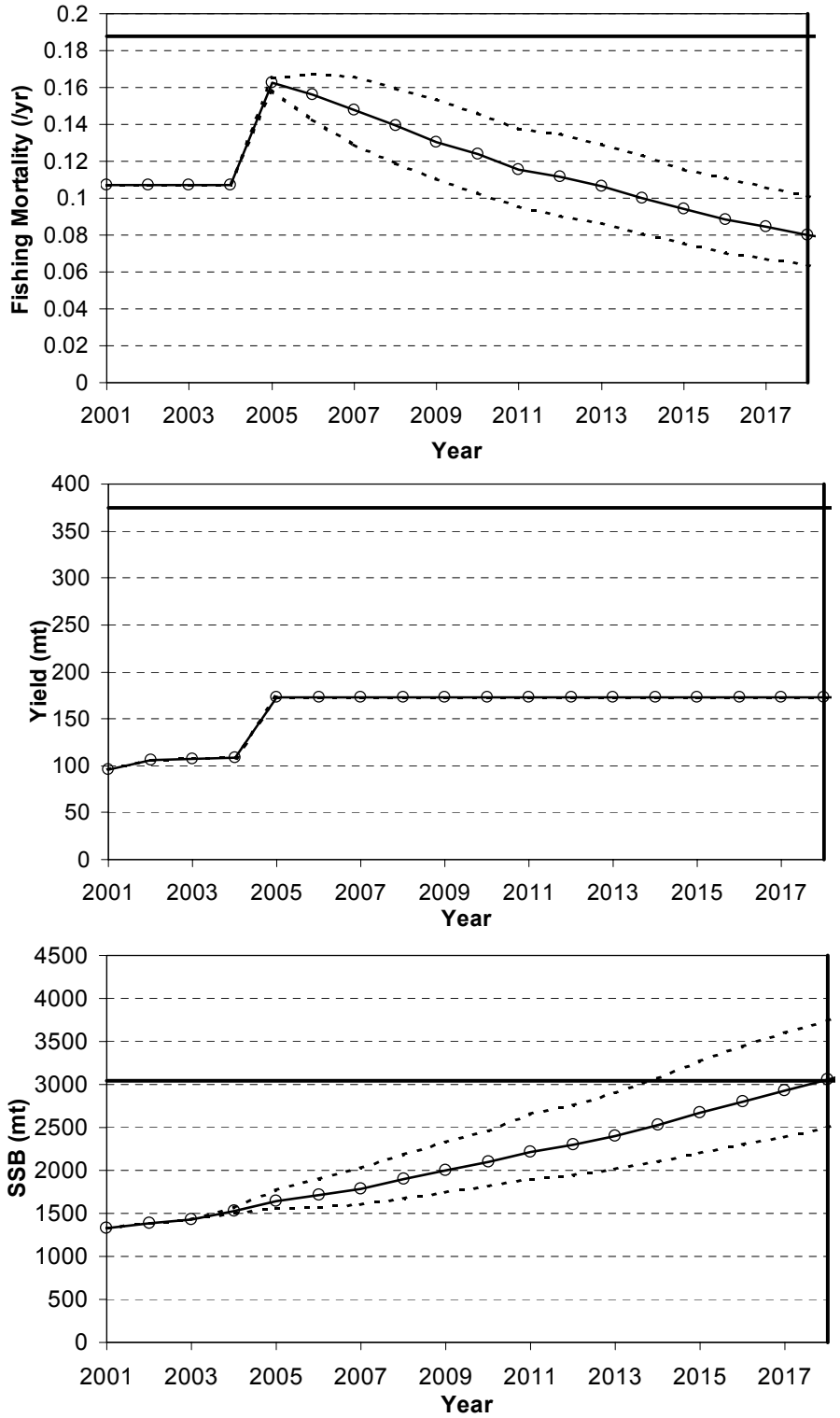


Figure 6. Strategy 1 (discard sensitivity model) projection results. Results presented for the median (circles), 5th percentile, and 95th percentile (dashed lines) of 1000 bootstrap replicates. The solid horizontal line in the top, bottom, and middle panels corresponds to Fmsy, MSY, and SSBmsy, respectively. Yield includes landings and dead discards.

