SEDAR
Southeast Data, Assessment, and Review

SEDAR 9 Stock Assessment Update Report

Gulf of Mexico Greater Amberjack

February 2011

SEDAR
4055 Faber Place Drive, Suite 201
North Charleston, SC 29405

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SECTION I: Introduction

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1. SEDAR OVERVIEW

Southeast Data, Assessment, and Review (**SEDAR**) is a cooperative Fishery Management Council process initiated in 2002 to improve the quality and reliability of fishery stock assessments in the South Atlantic, Gulf of Mexico, and US Caribbean. SEDAR seeks improvements in the scientific quality of stock assessments and the relevance of information available to address fishery management issues. SEDAR emphasizes constituent and stakeholder participation in assessment development, transparency in the assessment process, and a rigorous and independent scientific review of completed stock assessments.

SEDAR is managed by the Caribbean, Gulf of Mexico, and South Atlantic Regional Fishery Management Councils in coordination with NOAA Fisheries and the Atlantic and Gulf States Marine Fisheries Commissions (‘Cooperators’). Oversight is provided by a Steering Committee composed of NOAA Fisheries representatives: Southeast Fisheries Science Center Director and the Southeast Regional Administrator; Regional Council representatives: Executive Directors and Chairs of the South Atlantic, Gulf of Mexico, and Caribbean Fishery Management Councils; and Interstate Commission representatives: Executive Directors of the Atlantic States and Gulf States Marine Fisheries Commissions.

SEDAR workshops are public meetings organized by SEDAR staff and the lead Cooperator. Workshop 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.

1.2 *SEDAR ASSESSMENT UPDATE PROCESS DESCRIPTION*

Once an assessment is approved through a SEDAR benchmark process, the basic framework of input data and model configuration may be updated in the future by adding additional years of data. It is intended that the update process should be considerably less time consuming and require less manpower than benchmark assessments. Minor modifications and changes to input data and modeling techniques may also be incorporated in updates, although in all instances a strict update, defined as only including incorporation of additional data into the previous framework, will be prepared.

The Cooperator(s) involved in the update assessment shall make appointments to the update workshop panel in accordance with their SEDAR appointment guidelines. The Regional Administrator and Science Center Director shall designate appropriate participants from their staff.

Oversight and review of assessment updates will be provided by each Cooperator's SSC or scientific body. The scientific body shall establish specific terms of reference for the update assessment, including determining acceptable changes and modifications to the benchmark assessment procedures and analyses.

The update assessment shall provide current values for all inputs and outputs provided in the original benchmark assessment. The Cooperator shall appoint an update workshop chair, and it is suggested that the chair be a representative of the SSC or scientific body. The chair or another cooperator designee shall present workshop findings to their council, including its various committees as requested by Cooperator leadership. The lead analyst for the update assessment shall provide the technical presentation required for the SSC or scientific body review, similar to the presentations expected at a benchmark review panel.

All documentation standards of SEDAR workshops apply to assessment updates. Working papers, Stock Assessment Reports, and Summary Report shall be provided to the SEDAR coordinator for inclusion in the Administrative Record and website posting.

2. MANAGEMENT OVERVIEW

2.1 *MANAGEMENT UNIT DEFINITION*

Greater Amberjack, *Seriola dumerili*, is one of four jacks among 40 reef fish species in the management unit for the Gulf of Mexico Fishery Management Council (GMFMC) Reef Fish Fishery Management Plan (FMP). Other fishes managed under the FMP include 15 groupers, 14 snappers, 5 tilefishes, 4 jacks, 1 triggerfish and 1 wrasse. The jurisdiction of the Gulf of Mexico Reef Fish FMP includes all waters of the Gulf of Mexico (Gulf) bounded outside by 200 nautical miles (nm) and inside by the state's territorial waters which extend 3 nm from shore off Alabama, Mississippi and Louisiana and 3 leagues or about 9 nm from shore off Florida and Texas.

2.2 *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. Table 2.2.1 provides a chronology of the management history for Gulf of Mexico greater amberjack management unit. A detailed summary of the management history is provided below.

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 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 Gulf wide during 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 nm^2 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 5 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 $F_{30\%\ SPR}$, and MSST equal to $(1\text{-}M)*B_{MSY}$ or 75 percent of B_{MSY}. It also set a rebuilding plan limiting the harvest to 2.9 million pounds (mp) for 2003-2005, 5.2 mp for 2006-2008, and 7.0 mp for 2009-2011, and for 7.9 mp for 2012. This was expected to rebuild the stock in 7 years.

Amendment 30A

Implemented in August 2008, Amendment 30A increased the recreational minimum size limit from 28 to 30 inches FL, reduced the commercial quota, established a recreational quota, modified the greater amberjack rebuilding plan, and established commercial and recreational accountability measures that are triggered when a quota is exceeded.

Current Management Criteria and Stock Benchmarks

As established by Secretarial Amendment 2 to the Reef Fish FMP (implemented July 2003), 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 F40% SPR when the stock is at equilibrium. MFMT is equal to $F_{30\%\ SPR}$, and MSST is equal to $(1\text{-}M)*B_{MSY}$ or 75 percent of B_{MSY}.

A 7-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 30 inches fork length and the commercial size limit is 36 inches fork length. The recreational bag limit is one fish per person. The commercial greater amberjack fishery was closed October 28, 2010. The recreational greater amberjack sector is currently projected to remain open the remainder of 2010. The current proportional allocation of the total allowable catch (TAC) for the greater amberjack resource is 73 % recreational and 27% commercial.

Table 2.2.1. Gulf of Mexico greater amberjack management regulations 1984-2010.

Greater Amberjack History of Regulations - Gulf of Mexico EEZ							
Effective Date	**Action**	**Size limit (minimum, except where noted)**	**Bag Limit**	**Closed season**	**Quotas**	**Document**	**Federal Register Notice**
November 25, 1984	All Seriola species, including greater amberjack, listed in the FMP as in the fishery but not in the management unit.					Original FMP	48 FR 9554
February 21, 1990	- Greater amberjack and lesser amberjack added to species in the management unit. - Commercial reef fish permit required to harvest commercially or to sell fish. - Reporting requirements established for commercial, charter and headboats. - All reef fish subject to a minimum size limit must be landed head and tails attached.	Greater Amberjack 28" FL recreational 36" FL commercial	Greater amberjack 3 fish per person per day			Amendment 1	55 FR 2078
May 8, 1992	- Almaco jack and banded rudder fish added to species in the management unit. - Three year moratorium on issuance of commercial reef fish permits (May 8, 1992 - May 7, 1995).					Amendment 4	57 FR 11914
February 7, 1994	- Riley's Hump (near Dry Tortugas) closed to all fishing during May and June to protect mutton snapper spawning aggregations. - A special management zone is created off of Alabama within which fishing for reef fish is restricted to hook-and-line gear with 3 or less hooks per line and spearfishing gear.					Amendment 5	59 FR 966
July 27, 1994	The commercial reef fish permit moratorium is extended through December 31, 1995.					Amendment 9	59 FR 39301
January 1, 1996	- A new commercial reef fish permit moratorium is implemented for five years (January 1, 1996 - December 31, 2000). - A charter vessel/headboat permit is required for a vessel operating as a charter vessel/headboat in the EEZ to fish for or possess reef fish.					Amendment 11	60 FR 241

January 15, 1997			Greater amberjack 1 fish per person per day; 20 fish aggregate bag limit established for reef fish with no other bag limits, including lesser amberjack, Almaco jack, and banded rudderfish			Amendment 12	61 FR 242
January 29, 1998				Commercial harvest of greater amberjack closed March, April and May of each year.		Amendment 15	62 FR 249
November 24, 1999		Banded rudderfish and lesser amberjack: 14" FL minimum 22" FL maximum	Banded rudderfish and lesser amberjack combined: 5 fish (no longer subject to 20 reef fish aggregate limit)			Amendment 16B	64 FR 35981 and 64 FR 57403
June 19, 2000	Madison-Swanson and Steamboat Lumps marine reserves are created and closed to all fishing except for highly migratory species for four years (June 19, 2000 - June 16, 2004).					regulatory amendment	65 FR 31827
August 2, 2000	The commercial reef fish permit moratorium is extended for five years through December 31, 2005.					Amendment 17	65 FR 41016
July 29, 2002	Three year moratorium on issuance of charter vessel/headboat reef fish permits (July 29, 2002 - July 29, 2005)					Reef Fish Amendment 20, also Coastal Migratory Pelagics Amendment 14	67 FR 43558
August 19, 2002	The EEZ portion of the Tortugas North Ecological Reserve and the Tortugas South Ecological Reserve are created and are closed to fishing for any species and anchoring by fishing vessels. These reserves encompass the previously created Riley's Hump reserve. The remainder of the Tortugas North reserve falls under and is created by other regulatory jurisdictions.					Generic EFH Amendment 2 (also known as Reef Fish Amendment 19)	67 FR 47467

July 3, 2003	A 10-year greater amberjack rebuilding plan is approved. TAC is set at: 2.9 mp ww for 2003-2005; 5.2 mp ww for 2006-2008; 7.0 mp ww for 2009-2011. No regulatory changes are implemented as the current catches are below the TAC as a result of previous actions, and the stock, although overfished, is not undergoing overfishing.					Secretarial Amendment 2	68 FR 39898
August 17, 2005	A permanent limited access system is established in the commercial reef fish fishery by capping participation at the current level.					Amendment 24	70 FR 41161
June 15, 2006	A permanent limited access system is established for charter vessel/headboat (for-hire) permits for the reef fish and coastal migratory pelagic fisheries in the exclusive economic zone (EEZ) of the Gulf of Mexico that will continue to cap participation at current levels.					Reef Fish Amendment 25, also Coastal Migratory Pelagics Amendment 17	71 FR 28282
February 28, 2008	Require the use of non-stainless steel circle hooks when using natural baits to fish for Gulf reef fish, require the use of venting tools and de-hooking devices when participating in the commercial or recreational reef fish fisheries.					Reef Fish Amendment 27, also Shrimp Amendment 14	73 FR 5117
August 4, 2008	Establishes accountability measures and annual catch limits for greater amberjack and gray triggerfish.	Greater Amberjack 30" FL recreational	Greater amberjack: 1 per person per day, zero bag limit for captain and crew of a vessel operating as a charter vessel or headboat		Commercial: 503,000 lbs. ww Recreational: 1,368,000 lbs. ww	Amendment 30A	73 FR 38139
October 24, 2009				Quota closure - recreational fishery		Temporary rule	74 FR 54489
November 7, 2009				Quota closure - commercial fishery		Temporary rule	74 FR 57261
June 22, 2010	Accountability measures are implemented to temporarily reduce the 2010 commercial and recreational quotas due to overages in 2009.				Commercial for 2010: 373,072 lbs. ww Recreational for 2010: 1,243,184 lbs. ww	Temporary rule	75 FR 35335
October 28, 2010				Quota closure - commercial fishery		Temporary rule	75 FR 64171

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Executive Summary

The most recent comprehensive stock evaluation for the Gulf of Mexico greater amberjack stock was conducted in 2005 through the SEDAR process (SEDAR9, SAR). High uncertainty in the catch at size composition time series and inadequate age composition data were noted by the SEDAR9 Assessment Workshop Panel (SEDAR9 SAW Panel). The SEDAR9 AW Panel recommended the use of a simple production model (e.g., ASPIC) to evaluate stock status and provide management advice for greater amberjack. The results of the SEDAR9 stock assessment indicated the stock was overfished and was undergoing overfishing however, inconsistencies in catch per unit of effort (CPUE) trends between different fishing sectors in 2004 resulted in highly uncertain stock status projections. The SEDAR 9 Review Workshop (SEDAR9 RW Panel) recommended that an update assessment be undertaken before the next formal assessment in order to determine the actual trajectory being followed by the stock.

In 2010 an update stock assessment evaluation was initiated for greater amberjack. The update assessment involved multiple components including: 1) reviewing the literature for updated life history information, 2) extracting and replacing updated commercial and recreational catch statistics and incorporating new catch statistics for years since the previous 2005 stock assessment, 3) evaluating new information on commercial and recreational discard sizes and new information on commercial and recreational discard rates from observer studies, 4) extracting CPUE data and conducting index standardization analyses to provide a time series of updated abundance trends, 5) carrying out new population model analyses using ASPIC (as in SEDAR9), and 6) conducting new stock projection analyses under varying management scenarios. The 2010 updated stock assessment presents updated commercial and recreational catch statistics for 1981-2009, revised estimates of commercial and recreational discards (numbers and weight) through 2009, updated CPUE abundance trends through 2009 for four dependent fisheries datasets (recreational charter boat and private angler fisheries, headboat fishery, commercial vertical line, and commercial longline fisheries). Updated information on growth rates and reproduction for adult fish (Murie and Parkyn, 2008) is presented. New information on release mortality is provided (Murie and Parkyn 2010), and new information from Renshaw and Gold (2009) regarding genetic tools for use in distinguishing greater amberjack from other commonly caught *Seriola* spp. is presented.

The updated time series of commercial catch statistics shows, as in previous stock assessments, that commercial harvest of greater amberjack is mainly by vertical line gear (80% of self reported logbook records) with harvest by longlines following (17% of logbook records). Minor harvest levels of this species are reported using troll gear (3.2% of logbook records). Commercial harvest of greater amberjack is dominated by landings from west Florida ports followed by Texas, Louisiana, Alabama, and Mississippi. Commercial landings of greater amberjack have generally declined by about 35% since the previous stock assessment (averaging 626,393 pounds (ww) from 2005-2009. The commercial fishery closed to harvest in 2009 (November 7) and also in 2010 (October 28). Amendment 30A of the GMFMC, Reef Fish FMP implemented August 4th, 2008 reduced the commercial harvest to 503,000 lbs (whole weight). The current allocation ratios between commercial and recreational are 27% and 73% respectively.

The 2010 updated analyses of commercial discard rates from the self-reported coastal logbook records using vertical lines resulted in lower estimates of greater amberjack discards than previously determined for the 2005 stock assessment. These estimates reflect a correction in the computer program used for the previous 2005 analyses. New data on the size of commercial discards was available from observer studies for the 2010 update providing improved characterization of commercial discard size.

Recreational harvest of greater amberjack is dominated by the landings from the charter boat and private angler fisheries followed by the headboat fishery. Recent recreational landings estimates indicate that on average the headboat fishery contributes about 5% of the annual harvest (2005-2009). The differences in recreational landings estimates from the previous stock assessment and the 2010 update are most likely due to differences in the two assessments in sample sizes used to determine average weights resulting from small sample sizes, and varying minimum sample sizes used for calculating average weights between SEDAR9 and the 2010 update. New information on discard rates from the headboat fishery observer studies was also considered for the update for estimating headboat discards. Due to the short time series, the high variability in discard rates, and a concern regarding the representativeness of the observer samples to the overall fishery the 2010 update panel recommended to continue the discard estimating procedures in the previous assessment for estimating headboat discards.

Estimates of recent recreational landings and discards of greater amberjack since the previous stock evaluation show an overall decline in estimated landings and discards of about 31% since 2004 (average across 2005-2009). Amendment 30A of the GMFMC Reef Fish FMP (August 4th, 2008) implemented new regulations increasing the recreational minimum size from 28 inches to 30 inches FL and set the bag limit for captain and crew to zero of a vessel operating as a charter vessel or headboat. The recreational fishery for greater amberjack was closed October 24th 2009. The current allocation ratios between commercial and recreational are 27% and 73% respectively.

The 2010 updated CPUE standardization analyses resulted in reasonably similar abundance trends between the previous stock assessment and the 2010 update for the years of overlap. CPUE data from four fisheries were evaluated for developing abundance indices: the recreational charter and private angler fisheries, the recreational headboat fishery, the commercial vertical line and the commercial longline fisheries. In general, auxiliary variables with which to adjust the nominal trends in CPUE (e.g., main factors such as time, location fished, depth, bait type, etc...) were few. Still, the overall estimated trends in abundance were similar between the update and historical CPUE analyses. As in the previous stock assessment, the tendency for the estimated CPUE trends to diverge between fisheries, particularly during the later years was present. This was evident for the commercial longline index which tended to not track the commercial vertical line or recreational charter and private angler index in the latter years.

The updated trends in greater amberjack standardized CPUE were as follows. The charter and private angler standardized CPUE shows an early period of anomalously high and variable CPUE (through 1989) followed by a large decline in 1990. After 1990, MRFSS charter and private angler CPUE alternates between brief periods, about three years in length, of increasing and decreasing CPUE. CPUE briefly increased between 1990 and 1995, declined thereafter through 1999 to the lowest level of the time series. Between 2000 and 2003, CPUE showed moderate increases and again declines between 2004 and 2007. The charter and private angler CPUE showed a slight increase in 2008 again declining in 2009. The current period, since 2008, appears to be one of slightly declining to flat CPUE for the charter boat and private angler fishery.

Standardized greater amberjack CPUE from the headboat fishery declined between 1986 and 1990 as was observed for the charter and private angler fishery, showed a slight increase through 1992 thereafter declining in 1993 and remaining relatively unchanged through 2001. Headboat CPUE slightly increased through 2003 and thereafter again showed steady declines through 2007. Standardized headboat CPUE increased slightly in 2008 and 2009. Estimated increases in CPUE from the headboat fishery are of short duration, two to three years in length, across the time series. Of the four fisheries only the headboat and commercial longline showed increases in recent CPUE.

Standardized greater amberjack CPUE from the commercial vertical line fishery seem to show distinct levels (2) of CPUE across the time series, 1992-2009. CPUE increased between 1992 and 1996, declined through 1997, remaining unchanged through 2000, again increasing slightly through 2002. Vertical line CPUE entered a declining trend around 2006 that continued through 2009. The increases in vertical line CPUE are of brief intervals, usually lasting around three years in length.

Standardized greater amberjack CPUE from the commercial longline fishery showed a flat unchanging trend between 1992 and 2001, increased through 2005, thereafter declining through 2007. Longline CPUE increased in 2008 and 2009. Of the four fisheries evaluated only the headboat and commercial longline showed increases in recent CPUE.

Updated population analyses using the ASPIC production model (ASPIC 5.0 Suite of software) were conducted using the updated time series of landings and discards and the time series of CPUE abundance trends. As in the previous stock assessment the logistic model was implemented. The ASPIC model requires initial values for the parameters being estimated: B1/K, MSY, K and fishery specific selectivities (q's). All initial runs were carried out allowing the program to estimate the above mentioned parameters. ASPIC estimates B_{MSY} as K/2 and F_{MSY} as MSY/B_{MSY}. Prager et al. 1996 and Prager 1994 provide describe the parameter estimating equations and the model fitting process in detail.

The four time series of abundance trends, fisheries landings and discard data used in the ASPIC model corresponded to 1) the recreational charter and private angler, 2) the headboat fishery, 3) the commercial vertical line, and 4) the commercial longline fishery. The analyses included the years 1986-2009. As in the previous stock assessment, the Continuity case evaluations were conducted using landings + discards assuming 20% release mortality estimates. Initial ASPIC model analyses assumed equal index weighting and a penalty term for the B1/K >1.0 (penalty term=10). Sensitivity analyses were also conducted to evaluate the ASPIC model results to a variety of scenario inputs that included: 1) varying assumptions for discard release mortality (0 % and 40%), 2) varying the initial input values for beginning stock size to virgin stock size level (i.e., the B1/K ASPIC model parameter), 3) evaluating the impact on ASPIC model results to choice of index weighting options (i.e., equal index weighting or relative catch proportional index weighting), and 4) evaluating impact on ASPIC model results to changes in recreational catch estimates between the 2010 evaluation and the 2005 SEDAR9 evaluation.

For the 2010 update Continuity case landings + 20% discard runs, the B1/K ratio was fixed at 0.5 which assumes the greater amberjack population was at 50% of the virgin biomass at the beginning of the time series (i.e., in 1986). MSY was estimated to be about 4.9 million lbs, B_{MSY} 14.7 million lbs and maximum population size K 29.5 million lbs. Estimated F_{MSY} was 0.33 and current relative F (F_{2009}/F_{MSY}) was 1.83, current relative biomass (B_{2009}/B_{MSY}) was estimated at 0.31.

Biomass declined from 1986 through 1989, increased slightly in 1990, and continued to decline through about 1997. The lowest level of biomass was reached around 1997 (B_{1997} = 4.2 million pounds, B_{1997}/B_{MSY} = 0.28). The stock experienced a brief period of recovery between 1997 and 2001 reaching a biomass of about 7 million lbs in 2001 (B_{2001}/B_{MSY}=0.48) thereafter declining again. However, the stock has remained overfished with a relative biomass B_{2009}/B_{MSY} = 0.31).

For the continuity case landings + 20% discards ASPIC Run, ASPIC estimated F_{MSY} = 0.33. These results suggest that the Gulf of Mexico greater amberjack stock has experienced overfishing conditions since at least 1986 (F_{1986} = 0.59, F_{1986}/F_{MSY} = 1.77), with the exception of 1990 (F_{1990} = 0.3, F_{1990}/F_{MSY} = 0.89). The model results show large variability in the trend of fishing mortality however, the overall trend in F remained relatively high until around the late 1990's (i.e., year = 1998, F_{1998} = 0.37, F_{1998}/F_{MSY} = 1.1). This lower trend in F lasted only a brief period of time, around three years, thereafter more than doubling again by the mid 2000's. Between 2000 and 2004, F had increased to about 0.8 (F_{2004}/F_{MSY} = 2.4). In subsequent years estimated fishing mortality on greater amberjack has been slightly lower with average annual F = 0.57 and relative F's (F_{Year}/F_{MSY}) averaging around 1.7.

Impact on ASPIC model results from the three sensitivity scenarios provides useful feedback in evaluating the application of the ASPIC model for the greater amberjack stock evaluations. Sensitivity scenario 1 (considering the impact of varying initial B1/K input ratio (0.2, 0.5, 0.6, 0.75, 0.8, 1.0, and 0.5 fixed) and varying discard release mortality (0 and 20%) suggested that, the ASIPIC model produced similar results for the estimated parameters across most runs assuming 0 % and 20% discard mortality rate. Results of the sensitivity around initial input values of B1/K for the 20% discard mortality case indicated that estimated carrying capacity K ranged from 16.5 to 37.3 million lbs, while MSY ranged from 2.6 to 6.2 million lbs. Higher levels of release mortality resulted in higher estimates of K, MSY and FMSY and lower estimates of B_{MSY} however, model performance (in terms of convergence at various starting values) was not as successful for the 40% discard runs and one run of the 20% discard trials presented estimation problems for the MSY parameter.

ASPIC model results for sensitivity scenario 2 evaluations (considering the impact on model results from proportional index weighting vs. equal index weighting in the objective function fitting process) suggest, as observed in the previous SEDAR9 stock assessment, that index weighing choices do have an effect on ASPIC model results for the greater amberjack data. ASPIC runs were made for varying initial input B1/K values of 0.2, 0.5, 0.6, 0.75,0.8, 1.0, and 0.5 fixed) for the 2010 continuity case landings + 20% discards. Relative index weights were calculated as the proportional contribution by fishery of the overall landings and discards for 1997 forward. In general, the ASPIC model produced (for the runs with normal convergence) higher and more variable estimates of the K, MSY, and B/B_{MSY} than estimated for either the 2010 continuity ASPIC trials or the ASPIC sensitivity 1 trials. High variability between runs in ASPIC parameter estimates of K, MSY, and B1/K produced high uncertainty in the determination of the stock condition.

The third sensitivity scenario was conducted by substituting the SEDAR9 recreational charter and private angler landings and discards estimates for 1986-2004 into the 2010 updated time series with all other years for this fishery unchanged from the 2010 updated values. ASPIC runs were made assuming 20% discard mortality and varying initial input B1/K ratios (0.2, 0.5, and 1.0). A comparison of ASPIC estimates of relative biomass (B/B_{MSY}) and relative F($F/_{MSY}$) for the year 2004 did not reveal major differences as regards the determination of the overall condition of the stock for the final year (i.e., 2004) of the previous stock assessment time series. The results from sensitivity scenario 3 (with the SEDAR9 generally indicate that the relative biomass for 2004 was below biomass at MSY, ranging from 0.26 to 0.44 of B/B_{MSY}. The previous SEDAR9 stock assessment ASPIC run (assuming equal index weighting) estimated relative biomass (B/B_{MSY}) to be 0.71 for the year 2004. The updated 2010 stock assessment ASPIC continuity run (for B1/K=0.5, equal index weighting, 20% discards) estimated relative biomass (B/B_{MSY}) to be 0.38 for year 2004.

ASPIC model results from the 2010 continuity run (2010 updated landings + 20% discards, B1/K ratio=0.5, equal index weighting) were used to determine current stock status and to conduct projections of stock status for varying scenarios involving varying future fishing mortality and catch assumptions. The continuity run results indicate that 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_{2009}/B_{MSY} = 0.311, where MSST = $0.75B_{MSY}$. 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_{2009}/F_{MSY} 1.830, therefore exceeding the MFMT. Greater amberjack in the Gulf of Mexico are under a rebuilding plan implemented in June 2003 under Secretarial Amendment 2. The rebuilding time period was specified as 7 years, with year one specified as 2003.

Using ASPIC, the 2010 update Continuity case of landings + 20% release mortality and an initial value of B1/K=0.5 was chosen for bootstrap (1,000 runs) and projection analysis. Relative biomass projections for the years 2010-2025 were obtained for 1) different scenarios of future F_{Year}/F_{2009} (levels of 0.0, 0.2, 0.3, 0.45, 0.5, and 1.0 times F_{2009} were used) and also by keeping the 2009 catch constant ($Yield_{2009}$ + 20% discards), and 3). Two sensitivity catch projection scenarios runs were made to explore variation in estimated population trajectories under the constant catch scenario. Finally, projections were also made for varying scenarios of future F_{Year}/F_{2009} corresponding to varying levels of F_{OY} and F_{MFMT} as presented in the Terms of Reference for the 2010 assessment update.

The fishing mortality projection results indicate that the greater amberjack stock will not recover to B_{MSY} at current F by the end of the projection period (2025) under current levels of fishing mortality. Recovery to B_{MSY} could occur by 2018 with a reduction to ~ 45% of fishing mortality of 2009 levels ($F_{2009} = 0.3325$). A reduction in current fishing mortality results to F_{2009} * 0.5 results in no recovery of the stock. These results indicate that model projections are sensitive to the magnitude of the fishing mortality multiplier (scalar) in the range of 0.45 – 0.5.

Projections under constant yield show a more pessimistic view of population status than the fishing mortality projections. At status quo harvest (2.73 million lbs removed in 2009, assuming 20% discard mortality) projections indicate a continually declining population.

In addition to the constant catch projection, two sensitivity projection runs were conducted to explore potential impacts of the fishery closures associated with the Deepwater Horizon. As with the earlier fishing mortality and catch projections, the 2010 continuity case landings + 20% discard ASPIC run results (for B1/K ratio=0.5 fixed, equal index weighting) were used in the projections. These runs varied the total allowable removals (yields). These two projection runs were based on the observation that approximately 75% of recent recreational removals occur between the months of April and September (Table 2.1.7, Amendment 30 2010). No assumptions were made regarding additional mortality effect of the Deepwater Horizon Incident or other environmental effects. The first sensitivity run associated with catch projections assumed a 50% reduction in total catch in year 2010. The second projection assumed a 50% reduction in only the recreational catch in year 2010. Both of these catch based projection sensitivity runs indicate immediate improvement in stock status and trajectories suggesting eventual recovery of the stock.

Additional projections were made for relative biomass (B/B_{MSY}) under three SFA/MSSRA evaluation scenarios for fishing mortality levels relative to F_{OY} and F_{MFMT} for future F/F_{2009}. These projections indicate that the stock could recover by 2015 under the 65% MFMT evaluation scenario for future $F/F_{2009.}$

1. INTRODUCTION

1.1. ASSESSMENT UPDATE TIME AND PLACE

The SEDAR 2010 Gulf Greater Amberjack Stock Assessment Webinars took place on the following dates: 1) Data Webinar July 16, 2010, 2) Assessment Webinar I August 25, 2010, 3) Assessment Webinar II September 7, 2010, and 3) Assessment Webinar III November 22, 2010. An additional Assessment Conference call took place September 16, 2010.

1.2 *TERMS OF REFERENCE*

1. Evaluate any relevant data and parameters to be included into the stock assessment model. This evaluation should be conducted with all relevant scientific input.

2. Evaluate the relative reliability of fishery dependent and independent data sources and adjust model input appropriately.
3. Update the approved SEDAR 9 greater amberjack model base configuration, surplus production model ASPIC, with data through 2008. This configuration includes incorporation of fishery-dependent indices of abundance from commercial handline, commercial longline, recreational headboat, and MRFSS, and fishery-independent indices of abundance from SEAMAP shrimp/bottomfish surveys and their predecessors, and the SEAMAP reef fish video survey.
4. Document any changes or corrections made to input datasets and tabulate complete updated input datasets. Provide tables of commercial and recreational landings and discard in pounds gutted weight. Clarify units of measurement in all tables.
5. Estimate and provide complete updated tables of stock parameters.
6. Update measures of uncertainty and provide representative measures of precision for stock parameter estimates.
7. Update estimates of stock status and SFA parameters; provide declarations of stock status relative to current SFA criteria.
8. Specify OFL, and may recommend a range of ABC for review by the SSC in compliance with ACL guidelines.
9. Evaluate future stock status for 2009-2014 according to the specifications in Table 2. Note that under the rebuilding plan, the greater amberjack stock is required to be rebuilt (to the SSB_{MSY} level) by 2012.
10. A yield-per-recruit analysis should be made for the greater amberjack to act as a check against growth overfishing and whether the legal minimum length is appropriate.
11. Review the research recommendations from the previous assessment, note any which have been completed, and make any necessary additions or clarifications.
12. Develop a stock assessment workshop report to fully document the input data, methods, and results of the stock assessment update.

NOTES:

This update assessment is intended to update those population and status measures approved for the original assessment to and provide OFL and a range of ABC recommendations in compliance with ACL guidelines. A specific ABC recommendation will be the responsibility of the SSC, in compliance with Section 302 of the Magnuson-Stevens Act.

It is not the intent of this update to resolve any critical issues identified in the initial SEDAR 9 assessment.

Council requests reporting of both commercial and recreational landings in pounds whole weight.

Table 1.2.1 Required SFA and MSRA Evaluations.

Criteria	**Definition**	**Current Value**
Mortality Rate Criteria		
F_{MSY} or proxy	$F_{30\%\ SPR}$	0.333
MFMT	$F_{30\%\ SPR}$	0.333
F_{OY}	75%$F_{MSY\ =}$ (0.75*.333)	0.250
F_{2009}	SEDAR 2010 Update current = 2009	0.609
F_{2009}/MFMT	SEDAR2010 Update current = 2009	1.829
Base M		0.25
Biomass Criteria		
B_{MSY}	Equilibrium B @ $F_{30\%\ SPR}$	14.73 mp ww
MSST	(1-M)*B_{MSY} M=0.25	11.048 mp ww
$B_{Current}$	SEDAR 2010 Update current = 2009	4.587 mp ww
$B_{Current}$/B_{MSY}	SEDAR 2010 Update current = 2009	0.3114
Equilibrium MSY	Equilibrium Yield @$F_{30\%\ SPR}$	4.806 mp ww
Equilibrium OY	Equilibrium Yield @F_{OY} (= Equilibrium Yield @75%F_{MSY}) ww	1.28E+06 ww
OFL	Annual Yield @MFMT (ww)	
	2010	1.64E+06
	2011	2.02E+06
	2012	2.42E+06
	2013	2.82E+06
	2014	3.20E+06
	2015	3.55E+06
Annual OY (ACT):	Annual Yield @F_{OY} (proxy=75%$F_{\mathbf{MSY}}$ = 75%MFMT (ww)	
	2010	1.28E+06
	2011	1.69E+06
	2012	2.16E+06
	2013	2.63E+06
	2014	3.07E+06
	2015	3.46E+06
Alternative ACT:	Annual Yield @65% MFMT (2010) ww	1.13E+06
	Annual Yield @75% MFMT (2010) ww	1.28E+06
	Annual Yield @85% MFMT (2010) ww	1.43E+06
Alternative($F_{Rebuild}$)	Annual Yield% $F_{Rebuild}$ (2010), $F_{Rebuild}$ =0.055, ww	3.10E+05

Table 1.2.1- (Continued). Required SFA and MSRA Evaluations.

Generation Time		**not specified**
Rebuild Time T_{min}	(if B_{2009}<MSST) @ F=0	not specified
Midpoint	mid of T_{min}, T_{max}	not specified
T_{max}	if T_{min}>10y, Tmin + 1 Gen	10 years (2013)
ABC	Recommend Range	

* Calculated value

Values provided are from the SEDAR9 Assessment Advisory Report except where noted. All mortality rate and biomass values should be accompanied by 80% confidence intervals or other appropriate measure of precision where possible.

Table 1.2.2. Projection Scenario Details

Table 1.2.2a. Initial Assumptions

OPTION	**Value**
2010+ landings target	
2010+ Recruits	TBD by Panel
2010+ Selectivity	TBD by Panel
Projection Period	7 yrs (2010-2017)
1st year of change F, Yield	2011 (annual, or 3-year interval yields)

Table 1.2.2b. Scenarios to evaluate (preliminary, to be modified as appropriate)

1. Landings fixed at 2010 target.
2. $F_{MSY} = F_{Max}$
3. F_{OY}= 65% F_{MSY}
4. F_{OY}= 75% F_{MSY}
5. F_{OY}= 85% F_{MSY}
6. $F_{Rebuild}$ (if necessary)
7. F=0 (if necessary)

1.2.2c. Output values

1. Landings
2. Discard
3. Exploitation
4. F/F_{MSY}

1.3 DOCUMENTS LIST

Document #	Title	Authors
GAJ_Update_RD01	SEDAR 9 Gulf of Mexico Greater Amberjack Stock Assessment Report	SEDAR 9 Panels
GAJ_Update_RD02	Technical Report for Age, Growth and Sex Maturity of Greater Amberjack (*Seriola dumerili*) in the Gulf of Mexico	Debra J. Murie and Daryl C. Parkyn

1.4 LIST OF PARTICIPANTS

Update Panel

Barbara Dorf.......... GMFMC SSC
Ben Fairey .... GMFMC AP
Ching Ping-Chih .... NMFS Miami
Harry Blanchet .... GMFMC SSC
James Taylor.......... GMFMC AP
John Quinlan .... NMFS Miami
Kevin McCarthy.......... NMFS Miami
Nancie Cummings (Lead analyst) .... NMFS Miami
Read Hendon.......... GMFMC SSC
Refik Orhun .... NMFS Miami
Sean Powers.......... GMFMC SSC
Steve Turner.......... NMFS Miami
Vivian Matter .... NMFS Miami
Will Patterson .... GMFMC SSC

Council Representation

Bob Gill.......... GMFMC

Observers

Andy Strelcheck.......... NMFS SERO
Claudia Friess .... Ocean Conservancy
Clay Porch .... NMFS Miami
Debra Murie .... UFL
Dennis Heinemann.......... Ocean Conservancy
Kari Fenske .... SEDAR
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Staff

Carrie Simmons.......... GMFMC Staff
John Froeschke.......... GMFMC Staff

Julie Neer .... SEDAR
Steven Atran .... GMFMC Staff

1.2 Table of Contributors

I: Assessment Analyses	**Cummings**	**McCarthy**	**Matter**	**Orhun**	**Quinlan**	**Chih**	**Turner**	**Fairey**
Extract Rec. Landings			X					
Extract Com. Landings				X				
Extract Com. Size Composition						X		
Estimate Rec. Discards			X					
Extract, Develop Rec. Rec. Discard Sizes	X							
Estimate Com. Discards		X						
Develop Com. Discard size Composition		X						
Extract Rec. CH+PR & HB CPUE	X							
Extract Com HL & LL CPUE		X						
Develop Com HL & LL Index	X							
Develop Rec. CH+PR Index	X							
Production Model: Trial Runs, Sensitivities	X							
Production Model Bootstrap (CI estimates)	X				X			
Production Model Projections	X				X			
Regulatory and Rebuilding Analyses	X				X			
Provide Input on Com. Discard Estimations, discard sizing	X	X					X	X

X=contributed to task
R=Provided input into Review

Table 1.5.1. Table of Contributors (continued).

II: Report Preparation	Contributor										
Task	Cummings	McCarthy	Matter	Orhun	Quinlan	Porch	Murie	Atran	Patterson	Powers	Farmer	Strelcheck
Introduction (SEDAR, Manage.. Overview)	X							X, R	R	R	R	R
Life History	X	X					R		R	R	R	R
Commercial Catch Section text, tables, figures	X	X		X			R		R		R	R
Commercial Discard, section text, tables, figures		X, R							R		R	R
Recreational Catch Section text	X	X					R		R		R	R
Recreational Discard Section	X	X					R		R		R	R
Recreational tables, figures	X	X	X						R		R	R
Indices (Overview, Methods, Results	X	X							R	R	R	R
Production Model	X								R	R	R	R
Production Model (Projection Figures)	X				X	R						

X=contributed to task
R=Provided Review Input

2. LIFE HISTORY

Available life history information was discussed during the SEDAR update Data Webinar to ascertain if any new life history information existed since the previous benchmark assessment (SEDAR9) was conducted in 2006. New life history information provided by Murie and Parkyn (2008) in an updated age and growth and reproduction study are included below in addition to previous life history characterizations as presented in SEDAR9.

2.1 Stock Definition

Two management groups (Atlantic and Gulf of Mexico) are currently used by the SAFMC and GMFMC. The geographic boundary between 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); suggesting continuous gene flow exists within the region (Gold and Richardson 1998). Genetic results indicated there may be a split between western Atlantic (includes Florida Keys) and Gulf of Mexico (Gulf) populations, although evidence for two genetically distinct 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.).

1.1.2 Species Identification

Renshaw and Gold (2009) described the use of multiplexed PCR primers for mtDNA sequences that allow identification of each of the four species of the genus Seriola. Concern regarding accurate identification of the amberjack in commercial and recreational catches was previously noted by fisheries managers (RFSAP, 1996). These new tools could potentially provide a mechanism for correction of landings relative to individual species that could be incorporated into estimates of fishing mortality, especially for greater amberjack, thus improving the accuracy of future stock assessment advice.

2.1.2 Tagging

Analysis of historical tag and recapture data of greater amberjack collected from 1959-1995 suggests an exchange rate of 1.3% between the Atlantic and Gulf Greater amberjack populations (McClellan and Cummings 1997). Recaptures -reported on by McClellan and Cummings (1997) averaged 1.9 years (maximum: 14 years) at liberty, 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) described nearly two decades of tagging work conducted by the Cooperative Gamefish Tagging Program. Burch's analysis of 510 recaptures, greater amberjack migrated northward along the Florida east coast from June through November and southward from December to May.

2.2 Habitat Requirement

Juvenile greater amberjack are commonly collected in association with pelagic *Sargassum* mats throughout the Gulf (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-DW22), 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, rocky 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 and Growth

Age determination for greater amberjack is considered relatively difficult 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 using sectioned sagittal otoliths, collected from headboat catches off Texas and northwest Florida/Alabama. These authors reported greater amberjack up to 15 years. Manooch and Potts (1997b), using sectioned otoliths, aged greater amberjack from headboat and commercial handline catches off the southeastern U.S., reporting fish 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) using sectioned otoliths were able to age amberjack captured off Louisiana to 15 years, reporting reasonable consistency in annulus interpretation between readers; estimates for coefficient of variation and index of precision were 0.15 and 0.11, respectively.

Since the previous stock assessment two additional age and growth studies have been conducted for Atlantic and Gulf of Mexico greater amberjack populations. Harris et al. (2004, 2007) aged greater amberjack collected from the southeast Atlantic using sectioned otoliths and obtained a maximum age of 13 years. They obtained ages for 1,985 fish with relatively good between-reader precision (Harris et al. 2007). Recently, Murie and Parkyn (2008) aged 1,838 amberjack from the Gulf of Mexico, obtaining a maximum age of 15 years. After development of aging criteria, aging was shown to be precise between readers, with both the coefficient of variation and average percent error being <5%.

2.3.1 Annuli Formation (Timing and Periodicity)

To date, information on the timing of annulus formation in greater amberjack has differed 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 examined otolith sections of tagged and recaptured greater amberjack that had been injected with oxytetracycline, and inferred that otolith opaque zone formation was annual. 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 made comparisons with growth estimates from previously published studies. Growth curves for recapture data were similar to findings from Burch (1979) who studied south Florida populations and Beasley (1993) for fish off Louisiana, supporting the premise that observed growth increments in scales and otoliths represent annuli. Manooch and Potts (1997a) used marginal increment analysis and reported that the annuli in greater amberjack otoliths collected from headboats throughout the Gulf were laid down between March and May for fish 0-15 years of age, with the majority of the 340 amberjack sampled being ≤7 years old. Similarly, Manooch and Potts (1997b) using samples collected from the southeastern Atlantic reported annulus deposition primarily occurred in April. The majority of fish in Manooch and Potts study were ≤12 years old. Burch (1979), collecting greater amberjack from south Florida, noted that the marginal increment was at a minimum between February and April. Harris et al. (2007) using marginal increment analysis reported that annuli formation occurs primarily during June for amberjack sampled off the southeastern U.S. Murie and Parkyn (2008) observed deposition of the opaque zone to occur primarily during the months of April to August based on otolith edge analysis for fish sampled from the Gulf of Mexico, with younger fish (0-1 yr old) depositing their annuli earlier (April to June) than fish ≥2 years (May to August).

2.3.2 Juvenile Growth

Age of Young Of the Year (YOY) Gulf greater amberjack associated with *Sargassum* in the Gulf was 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.

2.3.3 Growth of Sub-Adult and Adult Fish

In the two most recent stock assessments for sub-adult and adult Gulf greater amberjack (SEDAR9 2006, Turner et al. 2000, using data up to and including 2004), catch-at-length data were converted to catch-at-age data by 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 (Cummings and McClellan 2000). More recently, Murie and Parkyn (2008) compiled growth data for sub-adult and adult greater amberjack in the Gulf, inclusive of amberjack sampled from Florida to Louisiana from all recreational sectors.

Estimated von Bertalanffy growth curves for all greater amberjack studies from the southeastern Atlantic and Gulf are given in Figure 2.3.3.1 and Table 2.3.3.1. 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 fractional ages, and Harris et al. (2004) and Murie and Parkyn (2008) that used observed age classes corrected for time of annulus deposition.

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 in their study was 1,441 mm FL and females accounted for 72% of fish greater than 1,000 mm FL. Male maximum size was 1,327 mm FL in Thompson's study. 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 using age determinations made from scale samples, reported that females grow larger than males (L_∞ = 159.7 versus 146.3 cm, respectively). Harris et al. (2007) also observed that females were larger at ages 3, 4, 7 and 9 compared to males for fish sampled from the southeastern U.S. Murie and Parkyn (2008) observed minimal sexual dimorphism in growth of males and females in the Gulf, with females larger than males at ages 2, 4, and 5 (over an age comparison of 0-8 yrs).

2.3.4 Conversion Factors

SEDAR9 provided updated meristic conversion relations using data from the NMFS, SEFSC, Trip Interview Program (TIP) program and from the Gulf States Marine Fisheries Commission (GSMFS) Fisheries Information Network (FIN) data base (SEDAR9-SAR, Figures 2-5, pages 9-10, and Table 2.3.4.1 and Table 2.3.4.2 this report).

2.4 Reproduction

2.4.1 Spawning

Early studies on greater amberjack conducted in south Florida indicated that the maximum gonad development occurred in the spring months (Burch 1979). Studies in the 1990s on greater amberjack in the Gulf of Mexico reported the spawning season off Louisiana peaked in April-June based on increased gonad weight (Beasley 1993) and in May and June (Thompson et al. 1991). Wells and Rooker (2003, 2004a, b) described seasonal and size distribution of greater amberjack larvae and juveniles sampled from floating *Sargassum* from the northwestern Gulf. Based on the size and season researchers estimated that peak spawning season occurred in March and April.

Sedberry et al. (2006) documented greater amberjack spawning in the South Atlantic over both the middle and outer shelf as well as on upper-slope reefs from 15-216 m, but spawning females were found at depths only ranging from 45 to 122 m. They collected spawning females from January to June, and estimated peak spawning occurred in April and May. Harris et al. (2007) completed a fishery-dependent and fishery-independent study on greater amberjack reproductive biology in the southeastern U.S. Atlantic from 2000-2004. Greater amberjack in spawning condition were captured from North Carolina to the Florida Keys; however, spawning was concentrated in areas off south Florida and the Florida Keys. Harris et al. (2007) documented evidence of spawning from January-June with peak spawning during April and May.

Murie and Parkyn (2008) completed a recent study on reproductive biology of greater amberjack throughout the Gulf of Mexico using fishery-dependent as well as fishery-independent data from 1989-2008. They also found that peak spawning occurred during March and April, and by May, they documented low gonad weights. Murie and Parkyn also noted that some spawning fish were observed as late as April – June similar to Beasley (1993) and Thompson et al.'s (1991) earlier observations. 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).

It was suggested by Harris et al. (2007) that there are known spawning aggregations of greater amberjack targeted by fishers in the South Atlantic, but no evidence of this was presented. Observations by SCUBA divers in Belize documented greater amberjack in pair courtship when they were in a school of approximately 120 fish (Graham and Castellanos 2003). However, no aggregation or indication of spawning aggregations was discussed by the Murie and Parkyn (2008) Gulf of Mexico study or other earlier Gulf studies.

2.4.2 Sexual Maturity

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). Based on histological sections, Thompson et al. (1991, and unpubl. data) estimated that female greater amberjack in the Gulf of Mexico 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. Based on recent macroscopic analysis of gonads by Murie and Parkyn (2008), female greater amberjack in the Gulf of Mexico attain 50% maturity between 850 to 900 mm FL (33-35 inches). The smallest female that was mature was 501 mm FL (~20 inches), which was similar to that found for greater amberjack in the South Atlantic (514 mm FL; Harris et al. 2007). Size of maturity for females in the Gulf was larger than for female amberjack from the South Atlantic spawning stock, where 50% maturity was attained between (719 and 745 mm FL (27-29 inches) (Harris et al. 2007). Females in the Gulf of Mexico attained sexual maturity between 1 and 6 years of age, with 50% maturity occurring between 3 and 4 years. The oldest female that was immature was 6 years of age, and the youngest female that was mature was 1 year old. This range of maturity was similar to Harris et al.'s (2007) study in the Florida Keys, which reported the youngest female that was mature as 1 year of age, and the oldest immature fish as 5 years of age. However, 50% maturity for female amberjack in the South Atlantic (Keys) was substantially younger at 1.3 years (Harris et al. 2007). In the Gulf of Mexico, there is <10% probability that females are sexually mature between 1 and 2 years of age (Murie and

Parkyn 2008). Sexual maturity of greater amberjack in the Gulf of Mexico is currently being analyzed based on gonadal histology to supplement the macroscopic gonad analysis (Murie, pers. comm.) to resolve any potential discrepancies based on methods used by Murie and Parkyn (2008) and Harris et al. (2007). In summary, 50% maturity for female greater amberjack is attained by about age 1.3 for Atlantic populations and age 4 for Gulf of Mexico populations.

2.4.3 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. 2007). Spawning frequency was estimated as approximately every 5 days over a spawning season of ~73 days (27 February 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. This indicates that an individual spawning female could spawn as frequently as 14 times during the season. A significant relationship existed between batch fecundity (BF) as a function of FL with BF=7.955*FL-6,093,049 (adjusted-r^2=0.53, n=31) and BF as a function of age (BF=387,897*Age+655,746; adjusted-r^2=0.26, n=23) (Harris et al. 2007). Greater amberjack are extremely fecund, releasing 18 to 59 million eggs per female in a single spawning season (Harris et al. 2007).

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. (2007) is recommended.

2.5 Stock-Recruitment Relationship

A Beverton-Holt stock recruitment relationship was examined in the previous two stock assessments of greater amberjack (Brown et al. 2005, SEDAR9-AW10, and RSAP 2000). In the 2000 stock assessment 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 2000 RFSAP: 1) the hockey-stick (piece-wise linear) (Barrowman and Meyers 2000); and 2) historical mean recruitment (Turner et al. 2000). The 2000 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.

2.6 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 (Table 2.6.1). 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 then was 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.

2.7 Natural Mortality

2.7.1 YOY

Catch-curve analysis was conducted to estimate daily instantaneous mortality of YOY greater amberjack from 40-130 days of age ($M = 0.0045\ d^{-1}$) (Wells and Rooker 2004b). Cumulative natural mortality for a 100 d period resulted in a cumulative mortality estimate of 36%. 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).

2.7.2 Sub-Adult/Adult

Greater amberjack in the Gulf can live to at least 15 years based on age samples available (see Manooch and Potts 1997a; Thompson et al. 1999; Murie and Parkyn 2008). Based upon this information, the method of Hoenig (1983) produces an estimated M of 0.28 d^{-1}. As the M estimate results from a sample taken from an exploited population, the value is likely to be biased high. Based upon this information, the SEDAR9 Data Workshop (SEDAR9 DW) suggested using a value of M of 0.25 for baseline evaluations, and agreed with the range of M = 0.2 to 0.35 for sensitivity evaluations. These values are consistent with those applied in the earlier 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. Manooch and Potts also stated "that Z may have been overestimated since 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).

2.8 Release Mortality

No estimate of release mortality rate for greater amberjack is available for Gulf of Mexico populations. A survival study of released undersized reef fishes using observers aboard headboats and commercial handline vessels off Beaufort, NC produced estimated acute mortality of greater amberjack from 8 to 9 (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 would appear to be a minimum acute release mortality; however, actual release mortality (i.e., not directly observed as floaters) would most likely be greater. The SEDAR9 DW Panel recommended that a sensitivity analysis be done using a range of release mortalities between 20% and 50%; release mortality rates of 0, 20, and 40 percent were used in the assessment, with 20% selected for the Base models.

Headboat observer data collected by the Florida Fish and Wildlife Conservation Commission indicates release mortality for greater amberjack may be lower than estimated by the SEDAR9 stock assessment. During 2005 and 2006, the conditions of 501 greater amberjack caught on headboats were observed. Ninety-four percent (n = 471) were released in good condition, two percent (n = 11) were released in fair condition, 1 percent (n = 5) were released in poor condition, one percent (n = 6) were released dead, and two percent (n = 6) were eaten. Overall post-release mortality for fish in fair or poor condition, or that were eaten, was 3.8 percent (www.regulations.gov/search/Regs/contentStreamer?objectId...pdf).

On-going research on release mortality rates gained through scientific tagging experiments of greater amberjack in the Gulf of Mexico (Murie and Parkyn 2010) indicates that acute mortality (i.e., dead on capture) may be low (<2 % preliminary data). This is also based on amberjack having some type of “self-venting” mechanism, whereby they blow bubbles out a tear under their opercula, despite having a “closed” swim bladder. There are also indications that release mortality may not be related to depth of capture as closely as other reef fishes with closed swim bladders, as preliminary tag returns indicate that tags are being returned in proportion to depth of capture and release (i.e., fish caught deep are still being returned at proportional rates to their tagging). In addition, three mature females and two mature males (963-1179 mm FL, or 38-46 inches) captured at depths of 250-350 ft off Louisiana were vented and tagged with archival satellite tags. All fish survived 1 month in the northeastern Gulf of Mexico before their tags popped-off and reported to the satellite. Combined, these data indicate that release mortality for Gulf of Mexico greater amberjack may be substantially lower than previously estimated.

Table 2.3.3.1. Estimated von Bertalanffy growth parameters for greater amberjack.

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. (2007)	SE Atlantic	124.15	0.28	-1.56	1,985
Murie and Parkyn (2008)	Gulf of Mexico	148.9	0.144	-2.526	1,838

Table 2.3.4.1. 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. Source of information NMFS, SEFSC Trip Interview Program (TIP) and GSMFC, FIN databases. Rates for M and K are per year.

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

Table 2.6.1. Proposed guideline indices of productivity for exploited fish species with specifics for Gulf of Mexico greater amberjack. Rates for M, K are per year.

Parameter	**Productivity**	**Level**		**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**
tmat (years)	> 8	3.3 - 8	< 3.3	**3**
tmax (years)	>25	14 - 25	<14	**15**
Examples:	orange roughy, various sharks	cod, hake	sardine, anchovy	**Productivity Score = 2.25 (Medium)**

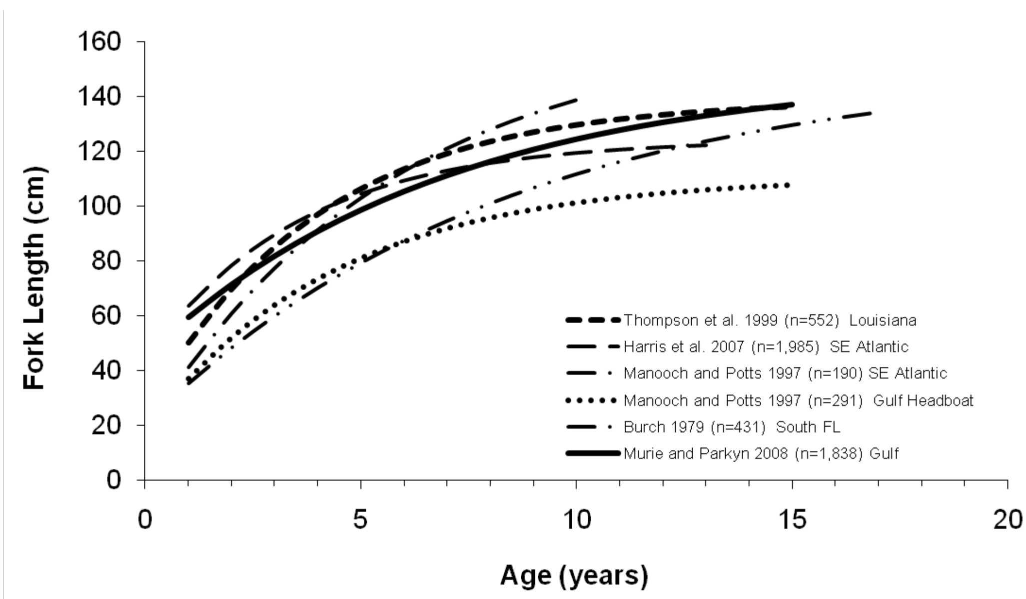


Figure 2.3.3.1. Estimated von Bertalanffy growth curves for greater amberjack collected in the southeastern Atlantic and Gulf of Mexico (Source, Debra Murie, personal communication).

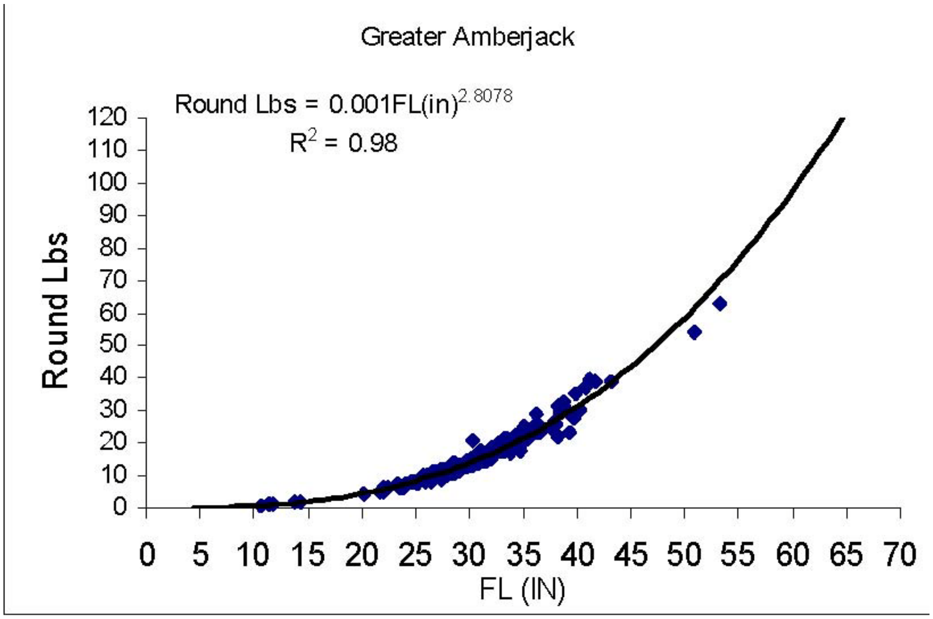


Figure 2.3.3.2. Combined NMFS, SEFSC TIP observations and Manooch and Potts (1997b) observations describing the relationship between whole weight and fork length in gulf greater amberjack. Source=SEDAR9-SAR, Figure 2, page 9.

