SEDAR

Southeast Data, Assessment, and Review

Stock Assessment Report
of
SEDAR 9

Gulf of Mexico Greater Amberjack

SEDAR9
Assessment Report 2

2006

SEDAR
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Stock Assessment Report 2

Gulf of Mexico Greater Amberjack

SECTION I. Introduction

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1. SEDAR Overview

SEDAR (Southeast Data, Assessment and Review) was initially developed by the Southeast Fisheries Science Center and the South Atlantic Fishery Management Council to improve the quality and reliability of stock assessments and to ensure a robust and independent peer review of stock assessment products. SEDAR was expanded in 2003 to address the assessment needs of all three Fishery Management Council in the Southeast Region (South Atlantic, Gulf of Mexico, and Caribbean) and to provide a platform for reviewing assessments developed through the Atlantic and Gulf States Marine Fisheries Commissions and state agencies within the southeast.

SEDAR strives to improve the quality of assessment advice provided for managing fisheries resources in the Southeast US by increasing and expanding participation in the assessment process, ensuring the assessment process is transparent and open, and providing a robust and independent review of assessment products. SEDAR is overseen by a Steering Committee composed of NOAA Fisheries representatives: Southeast Fisheries Science Center Director and the Southeast Regional Adminstrator; Regional Council representatives: the Executive Directors and Chairs of the South Atlantic, Gulf of Mexico, and Caribbean Fishery Management Councils; and Interstate Commissions: the Executive Directors of the Atlantic States and Gulf States Marine Fisheries Commissions.

SEDAR is organized around three workshops. First is the Data Workshop, during which fisheries, monitoring, and life history data are reviewed and compiled. Second is the Assessment workshop, during which assessment models are developed and population parameters are estimated using the information provided from the Data Workshop. Third and final is the Review Workshop, during which independent experts review the input data, assessment methods, and assessment products.

SEDAR workshops are organized by SEDAR staff and the lead Council. Data and Assessment Workshops are chaired by the SEDAR coordinator. Participants are drawn from state and federal agencies, non-government organizations, Council members, Council advisors, and the fishing industry with a goal of including a broad range of disciplines and perspectives. All participants are expected to contribute to the process by preparing working papers, contributing, providing assessment analyses, and completing the workshop report.

SEDAR Review Workshop Panels consist of a chair and 3 reviewers appointed by the Center for Independent Experts (CIE), an independent organization that provides independent, expert reviews of stock assessments and related work. The Review Workshop Chair is appointed by the SEFSC director and is usually selected from a NOAA Fisheries regional science center. Participating councils may appoint representatives of their SSC, Advisory, and other panels as observers to the review workshop.

SEDAR 9 was charged with assessing 3 stocks under the jurisdiction of the Gulf of Mexico Fishery Management Council: greater amberjack, gray triggerfish, and vermilion snapper.

2. Management Overview

2. Management Overview

2.1 Management Unit Definition

Greater Amberjack, *Seriola dumerili*, is one of four jacks of 40 species of reef fish in the management unit for the Gulf of Mexico Reef Fish FMP. Two Serranids are not managed, leaving 15 groupers, 14 snappers, five tilefishes, four jacks, one triggerfish and one wrasse. The jurisdiction of the Gulf of Mexico Reef Fish FMP includes all waters of the GOM bounded outside by 200 nautical miles (nm) and inside by the state's territorial waters which are 3 nm in Alabama, Mississippi and Louisiana and 3 leagues or about 9 nm in Florida and Texas.

2.0 History of Management Relating to Greater Amberjack

The Reef Fish FMP (with its associated environmental impact statement) was implemented in November 1984. The original list of species included in the management unit consisted of snappers, groupers, and sea basses. *Seriola* species, including greater amberjack, were in a second list of species included in the fishery, but not in the management unit. The species in this list were not considered to be target species because they were generally taken incidentally to the directed fishery for species in the management unit. Their inclusion in the FMP was for purposes of data collection, and their take was not regulated.

Amendment 1 [with its associated environmental assessment (EA), regulatory impact review (RIR), and initial regulatory flexibility analysis (IRFA)] to the Reef Fish Fishery Management Plan, implemented in 1990, added greater amberjack and lesser amberjack to the list of species in the management unit. It set a greater amberjack recreational minimum size limit of 28 inches fork length (FL) and a 3 fish recreational bag limit, and a commercial minimum size limit of 36 inches FL. This amendment set as a primary objective of the FMP the stabilization of long-term population levels of all reef fish species by establishing a survival rate of biomass into the stock of spawning age to achieve at least 20 percent spawning stock biomass per recruit (SSBR), relative to the SSBR that would occur with no fishing. A framework procedure for specification of TAC was created to allow for annual management changes. This amendment also established a commercial vessel reef fish permit as a requirement for harvest in excess of the bag limit and for the sale of reef fish.

Amendment 4 (with its associated EA and RIR), implemented in May 1992, added the remaining *Seriola* species (banded rudderfish and Almaco jack) to the management unit, and established a moratorium on the issuance of new commercial reef fish vessel permits for a maximum period of three years.

Amendment 5 (with its associated supplemental environmental impact statement, RIR, and IRFA), implemented in February 1994, required that all finfish except for oceanic migratory species be landed with head and fins attached, and closed the region of Riley's Hump (near Dry Tortugas, Florida) to all fishing during May and June to protect mutton snapper spawning aggregations.

Amendment 11 (with its associated EA and RIR) was partially approved by NMFS and implemented in January 1996. It implemented a new reef fish permit moratorium for no more than 5 years or until December 31, 2000, during which time the Council was to consider limited access for the reef fish fishery.

Amendment 12 (with its associated EA and RIR), submitted in December 1995 and implemented in January 1997, reduced the greater amberjack bag limit from 3 fish to 1 fish per person, and created an aggregate bag limit of 20 reef fish for all reef fish species not having a bag limit (including lesser amberjack, banded rudderfish, and Almaco jack). NMFS disapproved proposed provisions to include lesser amberjack and banded rudderfish along with greater amberjack in an aggregate 1-fish bag limit and to establish a 28-inch FL minimum size limit for those species.

Amendment 15 (with its associated EA, RIR, and IRFA), implemented in January 1998, closed the commercial greater amberjack fishery Gulfwide during the months of March, April, and May. An August 1999 regulatory amendment (with its associated EA, RIR, and IRFA) closed two areas (i.e., create two marine reserves), 115 and 104 square nautical miles respectively, year-round to all fishing under the jurisdiction of the Gulf Council with a 4-year sunset closure.

Generic Sustainable Fisheries Act Amendment (with its associated EA, RIR, and IRFA), partially approved and implemented in November 1999, set the maximum fishing mortality threshold (MFMT) for greater amberjack at $F_{30\%\ SPR}$. Estimates of MSY, MSST, and OY were disapproved because they were based on spawning potential ratio (SPR) proxies rather than biomass based estimates.

Amendment 16B (with its associated EA, RIR, and IRFA), implemented in November 1999, set a slot limit of 14 to 22 inches FL for banded rudderfish and lesser amberjack for both the commercial and recreational fisheries, and an aggregate recreational bag limit of five fish for banded rudderfish and lesser amberjack.

Amendment 17 (with its associated EA), implemented by NMFS in August 2000, extended the commercial reef fish permit moratorium for another 5 years, from its previous expiration date of December 31, 2000 to December 31, 2005, unless replaced sooner by a comprehensive controlled access system.

Secretarial Amendment 2 , implemented in July, 2003, specified MSY as the yield associated with $F_{30\%\ SPR}$ (proxy for F_{MSY}) when the stock is at equilibrium, OY as the yield associated with an $F_{40\%\ SPR}$ when the stock is at equilibrium, MFMT equal to $F_{30\%}$, and MSST equal to (1-M)*B_{MSY} or 75 percent of B_{MSY}. It also set a rebuilding plan limiting the harvest to 2.9 mp for 2003-2005, 5.2 mp for 2006-2008, 7.0 mp for 2009-2011, and for 7.9 mp for 2012. This was expected to rebuild the stock in 7 years.

2.3 Current Management Criteria and Stock Benchmarks

As established by Secretarial Amendment 2 to the Reef Fish FMP, MSY is specified as the yield associated with $F_{30\%\ SPR}$ (proxy for F_{MSY}) when the stock is at equilibrium, OY is set as the yield associated with an $F_{40\%\ SPR}$ when the stock is at equilibrium. MFMT is equal to $F_{30\%}$, and MSST is equal to (1-M)*B_{MSY} or 75 percent of B_{MSY}.

A seven year rebuilding plan implemented by Secretarial Amendment 2 limited the harvest to 2.9 mp for 2003-2005, 5.2 mp for 2006-2008, 7.0 mp for 2009-2011, and for 7.9 mp for 2012. No new management measures were put in place because the Council felt that regulations established in 1997 and 1998 were expected to rebuild the stock as specified in the rebuilding plan.

The current minimum size for recreationally caught greater amberjack is 28 inches fork length and the commercial size limit is 36 inches fork length. The recreational bag limit is one fish per person. The commercial fishery is closed from March through May.

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SouthEast Data, Assessment, and Review

SEDAR 9
Stock Assessment Report 2

Gulf of Mexico
Greater Amberjack

SECTION 2. Data Workshop

Results of the SEDAR 9 Data Workshop
June 20-24 2005
New Orleans, LA

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1. Introduction

1.1 Workshop Time and Place

The SEDAR 9 Data Workshop was held June 20 – 24, 2006, at the Hotel Monteleone in New Orleans, LA.

1.2 Terms of Reference

1. Characterize stock structure and develop a unit stock definition.
2. Tabulate available life history information (e.g., age, growth, natural mortality, reproductive characteristics). Provide models to describe growth, maturation, and fecundity by age, sex, or length as appropriate; recommend life history parameters (or ranges of parameters) for use in population modeling; evaluate the adequacy of life-history information for conducting stock assessments.
3. Provide indices of population abundance. Consider fishery dependent and independent data sources; develop index values for appropriate strata (e.g., age, size, area, and fishery); provide measures of precision; conduct analyses evaluating the degree to which available indices adequately represent fishery and population conditions. Document all programs used to develop indices, addressing program objectives, methods, coverage, sampling intensity, and other relevant characteristics.
4. Characterize commercial and recreational catches, including both landings and discard removals, in weight and numbers. Evaluate the adequacy of available data for accurately characterizing harvest and discard by species and fishery sector. Provide length and age distributions if feasible.
5. Evaluate the adequacy of available data for estimating the impacts of current management actions.
6. Recommend assessment methods and models that are appropriate given the quality and scope of the data sets reviewed and management requirements.
7. Provide recommendations for future research in areas such as sampling, fishery monitoring, and stock assessment. Include specific guidance on sampling intensity and coverage where possible.
8. Prepare complete documentation of workshop actions and decisions (Section II. of the SEDAR assessment report).

1.3 Participants

Workshop Participants:

Robert Allman..NMFS/SEFSC Panama City, FL
Luiz Barbieri ....FWC St. Petersburg, FL
Craig Brown...NMFS/SEFSC Miami, FL
Shannon Calay ....NMFS/SEFSC Miami, FL
Alan Collins ....NMFS/SEFSC Panama City, FL
Marianne Cufone ....Environment Matters
Guy Davenport..NMFS/SEFSC Miami, FL
Guillermo Diaz..NMFS/SEFSC Miami, FL
Bob Dixon..NMFS/SEFSC Beaufort, NC
Dave Donaldson..GSFMC
Chris Dorsett ....Nature Conservancy
Chris Gledhill..NMFS/SEFSC Pensacola FL
Terry Henwood ....NMFS/SEFSC, Pascagoula MS
David Hamisko ....NOAA Fisheries Pensacola, FL
Walter Ingram ....NMFS/SEFSC Pascagoula MS
Joanne Lyczkowski-Shultz ....NMFS.SEFSC Pascagoula, MS
Kevin McCarthy..NMFS/SEFSC Miami FL
Debra Murie ....University of Florida
Josh Sladek Nowlis ....NMFS/SEFSC Miami, FL
Scott Nichols ....NMFS/SEFSC Pascagoula MS
Dennis O'Hearn ....GMFMC Advisory Panel
Butch Pellegrin..NMFS/SEFSC Pascagoula MS
Larry Perruso ....NMFS/SEFSC Pascagoula MS
Jennifer Potts..NMFS/SEFSC Beaufort, NC
Jay Rooker ....Texas A&M University
Steven Saul...RSMAS/University of Miami
Jerry Scott ....NMFS/SEFSC Miami, FL
Bob Shipp...University of South Alabama
Tom Turke ....GMFMC Advisory Panel
Steve Turner...NMFS/SEFSC Miami, FL
Russell Underwood.....................................GMFMC Advisory Panel
Glenn Zapfe ....NOAA Fisheries Pascagoula, MS

Observers:

Bobbi Walker ....GMFMC
Donald Waters ....Fisherman
Bob Zales II..Panama City Boatmens Assoc.

Staff:

John Carmichael..SEDAR
Stu Kennedy..GMFMC
Dawn Aring...GMFMC
Patrick Gilles...NMFS/SEFSC Miami FL

1.4 Document List

Document #	Title	Authors
Documents Prepared for the SEDR 9 Data Workshop		
SEDAR9-DW1	History of vermillion snapper, greater amberjack, and gray triggerfish management in Federal waters of the US Gulf of Mexico, 1984-2005	Hood, P
SEDAR9-DW2	Vermillion Snapper Otolith Aging: 2001-2004 Data Summary	Allman, R J., J. A. Tunnell. B. K. Barnett
SEDAR9-DW3	Reproduction of vermillion snapper from the Northern and Eastern Gulf of Mexico, 1991-2002.	Collins, L. A., R. J. Allman, and H. M Lyon
SEDAR9-DW4	Standardized catch rate indices for vermilion snapper landed by the US recreational fishery in the Gulf of Mexico, 1986-2004	Cass-Calay, S. L.
SEDAR9-DW5	Standardized catch rate indices for vermilion snapper landed by the US commercial handline fishery in the Gulf of Mexico, 1990-2004	Kevin J. McCarthy and Shannon L. Cass-Calay
SEDAR9-DW6	Standardized catch rates of vermilion snapper from the US headboat fishery in the Gulf of Mexico, 1986-2004	Craig A. Brown
SEDAR9-DW7	Estimated Gulf of Mexico greater amberjack recreational landings (MRFSS, Headboat, TXPW) for 1981-2004	Guillermo Diaz
SEDAR9-DW8	Size frequency distribution of greater amberjack from dockside sampling of recreational landings in the Gulf of Mexico 1986-2003	Guillermo Diaz
SEDAR9-DW9	Size frequency distribution of greater amberjack from dockside sampling of commercial landings in the Gulf of Mexico 1986-2003	Guillermo Diaz
SEDAR9-DW10	Standardized catch rates of gulf of Mexico greater amberjack for the commercial longline and handline fishery 1990-2004	Guillermo Diaz
SEDAR9-DW11	Length Frequency Analysis and Calculated Catch at Age Estimations for Commercially Landed Gray Triggerfish (*Balistes capriscus*) From the Gulf of Mexico	Steven Saul
SEDAR9-DW12	Estimated Gray Triggerfish (*Balistes capriscus*) Landings From the Gulf of Mexico Headboat Fishery	Steven Saul
SEDAR9-DW13	Estimated Gray Triggerfish (*Balistes capriscus*) Commercial Landings and Price Information for the Gulf of Mexico Fishery	Steven Saul
SEDAR9-DW14	Estimated Gray Triggerfish (*Balistes capriscus*) Recreational Landings for the State of Texas	Steven Saul
SEDAR9-DW15	Estimated Gray Triggerfish (*Balistes capriscus*) Landings From the Marine Recreational Fishery Statistics Survey (MRFSS) In the Gulf of Mexico	Steven Saul and Patty Phares
SEDAR9-DW16	Length Frequency Analysis for the Gray Triggerfish (*Balistes capriscus*) Recreational Fishery In the Gulf of Mexico	Steven Saul
SEDAR9-DW17	Estimates of Vermilion Snapper, Greater Amberjack, and Gray Triggerfish Discards by Vessels with Federal Permits in the Gulf of Mexico	Kevin J. McCarthy
SEDAR9-DW18	Size Composition Data from the SEAMAP Trawl Surveys	Scott Nichols

SEDAR9-DW19	Species Composition of the various amberjack species in the Gulf of Mexico	Ching-Ping Chih
SEDAR9-DW20	Standardized Catch rates of Gulf of Mexico greater amberjack catch rates for the recreational fishery (MRFSS, Headboat) 1981-2004	Guillermo Diaz
SEDAR9-DW21	SEAMAP Reef Fish Survey of Offshore Banks: Yearly indices of Abundance for Vermilion Snapper, Greater Amberjack, and Gray Triggerfish	Gledhill, et. al.
SEDAR9-DW22	Data Summary of Gray Triggerfish (*Balistes capriscus),*Vermilion Snapper (*Rhomboplites aurorubens),* and Greater Amberjack (*Seriola dumerili)* Collected During Small Pelagic Trawl Surveys, 1988 – 1996	G. Walter Ingram, Jr.
SEDAR9-DW23	Abundance Indices of Gray Triggerfish and Vermilion Snapper Collected in Summer and Fall SEAMAP Groundfish Surveys (1987 – 2004)	G. Walter Ingram, Jr.
SEDAR9-DW24	Review of the Early Life History of Vermilion Snapper, *Rhomboplites auroubens,* With a Summary of Data from SEAMAP plankton surveys in the Gulf of Mexico: 1982 – 2002	Lyczkowski-Shultz, J. and Hanisko, D.
SEDAR9-DW25	Review of the early life history of gray triggerfish, *Balistes capriscus,* with a summary of data from SEAMAP plankton surveys in the Gulf of Mexico: 1982, 1984 – 2002	Lyczkowski-Shultz, J., Hanisko, D. and Zapfe, G.
SEDAR9-DW26	Shrimp Fleet Bycatch Estimates for the SEDAR9 Species	Scott Nichols
SEDAR9-DW27	SEAMAP Trawl Indexes for the SEDAR9 Species	Scott Nichols
SEDAR9-DW-28	Standardized Abundance Indices for Gulf of Mexico Gray Triggerfish (*Balistes capriscus)* based on catch rates as measured by the Marine Recreational Fisheries Statistics Survey (MRFSS)	Josh Sladek Nowlis
SEDAR9-DW-29	Standardized Abundance Indices for Gulf of Mexico Gray Triggerfish (*Balistes capriscus)* based on catch rates as measured by the NMFS Southeast Zone Headboat Survey	Josh Sladek Nowlis
SEDAR9-DW-30	Standardized Abundance Indices for Gulf of Mexico Gray Triggerfish (*Balistes capriscus)* based on catch rates as measured from commercial logbook entries with handline gear	Josh Sladek Nowlis
SEDAR9-DW-31	Estimated Gulf of Mexico vermillion snapper recreational landings (MRFSS, headboat, TPWD) for 1981-2004	Shannon & Guillermo

2. LIFE HISTORY

2.1 Stock Definition

Two management groups (Atlantic and Gulf of Mexico) are currently used by the SAFMC and GMFMC. The geographic boundary of these management units occurs from approximately the Dry Tortugas through the Florida Keys and to the mainland of Florida.

2.1.1 Genetic Differentiation

Analysis of mtDNA haplotypes in greater amberjack indicated spatial homogeneity across the northern Gulf of Mexico (Florida Middle Grounds to Port Aransas, Texas), suggestive of continuous gene flow within the region (Gold and Richardson 1998). Genetic results indicated there may be a split between western Atlantic (includes Florida Keys) and Gulf populations, albeit evidence for two populations was weak. Assuming heterogeneity exists between western Atlantic and Gulf populations, the hypothesized break probably occurs along the southwest coast of Florida (J. Gold, pers. comm.).

2.1.2 Tagging

Tag and recapture data of greater amberjack indicate that there is little exchange (1.3%) between the Atlantic and Gulf of Mexico (McClellan and Cummings 1997). Recaptures observed by McClellan and Cummings (1997) averaged 1.9 years (maximum: 14 years), and the majority of recaptured greater amberjack were within 25 nm of the release site (48% showed no net movement). Moreover, 72.9% and 92.7% of Atlantic and Gulf fish, respectively, were recaptured within 100 nm of the release site. Burch (1979) reported on nearly two decades of tagging work conducted by the Cooperative Gamefish Tagging Program. Based on 510 recaptures, greater amberjack migrated northward along the Florida east coast from June through November and southward from December to May.

2.1.3 Otolith Chemistry

Otolith chemistry studies are not available for greater amberjack in the Gulf of Mexico.

2.2 Habitat Requirements

Throughout the Gulf of Mexico juvenile greater amberjack are commonly collected in association with pelagic *Sargassum* mats (Bortone et al. 1977). YOY greater amberjack (< 200 mm SL) are most common during May-June in offshore waters of the Gulf (Wells and Rooker 2004a). The sizes of individuals associated with *Sargassum* range from approximately 3-20 mm SL (age range: 40-150 d) (Wells and Rooker 2004b). Individuals larger than 30 mm TL are common in NOAA small pelagic trawl surveys (SEDAR9-DW-22), as well as the headboat fishery (Manooch and Potts 1997a), suggesting a shift in habitat (pelagic to demersal) occurs at 5-6 months of age. After shifting to demersal habitats, sub-adults and adults congregate around reefs, rock outcrops, and wrecks. Since greater amberjack are only seasonally abundant in certain parts of their range, they likely utilize a variety of habitats and/or areas each year.

2.3 Age

2.3.1 Ageing

Greater amberjack are considered to be relatively difficult to age and several authors have expressed concern over age determination from scales, otoliths, and spines. Burch (1979) used scales to age greater amberjack from the Florida Keys and obtained a maximum age of 10 years. Manooch and Potts (1997a) aged greater amberjack from the headboat catch from Texas and northwest Florida/Alabama and aged amberjack up to 15 years using sectioned sagittal otoliths. Manooch and Potts (1997b) have aged greater amberjack from the southeastern U.S. headboats and commercial handline vessels up to 17 years. They reported that 71% of the otoliths were readable, with measurements possible on 48% of the samples. Thompson et al. (1999) were able to age amberjack off Louisiana to 15 years of age using sectioned otoliths and reported reasonable consistency in annulus interpretation between readers; estimates for coefficient of variation and index of precision were 0.15 and 0.11, respectively. Recently, Harris et al. (2004) aged greater amberjack collected from the southeast Atlantic using sectioned otoliths and obtained a maximum age of 13 years. These authors also indicated that 85.4% (1,996 out of 2,335) of otoliths collected in the southeastern Atlantic were readable, with relatively good agreement; 42.4% agreement for amberjack aged 0-13 years and agreement increased to 85.4% for ages differing by one year or less.

2.3.2 Validation

To date, information on the timing of annulus formation in greater amberjack differs slightly among aging studies. In Louisiana, Thompson et al. (1999) were unable to use marginal-increment analysis to determine the timing of annulus formation. Instead, they looked at tagged and recaptured greater amberjack that had been injected with oxytetracycline and their results supported age estimates from otoliths. Moreover, they determined that annuli must have been deposited sometime between November and March in 2- and 3-year old fish. Similarly, Schirripa and Burns (1997) used release-recapture observations to validate age and growth estimates from previous studies. Growth curves for recapture data are similar to findings from Burch (1979) and Beasley (1993), supporting the premise that observed growth increments in scales and otoliths represent annuli. Manooch and Potts (1997a) used marginal-increment analysis and determined that the annulus in greater amberjack collected from headboats throughout the Gulf was laid down between March and May for fish 0-15 years of age, with the majority of the 340 amberjack sampled ≤7 years. Similarly, Manooch and Potts (1997b) aging greater amberjack in the southeastern Atlantic reported annulus deposition primarily in April, with the majority of fish ≤12 years of age. Burch (1979), collecting greater amberjack from South Florida, noted that the marginal-increment was at a minimum between February and April. Overall, it would appear that annuli in either otoliths or scales of greater amberjack in the Gulf of Mexico are deposited once per year primarily during March-May.

2.4 Growth

Age of YOY Gulf greater amberjack associated with *Sargassum* in the Gulf of Mexico were approximately 40-150 days post-hatch (35-210 mm SL), and growth ranged from 1.65-2.00 mm/d (Wells and Rooker 2004a). Inter-annual differences in growth were present and late-season cohorts experienced the most rapid growth. In the most recent stock assessment for sub-adult and adult Gulf of Mexico greater amberjack (Turner et al. 2000, using data up to and including 1998), catch-at-length data were converted to catch-at-age data using the growth curve derived by Thompson et al. (1999). Although this growth curve represents greater amberjack caught in various fisheries and gears, only fish from Louisiana were sampled (Thompson et al. 1999). This growth model was preferred by the NMFS stock assessment analysts compared to an alternate growth model by Manooch and Potts (1997a) because the latter study only sampled fish from headboats in the Gulf of Mexico (Cummings and McClellan 2000). There are no new aging data available for sub-adult and adult greater amberjack in the Gulf since Thompson et al. (1999).

Theoretical von Bertalanffy growth curves for all greater amberjack studies from the southeastern Atlantic and Gulf of Mexico are given in Fig. 1 and Table 1. All von Bertalanffy growth curves shown were fit to back-calculated length at age except for Thompson et al. (1999), which used a 1 April birth date (which also corresponds to annulus deposition) to assign relative ages, and Harris et al. (2004), which used observed ages that are uncorrected for time of annulus deposition (i.e., they report age 0 fish as actually being 9-12 months old).

Greater amberjack may differ in size depending on sex but whether this is related to a difference in growth rates or a difference in maximum size is debatable. Thompson et al. (1999) showed no difference in growth models between males and females; however, maximum size was related to sex. Maximum size of females off Louisiana was 1441 mm FL and females accounted for 72% of fish greater than 1000 mm FL; male maximum size was 1327 mm FL. Although females were more common in Thompson et al.'s study, the sex ratio was variable by time of year and collection source. Burch (1979) reported that females grow larger than males (L_∞ = 159.7 versus 146.3 cm, respectively) using scales. Harris et al. (2004) also observed that females were larger at ages 3-9 and 11 compared to males in the southeastern U.S.

2.5 Conversion Factors

The updated TIP data and data from GulfFin can be used to estimate various conversions between different body measures of greater amberjack. Various estimated conversion are shown in the Figures 2-5 and with the associated equations describing the trends in the data given in Table 2.

2.6 Reproduction

2.6.1 Spawning

In the NW Gulf, hatch-dates of greater amberjack are protracted (Jan to May), and the majority of individuals associated with pelagic *Sargassum* were derived from spawning events in March and April (Wells and Rooker 2004b). Beasley (1993) estimated that spawning for greater amberjack in the northern Gulf of Mexico (off Louisiana) peaked in April to June, based on an increasing gonadosomatic index until June. This is similar to Burch's (1979) earlier study in South Florida, which also indicated that the maximum gonad development occurred in the spring months. Thompson et al. (1991) indicated that peak spawning of greater amberjack off Louisiana occurred in May and June, while more recent work by Harris et al. (2004) in the Florida Keys reported that the spawning season was from mid-March to mid-May. Some greater amberjack off the west coast of Florida (St. Petersburg area) may spawn as late as November (unpublished data, n=11; Alan Collins, NMFS Panama City, FL).

2.6.2 Sexual Maturity

Age and size at sexual maturity for greater amberjack in the Gulf of Mexico is not known well. Cummings and McClellan (2000) noted that maturation information reported by Burch

(1979) may not be applicable to greater amberjack in the Gulf, and suggested that maturation may have changed in the intervening decades (Burch sampled from 1977-78). Thompson et al. (1991) and unpublished data received from Thompson (pers. comm., previous stock assessment) provides the most current data available for greater amberjack in the Gulf of Mexico. Based on histological sections, Thompson estimated that female greater amberjack were all mature by age 4, 50% were mature by age 3, and 0% were mature at age 2; however, Thompson's study was not definitive because a large number of ovaries were not staged. Sexual maturity for greater amberjack in the southeastern U.S. has recently been estimated in detail by Harris et al. (2004) and it is recommended that their analysis be considered following correction of the age estimates from observed ages to ages at annulus formation.

2.6.3 Fecundity

Fecundity-at-size or fecundity-at-age data are currently lacking for greater amberjack in the Gulf of Mexico and weight at age has been used a proxy for fecundity (Cummings and McClellan 2000). Fecundity has been recently estimated for greater amberjack spawning offshore of the Florida Keys (Harris et al. 2004). Spawning frequency was estimated as approximately every 5 days over a spawning season of ~60 days (12 March through 10 May), based on histology of oocytes that either showed a migratory nucleus or hydration, as well as the occurrence of post-ovulatory follicles. A significant relationship existed between batch fecundity (BF) as a function of FL with BF=8.192*FL-6,394,879 (adjusted-r^2=0.54, n=28) and BF as a function of age (BF=458.601*Age+254,065; adjusted-r^2=0.36, n=21) (Harris et al. 2004). Since spawning females in the Harris et al. (2004) study were only sampled during March-May, which is also when the annulus in the otolith is deposited, ages for these specific females would be their ages at annulus formation, and hence the BF versus Age regression would reflect an accurate age of the fish.

Based on the lack of fecundity data for greater amberjack in the Gulf, a comparative analysis based on using female weight as a proxy for fecundity (previous assessment) versus fecundity estimates from Harris et al. (2004) may be warranted.

2.7 Stock-Recruitment Relationship

A Beverton-Holt stock recruitment relationship was examined in the most recent stock assessment of greater amberjack (RFSAP 2000) and the model did not produce a reasonable fit to the observed data because of the nearly linear relationship between estimated stock biomass and recruitment. As a result, estimates of stock biomass at MSY were overly large. Therefore, two alternative stock recruitment relationships were used by the RFSAP: 1) the hockey-stick (piece-wise linear) (Barrowman and Meyers 2000); and 2) historical mean recruitment (Turner et al. 2000). The RFSAP noted that the hockey-stick functionally resembled a Beverton-Holt curve and focused on the results using the hockey-stick relationship because of the relationship between recruitment and stock.

2.7.1 Relative Productivity and Resilience:

The classification scheme developed at the FAO SECOND TECHNICAL CONSULTATION ON THE SUITABILITY OF THE CITES CRITERIA FOR LISTING COMMERCIALLY-EXPLOITED AQUATIC SPECIES (Windhoek, Namibia, 22-25 October 2001; FAO 2001) was used to characterize the relative productivity of greater amberjack. This information is provided in Table 3. A productivity rank was assigned to each life-history characteristic (a value of 1 was assigned for low, 2 for medium, and 3 for high productivity characteristics) and ranks were averaged to produce an overall productivity score. This score was then used to prescribe a prior density function on steepness in the stock-recruitment relationship from the periodic life history strategists as summarized by Rose et al. (2001). The dominant portion of the steepness values from these analogous species range from 0.6-0.8 with 90% of the values less than 0.9. As the greater amberjack productivity score from this exercise is somewhat in the medium category, it is recommended that the prior density function on steepness for this species be lognormal with a mode of 0.7 and a CV such that there is no greater than a 10% probability of steepness values greater than 0.9.

2.8 Natural Mortality

2.8.1 YOY

Catch-curve analysis was used to estimate daily instantaneous mortality of YOY greater amberjack from 40-130 days (M = 0.0045); cumulative natural mortality for a 100 d period resulted in a cumulative mortality estimate of 36% (Wells and Rooker 2004b). Since the rate of natural mortality during the first year of life is likely to be lower the second half of the year, an additional value is required to adjust for mortality during the entire first year of life (note: mortality during the larval period will be markedly higher than the YOY estimate of mortality).

2.8.2 Sub-adult/Adult

Greater amberjack in the Gulf live to at least 15 years, based on age samples available (see Manooch and Potts 1997a and Thompson et al. 1999). Based upon this information, the method of Hoenig (1983) results in a value for M of 0.28. As this results from a sample taken from an exploited population, the value could be considered somewhat high. Based upon this information, the DW suggested using a value of M of 0.25 for baseline evaluations, and agreed with the range of M = 0.2 and 0.35 for sensitivity evaluations. These values are consistent with those applied in the previous Gulf greater amberjack assessment (Turner et al. 2000).

Due to the exploited nature of the fishery, previous studies have estimated total instantaneous mortality (Z). Manooch and Potts (1997a) reported Z for greater amberjack recruited to the headboat fishery in the Gulf; estimates were 0.68 and 0.73 for 1988 and 1993, respectively. It should be noted that most of the fish used to estimate Z were collected off Texas, and the authors also stated that their data may overestimate Z because headboat anglers are less experienced and less likely to land large amberjack compared to commercial fishermen. The same authors reported mortality of greater amberjack sampled from headboats and commercial handline vessels from the southeastern US, and estimates of Z ranged from 0.60 to 0.65 depending upon the year (Manooch and Potts 1997b).

2.9 Release Mortality

Release mortality for greater amberjack in the Gulf of Mexico is unreported. A survival study of released undersized reef fishes using observers aboard headboats and commercial handline vessels off Beaufort, NC estimated maximum acute mortality of greater amberjack as 0.09 (0.91 as survival, n=11) for the headboat fishery and 0.08 (0.92 survival, n=12) for the commercial handline fishery (unpublished data, R. Dixon, NMFS, Beaufort, NC). Acute mortality in this case was defined as the proportion of fish directly observed to float at the surface after release and therefore presumed to die. An estimate of 0.1 would therefore appear to be a minimum acute release mortality; however, actual release mortality (i.e., not directly observed as floaters) would most likely be greater. It is therefore recommended that a sensitivity analysis be done using a range of release mortalities between 0.2 and 0.5

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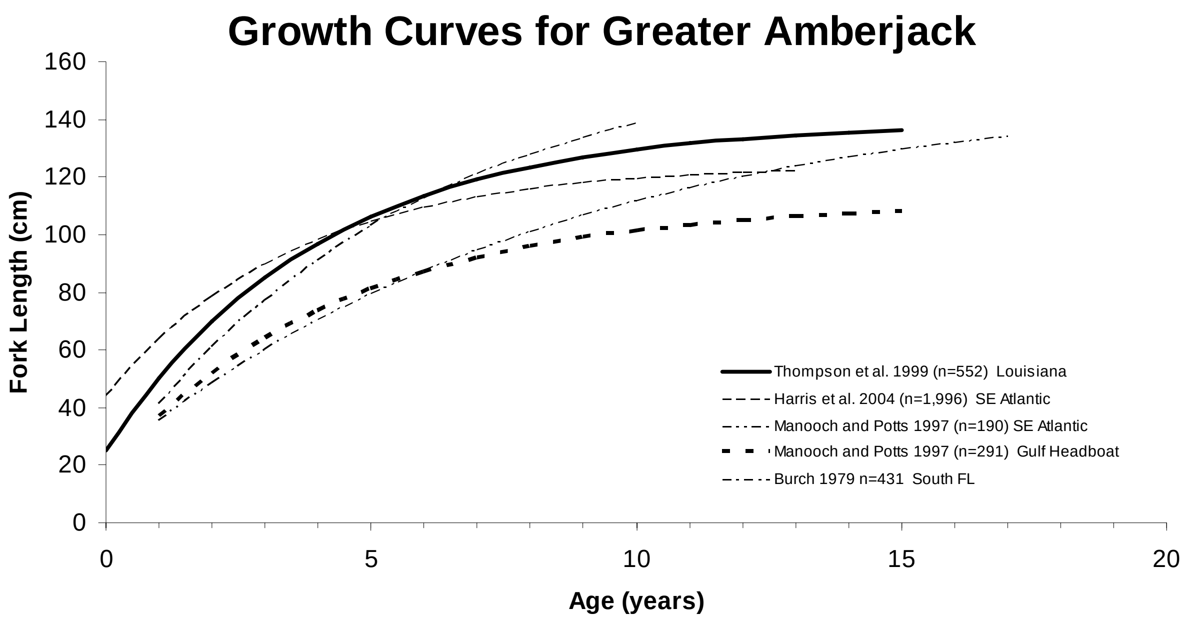


Figure 1. Theoretical von Bertalanffy growth curves for greater amberjack collected in the southeastern Atlantic and Gulf of Mexico. Growth curves were based on back-calculated length at age except for Harris et al. (2004; observed age) and Thompson et al. (1999; age relative to a birth date of 1 April).

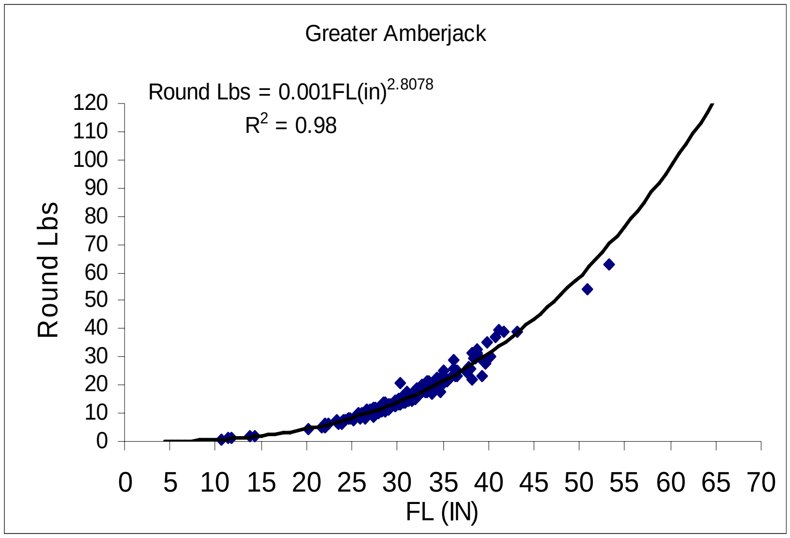


Figure 2. Combined TIP and measures from Manooch and Potts (1997b) describing the relationship between whole weight and fork length in gulf greater amberjack.

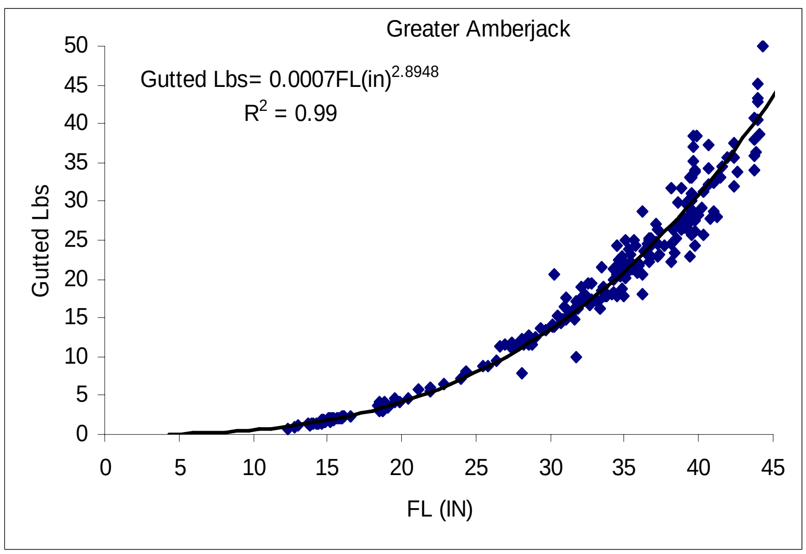


Figure 3. TIP measures describing the relationship between gutted weight and fork length in gulf greater amberjack.

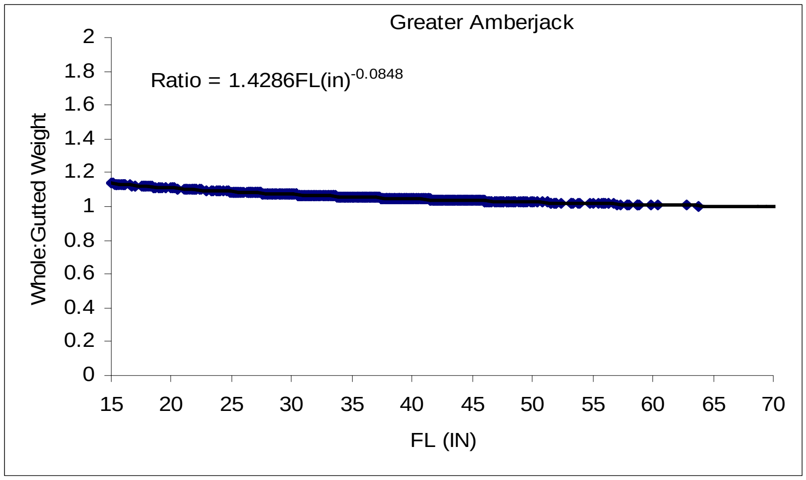


Figure 4. Ratio of whole weight to gutted weight as a function of FL in Gulf of Mexico greater amberjack.

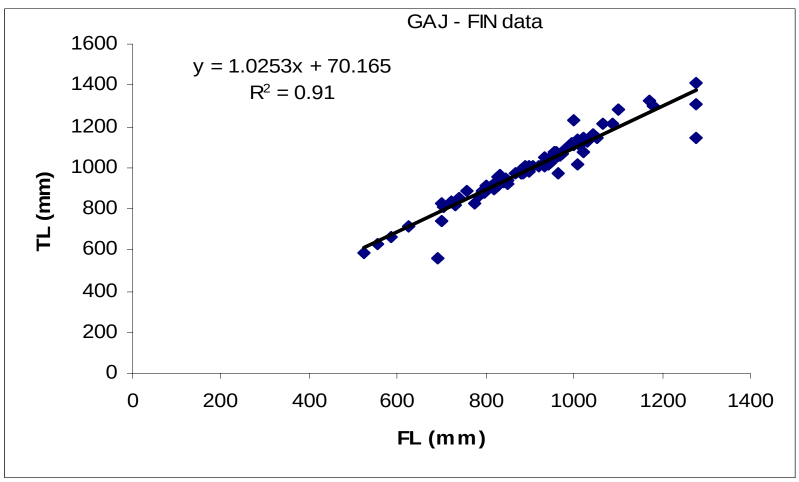


Figure 5. TL as a function of FL for Gulf of Mexico greater amberjack collected through GulfFIN..

Table 1. Theoretical von Bertalanffy growth parameters for greater amberjack. Growth curves were based on back-calculated length at age except for Harris et al. (2004; observed age) and Thompson et al. (1999; age relative to a birth date of 1 April).

Model	Area	L_{inf} (cm)	k	t_0	n
Burch (1979)	South FL	164.3	0.174	-0.653	431
Manooch and Potts (1997a)	SE Atlantic	151.4	0.119	-1.23	190
Manooch and Potts (1997b)	Gulf of Mexico	110.9	0.227	-0.791	291
Thompson et al. (1999, includes Beasley 1993)	Louisiana	138.9	0.25	-0.79	552
Harris et al. (2004)	SE Atlantic	124.15	0.28	-1.56	1,996

Table 2. Conversions of various weights and lengths for Gulf of Mexico greater amberjack. The ratio of whole weight to gutted weight was derived using regressions for round and gutted weights as a function of FL.

Conversion	Source	Model	r^2	n
Round Weight (lbs) vs. FL (in)	TIP	$Y = 0.001X^{2.8078}$	0.98	
Gutted Weight (lbs) vs. FL (in)	TIP	$Y = 0.0007X^{2.8948}$	0.99	
Whole Weight: Gutted Weight Ratio vs. FL (in)	Derived	$Y = 1.4286X^{-0.0848}$		
TL (mm) vs FL (mm)	FIN	$Y = 1.0253X + 70.165$	0.91	

Table 3. Proposed guideline indices of productivity for exploited fish species with specifics for Gulf of Mexico greater amberjack.