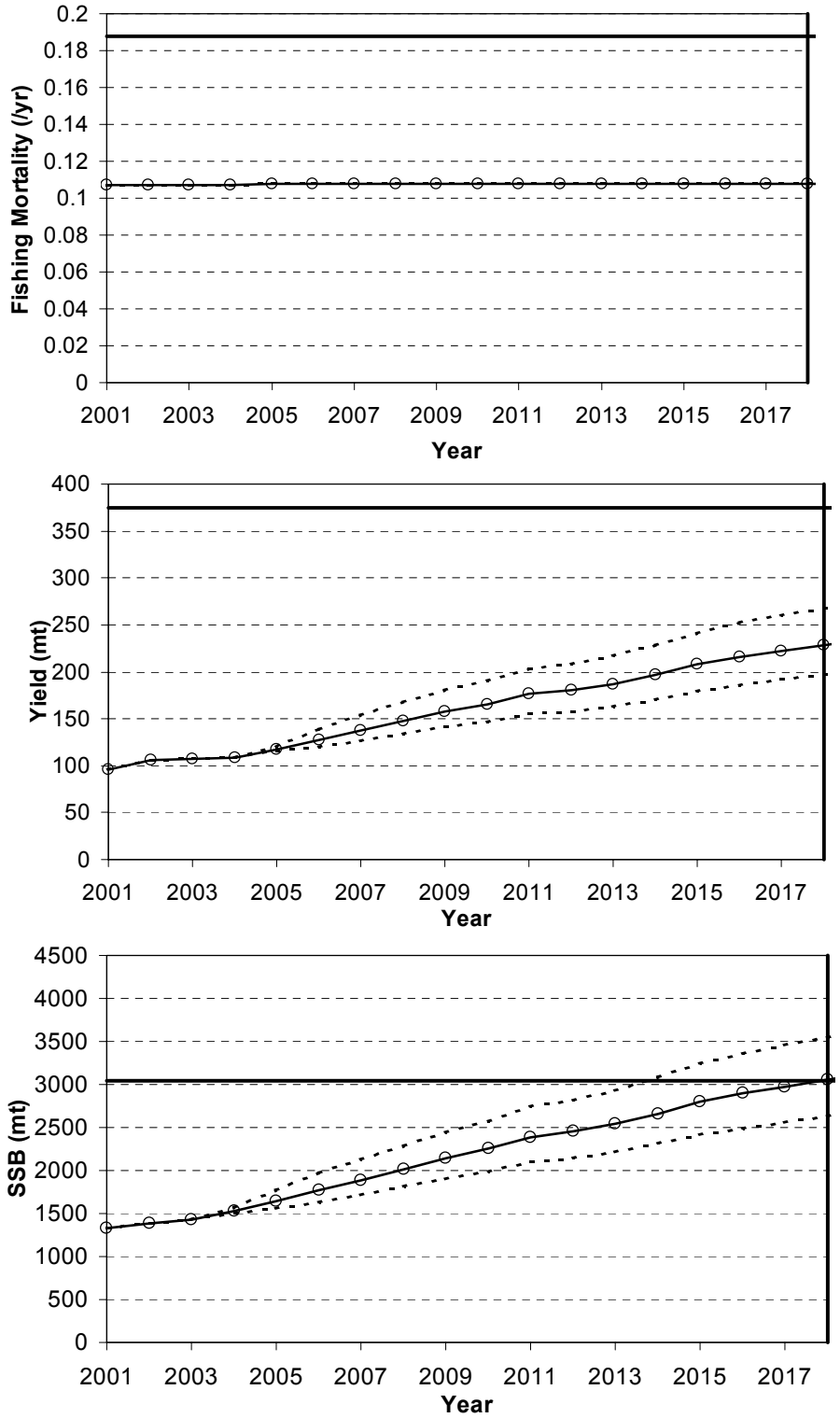


Figure 7. Strategy 2 (discard sensitivity model) projection results. Results presented for the median (circles), 5th percentile, and 95th percentile (dashed lines) of 1000 bootstrap replicates. The solid horizontal line in the top, bottom, and middle panels corresponds to Fmsy, MSY, and SSBmsy, respectively. Yield includes landings and dead discards.