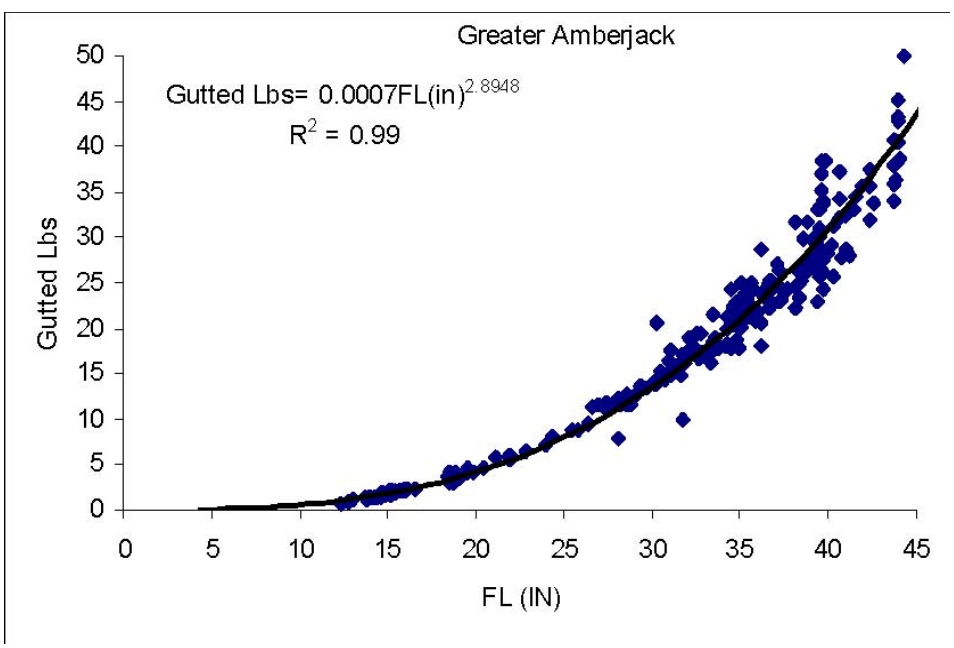


Figure 2.3.3.3. Observations from the NMFS, SEFSC TIP database describing the relationship between gutted weight and fork length in gulf greater amberjack. Source=SEDAR9-SAR, Figure 3, page 9.

3. Commercial Fishery Statistics Overview

3.1 Commercial Landings Collection and Statistics

3.1.1 Available Commercial Landings Data

Three data sources were used to update the time series of commercial landings for Gulf greater amberjack for the 2010 update (of SEDAR9). The NMFS, SEFSC, Accumulated Landings System (ALS) data were used for landings from 1963 to present for West Florida, Alabama, Mississippi, Louisiana, and Texas. From 1963 to 1976, the ALS landing records consists of annual records. In Florida, the landing records become monthly beginning in 1977. The landings records become monthly in 1983 for Alabama, in 1984 for Texas, and in 1985 for Louisiana and Mississippi.

The second data source, the Florida General Canvass, was specific to Florida landings. Data from this survey contain annual landings records with gear and information on the statistical area of capture, the latter referred to as "water body" information and which is lacking in much of the monthly Florida ALS landings data. Statistical area of capture (i.e., water body) is also referred to as the NMFS, SEFSC shrimp statistical grid in the landings data and is shown here in Figure 3.1.1.1.

The third data source used for this SEDAR update was the NMFS, SEFSC Coastal Logbook Program data. As an additional source of information, fishermen's logbooks were used from 1990 to present to assign fishing area and gear information to the ALS landings records. This was done because fishermen's information on gear and fishing area was considered to be more accurate than the gear and fishing area reported by dealers.

3.1.2 Data Handling

Commercial landings are presented in whole pounds (lb) throughout the tables. In order to achieve this throughout the landings record, a gutted to whole weight conversion factor of 1.04 was applied to the landings in Florida from 1963 to 1985 that had been recorded 'as landed' in gutted weight. These conversions were continued from earlier greater amberjack stock evaluations of Cummings and McClellan (1996, 2000), Turner et al. (2000), and SEDAR9-SAR.

In addition, prior to 1991 all caught amberjack, regardless of species, were classified in the landings data as unclassified amberjack or NMFS species code 0030. From 1991-1993 four species of the genus *Seriola* were reported in the landings. They were: the greater amberjack, *S. dumerili*, the almaco jack, *S. rivoliana*, the lesser amberjack, *S. fasciata*, and the banded rudderfish, *S. zonata*. Species differentiation into the four unique species categories did not begin until around 1991 to 1993 depending on state.

Texas began classifying all amberjack species as greater amberjack or NMFS code 1812 beginning in 1993. Louisiana and Alabama began differentiation of the amberjack landings into the four different species in year 2000, Mississippi began in 1993, and West Florida in 1992.

Consideration then was given to determining the fraction of unclassified amberjacks that were actually greater amberjack. As in the previous stock assessment (SEDAR9), for the revised catch series (see SEDAR9-SAR, Section 2.2 Revised Catch Series, page 7), the Panel considered for the 2010 SEDAR Update that the Texas landings of 1993 – 2009 were more likely to represent a mixture of the four amberjack species and similarly recommended to assume the amberjack species percentages of that found in Louisiana reflected the amberjack species compositions in Texas.

In summary, the percentage species composition used to calculate the amount of greater amberjack in the landings was updated for this assessment using new data available since the 2005 SEDAR9 assessment. For the previous SEDAR9 evaluations, species composition data through 2004 were used. For the updated assessment species composition data until 2009 were used.

3.2 Summarized Commercial Landings for Greater Amberjack SEDAR 2010 Update

3.2.1 Commercial landings species composition

Annual percentage species composition of the amberjack landings for the Gulf was calculated from the ALS landings records from 1963 to 2009 (Table 3.2.1). From the updated calculations, it shows the recording of the landings species composition for 1963-1990 was exclusively into the generic or unclassified amberjack category (i.e., NMFS species code 0030). From 1992 through 1999, a differentiation into the four species of amberjack began although still about 28% were being classified as unclassified amberjack (code 0030). Since then, i.e. 2000-2009, the use of the unclassified amberjack code 0030 has dropped to an annual average of 0.6%.

Table 3.2.2 and Figures 3.2.1.1 and 3.2.1.2 provide a summary of the calculated percentages of species composition by state and year used for landings calculation in this 2010 assessment update and also provides the percentages species composition and range of years used in the 2005 SEDAR9 assessment. As stated above, Figure 3.2.1.1 shows that until about 1999 that the reported landings continued to show significant amounts of unidentified *Seriola* spp. as occurring along with the species code 1812 (greater amberjack) dominating. Landings of the other *Seriola* spp. (i.e., lesser amberjack, banded rudderfish, and Almaco jack are reported in the landings beginning around 1991 with greater amberjack dominating the recorded landings.

3.2.2 Commercial Landings by State

Calculated commercial landings of greater amberjack by state for the Gulf, from 1963-2009, are shown in Table 3.2.3 and Figure 3.2.2.1. Calculated landings were derived from reported greater amberjack landings plus the amount of greater amberjack calculated from the proportion of greater amberjack in the unclassified amberjack (code 0030) landings.

There were also landings reported by dealers in East Florida; however, these landings were caught in Gulf fishing areas (statistical grids 1-21, see Figure 3.1.1.1) and therefore are considered part of Gulf landings.

3.2.3 Commercial Landings by Gear and Major Region

Calculated commercial landings of greater amberjack by gear from Gulf from 1963-2009 are shown in Table 3.2.4 and Figure 3.2.3.1. These landings are used in the stock assessment and distinguished as vertical line and longline gear. Vertical line includes vertical lines, i.e. hand and electric lines, as well as all other gears such as trolling, diving + spear, and all unreported gear. The unreported gear was about 14.5% in the dealer reported ALS data for 2009. However, this was subsequently completely accounted for in the presented landings data given to stock assessment scientists by using the fishermen's logbook information for gear assignment. Although greater amberjack are captured by longline gear, it is thought that this species is not intensely targeted with this gear. The self- reported logbook data suggest that some 17% of all trips landing greater amberjack reported using longline gear, about 80% used vertical lines, and 3.2% reported using trolling gear. Figure 3.2.3.2 provides summary commercial greater amberjack landings by gear and major region category for 1963-2009.

3.3 Commercial Vertical Line Fishery Discards

3.3.1 Discard Calculations

Greater amberjack discard rates were calculated for the Gulf vertical line fishery using both self-reported data (discard coastal logbook) and observer data. Total Gulf vertical line (handline and electric reel/bandit rig) effort was used along with the calculated discard rates to provide two estimates of total greater amberjack discards from the Gulf vertical line fishery. Those calculated discards were also compared with discard estimates calculated for the 2005 greater amberjack assessment.

Vertical line discards, calculated using the self-reported data, are presented in Table 3.3.1.1A. The available data included discard reports from a 20% sample of commercial vertical line vessels with permits to fish federally managed species in the Gulf. Calculation of discards followed the methods used in the 2005 assessment (SEDAR9- DW17). In that analysis, results from generalized linear models (GLM's) indicated significant differences in discard rates across period (Jan-Jul, Aug-Dec) and number of hooks per line fished (1-2, 3-9, >9). Mean discard rates were calculated for each year, period, and hooks per line stratum. Total effort was available from the coastal logbook data (a census of landings and effort data from vessels with federal fishing permits). Effort, defined as number of trips, was summed within each year/period/hooks per line stratum. Total discards were calculated for each stratum as: stratum mean discard rate per trip x the number of stratum total trips. Discards of all strata within a year were summed to provide total yearly discards. Confidence intervals (5% and 95%) were calculated for each stratum specific discard rate. The discard rates at the confidence intervals were also multiplied by total vertical line effort to provide a measure of uncertainty around the discard calculations. Discards were calculated as numbers of discarded fish and were converted to pounds by multiplying by 12.83 pounds, the mean weight of a discarded greater amberjack reported in observer data. Total weight of discards was also calculated for 20% and 40% discard mortality, following the methods of the 2005 assessment (SEDAR9).

Self-reported discard data were available for the years 2002-2009. Amendment 1 to the GMFMC, Reef Fish FMP implemented a 36 inch commercial minimum size regulation in 1990 thus discarding can be expected for years 1990 and later. To calculate discards for the years 1990-2001, the mean discard rate across the years 2002-2009 was calculated for each hook per line stratum. Those discard rates were multiplied by total vertical line effort within each year/hooks per line stratum. Uncertainty associated with those discard calculations was estimated as above. Total weight of discards was calculated as above.

While updating the total discard calculations for the 2010 SEDAR update (using the self-reported logbook data set, the continuity case of SEDAR9), a programming error in the 2005 SAS code was identified (K. McCarthy, personal communication). Correction of the coding error resulted in much lower discard totals than were calculated in 2005 using the same data set. At the request of the assessment update panel, a “strict continuity” calculation of greater amberjack was attempted using the original, flawed, SAS program. The original results could not be replicated because the programming error involved insufficient sorting while merging data sets. Due to the flawed merge step in the SAS Procedure, greater amberjack discards for a trip were often incorrect and resulted in the very high discards calculated for the 2005 SEDAR9 assessment (see SEDAR9-SAR, Table 3.4, page 23). The corrected SAS code was used to calculate total vertical line discards using the self-reported data for the 2010 SEDAR update.

An additional source of commercial handline discards was evaluated for the 2010 SEDAR update. Gulf reef fish observer data were also used to calculate greater amberjack discard rates of commercial vertical line vessels. Those observer data were available for only a brief time series having begun, in late 2006. Only the 2007 and later data were used in the SEDAR 2010 update. These observations, 2007-2009, also reflect only a small fraction of total commercial vertical line effort in the Gulf (<1% of total hook hours fished). Due to the small number of observed greater amberjack discards (387 discarded fish in 195 observed trips) the data were stratified by year only. Discard rate was calculated as: number of fish discarded per hook hour fished. Total effort in hook hours was available from the coastal logbook data. Total discards per year during 2007-2009 were calculated as: yearly mean discard rate per hook hour fished x total hook hours fished. Yearly discards for the years 1990-2006 were calculated using the mean discard rate across all years, 2007-09, multiplied by the yearly total effort in hook hours. Uncertainty around the yearly calculated discards was determined following the methods described above for self-reported discard analyses. Vertical line discards calculated using the observer data are presented in Table 3.3.1.1B. Yearly calculated discards are also provided in number of fish, weight in pounds, and weight assuming 20% and 40% discard mortality.

Figure 3.3.1.1 provides a comparison of yearly total discards of greater amberjack from commercial vertical line vessels calculated using both self-reported discard data and observer data. In addition, the total discards calculated for the previous SEDAR9 2005 assessment are graphically presented in Figure 3.3.1.1 alongside the update estimates. Total discards calculated in the SEDAR9 2005 stock assessment were greater than the other calculations in all but one year; however, those totals resulted from a newly identified programming error. Total discards calculated using the same data set for the update assessment, but with the corrected code were less than 500,000 pounds per year. It is also noted that the self-reported discards may be unrealistically low due to a proportion of fishers (often 40% of all trips in a year) reporting “no discards” for a trip. Total discards calculated using the observer data, in contrast, were more similar to the SEDAR9 2005 discards than to the 2010 self-reported discards.

Commercial vertical line discards calculated using observer reported discard rates were much higher in 2008 than in other years. The 2009 calculated discards, however, were the fewest of any year of the time series (Figure 3.3.1.1). That large variability between years may have resulted from the small number of hook hours observed which, by chance, had either much higher (2008) or lower (2009) discard rates than both the 2007 rate and the mean rate (Table 3.3.1.2). During each year of available observer data, the sampling fraction (percent of total effort observed) was less than one percent of the total effort reported to the coastal logbook program. Variability in discards among years prior to 2007 was due to yearly differences in total effort because the mean discard rate was applied to yearly effort during that period.

In the 2005 SEDAR evaluation of greater amberjack discard rates (SEDAR9-DW17), estimates of discards were not made for the longline fishery. For the 2010 update, this convention was carried forward. As summarized earlier in Section 3.2 (Commercial landings summary by gear), this species is not targeted by the longline fishery. Future benchmark evaluations should continue to examine both the self-reported and observer data to better quantify the levels of greater amberjack discards from the commercial longline fishery.

3.3.2 Discard Sizes

The mean size of greater amberjack commercial vertical line discards was assumed to be 36 inches for the previous 2005 assessment (SEDAR9-SAR, Section 3.4.1, page 18), however the 2010 assessment update panel thought that assumption unrealistic. The reef fish observer data were used to estimate the mean size of greater amberjack commercial vertical line discards for use in the update assessment. There was some concern among the assessment update panel that smaller fish in the genus *Seriola* may have been misidentified to species. When cases of uncertain species identification were suspected, either by the observer at sea or during the debriefing process, recent practice in the reef fish observer program has been to limit the identification to genus. This procedure has been in place since 2009. Identification of some individuals to genus, likely the smaller fish, may have resulted in a higher mean size of fish positively identified as greater amberjack. Mean size of greater amberjack discards was calculated for the periods August 2006-December 2008 and 2009-2010. Mean size of greater amberjack discards was larger in 2009-10 (Table 3.3.2.1). Whether that result was due to observer program procedure, sample size, or some other cause is unknown. The calculated mean fork length of greater amberjack discards was 726.8 mm (12.8 pounds), using the 2009-10 observer data. The assessment update panel recommended the use of the 2009-10 observer data for calculating mean discard size for converting estimates of discard numbers to discard weight.

3.4 <u>Shrimp Fishery Bycatch</u>

In the 2005 SEDAR9 greater amberjack stock assessment bycatch from the shrimp fishery was considered. Estimates of greater amberjack bycatch were considered using three estimation methods: 1) the Bayesian approach of SEDAR9 (see SEDAR7-DW3 and SEDAR9-DW26), 2) a delta distribution modification of the Bayesian approach, and 3) a fully mixed effects model (Model 3). The SEDAR9 DW Panel noted that greater amberjack at that time this species was not on the workup for the observer evaluation program. The Panel further noted that because their abundance in trawls is so low as supported by the average percent occurrence values with (99%) and without (8%) Bycatch Reduction Gear (BRDs) that reliable annual estimate would have been difficult with these statistical estimators (due to the high frequency of zero observations) (see SEDAR9 DW Report, Section 3.4.2, page 24, and Table 3.5). In general, estimation results from all the methods where estimations were produced (modified Bayesian and Model 7) indicated large to enormous uncertainty and the SEDAR9 DW Panel noted the results seemed unrealistic. Estimates from the Bayesian model were not successful. In addition, assigning size (or age) to estimates of shrimp trawl bycatch was not possible at the time of the 2005 SEDAR9 stock assessment as only a very few observations from the observer study had been measured.

3.5 Total Commercial Greater Amberjack Removals (landings and discards)

Table 3.5.1 and Figure 3.5.1 provides estimated total commercial removals (landings and discards) of greater amberjack by year and by gear category for the SEDAR 2010 update continuity case. The 2010 update continuity case assumes 20% release mortality rate for discards. Total removals (landings and 20% discards) are presented for only 1985-2009 corresponding to the years of inclusion for the stock assessment evaluation. Estimates of corresponding landings for the recreational charterboat fisheries are not available partitioned by sector prior to 1986. Recreational landings and discards will be characterized in the following section (Section 4 Recreational Landings).

Table 3.2.1. Percentage species composition of reported amberjack landings (pounds whole weight) in the NMFS, SEFSC ALS database for the Gulf of Mexico Fisheries management region from 1963 to 2009. Values in table = average percentage reporting of generic amberjack from 1992-1999 and 2000-2009.

NMFS Code	0030	1810	1812	1815	1817	
Common Name	Amberjack	Almaco	Greater	Lesser	Banded	
YEAR	(Generic)	Jack	Amberjack	Amberjack	Rudderfish	
1963	100%					
1964	100%					
1965	100%					
1966	100%					
1967	100%					
1968	100%					
1969	100%					
1970	100%					
1971	100%					
1972	100%					
1973	100%					
1974	100%					
1975	100%					
1976	100%					
1977	100%					
1978	100%					
1979	100%					
1980	100%					
1981	100%					
1982	100%					
1983	100%					
1984	100%					
1985	100%					
1986	100%					
1987	100%					
1988	100%					
1989	100%					
1990	100%					
1991	97.6%	1.0%	0.0%	1.3%	0.1%	
1992	28.9%	1.2%	68.8%	1.0%	0.1%	
1993	37.6%	1.4%	59.5%	1.2%	0.3%	
1994	37.2%	2.5%	58.0%	1.8%	0.5%	
1995	42.1%	2.4%	51.2%	3.2%	1.1%	
1996	34.2%	1.8%	58.9%	3.8%	1.3%	
1997	16.6%	3.6%	74.9%	2.9%	2.1%	Average
1998	10.9%	4.2%	81.1%	2.4%	1.3%	1992-1999
1999	15.9%	5.1%	74.0%	3.0%	2.0%	27.9%
2000	0.7%	5.0%	88.6%	3.7%	2.1%	
2001	0.8%	7.9%	85.0%	4.0%	2.4%	
2002	0.4%	5.4%	84.4%	8.8%	1.0%	
2003	0.7%	3.6%	89.3%	5.5%	0.9%	
2004	0.3%	2.8%	92.0%	4.4%	0.5%	
2005	0.4%	2.6%	93.2%	3.3%	0.4%	
2006	0.3%	2.8%	92.0%	4.3%	0.5%	
2007	0.3%	5.2%	90.8%	3.0%	0.8%	Average
2008	2.4%	5.5%	87.6%	2.9%	1.6%	2000-2009
2009	0.2%	4.5%	89.0%	5.1%	1.2%	0.6%

Table 3.2.2. Percentage species composition calculated for landings by state and range of years used to redistribute generic amberjack landings (NMFS code 0030) to the appropriate amberjack species.

			Greater Amberjack	Almaco Jack	Lesser Amberjack	Banded Rudderfish
Status	Years*	State	1812	1810	1815	1817
Sedar 9, 2006	1998-2004	FL	89.98%	2.86%	5.86%	2.28%
	2002-2004	AL	82.76%	0.25%	9.69%	-
	1993-2004	MS	78.40%	13.62%	4.55%	-
	2000-2004	LA+TX	82.63%	8.11%	9.15%	0.01%
2010 update	1998-2009	FL	90.70%	3.89%	3.75%	1.65%
	2002-2009	AL	85.95%	5.30%	8.74%	-
	1993-2009	MS	83.69%	12.87%	3.44%	-
	2000-2009	LA+TX	83.92%	7.43%	8.55%	0.10%

* Range of years used for calculating proportions

Table 3.2.3. Calculated commercial landings of Greater Amberjack by state for the Gulf of Mexico Fisheries management region from 1963 to 2009. Units are whole weight (lbs). *East Florida landings, but caught in the Gulf of Mexico.

	Texas	Louisiana	MS+AL	West Florida	East Florida	All States
YEAR	1	2	3,4	5	6	Grand Tota
1,963				8,584		8,584
1,964				6,414		6,414
1,965				5,282		5,282
1,966				7,452		7,452
1,967				29,430		29,430
1,968				11,602		11,602
1,969				73,482		73,482
1,970				13,772		13,772
1,971				38,769		38,769
1,972				41,976		41,976
1,973				28,487		28,487
1,974				42,070		42,070
1,975				78,764		78,764
1,976				87,159		87,159
1,977				120,829		120,829
1,978				151,878		151,878
1,979				152,674		152,674
1,980				179,814		179,814
1,981				236,997		236,997
1,982			4,143	221,386		225,529
1,983		379	2,919	277,837		281,135
1,984	11,666	305	24,384	494,648		531,002
1,985	40,480	80,736	67,492	574,459		763,168
1,986	100,533	263,557	109,655	642,602		1,116,346
1,987	88,475	319,607	65,102	1,082,662		1,555,846
1,988	152,463	596,463	64,762	1,241,951		2,055,639
1,989	116,883	509,357	69,252	1,259,111	776	1,955,379
1,990	60,557	264,679	31,929	866,775	73	1,224,013
1,991	23,894	165,258	18,794	1,593,906		1,801,852
1,992	142,034	341,388	32,572	500,601	114	1,016,710
1,993	182,899	407,980	22,683	994,535	226	1,608,323
1,994	102,117	295,344	11,223	866,009		1,274,693
1,995	151,466	254,091	8,229	849,108	498	1,263,392
1,996	156,859	260,140	36,691	815,532	1,929	1,271,150
1,997	189,993	220,225	34,149	672,632	1,704	1,118,704
1,998	139,372	102,533	11,015	445,947	1,399	700,265
1,999	83,428	158,122	9,738	528,842	719	780,849
2,000	111,114	205,796	15,615	583,371	562	916,458
2,001	56,878	217,314	13,351	444,191	2,222	733,956
2,002	68,816	259,687	10,466	445,142	3,377	787,489
2,003	63,305	320,101	16,674	594,116	260	994,457
2,004	34,782	406,521	16,246	510,771	7,549	975,870
2,005	59,282	162,346	17,593	492,892	11,803	743,916
2,006	88,392	117,563	24,483	391,925	10,220	632,583
2,007	183,175	92,407	26,792	309,830	6,301	618,505
2,008	88,792	76,988	33,384	303,590	1,360	504,114
2,009	138,689	137,802	38,247	317,978	133	632,849
*East Florida reported landings bu			0			

Table 3.2.4. Calculated commercial landings of Greater Amberjack by state for the Gulf of Mexico fisheries management region from 1963 to 2009. Units = whole weight (lbs).

YEAR	*Vertical Line+	Long Line	Grand Total
1963	8,584		8,584
1964	6,414		6,414
1965	5,282		5,282
1966	7,452		7,452
1967	29,430		29,430
1968	11,602		11,602
1969	73,482		73,482
1970	13,772		13,772
1971	38,769		38,769
1972	41,976		41,976
1973	28,487		28,487
1974	42,070		42,070
1975	78,764		78,764
1976	87,159		87,159
1977	120,829		120,829
1978	151,878		151,878
1979	149,938	2,736	152,674
1980	175,022	4,792	179,814
1981	214,368	22,629	236,997
1982	186,047	39,482	225,529
1983	235,199	45,936	281,135
1984	469,570	61,433	531,002
1985	653,604	109,563	763,168
1986	917,262	199,085	1,116,346
1987	1,303,596	252,250	1,555,846
1988	1,730,482	325,157	2,055,639
1989	1,656,123	299,256	1,955,379
1990	1,098,316	125,697	1,224,013
1991	1,795,708	6,143	1,801,852
1992	965,204	51,505	1,016,710
1993	1,524,434	83,889	1,608,323
1994	1,205,702	68,991	1,274,693
1995	1,181,064	82,329	1,263,392
1996	1,214,149	57,001	1,271,150
1997	1,059,124	59,580	1,118,704
1998	645,440	54,824	700,265
1999	719,267	61,583	780,849
2000	846,462	69,996	916,458
2001	688,450	45,505	733,956
2002	710,141	77,348	787,489
2003	867,364	127,092	994,457
2004	894,518	81,351	975,870
2005	671,877	72,039	743,916
2006	553,247	79,336	632,583
2007	558,138	60,367	618,505
2008	413,505	90,609	504,114
2009	577,837	55,013	632,849

*Vertical Line+ includes all other gears such trolling, diving+spear

Table 3.3.1.1a. Commercial vertical line (handline and electric reel/bandit rig) Gulf of Mexico total discards. Numbers of discards were calculated using the mean discard rate. Pounds of discards were calculated by applying the mean weight of a discarded fish to the number of discards. Number of discards assuming a 20% and 40% discard mortality were also calculated. Confidence intervals (CI) were the number of discards calculated by applying the discard rates at the 5% and 95% confidence intervals of the mean rate to total effort.

A. Self-reported NMFS, SEFSC Coastal Logbook Program Discard Data

Year	Number of discards (fish)	Discard 95% CI	Discard 5% CI	Pounds of discards	20% discard mortality (lbs)	40% discard mortality (lbs)
1990	13,660	17,765	9,554	175,256	35,051	70,102
1991	24,003	30,588	17,417	307,954	61,591	123,182
1992	19,979	26,113	13,846	256,335	51,267	102,534
1993	22,969	29,385	16,553	294,688	58,938	117,875
1994	23,450	29,596	17,303	300,861	60,172	120,345
1995	23,616	29,785	17,447	302,993	60,599	121,197
1996	26,230	33,135	19,324	336,525	67,305	134,610
1997	26,875	33,539	20,210	344,803	68,961	137,921
1998	27,488	34,441	20,535	352,669	70,534	141,067
1999	27,996	35,260	20,732	359,191	71,838	143,676
2000	27,392	34,895	19,889	351,442	70,288	140,577
2001	25,445	31,929	18,961	326,456	65,291	130,582
2002	36,241	56,602	16,317	464,970	92,994	185,988
2003	36,299	57,649	15,030	465,717	93,143	186,287
2004	26,180	37,272	15,182	335,885	67,177	134,354
2005	14,313	25,043	3,620	183,638	36,728	73,455
2006	8,406	14,327	2,572	107,846	21,569	43,139
2007	11,222	17,764	4,711	143,977	28,795	57,591
2008	11,509	17,557	5,853	147,665	29,533	59,066
2009	13,901	27,592	5,187	178,343	35,669	71,337

Table 3.3.1.1b. NMFS, SEFSC Galveston, Texas Laboratory Reef Fish Observer Program

Year	Number of discards (fish)	Discard 95% CI	Discard 5% CI	Pounds of discards	20% discard mortality (lbs)	40% discard mortality (lbs)
1990	86,678	112,766	60,590	1,112,079	222,416	444,832
1991	196,453	255,580	137,325	2,520,486	504,097	1,008,194
1992	116,427	151,468	81,385	1,493,754	298,751	597,502
1993	120,103	156,251	83,955	1,540,927	308,185	616,371
1994	142,946	185,969	99,923	1,833,993	366,799	733,597
1995	142,819	185,803	99,834	1,832,363	366,473	732,945
1996	154,095	200,473	107,716	1,977,037	395,407	790,815
1997	172,267	224,115	120,419	2,210,188	442,038	884,075
1998	160,801	209,198	112,404	2,063,074	412,615	825,230
1999	177,072	230,366	123,778	2,271,831	454,366	908,732
2000	169,229	220,163	118,296	2,171,212	434,242	868,485
2001	170,533	221,859	119,207	2,187,937	437,587	875,175
2002	175,117	227,823	122,411	2,246,752	449,350	898,701
2003	185,449	241,264	129,634	2,379,309	475,862	951,723
2004	168,820	219,631	118,010	2,165,966	433,193	866,386
2005	151,539	197,148	105,930	1,944,244	388,849	777,698
2006	154,076	200,448	107,703	1,976,789	395,358	790,716
2007	115,351	174,884	55,819	1,479,959	295,992	591,984
2008	265,288	379,021	151,555	3,403,647	680,729	1,361,459
2009	70,557	115,787	25,327	905,247	181,049	362,099

Table 3.3.2.1. Greater amberjack commercial vertical line mean size from the SEFSC, Pascagoula Laboratory observer data. The years 2009-10 have all fish of uncertain species identified to genus. Mean weights are mean weights of 2009-10 discarded greater amberjack. Units for length are all in mm, fork length.

Disposition	Years	Length (mm)	Standard deviation	min	max	N fish measured
Discarded	2009-10	726.7593	227.6759	311	1540	54
Discarded	2006-08	605.9761	183.5722	280	980	209
Kept	2009-10	821.7647	254.6852	452	1140	17
Kept	2006-08	997.731	197.0889	330	1600	145
Unknown	2006-08	515	148.4924	410	620	2
mean weight (kg)	5.82					
mean weight (lb)	12.83					

Table 3.5.1. Estimated total commercial removals (landings and discards) of greater amberjack by year and major gear category for the stock assessment Continuity Case, assuming 20% discard mortality rate, 1986-2009. Units are pounds whole weight.

Year	Vertical Line+ Fishery	Longline Fishery
1986	917,262	199,085
1987	1,303,596	252,250
1988	1,730,482	325,157
1989	1,656,123	299,256
1990	1,133,367	125,697
1991	1,857,299	6,143
1992	1,016,471	51,505
1993	1,583,371	83,889
1994	1,265,874	68,991
1995	1,241,662	82,329
1996	1,281,454	57,001
1997	1,128,084	59,580
1998	715,974	54,824
1999	791,105	61,583
2000	916,750	69,996
2001	753,742	45,505
2002	803,135	77,348
2003	960,508	127,092
2004	961,695	81,351
2005	708,604	72,039
2006	574,816	79,336
2007	586,933	60,367
2008	443,039	90,609
2009	613,505	55,013

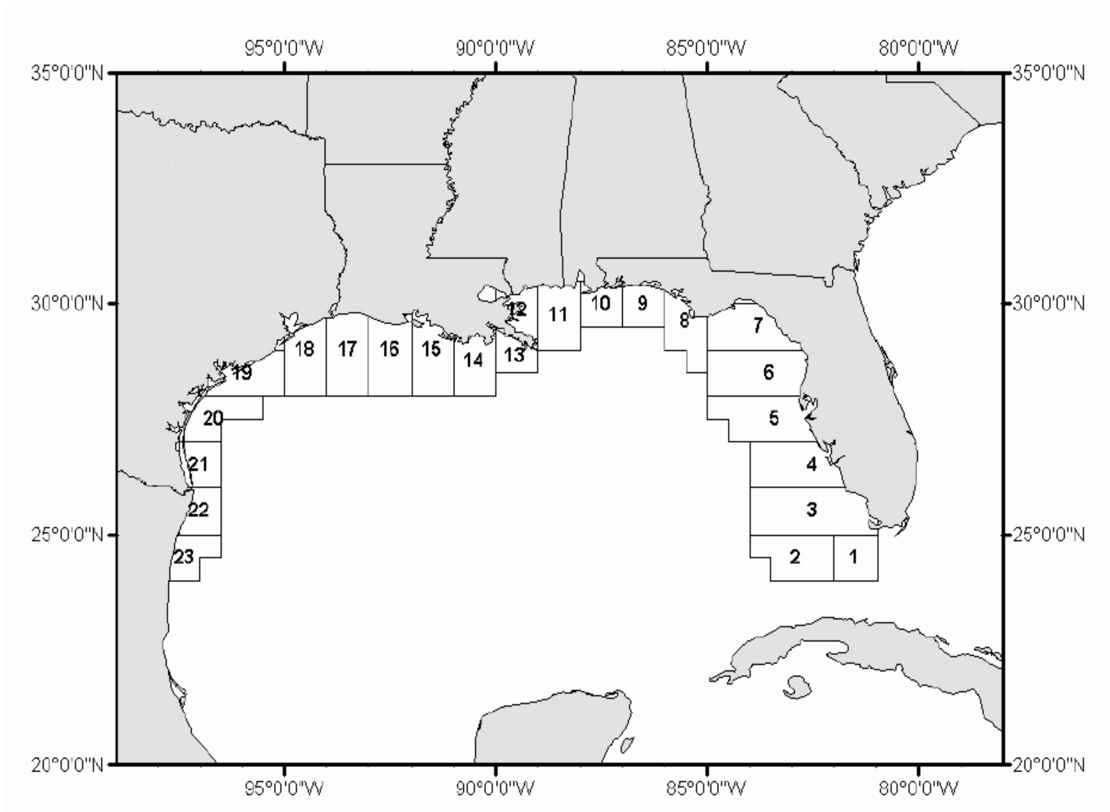


Figure 3.1.1.1. NMFS, SEFSC Statistical Shrimp Reporting Grids.

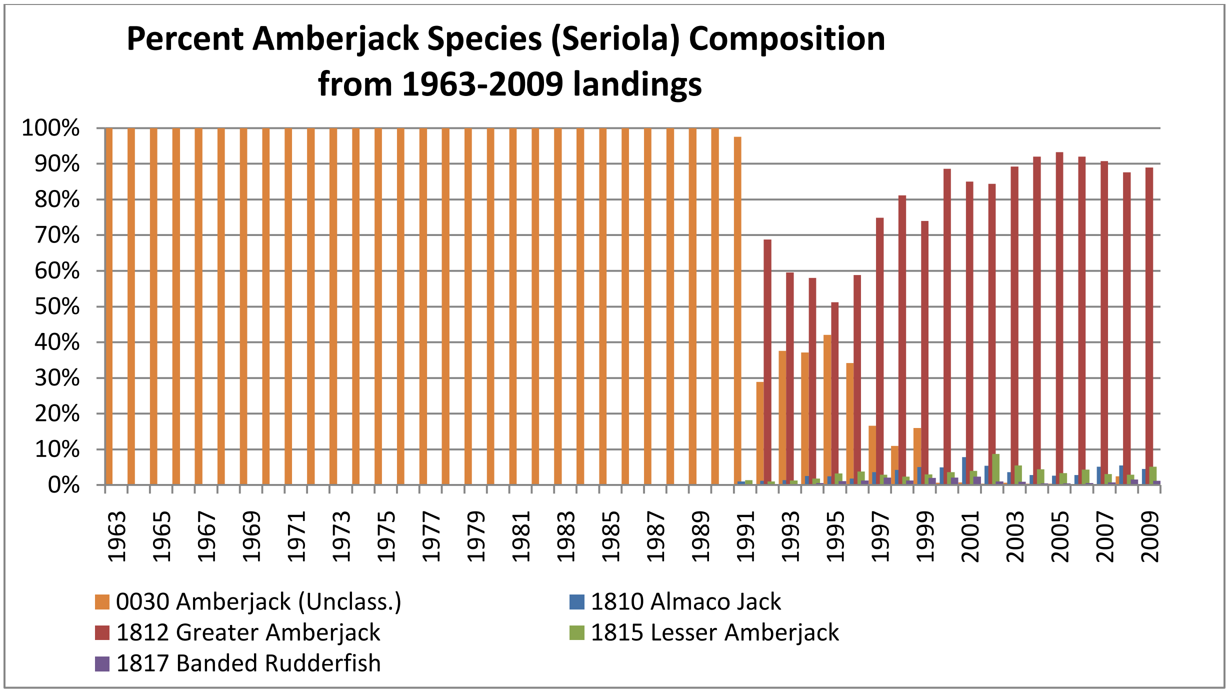
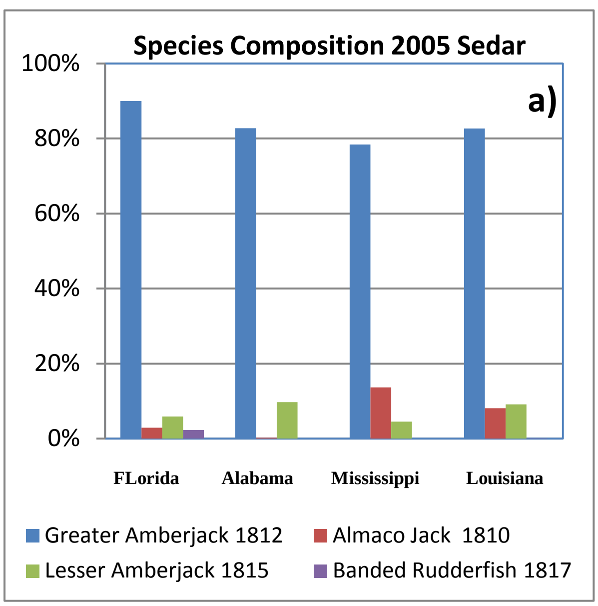


Figure 3.2.1.1. Percentage species composition of reported amberjack landings (whole weight (lbs.) in the ALS database for the Gulf of Mexico Fisheries management region from 1963 to 2009.



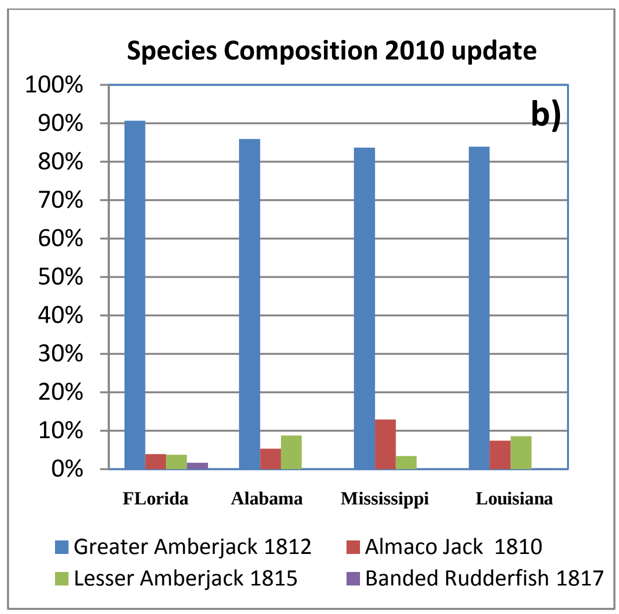


Figure 3.2.1.2. Percentage species composition calculated for landings by state and range of years to redistribute generic amberjack (*Seriola* spp.) landings to the unique amberjack species a) 2005 SEDAR9, b) SEDAR 2010 Update.

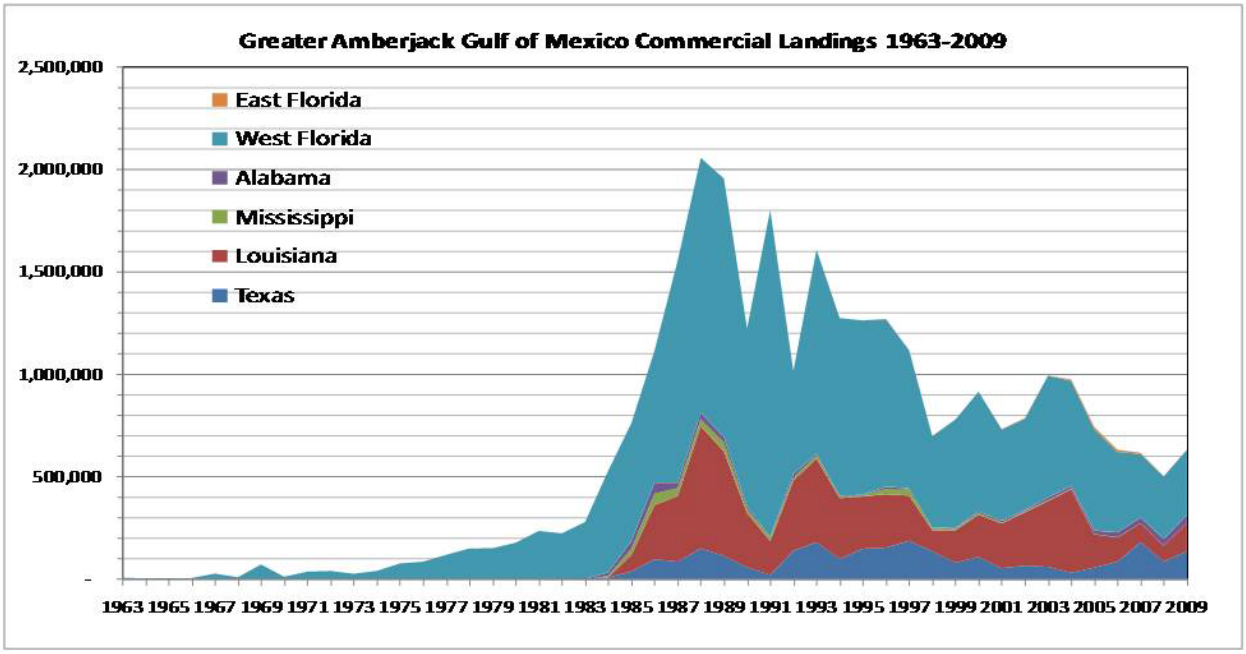


Figure 3.2.2.1. Calculated commercial landings of greater amberjack by state for the Gulf of Mexico Fisheries management region from 1963 to 2009 in whole weight (lbs).

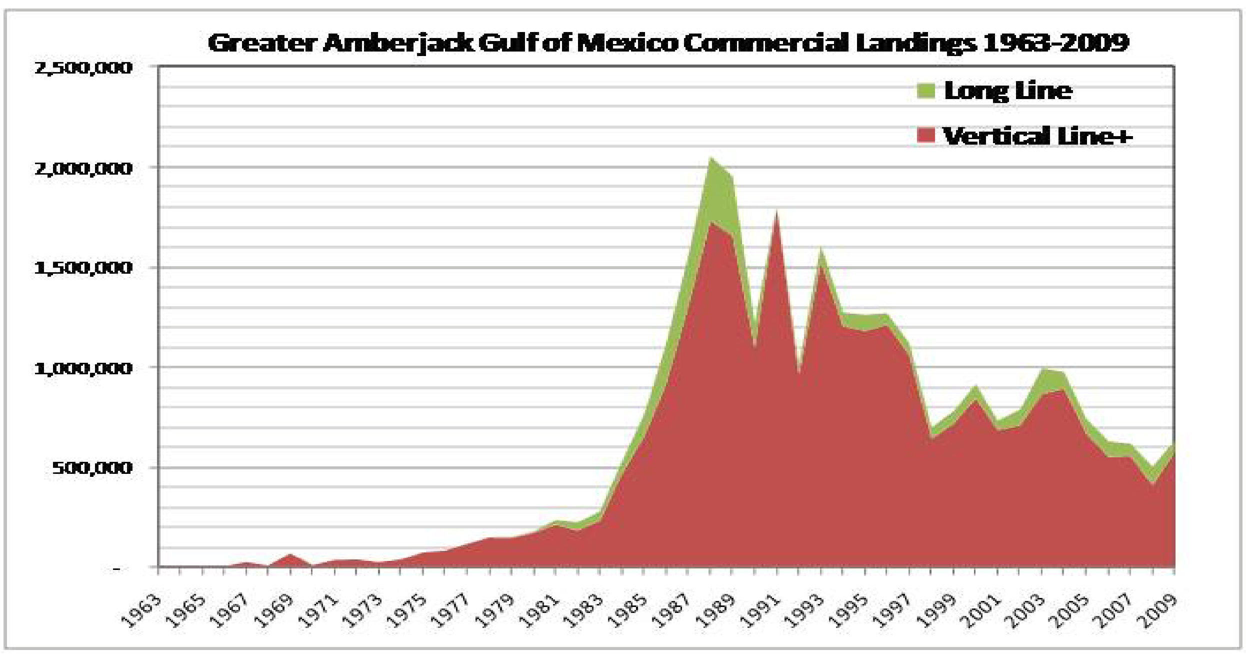


Figure 3.2.2.2. Calculated commercial landings of greater amberjack by gear for the Gulf of Mexico Fisheries management region from 1963 to 2009. Units are whole weight (lbs). Vertical line includes hand and electric line as well as other gears, such as trolling, diving and spear, etc.

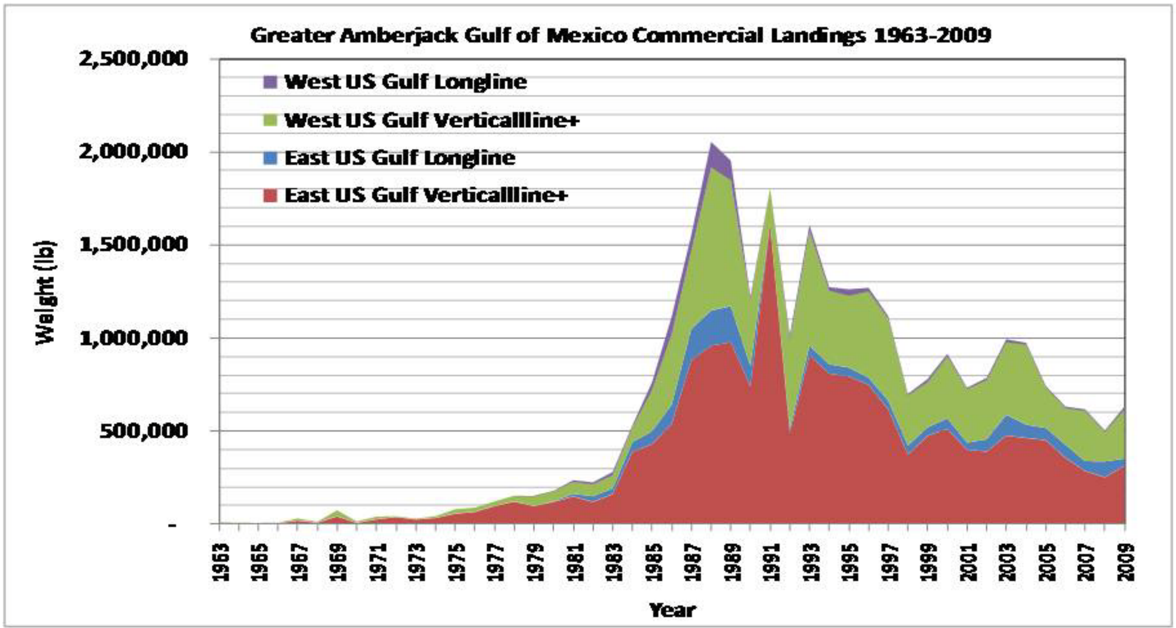


Figure 3.2.3.1. Calculated commercial landings of greater amberjack by year, gear, and major region category for the Gulf of Mexico Fisheries management region from 1963 to 2009. Units are whole weight (lbs). Vertical line includes hand and electric line as well as other gears, such as trolling, diving and spear, etc. Eastern region = NMFS Shrimp Statistical Grids 1-12 and Western region = NMFS Shrimp Statistical Grids 13-21, see Figure 3.2.1 for grid location.

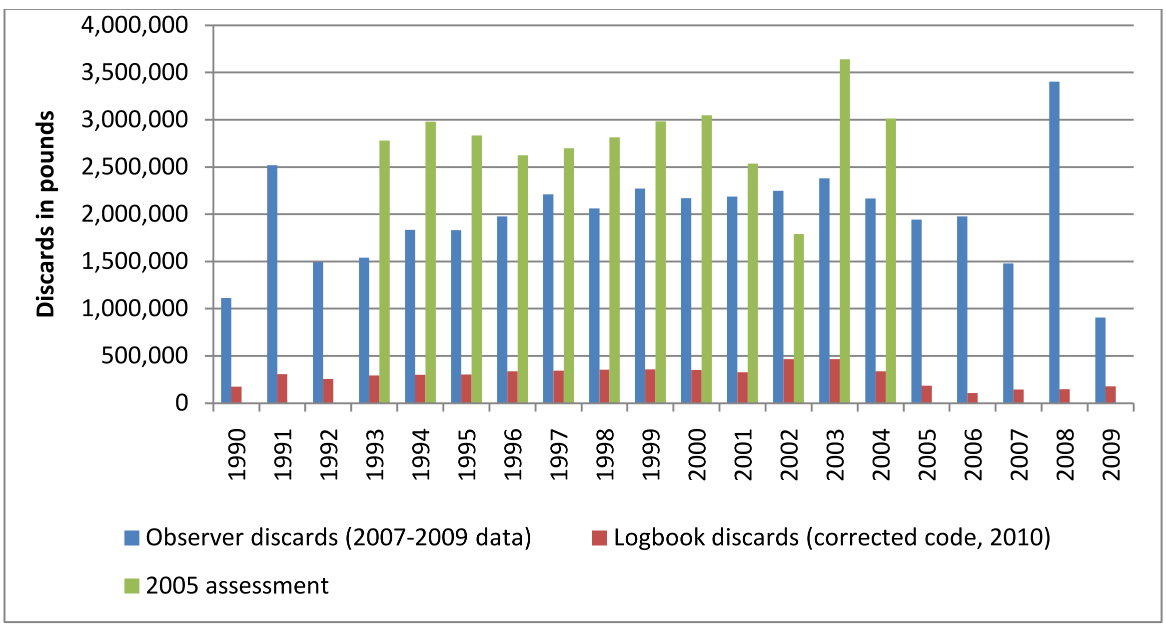


Figure 3.3.1.1. Gulf of Mexico commercial vertical line total discards; 2010 calculations and 2005 stock assessment (SEDAR9) calculations compared. Units are whole weight (lbs).

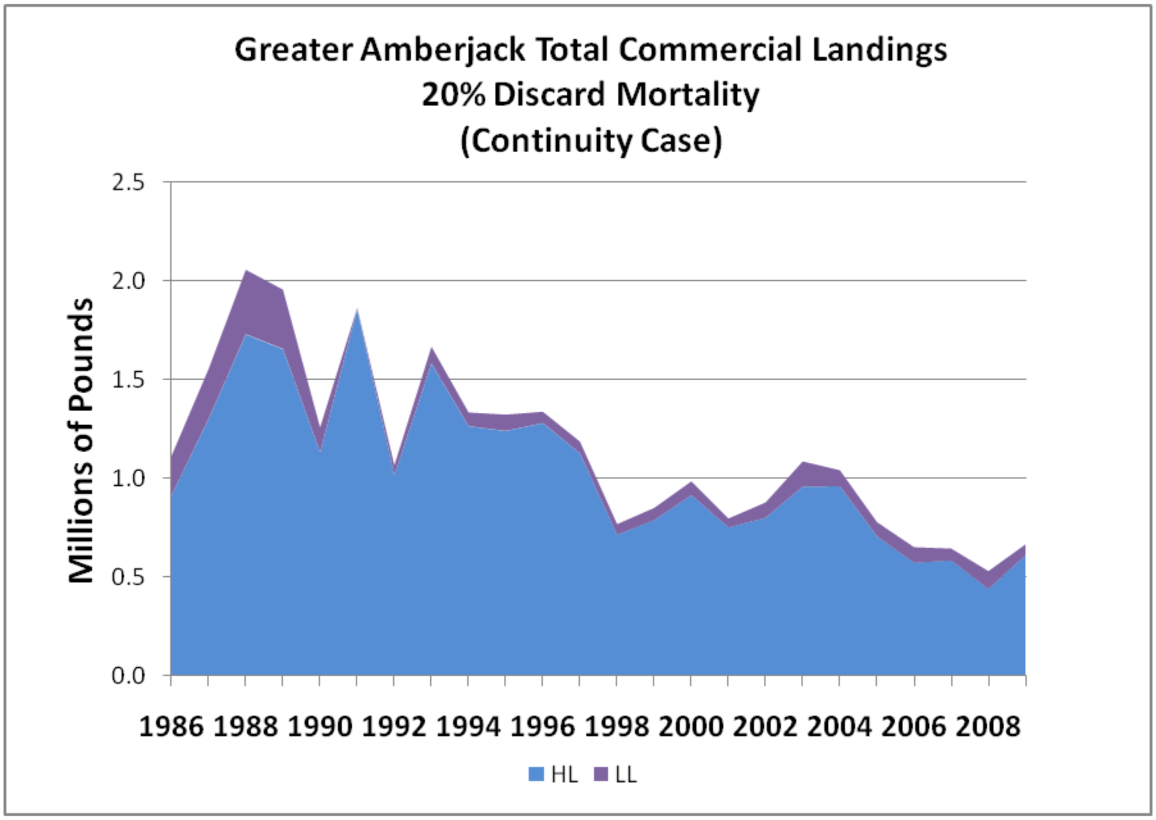


Figure 3.5.1. Estimated total greater amberjack commercial removals (landings and discards) 1986-2009 by year and gear category. Removals are presented for the stock assessment continuity case, assuming 20% discard mortality**.** Units are whole weight (lbs).

4. Recreational Landings Statistics Overview

For the 2010 greater amberjack SEDAR update, recreational fishery statistics were updated using similar data sources as in the previous stock assessment. Recreational fishery statistics for greater amberjack are collected through three separate surveys: 1) the Marine Recreational Fishing Statistical Survey (MRFSS), 2) the Texas Parks and Wildlife Department (TPWD), and 3) the NMFS Headboat Survey (HB). MRFSS collects information on shore based, charter boat and private/rental boat angler fishing modes. Information on estimated catch by mode since 1981 from Florida through Louisiana exists. MRFSS included headboats in the survey from 1981-1985 and provided estimated catches for the combined headboat/charterboat mode for those years. The HB survey was implemented in 1986 in the Gulf of Mexico extending from the west coast of Florida through Texas. TPWD has collected recreational fishing statistics since 1983 for 'for hire' and private fishing modes in the state of Texas.

4.1 Recreational Fishery Statistics Overview

4.1.1 MRFSS and TPWD

As with SEDAR9, the panel agreed that shore based landings identified as greater amberjack should be excluded- because this fishing mode or the species may have been misidentified and the probability of catching a greater amberjack from shore is not high. 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. Concern was expressed by the SEDAR9 Recreational Statistics working group over the accuracy of the MRFSS data for the reef fish species. The group noted "the recreational fishery landings for these species contribute a large proportion of the overall landings. The group's concern centered 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). The SEDAR9 DW Panel recommended: "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."

Unidentified Jack Landings

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

The protocol adopted by the SEDAR9 Data Workshop Panel regarding unidentified jack landings was continued in the SEDAR 2010 update. The recommendation for determining the portion of greater amberjack in the unidentified jack category was**:** 1) determine the total landings of identified jack species by year, region and mode and 2) 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 were 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 could be different.

Missing Data

The MRFSS and TPWD data set have missing information for landings in some years, waves, or states strata (cells) that need to be filled with some estimate. These missing data strata (i.e., year-wave-state) resulted from a variety of reasons including no survey for those strata. The protocol adopted by the SEDAR9 Data Workshop Panel for calculating landings in strata with missing data was carried forward in the SEDAR 2010 update. The recommendation made was: the missing landings were most commonly from the first wave in 1981 and Texas for all years. This topic was discussed by the SEDAR9 DW Panel who noted, "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 SEDAR9 DW it decided to accept it because it was already used and reviewed during the 2004 red snapper assessment" (SEDAR9 Section 4.3.1, page 33).

4.1.2 NMFS, SEFSC, HEADBOAT Survey

As in previous Gulf greater amberjack stock evaluations, landings from trips fishing in the Florida Keys (headboat area 12) and landings from Atlantic based vessels to the Dry Tortugas (Area 17) were excluded (Figure 4.1.2.1). The SEDAR9 DW Panel and SEDAR 10 DW panel (Matter, 2006**)** reported that greater than 99% of the trips in area 12 and area 17 are in South Atlantic jurisdictional waters thus should not be included as Gulf management group removals.