Parameter	Productivity			**Species**
	Low	Medium	High	**Greater Amberjack**
M	<0.2	0.2 - 0.5	>0.5	0.2, **0.25**, 0.35
K	<0.15	0.15 - 0.33	> 0.33	**0.25**
t_{mat} (years)	> 8	3.3 - 8	< 3.3	**3**
t_{max} (years)	>25	14 - 25	<14	**15**
Examples	orange roughy, many sharks	cod, hake	sardine, anchovy	**Amberjack Productivity Score = 2.25 (Medium)**

3. Commercial Fishery Statistics

3.1 Commercial Landings Collection and Statistics

3.1.1 Commercial Landings Data Collection

Commercial fishery statistics include information on landings of seafood products, fishing effort, and biological characteristics of the catch. A variety of sources of information are used to obtain these statistics.

The quantity (usually weight) and value of seafood products sold to licensed seafood dealers has been collected through various state and federal programs overtime. Landings statistics are currently collected by state fisheries agencies in Alabama, Florida, and Louisiana on each fishing trip (trip ticket programs). In Mississippi and Texas, monthly dealer reports of landings are either sent in by the dealer or collected by state and federal port agents. Prior to the implementation of trip ticket programs, landings were collected from seafood dealers each month by NMFS and state agents. Trip ticket programs generally provide information on the gear used and the fishing area. For the historical landings obtained from dealers each month, fishing gear and area were assigned by the agents on an annual basis.

At the National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC), commercial landings statistics from North Carolina through Texas from 1962 to present are maintained in a data base referred to as the Accumulated Landings System (ALS). Statistics on all seafood products except shrimp are maintained the ALS. Landings statistics prior to 1962 are maintained at NMFS Headquarters in Silver Spring, MD.

3.1.2 History and overview of landings data collection

Florida

Prior to 1986, commercial landings statistics were collected by a combination of monthly mail submissions and port agent visits. These procedures provided quantity and value, but did not provide information on gear, area or distance from shore. Because of the large number of dealers, port agents were not able to provide the gear, area and distance information for monthly data. Gear, area and distance from shore, however, are provided for annual summaries of the quantity and value and known as the Florida Annual Canvas data.

Mandatory reporting by all seafood dealers was implemented by the State of Florida in 1986. The state requires that a report (ticket) be completed and submitted to the state for every trip from which seafood was sold. Dealers are required to report the type of gear as well as the quantity (pounds) purchased for each species. Information on the area of catch can also be provided on the tickets for individual trips. As of 1986 the ALS system relies solely on the Florida trip ticket data to create the ALS landings data for all species other than shrimp.

Alabama

Data collection in Alabama prior to 2000 was voluntary and conducted by state and federal port agents through monthly dealer and dock visits. Total landings summaries in weight (pounds) and value for species and market category were recorded. Port agents provided information on gear and fishing area from their knowledge of the fisheries and interaction with fishermen and dealers. As of mid- 2000 the State of Alabama required fishermen and dealers to report all commercial landings data through a trip ticket system. As of 2001 the ALS system relies solely on the Alabama trip ticket data to create the ALS landings data for Alabama.

Mississippi

Data collection in Mississippi is voluntary and conducted by state and federal port agents that visit dealers and docks monthly. Summaries of total landings (pounds) and value for species and market category are recorded. Port agents provide information on gear and fishing area from their knowledge of the fisheries and interaction with fishermen and dealers.

Louisiana

Prior to 1993, commercial landings statistics were collected in Louisiana by federal port agents following the traditional procedures established by the NMFS. Monthly summaries of the quantity and value were collected from each dealer in the state. Information on gear, area and distance from shore were added by individual port agents.

Beginning in January 1993, the Louisiana Department of Wildlife and Fisheries began enforcing mandatory reporting requirements. Dealers are licensed by the state and are required to submit monthly summaries of purchases of individual species and market categories. With the implementation of the state statute, federal port agents did not participate in the collection of commercial fishery statistics.

Information on gear, area, and distance from shore has not been added to the landings statistics for 1992-1999. In 1998 the State of Louisiana required fishermen and dealers to report all commercial landings data through a trip ticket system. This data contains detailed landings information by trip including gear, area of capture and vessel information. As of 2000 the ALS system relies solely on the Louisiana trip ticket data to create the ALS landings data for Louisiana.

Texas

Texas has mandatory reporting requirements for state licensed dealers Dealer's are required to submit monthly summaries of the quantities (pounds) and value of the purchases that were made for individual species or market categories. Information on gear, area and distance from shore are added to the state data by SEFSC personnel.

3.1.3 Inter-state Transport

Often seafood products are landed in one state and transported by the purchasing dealer to another state; such landings may be recorded both in the state of landing and where the purchasing dealer is located. State and SEFSC personnel track these landings to assure that double counting does not occur and assign them to the state of landing.

3.2 Commercial Landings Data Base Organization and Data Handling

The data are organized into three primary components: historical annual data (1962-1976), monthly data (1977-present) and Florida annual data (1976-1996). The monthly 1977-present data for Florida does not have gear or fishing area for the period 1977-1996, while the annual Florida data (1976-1996) has gear and fishing area information which was provided by port agents based on their knowledge of the fisheries.

3.2.1 Accumulated Landings System (ALS)

1962-1976 Annual Landings by Year, State, County, Area, Gear, and Species for Florida West Coast through Texas.

1977-present Monthly Landings by Year, Month, State, County, Area, Gear, and Species for Florida West Coast through Texas. Data reported from some states do not have information on the area and gear of capture particularly during the 1990s.

Historically, the state and county recorded in the ALS indicates where the marine resource was landed. However, in recent years (with the advent of trip tickets as the source of the landings data) in some states, the state and county reflect the location of the main office of the purchasing dealer.

Fishing takes place in many different regions, including United States waters of the Gulf of Mexico and South Atlantic as well as in foreign waters. For the years 1976-present the area codes assigned to those regions are:

1.- South Atlantic catch in the ALS is considered all area codes 0010, 0019, and 7xxx and higher.

2.- Foreign Waters are area codes 022x- 060x and 186x.

3.- In order to define the area of capture for Florida West coast for years 1976-1996 previous assessments use the Florida Annual Canvass data set.

(Note: The State of Florida implemented their trip ticket program in 1985 with more complete reporting starting in 1986. This data set was to contain area of capture information, but due to the nature of a public reporting, some fields on the ticket (such as area) may not have been reported consistently or completely in the early implementation years.)

3.2.2 Florida Annual Canvas Landings

Florida Annual Canvass 1976-1996 considerations:

1976-1996 Florida Annual Canvass for area and gear estimates by county which are not in the Monthly Landings for Florida West Coast.

Florida Annual Data files from 1976 – 1996 represent annual landings by county based on dealer reports which are broken out on a percentage estimate by species, gear, area of capture, and distance from shore. These estimates are submitted by Port agents assigned responsibility for the particular county and from interviews and discussions with dealers and fishermen collected through out the year. The estimates are processed against the annual landings totals by county on a percentage basis to create the estimated proportions of catch by the gear, area and distance from shore.(The sum of percentages for a given Year, State, County, Species combination will equal 100.)

1976-1985 data are ‘as landed’ weight; amberjack and vermilion snapper were normally landed gutted and gray triggerfish landed whole. Gutted weight to whole weight conversion factors are 1.04 for amberjack and 1.11 for vermilion. All Area codes 0010, 0019, and 7xxx and higher are considered South Atlantic catch

State 00 and Grid 0000 in the data set are ‘marine product landed elsewhere’ and trucked into the State of Florida and are considered duplicated elsewhere because they are theoretically reported back to the state of landing and are not included in the Florida totals.

State 12 is in the data set which represent Florida interior counties which were landed on Florida East Coast and not included in the Gulf catches.

Coding considerations on greater amberjack ('1812') vs. Amberjacks ('0030'): 1. Florida - Data were edited according to FL species code on 10/8/1996 to make FL species code 103 (Greater Amberjack) = NMFS Species Code 1812 (Greater Amberjack). These edits went as far back as I could reference the 103 code in the computer data which was to 1992.

1. Florida - Florida trip ticket data distinguishes greater amberjack (Florida species code 103) starting in 1992. Prior to that all amberjack were considered 'unclassified amberjack' (NMFS species code 0030)
2. Florida - The State of Florida also submits greater amberjack data converted from 'cores' as code 471. These were left as code 0030 to differentiate them from the gutted greater amberjack.
3. Texas - The species code cross-reference table for Texas was updated in early April of 2001. All data loaded (re-loaded) after that was referenced to the '1812' code instead of the '0030' code previously used. 1994 and forward were updated
4. Louisiana - From 2000 on the data are from the State of Louisiana Trip Ticket System and the codes are specifically referenced.

Assignment of gear and area of capture 1990-present

Gear and fishing area designations in the landings data base are provided by various sources including port agents (annual and/or monthly landing reports), dealers (some trip ticket reports) and permit applications (some trip ticket reports, used only for gear). Not all states required reporting of area and gear when trip ticket programs were initiated. A logbook system was implemented in 1990 that requires fishermen to record gear and area as well as catch and effort. The working group recommended that landings for 1990 onward be classified by gear and area using year- and state-specific information from logbooks.

3.3 Commercial Landings

3.3.1 Commercial landings by State

Commercial landings in pounds by state and year are shown in Table 3.1. Since greater amberjack could be landed in several categories, landings are shown as reported for “greater amberjack”, “unclassified amberjack” and as “all jacks” combined.

3.3.2 Commercial Landings Species Composition

Species composition is a concern with amberjack. Greater amberjack landings could be recorded under the general code for amberjack (0030) as well as the specific code for greater amberjack (1812). Furthermore, It is believed of several species, including greater amberjack (Seriola dumerili), lesser amberjack (Seriola fasciata), almaco jack (Seriola rivoliana), and banded rudder fish (Seriola zonata), are reported as “unclassified amberjack” (0030).

Document SEDAR9-DW-19 presented three methods of calculating the species composition of unclassified amberjack:

Method 1 -the average percentage of landings by each Gulf state of the four species from recent years was used to estimate the percent of landings in the 0030 category that were greater amberjack.

Method 2 -the percentages were derived from the data recorded in the TIP interview program.

Method 3 -the TIP interview program records species composition by the data collectors which compares the landings recorded by the dealer.

There are potential problems with each method such as species identification errors by dealers (Method 1) non-random samples or selective sampling (Method 2), the limited number of samples (Method 3). Of the three methods, Method 1 was considered by the committee as being the most reliable estimate given the information presented in SEDAR9-DW-19. The Method 1 percentages by state were to be used for all unclassified amberjack (species code 0030) as well as all jacks combined to give estimates of the actual catch of greater amberjack. An additional consideration was for the Texas landings which were reported as 100% unclassified amberjack (0030) until 1992 and then as 100% greater amberjack (1812) from 1993 to present; the committee considered it likely that those landings were a mixture of jacks species. To calculate the amount of Texas landings which might have been greater amberjack the committee decided to assume the Louisiana percentages of greater amberjack in the catch of unclassified jacks. The break down by state for greater amberjack are as follows:

Florida ------ x 89.98%

Alabama----- x 82.76%

Mississippi--- x 78.40%

Louisiana---- x 82.63%

Texas---------- x 82.63%(Reference Louisiana)

3.3.3 Commercial Landings for Assessment by State

Commercial landings by state are shown in Table 3.2 and Figure 3.1.

The largest quantities of greater amberjack have been landed in Florida followed by Louisiana. The other states have accounted for comparably smaller quantities.

3.3.4 Commercial Landings for Assessment by Gear and Area

Table 3.3 and Figure 3.2 show commercial landings by gear and region. For landings from 1990-2004 gear and statistical area were assigned from log books by year and state. The eastern and western regions were separated at approximately the Mississippi River with east including statistical areas 1-12 and the west including areas 13-21. Longline included vertical longline and handline included all other gears.

3.4 Bycatch

3.4.1 Commercial Finfish Fishery Discards

Estimates of greater amberjack, vermilion snapper, and gray triggerfish commercial discards were presented in SEDAR9-DW-17. A 20% sample of the vessels with a Gulf of Mexico reef fish, king mackerel, Spanish mackerel or shark permit were selected to report discards. Data were available for the period August, 2001 through December, 2004. There were more than 800 trips on which greater amberjack were reported, about 300 with vermilion snapper and only about 50 with gray triggerfish. For greater amberjack and vermilion snapper generalized linear model (GLM) analyses were used to determine those variables with significant effects on the proportion of trips reporting discards of the species of interest and on the catch rates (in number of fish) of trips reporting discards; there were not sufficient data to conduct these analyses for gray triggerfish. Multiple factors were found to influence discard rates by species, but sampling period (August-December and January-July each year) and the number of hooks fished per line were consistently identified as the most important factors influencing discard rates. For the greater amberjack analyses the greater amberjack season (open/closed) was considered as a factor, however the models did not identify amberjack season as a significant factor.

The estimated number of discards was calculated by multiplying the number of trips in a stratum by the average catch rate in the stratum with the strata defined by the results of the general linear models and by the amount of available data (a minimum of 30 observations per stratum). Estimates were made only for the handline fishery (included electric reel and hydraulic 'bandit rig' gear) due to small sample sizes of discards reported from other gears. Discard estimates for both greater amberjack and gray triggerfish were made for each of the seven sampling periods (each about a half year) and for species specific levels of hooks per handline. There were very few observations of gray triggerfish discards so estimates were made only for each sampling period. Additionally estimates were made calculated for years before the discard program was initiated. These were made using the 2001-2004 average discard rates for each stratum (half year and hooks per line for greater amberjack and vermilion snapper, half year for gray triggerfish). These pre-July 2001 estimates were made only for periods when the size limit was the same as the size limit in 2001-2004.

Estimated discards are summarized in Table 3.4. Estimates of greater amberjack were made starting in 1993, the first year that all vessels in the Gulf of Mexico reef fish logbook program were required to provide logbook reports. The time series for vermilion snapper and gray triggerfish were truncated at the point when size limit changes occurred in the regulation in each species (September 14, 1997 for vermilion snapper; November 24, 1999 for gray triggerfish); therefore estimates for vermilion were made for part of 1997 and 1998-2004 and for gray triggerfish for 2000-2004. The committee reviewed the discard estimates of vermilion snapper in detail because of the magnitude of the estimates for 2002 (SEDAR9-DW-17). That review found no obvious difference in the frequency of trips reporting high numbers of discards during 2002 and showed patterns of frequency distributions which were similar to adjacent sampling periods throughout the years covered by the survey. Similarly, patterns of the number of estimated greater amberjack discards per trip did not appear to greatly differ among sampling periods (Figures 3.3 and 3.4).

The committee reviewed existing data which might be useful in estimating the average weight of discards. The committee suggested that the average size of discards might be estimated from information on the composition before and after minimum sized restrictions were imposed. A review of the gray triggerfish data before and after 2000 indicated no differences in the size composition with very few fish below the minimum size; therefore the committee suggested that the weight associated with the minimum size might be used.

3.4.2 Shrimp Fishery Bycatch

The Bayesian techniques used to estimate shrimp fleet bycatch for red snapper during SEDAR7 (SEDAR7-DW-3 and -54) were applied to vermilion snapper, gray triggerfish, and greater amberjack in SEDAR9-DW-26. Results for all three species do not appear to be as reliable as the results for red snapper, probably in large part due to their lower abundances, but also due to reasons unique for each species. Greater amberjack were not on the list for work-up under the evaluation protocol observer trips. Their abundance in trawls is so low that reliable annual estimates may not have been possible even if they had been included. It was not possible to obtain an estimate for bycatch with BRDs for triggerfish and amberjack with the Bayesian model. Because of doubts about the reliability of the annual estimates for these species from the SEDAR7 model, a delta distribution-based version of the Bayesian approach was introduced, and a fully mixed effects model ("Model 3") considered but not ultimately not used for red snapper was resurrected. There is some evidence that the delta implementation may be underestimating bycatch, and the frequencies of occurrence of for vermilion and greater amberjack are so low that one has to be suspicious about results of the CPUE portion of the delta distribution analysis. Model 3 central tendencies tended to be intermediate between the SEDAR7 and delta results, but the uncertainty estimates were enormous. Table 3.5 provides some summary statistics of the performances of the models when applied to the SEDAR9 species, and compare them with the more successful situation for red snapper. In view of the unrealistic results that cropped up for all three SEDAR9 species, the DW recommends setting aside the estimates of inter-annual variation in favor of estimating an overall average, and then constructing wide uncertainty intervals to incorporate estimation error within models, variation among model choices, and inter-annual variation. Working at a resolution below an annual time step is not recommended. The simplest statistic from SEDAR9-DW-26 (average CPUE in all observer trips times an approximate recent effort level) is recommended as the estimate of central tendency. It was not possible to partition the bycatch estimates by age as per SEDAR7-AW-20, as only a handful of fish for these 3 species have been measured across all the observer studies.

There are a number of options to be considered for providing estimates of central tendency and variation. These options will be developed, along with further exploration of why the SEDAR7 model performed as poorly as it did for these less abundant species. Results will be reported in a paper for the Assessment Workshop.

3.5 Size composition

The working group reviewed SEDAR9-DW-09 which reported on the numbers of samples available by year and state and by year and gear. The committee was concerned about the low numbers of greater amberjack measured in all years (Table3.6) and that samples were primarily limited to one state before 1990 (Louisiana) and after 1997 (Florida). Comparison of the size distributions from the two states from 1990-1997 indicated few differences (Figure 3.5), suggesting that it might be reasonable to use samples from one state as indicators of the size from other states. SEDAR9-DW-09 showed that longlines tended to catch larger fish than handlines; therefore the committee recommended that gears be treated separately in developing catch at size even though the numbers of fish measured from the longline fishery was quite low.

Table 3.1 Commercial landings (pounds whole weight) of greater amberjack, unclassified amberjack and unclassified jacks from all waters (Gulf, Atlantic and Caribbean).

	unclassified amberjack							unclassified jacks							greater amberjack							
	TX	LA	MS	AL	wF	eF	subtotal	TX	LA	MS	AL	wF	eF	subtotal	TX	LA	MS	AL	wF	eF	subtotal	total
1963					14,664	6,032	20,696															20,696
1964					10,192	7,696	17,888															17,888
1965					8,632	8,736	17,368															17,368
1966					9,464	21,736	31,200															31,200
1967					34,944	23,192	58,136															58,136
1968					14,144	26,624	40,768															40,768
1969					83,512	15,808	99,320															99,320
1970					20,592	40,248	60,840															60,840
1971					46,592	22,776	69,368															69,368
1972					46,280	11,856	58,136															58,136
1973					40,040	38,064	78,104															78,104
1974					59,800	36,504	96,304															96,304
1975					94,536	56,056	150,592															150,592
1976					99,424	68,744	168,168															168,168
1977					135,901	66,330	202,231															202,231
1978					172,931	39,063	211,995															211,995
1979					194,208	32,973	227,181															227,181
1980					211,947	33,178	245,125															245,125
1981					276,399	36,717	313,116															313,116
1982			4,950		339,660	44,859	389,469															389,469
1983		452	500	2,909	374,541	38,869	417,271															417,271
1984	13,901	364	9,336	19,279	650,644	90,077	783,601															783,601
1985	48,237	96,206	36,758	42,733	693,793	95,482	1,013,209															1,013,209
1986	119,796	314,057	67,403	61,949	881,014	239,367	1,683,586															1,683,586
1987	105,428	380,847	47,508	30,668	1,621,151	855,569	3,041,171															3,041,171
1988	181,677	710,752	40,598	35,951	1,889,651	637,844	3,496,473															3,496,473
1989	139,279	606,955	53,120	28,849	1,778,801	706,259	3,313,263															3,313,263
1990	72,511	315,395	22,535	15,206	1,648,478	690,235	2,764,360															2,764,360
1991	28,472	196,923	20,204	2,194	1,757,338	811,013	2,816,144															2,816,144
1992	170,026	406,802	16,909	21,432	128,082	407	743,658												1,799,601	976,326	2,775,927	3,519,585
1993	184,175	486,153	1,378	7,657	401,164	0	1,080,527										14,949		1,269,895	776,302	2,061,146	3,141,673
1994		351,935	275	5,824	365,340	1,487	724,861								102,696		5,987		1,061,659	965,624	2,135,966	2,860,827
1995		302,778	2,157	2,704	520,912	1,741	830,292					52,474	79,764	132,238	152,232		4,100		852,258	761,109	1,769,699	2,732,229
1996		310,219	2,467	11,922	302,689	7,947	635,244					55,274	100,783	156,057	159,773		24,379		898,508	657,099	1,739,759	2,531,060
1997		262,423	546	3,274	116,083	11,275	393,601					98,426	73,614	172,040	191,933		30,878		863,384	552,975	1,639,170	2,204,811
1998		122,237	894	1,932	4,631	4,401	134,095					98,022	61,906	159,928	139,511		8,606		774,110	519,641	1,441,868	1,735,891
1999		188,420	1,286	3,227	405	1,842	195,180					96,553	36,166	132,719	83,503		5,888		794,040	321,526	1,204,957	1,532,856
2000			606	7,668	4,441	76	12,791					103,271	19,106	122,377	111,526	205,796	8,517		742,835	362,189	1,430,863	1,566,031
2001			447	8,680	4,057	0	13,184					56,583	18,988	75,571	56,878	217,314	4,689	827	731,395	231,775	1,242,878	1,331,633
2002			3,242	2,067	1,379	0	6,688					35,661	24,854	60,515	70,671	260,872	2,972	3,245	736,399	260,575	1,334,734	1,401,937
2003			1,625	7,601	63	0	9,289					41,133	10,754	51,887	74,146	320,082	2,428	6,939	789,299	225,646	1,418,540	1,479,716
2004			1,902	3,503	7,234	0	12,639				8,659	40,310	7,123	56,092	38,122	406,521	1,991	3,634	957,673	210,098	1,618,039	1,686,770

Table 3.2. Commercial landings (pounds whole weight) considered to be greater amberjack for assessment (after adjustment for the fractions of amberjack unclassified and jack combined which were considered to be greater amberjack) from Gulf of Mexico waters.

year	TX	LA	MS	AL	wF	eF	total
1963					8,516		8,516
1964					6,363		6,363
1965					5,240		5,240
1966					7,393	187	7,580
1967					29,197		29,197
1968					11,510	1,404	12,914
1969					72,898		72,898
1970					13,663		13,663
1971					38,461		38,461
1972					41,643		41,643
1973					28,261		28,261
1974					41,736		41,736
1975					78,139		78,139
1976					86,467		86,467
1977					119,870		119,870
1978					150,672		150,672
1979					151,462		151,462
1980					178,386		178,386
1981					235,116		235,116
1982			3,881		219,629		223,509
1983		373	392	2,407	275,631		278,804
1984	11,486	301	7,319	15,955	490,721		525,783
1985	39,858	79,495	28,818	35,366	569,899		753,437
1986	98,987	259,505	52,844	51,269	637,501		1,100,107
1987	87,115	314,694	36,294	25,381	1,074,068		1,537,551
1988	150,120	587,294	31,721	29,753	1,232,092		2,030,980
1989	115,086	501,527	41,646	23,875	1,249,116	770	1,932,021
1990	59,626	260,611	17,667	12,584	859,484	72	1,210,045
1991	23,526	162,717	15,840	1,816	1,171,280		1,375,180
1992	139,850	336,140	13,257	17,737	484,058	113	991,156
1993	151,129	401,708	16,029	6,337	994,182	225	1,569,611
1994	102,117	290,804	6,203	4,820	866,009		1,269,952
1995	151,466	250,185	5,791	2,238	848,882	498	1,259,060
1996	156,859	256,141	26,313	9,867	815,723	1,929	1,266,832
1997	189,993	216,840	31,306	2,710	672,204	1,703	1,114,756
1998	139,371	100,956	9,307	1,599	446,050	1,398	698,681
1999	83,429	155,691	6,896	2,671	525,784	718	775,190
2000	111,114	205,796	8,992	6,346	588,980	567	921,795
2001	56,878	217,314	5,039	8,011	443,431	2,162	732,835
2002	68,807	260,872	5,514	4,956	446,319	3,936	790,403
2003	63,311	320,082	3,702	13,230	598,472	355	999,152
2004	32,982	406,521	3,482	13,699	491,080	7,023	954,787

Table 3.3 Commercial landings of greater amberjack by gear and region in pounds whole weight.

	handline+		longline		
	west US Gulf	east US Gulf	west US Gulf	east US Gulf	total
1963	2,714	5,802			8,516
1964	2,339	4,024			6,363
1965	2,059	3,182			5,240
1966	1,872	5,708			7,580
1967	10,294	18,903			29,197
1968	2,807	10,107			12,914
1969	31,349	41,549			72,898
1970	6,457	7,206			13,663
1971	12,914	25,547			38,461
1972	3,088	38,555			41,643
1973	3,650	24,611			28,261
1974	8,516	33,221			41,736
1975	21,991	56,148			78,139
1976	21,055	65,412			86,467
1977	23,479	96,391			119,870
1978	30,119	120,553			150,672
1979	52,352	96,396	2,714		151,462
1980	54,656	118,977	2,980	1,774	178,386
1981	65,322	147,344	9,054	13,396	235,116
1982	65,994	118,410	10,172	28,934	223,509
1983	72,960	160,272	16,628	28,943	278,804
1984	80,224	384,942	9,739	50,877	525,783
1985	218,757	426,450	41,357	66,873	753,437
1986	371,853	531,692	93,406	103,156	1,100,107
1987	414,997	873,098	83,066	166,390	1,537,551
1988	759,887	949,540	134,729	186,824	2,030,980
1989	668,829	967,284	103,871	192,037	1,932,021
1990	352,719	732,731	15,840	108,755	1,210,045
1991	186,117	1,183,016	4,536	1,511	1,375,180
1992	466,553	474,278	27,208	23,116	991,156
1993	584,267	905,340	29,276	50,727	1,569,611
1994	393,146	808,119	18,980	49,708	1,269,952
1995	384,616	792,594	34,264	47,586	1,259,060
1996	462,020	748,010	19,229	37,572	1,266,832
1997	439,472	615,874	12,688	46,722	1,114,756
1998	269,653	374,174	7,784	47,070	698,681
1999	242,238	472,515	16,741	43,695	775,190
2000	334,603	516,700	14,052	56,440	921,795
2001	287,774	397,807	9,282	37,971	732,835
2002	322,003	390,629	12,020	65,752	790,403
2003	391,248	482,389	15,887	109,628	999,152
2004	427,481	444,864	12,528	69,913	954,787

Table 3.4 Annual estimates of greater amberjack total discards in numbers of fish for the Gulf of Mexico handline fishery

Year	Estimate number of discards
1993	216,602
1994	232,352
1995	220,913
1996	204,475
1997	210,330
1998	219,424
1999	232,554
2000	237,460
2001	197,579
2002	139,632
2003	283,624
2004	234,794

Table 3.5. Summary of levels and ranges for shrimp fleet bycatch estimates for the SEDAR9 species from SEDAR9-DW-26, compared with similar analyses for red snapper, and some supporting statistics.

	Vermilion Snapper	Gray Triggerfish	Greater Amberjack	Red Snapper
average CPUE x approx effort	7.7M	3.8M	1.9k	27.6M
SEDAR7 model results				
median of annual medians	36M	8.3M	140k	26.3M
range of annual medians	530x	130x	88x	15x
range of annual 95% ci ranges	18x-1200x	4.9x-67x	18x-100x	1.7x-29x
Delta model results				
median of annuals	1.6M	2.2m	24k	13M
range of annual medians	160x	140x	78x	6x
range of annual 95% ci ranges	2.5x-700x	3.9x-360x	53x-1100x	1.4x-6.7x
Model 3 results				
median of annuals	3.8M	1.7M	73k	14M
range of annual medians	93x	160x	70x	19x
range of annual 95% ci ranges	23000x-38000x	810x-1300x	660x-1200x	190x-270x
frequency of occurrence in C	4%	9%	0.07%	43%
frequency of occurrence in R	2%	8%	0.50%	30%
frequency of occurrence in B	5%	0	0	55%
number of stations				
C	8460	2863	2866	9943
R	26487	26983	26487	26486
B	4920	402	402	8130

C refers to observer data for commercial shrimp tows without BRDs
B refers to observer data for commercial shrimp tows with BRDs
R refers to research vessel (Oregon II) tows

Table 3.6. Number of greater amberjack sampled from commercial landings by state and year.

Year	TX	LA	MS	AL	FL	Total
1984		146				146
1985		260				260
1986		124				124
1987		37				37
1988		52			1	66
1989		196			14	210
1990	13	259			355	627
1991		225			234	459
1992	104	488			347	939
1993	59	223	23		447	752
1994	17	326	6		653	1,002
1995	22	247			472	741
1996	37	185			321	543
1997	9	130			455	594
1998	1	1	2		602	606
1999	3	6	14		813	836
2000			1		822	823
2001		4			441	445
2002		24	3		763	790
2003		19	1	62	497	579
2004	1	21		8	288	318
Total	266	2,973	50	70	7,538	10,897

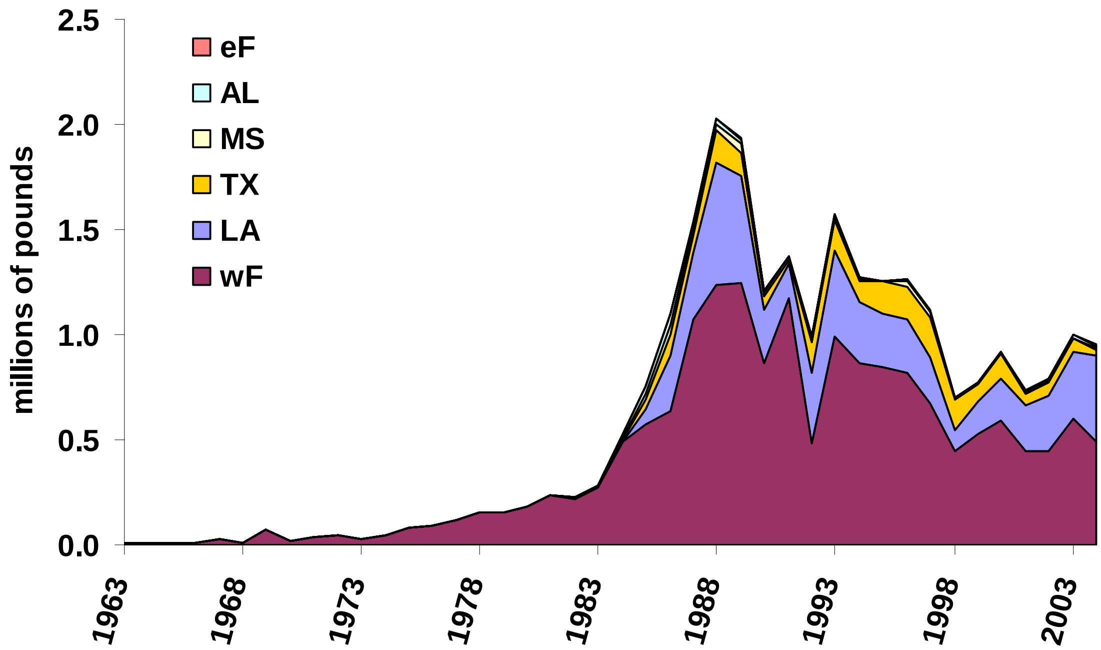


Figure 3.1. Commercial landings of greater amberjack by state from 1962-2004.

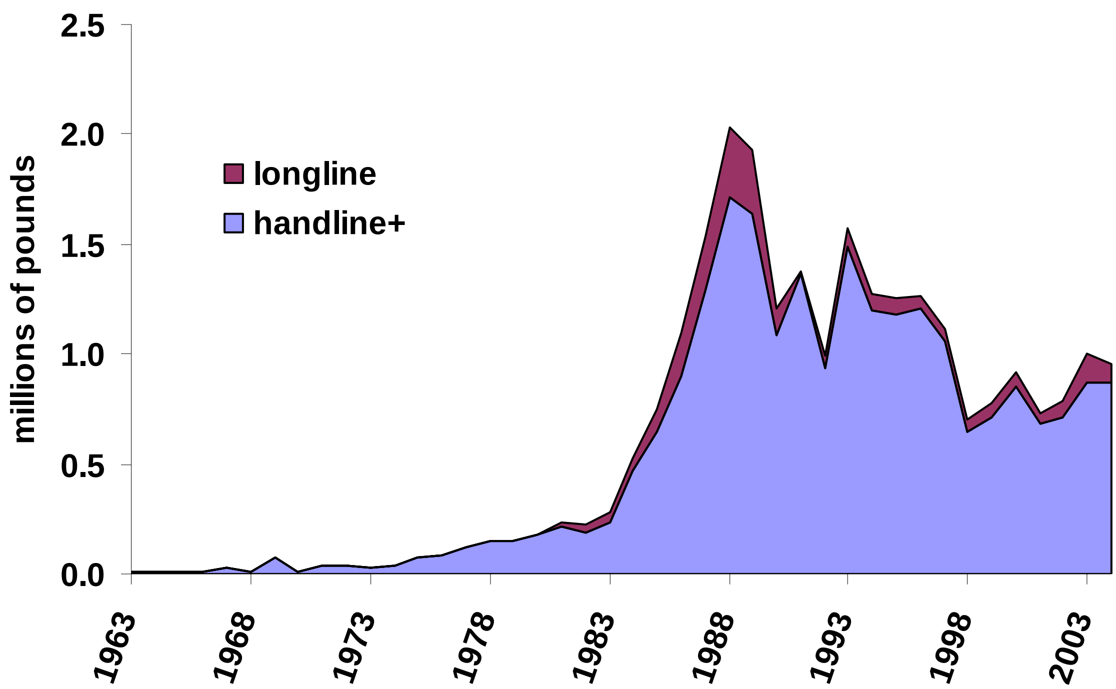


Figure 3.2. Commercial landings of greater amberjack by gear

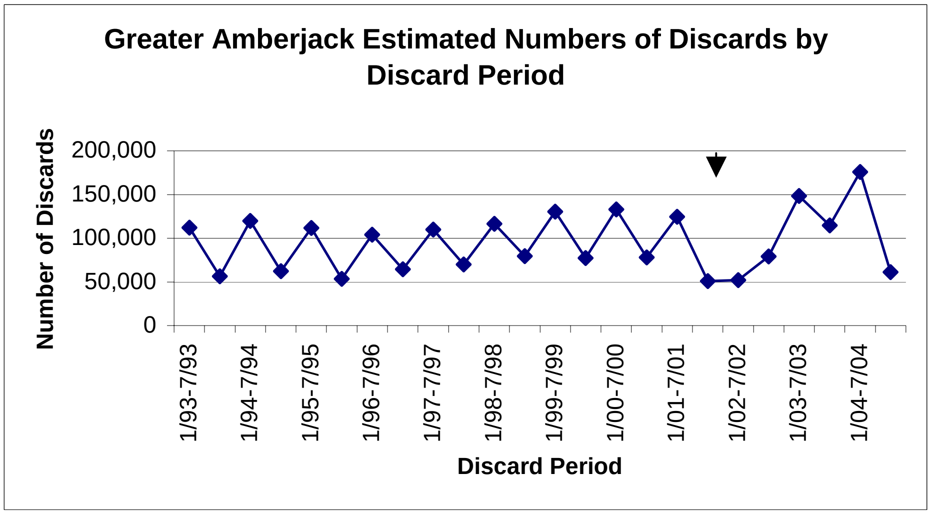


Figure 3.3. Estimated numbers of greater amberjack discards by discard period. Arrow indicates the beginning of the discard reporting program.

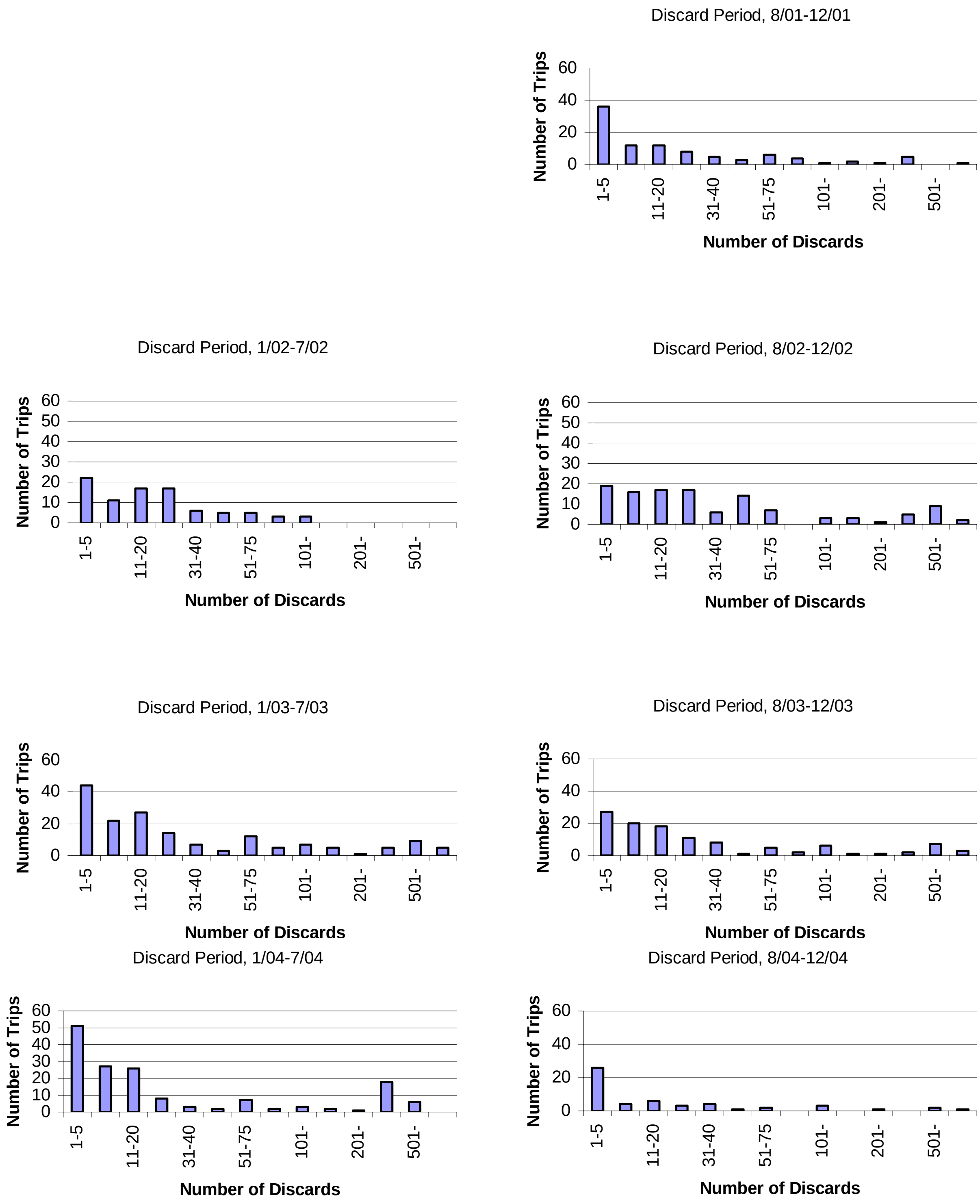
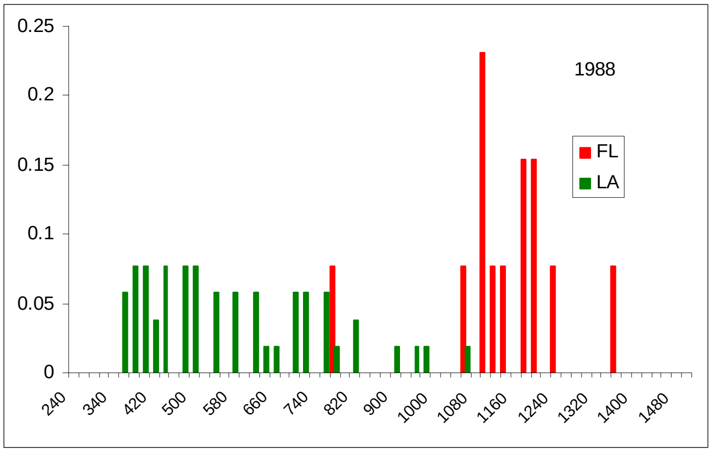
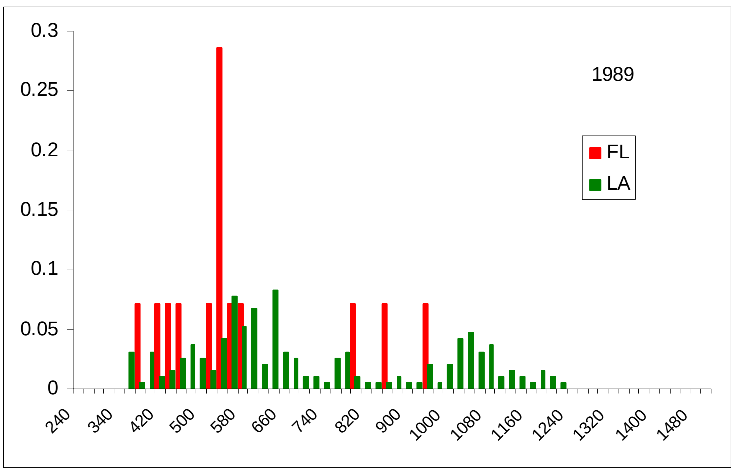
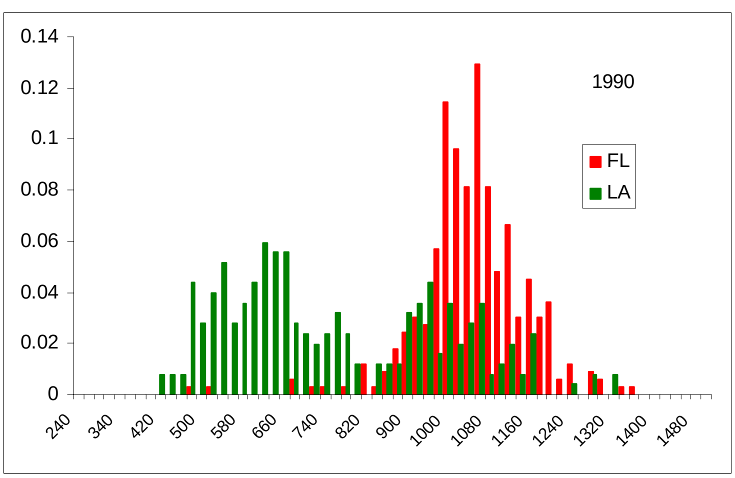


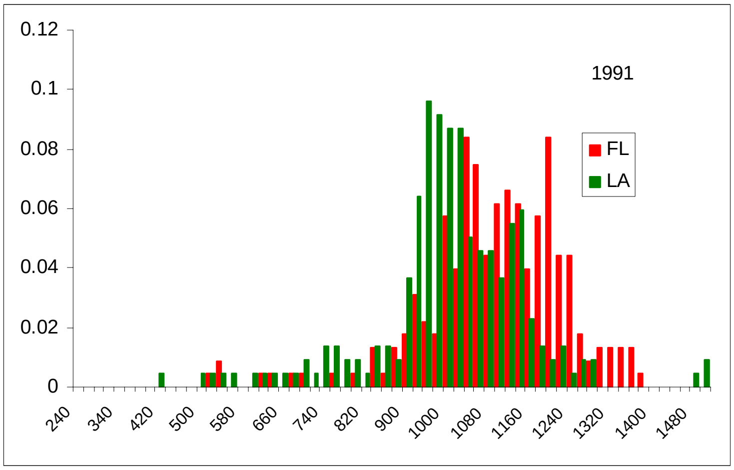
Figure 3.4 . Frequency of greater amberjack trips that reported discards by number of fish discarded and discard period.