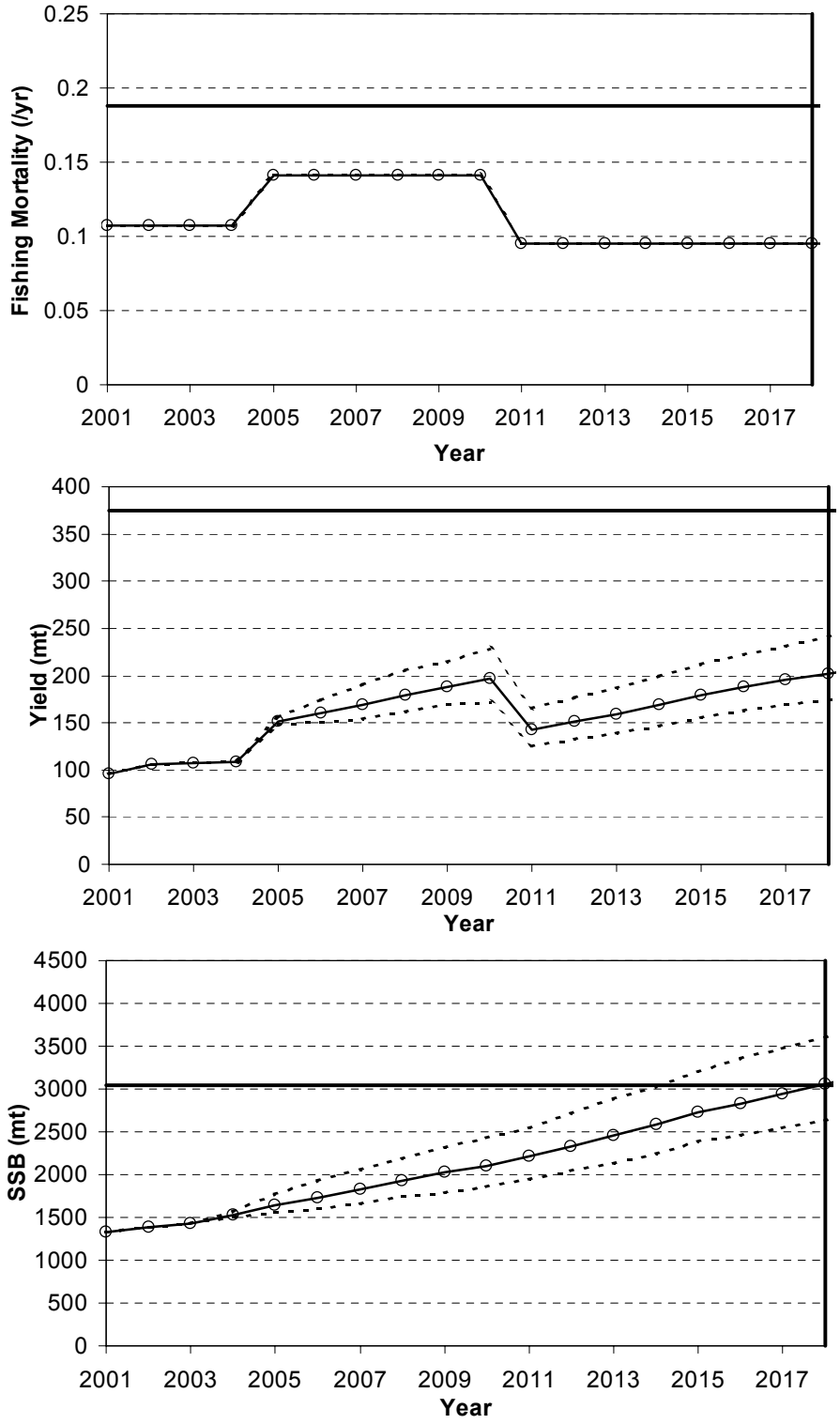


Figure 8. Strategy 3 (discard sensitivity model) projection results. Results presented for the median (circles), 5th percentile, and 95th percentile (dashed lines) of 1000 bootstrap replicates. The solid horizontal line in the top, bottom, and middle panels corresponds to Fmsy, MSY, and SSBmsy, respectively. Yield includes landings and dead discards.