4.1.3 Recreational Landings 2010 SEDAR Update Summary

Table 4.1.3.1 and Figure 4.1.3.1 presents estimated greater amberjack landings from the three sources combined: MRFSS, TPWD and the NMFS Headboat Survey. Table 4.1.3.2a,b summarizes differences in estimated total recreational landings as determined in SEDAR9 and this SEDAR update. These differences between the previous assessment and the SEDAR 2010 update can be compared by evaluating the overall difference for groups of years. As the following table shows, as more years are included in the comparison, the percentage difference declines. Again, these differences are most likely due to differences in the two assessments in sample sizes used to determine average weights. The resulting differences in annual estimates of recreational landings (Table 4.1.3.2a, b) result from the methods used to convert numbers of fish to pounds of fish. Several reasons for the differences include: small sample sizes, varying minimum sample sizes used for calculating average weights between SEDAR9 and this SEDAR update. Methods used in the SEDAR9 assessment to estimate sample weight followed the procedures of Cummings (2000). The current method used to convert numbers of fish to pounds of fish is consistent with approaches used by MRFSS and the other surveys (HBS, TPWD) (V. Matter, personal communication). Table 4.1.3.3 and Figure 4.1.3.1 provides estimates of uncertainty in the MRFSS AB1 estimates.

4.2 <u>Estimation of Greater Amberjack Recreational Discards</u>

Unlike MRFSS, the Headboat survey does not provide estimates of released fish. Because a proportion of the released fish is expected to die, the estimated number of releases is necessary in order to develop a complete time series of removals for use in subsequent population modeling analysis. Table 4.2.1 provides the time series of discard estimates (numbers of fish) from the MRFSS survey.

The protocols adopted by the SEDAR9 DW Panel to quantify discards for the headboat mode were continued for the SEDAR 2010 update. There were two main recommendations made: 1) estimate the ratio of headboat releases (B2) to the total catch (A+B1+B2) from MRFSS charter boat mode only (Table 4.2.2 and Figure 4.2.1) and 2) use this source (and sector) to estimate headboat releases. The SEDAR9 DW Panel felt that charterboat and headboat fishing are most similar and the rate of released fish would be most alike. Private boat fishing likely would not be the same as the "for-hire" sector. Table 4.2.3 presents estimated number of live releases for the headboat mode by year. New information on recreational discards available from self reported logbooks and also from observer trips was also reviewed for the 2010 update. These data are discussed below.

As in the previous two greater amberjack stock evaluations (SEDAR9, Turner et al. 2000) discards were not estimated for TPWD source.

4.3 Discard Ratios from Observer Samples and Self Reported Logbooks

For the 2010 SEDAR update, the Panel also considered supplemental information on discards of greater amberjack available since 2006 from self reported logbooks and from observations taken onboard fishing trips by observers. The calculated mean proportional discard rates are presented in Tables 4.3.1 and Table 4.3.2 and Figures 4.3.1A and B. The SEDAR 2010 update panel recommended that the methods used in the previous SEDAR9 assessment for estimating total discards be followed for the update. The reasons included that although the observer sample information was informative, the time series was very brief, only having begun in 2006. In addition, the variability in annual discard estimates was large and showed inconsistency in the ratios across time. The Panel recommended that the observer series be evaluated further at the next benchmark assessment. The Panel also made the recommendation to continue the review of the self reported logbook discard data at the next benchmark citing similar reasons: short time series and high variability in estimates between years.

Time series of total discards were calculated using the above procedures and assuming three levels of discard mortality, 0%, 20% and 40%. Table 4.3.1 presents greater amberjack discard numbers for the stock assessment continuity case assuming 20% discard mortality rate.

4.4 Conversion of Recreational Discard Numbers to Discard Weight

Explicit information regarding the methods used to convert recreational greater amberjack discards (numbers of fish) to weight was not included in the SEDAR9 DW report nor the SEDAR9-SAR however, some information was derived from copies of computer software made available to the analyst (V. Matter personal communication). That information indicated that the procedure used by Cummings 2000 was followed for SEDAR9 to convert discard numbers to discard weight. Those procedures were maintained for the SEDAR 2010 update Assessment and are briefly detailed below.

Three amendments to the GMFMC Reef Fish FMP are important when considering appropriate procedures calculating greater amberjack discard size. Amendment 1 (1990) enacted a 28 inch fork length recreational size limit and a three fish per angler personal bag limit. Amendment 12, implemented January 1997, enacted a one fish personal bag limit. Amendment 30A, implemented in August 2008, enacted a 30 inch fork length recreational size limit. The procedures used by Cummings and McClellan (2000) and maintained by in the SEDAR9 stock assessment and followed for the 2010 update are described below.

For years prior to 1990, discards in numbers (B2s) were converted to weight by multiplying by the average annual weight for each respective fishery mode (charterboat, private angler, headboat). For years subsequent to the minimum size and bag limit implementation, the ratio of discards (B2s) to retained catch (AB1) was calculated as B2/AB1 and then compared to the B2/AB1 ratio before the size/bag limit implementation. That fraction of B2/AB1 above the B2/AB1 ratio before the implementation was then attributed to the bag limit and sized with the average annual weight (for each respective fishery mode (charterboat, private angler, headboat)) above the size limit. The fraction of B2/AB1 less than or equal to the ratio before the regulation was sized with the average annual weight (for each respective fishery mode (charterboat, private angler, headboat)) below the 28 inch size limit.

Because of the changes in bag and size limits, it was necessary to consider four periods for basing the B2/AB1 ratio comparisons. Period one was 1986-1989 corresponding to years prior to the size limit. Period two was 1990-1996 corresponding to the initial implementation of the 3 fish per person bag limit. The bag limit regulation changed again in December 1997 from three fish to one fish per person. The final period was 2009 forward when the recreational size limit changed in 2008 (August) from 28 inch to 30 inch fork length.

4.5 Total Recreational Removals (landings and discards)

Estimated total recreational removals of Gulf of Mexico greater amberjack are presented in Table 4.5.1 for the stock assessment continuity case assuming 20% discard release mortality.

Table 4.1.3.1. Estimated recreational landings (AB1) of greater amberjack in the Gulf of Mexico from the MRFSS, TPWD, and Headboat Survey sources 1981-2009. Units for AB1 are whole weight (pounds).

	AB1	AB1	AB1	AB1	AB1
YEAR	**Cbt**	**Hbt**	**Cbt/Hbt**	**Priv**	**Grand Total**
1981	0	0	126,451	498,970	625,421
1982	0	0	3,446,898	1,170,695	4,617,593
1983	0	0	1,936,082	755,384	2,691,466
1984	0	0	1,065,311	241,678	1,306,988
1985	0	0	1,802,990	523,612	2,326,602
1986	3,530,395	750,632	0	1,525,870	5,806,897
1987	2,022,468	378,888	0	2,243,409	4,644,765
1988	1,095,384	173,613	0	988,588	2,257,586
1989	1,965,459	204,289	0	1,332,874	3,502,622
1990	389,136	77,654	0	480,806	947,597
1991	2,688,238	102,687	0	175,784	2,966,709
1992	1,675,541	312,152	0	508,327	2,496,021
1993	2,218,096	225,868	0	576,282	3,020,246
1994	1,135,435	213,119	0	266,416	1,614,970
1995	350,849	143,994	0	374,195	869,039
1996	658,254	139,588	0	489,234	1,287,077
1997	764,589	125,349	0	297,063	1,187,001
1998	374,926	88,595	0	186,955	650,476
1999	483,402	73,508	0	291,268	848,178
2000	633,984	100,732	0	302,691	1,037,407
2001	571,319	89,436	0	598,387	1,259,142
2002	1,243,479	160,636	0	643,471	2,047,586
2003	1,090,892	199,347	0	1,369,746	2,659,985
2004	1,130,351	108,769	0	1,142,251	2,381,372
2005	473,919	61,281	0	909,513	1,444,712
2006	941,682	79,892	0	390,384	1,411,958
2007	687,492	59,436	0	331,524	1,078,451
2008	539,854	54,544	0	705,833	1,300,232
2009	713,727	103,191	0	777,489	1,594,406

Table 4.1.3.2a. Comparison of calculated recreational landings (AB1) for the SEDAR 2010 update and the previous SEDAR9 stock assessment. AB1 units= whole weight (lbs). (Percent difference calculated as: (SEDAR9 landings – 2010 update landings)/SEDAR9 landings *100.

Comparison between SEDAR9 recreational landings and SEDAR 2010 update landings. Units =whole weight (lbs)		
Year	**Difference in Weight (SEDAR9 - 2010 update).**	**Percent difference**
1981	472,948	41%
1982	1,940,847	29%
1983	411,344	13%
1984	242,380	15%
1985	-331,547	-16%
1986	-348,456	-6%
1987	204,003	4%
1988	-699,162	-45%
1989	2,422,014	41%
1990	166,575	15%
1991	582,595	16%
1992	155,535	6%
1993	71,137	2%
1994	641,161	28%
1995	-13,205	-2%
1996	208,682	14%
1997	-118,212	-11%
1998	85,676	12%
1999	28,580	3%
2000	14,510	1%
2001	67,040	5%
2002	40,840	2%
2003	29,210	1%
2004	-241,333	-11%
2005	13,624	1%

Table 4.1.3.2b. Summary of differences in results compared to SEDAR9 estimated recreational landings (Table 3.3.1.2.1, SEDAR9 -SAR, page 39). Percent Difference calculated as: (SEDAR9 recreational landings weight - 2010 Update recreational landings weight) divided by SEDAR9 recreational landings weight *100.

#Years used in Comparison	**Percent Difference**
5	28%-45%
9	11%-16%
11	under 6%

Table 4.1.3.3. Summary of estimated CV for MRFSS AB1 and B2 Gulf greater amberjack Catch.

YEAR	AB1 Fish	CV_AB1	B2 Fish	CV_B2
1981	108479	0.29	3421	0.81
1982	585024	0.44	30288	0.68
1983	239068	0.27	79790	0.70
1984	93485	0.34	8742	0.68
1985	189972	0.29	0	
1986	349239	0.21	99535	0.26
1987	485935	0.18	35827	0.39
1988	219458	0.22	15117	0.50
1989	351819	0.20	89556	0.45
1990	62351	0.31	70223	0.47
1991	239238	0.30	252324	0.23
1992	157404	0.14	177628	0.14
1993	135695	0.21	177761	0.17
1994	102758	0.18	100940	0.22
1995	40354	0.36	64539	0.27
1996	81353	0.19	63074	0.29
1997	48445	0.24	36492	0.22
1998	27889	0.11	60983	0.24
1999	45680	0.11	43935	0.16
2000	52494	0.10	82371	0.19
2001	66200	0.12	393118	0.21
2002	114981	0.07	199716	0.11
2003	144271	0.09	201798	0.14
2004	102856	0.10	141770	0.15
2005	83451	0.11	117993	0.13
2006	61640	0.11	98043	0.23
2007	49630	0.11	148616	0.16
2008	65994	0.11	161258	0.10
2009	70380	0.13	136846	0.10

Table 4.2.1. Estimated greater amberjack discards (B2) for the charterboat, charter/headboat combined and private angler fisheries from the MRFSS survey. Units for B2 = numbers of fish.

	Charter	**Cbt/Hbt**	**Private**
YEAR	**B2**	**B2**	**B2**
1981		0	15,241
1982		0	45,085
1983		21,562	65,994
1984		3,595	5,242
1985		0	0
1986	53,124		90,249
1987	33,125		60,659
1988	1,043		18,381
1989	19,267		99,683
1990	23,748		46,475
1991	223,982		31,737
1992	91,758		87,662
1993	126,098		70,870
1994	64,783		40,143
1995	10,986		55,409
1996	42,758		20,355
1997	18,478		20,741
1998	39,120		42,782
1999	42,037		36,835
2000	31,872		80,717
2001	55,808		393,931
2002	82,883		185,028
2003	56,535		171,196
2004	30,730		123,898
2005	27,093		111,463
2006	30,418		81,417
2007	34,609		132,165
2008	65,630		130,548
2009	58,995		83,474
Grand Total	1,264,881	25,156	2,347,379

Table 4.2.2. Estimated discard ratios (B2/AB1B2) for Gulf of Mexico greater amberjack from the charter, charter/headboat, and private angler fisheries from the MRFSS survey. Units for B2 and AB1B2 are number of fish.

YEAR	Cbt	Cbt/Hbt	Priv	Grand Total
1981	0.00	0.00	0.13	0.12
1982	0.00	0.00	0.23	0.07
1983	0.00	0.10	0.58	0.26
1984	0.00	0.04	0.54	0.08
1985	0.00	0.00	0.00	0.00
1986	0.17	0.00	0.46	0.28
1987	0.10	0.00	0.23	0.16
1988	0.01	0.00	0.18	0.08
1989	0.11	0.00	0.34	0.25
1990	0.50	0.00	0.54	0.53
1991	0.50	0.00	0.73	0.52
1992	0.42	0.00	0.72	0.53
1993	0.53	0.00	0.68	0.57
1994	0.43	0.00	0.68	0.50
1995	0.39	0.00	0.70	0.62
1996	0.47	0.00	0.39	0.44
1997	0.34	0.00	0.62	0.45
1998	0.67	0.00	0.79	0.73
1999	0.60	0.00	0.67	0.63
2000	0.46	0.00	0.83	0.68
2001	0.66	0.00	0.91	0.87
2002	0.53	0.00	0.82	0.70
2003	0.47	0.00	0.68	0.61
2004	0.36	0.00	0.72	0.60
2005	0.49	0.00	0.66	0.62
2006	0.41	0.00	0.71	0.59
2007	0.51	0.00	0.87	0.76
2008	0.69	0.00	0.76	0.73
2009	0.63	0.00	0.70	0.67
Grand Total	0.39	0.03	0.59	0.44
Ave-2009	0.44	0.03	0.58	0.47
Ave-2003	0.41	0.03	0.54	0.42
Ave 2004-2009	0.52		0.74	0.66

Table 4.2.3. Estimated recreational releases (B2) of greater amberjack from the Gulf of Mexico from the Headboat Survey 1986-2009. Units are whole weight (lbs).

Year	**HBS B2s**
1986	17,737
1987	5,802
1988	218
1989	6,385
1990	24,271
1991	9,704
1992	14,537
1993	15,583
1994	10,037
1995	5,554
1996	9,153
1997	3,891
1998	10,485
1999	7,979
2000	5,182
2001	11,565
2002	11,987
2003	10,517
2004	3,439
2005	3,857
2006	3,326
2007	4,665
2008	10,729
2009	8,941
Grand Total	215,544

Table 4.3.1. Estimated discard ratios (B2/AB1B2) of greater amberjack from the Gulf of Mexico from three sources 2004-2007. Units for B2 and AB1B2 are number of fish.

Source	Source of Discard Information	Discard Estimate	Discard Estimate
HBT Observer Program	**HBT Observer Program**	**B2/AB1B2**	**B2/AB1B2**
	Year	**AL+FLW Panhandle**	**FLW Peninsula**
	2004	0.91	
	2005	0.79	0.63
	2006	0.87	0.55
	2007	0.80	0.57
HBS Logbook data self reported	**HBS logbook data Summary Source: Self Reported Logbook data**	**HBT Area**	**HBT Area**
		Area 23 (Panhandle FL)	**Areas 18+21+22 (FLW Peninsula)**
	Year	**live/kept+dead+live**	**live/kept+dead+live**
	2004	0.34	0.25
	2005	0.39	0.41
	2006	0.50	0.22
	2007	0.79	0.27
MRFSS Survey	**MRFSS Charterboat (CH) Summary**	**B2/AB1B2**	
	1986-2009 All areas	0.44	
	1986-2003 All areas	0.41	
	2003-2007 All areas	0.44	
MRFSS Survey	**MRFSS Private Angler (PR) Summary**		
	1981-2009 All areas	0.58	
	1981-2003 All areas	0.61	
	2003-2007 All areas	0.69	
	Average: 1981-2009 = 0.44 (CH), 0.58 (PR)		
	Average: 1981-2003 =0.41 (CH), 0.61 (PR)		

Table 4.3.2. Estimated total recreational landings (AB1) and discards (B2) of Gulf of Mexico greater amberjack for the 2010 stock assessment update continuity case, assuming 20 % discard mortality rate. Units are numbers of fish.

Table of AB1 and B2 for 20% mortality								
Units are number of fish	**Landings**	**Discards**	**Landings**	**Discard s**	**Landings**	**Discard s**	**Landings**	**Discard s**
	Charter	**Charter**	**Cbt/Hbt**	**Cbt/Hbt**	**Private**	**Private**	**HBT**	**HBT**
YEAR	**AB1**	**B2**	**AB1**	**B2**	**AB1**	**B2**	**AB1**	**B2**
1981			13,773	0	97,956	3,048		
1982			444,410	0	154,812	9,017		
1983			200,635	4,312	48,670	13,199		
1984			94,037	719	4,477	1,048		
1985			161,959		73,033	0		
1986	257,652	10,625			103,837	18,050	75,118	3,547
1987	301,766	6,625			207,847	12,132	54,316	1,160
1988	141,621	209			83,173	3,676	551	44
1989	158,556	3,853			197,299	19,937	47,854	1,277
1990	23,735	4,750			39,769	9,295	11,514	4,854
1991	227,427	44,796			12,026	6,347	3,141	1,941
1992	124,632	18,352			34,791	17,532	21,700	2,907
1993	113,719	25,220			33,804	14,174	13,068	3,117
1994	84,665	12,957			19,025	8,029	11,252	2,007
1995	17,146	2,197			24,178	11,082	6,587	1,111
1996	49,111	8,552			32,405	4,071	8,831	1,831
1997	35,807	3,696			12,638	4,148	3,761	778
1998	19,062	7,824			11,334	8,556	5,119	2,097
1999	27,852	8,407			18,190	7,367	3,532	1,596

2000	36,914	6,374			17,070	16,143	1,783	1,036
2001	28,994	11,162			38,063	78,786	935	2,313
2002	73,939	16,577			41,143	37,006	5,644	2,397
2003	64,373	11,307			79,957	34,239	10,194	2,103
2004	55,768	6,146			48,511	24,780	3,584	688
2005	28,083	5,419			56,709	22,293	4,372	771
2006	43,173	6,084			33,924	16,283	3,371	665
2007	33,078	6,922			19,159	26,433	3,728	933
2008	29,505	13,126			41,491	26,110	3,523	2,146
2009	34,552	11,799			36,456	16,695	5,821	1,788
Grand Total	2,011,129	252,976	914,813	5,031	1,621,746	469,476	309,300	215,544

Table 4.5.1. Estimated total recreational Gulf of Mexico greater amberjack landings and discards 1986-2009 for the 2010 stock assessment update continuity case, assuming a 20% discard release mortality. Units are whole weight (lbs).

Year	Charter+Private	Headboat
1986	5,787,242	826,192
1987	4,543,296	401,052
1988	2,150,945	174,803
1989	3,838,938	254,731
1990	1,132,616	172,090
1991	3,641,147	133,155
1992	2,735,841	391,114
1993	3,449,270	279,272
1994	1,797,078	242,886
1995	915,035	161,056
1996	1,309,048	164,530
1997	1,130,605	129,629
1998	783,722	112,882
1999	987,920	92,461
2000	1,302,711	113,093
2001	2,701,177	125,294
2002	2,657,085	189,545
2003	3,035,576	215,332
2004	2,811,945	115,991
2005	1,739,045	67,529
2006	1,721,208	86,544
2007	1,478,989	64,929
2008	1,898,731	85,673
2009	1,942,622	117,491

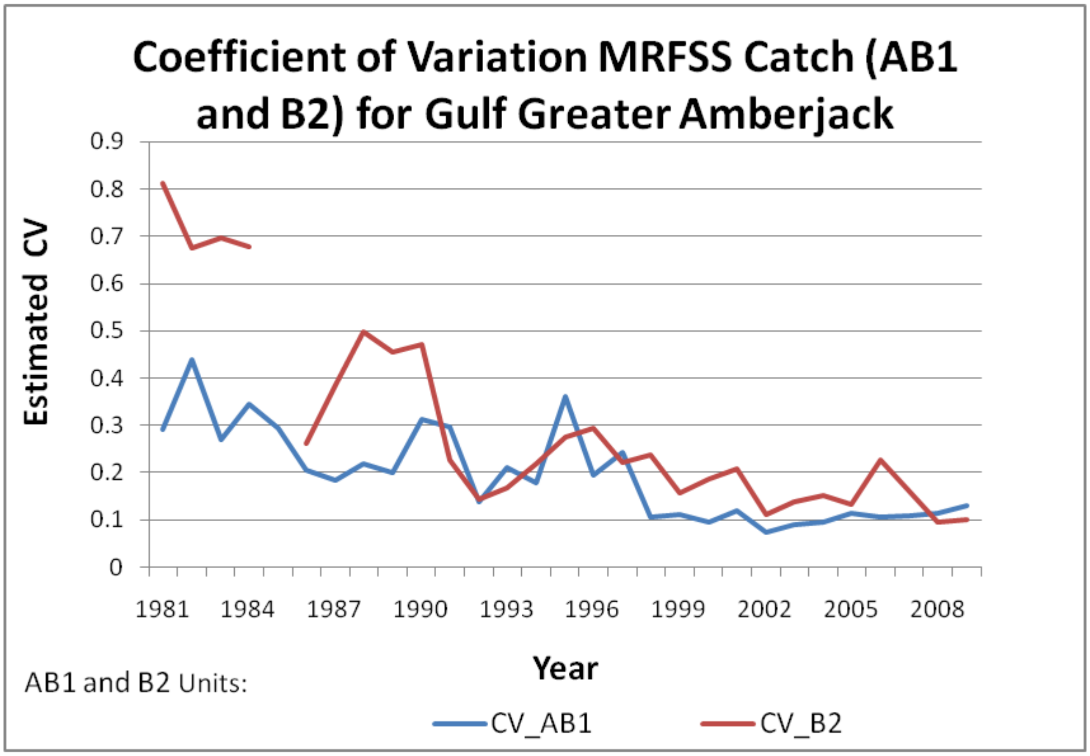


Figure 4.1.3.1. Summary of estimated CV for MRFSS AB1 and B2 Gulf greater amberjack Catch.

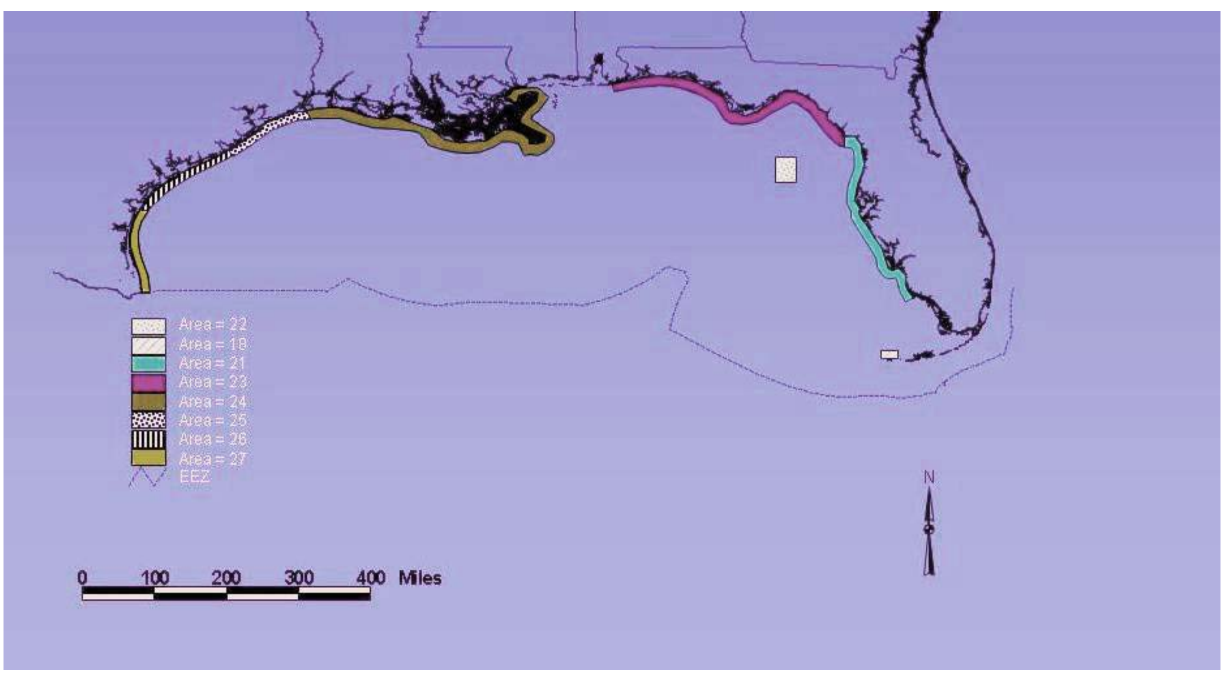


Figure 4.1.1.2.1. NMFS, Beaufort Headboat Survey Fishing areas chart.

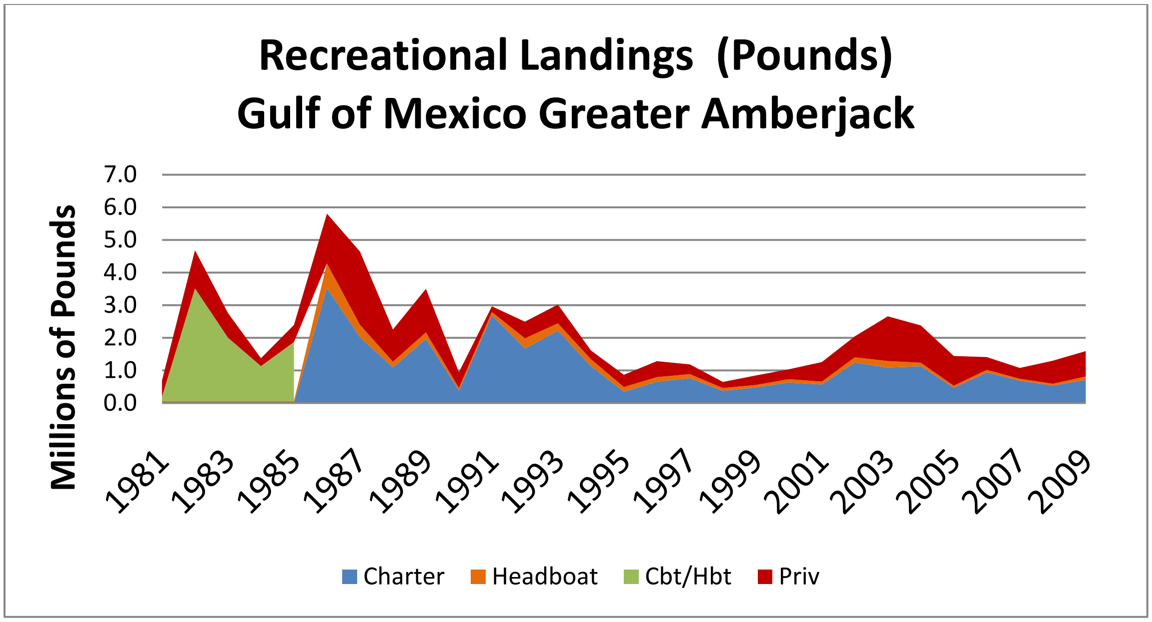


Figure 4.1.3.1. Estimated recreational landings (AB1) of greater amberjack from the Gulf of Mexico from the MRFSS, TPWD, and Headboat Survey sources 1981-2009. Units are whole weight (lbs). Gap in figure denotes point in time when MRFSS charter/headboat estimates separated.

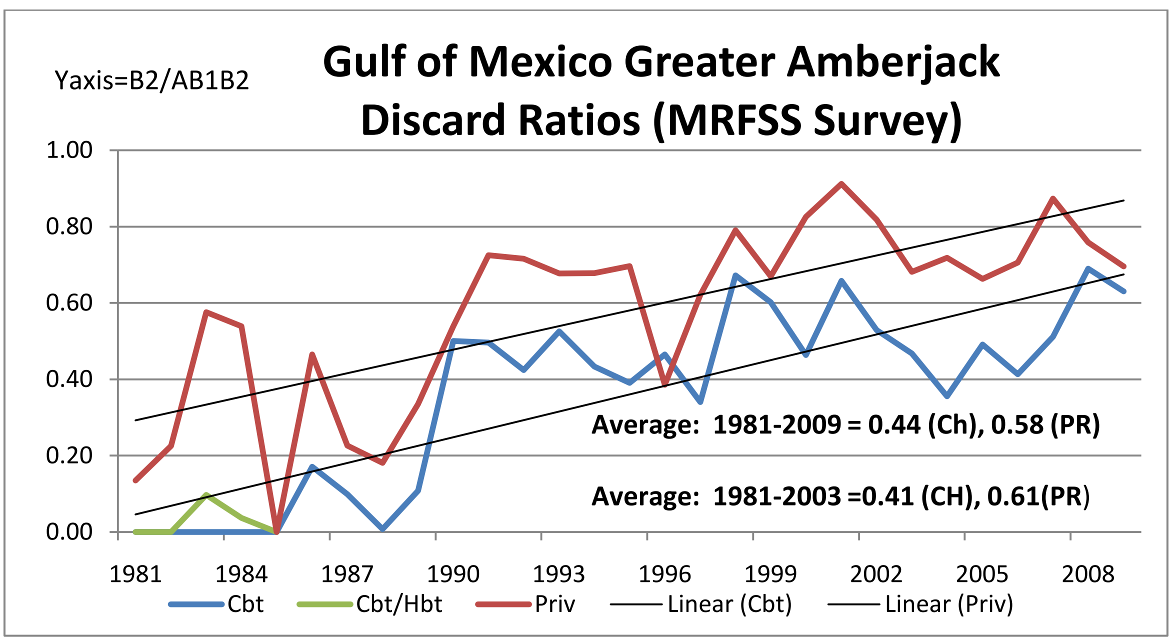


Figure 4.2.1. Discard ratios (B2/AB1B2) of greater amberjack for charter (1986-2009), charter and headboat combined (1981-1985), and private angler (1986-2009) fisheries from the MRFSS survey. Discard ratio computed as B2/AB1B2. Discard ratio units based on numbers of fish.

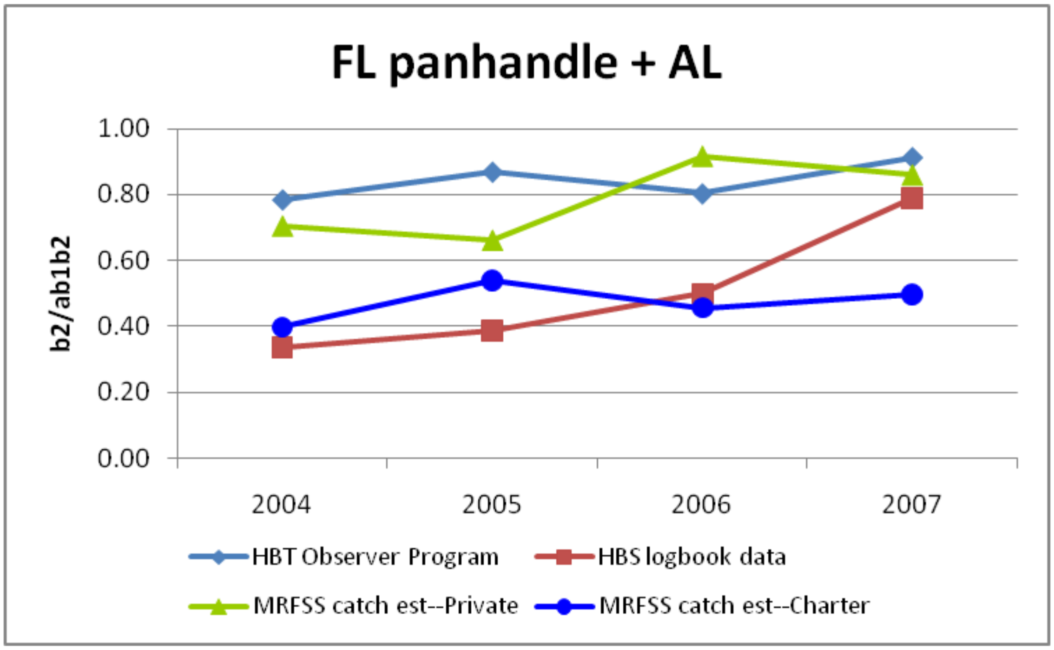


Figure 4.3.1A. Estimated discard ratios (B2/AB1B2) of greater amberjack for Florida Panhandle and Alabama region from three sources (MRFSS, HBT observer program, and HBT self reported logbooks) for years where all three surveys exist. HBT area 23=Northwest Florida and Alabama Panhandle + Alabama. Ratio computed on numbers of fish.

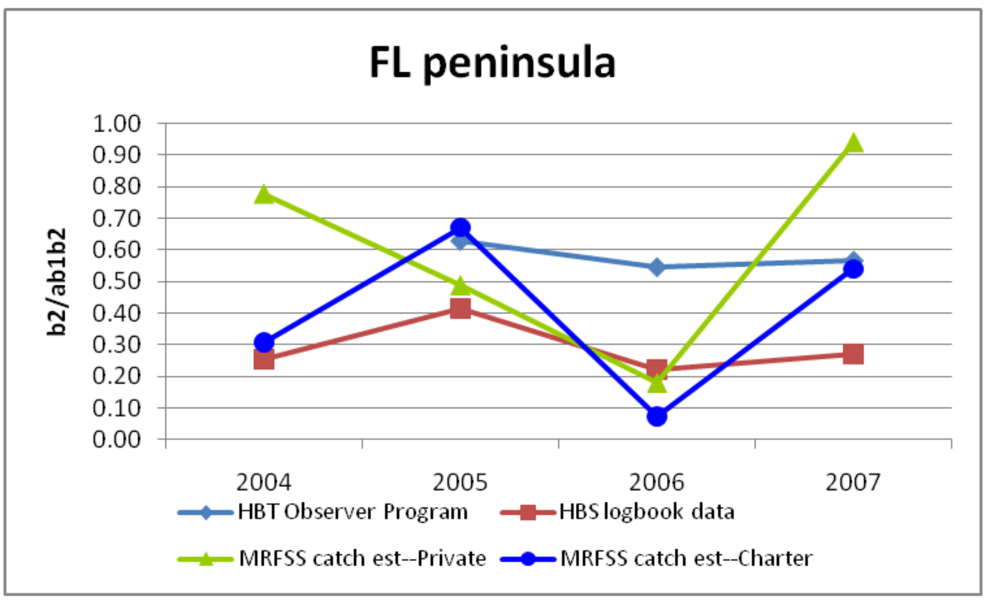


Figure 4.3.1B. Estimated discard ratios (B2/AB1B2) of greater amberjack for Florida Peninsula from three sources (MRFSS, HBT observer program, and HBT self reported logbooks) for years where all three surveys exist. HBT area 18+21+22= Dry Tortugas (Gulf vessels) + SW FL (Naples to Crystal River) + Fl. Middle Grounds = Florida Peninsula. Ratio computed on numbers of fish.

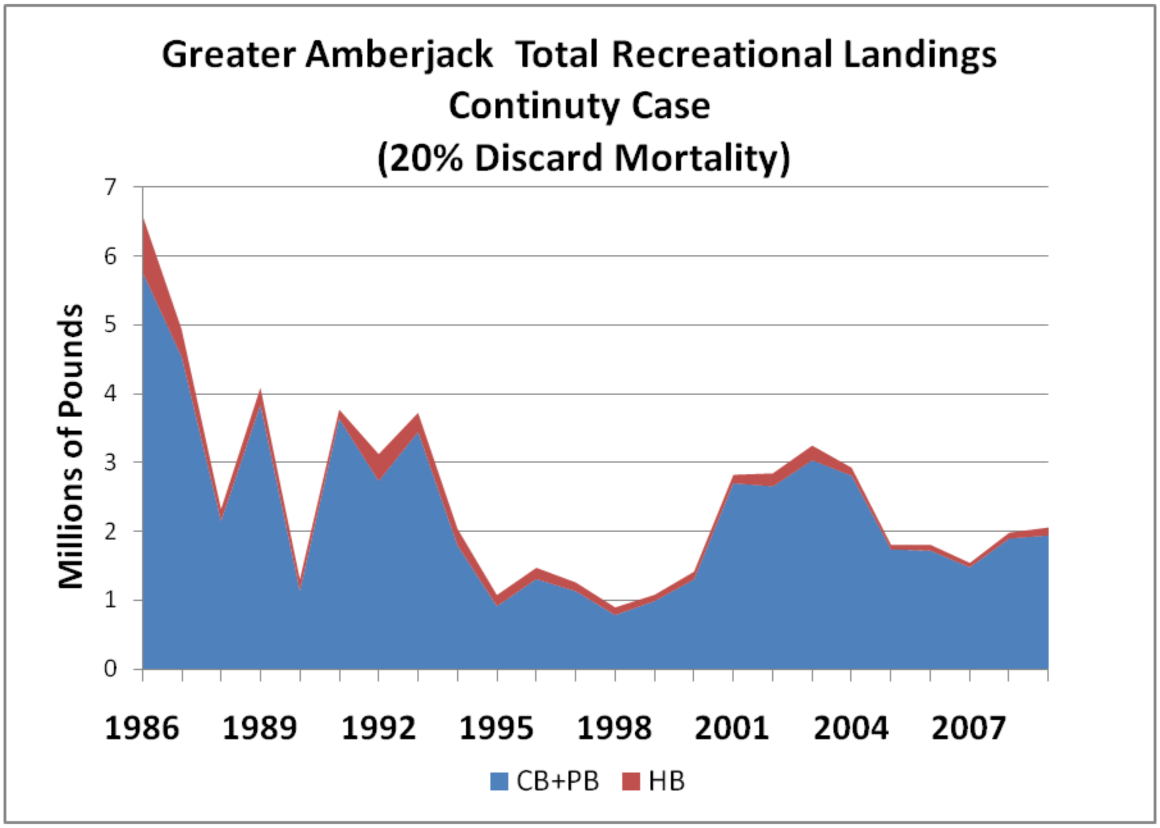


Figure 4.5.1. Estimated total recreational landings and discards for the 2010 update stock assessment continuity case, assuming 20% release mortality. Units are whole weight (lbs).

5. Trends in Abundance

Previous stock assessments evaluations of Gulf of Mexico greater amberjack examined observations of catch and effort from the fishery dependent commercial (vertical line and longline) and recreational (charter and private, headboat) fisheries to develop indices of abundance (DW-10 and DW-20, Cummings 2000; Turner 2000a,b; and Cummings and McClellan 1996). Many of the conventions used in these earlier abundance analyses relating to selection of data for use in model development (e.g., aggregating data into spatial and/or temporal units, treatment of close seasons) were retained in this SEDAR 2010 update. Cummings (2000) and Diaz (2005) provided details on these specific data handling choices and these details are included below for each source of abundance data evaluated.

The SEDAR9 stock assessment also summarized information available from four fishery independent surveys: 1) the SEAMAP Icthyoplankton survey, 2) SEAMAP Reef Fish Video Survey, 3) SEAMAP small pelagic Trawl Survey, and the 4) SEAMAP Bottomfish Survey. SEDAR9 SAW report characterized these surveys as follows. The small pelagic data may be useful for extended distributional information, but is not a rigorous time series, and is not considered further for the 2010 update. The icthyoplankton and reef fish surveys (bottom fish and video) are intended to index spawning stock size. The trawl indexes are intended to index new recruitment.

At the time of the previous SEDAR9 stock assessment an abundance index for greater amberjack was not available for the larval index. Although *Seriola* spp. was reported in the bongo and neuston net samples (n=~ 3,500 individuals up to 2005) none of the samples had been processed to species at the time of SEDAR9. The SEDAR9 DW Panel indicated that the trawl survey data would not be useful for developing indices for greater amberjack due to the extremely low occurrence in the surveys (SEDAR9-DW27). The SEDAR9 DW Panel also noted that the trawl surveys provide general information on frequency of occurrence of greater amberjack over blocks of years. The trawl surveys were not considered further in the SEDAR9 evaluations and due to the observed low frequency of occurrence they were not considered for the 2010 update. However, it is recommended at this date, to continue consideration of the surveys in future full benchmark assessments as a possible approach to identifying large changes in frequency of occurrence over large blocks of time.

Finally, the SEDAR9 DW Panel recommended for further use in the greater amberjack 2010 stock assessment update the inclusion of only the fishery dependent data series (i.e., commercial and recreational fisheries data series). These data series and the examinations carried out for the 2010 SEDAR update are discussed below.

5.1 Fishery Dependent Available Data

As in the previous SEDAR9 stock assessment for greater amberjack (Diaz 2005, 2006), three sources of fishery dependent abundance information were used for the SEDAR 2010 update for developing catch per unit of effort. These data sources included: 1) the MRFSS dataset, 2) the NMFS, SEFSC Headboat Survey, and 3) the NMFS, Coastal Logbook database. Details on data inclusion for each separate data source are described below.

5.1.1. MRFSS Survey

The MRFSS survey was used to characterize abundance trends for the charterboat and private angler fisheries (coded as modes 3 and 4 respectively in the MRFSS survey). Observations for charterboats and private angler trips from 1981-2009 were included in the analyses. Observation on catch included the number of fish landed (Type A fish) observed by the interviewer, number of fish caught but not available to the interviewer (Type B1), and the number of released fish (B2) also not observed by the interviewer. Information on effort included hours fished as reported to the interviewer. CPUE was calculated as catch (A+B1+B2) divided by total hours fished for each interviewed trip. Catch not observed by the interviewer (B1 and B2) was adjusted upwards by the ratio of non-interviewed to interviewed anglers in each party. Since MRFSS routinely collects information on releases (i.e., discards, coded as B2s in the survey), possible effects from bag limits and/or minimum size change regulations do not need to be investigated. Auxiliary information available to standardize CPUE included attributes such as: year, month, state (county). Following Cummings (2000) and SEDAR9, areas were aggregated as follows for the 2010 update CPUE analyses: 1) SW FL, 2) NW FL, 3) FL Panhandle – AL, and 4) LA-MS.

5.1.2. NMFS, Headboat Survey

This survey provides information on catch (number of fish) and effort (number anglers) for the Gulf of Mexico headboat fishery since 1986. Observations of catch and effort from only full day trips operating from 1986 forward were included in the CPUE examinations. CPUE was calculated as catch per angler hour. In the previous SEDAR9 stock assessment Diaz (2005) examined the impact of bag limit regulations (3 fish, 1 fish) for three periods (1986-2003, 1986-1996, and 1997-2003) on index standardization. Those analyses indicated that index results were not affected by the bag limit as the proportion of trips with CPUE ranging from 0.001-3 fish per angler did not increase substantially after the regulation change therefore no further considerations of bag limits were necessary. In fact, Diaz noted that the proportion of trips with CPUE ranging from 0.001-1 fish was relatively high in all years particularly in the late 1990s and later, suggesting that headboat catch rates of greater amberjack was fairly low in most years irrespective of the bag and size limit regulations.

5.1.3. NMFS, SEFSC Coastal Logbook Program

The coastal logbook program provides information on trip specific commercial catch (landed weight) and effort from self reported logbooks since 1990. Between 1990 and 1993 in Florida, a 20% random selection of vessels was required to report. The CPUE abundance trends analysis was restricted to the years 1993 and forward as in previous evaluations Cummings (2000) and Diaz (SEDAR9 2005) to maintain consistency. Diaz followed the convention of Cummings (2000) in excluding observations from statistical grid 1 in the analyses as catches from that area (see section 3, Figure 3.2.1) are considered part of the Atlantic stock management unit. As well, catches from the months of March-May, the closed season established in 1998 through GMFMC Amendment 15 implemented January 1998, were excluded from the analysis. By excluding observations during the closure seasons, effects from management measures on the resulting CPUE trends are minimized. Seasons were defined as January – March, April – June, July - September, and October - December. CPUE observations for the vertical line and the longline fishery were modeled separately as these fisheries are carried out differently and in addition it is generally believed that greater amberjack is not actively fished for (targeted) by the longline fishery.

CPUE for the vertical line fishery was calculated as catch (weight in pounds) divided by hook-days (i.e., number hooks per line x trip days). Vertical line trips were restricted to records indicating <10 hooks per line as in SEDAR9. CPUE for the longline fishery was calculated as catch (weight in pounds) per 100 hooks as in SEDAR9. In addition, only trip records reporting at least 10 sets per day or 1 day trip duration were included in the analysis as in SEDAR9.

5.2. <u>Analysis Methods</u>

Two statistical treatments of the data were used to develop the standardized indices of abundance. This involved 1) conducting a data reduction analysis in order to identify a suite of CPUE observations (i.e., catch records) for index development and 2) conducting a general linear modeling (GLM) analysis of the CPUE observations. These procedures follow the previous greater amberjack CPUE analyses carried out by Cummings 2000 and Diaz (SEDAR9, 2005) and are consistent with CPUE modeling protocols used in other SEDAR evaluations and as well as those used in other fisheries analyses worldwide.

5.2.1. Data Reduction Analysis

It was necessary to carry out a data reduction analysis of each data set (i.e., MRFSS, Headboat, Logbook) to identify trips on which greater amberjack could have been caught. The Stephens and MacCall (2004) procedure (aka the 'SM' approach) was used as in previous evaluations and is an objective procedure for identification of zero catch trips for the species under study. The SM procedure utilizes a logistic regression to identify species which could co-occur with a given target species (greater amberjack in this case). The Stephens and MacCall procedure tends not to predict (or select) trips on which the target species is the only species caught. Thus, most analysts include in the final set of CPUE observations both the trips selected/identified through the SM data reduction analysis in addition to all trips on which the target species was caught. In the initial SM analyses species occurring in at least 1% of all the trips were included in the data reduction analysis. The final list of species included in the CPUE analysis is made up of only the species that are significant in the logistic model.

5.2.2. General Linear Modeling (GLM) Analysis

The second statistical procedure involved carrying out the GLM modeling of the selected data. For each data source (i.e., the MRFSS charter and private, the Headboat, the Logbook vertical line, and the Logbook longline) indices were developed using a delta – lognormal model method (Lo et al. 1992) which fits two models to the data series. First a lognormal model is fitted to the positive trip CPUE observations and then a binomial model to the distribution of zero (proportion of positive) observations. The two models assume a lognormal and binomial error distribution, respectively. The final standardized index is the product of the two components, the lognormal and the binomial parts. As is the norm with many fisheries CPUE modeling exercises, auxiliary information is incorporated into the model parameterization in an attempt to reduce the variation in the index. Factors available for the stepwise selection included: year, month or season (January – March, April – June, July - September, and October - December), mode (in case of MRFSS), and region – area offshore (MRFSS). Statistically important independent auxiliary factors were identified through a deviance reduction analysis and these factors and sometime the interaction effects between one or more factors were then incorporated into the final index standardizations. The main factor year was always included in each model as a main effect. All models were carried out using Version 9.1 PROC GLIMMIX routine of SAS.

5.3. <u>Fishery Dependent Abundance Trends Results</u>

5.3.1. MRFSS Recreational Charter and Private Angler Fisheries Survey

Table 5.3.1.1 and Figure 5.3.1.1 provide summary results for the Stephens and MacCall (2004) data reduction analysis for the recreational charterboat and private angler fisheries.

Results from the deviance analysis for the observations of positive catch rates and for the proportion of positives are presented in Table 5.3.1.2. Although the MRFSS data series begins with 1981, problems with model convergence for data prior to 1985 necessitated restricting the GLM analysis to 1985 forward. The final GLM model included for the positives included terms for: Year + Month + Mode + Region. The final model terms included for the proportion of positive Model was: Year + Month + Mode + Region. Although interaction terms as well as a term for species composition (Guild) were included in both the deviance analysis and in the

GLM exercises, these terms were not included in the final model because either the model did not converge (in the case of interaction terms) or were not significant in explaining the variance in CPUE (in the case of Guild factor).

Final estimates from the delta lognormal analysis of standardized CPUE in addition to nominal values and a normalized index from SEDAR9 are presented in Table 5.3.1.3 and in Figure 5.3.1.2 for the recreational charterboat and private angler fisheries combined. These results indicate that greater amberjack charterboat and private angler CPUE was highest in 1986 and followed by a series of declines/increases. Standardized CPUE declined from 1986 through 1990, increased through 1993 and continued to decline through about 1999 to the lowest levels on record. Standardized CPUE increased through the 2002/2003 period, following again by declining CPUE through 2006/2007. CPUE increased slightly in 2008 and declined again in 2009. Standardized CPUE in 2009 was 85% lower than that predicted in 1985. Nominal catch rates appear to have fluctuated without trend since 1996.

5.3.2. Recreational Headboat fishery (NMFS, Headboat Survey)

Table 5.3.2.1 and Figure 5.3.2.1 provide summary results for the Stephens and MacCall (2004) data reduction analysis for the recreational headboat fishery.

Results from the deviance analysis for the observations of positive catch rates and for the proportion of positives are presented in Table 5.3.2.2. The final GLM model included for the positives included terms for: Year + Area + Month. The final model terms included for the Proportion of positive Model was: Year + Area + Month. Although interaction terms for Area*Month and Year*Month were included in both the deviance analysis and in the GLM exercises, these terms were not included in the final model because the model did not converge.

Final estimates from the delta lognormal analysis of standardized CPUE in addition to nominal values and a normalized index from SEDAR9 are presented in Table 5.3.2.3 and in Figure 5.3.2.2 for the headboat fishery. These results indicate that greater amberjack headboat CPUE was highest in 1986 then CPUE declined through 1999. CPUE showed an apparent but spurious increase in 1991 and again declined thereafter through 1998. Standardized CPUE increased through 2003 and followed by further decline through 2007 to the lowest level on record. Standardized CPUE increased from 2007 through 2008. Estimated CPUE in 2009 was slightly above the 2008 level but was 74% lower than the 1985 level. Headboat nominal CPUE varied without major trend from the initial beginning (1986) of the time series until 2007, showing a slight increase between 2007 and 2008 and again in 2009, but still remaining below the observed nominal CPUE of 1986 the first year in the time series.

5.3.3 Commercial Vertical line fishery (NMFS, SEFSC Coastal Logbook Survey)

Figure 5.3.1.1 and Table 5.3.1.1 provide summary results for the Stephens and MacCall (2004) data reduction analysis for the commercial vertical line fishery.

Results from the deviance analysis for the observations of positive catch rates from trips reporting and for the proportion of positives are presented in Table 5.3.3.2. The final GLM model included for the positives included the terms: Year + Month + Area. The final model terms included in the Proportion of positive included: Year + Month + Area. Although, interaction terms for Area*Month and Year*Month were included in both the deviance analysis and in the GLM exercises, these terms were not included in the final model because the model did not converge.

Final estimates from the delta lognormal analysis of standardized CPUE in addition to nominal values and a normalized index from SEDAR9 are presented in Table 5.3.3.3 and in Figure 5.3.3.2. These results indicate that greater amberjack standardized CPUE from the vertical line fishery was highest during the early part of the time series, around 1994. Standardized vertical line CPUE seems to indicate two levels during the time series with a low period beginning around 1997 and continuing through the current period. During this lower scale time period, standardized CPUE has shown two spurious increases, one in 2004 and another in 2006. The trend since 2006, suggests possibly a third level of CPUE, much lower than during any of the time series. Standardized greater amberjack CPUE from the vertical line fishery has declined steadily since 2006 through the 2009 data point to the lowest level on record. Estimated standardized CPUE in 2009 was 71% lower than the maximum on record. Nominal CPUE from the vertical line fishery followed the same trend as the indexed CPUE and also shows the differing levels of CPUE throughout the time series.

5.3.4 Commercial Longline fishery (NMFS, SEFSC Coastal Logbook Survey)

Table 5.3.4.1 and Figure 5.3.4.1 provide summary results for the Stephens and MacCall (2004) data reduction analysis for the commercial longline fishery.

Results from the deviance analysis for the observations of positive catch rates and for the proportion of positives are presented in Table 5.3.4.2. The final GLM model included for the positives included the terms: Year + Area. The final model terms included for the Proportion of positive Model were: Year + Area. Interaction terms for Area*Month and Year*Month were included in both the deviance analysis and in the GLM exercises, but these terms were not included in the final model because the model did not converge.

Final estimates from the delta lognormal analysis of standardized CPUE in addition to nominal values and a normalized index from SEDAR9 are presented in Table 5.3.4.3 and in Figure 5.3.4.2. The GLM results suggest that standardized CPUE of greater amberjack for the longline fishery increased steadily from 1993-2004, then declined through 2007 and increased thereafter. Nominal CPUE showed the same general trends as the index throughout the series.

5.3.5 Abundance Indices Overall Summary

Table 5.3.5.1 and Figure 5.3.5.1 provides a summary of standardized indices for all four fishery dependent abundance indices. These four time series of standardized CPUE indices and yield data series were used in all subsequent population model analyses. A comparison of the updated abundance indices and the previous stock assessment is useful. When comparing the updated index trends to the same index presented for the SEDAR9 stock assessment, for overlapping years, the overall trends are not dissimilar. It is noted however that the commercial longline index exhibits a departure from the MRFSS charter and private angler index and also the commercial longline index particularly in later years. This characteristic was also noted for the longline index developed for the SEDAR9 stock assessment. In the SEDAR9 assessment the departure was particularly strong for the last year of the time series, 2004, with the charterboat showing a marked decline, the headboat and longline indices showing an increase, and the vertical line a slight decline (SEDAR9-SAR, Section 2.2.3, RW Consensus Summary, page 13). For the 2010 update assessment, the commercial longline index shows a marked increase in the later years, the headboat a modest increase since 2006, while the commercial vertical line shows a marked decline since 2006 and the MRFSS charter and private angler indices shows a decline between 2002 and 2008 followed by a slight increase and again a decline after 2008. Overall the MRFSS charter and private angler index, which represents the largest contributor to overall fishery removals, shows a picture of a substantial decline in abundance since 1993. Interestingly, both the MRFSS charter and private angler index and the NMFS, Headboat Survey index show periods of very high standardized CPUE for the very early years of the time series, 1986 through about 1989 followed by significant declines. To allow further visual comparisons of the agreement between indices, the commercial longline index was plotted against the MRFSS charter and private angler, the NMFS, Headboat, and the commercial vertical line separately (Figures 5.3.5.2, 5.3.5.3, and 5.3.5.4). The tendency for the longline index to depart from the trends of the commercial vertical line fishery and the recreational charter and private angler fishery is apparent in these figures. This observation of disagreement between some indices was also observed in the previous stock assessment (SEDAR9, RW, page 152) as the longline index trended upwards in the last year (2004) in the SEDAR9 stock assessment while a marked decline in the MRFSS charterboat and angler index was observed as in this update.

Table 5.3.1.1. Stephens and MacCall (2004) regression coefficients for the MRFSS charterboat and private angler fisheries for species occurring in at least 1% of all charterboat and private angler trip and indicated in the logistic regression as being significant.

Species	**Parameter**	**Estimate**	**Error**	**L_Limit**	**U-Limit**	**Chi-Square**	**Pr>ChiSq**
Intercept	Intercept	**-13.5875**	0.4913	-14.5506	-12.6245	764.74	<.0001
ArchosargusProbatocepha	sp1	**1.9777**	0.123	1.7366	2.2189	258.37	<.0001
AriusFelis	sp2	**0.7507**	0.0469	0.6587	0.8427	255.98	<.0001
BagreMarinus	sp3	**1.6007**	0.1224	1.3608	1.8406	171.02	<.0001
BalistesCapriscus	sp4	**-0.1913**	0.0148	-0.2204	-0.1623	166.69	<.0001
CaranxHippos	sp5	**-0.0427**	0.0546	-0.1498	0.0644	0.61	0.4349
CentropomusUndecimalis	sp6	**3.2954**	0.4088	2.4942	4.0965	64.99	<.0001
CentropristisStriata	sp7	**0.3798**	0.0526	0.2768	0.4828	52.21	<.0001
CynoscionArenarius	sp8	**-0.2158**	0.0454	-0.3048	-0.1268	22.6	<.0001
CynoscionNebulosus	sp9	**2.6828**	0.092	2.5025	2.8631	850.83	<.0001
ElopsSaurus	sp11	**1.241**	0.1088	1.0278	1.4542	130.15	<.0001
EpinephelusMorio	sp12	**-0.1708**	0.0167	-0.2036	-0.138	104.3	<.0001
HaemulonPlumieri	sp13	**0.0094**	0.0386	-0.0663	0.0851	0.06	0.8075
LagodonRhomboides	sp14	**-0.4725**	0.0349	-0.5409	-0.404	182.93	<.0001
LutjanusCampechanus	sp15	**-2.8795**	0.0194	-2.9174	-2.8416	22135.4	<.0001
LutjanusGriseus	sp16	**-0.2509**	0.0173	-0.2848	-0.217	210.26	<.0001
MicropogoniasUndulatus	sp17	**0.1055**	0.0619	-0.0158	0.2268	2.91	0.0881
MycteropercaMicrolepis	sp18	**-0.3434**	0.015	-0.3728	-0.314	524.19	<.0001
ParalichthysLethostigma	sp19	**0.3772**	0.0743	0.2316	0.5228	25.79	<.0001
PogoniasCromis	sp20	**0.5798**	0.1019	0.38	0.7795	32.36	<.0001
SciaenopsOcellata	sp21	**0.7329**	0.0397	0.655	0.8107	340.41	<.0001
ScomberomorusCavalla	sp22	**-0.1116**	0.0161	-0.1431	-0.0801	48.27	<.0001
ScomberomorusMaculatus	sp23	**0.4044**	0.0284	0.3487	0.4601	202.55	<.0001

Table 5.3.1.2. Deviance analysis for the MRFSS charterboat and private angler fisheries.