Figure 3.5. Relative size frequency of greater amberjack from TIP samples by state from 1988-1998









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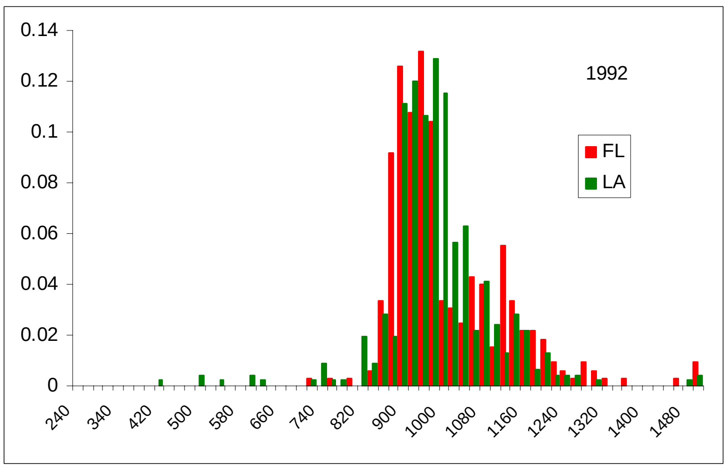

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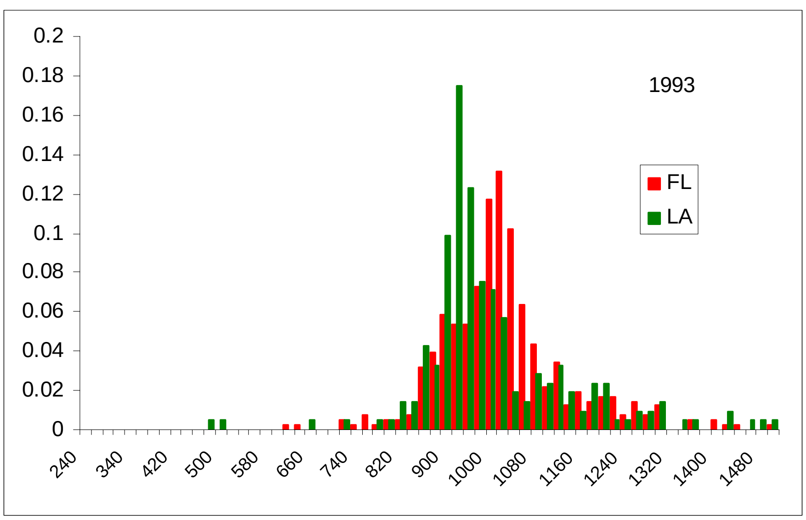

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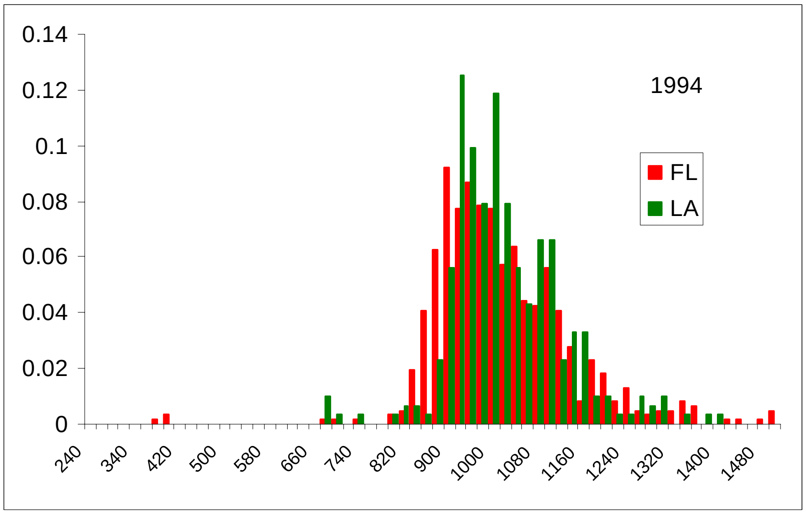
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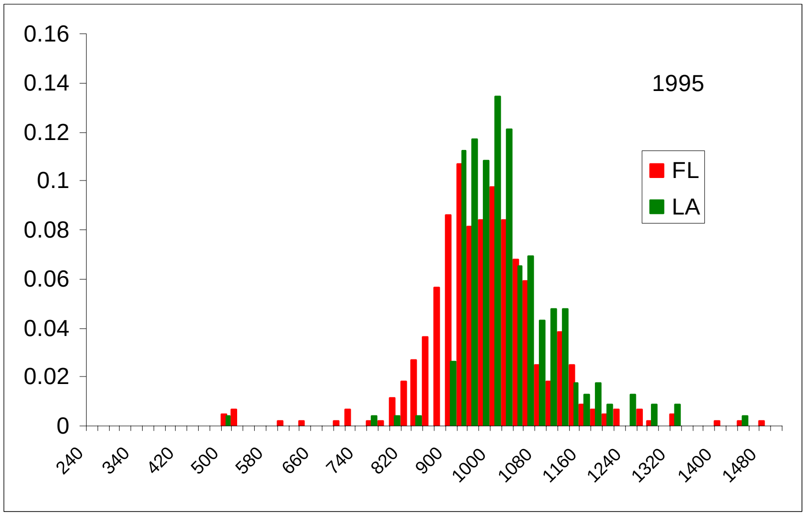
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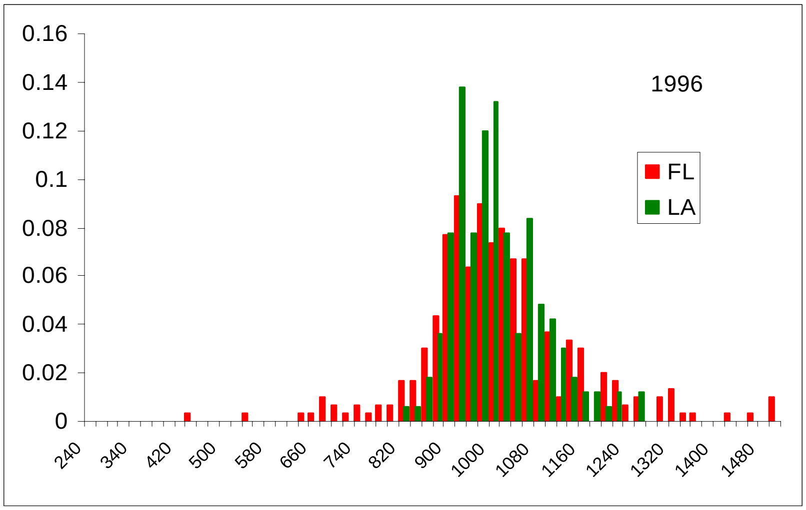
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4. Recreational Fishery Statistics

The recreational fishery statistics for greater amberjack are collected by three separate surveys: Marine Recreational Fishing Statistical Survey (MRFSS), Texas Parks and Wildlife Department (TPW) and the NMFS Headboat Survey (HB). MRFSS has captured statistics on shore based, charter boat and private/rental boat fishing and provided estimated catch for each one of these modes since 1981 from Florida through Louisiana. MRFSS included headboats in the survey from 1981-1985 and provided estimated catches for the combined mode headboat-charterboat for that period. The HB survey began in 1986 extending from the west coast of Florida through Texas. TPW has collected recreational fishing statistics from 1981-1985, and for all fishing modes except headboats in the state of Texas since 1986.

4.1 SIZE SAMPLES

MRFSS Sampling Adequacy

Document SEDAR9-DW-08 provided a summary of the number of length samples available from each survey/mode. The group had a major concern with the number of fish intercepted to obtain length samples because they are generally too low to characterize the recreational fishery (see document SEDAR9-DW-08). Many of the years have less than 100 length samples in a year across fishing modes (Table 1). MRFSS Sampling intensity by mode and across years ranged from 0.01% to 4.78%. Charter and private boat modes combined had lower sample sizes than headboat. Because charter boats catch a different size range of fish compared to the private boat fishing mode, length samples from the headboat fishery can not be used to characterize the catches of the private and charterboat modes.

Recommendation: the group did not feel that the number of length samples should be combined across modes or years to fill missing cells, because any change in population and size selectivity of the different fishing modes would be masked. In addition, the low number of length samples might not be enough to characterize the landings from some modes during certain years. Thus, we suggest not using a model that requires catch-at-age matrixes (e.g., VPA) because of the high degree of uncertainty associated with estimation of catch-at-length using low numbers of size samples.

Headboat length sample adequacy (Tables 2a and b)?

DW recommendation: Generally in most areas, as defined by the HB, there is adequate number of samples to characterize the headboat fishery, except in southwest and central Florida. The group felt that those samples could be combined with the NW FL and AL samples by year to increase the sample size (Tables 5a-b).

4.2 LANDINGS

4.2.1 MRFSS and TPW

Estimated greater amberjack landings by MRFSS and TPW are shown in Tables 3 and 4, respectively. The Recreational Statistics working group expressed concern over the accuracy of the MRFSS data for the reef fish species. The group agrees that the recreational fishery landings for these species contribute a large proportion of the overall landings. The group's concern centers on the low number of intercepted fish that is used in conjunction with the fishing effort estimates from the phone survey to estimate total catch (e.g., small anomalies in the data can be expanded to large anomalies). Another concern is over species identification by contract port agents in the early years of the MRFSS and by fisherman for the B1 and B2 catches. For the majority of recreational anglers, species identification for the jack family (Carangidae) is very difficult.

Estimated landings of greater amberjack in numbers of fish from the shore-based mode ranged from 0 to 126,747 (SEDAR-DW-07). These greater amberjack estimated landings were based on only 40 intercepts (only 17 measured) within a 24 year period. During the plenary meeting it was discussed and agreed that greater amberjack is very unlikely to be caught from shore. Thus, shore-based catches are most likely to be other jack species, not greater amberjack.

DW recommendation: The MRFSS data is the best available data and cannot be ignored. The estimated landings have CVs associated with them that will capture the level of uncertainty and might be incorporated into the assessment model (Tables 2a-b).

Omit shore based landings, because it was felt that the fishing mode or the species may have been misidentified and the chance of a greater amberjack being caught from the shore is highly unlikely. If the fishing mode was misidentified the expansion factor for fishing effort from shore mode would greatly inflate any landings of greater amberjack classified as shore mode.

Research recommendation: review this problem and collect more information (hasn't been done for this assessment, needs to be for future)

Unidentified Jack Landings

There is a large amount of MRFSS estimated landings of unidentified jack (Carangidae and *Seriola*), especially in the earliest years. Because some of these landings are comparable to greater amberjack landings, it is necessary to estimate what proportion of the unidentified landings are actually greater amberjack.

DW recommendation: Determine the total landings of identified jack species by year, region and mode. Then apply the proportion of the jack species that are greater amberjack to the unidentified jacks by year, region and mode. The two regions considered will be east and west of the Mississippi River. Information from professional fishermen indicates banded rudderfish occur in the eastern part of the Gulf and lesser amberjack occur in the western portion, but the two rarely overlap. Thus, species composition from the two regions would be different. The data were not available at the SEDAR9 Data Workshop to complete this analysis. The data will be presented at the SEDAR9 Assessment Workshop.

Missing Data

The MRFSS and TPW data set have missing information for landings in some years, waves, or states that need to be filled with some estimate.

DW recommendation: Staff of NMFS SEFSC are presently working to fill in the missing landings information. The missing landings are most commonly from the first wave in 1981 and Texas for all years. Although the group was not able to review the methodology at the time of the data workshop (see attached document from Patty Phares, NMFS, SEFSC, Miami Laboratory) it decided to accept it because it was already used and reviewed during the 2004 red snapper assessment.

4.3 HEADBOAT

Table 5 shows estimated greater amberjack landings by the NMFS Headboat Survey.

Discards

Unlike MRFSS (Table 6), the Headboat survey does not provide estimates of released fish. Because a proportion of the released fish is expected to die, estimated number of releases are necessary for the estimation of fishing mortality rates.

DW recommendation: Estimate the ratio of releases (B2) to the total catch (A+B1+B2) from MRFSS charter boat mode only (Table 6) and use it to estimate headboat releases. The group felt that charterboat and headboat fishing are most similar and the rate of released fish would be most alike. Private boat fishing would not be the same as the "for-hire" sector. Table 6 includes MRFSS estimated number of live releases (B2) by year and mode.

Dry Tortugas and Keys

Headboat landings from the Florida Keys and Atlantic based trips to the Dry Tortugas (areas 12 and 17):

DW recommendation: The landings from areas 12 and 17 should not be included in the Gulf of Mexico analysis. The group felt that better than 99% of the trips in area 12 and area 17 are in South Atlantic jurisdiction waters. Table 4 includes estimated landings from the HB.

4.4 Recreational landings estimates for TX, 1981-1985

Summary prepared June 21, 2005, Patty Phares

4.4.1 Available estimates for gray triggerfish, greater amberjack and vermilion snapper in TX

TPWD Management Data Series 204

Private and charterboat only (no headboat).

Annual landings estimates, with a year defined as May 15 - May 14, for 1983/84 through 1997/98.

(Estimates for 1998-99 and later years have not been received yet.)

These annual estimates are what TPWD uses and are based on the same survey data they use to compute the TPWD wave estimates sent to us. If landings by wave are not needed, these annual estimates may be best, at least until the wave estimates for 1983-1997 are replaced (see notes below).

Notes:

(1) The annual estimates were recomputed in the mid-1990s using a revision to the "pressure files", thus eliminating some extreme estimates. The wave estimates for the 1980s and early 1990s have not yet been recomputed to use the revised pressure files and still contain outliers which may disappear when the wave estimates are recomputed.

(2) The annual estimates are based on 2 fishing seasons (high use and low use)

and may be more precise than the sum of the 6 wave estimates.

(3) The annual estimates incorporate data entry corrections not yet made to the wave estimates.

(4) TPWD makes species-specific estimates for selected "target species". The rest of the species are combined in to "other". A "substitute" estimate can be derived for the species in "other" based on the counts of species observed, but these may not be very reliable estimates.

The annual estimates have species-specific estimates for each of these 3 species in gulf areas (not bays) in all years.

Before 1994, the wave estimates have species-specific estimates for vermilion snapper in gulf areas but not for gray triggerfish and vermilion snapper.

TPWD Management Data Series 29 and 58

gulf headboats, through May 1983.

(#29) Annual landings estimates (use gulf headboats):

Sept 1978 - Aug 1979, Sept 1980 -- Aug 1981, Sept 1981 -- Aug 1982

(#58) Landings estimates for a partial year (use gulf headboats):

Sept 1 1982 -- May 14 1983

Notes:

(1) These estimates were published in 1984 and may not incorporate needed revisions as do those in MDS 204 (no confirmation from TPWD on this yet).

(2) The Sept-Aug years are not comparable to either the May 15-May 14 years or to calendar years.

(3) According to the MDS, not all headboat in the survey areas were found and contacted (apparently a census was attempted) and possibly not all regions were covered (survey areas listed do not include the current "major areas" of gulf waters off Sabine Lake, Matagorda, San Antonio). **The MDS 29 states "Harvest estimates in this study should be considered minimum estimates...".**

TPWD wave estimates (estimates made for NMFS)

Summed to be comparable to TPWD annual estimates in A (May 1 - April 30, 1983/84 -- 2002/03).

Private and charter boats all years, headboats only in May 1983 - Aug 1984.

TPWD wave estimate (estimates made for NMFS)

Summed into annual estimates (Jan-Dec) as would be used in assessments.

Private and charter boats (wave 3-6 only in 1983), headboats only in May 1983 - Aug 1984.

MRFSS 1981- 1985

1981 waves 2, 3, 5, 6 (waves 1 and 4 are missing). All modes, charterboat and headboat combined.

1982-1984 waves 1-3, 5-6 (wave 4 is missing). Only shore mode.

1985 waves 1-2, 5-6 (wave 4 is missing). All modes, charterboat and headboat combined.

NMFS HEADBOAT SURVEY

1986-1989

Use these estimates to evaluate magnitude and trends in pre-1986 headboat landings in TX.

Before 1997, TX landings were combined for Jan-May and for Sept-Dec.

Area (TTS, EEZ is not known), but all can be assigned to EEZ (area=4) for this purpose. These are gulf headboats (not in the bays).

4.4.2 Summary of "holes"

If both MRFSS and TPWD wave estimates are used:

* charter and headboat are combined in MRFSS (are bay headboats included in MRFSS?)

x = "hole" (no survey or MRFSS estimate lost)

		Shore	Private	Charter	Headboat (gulf)	Headboat (bay)
1981	wave 1	x	x	x	x	x
	wave 2	MR	MR	MR*	MR*	with gulf?
	wave 3	MR	MR	MR*	MR*	with gulf?
	wave 4	x	x	x	x	x
	wave 5	MR	MR	MR*	MR*	with gulf?
	wave 6	MR	MR	MR*	MR*	with gulf?
1982	wave 1	MR	x	x	x	x
	wave 2	MR	x	x	x	x
	wave 3	MR	x	x	x	x
	wave 4	x	x	x	x	x
	wave 5	MR	x	x	x	x
	wave 6	MR	x	x	x	x
1983	wave 1	MR	x	x	x	x
	wave 2	MR	x	x	x	x
	wave 3	MR	TX	TX	TX	TX
	wave 4	X	TX	TX	TX	TX
	wave 5	MR	TX	TX	TX	TX
	wave 6	MR	TX	TX	TX	TX
1984	wave 1	MR	TX	TX	TX	TX
	wave 2	MR	TX	TX	TX	TX
	wave 3	MR	TX	TX	TX	TX
	wave 4	X	TX	TX	TX	TX
	wave 5	MR	TX	TX	x	TX
	wave 6	MR	TX	TX	x	TX
1985	wave 1	MR	TX/MR	TX/MR*	x/MR*	TX/MR*
	wave 2	MR	TX/MR	TX/MR*	x/MR*	TX/MR*
	wave 3	MR	TX/MR	TX/MR*	x/MR*	TX/MR*
	wave 4	x	TX/x	TX/x	x/x	TX/x
	wave 5	MR	TX/MR	TX/MR*	x/MR*	TX/MR*
	wave 6	MR	TX/MR	TX/MR*	x/MR*	TX/MR*

4.4.3 DISCUSSION

Comparing data sources in Tables 1 and 2, there is not appearance of comparability among data sources. For instance, in Table 1(a) for gray triggerfish, the TPWD Management Data Series estimates (based on May15-May14 year) and TPWD wave estimates made for NMFS are very different in many years. For MRFSS, there are almost no gray triggerfish estimates, but the leatherjacket family (Table 1(d) bears slight resemblance to the estimates from other sources.

This is true for private and charter (including MRFSS charter + headboat) for all three species (gray triggerfish, greater amberjack, vermilion snapper).

For headboats (without charterboats) compared between TPWD and the NMFS Headboat Survey, the comparisons cannot be made in the same year, but the general magnitude of TPWD estimates before 1985 is not like that of Headboat Survey estimates in 1986+ except for vermilion snapper.

Comparisons are destined to be faulty because of the abundance of "holes" and the different time periods for estimates (not the same 12-month period), different grouping of modes (charterboat and headboat alone vs. separate), and poor quality of some of the estimates. The TPWD wave estimates for these years do not have the benefit of revisions slated to be done, and the sampling levels are especially low for charterboats. The MRFSS estimates before 1986 also are considered less reliable – the charterboat component uses the "old" method for charterboats, and there are weaknesses in the estimates for all modes (early years of survey, less thorough editing of data when all estimates were revised in early 1990s, some procedural or methodological differences?).

In short, it's too messy to try to consolidate the different estimates and fill in the holes. Suggestions:

(1) Use MDS private and charterboat estimates for 1983-1997 (and use then as though they are calendar year estimates)

(2) Use TPWD wave estimates for 1998+ (these use the calculation procedures that will be applied to the earlier years when time allows for TPWD to do replace the old estimates).

(3) Use the average of the Headboat Survey for 1986-1989 for all years 1981-1985 (perhaps modified by Bob Dixon and TPWD if they believe the fleet was smaller or different).

If this is unsatisfactory, anyone's procedure may be just as good. But there will never be more data, just re-hashing of the same data presented here.

Table 1: Number of greater amberjack measured (sampled) and percentage of the estimated landings sampled (%) by MRFSS by state and year, fishing modes combined.

	FL		AL		MS		LA		
Year	Sampled	%	Sampled	%	Sampled	%	Sampled	%	Total
1986	159	0.05	15	0.20			56	1.12	230
1987	554	0.13	129	0.43			100	0.35	783
1988	120	0.06	78	0.31			3	0.12	201
1989	37	0.01	66	0.13			19	0.14	122
1990	6	0.01	26	0.12					32
1991	85	0.04	84	0.76	3	0.96	63	0.25	235
1992	166	0.11	423	0.96			73	0.69	662
1993	55	0.07	44	0.07			10	0.28	109
1994	12	0.02	47	0.14	1	0.95	7	0.22	67
1995	11	0.07	7	0.04	1	0.12	4	0.05	23
1996	15	0.04	16	0.05			14	0.11	45
1997	54	0.15	28	0.32	1	0.18	8	0.17	91
1998	129	1.62	25	0.75			15	0.11	169
1999	428	4.78	89	0.80			10	0.41	527
2000	561	1.33	145	1.49			11	0.17	717
2001	307	0.92	107	0.46			22	0.21	436
2002	732	0.93	153	0.64			84	0.66	969
2003	697	0.84	273	0.54			98	0.80	1,068
2004	463	0.73	90	0.42			85	0.46	638
Total	4,591	0.20	1,845	0.38	6	0.23	682	0.35	7,124

Table 2a. Number of greater amberjack sampled from Headboat landings by year and area.

Year	SW-C FL	NW FL, AL	LA	TX	Total
1986	283	69		200	552
1987	198	66		253	517
1988	69	86	15	184	354
1989	227	669	87	275	1,258
1990	93	33		105	231
1991	7	59	50	67	183
1992	18	55	218	94	385
1993	6	38	92	103	239
1994	12	72	24	138	246
1995	3	43	74	144	264
1996		33	72	45	150
1997		29	59	18	106
1998		28	67	27	122
1999		15	96	5	116
2000		71	27	3	101
2001	7	44	117	13	181
2002	2	22	104	14	142
2003	39	53	117	69	278
2004	4	17	0	44	65
Total	968	1,485	1,219	1,757	5,425

Table 2b: Percentage of the landings sampled by area and year by the Headboat survey.

Year	SW-C FL	NW FL, AL	LA	TX	Total
1986	0.51	0.33		2.11	0.64
1987	0.87	0.32		2.76	0.98
1988	0.44	1.78	1.20	2.32	1.19
1989	1.33	2.60	40.28	2.88	2.40
1990	0.45	5.31		3.88	0.95
1991	0.14	3.96	4.56	2.76	1.86
1992	0.21	3.61	5.54	1.59	1.95
1993	0.11	4.99	3.08	2.20	1.70
1994	0.20	7.27	1.41	3.04	1.88
1995	0.14	7.18	5.08	3.21	3.04
1996		3.19	1.87	1.31	1.43
1997		4.20	6.24	0.61	1.41
1998		5.96	10.11	1.42	2.39
1999		1.57	9.70	0.57	2.19
2000		4.48	18.37	0.18	1.68
2001	0.44	5.46	5.46	0.88	3.01
2002	0.06	1.61	4.80	0.38	1.33
2003	1.23	2.96	4.33	1.60	2.32
Total	0.54	1.71	4.41	2.16	1.45

Table 3: Estimated greater amberjack landings (A+B1) and associated coefficient of variation (CV) for shore, charterboat , private boat and the combined charterboat-headboat mode.

	Shore		Charterboat		Private boat		Charterboat + headboat		
Year	Landings	CV	Landings	CV	Landings	CV	Landings	CV	Total
1981					97,795	0.32	13,773	0.54	111,569
1982	12,307	0.87			149,066	0.35	479,900	0.78	641,274
1983					47,390	0.33	191,678	0.47	239,068
1984	7,073	0.71			4,477	1.00	89,008	0.56	100,558
1985					37,579	0.52	156,220	0.47	193,799
1986			254,003	0.24	97,892	0.26			351,895
1987	4,351	0.73	293,391	0.28	192,545	0.20			490,286
1988	25,078	0.49	140,579	0.31	79,549	0.20			245,206
1989	126,747	0.48	158,556	0.31	193,263	0.22			478,566
1990	1,278	0.47	23,735	0.53	38,616	0.44			63,629
1991	8,152	1.00	227,427	0.33	11,812	0.33			247,390
1992	53,487	1.00	123,756	0.20	33,649	0.17			210,891
1993	3,703	0.60	104,232	0.45	33,809	0.22			141,744
1994			83,733	0.25	19,025	0.26			102,758
1995			17,160	0.33	24,178	0.49			41,338
1996			49,111	0.42	32,243	0.25			81,353
1997			35,807	0.33	13,264	0.33			49,072
1998	13,149	0.99	19,139	0.09	8,828	0.28			41,115
1999	455	1.00	28,925	0.90	18,364	0.24			46,745
2000	3,796	0.58	36,853	0.80	17,785	0.25			58,434
2001			29,060	0.11	38,063	0.19			67,123
2002			73,973	0.06	41,143	0.17			115,115
2003			64,387	0.06	81,071	0.15			145,457
2004			54,211	0.06	48,540 0.18	0.18			102,751
Total	259,575		1,817,038		1,359,945		930,580		4,367,138

Table 4: Estimated landings by TPW by mode and year.

Year	Headboat	Charter Boat	Private Boat	Total
1983	64,449		2,397	66,846
1984	38,510		8,139	46,649
1985		372	3,157	3,529
1986		485	5,929	6,414
1987			4,434	4,432
1988		203	1,547	1,750
1989		813	1,169	1,982
1990			835	835
1991			1,816	1,816
1992			4,851	4,851
1993		16,858	344	17,202
1994			239	239
1995		76	337	413
1996		268	517	785
1997		472	969	1,441
1998		48	403	451
1999		55	277	332
2000		78	503	581
2001		450	753	1,203
2002		1,886	1,731	3,617
2003		1,603	1,264	2,867
Total	102,959	23,667	41,611	168,237

Table 5: Estimated greater amberjack landings (in numbers) by the Headboat fishery.

Year	FL	FL-AL	LA	TX	Total
1986	55,040	20,760	739	9,485	86,024
1987	22,688	20,623	402	9,179	52,892
1988	15,628	4,845	1,251	7,936	29,660
1989	17,052	25,693	216	9,560	52,521
1990	20,689	621	245	2,705	24,260
1991	4,836	1,489	1,097	2,430	9,852
1992	8,388	1,525	3,932	5,902	19,747
1993	5,614	761	2,989	4,689	14,053
1994	5,886	990	1,697	4,543	13,116
1995	2,129	599	1,456	4,486	8,670
1996	2,191	1,035	3,841	3,444	10,511
1997	2,960	691	945	2,942	7,538
1998	2,079	470	663	1,898	5,110
1999	2,462	954	990	880	5,286
2000	2,616	1,584	147	1,653	6,000
2001	1,579	806	2,142	1,482	6,009
2002	3,494	1,370	2,167	3,658	10,689
2003	3,178	1,790	2,699	4,309	11,976
Total	178,509	86,606	27,618	81,181	373,914

Table 6: Estimated greater amberjack discards (B2) and associated coefficient of variation (CV) for shore, charter boat, private boat and the combined charterboat-headboat mode.

	Shore		Charter boat		Private boat		Charterboat + headboat		
Year	Discards	CV	Discards	CV	Discards	CV	Discards	CV	Total
1981	14,952	0.91			5,132	0.60	0		20,084
1982	32,829	0.65			31,165	0.66	19,964	1.49	83,957
1983					64,649	0.83	15,141	1.08	79,790
1984					5,242	1.00	3,500	0.86	8,742
1985					0		0		0
1986			31,273	0.45	68,262	0.32			99,535
1987	5,773	0.81	10,278	0.47	25,549	0.50			41,600
1988			1,404	0.67	31,411	0.38			32,816
1989	75,621	0.50	7,866	0.61	81,690	0.49			165,177
1990	5,174	1.00	23,748	0.48	46,475	0.67			75,397
1991	17,046	1.00	223,034	0.32	29,290	0.40			269,370
1992	140,147	0.78	91,422	0.26	86,205	0.20			317,775
1993	17,808	0.32	109,152	0.21	68,609	0.25			195,570
1994	7,201	0.69	65,235	0.33	44,957	0.36			117,393
1995	4,649	0.61	10,986	0.53	55,997	0.26			71,632
1996	8,873	42.0	42,719	0.72	21,065	0.37			72,657
1997	1,541	1.00	22,723	0.42	21,428	0.26			45,692
1998	2,005	0.71	40,668	0.13	55,715	0.30			98,387
1999	4,033	0.62	44,006	0.09	51,201	0.23			99,240
2000	5,845	0.52	32,922	0.09	86,802	0.19			125,570
2001	20,401	0.89	56,422	0.09	387,050	0.21			463,872
2002	3,477	0.61	81,799	0.07	182,489	0.14			267,764
2003			56,882	0.07	171,092	0.17			227,974
2004	9,577	0.67	30,787	0.08	123,341	0.18			163,705
Total	376,951		983,326		1,744,815		38,605		3,143,697

5. MEASURES OF ABUNDANCE

5.1 Fishery-Dependent Indices

5.1.1 Commercial Fishery Catch Rates

SEDAR9-DW-10 used data from the National Marine Fisheries Service (NMFS) reef fish logbook program to develop greater amberjack abundance indices for the commercial longline and handline fisheries. Because for the period 1990-1992 only 20% of vessels registered in FL were sampled, indexes of abundance were estimated for the period 1993 onwards. Trips were selected for inclusion in the analyses of both fisheries based upon the species composition of the landings (Stephens and MacCall 2004). Trips were retained if this species composition reflected species usually associated with greater amberjack in the landings. This process was intended to select trips with a reasonable probability of catching greater amberjack, based upon some combination of location, timing, technique, habitat, etc.

5.1.2 Commercial Longline

The longline index was estimated from trips recording at least 10 sets per day or 1-day trips. This criteria was used to select only trips that reported total effort for the entire trips, instead of daily effort. The index of abundance selected for the analysis was lbs/100 hooks. The estimated standardized index of abundance showed no trend for 1993-1999 and a clear increasing trend afterwards (Figure 1.1). The Working Group recommended that the index could be considered for use in the assessment, subject to revisions described in section 4.3.

5.1.3 Commercial Handline

The selected unit of effort for the analysis of handline trips was hook-days (number of hooks used per line multiplied by the duration of the trip in days). Separate standardized indexes of abundance were estimated for handline vessels fishing with 1-9 and 10-40 hooks per line because these two groups are believed to target different species and their greater amberjack nominal indexes of abundance are very different (the catch rate of trips using 10-40 hooks per line is much lower). There was concern that a subset of vessels may strongly target greater amberjack, fishing in areas of high local abundance and returning when specific catch levels, perhaps dictated by dealer capacities, were achieved. This practice, if it exists, has the potential to adversely affect any relationship between catch rates and abundance trends. In order to investigate the possible effect of this practice, handline vessels which appear to strongly target greater amberjack in each year were identified (those returning with greater amberjack constituting greater than 80% of their landings on at least 3 trips in that year). For the 1-9 hooks per line trips, this effect on the index of abundance was investigated by estimating the index for all trip and for a subset of trips that excluded those vessels identified as targeting greater amberjack on a yearly basis. The estimated indexes for handline trips with 1-9 hooks per line for all trips and the subset of trips excluding vessels targeting greater amberjack showed the similar results. In general, these indexes showed inter-annual variability but without any discernable trend. The index estimated for trips using 10-40 hooks per line was less variable but it also showed no discernable trend. The Working Group recommended that the index of trips using 1-9 hooks per line and incorporating all vessels could be considered for use in the assessment, subject to revisions described in section 4.3. There appeared to be no need to exclude vessels identified as highly targeting and catch rates were likely too low and variable on trips using 10-40 hooks per line to be reflective of abundance trends.

5.2 Recreational Fishery Catch Rates

SEDAR9-DW-20 used data from the Marine Recreational Fisheries Statistics Survey (MRFSS), including modes private and charterboat only, and the NMFS Beaufort Headboat Survey to develop greater amberjack abundance indices for the recreational rod and reel fisheries. Trips were selected for inclusion in the analyses based upon the species composition of the landings (Stephens and MacCall 2004).

5.2.1 Marine Recreational Fisheries Statistics Survey Catch Rates

MRFSS data include fish landed and observed by the interviewer (A), dead fish not observed by the interviewer (B1; e.g., unavailable, filleted, used for bait, discarded dead at sea) and fish released alive (B2). Since the index was estimated on the total catch (A+B1+B2) instead of on landings, it was not necessary to account for changes in size (or, to a large extent, bag limit) regulations in the estimation of the indexes. The MRFSS standardized index showed very high and variable values in the part time of the series followed by a decline until 1998 when it reached the lowest value of the series. The index increased from 1998 to 2002 to decrease again in 2003-2004. The Working Group recommended that the index could be considered for use in the assessment, subject to revisions described in section 4.3.

5.2.2 Headboat Survey Catch Rates

The index for the headboat recreational fishery was estimated using data from full day trips. The possible effect of regulations on the catch rate was investigated by estimating indexes of abundance for the entire time series 1986-2003 and for the periods before and after the 1 fish bag limit was introduced in early 1996. The results, along with examination of the nominal catch frequencies, indicated that the implementation of the 1 fish bag limit did not have any effect on the standardized indexes. In general, headboat catch rates were very high in 1986 and showed a continuous decline until 1991 and it remained approximately constant until 1996 when a period of recovery started. Year 2003 showed a decline with respect to 2002. The Working Group recommended that the index could be considered for use in the assessment, subject to revisions described in section 4.3.

5.3 Recommendations

5.3.1 Indices to be considered for use in the assessment

As a general recommendation, the indices recommended for use from each fishery are those gulf-wide indices which employed the Stephens and MacCall (2004) approach to subsetting the data.

5.3.2 Data and/or analysis revisions

The protocol outlined by Stephens and MacCall (2004) results in observations which catch only greater amberjack on a trip were excluded from the data set. The analyses which developed the recommended indices departed from this protocol in that those observations were reintroduced into the analysis the data set. For consistency with the protocol and with the analyses for other species, the analyses should be rerun prior to the assessment with those observations excluded. It is expected that this would have minor influence on the trends and would not change the recommendations for these indices.

Data are now available from the Headboat Survey in 2004. These should be incorporated in the headboat analysis prior to the assessment.

The question of whether or not size limit changes may have impacted the indices should be revisited, incorporating information such as size frequency distributions, and included in the paper(s).

5.3.3 References:

Stephens, A. and A. MacCall. 2004. A multispecies approach to subsetting logbook data for purposes of estimating CPUE. Fisheries Research 70 (2004), 299–310.

5.4 Fishery Independent Indices

In preparation for the SEDAR, four fishery independent surveys were analyzed and indices of relative abundance developed. These were the Southeast Area Monitoring and Assessment Program (SEAMAP) shrimp/bottomfish surveys and their predecessors, the SEAMAP ichthyoplankton surveys, the SEAMAP reef fish survey, and the small pelagic trawl survey. The small pelagic data may be useful for extended distributional information, but is not a rigorous time series, and is not considered further here. The ichthyoplankton and reef fish surveys are intended to index spawning stock size. The trawl indexes are intended to index new recruitment.

5.4.1 SEAMAP Ichthyoplankton Surveys:

At this time, no larval abundance index for greater amberjack is available. *Seriola spp*. larvae are taken in both bongo and neuston nets during SEAMAP surveys. There are at least 3,500 specimens initially identified as *Seriola spp*., however these specimens will have to be re-examined to verify identification. This task cannot be accomplished before the stock assessment in August.

5.4.2 SEAMAP Reef Fish Survey:

The SEAMAP reef fish survey employs video cameras to estimate the abundance of fish associated with reefs and banks located on the continental shelf of the Gulf of Mexico. Fish traps are also employed to capture fish for aging. Details of survey design and estimates of abundance for greater amberjack are in the working paper. We recommend the use of design-based estimates of abundance for greater amberjack. There was no advantage to using the model-based estimates because no gaps were present in the survey time series that could be accounted for using a GLM approach. The size of the fish observed during the survey come from two sources, fish captured in traps and fish measured on video tape with lasers. Lasers were first introduced in 1995. However, since both the capture of fish in traps, and the instances where fish are hit by lasers was infrequent, size distributions were not estimated. We report only the average size and size range of fish. Survey indices are in working paper SEDAR9-DW21 (Figure 1.2). No greater amberjack were captured in fish traps so size was determined only with lasers. The size of greater amberjack observed ranged from 265 mm FL to 1563 mm FL. Therefore the video survey observes fish age 0+. The results of a 2004 survey will be added. These will be provided prior to the August stock assessment by Chris Gledhill, NMFS Pascagoula, MS.

5.4.3 SEAMAP Trawl Surveys:

Portions of the procedures used in SEDAR7 to derive trawl survey indexes of abundance for red snapper (those in SEDAR7-DW-1) were applied to greater amberjack, and reported in SEDAR9-DW-27. Greater amberjack are uncommon in the survey data, with abundances too low for the procedures of SEDAR7-DW-2, used to link separate time series into extended fall and summer indexes, to be useful. Therefore, the analyses reported only separate 'base index' values for each time series in the data base. In many years, greater amberjack did not occur at all in the surveys. Except for possibly looking at something like frequencies of occurrence over blocks of years, the survey data will probably not be useful in the amberjack assessment. Size composition data were collected from 1987 on. What size data there are for amberjack look consistent with a single vulnerable year class, with a peak at about 200 mm in the summer, and 300 mm in the fall (SEDAR9-DW-18).

5.5 Summary of Outstanding Items:

The only outstanding item for fishery independent indexes for greater amberjack is an update of the Reef Fish survey – addition of the 2004 point (Gledhill).

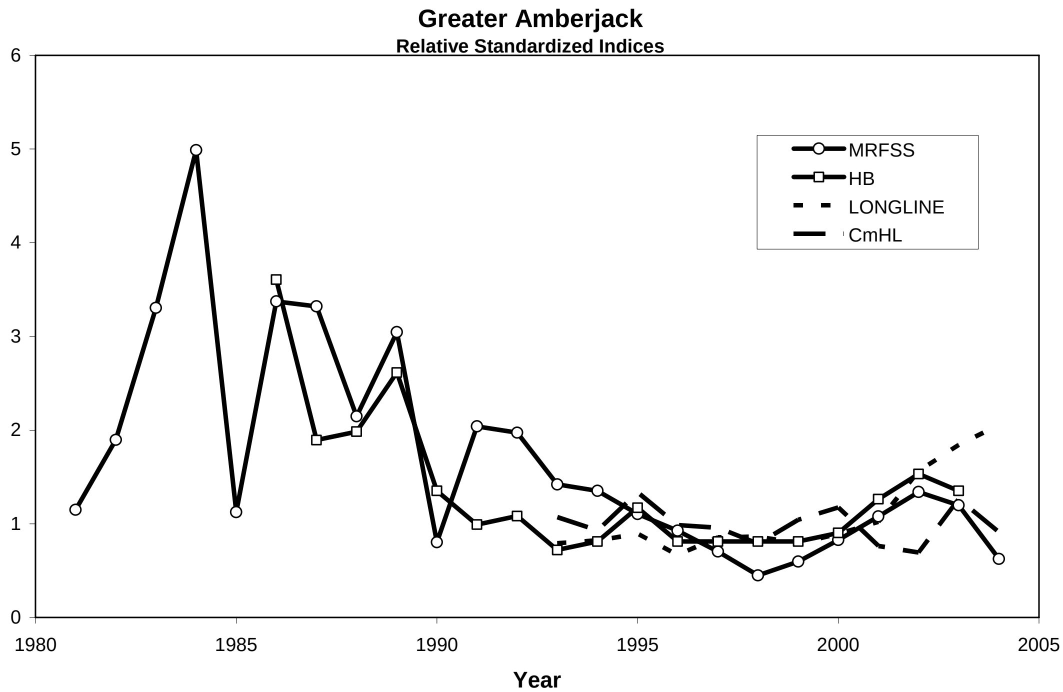

Figure 1.1: Relative standardized indices of Gray Triggerfish from the MRFSS, Headboat (HB), Longline and Commercial Handline (CmHL) fishery dependent surveys.

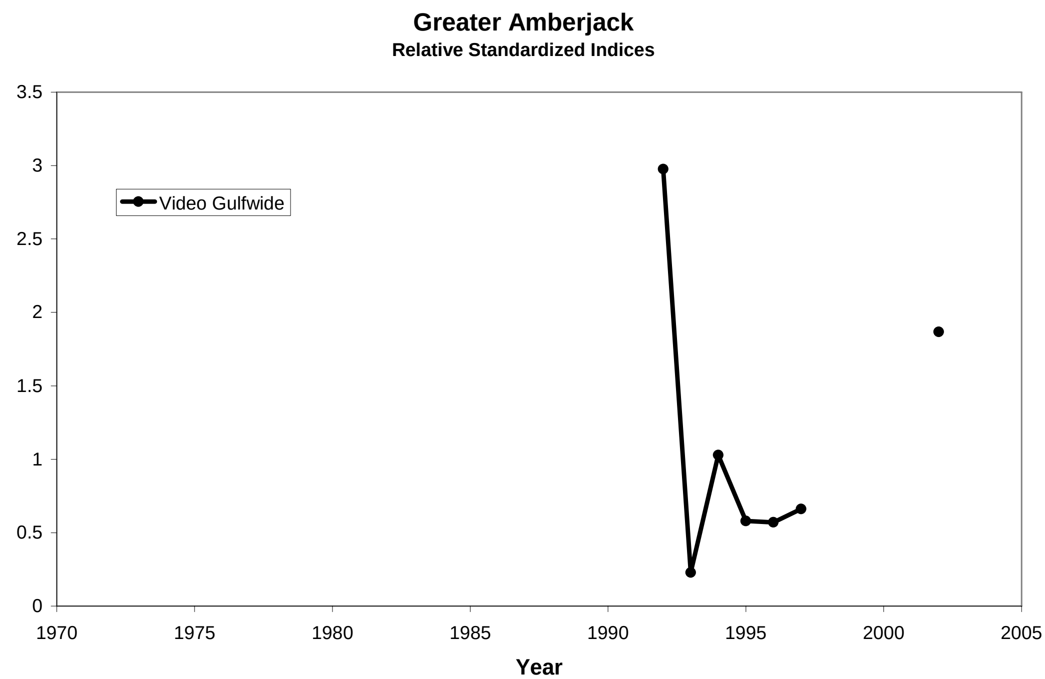

Figure 1.2: Relative standardized indices from the Gulf-wide Reef Fish Video fishery independent survey.