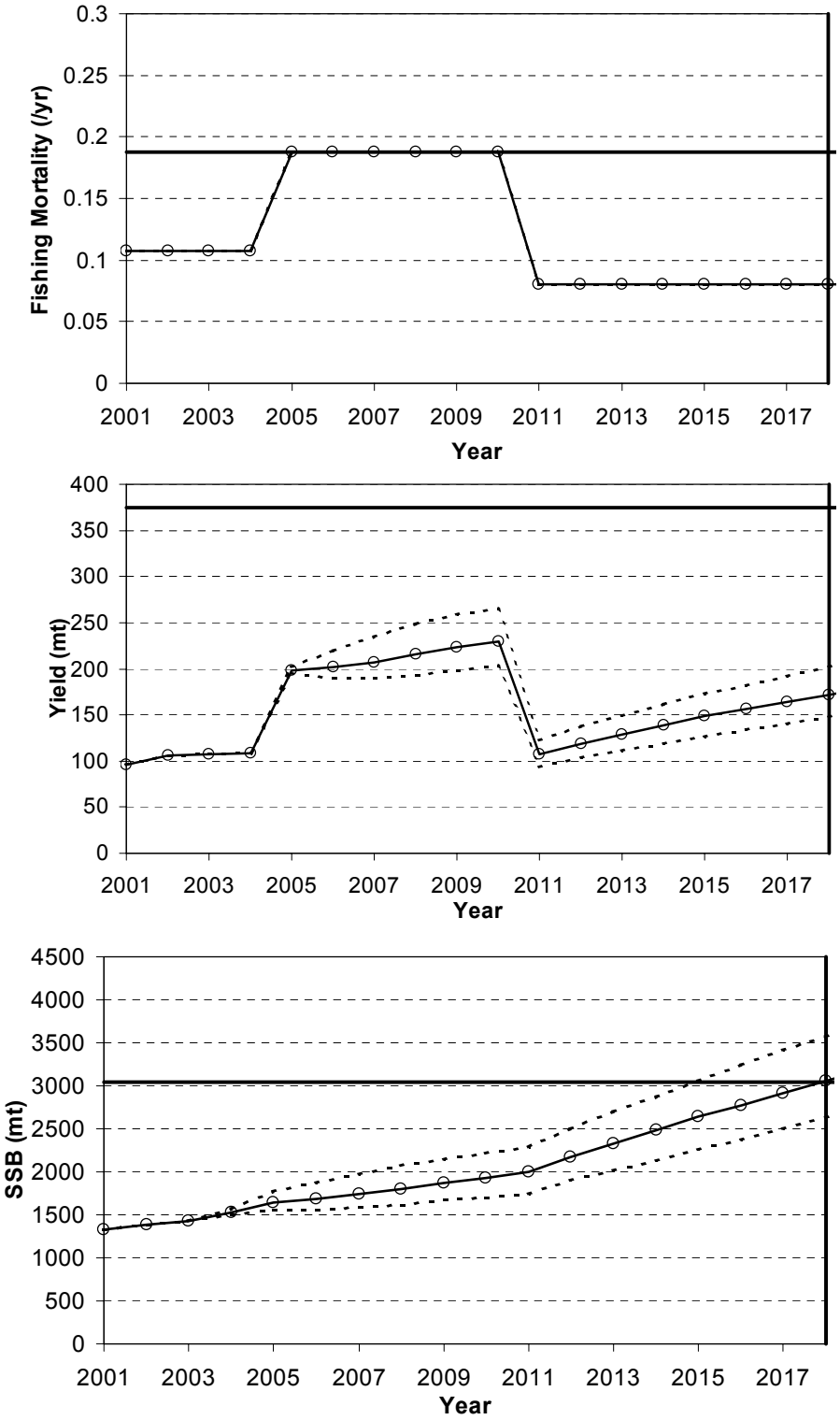


Figure 9. Strategy 4 (discard sensitivity model) projection results. Results presented for the median (circles), 5th percentile, and 95th percentile (dashed lines) of 1000 bootstrap replicates. The solid horizontal line in the top, bottom, and middle panels corresponds to Fmsy, MSY, and SSBmsy, respectively. Yield includes landings and dead discards.