Model factors positive catch rates values	**degrees of freedom**	**Residual deviance**	**Change in deviance**	**% of total deviance**	**chi-sq**	***p***
1		783.2423				
Year	23	632.8572	150.3851	26.52599	0.000	<0.0001
Year Area	2	630.8757	1.981501	0.349511	0.371	0.371298
Year Area Month	11	542.4051	88.47066	15.60508	0.000	<0.0001
Year Area Month Mode	1	432.8121	109.593	19.33079	0.000	<0.0001
Year Area Month Mode Region	3	429.2887	3.523347	0.621473	0.318	0.317747
Year Area Month Mode Region Guild	4	425.9931	3.295602	0.581302	0.510	0.509629
Year Area Month Mode Region Guild Area*Mode	1	425.8537	0.139455	0.024598	0.709	0.708823
Year Area Month Mode Region Guild Area*Region		423.8141	2.03959	0.359757		
Year Area Month Mode Region Guild Mode*Guild	2	422.0419	1.772202	0.312594	0.412	0.41226
Year Area Month Mode Region Guild Area*Guild	2	421.5477	0.494235	0.087177	0.781	0.781049
Year Area Month Mode Region Guild Mode*Region	3	412.9486	8.599026	1.516757	0.035	0.035126
Year Area Month Mode Region Guild Area*Month	9	406.1403	6.808303	1.200897	0.657	0.65707
Year Area Month Mode Region Guild Year*Area	17	405.7566	0.383707	0.067681	1.000	1
Year Area Month Mode Region Guild Month*Mode	11	405.2433	0.513288	0.090537	1.000	0.999998
Year Area Month Mode Region Guild Year*Mode	18	401.6853	3.55805	0.627594	1.000	0.999899
Year Area Month Mode Region Guild Region*Guild	5	393.2123	8.47299	1.494526	0.132	0.132023
Year Area Month Mode Region Guild Year*Guild	31	390.2525	2.959761	0.522064	1.000	1
Year Area Month Mode Region Guild Month*Guild	19	348.8831	41.36942	7.297032	0.002	0.002154
Year Area Month Mode Region Guild Year*Region	44	305.7349	43.14818	7.610782	0.508	0.508034
Year Area Month Mode Region Guild Year*Month	95	216.3074	89.4275	15.77386	0.642	0.642007
Model factors proportion of positive / total obs	**degrees of freedom**	**Residual deviance**	**Change in deviance**	**% of total deviance**	**chi-sq**	***p***
1		2935.545				
Year	24	2659.223	276.3218	18.63415	0.000	<0.0001
Year Area	2	2659.047	0.175464	0.011833	0.916	0.916006
Year Area Month	11	2495.659	163.3881	11.01831	0.000	<0.0001
Year Area Month Mode	1	2314.305	181.354	12.22986	0.000	<0.0001
Year Area Month Mode Region	3	2228.411	85.89437	5.792408	0.000	<0.0001
Year Area Month Mode Region Guild	5	2114.985	113.4256	7.649017	0.000	<0.0001
Year Area Month Mode Region Guild Area*Mode	2	2111.181	3.803854	0.256518	0.149	0.149281
Year Area Month Mode Region Guild Area*Month	14	2057.383	53.79882	3.627999	0.000	<0.0001
Year Area Month Mode Region Guild Year*Area	25	1999.174	58.20885	3.925395	0.000	0.000184
Year Area Month Mode Region Guild Year*Mode	24	1982.93	16.24417	1.095448	0.879	0.879062
Year Area Month Mode Region Guild Year*Guild	48	1899.67	83.25982	5.614742	0.001	0.001202
Year Area Month Mode Region Guild Year*Region	61	1783.989	115.6803	7.801065	0.000	<0.0001
Year Area Month Mode Region Guild Year*Month	185	1176.344	607.6452	40.97741	0.000	<0.0001

Table 5.3.1.3. Standardized abundance index for Gulf of Mexico greater amberjack for the MRFSS charterboat and private angler fisheries.

year	Index	LCI	UCI	Nominal
1985	1.19	0.21	6.84	0.19
1986	2.28	0.49	10.69	2.75
1987	4.20	1.01	17.50	5.81
1988	2.48	0.60	10.19	0.83
1989	4.56	1.50	13.86	0.92
1990	0.31	0.01	6.65	0.43
1991	0.66	0.13	3.45	1.04
1992	1.03	0.47	2.25	0.37
1993	1.42	0.30	6.76	1.41
1994	0.91	0.29	2.86	0.67
1995	1.40	0.15	12.97	3.09
1996	0.86	0.28	2.61	0.42
1997	0.57	0.08	4.20	0.69
1998	0.33	0.08	1.41	0.83
1999	0.07	0.02	0.24	0.26
2000	0.17	0.05	0.60	0.83
2001	0.35	0.16	0.77	0.78
2002	0.55	0.32	0.95	0.43
2003	0.49	0.25	0.95	0.72
2004	0.12	0.06	0.25	0.35
2005	0.13	0.06	0.29	0.46
2006	0.11	0.03	0.38	0.58
2007	0.15	0.05	0.41	0.50
2008	0.37	0.18	0.78	0.27
2009	0.30	0.09	1.05	0.38

Table 5.3.2.1. Stephens and MacCall (2004) regression coefficients for the Headboat fishery for species occurring in at least 1% of all trips and significant in the logistic regression.

Species	Parameter	Estimate	StdErr	LowerWaldCL	UpperWaldCL	ChiSq	ProbChiSq
Intercept	Intercept	0.8367	0.2725	0.3027	1.3707	9.4308	0.0021
sp1	sp1	0.4642	0.0251	0.4151	0.5133	343.2839	0.0000
sp10	sp10	0.9935	0.0218	0.9507	1.0363	2070.5314	0.0000
sp11	sp11	-0.3234	0.0219	-0.3663	-0.2805	218.1064	0.0000
sp116	sp116	0.1224	0.0263	0.0709	0.1739	21.6781	0.0000
sp117	sp117	-0.0588	0.0311	-0.1199	0.0022	3.5723	0.0588
sp121	sp121	-0.9022	0.0475	-0.9953	-0.8090	360.4868	0.0000
sp123	sp123	0.2883	0.0484	0.1936	0.3831	35.5587	0.0000
sp126	sp126	-1.0113	0.0361	-1.0821	-0.9406	785.6834	0.0000
sp129	sp129	0.4190	0.0907	0.2414	0.5967	21.3650	0.0000
sp139	sp139	0.0592	0.1067	-0.1499	0.2683	0.3078	0.5790
sp15	sp15	-1.1599	0.0476	-1.2531	-1.0666	594.6256	0.0000
sp16	sp16	-0.1773	0.0196	-0.2157	-0.1389	81.8836	0.0000
sp18	sp18	0.3542	0.0223	0.3106	0.3979	252.5503	0.0000
sp2	sp2	0.3852	0.0353	0.3161	0.4543	119.3808	0.0000
sp22	sp22	0.1552	0.0268	0.1026	0.2078	33.4545	0.0000
sp23	sp23	-0.7479	0.0344	-0.8153	-0.6806	473.9594	0.0000
sp230	sp230	0.1468	0.0263	0.0952	0.1983	31.1264	0.0000
sp231	sp231	-0.2344	0.0477	-0.3279	-0.1409	24.1488	0.0000
sp234	sp234	-0.6624	0.0522	-0.7648	-0.5600	160.8332	0.0000
sp254	sp254	0.4138	0.0678	0.2809	0.5467	37.2195	0.0000
sp26	sp26	-0.5259	0.0361	-0.5968	-0.4551	211.7318	0.0000
sp29	sp29	0.3175	0.0214	0.2756	0.3595	220.2580	0.0000
sp299	sp299	1.4070	0.1188	1.1742	1.6397	140.3404	0.0000
sp3	sp3	-0.0158	0.0404	-0.0950	0.0634	0.1522	0.6964
sp30	sp30	-0.8367	0.0239	-0.8835	-0.7898	1224.3557	0.0000
sp32	sp32	0.6713	0.0591	0.5555	0.7872	129.0853	0.0000
sp33	sp33	-0.5480	0.0639	-0.6733	-0.4227	73.4795	0.0000
sp34	sp34	0.3956	0.0423	0.3127	0.4784	87.5467	0.0000
sp38	sp38	0.4426	0.0469	0.3507	0.5344	89.1297	0.0000
sp47	sp47	0.0736	0.0451	-0.0148	0.1620	2.6644	0.1026
sp5	sp5	0.8100	0.0671	0.6784	0.9416	145.5267	0.0000
sp50	sp50	-1.6723	0.0391	-1.7489	-1.5957	1829.7301	0.0000
sp51	sp51	-0.0772	0.0294	-0.1348	-0.0195	6.8812	0.0087
sp55	sp55	0.9971	0.0245	0.9491	1.0451	1657.4705	0.0000
sp56	sp56	0.3928	0.0647	0.2661	0.5196	36.8821	0.0000
sp57	sp57	-0.3943	0.0835	-0.5580	-0.2307	22.2945	0.0000
sp6	sp6	0.3321	0.0534	0.2274	0.4368	38.6375	0.0000
sp62	sp62	-0.7770	0.0311	-0.8380	-0.7160	623.0436	0.0000
sp74	sp74	-0.0884	0.0196	-0.1268	-0.0499	20.3131	0.0000
sp77	sp77	-0.1514	0.0200	-0.1907	-0.1121	57.0408	0.0000
sp79	sp79	-0.2857	0.0439	-0.3717	-0.1997	42.3935	0.0000
sp81	sp81	-0.4578	0.0608	-0.5769	-0.3387	56.7437	0.0000
sp83	sp83	0.3121	0.0819	0.1516	0.4726	14.5234	0.0001

Table 5.3.2.1. (Continued). Stephens and MacCall (2004) regression coefficients for the Headboat fishery for species occurring in at least 1% of all trips and indicated in the logistic regression as being significant.

Species	Parameter	Estimate	StdErr	LowerWaldCL	UpperWaldCL	ChiSq	ProbChiSq
sp87	sp87	0.2905	0.0609	0.1712	0.4098	22.7699	0.0000
sp97	sp97	-0.6226	0.0385	-0.6981	-0.5471	261.0394	0.0000

Table 5.3.2.2. Deviance analysis for the headboat fishery.

Model factors positive catch rates values	degrees of freedom	Residual deviance	Change in deviance	% of total deviance	chi-sq	*p*
1		14734.24				
Year	23	13813.33	920.9044	27.89194	8.4346E-180	<0.0001
Year Area	7	12440.59	1372.743	41.57702	3.0481E-292	<0.0001
Year Area Month	11	12321.87	118.7183	3.595687	3.28167E-20	<0.0001
Year Area Month Area*Month	77	11916.36	405.507	12.28181	4.14593E-46	<0.0001
Year Area Month Year*Month	249	11515.05	401.3165	12.15489	3.05236E-09	<0.0001
Year Area Month Year*Area	138	11432.55	82.49765	2.498652	0.999950872	0.999950872
Model factors proportion of positive / total obs	**degrees of freedom**	**Residual deviance**	**Change in deviance**	**% of total deviance**	**chi-sq**	***p***
1		5874.301				
Year	23	5176.722	697.5793	21.67226	1.4362E-132	<0.0001
Year Area	7	3528.45	1648.272	51.20817	0	<0.0001
Year Area Month	11	3402.411	126.0389	3.915751	1.10003E-21	<0.0001
Year Area Month Area*Month	77	2915.82	486.5918	15.11734	9.18565E-61	<0.0001
Year Area Month Year*Month	253	2820.658	95.16116	2.956448	1	1
Year Area Month Year*Area	140	2655.535	165.1238	5.130034	0.072243952	0.072243952

Table 5.3.2.3. Standardized abundance index for Gulf of Mexico greater amberjack for the headboat fishery.

YEAR	Index	LCI	UCI	Nominal
1986	3.36	2.59	4.37	1.24
1987	2.13	1.48	3.05	1.23
1988	1.43	0.92	2.22	1.31
1989	1.63	1.08	2.48	1.20
1990	0.66	0.27	1.60	0.89
1991	0.71	0.33	1.56	0.99
1992	1.26	0.79	1.99	1.15
1993	0.78	0.40	1.51	1.05
1994	0.81	0.40	1.63	0.94
1995	0.85	0.43	1.66	0.95
1996	0.80	0.38	1.70	0.87
1997	0.69	0.31	1.54	0.89
1998	0.50	0.18	1.40	0.82
1999	0.59	0.23	1.56	0.94
2000	0.58	0.21	1.66	0.81
2001	0.67	0.29	1.53	0.98
2002	0.95	0.48	1.88	0.95
2003	1.22	0.73	2.05	1.09
2004	0.95	0.50	1.78	1.05
2005	0.62	0.26	1.52	0.90
2006	0.66	0.28	1.54	0.94
2007	0.42	0.13	1.37	0.77
2008	0.86	0.39	1.91	0.90
2009	0.87	0.48	1.60	1.13

Table 5.3.3.1. Stephens and MacCall (2004) regression coefficients for the commercial vertical line fishery for species occurring in at least 1% of all trips and indicated in the logistic regression as being significant.

Parameter	Estimate	StdErr	Lower WaldCL	Upper WaldCL	ChiSq	ProbChiSq
Intercept	-0.0876	0.3129	-0.7008	0.5256	0.0784	0.7794
sp3763	-0.6411	0.0463	-0.7319	-0.5504	191.6466	0.0000
sp3767	0.6264	0.0420	0.5442	0.7086	222.8221	0.0000
sp3762	-0.2749	0.0252	-0.3243	-0.2256	119.0807	0.0000
sp1422	-0.7655	0.0326	-0.8293	-0.7017	552.5503	0.0000
sp3761	0.6667	0.0512	0.5663	0.7670	169.4952	0.0000
sp1416	0.3256	0.0306	0.2656	0.3856	113.0497	0.0000
sp1441	0.7919	0.0716	0.6517	0.9322	122.4482	0.0000
sp1050	-0.4836	0.0509	-0.5834	-0.3838	90.2681	0.0000
sp1940	0.0037	0.0334	-0.0618	0.0691	0.0120	0.9127
sp4710	-0.8040	0.0753	-0.9515	-0.6564	114.0586	0.0000
sp0270	-0.5429	0.0562	-0.6530	-0.4327	93.3028	0.0000
sp1440	0.7914	0.0847	0.6253	0.9574	87.2690	0.0000
sp1790	-0.1911	0.1043	-0.3956	0.0134	3.3537	0.0671
sp1444	0.5455	0.1035	0.3426	0.7484	27.7680	0.0000
sp3765	-0.7686	0.0301	-0.8276	-0.7096	652.5910	0.0000
sp1414	-0.3523	0.0742	-0.4977	-0.2070	22.5621	0.0000
sp0570	-0.5330	0.0400	-0.6114	-0.4546	177.5738	0.0000
sp4561	-0.1776	0.0314	-0.2391	-0.1160	31.9419	0.0000
sp1415	-0.5887	0.0733	-0.7324	-0.4450	64.4899	0.0000
sp3764	0.5186	0.0307	0.4585	0.5787	286.1323	0.0000
sp4474	-0.0968	0.0869	-0.2672	0.0736	1.2386	0.2657
sp1810	-0.2335	0.0577	-0.3466	-0.1203	16.3623	0.0001
sp1442	0.3469	0.0693	0.2111	0.4827	25.0664	0.0000
sp3312	0.0007	0.0683	-0.1332	0.1346	0.0001	0.9921
sp3306	0.0291	0.0561	-0.0809	0.1391	0.2683	0.6045
sp1423	-0.3776	0.0321	-0.4405	-0.3147	138.4783	0.0000
sp3302	0.0548	0.0364	-0.0166	0.1262	2.2640	0.1324
sp3840	0.4440	0.0736	0.2997	0.5883	36.3864	0.0000
sp4740	-1.0472	0.0546	-1.1542	-0.9403	368.1381	0.0000
sp1424	-1.0372	0.0290	-1.0940	-0.9804	1281.0990	0.0000
sp1815	0.2767	0.0784	0.1230	0.4303	12.4530	0.0004
sp3308	0.2887	0.0825	0.1271	0.4503	12.2568	0.0005
sp4560	-0.4342	0.0800	-0.5911	-0.2773	29.4329	0.0000
sp3360	0.8090	0.1055	0.6022	1.0158	58.7852	0.0000
sp3455	-0.0101	0.0856	-0.1779	0.1577	0.0139	0.9063

Table 5.3.3.2. Deviance analysis for the commercial vertical line fishery.

Model factors positive catch rates values	degrees of freedom	Residual deviance	Change in deviance	% of total deviance	chi-sq	*p*
1		10995.44				
Year	16	10871.71	123.7256	4.727944	1.05216E-18	<0.0001
Year Area	21	10029.8	841.9187	32.17236	1.1628E-164	<0.0001
Year Area Month	11	9764.585	265.2115	10.13457	1.80966E-50	<0.0001
Year Area Month Year*Month	161	9121.349	643.236	24.58007	7.53104E-59	<0.0001
Year Area Month Area*Month	196	8697.7	423.6487	16.18894	8.03955E-19	<0.0001
Year Area Month Year*Area	256	8378.54	319.1604	12.19612	0.004410341	0.00441
Model factors proportion of positive / total obs	**degrees of freedom**	**Residual deviance**	**Change in deviance**	**% of total deviance**	**chi-sq**	***p***
1		4983.325				
Year	16	4816.641	166.6835	6.821905	3.85776E-27	<0.0001
Year Area	21	4067.046	749.5953	30.6789	4.3183E-145	<0.0001
Year Area Month	11	3167.615	899.4312	36.81128	8.217E-186	<0.0001
Year Area Month Area*Month	214	2824.657	342.9576	14.03633	5.04597E-08	<0.0001
Year Area Month Year*Area	285	2637.788	186.8692	7.64805	0.999998557	0.999999
Year Area Month Year*Month	175	2539.967	97.8207	4.003536	0.999999575	1

Table 5.3.3.3. Standardized abundance index for Gulf of Mexico greater amberjack for the commercial vertical line fishery.

YEAR	Index	LCI	UCI	Nominal
1993	1.28	0.89	1.85	1.20
1994	1.45	1.03	2.03	1.35
1995	1.66	1.18	2.34	1.23
1996	1.42	1.03	1.97	1.27
1997	1.48	1.10	1.98	1.34
1998	0.70	0.50	0.99	0.93
1999	0.84	0.60	1.17	1.01
2000	0.87	0.59	1.28	0.91
2001	0.76	0.52	1.11	0.85
2002	0.88	0.61	1.28	0.83
2003	1.14	0.80	1.64	1.00
2004	0.81	0.54	1.21	0.74
2005	0.71	0.48	1.05	0.85
2006	1.07	0.73	1.58	0.97
2007	0.86	0.55	1.35	0.99
2008	0.57	0.35	0.91	0.87
2009	0.49	0.27	0.87	0.66

Table 5.3.4.1. Stephens and MacCall (2004) regression coefficients for the commercial longline fishery for species occurring in at least 1% of all trips and as being significant.

Parameter	Estimate	StdErr	LowerWaldCL	UpperWaldCL	ChiSq	ProbChiSq
sp0570	-0.0854	0.0581	-0.1992	0.0284	2.1618	0.1415
sp1050	-0.3184	0.0710	-0.4575	-0.1794	20.1392	0.0000
sp1416	0.6095	0.0823	0.4481	0.7709	54.7829	0.0000
sp1422	-0.3179	0.0648	-0.4449	-0.1908	24.0479	0.0000
sp1442	-0.3889	0.0682	-0.5226	-0.2551	32.4697	0.0000
sp3312	-0.4592	0.1277	-0.7095	-0.2088	12.9205	0.0003
sp3763	-0.7504	0.0674	-0.8824	-0.6184	124.0722	0.0000
sp4470	-0.2281	0.0738	-0.3727	-0.0836	9.5681	0.0020
sp1424	-0.1605	0.0574	-0.2729	-0.0481	7.8317	0.0051
sp3306	-0.5308	0.1198	-0.7656	-0.2960	19.6362	0.0000
sp3508	0.0305	0.1084	-0.1820	0.2430	0.0792	0.7783
sp3762	-0.0562	0.0607	-0.1751	0.0627	0.8589	0.3540
sp1415	-0.3452	0.0807	-0.5033	-0.1871	18.3129	0.0000
sp3513	-0.2001	0.1064	-0.4087	0.0085	3.5353	0.0601
sp1411	0.1134	0.0731	-0.0300	0.2567	2.4036	0.1211
sp1423	-0.1092	0.0663	-0.2391	0.0208	2.7112	0.0996
sp3302	-0.4215	0.0625	-0.5440	-0.2991	45.5181	0.0000
sp3758	-0.3044	0.0750	-0.4514	-0.1574	16.4765	0.0000
sp3767	-0.1406	0.1473	-0.4293	0.1482	0.9103	0.3400
sp1414	-0.2788	0.0695	-0.4149	-0.1426	16.1101	0.0001
sp3761	0.0663	0.0959	-0.1217	0.2543	0.4779	0.4894
sp3757	-0.2603	0.1219	-0.4992	-0.0214	4.5612	0.0327
sp4474	-0.3647	0.0806	-0.5227	-0.2067	20.4721	0.0000
sp4710	-0.2593	0.0922	-0.4399	-0.0787	7.9192	0.0049
sp4740	-0.3037	0.0694	-0.4397	-0.1677	19.1564	0.0000
sp1426	-0.1924	0.1690	-0.5237	0.1389	1.2959	0.2550
sp3770	-0.5084	0.1271	-0.7575	-0.2594	16.0142	0.0001
sp3764	0.0401	0.0738	-0.1045	0.1848	0.2957	0.5866
sp3495	-0.0947	0.1754	-0.4384	0.2490	0.2915	0.5892
sp3765	-0.3131	0.0825	-0.4748	-0.1515	14.4105	0.0001
sp1410	0.1905	0.1835	-0.1692	0.5502	1.0771	0.2994
sp1810	0.7531	0.1809	0.3985	1.1077	17.3243	0.0000
sp1138	-0.2189	0.1424	-0.4980	0.0602	2.3628	0.1243
sp1412	-0.0406	0.1573	-0.3489	0.2677	0.0666	0.7963
sp4561	-0.2495	0.0743	-0.3952	-0.1039	11.2751	0.0008
sp3580	-0.0923	0.1410	-0.3687	0.1840	0.4291	0.5124
sp1550	-0.4109	0.0964	-0.5998	-0.2220	18.1719	0.0000
sp2959	0.0806	0.0907	-0.0972	0.2584	0.7897	0.3742
sp1440	-0.3185	0.1527	-0.6179	-0.0192	4.3499	0.0370
sp1811	0.9765	0.2206	0.5441	1.4089	19.5917	0.0000
sp1420	0.3426	0.1266	0.0945	0.5907	7.3263	0.0068
sp1815	1.2614	0.1966	0.8761	1.6467	41.1702	0.0000

Table 5.3.3.1. (Continued). Stephens and MacCall (2004) regression coefficients for the commercial longline fishery for species occurring in at least 1% of all trips and indicated in the logistic regression as being significant

Parameter	Estimate	StdErr	Lower WaldCL	Upper WaldCL	ChiSQ	ProbChiSq
sp4658	-0.3062	0.1214	-0.5441	-0.0683	6.3618	0.0117
sp5260	-0.2456	0.1409	-0.5217	0.0305	3.0399	0.0812
sp1940	-0.5161	0.1391	-0.7886	-0.2435	13.7707	0.0002
sp3295	-0.2037	0.2007	-0.5971	0.1897	1.0300	0.3102
sp4480	-0.9265	0.1878	-1.2946	-0.5584	24.3409	0.0000
sp3768	-0.2207	0.1894	-0.5919	0.1506	1.3573	0.2440
sp1144	-0.0718	0.1588	-0.3830	0.2395	0.2043	0.6512
sp3263	-0.4564	0.1923	-0.8332	-0.0795	5.6333	0.0176
sp0180	-0.6130	0.1861	-0.9778	-0.2483	10.8521	0.0010
Intercept	5.9821	0.7043	4.6017	7.3624	72.1460	0.0000

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Table 5.3.4.2. Deviance analysis for the commercial longline fishery.

Analysis of Positives								
Source	**Deviance**	**NumDF**	**DenDF**	**F-value**	**ProbF**	**ChiSq**	**ProbChiSq**	**Model Inclusion**
Intercept	2261.0464							
year	2183.5287	16	1219	3.393745	6.43E-06	54.29992	4.63188E-06	*** Yes**
AREA	2033.9636	20	1219	5.238394	7.54E-13	104.7679	1.74932E-13	***Yes**
month	2010.3592	11	1219	1.503136	0.124097	16.5345	0.122418975	
year*month	1788.7401	130	1260	1.200846	0.070159	156.1099	0.059057867	
AREA*month	1740.2262	171	1219	1.106572	0.179668	189.2238	0.161527642	
year*AREA	1610.5592	212	1178	1.379353	0.000724	292.4229	0.000207688	
Analysis of Proportion of Positives								
Source	**Deviance**	**NumDF**	**DenDF**	**F-value**	**ProbF**	**ChiSq**	**ProbChiSq**	
Intercept	1742.1832							
year	1667.2219	16	927	3.416767	6.22E-06	54.66828	4.03105E-06	*** Yes**
AREA	1515.953	20	927	5.515925	1.44E-13	110.3185	1.71815E-14	***Yes**
month	1498.6247	11	927	1.14884	0.319393	12.63724	0.317694507	
AREA*month	1271.1042	184	927	0.901781	0.807676	165.9278	0.826331106	
year*month	1251.384	133	978	1.452836	0.001237	193.2272	0.000505387	
year*AREA	1171.93	244	867	0.990535	0.529296	241.6905	0.529761722	

Table 5.3.5.1. Standardized abundance index for Gulf of Mexico greater amberjack for the commercial longline fishery.

YEAR	**Index**	**LCI**	**UCI**	**Nominal**
1993	0.49	0.05	4.73	0.84
1994	0.38	0.04	3.54	0.91
1995	0.71	0.12	4.36	0.82
1996	0.51	0.05	4.81	0.80
1997	0.71	0.14	3.62	0.80
1998	0.62	0.10	3.73	0.94
1999	0.76	0.15	3.97	0.99
2000	0.64	0.11	3.71	0.97
2001	0.76	0.16	3.53	1.06
2002	1.07	0.31	3.64	1.17
2003	1.39	0.53	3.68	1.15
2004	1.67	0.56	5.00	1.03
2005	1.64	0.55	4.94	1.10
2006	1.10	0.30	4.01	1.13
2007	1.06	0.26	4.39	1.06
2008	1.48	0.50	4.38	1.12
2009	2.01	0.67	6.08	1.09

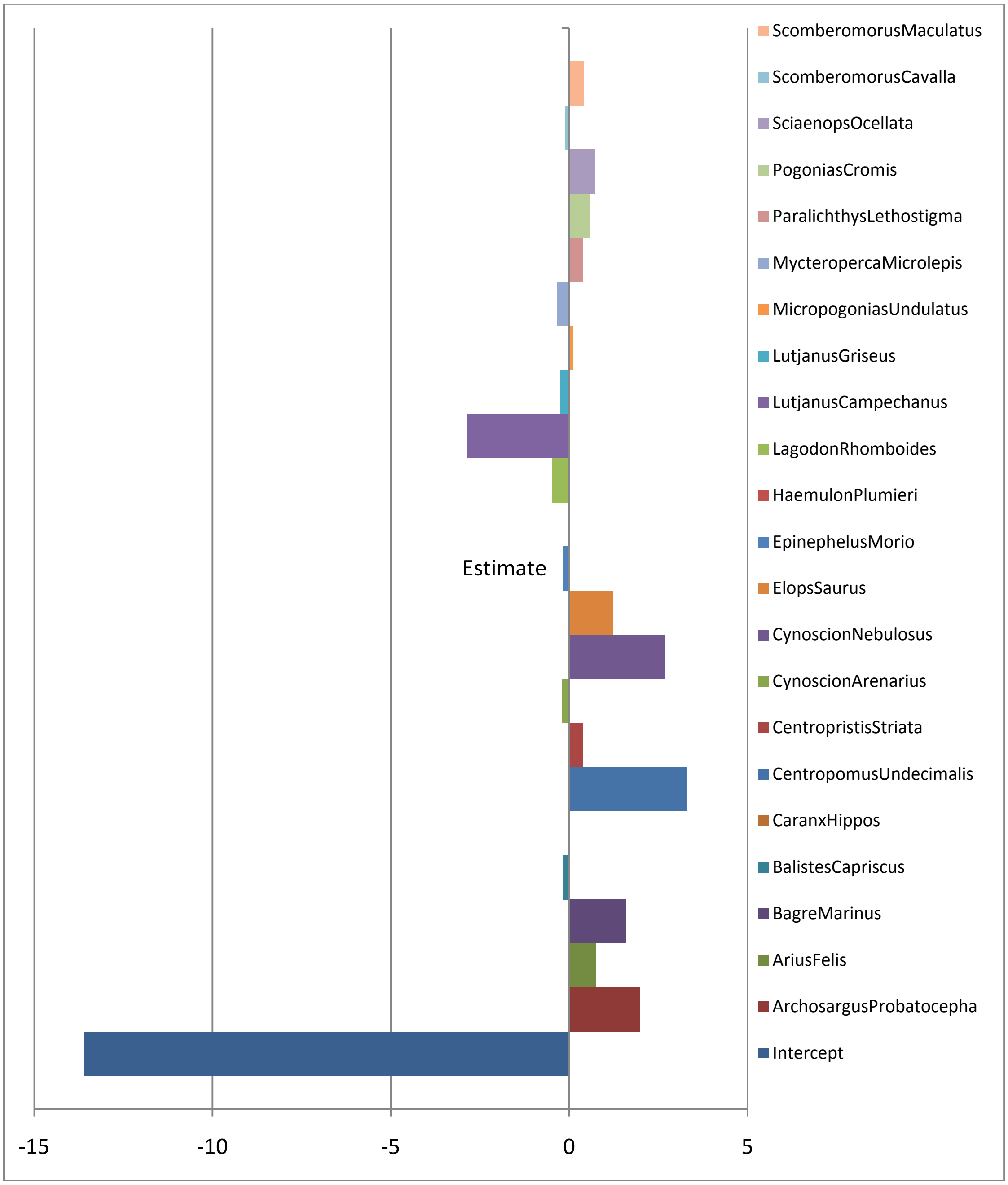

Figure 5.3.1.1. Stephens and MacCall (2004) reduction analysis results for the MRFSS charterboat and private angler fisheries.

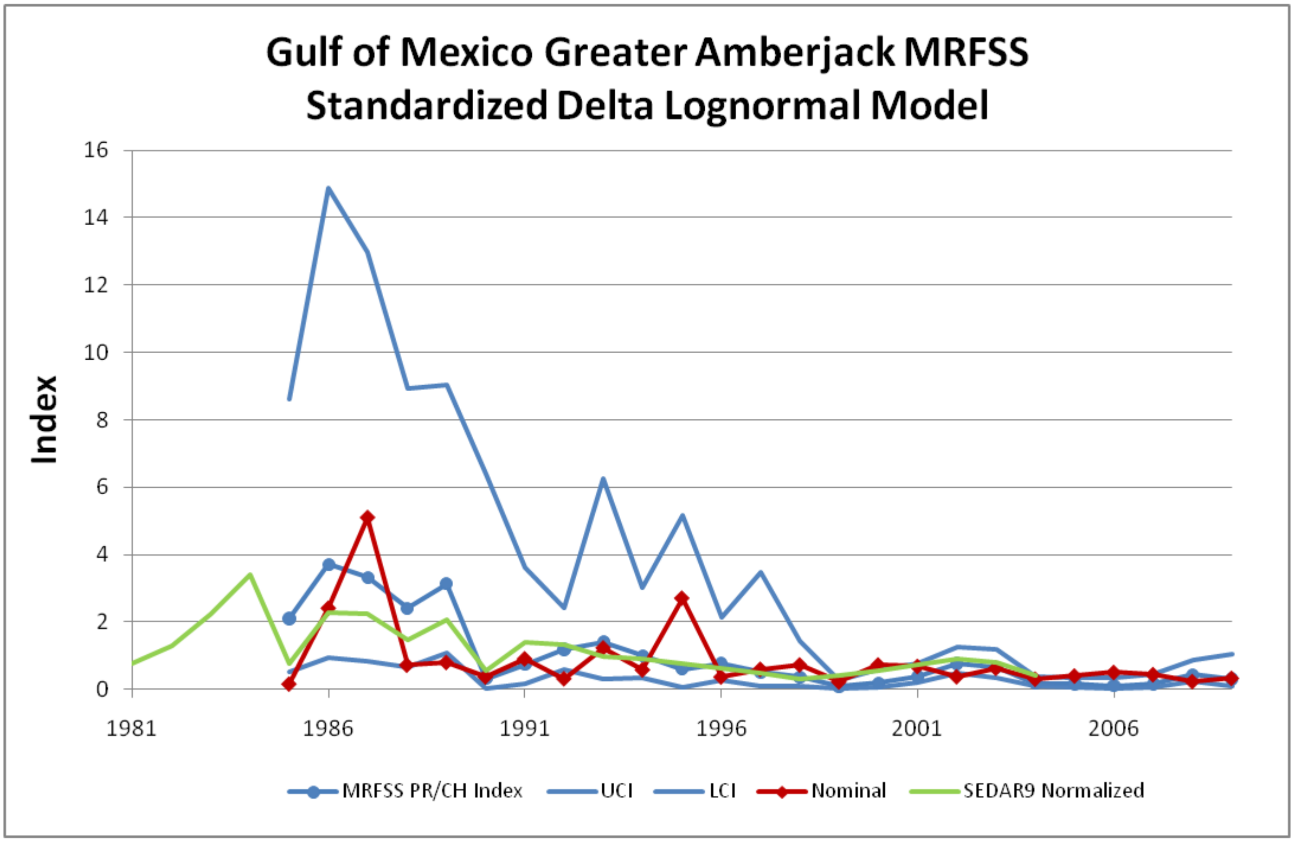

Figure 5.3.1.2. Estimated greater amberjack standardized index of abundance for the MRFSS charter and private angler fishery in the Gulf of Mexico. Updated standardized abundance index is contrasted with the previous SEDAR9 standardized index. All indices scaled to the mean of the overlapping series.

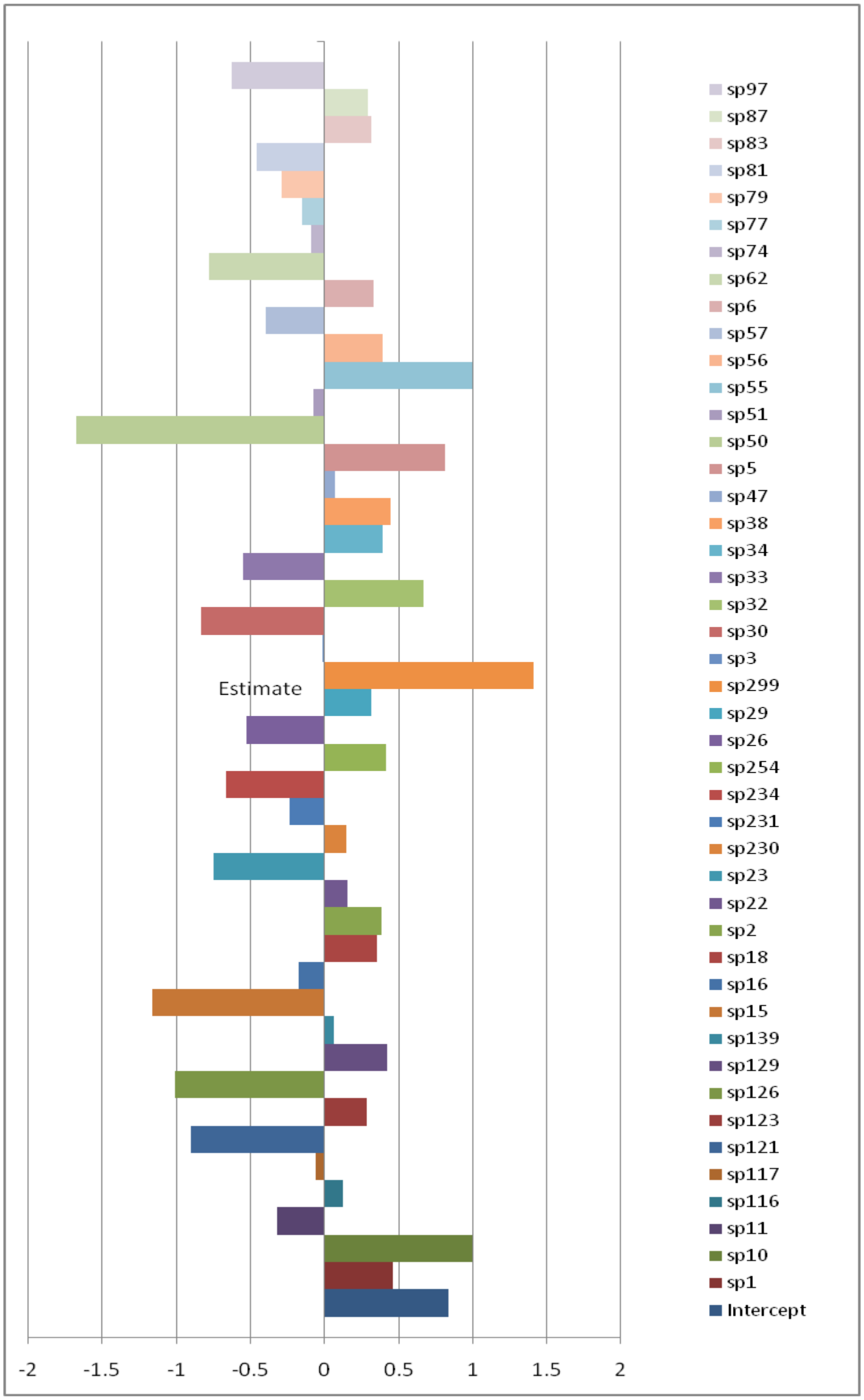

Figure 5.3.2.1. Stephens and MacCall (2004) results for greater amberjack for the headboat fishery.

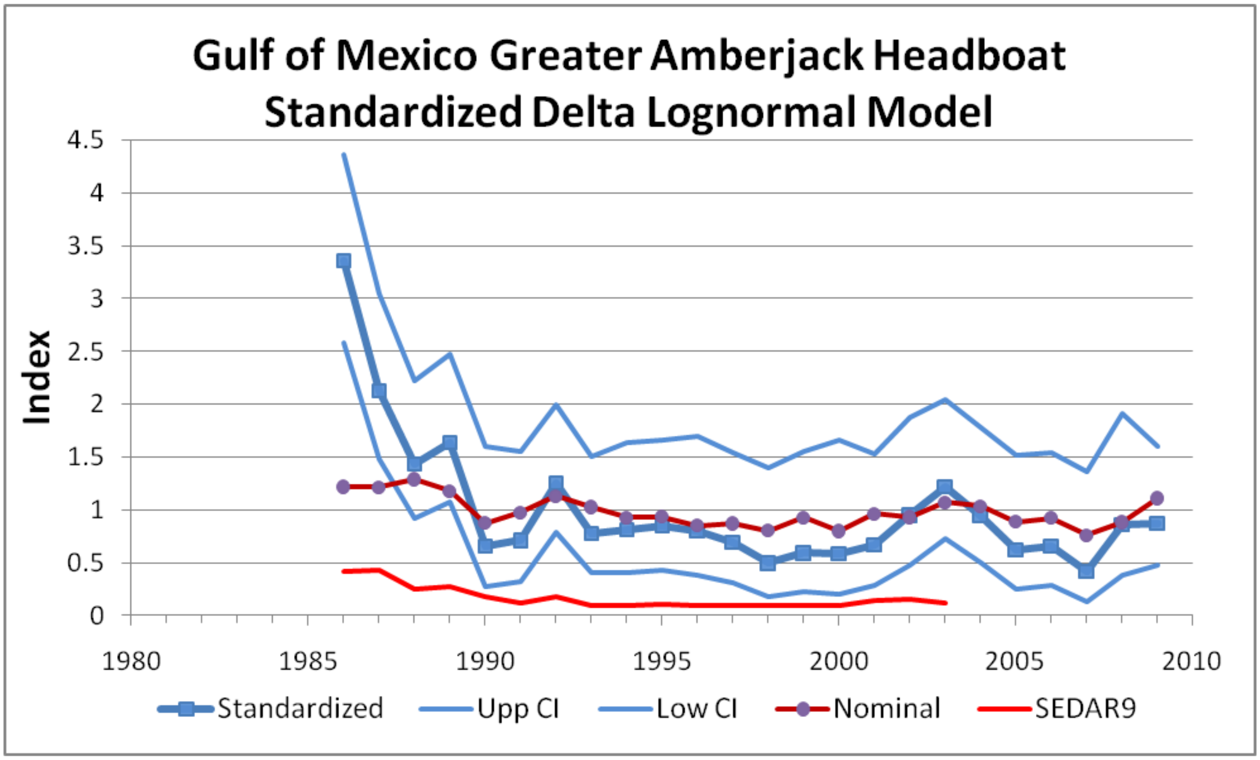

Figure 5.3.2. Estimated greater amberjack standardized index of abundance for the headboat fishery in the Gulf of Mexico. Updated standardized abundance index is contrasted with the previous SEDAR9 standardized index. All indices scaled to the mean of the overlapping series.

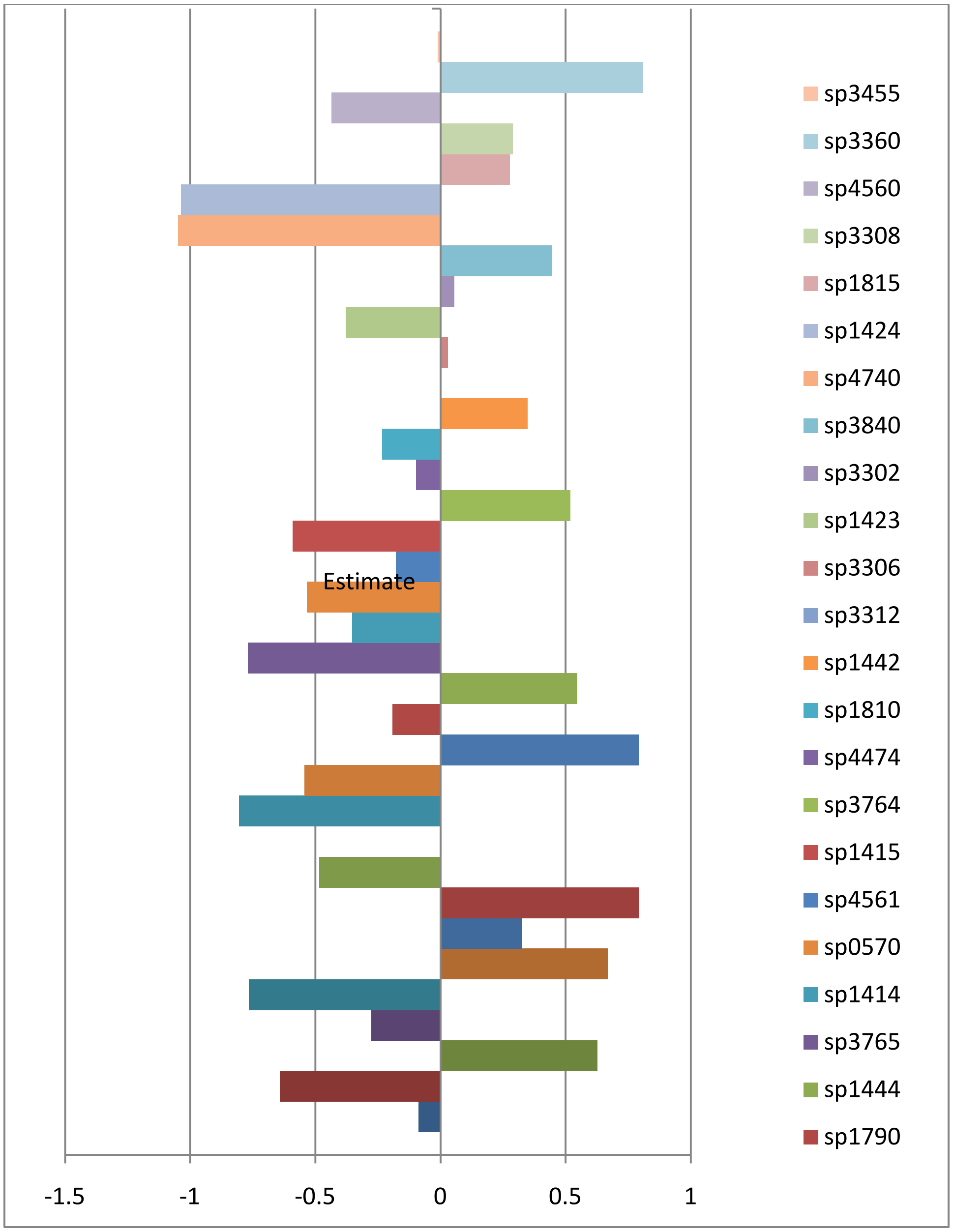

Figure 5.3.3.1. Stephens and MacCall (2004) analysis results for the commercial vertical line fishery.

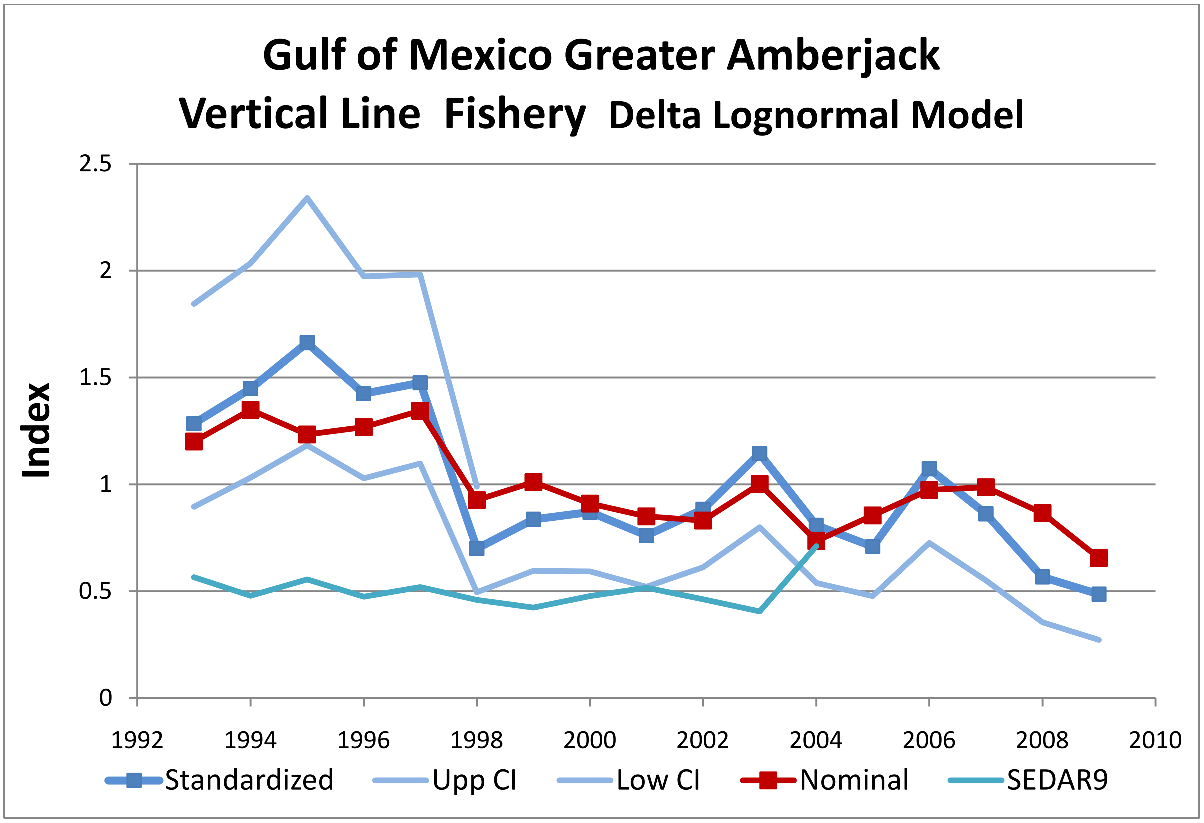

Figure 5.3.3.2. Estimated greater amberjack standardized index of abundance for the commercial vertical line fishery in the Gulf of Mexico. Updated standardized abundance index is contrasted with the previous SEDAR9 standardized index. All indices scaled to the mean of the overlapping series.

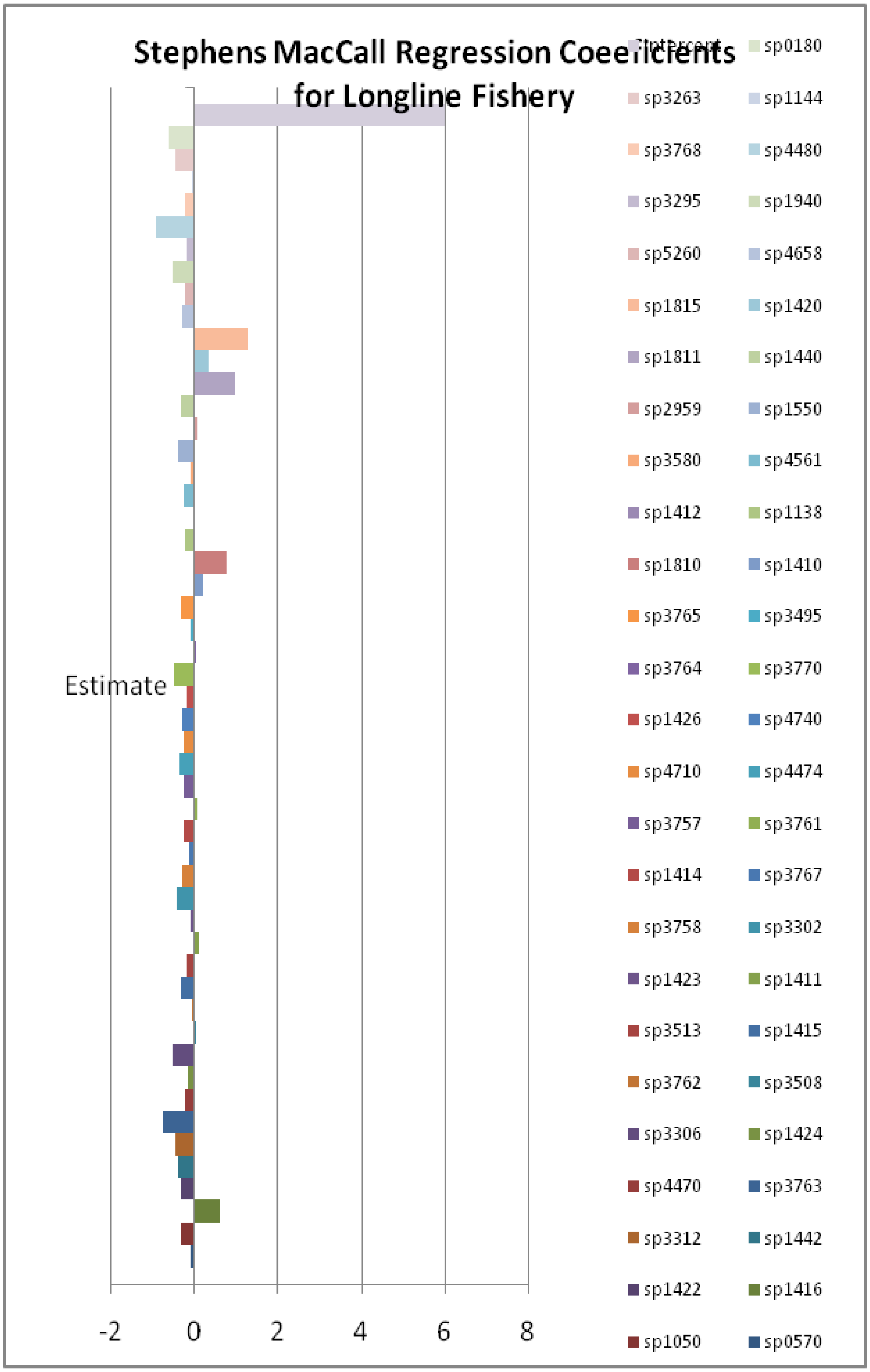

Figure 5.3.4.1. Stephens and MacCall (2004) reduction analysis results for the commercial longline fishery.

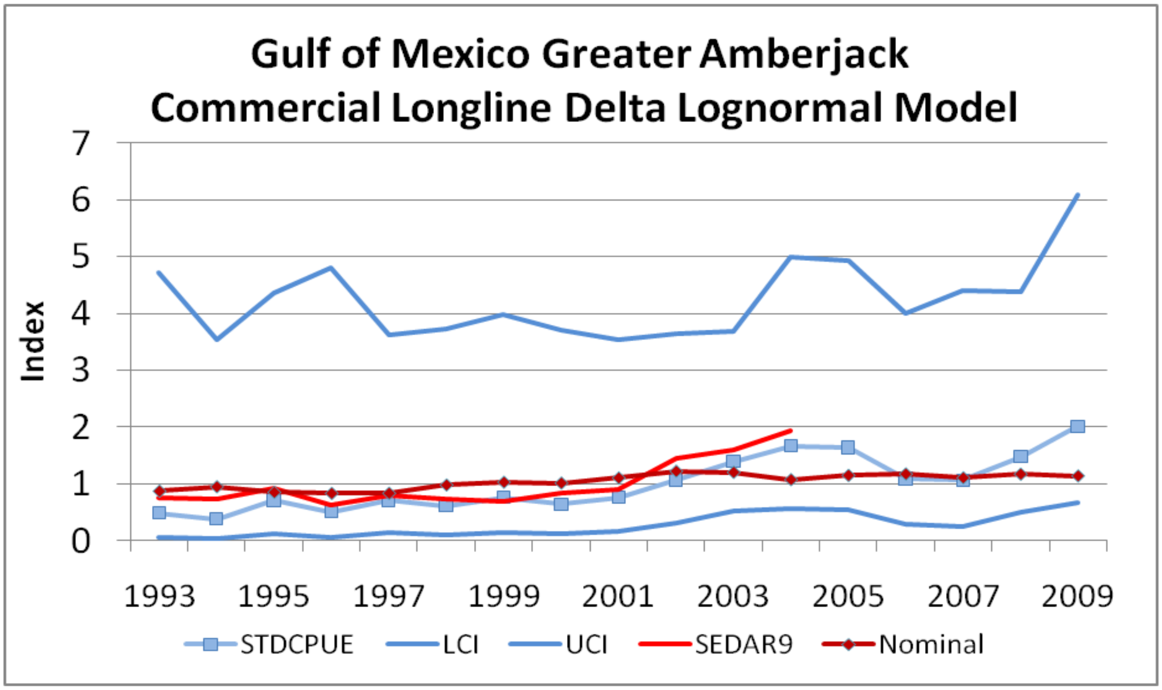

Figure 5.3.4.2. Estimated greater amberjack standardized index of abundance for the commercial longline fishery in the Gulf of Mexico. Updated standardized abundance index is contrasted with the previous SEDAR9 standardized index. All indices scaled to the mean of the overlapping series.