SEDAR

SouthEast Data, Assessment, and Review

SEDAR 9
Stock Assessment Report 2

Gulf of Mexico
Greater Amberjack

SECTION 3. Assessment Workshop Report

SEDAR 09

SOUTHEAST DATA, ASSESSMENT, AND REVIEW

Greater Amberjack, *Seriola dumerili*, in the Gulf of Mexico

Stock Assessment Report

Prepared by

SEDAR 09 Stock Assessment Panel

10 March 2006

Table of Contents

1. Introduction

1.1. Workshop Time and Place

The SEDAR 9 Assessment Workshop was held in Miami, FL, August 22 – 26, 2005. A follow-up Assessment Workshop was held in Atlanta, GA, December 19-20, 2005.

1.2. Terms of Reference

1. Select several appropriate modeling approaches, based on available data sources, parameters and values required to manage the stock, and recommendations of the Data Workshop.
2. Provide justification for the chosen data sources and for any deviations from Data Workshop recommendations.
3. Estimate stock parameters (fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship, etc); include appropriate and representative measures of precision for parameter estimates and measures of model 'goodness of fit'.
4. Characterize uncertainty in the assessment, considering components such as input data, modeling approach, and model configuration.
5. Provide yield-per-recruit and stock-recruitment analyses.
6. Provide complete SFA criteria. This may include evaluating existing SFA benchmarks or estimating alternative SFA benchmarks (SFA benchmarks include MSY, Fmsy, Bmsy, MSST, and MFMT). Develop stock control rules.
7. Provide declarations of stock status relative to SFA benchmarks: MSY, Fmsy, Bmsy, MSST, MFMT.
8. Estimate Allowable Biological Catch (ABC) and provide an appropriate confidence interval.
9. Project future stock conditions and develop rebuilding schedules if warranted; include estimated generation time. Projections shall be developed in accordance with the following:
    A) If stock is overfished:
        F=0, F=current, F=Fmsy, Ftarget (OY),
        F=Frebuild (max that rebuild in allowed time)
    B) If stock is overfishing
        F=Fcurrent, F=Fmsy, F= Ftarget (OY)
    C) If stock is neither overfished nor overfishing
        F=Fcurrent, F=Fmsy, F=Ftarget (OY)
10. Evaluate the results of past management actions and probable impacts of current management actions with emphasis on determining progress toward stated management goals.
11. Provide recommendations for future research and data collection (field and assessment); be as specific as practicable in describing sampling design and sampling intensity. Prioritize recommendations based on their likelihood for improving stock assessment.

12. Fully document all activities: Draft Section III of the SEDAR Stock Assessment Report and provide complete tables of estimated values.
    Reports to be finalized and distributed to the panel for review by September 30.
    Comments due to editors by October 14.
    Final version due to Coordinator by October 28.

1.3. List of Participants

1.3.1. Assessment Workshop I, August 22-26 2005

Workshop Participants:
Harry Blanchet..................................LA DWF
Liz Brooks...NMFS/SEFSC Miami, FL
Craig Brown......................................NMFS/SEFSC Miami, FL
Shannon Calay ....NMFS/SEFSC Miami, FL
Guillermo Diaz..................................NMFS/SEFSC Miami, FL
Bob Dixon..NMFS/SEFSC Beaufort, NC
Bob Gill...GMFMC Advisory Panel
George Guillen..................................Univ. Houston Clear Lake/GMFMC SSC
David Hanisko ....NMFS/SEFSC, Pascagoula MS
Walter Ingram ....NMFS/SEFSC Pascagoula MS
Bob Muller..FL FWCC/GMFMC SSC
Debra Murie......................................University of Florida/GMFMC FINFISH SAP
Josh Sladek Nowlis...........................NMFS/SEFSC Miami, FL
Scott Nichols.....................................NMFS/SEFSC Pascagoula MS
Dennis O'Hern..................................GMFMC Advisory Panel
Larry Perruso ....NMFS/SEFSC Pascagoula MS
Steven Saul..RSMAS/ SEFSC Miami FL
Jerry Scott ....NMFS/SEFSC Miami, FL
Steve Turner......................................NMFS/SEFSC Miami, FL

Observers:
Kay Williams ....GMFMC
Elizabeth Fetherston...........................Ocean Conservancy
Albert Jones ....GMFMC SSC

Staff:
John Carmichael................................SEDAR
Stu Kennedy......................................GMFMC
Dawn Aring.......................................GMFMC
Patrick Gilles.....................................NMFS/SEFSC Miami FL

1.3.2. Assessment Workshop II, December 19-20 2005

Workshop Participants:
Liz Brooks..NMFS/SEFSC Miami, FL
Craig Brown.......................................NMFS/SEFSC Miami, FL
Shannon Calay ....NMFS/SEFSC Miami, FL
Guillermo Diaz...................................NMFS/SEFSC Miami, FL
George Guillen...................................Univ. Houston Clear Lake/GMFMC SSC
Walter Ingram ....NMFS/SEFSC Pascagoula MS
Bob Muller ....FL FWCC/GMFMC SSC
Debra Murie ....University of Florida/GMFMC FINFISH SAP
Josh Sladek Nowlis ....NMFS/SEFSC Miami, FL
Dennis O'Hern ....GMFMC Advisory Panel
Jerry Scott ....NMFS/SEFSC Miami, FL
Steve Turner.......................................NMFS/SEFSC Miami, FL
Clay Porch..NMFS/SEFSC Miami FL

Observers:
Roy Williams ....GMFMC

Staff:
John Carmichael.................................SEDAR
Stu Kennedy.......................................GMFMC
Dawn Aring..GMFMC
Patrick Gilles.....................................NMFS/SEFSC Miami FL

1.4. List of Assessment Workshop Working Papers, Assessment Workshops I & II

SEDAR9-AW1	Incorporating Age Information into SEAMAP Trawl Indices for SEDAR9 Species	Nicholls, S.
SEDAR9-AW2	Separating Vermilion Snapper Trawl Indexes into East and West Components	Nicholls, S
SEDAR9-AW3	Modeling Shrimp Fleet Bycatch for the SEDAR9 Assessments	Nicholls, S
SEDAR9-AW4	Status of the Vermilion Snapper (*Rhomboplites aurorubens)* Fisheries of the Gulf of Mexico	Cass-Calay, S.
SEDAR9-AW5-REV	Gulf of Mexico Greater Amberjack Stock Assessment	Diaz, Guillermo A., and Elizabeth Brooks
SEDAR9-AW6	A Categorical Approach to Modeling Catch at Age for Various Sectors of the Gray Triggerfish (*Balistes capriscus)* Fishery in the Gulf of Mexico	Saul, Steven and G. Walter Ingram, Jr.

SEDAR9-AW7	Updated Fishery-Dependent Indices of Abundance for Gulf of Mexico Gray Triggerfish (*Balistes capriscus)*	Nowlis, Joshua Sladek
SEDAR9-AW8	An Aggregated Production Model for the Gulf of Mexico Gray Triggerfish (*Balistes capriscus)* Stock	Nowlis, Joshua Sladek and Steven Saul
SEDAR9-AW9	Age-Based Analyses of the Gulf of Mexico Gray Triggerfish (*Balistes capriscus*) Stock	Nowlis, J. S.
SEDAR9-AW10	Gulf of Mexico Greater Amberjack Virtual Population Analysis Assessment	Brown, C. A.,C. E. Porch, and G. P. Scott
SEDAR9-AW11	Rebuilding Projections for the Gulf of Mexico Gray Triggerfish (*Balistes capriscus*) Stock.	Nowlis, J. S.

2. Data Issues and Deviations from Data Workshop Recommendations

2.1. Indices of Abundance

Documents SEDAR9-DW10 and SEDAR9-DW20 presented greater amberjack standardized indexes of abundance for the commercial and recreational fisheries, respectively. The SEDAR9-DW recommended the use of four indices of abundance for the greater amberjack stock assessment: 1) commercial handline (1-9 hooks per line), 2) commercial longline, 3) recreational headboat and 4) recreational charter boat and private boat combined. Trip selection for the CPUE analysis followed the species composition method developed by Stephen and McCall (2000) and already presented during the SEDAR9-DW. However, the 'default' threshold value estimated by this method was reduced between 25% and 50% to increase the number of trips included in the final data sets to be analyzed. Initial exploratory analysis showed that CPUE trends did not change when the threshold value was reduced. Trips selection for the commercial handline (1-9 hooks per line) and the combined private boat and charter boat fisheries were performed by reducing the threshold value by 50%, in the case of the commercial longline fishery the threshold was reduced by 25%. For the headboat fishery, all available trips were used for the analysis of indexes of abundance.

2.2. Revised Catch Series

During Assessment Workshop II, a revised catch series was used for additional model runs, based on the inclusion of landings reported in the category of 'Other jacks', which did not exist in earlier years. This revised series included higher commercial catches for the period 1990-2004, for both commercial hook and line and longline gears. Commercial yield for the period 1963-1989 was unchanged from the original catch series. Yield from recreational gears was not revised from the original catch series.

3.0. Stock Assessment Models and Results

Three stock assessment models were presented at the Stock Assessment workshop, including a Virtual Population Analysis (VPA), a non-equilibrium surplus production model (ASPIC), and a State-Space Age-Structured Production Model (SSASPM). The VPA was presented for continuity with the most recent stock assessment for greater amberjack (Turner et al. 2000). ASPIC and SSASPM were presented because they rely less on knowing the age structure of the catch explicitly, which has been raised as a concern in using the VPA alone for the stock assessment of greater amberjack in the Gulf of Mexico.

3.1. Model 1: Virtual Population Analysis

3.1.1. Model 1: Virtual Population Analysis Methods

3.1.1.1 Overview

The previous assessment (Turner et al. 2000) used a calibrated VPA to obtain estimates of population abundance and mortality rates using data through 1998. Sensitivity analyses included examination of various combinations of the three indices available for tuning (MRFSS, headboat, and commercial hook and line), truncation of the time series for the three indices to a period in which size limits were generally constant, examination of alternatives for the F ratios for the terminal age group (fixing or estimating F), examination of two alternative stock-recruitment relationships, and an examination of the assumed level of M (0.15, 0.25, 0.35).

The current VPA analyses (Brown et al. 2005; SEDAR9-AW10) maintained the base case configuration of the previous assessment with respect to M, F-ratios and stock-recruitment relationship. This "**Continuity Case-VPA**" was considered to be the equivalent of the model used in the previous assessment (Turner et al. 2000) and was to provide continuity between that assessment and the current assessment. The inputs to this model were the same as in the previous assessment with the exception of updated catch statistics.

In addition to the Continuity Case-VPA, four other VPA's were run with various options. Option 1 was the same as the Continuity Case-VPA except that two additional abundance indices were used, including an index of the longline catch rate data and a fishery-independent index developed from SEAMAP reef fish video survey data. Option 2 was the same as Option 1 except that the VPA run was performed with equal weighting among indices. Option 1, similar to the Continuity Case-VPA, had index values weighted by the coefficients of variation estimated in the standardization process (input variance weighting) but it was rationalized that the measures of uncertainty were not truly comparable between the indices. Option 3 was identical to Option 2 except that the selectivity of the handline index was allowed to vary over time, rather than constraining it to be identical across the catch history (as in Option 2), which was reasonable given a size limit implementation. Option 4 was identical to Option 3 except for the age-slicing method used and hence the catch-at-age matrix used as input. The catch-at-age matrix used in the Continuity Case-VPA and Options 1-3 was calculated by applying monthly slicing limits, the same as those used in the previous assessment, to the catch-at-size data. These slicing limits were based upon the growth curve developed by Thompson et al. (1999), which assumed a birth date of June 1.

Unfortunately, there was insufficient size sample information to adequately create catch-at-size on a monthly basis. Instead, yearly size samples were applied to the corresponding catches. As it was considered inappropriate to apply month-specific age slicing limits to the catch-at-size, alternative yearly slicing limits were constructed for the Option 4-VPA. Furthermore, the birth date was assumed to be April 1, as this was the birth date assumed by Thompson et al. (1999) in developing the growth curve.

For the Continuity Case-VPA, weight-at-age inputs were the same as used for the previous assessment, calculated from the growth curve but corresponding to the weights-at-age at the end of the year. Since it was more appropriate to use mid-year weight-at-age, these were used for the Option 4-VPA. Mid-year and spawning weight-at-age were calculated assuming the April 1 birth date.

In summary, the Option 4-VPA model was an extension of the Continuity-VPA and used updated catch statistics, as in the Continuity Case-VPA, but used an alternative approach to age slicing to define catch-at-age, an alternative calculation of weight-at-age, time-variant selectivity in the handline index, and two additional indices to tune the VPA (longline fishery index and a fishery-independent video survey index). The Option 4-VPA was considered by the SEDAR9-AW to be the preferred option, hereafter referred to as the "**Preferred Case-VPA"**.

3.1.1.2. Data Sources

The catch-at-age matrix used for the Continuity Case-VPA is shown in Table 3.1.1.2.1 and in Figure 3.1.1.2.1. Applying the alternative slicing limits (Table 3.1.1.2.2), the resulting catch-at-age matrix used for the Preferred Case-VPA is shown in Table 3.1.1.2.3 and in Figure 3.1.1.2.2.

In addition to the fishery data, three indices were used in the Continuity Case-VPA (MFRSS, Headboat, and Commercial hook and line), and all five indices were used in the Preferred-Case VPA (inclusive of a commercial longline index and a SEAMAP reef fish index).

As in the previous assessment, a hockey-stick (piece-wise linear) stock recruitment relationship (Barrowman and Meyers 2000) was fit to the observed data. The biological parameters used as inputs to the VPA's are summarized in Table 3.1.1.2.4.

Based on the SEDAR9-DW, 20% of discarded greater amberjack were assumed to have died. This was the same as the 2000 assessment (Turner et al. 2000; Cummings and McClellan 2000).

3.1.1.3. Model Configuration and Equations

VPA's (Brown et al. 2005) were conducted using the program VPA-2box (Porch 1999). VPA-2box employs methods similar to the ADAPT approach (Powers and Restrepo 1992) to obtain estimates of population abundance and mortality rates. Details of this model are given in Turner et al. (2000) and http://www.iccat.es/AssessCatalog.htm.

3.1.1.4. Parameters Estimated

VPA-2box estimates F at age, N at age, spawning stock biomass, and recruitment (Brown et al. 2005). Once the final values have been identified, then the benchmarks can be calculated (Tables 3.1.2.2.1.a,b).

3.1.1.5. Uncertainty and Measures of Precision

Bootstrap estimates were produced for all VPA models and projection runs.

3.1.2 Model 1: Virtual Population Analysis Results

3.1.2.1. Measures of Overall Model Fit

The fits of the indices are shown in Figure 3.1.2.1.1 for the Continuity Case-VPA and Figure 3.1.2.1.2 for the Preferred Case-VPA. Details of the fits of the indices are given in Brown et al. (2005, Tables 7 & 12).

3.1.2.2. Parameter Estimates

The estimated benchmarks from the Continuity Case-VPA are shown in Table 3.1.2.2.1a and for the Preferred Case-VPA in Table 3.1.2.2.1b.

Projected yields for the Continuity Case-VPA are shown in Tables 3.1.2.2.2a and 3.1.2.2.3a, as well as Figure 3.1.2.2.1. Projected yields for the Preferred Case-VPA are shown in Tables 3.1.2.2.2b and 3.1.2.2.3b, as well as Figure 3.1.2.2.2.

Selected results from the Continuity Case-VPA are compared to those of the last assessment (using a VPA, Turner et al. 2000) in Figure 3.1.2.2.3.

3.1.2.3. Stock Abundance and Recruitment

The estimated abundance of each age class is shown in Table 3.1.2.3.1 (Continuity Case-VPA) and Table 3.1.2.3.2 (Preferred Case-VPA).

3.1.2.4. Stock Biomass (Total and Spawning Stock)

The spawning stock biomass estimates are shown in Table 3.1.2.4.1a and Table 3.1.2.4.1b for the Continuity Case-VPA and the Preferred Case-VPA, respectively. The dispersions of bootstrap estimates of current stock status are shown in Figure 3.1.2.4.1 (Continuity Case-VPA) and Figure 3.1.2.4.2 (Preferred Case-VPA).

3.1.2.5. Fishery Selectivity

The overall selectivity pattern estimated through VPA for the greater amberjack fisheries is compared to the selectivity pattern from SSASPM (See section 3.3) in Figure 3.1.2.5.1. In general, the VPA showed greater selectivity at younger age classes compared to SSASPM.

3.1.2.6. Fishing Mortality

The estimated fishing mortality rates are shown in Table 3.1.2.6.1 (Continuity Case-VPA) and Table 3.1.2.6.2 (Preferred Case-VPA).

3.1.2.7. Stock-Recruitment Parameters

The parameter values for the hockey-stick (piece-wise linear) stock recruitment relationship (Barrowman and Meyers 2000) were 314055 (maximum recruitment) and 163841 (spawning biomass scaling parameter). The estimated spawning biomass and recruitment are shown in Table 3.1.2.7.1 (Continuity Case-VPA) and Table 3.1.2.7.2 (Preferred Case-VPA).

3.1.2.8. Measures of Parameter Uncertainty

The measures of uncertainty are reported under each section, based upon the bootstrap runs.

3.1.2.9. Retrospective and Sensitivity Analyses

No retrospective analyses were conducted. VPA's (Options 2 & 3) (see section 3.1.1.1), alternatives to the Continuity Case-VPA, are discussed in detail in the VPA analysis supporting document (Brown et al. 2005).

3.2. Model 2: Surplus Production Model (ASPIC)

In the previous stock assessment (Turner et al. 2000), there was concern that the VPA relied on the catch at age matrix being known exactly when in fact the ages were inferred using the length composition using a growth curve (age-slicing, which is done by inserting fish lengths into an inverted von Bertalanffy growth model). This approach does not take into account the effects of different year-class strengths and mortality on the observed length distributions or the degree of overlap between the length distributions of adjacent age groups. Therefore, the length composition data may be insufficient to accurately estimate the degree of variability in length at age. In addition, the preferred growth curve of Thompson et al. (1999) covered various gear sectors but was restricted geographically to Louisiana and therefore not Gulf-wide. Preferably, age-length keys representative of all sectors and regions of the fishery would be used to ameliorate this concern but these keys are inadequate currently for greater amberjack in the Gulf. Since the catch-at-age matrix used in the VPA's may be inexact, a surplus production model was used because it does not require a catch-at-age matrix as input.

3.2.1. Model 2: Surplus Production Model (ASPIC) Methods

3.2.1.1. Overview

Version 5.10 of ASPIC was used to fit a non-equilibrium production model conditioned on yield to the Gulf of Mexico greater amberjack data (Diaz et al. 2005; SEDAR9-AW5-REV). ASPIC includes the possibility of including several data from several fisheries on the same stock and 'tunes' the model to one or more indices of abundance.

3.2.1.2. Data Sources

Table 3.2.1.2.1 shows the yield (including 20% discard mortality) and estimated indices of abundance by fishery used as input for ASPIC. The recreational charterboat-private boat fishery is the major contributor to the total landings of this species followed by the commercial handline fishery.

The catch-CPUE series analyzed with ASPIC corresponded only to the period 1986-2004 because the condition on yield used on the ASPIC model requires catch information for each fishery for every year, and yield for the charterboat fishery is not available prior to 1986.

3.2.1.3. Model Configuration and Equations

The initial investigation was to compare the generalized versus the logistic production model. The estimated value of the exponent by the generalized model (2.33) was not significantly different (P=0.3824) from the logistic model exponent (2), while the other estimated parameters B_1/K, MSY, and K were very similar. The result of this comparison was that the logistic model provided as good a fit as the generalized. Therefore, the more parsimonious model (the logistic) was selected for subsequent evaluations. All indices were equally weighted.

ASPIC requires initial values of B_1/K, MSY, K and selectivity *q* by fleet. All runs were performed allowing the program to estimate the parameters mentioned above.

3.2.1.4. Parameters Estimated

Using the logistic option, ASPIC estimates B_{MSY} as K/2 and F_{MSY} as MSY/B_{MSY}. Once the final values have been identified, then the benchmarks can be calculated.

3.2.1.5. Uncertainty and Measures of Precision

Bootstrap analyses were performed to estimate variability around the estimated parameters and projection analyses were also performed for different scenarios of F and for constant yield.

3.2.2. Model 2: Surplus Production Model (ASPIC) Results

3.2.2.1. Measures of Overall Model Fit

Initial runs of the production model ASPIC showed no convergence problems. Figure 3.2.2.1.1 shows the observed CPUE series for each fishery and the predicted values by ASPIC assuming a 20% release mortality.

3.2.2.2. Parameter Estimates

ASPIC estimated that in 1986 (the beginning of the time series) the greater amberjack stock was approximately 84% of the virgin level. MSY was estimated to be about 4.8 million lbs, B_{MSY} 9.9 million lbs and maximum population size K 19.9 million lbs. Estimated F_{MSY} was 0.48 and current relative F (F_{2004}/ F_{MSY}) was 1.02, current relative biomass (B_{2004}/ B_{MSY}) was estimated at 0.71. Table 3.2.2.2.1 summarizes all parameters estimated by ASPIC for the base model.

3.2.2.3. Stock Biomass

Virgin biomass (K) was estimated to be about 19.9 million lbs and B_{MSY} 9.94 million lbs (50% of K by definition). At the beginning of the time series, biomass B_{1986} was 16.7 million lbs and relative biomass B_{1986}/B_{MSY}=1.7 (Figure 3.2.2.3.1). Biomass declined from 1986 through 1998. The stock became overfished in 1990 with B_{1990}=6.4 million lbs and relative biomass=0.64. The lowest level of biomass was reached in 1998 (B_{1998}=2.7 million, B_{1998}/B_{MSY}=0.27). The stock showed a continuous period of recovery since then reaching a biomass of about 7 million lbs in 2004. However, the stock still remained overfished with a relative biomass B_{2004}/B_{MSY}=0.7 (Figure 3.2.2.3.1).

3.2.2.4. Fishing Mortality

ASPIC estimated F_{MSY}=0.48. The results of the surplus production model showed that the Gulf of Mexico greater amberjack stock has experienced overfishing conditions since at least 1986 (F_{1986}=0.50), with the exception of 1988 (F_{1988}/F_{MSY}=0.86) and 1990 (F_{1990}/F_{MSY}=0.84). Although variable, F remained relatively high until 1997 (F_{1997}=0.95) when a discernible declining trend started. Relative F reached the lowest value after 1997 in 2001 (F_{2001}/F_{MSY}=1.04), it increased during 2002 and 2003 and decreased in 2004 to a value of 1.02. Therefore, the stock still remained slightly overfished (Figure 3.2.2.3.2). Figure 3.2.2.3.1 shows the ASPIC estimated relative F trajectory.

3.2.2.5. Measures of Parameter Uncertainty

Initial runs with 1000 bootstraps showed no difference between the 10-90th and 50th percentiles when compared with 500 bootstrap run. Therefore, to reduce computation time 500 bootstraps were selected for the analysis. Figure 3.2.2.3.1 shows relative F (F/F_{MSY}) and relative biomass (B/B_{MSY}) with the estimated 10-90th percentiles.

3.2.2.6. Retrospective and Sensitivity Analyses

Sensitivities were run for three initial values of B_1/K (0.2, 0.5, 1.0) and two additional levels of discard mortality (0% and 40%), given that 20% discard mortality was chosen for the base case. ASPIC estimates of relative B and relative F showed little differences between the base model and the sensitivities (Figures 3.2.2.6.1 and 3.2.2.6.2).

Table 3.2.2.6.1 summarizes the estimated parameters for the base case and the sensitivities. ASPIC runs with starting conditions for B_1/K=1 for release mortality 20% and 40% did not produce feasible results ($B_1/K > 1$, total objective function approximately doubled the value of previous runs).

In general, the model reached similar values for the estimated parameters for all initial conditions and release mortalities. Estimated carrying capacity K ranged from 19.9 to 21.5 million lbs, while MSY ranged from 4.11 to 5.67 million lbs. In general, higher levels of release mortality resulted in higher estimates of K, MSY and F_{MSY} and lower estimates of B_{MSY}. By assuming a release mortality of 40% the stock biomass at the beginning of the time series (1986) should have been very close to the virgin biomass (K). Conversely, a 0% release mortality indicated that the stock biomass was approximately 68% of the virgin biomass in 1986. Basically, higher levels of release mortality resulted in higher yields that required B_1 to correspond to higher proportions of K. Similarly, the estimated relative biomass assuming 40% release mortality is larger than that estimated with lower release mortalities (i.e., 20% and 0%). This model result indicated that for higher levels of release mortality, the greater amberjack stock is required to have higher productivity to sustain the observed levels of yield. However, all the results obtained using the different levels of release mortality showed the same trend.

3.3. Model 3: State-Space Age-Structured Production Model (SSASPM)

The SSASPM represents a step-up in model complexity from the a surplus production model, such as ASPIC, because it can incorporate age-specific differences in model parameters such as growth, fecundity, and gear vulnerability (selectivity). In the case where there are multiple fisheries that exploit different age classes, having the flexibility to incorporate age-specific information could lead to a better fit to observation data.

3.3.1. Model 3: State-Space Age-Structured Production Model Methods

3.3.1.1. Overview

A Bayesian implementation of a State-Space Age-Structured Production Model (SSASPM) developed by Porch (2002) was applied to greater amberjack (Diaz et al. 2005; SEDAR9-AW5-REV). Currently, this age structure production model allows specification of age-specific vectors for fecundity, maturity, and selectivity. Length and weight at age are calculated within the model based on user-specified growth functions. In addition, one can specify or estimate a level of historical fishing with one of three trends (constant, linear or exponential) to be in equilibrium at that level of fishing.

3.3.1.2. Data Sources

Statistics of the commercial handline fishery extends back to 1963 while data for the commercial handline fishery are only available since 1979. In the case of the recreational fishery, landings of the headboat fishery are available from 1986 and from MRFSS since 1981. ‘Historical’ catches for the recreational sector were estimated for the period 1963-1980 (G. Scott, pers. comm.) assuming that the fishery evolved following a pattern similar to the handline fishery during the same period and as a function of coastal population size (Table 3.3.1.2.1). Greater amberjack catches of the longline fishery were assumed to be 100 lbs. prior to 1979.

3.3.1.3. Model Configuration and Equations

A thorough explanation of the SSASPM model and equations is given in Porch (SEDAR-RD17). Values of input parameters followed the selections made by the SEDAR9-DW (Table 3.3.1.3.1). Following Thompson et al. (1991), age 3 was selected as age of 50% maturity. Batch fecundity (BF) was estimated as a function of age as BF = 458.601 * Age + 254,065 (Harris at al. 2004). Although batch fecundity was used in the current assessment, any future assessment requiring an estimate of egg production would need to use total annual fecundity at age, which would be estimated from Harris (2004) as the batch fecundity multiplied by 12 (number of batches spawned over a spawning season). Sex ratio was assumed to be 1:1. The SEDAR9-DW recommended a prior density function on steepness be lognormal with a mode of 0.7. Fishery specific selectivity at age was estimated from length samples (all years combined). A natural mortality of 0.25 and 0% discard mortality were chosen as input values for the base model. Results from exploratory runs showed that the program behaved better if it estimated effort only for the period 1963-1967. This effort was estimated assuming a linear increase. Catches for the historic period 1963-1980 were down weighted compared to the rest of the catch series. Because there was no index reflecting the abundance of age 0 fish (e.g. shrimp bycatch data), all runs were performed without attempting to estimate any annual recruitment deviation.

3.3.1.4. Parameters Estimated

SSASPM estimates fishing mortality rates, yield, and spawning stock biomass. Once the final values have been identified, then the benchmarks can be calculated.

3.3.1.5. Uncertainty and Measures of Precision

The point estimates for model parameters obtained from each model run minimize the overall objective function. Likelihood profiling was used to characterize the uncertainty of α (maximum lifetime reproductive rate), R0 (virgin recruitment), and estimates of current spawning stock biomass (SSB_{2004}) and fishing mortality rate (F_{2004}).

3.3.2. Model 3: State-Space Age-Structured Production Model Results

3.3.2.1. Measures of Overall Model Fit

Initial runs of the SSASPM were performed assuming natural mortality M= 0.25 and 0.35). Generally, model runs performed adequately. Figure 3.3.2.1.1 shows the estimated and observed yield and CPUE series for the base model (M=0.25). Estimated yield showed a fairly good fit to the observed values. However, the fit to the indices of abundance was poor, particularly for the recreational fisheries.

3.3.2.2. Parameter estimates

SSASPM estimated parameters and relative benchmarks are presented in Table 3.3.2.2.1.

3.3.2.3. Stock Abundance and Recruitment

SSASPM estimated that stock abundance remained approximately constant from the initiation of the time series (1963 corresponded to the assumed virgin level) until the early 1980's, followed by a sharp decline that continued until 1995 when the stock was 50% of the virgin level. Afterwards, a period of recovery started and continued until early 2002 when the stock improved to 60% of the virgin level. Years 2003 and 2004 showed little change with respect to 2002. SSASPM estimated that recruits followed a similar trend as the stock biomass. Lowest estimated level of recruits was in 1996 and corresponded to 73% of the virgin level. The recovery period followed and in 2004 the level of recruits was 83% of the virgin level and 4% higher than recruitment at MSY.

3.3.2.4. Spawning Stock Biomass

SSASPM estimated at the virgin level, SSB_{virgin}=2.13E+11, while SSB_{MSY} was about 36% of SSB_{virgin} (SSB_{MSY}=7.65E+10) and SSB_{2004} was about 9% higher than SSB_{MSY} (SSB_{2004}=8.35E+10). Based on MSST [(1-M)*SSB_{MSY}], the greater amberjack stock approached an overfished condition in the mid-1990s (Figure 3.3.2.4.1) but has never exceeded the overfished threshold (Figure 3.3.2.4.2). The model estimated that the stock is currently almost 2/3 depleted (SSB_{2004}/SSB_{virgin}=0.36). Relative SSB to different benchmarks are presented in Table 3.3.2.2.1.

3.3.2.5. Fishing Mortality

SSASPM estimated fishing mortality F is presented in Figure 3.3.2.4.1. Estimated F_{MSY}=0.22 and current level of F_{2004}=0.21 (Table 3.3.2.2.1) indicated that the stock is currently not undergoing overfishing (Figure 3.3.2.4.2). Using F_{MSY} as a benchmark, overfishing conditions started in 1987 and continued until 1997, with the exception of 1988 and 1990 (Figure 3.3.2.4.1). Relative F remained approximately constant at ~0.75 from 1998 to 2001, followed by a significant increase in 2002 and 2003. Year 2004 showed a slight decline in relative F (F_{2004}/F_{MSY}=0.96). Relative F to different benchmarks is presented in Table 3.3.2.2.1.

3.3.2.6. Stock-Recruitment Parameters

SSASPM estimated a lower steepness (h=0.63) than the mean value of the prior (h=0.7). While this suggests that the data contained information that stock resiliency was lower than implied by the prior, the prior mode is contained within the 95% likelihood profile confidence interval.

3.3.2.7. Measures of Parameter Uncertainty

As mentioned in Section 3.3.1.5, uncertainty was examined by developing likelihood profiles for α (maximum lifetime reproductive rate), R0 (virgin recruitment), and for estimates of current spawning stock biomass (SSB_{2004}) and fishing mortality rate (F_{2004}). The prior on α was lognormal and the peak (9.33) corresponded to a steepness of 0.7, while the mode of the likelihood profile (6.2) corresponded to a steepness of 0.61. While this suggested that the data contained information that the stock resiliency was lower than implied by the prior, the prior mode was contained within the 95% likelihood profile confidence interval.

3.3.2.8. Retrospective and Sensitivity Analyses

Sensitivities were run for: 1) two additional levels of natural mortality (M=0.2 and M=0.35) with the same steepness prior (mean=0.7, CV=0.35) of the base model; 2) the base case natural mortality (M=0.25) and steepness prior with two different mean values (0.8 and 0.9); and 3) the natural mortality and steepness of the base model and age of 50% selectivity of each gear reduced by one year. Table 3.3.2.8.1 shows SSASPM estimated parameters for different levels of M and steepness. Sensitivities for different levels of natural mortality showed similar trends and stock status estimates (Figure 3.3.2.8.1). Overfishing conditions started in 1986 and the stock became overfished around 1991. Relative SSB showed that a period of recovery started around the mid 90's and overfishing did not occur after 1998. However, a decline in relative SSB was observed for the last two years of the series. Higher steepness implies greater stock resilience. At the upper limit a steepness of 1 would imply constant recruitment. The model showed that at higher steepness the status of the stock is better (Table 3.3.2.8.1). For example, for a steepness of 0.9, which implies a highly resilient stock, the model estimated that the stock was never overfished and never experienced overfishing (Figure 3.3.2.8.2). To test the sensitivity of the results to gear selectivity, an additional run was performed for the base case reducing the age at 50% selectivity of each gear by one year. The results (Figure 3.3.2.8.3) indicated that reducing the age at 50% selectivity did not change the relative SSB and F trends. However, unlike the original selectivity, the alternative selectivity shows a scenario where the stock did not recover from its overfished condition and overfishing still occurs.

4. Models Comparison

4.1. Compare and Contrast Models Considered

The Continuity Case-VPA and Preferred Case-VPA both indicated that greater amberjack are overfished and that overfishing is still occurring in 2004 (Figures 3.1.2.4.1 and 3.1.2.4.2).

Overall, both VPA's estimated $F_{2004}/F_{30\text{-}40\%SPR}$ to be 2.12-4.70 (Tables 3.1.2.2.1a,b) and $SSB_{2004}/SSB_{30\text{-}40\%SPR}$ to be 0.29-0.44 (Tables 3.1.2.2.1a,b). The accuracy of the VPA results were questioned, however, since the catch-at-age matrix is not known exactly due to reliance on assigning fish to an age based on their length using a compromised age-slicing method.

Based on the ASPIC model, the greater amberjack stock has experienced overfishing ($F/F_{MSY} > 1.0$) conditions since at least 1986 (except 1988 and 1990) and it has been overfished ($B/B_{MSY} < 0.75$) since 1990 (Figure 3.2.2.3.1). Relative SSB showed that a period of recovery started in 1998, two years after the implementation of the one fish bag limit for the recreational fishery. Although the recovery period continued until the present, the greater amberjack stock still remains overfished and overfishing is still occurring (Figure 3.2.2.3.2).

Based on SSASPM, overfishing conditions began in 1986 and persisted through 1997 (except 1988 and 1990) but the stock was not undergoing overfishing in 2004 (Figure 3.3.2.4.2). In addition, SSASPM results indicated that the greater amberjack stock has never been overfished through the period of 1963 to 2004 (Figure 3.3.2.4.2).

4.2. Preferred Model Recommendation

The SEDAR9-AW preferred the use of ASPIC, the non-equilibrium production model, for assessing the stock status of greater amberjack in the Gulf of Mexico. This was primarily due to the VPA and SSASPM being reliant on a catch-at-age matrix or age-specific vectors, respectively, when there was considerable uncertainty in assigning age to amberjack using an age-slicing approach. Differences between the selectivity patterns estimated by VPA and SSASPM were also considerable for ages 1-3 (Figure 3.1.2.5.1). Whereas the Preferred Case-VPA indicated that the greater amberjack stock was undergoing overfishing and was overfished in 2004 (Figure 3.1.2.4.2), SSASPM indicated that the stock had never been overfished and that overfishing was not occurring in 2004 (Figure 3.3.2.4.2). The divergent status of the stock based on these latter two models further indicated problems in relying on a stock assessment model based on age-specific parameters, since they currently may not be well enough defined for the greater amberjack stock in the U.S. Gulf of Mexico.

5. Biological Reference Points (SFA Parameters)

5.1. Existing Definitions and Standards

Status determination criteria include a Minimum Stock Size Threshold (MSST), i.e., the overfished criterion, and a Maximum Fishing Mortality Threshold (MFMT), i.e., the overfishing criterion.

Amendment 22 (May 2004) of the Gulf Council's Reef Fish Fishery Management Plan provides the preferred definitions of the overfishing criterion (MFMT) and overfished criterion (MSST) for the Gulf of Mexico reef fish stocks. Within that amendment, MSST is defined as: (1-M) *B_{MSY} , where M is the adult natural mortality rate (M=0.25) of greater amberjack, and greater amberjack MFMT is equal to F_{MSY}. As such, the greater amberjack stock would be considered undergoing overfishing if F_{CURR} is greater than MFMT (F_{MSY}) and the greater amberjack stock would be considered overfished if B_{CURR} is less than MSST.

For overfished stocks, a recovery plan must be developed to end overfishing and restore the stock to the biomass level (B_{MSY}) capable of producing maximum sustainable yield (MSY) on a continuing basis. Rebuilding is to occur in as short a time period as possible, but should not exceed 10 years unless conditions dictate otherwise.

5.2. Results

5.2.1. Overfishing Definitions and Recommendations

Under the Council's preferred definition for MFMT (overfishing criterion), the greater amberjack resource in the U.S. Gulf of Mexico is still considered to be undergoing overfishing, with F_{2004}/F_{msy} = 1.017, therefore exceeding the MFMT (Figure 3.2.2.3.2).

5.2.2. Overfished Definitions and Recommendations

Under the Council's preferred definition for MSST (overfished criterion), the greater amberjack resource in the U.S. Gulf of Mexico is considered to be overfished, with B_{2004} /B_{msy} = 0.706, where MSST = 0.75B_{msy} (Figure 3.2.2.3.2).

5.2.3. Control Rule and Recommendations

Greater amberjack in the Gulf of Mexico are under a rebuilding plan implemented in June 2003 under Secretarial Amendment 2. The rebuilding time period is specified as 7 years, with year one specified as 2003. Progress toward the rebuilding goal is addressed in Section 6.3.1 below.

6. Projections and Management Impacts

6.1. Projection Methods and Assumptions

Using ASPIC, the case of 20% release mortality and an initial value of B_1/K=0.5 was chosen for bootstrap (500 runs) and projection analysis. Relative biomass projections for the years 2005-2020 were obtained for 1) different scenarios of future F/F_{2004} (values from 0.5 to 1 by 0.1 intervals) and 2) by keeping the 2004 catch constant (yield + 20% discards).

6.2. Projection Results

The estimated relative biomass (B/B_{MSY}) with the 10^{th}-90^{th} percentiles of the bootstrap, as well as projected values under different values of F/F_{2004}, are shown in Figure 6.2.1., with projections in Table 6.2.1. Projections indicate that the greater amberjack stock will not recover to B_{MSY} at current F within year 2020 (B_{2020}/B_{MSY}= 0.98). Recovery to B_{MSY} could occur between 2006 and 2008 depending on the reduction of fishing mortality from its current level (F=0.49) (i.e., in the year 2008 with an F of 90% of F_{2004}) (Table 6.2.1). Figure 6.2.2 presents the control rule plot for $F_{2005\text{-}2020}=F_{2004}$ (status quo F scenario), indicating that under the current estimated levels of F that the greater amberjack stock is projected to remain overfished and overfishing is projected to continue. Table 6.2.2 presents projected yields under different scenarios of constant F/F_{2004}.

Projections under constant yield showed a more optimistic view and if the current catch (yield + 20% discard mortality) of 3.67 million lbs is kept constant, then the greater amberjack stock is projected to recover from the overfished condition by the year 2007 (Figure 6.2.3) and overfishing will not occur after 2004 (Figure 6.2.4). The recovery is projected to reach a plateau at a relative biomass of 1.48 by the year 2017.

6.3 Past Regulatory Actions and Impacts

6.3.1. Evaluation of the Rebuilding Plan

The greater amberjack stock in the U.S. Gulf of Mexico is not predicted to recover to B_{MSY}, nor is overfishing predicted to be curtailed, within the timeframe of the current rebuilding plan (year 2010) based on projections of current exploitation (F). The goal of rebuilding the stock by 2010 can be obtained by reducing F to 90% of current F; under such a scenario biomass will exceed the rebuilding target (i.e., B/B_{MSY} >1) in 2008 (Table 3.2.2.8.1). Alternatively, the biomass rebuilding target (Bmsy) can be achieved by 2007 under a constant current catch strategy (Figure 6.2.3).

7. Research Recommendations

- age-length keys representative of all sectors and regions of the fishery in the U.S. Gulf of Mexico (in part being addressed by current MARFIN NA05NMF4331071).

- reproductive parameters, such as age of sexual maturity and fecundity at age for the Gulf of Mexico stock of amberjack (age at maturity being addressed by current MARFIN NA05NMF4331071).

- fishery-specific release mortality

8. Literature Cited

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9. List of Tables

10. List of Figures

Table 3.1.1.2.1. Catch-at-age (numbers) used in the Continuity Case-VPA.

	Age					
Year	0	1	2	3	4	5+
1987	130751	249214	123367	56446	20499	29879
1988	89205	223268	176072	52855	18260	22629
1989	86820	224426	99856	97260	43279	43686
1990	28795	47513	36357	27664	18736	19775
1991	21847	76853	136509	94833	21427	25490
1992	17285	39515	134388	85111	19777	15248
1993	17603	53162	86816	97076	49583	25571
1994	19534	41502	74783	69807	26389	25941
1995	23588	41295	65082	35615	23545	13402
1996	10506	32226	92495	63800	23168	16107
1997	15213	28193	30310	28726	17306	11032
1998	15522	33122	43889	21727	11836	13834
1999	15250	30769	45329	16358	5666	12752
2000	32362	51476	76365	38104	16777	9018
2001	132444	170716	171961	26685	12048	16130
2002	68392	93485	160457	59266	17087	12992
2003	64681	89895	176721	66146	28287	16929
2004	42199	68573	118412	64474	36419	16002

Table 3.1.1.2.2. New yearly age-slicing limits (cm, fork length, integer value).

Age Class	lower limit	upper limit
0	0	43
1	44	64
2	65	80
3	81	93
4	94	103
5+	104	Infinity

Table 3.1.1.2.3. Catch-at-age used for the Preferred Case-VPA.

Year	Age 0	1	2	3	4	5+
1987	125230	277383	105245	52868	21164	28274
1988	102275	261124	150179	28024	20288	20399
1989	101156	226032	107564	83867	34608	42105
1990	32434	45666	36565	25766	18710	19287
1991	32658	74672	178331	50353	16787	24156
1992	22508	39647	175442	42273	16850	14509
1993	22836	52596	96665	101003	34190	22300
1994	24285	40463	90713	56562	22288	23609
1995	27397	40395	67221	31474	23407	12520
1996	12516	33236	116783	35862	24945	14799
1997	19282	26823	30772	27778	15207	10888
1998	26245	31391	38636	18339	12093	13168
1999	23462	29041	45909	9607	5877	12122
2000	44919	49117	69827	36118	15213	8722
2001	184311	152308	148384	18040	12340	14582
2002	92070	87545	164871	42603	12162	12028
2003	88269	84824	175732	51269	26789	15550
2004	64525	64152	110559	57753	35450	13289

Table 3.1.1.2.4. Biological parameters used for VPA and projection runs.