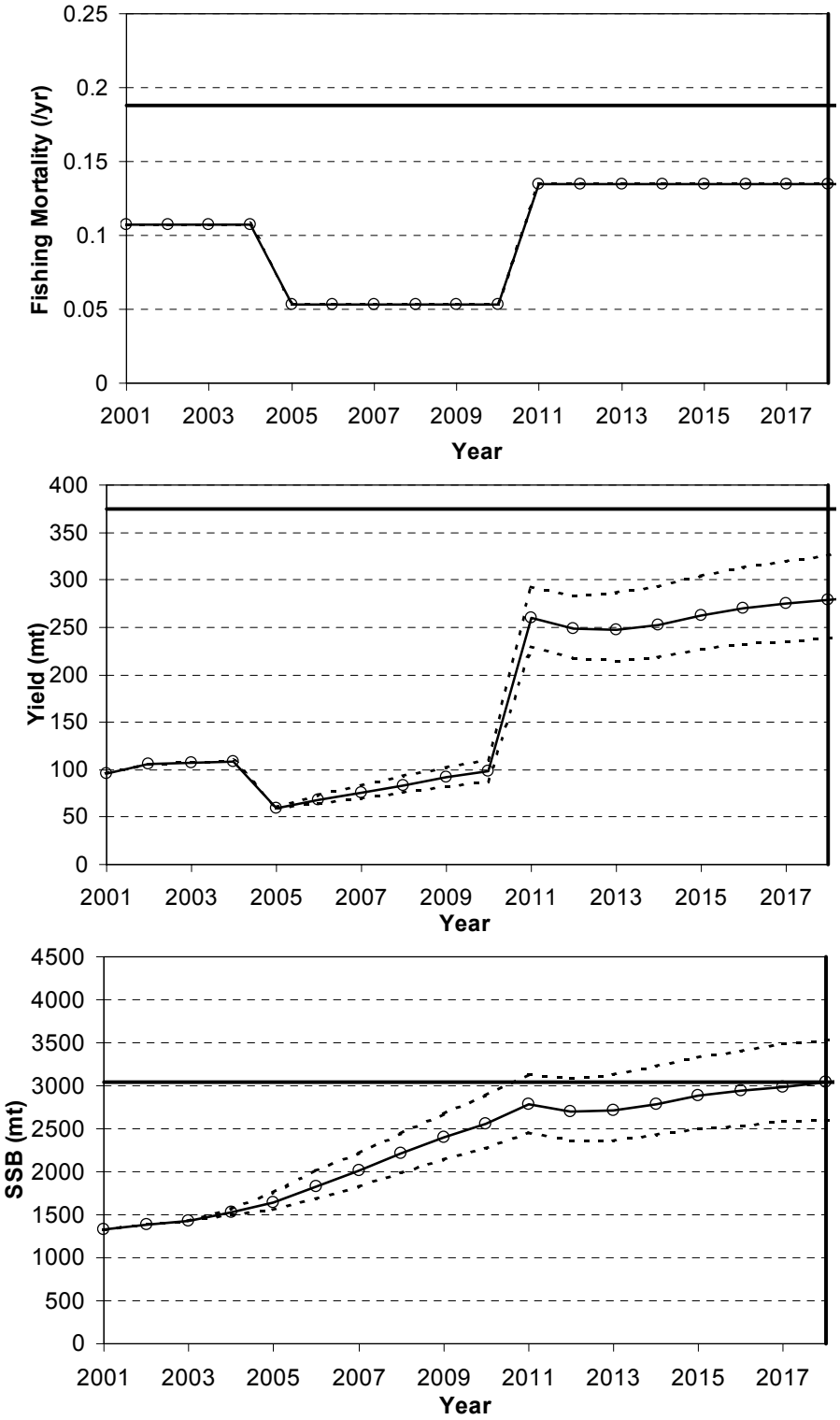


Figure 10. Strategy 5 (discard sensitivity model) projection results. Results presented for the median (circles), 5th percentile, and 95th percentile (dashed lines) of 1000 bootstrap replicates. The solid horizontal line in the top, bottom, and middle panels corresponds to Fmsy, MSY, and SSBmsy, respectively. Yield includes landings and dead discards.