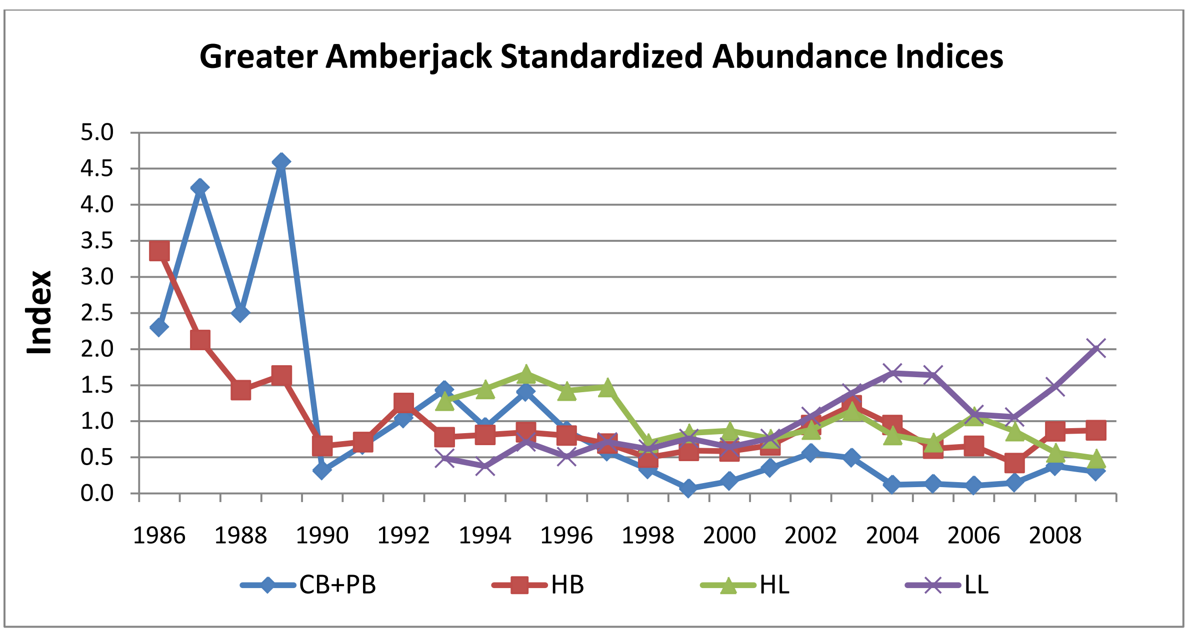

Figure 5.3.5.1. Gulf of Mexico greater amberjack standardized abundance indices for four fishery dependent data sets: MRFSS charter and private angler (CB+PB), NMFS Headboat Survey (HB), NMFS, SEFSC Coastal Logbook Commercial Vertical Line (HL), and the NMFS, SEFSC Coastal Logbook Commercial Longline (LL).

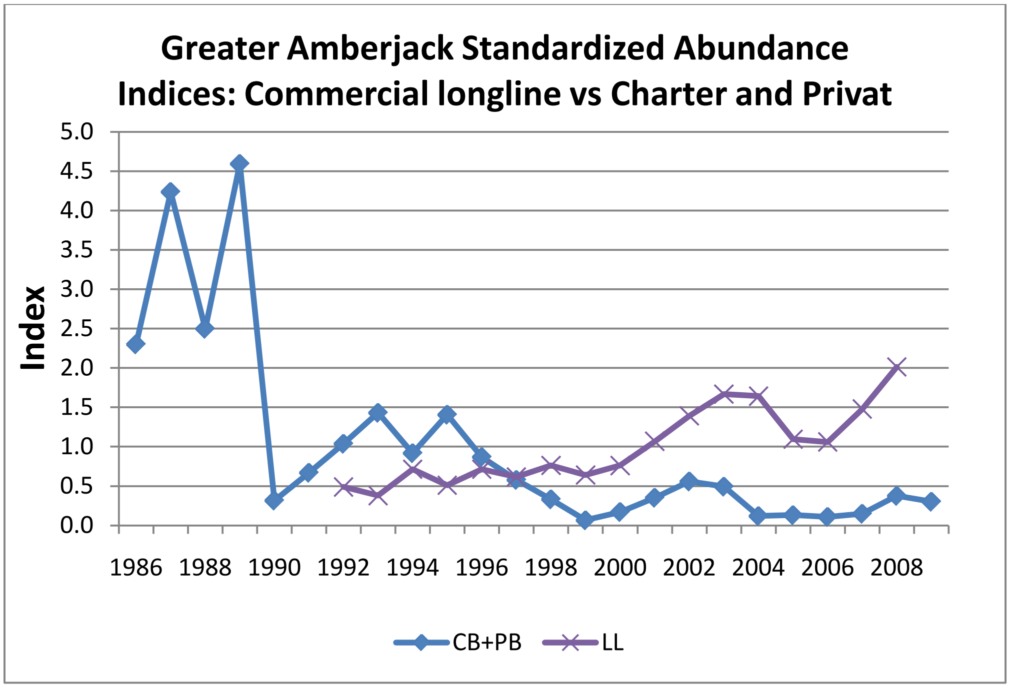

Figure 5.3.5.2. Gulf of Mexico greater amberjack standardized abundance indices for the commercial longline and the MRFSS charter and private angler (CB+PB) fishery data over time.

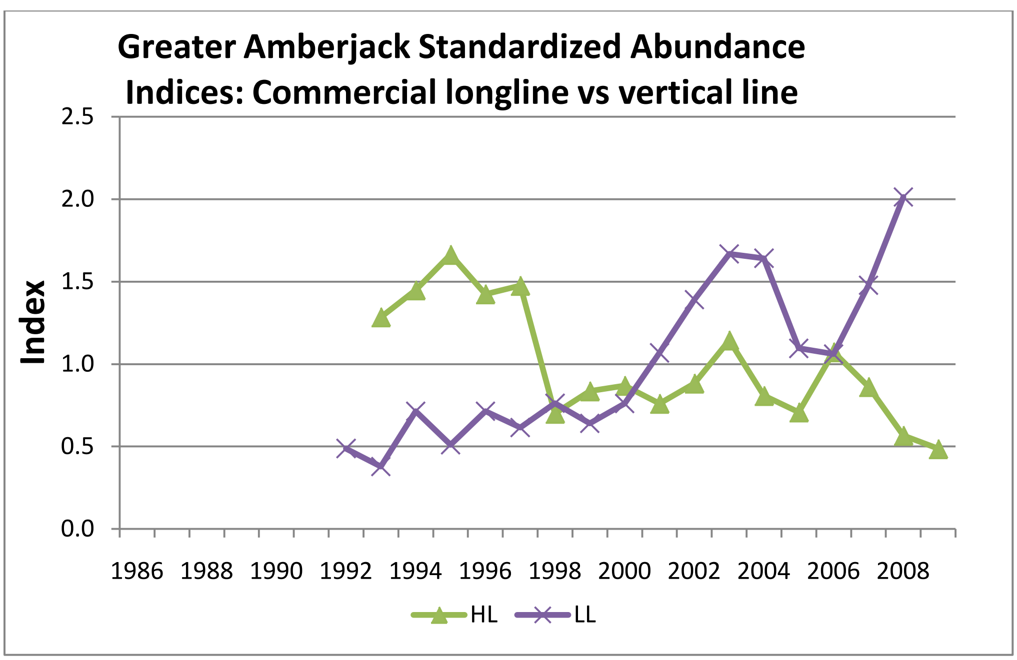

Figure 5.3.5.3. Gulf of Mexico greater amberjack standardized abundance indices for the commercial handline and commercial longline fisheries over time.

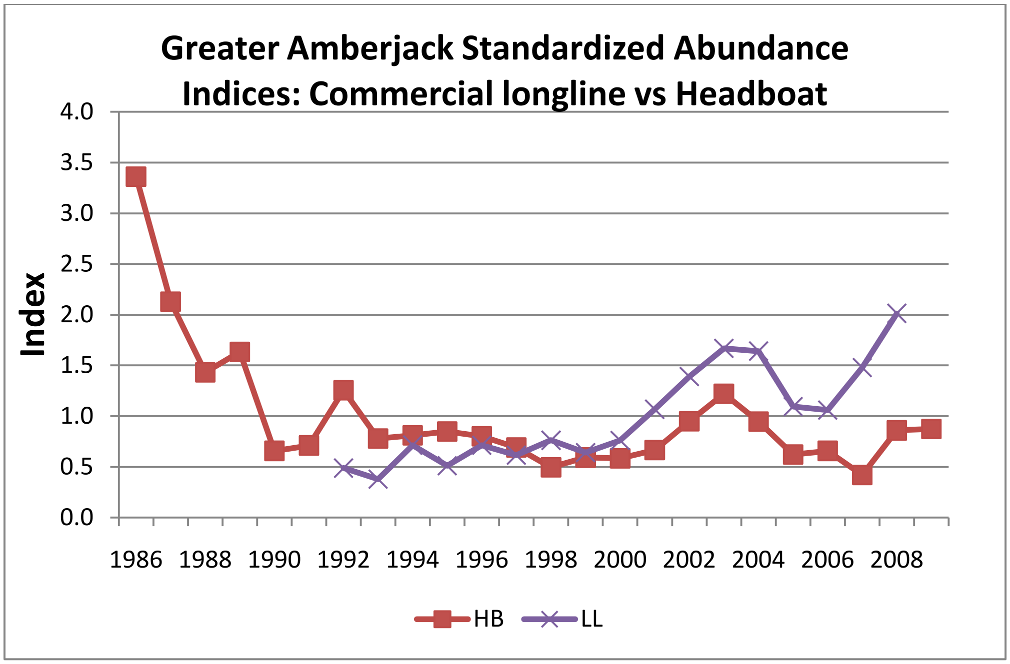

Figure 5.3.5.4. Gulf of Mexico greater amberjack standardized abundance indices for the commercial longline and Headboat fisheries over time.

6. Stock Assessment Analyses and Results

The previous greater amberjack stock assessment (Diaz et al. 2005, SEDAR9-AW5-REV) considered three stock assessment models for use in quantifying population status. The three models presented for SEDAR9 were a Virtual Population Analysis (VPA), a non-equilibrium surplus production model (ASPIC, Prager et al. 1996, Prager 1994), and a State-Space Age-Structured Production Model (SSASPM). The VPA was presented for continuity with the prior 2000 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. The ASPIC Stock Production model was the final preferred model selected for use by the SEDAR9 Stock Assessment Workshop in providing management advice (SEDAR9-RW).

Justification for selecting the ASPIC model as the preferred model for evaluating stock status of greater amberjack for the previous stock assessment was discussed in detail. Three main reasons were given in the SEDAR9-SAR (page 19) for preferring the ASPIC model over the VPA and SSAPSM. These were: 1) the Panel felt the level of uncertainty associated with the catch at age matrix (required as an input in both the VPA and the SSAPSM models) was sufficiently high to perpetuate high uncertainty in results from the VPA and SSAPSM models; 2) resulting selectivity vectors for ages 1-3 from the VPA and the SSAPSM models differed considerably; and, 3) resulting population status trends from the VPA and the SSAPSM were grossly different with one model (the VPA) indicating the stock was undergoing overfishing and was overfished in 2004 while the SSPASM model indicated the stock had never been overfished.

In summary, the SEDAR9 AW Panel felt that relying on a stock assessment model that was heavily dependent on age specific information introduced additional problems into determining stock status and therefore recommended the ASPIC model for use in providing management advice.

In the previous stock assessments (SEDAR9-SAR, 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 from using the length composition and a growth curve (age-slicing, which is done by inserting fish lengths into an inverted von Bertalanffy growth model). Using the deterministic age slicing 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.

For the 2010 assessment, since this was an "update assessment", the preferred model as recommended by the previous stock assessment RW Panel was used.

6.1 Surplus Production Model (ASPIC) Model Overview

In the 2010 SEDAR update, Version 5X (January 3 2007) of ASPIC Suite 5.X was used to fit a non-equilibrium production model conditioned on yield to the Gulf of Mexico greater amberjack data (SEDAR9-AW5-REV). The previous stock assessment determined that the simple form of the production model was appropriate. The ASPIC model also 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.

6.1.1 Data Sources

The updated fishery dependent indices developed for the recreational charter and private angler, headboat, and commercial vertical line, and commercial longline fisheries previously discussed in Section 5 were used to configure the ASPIC model. Table 6.1.1.1 and Figure 6.1.1.1 presents the fishery yields (landings and discards combined) developed for the SEDAR 2010 stock assessment Continuity Case (landings + 20% discard mortality).

Table 6.1.1.2 and Figure 6.1.1.2 presents estimated indices of abundance resulting from the GLM analyses and also the yields (landings and discards combined) for each fishery used as input for ASPIC model. The recreational charterboat-private boat fishery is the major contributor to the total landings of this species followed by the commercial handline fishery. Indices development and trends were previously discussed in Section 5 of this document.

The catch-CPUE series analyzed with ASPIC for the SEDAR 2010 update corresponded only to the period 1986-2009, because the condition on yield used on the ASPIC model requires catch information for each fishery for every year. Yield for the charterboat fishery is not available prior to 1986, although yield is available for the charterboat and headboat combined fisheries combined.

As discussed in Section 5 (Abundance Indices), the commercial longline index showed a tendency for departure from the trend of the recreational MRFSS charter and private angler index and the commercial vertical line index, particularly in later years. This tendency of incongruence between indices was observed for the last year of the SEDAR 9 indices. Table 6.1.1.3 presents the estimated pair wise correlations between four fishery indices of abundance. These differences in trends could be the result of differing selectivities between sectors, changes in recruitment, and/or spatial variability between sectors in fishing locations.

6.1.2 ASPIC Model Configuration and Parameters Estimated

For the SEDAR 2010 update, the Continuity case was defined as 1) assuming the logistic model applying equal index weightings, and 3) a B1/K fixed ratio equal to 0.5. The input yields which assumed a 20% release mortality rate (see Table 6.1.1.1) and the standardized abundance indices from the updated GLM analyses (Table 6.1.1.2) formed the data stream for the SEDAR 2010 greater amberjack Continuity Case. As discussed above, the four fisheries dependent data series were: the recreational charter and private angler, the headboat, the commercial vertical line, and the commercial longline fisheries. The ASPIC model requires initial values for the parameters being estimate: B1/K, MSY, K and fishery specific selectivities (q's). All initial runs were carried out allowing the program to estimate the above mentioned parameters. Prager et al. 1996 and Prager 1994 provide describe the parameter estimating equations and the model fitting process in detail.

6.1.3 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.

6.1.4 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. The bootstrap run was carried out using the Continuity Run scenario.

6.2 Surplus Production Model (ASPIC) Results Continuity Run

6.2.1 Measures of Overall Model Fit

The majority of the ASPIC runs of the production model showed no convergence problems. Figure 6.2.1.1.1 shows the observed CPUE series for each fishery and the predicted values by ASPIC for the Continuity case (Release mortality = 20%, equal weighting, initial B1/K value=0.5 fixed).

6.2.2 Parameter Estimates

For the 2010 update Continuity case, the B1/K ratio was set at 0.5 which assumes the greater amberjack population was at 50% of the virgin biomass at the beginning of the time series (i.e., in 1986). MSY was estimated to be about 4.9 million lbs, B_{MSY} 14.7 million lbs and maximum population size K 29.5 million lbs. Estimated F_{MSY} was 0.33 and current relative F (F_{2009}/F_{MSY}) was 1.83, current relative biomass (B_{2009}/B_{MSY}) was estimated at 0.31. Table 6.2.2.1 summarizes all parameters estimated by ASPIC for the base model.

6.2.3 Stock Biomass

For the Continuity case ASPIC run, virgin biomass (K) was estimated to be about 29.5 million lbs and B_{MSY} about 14.7 million lbs (50% of K by definition). At the beginning of the time series, biomass B_{MSY} was 14.7 million lbs and relative biomass $B_{1986}/B_{MSY=}$ = 1.0 (Figure 6.2.3.1.

Biomass declined from 1986 through 1989, increased slightly in 1990, and continued to decline through about 1997. The lowest level of biomass was reached around 1997 (B_{1997} = 4.2 million pounds, B_{1997}/B_{MSY} = 0.28). The stock experienced a brief period of recovery between 1997 and 2001 reaching a biomass of about 7 million lbs in 2001 (B_{2001}/B_{MSY}=0.48) thereafter declining again. However, the stock has remained overfished with a relative biomass B_{2009}/B_{MSY} = 0.31 (Figure 6.2.3.1). Figure 6.2.3.2 provides a comparison of the biomass and fishing mortality trajectory from the SEDAR9 stock assessment.

6.2.4 Fishing Mortality

For the Continuity case ASPIC Run, ASPIC estimated F_{MSY} = 0.33. These results suggest that the Gulf of Mexico greater amberjack stock has experienced overfishing conditions since at least 1986 (F_{1986} = 0.59, F_{1986}/F_{MSY} = 1.77), with the exception of 1990 (F_{1990} = 0.3, F_{1990}/F_{MSY} = 0.89). The model results show large variability in the trend of fishing mortality however, the overall trend in F remained relatively high until around the late 1990's (i.e., year = 1998, F_{1998} = 0.37, $F_{1998}/F_{MSY\,=}$ 1.1). This lower trend in F lasted only a brief period of time, around three years, thereafter more than doubling again by the mid 2000's. Between 2000 and 2004, F had increased to about 0.8 (F_{2004}/F_{MSY} = 2.4). In subsequent years estimated fishing mortality on greater amberjack has been slightly lower with average annual F = 0.57 and relative F's (F_{Year}/F_{MSY}) averaging around 1.7. (Figure 6.2.3.1).

6.2.5 Measures of Parameter Uncertainty

To quantify uncertainty around the parameter estimates bootstrap runs were made for the Continuity case as in SEDAR9. SEDAR9 results indicated that initial runs with 500 bootstraps showed no difference between the 10-90th and 50th percentiles when compared with 1000 bootstrap runs and showed results for the n=500 runs. For the update, runs were made using both 500 and 1,000 bootstrap runs. Since the amount of processing time did not produce a problem, results are shown here for the 1,000 bootstrap runs. Figure 6.2.3.1 above shows relative F (F_{Year}/F_{MSY}) and relative biomass (B_{Year}/B_{MSY}) and the estimated 10-90th percentiles. Estimated mean and median relative biomass and fishing mortality trajectories are also shown in Figures 6.2.5.1 and Figure 6.2.5.2. These two measures of central tendency are divergent in particular for the relative biomass trajectory.

6.3 <u>Retrospective and Sensitivity Analyses</u>

It was important to evaluate changes in the Continuity model run results also. Three different scenarios were evaluated and those results are presented below. Three sensitivity scenarios were considered. The fist scenario evaluated the effect on ASPIC model results to the selection of initial input values for the B1/K ratio. Sensitivity runs were made varying the input B1/K ratio as done in SEDAR9 and also varying the input landings data to reflect differing levels of assumed discard mortality (i.e., 0%, 20% (Continuity case), and 40%. The second sensitivity scenario evaluated using proportional index weighting and iterative re-weighting (IRF) of the indices in the model fitting. The sensitivity scenario considered the impact on ASPIC model results from substituting the SEDAR9 recreational landings data into the model vs those of the 2010 update. As in the previous stock assessment and in the initial trials (see Section 6.1.2 above), a penalty factor equal to 10.0 was applied to the objective function fitting process for B1/K ratios > 1.0 (see SEDAR9-SAR RW report). Further details for each of the three sensitivity scenarios and the results are presented below.

6.3.1 Sensitivity Scenario 1 Results: Varying Initial Input B1/K Ratio

The previous stock assessment investigated model performance and results by varying the initial input parameter values for the B1/K (ratio of initial biomass to total stock (K)). Values of the B1/K initial ratio considered for the SEDAR9 stock assessment were 0.2, 0.5, and 1.0. For the 2010 update assessment B1/K input ratio values considered were: 0.2, 0.4, 0.5, 0.6, 0.75, and 1.0. In addition, as in SEDAR9, a penalty term equal to 10.0 was applied to the fitting process for B1/K ratios > 1.0. Two additional levels of discard mortality (0% and 40%) were evaluated, given that 20% discard mortality was chosen for the Continuity case. ASPIC estimates of the primary benchmarks (i.e., B_1/K, MSY, K, and relative F and B for 2009) showed reasonable agreement between the base model and the sensitivities. Figure 6.3.1.1 illustrates that estimates of relative B_{MSY} and F_{MSY} trajectories are very similar between the 20% Continuity model and the discard mortality sensitivities.

Table 6.3.1.1 and Figure 6.3.1.1a, b summarizes the estimated parameters from ASPIC for the Continuity case (landings and 20% discard mortality) and the sensitivity scenario 1 runs with starting conditions for B1/K ratio ranging from 0.2 to 1.0 for release mortality 0% and 40%. Some of the ASPIC runs for the 40% discard mortality case resulted in parameter estimates hitting low bounds for the MSY parameter. In general however, the ASIPIC model produced similar values for the estimated parameters for sensitivity trials run with the 20% discard mortality rate and the 0% rate for the majority of the initial conditions set for B1/K. Results of the sensitivity around initial input values of B1/K for the 20% discard mortality case indicated that estimated carrying capacity K ranged from 16.5 to 37.3 million lbs, while MSY ranged from 2.6 to 6.2 million lbs.

In general, higher levels of release mortality resulted in higher estimates of K, MSY and FMSY and lower estimates of B_{MSY}; however, model performance (in terms of convergence at various starting values) was not as successful for the 40% discard runs, and one run of the 20% discard trials presented estimation problems for the MSY parameter. By assuming a release mortality of 40% for B1/K input values ranging from 0.2 to 0.4, ASPIC estimated the stock biomass at the beginning of the time series (1986) to be a relatively small proportion of the virgin biomass (K). These results are suspect as the estimate of the MSY parameter was at the lower bound (MSY parameter range set as min=5.0E+04 and max= 3.0E+12). 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.

Basically, higher levels of release mortality resulted in higher yields that required B1 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%). Figure 6.3.1.1a,b present the F/F_{MSY} and B/B_{MSY} trajectories for the sensitivity run with B1/K ratio input value=0.5.

6.3.2 Sensitivity Scenario 2 Proportional Index Weighting

The second sensitivity scenario evaluations considered the impact on ASPIC model results to the selection of index weighting methods applied in model fitting. In the initial trials and in sensitivity 1 evaluations (varying B1/K ratios and varying levels of discard mortality) equal index weighing was applied. In sensitivity 2, proportional index weighting (via the ASPIC FIT model mode) was used in the model fitting. All of the sensitivity 2 runs assumed: 1) 2010 continuity case landings + 20% discard mortality, 2) B1/K input ratios = 0.2, 0.5, 0.6, 0.75,0.8, 1.0, and 0.5 fixed B1/K ratio, and 3) B1/K ratio penalty factor = 10.0 applied as in SEDAR9 and the 2010 SEDAR update initial trials.

Index weights for the four fisheries proportional to the total catch contributions for the 2010 SEDAR update date series were calculated for 1997 forward as: charterboat + private angler fishery 66.1%, headboat fishery 4.14%, commercial vertical line fishery 27.21%, and commercial longline fishery 2.5%. The reference year (1997) selected for the previous stock assessment to calculate index weights from was 1997. The SEDAR9 panel felt that this year corresponded to the point in time when the fishery was more stable in terms of management measures. The proportional index weights corresponding to the four fisheries for the previous 2005 SEDAR9 stock assessment were: 1997 to 2004 = CB+PB 52.85, HB 4.42, HL 40.06 and LL 2.67.

Table 6.3.2.1 presents the results of ASPIC model sensitivity scenario 2 runs for the proportional index weighting options. In the FIT mode, the proportions are applied as weights and are unchanged in the fitting process. The estimation model uses the fishery specific residual from the respective fishery by the fishery specific proportional weight (see Prager 2004). In the proportional model fitting option (ASPIC FIT mode), the final index weights are however normalized for model output.

In general, the ASPIC model did not have difficulties finding a solution when the use of proportional index weighting was applied in the model fitting process. As indicated above, model results were evaluated for varying levels of input B1/K ratios (0.2, 0.5,0.6, 0.75, 0.8, 1.0, and 0.5 fixed) assuming: 1) the 2010 SEDAR updated landings +20% discards and 2) the B1/K penalty factor = 10.0 (as in SEDAR9 and the 2010 update trials). Parameter estimates for MSY hit the lower bound for the sensitivity scenario 2 run where B1/K fixed = 0.5 and run with B1/K = 1.0. The MSY parameter range for all ASPIC model parameters estimated was set for all the ASPIC trials and sensitivity scenario runs at the parameter bound search range used in the SEDAR9 ASPIC runs (MSY range= 5.0E+04 – 3.0E+12). The results for these two sensitivity scenario 2 runs are suspect. In addition, for the run with initial B1/K ratio = 0.2, the estimate for the selectivity parameter (q) for the Charterboat and Private angler fishery was equal to the starting guesstimate. The parameter bound range for the ASPIC search was initially set at that of the SEDAR9 ASPIC runs; however, when the starting estimate for the CH+PR q was modified to 1.0d-12, this resulted in a normal convergence run. These latter results (for the run with the modified starting guesstimate for CH+PR q) are also included in Table 6.3.2.1 for review.

The results of the sensitivity scenario 2 runs, evaluating the impact form proportional index weighting on the ASPIC model estimates (shown in Table 6.3.2.1), suggest that as observed in the previous SEDAR9 stock assessment index weighing choices do have an effect on ASPIC model results for the greater amberjack data. In general, the ASPIC model produced (for the runs with normal convergence) higher and more variable estimates of the K, MSY, and B/B_{MSY} than estimated for either the initial ASPIC trials (Table 6.2.2.1) or the ASPIC sensitivity 1 trials (Table 6.3.2.1). Estimates of the B1/K parameter were >1.0 (range= 1.2 to 2.5) for the entire set of sensitivity scenario 2 runs and, in general, most runs produced estimates of B1/K ratio >2.0, which seem unreasonable give the lengthy and extensive history of exploitation for this stock, which dates back to the mid 1950's. In general, the high variability between runs in ASPIC parameter estimates of K, MSY, and B1/K produced high uncertainty in the determination of the stock condition (Figures 6.3.2.1a,b,c). The previous SEDAR9 stock assessment and this 2010 update assumed a B1/K penalty factor of 10.0 for model fitting. It is recommended that future stock assessments evaluating the ASPIC model also evaluate other penalty terms into model fitting process.

6.3.3 Sensitivity Scenario 3 Results: Substitution of SEDAR9 Recreational Landings for the 2010 Update Landings in the ASPIC model

The third sensitivity scenario considered evaluated the impact on ASPIC model results of the observed differences in the SEDAR9 recreational landings estimates and that of the 2010 update. The procedures were: 1) substitute the SEDAR9 estimated recreational CH+PR fishery landings for 1986-2004 into the model input yield stream, 2) assume 2010 estimated CH+PR landings for 2005-2009, 3) assume 2010 estimated landings for Headboat and Commercial vertical line and longline fisheries, 4) evaluate results varying B1/K ratios of 0.2, 0.5 and 1.0, 3) and apply equal index weighting in the model fitting, and5) apply the B1/K penalty term=10.0 (as in SEDAR9 and the Continuity case and Sensitivity 1 runs). Table 6.3.3.1 presents the results of ASPIC runs for sensitivity scenario 3 and also provides comparison ASPIC results using the full updated data set for the B1/K ratio fixed at 0.5 and previous SEDAR9 initial base run (B1/K fixed at 0.5). In addition, estimates of relative biomass (B/B_{MSY}) as determined by the model runs for the year 2004 are presented for comparison across runs.

The ASPIC sensitivity scenario 3 runs resulted in normal convergence across the three levels of B1/K (0.2, 0.5, and 1.0). ASPIC estimates of MSY, K, and B_{MSY} were in general similar for two of the runs assuming B1/K =0.5 and 1.0. Although the sensitivity run at B1/K = 0.2 reached normal convergence, the parameter estimates for MSY, K and B_{MSY} for this trial differed from the two other sensitivity scenario 3 runs at 0.5 and 1.0, and also that of the SEDAR9 base trial run as well as the 2010 update run at B1/K=0.2.

A comparison of ASPIC estimates of relative biomass (B/B_{MSY}) and relative F (F/F_{MSY}) for the year 2004 from the sensitivity scenario 3 runs, evaluating the impact from the differences in the updated recreational landings estimates with those of the previous assessment, does not reveal major differences with regard to the condition of the stock for the year in the previous stock assessment time series. The results generally indicate that the relative biomass for 2004 was below biomass at MSY, ranging from 0.26 to 0.44 of B/B_{MSY}. The previous SEDAR9 stock assessment estimated relative biomass (B/B_{MSY}) to be 0.71 for the year 2004. The updated 2010 stock assessment ASPIC run (for B1/K=0.5) estimated relative biomass (B/B_{MSY}) to be 0.38 for year 2004.

Table 6.1.1.1 Calculated total commercial and recreational landings and discards for the Gulf of Mexico greater amberjack stock assessment continuity case, assuming 20% discard mortality rate. Units are whole weight (pounds).

Greater Amberjack	**Estimated Landings and discards, 20% Release Mortality Rate, Units = whole weight in pounds**			
Year	**Charter + Private**	**Headboat**	**Vertical Line+**	**Longline**
1986	5,787,242	826,192	917,262	199,085
1987	4,543,296	401,052	1,303,596	252,250
1988	2,150,945	174,803	1,730,482	325,157
1989	3,838,938	254,731	1,656,123	299,256
1990	1,132,616	172,090	1,133,367	125,697
1991	3,641,147	133,155	1,857,299	6,143
1992	2,735,841	391,114	1,016,471	51,505
1993	3,449,270	279,272	1,583,371	83,889
1994	1,797,078	242,886	1,265,874	68,991
1995	915,035	161,056	1,241,662	82,329
1996	1,309,048	164,530	1,281,454	57,001
1997	1,130,605	129,629	1,128,084	59,580
1998	783,722	112,882	715,974	54,824
1999	987,920	92,461	791,105	61,583
2000	1,302,711	113,093	916,750	69,996
2001	2,701,177	125,294	753,742	45,505
2002	2,657,085	189,545	803,135	77,348
2003	3,035,576	215,332	960,508	127,092
2004	2,811,945	115,991	961,695	81,351
2005	1,739,045	67,529	708,604	72,039
2006	1,721,208	86,544	574,816	79,336
2007	1,478,989	64,929	586,933	60,367
2008	1,898,731	85,673	443,039	90,609
2009	1,942,622	117,491	613,505	55,013

Table 6.1.1.2. Input yields and abundance indices by fishery included in the ASPIC model.

Year	Index CB+PR	Yield CB+PR	Index HB	Yield HB	Index Vertical Line+	Yield Vertical Line+	Index Longline	Yield Longline
1986	2.2997	5,787,242	3.3605	826,192		917,262		199,085
1987	4.2345	4,543,296	2.1283	401,052		1,303,596		252,250
1988	2.4965	2,150,945	1.4316	174,803		1,730,482		325,157
1989	4.5908	3,838,938	1.6344	254,731		1,656,123		299,256
1990	0.3163	1,132,616	0.6577	172,090		1,133,367		125,697
1991	0.6691	3,641,147	0.7115	133,155		1,857,299		6,143
1992	1.0370	2,735,841	1.2551	391,114		1,016,471		51,505
1993	1.4302	3,449,270	0.7788	279,272	1.2850	1,583,371	0.4881	83,889
1994	0.9176	1,797,078	0.8100	242,886	1.4484	1,265,874	0.3785	68,991
1995	1.4060	915,035	0.8488	161,056	1.6632	1,241,662	0.7145	82,329
1996	0.8684	1,309,048	0.8017	164,530	1.4245	1,281,454	0.5108	57,001
1997	0.5784	1,130,605	0.6914	129,629	1.4756	1,128,084	0.7137	59,580
1998	0.3318	783,722	0.4967	112,882	0.7006	715,974	0.6151	54,824
1999	0.0659	987,920	0.5922	92,461	0.8365	791,105	0.7623	61,583
2000	0.1708	1,302,711	0.5835	113,093	0.8701	916,750	0.6407	69,996
2001	0.3519	2,701,177	0.6656	125,294	0.7611	753,742	0.7605	45,505
2002	0.5586	2,657,085	0.9498	189,545	0.8835	803,135	1.0681	77,348
2003	0.4927	3,035,576	1.2202	215,332	1.1446	960,508	1.3909	127,092
2004	0.1193	2,811,945	0.9471	115,991	0.8085	961,695	1.6677	81,351
2005	0.1311	1,739,045	0.6217	67,529	0.7090	708,604	1.6416	72,039
2006	0.1083	1,721,208	0.6578	86,544	1.0732	574,816	1.0950	79,336
2007	0.1483	1,478,989	0.4204	64,929	0.8627	586,933	1.0604	60,367
2008	0.3754	1,898,731	0.8601	85,673	0.5674	443,039	1.4786	90,609
2009	0.3012	1,942,622	0.8750	117,491	0.4863	613,505	2.0134	55,013

Table 6.1.1.3 Estimated pair wise correlations for four greater amberjack fishery indices.

Index	**CH+PR**	**HB**	**Com_HL**	**Com_LL**
CH-PR	1.0			
HB	0.691	1.0		
Com_HL	0.746	0.193	1.0	
Com_LL	-0.507	0.349	-0.629	1.0

Table 6.2.2.1. Estimated parameters from the ASPIC Continuity Run (landings + 20 % discards, equal index weighting, B1/K=0.5). The q parameter corresponds to estimated selectivities for the commercial handline (HL), commercial longline (LL), recreational headboat (HB) and recreational charterboat and private angler fisheries (CB+PR).

Parameter	**Estimate**
B1/K	5.00E-01
MSY	4.90E+06
K	2.95E+07
q_HL	1.869E-07
q_LL	1.756E-07
q_HB	1.432E-07
q_CB&PB	8.703E-08
B_{MSY}	1.47E+07
F_{MSY}	3.33E-01
B/B_{MSY}	3.11E-01
F/F_{MSY}	1.83E+00
F_{MSY}/F_{2009}	5.46E-01

Table 6.3.1.1 ASPIC estimated parameter values for six sensitivity scenario 1 runs evaluating varying levels of input values of B1/K ratios (0.2, 0.4, 0.5, 0.6, 0.75, and 1.0) for three levels of discard mortality (0%, 20%, and 40%). Estimates shaded gray are questionable.

Case		Initial Input Value for B1/K Ratio					
Discard Mortality	Estimated Parameters	0.2	0.4	0.5	0.6	0.75	1
0%	B1/K	1.755E-01	1.035E+00	5.000E-01	6.164E-01	1.497E+00	1.37E+00
	MSY	9.749E+06	3.633E+06	4.841E+06	4.291E+06	4.649E+08	7.12E+08
	K	6.187E+07	1.531E+07	2.092E+07	1.933E+07	4.818E+09	4.78E+09
	B_{MSY}	3.093E+07	7.657E+06	1.046E+07	9.667E+06	2.409E+09	2.39E+09
	F_{MSY}	3.152E-01	4.745E-01	4.629E-01	4.439E-01	1.930E-01	2.98E-01
	$B(2009)/B_{MSY}$	1.155E-01	3.938E-01	2.696E-01	3.120E-01	1.998E+00	2.00E+00
	$F(2009)/F_{MSY}$	2.016E+00	1.528E+00	1.689E+00	1.648E+00	2.395E-03	1.56E-03
	FMSY/F(2009)	4.961E-01	6.545E-01	5.922E-01	6.070E-01	4.175E+02	6.39E+02
	Contrast (Ideal = 1.0)	0.1296	0.9030	0.4087	0.5088	0.4979	0.3704
	Nearness Index (Ideal =1.0)	0.6755	1.0000	1.0000	1.0000	0.5013	0.5010
	Objective function	3.020E+00	2.828E+01	2.890E+01	2.887E+01	4.033E+01	4.119E+01
	Model Performance	Normal Convergence	Normal Convergence	Normal Convergence	Normal Convergence	Normal Convergence	Normal Convergence

Table 6.3.1.1. Continued (Sensitivity Scenario 1: Evaluating Varying B1/K Ratio Input Values) Values and three levels of discard mortality.

Case		Initial Input Value for B1/K Ratio					
Discard Mortality	Estimated Parameters	0.2	0.4	0.5	0.6	0.75	1
20%	B1/K	3.767E-01	2.861E-02	1.176E+00	1.175E+00	1.064E+00	1.176E+00
	MSY	6.162E+06	5.000E+04	2.647E+06	2.650E+06	4.046E+06	2.647E+06
	K	2.973E+07	4.415E+09	3.734E+07	3.729E+07	1.651E+07	3.733E+07
	B_{MSY}	1.486E+07	2.207E+09	1.867E+07	1.865E+07	8.256E+06	1.867E+07
	F_{MSY}	4.145E-01	2.265E-05	1.418E-01	1.421E-01	4.901E-01	1.418E-01
	B(2009)/B_{MSY}	2.462E-01	1.878E-02	5.985E-01	5.979E-01	4.345E-01	5.983E-01
	F(2009)/F_{MSY}	1.824E+00	3.005E+03	1.766E+00	1.766E+00	1.544E+00	1.766E+00
	FMSY/F(2009)	5.482E-01	3.327E-04	5.662E-01	5.664E-01	6.475E-01	5.661E-01
	Contrast (Ideal = 1.0)	0.2814	0.0198	0.8914	0.8902	0.9007	0.8913
	Nearness Index (Ideal =1.0)	0.8767	0.5286	1	1.0000	1.0000	1.0000
	Objective function	3.309E+01	3.360E+01	31.7756176	3.178E+01	3.203E+01	3.178E+01
	Model Performance	Normal Convergence	MSY Parm. Estimate hit low bound	Normal Convergence	Normal Convergence	Normal Convergence	Normal Convergence

Table 6.3.1.1. Continued (Sensitivity Scenario 1: Evaluating Varying B1/K Ratio Input Values and three levels of discard mortality.

Case		Initial Input Value for B1/K Ratio					
Discard Mortality	Estimated Parameters	0.2	0.4	0.5	0.6	0.75	1
40%	B1/K	1.05E-01	1.37E-01	7.717E-01	1.942E-01	1.096E+00	4.48E-01
	MSY	5.00E+04	5.00E+04	4.719E+06	5.001E+04	4.096E+06	5.99E+06
	K	1.28E+09	9.77E+08	2.211E+07	6.873E+08	2.404E+07	2.76E+07
	B_{MSY}	6.40E+08	4.89E+08	1.106E+07	3.436E+08	1.202E+07	1.38E+07
	F_{MSY}	7.82E-05	1.02E-04	4.268E-01	1.455E-04	3.407E-01	4.35E-01
	B(2009)/B_{MSY}	6.61E-02	8.62E-02	3.762E-01	1.226E-01	4.394E-01	2.74E-01
	F(2009)/F_{MSY}	8.94E+02	6.85E+02	1.597E+00	4.814E+02	1.592E+00	1.75E+00
	FMSY/F(2009)	1.12E-03	1.46E-03	6.262E-01	2.077E-03	6.281E-01	5.72E-01
	Contrast (Ideal = 1.0)	0.0738	0.0965	0.6215	0.1370	0.9109	0.3380
	Nearness Index (Ideal =1.0)	0.6046	0.6367	1.0000	0.1370	1.0000	0.9480
	Objective function	3.30E+01	3.30E+01	3.015E+01	3.302E+01	2.954E+01	3.122E+01
	Model Performance	MSY Parm. Estimate hit low bound	MSY Parm. Estimate hit low bound	Normal Convergence	MSY Parm. Estimate hit low bound	Normal Convergence	Normal Convergence

Table 6.3.2.1. ASPIC estimated parameter values for the sensitivity 2 scenario, evaluating proportional index weighting on ASPIC parameter estimates. Seven levels of input B1/K ratio evaluated (0.2, 0.5,0.6, 0.75, 0.8 and 1.0) for the 2010 continuity case landings + 20% discard mortality level. Estimates shaded gray are questionable.

Initial B1/K Value, Proportional Index Weighting										
Discard Mortality	**Estimated Parameters**	**0.2**	**0.2***	**0.5**	**0.6**	**0.75**	**0.8**	**1.0**	**B1K=0.5 fixed**	**SEDAR 2010 Update, B1/K fixed=0.5 (Table 6.3.2.1)**
20%	**B1/K**	1.95E+00	2.48E+00	2.42E+00	2.05E+00	1.72E+00	1.41E+00	1.01E+00	0.5	0.5
	MSY	1.04E+08	1.37E+08	5.18E+07	2.78E+08	5.19E+08	7.57E+08	5.00E+04	5.00E+04	4.898E+06
	K	4.41E+09	6.09E+09	2.36E+09	8.53E+09	4.58E+09	3.24E+09	9.63E+07	1.96E+08	2.946E+07
	B_{MSY}	2.21E+09	3.05E+09	1.18E+09	4.27E+09	2.29E+09	1.62E+09	4.82E+07	9.77E+07	1.473E+07
	F_{MSY}	4.73E-02	4.49E-02	4.38E-02	6.52E-02	2.27E-01	4.67E-01	1.04E-03	5.12E-04	3.33E-01
	B(2009)/B_{MSY}	2.11E+00	2.16E+00	2.15E+00	2.05E+00	2.00E+00	2.00E+00	2.82E-01	1.39E-01	3.11E-01
	F(2009)/F_{MSY}	1.25E-02	9.30E-03	2.46E-02	4.80E-03	2.63E-03	1.81E-03	2.16E+02	4.37E+02	1.83E+00
	FMSY/F(2009)	8.03E+01	1.08E+02	4.06E+01	2.08E+02	3.80E+02	5.54E+02	4.64E-03	2.29E-03	5.46E-01
	Contrast (Ideal = 1.0)	0.8973	1.4078	1.3532	1.024	0.7175	0.4103	0.9006	0.4442	0.3603
	Nearness Index (Ideal =1.0)	0.4527	0.4295	0.4332	0.5	0.5017	0.5015	1.0	1.0	1.0
	Objective function	6.93E+01	6.83E+01	6.82E+01	6.94E+01	7.68E+01	7.98E+01	4.70E+01	4.70E+01	33.1468339

Table 6.3.2.1. (Continued). ASPIC estimated parameter values for the sensitivity 2 scenario, evaluating proportional index weighting on ASPIC parameter estimates. Seven levels of input B1/K ratio evaluated (0.2, 0.5,0.6, 0.75, 0.8 and 1.0) for the 2010 continuity case landings + 20% discard mortality level. Estimates shaded gray are questionable.

Discard Mortality 20%	Model Performance	Estimate of q parmeter at low bound for CH+PR fishery	Normal convergence	Normal convergence	Normal convergence	Normal convergence	Normal convergence	MSY Parameter estimate at low bound	MSY Parameter estimate at low bound	Normal convergence
	CH+PR weight	2.47E+00	2.47E+00	2.47E+00	2.47E+00	2.47E+00	2.47E+00	2.47E+00	2.47E+00	1.0
	HB weight	1.55E-01	1.55E-01	1.55E-01	1.55E-01	1.55E-01	1.55E-01	1.55E-01	1.55E-01	1.0
	Com HL weight	1.02E+00	1.02E+00	1.02E+00	1.02E+00	1.02E+00	1.02E+00	1.02E+00	1.02E+00	1.0
	Com LL weight	9.54E-03	9.54E-03	9.54E-03	9.54E-03	9.54E-03	9.54E-03	9.54E-02	9.54E-02	1.0

***: q starting estimate for CH + PR index modified to 1.d-12 from 1.d-8, all other starting guesses from index q's remained at 1.d-8.

Table 6.3.3.1. ASPIC estimated parameter values sensitivity scenario 3 runs evaluating impact on ASPIC model results from differences in SEDAR9 recreational landings and the 2010 update estimated landings. The ASPIC sensitivity runs were carried out for three varying levels of input values of B1/K ratio (0.2, 0.5, and 1.0) for the 2010 Continuity level of discard mortality (20%) . Equal index weighting was applied.

Initial Input B1/K Value					
Estimated Parameters	**0.2**	**0.5**	**1**	**B1/K Fixed at 0.5 (SEDAR 2010 Update, Table 6.3.2.1)**	**SEDAR9 Base B1/K Initial B1/K=0.5**
B1/K	4.222E-04	3.551E-01	1.081E+00	0.5	0.840
MSY	4.257E+07	6.172E+06	4.288E+06	5.000E+06	4.815E+06
K	2.813E+11	3.394E+07	1.564E+07	2.000E+07	1.987E+07
B_{MSY}	1.407E+11	1.697E+07	7.819E+06	1.473E+07	9.937E+06
F_{MSY}	3.027E-04	3.637E-01	5.485E-01	3.33E-01	0.484
$B(2009)/B_{MSY}$	2.651E-04	2.285E-01	3.844E-01	3.11E-01	na
$F(2009)/F_{MSY}$	2.509E+02	2.021E+00	1.685E+00	1.83E+00	na
$F_{MSY}/F(2009)$	3.985E-03	4.947E-01	5.936E-01	5.46E-01	na
Contrast (Ideal = 1.0)	0.0003	0.2663	0.9566	0.3603	na
Nearness Index (Ideal =1.0)	0.5004	0.8551	1.0000	1	na
Objective function	3.309E+01	3.02E+01	2.832E+01	3.31E+01	na
Model Performance	Normal convergence	Normal Convergence	Normal Convergence	Normal Convergence	Normal Convergence
$B(2004)/B_{MSY}$	3.57E-04	2.67E-01	4.37E-01	3.82E-01	7.059E-01
F(2004)/FMSY	2.27E+02	2.198E+00	1.98E+00	2.40E+00	1.017E+00

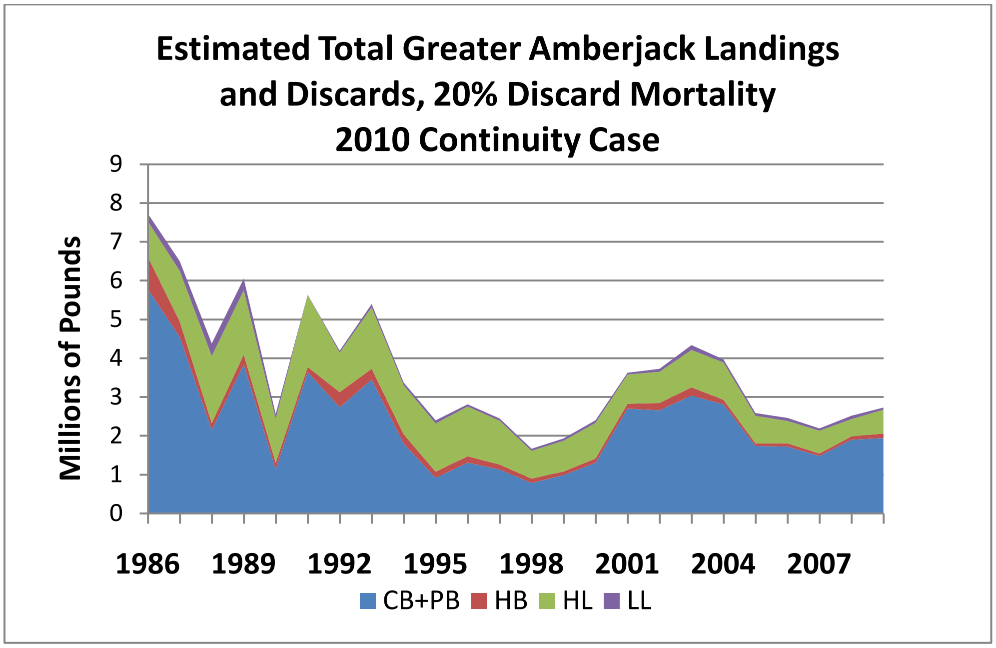

Figure 6.1.1.1. Calculated total commercial and recreational landings and discards for the Gulf of Mexico greater amberjack stock assessment continuity case, assuming 20% discard mortality rate.

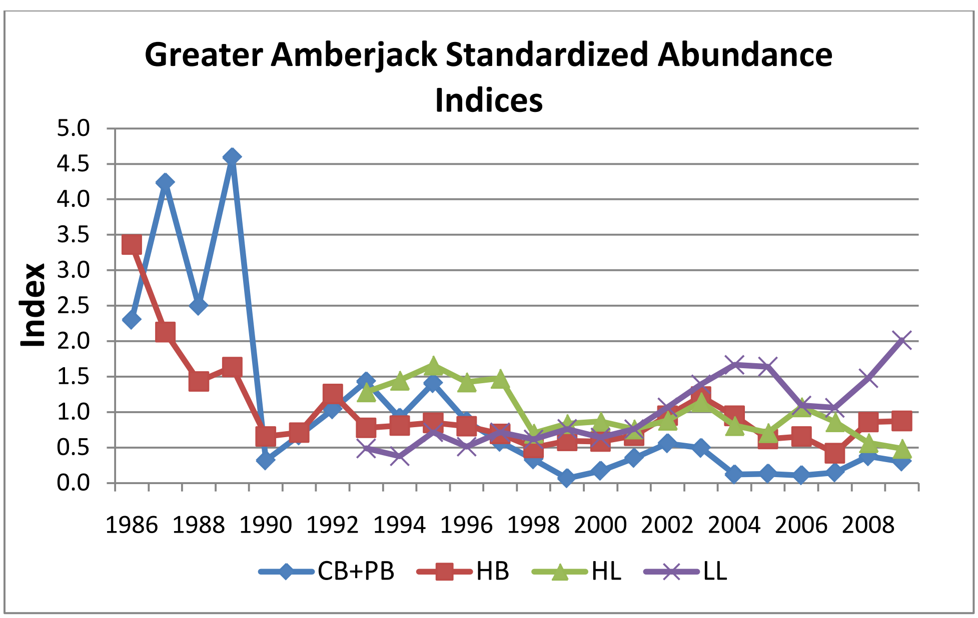

Figure 6.1.1.2. Gulf of Mexico greater amberjack standardized abundance indices for four fishery dependent data sets: MRFSS charter and private angler (CB+PB), NMFS Headboat Survey HB), NMFS, SEFSC Coastal Logbook Commercial Vertical Line (HL), and the NMFS, SEFSC, Coastal Logbook Commercial Longline fisheries.

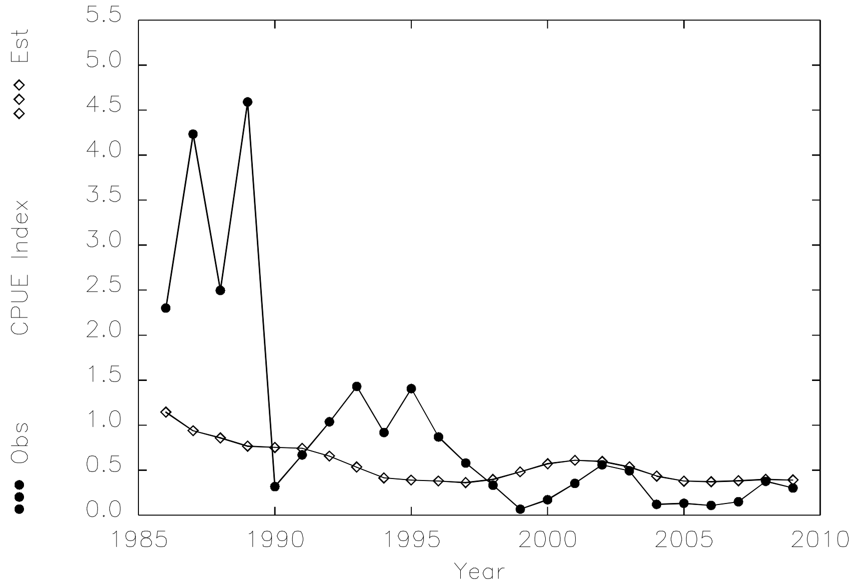

Figure 6.2.1.1a**.** ASPIC estimated and observed CPUE series for the charter and private angler (CB+PR) fisheries for the 2010 Continuity case (B1/k=0.5 run, equal index weighting).

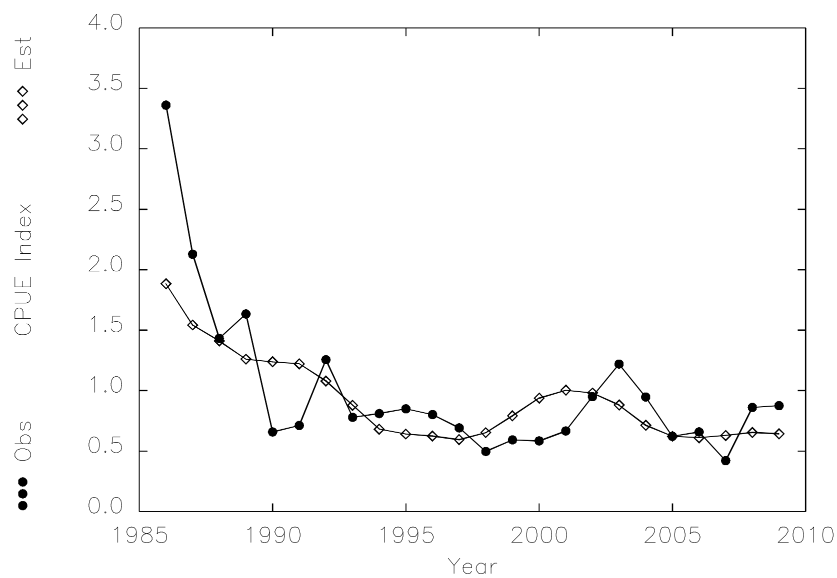

Figure 6.2.1.1b. ASPIC estimated and observed CPUE series for the recreational headboat (HB) fisheries the 2010 Continuity case (B1/k=0.5 run, equal index weighting).

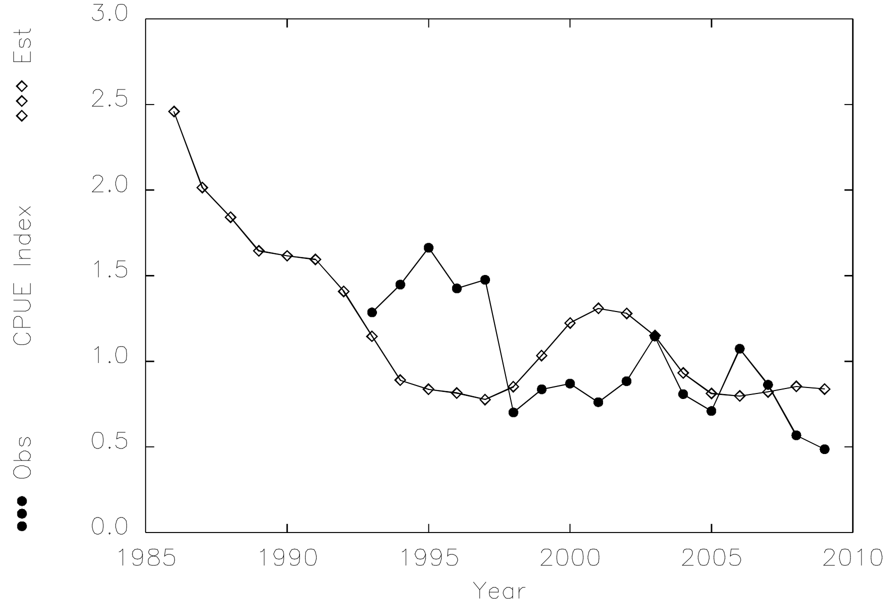

Figure 6.2.1.1c. ASPIC estimated and observed CPUE series for the commercial vertical line fisheries the 2010 Continuity case (B1/k=0.5 run, equal index weighting).

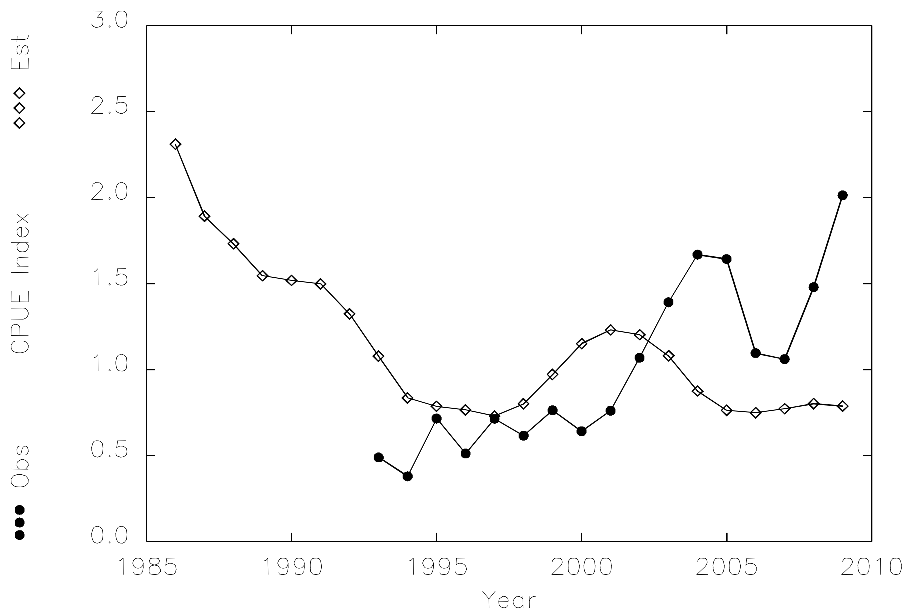

Figure 6.2.1.1d. ASPIC estimated and observed CPUE series for the commercial longline fisheries the 2010 Continuity case (B1/k=0.5 run, equal index weighting).