Natural mortality	Assumed to be 0.25 for all ages
Assumed "birth date" of age 0 fish	Continuity Case: June Preferred Case/Option 4: April 1 (also approximate mid-point of the peak spawning season)
Plus group	Age 5+
Growth rates	Length at age was calculated from the Thompson *et al.* (1999) growth equation: $FL_{(cm)} = 138.9 * (1 - \exp^{(-0.246 * (t-(-0.79)))})$
Weights at age	Average weights-at-age were based on the Thompson *et al.* (1999) growth equation and the Manooch and Potts (1997) length-weight relationship: $W_{(kg)} = 5.3 \times 10^{-8} *(L_{(cm)} * 10)^{2.976}$ For historical catches only, the following values were used: age: 0, 1, 2, 3, 4, 5+ $weight_{(lbs)}$ (mid-year and peak spawning, Continuity Case[1]): 2.04, 7.42, 15.13, 23.8, 32.43, 47.43 $weight_{(lbs)}$ (mid-year, Preferred Case/Option 4[2]): 0.98, 5.30, 12.39, 20.87, 29.60, 45.17 $weight_{(lbs)}$ (peak spawning, Preferred Case/Option 4[2]): 0.61, 4.35, 11.07, 19.41, 28.16, 43.59 [1] Continuity Case calculated predicted length using a birth date of Jan 1. [2] Preferred Case/Option 4 calculated predicted length using a birth date of April 1.
Maturity schedule	age: 0, 1, 2, 3, 4, 5+ 0, 0, 0, 0.5, 1.0, 1.0
Fecundity at age	Weight at age is used as a proxy for fecundity at age

Table 3.1.2.2.1a. Continuity Case-VPA benchmarks.

ref:	F2004	Fmax	F0.1	F20%	F30%	F40%
	0.669	0.285	0.170	0.279	0.196	0.142
F2004/ref	1	2.34	3.93	2.39	3.41	4.70
Fcurrent	0.605					
Fcurrent/ref	1	2.12	3.55	2.16	3.08	4.25
ref:	SSB2004	SSBmax	SSB0.1	SSB20%	SSB30%	SSB40%
	5219	8729	15350	8972	13410	17870
SSB2004/ref	1	0.60	0.34	0.58	0.39	0.29

Table 3.1.2.2.1b. Preferred Case-VPA (Option 4) benchmarks.

ref:	F2004	Fmax	F0.1	F20%	F30%	F40%
	0.522	0.330	0.209	0.349	0.247	0.181
F2004/ref	1	1.58	2.50	1.50	2.12	2.89
Fcurrent	0.548					
Fcurrent/ref	1	1.662	2.626	1.571	2.221	3.034
ref:	SSB2004	SSBmax	SSB0.1	SSB20%	SSB30%	SSB40%
	5877	9479	15530	8815	13210	17560
SSB2004/ref	1	0.62	0.38	0.67	0.44	0.33

Table 3.1.2.2.1a. Projected yield (lbs) based on the Continuity case-VPA for 2007-2009.

Scenario	Percentile	Year 2007	2008	2009
F30%	10th	290,900	505,200	666,400
	25th	410,500	661,200	907,000
	Median	656,600	1,085,000	1,448,000
	75th	1,159,000	1,636,000	2,212,000
	90th	1,920,000	2,516,000	3,100,000
F40%	10th	214,700	387,500	530,300
	25th	302,800	514,500	721,200
	Median	487,700	831,700	1,148,000
	75th	856,400	1,260,000	1,751,000
	90th	1,416,000	1,923,000	2,450,000

Table 3.1.2.2.1b. Projected yield (lbs) based on the Preferred case-VPA (Option 4) for 2007-2009.

Scenario	Percentile	Year 2007	2008	2009
F30%	10th	362,200	500,900	657,600
	25th	568,500	848,400	1,131,000
	Median	1,181,000	1,520,000	1,890,000
	75th	2,239,000	2,511,000	2,913,000
	90th	3,552,000	3,731,000	4,108,000
F40%	10th	271,700	386,700	535,200
	25th	425,100	658,700	913,500
	Median	879,200	1,180,000	1,518,000
	75th	1,654,000	1,957,000	2,353,000
	90th	2,619,000	2,895,000	3,287,000

Table 3.1.2.2.3a. Projected yield (in thousands of lbs) for the Continuity case-VPA.

	F30% scenario			F40% scenario		
	10th percentile	median	90th percentile	10th percentile	Median	90th percentile
2007	289	657	1,936	214	488	1,432
2008	495	1,085	2,519	378	832	1,943
2009	662	1,448	3,123	530	1,148	2,472
2010	908	1,899	3,562	747	1,560	2,906
2011	1,287	2,337	4,181	1,054	1,971	3,460
2012	1,665	2,786	4,578	1,409	2,368	3,862
2013	1,981	3,114	5,019	1,717	2,683	4,320
2014	2,211	3,334	5,422	1,930	2,926	4,642
2015	2,380	3,501	5,571	2,089	3,075	4,870
2016	2,579	3,639	5,634	2,318	3,220	5,025
2017	2,661	3,779	5,660	2,392	3,373	5,014
2018	2,767	3,935	5,837	2,490	3,534	5,111
2019	2,751	3,990	5,751	2,516	3,573	5,126
2020	2,817	4,060	5,962	2,608	3,650	5,232
2021	2,919	4,062	5,847	2,679	3,700	5,365
2022	2,945	4,035	5,778	2,744	3,691	5,201
2023	3,004	4,028	5,923	2,762	3,683	5,359
2024	2,984	4,049	5,904	2,804	3,709	5,366
2025	3,019	4,135	5,795	2,781	3,808	5,242
2026	2,875	4,100	5,823	2,740	3,758	5,195

Table 3.1.2.2.3b. Projected yield (in thousands of lbs) for the Preferred case-VPA.

	F30% scenario			F40% scenario		
	10th percentile	median	90th percentile	10th percentile	median	90th percentile
2007	359	1,181	3,635	268	879	2,683
2008	500	1,520	3,737	387	1,180	2,904
2009	650	1,890	4,112	527	1,518	3,312
2010	939	2,181	4,215	801	1,806	3,478
2011	1,327	2,621	4,525	1,134	2,186	3,831
2012	1,631	2,871	4,572	1,406	2,477	3,911
2013	1,850	3,051	4,730	1,603	2,665	4,201
2014	2,054	3,196	4,915	1,811	2,826	4,353
2015	2,158	3,309	4,904	1,936	2,979	4,371
2016	2,227	3,359	4,961	2,014	3,036	4,474
2017	2,341	3,377	5,124	2,147	3,063	4,588
2018	2,433	3,464	5,324	2,234	3,164	4,806
2019	2,415	3,551	5,205	2,239	3,258	4,672
2020	2,458	3,565	5,494	2,297	3,270	4,956
2021	2,491	3,573	5,341	2,306	3,296	4,822
2022	2,486	3,574	5,254	2,341	3,314	4,840
2023	2,572	3,542	5,227	2,404	3,302	4,773
2024	2,631	3,579	5,260	2,438	3,317	4,780
2025	2,629	3,633	5,145	2,452	3,366	4,720
2026	2,570	3,642	5,073	2,426	3,345	4,699

Table 3.1.2.3.1. Abundance at the beginning of the year for the Continuity case-VPA.

	Age					
Year	0	1	2	3	4	5+
1987	852998	833026	358243	154410	69016	100596
1988	871339	549681	431250	171498	71107	88120
1989	882588	600282	234003	182808	87446	88268
1990	754508	611126	272153	95510	58310	61543
1991	558314	562290	434204	180059	50230	59755
1992	459561	415602	370500	219077	58244	44906
1993	497141	342707	288971	171521	96577	49807
1994	421896	371694	220293	149281	49832	48986
1995	229951	311397	253047	106387	55737	31726
1996	325358	158377	206290	140191	51809	36019
1997	329497	244148	95131	80396	53834	34317
1998	395718	243237	165399	47651	37593	43939
1999	725765	294537	160380	90463	18263	41104
2000	996546	551808	202373	85320	56122	30167
2001	989320	747645	384543	91147	33379	44689
2002	653153	654303	432923	150253	47689	36260
2003	524544	448635	427584	197477	65472	39183
2004	308711	351758	270691	179421	96136	42241
2005		203410	213900	108012	83583	62149

Table 3.1.2.3.2. Abundance at the beginning of the year for the Preferred case-VPA.

	Age					
Year	0	1	2	3	4	5+
1987	887842	805169	280014	162426	68143	91036
1988	766157	581618	385355	126474	80397	80837
1989	806527	506964	226377	169476	73978	90003
1990	819361	539366	198660	83075	59367	61198
1991	551773	609600	379948	122687	42219	60752
1992	493885	401015	409235	141301	51784	44589
1993	423445	364849	277500	166340	73150	47711
1994	468538	309704	238020	131897	42622	45148
1995	231079	343550	205699	106433	53597	28668
1996	289690	155921	232107	101586	55417	32877
1997	336942	214606	92343	79682	47875	34278
1998	349518	245461	143601	45091	37855	41220
1999	656885	249146	163624	78081	19175	39551
2000	1038722	490947	168548	87336	52380	30031
2001	1030468	769462	339224	70584	36629	43284
2002	727552	641053	465895	135365	39203	38771
2003	669971	485834	422462	219221	68259	39622
2004	573170	444337	304044	176309	125887	47191
2005		389750	289791	140519	86954	92228

Table 3.1.2.4.1a. Projected SSB/SSB_{40} for the Continuity case-VPA.

Year	F30% scenario			F40% scenario		
	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile
2007	0.03	0.07	0.28	0.03	0.07	0.29
2008	0.05	0.12	0.39	0.06	0.12	0.42
2009	0.11	0.23	0.56	0.12	0.26	0.63
2010	0.15	0.34	0.71	0.18	0.40	0.83
2011	0.19	0.42	0.81	0.23	0.50	0.98
2012	0.27	0.52	0.93	0.33	0.64	1.13
2013	0.37	0.63	1.05	0.47	0.77	1.31
2014	0.45	0.69	1.13	0.58	0.87	1.42
2015	0.50	0.76	1.19	0.64	0.96	1.51
2016	0.52	0.80	1.27	0.67	1.02	1.63
2017	0.56	0.82	1.32	0.74	1.06	1.68
2018	0.58	0.84	1.29	0.77	1.09	1.70
2019	0.61	0.88	1.28	0.80	1.15	1.66
2020	0.62	0.89	1.29	0.82	1.17	1.67
2021	0.62	0.91	1.29	0.82	1.19	1.72
2022	0.64	0.91	1.34	0.86	1.21	1.75
2023	0.64	0.90	1.34	0.86	1.20	1.74
2024	0.65	0.89	1.34	0.88	1.19	1.73
2025	0.66	0.90	1.32	0.90	1.19	1.75
2026	0.66	0.90	1.32	0.90	1.21	1.73

Table 3.1.2.4.1b. Projected SSB/SSB40 for the Preferred case-VPA.

Year	F30% scenario			F40% scenario		
	10th percentile	Median	90th percentile	10th percentile	median	90th percentile
2007	0.04	0.20	0.74	0.04	0.20	0.76
2008	0.07	0.27	0.84	0.07	0.28	0.90
2009	0.11	0.35	0.90	0.13	0.40	1.01
2010	0.16	0.47	0.98	0.18	0.54	1.15
2011	0.22	0.54	1.04	0.26	0.65	1.24
2012	0.32	0.63	1.05	0.39	0.77	1.29
2013	0.41	0.70	1.11	0.52	0.88	1.38
2014	0.47	0.76	1.17	0.60	0.98	1.48
2015	0.51	0.82	1.19	0.67	1.05	1.53
2016	0.54	0.83	1.28	0.71	1.08	1.61
2017	0.57	0.85	1.33	0.75	1.10	1.71
2018	0.59	0.86	1.31	0.78	1.12	1.70
2019	0.62	0.88	1.29	0.83	1.15	1.67
2020	0.63	0.90	1.29	0.83	1.18	1.69
2021	0.63	0.90	1.30	0.84	1.19	1.70
2022	0.65	0.91	1.34	0.86	1.21	1.75
2023	0.65	0.90	1.32	0.88	1.20	1.71
2024	0.65	0.90	1.33	0.88	1.19	1.73
2025	0.66	0.90	1.31	0.90	1.20	1.73
2026	0.67	0.90	1.31	0.90	1.21	1.73

Table 3.1.2.6.1. Fishing mortality rates for the Continuity case-VPA.

	Age					
Year	0	1	2	3	4	5+
1987	0.189	0.408	0.487	0.525	0.405	0.405
1988	0.123	0.604	0.608	0.424	0.34	0.34
1989	0.118	0.541	0.646	0.893	0.799	0.799
1990	0.044	0.092	0.163	0.393	0.446	0.446
1991	0.045	0.167	0.434	0.879	0.646	0.646
1992	0.043	0.113	0.52	0.569	0.478	0.478
1993	0.041	0.192	0.41	0.986	0.845	0.845
1994	0.054	0.134	0.478	0.735	0.886	0.886
1995	0.123	0.162	0.341	0.47	0.637	0.637
1996	0.037	0.26	0.692	0.707	0.69	0.69
1997	0.054	0.139	0.441	0.51	0.446	0.446
1998	0.045	0.166	0.353	0.709	0.435	0.435
1999	0.024	0.125	0.381	0.227	0.427	0.427
2000	0.037	0.111	0.548	0.688	0.408	0.408
2001	0.163	0.296	0.69	0.398	0.517	0.517
2002	0.126	0.175	0.535	0.581	0.512	0.512
2003	0.15	0.255	0.618	0.47	0.657	0.657
2004	0.167	0.247	0.669	0.514	0.55	0.55

Table 3.1.2.6.2. Fishing mortality rates for the Preferred case-VPA.

	Age					
Year	0	1	2	3	4	5+
1987	0.173	0.487	0.545	0.453	0.428	0.428
1988	0.163	0.694	0.571	0.286	0.333	0.333
1989	0.152	0.687	0.752	0.799	0.736	0.736
1990	0.046	0.1	0.232	0.427	0.435	0.435
1991	0.069	0.149	0.739	0.613	0.587	0.587
1992	0.053	0.118	0.65	0.408	0.453	0.453
1993	0.063	0.177	0.494	1.112	0.735	0.735
1994	0.06	0.159	0.555	0.651	0.869	0.869
1995	0.143	0.142	0.456	0.403	0.667	0.667
1996	0.05	0.274	0.819	0.502	0.696	0.696
1997	0.067	0.152	0.467	0.494	0.44	0.44
1998	0.089	0.156	0.359	0.605	0.443	0.443
1999	0.041	0.141	0.378	0.149	0.421	0.421
2000	0.05	0.12	0.62	0.619	0.394	0.394
2001	0.225	0.252	0.669	0.338	0.473	0.473
2002	0.154	0.167	0.504	0.435	0.427	0.427
2003	0.161	0.219	0.624	0.305	0.577	0.577
2004	0.136	0.177	0.522	0.457	0.379	0.379

Table 3.1.2.7.1. Spawning stock fecundity and recruitment for the Continuity case-VPA.

year	spawning biomass	recruits from VPA
1987	6662.	852998.
1988	6610.	871339.
1989	5884.	882588.
1990	4466.	754508.
1991	4409.	558314.
1992	4818.	459561.
1993	4699.	497141.
1994	3630.	421896.
1995	3225.	229951.
1996	3409.	325358.
1997	3219.	329497.
1998	2862.	395718.
1999	2798.	725765.
2000	3156.	996546.
2001	3153.	989320.
2002	3641.	653153.
2003	4467.	524544.
2004	5219.	308711.

Table 3.1.2.7.2. Spawning stock fecundity and recruitment for the Preferred case-VPA (Option 4).

year	spawning biomass	recruits from VPA
1987	5886.	887842.
1988	5786.	766157.
1989	5291.	806527.
1990	4052.	819361.
1991	3712.	551773.
1992	3767.	493885.
1993	3851.	423445.
1994	3017.	468538.
1995	2812.	231079.
1996	2882.	289690.
1997	2835.	336942.
1998	2564.	349518.
1999	2470.	656885.
2000	2857.	1038722.
2001	2825.	1030468.
2002	3258.	727552.
2003	4515.	669971.
2004	5877.	573170.

Table 3.2.1.2.1. Greater amberjack yield (including 20% discard mortality) and estimated indices of abundance for the recreational charterboat-private boat (CB+PB), recreational headboat (HB), commercial handline (HL) and longline (LL) fisheries used as input for ASPIC.

	CB+PB		HB		HL		LL	
	Index	Yield	Index	Yield	Index	Yield	Index	Yield
1986	1.925	5,124,193	2.641	694,998		1,333,090		213,781
1987	1.952	4,664,941	1.179	362,058		1,900,455		271,309
1988	1.243	1,383,742	1.256	210,814		2,522,088		349721
1989	2.911	6,022,928	1.705	247,605		2,413,920		321,830
1990	0.459	1,010,308	0.718	189,954		1,601,474		135,509
1991	1.716	3,687,417	0.564	127,840		2,020,019		6,577
1992	1.472	2,509,589	0.654	340,667		1,388,103		54,733
1993	0.885	3,045,696	0.462	253,723	1.071	2,197,766	0.751	87,012
1994	0.696	2,149,369	0.449	219,087	0.968	1,772,346	0.731	74,705
1995	0.473	778,617	0.718	146,621	1.191	1,736,856	0.927	89,020
1996	0.446	1,407,816	0.513	157,637	0.984	1,785,278	0.626	61,778
1997	0.304	984,974	0.500	126,239	0.764	1,557,058	0.793	64,614
1998	0.277	745,553	0.564	101,582	0.743	949,902	0.725	59,659
1999	0.371	893,017	0.551	85,133	0.877	1,054,547	0.700	65,731
2000	0.547	1,067,442	0.705	99,936	0.889	1,256,012	0.845	76,667
2001	0.588	1,699,666	1.179	103,329	0.956	1,011,507	0.907	52,392
2002	1.182	2,178,511	1.513	213,714	0.909	1,051,417	1.453	84,584
2003	1.033	2,720,301	1.397	201,991	1.367	1,288,963	1.604	136,510
2004	0.520	2,184,881	1.731	111,152	1.280	1,287,059	1.939	89,664

Table 3.2.2.2.1. Estimated parameters by ASPIC, q corresponds to estimated selectivities for the commercial handline (HL), longline (LL), recreational headboat (HB) and charterboat-private boat fisheries (CB+PB).

Parameter	Estimate
B1/K	0.840
MSY	4.815E+06
K	1.987E+07
q HL	2.15E-07
q LL	2.04E-07
q HB	1.47E-07
q CB+PB	1.35E-07
Bmsy	9.937E+06
Fmsy	0.484
B/Bmsy	0.706
F/Fmsy	1.02

Table 3.2.2.6.1. ASPIC estimated parameters for three different initial values of B_1/K and three different levels of discard mortality.

Assumed release mortality	Estimated parameters	Initial input value of B_1/K		
		1.0	0.5	0.2
0%	B_1/K	0.726	0.683	0.664
	MSY	4.113E+06	4.250E+06	4.295E+06
	K	2.025E+07	2.011 E+07	2.037 E+07
	B_{MSY}	1.012 E+07	1.006 E+07	1.018 E+07
	F_{MSY}	0.406	0.422	0.422
	B_{2004}/B_{MSY}	0.641	0.618	0.610
	F_{2004}/F_{MSY}	0.890	0.894	1.122
20%	B_1/K		0.840	0.839
	MSY		4.815 E+06	4.815 E+06
	K		1.987 E+07	1.990 E+07
	B_{MSY}		9.937 E+06	9.948 E+06
	F_{MSY}		0.485	0.484
	B_{2004}/B_{MSY}		0.706	0.691
	F_{2004}/F_{MSY}		1.017	0.961
40%	B_1/K		0.984	0.810
	MSY		5.456 E+06	5.671 E+06
	K		2.075 E+07	2.153 E+07
	B_{MSY}		1.038 E+07	1.076 E+07
	F_{MSY}		0.526	0.527
	B_{2004}/B_{MSY}		0.765	0.721
	F_{2004}/F_{MSY}		0.955	0.966

Table 3.3.1.2.1. Greater amberjack yield (whole weight in lbs) used as input for SSASPM for the period 1963-2004. Refer to text for details on the estimation of the historic data (1963-1980).

	CB+PB		HB		HL		LL	
	Index	Yield	Index	Yield	Index	Yield	Index	Yield
1963		14,318		1,700		7,081		100
1964		17,684		2,100		6,176		100
1965		21,832		2,592		5,053		100
1966		26,939		3,199		6,738		100
1967		3,326		3,945		29,197		100
1968		40,963		4,864		11,510		100
1969		50,480		5,994		72,898		100
1970		62,184		7,384		13,663		100
1971		77,637		9,219		38,461		100
1972		96,827		11,497		41,643		100
1973		120,640		14,325		28,261		100
1974		150,167		17,831		41,736		100
1975		186,754		22,175		78,139		100
1976		232,062		27,555		86,467		100
1977		288,134		34,213		119,870		100
1978		357,487		42,447		150,672		100
1979		443,219		52,627		148,748		2,714
1980		549,141		65,204		173,632		4,754
1981		1,043,546		123,909		212,666		22,450
1982		5,924,108		703,418		184,403		39,106
1983		2,835,244		336,652		233,233		45,571
1984		1,446,678		171,776		465,166		60,616
1985		1,845,062		219,079		645,207		108,229
1986	1.925	4,779,781	2.641	678,660		903,545		196,562
1987	1.952	4,489,630	1.179	359,138		1,288,095		249,456
1988	1.243	1,348,090	1.256	210,334		1,709,427		321,553
1989	2.911	5,679,784	1.705	244,852		1,636,113		295,908
1990	0.459	940,377	0.718	173,795		1,085,450		124,595
1991	1.716	3,427,895	0.564	121,409		1,369,133		6,047
1992	1.472	2,320,599	0.654	330,957		940,832		50,324
1993	0.885	2,847,441	0.462	243,942	1.071	1,489,607	0.751	80,003
1994	0.696	2,043,843	0.449	212,288	0.968	1,201,265	0.731	68,688
1995	0.473	712,905	0.718	142,929	1.191	1,177,210	0.927	81,850
1996	0.446	1,344,207	0.513	151,552	0.984	1,210,030	0.626	56,802
1997	0.304	945,735	0.500	123,054	0.764	1,055,346	0.793	59,410
1998	0.277	646,933	0.564	89,219	0.743	643,827	0.725	54,854
1999	0.371	800,407	0.551	76,351	0.877	714,753	0.700	60,437
2000	0.547	955,546	0.705	96,371	0.889	851,303	0.845	70,492
2001	0.588	1,235,599	1.179	90,583	0.956	685,581	0.907	47,253
2002	1.182	1,887,625	1.513	200,801	0.909	712,632	1.453	77,771
2003	1.033	2,494,241	1.397	194,954	1.367	873,636	1.604	125,515
2004	0.520	2,031,254	1.731	108,785	1.280	872,346	1.939	82,442

Table 3.3.1.3.1. Biological inputs for the SSASPM base model. The value of t_0 was adjusted for a birthday of June 1st.

Parameter	Value	Prior
Maturity	Age 1-2: 0.0 Age 3: 0.5 Age 4+: 1.0	(constant)
Steepness	0.7 (α = 9.33)	LN (mean=0.7 CV=0.35)
R_0	1.00E+04	Uniform [1.0E+03 – 1.0E+06]
M	0.25	(constant)
L_∞	138.9 cm (FL)	(constant)
K	0.25	(constant)
t_0	-0.3773	(constant)
L-W scalar	7.5438E-05	(constant)
L-W exponent	2.81	(constant)
Batch fecundity (at age) slope	458.601	(constant)
Batch fecundity (at age) intercept	254.065	(constant)

Table 3.3.2.2.1. SSASPM estimated parameters and benchmarks for base model (M=0.25 h=0.7).

Type	F	Y/R	SSB/SSB_0	SPR	Recruits	F/F_{MSY}	SSB/SSB_{MSY}
Virgin	0.000	0.00	1.000	1.000	3.70E+05	0.00	2.79
MSY	0.224	9.17	0.358	0.452	2.93E+05	1.00	1.00
Current (2004)	0.214	9.38	0.392	0.475	3.05E+05	0.96	1.09
MAX YPR	0.550	10.40	0.079	0.213	1.38E+05	2.46	0.22
$F_{0.1}$	0.241	9.36	0.334	0.431	2.87E+05	1.08	0.93
20% SPR	0.583	10.40	0.064	0.200	1.18 E+05	2.60	0.18
30% SPR	0.387	10.20	0.181	0.300	2.23 E+05	1.73	0.51
40% SPR	0.268	9.62	0.299	0.400	2.76 E+05	1.20	0.83
50% SPR	0.188	8.66	0.416	0.500	3.07 E+05	0.84	1.16
60% SPR	0.130	7.39	0.533	0.600	3.28 E+05	0.58	1.49

Table 3.3.2.8.1. SSASPM estimated parameters for base model (bold font) and sensitivities.

	F_{MSY}	Y_{MSY}	SSB_{MSY}	SPR_{MSY}	$Recruits_{MSY}$	F_{2004}/F_{MSY}	SSB_{2004}/SSB_{MSY}
M=0.25 h=0.7	**0.224**	**2.69E+06**	**7.65E+10**	**0.452**	**2.93E+05**	**0.96**	**1.09**
M=0.20-h=0.7	0.200	2.61E+06	7.93E+10	0.428	2.29E+05	0.99	1.08
M=0.35-h=0.7	0.259	2.78E+06	7.28E+10	0.495	4.49E+05	0.90	1.13
M=0.25-h=0.8	0.267	2.90E+06	6.95E+10	0.399	3.02E+05	0.68	1.40
M=0.25-h=0.9	0.379	3.63E+06	6.07E+10	0.295	3.56E+05	0.33	2.24

Table 6.2.1. Projected biomass for different values of $F/F_{current}$ for the greater amberjack stock. The column labeled '1' corresponds to projections made with the current level of F; the column labeled '0' has projections with no fishing; and the column labeled '0.9' has projections with F at 90% of the current level.

YEAR	1	0.9	0.8	0.7	0.6	0.5	0
2005	7.852E+06	7.852E+06	7.852E+06	7.852E+06	7.852E+06	7.852E+06	7.852E+06
2006	8.481E+06	8.831E+06	9.194E+06	9.568E+06	9.956E+06	1.036E+07	1.257E+07
2007	8.926E+06	9.534E+06	1.017E+07	1.084E+07	1.153E+07	1.226E+07	1.628E+07
2008	9.226E+06	1.001E+07	1.082E+07	1.167E+07	1.255E+07	1.345E+07	1.834E+07
2009	9.423E+06	1.031E+07	1.122E+07	1.217E+07	1.313E+07	1.412E+07	1.926E+07
2010	9.549E+06	1.049E+07	1.146E+07	1.245E+07	1.346E+07	1.447E+07	1.964E+07
2011	9.630E+06	1.061E+07	1.160E+07	1.261E+07	1.363E+07	1.465E+07	1.978E+07
2012	9.680E+06	1.067E+07	1.168E+07	1.270E+07	1.371E+07	1.474E+07	1.984E+07
2013	9.712E+06	1.072E+07	1.173E+07	1.274E+07	1.376E+07	1.478E+07	1.986E+07
2014	9.732E+06	1.074E+07	1.175E+07	1.277E+07	1.378E+07	1.480E+07	1.987E+07
2015	9.744E+06	1.075E+07	1.177E+07	1.278E+07	1.380E+07	1.481E+07	1.987E+07
2016	9.752E+06	1.076E+07	1.178E+07	1.279E+07	1.380E+07	1.481E+07	1.987E+07
2017	9.757E+06	1.077E+07	1.178E+07	1.279E+07	1.381E+07	1.482E+07	1.987E+07
2018	9.760E+06	1.077E+07	1.178E+07	1.279E+07	1.381E+07	1.482E+07	1.987E+07
2019	9.761E+06	1.077E+07	1.178E+07	1.280E+07	1.381E+07	1.482E+07	1.987E+07
2020	9.763E+06	1.077E+07	1.179E+07	1.280E+07	1.381E+07	1.482E+07	1.987E+07

Table 6.2.2. Projected yield for different values of $F/F_{current}$ for the greater amberjack stock. The column labeled '1' corresponds to projections made with the current level of F; the column labeled '0' has projections with no fishing; and the column labeled '0.9' has projections with F at 90% of the current level.

YEAR	1	0.9	0.8	0.7	0.6	0.5	0
2005	4.034E+06	3.711E+06	3.372E+06	3.017E+06	2.644E+06	2.253E+06	0.000E+00
2006	4.297E+06	4.084E+06	3.830E+06	3.534E+06	3.193E+06	2.802E+06	0.000E+00
2007	4.479E+06	4.342E+06	4.149E+06	3.894E+06	3.573E+06	3.181E+06	0.000E+00
2008	4.600E+06	4.511E+06	4.353E+06	4.120E+06	3.806E+06	3.407E+06	0.000E+00
2009	4.678E+06	4.617E+06	4.477E+06	4.252E+06	3.937E+06	3.529E+06	0.000E+00
2010	4.729E+06	4.683E+06	4.550E+06	4.326E+06	4.008E+06	3.591E+06	0.000E+00
2011	4.760E+06	4.722E+06	4.592E+06	4.368E+06	4.045E+06	3.623E+06	0.000E+00
2012	4.780E+06	4.746E+06	4.617E+06	4.390E+06	4.064E+06	3.638E+06	0.000E+00
2013	4.793E+06	4.760E+06	4.630E+06	4.402E+06	4.074E+06	3.645E+06	0.000E+00
2014	4.801E+06	4.768E+06	4.638E+06	4.408E+06	4.079E+06	3.649E+06	0.000E+00
2015	4.805E+06	4.773E+06	4.642E+06	4.412E+06	4.081E+06	3.651E+06	0.000E+00
2016	4.808E+06	4.776E+06	4.645E+06	4.414E+06	4.083E+06	3.652E+06	0.000E+00
2017	4.810E+06	4.778E+06	4.646E+06	4.415E+06	4.083E+06	3.652E+06	0.000E+00
2018	4.811E+06	4.779E+06	4.647E+06	4.415E+06	4.084E+06	3.652E+06	0.000E+00
2019	4.812E+06	4.780E+06	4.647E+06	4.416E+06	4.084E+06	3.652E+06	0.000E+00

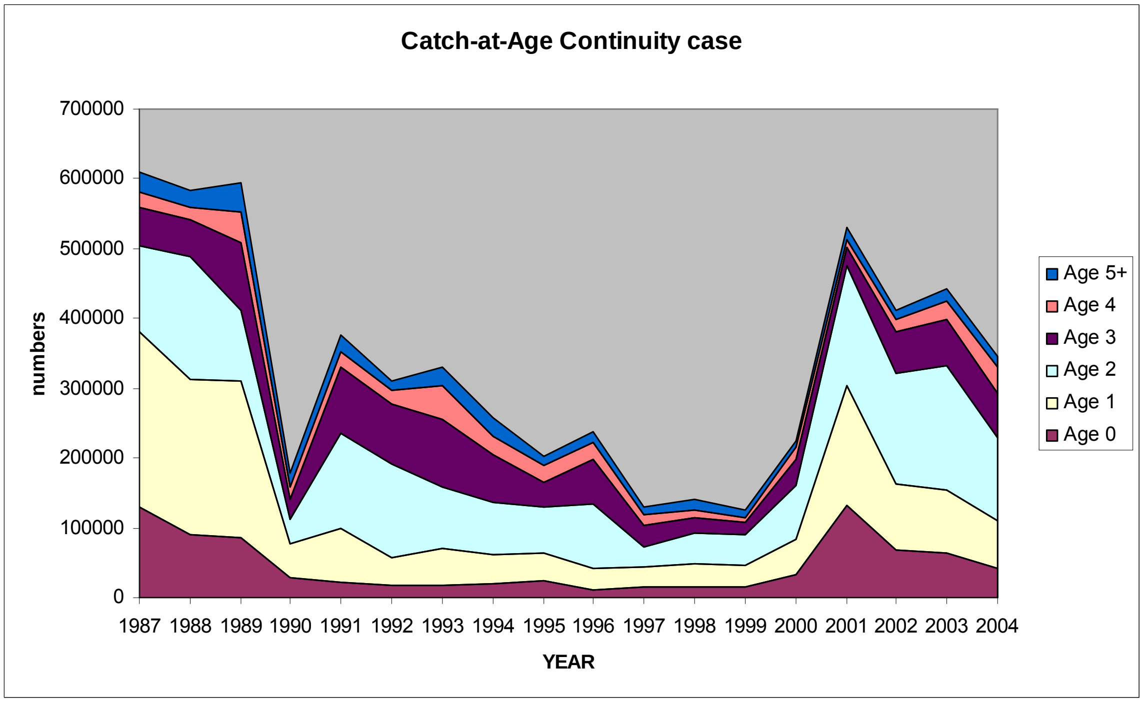

Figure 3.1.1.2.1. Catch-at-age distribution applied in the Continuity Case-VPA model.

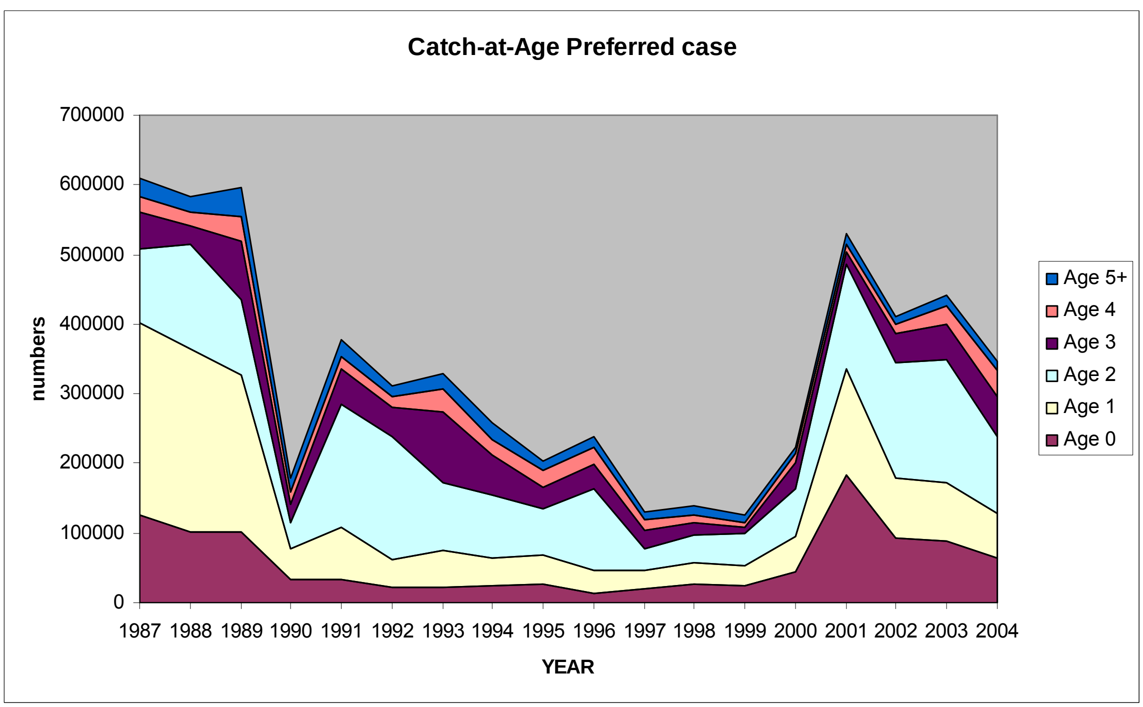

Figure 3.1.1.2.2. Catch-at-age distribution applied in the Preferred Case-VPA model.

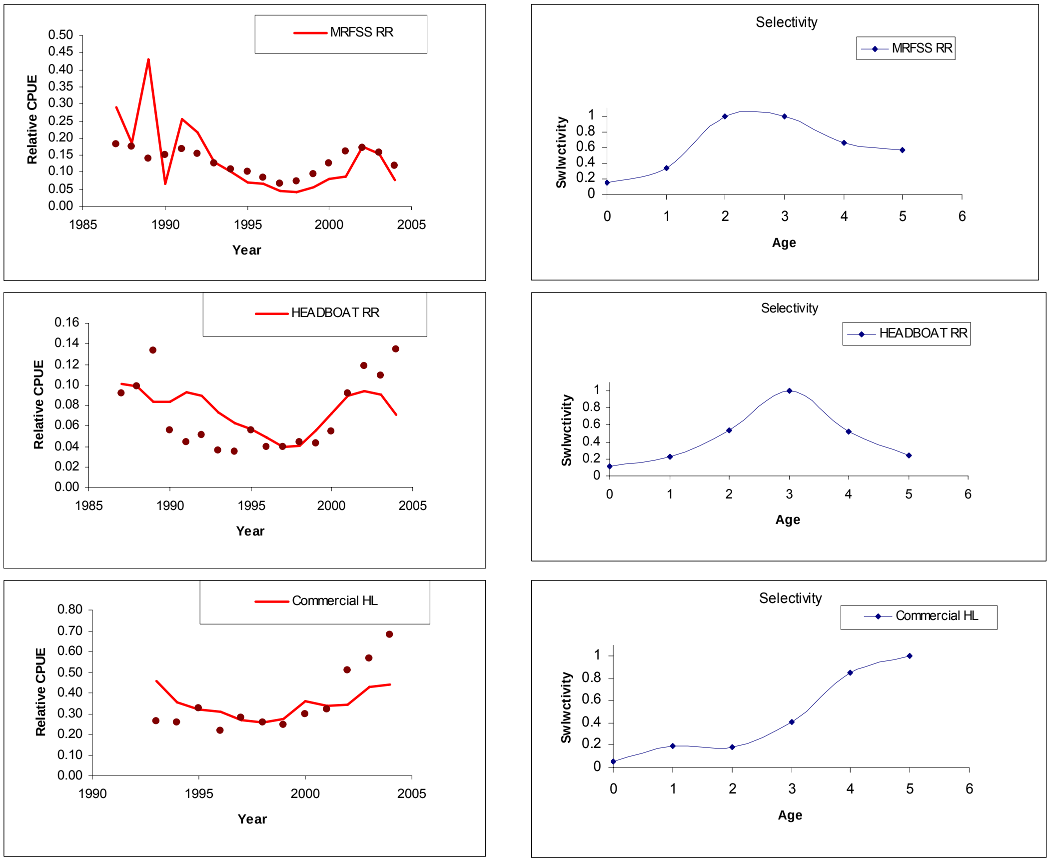

Figure 3.1.2.1.1. Fits of abundance indices (left) and selectivity patterns (right) for the Continuity Case-VPA.

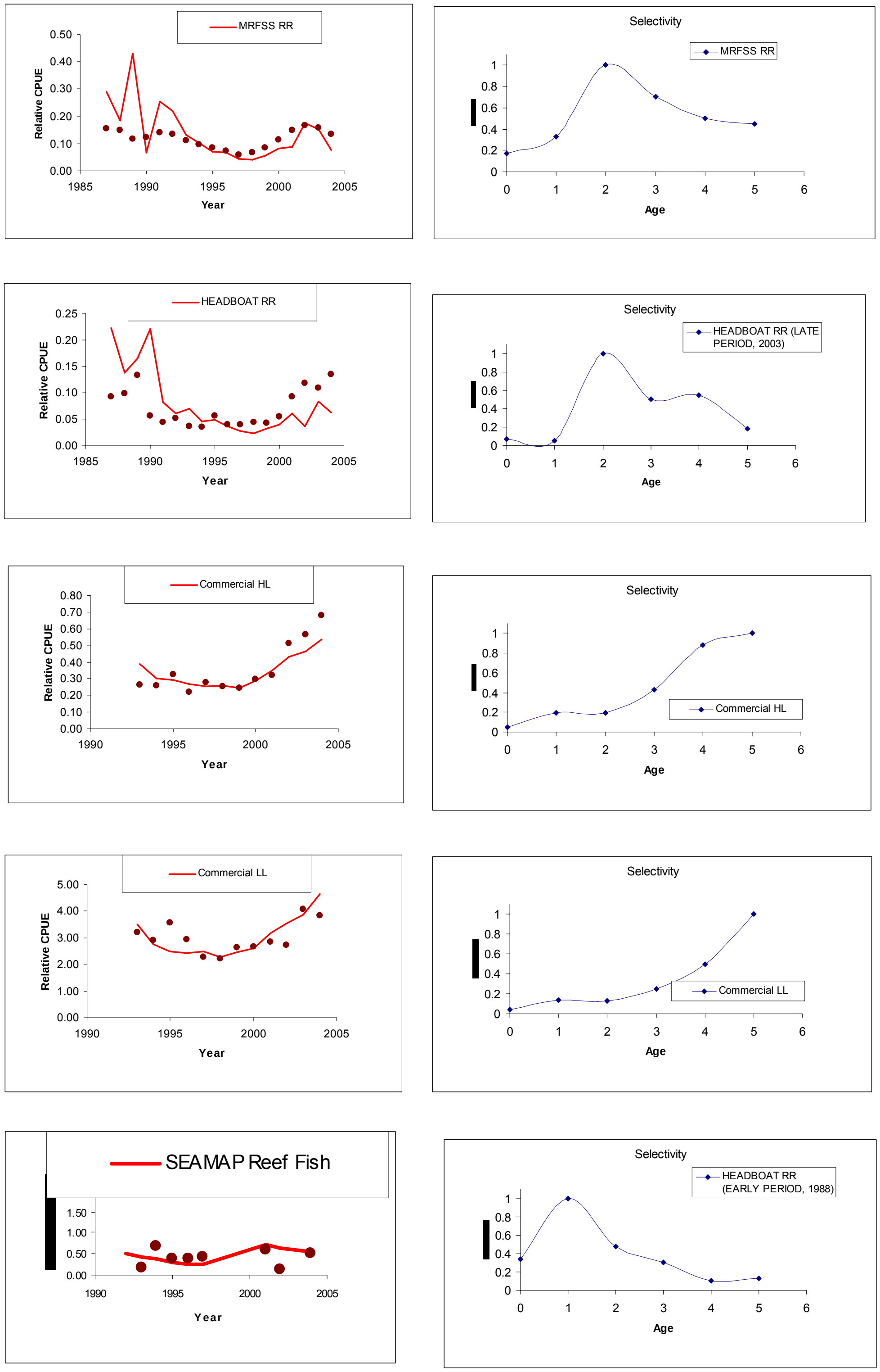

Figure 3.1.2.1.2. Fits of abundance indices (left) and the selectivity patterns (right) for the Preferred Case-VPA (Option 4). NOTE: The graph in the lower right is not the selectivity pattern for the SEAMAP index (which was assumed to be evenly selected across ages), but rather it is the headboat selectivity pattern in 1988.