Addendum to Report of the First SEDAR (Southeast Data, Assessment, and Review) Stock Assessment Cycle: Assessment, Review, and Management Recommendations for the Red Porgy, *Pagrus pagrus*, stock of the Southeastern United States

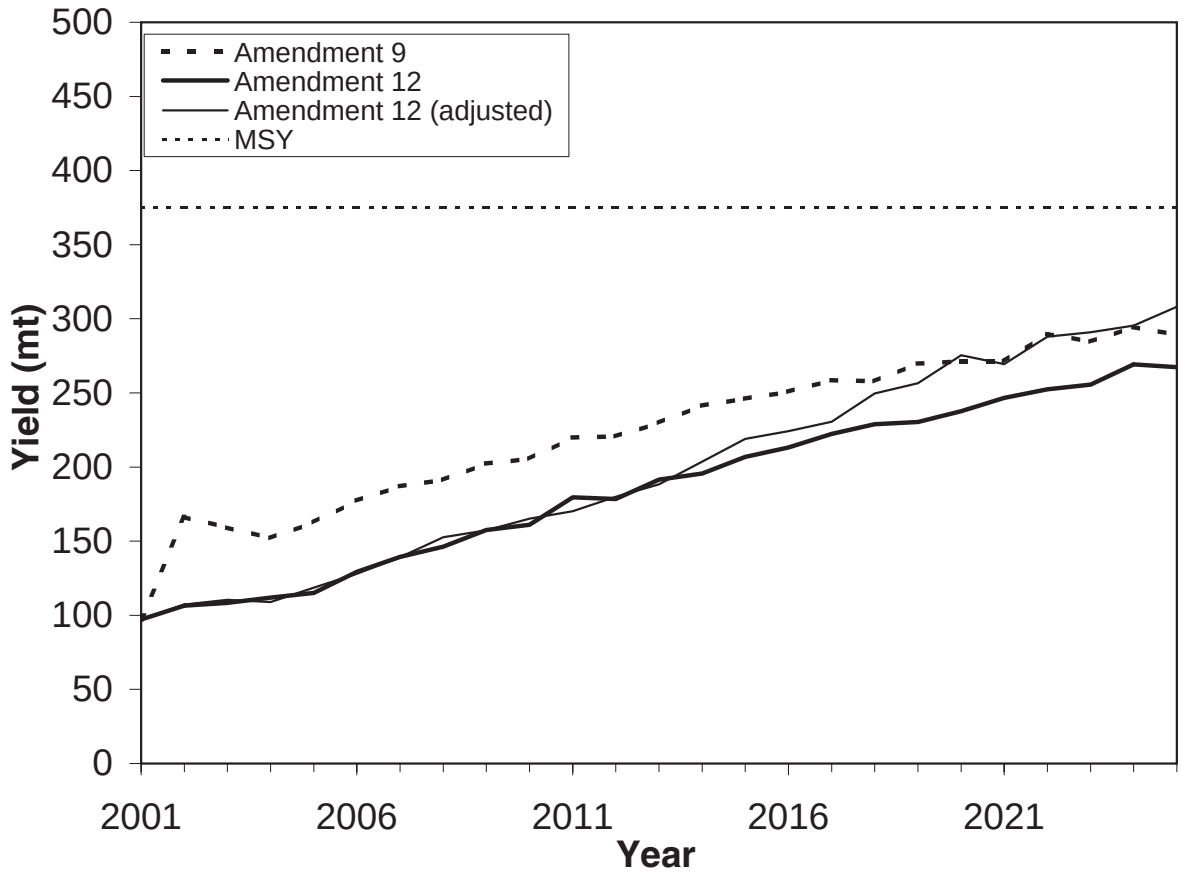
February, 2003

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
Center for Coastal Habitat and Fisheries Research
101 Pivers Island Road, Beaufort, NC 28516

Table 1. Projections of the yield (mt) from the red porgy stock for 25 years. Amendment 9 and 12 applied a constant fishing mortality rate of 0.173 and 0.107 for all years, respectively. Amendment 12 (adjusted) applied a constant fishing mortality rate of 0.107 for years when the population remained below SSB_{MSY} and a fishing mortality rate of 0.143 (75% of F_{MSY}) in years after population reached SSB_{MSY}. Under Amendment 9 the population does not rebuild to SSB_{MSY} in 25 years.