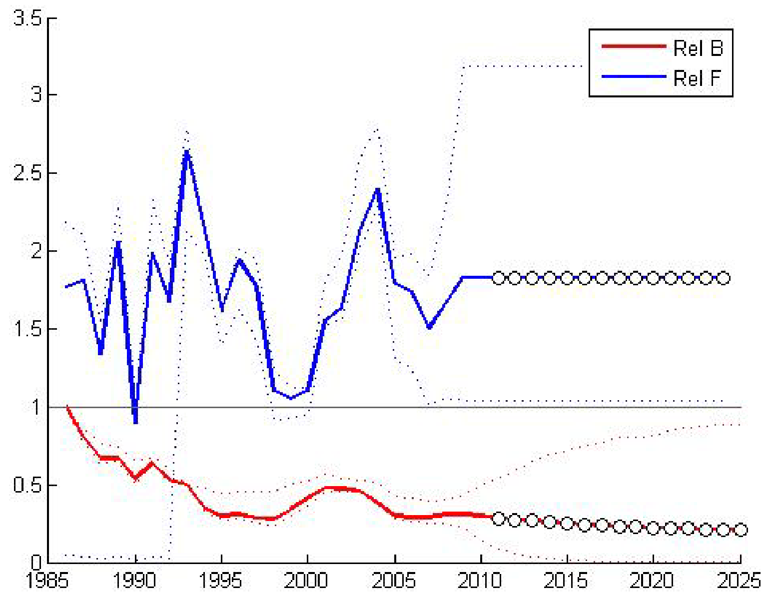

Figure 6.2.3.1. ASPIC estimated relative biomass (B/BMSY) and relative F (F/FMSY) trajectories for the Continuity case (landings + 20% discard mortality rate, B1/K initial value fixed at 0.5, and equal index weighting). Dashed lines correspond to 10-90th percentiles.

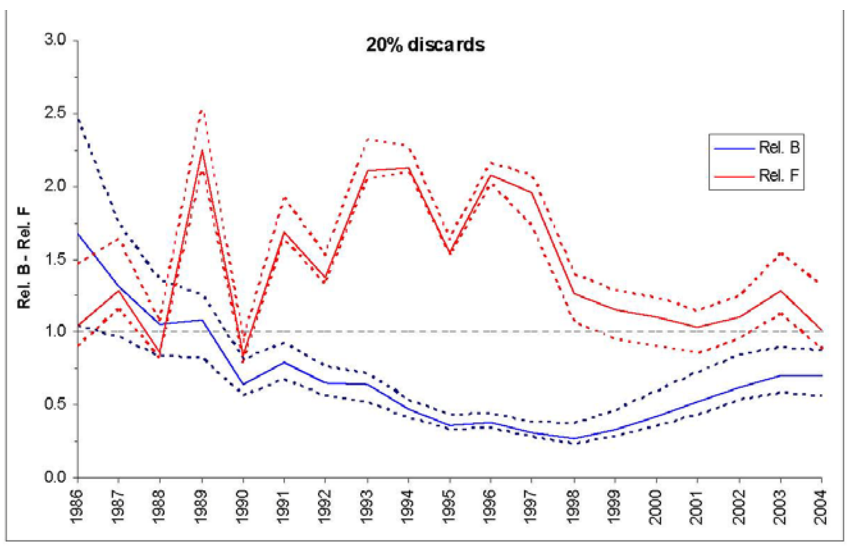

Figure 3.2.2.3.1. ASPIC estimated relative biomass (B/B_{MSY}) and relative F (F/F_{MSY}) trajectories assuming 20% discard mortality. Dashed lines correspond to 10-90th percentiles

Figure 6.2.3.2. SEDAR 9 ASPIC estimated relative biomass (B/BMSY) and relative F (F/FMSY) trajectories for the Continuity case (landings + 20% discard mortality rate, B1/K initial value fixed at 0.5, and equal index weighting). Dashed lines correspond to 10-90th percentiles. Source = SEDAR9-SAR, Section 3.2.2.3, Figure 3.2.2.3.1, page 53.

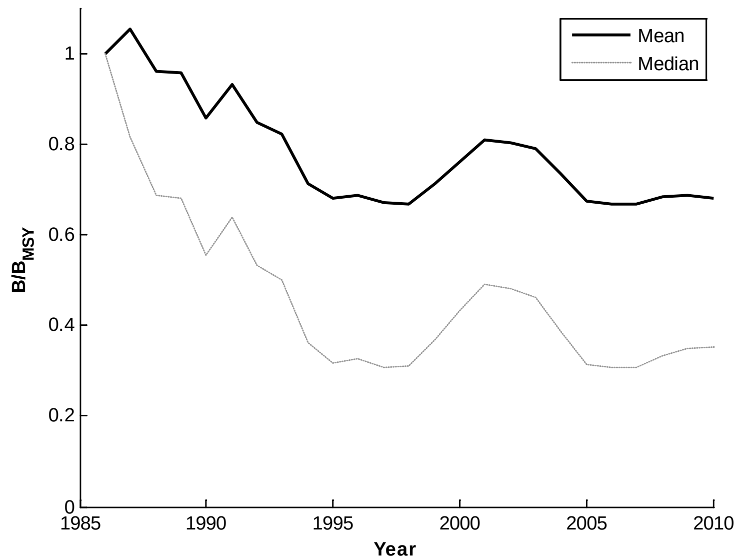

Figure 6.2.5.1. ASPIC estimated relative mean and median biomass (B/B_{MSY}) trajectories for the Continuity case (landings + 20% discard mortality rate, B1/K initial value fixed at 0.5, and equal index weighting).

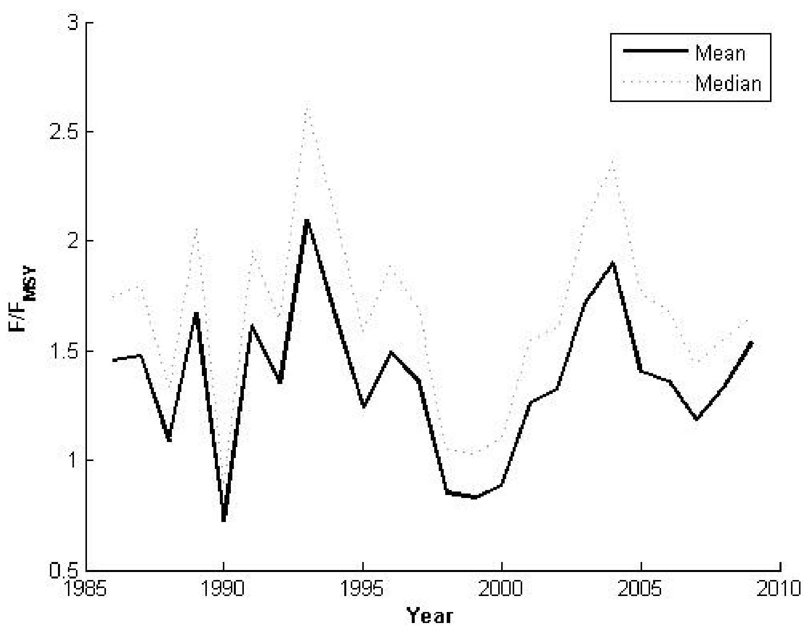

Figure 6.2.5.2. ASPIC estimated relative mean and median fishing mortality (F/F_{MSY}) trajectories for the Continuity case (landings + 20% discard mortality rate, B1/K initial value fixed at 0.5, and equal index weighting).

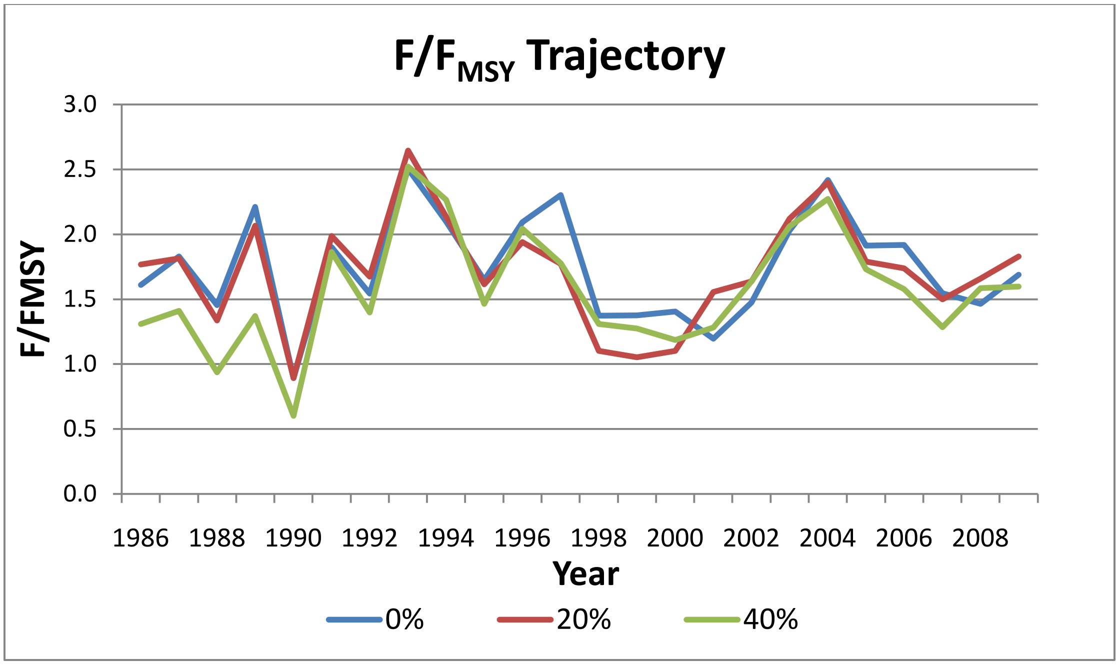

Figure 6.3.1.1a. ASPIC estimated relative F (F/F_{MSY}) for Sensitivity Scenario 1 evaluating three levels of discard mortality. Continuity case = 20% release mortality line. B1/K input ratio =0.5.

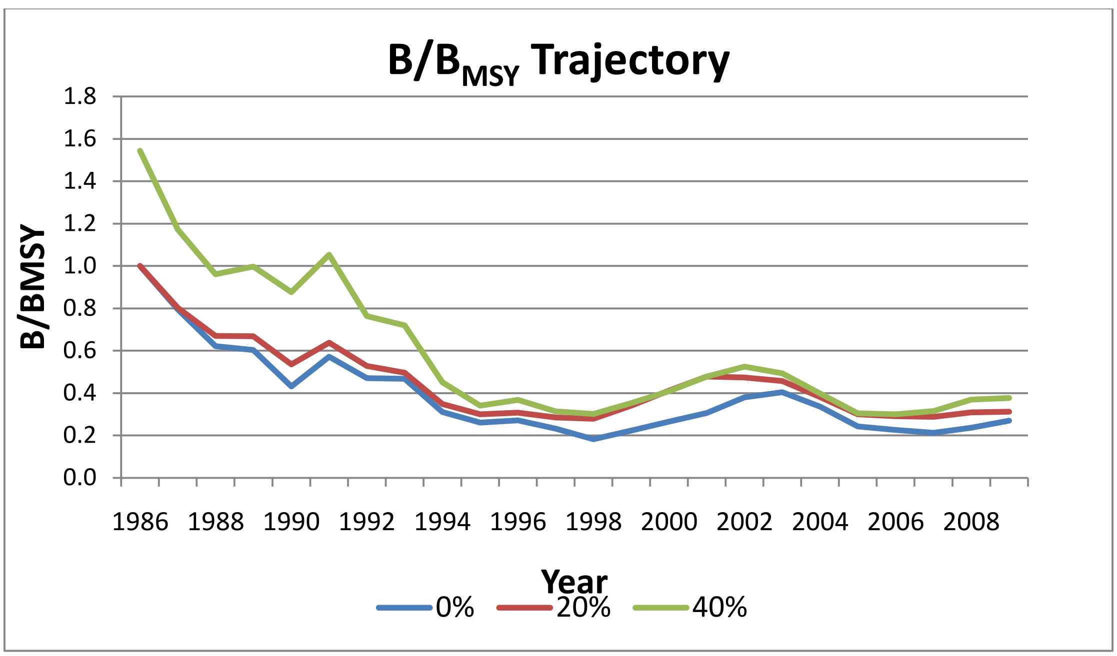

Figure 6.3.1.1b. ASPIC estimated relative biomass (B/B_{MSY}) for Sensitivity Scenario 1 evaluating three levels of discard mortality. Continuity case = 20% release mortality line. B1/K input ratio= 0.5.

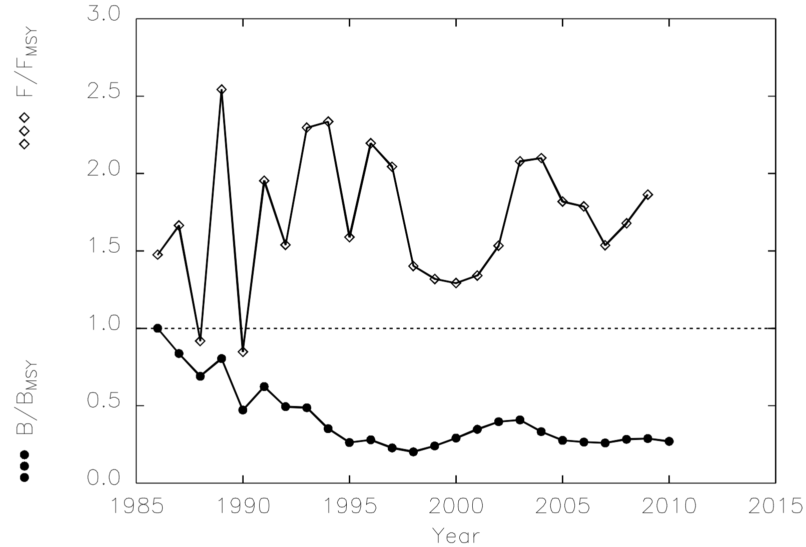

Figure 6.3.3.1 ASPIC estimated relative biomass (B/B_{MSY}) and relative F (F/F_{MSY}) trajectories for Sensitivity Scenario 3: Evaluation of differences in SEDAR9 Recreational landings + 20% discard data for 1986-2004 and the SEDAR 2010 updated data for 2005-2009. ASPIC model run estimates estimated for the B1/K =0.5 fixed value, equal index weighting.

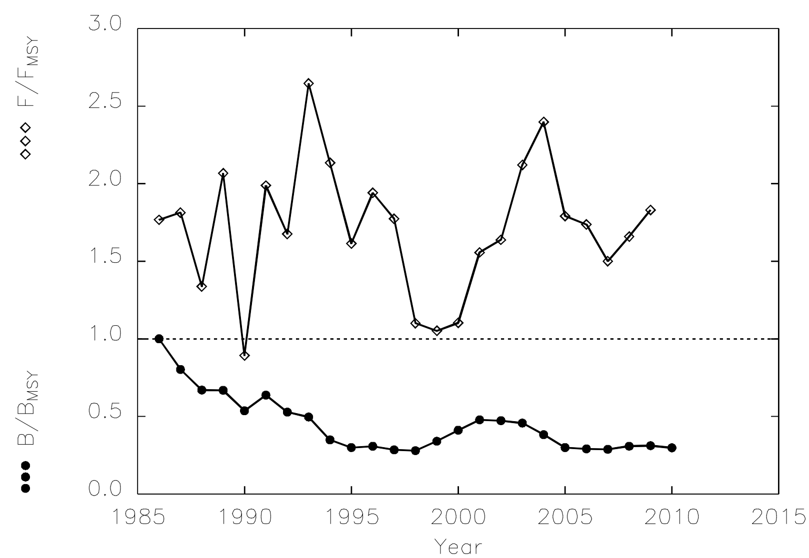

Figure 6.3.3.2. ASPIC estimated relative biomass (B/B_{MSY}) and F (F/F_{MSY}) trajectories for the 2010 Continuity case (2010 landings + 20% discards). ASPIC model run estimates for the B1/K fixed=0.5, equal index weighting) (presented earlier in this document as Figure 6.2.3.1).

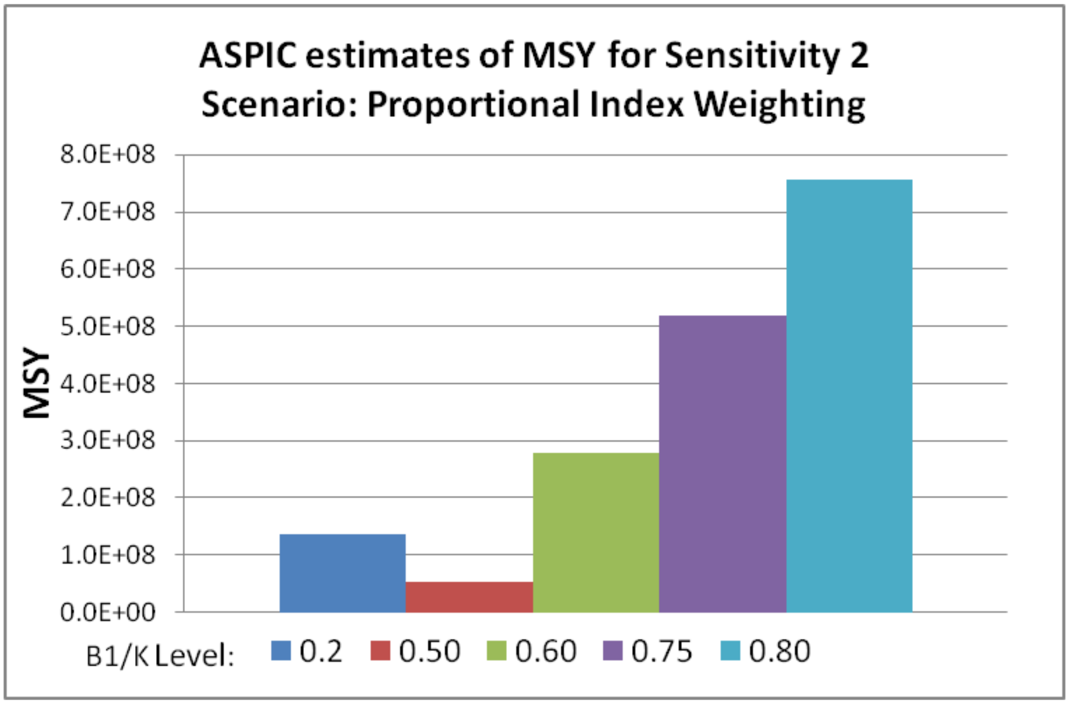

Figure 6.3.3.1a. ASPIC estimates of MSY for Sensitivity 2 Scenario: Proportional Index Weighting.

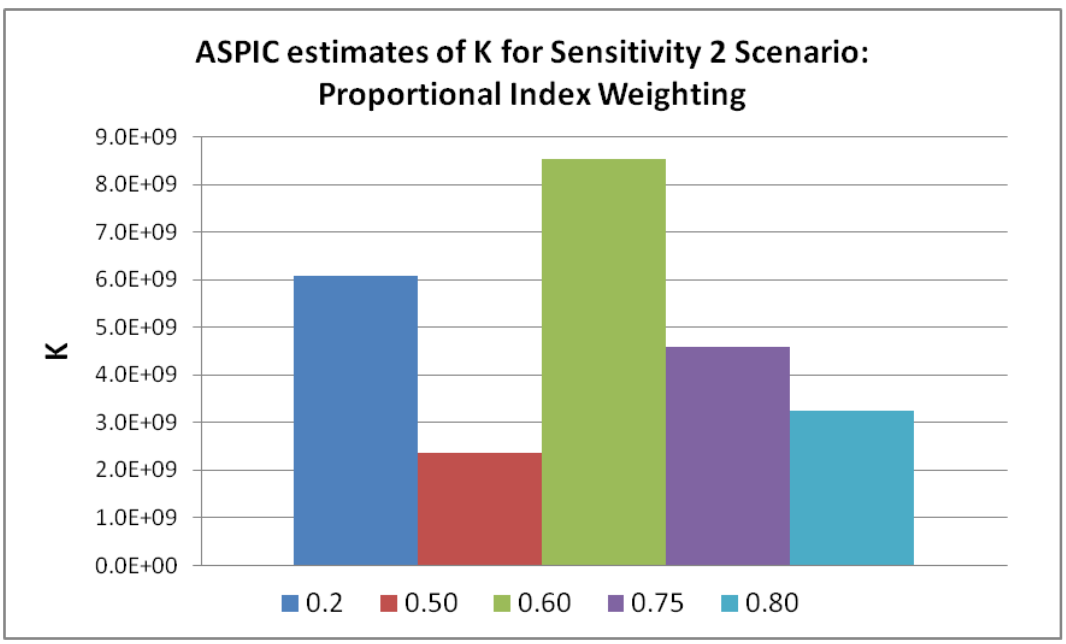

Figure 6.3.3.1b. ASPIC estimates of K for Sensitivity 2 Scenario: Proportional Index Weighting.

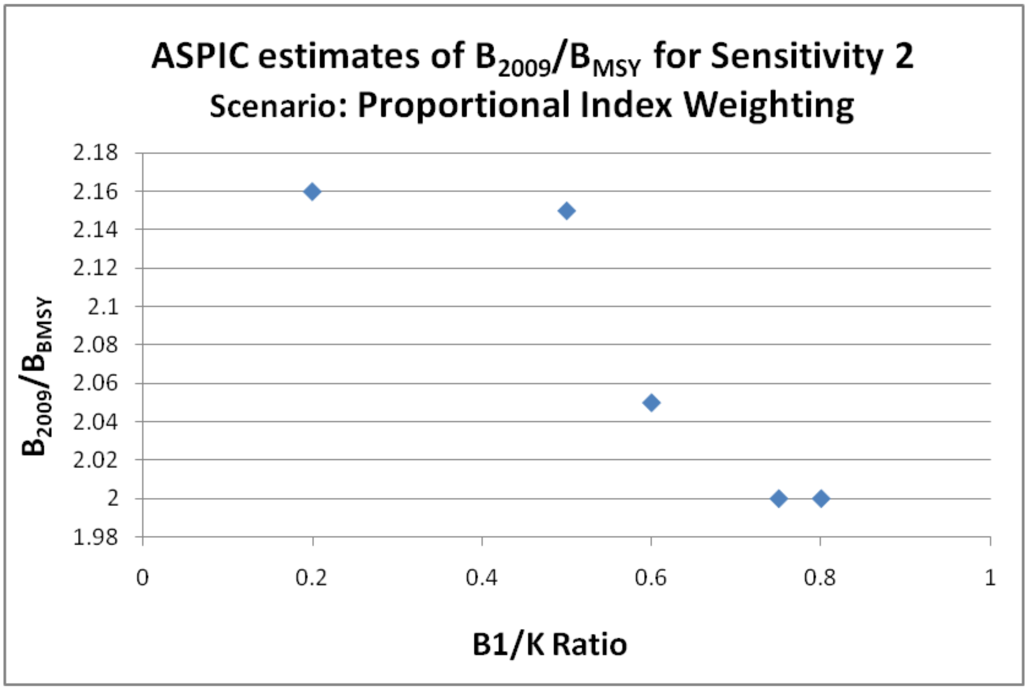

Figure 6.3.3.1c. ASPIC estimates of B_{2009}/B_{MSY} for Sensitivity 2 Scenario: Proportional Index Weighting.

7. Biological Reference Points (SFA Parameters)

7.1 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 (July 2005) 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 $F_{CURRENT}$ is greater than MFMT (F_{MSY}) and the greater amberjack stock would be considered overfished if $B_{CURRENT}$ 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.

7.2 Results

7.2.1 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_{2009}/F_{MSY} =1.830, therefore exceeding the MFMT (Figure 7.2.1).

7.2.2 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_{2009}/B_{MSY} = 0.311, where MSST = $0.75B_{MSY}$ (Figure 7.2.1).

7.2.3 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 was specified as 7 years, with year one specified as 2003. Progress toward the rebuilding goal is addressed in Section 8.2.1 below.

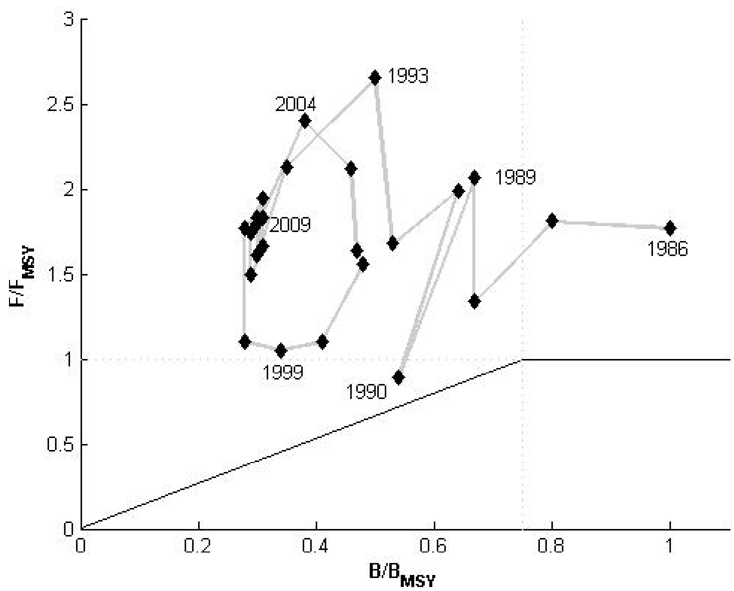

Figure 7.2.1. Projected status of greater amberjack based on ASPIC with respect to F/F_{MSY} and B/B_{MSY}. The limit and threshold control rules from a rebuilding stock are shown by dashed lines.

8. **Projections and Management Impacts**

8.1 Projection Methods and Assumptions

Using ASPIC, the 2010 update Continuity case of landings + 20% release mortality and an initial value of B1/K=0.5 was chosen for bootstrap (1,000 runs) and projection analysis. Relative biomass projections for the years 2010-2025 were obtained for 1) different scenarios of future F_{Year}/F_{2009} (levels of 0.0, 0.2, 0.3, 0.45, 0.5, and 1.0 times F_{2009} were used) and also by keeping the 2009 catch constant ($Yield_{2009}$ + 20% discards). Two sensitivity catch projection scenarios runs were made to explore variation in estimated population trajectories under the constant catch scenario. Finally, projections were also made for varying scenarios of future F_{Year}/F_{2009} corresponding to varying levels of F_{OY} and F_{MFMT} as presented in Table 1.2.1 of the Terms of Reference for the 2010 assessment update.

8.2 <u>Projection Results</u>

8.2.1 Fishing Mortality Projections

Bootstrap projections of relative biomass (B_{Year}/B_{MSY} with the 10^{th}-90^{th} percentiles) with varied assumptions for fishing mortality (0.0, 0.2, 0.3, 0.45, 0.5, and 1.0 times F_{2009}) in the projected period are shown in Figures 8.2.1.1(a-e) and Figure 8.2.1.2 with projection data in Table 8.2.1.1. The specified fishing mortality rate was held constant over the entire projection period (2010-2025).

The fishing mortality projection results (Figures 8.2.1.2 and 8.2.1.3) indicate that the greater amberjack stock will not recover to B_{MSY} at current F by the end of the projection period (2025) under current levels of fishing mortality. Recovery to B_{MSY} could occur by 2018 with a reduction to ~ 45% of fishing mortality of 2009 levels (F_{2009} = 0.3325). A reduction in current fishing mortality results to F_{2009}*.5 results in no recovery of the stock. These results indicate that model projections are sensitive to the magnitude of the fishing mortality multiplier (scalar) in the range of 0.45 – 0.5. Table 8.2.1.2 presents projected yields under varying scenarios of F/F_{2009}.

Table 8.2.1.3a,b and Figures 8.2.1.4 and 8.2.1.5 present projected yields and projected relative biomass (B/B_{MSY}) under three SFA/MSSRA evaluation scenarios for fishing mortality levels relative to F_{OY} and F_{MFMT} for future F/F_{2009}. These projections indicate that the stock could recover by 2015 under the 65% MFMT evaluation scenario for future $F/F_{2009.}$ This level of fishing mortality corresponds to the scalar for F/F_{2009} = 0.355.

Figure 8.2.1.5 presents the control rule plot for F_{2010}-F_{2025} = F_{2009} (status quo F scenario), indicating that under current levels of F that the greater amberjack stock is projected to remain overfished and overfishing is projected to continue.

8.2.2 Catch Projections

Projections were carried out also considering variation in total allowable fishery removals (yields). Projections under constant yield showed a more pessimistic view of population status. At status quo harvest (2.73 million lbs removed in 2009, assuming 20% discard mortality) projections indicate a continually declining population (Figure 8.2.2.1a, b).

In addition to the constant catch projection, two sensitivity projection runs were conducted to explore potential impacts of the fishery closures associated with the Deepwater Horizon. These runs varied the total allowable removals (yields). These two projection runs were based on the observation that approximately 75% of recent recreational removals occur between the months of April and September (Table 2.1.7, Amendment 30 2010). No assumptions were made regarding additional mortality effect of the Deepwater Horizon Incident or other environmental effects.

The first sensitivity run associated with catch projections assumed a 50% reduction in total catch in year 2010. The second projection assumed a 50% reduction in only the recreational catch in year 2010. Both of these catch based projection sensitivity runs indicate immediate improvement in stock status and trajectories suggesting eventual recovery of the stock (Figures 8.2.2.2 and 8.2.2.3).

8.3 Past Regulatory Actions and Impacts

8.3.1 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_{2009}) (see Figures (section 8.2.1, Fishing Mortality Projections). The goal of rebuilding the stock could possibly be obtained by reducing F by at least 45% of current F; under such a scenario biomass will exceed the rebuilding target (i.e., $B_{Year}/B_{MSY} > 1$) around 2018 (Table 8.3.1.1). The control rule plot for $F_{2010} = F_{2009}$ (status quo F scenario) (Figure 8.3.1.1) shows 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 8.2.1.2 presents projected yields under different scenarios of constant F/F_{2009} and Table 8.2.1.3a presents projected yields under four SFA/MSRA F/F_{2009} evaluation scenarios.

Recovery of the stock under the current rebuilding plan, which sets yield in 2009-2011 at 7.0 million pounds and 7.9 million pounds thereafter, does not appear feasible (Figure 8.3.1.2a,b). An important consideration in the recovery of the stock is the possible effects from the fishery closures and environmental processes that occurred in 2010. As shown by the two sensitivity runs (Section 8.2.2, Figures 8.2.2.2 and 8.2.2.3) that evaluated reductions in 2010 catch, the biomass rebuilding target (B_{MSY}) could be eventually achieved by adopting a more conservative approach to total allowable catch limits.

Table 8.2.1.1. Projected biomass for different values of F/F_{2009} for the greater amberjack stock. The column labeled '1' corresponds to projections made with the current level of F (status quo F); the column labeled '0' has projections with no fishing. Units are pounds (whole weight).

	TRAJECTORY OF ABSOLUTE BIOMASS (BOOTSTRAPPED) for six levels of F/F_{2009}					
Year	**1.0**	**0.5**	**0.45**	**0.3**	**0.2**	**0.0**
2010	4.386E+06	4.386E+06	4.386E+06	4.386E+06	4.386E+06	4.386E+06
2011	4.212E+06	5.622E+06	5.785E+06	6.304E+06	6.674E+06	7.478E+06
2012	4.060E+06	6.995E+06	7.376E+06	8.634E+06	9.575E+06	1.173E+07
2013	3.926E+06	8.430E+06	9.061E+06	1.119E+07	1.281E+07	1.657E+07
2014	3.807E+06	9.838E+06	1.072E+07	1.368E+07	1.593E+07	2.105E+07
2015	3.701E+06	1.113E+07	1.223E+07	1.587E+07	1.856E+07	2.444E+07
2016	3.606E+06	1.226E+07	1.352E+07	1.760E+07	2.053E+07	2.664E+07
2017	3.521E+06	1.319E+07	1.455E+07	1.888E+07	2.188E+07	2.794E+07
2018	3.444E+06	1.393E+07	1.535E+07	1.976E+07	2.275E+07	2.866E+07
2019	3.374E+06	1.449E+07	1.594E+07	2.035E+07	2.328E+07	2.904E+07
2020	3.311E+06	*1.491E+07*	1.636E+07	2.073E+07	2.361E+07	2.925E+07
2021	3.253E+06	1.522E+07	1.667E+07	2.097E+07	2.380E+07	2.935E+07
2022	3.200E+06	1.544E+07	1.687E+07	2.112E+07	2.391E+07	2.941E+07
2023	3.152E+06	1.560E+07	1.702E+07	2.122E+07	2.398E+07	2.943E+07
2024	3.108E+06	1.572E+07	1.712E+07	2.128E+07	2.402E+07	2.945E+07

Table 8.2.1.2. Projected yield for different values of F/F_{2009} for the greater amberjack stock. The column labeled '1' corresponds to projections made with the current level of F(status quo F); the column labeled '0' has projections with no fishing. Units are pounds (whole weight).

	TABLE OF PROJECTED YIELDS at varying levels of F/F_{2009}					
Year	**1.**	**0.5**	**0.45**	**0.3**	**0.2**	**0.0**
2010	2.615E+06	1.518E+06	1.387E+06	9.687E+05	6.662E+05	0.000E+00
2011	2.516E+06	1.917E+06	1.798E+06	1.358E+06	9.835E+05	0.000E+00
2012	2.429E+06	2.346E+06	2.250E+06	1.808E+06	1.361E+06	0.000E+00
2013	2.352E+06	2.781E+06	2.710E+06	2.273E+06	1.752E+06	0.000E+00
2014	2.284E+06	3.194E+06	3.146E+06	2.703E+06	2.105E+06	0.000E+00
2015	2.223E+06	3.564E+06	3.530E+06	3.062E+06	2.386E+06	0.000E+00
2016	2.168E+06	3.877E+06	3.849E+06	3.336E+06	2.586E+06	0.000E+00
2017	2.119E+06	4.130E+06	4.099E+06	3.532E+06	2.720E+06	0.000E+00
2018	2.074E+06	4.327E+06	4.288E+06	3.665E+06	2.804E+06	0.000E+00
2019	2.034E+06	4.476E+06	4.426E+06	3.752E+06	2.855E+06	0.000E+00
2020	1.997E+06	4.587E+06	4.525E+06	3.808E+06	2.886E+06	0.000E+00
2021	1.963E+06	4.667E+06	4.594E+06	3.843E+06	2.904E+06	0.000E+00
2022	1.933E+06	4.725E+06	4.642E+06	3.866E+06	2.915E+06	0.000E+00
2023	1.904E+06	4.766E+06	4.675E+06	3.879E+06	2.921E+06	0.000E+00
2024	1.879E+06	4.795E+06	4.698E+06	3.888E+06	2.924E+06	0.000E+00

Table 8.2.1.3a. Projected yields for different values of F/F_{2009} corresponding to the SFA/MSRA evaluation scenarios presented in Table 1.2.1 for the greater amberjack stock. The column labeled MFMT corresponds to projections made with the MFMT fishing mortality level of F. Units are pounds (whole weight). Shadings indicates where $B1/B_{MSY}$ >1.0.

PROJECTED YIELDS				
Year	**MFMT**	**65%MFMT**	**75%MFMT**	**85%MFMT**
2010	1.64E+06	1.13E+06	1.28E+06	1.43E+06
2011	2.02E+06	1.54E+06	1.69E+06	1.83E+06
2012	2.42E+06	2.00E+06	2.16E+06	2.28E+06
2013	2.82E+06	2.48E+06	2.63E+06	2.73E+06
2014	3.20E+06	2.92E+06	3.07E+06	3.16E+06
2015	3.55E+06	3.31E+06	3.46E+06	3.55E+06
2016	3.85E+06	3.61E+06	3.78E+06	3.86E+06
2017	4.10E+06	3.83E+06	4.02E+06	4.12E+06
2018	4.30E+06	3.99E+06	4.20E+06	4.31E+06
2019	4.45E+06	4.09E+06	4.32E+06	4.45E+06
2020	4.57E+06	4.17E+06	4.41E+06	4.55E+06
2021	4.66E+06	4.21E+06	4.47E+06	4.62E+06
2022	4.72E+06	4.24E+06	4.51E+06	4.68E+06
2023	4.77E+06	4.26E+06	4.54E+06	4.71E+06
2024	4.81E+06	4.28E+06	4.56E+06	4.74E+06

Table 8.2.1.3b. Projected relative biomass (B/B_{MSY}) for different values of F/F_{2009} corresponding to the SFA/MSRA evaluation scenarios presented in Table 1.2.1 for the greater amberjack stock. The column labeled MFMT corresponds to projections made with the MFMT fishing mortality level of F. Shadings indicates where $B1/B_{MSY}$ >1.0.

Year	**MFMT**	**65% MFMT**	**75% MFMT**	**85% MFMT**
2010	0.30	0.30	0.30	0.30
2011	0.37	0.41	0.40	0.39
2012	0.45	0.55	0.52	0.49
2013	0.53	0.70	0.65	0.60
2014	0.62	0.85	0.78	0.71
2015	0.69	0.98	0.89	0.81
2016	0.76	1.09	0.99	0.89
2017	0.81	1.17	1.06	0.96
2018	0.86	1.23	1.12	1.01
2019	0.89	1.27	1.16	1.05
2020	0.92	1.30	1.19	1.08
2021	0.94	1.32	1.21	1.10
2022	0.96	1.33	1.22	1.12
2023	0.97	1.34	1.23	1.13
2024	0.98	1.34	1.24	1.14

Table 8.3.1.1. ASPIC estimated relative biomass (B/B_{MSY}) and projected values for varying levels of F/F_{2009}.

F/F_{2009} Value									
Year	**1**	**0.75**	**0.5**	**0.45**	**0.4**	**0.3**	**0.2**	**0.1**	**0**
1986	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1987	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
1988	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
1989	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
1990	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
1991	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64
1992	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
1993	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
1994	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
1995	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
1996	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
1997	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
1998	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
1999	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
2000	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
2001	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
2002	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
2003	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
2004	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
2005	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
2006	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
2007	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
2008	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
2009	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31

Table 8.3.1.1. (Continued). ASPIC estimated relative biomass (B/B_{MSY}) and projected values for varying levels of F/F_{2009}. Shadings indicates where $B1/B_{MSY}$ >1.0.

	F/F_{2009} Value								
Year	**1**	**0.75**	**0.5**	**0.45**	**0.4**	**0.3**	**0.2**	**0.1**	**0**
2010	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
2011	0.29	0.33	0.38	0.39	0.40	0.43	0.45	0.48	0.51
2012	0.28	0.36	0.47	0.50	0.53	0.59	0.65	0.72	0.80
2013	0.27	0.39	0.57	0.62	0.66	0.76	0.87	0.99	1.13
2014	0.26	0.42	0.67	0.73	0.79	0.93	1.08	1.25	1.43
2015	0.25	0.45	0.76	0.83	0.91	1.08	1.26	1.46	1.66
2016	0.24	0.48	0.83	0.92	1.01	1.20	1.39	1.60	1.81
2017	0.24	0.50	0.90	0.99	1.08	1.28	1.49	1.69	1.90
2018	0.23	0.52	0.95	1.04	1.14	1.34	1.54	1.75	1.95
2019	0.23	0.54	0.98	1.08	1.18	1.38	1.58	1.78	1.97
2020	0.22	0.55	1.01	1.11	1.21	1.41	1.60	1.80	1.99
2021	0.22	0.56	1.03	1.13	1.23	1.42	1.62	1.81	1.99
2022	0.22	0.58	1.05	1.15	1.24	1.43	1.62	1.81	2.00
2023	0.21	0.58	1.06	1.16	1.25	1.44	1.63	1.81	2.00
2024	0.21	0.59	1.07	1.16	1.26	1.44	1.63	1.82	2.00

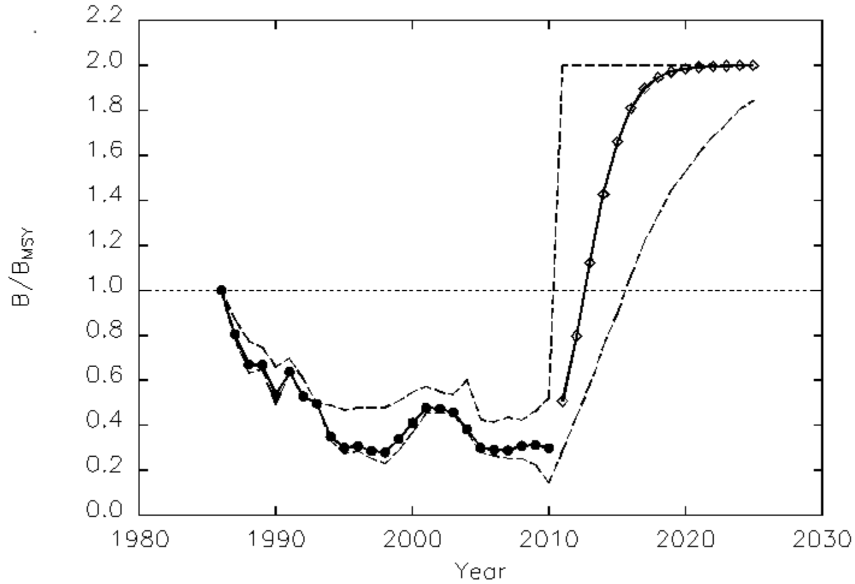

Figure 8.2.1.1a. ASPIC estimated and projected relative biomass (B/B_{MSY}) values for F/F_{2009} = 0.0 (no fishing). Dashed lines correspond to 10-90th percentiles.

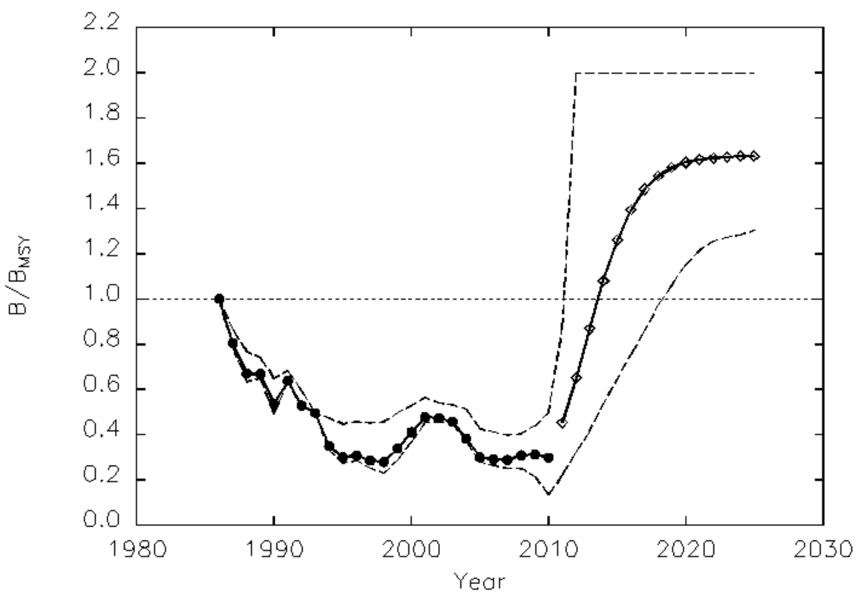

Figure 8.2.1.1b. ASPIC estimated and projected relative biomass (B/B_{MSY}) values for F/F_{2009} = 0.2. Dashed lines correspond to 10-90th percentiles.

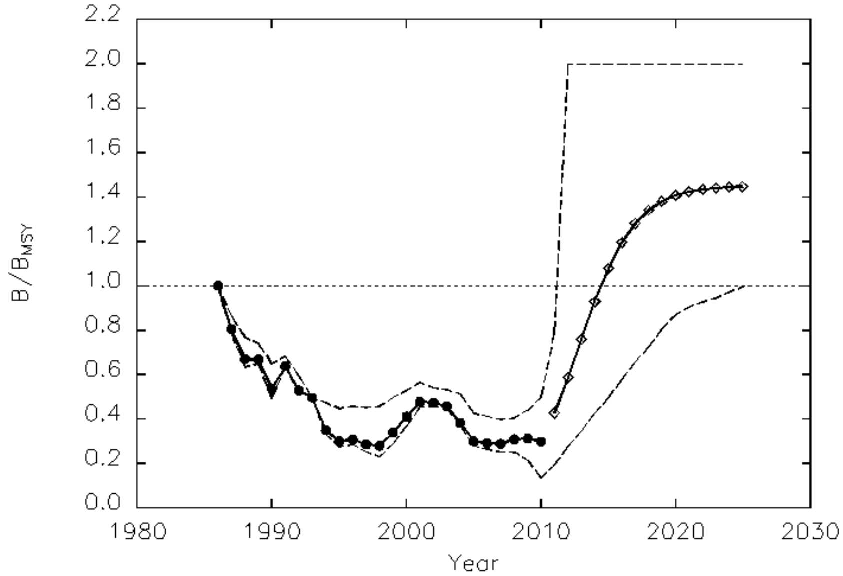

Figure 8.2.1.1c. ASPIC estimated and projected relative biomass (B/B_{MSY}) values for F/F_{2009} = 0.3. Dashed lines correspond to 10-90th percentiles.

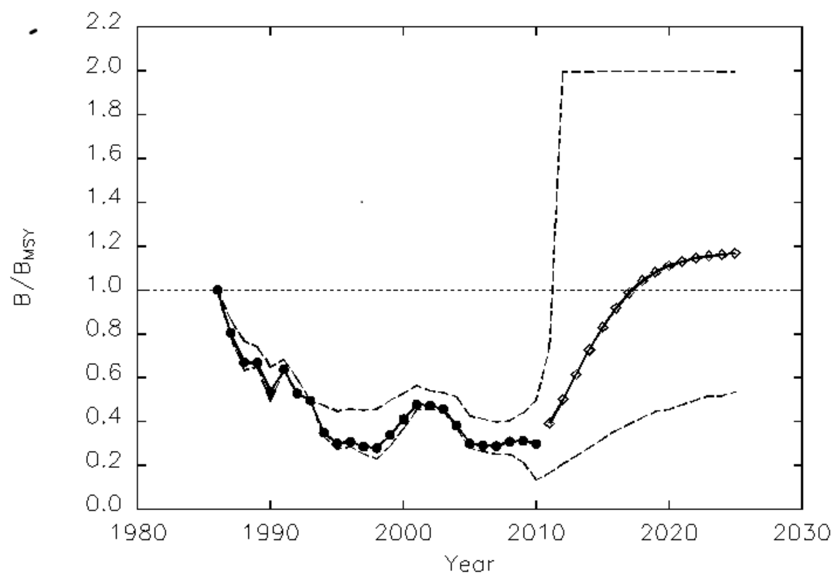

Figure 8.2.1.1d. ASPIC estimated and projected relative biomass (B/B_{MSY}) values for F/F_{2009} = 0.45. Dashed lines correspond to 10-90th percentiles.

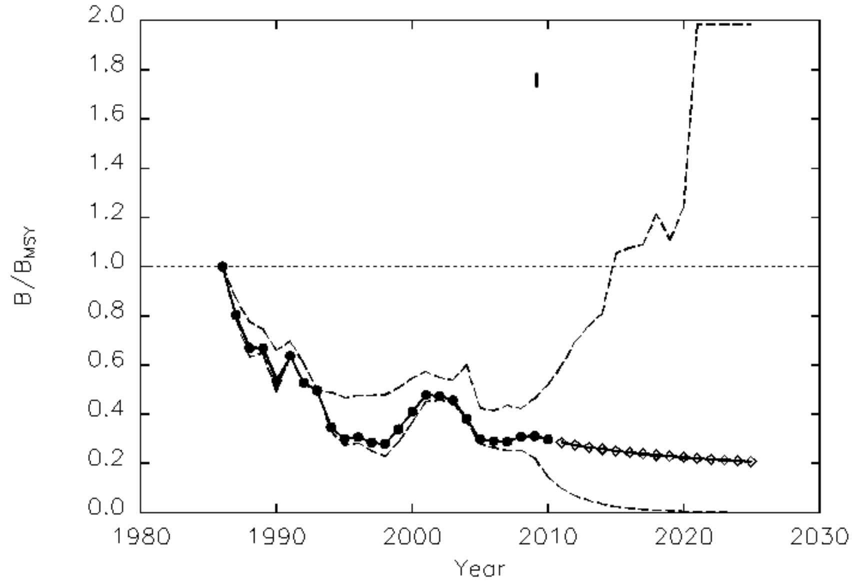

Figure 8.2.1.1e. ASPIC estimated and projected relative biomass (B/B_{MSY}) values for $F/F_{2009\,=}$ 0.5. Dashed lines correspond to 10-90th percentiles.

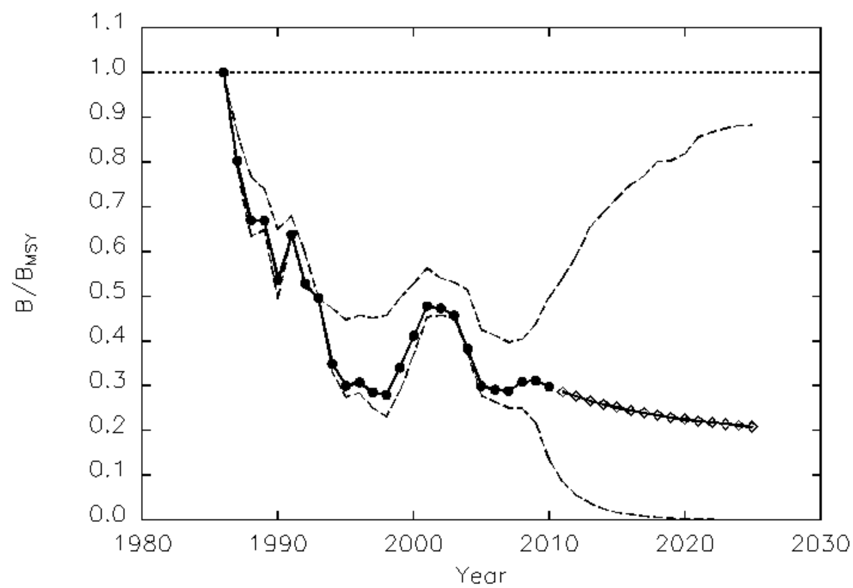

Figure 8.2.1.1f. ASPIC estimated and projected relative biomass (B/B_{MSY}) values for F/F_{2009} = 1.0 (status quo F_{2009}). Dashed lines correspond to 10-90th percentiles.

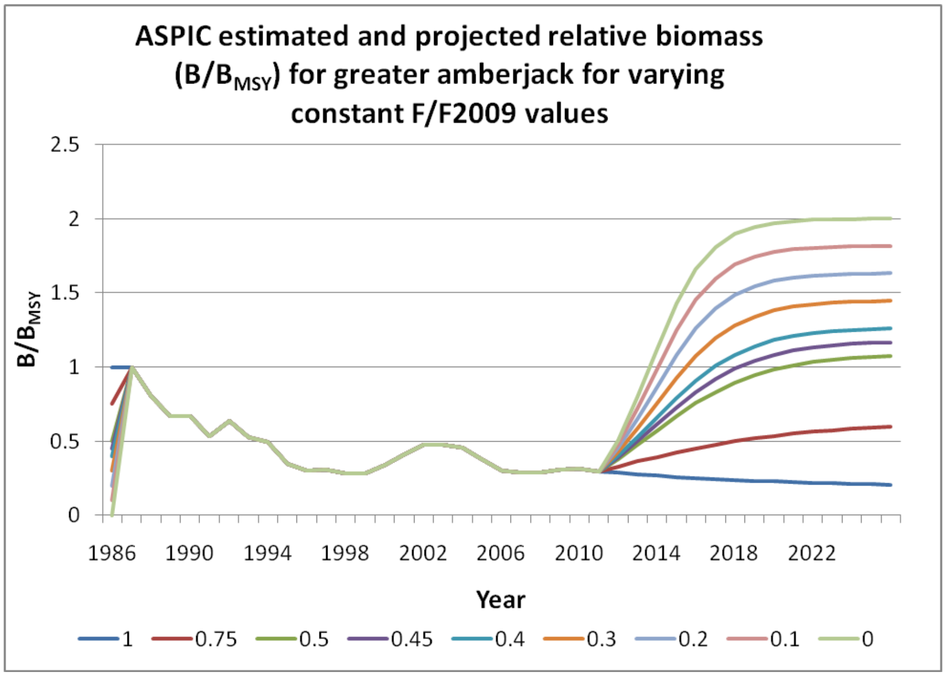

Figure 8.2.1.2. ASPIC estimated) and projected relative biomass (B/B_{MSY}) values for nine values of constant F/F_{2009}.

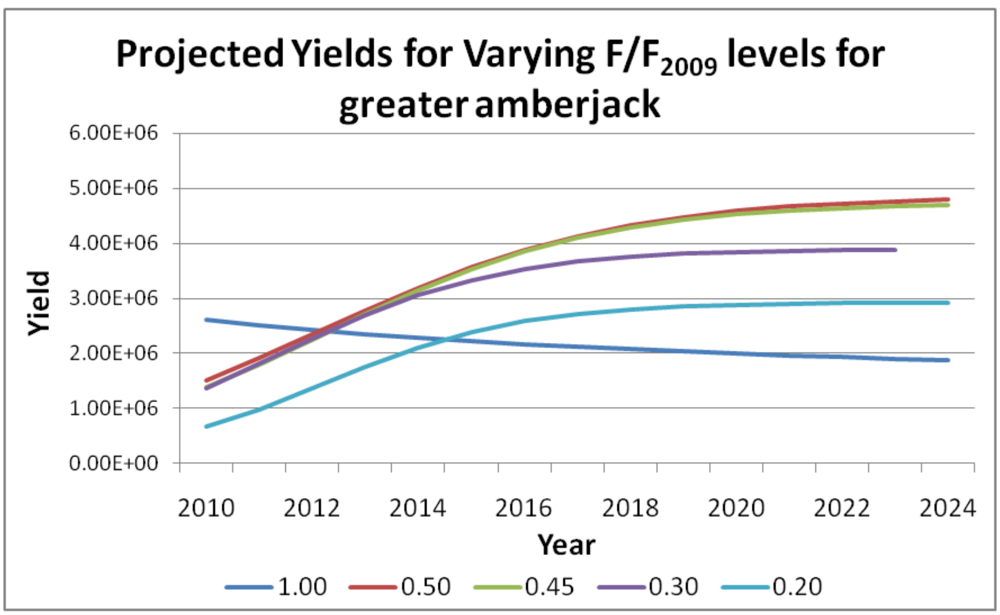

Figure 8.2.1.3. Projected yields for five varying levels of constant F/F_{2009}. Units are millions of pounds (whole weight).