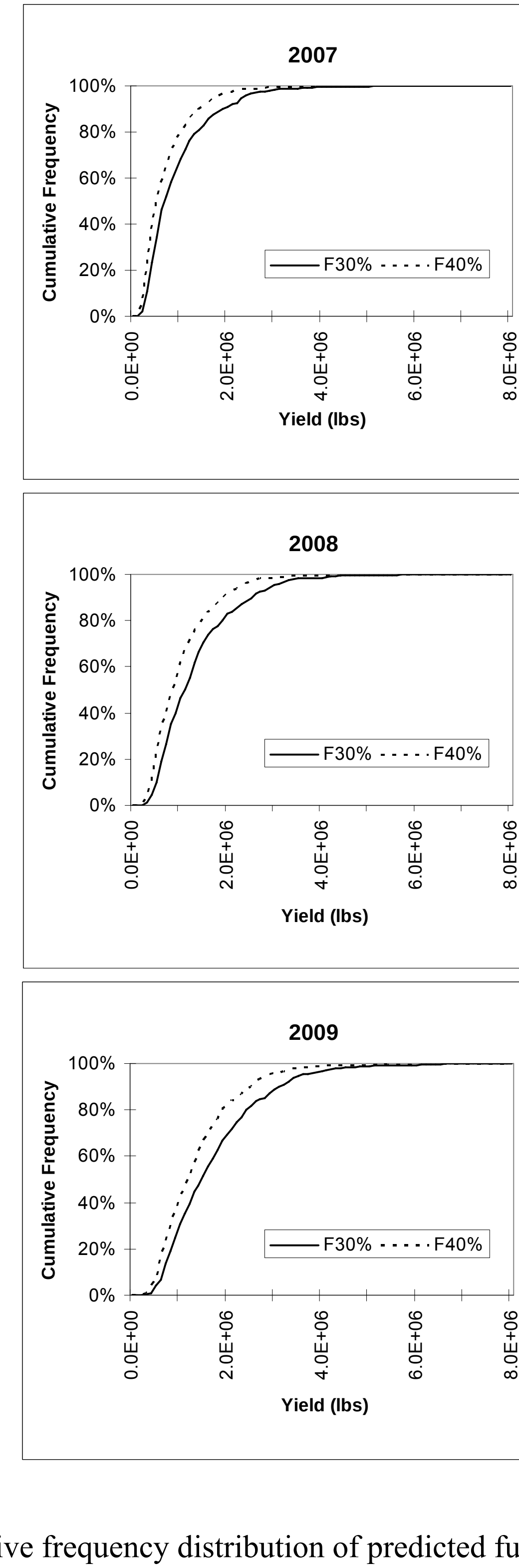

Figure 3.1.2.2.1. Cumulative frequency distribution of predicted future yields from the Continuity Case-VPA results under F30% and F40% for 2007, 2008 and 2009.

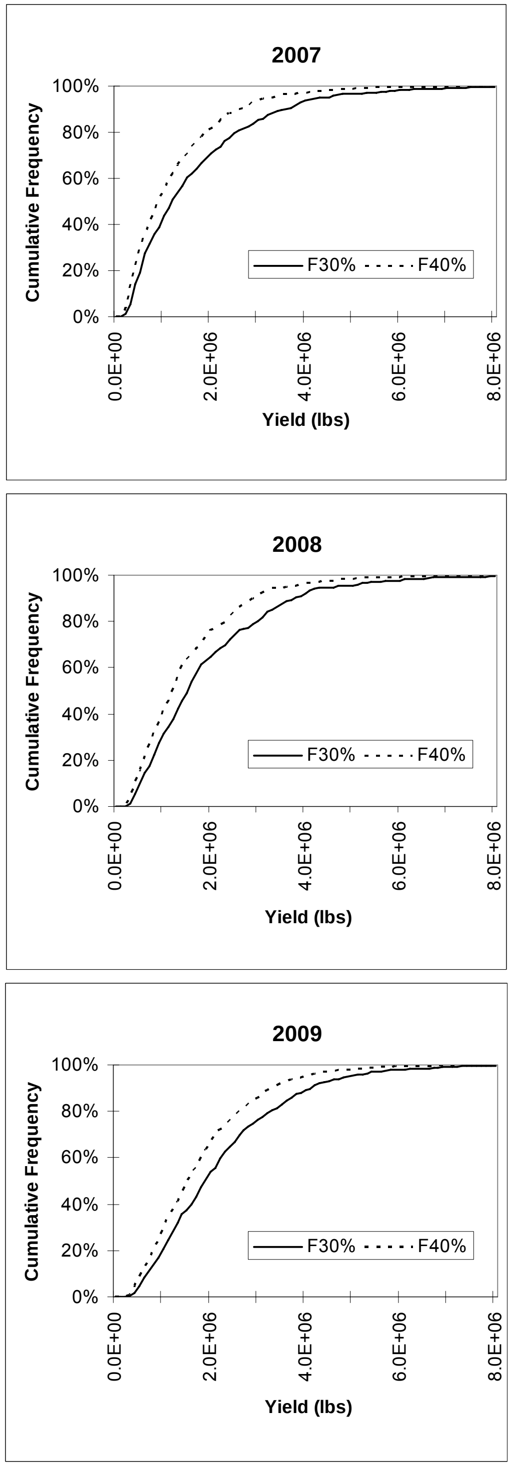

Figure 3.1.2.2.2. Cumulative frequency distribution of predicted future yields from the Preferred Case-VPA (Option 4) results under F30% and F40% for 2007, 2008 and 2009.

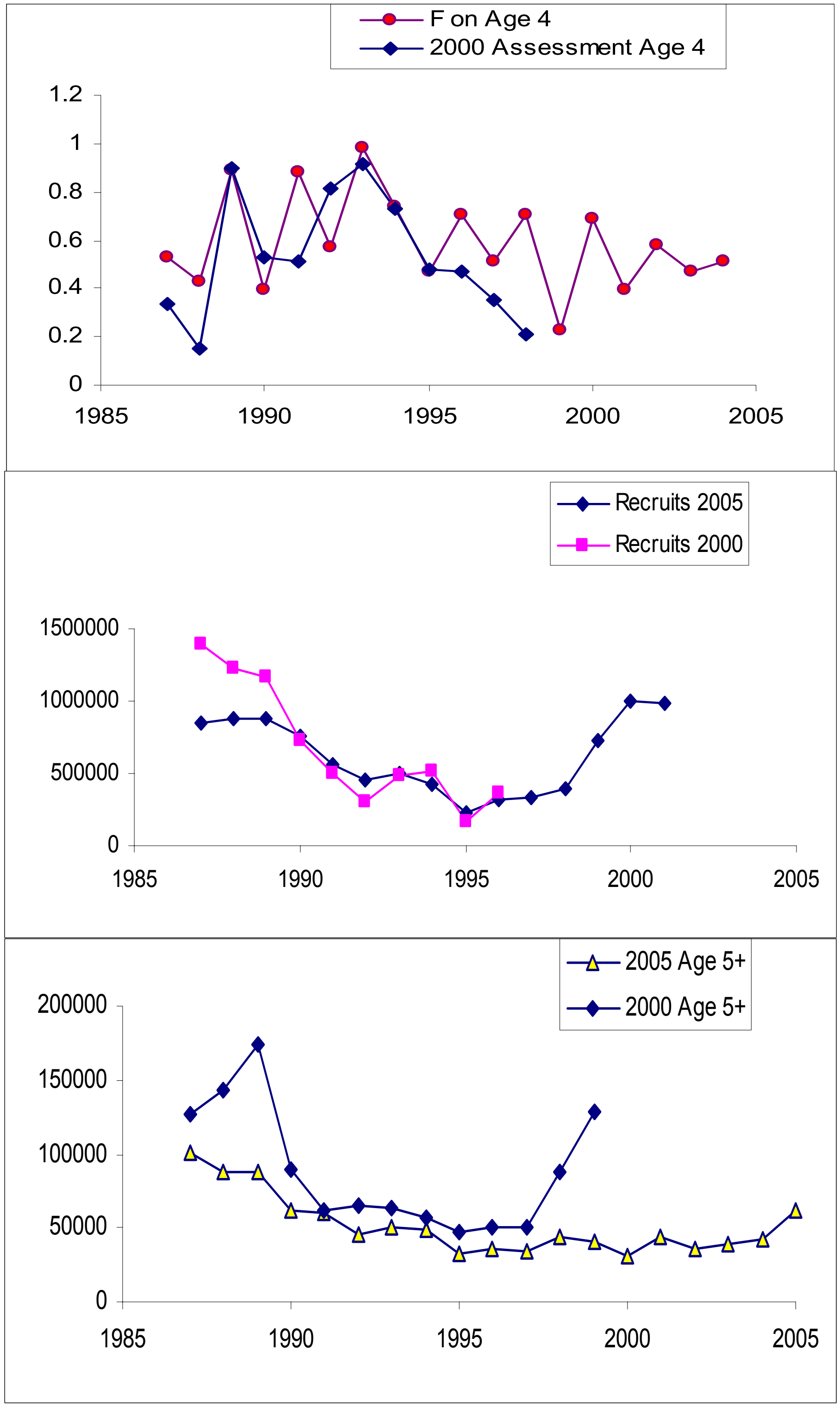

Figure 3.1.2.2.3. Comparison of selected results from Continuity Case-VPA to VPA results from the 2000 assessment.

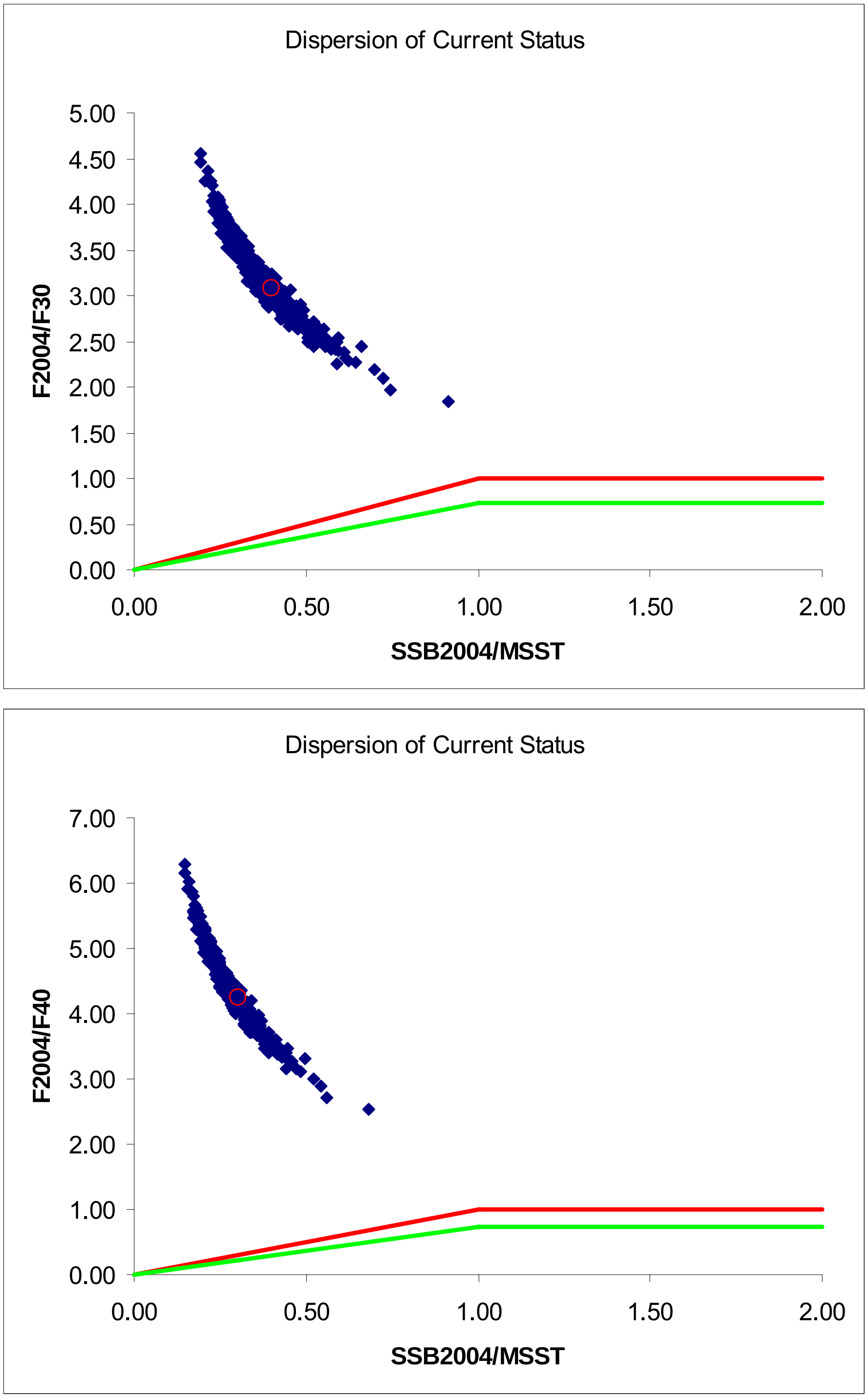

Figure 3.1.2.4.1. Estimates of stock status in the terminal year based on 501 bootstrap results for the Continuity Case-VPA. Open red circle represents the deterministic outcome. The solid red line represents an MFMT control rule and the solid green line represents an OY target control rule.

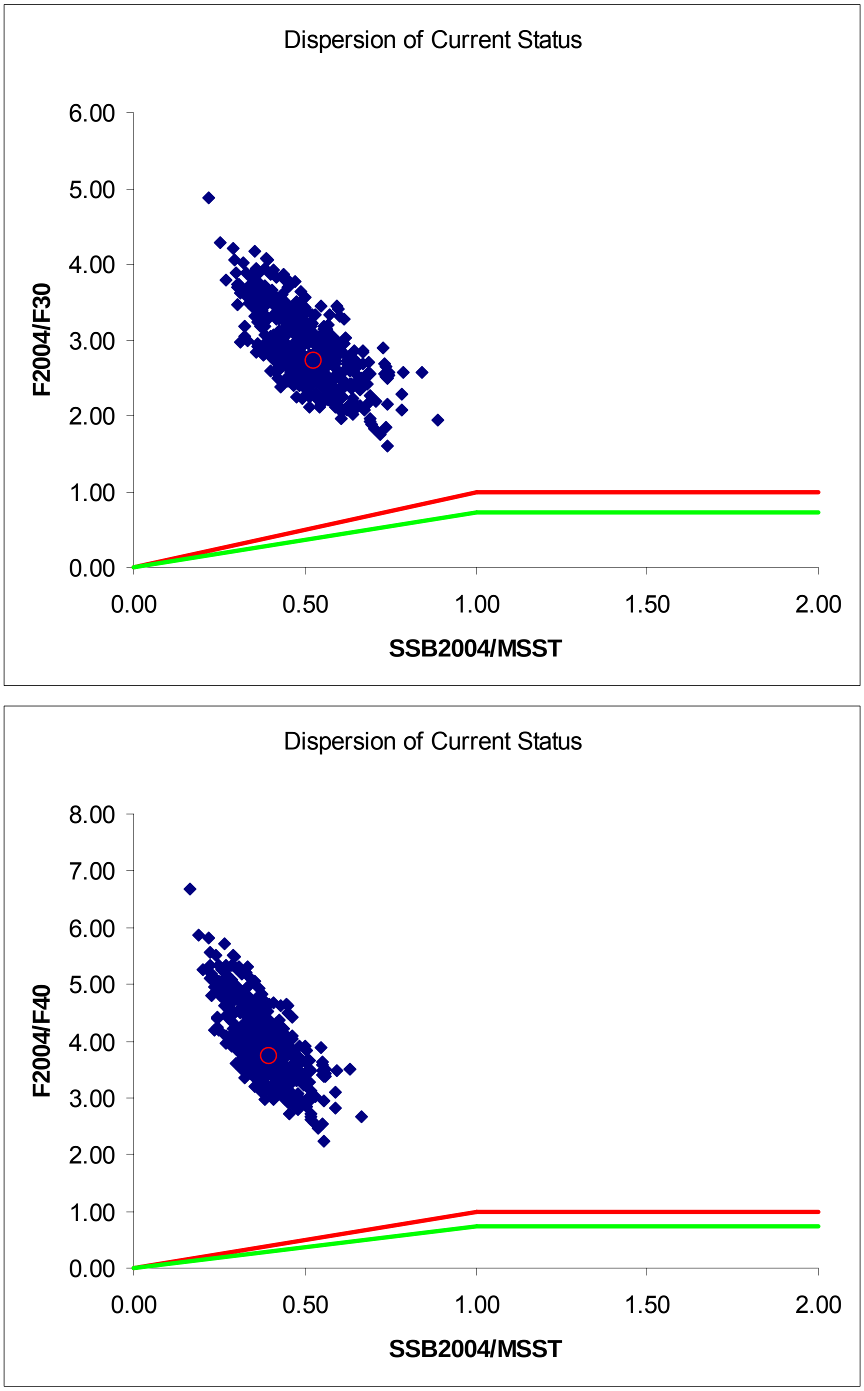

Figure 3.1.2.4.2. Estimates of stock status in the terminal year based on 501 bootstrap results for the Preferred Case-VPA (Option 4). Open red circle represents the deterministic outcome. The solid red line represents an MFMT control rule and the solid green line represents an OY target control rule.

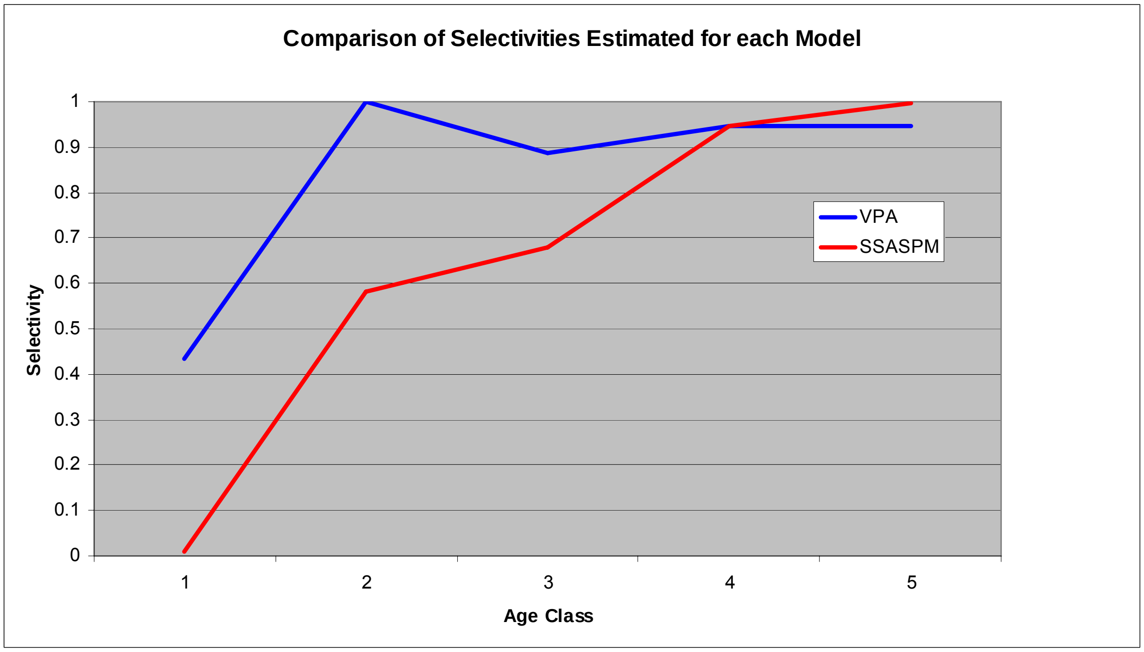

Figure 3.1.2.5.1. Comparison of the selectivity patterns estimated by VPA and SSASPM.

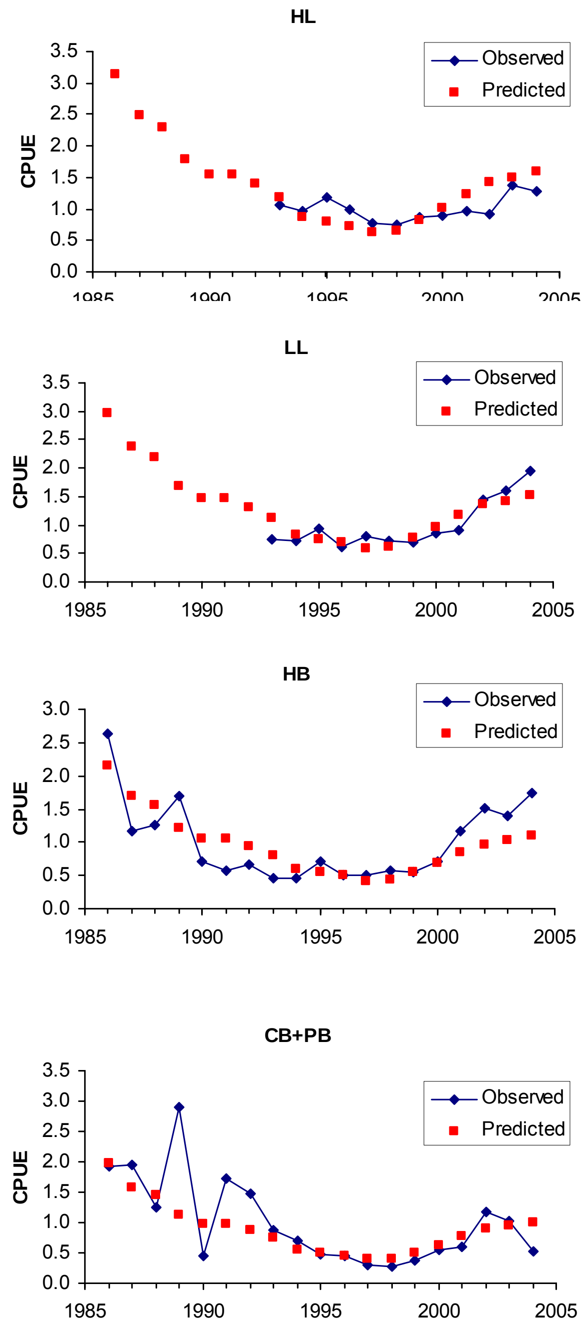

Figure 3.2.2.1.1. ASPIC estimated and observed CPUE series for the commercial handline (HL), longline (LL), recreational headboat (HB) and charterboat-private boat (CB+PB) fisheries.

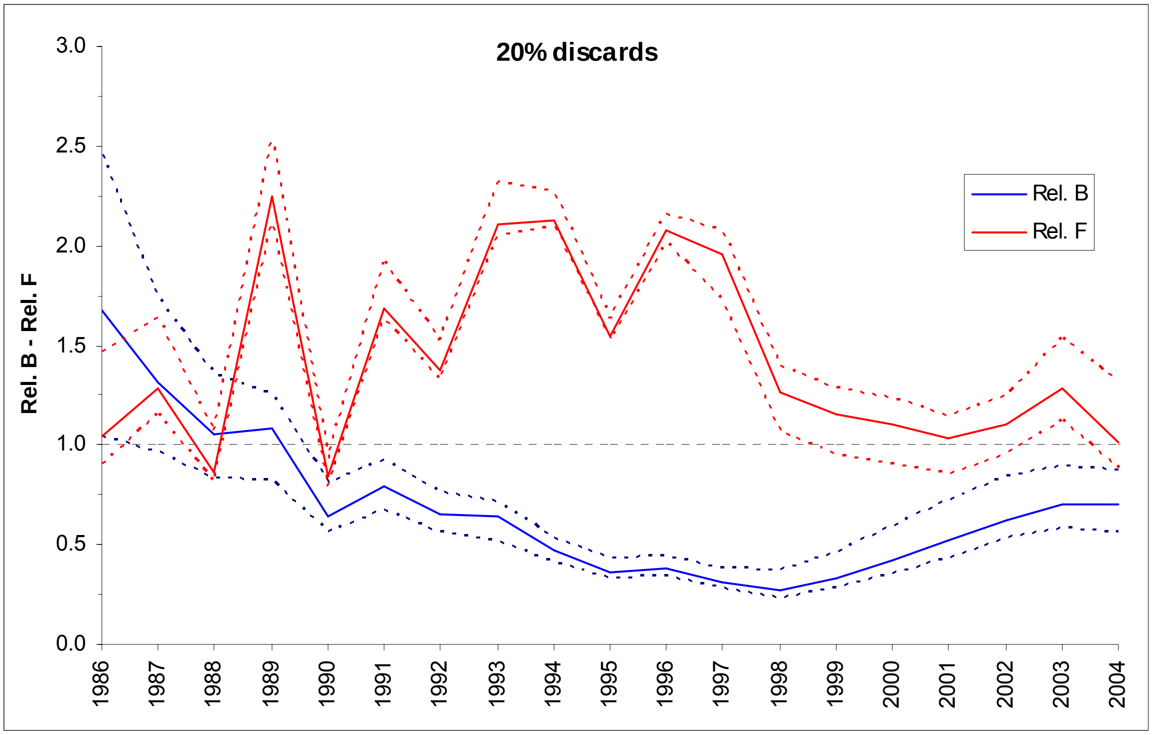

Figure 3.2.2.3.1. ASPIC estimated relative biomass (B/B_{MSY}) and relative F (F/F_{MSY}) trajectories assuming 20% discard mortality. Dashed lines correspond to 10-90th percentiles

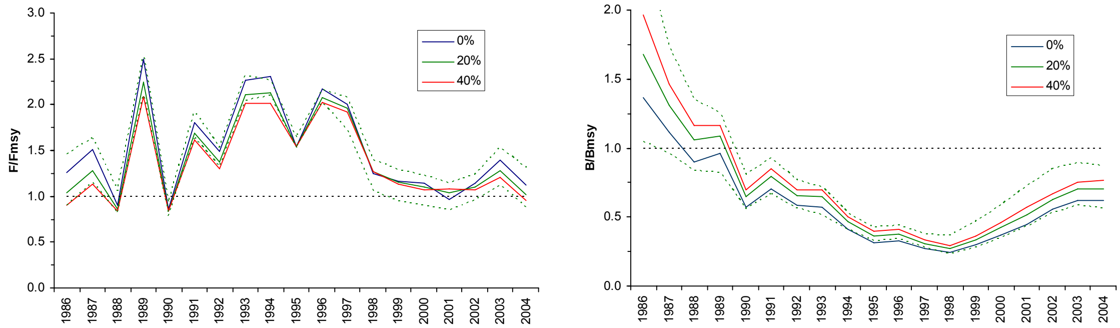

Figure 3.2.2.6.1. ASPIC estimated relative F (F/F_{MSY}) and relative biomass (B/B_{MSY}) for three levels of discard mortality. Dashed lines correspond to estimated 10-90th percentiles for the base case (20% discard mortality).

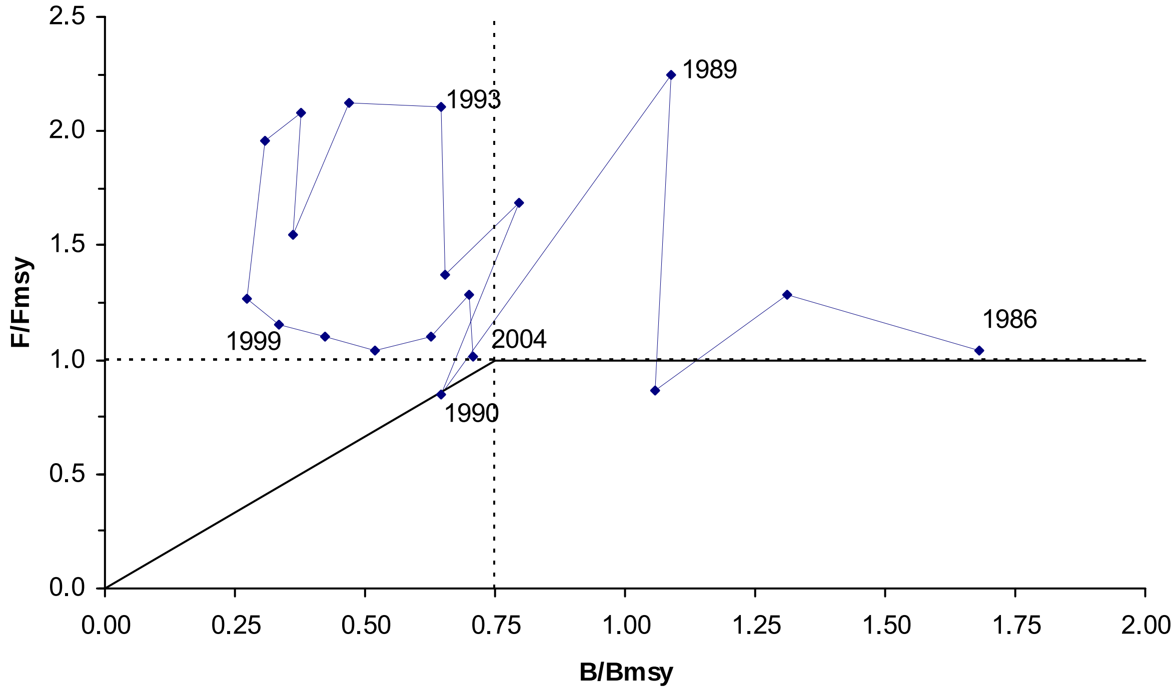

Figure 3.2.2.3.2. Status of greater amberjack with respect to F/Fmsy and B/Bmsy for ASPIC. The limit and threshold control rules are shown by dashed lines.

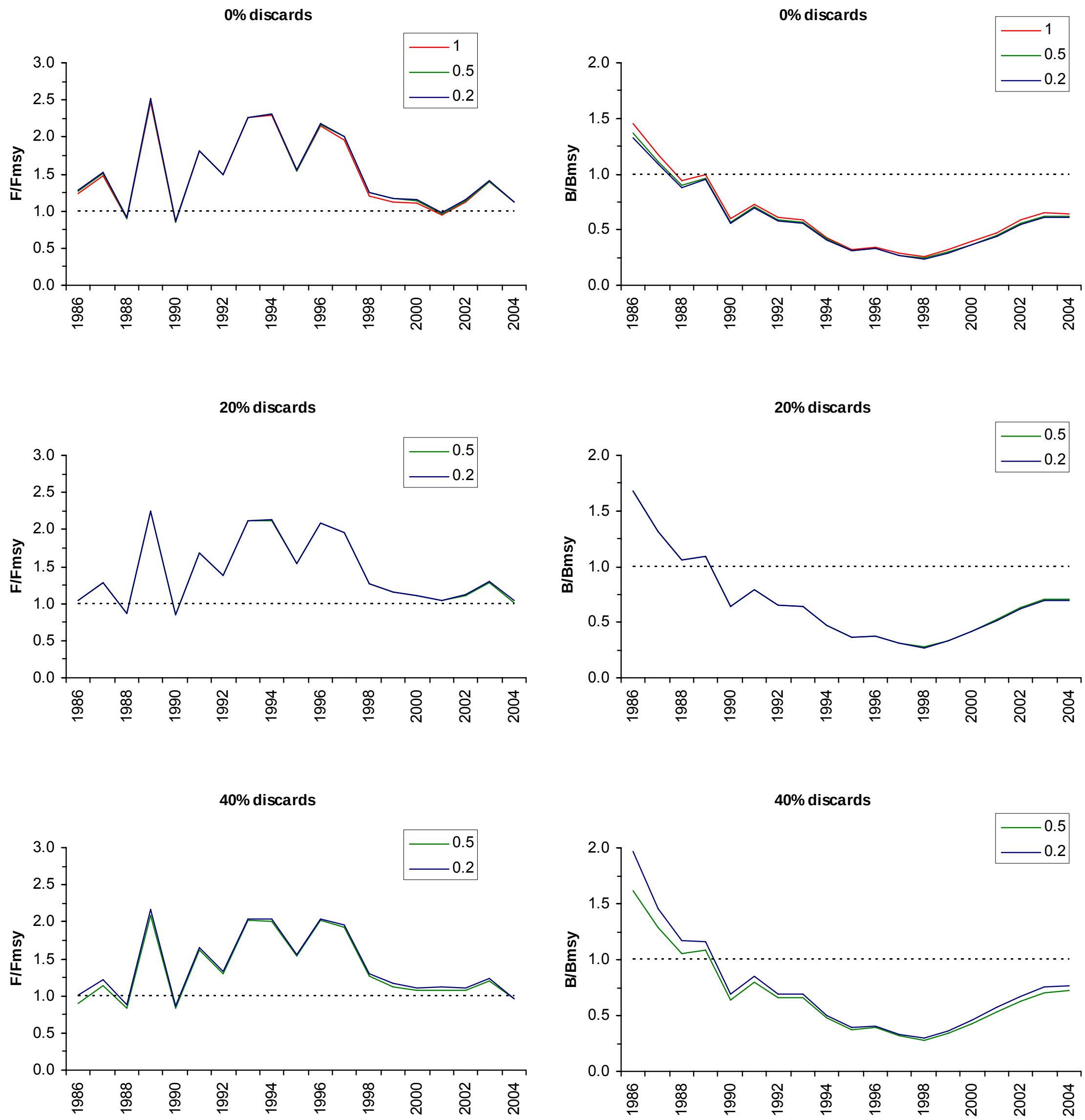

Figure 3.2.2.6.2. ASPIC estimated relative F (F/F_{MSY}) and relative biomass (B/B_{MSY}) for three levels of discard mortality and initial values of B_1/K.

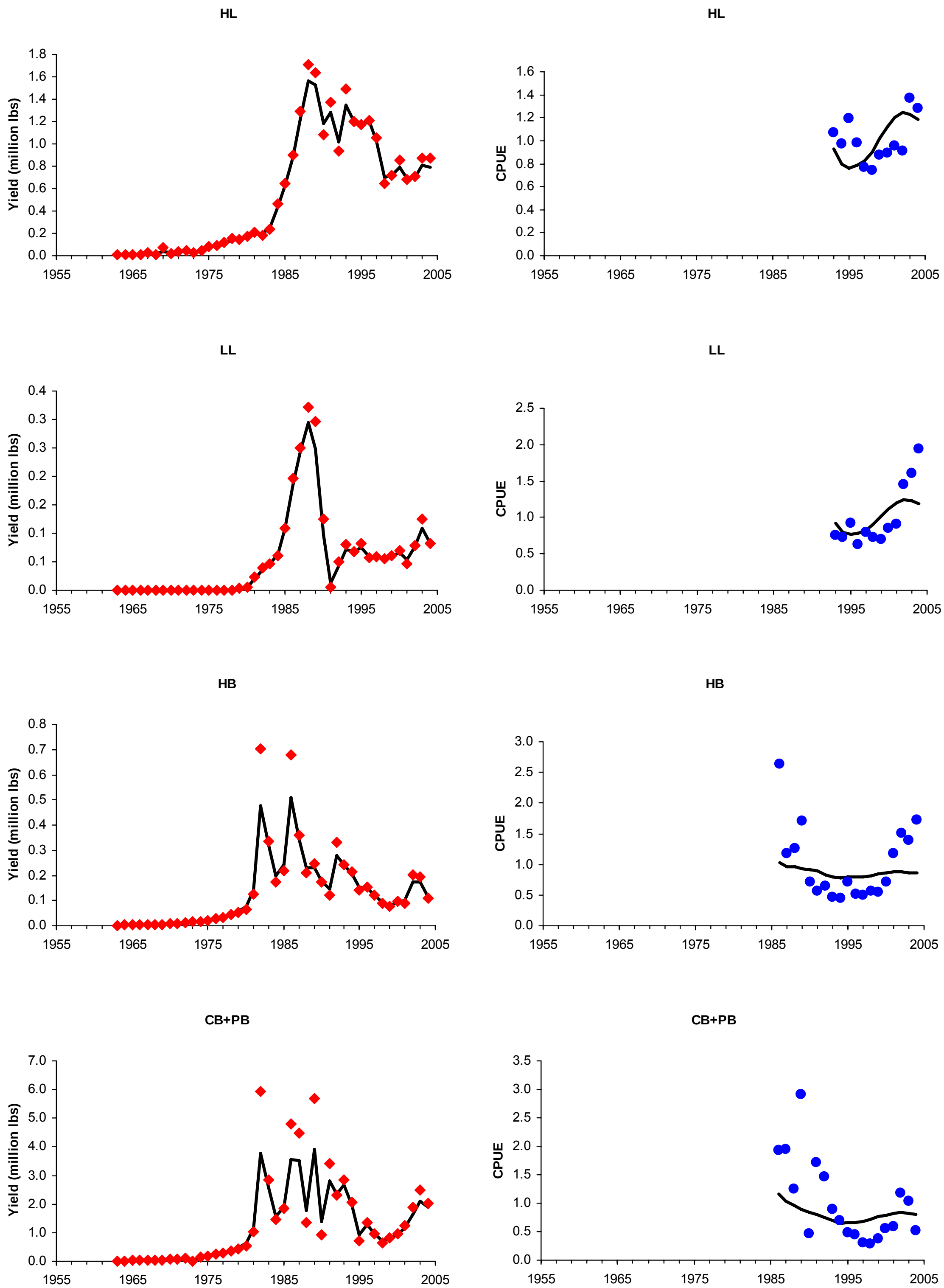

Figure 3.3.2.1.1. SSASPM fits to yield (left panels) and indices of abundance (right panels).

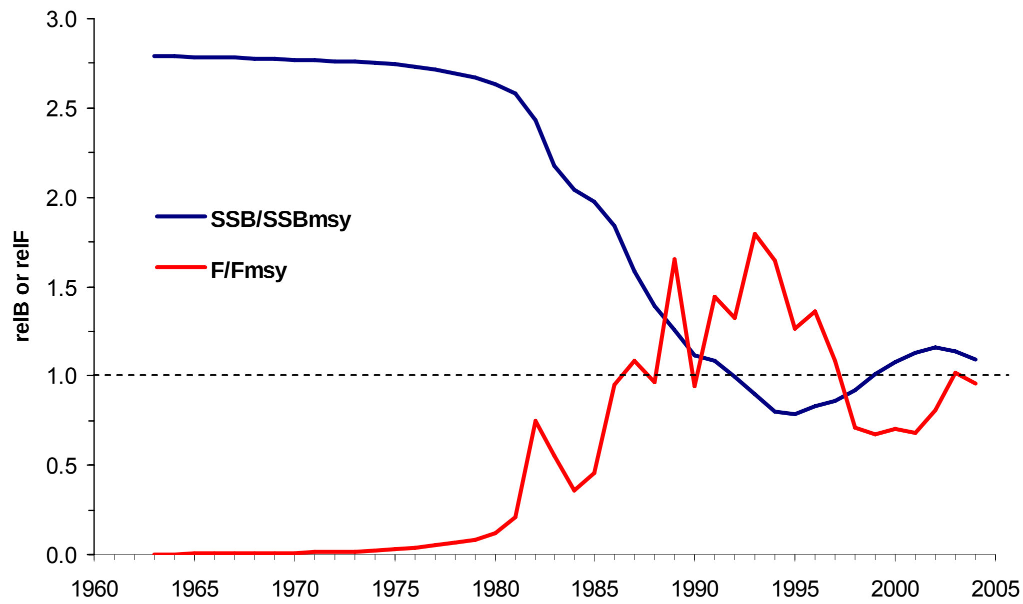

Figure 3.3.2.4.1. SSASPM estimated relative F (F/F_{MSY}) and relative SSB (SSB/SSB_{MSY}).

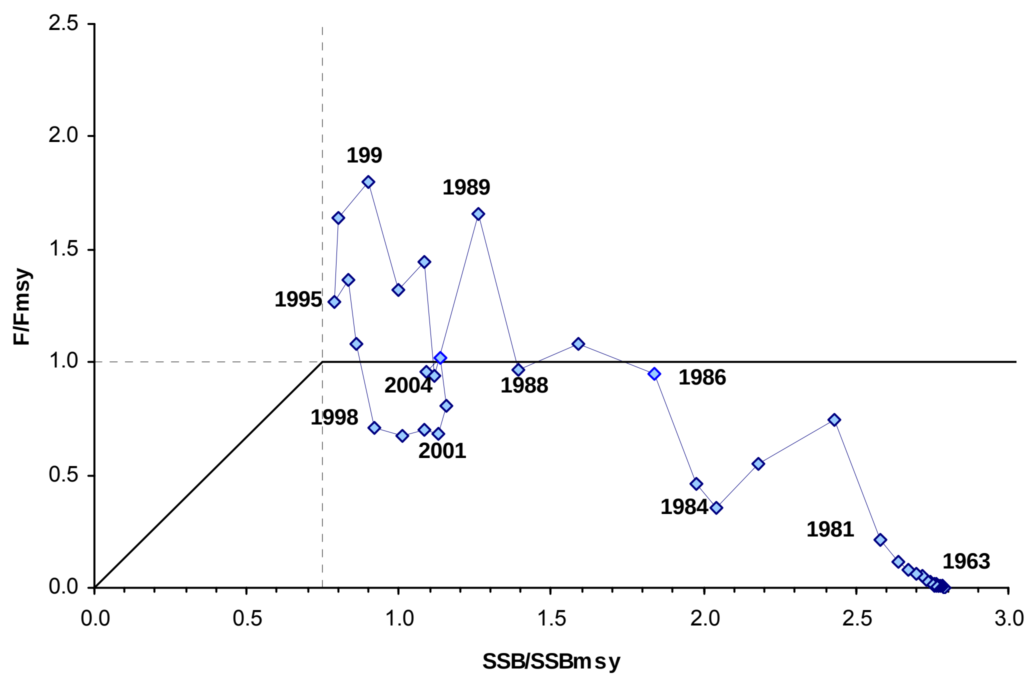

Figure 3.3.2.4.2. Status of greater amberjack with respect to F/Fmsy and SSB/SSBmsy based on SSASPM. The limit and threshold control rules are shown by dashed lines.

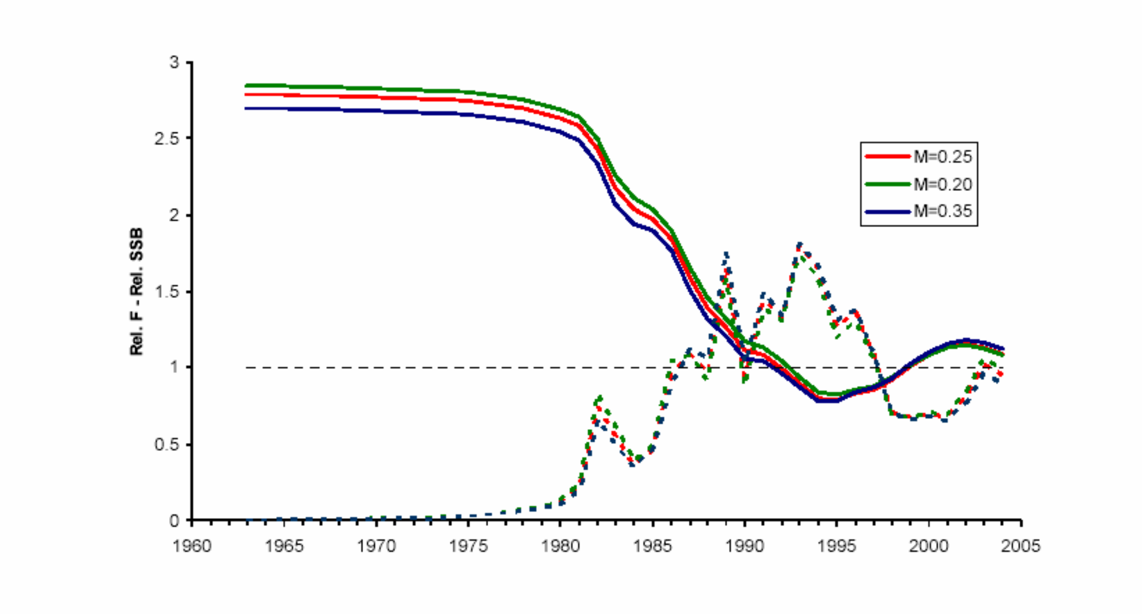

Figure 3.3.2.8.1. SSASPM estimated relative SSB (SSB/SSB_{MSY}) (solid lines) and relative F (F/F_{MSY}) (dashed lines) for base case (M=0.25) and two other levels of natural mortality (M=0.2, M=0.35).