	Amendment 9			Amendment 12			Amendment 12 (adjusted)		
Year	**5th Percentile**	**50th Percentile**	**95th Percentile**	**5th Percentile**	**50th Percentile**	**95th Percentile**	**5th Percentile**	**50th Percentile**	**95th Percentile**
2001	97	97	97	97	97	97	97	97	97
2002	96	166	236	60	107	151	62	107	151
2003	91	159	229	60	108	152	62	110	155
2004	88	152	220	63	112	156	61	109	155
2005	94	163	232	67	115	170	66	119	167
2006	99	177	257	73	129	185	74	128	185
2007	106	187	270	78	139	202	78	139	201
2008	111	191	282	83	146	219	85	153	218
2009	112	202	303	89	158	232	88	157	234
2010	119	206	306	90	161	243	92	165	246
2011	121	220	329	100	180	261	97	170	263
2012	129	221	331	101	178	268	101	180	273
2013	128	230	345	106	192	277	106	188	283
2014	132	241	357	108	196	290	109	204	306
2015	142	246	371	117	207	307	115	219	351
2016	145	251	376	123	213	327	117	224	380
2017	144	259	386	125	222	335	122	231	410
2018	149	258	399	130	229	341	128	250	420
2019	149	270	404	128	230	355	131	257	433
2020	155	271	422	132	238	359	142	275	431
2021	159	271	420	139	247	370	146	270	446
2022	155	290	432	141	252	378	148	288	454
2023	163	284	445	137	256	383	157	291	452
2024	168	294	445	147	269	400	158	295	462
2025	171	289	443	148	267	404	167	308	474
Total		5596			4649			4934	

Figure 1. Projections of the median yield (mt) from the red porgy stock for 25 years. Amendment 9 and 12 applied a constant fishing mortality rate of 0.173 and 0.107 for all years, respectively. Amendment 12 (adjusted) applied a constant fishing mortality rate of 0.107 for years when the population remained below SSB_{MSY} and a fishing mortality rate of 0.143 (75% of F_{MSY}) in years after population reached SSB_{MSY}. Under Amendment 9 the population does not rebuild to SSB_{MSY} in 25 years.



SECTION VI.

Report to the CIE by the CIE appointed chair.

(exclusive of appendices duplicating material already enclosed)

Report to CIE of the 1st Southeast Atlantic Stock Assessment Review Committee (SARC)
Raleigh, N. Carolina 14-16 May 2002

R. Mohn
Department of Fisheries and Oceans
Bedford Institute of Oceanography
Dartmouth, N.S., Canada

History of events

The first SARC in the Southeast was convened on the afternoon of May 14th and continued until May 16, 2002. It followed a Data Workshop and a Stock Assessment Workshop. A summary document from the latter and a CD-ROM of supporting information were circulated prior to the SARC.

Once underway, Drs. Berkson and Prager led the SARC through the SAW assessment. During their presentation, clarifications and requests for more information were made. Time was also used to discuss developing the SARC process for the Southeast. The first draft of the Advisory Document was produced following the format of the Northeast series. Time constraints meant that the Consensus Document was developed only to point form before the meeting broke up. New figures and tables were required for both the Advisory and Consensus documents, most of which were supplied during the meeting.

After the meeting, the Chair formatted and finished the first draft of the Advisory and sent it out to the SARC panel for final feedback. While waiting their responses, the Consensus Document, which was in a much rougher form, was developed to a draft status and circulated by e-mail. The final, approved versions of these two documents were sent to Dr. Nancy Thompson on June 5.

Executive summary, findings and recommendations

This summary will be partitioned into two sections; the first will deal with the technical aspects of the review, and the second on those related to the process.