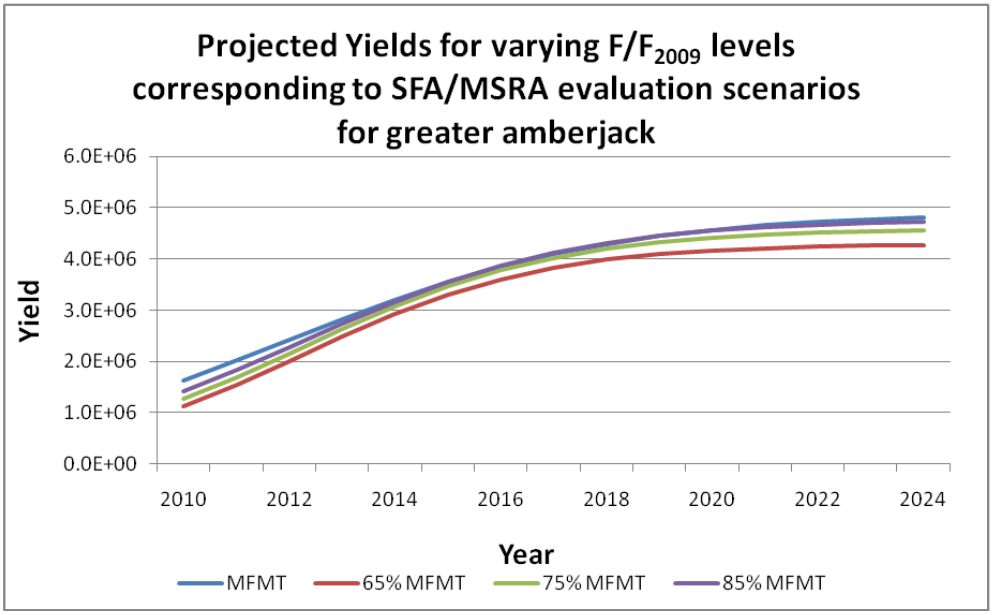

Figure 8.2.1.4 Projected yield for different values of F/F_{2009} corresponding to the SFA/MSRA scenarios presented in Table 1.2.1 for the greater amberjack stock. The column labeled MFMT corresponds to projections made with the MFMT fishing mortality level of F. Units are millions of pounds (whole weight).

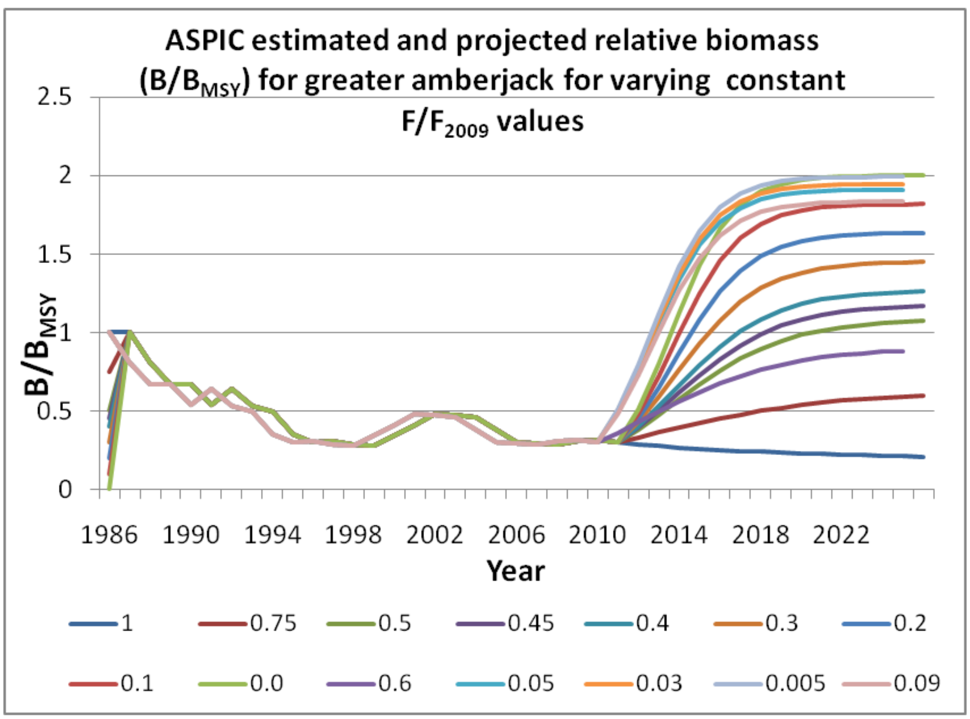

Figure 8.2.1.5. ASPIC estimated and projected relative biomass (B/B_{MSY}) for different F/F2009 SFA/MSRA evaluation scenarios.

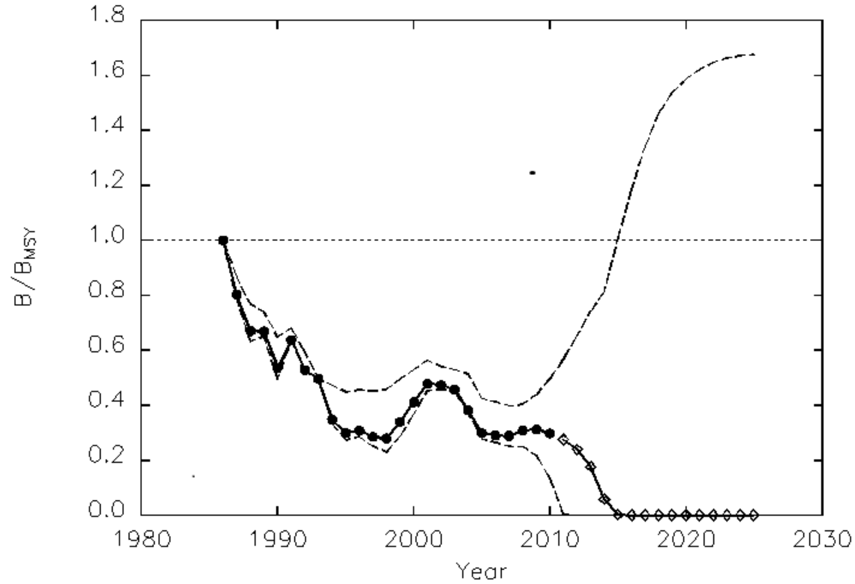

Figure 8.2.2.1a. ASPIC estimated and projected relative biomass (B/B_{MSY}) values for constant values of catch for 2010-2025. Dashed lines correspond to 10-90[th] percentiles of bootstrap.

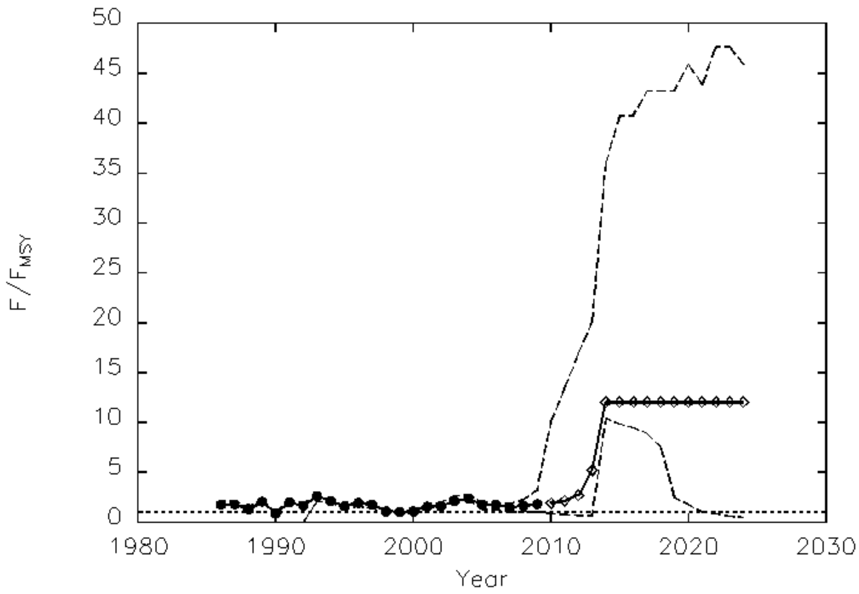

Figure 8.2.2.1b. ASPIC estimated and projected relative F (F/F_{MSY}) values for constant values of catch for 2010-2025. Dashed lines correspond to 10-90[th] percentiles of bootstrap.

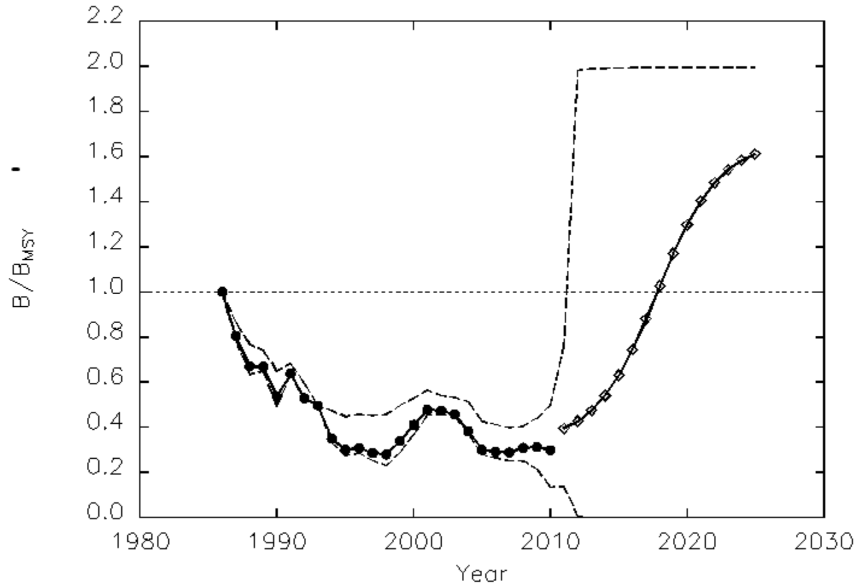

Figure 8.2.2.2a. ASPIC estimated and projected relative biomass (B/B_{MSY}) values for the sensitivity run exploring a 50% reduction in total catch for 2010. Dashed lines correspond to 10-90th percentiles of bootstrap.

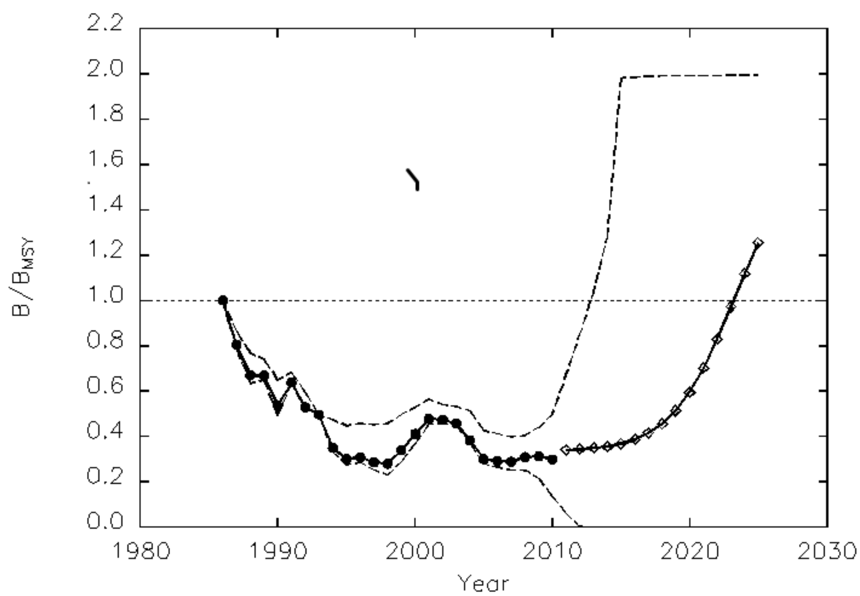

Figure 8.2.2.2b. ASPIC estimated and projected relative biomass (B/B_{MSY}) values for the sensitivity run exploring a 50% reduction in recreational catch for 2010. Dashed lines correspond to 10-90th percentiles of bootstrap.

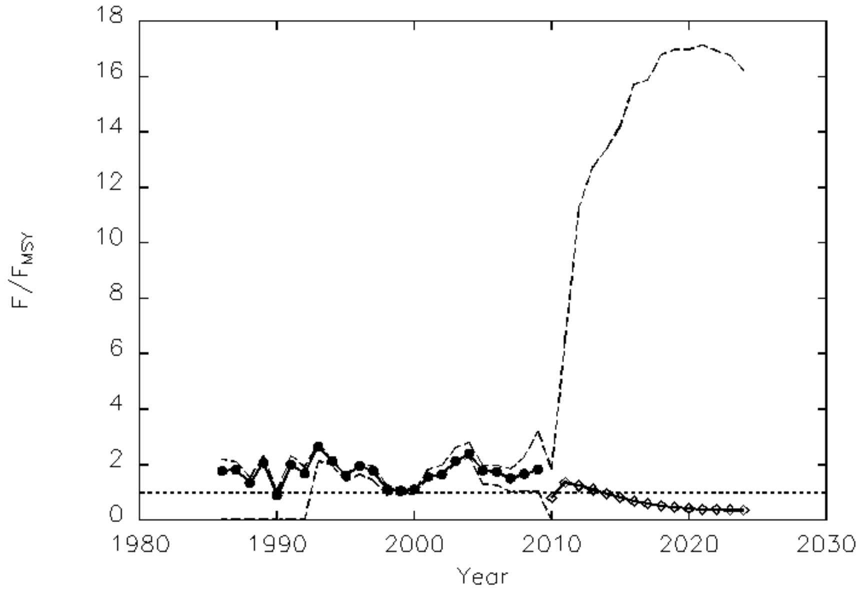

Figure 8.2.2.3.a. ASPIC estimated and projected relative F (F/F_{MSY}) values for the catch projection sensitivity run exploring a 50% reduction in total catch for 2010. Dashed lines correspond to 10-90th percentiles of bootstrap.

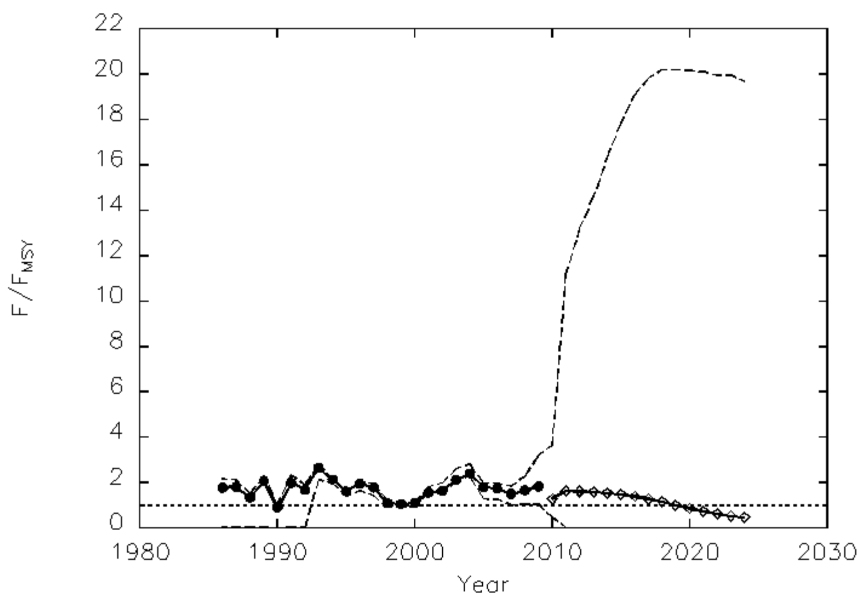

Figure 8.2.2.3b. ASPIC estimated and projected relative F (F/F_{MSY}) for the sensitivity run exploring a 50% reduction in recreational catch for 2010. Dashed lines correspond to 10-90th percentiles of bootstrap.

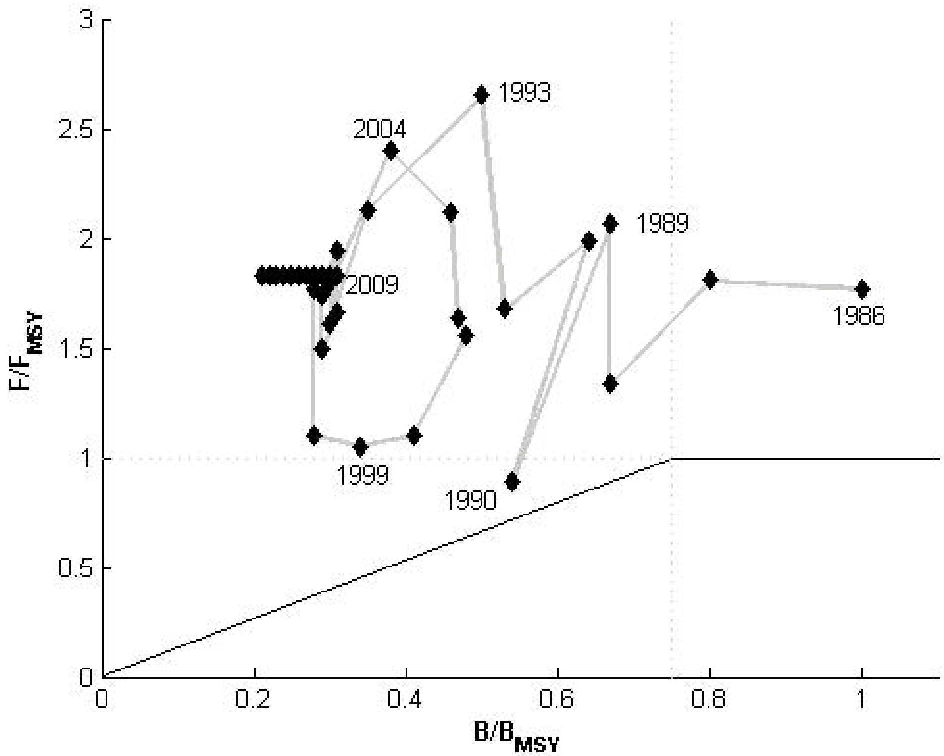

Figure 8.3.1.1. Projected status of greater amberjack based on ASPIC with respect to F/F_{MSY} and B/B_{MSY}. The limit and threshold control rules for a rebuilding stock are shown by dashed lines.

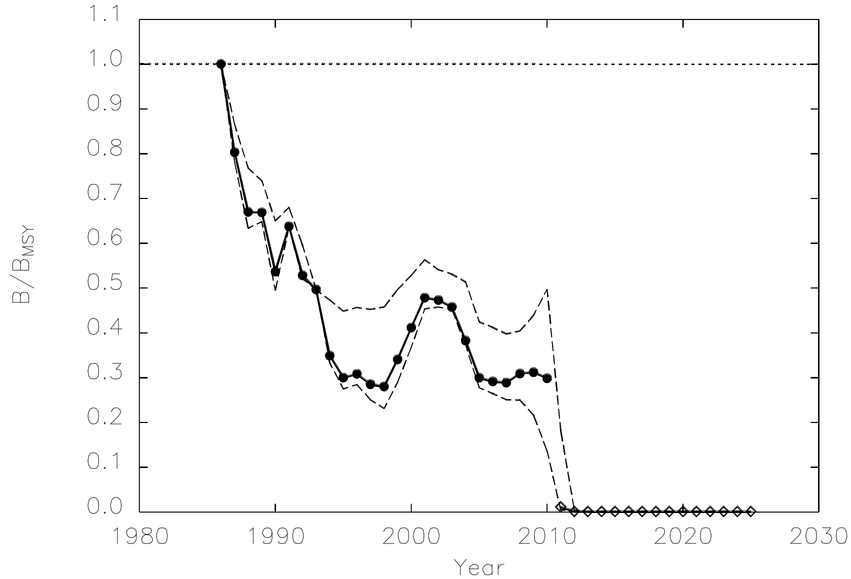

Figure 8.3.1.2a. Estimated and projected relative biomass trajectory (B/B_{MSY}) for greater amberjack for the Continuity case (landings + 20% discard mortality rate, B1/K initial value fixed at 0.5, and equal index weighting) using catch projection as specified under the current rebuilding plan (2010-2011 = 7.0 million pounds, 2012-2025 = 7.9 million pounds). Dashed lines correspond to 10-90th percentiles.

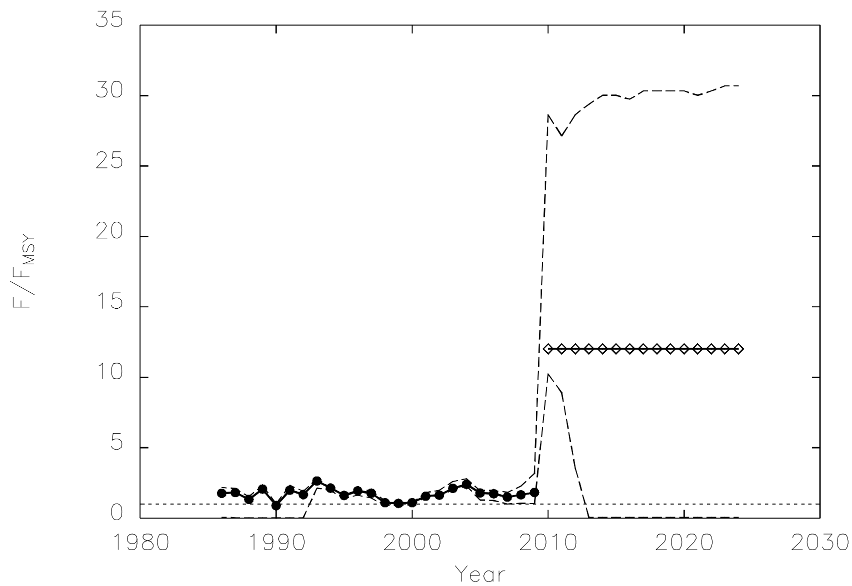

Figure 8.3.1.2b. Estimated relative fishing mortality trajectory (F/F_{MSY}) for greater amberjack for the Continuity case (landings + 20% discard mortality rate, B1/K initial value fixed at 0.5, and equal index weighting) using catch projection as specified under the current rebuilding plan (2010-2011=7.0 million pounds, 2012-2025 = 7.9 million pounds). Dashed lines correspond to 10-90th percentiles.

9. Research Recommendations

Since the previous stock assessment, updated life history studies have been conducted which address some of the research recommendations put forth in SEDAR9. In particular, updated information on reproductive parameters, such as age of sexual maturity, has been presented. Still, additional research needs are pressing for this population as follows:

i. Age-length keys representative of all sectors and regions of the fishery (i.e., commercial, recreational) in the U.S. Gulf of Mexico (in part being addressed by current MARFIN NA05NMF4331071),
ii. Fecundity data needs to be collected by region,
iii. Fishery specific release mortality information is required,
iv. Fishery independent stock evaluations should be considered and in this regard several of the current fishery independent surveys need expanding (e.g. reef fish video, larval index),
v. Routine sampling of the Sargassum communities needs to be carried out to evaluate development of larval and early juvenile abundance indices and,
vi. Develop fishery independent surveys to better characterize natural mortality profiles.

10. Outstanding Items

A Yield per Recruit analysis was not conducted for the SEDAR 2010 update assessment.

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14. Glossary of Terms

ABC - Acceptable Biological Catch as specified by MSRA
ASPIC - Aggregated surplus production model with integrated covariates
B_{MSY} - Biomass Level at MSY
EA - Environmental Assessment
$F_{Current}$ - Current Year Fishing Mortality Rate (F_{2009} in this case)
F_{MSY} - Fishing Mortality Rate at MSY Level
FMP - Fishery Management Plan
F_{OY} - F at optimal yield or $0.75F_{MSY}$
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
MSRA - Magnuson-Stevens Reauthorization Act
MSST - Minimum Stock Size Threshold or $(1\text{-}M)B_{MSY}$ – overfished criterion
NMFS - National Marine Fish Service
OY - Optimal Yield or yield at $0.75F_{MSY}$ for greater amberjack but see MSRA
OFL - Overfishing Limit
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 Program
TAC - Total Allowable Catch
TPW(D) - Texas Parks and Wildlife (Department)
VPA - Virtual Population Analysis
YOY - Young of the year, age-0 fish

SEDAR

Southeast Data, Assessment, and Review

SEDAR 9 Stock Assessment Update Report

Gulf of Mexico Greater Amberjack

SECTION III: Appendix I

SEDAR
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Appendix 1

Post Update Assessment Analysis and Projections

Additional fishing mortality projections were made to evaluate additional management scenarios. Section 8.2.1 presented results of projections made by varying levels of F/F_{2009} (0.0, 0.2, 0.3, 0.45, 0.4, 0.5, and 1.0 times $F_{2009.}$ Additional projections were also made F/F_{2009} levels of: 0.6, 0.09, 0.05, 0.03, and 0.005 to determine at what level of F/F_{2009} the greater amberjack stock could rebuild to $B_{MSY.}$ Appendix Table 1 presents estimates of ASPIC estimated relative biomass (B/B_{MSY}) and projected estimates for the full suite of F/F_{2009} levels evaluated. These results indicate that the greater amberjack stock could attain recovery in 2013 at an F scalar level (F/F_{2009}) = 0.09, corresponding to $F_{(Rebuild)}$ fishing mortality level = 0.05 (0.09*F(2009) = 0.09 x 0.609=0.0548). Appendix Figures 1 - 3 present ASPIC estimated and projected relative biomass (B/B_{MSY}), total biomass, and projected yields for the full suite of F/F_{2009} levels evaluated.

Previously in Section 8.2.1 (Fishing Mortality Projections), projection results under three SFA/MSRA scenarios relative to F_{OY} and MFMT were presented. Scenarios considered were projections based on fishing mortality at: MFMT(F=0.333), 65%MFMT, 75%MFMT and 85%MFMT. Other management scenarios considered subsequently were 60%F_{2009} (=0.365) and at $F_{(Rebuild)}$(=0.055). Note that 75%F_{MSY} corresponds to 75%MFMT (see Table 1.2.1). Appendix Tables 2 and 3 present projected relative biomass (B/B_{MSY}) and projected yields for the full suite of additional SFA/MSSRA evaluations. Appendix Figures 4 and 5 present projected relative biomass (B/B_{MSY}) and yields for the full suite of SFA/MSRA evaluations considered.

Appendix 1. Table 1. ASPIC estimated relative biomass (B/B_{MSY}) and projected values for varying levels of F/F_{2009}. Shaded cells indicate B/B_{MSY}>1.0. F_{2009} = 0.609 (see Table 1.2.1).

Year	1	0.75	0.6	0.5	0.45	0.4	0.3	0.2	0.1	0.09	0.05	0.03	0.005	0
1986	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1987	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
1988	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
1989	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67
1990	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
1991	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64
1992	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
1993	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
1994	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
1995	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
1996	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
1997	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
1998	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
1999	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
2000	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
2001	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
2002	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
2003	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
2004	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
2005	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
2006	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
2007	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
2008	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31

Appendix 1. Table 1(Continued). ASPIC estimated relative biomass (B/B_{MSY}) and projected values for varying levels of F/F_{2009}. Shaded cells indicate B/B_{MSY}>1.0. F_{2009} = 0.609 (see Table 1.2.1).

Year	1	0.75	0.6	0.5	0.45	0.4	0.3	0.2	0.1	0.09	0.05	0.03	0.005	0
2009	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
2010	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
2011	0.29	0.33	0.36	0.38	0.39	0.40	0.43	0.45	0.48	0.48	0.49	0.50	0.51	0.51
2012	0.28	0.36	0.43	0.47	0.50	0.53	0.59	0.65	0.72	0.73	0.76	0.77	0.79	0.80
2013	0.27	0.39	0.49	0.57	0.62	0.66	0.76	0.87	0.99	1.00	1.06	1.08	1.12	1.13
2014	0.26	0.42	0.56	0.67	0.73	0.79	0.93	1.08	1.25	1.27	1.34	1.37	1.42	1.43
2015	0.25	0.45	0.62	0.76	0.83	0.91	1.08	1.26	1.46	1.48	1.56	1.60	1.65	1.66
2016	0.24	0.48	0.68	0.83	0.92	1.01	1.20	1.39	1.60	1.62	1.70	1.75	1.80	1.81
2017	0.24	0.50	0.72	0.90	0.99	1.08	1.28	1.49	1.69	1.71	1.79	1.84	1.89	1.90
2018	0.23	0.52	0.76	0.95	1.04	1.14	1.34	1.54	1.75	1.77	1.85	1.89	1.94	1.95
2019	0.23	0.54	0.79	0.98	1.08	1.18	1.38	1.58	1.78	1.80	1.88	1.91	1.96	1.97
2020	0.22	0.55	0.82	1.01	1.11	1.21	1.41	1.60	1.80	1.81	1.89	1.93	1.98	1.99
2021	0.22	0.56	0.84	1.03	1.13	1.23	1.42	1.62	1.81	1.82	1.90	1.94	1.98	1.99
2022	0.22	0.58	0.85	1.05	1.15	1.24	1.43	1.62	1.81	1.83	1.90	1.94	1.99	2.00
2023	0.21	0.58	0.87	1.06	1.16	1.25	1.44	1.63	1.81	1.83	1.91	1.94	1.99	2.00
2024	0.21	0.59	0.88	1.07	1.16	1.26	1.44	1.63	1.82	1.83	1.91	1.94	1.99	2.00
2025	0.21	0.60	0.88	1.07	1.17	1.26	1.45	1.63	1.82	1.83	1.91	1.94	1.99	2.00

Appendix 1. Table 2. ASPIC estimated relative biomass (B/B_{MSY}) and projected relative biomass (B/B_{MSY}) for different values of F/F_{2009} corresponding to the SFA/MSRA evaluation scenarios presented in Table 1.2.1 for the greater amberjack stock. The column labeled MFMT corresponds to projections made with the MFMT fishing mortality level of F. Shadings indicates where $B1/B_{MSY}$ >1.0.

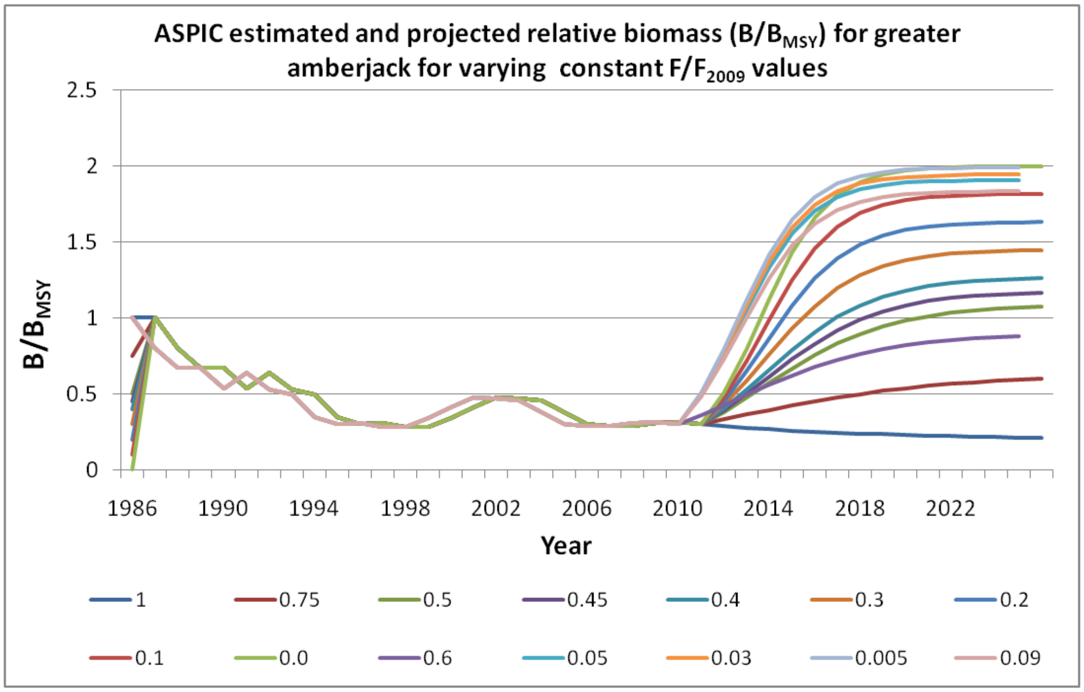
Year	MFMT = 0.333	65% MFMT	75% MFMT=0.250	85% MFMT	60% (F_{2009}) =0.365	$F_{(Rebuild)}$ =0.055
1986	1.00	1.00	1.00	1.00	1.00	1.00
1987	0.80	0.80	0.80	0.80	0.80	0.80
1988	0.67	0.67	0.67	0.67	0.67	0.67
1989	0.67	0.67	0.67	0.67	0.67	0.67
1990	0.54	0.54	0.54	0.54	0.54	0.54
1991	0.64	0.64	0.64	0.64	0.64	0.64
1992	0.53	0.53	0.53	0.53	0.53	0.53
1993	0.50	0.50	0.50	0.50	0.50	0.50
1994	0.35	0.35	0.35	0.35	0.35	0.35
1995	0.30	0.30	0.30	0.30	0.30	0.30
1996	0.31	0.31	0.31	0.31	0.31	0.31
1997	0.28	0.28	0.28	0.28	0.28	0.28
1998	0.28	0.28	0.28	0.28	0.28	0.28
1999	0.34	0.34	0.34	0.34	0.34	0.34
2000	0.41	0.41	0.41	0.41	0.41	0.41
2001	0.48	0.48	0.48	0.48	0.48	0.48
2002	0.47	0.47	0.47	0.47	0.47	0.47
2003	0.46	0.46	0.46	0.46	0.46	0.46
2004	0.38	0.38	0.38	0.38	0.38	0.38
2005	0.30	0.30	0.30	0.30	0.30	0.30
2006	0.29	0.29	0.29	0.29	0.29	0.29
2007	0.29	0.29	0.29	0.29	0.29	0.29
2008	0.31	0.31	0.31	0.31	0.31	0.31
2009	0.31	0.31	0.31	0.31	0.31	0.31

Appendix 1. Table 2 (Continued). ASPIC estimated relative biomass (B/B_{MSY}) and projected relative biomass (B/B_{MSY}) for different values of F/F_{2009} corresponding to the SFA/MSRA evaluation scenarios presented in Table 1.2.1 for the greater amberjack stock. The column labeled MFMT corresponds to projections made with the MFMT fishing mortality level of F. Shadings indicates where $B1/B_{MSY}$ >1.0.

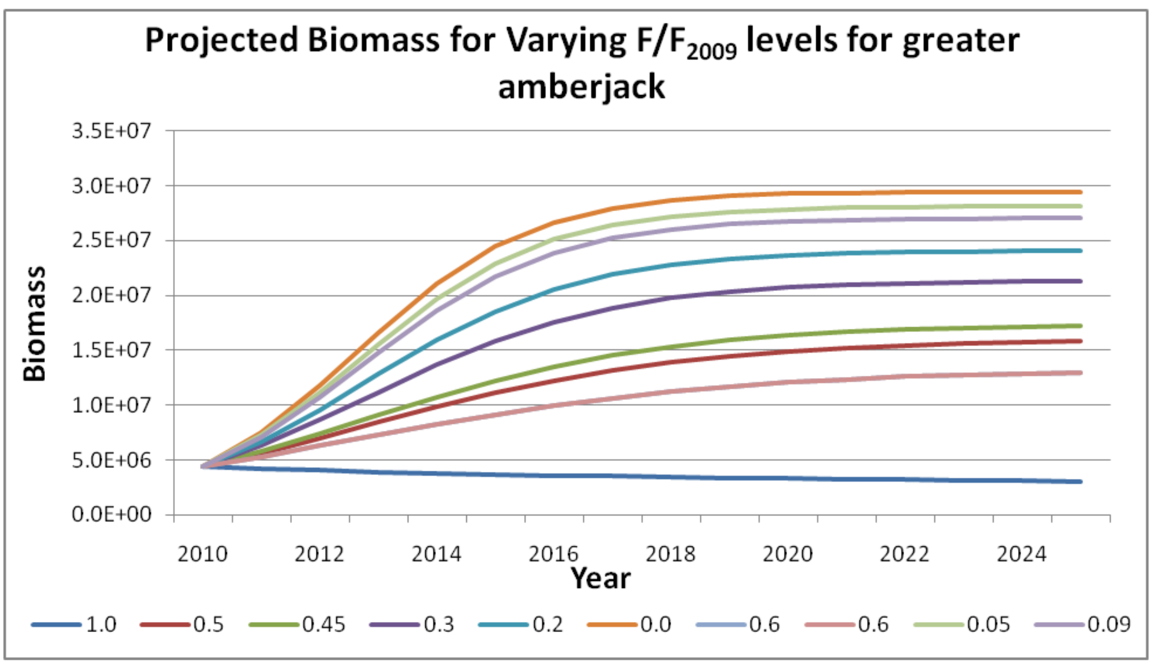
Year	**MFMT = 0.333**	**65% MFMT=0.216**	**75% MFMT=0.250 (=75%F_{MSY})**	**85% MFMT=0.283**	**60% (F_{2009}) =0.365**	**F(Rebuild) =0.055**
2010	0.30	0.30	0.30	0.30	0.30	0.30
2011	0.37	0.41	0.40	0.39	0.36	0.48
2012	0.45	0.55	0.52	0.49	0.43	0.73
2013	0.53	0.70	0.65	0.60	0.49	1.00
2014	0.62	0.85	0.78	0.71	0.56	1.27
2015	0.69	0.98	0.89	0.81	0.62	1.48
2016	0.76	1.09	0.99	0.89	0.68	1.62
2017	0.81	1.17	1.06	0.96	0.72	1.71
2018	0.86	1.23	1.12	1.01	0.76	1.77
2019	0.89	1.27	1.16	1.05	0.79	1.80
2020	0.92	1.30	1.19	1.08	0.82	1.81
2021	0.94	1.32	1.21	1.10	0.84	1.82
2022	0.96	1.33	1.22	1.12	0.85	1.83
2023	0.97	1.34	1.23	1.13	0.87	1.83
2024	0.98	1.34	1.24	1.14	0.88	1.83
2025	0.98	1.34	1.24	1.14	0.88	1.83

Appendix 1. Table 3. ASPIC projected yields for different values of F/F_{2009} corresponding to the SFA/MSRA evaluation scenarios. The column labeled MFMT corresponds to projections made with the MFMT fishing mortality level of F (0.33). Units are pounds (whole weight).

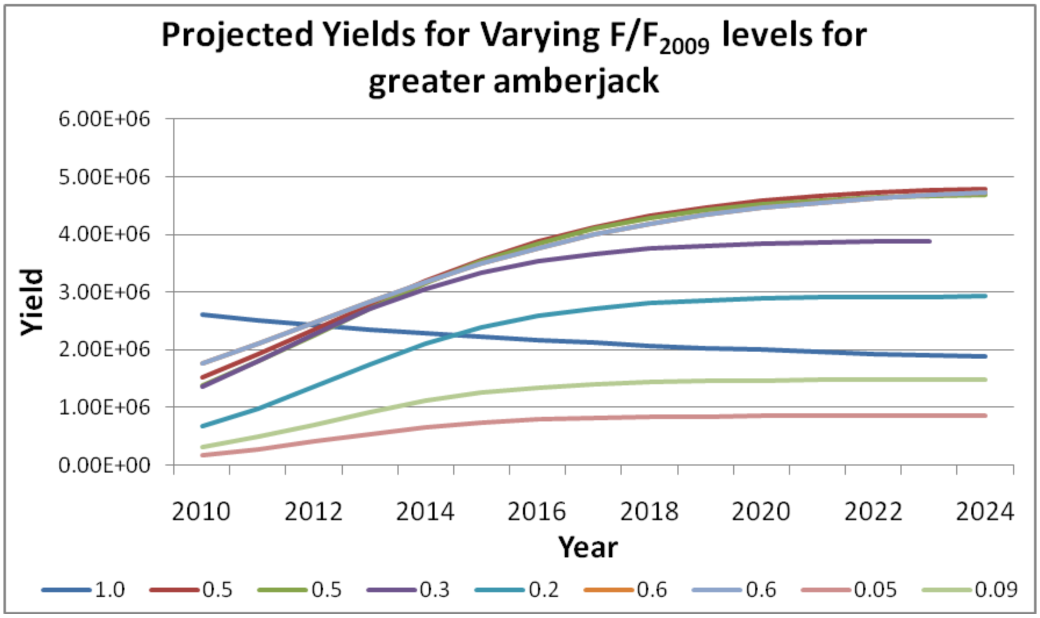
Year	MFMT	65% MFMT	75% MFMT	85% MFMT	60% (F_{2009})	F($_{Rebuild}$)
2010	1.64E+06	1.13E+06	1.28E+06	1.43E+06	1.77E+06	3.10E+05
2011	2.02E+06	1.54E+06	1.69E+06	1.83E+06	2.12E+06	4.84E+05
2012	2.42E+06	2.00E+06	2.16E+06	2.28E+06	2.48E+06	6.98E+05
2013	2.82E+06	2.48E+06	2.63E+06	2.73E+06	2.84E+06	9.18E+05
2014	3.20E+06	2.92E+06	3.07E+06	3.16E+06	3.18E+06	1.11E+06
2015	3.55E+06	3.31E+06	3.46E+06	3.55E+06	3.49E+06	1.25E+06
2016	3.85E+06	3.61E+06	3.78E+06	3.86E+06	3.76E+06	1.35E+06
2017	4.10E+06	3.83E+06	4.02E+06	4.12E+06	3.99E+06	1.41E+06
2018	4.30E+06	3.99E+06	4.20E+06	4.31E+06	4.19E+06	1.44E+06
2019	4.45E+06	4.09E+06	4.32E+06	4.45E+06	4.34E+06	1.46E+06
2020	4.57E+06	4.17E+06	4.41E+06	4.55E+06	4.46E+06	1.47E+06
2021	4.66E+06	4.21E+06	4.47E+06	4.62E+06	4.56E+06	1.47E+06
2022	4.72E+06	4.24E+06	4.51E+06	4.68E+06	4.63E+06	1.48E+06
2023	4.77E+06	4.26E+06	4.54E+06	4.71E+06	4.68E+06	1.48E+06
2024	4.81E+06	4.28E+06	4.56E+06	4.74E+06	4.73E+06	1.48E+06



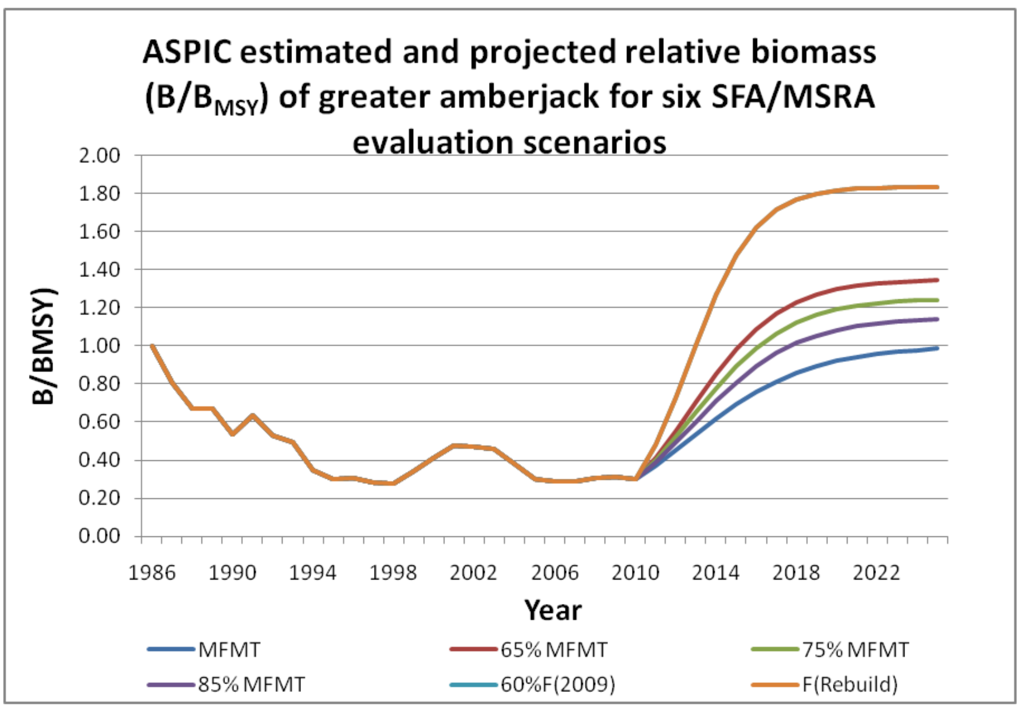
Appendix 1. Figure 1. ASPIC estimated relative biomass (B/B_{MSY}) and projected relative biomass (B/B_{MSY}) values for varying values of constant F/F_{2009}. Scenario corresponding to 0.09 corresponds to $F_{Rebuild}$ evaluation scenario.



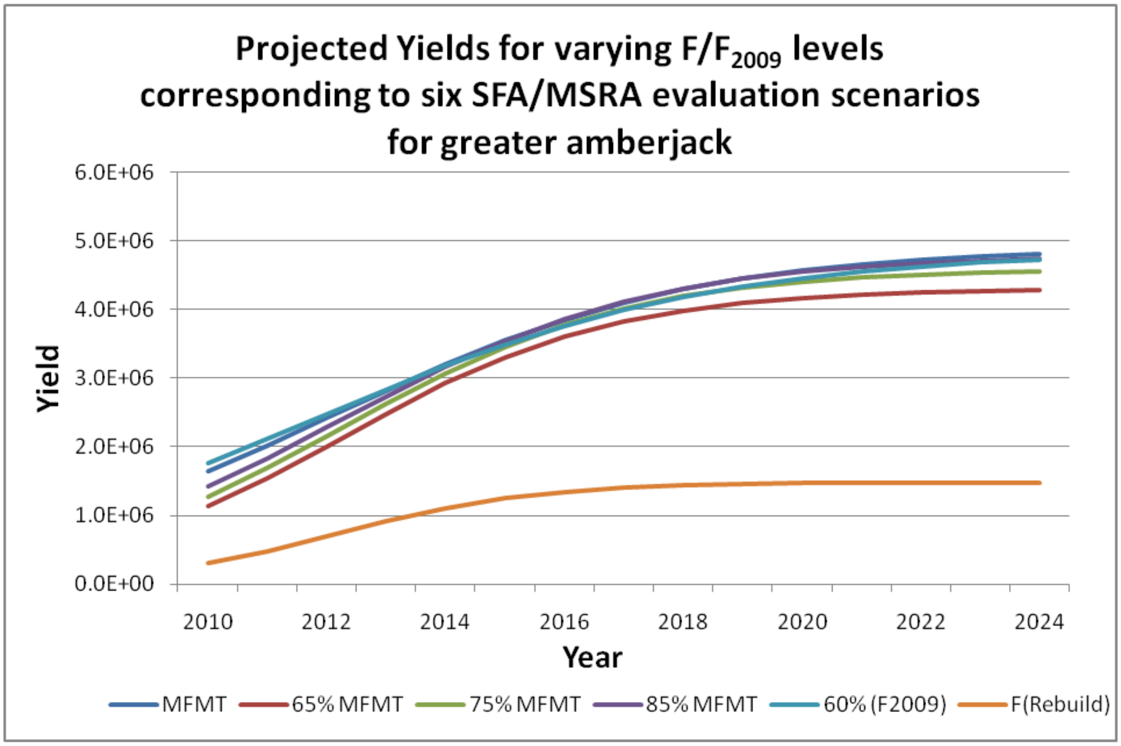
Appendix 1. Figure 2. Projected biomass for varying levels of constant F/F_{2009}. Units are millions of pounds (whole weight). Scenario corresponding to 0.09 corresponds to $F_{Rebuild}$ evaluation scenario.



Appendix 1. Figure 3. ASPIC projected yields for varying levels of constant F/F_{2009}. Units are millions of pounds (whole weight). Scenario corresponding to 0.09 corresponds to $F_{Rebuild}$ evaluation scenario.



Appendix 1. Figure 4. ASPIC estimated and projected relative biomass (B/B_{MSY}) for greater amberjack for six SFA/MSRA evaluation scenarios presented in Table 1.2.1 for the greater amberjack stock. The column labeled MFMT corresponds to projections made with the MFMT fishing mortality level of F. MFMT=0.333, $F_{Rebuild}$=0.055.



Appendix 1. Figure 5. ASPIC projected yield for different values of F/F_{2009} corresponding to the SFA/MSRA scenarios presented in Table 1.2.1 for the greater amberjack stock. The column labeled MFMT corresponds to projections made with the MFMT fishing mortality level of F. Units are millions of pounds (whole weight). MFMT=0.333, $F_{Rebuild}$=0.055.

Appendix 1. List of Tables.

Appendix 1. List of Figures

SEDAR

Southeast Data, Assessment, and Review

SEDAR 9 Stock Assessment Update Report

Gulf of Mexico Greater Amberjack

SECTION IV: Appendix II

Added 24 March, 2011

SEDAR
4055 Faber Place Drive, Suite 201
North Charleston, SC 29405

Appendix 2

SEDAR 9 Gulf of Mexico Greater Amberjack Stock Assessment Update Projections Continued

Projections presented in the SEDAR 9 SAR Update document were based on catch and/or fishing mortality projections from 2010 forward. As the update assessment was completed late in 2010 and would not be presented to managers in March 2011. Because any additional required management changes would not be implemented until 2011, projections beginning in 2011 were also of interest. Additional information was available with which to generate preliminary estimates of total removals (landings + dead discards) for 2010, and thus to update the stock status projections from 2011 forward. Those projection results are presented in this Appendix document. All projections followed procedures presented earlier in Section 8 of the SEDAR 9 SEDAR Update document and specifically to sections 8.2.1 for fishing mortality based projections. Appendix Tables 1-3 and Appendix 2, Figures 1-3 presented results for varying SFA/MSRA evaluation scenarios varying future fishing mortality in the last year of known data. All projections assumed 2010 catch known. In addition, additional catch based projections were run, incorporating the preliminary estimate of catch in 2010 as well as varying levels of constant catch. Appendix 2, Tables 4-5 and Figures 4-5 present updated catch based projection analyses.

Appendix 2. Table 1. ASPIC estimated relative biomass (B/B_{MSY}) and projected relative biomass (B/B_{MSY}) for varying values of F_{Year}/F_{2009} for 2011+ corresponding to SFA/MSRA evaluation scenarios for the greater amberjack stock. The column labeled MFMT corresponds to projections made with the MFMT fishing mortality level of F. Shadings indicates where B/BMSY >1.0. Projections assumed 2010 catch = 2.493mp.

Year	MFMT	5%MFMT	10%MFMT	50%MFMT	65% MFMT	75% MFMT	85% MFMT	F=0.0 * (F2009)
1986	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
1987	8.03E-01	8.03E-01	8.03E-01	8.03E-01	8.03E-01	8.03E-01	8.03E-01	8.03E-01
1988	6.70E-01	6.70E-01	6.70E-01	6.70E-01	6.70E-01	6.70E-01	6.70E-01	6.70E-01
1989	6.68E-01	6.68E-01	6.68E-01	6.68E-01	6.68E-01	6.68E-01	6.68E-01	6.68E-01
1990	5.36E-01	5.36E-01	5.36E-01	5.36E-01	5.36E-01	5.36E-01	5.36E-01	5.36E-01
1991	6.37E-01	6.37E-01	6.37E-01	6.37E-01	6.37E-01	6.37E-01	6.37E-01	6.37E-01
1992	5.28E-01	5.28E-01	5.28E-01	5.28E-01	5.28E-01	5.28E-01	5.28E-01	5.28E-01
1993	4.96E-01	4.96E-01	4.96E-01	4.96E-01	4.96E-01	4.96E-01	4.96E-01	4.96E-01
1994	3.49E-01	3.49E-01	3.49E-01	3.49E-01	3.49E-01	3.49E-01	3.49E-01	3.49E-01
1995	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01
1996	3.08E-01	3.08E-01	3.08E-01	3.08E-01	3.08E-01	3.08E-01	3.08E-01	3.08E-01
1997	2.85E-01	2.85E-01	2.85E-01	2.85E-01	2.85E-01	2.85E-01	2.85E-01	2.85E-01
1998	2.79E-01	2.79E-01	2.79E-01	2.79E-01	2.79E-01	2.79E-01	2.79E-01	2.79E-01
1999	3.40E-01	3.40E-01	3.40E-01	3.40E-01	3.40E-01	3.40E-01	3.40E-01	3.40E-01
2000	4.11E-01	4.11E-01	4.11E-01	4.11E-01	4.11E-01	4.11E-01	4.11E-01	4.11E-01
2001	4.78E-01	4.78E-01	4.78E-01	4.78E-01	4.78E-01	4.78E-01	4.78E-01	4.78E-01
2002	4.73E-01	4.73E-01	4.73E-01	4.73E-01	4.73E-01	4.73E-01	4.73E-01	4.73E-01
2003	4.57E-01	4.57E-01	4.57E-01	4.57E-01	4.57E-01	4.57E-01	4.57E-01	4.57E-01
2004	3.82E-01	3.82E-01	3.82E-01	3.82E-01	3.82E-01	3.82E-01	3.82E-01	3.82E-01
2005	2.99E-01	2.99E-01	2.99E-01	2.99E-01	2.99E-01	2.99E-01	2.99E-01	2.99E-01
2006	2.91E-01	2.91E-01	2.91E-01	2.91E-01	2.91E-01	2.91E-01	2.91E-01	2.91E-01
2007	2.88E-01	2.88E-01	2.88E-01	2.88E-01	2.88E-01	2.88E-01	2.88E-01	2.88E-01
2008	3.08E-01	3.08E-01	3.08E-01	3.08E-01	3.08E-01	3.08E-01	3.08E-01	3.08E-01
2009	3.11E-01	3.11E-01	3.11E-01	3.11E-01	3.11E-01	3.11E-01	3.11E-01	3.11E-01
2010	2.98E-01	2.98E-01	2.98E-01	2.98E-01	2.98E-01	2.98E-01	2.98E-01	2.98E-01
2011	2.97E-01	2.97E-01	2.97E-01	2.97E-01	2.97E-01	2.97E-01	2.97E-01	2.97E-01
2012	3.71E-01	4.92E-01	4.91E-01	4.33E-01	4.14E-01	4.01E-01	3.88E-01	5.06E-01
2013	4.51E-01	7.56E-01	7.52E-01	6.01E-01	5.52E-01	5.21E-01	4.92E-01	7.94E-01
2014	5.34E-01	1.06E+00	1.05E+00	7.86E-01	7.02E-01	6.50E-01	6.01E-01	1.12E+00
2015	6.15E-01	1.34E+00	1.33E+00	9.67E-01	8.50E-01	7.77E-01	7.09E-01	1.43E+00
2016	6.90E-01	1.56E+00	1.55E+00	1.12E+00	9.81E-01	8.92E-01	8.07E-01	1.66E+00
2017	7.56E-01	1.70E+00	1.69E+00	1.25E+00	1.09E+00	9.88E-01	8.92E-01	1.81E+00
2018	8.12E-01	1.79E+00	1.78E+00	1.34E+00	1.17E+00	1.06E+00	9.60E-01	1.90E+00
2019	8.58E-01	1.85E+00	1.84E+00	1.40E+00	1.23E+00	1.12E+00	1.01E+00	1.95E+00
2020	8.94E-01	1.88E+00	1.87E+00	1.44E+00	1.27E+00	1.16E+00	1.05E+00	1.97E+00
2021	9.22E-01	1.89E+00	1.88E+00	1.46E+00	1.30E+00	1.19E+00	1.08E+00	1.99E+00
2022	9.42E-01	1.90E+00	1.89E+00	1.48E+00	1.32E+00	1.21E+00	1.10E+00	1.99E+00
2023	9.58E-01	1.90E+00	1.90E+00	1.49E+00	1.33E+00	1.22E+00	1.12E+00	2.00E+00
2024	9.70E-01	1.91E+00	1.90E+00	1.49E+00	1.34E+00	1.23E+00	1.13E+00	2.00E+00
2025	9.78E-01	1.91E+00	1.90E+00	1.49E+00	1.34E+00	1.24E+00	1.13E+00	2.00E+00

Appendix 2. Table 2. ASPIC estimated absolute biomass and projected absolute biomass for different values of F_{Year}/F_{2009} for 2011+ corresponding to SFA/MSRA evaluation scenarios for the greater amberjack stock. The column labeled MFMT corresponds to projections made with the MFMT fishing mortality level of F. Shadings indicates where B/B_{MSY} >1.0. Projections assumed 2010 catch = 2.493mp. TAC 2010=7.0mp as set by Secretarial Amendment 2 (July 2003).