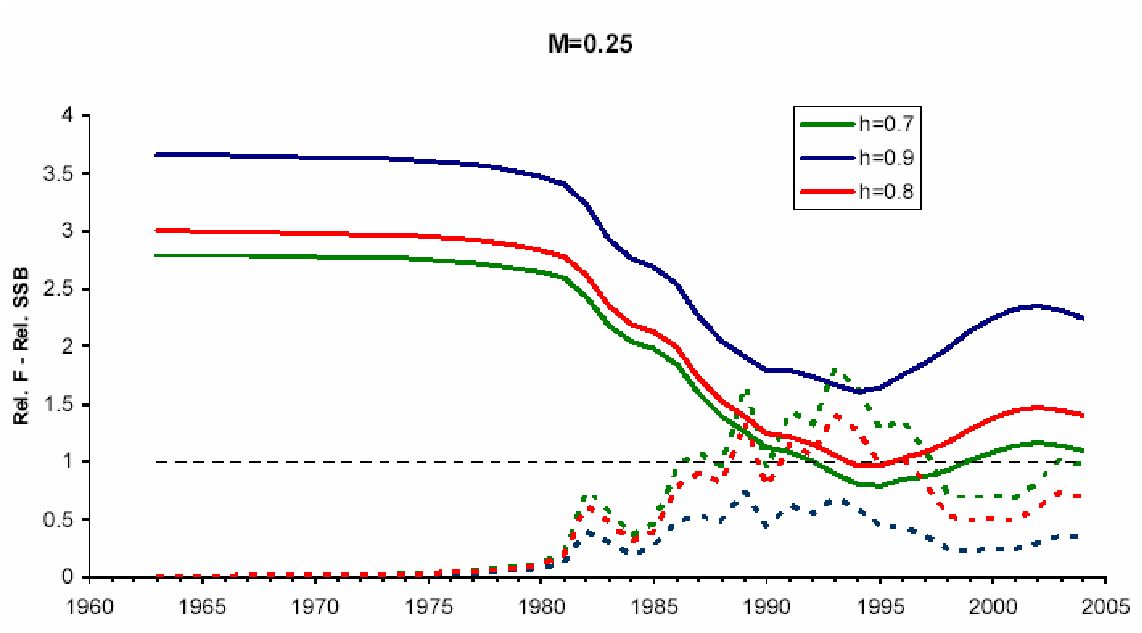

Figure 3.3.2.8.2. SSASPM estimated relative SSB (SSB/SSB_{MSY}) (solid lines) and relative F (F/F_{MSY}) (dashed lines) for three levels for the steepness prior (M=0.25).

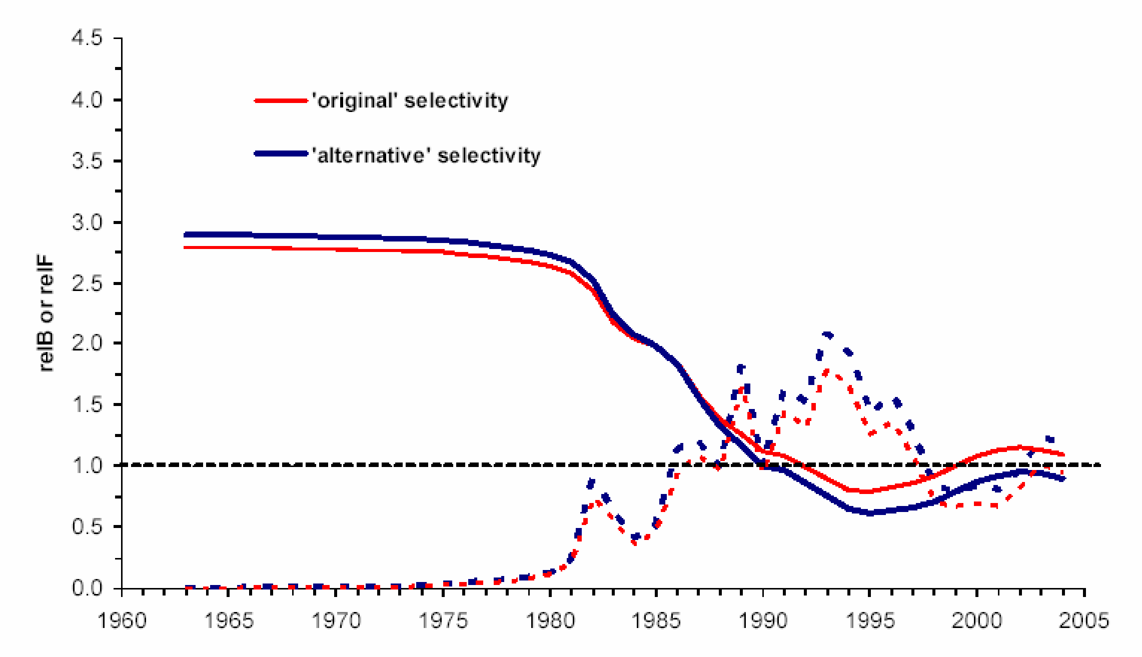

Figure 3.3.2.8.3. SSASPM estimated relative SSB (SSB/SSB_{MSY}) (solid lines) and relative F (F/F_{MSY}) (dashed lines) for two different gear selectivities.

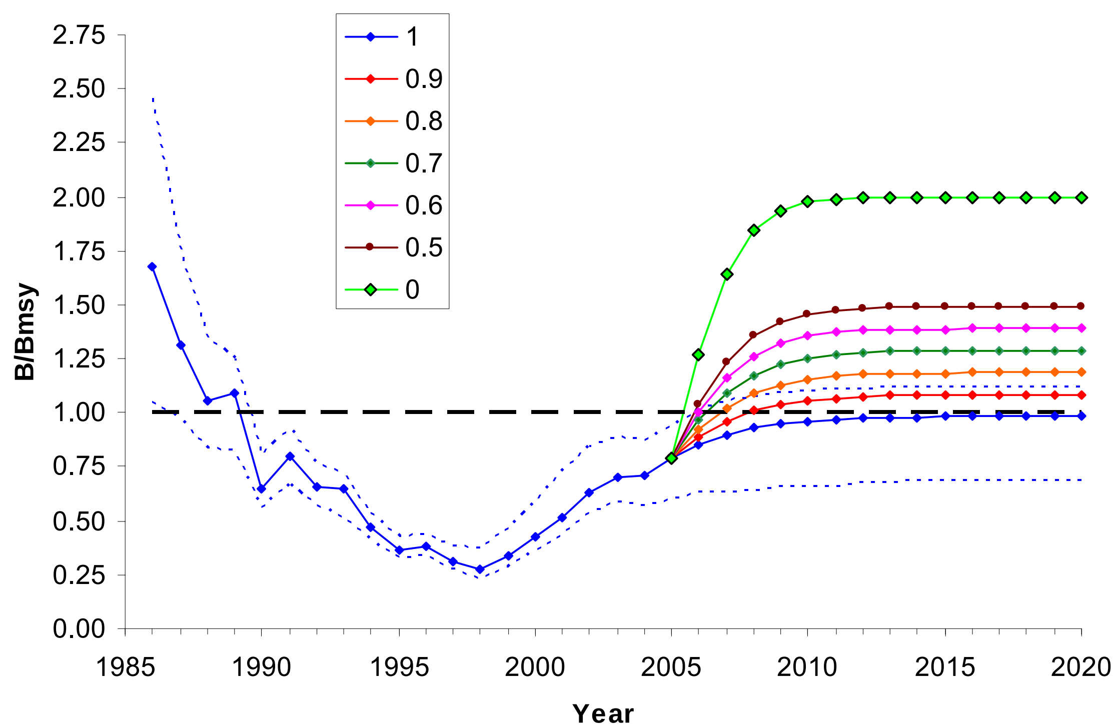

Figure 6.2.1. ASPIC estimated relative biomass (B/B_{msy}) and projected values for different constant values of F/F_{2004}.

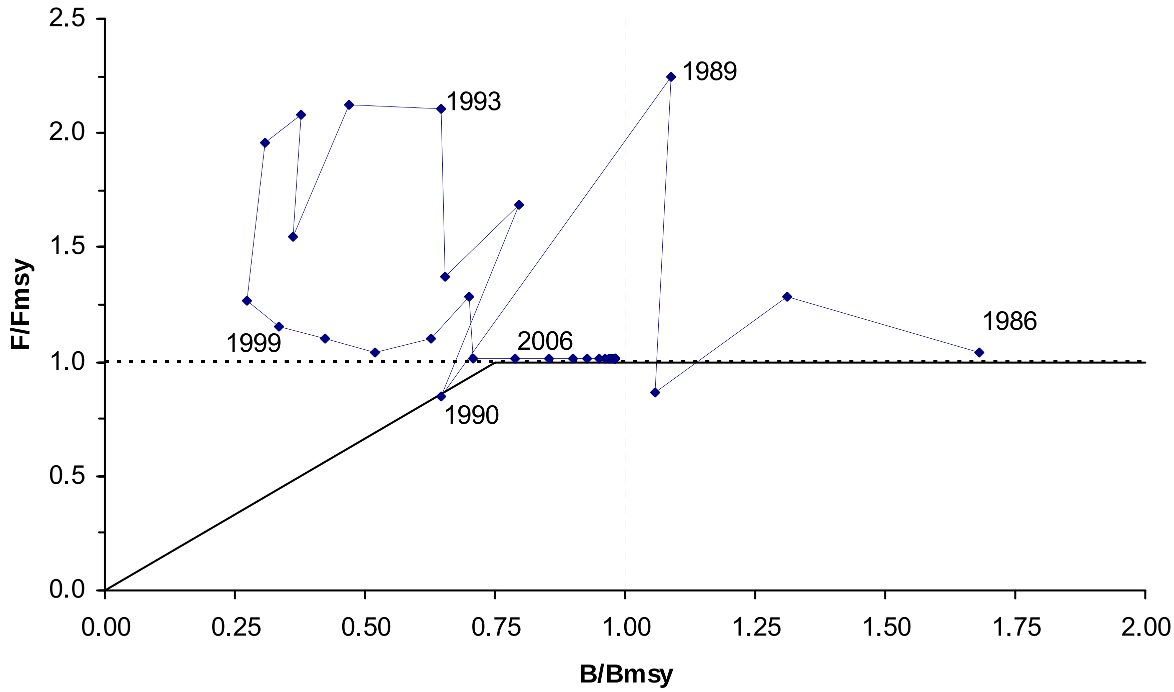

Figure 6.2.2. Projected status of greater amberjack based on ASPIC with respect to F/FMSY and B/B_{MSY}. The limit and threshold control rules for a rebuilding stock are shown by dashed lines.

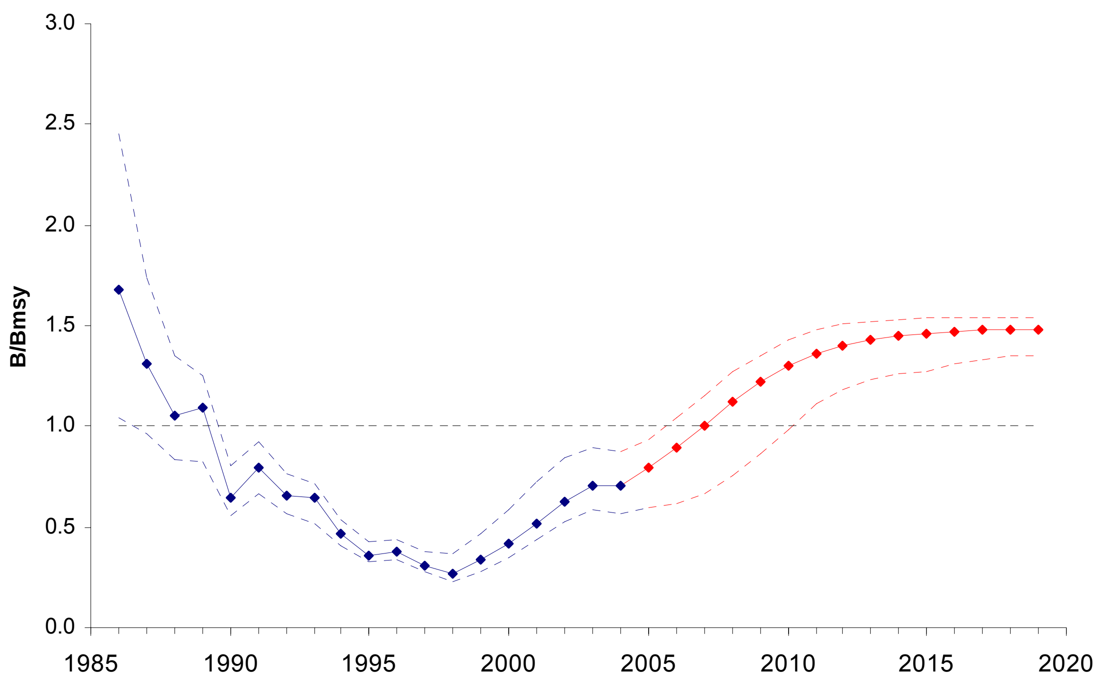

Figure 6.2.3. ASPIC estimated projected relative biomass (B/B_{MSY}) for constant values of catch for 2005-2019. Dashed lines correspond to 10-90th percentiles of bootstrap.

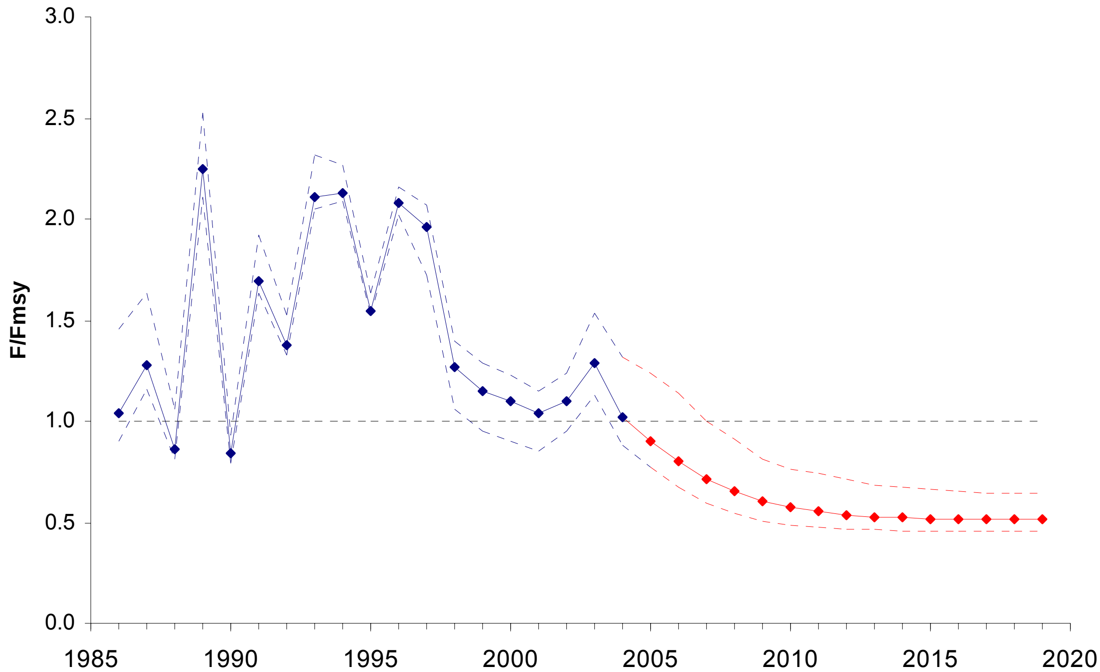

Figure 6.2.4. ASPIC estimated projected relative F (F/F_{MSY}) for constant values of catch for 2005-2019. Dashed lines correspond to 10-90th percentiles of bootstrap.

SEDAR

SouthEast Data, Assessment, and Review

Gulf of Mexico Greater Amberjack

SEDAR 9
Stock Assessment Report 2

SECTION 4. Review Workshop

Contents

Consensus Summary Report

Gulf of Mexico Greater Amberjack (*Seriola dumerili*)

Prepared by the SEDAR 9 Review Panel

Edited by M. Elizabeth Clarke for
SEDAR 9, March 27- 31, 2006
New Orleans, Louisiana

Executive summary

The SEDAR 9 Review Workshop met in New Orleans, LA from March 27 to 31, 2006 to review the stock assessment of Greater Amberjack in the Gulf of Mexico. The first day consisted primarily of presentations by the Assessment Team covering the Data Workshop, the two Assessment Workshops, and their preferred base case assessment. During the second and third days, the workshop reviewed the assessment by addressing the terms of reference for the Review Workshop, including the consideration of additional model runs. On the final day, preliminary drafts of the Consensus Summary Report and the Advisory Report were discussed.

The SEDAR for Greater Amberjack has extended over more than 12 months and was interrupted by the impact of Hurricane Katrina. During this time the Assessment Team and other Data Workshop and Assessment Workshop participants worked towards producing a credible and reliable stock assessment. The previous stock assessment was conducted in 2000. The previous assessment used a calibrated VPA to obtain estimates of population abundance and mortality rates using data through 1998.

During the panel's deliberations the base case model selected as most appropriate was the simple surplus production model known as ASPIC. The assessment using the suggested base case model is documented in an Addendum to the Stock Assessment document. The final assessment using this method indicates that the stock is both overfished and experiencing overfishing.

The Review Panel was impressed by the quantity of work that had gone into the assessment, however, small but significant changes to the base case assessment were requested during the Review Workshop. The model initially presented to the panel was an age-structured production model. The panel recommended that because of the difficulty in obtaining representative aging and catch at age data that neither the VPA (the continuity case) nor the age-structured production model be used as the base case model. Instead, the panel recommended that a simple production model be used.

The panel felt that the final assessment using the base case model, recommended by the panel, is adequate to provide management advice. The data used in the assessment of greater amberjack were generally appropriate and were also applied in an appropriate manner. However, the last year of catch rate indices were inconsistent among different sectors within the recreational and commercial fisheries. Some particular methods exhibited an increase while others exhibited a decrease and the decreasing trends accounted for most of the catch on both the commercial and the recreational fisheries. This led the panel to recommend that the assessment be updated in the next few years to determine the trajectory of the stock more precisely. The panel also recommended that a yield-per-recruit analysis should be made for the greater amberjack as an addition to future assessments. This analysis would act as a check against growth overfishing.

The panel thanks the authors for their efforts and suggests that sufficient resources and time should always be provided to the scientific staff to prepare the materials to normal scientific standards and allowance be made for any major un-avoidable disruption to this process (such as Hurricane Katrina).

The panel made several recommendations that would improve the documentation of data and methods used in the assessments. A summary table for each assessment should be provided stating each data stream to be used with its constraints and any treatments or modifications made. Included in this table should be an indication of the reliability of each data stream. It could be included in either the Data Workshop or Assessment Workshop reports. The various model outputs and management benchmarks (e.g. MSY, Fmsy, Bmsy, MSST, MFMT) for the accepted base case model should be defined in one place within the stock assessment report along with how they were defined mathematically. Each assessment document should contain appendices detailing the structure and likelihood estimator for at least the base case model, or alternatively refer to a readily available document containing these details. Whenever a major data stream (effort, catches or catch rates) is to be modified the details of any modifications should be stated explicitly and documented completely.

1. Introduction

1.1 Time and Place

The SEDAR 9 Review Workshop met in New Orleans, Louisiana, from 27 to 31 March 2006.

1.2 Terms of Reference for the Review Workshop

1. Evaluate the adequacy, appropriateness, and application of data used in the assessment.
2. Evaluate the adequacy, appropriateness, and application of methods used to assess the stocks.
3. Recommend appropriate estimates of stock abundance, biomass, and exploitation*.
4. Evaluate the methods used to estimate population benchmarks and management parameters (*e.g., MSY, Fmsy, Bmsy, MSST, MFMT, or their proxies*); provide estimated values for management benchmarks, a range of ABC, and declarations of stock status*.
5. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status; recommend appropriate estimates of future stock condition* (e.g., exploitation, abundance, biomass).
6. Evaluate the adequacy, appropriateness, and application of methods used to characterize uncertainty in estimated parameters. Provide measures of uncertainty for estimated parameters*. Ensure the implications of uncertainty in technical conclusions are clearly stated.
7. Ensure that stock assessment results are clearly and accurately presented in the Stock Assessment Report and that reported results are consistent with Review Panel recommendations. (In the event corrections are made in the assessment, alternative model configurations are recommended, or additional analyses are prepared as a result of review panel findings regarding the TORs above, ensure that corrected estimates are provided by addenda to the assessment report)
8. Evaluate the performance of the Data and Assessment Workshops with regard to their respective Terms of Reference; state whether or not the Terms of Reference for those previous workshops were met and are adequately addressed in the Stock Assessment Report.
9. Review research recommendations provided by the Data and Assessment workshops and make any additional recommendations warranted. Clearly indicate the research and monitoring needs that may appreciably improve the reliability of future assessments.
10. Prepare a Peer Review Consensus Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Prepare an Advisory Report summarizing key assessment results. (Reports to be drafted by the Panel during the review workshop with a final report due two weeks after the workshop ends.)

1.3 List of Participants

Participants	Affiliation
Panel Chair:	
M. Elizabeth Clarke	NOAA Fisheries/NWFSC
Review Panel:	
Haddon, Malcolm	CIE Reviewer
Patterson, Kenneth	CIE Reviewer
Chen, Din	CIE Reviewer
Presenters:	
Craig Brown	NMFS/SEFSC Miami
Shannon Cass-Calay	NMFS/SEFSC Miami
Guillermo Diaz	NMFS/SEFSC Miami
Josh Sladek-Nowlis	NMFS/SEFSC Miami
Steve Turner	NMFS/SEFSC Miami
Jerry Scott `	SEFSC
Observers:	
Chris Dorsett	The Ocean Conservancy/GMFMC AP
Myron Fischer	GMFMC
Mike Nugent	GMFMC AP
Andy Strelcheck	NMFS/SERO
Wayne Werner	GMFMC AP
Joseph Powers	NMFS/SEFSC Miami
Staff support:	
John Carmichael	SEDAR
Dawn Aring	GMFMC Staff
Patrick Gilles	NMFS/SEFSC Miami
Stu Kennedy	GMFMC Staff
Joseph Powers	NMFS/SEFSC Miami
Jerry Scott `	SEFSC

1.4 Review Workshop Documents

The following documents were available to the Review Panel during SEDAR 9.

Document #	Title	Authors
	Documents Prepared for the Data Workshop	

SEDAR9-DW1	History of vermillion snapper, greater amberjack, and gray triggerfish management in Federal waters of the US Gulf of Mexico, 1984-2005	Hood, P.
SEDAR9-DW2	Vermillion Snapper Otolith Aging: 2001-2004 Data Summary	Allman, R J., J. A. Tunnell. B. K. Barnett
SEDAR9-DW3	Reproduction of vermillion snapper from the Northern and Eastern Gulf of Mexico, 1991-2002.	Collins, L. A., R. J. Allman, and H. M Lyon
SEDAR9-DW4	Standardized catch rate indices for vermilion snapper landed by the US recreational fishery in the Gulf of Mexico, 1986-2004	Cass-Calay, S. L.
SEDAR9-DW5	Standardized catch rate indices for vermilion snapper landed by the US commercial handline fishery in the Gulf of Mexico, 1990-2004	McCarthy, Kevin J., and Shannon L. Cass-Calay
SEDAR9-DW6	Standardized catch rates of vermilion snapper from the US headboat fishery in the Gulf of Mexico, 1986-2004	Brown, Craig A.
SEDAR9-DW7	Estimated Gulf of Mexico greater amberjack recreational landings (MRFSS, Headboat, TXPW) for 1981-2004	Diaz, Guillermo
SEDAR9-DW8	Size frequency distribution of greater amberjack from dockside sampling of recreational landings in the Gulf of Mexico 1986-2003	Diaz, Guillermo
SEDAR9-DW9	Size frequency distribution of greater amberjack from dockside sampling of commercial landings in the Gulf of Mexico 1986-2003	Diaz, Guillermo
SEDAR9-DW10	Standardized catch rates of gulf of Mexico greater amberjack for the commercial longline and handline fishery 1990-2004	Diaz, Guillermo
SEDAR9-DW11	Length Frequency Analysis and Calculated Catch at Age Estimations for Commercially Landed Gray Triggerfish (*Balistes capriscus*) From the Gulf of Mexico	Saul, Steven
SEDAR9-DW12	Estimated Gray Triggerfish (*Balistes capriscus*) Landings From the Gulf of Mexico Headboat Fishery	Saul, Steven
SEDAR9-DW13	Estimated Gray Triggerfish (*Balistes capriscus*) Commercial Landings and Price Information for the Gulf of Mexico Fishery	Saul, Steven
SEDAR9-DW14	Estimated Gray Triggerfish (*Balistes capriscus*) Recreational Landings for the State of Texas	Saul, Steven
SEDAR9-DW15	Estimated Gray Triggerfish (*Balistes capriscus*) Landings From the Marine	Saul, Steven, and Patty Phares

	Recreational Fishery Statistics Survey (MRFSS) In the Gulf of Mexico	
SEDAR9-DW16	Length Frequency Analysis for the Gray Triggerfish (*Balistes capriscus*) Recreational Fishery In the Gulf of Mexico	Saul, Steven
SEDAR9-DW17	Estimates of Vermilion Snapper, Greater Amberjack, and Gray Triggerfish Discards by Vessels with Federal Permits in the Gulf of Mexico	McCarthy, Kevin J.
SEDAR9-DW18	Size Composition Data from the SEAMAP Trawl Surveys	Nichols, Scott
SEDAR9-DW19	Species Composition of the various amberjack species in the Gulf of Mexico	Chih, Ching-Ping
SEDAR9-DW20	Standardized Catch rates of Gulf of Mexico greater amberjack catch rates for the recreational fishery (MRFSS, Headboat) 1981-2004	Diaz, Guillermo
SEDAR9-DW21	SEAMAP Reef Fish Survey of Offshore Banks: Yearly indices of Abundance for Vermilion Snapper, Greater Amberjack, and Gray Triggerfish	Gledhill, et. al.
SEDAR9-DW22	Data Summary of Gray Triggerfish (*Balistes capriscus),*Vermilion Snapper (*Rhomboplites aurorubens)*, and Greater Amberjack (*Seriola dumerili)* Collected During Small Pelagic Trawl Surveys, 1988 – 1996	Ingram, Jr., G. Walter
SEDAR9-DW23	Abundance Indices of Gray Triggerfish and Vermilion Snapper Collected in Summer and Fall SEAMAP Groundfish Surveys (1987 – 2004)	Ingram, Jr., G. Walter
SEDAR9-DW24	Review of the Early Life History of Vermilion Snapper, *Rhomboplites auroubens,* With a Summary of Data from SEAMAP plankton surveys in the Gulf of Mexico: 1982 – 2002	Lyczkowski-Shultz, J. and Hanisko, D.
SEDAR9-DW25	Review of the early life history of gray triggerfish, *Balistes capriscus,* with a summary of data from SEAMAP plankton surveys in the Gulf of Mexico: 1982, 1984 – 2002	Lyczkowski-Shultz, J., Hanisko, D. and Zapfe, G.
SEDAR9-DW26	Shrimp Fleet Bycatch Estimates for the SEDAR9 Species	Nichols, Scott
SEDAR9-DW27	SEAMAP Trawl Indexes for the SEDAR9 Species	Nichols, Scott
SEDAR9-DW-28	Standardized Abundance Indices for Gulf of Mexico Gray Triggerfish (*Balistes capriscus)* based on catch rates as measured by the Marine Recreational Fisheries Statistics Survey (MRFSS)	Nowlis, Josh Sladek

SEDAR9-DW-29	Standardized Abundance Indices for Gulf of Mexico Gray Triggerfish (*Balistes capriscus)* based on catch rates as measured by the NMFS Southeast Zone Headboat Survey	Nowlis, Josh Sladek
SEDAR9-DW-30	Standardized Abundance Indices for Gulf of Mexico Gray Triggerfish (*Balistes capriscus)* based on catch rates as measured from commercial logbook entries with handline gear	Nowlis, Josh Sladek
SEDAR9-DW-31	Estimated Gulf of Mexico vermillion snapper recreational landings (MRFSS, headboat, TPWD) for 1981-2004	Cass-Calay, Shannon, & Guillermo Diaz
Documents Prepared for the Assessment Workshop		
SEDAR9-AW1	Incorporating age information into SEAMAP trawl indices for SEDAR9 species	Nicholls, S.
SEDAR9-AW2	Separating Vermilion Snapper Trawl Indexes into East and West Components	Nicholls, S
SEDAR9-AW3	Modelling Shrimp Fleet Bycatch for the SEDAR9 Assessments	Nicholls, S
SEDAR9-AW4	Status of the Vermilion Snapper (*Rhomboplites Aurorubens)* Fisheries of the Gulf of Mexico	Cass-Calay, S.
SEDAR9-AW5	Gulf of Mexico Greater Amberjack Stock Assessment	Diaz, Guillermo A., and Elizabeth Brooks
SEDAR9-AW6	A Categorical Approach to Modelling Catch at Age for Various Sectors of the Gray Triggerfish (*Balistes Capriscus)* Fishery in the Gulf of Mexico	Saul, Steven and G. Walter Ingram, Jr.
SEDAR9-AW7	Updated Fishery-Dependent Indices of Abundance for Gulf of Mexico Gray Triggerfish (*Balistes Capriscus)*	Nowlis, Joshua Sladek
SEDAR9-AW8	An Aggregated Production Model for the Gulf of Mexico Gray Triggerfish (Balistes Capriscus) Stock	Nowlis, Joshua Sladek and Steven Saul
SEDAR9-AW9	Age-Based Analyses of the Gulf of Mexico Gray Triggerfish (Balistes capriscus) Stock	Nowlis, J. S.
SEDAR9-AW10	Gulf of Mexico greater amberjack virtual population analysis assessment	Brown, C. A.,C. E. Porch, and G. P. Scott
SEDAR9-AW11	Rebuilding Projections for the Gulf of Mexico Gray Triggerfish (Balistes capriscus) Stock.	Nowlis, J. S.
Documents Provided for the Review Workshop		
SEDAR9-RW01	Performance of production models on simulated data. (Presentation for NMFS National SAW 8, 2006)	Brooks, E. N. et al

Reference Documents Provided at Workshops		
SEDAR9-RD01 Univ. South AL. PhD Thesis	Stock structure of gray triggerfish on multiple spatial scales in the Gulf of Mexico.	Ingram, W.G.
SEDAR9 RD02 2002. Proc. 53rd GCFI	Indirect estimation of red snapper and gray triggerfish release mortality	Patterson, W. F. et al.
SEDAR9-RD03 1997 Proc. 49th GCFI	Preliminary Analysis of Tag and Recapture Data of the Greater Amberjack, *Seriola dumerili*, in the Southeastern United States	McClellan, D. and Cummings, N.
SEDAR9 RD04 SEFSC Doc. No. SFD-99/00-99	Trends in Gulf of Mexico Greater Amberjack Fishery through 1998: Commercial landings, Recreational Catches, Observed length Frequencies, Estimates of Landed and Discarded Catch at Age, and Selectivity at Age.	Cummings, N. J., and D. B McClellan
SEDAR9-RD05 Fish. Res. 70 (2004) 299-310	A multispecies approach to subsetting logbook data for purposes of estimating CPUE	Stephens, A. and A. MacCall.
S9-RD06 SFD 99/00-100	Stock assessments of Gulf of Mexico greater amberjack using data through 1998.	Turner, S. C, N.J. Cummings, and C. E. Porch
S9-RD07 SFD 99/00-92	Catch rates of greater amberjack caught in the handline fishery in the Gulf of Mexico in 1990-1998	Turner, S. C.
S9-RD08 SFD 99/00-107	Catch rates of greater amberjack caught in the headboat fishery in the Gulf of Mexico, 1986-1998.	Turner, S. C.
S9-RD09 SFD 01/02-150	Projections of Gulf of Mexico greater amberjack from 2003-2012	Tuner, S. C. and G. P. Scott
S9-RD10 SFD 99/00-98	Gulf of Mexico greater amberjack abundance from recreational charter and private boat anglers from 1981-1998.	Cummings, N. J.
S9-RD11 SFD00/01-124	A stock assessment for gray triggerfish in the Gulf of Mexico.	Valle, M, C. Legault, and M. Ortiz.
S9-RD12 SFD00/01-126	Another assessment of gray triggerfish in the Gulf of Mexico using a space-state implementation of the Pella-Tomlinson production Model	Porch, C. E.
S9-RD13 SFD01/02-129	Status of the vermilion snapper fishery in the Gulf of Mexico. Assessment 5.0	Porch, C. E. and S. Cass-Calay.
S9-RD14 Panama City	Report of vermilion snapper otolith aging; 1994-2000 data summary	Allman, R. J., G. R. Fitzhugh, and W. A.

01-1		Fable
S9-RD15 FWRI IHR2005-3	Genetic stock structure of vermilion snapper in the Gulf of Mexico and southeastern United States	Tringali, M. D. and M. Higham
S9-RD16 SCDNR	Age, growth, and reproduction of greater amberjack in the Southwestern North Atlantic. December 2004 Analytical Report	Harris, P. J.
S9-RD17	Preliminary Assessment of Atlantic white marlin using a state-space implementation of an age-structured production model	Porch, C. E.
S9-RD18	VPA-2BOX Program Documentation, Version 2.01. 2003. ICCAT Assessment Program Documentation.	Porch, C. E.
S9-RD19	VPA-2BOX Program Documentation, Version 3.01. 2003. ICCAT Assessment Program Documentation.	Porch, C. E.
Final Assessment Reports		
SEDAR9-AR1	Gray Triggerfish	
SEDAR9-AR2	Greater Amberjack	
SEDAR9-AR3	Vermillion Snapper	

2. Response to Terms of Reference

2.1 Background

The panel examined and reviewed the reports and related documents from both the Data Workshop and the Assessment Workshops relating to the greater amberjack.

The assessments were reviewed in detail and minor modifications were recommended which had significant implications for the assessment outcomes. So an addendum will be produced to the assessment report for the greater amberjack.

2.2 Review of the Panel's deliberations

The deliberations on each species are presented in the form of responses to the terms of reference questions specifically, followed by relevant comments on the discussions.

2.2.1. Evaluate the adequacy, appropriateness, and application of data used in the assessment.

The data used in the assessment of greater amberjack were generally appropriate and were also applied in an appropriate manner. The data were also generally adequate to provide an informative assessment except in the latest year (2004) where the catch rate indices are inconsistent between the different sectors. Depending on what weight is given to the different sectors (equal weights or weighted relative to proportional catch) this inconsistency results in great uncertainty over the current stock status and the projections into the future. It is recommended that this uncertainty will only be *clarified by conducting an update assessment in the next few years to determine the trajectory of the stock more precisely.*

The Data Workshop (DW) for greater amberjack considered the life history characteristics (stock structure, habitat requirements, ageing, growth, age-at-maturity, natural mortality, and release mortality of greater amberjack taken as bycatch). Then the DW detailed the commercial and recreational fishing statistics (the catch statistics), and finally the measures of abundance (catch rates) for the different commercial and recreational sectors was discussed and presented.

All of this is useful and a sensible selection of information for the development of appropriate stock assessments. As with all fisheries data, different data streams tend to be of varying detail and quality, for example the age-at-maturity information is clearly approximate for greater amberjack (0% at age 2 year, 50% at age 3, and 100% beyond). Nevertheless, the attention paid to collecting detailed recreational fishing data on catches and catch rates is both welcome and necessary in a fishery which has such large recreational catches. This is a significant advance over the state of affairs as found in Europe and is more detailed than in New Zealand and Australia. Greater precision of the recreational catch rates and catches would undoubtedly be beneficial to the assessments, but these assessments are only possible at all, for fisheries in which recreational fishing is so significant, because such recreational data is available.

The application of the data analyses is usually clear with details of the standardizations of the catch rate data being given in separate SEDAR documents. At times the clarity of documentation of some of the treatments that the different data streams undergo varies. The most important instance of obscurity in the case of greater amberjack is the manner in which the catch history is developed for each sector. There is an issue with sub-dividing catches reported in summary categories (e.g. amberjacks – there are four species that are commonly included in this category) into their component species. Also there is the addition of an assumed 20% discard mortality rate in some sectors which is not described in sufficient detail. The full details of the treatments should be documented. It is recommended that whenever a major data stream (effort, catches or catch rates) is to be modified then those modifications be stated explicitly and documented completely; this is so obvious that underlying this recommendation is another more fundamental recommendation, which is that sufficient resources and time be provided to the scientific staff to prepare the materials and allowance be made for any major un-avoidable disruption to the process. This is not a criticism of the scientific staff involved in the assessments, who appear to have done an excellent job with the data available. It is understood that in this instance the advent of Hurricane Katrina was a large impediment to the smooth running of the SEDAR9 process. Thus, analyses were completed but it was apparent that insufficient time remained to completely document all aspects.

Sometimes the documentation fails to be explicit in listing exactly which data were finally to be used in the assessments and it is recommended that clarity would be improved by providing a summary table stating each data stream to be used with its constraints and any treatments or modifications made. This could be either in the Data Workshop report or the Assessment Workshop report.

It is relatively straightforward to assess the appropriateness and application of the data but more difficult to determine the adequacy of the different data streams. As a minimum if it proves possible to generate an assessment then in a sense the data could be deemed adequate. But without stated standards of precision and other performance measures then making firmer statements with respect to adequacy is difficult. In the case of greater amberjack the recreational MRFSS data in the final year appears to have enormous influence over the outcomes of the assessment. Up to and including 2003 the assessment appears to perform well but the addition of the 2004 recreational data (which makes up over half the total catch) can lead to the final outcomes of the assessment taking diverging paths in the projections. This difference depends upon what weighing scheme is placed on the different data streams (either equal weight to each data source or weighted according to their relative contribution to the total catch – which emphasizes the recreational and down-weights things like commercial long line). The weighting scheme selected (that of using the relative catches by sector over the last eight years) makes the assumption that the greater the catch the greater the chance that those catches are representative of the wider stock of greater amberjack. This is debatable considering the different sectors may target different ages or areas but is the best assumption currently available. We can conclude that the data up until 2003 are adequate for the production of a stable assessment but that the 2004 data leads to such uncertainty that the data series could be considered as no longer adequate to provide precise estimations of stock status and future potential yields. This was determined by experimentally removing the 2004 data from the analysis. The review panel concluded that because of the great uncertainty arising from the final year of data, more years of data are required to clarify the most recent trends in the stock. It is recommended that an update assessment be conducted (outside the usual benchmark assessment process) to elucidate the most likely forecasts and track the trajectory being followed by the stock.

2.2.2. Evaluate the adequacy, appropriateness, and application of methods used to assess the stocks.

The methods used to select and standardize the catch and effort data are innovative and appropriate. Other methods used to prepare the data for the assessments also appear appropriate and adequate. The stock assessment models utilized were also appropriate given the data available.

It was found that because of the difficulty in obtaining representative ageing data and lack of any representative catch-at-age data, the VPA (the continuity case) and the age-structured production model were inadequate to provide appropriate analyses of stock status. Even if future ageing data improves in quality and quantity it is recommended that the VPA option be abandoned as there is less chance that it could improve its performance in the face of poor early data. In the face of these problems the simple production model was the most appropriate of the available methods. Its implementation is via a user-friendly interface that appears to operate well. This method is capable of providing estimates of some of the management benchmarks of interest and in that sense at least is clearly adequate.

The Stephens and MacCall (2004) method of using catch composition of individual trips to identify appropriate sub-sets of trip data to be used when estimating the standardized CPUE time series was not reviewed in detail and its performance is unknown (though the method has been published in the formal literature).

Nevertheless, on theoretical grounds alone the method is considered appropriate. To avoid possible biases potentially introduced by this method, if different species exhibit different stock trends, it is considered that the application of this modelling approach separately each year is appropriate. In effect, the use of catch composition as part of the analysis of catch rates takes some account of multi-species considerations in these single species assessments.

Comparing more than one assessment model is an excellent strategy for exploring the most appropriate method to use within the constraints imposed by the available data. Such comparisons are also useful for exploring uncertainty due to model uncertainty. The three methods compared were a standard VPA, an age structured production model, and a simpler production model. The latter two models are estimated using penalized maximum likelihood methods. References to priors and methods typically associated with Bayesian methods should not be taken to imply that Bayesian methods were used. It is assumed that the priors were used as penalty functions during the model fitting process. The use of continuity cases (in this case the VPA) is applauded as it should indicate the influence of new data in the previous context. However, the development and use of other methods is desirable, especially in this case, because of the limitations in the ageing data. It is recommended that, if future ageing data can be improved, the age-structured modelling be restricted to the age-structured production modelling (ASPM) and the VPA be dropped as an option. The early ageing data will not be improved so the VPA method will remain compromised into the future whereas the ASPM may be able to improve its performance.

Given the constraints with greater amberjack data (primarily related to ageing difficulties and a lack of detailed catch-at-age data or low sample sizes) the assessment methods used are considered to be appropriate. The methods chosen reflected the character of the data available and the way in which it was collected. However, it was clear that insufficient time and resources had been made available to consider fully the model constraints and possible parameterisations. In this context, the further model and data explorations that occurred at the review workshop were able to lead to significant improvements. The practice of testing the sensitivity of model parameters of interest (e.g. F_{2004}/F_{msy}) to the use of alternative data series, and to the fixing of structural parameters and constraints is essential in the application of stock assessment models and this process should be developed and continued. In this workshop considerable changes to the assessment outcomes were affected by a more detailed consideration of different weighting being given to the different data streams. Such investigations should be a part of every assessment. For this to happen sufficient time must be allocated or permitted to the assessment staff to conduct these detailed analyses.

The application of the methods is not always simple to assess as details of the implementations are not always provided (it is recommended that each assessment should, preferably, contain appendices detailing at least the base case model or else refer to a readily available document).

In the absence of good quality ageing data it is difficult to obtain an unambiguous selectivity curve. Without either catch-at-age data or selectivity curves then the use of an age-structured method, such as VPA or the age-structure production model, can ask questions about the stock's status that cannot be answered by the information available in the data. Because of this neither the VPA nor the age-structured production model were deemed appropriate or adequate for greater amberjack. Instead it was the appropriate choice to select the simple production model to act as the base case assessment. Whether this model was adequate to characterize the stock status is difficult to assess in the absence of a formal simulation study. However, with what appears to be inconsistent data between sectors in the final year (2004), while the surplus production model was able (and therefore adequate) to provide an estimate of the current status of the stock the uncertainty in the final year means that the projections are not unambiguously informative.