Technical summary

The assessment well represented the status of the red porgy stock, which has fallen and is currently overfished, but overfishing is not occurring. The current index of spawning stock biomass is low; the 2001 spawning stock size is estimated at about 43% of SSBmsy and 55% of MSST. The 2001 fishing mortality rate is estimated at about 45% of Fmsy. Recruitment, as measured by the age-structured model, has trended down from 1972 with an upturn in 2001. The size structure of the stock has been reduced after a period of high fishing mortality.

There is considerable uncertainty in future rates of recovery due to uncertainty about the
biology of the species, model uncertainty, and quality of the data available. Projections simulating current fishing mortality (Amendment 12 regulations) show less than 50% probability of achieving SSBmsy in 2016 which is the last year of the Council.s 18 year rebuilding program. Several other scenarios and models were investigated and showed considerable divergence in the recovery rates. Because of this divergence and the difficulty in extrapolation outside the regions for which data are available, until further investigation, the projections should be used only as broad indicators of trend.

Procedural summary.

The unusual degree of haste made pre-meeting preparation difficult, both in terms oflead-time and confusion. The FEDEX package containing the document and CD-ROMdid not arrive in Halifax until after I left. Fortunately, Dr. Merriner called and arrangedwith Dr. Prager to direct me to a website so that a copy of the SAW assessmentmanuscript could be reviewed before the meeting. Another aspect of the lack of sufficientpre-meeting preparation time was that I did not receive the final Terms of Reference untilarriving in Raleigh. The situation was compounded by the limited circulation of two othersets of ToRs, which although similar, were not identical to the final version.

The two and a half days allotted for the meeting were insufficient. The assessmentreceived a thorough review, but there was not enough time for document preparation. There were two reasons for this. The first was the SAW assessment manuscript itself. Itwas well prepared and edited. However, it was insufficiently informative for systematiccritical and technical review. There were few tables, even basics such as catch history and abundance data were not in the document. Although much of the missing information was in an accompanying compact disk, a certain minimum level in the printed material is needed for immediate reference. Also the degree of documentation describing the details of the models, alternative analyses (especially those that were later rejected), and diagnostics was insufficient. It is more efficient for a review to have more detail than will be needed in the final documentation and then edit out the superfluous than to have not enough and have to guess what is missing and request more information during the meeting. To paraphrase, this meant the reviewers did not know what they did not know. The second reason for the failure to complete the agenda during the meeting was the lack of familiarity with the SARC proceedings among the assessment production team. This meant that standards and default formats for figure and text exchange were not at hand. The other aspect of the lack of SARC experience was the document (advisory and consensus) preparation phase was less efficient than desirable. As an example there was no analog to the .SARC Leader. in the New England reviews to help in document
preparation nor were first drafts. Exchange of personnel with the Northeast for SARCs would expedite the transition to an experienced team, especially those about to do assessments in the Southeast. Also, Dr. Terry Smith from Woods Hole would be a good source of experience and information on the SARC process and document production.

Considerable time was spent describing the SAW/SARC process in New England and discussing what attributes would be directly applicable and what amendments would make the process better suited for the Southeast. Both the SARC panel and the other attendees actively participated in this discussion and the Consensus Document contains a summary. Opening this discussion to all was appreciated and it should help to assure that the system and the review process more transparent.

Although adequate and effective, the SARC was smaller than ideal. A second person from either CIE or NMFS (Northeast) would have been useful. This will be more of an issue

when more than one stock is reviewed. The Chair had to act as both chair and a technical reviewer. These roles were sometimes in conflict. As chair, he would try to move the discussion along towards consensus; as a reviewer he would try to slow it down to examine details or propose alternative analysis. A Chair should not dominate, but rather solicit the panel.s viewpoints. When acting as a technical expert, he must make his point but guard against giving his own point of view too much weight.

Future SARCs will need realistic support, enough people on the SARC and enough time to produce good drafts. A default standard format for exchange of text and figures would be expeditious. Finally, a glossary (eg, MSST, Fmsy.) for both output documents should be developed.

The hotel environment is less productive than a government lab, especially the lab of the team producing the assessment(s), such aspects as copying, technical support, libraries etc.