Year	MFMT	5%MFMT	10%MFMT	50%MFMT	65% MFMT	75% MFMT	85% MFMT	F=0.0 * (F2009)
1986	1.47E+07	1.47E+07	1.47E+07	1.47E+07	1.47E+07	1.47E+07	1.47E+07	1.47E+07
1987	1.18E+07	1.18E+07	1.18E+07	1.18E+07	1.18E+07	1.18E+07	1.18E+07	1.18E+07
1988	9.87E+06	9.87E+06	9.87E+06	9.87E+06	9.87E+06	9.87E+06	9.87E+06	9.87E+06
1989	9.85E+06	9.85E+06	9.85E+06	9.85E+06	9.85E+06	9.85E+06	9.85E+06	9.85E+06
1990	7.90E+06	7.90E+06	7.90E+06	7.90E+06	7.90E+06	7.90E+06	7.90E+06	7.90E+06
1991	9.39E+06	9.39E+06	9.39E+06	9.39E+06	9.39E+06	9.39E+06	9.39E+06	9.39E+06
1992	7.78E+06	7.78E+06	7.78E+06	7.78E+06	7.78E+06	7.78E+06	7.78E+06	7.78E+06
1993	7.31E+06	7.31E+06	7.31E+06	7.31E+06	7.31E+06	7.31E+06	7.31E+06	7.31E+06
1994	5.13E+06	5.13E+06	5.13E+06	5.13E+06	5.13E+06	5.13E+06	5.13E+06	5.13E+06
1995	4.41E+06	4.41E+06	4.41E+06	4.41E+06	4.41E+06	4.41E+06	4.41E+06	4.41E+06
1996	4.53E+06	4.53E+06	4.53E+06	4.53E+06	4.53E+06	4.53E+06	4.53E+06	4.53E+06
1997	4.19E+06	4.19E+06	4.19E+06	4.19E+06	4.19E+06	4.19E+06	4.19E+06	4.19E+06
1998	4.12E+06	4.12E+06	4.12E+06	4.12E+06	4.12E+06	4.12E+06	4.12E+06	4.12E+06
1999	5.01E+06	5.01E+06	5.01E+06	5.01E+06	5.01E+06	5.01E+06	5.01E+06	5.01E+06
2000	6.06E+06	6.06E+06	6.06E+06	6.06E+06	6.06E+06	6.06E+06	6.06E+06	6.06E+06
2001	7.04E+06	7.04E+06	7.04E+06	7.04E+06	7.04E+06	7.04E+06	7.04E+06	7.04E+06
2002	6.97E+06	6.97E+06	6.97E+06	6.97E+06	6.97E+06	6.97E+06	6.97E+06	6.97E+06
2003	6.73E+06	6.73E+06	6.73E+06	6.73E+06	6.73E+06	6.73E+06	6.73E+06	6.73E+06
2004	5.63E+06	5.63E+06	5.63E+06	5.63E+06	5.63E+06	5.63E+06	5.63E+06	5.63E+06
2005	4.41E+06	4.41E+06	4.41E+06	4.41E+06	4.41E+06	4.41E+06	4.41E+06	4.41E+06
2006	4.28E+06	4.28E+06	4.28E+06	4.28E+06	4.28E+06	4.28E+06	4.28E+06	4.28E+06
2007	4.25E+06	4.25E+06	4.25E+06	4.25E+06	4.25E+06	4.25E+06	4.25E+06	4.25E+06
2008	4.54E+06	4.54E+06	4.54E+06	4.54E+06	4.54E+06	4.54E+06	4.54E+06	4.54E+06
2009	4.59E+06	4.59E+06	4.59E+06	4.59E+06	4.59E+06	4.59E+06	4.59E+06	4.59E+06
2010	4.39E+06	4.39E+06	4.39E+06	4.39E+06	4.39E+06	4.39E+06	4.39E+06	4.39E+06
2011	4.37E+06	4.37E+06	4.37E+06	4.37E+06	4.37E+06	4.37E+06	4.37E+06	4.37E+06
2012	5.46E+06	7.34E+06	7.23E+06	6.38E+06	6.09E+06	5.90E+06	5.72E+06	7.46E+06
2013	6.64E+06	1.14E+07	1.11E+07	8.86E+06	8.13E+06	7.68E+06	7.25E+06	1.17E+07
2014	7.86E+06	1.60E+07	1.55E+07	1.16E+07	1.03E+07	9.58E+06	8.86E+06	1.66E+07
2015	9.06E+06	2.03E+07	1.96E+07	1.42E+07	1.25E+07	1.14E+07	1.04E+07	2.10E+07
2016	1.02E+07	2.36E+07	2.28E+07	1.66E+07	1.45E+07	1.31E+07	1.19E+07	2.44E+07
2017	1.11E+07	2.58E+07	2.50E+07	1.84E+07	1.60E+07	1.46E+07	1.31E+07	2.66E+07
2018	1.20E+07	2.71E+07	2.63E+07	1.97E+07	1.72E+07	1.57E+07	1.41E+07	2.79E+07
2019	1.26E+07	2.79E+07	2.71E+07	2.06E+07	1.81E+07	1.65E+07	1.49E+07	2.87E+07
2020	1.32E+07	2.83E+07	2.75E+07	2.11E+07	1.87E+07	1.71E+07	1.55E+07	2.90E+07
2021	1.36E+07	2.85E+07	2.77E+07	2.15E+07	1.91E+07	1.75E+07	1.59E+07	2.93E+07
2022	1.39E+07	2.86E+07	2.79E+07	2.17E+07	1.94E+07	1.78E+07	1.62E+07	2.94E+07
2023	1.41E+07	2.87E+07	2.79E+07	2.19E+07	1.96E+07	1.80E+07	1.65E+07	2.94E+07
2024	1.43E+07	2.87E+07	2.80E+07	2.20E+07	1.97E+07	1.82E+07	1.66E+07	2.94E+07

2025	1.44E+07	2.87E+07	2.80E+07	2.20E+07	1.98E+07	1.82E+07	1.67E+07	2.95E+07

Appendix 2. Table 3. ASPIC projected yields for different values of F/F_{2009} corresponding to SFA/MSRA evaluation scenarios for the greater amberjack stock. The column labeled MFMT corresponds to projections made with the MFMT fishing mortality level of F. Shadings indicates where $B1/B_{MSY}$ >1.0. Projections assumed 2010 catch = 2.493 mp.

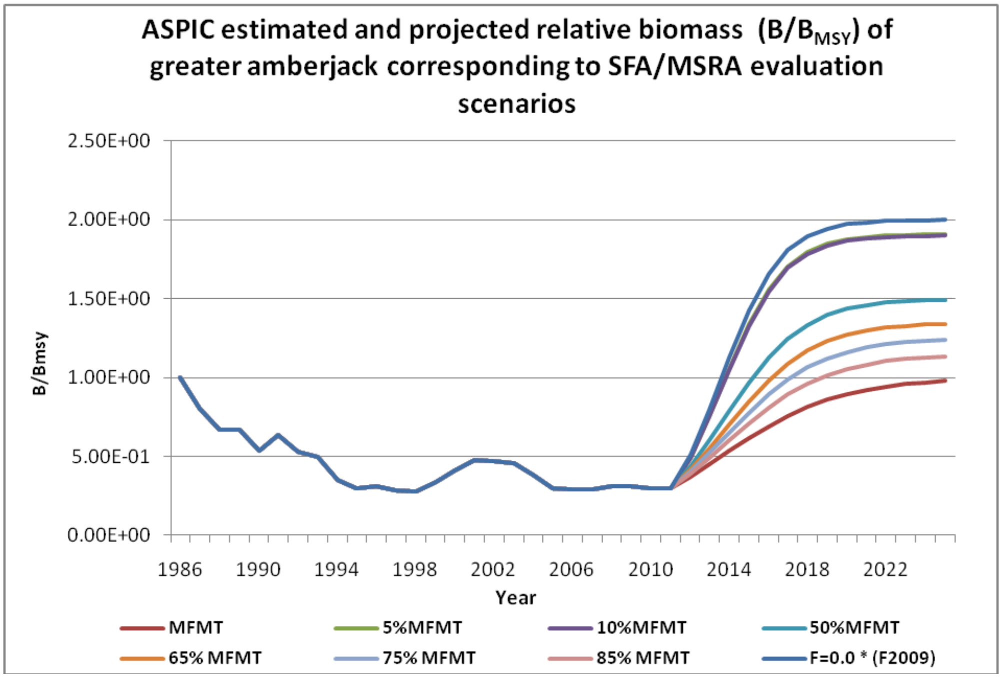
Year	MFMT	5%MFMT	10%MFMT	50%MFMT	65% MFMT	75% MFMT	85% MFMT	F=0.0 * (F2009)
2010	2.49E+06	2.49E+06	2.49E+06	2.49E+06	2.49E+06	2.49E+06	2.49E+06	2.49E+06
2011	1.63E+06	9.57E+04	1.90E+05	8.87E+05	1.12E+06	1.28E+06	1.42E+06	0.00E+00
2012	2.01E+06	1.54E+05	3.02E+05	1.26E+06	1.53E+06	1.69E+06	1.83E+06	0.00E+00
2013	2.41E+06	2.27E+05	4.40E+05	1.70E+06	2.00E+06	2.15E+06	2.28E+06	0.00E+00
2014	2.81E+06	3.02E+05	5.83E+05	2.15E+06	2.47E+06	2.62E+06	2.73E+06	0.00E+00
2015	3.20E+06	3.66E+05	7.06E+05	2.57E+06	2.92E+06	3.07E+06	3.16E+06	0.00E+00
2016	3.55E+06	4.12E+05	7.95E+05	2.91E+06	3.30E+06	3.46E+06	3.54E+06	0.00E+00
2017	3.85E+06	4.40E+05	8.53E+05	3.17E+06	3.60E+06	3.78E+06	3.86E+06	0.00E+00
2018	4.09E+06	4.57E+05	8.87E+05	3.35E+06	3.83E+06	4.02E+06	4.11E+06	0.00E+00
2019	4.29E+06	4.67E+05	9.07E+05	3.47E+06	3.99E+06	4.20E+06	4.31E+06	0.00E+00
2020	4.45E+06	4.72E+05	9.18E+05	3.55E+06	4.09E+06	4.32E+06	4.45E+06	0.00E+00
2021	4.57E+06	4.74E+05	9.23E+05	3.60E+06	4.17E+06	4.41E+06	4.55E+06	0.00E+00
2022	4.66E+06	4.76E+05	9.26E+05	3.63E+06	4.21E+06	4.47E+06	4.62E+06	0.00E+00
2023	4.72E+06	4.76E+05	9.28E+05	3.64E+06	4.24E+06	4.51E+06	4.67E+06	0.00E+00
2024	4.77E+06	4.77E+05	9.29E+05	3.66E+06	4.26E+06	4.54E+06	4.71E+06	0.00E+00

Appendix 2. Table 4. ASPIC estimated relative biomass (B/B_{MSY}) and projected relative biomass (B/B_{MSY}) for varying constant catch scenarios from 2011 forward for the greater amberjack stock. Shadings indicates where $B/B_{MSY} > 1.0$

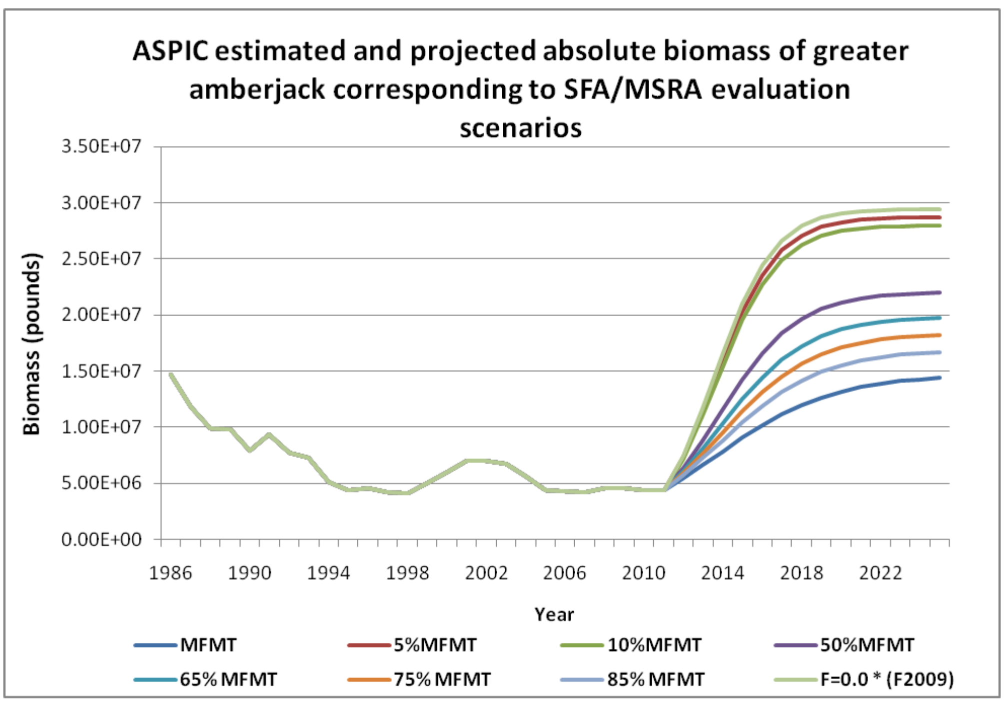
Year	Rebuilding Schedule	Constant Catch of 2010	Constant Catch 2010 *0.99	Constant Catch 2010 *0.95	Constant Catch 2010 *0.9	Constant Catch 2010*.8	Constant Catch 2010*0.5
1986	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
1987	8.03E-01	8.03E-01	8.03E-01	8.03E-01	8.03E-01	8.03E-01	8.03E-01
1988	6.70E-01	6.70E-01	6.70E-01	6.70E-01	6.70E-01	6.70E-01	6.70E-01
1989	6.68E-01	6.68E-01	6.68E-01	6.68E-01	6.68E-01	6.68E-01	6.68E-01
1990	5.36E-01	5.36E-01	5.36E-01	5.36E-01	5.36E-01	5.36E-01	5.36E-01
1991	6.37E-01	6.37E-01	6.37E-01	6.37E-01	6.37E-01	6.37E-01	6.37E-01
1992	5.28E-01	5.28E-01	5.28E-01	5.28E-01	5.28E-01	5.28E-01	5.28E-01
1993	4.96E-01	4.96E-01	4.96E-01	4.96E-01	4.96E-01	4.96E-01	4.96E-01
1994	3.49E-01	3.49E-01	3.49E-01	3.49E-01	3.49E-01	3.49E-01	3.49E-01
1995	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01
1996	3.08E-01	3.08E-01	3.08E-01	3.08E-01	3.08E-01	3.08E-01	3.08E-01
1997	2.85E-01	2.85E-01	2.85E-01	2.85E-01	2.85E-01	2.85E-01	2.85E-01
1998	2.79E-01	2.79E-01	2.79E-01	2.79E-01	2.79E-01	2.79E-01	2.79E-01
1999	3.40E-01	3.40E-01	3.40E-01	3.40E-01	3.40E-01	3.40E-01	3.40E-01
2000	4.11E-01	4.11E-01	4.11E-01	4.11E-01	4.11E-01	4.11E-01	4.11E-01
2001	4.78E-01	4.78E-01	4.78E-01	4.78E-01	4.78E-01	4.78E-01	4.78E-01
2002	4.73E-01	4.73E-01	4.73E-01	4.73E-01	4.73E-01	4.73E-01	4.73E-01
2003	4.57E-01	4.57E-01	4.57E-01	4.57E-01	4.57E-01	4.57E-01	4.57E-01
2004	3.82E-01	3.82E-01	3.82E-01	3.82E-01	3.82E-01	3.82E-01	3.82E-01
2005	2.99E-01	2.99E-01	2.99E-01	2.99E-01	2.99E-01	2.99E-01	2.99E-01
2006	2.91E-01	2.91E-01	2.91E-01	2.91E-01	2.91E-01	2.91E-01	2.91E-01
2007	2.88E-01	2.88E-01	2.88E-01	2.88E-01	2.88E-01	2.88E-01	2.88E-01
2008	3.08E-01	3.08E-01	3.08E-01	3.08E-01	3.08E-01	3.08E-01	3.08E-01
2009	3.11E-01	3.11E-01	3.11E-01	3.11E-01	3.11E-01	3.11E-01	3.11E-01
2010	2.98E-01	2.98E-01	2.98E-01	2.98E-01	2.98E-01	2.98E-01	2.98E-01
2011	2.97E-01	2.97E-01	2.99E-01	3.08E-01	3.19E-01	3.41E-01	4.05E-01
2012	2.03E-01	2.95E-01	3.01E-01	3.24E-01	3.52E-01	4.07E-01	5.62E-01
2013	7.07E-03	2.93E-01	3.05E-01	3.50E-01	4.04E-01	5.06E-01	7.72E-01
2014	2.52E-04	2.89E-01	3.10E-01	3.89E-01	4.80E-01	6.42E-01	1.01E+00
2015	8.97E-06	2.83E-01	3.18E-01	4.48E-01	5.88E-01	8.13E-01	1.25E+00
2016	3.19E-07	2.72E-01	3.32E-01	5.34E-01	7.29E-01	1.01E+00	1.46E+00
2017	1.14E-08	2.55E-01	3.53E-01	6.49E-01	8.96E-01	1.20E+00	1.61E+00
2018	4.05E-10	2.27E-01	3.86E-01	7.95E-01	1.08E+00	1.37E+00	1.71E+00
2019	1.44E-11	1.78E-01	4.36E-01	9.61E-01	1.25E+00	1.50E+00	1.77E+00
2020	5.14E-13	8.72E-02	5.08E-01	1.13E+00	1.39E+00	1.60E+00	1.81E+00
2021	1.83E-14	3.08E-03	6.07E-01	1.29E+00	1.50E+00	1.66E+00	1.83E+00
2022	6.52E-16	1.10E-04	7.36E-01	1.42E+00	1.58E+00	1.70E+00	1.85E+00
2023	2.32E-17	3.91E-06	8.88E-01	1.52E+00	1.64E+00	1.73E+00	1.85E+00
2024	8.26E-19	1.39E-07	1.05E+00	1.59E+00	1.68E+00	1.75E+00	1.86E+00
2025	2.94E-20	4.96E-09	1.21E+00	1.63E+00	1.70E+00	1.76E+00	1.86E+00

Appendix 2. Table 5. ASPIC estimated absolute biomass and projected absolute biomass for varying constant catch scenarios from 2011 forward for the greater amberjack stock. Shadings indicates where $B/B_{MSY} > 1.0$

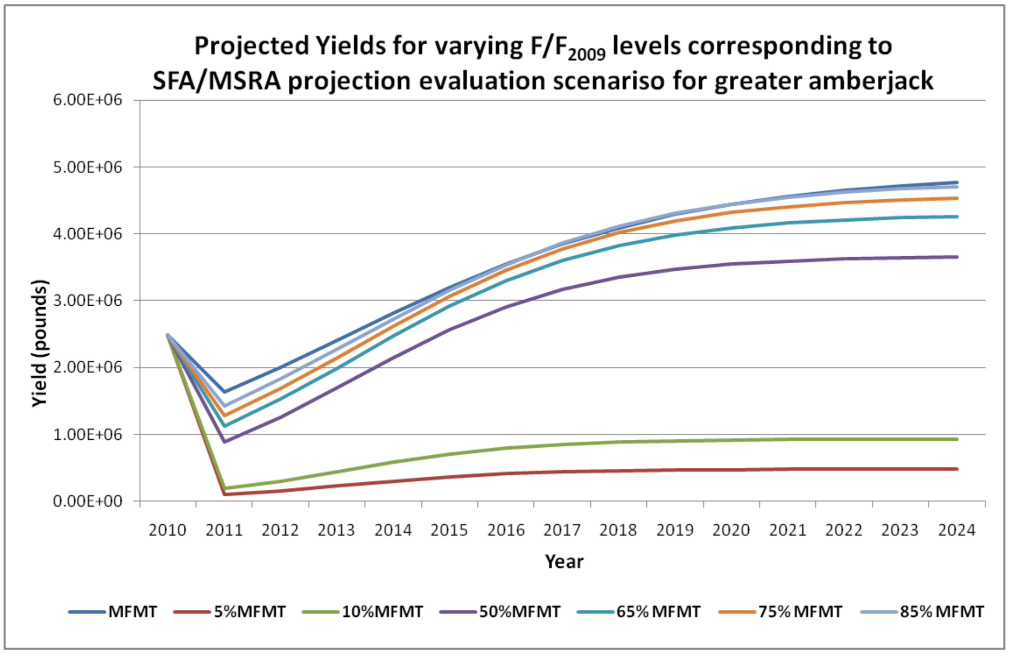
Year	Rebuilding Schedule	Constant Catch of 2010	Constant Catch 2010 *0.99	Constant Catch 2010 *0.95	Constant Catch 2010 *0.9	Constant Catch 2010*.8	Constant Catch 2010*0.50
1986	1.47E+07	1.47E+07	1.47E+07	1.47E+07	1.47E+07	1.47E+07	1.47E+07
1987	1.18E+07	1.18E+07	1.18E+07	1.18E+07	1.18E+07	1.18E+07	1.18E+07
1988	9.87E+06	9.87E+06	9.87E+06	9.87E+06	9.87E+06	9.87E+06	9.87E+06
1989	9.85E+06	9.85E+06	9.85E+06	9.85E+06	9.85E+06	9.85E+06	9.85E+06
1990	7.90E+06	7.90E+06	7.90E+06	7.90E+06	7.90E+06	7.90E+06	7.90E+06
1991	9.39E+06	9.39E+06	9.39E+06	9.39E+06	9.39E+06	9.39E+06	9.39E+06
1992	7.78E+06	7.78E+06	7.78E+06	7.78E+06	7.78E+06	7.78E+06	7.78E+06
1993	7.31E+06	7.31E+06	7.31E+06	7.31E+06	7.31E+06	7.31E+06	7.31E+06
1994	5.13E+06	5.13E+06	5.13E+06	5.13E+06	5.13E+06	5.13E+06	5.13E+06
1995	4.41E+06	4.41E+06	4.41E+06	4.41E+06	4.41E+06	4.41E+06	4.41E+06
1996	4.53E+06	4.53E+06	4.53E+06	4.53E+06	4.53E+06	4.53E+06	4.53E+06
1997	4.19E+06	4.19E+06	4.19E+06	4.19E+06	4.19E+06	4.19E+06	4.19E+06
1998	4.12E+06	4.12E+06	4.12E+06	4.12E+06	4.12E+06	4.12E+06	4.12E+06
1999	5.01E+06	5.01E+06	5.01E+06	5.01E+06	5.01E+06	5.01E+06	5.01E+06
2000	6.06E+06	6.06E+06	6.06E+06	6.06E+06	6.06E+06	6.06E+06	6.06E+06
2001	7.04E+06	7.04E+06	7.04E+06	7.04E+06	7.04E+06	7.04E+06	7.04E+06
2002	6.97E+06	6.97E+06	6.97E+06	6.97E+06	6.97E+06	6.97E+06	6.97E+06
2003	6.73E+06	6.73E+06	6.73E+06	6.73E+06	6.73E+06	6.73E+06	6.73E+06
2004	5.63E+06	5.63E+06	5.63E+06	5.63E+06	5.63E+06	5.63E+06	5.63E+06
2005	4.41E+06	4.41E+06	4.41E+06	4.41E+06	4.41E+06	4.41E+06	4.41E+06
2006	4.28E+06	4.28E+06	4.28E+06	4.28E+06	4.28E+06	4.28E+06	4.28E+06
2007	4.25E+06	4.25E+06	4.25E+06	4.25E+06	4.25E+06	4.25E+06	4.25E+06
2008	4.54E+06	4.54E+06	4.54E+06	4.54E+06	4.54E+06	4.54E+06	4.54E+06
2009	4.59E+06	4.59E+06	4.59E+06	4.59E+06	4.59E+06	4.59E+06	4.59E+06
2010	4.39E+06	4.39E+06	4.39E+06	4.39E+06	4.39E+06	4.39E+06	4.39E+06
2011	4.37E+06	4.37E+06	4.41E+06	4.54E+06	4.70E+06	5.02E+06	5.96E+06
2012	2.98E+06	4.35E+06	4.44E+06	4.77E+06	5.19E+06	6.00E+06	8.28E+06
2013	1.04E+05	4.32E+06	4.49E+06	5.15E+06	5.95E+06	7.45E+06	1.14E+07
2014	3.71E+03	4.26E+06	4.56E+06	5.73E+06	7.07E+06	9.45E+06	1.49E+07
2015	1.32E+02	4.16E+06	4.69E+06	6.60E+06	8.66E+06	1.20E+07	1.85E+07
2016	4.70E+00	4.01E+06	4.89E+06	7.86E+06	1.07E+07	1.48E+07	2.15E+07
2017	1.68E-01	3.76E+06	5.20E+06	9.57E+06	1.32E+07	1.77E+07	2.37E+07
2018	5.97E-03	3.34E+06	5.69E+06	1.17E+07	1.58E+07	2.02E+07	2.52E+07
2019	2.13E-04	2.62E+06	6.42E+06	1.42E+07	1.84E+07	2.21E+07	2.61E+07
2020	7.57E-06	1.29E+06	7.48E+06	1.67E+07	2.05E+07	2.35E+07	2.67E+07
2021	2.70E-07	4.54E+04	8.94E+06	1.90E+07	2.21E+07	2.45E+07	2.70E+07
2022	9.60E-09	1.62E+03	1.08E+07	2.09E+07	2.33E+07	2.51E+07	2.72E+07
2023	3.42E-10	5.76E+01	1.31E+07	2.23E+07	2.41E+07	2.55E+07	2.73E+07
2024	1.22E-11	2.05E+00	1.55E+07	2.34E+07	2.47E+07	2.57E+07	2.74E+07
2025	4.34E-13	7.30E-02	1.78E+07	2.41E+07	2.50E+07	2.59E+07	2.74E+07



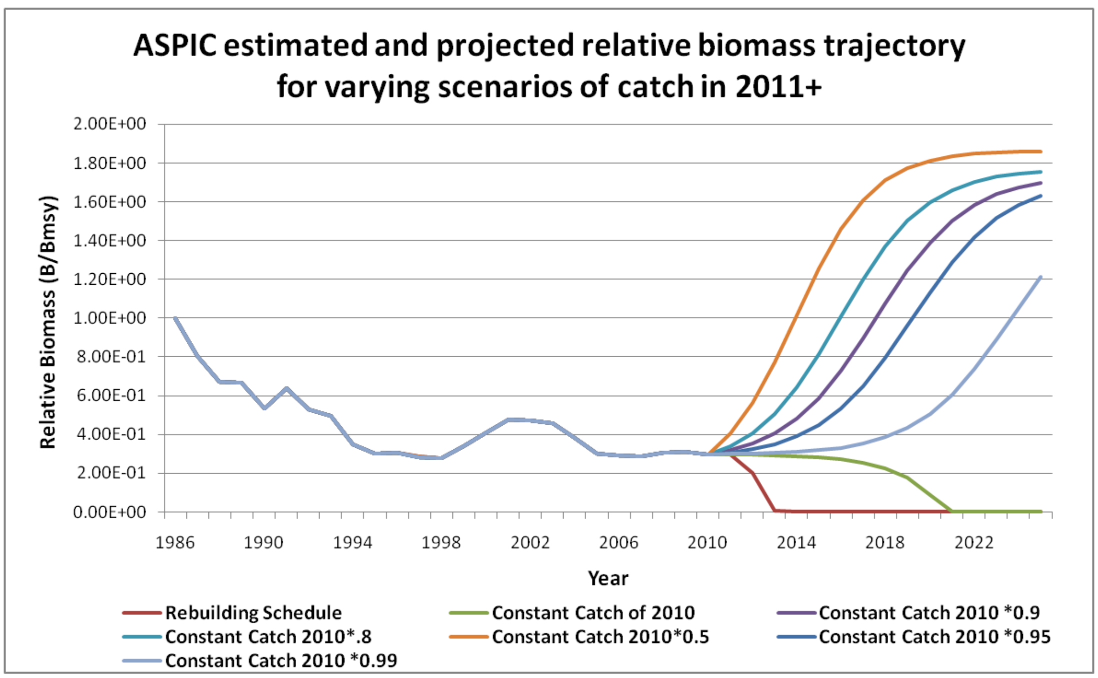
Appendix 2. Figure 1. ASPIC estimated and projected relative biomass (B/B_{MSY}) for Varying values of F_{Year}/F_{2009} for 2011+ corresponding to SFA/MSRA evaluation scenarios for the greater amberjack stock. Projections assume catch in 2010 = 2.493 mp.



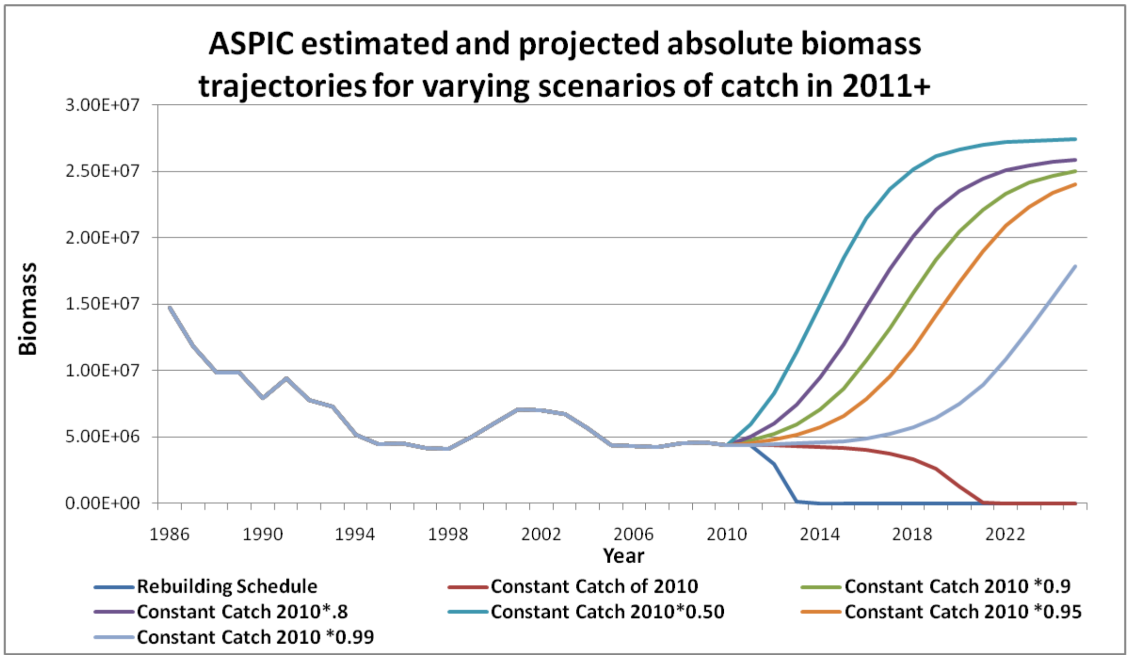
Appendix 2. Figure 2. ASPIC estimated and projected absolute biomass values for varying values of F_{Year}/F_{2009} for 2011+ corresponding to SFA/MSRA evaluation scenario for the greater amberjack stock. Units are whole weight (millions of pounds). Projections assume catch in 2010 = 2.493 mp.



Appendix 2. Figure 3. ASPIC projected yields for varying values of F_{Year}/F_{2009} for 2011+ corresponding to SFA/MSRA evaluation scenarios for the greater amberjack stock. Units are millions of pounds (whole weight). Projections assume catch in 2010 = 2.493 mp.



Appendix 2. Figure 4. ASPIC estimated and projected relative biomass (B/BMSY) values corresponding to varying levels of 2011 forward constant catch evaluation scenarios for the greater amberjack. Projections assume catch in 2010 = 2.493 mp.



Appendix 2. Figure 5. ASPIC estimated and projected absolute biomass values corresponding to varying constant catch evaluation scenario for the greater amberjack stock. Units are whole weight (millions of pounds). Projections assume catch in 2010 = 2.493 mp.

SEDAR

Southeast Data, Assessment, and Review

SEDAR 9 Stock Assessment Update Report

Gulf of Mexico Greater Amberjack

SECTION V: Appendix III
Added 5 April, 2011

SEDAR
4055 Faber Place Drive, Suite 201
North Charleston, SC 29405

Appendix 3:

SEDAR 9 Gulf of Mexico Greater Amberjack Stock Assessment Update Landings

During their March meeting, the Gulf of Mexico Scientific and Statistical Committee opted to use the average recreational and commercial landings for Gulf of Mexico greater amberjack from 2000-2009 to set Allowable Biological Catch (ABC) and the Overfishing Limit (OFL). Based on the SSC motion to set OFL at the mean of the 2000-2009 landings, an ABC at 75% of OFL, the new numbers are:

OFL = 2.38 mp whole weight
ABC = 1.78 mp whole weight

Tables 3.2.4, 4.1.3.1, A3.1, A3.2, and A3.3 in this appendix present these landings.

Table 3.2.4. Calculated commercial landings of Greater Amberjack by gear for the Gulf of Mexico fisheries management region from 1963 to 2009. Units = whole weight (lbs). Vertical Line+ includes all other gears such as trolling, diving+spear. 2009 data are preliminary.

	Gear Group		
YEAR	**Vertical Line+**	**Longline**	**Grand Total Com**
1963	8583.848		8583.848
1964	6414.304		6414.304
1965	5282.368		5282.368
1966	7451.912		7451.912
1967	29430.336		29430.336
1968	11602.344		11602.344
1969	73481.512		73481.512
1970	13771.888		13771.888
1971	38768.808		38768.808
1972	41975.96		41975.96
1973	28487.056		28487.056
1974	42070.288		42070.288
1975	78763.88		78763.88
1976	87159.072		87159.072
1977	120829.4516		120829.4516
1978	151877.7536		151877.7536
1979	149938.2705	2736.171	152674.4412
1980	175021.8309	4791.862	179813.6933
1981	214367.9262	22629.29	236997.2134
1982	186046.8912	39481.69	225528.5844
1983	235198.7255	45935.85	281134.5749
1984	469569.7569	61432.57	531002.3294
1985	653604.4473	109563.3	763167.7559
1986	917261.7978	199084.6	1116346.418
1987	1303595.715	252250.3	1555846.056
1988	1730481.769	325156.9	2055638.677
1989	1656122.55	299256.3	1955378.813
1990	1098315.838	125697.3	1224013.104
1991	1795708.282	6143.239	1801851.521
1992	965204.2507	51505.39	1016709.638
1993	1524433.654	83888.86	1608322.513
1994	1205701.972	68990.71	1274692.679
1995	1181063.578	82328.58	1263392.159
1996	1214148.98	57001.29	1271150.275
1997	1059123.583	59580.09	1118703.675
1998	645440.4987	54824.31	700264.8133
1999	719266.7436	61582.6	780849.3475

Table 3.2.4. (continued) Calculated commercial landings of Greater Amberjack by gear for the Gulf of Mexico fisheries management region from 1963 to 2009. Units = whole weight (lbs). Vertical Line+ includes all other gears such as trolling, diving+spear. 2009 data are preliminary.

	Gear Group		
YEAR	**Vertical Line+**	**Longline**	**Grand Total Com**
2000	846461.5769	69996	916457.5769
2001	688450.4698	45505.42	733955.8891
2002	710140.8507	77347.89	787488.7446
2003	867364.4588	127092.2	994456.6135
2004	894518.2921	81351.49	975869.7865
2005	671876.8543	72039.43	743916.2854
2006	553246.7341	79336.09	632582.8285
2007	558137.757	60367.05	618504.8036
2008	413505.4909	90608.61	504114.1031
2009	577836.6593	55012.53	632849.1853

Table 4.1.3.1. Estimated recreational landings (AB1) of greater amberjack in the Gulf of Mexico from the MRFSS, TPWD, and Headboat Survey sources 1981-2009. Units for AB1 are whole weight (pounds). 2009 data are preliminary.

			Mode		
YEAR	**Charterboat**	**Headboat**	**Cbt/Hbt**	**Private**	**Grand Total Rec**
1981	0	69086	126451.295	498969.6	694506.857
1982	0	69086	3446897.97	1170695	4686679.195
1983	0	69086	1936082.27	755383.8	2760552.081
1984	0	69086	1065310.87	241677.6	1376074.459
1985	0	69086	1802989.64	523612.4	2395687.992
1986	3530394.775	750632.1309	0	1525870	5806896.896
1987	2022467.683	378888.0366	0	2243409	4644764.544
1988	1095384.463	173613.1164	0	988588.2	2257585.768
1989	1965458.74	204289.0959	0	1332874	3502621.586
1990	389136.2647	77654.47766	0	480805.9	947596.6198
1991	2688237.946	102687.2918	0	175783.6	2966708.813
1992	1675540.972	312152.4445	0	508327.1	2496020.508
1993	2218095.97	225867.509	0	576282	3020245.522
1994	1135435.056	213118.704	0	266416.2	1614969.986
1995	350849.3375	143994.3308	0	374195.4	869039.0371
1996	658254.3001	139588.4818	0	489233.7	1287076.506
1997	764589.3886	125349.3452	0	297062.6	1187001.335
1998	374926.3136	88595.02562	0	186954.8	650476.141
1999	483401.8474	73508.48486	0	291268	848178.3033
2000	633984.1762	100732.2084	0	302690.7	1037407.04
2001	571318.9343	89435.6837	0	598387.2	1259141.796
2002	1243478.865	160636.3271	0	643470.9	2047586.101
2003	1090891.777	199346.5238	0	1369746	2659984.515
2004	1130351.426	108769.3643	0	1142251	2381371.973
2005	473918.6864	61280.56073	0	909513.2	1444712.422
2006	941681.9371	79892.03643	0	390383.6	1411957.536
2007	687491.6019	59435.94104	0	331523.5	1078451.048
2008	539854.4261	54543.84546	0	705833.2	1300231.517
2009	713726.8211	103190.5535	0	777488.9	1594406.23

Table A3.1. Gulf GAJ 2010 SAR Update Landings for recreational fisheries 1986-2009. Units are whole weight pounds. Discards not included. 2009 preliminary.

	Recreational				
YEAR	**Charterboat**	**Headboat**	**Cbt/Hbt**	**Private**	**Grand Total Rec**
1986	3,530,395	750,632	0	1,525,870	5,806,897
1987	2,022,468	378,888	0	2,243,409	4,644,765
1988	1,095,384	173,613	0	988,588	2,257,586
1989	1,965,459	204,289	0	1,332,874	3,502,622
1990	389,136	77,654	0	480,806	947,597
1991	2,688,238	102,687	0	175,784	2,966,709
1992	1,675,541	312,152	0	508,327	2,496,021
1993	2,218,096	225,868	0	576,282	3,020,246
1994	1,135,435	213,119	0	266,416	1,614,970
1995	350,849	143,994	0	374,195	869,039
1996	658,254	139,588	0	489,234	1,287,077
1997	764,589	125,349	0	297,063	1,187,001
1998	374,926	88,595	0	186,955	650,476
1999	483,402	73,508	0	291,268	848,178
2000	633,984	100,732	0	302,691	1,037,407
2001	571,319	89,436	0	598,387	1,259,142
2002	1,243,479	160,636	0	643,471	2,047,586
2003	1,090,892	199,347	0	1,369,746	2,659,985
2004	1,130,351	108,769	0	1,142,251	2,381,372
2005	473,919	61,281	0	909,513	1,444,712
2006	941,682	79,892	0	390,384	1,411,958
2007	687,492	59,436	0	331,524	1,078,451
2008	539,854	54,544	0	705,833	1,300,232
2009	713,727	103,191	0	777,489	1,594,406

Table A3.2. Gulf GAJ 2010 SAR Update Landings for commercial fisheries 1986-2009. Units are whole weight pounds. Discards not included. 2009 preliminary.

YEAR	Vertical Line+	Commercial Longline	Grand Total Com
1986	917,262	199,085	1,116,346
1987	1,303,596	252,250	1,555,846
1988	1,730,482	325,157	2,055,639
1989	1,656,123	299,256	1,955,379
1990	1,098,316	125,697	1,224,013
1991	1,795,708	6,143	1,801,852
1992	965,204	51,505	1,016,710
1993	1,524,434	83,889	1,608,323
1994	1,205,702	68,991	1,274,693
1995	1,181,064	82,329	1,263,392
1996	1,214,149	57,001	1,271,150
1997	1,059,124	59,580	1,118,704
1998	645,440	54,824	700,265
1999	719,267	61,583	780,849
2000	846,462	69,996	916,458
2001	688,450	45,505	733,956
2002	710,141	77,348	787,489
2003	867,364	127,092	994,457
2004	894,518	81,351	975,870
2005	671,877	72,039	743,916
2006	553,247	79,336	632,583
2007	558,138	60,367	618,505
2008	413,505	90,609	504,114
2009	577,837	55,013	632,849

Table A3.2. Gulf GAJ 2010 SAR Update Landings for recreational and commercial fisheries 1986-2009. Units are whole weight pounds. Discards not included. 2009 preliminary. Average landings for 2000-2009 are 2,375,545 pounds whole weight.

	All Modes
YEAR	**Rec+Com**
1986	6,923,243
1987	6,200,611
1988	4,313,224
1989	5,458,000
1990	2,171,610
1991	4,768,560
1992	3,512,730
1993	4,628,568
1994	2,889,663
1995	2,132,431
1996	2,558,227
1997	2,305,705
1998	1,350,741
1999	1,629,028
2000	1,953,865
2001	1,993,098
2002	2,835,075
2003	3,654,441
2004	3,357,242
2005	2,188,629
2006	2,044,540
2007	1,696,956
2008	1,804,346
2009	2,227,255

Supplemental ASPIC Projection Results for Gulf greater amberjack 2010 SAR Update

During the March 22-25 GFMC SSC meeting the greater amberjack analyst was requested to make additional projections of the stock status considering various future constant catch scenarios for 2011+ based on the ten year average catch for 2000-2009. Supplement Tables 1 and 2 and Figures 1 and 2 present these results .

ASPIC estimates and projections of relative biomass (B/B_{MSY}) considering future constant catch scenarios for 2011+ catch indcate that the greater amberjack stock could recover to B_{MSY} by 2020 under the future constant catch projection scenario of catch of 2.38 mp (=average catch from 2000-2009) (Table 1, Figure 1, this document). Under the average catch ASPIC projection scenario, relative biomass (B/B_{MSY})is projected to increase by about 7% annually through 2014 and thereafter by about 19% annually through 2020 the year recovery is projected. Similar projectons that considered future constant catch of 75% and 65% of the average ten year catch series (2000-2009) project stock recovery at 2015 and 2014 respectively (Table 1 this document).

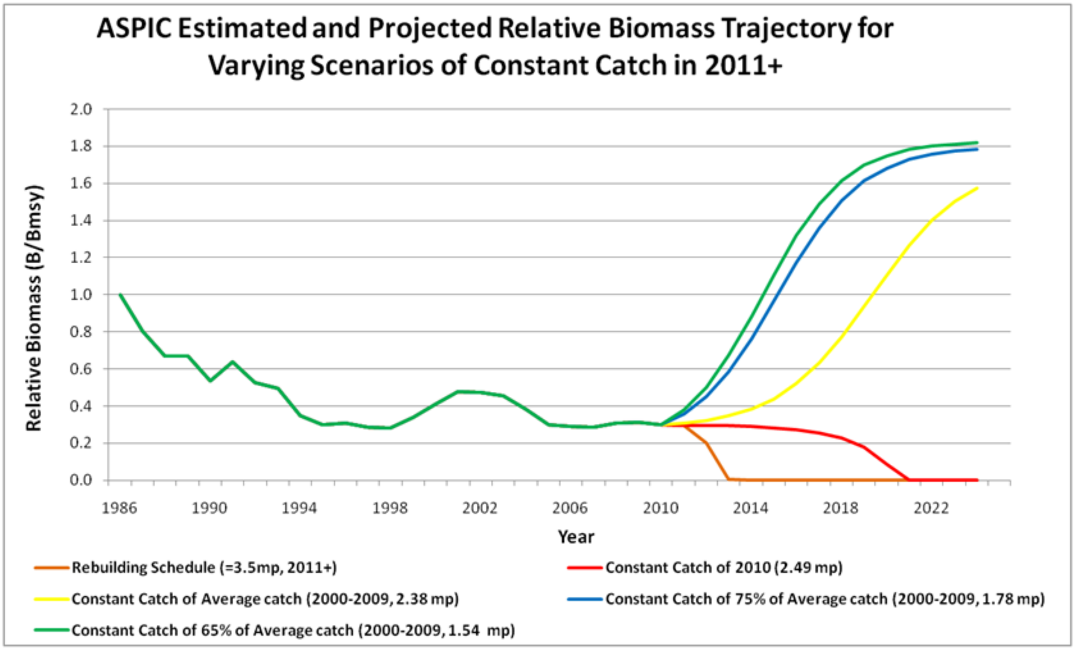
The results from these supplemental analyses, that considered projections based on future constant catch levels of the average ten year (2000-2009) catch series, may be compared to the previous projections that considered various decremets of the 2010 constant catch (Appendix 2, Table 4, Figure 4; SAR GAJ Update). The latter projections indicated for a future constant catch of 99% of the 2010 catch level (2.49 mp) stock recovery in 2024 (Appendix 2, Table 4, SAR Update). This catch level equates to a catch of 2.47 mp. The supplemental ASPIC projecton results presented in this document, for the future constant catch scenario of the ten year average catch (2000-2009, = 2.38 mp) equates to 95.5% of the 2010 catch and indicates stock recovery in 2020 (Table 1, this document). Under the projection scenario based on the 99% 2010 catch level or 2.47 mp, annual relative stoock growth (B/B_{MSY}) is estimated to be very low (average relative stock growth (B/B_{MSY}) = 1.3%) through 2019 and thereafter about 10% and the stock recovers in 2024. Under the ASPIC projection scenario based on the ten year average catch (2.38 mp, 2000-2009 catdch average), the stock is projected to recover five years earlier (2020) and annual relative stock biomass growth (B/B_{MSY}) is projected to be higher at about 7% through 2014 and, about 19% on average through 2020 the year of estimated stock recovery. In addition, under the ASPIC projection scenario based on future constant catch of the ten year avearage, the projected stock relative biomass in year 2024 (i.e., the year recovery is projected for the 99% constant catch scenario), is projected to be about 50.5% higher than the 99% constant catch projected relative biomass (Table 1 this document and Appendix Table 4, SAR Update, B/B_{MSY} = 1.58 (avearage catch scenari) vs B/B_{MSY} = 1.05 (99% of 2010 catch scenario).

Supplement Table 1. ASPIC estiamted and projected relative biomass (B/B_{MSY}) for varying levels of constnat catch for 2011+. Shaded cells indicate year where $B/_{MSY}$ >1.0.

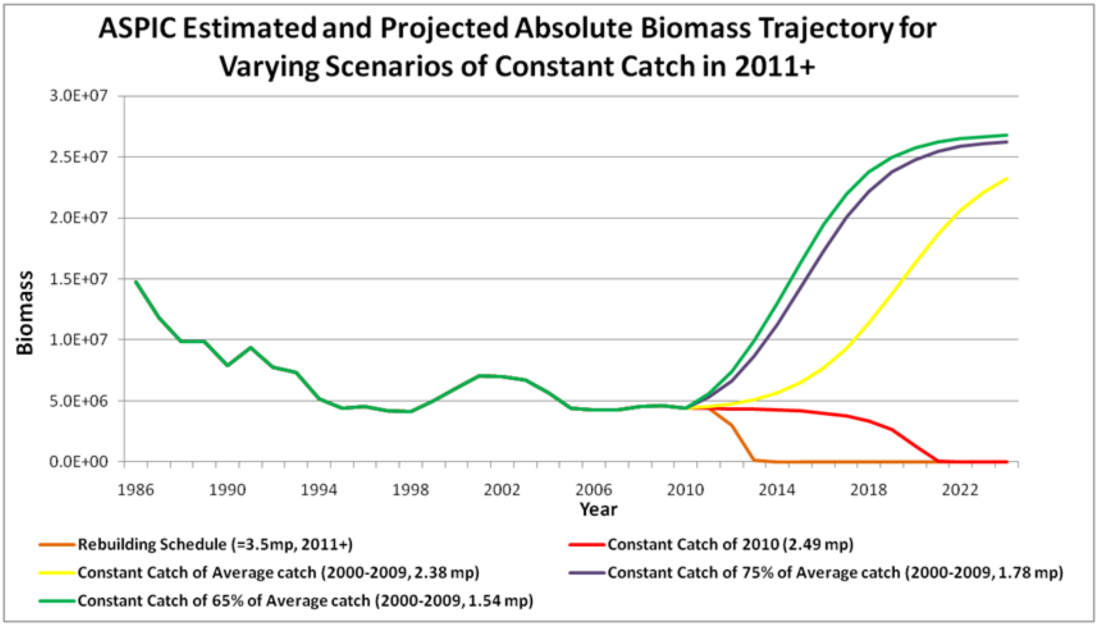
Year	Rebuilding Schedule (=3.5mp, 2011+)	Constant Catch of 2010 (2.49 mp)	Constant Catch of Average catch (2000-2009, 2.38 mp)	Constant Catch of 75% of Average catch (2000-2009, 1.78 mp)	Constant Catch of 65% of Average catch (2000-2009, 1.54 mp)
1986	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
1987	8.03E-01	8.03E-01	8.03E-01	8.03E-01	8.03E-01
1988	6.70E-01	6.70E-01	6.70E-01	6.70E-01	6.70E-01
1989	6.68E-01	6.68E-01	6.68E-01	6.68E-01	6.68E-01
1990	5.36E-01	5.36E-01	5.36E-01	5.36E-01	5.36E-01
1991	6.37E-01	6.37E-01	6.37E-01	6.37E-01	6.37E-01
1992	5.28E-01	5.28E-01	5.28E-01	5.28E-01	5.28E-01
1993	4.96E-01	4.96E-01	4.96E-01	4.96E-01	4.96E-01
1994	3.49E-01	3.49E-01	3.49E-01	3.49E-01	3.49E-01
1995	3.00E-01	3.00E-01	3.00E-01	3.00E-01	3.00E-01
1996	3.08E-01	3.08E-01	3.08E-01	3.08E-01	3.08E-01
1997	2.85E-01	2.85E-01	2.85E-01	2.85E-01	2.85E-01
1998	2.79E-01	2.79E-01	2.79E-01	2.79E-01	2.79E-01
1999	3.40E-01	3.40E-01	3.40E-01	3.40E-01	3.40E-01
2000	4.11E-01	4.11E-01	4.11E-01	4.11E-01	4.11E-01
2001	4.78E-01	4.78E-01	4.78E-01	4.78E-01	4.78E-01
2002	4.73E-01	4.73E-01	4.73E-01	4.73E-01	4.73E-01
2003	4.57E-01	4.57E-01	4.57E-01	4.57E-01	4.57E-01
2004	3.82E-01	3.82E-01	3.82E-01	3.82E-01	3.82E-01
2005	2.99E-01	2.99E-01	2.99E-01	2.99E-01	2.99E-01
2006	2.91E-01	2.91E-01	2.91E-01	2.91E-01	2.91E-01
2007	2.88E-01	2.88E-01	2.88E-01	2.88E-01	2.88E-01
2008	3.08E-01	3.08E-01	3.08E-01	3.08E-01	3.08E-01
2009	3.11E-01	3.11E-01	3.11E-01	3.11E-01	3.11E-01
2010	2.98E-01	2.98E-01	2.98E-01	2.98E-01	2.98E-01
2011	2.97E-01	2.97E-01	3.07E-01	3.59E-01	3.79E-01
2012	2.03E-01	2.95E-01	3.22E-01	4.53E-01	5.02E-01
2013	7.07E-03	2.93E-01	3.46E-01	5.87E-01	6.72E-01
2014	2.52E-04	2.89E-01	3.84E-01	7.62E-01	8.82E-01
2015	8.97E-06	2.83E-01	4.40E-01	9.66E-01	1.11E+00
2016	3.19E-07	2.72E-01	5.21E-01	1.18E+00	1.32E+00
2017	1.14E-08	2.55E-01	6.32E-01	1.36E+00	1.49E+00
2018	4.05E-10	2.27E-01	7.73E-01	1.51E+00	1.61E+00
2019	1.44E-11	1.78E-01	9.37E-01	1.61E+00	1.70E+00
2020	5.14E-13	8.72E-02	1.11E+00	1.68E+00	1.75E+00
2021	1.83E-14	3.08E-03	1.27E+00	1.73E+00	1.78E+00
2022	6.52E-16	1.10E-04	1.40E+00	1.76E+00	1.80E+00
2023	2.32E-17	3.91E-06	1.50E+00	1.77E+00	1.81E+00
2024	8.26E-19	1.39E-07	1.58E+00	1.78E+00	1.82E+00

Supplement Table 2. ASPIC estiamted and projected absolute biomass for varying levels of constant catch for 2011+. Units are millions of pounds whole weight. Shaded cells indicate year where $B/B_{MSY} > 1.0$.

Year	Rebuilding Schedule (=3.5mp, 2011+)	Constant Catch of 2010 (2.49 mp)	Constant Catch of Average catch (2000-2009, 2.38 mp)	Constant Catch of 75% of Average catch (2000-2009, 1.78 mp)	Constant Catch of 65% of Average catch (2000-2009, 1.54 mp)
1986	1.47E+07	1.47E+07	1.47E+07	1.47E+07	1.47E+07
1987	1.18E+07	1.18E+07	1.18E+07	1.18E+07	1.18E+07
1988	9.87E+06	9.87E+06	9.87E+06	9.87E+06	9.87E+06
1989	9.85E+06	9.85E+06	9.85E+06	9.85E+06	9.85E+06
1990	7.90E+06	7.90E+06	7.90E+06	7.90E+06	7.90E+06
1991	9.39E+06	9.39E+06	9.39E+06	9.39E+06	9.39E+06
1992	7.78E+06	7.78E+06	7.78E+06	7.78E+06	7.78E+06
1993	7.31E+06	7.31E+06	7.31E+06	7.31E+06	7.31E+06
1994	5.13E+06	5.13E+06	5.13E+06	5.13E+06	5.13E+06
1995	4.41E+06	4.41E+06	4.41E+06	4.41E+06	4.41E+06
1996	4.53E+06	4.53E+06	4.53E+06	4.53E+06	4.53E+06
1997	4.19E+06	4.19E+06	4.19E+06	4.19E+06	4.19E+06
1998	4.12E+06	4.12E+06	4.12E+06	4.12E+06	4.12E+06
1999	5.01E+06	5.01E+06	5.01E+06	5.01E+06	5.01E+06
2000	6.06E+06	6.06E+06	6.06E+06	6.06E+06	6.06E+06
2001	7.04E+06	7.04E+06	7.04E+06	7.04E+06	7.04E+06
2002	6.97E+06	6.97E+06	6.97E+06	6.97E+06	6.97E+06
2003	6.73E+06	6.73E+06	6.73E+06	6.73E+06	6.73E+06
2004	5.63E+06	5.63E+06	5.63E+06	5.63E+06	5.63E+06
2005	4.41E+06	4.41E+06	4.41E+06	4.41E+06	4.41E+06
2006	4.28E+06	4.28E+06	4.28E+06	4.28E+06	4.28E+06
2007	4.25E+06	4.25E+06	4.25E+06	4.25E+06	4.25E+06
2008	4.54E+06	4.54E+06	4.54E+06	4.54E+06	4.54E+06
2009	4.59E+06	4.59E+06	4.59E+06	4.59E+06	4.59E+06
2010	4.39E+06	4.39E+06	4.39E+06	4.39E+06	4.39E+06
2011	4.37E+06	4.37E+06	4.53E+06	5.29E+06	5.59E+06
2012	2.98E+06	4.35E+06	4.75E+06	6.67E+06	7.40E+06
2013	1.04E+05	4.32E+06	5.10E+06	8.64E+06	9.90E+06
2014	3.71E+03	4.26E+06	5.65E+06	1.12E+07	1.30E+07
2015	1.32E+02	4.16E+06	6.48E+06	1.42E+07	1.63E+07
2016	4.70E+00	4.01E+06	7.67E+06	1.73E+07	1.94E+07
2017	1.68E-01	3.76E+06	9.31E+06	2.01E+07	2.20E+07
2018	5.97E-03	3.34E+06	1.14E+07	2.22E+07	2.38E+07
2019	2.13E-04	2.62E+06	1.38E+07	2.38E+07	2.50E+07
2020	7.57E-06	1.29E+06	1.63E+07	2.48E+07	2.58E+07
2021	2.70E-07	4.54E+04	1.87E+07	2.55E+07	2.63E+07
2022	9.60E-09	1.62E+03	2.06E+07	2.59E+07	2.65E+07
2023	3.42E-10	5.76E+01	2.21E+07	2.61E+07	2.67E+07
2024	1.22E-11	2.05E+00	2.32E+07	2.63E+07	2.68E+07



Supplement Figure 1. ASPIC estimated and projected relative biomass (B/B_{MSY}) trajectory for Gulf of Mexico greater amberjack for varying levels of constant catch 2011+.



Supplement Figure 2. ASPIC estimated and projected absolute biomass trajectory for Gulf of Mexico greater amberjack for varying levels of constant catch 2011+.