2.2.3. Recommend appropriate estimates of stock abundance, biomass, and exploitation.

The base case model selected as being the best available was the simple production model known as ASPIC. Production models are based around a production curve that describes how the stock's productivity changes with stock size. While ASPIC has the flexibility to have an asymmetric production curve a symmetric curve was deemed most appropriate in this case. The data sources were the four fishery dependent indices of relative abundance (the different sectors commercial fisheries: Long Line, Hand Line and recreational fisheries: Headboat and Charter Boat/Private Boat). The relative contributions made by the different sectors varied greatly (in 2004 the charter boat sector took 59.5% of the catches, Headboat took only 3%, commercial handline took 35% and longline took 2.5%). In addition, the trends exhibited in the indices of relative abundance differed, especially in the last year, between sectors (with charter boat showing a marked decline, Headboat and longlines showing an increase and handline a slight decrease). In order to account for these differences in the base case model the relative contribution of each index of relative abundance to the overall likelihood was weighted relative to their relative contribution to the total catches over the final eight years. The base case was conducted using the following conditions:

Definition of Base Case Surplus Production model for Greater Amberjack	
Model Used	Non-equilibrium surplus production model conditioned on yield (ASPIC software was used).
Production Curve	Logistic model, leading to a symmetric production curve, implying that the maximum productivity is found at B_{MSY} = K/2.
Four fisheries	Commercial Long Line, Hand Line, Recreational Head Boat and Charter Boat and Private Boat.
Indices of Abundance	Fishery dependent indices of abundance were available for each of the four separate sectors (fisheries) listed above. The relative weighting applied to these different indices was made with respect to their individual percent contribution to the overall catch over the last 8 years: 1997 to 2004 – CB+PB 52.85, HB 4.42, HL 40.06 and LL 2.67.
Years of data and modelling.	1986 - 2004
Assumptions	20% discard mortality for each sector (see DW report).
Model Parameters	Population size relative to unfished biomass (B_1/K), Maximum Sustainable Yield – MSY, unfished biomass K and catchability *q* by fleet. In addition, F_{MSY} and B_{MSY} and the ratios of F_{2004} and B_{2004} with respect to these were also estimated.
Uncertainty Characterization	Bootstrapping was used to characterize uncertainty in the estimated parameters and model outputs.

Appropriate estimates of stock abundance, biomass and stock status, along with some sensitivity tests. The 'relative catch weighting' column relates to the optimum base case model and the 'equal weighting' sensitivity test relates to weighting the different indices of relative abundance equally (which would down-weight the MRFSS data and up-weight the HeadBoat and Long Line data).

Estimated Parameter	**Relative Catch Weighting**	**Equal Weighting**
B1/K	0.820	0.840
MSY (million lbs)	5.039	4.815
K (million lbs)	17.75	19.87
BMSY	8.873	9.937
FMSY	0.568	0.485
B2004/BMSY	0.479	0.706
F2004/FMSY	1.520	1.017

2.2.4. Evaluate the methods used to estimate population benchmarks and management parameters (*e.g., MSY, Fmsy, Bmsy, MSST, MFMT, or their proxies*); provide estimated values for management benchmarks, a range of ABC, and declarations of stock status.

Using the base case model, which was the simple production model implemented as ASPIC, the methods used to estimate the population benchmarks and management parameters appear to be either standard (*e.g.* B_{MSY} = K/2 – for a production model with a symmetric production curve) or constitute a completely appropriate approximation (*e.g.* MSST = (1-M)*B_{MSY} or 0.75*B_{MSY}). It is recommended that the various model outputs and management benchmarks (*e.g. MSY, Fmsy, Bmsy, MSST, MFMT*) for the accepted base case model be defined in one place along with how they were defined mathematically. This is especially important when the definitions of these values differ between models and possibly species. At the same time, it is recommended that a glossary of all the acronyms used in the assessments should be provided as the range of readers likely to be interested in this work will be large and acronyms are not always an aid to clarity. It should be noted that because there are no age-related data involved in this kind of assessment management benchmarks involving spawners-per-recruit are not available from simple surplus production models.

The summary of the stock status is provided in a table under section 2.3.

The assessment indicates that the stock is both overfished and experiencing overfishing.

2.2.5. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status; recommend appropriate estimates of future stock condition (e.g., exploitation, abundance, biomass).

The method used to conduct projections from the simple production model was built into the software implementation of ASPIC. There is more than one way to project the outcomes of a surplus production model (Haddon, 2001). While it can be assumed on authority that this software is adequate and performs appropriately it would be better practice to have the algorithms behind the software documented along with copies of the software documentations available to those considering the assessments. As described above, the last year of data contains inconsistencies between sectors so that, depending on the weighting schema used, the projections are highly uncertain with regard to how long recovery of the stock to the management targets would take (assumed to be Bmsy with this assessment). In order to increase the chances of being able to make adequate projections to be made in the future it is recommended that an update assessment be made before the next formal assessment of greater amberjack is due to be made.

2.2.6. Evaluate the adequacy, appropriateness, and application of methods used to characterize uncertainty in estimated parameters. Provide measures of uncertainty for estimated parameters. Ensure the implications of uncertainty in technical conclusions are clearly stated.

For the greater amberjack the preferred base case model was the simple production model. Bootstrapping was used to characterize the uncertainty of the estimated parameters and model outputs (management benchmarks). This method is both appropriate and is usually adequate with production models (Haddon, 2001). The classic application method of bootstrapping with surplus production models is to bootstrap the residuals between the observed data and the optimal model fit. These bootstrapped residuals are then added to the original fitted values and the model refitted to provide the bootstrap estimates of the parameters of interest. This process is repeated many times which provides the characterization of uncertainty. The implementation of this process was verbally reported as being correct and appropriate within ASPIC. Better documentation would be preferable. In this instance the bootstrapping led to a broad spread of potential outcomes reflecting the uncertainty and variation in the data and the production modelling analysis.

The implication of the uncertainty in the parameter estimates and model outcomes will be expressed in the addendum to the assessment report. The draft material presented at the SEDAR Review Workshop expressed this appropriately.

2.2.7. Ensure that stock assessment results are clearly and accurately presented in the Stock Assessment Report and that reported results are consistent with Review Panel recommendations. (In the event corrections are made in the assessment, alternative model configurations are recommended, or additional analyses are prepared as a result of review panel findings regarding the TORs above, ensure that corrected estimates are provided by addenda to the assessment report).

Corrections were made to the assessment (the base case selected involved small changes to the emphasis placed on the different indices of relative abundance that led to significant changes to the conclusions). The revised assessment was still be developed at the time of the SEDAR workshop but the outcomes of the revised assessment were presented at SEDAR 9 (this was not a correction but rather a revision). The formal revised assessment will be included as an addendum to the greater amberjack assessment document.

2.2.8. Evaluate the performance of the Data and Assessment Workshops with regard to their respective Terms of Reference; state whether or not the Terms of Reference for those previous workshops were met and are adequately addressed in the Stock Assessment Report.

The Data Workshop on Greater Amberjack was reported in *S9DWREP GAJ.pdf*. Overall the important terms of reference were well met with details being provided for life history (including stock structure, ageing, growth, and natural mortality, which received detailed reviews), Commercial fishing statistics, recreational fishing statistics, and the various indices of relative abundance. In some places the recommendations were not as explicit as they could have been. For example, on page 48 in section “5.3.1 Indices to be considered for use in the assessment″ the document states “As a general recommendation, the indices recommended for use from each fishery are those gulf-wide indices which employed the Stephens and MacCall (2004) approach to subsetting the data.” While this is useful in identifying the approach to be used it would have been simpler and more constructive to have explicitly listed the data series to be used in each of the different assessment methods to be applied [i.e. 1) commercial handline (1-9 hooks per line), 2) commercial longline, 3) recreational headboat and 4) recreational charter boat and private boat combined, and not the others]

At least two of the Terms of Reference for the Data Workshop did not appear to be addressed well and these were “5. Evaluate the adequacy of available data for estimating the impacts of current management actions.” Also “6. Recommend assessment methods and models that are appropriate given the quality and scope of the data sets reviewed and management requirements.” The relationship between the different data sources and recent and current management was not elucidated in many instances. Neither were suggestions documented as to what models would be most appropriate given the available data. However, answering both of these questions seems more appropriate in the assessment and overall review meetings rather than the Data meeting so this absence is not critical. It is recognized that the stock assessment staff involved in the modelling were mostly involved in the Data Workshop as well, so this failure to meet the TOR, in this case, may be more a matter of failure to document decisions. It is recommended that these TORs should be removed from consideration by the Data Workshop to one of the other workshops.

The Report from the Stock Assessment Workshop (AW) was S9SAR2 SectIIISAW GAJ.pdf. The time table for the assessments was greatly influenced by the advent of Hurricane Katrina. Nevertheless, while there were some deviations from the recommendations of the Data Workshop most of the details of the terms of reference for the Assessment Workshop were met satisfactorily.

The deviations from the Data Workshop (DW) recommendations constituted a constructive change that was fully justified. When standardizing the indices of relative abundance the selection of records to be included in the analyses used a strategy that attempted to account for where species were expected to be caught by considering the species mix of reported catches. This provides an estimate of the number of zero fishing events, which is a decided advantage but can also have the effect of excluding those trips which only had a single target species. The change away from the recommendation of the DW was to lower the thresholds required in a record to permit its inclusion in the analysis. This had the potential to make the results more robust and so was a positive move.

A further issue within the assessment document was with reference to the species composition of commercial catches. There are four species of *Seriola* that are sometimes reported in combination as “amberjack” or even as “unclassified amberjack”. The DW recommended that the yields reported as unclassified amberjack and unclassified jacks be identified by species and the proportions allocated to greater amberjack where appropriate for use in the stock assessments. This alternative catch series only involved changes from 1990 to 2004, and the ambiguous reporting was mostly a problem during the 1990s. Nevertheless, the ambiguous records in the early 1990s constituted an important proportion of the commercial catch. The inclusion of these data is a sensible precaution against omitting yield. The issue is in the documentation of these changes. It would have been better to have been explicit and provided the full details of the algorithms actually used to make the species sub-division and then to make the re-allocation to greater amberjack. Undoubtedly, the disturbed assessment timetable in 2005 has contributed to this omission in the documentation. Spreadsheets showing the calculations were made available during SEDAR9, but for future stock assessments it is recommended that the process of adjusting the catch time series be fully documented.

In the Assessment Workshop the Terms of Reference included: 5. Provide yield-per-recruit and stock-recruitment analyses. While information on the stock recruitment characteristics were provided in the DW and discussed in the AW the only reference to Yield per Recruit in the AW was as part of Table 3.3.2.2.1 on page 40 showing results from a particular SSASPM. Presumably the value of a YPR analysis would be to determine whether growth overfishing is occurring as a check on the legal minimum length (even though this is not listed as one of the fishery performance measured listed to be considered). When the assessments for a species are highly uncertain or omit important aspects of the fishery then a YPR is an excellent minimum fall-back position and should be developed more fully. In the case of greater amberjack it is a recommended a full YPR analysis would appear to be a valuable addition to future assessments.

Terms of reference 10 stated: Evaluate the results of past management actions and probable impacts of current management actions with emphasis on determining progress toward stated management goals. This is an ambitious request and could only be treated relatively lightly at the AW. Once again, further clarity in the terms of reference would be helpful or this term of reference is not appropriate for the AW.

2.2.9. Review research recommendations provided by the Data and Assessment workshops and make any additional recommendations warranted. Clearly indicate the research and monitoring needs that may appreciably improve the reliability of future assessments.

1) Research recommendations were reported as being discussed in the DW but were not documented.
2) The research recommendations from the AW were sensible and would assist in clarifying problems with the current assessment and provide the possibility of extending the assessment to more advanced methods (age-structured production model).
3) An additional research recommendation that may be helpful would be to collect information on the species composition and total catch of shore based landings of Greater Amberjack and other species.

2.2.10. Prepare a Peer Review Consensus Summary summarizing the Panel's evaluation of the stock assessment and addressing each Term of Reference. Prepare an Advisory Report summarizing key assessment results. (Reports to be drafted by the Panel during the review workshop with a final report due two weeks after the workshop ends.)

See separate Advisory Report

2.3. Comments on the SEDAR Process

The SEDAR process appears to be remarkably thorough and detailed, with many opportunities for clarification and communication of the stock assessment processes. The whole idea of such detailed reviews is to be applauded as demonstrating a willingness to be open and to provide the best defensible assessments possible with available data.

The process itself is relatively intensive and after observing the difficulties involved in review three species at the same time it is recommended that future SEDAR events only consider two species at the most. With three fisheries there are greater opportunities for confusion between species and the time available for detailed discussion could be compromised. If there were to be multiple species considered in future SEDAR workshops it would be beneficial to allocate species among reviewers prior to arrival at the workshop so they could begin the detailed and focussed examination of the very many reports from the Data and Assessment Workshops before arriving at the review venue.

The final review workshop report appears to be asking for the review panellists to produce an independent assessment summary and while the review panel may have possibly provided significant input to the assessment development the work is still mostly all that of the assessment scientists. As such it feels contrary to general practice to not have their names associated with the final consensus report.

Some of the review reporting, such as the advisory report, appears to be primarily an editorial effort which could be produced by anyone rather than the review panellist. The chances for errors of omission would be significantly lower if the advisory report were produced by the assessment scientists concerned and merely edited and agreed to by the review panellists.

Recommendations

2.1.1 Whenever a major data stream (effort, catches or catch rates) is to be modified the details of any modifications should be stated explicitly and documented completely.

2.1.2 To avoid overloading the scientific staff, sufficient resources and time should always be provided to prepare the materials to normal scientific standards and allowance be made for any major un-avoidable disruption to this process (such as Hurricane Katrina).

2.1.3 A summary table for each assessment should be provided stating each data stream to be used with its constraints and any treatments or modifications made. Included in this table should be an indication of the reliability of each data stream. It could be included in either the Data Workshop or Assessment Workshop reports.

2.1.4 Within the greater amberjack assessment, because of the uncertainty caused by the final year of data, an update assessment should be conducted within a few years (outside the usual benchmark assessment process) to elucidate the most likely trajectory being followed by the stock and enable the provision of remedial management measures should these be necessary.

2.2.1 Each assessment document should, preferably, contain appendices detailing the structure and likelihood estimator for at least the base case model, or alternatively refer to a readily available document containing these details.

2.2.8 A yield-per-recruit analysis should be made for the greater amberjack as an addition to future assessments to act as a check against growth overfishing and whether the legal minimum length is appropriate.

2.4.1 The various model outputs and management benchmarks (e.g. MSY, Fmsy, Bmsy, MSST, MFMT) for the accepted base case model should be defined in one place within the stock assessment report along with how they were defined mathematically.

2.4.2 A glossary of all the acronyms used in the assessments should be provided as an appendix in every assessment report.

2.8.1 If the data available are adequate for conducting an assessment then the 5th and 6th Terms of Reference in the Data Workshop should be removed from consideration by the Data Workshop and shifted instead to the Assessment Workshop.

List of Acronyms

ABC	Acceptable Biological Catch – variable interpretations
ASPIC	aggregated surplus production model with integrated covariates
EA	environmental assessment
FMP	Fishery Management Plan
Foy	F optimal yield = 0.75 Fmsy
ICCAT	International Commission for the Conservation of Atlantic Tuna
IRFA	initial regulatory flexibility analysis
MFMT	Maximum Fishing Mortality Threshold – overfishing criterion
MRFSS	marine recreational fisheries statistical survey
MSST	= (1-M)MSY Minimum Stock Size Threshold – overfished criterion
NMFS	National Marine Fish Service
OY	Optimal Yield 0.75 MSY for greater amberjack but see Magnusson Act
RIR	Regulatory Impact Review
Sector	any recognizable group, recreational, commercial or bycatch that impacts on the fish stock of interest.

SFA	Sustainable Fisheries Act
SPR	Spawning Potential Ratio
SSASPM	State Space Age-Structures Production Model
SSB(R)	Spawning Stock Biomass (per recruit)
TIP	Trip Intercept Programme
TAC	Total Allowable Catch
TPW(D)	Texas Parks and Wildlife (Department)
VPA	Virtual Population Analysis
YOY	Young of Year

References

Haddon, M. (2001) *Modelling and Quantitative Method in Fisheries*. CRC/Chapman & Hall, Boca Raton, 406 p.

Stephens, A. and A. MacCall. 2004. A multispecies approach to subsetting logbook data for purposes of estimating CPUE. Fisheries Research 70 (2004), 299–310.

SEDAR Review Panel Advisory Report
SEDAR 9
Greater Amberjack

1. Stock Distribution and Identification

Genetic studies indicate that the stock within the Gulf of Mexico constitutes a single biological stock. The geographic boundary of the management units occurs from the Dry Tortugas through the Florida Keys. Treating this region as a single biological stock is appropriate.

2. Assessment methods

The preferred assessment method chosen is a simple production model of the Schaefer type (uses a symmetric production curve) which assumes all individuals are equivalent and selectivity is ignored. Alternative and previous assessments (a VPA and an age-structured surplus production model) show similar assessment outcomes but a lack of good quality ageing data adds an unknown amount of uncertainty to these methods and they are not adequate at present.

3. Assessment data

The data sources and assumptions used were:

MRFSS estimates of catch and standardized catch rates.
Head boat estimates of catches and standardized catch rates.
Commercial hand line catches and standardized catch rates.
Commercial long line catches and standardized catch rates.

Date was available and modelled from 1986 to 2004.
Release mortality was assumed to be 20%.
Bycatch in the prawn fishery is assumed to be negligible.

4. Catch trends

Total catches are modelled from 1986.

Early catches were relatively variable which may be simply a reflection of early variation in the MRFSS catch estimates.

The general trend in catches across all sectors was a decline to 1998 followed by an increase to 2003 with a small drop in 2004.

5. Fishing mortality trends

Fishing mortality, as expressed as $F_{current}/F_{MSY}$, was variable and above 1.0 until about 1998 after which there is a reduction closer to a ratio of 1.0 but remaining above this threshold. Full details will only become available in the addendum to the assessment report deriving from the new analysis.

6. Stock abundance and biomass trends

Stock biomass followed a pattern similar to total catches except it was less variable. There was a decline from 1986 down to 1998 until the ratio $B_{current}/B_{MSY}$ was below of 1.0. This decline was followed by a slow increase to the present. Full details will only become available in the addendum to the assessment report deriving from the new analysis.

7. Status determination criteria

The stock appears to be in both an overfished condition and was being overfished in 2004. This was determined by a consideration of the ratios of the current biomass estimate B_{2004} with B_{MSY} and the current fishing mortality F_{2004} with F_{MSY}; biomass is less than half the limit reference point of B_{MSY}, and fishing mortality was 50% greater than its limit reference point of F_{MSY}. However, these results are very dependent upon the weighting applied to the different time series of catch rates, the base case is to weight each series of catch rate indices in line with the total proportion catch by each sector over the past eight years. When each catch rate is weighted equally (the poorest assumption) the stock remains overfished but less so than the base case, and is only just in the overfishing state.

Much of the uncertainty in the stock status derives from the indices of relative abundance being inconsistent between sectors in 2004. This makes the projections both uncertain and uninformative so that it is recommended that an update assessment be conducted in the next few years to determine the stock trajectory with more precision.

8. Stock Status

The parameters relevant to management are estimated as follows:

Parameter	***Value***
Population parameters and management benchmarks	
MSY (million pounds)	5.039
B_{MSY}	8.873
F_{MSY}	0.568
Stocks parameters in 2004	
F_{2004}	0.863
F_{2004}/ F_{MSY}	1.520
B_{2004}	4.250
B_{2004}/ B_{MSY}	0.479

Declarations of Stock Status:

- the stock was overfished in 2004 ($B_{2004}/B_{MSY} < 1.0$);
- the stock was undergoing overfishing in 2004 ($F_{2004}/ F_{MSY} > 1.0$);
- the stock was overexploited with respect to the optimum fishing mortality;

- uncertainty has been added to the assessment by the 2004 data. Catch rate data from the four different sectors exhibits significant differences in 2004 and the assessment outcome and projections are very dependent upon how the catch rate series are weighted;

9. Projections

Only draft projection have been presented (SEDAR9 Review Workshop). Full quantitative projections will be available as an Addendum to the greater amberjack assessment document. The draft projections are uncertain depending upon the last year of catch rate data and how the catch rate series are weighted when fitting the model. This uncertainty is so great that the future stock status cannot be forecast adequately. *Because of this uncertainty it is recommended that an update assessment be conducted in the next few years to determine the most likely stock status trajectory and respond appropriately at that time.*

10. Allowable biological catch

Adequate projections are not available and will remain in that state until an update assessment is conducted. In the meantime, it would be precautionary to not recommend that the catch should remain as it is and should not be increased.

11. Special Comments

The change of assessment model from the VPA base case used previously to the simpler simple stock production curve was the most appropriate move given the uncertainty in ageing greater amberjack combined with the small samples used to characterize the catch-at-age. However, the stock status remains unchanged with the introduction of the simpler model. It was concluded that the stock was both overfished in 2004 and was experiencing overfishing in 2004. It is stressed, however that:

(1) the catch rate data in 2004 was inconsistent between sectors; the minor components of the fishery (recreational headboats and commercial longline) exhibited an increase while the major components of the fishery (recreational charter boat and private boats with commercial hand line vessels) exhibited different degrees of decrease. This is why different weightings produced different outcomes.

(2) there may be other reasons why the different sectors exhibited different trends in 2004, these include a) different selectivities between sectors, b) different fishing locations of each sector with some being more representative than others, and even c) a very strong recruitment into the fishery combined with the selectivity by the charter boats for smaller fish.

(3) the assessments were well developed but the assessment staff had clearly not had sufficient time to fully explore all options. It is recognized that scientific advice is required for many species but additional scientific and technical resources need to be made available or else current stock assessment staff will be hard pressed to maintain the high quality of their work.

12. Sources of information

The report from the Data Workshop for greater amberjack along with the associated workshop documents.

The report from the Assessment workshop for greater amberjack along with associated documents.

The SEDAR9 Review workshop discussions and presentations.

SEDAR

SouthEast Data, Assessment, and Review

Gulf of Mexico Greater Amberjack
SEDAR 9
Stock Assessment Report 2

SECTION 5. Post Review Addendums

Contents

ADDENDUM 1. Updated ASPIC Model Results.


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SEDAR 9 Greater Amberjack Gulf of Mexico
ASPIC Configuration and Results: Review Panel recommended configuration ‘relative catch weighting’

                                                                             Thursday, 30 Mar 2006 at 11:53:50
ASPIC -- A Surplus-Production Model Including Covariates (Ver. 5.10)
                                                                                              BOT program mode
Author:     Michael H. Prager; NOAA Center for Coastal Fisheries and Habitat Research             LOGISTIC model mode
            101 Pivers Island Road; Beaufort, North Carolina  28516  USA                        YLD conditioning
            Mike.Prager@noaa.gov                                                                SSE optimization

Reference:  Prager, M. H. 1994. A suite of extensions to a nonequilibrium             ASPIC User's Manual is available
            surplus-production model.  Fishery Bulletin 92: 374-389.                          gratis from the author.

CONTROL PARAMETERS (FROM INPUT FILE)           Input file: c:\aj\review_panel\ratio05_weighted_2_boot_500_somerestrict.
-----------------------------------------------------------------------------------------------------------------------
Operation of ASPIC:  Fit logistic (Schaefer) model by direct optimization with bootstrap.
Number of years analyzed:                        19             Number of bootstrap trials:                        500
Number of data series:                            4             Bounds on MSY (min, max):       5.000E+04     3.000E+08
Objective function:                   Least squares             Bounds on K (min, max):         2.000E+06     7.000E+09
Relative conv. criterion (simplex):       1.000E-08             Monte Carlo search mode, trials:        0         10000
Relative conv. criterion (restart):       3.000E-08             Random number seed:                             9210570
Relative conv. criterion (effort):        1.000E-04             Identical convergences required in fitting:           6
Maximum F allowed in fitting:                 8.000
```

PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS) error code 0

Normal convergence

CORRELATION AMONG INPUT SERIES EXPRESSED AS CPUE (NUMBER OF PAIRWISE OBSERVATIONS BELOW)

		1	2	3	4
1	handline	1.000 12			
2	longline	0.667 12	1.000 12		
3	headboat	0.550 12	0.937 12	1.000 19	
4	cb-pb	0.434 12	0.484 12	0.548 19	1.000 19

GOODNESS-OF-FIT AND WEIGHTING (NON-BOOTSTRAPPED ANALYSIS)

Loss component number and title		Weighted SSE	N	Weighted MSE	Current weight	Inv. var. weight	R-squared in CPUE
Loss(-1)	SSE in yield	0.000E+00					
Loss(0)	Penalty for B1 > K	0.000E+00	1	N/A	1.000E+01	N/A	
Loss(1)	handline	6.472E-01	12	6.472E-02	1.551E+00	2.572E+00	-0.065
Loss(2)	longline	1.807E-01	12	1.807E-02	1.163E-01	6.910E-01	0.008
Loss(3)	headboat	5.479E-01	19	3.223E-02	1.551E-01	5.165E-01	0.388
Loss(4)	cb-pb	5.470E+00	19	3.217E-01	2.055E+00	6.856E-01	0.515
TOTAL OBJECTIVE FUNCTION, MSE, RMSE:		6.84551128E+00		1.245E-01	3.528E-01		
Estimated contrast index (ideal = 1.0):		0.7015		C* = (Bmax-Bmin)/K			
Estimated nearness index (ideal = 1.0):		1.0000		N* = 1 - |min(B-Bmsy)|/K			

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	User/pgm guess	2nd guess	Estimated	User guess
B1/K	Starting relative biomass (in 1986)	8.196E-01	5.000E-01	7.484E-01	1	1
MSY	Maximum sustainable yield	5.039E+06	1.700E+07	3.609E+06	1	1
K	Maximum population size	1.775E+07	2.400E+07	2.166E+07	1	1
phi	Shape of production curve (Bmsy/K)	0.5000	0.5000	----	0	1
---------	Catchability Coefficients by Data Series ---------------					
q(1)	handline	2.803E-07	1.000E-08	9.500E-07	1	1
q(2)	longline	2.160E-07	1.000E-08	9.500E-07	1	1
q(3)	headboat	1.981E-07	1.000E-08	9.500E-07	1	1
q(4)	cb-pb	1.720E-07	1.000E-08	9.500E-07	1	1

MANAGEMENT and DERIVED PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Logistic formula	General formula
MSY	Maximum sustainable yield	5.039E+06	----	----
Bmsy	Stock biomass giving MSY	8.873E+06	K/2	K*n**(1/(1-n))
Fmsy	Fishing mortality rate at MSY	5.679E-01	MSY/Bmsy	MSY/Bmsy
n	Exponent in production function	2.0000	----	----
g	Fletcher's gamma	4.000E+00	----	[n**(n/(n-1))]/[n-1]
B./Bmsy	Ratio: B(2005)/Bmsy	4.781E-01	----	----
F./Fmsy	Ratio: F(2004)/Fmsy	1.524E+00	----	----
Fmsy/F.	Ratio: Fmsy/F(2004)	6.563E-01	----	----
Y.(Fmsy)	Approx. yield available at Fmsy in 2005	2.409E+06	MSY*B./Bmsy	MSY*B./Bmsy
	...as proportion of MSY	4.781E-01	----	----
Ye.	Equilibrium yield available in 2005	3.667E+06	4*MSY*(B/K-(B/K)**2)	g*MSY*(B/K-(B/K)**n)
	...as proportion of MSY	7.277E-01	----	----
---------	Fishing effort rate at MSY in units of each CE or CC series ---------			
fmsy(1)	handline	2.026E+06	Fmsy/q(1)	Fmsy/q(1)
fmsy(2)	longline	2.630E+06	Fmsy/q(2)	Fmsy/q(2)
fmsy(3)	headboat	2.867E+06	Fmsy/q(3)	Fmsy/q(3)
fmsy(4)	cb-pb	3.303E+06	Fmsy/q(4)	Fmsy/q(4)

ESTIMATED POPULATION TRAJECTORY (NON-BOOTSTRAPPED)

Obs	Year or ID	Estimated total F mort	Estimated starting biomass	Estimated average biomass	Observed total yield	Model total yield	Estimated surplus production	Ratio of F mort to Fmsy	Ratio of biomass to Bmsy
1	1986	0.584	1.454E+07	1.262E+07	7.366E+06	7.366E+06	4.086E+06	1.028E+00	1.639E+00
2	1987	0.722	1.126E+07	9.971E+06	7.199E+06	7.199E+06	4.935E+06	1.271E+00	1.270E+00
3	1988	0.480	9.000E+06	9.304E+06	4.466E+06	4.466E+06	5.025E+06	8.452E-01	1.014E+00
4	1989	1.277	9.559E+06	7.055E+06	9.006E+06	9.006E+06	4.734E+06	2.248E+00	1.077E+00
5	1990	0.481	5.287E+06	6.102E+06	2.937E+06	2.937E+06	4.534E+06	8.476E-01	5.959E-01
6	1991	0.945	6.884E+06	6.183E+06	5.842E+06	5.842E+06	4.568E+06	1.664E+00	7.758E-01
7	1992	0.759	5.609E+06	5.653E+06	4.293E+06	4.293E+06	4.376E+06	1.337E+00	6.322E-01
8	1993	1.165	5.692E+06	4.793E+06	5.584E+06	5.584E+06	3.960E+06	2.052E+00	6.415E-01
9	1994	1.200	4.067E+06	3.514E+06	4.216E+06	4.216E+06	3.195E+06	2.112E+00	4.584E-01
10	1995	0.875	3.047E+06	3.142E+06	2.751E+06	2.751E+06	2.937E+06	1.542E+00	3.434E-01
11	1996	1.190	3.233E+06	2.867E+06	3.413E+06	3.413E+06	2.728E+06	2.096E+00	3.644E-01
12	1997	1.184	2.548E+06	2.309E+06	2.733E+06	2.733E+06	2.280E+06	2.084E+00	2.872E-01
13	1998	0.806	2.096E+06	2.305E+06	1.857E+06	1.857E+06	2.277E+06	1.419E+00	2.362E-01
14	1999	0.748	2.516E+06	2.806E+06	2.098E+06	2.098E+06	2.681E+06	1.317E+00	2.835E-01
15	2000	0.732	3.099E+06	3.416E+06	2.500E+06	2.500E+06	3.131E+06	1.289E+00	3.492E-01
16	2001	0.701	3.729E+06	4.086E+06	2.866E+06	2.866E+06	3.570E+06	1.235E+00	4.203E-01
17	2002	0.765	4.433E+06	4.615E+06	3.528E+06	3.528E+06	3.878E+06	1.346E+00	4.997E-01
18	2003	0.967	4.783E+06	4.497E+06	4.348E+06	4.348E+06	3.812E+06	1.702E+00	5.391E-01
19	2004	0.865	4.247E+06	4.245E+06	3.673E+06	3.673E+06	3.668E+06	1.524E+00	4.787E-01
20	2005		4.242E+06						4.781E-01

RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED) handline

Data type CC: CPUE-catch series Series weight: 1.551

Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale
1	1986	*	3.536E+00	0.1057	1.333E+06	1.333E+06	0.00000
2	1987	*	2.794E+00	0.1906	1.900E+06	1.900E+06	0.00000
3	1988	*	2.608E+00	0.2711	2.522E+06	2.522E+06	0.00000
4	1989	*	1.977E+00	0.3421	2.414E+06	2.414E+06	0.00000
5	1990	*	1.710E+00	0.2624	1.601E+06	1.601E+06	0.00000
6	1991	*	1.733E+00	0.3267	2.020E+06	2.020E+06	0.00000
7	1992	*	1.584E+00	0.2455	1.388E+06	1.388E+06	0.00000
8	1993	1.071E+00	1.343E+00	0.4586	2.198E+06	2.198E+06	0.22646
9	1994	9.680E-01	9.848E-01	0.5044	1.772E+06	1.772E+06	0.01718
10	1995	1.191E+00	8.807E-01	0.5527	1.737E+06	1.737E+06	-0.30185
11	1996	9.840E-01	8.035E-01	0.6227	1.785E+06	1.785E+06	-0.20271
12	1997	7.640E-01	6.471E-01	0.6743	1.557E+06	1.557E+06	-0.16602
13	1998	7.430E-01	6.459E-01	0.4122	9.499E+05	9.499E+05	-0.14012
14	1999	8.770E-01	7.863E-01	0.3759	1.055E+06	1.055E+06	-0.10912
15	2000	8.890E-01	9.572E-01	0.3677	1.256E+06	1.256E+06	0.07395
16	2001	9.560E-01	1.145E+00	0.2475	1.012E+06	1.012E+06	0.18062
17	2002	9.090E-01	1.293E+00	0.2278	1.051E+06	1.051E+06	0.35259
18	2003	1.367E+00	1.260E+00	0.2866	1.289E+06	1.289E+06	-0.08125
19	2004	1.280E+00	1.190E+00	0.3032	1.287E+06	1.287E+06	-0.07328

* Asterisk indicates missing value(s).

RESULTS FOR DATA SERIES # 2 (NON-BOOTSTRAPPED) longline

Data type CC: CPUE-catch series Series weight: 0.116

Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale
1	1986	*	2.725E+00	0.0169	2.138E+05	2.138E+05	0.00000
2	1987	*	2.153E+00	0.0272	2.713E+05	2.713E+05	0.00000
3	1988	*	2.009E+00	0.0376	3.497E+05	3.497E+05	0.00000
4	1989	*	1.524E+00	0.0456	3.218E+05	3.218E+05	0.00000
5	1990	*	1.318E+00	0.0222	1.355E+05	1.355E+05	0.00000
6	1991	*	1.335E+00	0.0011	6.577E+03	6.577E+03	0.00000
7	1992	*	1.221E+00	0.0097	5.473E+04	5.473E+04	0.00000
8	1993	7.510E-01	1.035E+00	0.0182	8.701E+04	8.701E+04	0.32082
9	1994	7.310E-01	7.589E-01	0.0213	7.470E+04	7.470E+04	0.03742
10	1995	9.270E-01	6.787E-01	0.0283	8.902E+04	8.902E+04	-0.31183
11	1996	6.260E-01	6.191E-01	0.0215	6.178E+04	6.178E+04	-0.01101
12	1997	7.930E-01	4.987E-01	0.0280	6.461E+04	6.461E+04	-0.46385
13	1998	7.250E-01	4.977E-01	0.0259	5.966E+04	5.966E+04	-0.37617
14	1999	7.000E-01	6.060E-01	0.0234	6.573E+04	6.573E+04	-0.14427
15	2000	8.450E-01	7.377E-01	0.0224	7.667E+04	7.667E+04	-0.13586
16	2001	9.070E-01	8.825E-01	0.0126	5.139E+04	5.139E+04	-0.02734
17	2002	1.453E+00	9.966E-01	0.0183	8.458E+04	8.458E+04	-0.37703
18	2003	1.604E+00	9.712E-01	0.0304	1.365E+05	1.365E+05	-0.50170
19	2004	1.939E+00	9.167E-01	0.0211	8.966E+04	8.966E+04	-0.74917

* Asterisk indicates missing value(s).

RESULTS FOR DATA SERIES # 3 (NON-BOOTSTRAPPED) headboat

Data type CC: CPUE-catch series Series weight: 0.155

Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale
1	1986	2.641E+00	2.499E+00	0.0551	6.950E+05	6.950E+05	-0.05530
2	1987	1.179E+00	1.975E+00	0.0363	3.621E+05	3.621E+05	0.51584
3	1988	1.256E+00	1.843E+00	0.0227	2.108E+05	2.108E+05	0.38342
4	1989	1.705E+00	1.397E+00	0.0351	2.476E+05	2.476E+05	-0.19894
5	1990	7.180E-01	1.209E+00	0.0311	1.900E+05	1.900E+05	0.52077
6	1991	5.640E-01	1.225E+00	0.0207	1.278E+05	1.278E+05	0.77541
7	1992	6.540E-01	1.120E+00	0.0603	3.407E+05	3.407E+05	0.53772
8	1993	4.620E-01	9.493E-01	0.0529	2.537E+05	2.537E+05	0.72014
9	1994	4.490E-01	6.960E-01	0.0624	2.191E+05	2.191E+05	0.43828
10	1995	7.180E-01	6.224E-01	0.0467	1.466E+05	1.466E+05	-0.14287
11	1996	5.130E-01	5.678E-01	0.0550	1.576E+05	1.576E+05	0.10154
12	1997	5.000E-01	4.574E-01	0.0547	1.262E+05	1.262E+05	-0.08916
13	1998	5.640E-01	4.564E-01	0.0441	1.016E+05	1.016E+05	-0.21158
14	1999	5.510E-01	5.557E-01	0.0303	8.513E+04	8.513E+04	0.00855
15	2000	7.050E-01	6.765E-01	0.0293	9.994E+04	9.994E+04	-0.04125
16	2001	1.179E+00	8.094E-01	0.0253	1.033E+05	1.033E+05	-0.37615
17	2002	1.513E+00	9.140E-01	0.0463	2.137E+05	2.137E+05	-0.50402
18	2003	1.397E+00	8.907E-01	0.0449	2.020E+05	2.020E+05	-0.45006
19	2004	1.731E+00	8.407E-01	0.0262	1.112E+05	1.112E+05	-0.72222

RESULTS FOR DATA SERIES # 4 (NON-BOOTSTRAPPED) cb-pb

Data type CC: CPUE-catch series Series weight: 2.055

Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale
1	1986	1.925E+00	2.170E+00	0.4062	5.124E+06	5.124E+06	0.11963
2	1987	1.952E+00	1.715E+00	0.4679	4.665E+06	4.665E+06	-0.12966
3	1988	1.243E+00	1.600E+00	0.1487	1.384E+06	1.384E+06	0.25252
4	1989	2.911E+00	1.213E+00	0.8537	6.023E+06	6.023E+06	-0.87518
5	1990	4.590E-01	1.049E+00	0.1656	1.010E+06	1.010E+06	0.82688
6	1991	1.716E+00	1.063E+00	0.5964	3.687E+06	3.687E+06	-0.47860
7	1992	1.472E+00	9.722E-01	0.4439	2.510E+06	2.510E+06	-0.41486
8	1993	8.850E-01	8.242E-01	0.6355	3.046E+06	3.046E+06	-0.07119
9	1994	6.960E-01	6.043E-01	0.6117	2.149E+06	2.149E+06	-0.14135
10	1995	4.730E-01	5.404E-01	0.2478	7.786E+05	7.786E+05	0.13319
11	1996	4.460E-01	4.930E-01	0.4911	1.408E+06	1.408E+06	0.10019
12	1997	3.040E-01	3.971E-01	0.4266	9.850E+05	9.850E+05	0.26711
13	1998	2.770E-01	3.963E-01	0.3235	7.456E+05	7.456E+05	0.35815
14	1999	3.710E-01	4.825E-01	0.3183	8.930E+05	8.930E+05	0.26277
15	2000	5.470E-01	5.874E-01	0.3125	1.067E+06	1.067E+06	0.07119
16	2001	5.880E-01	7.027E-01	0.4159	1.700E+06	1.700E+06	0.17824
17	2002	1.182E+00	7.936E-01	0.4721	2.179E+06	2.179E+06	-0.39844
18	2003	1.033E+00	7.733E-01	0.6049	2.720E+06	2.720E+06	-0.28950
19	2004	5.200E-01	7.299E-01	0.5148	2.185E+06	2.185E+06	0.33910

ESTIMATES FROM BOOTSTRAPPED ANALYSIS

Param name	Point estimate	Estimated bias in pt estimate	Estimated relative bias	Bias-corrected approximate confidence limits 80% lower	80% upper	50% lower	50% upper	Inter-quartile range	Relative IQ range
B1/K	8.196E-01	2.594E-02	3.17%	5.112E-01	1.032E+00	6.946E-01	9.118E-01	2.172E-01	0.265
K	1.775E+07	2.339E+08	1317.99%	1.554E+07	1.982E+07	1.629E+07	1.794E+07	1.648E+06	0.093
q(1)	2.803E-07	-4.781E-08	-17.06%	2.497E-07	3.496E-07	2.775E-07	3.276E-07	5.010E-08	0.179
q(2)	2.160E-07	-2.547E-08	-11.80%	1.408E-07	3.322E-07	1.887E-07	2.628E-07	7.408E-08	0.343
q(3)	1.981E-07	-2.577E-08	-13.01%	1.590E-07	3.098E-07	1.888E-07	2.496E-07	6.083E-08	0.307
q(4)	1.720E-07	-2.818E-08	-16.39%	1.526E-07	2.030E-07	1.696E-07	1.941E-07	2.456E-08	0.143
MSY	5.039E+06	1.301E+07	258.13%	4.492E+06	5.888E+06	4.734E+06	5.137E+06	4.032E+05	0.080
Ye(2005)	3.667E+06	-3.188E+05	-8.69%	2.736E+06	4.458E+06	3.308E+06	4.086E+06	7.784E+05	0.212
Y.@Fmsy	2.409E+06	2.634E+07	1093.38%	1.670E+06	3.498E+06	2.011E+06	2.798E+06	7.866E+05	0.326
Bmsy	8.873E+06	1.169E+08	1317.99%	7.772E+06	9.908E+06	8.147E+06	8.971E+06	8.241E+05	0.093
Fmsy	5.679E-01	-8.809E-02	-15.51%	5.116E-01	6.554E-01	5.631E-01	6.280E-01	6.484E-02	0.114
fmsy(1)	2.026E+06	2.788E+07	1375.75%	1.754E+06	2.339E+06	1.866E+06	2.126E+06	2.606E+05	0.129
fmsy(2)	2.630E+06	3.818E+07	1451.82%	1.922E+06	9.130E+07	2.246E+06	3.295E+06	1.049E+06	0.399
fmsy(3)	2.867E+06	3.018E+07	1052.64%	2.204E+06	8.672E+07	2.468E+06	3.340E+06	8.715E+05	0.304
fmsy(4)	3.303E+06	3.481E+07	1054.13%	3.000E+06	1.175E+08	3.145E+06	3.484E+06	3.384E+05	0.102
B./Bmsy	4.781E-01	1.571E-01	32.86%	2.937E-01	6.764E-01	3.817E-01	5.501E-01	1.684E-01	0.352
F./Fmsy	1.524E+00	-2.433E-02	-1.60%	1.098E+00	2.006E+00	1.344E+00	1.748E+00	4.044E-01	0.265
Ye./MSY	7.277E-01	-8.443E-02	-11.60%	4.540E-01	8.909E-01	6.455E-01	8.253E-01	1.798E-01	0.247
q2/q1	7.706E-01	5.004E-02	6.49%	5.123E-01	1.040E+00	6.295E-01	8.780E-01	2.485E-01	0.322
q3/q1	7.067E-01	6.138E-02	8.68%	5.243E-01	8.771E-01	5.944E-01	7.751E-01	1.807E-01	0.256
q4/q1	6.136E-01	2.752E-02	4.49%	5.180E-01	6.935E-01	5.633E-01	6.417E-01	7.838E-02	0.128

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INFORMATION FOR REPAST (Prager, Porch, Shertzer, & Caddy. 2003. NAJFM 23: 349-361)
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Unitless limit reference point in F (Fmsy/F.):              0.6563
CV of above (from bootstrap distribution):                   37.81


NOTES ON BOOTSTRAPPED ESTIMATES:
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- Bootstrap results were computed from 500 trials.
- Results are conditional on bounds set on MSY and K in the input file.
- All bootstrapped intervals are approximate. The statistical literature recommends using at least 1000 trials
  for accurate 95% intervals. The default 80% intervals used by ASPIC should require fewer trials for equivalent
  accuracy. Using at least 500 trials is recommended.
- Bias estimates are typically of high variance and therefore may be misleading.

Trials replaced for lack of convergence:       0           Trials replaced for MSY out of bounds:                55
Trials replaced for q out-of-bounds:           0
Trials replaced for K out-of-bounds:           0           Residual-adjustment factor:                       1.0617

Elapsed time: 0 hours, 29 minutes, 23 seconds.
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